HANDBOOK OF SCHEME OF INSTRUCTION AND SYLLABI

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2018-19

PES UNIVERSITY
(Established under Karnataka Act No. 16 of 2013)
100 Feet Ring Road, BSK III Stage, Bengaluru - 560 085.

About the handbook

This compendium is a handy guide that provides information about facilities and amenities available at the PES University campus. It provides guidelines about appropriate conduct and interaction with others. It also details the assessment process covering in-semester (ISA) and end-semester (ESA) assessments. This handbook should be every student's first stop to find basic information about facilities and processes related to day-to-day activities in the University.

Who should read this handbook?

This handbook should be read by every student, parent and staff of the University.

How to get this handbook?

This handbook is provided free of cost to all students. In case a student has not received a copy, please contact the parent department. A soft copy of the handbook is available at the following url – www.pes.edu

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Message from the Chancellor

PES is a top ranking group of educational institutions in India that aspires to build a better tomorrow by equipping today's youth with a sense of learning, values and societal orientation. PES's quality of teaching and infrastructure will stimulate students to excel in their chosen course of study. I believe the information contained in this Student Handbook will be a step towards achieving excellence.

I extend a hearty welcome students of batch 2016 to the portals of PES University. I wish the students great success in their academic endeavors at PES University.

Dr. M. R. Doreswamy

Chancellor, PES University
Founder & Chairman, PES Institutions
Former MLC, Government of Karnataka

Message from the Pro Chancellor

I am pleased that Student Handbook is being published by the University. I acknowledge the release of this handbook as an expression of PES University's sustained commitment to excellence in academic and administrative processes.

The handbook is a resource, not only to the students but also to the teachers as it provides information about Programs, Code of Conduct, Rules and Academic Regulations, apart from a host of other useful information.

I hope this handbook will further the cause of making every PES student a brand ambassador for the University. I wish PES will pave the way in realising your career ambitions.

Prof. D. Jawahar

Pro Chancellor, PES University
CEO, PES Institutions

Message from the Vice-Chancellor

I am very glad that PES University has prepared the Student Handbook. This handbook provides guidelines to all of us to work in synergy to realise the dream of every student as well as the vision of PES.

This handbook provides insights into the policies and governing philosophy of the University. Although substantial effort has gone into preparing this handbook, there will always be scope for improvement. PES welcomes thoughts from students to incorporate into future editions of this handbook.

I wish the very best and success to all the students.

Dr. K. N. Balasubramanya Murthy
Vice-Chancellor, PES University

Message from the Registrar

PES University has endeavoured to bring out a concise Student Handbook that serves as a quick reference to the academic regulations and conduct of students in the University. This handbook also highlights all the pertinent functions and facilities in the University that helps the student to plan his/her academic sessions.

I wish all the students the very best in their academic pursuit.

Dr. V. Krishna Murthy
Registrar, PES University

VISION, MISSION AND QUALITY POLICY

Vision

To create a professionally superior and an ethically strong global workforce.

Mission

To provide students with a sense of history, an understanding of values and ethics, a commitment to law and morality, an appreciation of human creativity and an analytical inquiring mind.

Quality Policy

To develop highly skilled human resources with the ability to adapt to an intellectually and technologically changing environment with collaborative and participative efforts of management, staff, students and parents.

Core Values of PES

Perseverance, **E**xcellence, **S**ervice

CONTENTS

GENERAL INFORMATION, ACADEMIC POLICIES AND REGULATION

PES Group of Institutions – an overview

PES was founded in 1972 with just over 40 students studying in a rented gymnasium at Bangalore. Today, PES has more than 15,000 students and more than 1,000 staff spread across six different campuses in Karnataka and Andhra Pradesh.

PES is focused on five main educational areas: Architecure and Design, Engineering, Medicine, Management and Life Sciences and. PES offers both foundation and specialization programs leading to Bachelors, Masters and Ph.D Degrees. An indicative list is given below.

No.	Name of Institution	Courses Offered	Affiliating / RecognisingAuthority
1	PES Pre-University College of Commerce & Science	PUC	Pre-University Board, Karnataka
2.	PES Degree College	BCA, B Sc., B Com, BBM, BHM,	Bangalore University
3.	PES Polytechnic	Diploma in Engineering	Directorate of Technical Education, Karnataka
4.	PES College of Pharmacy (PESCP)	DPharma, B Pharma, M Pharma, Ph D.	Rajiv Gandhi University of Health Sciences
5.	PES Institute of Technology (PESIT)	BE, , MCA, M Sc. (Engg) and Ph D	Visvesvaraya Technological University, Belgaum
6.	PES Institute of Medical Sciences and Research (PESMSR)	MBBS, MD	NTR University, Andhra Pradesh
7.	PES University (Electronic City Campus),	B.tech	PES University
8.	The Amaatra Academy	High School, PUC.	CBSE, New Delhi and Govt. of Karnataka
9.	PES Public School	High School, PUC	Chittoor, AndhraPradesh
10.	PES University (Ring Road Campus)	BTech, BBA, BBA-HEM, BCA, BArch, BDes, BBA-LLB, EMBA, PG Diploma in Clinical Research and Data Management (BiSEPS), M Tech ,MBA, MCA, MDes, Msc in Applied Economics, MTech by Research, PhD	PES University
11.	PES Institute of Technology (Electronic Campus)	BTech, BCA, M Tech	PES University

About PES University

PES University (PESU) came into existence as a Karnataka State Private University on November 19, 2013, in recognition of the pioneering efforts of the PES Group of Institutions in imparting quality higher education.

PESU combines years of experience in education with a unique curriculum, world-class infrastructure and a committed, responsive faculty. Processes at PES cover all aspects that build synergy between education and industry, and ensure that the programs are synchronous with contemporary economic context.

Education at PESU is focused on equipping students with the critical skills they need to compete in today's globalized world. Whether they choose to be entrepreneurs or build careers with leading organizations, their time at PES gets them started on the way to achieving their goals.

At PESU, students find an environment that opens up new worlds of opportunity, helps them make the right choices and ensures they are ready to start out on their own. PES students could connect to the strong, global alumni network which help them in career and academic opportunitites .

ACADEMIC PROGRAMS OFFERED

PESU offers a spectrum of undergraduate and graduate / certificate programs which are aligned to the requirements of the society.

PES UNIVERSITY - PROGRAMS OFFERED					
	UG PROGRAMS			PG PROGRAMS	
1.	B Tech	Biotechnology		M Tech	Mechanical Engineering
2.		Computer Science & Engg.			Computer Science and Engineering
3.		Civil Engineering			Electronics & Communication Engg.
4.		Electronics & Communication Engg.			Electrical and Electronics Engineering
5.		Electrical & Electronics Engg.		MCA	Computer Applications
6.		Mechanical Engg.		M.Tech by Research	
7.	BArch	Architechure		MBA	Business Management
8	BDes	Design		Executive MBA in Product Leadership	
9.	BCA	Computer Applications		BiSEPS - PG Diploma in Clinical Research and Data Management	
10.	BBA	Business Administration		M.Sc in Applied Economics	
11.	BBA(HEM)	Business Administration - Hospitality and Event Management			
12.	BBA,LLB	Integrated 5-year dual degree program			

Education at PES University focusses on the three guiding principles of PERSEVERANCE, EXCELLENCE and SERVICE. Students at PES University are provided opportunities / exposures to all aspects - academic, extra curricular and social responsibilities. Students perserverance with problems / issues leads to excellence. Excellence combined with a social responsibility leads to a holistic development and turns them into citizens who can take initiatives and lead.

PESU offers a plethora of opportunities for students towards this holistic development through various interventions. Exposure to various current technologies – satellite, mobile, network, security, imaging, automobile and energy, open up opportunities for students to get involved and contribute to current developments.

It is heartening to note that in a short span of four years involving more than 250 students working with a team of satellite technology scientists have realised the dream of the student satellite –PISATwhich is qualified to be flown into space by ISRO.

SCHOLARSHIPS AND AWARDS FOR STUDENTS

PESU strongly believes that academic excellence of students have to be identified, nurtured and rewarded. PESU has instituted incentives and scholarships to encourage and recognize talent at various levels. Some of the scholarships, awards and incentives available to students are

PROF. CNR RAO MERIT SCHOLARSHIPS - Top twenty percent of students in all Programs of Study would be offered Prof CNR Rao Merit Scholarships in form of tuition fee waiver to the tune of 15 percent for the subsequent year subject to satisfying prescribed conditions each semester.

RURAL STUDENT SCHOLARSHIPS - PESU is presumably the FIRST Private University to demonstrate its community commitment by encouraging rural talents. Upto five eligible kannada medium students joining the Engineering programs would be offered tuition fee waiver every year subject to satisfying prescribed norms.

DISTINCTION AWARDS –All students securing an SGPA of 7.75 or more in the semester are awarded a merit certificate. Students with an SGPA of 8.00 and above are additionally given financial incentives to encourage merit.

PROF. MRD MERIT SCHOLARSHIPS – This scholarship has been instituted by the founder of PES group of institutions and Chancellor PES University, Dr. M. R. Doreswamy. Top FIVE students in UG program of study and top THREE students in PG program of study who are securing CGPA 9.0 and above are awarded a scholarship in the form of a cash incentive along with a certificate of Merit / Appreciation.

RANK AWARDS AND MEDALS – Rank holders and program toppers are awarded gold medals at the Convocation along with a certificate of Merit/ Appreciation.

INDUSTRY SPONSORED SCHOLARSHIPS - Corporates such as Cognizant Foundation, Schneider Electric and Meritor have instituted scholarships to meritorious students.

Details of the scholarships and the eligibility criteria can be obtained from the Scholarship section.

Faculty Advisor(s)

PES Unversity has a Faculty Advisor System where a faculty is assigned a group of students for the whole duration of their study. The functions of the faculty advisors shall include

(a) monitoring the academic and general progress of the students,
(b) advising the students on registration of various courses in a semester,
(c) assessing the academic progress of students on a continuous basis,
(d) advising students on the courses to be dropped/audited based on the student progress,
(e) monitoring class attendance,
(f) coordinating the dispatch of progress reports to parents on a regular basis,
(g) counseling the students as and when needed on academic and general matters, and
(h) monitoring student discipline and initiating appropriate actions as and when necessary.

The faculty advisor shall meet students under them and discuss about their progress and greivances at least twice in a semester and record the notes in the prescribed Faculty Advisor Meeting Book and maintain confidentiality.

STUDENT DEVELOPMENT PROGRAMS

The University organizes various student support programs to enhance academic performance and prepare the students in industrial skills.

Campus Wide Quality Improvement Program (CWQIP): CWQIP targets enhancing teaching and learning methods across campus and focuses on :

(a) creating an environment where each student is constantly motivated to excel and reach higher performance through supply of course information, student notes, access to videos lectures and progress monitoring,
(b) providing proactive career management training that help students find internships and placements, and
(c) a system for accountability and continuous improvement in classroom experience

Student Academic Support Program (SASP) – Additional classes are conducted by faculty for slow learners and students who miss classes for various reasons which help briding the gap between student performances.

Total Student Development Program (TSDP) – Focusses on the the overall development of student by imparting domain specific and personality development skills to meet industry expectations.

Gifted Student Development Program (GSDP) – Outstanding students are identified and offered opportunity to work with faculty on research projects and Innovative projects.

Student Teaching Assistantship Program (STAP): Students with academic excellence are offered student assistantships which provides an opportunity to work closely with their faculty, assisting them with their teaching and research.

COMMUNITY DEVELOPMENT PROGRAMS

Community Development programs of PESU aims to sensitise students to the needs of the community. Each faculty of PESU has a mandate to identify needs of the society and develop programs involving students that make them sensitive to the society around them.

Some of the community development programs initiated at PES include:

- Adopting rural government schools for improving academic experience of students.
- Donating books, clothes, etc. to the needy students in Government Schools.
- Faculty development programs for Government school teachers.
- Conducting regular health camps and blood donation camps.
- Conducting awareness drives on environmental pollution.
- Vocational Training Programs for school drop-outs.
- Providing support services to differently abled students / Government School children.
- Adopting public parks.

Students are strongly urged to volunteer for at least two hours per week to contribute their time and skills towards one or more of these initiatives.

PLACEMENTS, INTERNSHIPS AND INDUSTRY INTERFACE

PESU has a strong placement activity in place for students. Over 100 companies comprising different sectors – IT/ ITES/Core/Product/Finance/ Banking/Analytics/start ups and others offer placement opportunities to our students every year. Companies conduct online / offline tests, followed by personal interviews.

Placement Central – the placement section coordinates with all departments to make the placement process a smooth affair for the students. Students are exposed to the placement process through a series of activities such as

- pre-placement skill enhancement programs
- maintaining a database of students eligible for placements
- identifying students meeting eligility criteria for different companies
- keep a track of the placement status of students

Leading companies have placed faith in the intellectual and professional readiness of our students. Students of PES are among those who command salaries in the top bracket.

Student Internships in Companies has a lot of value addition and enhances the student's prospects. Students are encouraged to take summer internships between June and July either in companies or Universities abroad. Student also have an opportunity to get final semester internships with companies with the prospects of attractive financial compensation and likely hood of these converting into a regular employment.

PESU have a strong institution industry interface which is oriented to improving the student experience on campus. Some of the initiatives include

- inviting industry leaders and experts to be on the Board of Studies for curriculam development,
- enabling students to pursue real time projects in companies
- conducting workshops and seminars on current technologies with industry experts
- conduct courses in niche areas fully developed by experts from industry

SUMMER PROGRAMS AT UNIVERSITIES ABROAD

PES University students of the previous batches have successfully completed summer internship / research projects in Universities abroad. This provides students a visibility in these universities and network with the faculty to in these places for future opportunites of higher education.

1. Rutgers University
2. University of Southern California
3. New Jersey Institute of Technology
4. Syracuse University
5. Carnegie Mellon University
6. Temple University
7. Drexel University
8. University of Akron
9. University of Illinois
10. Binghamton University
11. Case Western University
12. Imperial College London
13. Duisburg Germany
14. University of Edinburgh
15. State University of New York
16. Arizona State University
17. North Dakota State University
18. Missouri University of Science and Technology
19. Dalhousie University
20. Canadian University
21. University of Calgary
22. EcolePolytechnique
23. Bournemouth University
24. National Taiwan University of Technology
25. Nanhua University
27. Indiana University of Pennsylvania
26. Institute of Electronic Materials and Devices (MBE)

Research Domains at PES University

Currently, PES University has active research communities in the following domains:

1. Advanced Composites Research Centre
2. Cellular and Molecular Biotechnology Centre
3. Centre for Automobile Research and Engineering (CARE)
4. Centre for Knowledge Analytics and Ontological Engineering (KAnOE)
5. Centre for Research and Engineering in Sensor Technologies
6. Cloud Computing and Big Data (CCBD)
7. Green Chemistry
8. Medical and Environmental Biotechnology
9. Process Engineering and Computation Biology
10. Mobile Systems Engineering (MSE)
11. Networks and Security
12. Power and Energy Systems
13. Satellite Technologies
14. Signal Processing
15. Smart Power Control
16. Thermo-Fluids Engineering
17. VLSI Technologies
18. Centre for Socio Economic Research (CSER)
19. Centre for Research in Space Science Technology (CRSST)
20. Centre for Development Studies (CDS)
21. Centre for Pattern Recogonition and Machine Inteligence (CPRMI)
22. Centre for Data Science and Applied Machine Learning

The Crucilble of Research and Innovation (CORI) is an exclusive intiative to develop multi-disciplinary research under one umbrella. Guided by experienced scientists of repute, projects from satellite technology to biomedical research are offered to students to pursue as a part of their curriculum requirements. This is apart from the various research facilities attached to the above domains.

INDUSTRY ON CAMPUS

PESU provides a platform for students and faculty for industrial exposure. This helps them apply academic training in an industrial environment and gain valuable first-hand experience of the challenges and issues in the real world and makes them industry-ready. This activity is facilitated by a number of leading organizations who have offices right on the PESU campus. These organizations include Televital Pvt. Ltd., TCL India Pvt. Ltd, IGS India Pvt. Ltd., Shruth & Smith India Pvt. Ltd., and CBayS India Pvt. Ltd. PES also offers incubator facilitites for start-up companies for our students / alumini.

EXTRA CURRICULAR AND CO–CURRICULAR ACTIVITIES AT PESU

PES University encourages extracurricular activities and co-curricular activities which add to the students dimensions apart from academics. Different clubs, activities and events provide opportunites to interested students develop their passions.

The following teams / events focus on Extra Curricular Activities

- Extended Week Day
- Pulse – The Dance Team
- Nautanki – The Dramatics Team
- Ninadha – Forum for Indian classical culture
- Exclusive music room
- Aatmathrisha – Annual cultural fest
- Sanskruthi – The Indian Contemporary dance team
- Paisa Vasool – The Skit and Spoofs Team
- Fantom – The Western Band
- Sugama Sangeetha Abhiyana
- Pixels – The Photography Club
- Samarpana – Event to honor the martyr of the Indian Defence Forces
- CSR Club – Actively organizes blood donation camps, emission testing camps, and health check-up camps and Swachh Bharat Abhiyan, cloth and books donation to schools, fund raising for the downtrodden and needy children of Govt. Schools.
- Icare – Social Initiatives

Clubs / initiatites focussing on Co-Curricular Activities

- The Amateur Scientist – All India Science Exhibition
- JEDI – Joy of Engineering Design and Innovation
- Prakalapa – Project exhibition forum
- Impetus – Impact of Technology on us
- Ordell Ugo- Virtual company working on real time industry projects
- Haya – Racing Car Team
- Ayana – 24 Hours Hacathon
- Aeolus – Team for making unmanned vehicles and aero modelling
- PACE – Partners for Advancement of Collabroative Engineering Education - a General Motors initiative
- Samkaran – Team for Hybrid Vehicles
- Robotics – Building robots
- Quotient Quiz Club – Dedicated for quiz competitions
- TEDx - Organize talks from eminent personalities
- PES Open Source
- DEBSoC – The official debating society
- ECLAT – The College Magazine
- Student Chapters of Professional Societies across departments
- Noika Developer – Forum for mobile apps and hackathon.
- CORI – A multidisciplinary research Platform
- Talk+ - Organize talks from famous speakers
- E-Cell – Promoting entrepreneurship
- PES Chronicles – Connecting students and Industry
- PESMUN – Modern United Nations
- Papyrus – The College Newsletter

PROGRESS REPORTS / ACADEMIC DOCUMENTS

Attendance status of students uploaded on the University website periodically from the commencement of the semester. In addition, progress reports along with acknowledgement are also dispatched to parents by post / courier at the end of every test event.

Students are required to collect all relevant academic documents only in person. However, under extraneous circumstances where the student is unable to collect the document in person, the documents will be handed over to a representative authorized by the student. In such cases, the authorized representative is required to produce an affidavit along with a photos and signatures of both the student and the authorized representative. The format for the affidavit is available with the office of the COE.

NOTICE BOARDS

All important announcements are displayed on department notice boards frequently. Students are advised to regularly check the notice boards for announcements. In addition, there is a facility to disseminate information via e-mail and social networking platforms.

LIBRARY

The Central Library located in the Prof. MRD Block enables students access a vast repository of books, technical e-journals and periodicals, and has an ambience that provides ideal study spaces. The library is digitized and bar-coded. Completely automated library management system “Online Public Access Catalogue (OPAC)” (http://library@pes.edu) makes it possible to borrow books at any time of the day or night, as well as make reservations online. Adequate number of books at the Central and Departmental libraries ensures that resources are easily available for reference. Trained library personel are available to assist the students. The Library is open during University working hours normally and is open for extended periods during examinations.

STUDENT COUNSELING AND LIFESTYLE MANAGEMENT CENTER

Student Counselling and Lifestyle Management Center at the University caters to students from different backgrounds, environments and cultures. The Center assists students with issues relating to a new environment and students who have academic performance or personality issues. Students are guided through stress and lifestye management issues through training and counselling sessions to help them integrate seamlessly with the main stream campus fabric. The center is staffed by professional counsellors. Confidentiality of student interactions are strictly maintained, except under circumstances that may pose dire threat to the well being of the student. Counselors also help students in personality enhancement and career mapping. There are separate counselors for male and female students.

WIFI

The campus is fully WiFi enabled for academic pursuits with appropriate security. Students are provided separate login ids and passwords by the IT team.

MEDICAL FACILITIES

A qualified registered medical practitioner is available for medical service from 4PM to 8 PM on all the working days, in the clinic located in the hostel inside the University campus. 24 hour ambulance facility is available in the event students require emergency shift to hospital for medical care. The University has a tie-up with M/s. EXCELCARE HOSPITAL located 4 km. away from the campus. Besides these amenities, all the students of the University are covered under medical insurance that covers accident events.

ACCOMMODATION

PESU believes that living experience in the campus encourages independence and helps students develop the ability to adapt. The campus provides students with open air facilities such as the Open Air Theater (OAT) and Student Interaction Lounge (πR^3) (πR^3) and many other lush green spaces for relaxing, studying and interaction.

Separate hostels with comfortable rooms are available for boys - on campus, and for girls - off campus. A stringent, round-the-clock security and a medical doctor on call ensure attention to all student needs.

Apart from the hostel mess, sufficient number of food points exist on campus.

GYM AND SPORTS FACILITIES

Well maintained sports facilities for both indoor and outdoor games that conform to international standards are available. A gymnasium with physical training equipment for physical fitness is available under the guidance of a fitness trainer. The sports department holds an annual international sports festival which provides students an opportunity to participate in various games and meet and interact with sports personalities.

CONTACT INFORMATION OF KEY PERSONNEL

Sl. No	Name	Designation	Email ID	PESU Extn. #
1.	Prof. D. Jawahar	Pro Chancellor	jawahar@pes.edu	202
2.	Prof. Ajoy Kumar	Chief Operating Officer, PES Institutions	ajoy@pes.edu	219
3.	Dr. K.N. Balasubramanya Murthy	Vice-Chancellor	vice.chancellor@pes.edu	203
4.	Dr. V. Krishna Murthy	Registrar	registrar@pes.edu	214
5.	Dr. B.A. Kanchan Garg	Controller of Examinations	coe.pesu@pes.edu	841
6.	Dr. T S B Sudarshan	Dean-Research	dean.research@pes.edu	215
7.	Dr. Vijay Kumar	Dean-Faculty of Management Studies	vijay.kumar@pes.edu	586
8.	Dr. N. Anuradha	Dean -Architechure & Design	dean.architechure@pes.edu	885
9.	Dr. Sandeep Desai	Dean – Faculty of Law	dean.law@pes.edu	
10.	Dr. B.K. Keshavan	Dean – Engineering & Technology	keshavanbk@pes.edu	271
11.	Dr. K.S. Sridhar	Dean – Placement & Training	kssridhar@pes.edu	251
12.	Mr. A. Vinay	Special Officer	a.vinay@pes.edu	293
13.	Prof. Nitin V Pujari	Chairperson, Dept. of PG Studies in Computer Science & Engg.	nitin.pujari@pes.edu	700
14.	Dr. V. Krishna	Chairperson, Dept. of PG Studies in Mechanical Engg.	vkrishna@pes.edu	253
15.	Dr. B.K. Keshavan	Chairperson, Dept. of Electrical & Electronics & Engg.	keshavanbk@pes.edu	271
16.	Dr. K.S. Sridhar	Chairperson , Dept. of Mechanical Engg.(UG)	kssridhar@pes.edu	251
17.	Dr. Lata Pasupulety	Chairperson, Dept. of Science & Humanities	lata.p@pes.edu	863
18.	Dr.M. Anuradha	Chairperson, Dept. of Electronics & Communication Engg.	anuradha@pes.edu	740
19.	Dr. Shylaja S S	Chairperson, Dept. of Computer Science & Engg. (UG)	shylaja.sharath@pes.edu	720
20.	Dr. K N Shanti	Chairperson , Dept. of Biotechnology	shantikoppala@pes.edu	343
21.	Dr. V. Krishna Murthy	Chairperson (I/C), Dept. of Civil Engg.	hod-cv@pes.edu	570
22.	Dr. Jaykumar V	Chairperson , Dept. of BBA-HEM	jaykumarv@pes.edu	373
23.	Dr. Veena S	Chairperson, Dept. of MCA	sveena@pes.edu	507
24.	Dr. Veena A	Program Chair -MBA	veenaandini@pes.edu	585
25.	Prof. Harish G Ugraiah	Chairperson , Dept. of BBA	harishgu@pes.edu	359
26.	Mr. Subhash Reddy	Librarian	librarian@pes.edu	229
27.	Dr. Krishnaveni	Doctor (Part-time)	--	288

28.	Mrs. Ancy Mathews	Student Counsellor	ancym@pes.edu	243
29.	Mr. Vijendar Kumar	Student Counsellor	vijendrak@pes.edu	828
30.	Mr. Satish P	Deputy Finance Officer	sathishp@pes.edu	505
31.	Mr. Deepak Anand	Admissions Manager	deepakanand@pes.edu	503
32.	Mr. Ganesha Marakala C	Assistant Manager-Admission	ganesha319@gmail.com	209
33.	Mr. M.S. Vinay	Sports Director & Chief Warden, Girls' Hostel	vinaymodhe@pes.edu	270
34.	Mr. Chinni Sridhar	Physical Education Director	--	539
35.	Mrs. Rashmi Ramachandra	Physical Education Director	--	567
36.	Prof. M V Satyanarayan	Chief Warden, Boys' Hostel	mvs@pes.edu	288
37.	Mr. Prajoth S. U	Facility Manager	prajoth@pes.edu	249
38.	Mrs. Rekha	Receptionist	--	200
39.	Security	--	--	287

CODE OF CONDUCT AND CAMPUS DISCIPLINE

The University considers every student of PESU as a brand ambassador of the institution. Consequently, it expects them to display high standards of behavior and decorum. Students should conduct themselves within and outside the premises of the University in a manner befitting the institutional values.

1. **PUNCTUALITY AND DECORUM**

   Each day of class is valuable to every student. Students should compulsorily attend classes from the first day of the academic calendar. A student unable to attend classes on day one due to unforeseen circumstances should obtain prior permission from the Chairperson by submitting a letter of request signed by the parent. Photo copies or fax print out of request letters are not acceptable.

   Student should maintain punctuality for class sessions, laboratories and workshops. Habitual latecomers distract the class and affect the morale of the whole class, and will be denied admission to class by the concerned faculty.

2. **MOBILE PHONES / ELECTRONIC GADGETS**

   Use of mobile phones, tablets and such electronic gadgets are strictly prohibited the class room, unless specifically instructed by the faculty for academic purposes. While in the class room, all such gadgets should be in the switched off mode (and not 'silent' mode). Even when not in the class, students are urged to refrain use of such gadgets and spend time usefully interacting with other students and faculty.

   The University authorities will have the right to confiscate any electronic gadget being used by any student if it finds reasonable grounds that the gadget is not being used in accordance with this policy.

3. **WEARING AND DISPLAY OF ID CARDS**

   Every student is provided with an Identity Card that is to be worn and visible at all times in the campus. Students without a valid ID card will not be permitted to enter the campus or to attend the classes. Duplicate ID cards will be issued only in exceptional circumstances and will be limited to no more than once in the academic year. The duplicate card will be issued only on submission of the First Information Report (FIR, issued by the police on complaint of loss/theft) along with the fees paid receipt.

4. **DRESS CODE / APPEARANCE**

   The University's dress code is framed to impart the importance of proper appearance and good hygiene. Any disruptive or distracive mode of clothing or appearance that negatively impacts the educational atmosphere are not permitted. Students are required to dress formally while coming to campus. Printed/collarless T-shirts, T shirts with distracting prints, cargo pants and sleeveless tops are strictly prohibited.

   Punk /distractive appearance is prohibited. Boys are not to wear caps, bracelets, chains, earrings, etc.

5. **TRANSPORTATION**

   Limited bus transport facility is provided by the University to enable students to reach the campus on time. Information on the routes and the charges are announced by theTransport Department for availing the University bus facility. Students using the transport facility are expected to display courteous behavior to the transport personel, faculty and fellow students travelling in the bus. Follow the queue system while boarding and alighting the bus. Students must use only the designated bus routes and bus stop assigned to them. Bus drivers are authorized to maintain complete control of students in the bus and report misbehavior, if any, to the authorities. Contact If you need any clarifications or have any complaints, please contact the Transport Department in the basement floor of the Prof. MRD Block.

6. **VEHICLE SPEED AND PARKING WITHIN CAMPUS**

   Limited two-wheeler parking facility is available on campus for students. Students advised to park their two-wheeler in designated places only. Students are advised to wear helmets in the interest of their safety whether they are driving in the campus or outside. Maintain a safe campus environment by driving your vehicles in designated areas in the campus. Honking is strictly prohibited inside the campus. Students found violating these guidelines may be barred from bringing the two-wheeler into the campus.

7. **DISCIPLINE**

   Students indulging in acts of indiscipline, misconduct or breach of code of conduct are liable to be issued an Infraction Slip by concerned authority/faculty. The disciplinary rules and code of conduct may be updated on a need basis and the prevailing set of regulations at the time of an incident will apply. The disciplinary actions, beyond verbal warning, written warning and reprimand as recorded by the teacher in the Infraction Slip, shall be finally decided and imposed by the Disciplinary Committee of the University.

   Circumstances under which an Infraction Slip may be given is provided in the sample of the infraction slip. The Disciplinary Committee reserves the right to withhold the issue of Grade Cards and Degree Certificates till the resolution of any infraction incidence.

8. RAGGING

As per the order of Honorable Supreme Court of India and directions of the UGC, ragging in any form is considered as a criminal and culpable offence and is banned in all forms, inside and outside the campus. Any form of ragging will be severely dealt with through an inquiry committee and disciplinary action may include:

i. University authorities exercising the right to emboss the final Grade Card, Degree Certificate that he/she indulged in ragging.

ii. Summary expulsion from the University

STUDENT INFRACTION SLIP

Student/s Name		**Program of Study & Sem.**	
SRN		**Date/Location of Incidence**	

Indiscipline/ Misconduct in the University / Hostel / Outside Campus

1	Class Room/Pathway/Corridor Disruption		12	Any kind of immoral activity	
2	Collarless T-shirts/cargo pants/flimsy dress/long hair/stylish beard/fancy moustache/punk appearance/sleeve-less tops/low waist pants/ any other indecent dress; non wearing of ID card		13	Unfair means / malpractices/ proxy/ impersonation in attendance/tests/ exams	
3	Inappropriate behavior outside classroom		14	Irregular attendance in class, labs, workshops	
4	Late arrival to class, lab & other University activities		15	Misuse of mobile phones, laptops & other gadgets	
5	Failure to return required signed forms		16	Ragging of any form, on & off campus	
6	Verbal / written/ physical abuse towards other students / staff		17	Behavior which brings the University into disrepute	
7	Damage/ misuse/ stealing of tools, equipment or material		18	Extortion, inducement to part money for inappropriate or false purposes	
8	Argumentative, defiant or irresponsible behavoir		19	Spreading harmful rumours	
9	Possession of firearms, fireworks or weapons		20	Fraud, deceit, deception or dishonesty	
10	Possession, consumption or distribution of alcoholic drinks, addictive/ objectionable drugs or smoking		21	Breach of any other University/ Hostel Regulation or Code of Conduct	
			22	Indulging in mass absenting from classes	
11	Threatening / intimidation/ actual acts of violence & attacks		23	Any other (to be detailed by the teacher)	

Gravity of Indiscipline / Misconduct

Minor			Major			Severe		
Penal Action Recommended								
1	Verbal warning / reprimand		5	Final written warning		9	Suspension (indicate duration)	
2	Written warning / reprimand		6	Exclusion from extra-curricular activities/ distinctions/ ranks/ awards/placement/ scholarships		10	Expulsion from Hostel/ University, rustication	
3	Restitution / reimbursement / fine (mention amount)		7	Entry in conduct register / certificates		11	Other actions (to be mentioned)	
4	Call parents		8	Discount internal marks/ grade/ SGPA/CGPA		12	Seizure/ confiscation of mobile phones or other disapproved materials	

Observations / Remarks by the Teacher:

Authorized Signatory		**Signature of Student**	

The student has the right to appeal to the University Disciplinary Committee in writing after issue of this Infraction Slip. Ignorance of the above mentioned disciplinary rules & regulations and the Code of Conduct is not an excuse in any case of violation.

MANDATORY DECLARATIONS

"Student and Parent / Gaurdian / Local Gaurdian Declaration" are mandatory declarations which is issued to the student on the last day of every semester. They need to be duly filled, signed and submitted to University authorities on the first day of the ensuing semester.

STUDENT DECLARATION / UNDERTAKING

Name of the Student	
SRN	
Program of Study	
Semester	
E-mail ID	
Contact Number	
Name and Address of the parents with phone number and e-mail ID	
Name and Address of the Local Guardian with phone number and e-mail ID	

I have gone through the Student Monitoring Guidelines provided by the University and agree to abide by the same. I assure that I shall not indulge in any act of indiscipline inside or outside the campus. I agree to take appropriate corrective actions for my academic improvement. I agree to keep my personal problems away from my academics and shall sort out any issues with my parents / counselor. I shall keep my parents informed at all times about my personal issues.

Signature of the student

PARENT / LOCAL GUARDIAN DECLARATION / UNDERTAKING

I have gone through the Student Monitoring Guidelines provided by the University and extend my full support to the points mentioned therein. I hereby certify that the information provided by my ward is correct and take the responsibility to intimate any changes to the office from time to time. I understand that the student's personal and non academic problems which affect the student are beyond the control of the University. I / we shall put our best efforts to resolve them and will not hold the University responsible for such problems.

Place :

Date : Signature of the Parent / Guardian

ACADEMIC POLICIES AND REGULATIONS

Programs of Study and duration

The University shall offer a variety of programmes of study representing different Faculties, in accordance with the spirit of a university.

The Program offered by the University and their minimum durations are listed in the table.

Sl No	Program	Minimum duration
1.	Bachelor of Technology	4 years / 8 semesters
2.	Bachelor of Computer Applications	3 years / 6 semesters
3.	Bachelor of Business Administration	3 years / 6 semesters
4.	Bachelor of Business Administration - Hospitality and Event Management	3 years / 6 semesters
5.	Bachelor of Architecture	5 years / 10 semesters
6.	Bachelor of Design	4 years / 8 semesters
7.	BBA, LLB	5 years / 10 semesters
8.	Master of Technology	2 years / 4 semesters
9.	Master of Business Administration	2 years / 4 semesters
10.	Master of Computer Applications	3 years / 6 semesters
11.	Masters in Applied Economics	2 years / 4 semesters
12.	Master of Technology by Research	2 years / 4 semesters
13.	PhD	3 years / 6 semesters
14.	Executive MBA in Product Leadership	15 months / 5 trimesters
15.	PG Diploma in Clinical Research and Data Management	1 year / 2 semesters

A student has to complete the courses in a maximum of twice the prescribed minimum duration.

The Architecture Program shall be completed in a maximum period of 8 years. However, in special circumstances a candidate may be granted an extension of 1 year by the University/ Institution to complete the program. This extension shall be given only once to the candidate.

- The architecture course shall be of minimum duration of 5 academic years or 10 semesters of approximately 16 working weeks each inclusive of six months/one semester of approximately 16 working weeks of practical training after the first stage in a professional office.
- The students shall undergo Practical Training in a recognized architectural firm which has COA registered architect, having experience of at least 5 years.
- The completion of first stage shall not qualify candidates for registration under the Architects Act, 1972.
- For registration as an Architect, a candidate must successfully complete both stages.
- A candidate shall not be permitted to enroll for the Architectural Design course in a semester unless he/ she has completed the Architectural Design course of the previous semester.
- A candidate shall not be permitted to enroll for the tenth semester Architectural Design Thesis/ dissertation/project course unless he/ she has successfully completed Practical Training/ Internship.
- In case a candidate is not able to complete the program in the prescribed duration, the University/ Institution may provide an exit option for the candidate if he/ she has completed and earned all credits for the first three years of study.

Credit system

Semester-wise credit-based system is followed in each programme of study except in the case of very-short non-degree programmes.

Generally credits shall be assigned to each course in a programme of study based on the following pattern:

ONE credit for ONE lecture (L) hour;

ONE credit for TWO tutorial (T) hours;

ONE credit for TWO laboratory/seminar (P) hours;

ONE credit for FOUR self study (S) hours.

Each course shall be represented in the form of 'L-T-P-S-C' where L, T, P, S and C mean respectively, the number of lecture hours per week, number of tutorial hours per week, number of practical hours per week, the number of self study hours per week and the number of credits assigned to the course. The credits assigned to each course shall be calculated as $C = L + T/2 + P/2 + S/4$.

For example, '3-2-0-0-4' means three lecture hours and two tutorial hours amounting to a total of 4 credits.

The minimum number of credits required to be earned for a degree programme shall be calculated on the basis of TWENTY to TWENTY TWO credits per regular semester. For example,

- a 5-year degree programme shall comprise of ten regular semesters and therefore require a minimum of 22 x 10 = 220 credits (except BArch);
- a 4-year degree programme shall comprise of eight regular semesters and therefore require a minimum of 22 x 8 = 176 credits (BTech from 2018 batch onwards is 160 credits except BDes)

- a 3-year degree program shall comprise of six regular semesters and therefore require a minimum of 22 x 6 = 132 credits (MCA is 120 credits);
- a 2-year degree program shall comprise of four regular semesters and therefore require a minimum of 20 x 4 = 80 credits.

A full-time student shall normally register for TWENTY THREE credits in a regular semester and exceptional full-time student may be permitted to register for a maximum of TWENTY EIGHT credits during a regular semester.

Every course in a programme of study normally runs for the full length of a semester.

Category of courses

Courses offered in various programmes of study shall be categorized into the following six types:

Preliminary Courses (PC): Preliminary courses enable students by endowing them with skills essential to pursue a given programme of study. Generally, they comprise courses in linguistics, communication, humanities & social sciences, economics, environment, psychology, philosophy, history, law, political science, professional ethics, and so on. Preliminary courses shall be in the range of 3-6% of the total minimum credits for a programme.

Foundation Courses (FC): Foundation courses constitute the fundamental learning of a given programme of study. Generally, they comprise courses such as basic & life sciences, logic & mathematics, statistics & analytics, basic engineering, technical arts and computer programming skills. Foundation courses shall be in the range of 30-40% of the total minimum credits for a programme.

Core Courses (CC): Core courses constitute the core of the programme of study. Core courses shall be in the range of 30-40% of the total minimum credits for a programme.

Elective Courses (EC): Elective courses offer a choice of advanced or specialized courses related to the programme of study. They enable students to specialize in a domain of interest or tune their learning to suit career needs and current trends. Elective courses shall be in the range of 10-20% of the total minimum credits for a programme.

Internship, Research or Project Work (PW): These are intended to enhance the student's practical knowledge and exposure to research and industry. The credits for this category shall not exceed 6-12% of the total minimum credits for a programme.

Non-credit courses: A few courses may not be assigned credits. Such courses shall be referred to as non-credit (NC) courses, and may be mandatory in a programme of study.

Certain programmes of study may have additional requirements such as apprenticeship and residency.

Audit courses

A student may be permitted to take any number of audit courses over and above the graduation requirements for learning a subject.

Specialization and Minor

A student shall have four options with regard to Specializations and Minor:

i. A student shall register for a ***Specialization*** in the program of study and successfully complete at least FOUR courses (minimum of 12 credits) in the EC category in a particular domain as prescribed by the concerned Departmental Curriculum Committee.
ii. A student may register for a ***Minor*** in a program area outside his/her Major discipline. Students opting for Minors should register and successfully complete at least FOUR (minimum of 12 credits) courses as specified by the concerned Departmental Curriculum Committee.
iii. A student meeting both the preceding requirements shall qualify for *Specialization* as well as *Minor* in the chosen areas.
iv. A student opting for a mix of elective courses not meeting the prescribed course requirements shall not qualify for *Specialization* or *Minor.*

Academic Calendar

The calendar of events in respect of each academic session shall be framed by the University from time to time. The calendar shall contain the schedule of academic activities for a semester prepared by the Dean of Faculty.

Typically the **odd semester** 22 weeks during August – Dec and **even semester** consists of 22 weeks during January - May. The **summer term** consists of 8 weeks during June – July.

The schedule of chronological events in an academic session is depicted in the table below:

REGULAR SEMESTER SCHEDULE	
#	EVENT
1	Course Registration, Lesson Plan Distribution, Class Policy, Course objectives, Tests and quiz formats
2	Dropping/Adjustment of Courses
3	First Test (T1)
4	Second Test (T2)
5	End Semester Assessment
6	Evaluation, announcement of results and vacation for students
SUMMER TERM SCHEDULE	
1	Course registration, course information distribution, class policy, course objectives, tests and quiz formats
2	First Test (T1)
3	Second Test (T2)
4	End Semester Assessment, evaluation, announcement of results

The Academic Calendar shall strictly be adhered to and activities such as co-curricular and extra-curricular shall not interfere with the curricular activities as stipulated in the Academic Calendar.

Under circumstances where teaching days are declared as holidays or when classes get suspended, for whatever reasons, make-up classes for such lost days shall be conducted on Saturdays/Sundays with prior announcements.

Registration for courses

In each semester, an eligible student shall register for the courses he/she intends to study. Only registered students shall be allowed to attend the classes of those courses.

Students shall register for the courses to be studied in a particular semester before the end of the previous semester except for the courses in the first semester. Registration for the first semester of a programme shall be a part of admission process.

Registration process, either online or offline shall consist of the following steps:

i Meeting with the course coordinator, if required, to verify prerequisites;

ii Enrolment of students for different courses offered by particular teacher;

iii Payment of prescribed tuition fees and other dues.

A student in the higher semesters who obtains 'F' or 'W' grade in a course other than elective (EC category) shall re-register for the same course when offered next. A student who obtains 'F' or 'W' grade in an elective course shall have an option of repeating the same elective course when offered next or register for any other elective course in the EC category.

If a student fails to register for course(s) during a semester without intimation to the concerned Dean of Faculty, his/her admission shall be liable to be cancelled.

Late registration may be permitted by the concerned Dean of Faculty under exceptional circumstances.

Registration Record

Students shall ensure that the registration details are entered on the registration record which may be maintained on-line. Queries related to registration shall be considered only when accompanied by the original registration record. This record shall be preserved until the semester grade card is received by the student.

Minimum student enrollment in a course

A course shall be offered only if a minimum number of students register for that course, as specified by the concerned Dean of Faculty. Under special circumstances, a course may be offered with fewer students, with the prior permission of the Vice-Chancellor. Courses without the minimum number of student registrations on the last date for adding/dropping of courses shall not be offered. Such students who registered for the courses shall be given additional time for registering for alternate courses.

Add/Drop, audit and withdrawal from courses

a. Add/Drop: A student may add or drop one or more course(s) before the deadline with the approval of the concerned Dean of Faculty, upon payment of additional fees, if any.

b. Withdrawal: A student may withdraw from a course before the deadline specified for the purpose, with the approval of the concerned Dean of Faculty. A withdrawal grade shall be awarded in such case(s).

c. Audit: A student may change a credit course to an audit one before the deadline specified for the purpose, with the approval of the concerned Dean of Faculty.

Registration for Summer Term

A student may be permitted to register for maximum of four courses or sixteen credits, whichever is higher during a Summer Term.

A student who registers for a course in the Summer Term on account of failure, withdrawal or any other form of discontinuance shall pay additional fees as prescribed from time to time.

ATTENDANCE REQUIREMENT

Students shall maintain the prescribed minimum attendance of 85% in each individual course. Without the minimum attendance in a course, the student shall be ***ineligible to appear for the End Semester Assessment in that course***. Such a student shall be awarded 'F' grade in that course and he/she shall register for and repeat the course when offered next.

Students shall make every effort to attend all classes, laboratory / practical and other sessions.

Students are informed about their attendance status periodically by the respective departments so that the students get advance notice to make up any shortage in attendance.

If a student is absent from the University for more than SIX weeks without permission of the concerned Dean of Faculty, his/her registration is liable to be cancelled.

Condoning Attendance Shortage

In genuine cases, the Vice Chancellor / Registrar may condone a shortage of attendance to a maximum extent of 10% on the recommendation of the concerned Dean of Faculty. This facility can be availed by any student only once in the entire duration of study.

In Semester Assessment (ISA)

ISA for course is carried out by the way of various components such as tests, quizzes, seminars, term papers, demonstrations, and award of marks for attendance. Practical components of courses may be evaluated by the way of experiments, demonstrations, field work, models, worksheets, practical record books, quizzes and tests. If a student misses a practical / laboratory session owing to genuine reasons, he/she shall complete the activity of that session before the end of the semester, with the approval of the concerned Departmental Chairperson.

Conduct of ISA

Theory Courses

The weight and syllabus for each component of ISA for a course are indicated in the course information book given to the students at the beginning of the semester / year. The weightage of ISA for all theory course (UG Programs) is 40% and ESA is 60% and PG Programs is 60% : 40%. The weightage for the lab courses (UG and PG Programs) is 60% : 40%.

The ISA for any theory course would be for 40 marks and evaluated (in general) as follows:

<table>
<tr><th colspan="3">UG PROGRAMS</th><th colspan="3">PG PROGRAMS</th></tr>
<tr><th>Test-1</th><th>Test-2</th><th>Assignment / Mini project / Other components</th><th>Test-1</th><th>Test-2</th><th>Assignment / Mini project / Other components</th></tr>
<tr><td>15 M</td><td>15M</td><td>10M</td><td>20 M</td><td>20 M</td><td>20 M</td></tr>
<tr><td>20M</td><td>20M</td><td>No assignment / Mini-project</td><td>30 M</td><td>30 M</td><td>No assignment / Mini-project</td></tr>
<tr><td>20M**</td><td>--</td><td>20M</td><td rowspan="2">30 M**</td><td rowspan="2">--</td><td rowspan="2">30 M</td></tr>
<tr><td>10 M</td><td>10 M</td><td>20 M</td></tr>
<tr><td colspan="6">*Assignment / Mini project submission by student is compulsory as proposed for the course
**Course has only one test</td></tr>
</table>

Laboratory Courses: The ISA (60 M) for practical courses would be evaluated as follows:

Conduct of 10 / 12 experiments / activities	25 marks
Record of experiments / activities	25 marks
Internal lab test /quiz	10 marks

The weightage of ISA for all laboratory courses is 60% and ESA is 40%.

PRACTICAL - FSA	
Exam event	**Weight (%)**
Lab Quiz	20%
Application	20%

ISA of Special Topics / Mini-Projects, Seminar, Major Project

The ISA for Special Topics / Mini-projects, Seminar, and Major project may be carried out in the form of various components, such as oral presentations, demonstrations, technical / project report, and viva-voce.

Announcement of ISA marks

After each event of ISA, students shall have an opportunity to view his/her performance and bring discrepancies or errors, if any, to the notice of the concerned teacher, for addressing the same.

The final ISA marks obtained by the students in the registered courses are displayed at the end of each semester by the concerned Dean of Faculty on the notice boards and /or web site. Students shall be given THREE working days time for verification, redressal of discrepancies or errors, if any.

Though there is no minimum requirement of ISA marks for eligibility to appear in the End Semester Assessment, the student has to obtain the minimum attendance as prescribed.

END SEMESTER ASSESSMENT (ESA)

Registration for ESA

A student, who has complied with the minimum specified attendance in a course, shall register for ESA for that course. The registration of a student shall be liable to be cancelled by the Office of the Controller of Examinations when disciplinary issues are raised by the concerned Dean of Faculty.

Admit Card

The Controller of Examinations shall issue Admit Cards to eligible students, based on the ESA registration list. The Admit Card of a student shall be valid only for the ESA for which it is issued. The Admit Card of a student shall include (i) recent photograph of the student and (ii) registered courses for ESA with course codes.

ESA and Evaluation:

The ESA is conducted for 3 hours for each course for a maximum of 100 marks for 3 / 4 / 5 credit courses; for 2 credit courses, it is for a maximum of 50 marks for 2 hour duration. The pattern of questions shall be 5 questions covering the entire syllabus with appropriate apportioning for each unit of the syllabus. All questions are compulsory and there shall be no choice in the examinations.

Each answer book may be evaluated by up to two examiners independently. If the difference between two evaluations of the same book is significant, such an answer book shall be subjected to a third evaluation.

ESA for Laboratory

End Semester Assessment for a laboratory course may be carried out as follows

Laboratory written quiz	20 marks
Laboratory experiment performance	20 marks

ESA for Mini and Major Projects

The ESA for mini and major projects shall be held in batches which may span over several days. Each student shall be evaluated individually (in person) based on the evaluation comprising of various components such as writing of abstract, project or technical report, oral presentation, demonstration, and viva voce.

Grading System

A student is awarded a grade for each of the course he appeared in the ESA depending on the overall marks obtained in ISA and ESA.

Missing Test Event/s in ISA and consequent weights in theory courses (UG Programs)

(ISA:ESA = 40%:60%)

1. Category T1=15 + T2=15**;** and assignment = 10M:
   (a) If a student misses one test event, then the weight for ESA shall be 70%
   (b) If student misses both the test events, then the weight for ESA shall be 80%
2. Category T1=20 + T20; and no assignment:
   (a) If a student misses one test event, then the weight for ESA shall be 75%%
   (b) If student misses both the test events, then the weight for ESA shall be 90%
3. Category T1=10 + T2=10**;** assignment = 20M:
   (a) If a student misses one test event, then the weight for ESA shall be 65%%
   (b) If student misses both the test events, then the weight for ESA shall be 70%
4. Category T1=20 + Assignment / Mini-project = 20 M:
   (a) If a student misses the test event, then the weight for ESA shall be 75%

Submission of the assignment / Mini-project for evaluation, wherever applicable, mandatory in the above cases. In case of non-submission, the student shall be awarded zero for the mentioned components.

Missing Test Event/s in ISA and consequent weights in theory courses (PG Programs)

(ISA:ESA = 60%:40%)

1. Category T1=20 + T2=20; and assignment =20M:
   (a) If a student misses one test event, then the weight for ESA shall be 90%
   (b) If student misses both the test events, then the weight for ESA shall be 80%
2. Category T1=30 + T30 and no assignment:
   (a) If a student misses one test event, then the weight for ESA shall be 90%%
   (b) If student misses both the test events, then the weight for ESA shall be 80%
3. Category T1=10 + T2=10:
   (a) If a student misses one test event, then the weight for ESA shall be 65%%
   (b) If student misses both the test events, then the weight for ESA shall be 70%
4. Category T1=30 + Assignment / Mini-project = 30 M:
   (a) If a student misses the test event, then the weight for ESA shall be 90%

Submission of the assignment / Mini-project is mandatory. In case of non-submission, the student shall be awarded zero for the mentioned components.

The University shall follow a letter grading system by allocating a letter grade for a band of marks appropriately for each course. The letter grades shall be awarded grade points, as per the following table:

#	Letter Grade	Grade points	Remarks
1	S	10	Outstanding
2	A	9	Excellent
3	B	8	Very good
4	C	7	Good
5	D	6	Fair
6	E	5	Satisfactory
7	F	0	Fail
8	I*	-	Incomplete
9	W*	-	Withdrawal
10	AP	-	Audit Pass
11	AF	-	Audit Fail

* 'W' and 'I' grades are transitional grades.

'AP' and 'AF' grades: A student shall be awarded either an AP (Audit Pass) or an AF (Audit Fail) grade for an audit course. The AP grade shall be awarded if the student satisfies the attendance and performance criteria specified for the course by the concerned teacher. Otherwise, an AF grade shall be awarded.

'W' grade: 'W' grade shall be awarded to a student who has withdrawn from a course. Further, the 'W' grade shall be recorded in the grade card. A student may withdraw from an audit course in which case there shall be no mention of the course in the grade card.

'I' grade: An 'I' grade shall be awarded temporarily to a student who is unable to appear for ESA for one or more courses, with the permission of the Vice-Chancellor in response to a written appeal by the student, due to valid reasons such as medical emergency and calamity in the family. For such a student, the 'I' grade shall be converted to one of the other letter grades (S to F) after the completion of scheduled make-up ESA. If the student does not appear for the make-up ESA, the 'I' grade shall be converted to 'F' grade.

'F' grade: A student shall be awarded 'F' grade if he/she either fails in the course or is absent for the ESA of that course. If a course has theory and laboratory / practical components, the student shall appear for ESA in both of them. Absenting in any one or both of them shall result in the award of 'F' grade.

SGPA and CGPA

The overall performance of a student shall be indicated by two indices namely, Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA).

The **SGPA** is the weighted average of the grade points obtained in all courses registered by the student during a particular semester. The SGPA shall be calculated as:

SGPA = ∑ CiGi / ∑ Ci,

where Ci's, are the number of credits for the courses registered for the semester, and Gi's are the corresponding grade points secured by the student.

The **CGPA** is an indication of an up-to-date overall performance of a student and the weighted average of the grade points obtained in all the courses registered by the student since he/she is admitted to the University. It shall be calculated as:

CGPA = ∑ CiGi / ∑ Ci

The summations being carried out over the total number of courses registered by the student.

If a student obtains an 'F' grade in a course and registers for the same course in a subsequent semester, the new grade obtained shall replace the previous 'F' grade in calculating the CGPA.

If a student obtains an 'F' grade in an elective course and registers for the same or equivalent course in a subsequent semester, the new grade obtained shall replace the previous 'F' grade in calculating the CGPA.

Grades obtained in audit courses and transitional grades shall not be considered in the calculations of CGPA and SGPA.

Class / Division Declaration

The following classes of results shall be declared, for a student upon graduation, considering the below specified criteria:

CGPA	Equivalent Percentage	Class / Division
≥ 5.0 – < 5.75	-	Pass Class
≥ 5.75 – < 6.75	≥ 50 & < 60	Second Class
≥ 6.75 – < 7.75	≥ 60 & < 70	First Class
≥ 7.75 – < 9.50	≥ 70 & < 87.5	First Class with Distinction
>9.50	≥ 87.5	First Class with Honors

1. **First Class with Honors:** A student completing a Program of Study within the specified minimum duration, securing a CGPA of 9.50 or above, passing all the courses of the program in the first appearance, and not obtaining any transitional grades shall be declared to have passed in First Class with Honors.
2. **First Class with Distinction:** A student completing a Program of Study within the specified minimum duration, securing a CGPA between 7.75 and 9.49 (both inclusive), passing all the courses of the program in the first appearance, and not obtaining any transitional grades shall be declared to have passed in First Class with Distinction.
3. **First Class:** A student completing a Program of Study by securing a CGPA between 6.75 and 7.74 (both inclusive) shall be declared to have passed in First Class.
4. **Second Class:** A student completing the programme of study by securing a CGPA between 5.75 and 6.74 shall be declared to have passed in Second Class.
5. **Pass Class:** A student completing the programme of study by securing a CGPA of less than 5.75 shall be declared to have passed in Pass Class.

Declaration of Ranks

Ranks shall be awarded to the graduating students in each programme of study on the basis of CGPA. The ranks shall be awarded to top FIVE percent of students of the graduating class. However, the total number of ranks shall not exceed FIVE irrespective of the total number of graduating students in a programme of study. A student shall be eligible for a rank at the time of award of degree in the programme of study, provided he/she has:

i. Passed in all the courses of all semesters in FIRST attempt;
ii. Not obtained any transitional grades;
iii. Completed the program of study within the specified minimum duration;
iv. Not rejected any of the semester results;
v. Not taken re-admission; and
vi. Obtained a CGPA of 9.0 and above.
vii. Not faced any disciplinary action.

Not Fit for Programme of Study (NFPS)

A student shall be declared as "Not Fit for Program of Study" (NFPS) and terminated from the programme of study if he/she:

i. secures "F" grade in a particular course for five times. A warning shall be issued by the Controller of Examinations to any student who fails to obtain a passing grade in a course after three attempts and, a show cause notice issued after four attempts, each of which shall be intimated to the parents or guardians;
ii. fails to obtain a semester grade point average of at least 4.0 on a number of occasions numerically equal to the minimum duration of the programme in years. If the performance of a student at the end of a registered semester is below 4.0, he/she shall be issued a warning by the Controller of Examinations in the first two instances and a show cause notice in the third instance, each of which shall be intimated to the parents or guardians.

iii. Such students, if interested, shall be eligible to apply for re-admission to the programme of study at the first year level or second year level as the case may be.

In addition to the above, the following is applicable to B.Arch:

a.does not complete Stage-1 of the program within 7 years of admission to the B.Arch program.

b.does not complete Stage-2 within a maximum of FOUR years after the successful completion of Stage-1.

TRANSPARENCY IN EXAMINATION SYSTEM

A student shall be eligible to apply for re-totaling, challenge valuation and/or obtaining photocopies of the answer books of ESA only for theory component of courses. Any delay in the announcement of re-totaling and/or challenge valuation results for any reason whatsoever shall not confer the right upon the student for admission to the subsequent semester and for any other kind of claim. There shall be no provision for re-totaling, obtaining the photocopy of answer books and challenge valuation of ESA for practical components of courses, including drawing, seminar, mini project / special topics, and major project.

Re-Totaling

A student shall be eligible to apply for re-totaling of marks of ESA for any number of theory components of courses. Such a student shall submit the application for re-totaling in the prescribed form, upon the payment of prescribed fee, to the Controller of Examinations, within THREE working days from the date of announcement of the results.

Students who have applied for the re-totaling shall be called in batches to the Office of Controller of Examinations, on the dates fixed for re-totaling of marks. Such students shall be accompanied by Faculty Advisor / Class Teacher / Parent / Guardian.

A student, who has applied for re-totaling, shall be shown his/her answer books to verify the marks, totaling of the marks and to find out whether or not all the answers of the questions attempted were awarded marks. If such a student finds any discrepancy in totaling of marks, he / she shall bring the same to the notice of the concerned officials for incorporating the necessary corrections.

Photocopy of Answer scripts

A student may apply for obtaining the photocopies of his answer books of ESA to the Controller of Examinations, upon the payment of prescribed fee, within THREE working days from the date of the announcement of results. The photocopies of the answer books of theory component of courses shall be made available within THREE working days after the receipt of the application at the Office of the Controller of Examinations.

Challenge valuation

A student may apply to the Controller of Examinations for challenge valuation of theory components of courses in ESA, within THREE working days after obtaining the photocopies of concerned answer books and upon payment of prescribed fee. The marks obtained in the challenge valuation shall be considered for the re-computation of grade. However, if the new grade is found to be lower than the declared grade, the declared grade shall be retained. In the event of no change in the grade after challenge valuation, it shall be declared as “No Change”.

Refund of fee

A refund of 75% of re-totaling or challenge valuation fees shall be made to a student in the event of an improvement in the letter grade.

Rejection of whole semester results

A student may reject the results of a whole semester irrespective of performance in an individual course. However, there shall be no provision for the rejection of results of any individual course. Upon rejection, the results shall be considered as null and void. Such rejection may be permitted only once during the entire programme of study. A student, who has rejected the whole semester results, shall re-register for the courses of rejected semester upon payment of the prescribed fees.

Malpractice during In Semester Assessment / End Semester Assessment

No.	Nature of malpractice	Penalty to be imposed
1.	Revealing the identity of the candidate in ESA in the answer scripts	Deny the benefit of the performance of that semester examination in which the candidate has appeared.
2.	Showing part of answer either covertly or overtly; discussion or talking (either seeking or giving any information) to others. Communicating with other students in the examination hall without permission of invigilator.	Deny the benefit of the performance of that semester examination in which the candidate has appeared.
3.	Possession of manuscript / printed or typed matter, books or notes and written matter on calculator, instrument box, etc. or having any other written matter on the person (for e.g. palm, hand, leg, clothes, socks, etc.) pertaining to previous, present and further examinations the candidate is taking during the semester.	To deny the benefit of performance of the examinations of one or more courses for which the candidate has appeared in that semester and debar him / her for a further number of chances depending on the gravity of the malpractice.
4.	Detection of identical answers in the answer scripts of different candidates or allowing another candidate to copy from his/her answer script.	To deny the benefit of performance of the examination of all the courses for which the candidate has appeared (both attended and to be attended of the particular examination conducted) and involved in the said act, debar them for further number of chances extending up to three or more of all examinations.
5.	Appeal to the examiner with money as enclosures to the answer book/use of abusive, obscene language or threatening, remarks in the answer book.	To deny the benefit of performance of all courses of that semester examinations for which the candidate has appeared (both attended and to be attended).

6.	Found giving or receiving assistance at the examination, passing the question paper with written answers / formulae answer script/additional sheet / graph sheet/drawing sheet for purpose of copying.	To deny the benefit of performance of the examination of the course for which the candidate has appeared (both attended and to be attended of the particular examination conducted) and debarring him/her for a further number of chances extending up to three or more examinations.
7.	Destroying the documentary evidence, running away with answer scripts / question paper / written / printed matter or both before 30 minutes after starting of examination of that paper, also taking away the answer book without handing it over to the invigilator while leaving the examination hall.	To deny the benefit of performance of the examination of the course for which the candidate has appeared (both attended and to be attended of the particular examination conducted) and debarring him/her for a further number of chances extending up to three or more examinations.
8.	Insertion of additional sheets / graph sheets / drawing sheets, use of answer books which is not issued at the examination hall.	To deny the benefit of performance of the examination of the course for which the candidate has appeared (both attended and to be attended of the particular examination conducted) and debar him/her for a further number of chances extending up to four more examinations, however the period of debarment not to exceed three years excluding the examination already taken.
9.	In case of impersonation or found guilty of deliberate prior arrangements to cheat in the examination.	To deny the benefit of performance of the examination of the course for which the candidate (Impersonator / impersonated students) appeared and who has arranged another person to impersonate (both attended and to be attended of the particular examination conducted) and debar him/her for a minimum of six more examinations.
10.	Abusing, threatening, manhandling examination authorities at the examination hall or in the premises of examination center as well as misconduct of a very serious nature.	To deny the benefit of performance of the examination of the course for which the candidate has appeared (both attended and to be attended of the particular examination conducted) and debar him/her for a minimum five more examinations depending upon the degree of misconduct.
11.	Any other malpractices connected with the exam events of autonomous program not covered above.	Examinations Malpractice Review Committee of the University can recommend suitable penalties and punishments.

Note:

The concerned student who has been alleged of having indulged in malpractice shall be allowed to all subsequent examinations; however, the announcement of the results of such candidates shall be withheld pending decision of the Examinations Malpractice Review Committee.

If the examiner who values the answer scripts of ESA suspects malpractice while valuing the answer scripts or finds other material such as insertion of answer sheets, revealing of identity or enclosures such as currency, he/she shall return those answer scripts with reasons in writing to the Controller of Examinations. If already valued, marks shall not be entered in the regular marks list, but shall be entered in a separate list which shall be enclosed in a sealed cover and forwarded to the Controller of Examinations.

STUDENT DISCIPLINE, ANTI-RAGGING AND INTERNAL COMPLAINT COMMITTEE

Every student shall maintain discipline and decorous behavior both inside and outside the Campus and not indulge in any activity that may bring down the reputation of the University.

Undertaking to be signed by a student

At the time of admission, every student jointly with one of his/her parents or an authorized local guardian, shall sign in person an undertaking, in the prescribed format, to maintain conduct and discipline as well as not to indulge in or abet ragging or sexual harassment.

Acts of Indiscipline and Misconduct

Types of indiscipline or misconduct include:

a. Academic indiscipline;
b. Ragging;
c. Sexual harassment; and
d. Other acts of indiscipline or misconduct.

Academic Indiscipline

Students shall maintain academic integrity at all times. The broad categories of academic indiscipline are:

(a) Plagiarism; (b) Cheating; and (c) Conflict of interest.

Plagiarism: Use of material, ideas, figures, code or data without appropriate acknowledgement or permission of the original source shall be treated as cases of plagiarism. Submission of material, verbatim or paraphrased, that is authored by another person or published earlier by oneself shall also be considered as cases of plagiarism. Examples of plagiarism include:

a. Reproducing, in whole or part, text/sentences from a report, book, thesis, publication or the internet;
b. Reproducing one's own previously published data, illustrations, figures, images, or someone else's data, etc.;
c. Taking material from class-notes or downloading material from internet sites, and incorporating it in one's class reports, presentations, manuscripts or thesis without citing the original source;
d. Self plagiarism which constitutes copying verbatim from one's own earlier published work in a journal or conference proceedings without appropriate citations.

Cheating: Any of the following types of acts shall be considered as cheating:

a. Copying during tests, quizzes, examinations, and copying of homework assignments, term papers or manuscripts;
b. Allowing or facilitating copying, or writing a report or examination for someone else;
c. Using unauthorized material, copying, collaborating when not authorized, and purchasing or borrowing papers or material from various sources; and
d. Fabricating (making up) or falsifying (manipulating) data and reporting them in reports and publications.

Conflict of Interest: A conflict of interest may arise from any clash of personal or private interests with academic and professional activities such as learning, research, publication, work on projects and internships. A student shall disclose in writing any potential conflicts of interests to the concerned Dean immediately after coming to know of the conflict. The Dean may constitute a committee to inquire on a case to case basis and give its recommendation to the Vice-Chancellor.

Handling of Academic Indiscipline: Any incidence of indiscipline or misconduct related to an examination shall be referred to the Examinations Malpractice Review Committee by the Controller of Examinations. The Examinations Malpractice Review Committee shall hold an inquiry and recommend the disciplinary action, if any, to the Vice-Chancellor as per the prevailing guidelines. All other incidences of academic indiscipline shall be referred to the Student Discipline Committee by the Registrar. The Student Discipline Committee shall inquire into the incident and recommend suitable disciplinary action, if any, to the Vice-Chancellor as per the prevailing guidelines.

Ragging:

All forms of ragging are prohibited. Any individual or collective act or practice of ragging shall constitute an act of gross indiscipline and shall be dealt with under the provisions of national regulatory bodies and judiciary.

Ragging, for the purposes of these regulations, shall ordinarily mean any act, conduct or practice by which the dominant power or status of senior students is brought to bear upon the students who are in any way considered junior or inferior by the former and includes individual or collective acts or practices which:

a. Involve physical assault or threat to use physical force;
b. Violate the status, dignity and honour of students, in particular female students;
c. Expose students to ridicule or contempt or commit an act which may lower their self esteem; and
d. Entail verbal abuse, mental torture, aggression, harassment, trauma, indecent gesture and obscene behaviour.

Handling of Incidences of Ragging:

(a) Any incidence, either inside or outside the Campus, of ragging, as defined in legal parlance, may be reported by anyone to the Anti-Ragging Committee.
(b) Depending on the nature and gravity of the guilt established by the Anti-Ragging Committee, the Vice-Chancellor may impose, to those found guilty, punishments such as:
    i. Cancellation of admission;
    ii. Rustication from the University;
    iii. Withholding/withdrawing scholarship/ fellowship and other benefits;
    iv. Debarring from appearing in any test/examination or other evaluation process;
    v. Imposing a fine; and
    vi. When the persons or a group of students committing or abetting the crime of ragging are not identifiable, the University shall resort to collective punishment as a deterrent to potential offenders.
(c) The Registrar / Dean of Faculty, as the case may be, shall take immediate action on the receipt of any information that ragging has taken place or is likely to take place.
(d) The Vice-Chancellor / Registrar / Dean of Faculty, as the case may be, may take help of local police or other law enforcing authorities for immediate action.
(e) The Chairperson of Anti-Ragging Committee or any other Officer of the University may *suo motu* inquire into any incident of ragging or likelihood of such incident and make a report in writing to the Vice-Chancellor clearly pinpointing, among other details, the identity of the student or the students who were involved in the incident and the nature of the incident.
(f) The Chairperson of Anti-Ragging Committee or any other Officer of the University, as the case may be, may also submit an interim report to the Vice-Chancellor establishing the identity of the perpetrators of ragging and the nature of the incident.

Sexual Harassment : Students shall conduct themselves in a manner that provides a safe working environment for women. Sexual harassment of any kind is unacceptable and shall attract disciplinary action.

Acts of sexual harassment shall be as defined in legal parlance.

Handling of Incidents of Sexual Harassment:

a) Any incidence, either inside or outside the Campus, of Sexual Harassment, as defined in legal parlance, may be reported by anyone to the Internal Complaint Committee.
b) Depending on the nature and gravity of the guilt established by the Internal Complaint Committee, the Vice-Chancellor may impose, to those found guilty, punishments such as:
    i. Cancellation of admission;
    ii. Rustication from the University;
    iii. Withholding/withdrawing scholarship/ fellowship and other benefits;
    iv. Debarring from appearing in any test/examination or other evaluation process;
    v. Imposing a fine; and
    vi. When the persons or a group of students committing or abetting the crime of Sexual Harassment are not identifiable, the University shall resort to collective punishment as a deterrent to potential offenders.

Other acts of indiscipline or misconduct

Without prejudice to the generality of the power to maintain and enforce discipline, the following actions shall amount to acts of indiscipline or misconduct on the part of a student of the University:

i. physical assault or threat to use physical force against any teaching or non-teaching staff or student of the University or any individual of the society;
ii. carrying of, use of or threat to use, any weapon;
iii. indulging in or instigating any kind of gambling / betting activities;
iv. misbehaving or cruelty towards any teaching or non-teaching staff or student of the University or any individual of the society;
v. use of banned drugs, intoxicants, alcohol, and tobacco products;
vi. any violation of the provisions of the Civil Rights Protection Act, 1976;
vii. indulging in or encouraging violence or any conduct which involves moral turpitude;
viii. violation of the status, dignity and honour of a student belonging to scheduled caste or scheduled tribe;
ix. creating / circulating bad information / rumors / gossip on social media, websites, blogs, internet, sms and other e-communications, against any teaching or non-teaching staff or student of the University or any individual of the Society;
x. discrimination against any teaching or non-teaching staff or student of the University or any individual of the society on grounds of caste, creed, language, place of origin, social and cultural background;
xi. practicing casteism and untouchability in any form or inciting any other person to do so;
xii. any act, whether verbal or otherwise, derogatory to women;
xiii. any form of bribing or corruption;
xiv. willful destruction of the property of the University or public property;
xv. behaving in a rowdy, intemperate or disorderly manner in the premises of the University or outside the campus or encouraging or inciting any other person to do so;
xvi. creating discord, ill-will or intolerance among the students on sectarian or communal grounds or inciting any other student to do so;
xvii. causing any kind of disruption of the academic functioning of the University;
xviii. staying away from the University without permission and unpunctuality; and
xix. giving information / misrepresentation of the University to any external agency including press or media without the consent of the University;

The University may amend or add to the list of acts of indiscipline and misconduct on the part of a student of the University.

Handling of other acts of indiscipline or misconduct:

a) Any Other act of indiscipline by one or more students shall be dealt with by the concerned Dean of Faculty.
b) A serious act of indiscipline by one or more students shall be referred by the concerned Dean of Faculty to the Discipline Committee for necessary action. The Committee shall inquire into the charges and give the concerned student an opportunity to explain himself/herself. After the hearing, the Committee shall recommend to the Vice-Chancellor suitable action if the charges are substantiated.

Penalties for breach of discipline and conduct

Without prejudice to the generality of the powers relating to the maintenance of discipline and taking such action in the interest of maintaining discipline as deemed appropriate, the Vice-Chancellor / Registrar / Deans of Faculties may in the exercise of the vested powers aforesaid, order or direct that any student:

i. be expelled from the University, in which case the student shall not be re-admitted to the University;
ii. be, for a stated period, suspended in which case the student shall not be admitted to the University till the expiry of the period of suspension;
iii. be imposed with fine of a specified amount of money;
iv. be debarred from appearing in a University examination or examinations for one or more terms / years; and
v. be reported to the local state law and order authority.

The Vice-Chancellor, in exercise of powers aforesaid or on the recommendations of the Registrar / Deans of Faculties, may also order or direct that the result of the student concerned of the examination or examinations at which he has appeared, be cancelled.

Mass absence shall be deemed as an act of indiscipline. The concerned Teachers are not obligated to cover the lessons planned for the missed classes.

A student shall be required to withdraw from the programme and leave the University on the following additional grounds:

Conditions for termination from the programme

a) Absence from classes for more than SIX weeks at a time in a semester without leave of absence being granted by the concerned Dean of Faculty; and
b) Failure to meet the standards of discipline as prescribed by the University from time to time.

All the rules and regulations are subject to modification. All clarifications regarding these regulations shall be addressed to the Vice-Chancellor / Registrar.

ACADEMIC POLICIES AND REGULATIONS- B.Arch. 2016-2021 batch & B. Arch. 2017-2022 batch

A student has to complete the courses in a maximum of twice the prescribed minimum duration.

- The architecture course shall be of minimum duration of 5 academic years or 10 semesters of approximately 16 working weeks each inclusive of six months/one semester of approximately 16 working weeks of practical training after the first stage in a professional office.
- The architecture course may be conducted in TWO stages.

- The first 3 academic years / 6 semesters of approximately 16 working weeks each of the course shall be a basic standard course and shall be the FIRST STAGE:
  Provided that candidates admitted to the course shall complete the first stage within 5 years of admission to the course.
- The SECOND STAGE of the course shall be of 2 academic years / 4 semesters of approximately 16 working weeks each. The students shall undergo Practical Training in a recognized architectural firm which has COA registered architects.
- The completion of first stage shall not qualify candidates for registration under the Architects Act, 1972.
- For registration as an Architect, a candidate must successfully complete both stages.

Credit system

Exceptional full-time student may be permitted to register for a maximum of THIRTY credits during a regular semester. A student shall register for a minimum of 18 credits during a regular semester.

SUMMER TERM ASSIGNMENT

Summer Term Assignment shall be mandatory in the summer term between SECOND and THIRD semesters, FOURTH and FIFTH semesters. Summer term assignment may be a measured drawing and documentation work or any other project. The Chairperson/Dean shall assign the summer term assignment to the students, either in a group or individually. The students shall submit the assignment within 15 days at the beginning of the THIRD semester or FIFTH semester as the case may be. The submissions are to be assessed in the form of viva-voce by the Department.

Conduct of ISA

Theory Courses

The weightage of ISA for all theory course (UG Programs) is 50% and ESA is 50%. A student shall have to secure a minimum of 50% marks in ISA to be eligible for taking up ESA.

Students who have passed in the ISA, shall only be permitted to appear in ESA.

UG PROGRAMS		
Test-1	Test-2	Assignment / Mini project*
15 M	15M	20M

ISA of Special Topics / Mini-Projects, Seminar, Major Project/ Studio

The ISA for Special Topics / Mini-projects, Seminar, Major project and studio may be carried out in the form of various components, such as oral presentations, demonstrations, technical / project report, term work and viva-voce.

END SEMESTER ASSESSMENT (ESA)

The ESA is conducted for 3 hours for each course for a maximum of 100 marks for theory subjects. The pattern of questions shall be 5 questions covering the entire syllabus with appropriate apportioning for each unit of the syllabus. All questions are compulsory and there shall be no choice in the examinations.

ESA for Mini and Major Projects

The performance assessment of a student in theory / practical / studio / seminar / project shall be in the form of In Semester Assessment (ISA) and End Semester Assessment (ESA), wherever applicable and specified. ISA and ESA shall be in proportion of 50:50.

A student shall have to secure a minimum of 40% marks in ESA with an aggregate of 45% (in ISA and ESA put together) in the course to be eligible for getting a pass grade.

The pass percentage shall not be less than 45% in each course of study and shall not be less than 50% in the aggregate.

A student shall undergo Practical Training in the TENTH semester under the supervision of a registered practicing architect for a period of 16 weeks. The student opting to undergo training abroad has to work under a registered architect. The student shall submit the logbook, training report and certificate to the effect that the student has undergone practical training to the Chairperson / Dean. The student shall appear for a viva-voce examination for Practical Training conducted by two examiners, one internal and one external. If the student fails in the viva-voce examination, the student shall repeat the training afresh and appear for the viva-voce examination again.

Grading System

Overall marks would consists of 50% of the ISA marks and 50% of the ESA marks.

Missing Tests and internal assessment components of ISA, will result in ineligibility to appear in ESA.

Submission of the assignment / Mini-project for evaluation, wherever applicable, mandatory in the above cases. In case of non-submission, the student shall be awarded zero for the mentioned components.

Not Fit for Programme of Study (NFPS)

In addition to the PES UNIVERSITY ‘Not Fit for Programme of Study (NFPS)’ regulations , the following is also applicable to B.Arch:

i. does not complete Stage-1 of the program within 5 years of admission to the B.Arch program.

ADDITIONAL POLICIES AND REGULATIONS FOR B ARCH (2018-2023 BATCH)

Programs of Study and duration

The Architecture Program shall be completed in a maximum period of 8 years. However, in special circumstances a candidate may be granted an extension of 1 year by the University/ Institution to complete the program. This extension shall be given only once to the candidate.

- The architecture course shall be of minimum duration of 5 academic years or 10 semesters of
  approximately 16 working weeks each inclusive of six months/one semester of approximately 16 working weeks of practical training after the first stage in a professional office.

- The students shall undergo Practical Training in a recognized architectural firm which has COA registered architect, having experience of at least 5 years.
- The completion of first stage shall not qualify candidates for registration under the Architects Act, 1972.
- For registration as an Architect, a candidate must successfully complete both stages.
- A candidate shall not be permitted to enroll for the Architectural Design course in a semester unless he/ she has completed the Architectural Design course of the previous semester.
- A candidate shall not be permitted to enroll for the tenth semester Architectural Design Thesis/ dissertation/project course unless he/ she has successfully completed Practical Training/ Internship.
- In case a candidate is not able to complete the program in the prescribed duration, the University/ Institution may provide an exit option for the candidate if he/ she has completed and earned all credits for the first three years of study.

Credit system

Credits shall be assigned to each course in a programme of study based on the following pattern:

- 1 lecture period/ hour shall have 1 credit
- 2 lab/workshop/ studio exercises/seminar periods/ hours shall have 1 credit
- 1 design studio/construction studio/project/thesis period/ hour shall have 1.5 credits.
- Self study is a non credit component.

Each course shall be represented in the form of 'L/T-S-P-S-C' where L, T, S, P, S and C mean respectively, the number of lecture hours per week, number of tutorial hours per week, number of studio hours per week, number of practical hours per week, the number of self study hours per week and the number of credits assigned to the course. The credits assigned to each course shall be calculated as C = (L or T)+ (S x 1.5) + P/2

For example, '0-2-2-0-4' means two studio hours and two practical hours amounting to a total of 4 credits.

The number of credits required to be earned for B. Arch. degree programme shall be calculated on the following basis:

- Every semester shall offer a minimum of 26 credits and a maximum of 30 credits.
- Credits for the Architectural Design Project/Thesis can vary from 15 to 18.
- The total number of credits for the B. Arch Degree Course could vary from a minimum of 260 credits to a maximum of 300 credits

Every course in a programme of study normally runs for the full length of a semester.

For B.Arch, exceptional full-time student may be permitted to register for a maximum of THIRTY credits during a regular semester. A student shall register for a minimum of 18 credits during a regular semester.

Courses offered in various programmes of study shall be categorized into the following types:

- Professional Core (PC) Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
- Basic Sciences and Applied Engineering (BS & AE) Course: A course which informs the Professional core and should compulsorily be studied.
- Elective Course: Generally a course which can be chosen from a pool of courses and are of two types
  - (i) Professional Elective (PE) which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope
  - (ii) Open Elective (OE) which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill
- Employability Enhancement Courses (EEC) which may be of two kinds:
  - (i) Employability Enhancement Compulsory Courses (EECC)
  - (ii) Skill Enhancement Courses (SEC)
- Non-credit courses: A few courses may not be assigned credits. Such courses shall be referred to as non-credit (NC) courses, and may be mandatory in a programme of study.

Certain programmes of study may have additional requirements such as apprenticeship and residency.

The Weightage in terms of Credits for each of the above in the prescribed curriculum of the institution shall be as follows:

1. Professional Core Courses (PC) : 45%
2. Building Science and Applied Engineering (BS& AE) : 20 %
3. Elective Courses
   - (i) Professional Electives (PE) : 10%
   - (ii) Open Electives (OE) : 5%
4. Professional Ability Enhancement Courses (PAEC)
   - (i) Professional Ability Enhancement Compulsory Courses (PAECC) : 15%
   - (ii) Skill Enhancement Courses (SEC) : 5%

Note: Where it is not possible to offer Open Electives, Professional Electives may have a weightage 15% of the total credits.

SUMMER TERM ASSIGNMENT

Summer Term Assignment shall be mandatory in the summer term between SECOND and THIRD semesters, FOURTH and FIFTH semesters. Summer term assignment may be a measured drawing and documentation work or any other project. The Chairperson/Dean shall assign the summer term assignment to the students, either in a group or individually. The students shall submit the assignment within 15 days at the beginning of the THIRD semester or FIFTH semester as the case may be. The submissions are to be assessed in the form of viva-voce by the Department.

In Semester Assessment (ISA)

Theory Courses

The weightage of ISA for all theory course (UG Programs) is 50% and ESA is 50%. A student shall have to secure a minimum of 50% marks in ISA to be eligible for taking up ESA.

Students who have passed in the ISA, shall only be permitted to appear in ESA.

UG PROGRAMS		
Test-1	**Test-2**	**Assignment / Mini project***
15 M	15M	20M

ISA of Special Topics / Mini-Projects, Seminar, Major Project/ Studio

The ISA for Special Topics / Mini-projects, Seminar, Major project and studio may be carried out in the form of various components, such as oral presentations, demonstrations, technical / project report, term work and viva-voce.

END SEMESTER ASSESSMENT (ESA)

ESA and Evaluation:

The ESA is conducted for 3 hours for each course for a maximum of 100 marks for theory subjects. The pattern of questions shall be 5 questions covering the entire syllabus with appropriate apportioning for each unit of the syllabus. All questions are compulsory and there shall be no choice in the examinations.

Each answer book may be evaluated by up to two examiners independently. If the difference between two evaluations of the same book is significant, such an answer book shall be subjected to a third evaluation.

The performance assessment of a student in theory / practical / studio / seminar / project shall be in the form of In Semester Assessment (ISA) and End Semester Assessment (ESA), wherever applicable and specified. ISA and ESA shall be in proportion of 50:50.

A student shall have to secure a minimum of 40% marks in ESA with an aggregate of 45% (in ISA and ESA put together) in the course to be eligible for getting a pass grade.

The pass percentage shall not be less than 45% in each course of study and shall not be less than 50% in the aggregate.

A student shall undergo Practical Training in the NINTH semester under the supervision of a registered practicing architect for a period of 16 weeks. The student opting to undergo training abroad has to work under a registered architect. The student shall submit the logbook, training report and certificate to the effect that the student has undergone practical training to the Chairperson / Dean. The student shall appear for a viva-voce examination for Practical Training conducted by two examiners, one internal and one external. If the student fails in the viva-voce examination, the student shall repeat the training afresh and appear for the viva-voce examination again.

Grading System

Overall marks would consists of 50% of the ISA marks and 50% of the ESA marks.

Missing Test Event/s in ISA and consequent weights in theory courses (UG Programs)

Missing Tests and internal assessment components of ISA, will result in ineligibility to appear in ESA. Submission of the assignment / Mini-project for evaluation, wherever applicable, mandatory in the above cases. In case of non-submission, the student shall be awarded zero for the mentioned components.

ACADEMIC POLICIES AND REGULATIONS- B.Des. 2016-20 Batch & 2017-2021 Batch

SUMMER TERM ASSIGNMENT

Summer Term Assignment shall be mandatory in the summer term between SECOND and THIRD semesters, FOURTH and FIFTH semesters. The Chairperson/Dean shall assign the summer term assignment to the students, either in a group or individually. The students shall submit the assignment within 15 days at the beginning of the THIRD semester or FIFTH semester as the case may be. The submissions are to be assessed in the form of viva-voce by the Department.

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The ISA for Special Topics / Mini-projects, Seminar, Major project and studio may be carried out in the form of various components, such as oral presentations, demonstrations, technical / project report, term work and viva-voce.

END SEMESTER ASSESSMENT (ESA)

ESA and Evaluation:

The ESA is conducted for 3 hours for each course for a maximum of 100 marks for theory subjects. The pattern of questions shall be 5 questions covering the entire syllabus with appropriate apportioning for each unit of the syllabus. All questions are compulsory and there shall be no choice in the examinations.

ESA for Mini and Major Projects

The performance assessment of a student in theory / practical / studio / seminar / project shall be in the form of In Semester Assessment (ISA) and End Semester Assessment (ESA), wherever applicable and specified. ISA and ESA shall be in proportion of 50:50.

A student shall have to secure a minimum of 40% marks in ESA with an aggregate of 45% (in ISA and ESA put together) in the course to be eligible for getting a pass grade.

The pass percentage shall not be less than 45% in each course of study and shall not be less than 50% in the aggregate.

Grading System

Overall marks would consists of 50% of the ISA marks and 50% of the ESA marks.

Missing Tests and internal assessment components of ISA, will result in ineligibility to appear in ESA.

Submission of the assignment / Mini-project for evaluation, wherever applicable, mandatory in the above cases. In case of non-submission, the student shall be awarded zero for the mentioned components.

FACULTY OF ARCHITECTURE AND DESIGN

FACULTY OF ARCHITECTURE AND DESIGN

SCHEME OF INSTRUCTION

Program of Study: B.ARCH

Sl. No.	Course Type
1	Professional Core Courses (PC)
2	Building Science and Applied Engineering (BS& AE)
3	Professional Electives (PE)
4	Open Electives (OE)
5	Professional Ability Enhancement Compulsory Courses (PAECC)
6	Skill Enhancement Courses (SEC)

STRUCTURE OF CURRICULUM

BACHELOR OF ARCHITECTURE

(As per Council Of Architecture Draft Minimum Standards of Architectural Education Regulations, 2017)

(THE FOLLOWING CURRICULUM AND STRUCTURE IS SUBJECT TO CHANGE AS PER DIRECTIONS OF COUNCIL OF ARCHITECTURE)

I SEMESTER(2018-23 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			Lec./ Tut.	Studio	Practical	S$		
1.	UA18BA101	Visual Arts & Basic Design I	0	6	0	4	9	PC
2.	UA18BA102	Building Construction Technology & Materials I	0	2	2	0	4	BS &AE
3.	UA18BA103	Graphics I	0	0	4	0	2	PC
4.	UA18BA104	History of Art, Architecture & Design I	2	0	0	1	2	PC
5.	UA18BA105	Structural Mechanics I	2	0	0	1	2	BS &AE
6.	UA18BA106	Carpentry, Model Making & Creative Workshop	0	0	4	0	2	PC
7.	UA18BA107	Communication Skills	1	0	0	0	1	SEC
8.	UA18BA108	Seminar/ Activities I	0	0	2	0	1	PAECC
9.	UA18BA109	Site Exposure I	0	0	4	0	0	NC
		ELECTIVEI						
10.	UA18BA111E	Photography & Videography	1	0	4	0	3	PE
		Total	**6**	**8**	**20**	**6**	**26**	

One lecture period/hour shall have one credit. Two Lab/workshop/studio exercises/seminar periods/ hours shall have one credit. One Design studio/ construction studio/project/thesis period/hour shall have 1.5 credits. $ Self study is a non credit component.

II SEMESTER (2018-23 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			Lec./ Tut.	Studio	Practical	S$		
1.	UA18BA151	Design II	0	6	0	4	9	PC
2.	UA18BA152	Building Construction Technology & materials II	0	2	2	0	4	BS &AE
3.	UA18BA153	Graphics II	2	0	2	0	3	PC
4.	UA18BA154	History of Art, Architecture & Design II	2	0	0	1	2	PC
5.	UA18BA155	Structural Mechanics II	2	0	0	1	2	BS &AE
6.	UA18BA156	Introduction to Computers , Digital Graphics & Art	2	0	2	0	3	SEC
7.	UA18BA157	Kannada Kali	1	0	0	0	0	NC
8.	UA18BA158	Seminar/ activities II	0	0	2	0	1	PAECC
9.	UA18BA159	Site Exposure II	0	0	4	0	0	NC
		ELECTIVEII						
10.	UA18BA121E	Applied Art & Appreciation	1	0	2	0	2	PE
11.	UA18BA122E	Introduction to Product, Interaction & Communication Design	0	0	2	0	1	PE
		Total	**10**	**8**	**16**	**6**	**27**	
Note: Vacation Assignment/ Study Tour to be undertaken								

One lecture period/hour shall have one credit. Two Lab/workshop/studio exercises/seminar periods/ hours shall have one credit. One Design studio/ construction studio/project/thesis period/hour shall have 1.5 credits. $ Self study is a non credit component.

SCHEME OF INSTRUCTION

Sl. No.	Course Type
1	Preliminary Course (PC)
2	Foundation Course (FC)
3	Core course (CC)
4	Elective Course (EC)
5	Project Work / Self learning/ Seminar/ Internship/ Research (PW)
6	Non credit -All non credit courses are mandatory (NC)

BACHELOR OF ARCHITECTURE

(AS PER COUNCIL OF ARCHITECTURE MINIMUM STANDARDS OF ARCHITECTURAL EDUCATION REGULATIONS, 1983)

III SEMESTER B ARCH (2017-22BATCH)

Sl. No.	Course Code	Course Title	Hours / week			Credits	Course Type
			L/St/ T*	P	S$		
1.	UA17BA201	Design III	6	2	4	7	CC
2.	UA17BA202	Building Construction Technology & Materials III	4	0	0	4	CC
3.	UA17BA203	Theory of Architecture I	2	0	0	2	FC
4.	UA17BA204	History of Art, Architecture & Design III	2	0	1	2	FC
5.	UA17BA205	Structures I	2	0	1	2	FC
6.	UA17BA206	Building Services I (Surveying & Leveling, water supply &Sanitation)	3	0	0	3	FC
7.	UA17BA207	Computers in Architecture I	3	0	0	3	FC
8.	UA17BA208	Vacation Assignment/ Study Tour/ Summer term Assignment-I	0	0	0	0	NC
9.	UA17BA209	Seminar/ Activities- III	0	2	0	0	NC
10.	UA17BA210	Site Exposure III	0	6	0	0	NC
		ELECTIVE I					
11.	UA17BA211	Vernacular Design	2	0	0	2	EC
	UA17BA212	Conservation					
		Total	**24**	**10**	**6**	**25**	

IV SEMESTER B ARCH (2017-22BATCH)

Sl. No.	Course Code	Course Title	Hours / week			Credits	Course Type
			L/St/ T*	P	S$		
1.	UA17BA251	Design IV	6	2	4	7	CC
2.	UA17BA252	Building Construction Technology & Materials IV	4	0	0	4	CC
3.	UA17BA253	Theory of Architecture II	2	0	0	2	FC
4.	UA17BA254	Climate Responsive Architecture	3	0	1	3	FC
5.	UA17BA255	Structures II	2	0	1	2	FC
6.	UA17BA256	Building Services II (Electrical services & illumination)	3	0	0	3	FC
7.	UA17BA257	Computers in Architecture II	2	0	0	2	FC
8.	UA17BA258	Seminar/ activities- IV	0	2	0	0	NC
9.	UA17BA259	Site Exposure IV	0	6	0	0	NC
		ELECTIVE II					
10.	UA17BA221	Energy Efficient Design	2	0	0	2	EC
	UA17BA222	Material Efficient Design					
		Total	24	**10**	**6**	**25**	
Note: Vacation Assignment/ Study Tour to be undertaken							

* One Tutorial hour is equal to one Lecture hour. $ Self study is a non credit component.

V SEMESTER B. ARCH (2016-21 BATCH)

Sl. No.	Course Code	Course Title	Hours / week			Credits	Course Type
			L/St/ T*	P	S$		
1.	UA16BA301	Design V	6	2	4	7	CC
2.	UA16BA302	Building Construction Technology & Materials V	4	0	0	4	CC
3.	UA16BA303	Contemporary Architecture	2	0	0	2	FC
4.	UA16BA304	Sociology & Economics	2	0	0	2	FC
5.	UA16BA305	Structures III	2	0	1	2	FC
6.	UA16BA306	Building Services III (HVAC, Lifts & Fire Fighting)	3	0	1	3	FC
7.	UA16BA307	Landscape Design	1	2	0	2	FC
8.	UA16BA308	Vacation Assignment/ Study Tour/ Summer Term Assignment- II	0	0	0	0	NC
9.	UA16BA309	Seminar/ Activities V	0	2	0	0	NC
10.	UA16BA310	Site Exposure V	0	6	0	0	NC
		ELECTIVE III					
11.	UA16BA331	Furniture Design	2	0	0	2	EC
	UA16BA332	Product Design					
		Total	22	12	6	24	

*One Tutorial hour is equal to one Lecture hour. $ Self study is a non credit component

VI SEMESTER B. ARCH (2016-21 BATCH)

Sl. No.	Course Code	Course Title	Hours / week			Credits	Course Type
			L/St/ T*	P	S$		
1.	UA16BA351	Design VI	8	0	4	8	CC
2.	UA16BA352	Building Materials & Construction Technology VI	4	0	0	4	CC
3.	UA16BA353	Estimation & Costing	3	0	0	3	FC
4.	UA16BA354	Working Drawing	2	2	0	3	FC
5.	UA16BA355	Structures IV	2	0	1	2	FC
6.	UA16BA356	Building Services IV (Acoustics)	2	0	1	2	FC
7.	UA16BA357	Environmental Studies	1	0	0	0	NC
8.	UA16BA358	Seminar/ Activities VI	0	2	0	0	NC
9.	UA16BA359	Site Exposure VI	0	6	0	0	NC
		ELECTIVE IV					
10.	UA16BA341	Architectural Design with Steel	2	0	0	2	EC
	UA16BA342	Architectural Design with Glass					
		Total	24	10	6	24	

* One Tutorial hour is equal to one Lecture hour. $ Self study is a non credit component.

BACHELOR OF DESIGN

I SEMESTER (2018-22 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			Lec./ Tut.	Studio	Practical	S$		
1.	UA18BA101	Visual Arts & Basic Design I	0	6	0	4	9	PC
2.	UA18BD101	Introduction to Materials	0	2	2	0	4	BS &AE
3.	UA18BA103	Graphics I	0	0	4	0	2	PC
4.	UA18BA104	History of Art, Architecture & Design I	2	0	0	1	2	PC
5.	UA18BA105	Structural Mechanics I	2	0	0	1	2	BS &AE
6.	UA18BA106	Carpentry, Model Making & Creative Workshop	0	0	4	0	2	PC
7.	UA18BA107	Communication Skills	1	0	0	0	1	SEC
8.	UA18BA108	Seminar/ Activities I	0	0	2	0	1	PAECC
9.	UA18BA109	Site Exposure I	0	0	4	0	0	NC
	Elective I							
10.	UA18BA111E	Photography & Videography	1	0	4	0	3	PE
		Total	**6**	**8**	**20**	**6**	**26**	

- One lecture period/hour shall have one credit.
- Two Lab/workshop/studio exercises/seminar periods/ hours shall have one credit.
- One Design studio/ construction studio/project/thesis period/hour shall have 1.5 credits.
- $ Self study is a non credit component.

II SEMESTER (2018-22 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			Lec./ Tut.	Studio	Practical	S$		
1.	UA18BA151	Design II	0	6	0	4	9	PC
2.	UA18BD151	Projects of Product, Interaction and Communication Design	0	2	2	0	4	BS &AE
3.	UA18BA153	Graphics II	2	0	2	0	3	PC
4.	UA18BA154	History of Art, Architecture & Design II	2	0	0	1	2	PC
5.	UA18BA155	Structural Mechanics II	2	0	0	1	2	BS &AE
6.	UA18BA156	Introduction to Computers , Digital Graphics & Art	2	0	2	0	3	SEC
7.	UA18BA157	Kannada Kali	1	0	0	0	0	NC
8.	UA18BA158	Seminar/ activities II	0	0	2	0	1	PAECC
9.	UA18BA159	Site Exposure II	0	0	4	0	0	NC
	Elective II							
10.	UA18BA121E	Applied Art & Appreciation	1	0	2	0	2	PE
11.	UA18BA122E	Introduction to Product, Interaction & Communication Design	0	0	2	0	1	PE
		Total	**10**	**8**	**16**	**6**	**27**	

- Vacation Assignment/ Study Tour to be undertaken
- One lecture period/hour shall have one credit.
- Two Lab/workshop/studio exercises/seminar periods/ hours shall have one credit.
- One Design studio/ construction studio/project/thesis period/hour shall have 1.5 credits.
- $ Self study is a non credit component.

III SEMESTER (2017-21BATCH)

Sl. No	Course Code	Course Title	Hours/week			Credits	Course Type
			L/St/T#	P	S$		
1	UA17BD201	Design History	3	0	2	3	CC
2	UA17BD202	Design Methods and Creativity	4	0	0	4	CC
3	UA17BD203	Seminar/ Activities III	0	2	0	0	NC
4	UA17BD204	Site Exposure III	0	6	0	0	NC
5	UA17BA208	Vacation Assignment/Study Tour I	0	0	0	0	NC
6	UA17BD206+	Graphic Design	6	0	2	6	CC
	Product Design						
7	UA17BD201P	Product Design and Development	6	0	2	6	CC
8	UA17BD202P	Material Selection and Manufacturing Processes	2	2	0	3	CC
9	UA17BD203P	Form Studies and Sculpting	3	2	2	4	CC
	Elective - I						
10	UA17BD211P	Design Math					
11	UA17BD212P	Digital Solid Sculpting	2	0	0	2	EC
	Communication Design						
12	UA17BD201C	Introduction to Animation	3	2	2	4	FC
13	UA17BD202C	Introduction to Film Making	2	2	1	3	FC
	Elective - I						
14	UA17BD211C	Fashion Communication	2	0	0	2	EC
15	UA17BD212C	Printing Technologies					
	Interaction Design						
16	UA17BD201T	Game Design	3	2	2	4	FC
17	UA17BD202T	Human Computer Interaction I	2	2	1	3	FC
	Elective - I						
18	UA17BD211T	User Experience Studies	2	0	0	2	EC
19	UA17BD212T	Space Design					
		Total	20	12	**6$/7$**	22	
	Note: +Applicable to Communication Design and Interaction Design # One Tutorial hour is equal to one Lecture hour $ Self study is a non credit component.						

IV SEMESTER (2017-21BATCH)

Sl. No	Course Code	Course Title	Hours/week		S$	Credits	Course Type
			L/St/T#	P			
1.	UA17BD251	Contemporary Design	2	2	0	3	CC
2.	UA17BD252	Seminar/ Activities IV	0	2	0	0	NC
3.	UA17BD253	Site Exposure - IV	0	6	0	0	NC
4.	UA17BD254+	Advanced Graphic Design	6	0	2	6	CC
	Product Design						
5.	UA17BD251P	Advanced Design Methods and Form Studies	6	0	2	6	CC
6.	UA17BD252P	CAE in Product Design I	3	2	0	4	CC
7.	UA17BD253P	Mechanism Design	2	2	0	3	CC
8.	UA17BD254P	Ergonomics	3	2	0	4	CC
	Elective - II						
9.	UA17BD221P	Color Design	2	0	0	2	EC
	UA17BD222P	Digital Surface Sculpting					
	Communication Design						
10.	UA17BD251C	Advanced Animation	3	2	2	4	CC
11.	UA17BD252C	Web Design and Development	2	2	1	3	FC
12.	UA17BD253C	Film Studies	3	2	2	4	CC
	Elective - II						
13.	UA17BD221C	Brand Communication	2	0	1	2	EC
	UA17BD222C	Photo Journalism					
	Interaction Design						
14.	UA17BD251T	Advanced Game Design	2	4	2	4	CC
15.	UA17BD252T	Coding	2	2	1	3	FC
16.	UA17BD253T	Human Computer Interaction II	4	0	2	4	CC
	Elective - II						
17.	UA17BD221T	User Interface Studies	2	0	1	2	EC
	UA17BD222T	Cognitive Studies					
		Total	**18**	**16**	**4/8/8$**	**22**	

Note: +Applicable to Communication Design and Interaction Design
Vacation assignment/ Study tour to be undertaken.
* One Tutorial hour is equal to one Lecture hour.
$ Self study is a non credit component.

V SEMESTER (2016-20 BATCH)

Sl. No	Course Code	Course Title	Hours/week			Credits	Course Type
			L/St/T#	P	S$		
1	UE18HS101	Constitution of India and Professional Ethics	1	0	0	0	NC
2	UA16BD301	Seminar/ Activities V	0	2	0	0	NC
3	UA16BD302	Site Exposure V	0	6	0	0	NC
4	UA16BD303	Vacation Assignment / Study Tour II	0	0	2	0	NC
Product Design							
5	UA16BD301P	Product Design Project Studio - 1	6	0	0	6	CC
6	UA16BD302P	Product Planning, and Marketing Management	2	2	1	3	CC
7	UA16BD303P	Basic Computing and Design	3	2	2	4	CC
8	UA16BD304P	Mechatronics	4	0	1	4	CC
9	UA16BD305P	Introduction to Electricals and Electronics	2	2	1	3	CC
	Elective III						
10	UA16BD331P	Furniture Design	2	0	0	2	EC
	UA16BD332P	Toy Design					
Communication Design							
11	UA16BD301C	Communication Design Project Studio I	6	0	2	6	CC
12	UA16BD302C	3D Animation Lab - I	4	0	1	4	CC
13	UA16BD303C	Infographics - I	2	2	1	3	CC
14	UA16BD304C	Visual Effects - I	3	2	2	4	FC
15	UA16BD305C	Packaging and Visual Communication	2	2	1	3	CC
	Elective III						
16	UA16BD331+	Visual Ergonomics	2	0	0	2	EC
	UA16BD332C	Illustrations and Storytelling					
Interaction Design							
17	UA16BD301T	Interaction Design Project Studio I	6	0	2	6	CC
18	UA16BD302T	UI/UX - I	4	0	1	4	CC
19	UA16BD303T	Designing Interactive Experiences	2	2	1	3	CC
20	UA16BD304T	Customer Experience and Virtual Reality	3	2	2	4	FC
21	UA16BD305T	Responsive Applications and Coding	2	2	1	3	CC
	Elective III						
22	UA16BD331+	Visual Ergonomics	2	0	0	2	EC
	UA16BD332T	Design for Multimedia and Environment					
		Total	**20**	**14**	**5/9/7**	**22**	
	* One Tutorial hour is equal to one Lecture hour. $ Self study is a non credit component						

VI SEMESTER (2016-20 BATCH)

Sl. No	Course Code	Course Title	Hours/week			Credits	Course Type
			L/St/T*	P	S$		
1	UE18HS102	Environmental Studies	1	0	0	0	NC
2	UA16BD351	Design, Innovation and Management	3	2	2	4	CC
3	UA16BD352	Seminar/ Activities VI	0	2	0	0	NC
4	UA16BD353	Site Exposure VI	0	6	0	0	NC
Product Design							
5	UA16BD351P	Product Design Project Studio - 2	6	0	2	6	CC
6	UA16BD352P	Vehicle Design	4	0	2	4	CC
7	UA16BD353P	Design for Manufacturability and Cost	3	0	2	3	CC
8	UA16BD354P	CAE in Product Design - II	1	4	0	3	CC
	Elective IV						
9	UA16BD341P	Transportation Planning	2	0	0	2	EC
	UA16BD342P	Packaging Design					
Communication Design							
10	UA16BD351C	Communication Design Project Studio II	6	0	2	6	CC
11	UA16BD352C	Infographics - II	3	0	1	3	CC
12	UA16BD353C	Visual Effects - II	2	2	1	3	CC
13	UA16BD354C	3D Animation Lab - II	3	2	2	4	CC
	Elective IV						
14	UA16BD341C	Applied Ergonomics	2	0	0	2	EC
	UA16BD342C	Storyboarding Techniques					
Interaction Design							
15	UA16BD351T	Interaction Design Project Studio II	6	0	2	6	CC
16	UA16BD352T	UI/UX - II	2	2	1	3	CC
17	UA16BD353T	Artificial Intelligence, Augmented Reality	3	2	2	4	CC
18	UA16BD354T	Technology Trends and Analysis	3	0	1	3	CC
	Elective IV						
19	UA16BD341T	Applied Ergonomics	2	0	0	2	EC
	UA16BD342T	Interactive Smart Devices					
		Total	**20**	**14**	**8**	**22**	

* One Tutorial hour is equal to one Lecture hour.
$ Self study is a non credit component.

BACHELOR OF ARCHITECTURE
(AS PER COUNCIL OF ARCHITECTURE DRAFT MINIMUM STANDARDS OF ARCHITECTURAL EDUCATION REGULATIONS, 2017)

Program Education Objectives:

- **UA16BA_UG_PEO1 :** Train students in contemporary, cutting-edge domains and engineering principles, so as to build capabilities to solve real world problems using Computing, Information and Communication Technology
- **UA16BA_UG_PEO2 :** Prepare students for higher education in the best universities across the globe in all related areas of engineering and technologies through strong fundamentals .
- **UA16BA_UG_PEO3** : Instill research culture in students through research assistantships, research oriented projects, sponsored and collaborative research, patronizing publications and presentations.
- **UA16BA_UG_PEO4 :** Hone students to develop an ability to innovate efficient solutions , which will have long term impact on the well being of the society.
- **UA16BA_UG_PEO5 :** Create professionally superior and ethically strong globally competent employees and entrepreneurs.

Program Outcomes:

- **UA16BAPO1:** Engineering Knowledge: Apply the knowledge of Mathematics, Science, Engineering fundamentals and an engineering specialization to the solution of complex engineering problems. (Architecture Fundamentals)
- **UA16BAPO2:** Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (complex architectural problems)
- **UA16BAPO3:** Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations. (complex architectural problems)
- **UA16BAPO4:** Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **UA16BAPO5:** Modern Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. (complex architectural activities)
- **UA16BAPO6:** The Engineer & Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. (architectural practice)
- **UA16BAPO7:** Environment & Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. (architectural solutions)
- **UA16BAPO8:** Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. (architectural practice)
- **UA16BAPO9:** Individual & team work: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
- **UA16BAPO10:** Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. (architectural activities)
- **UA16BAPO11:** Project Management & Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. (architectural principles)
- **UA16BAPO12:** Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

I SEMESTER B.Arch (2018-23 BATCH)

UA18BA101
VISUAL ARTS & BASIC DESIGN I (0-6-0-4-9)

Course Objectives:

- Introduce students to the meaning of design and its purpose.
- Develop basic artistic skills in sketching, free-hand drawing, calligraphy, etc.
- Understand and apply different techniques and media of rendering.
- Introduce to the students the elements of visual composition using 2D & 3D objects and train the students to observe and identify components and to prepare drawings and documentation.
- Introduce to the students the studies of Anthropometry and Ergonomics

Course Outcomes:

The students will be able to:

- Make compositions using basic principles of design, elements of design & materials.
- Apply different types of rendering and visualization techniques.
- Prepare drawings, render using various presentation techniques, identify building and product components & document works.
- Realize the significance of universally accepted Architectural Notations.
- Apply anthropometry and Ergonomics principles in designs.

Course Content:

1. **Introduce students to the meaning of design and its purpose:** (i) Randomness to orderliness. pattern generation; (ii) Introduce the Gestalt laws, principles and elements of Design & composition.
2. **Undertake 2D & 3D exercises:** (i) Introduce exercises using single and multiple elements, colors, textures and different materials: Generate feelings; (ii) To bring out the relationship of aesthetic principles, design and feelings.
3. **Emphasize on Transformation of Conceptual Drawings to 2D Drawings:** (i) Orient students towards observation; (ii) Observe building and product components; (iii) color schemes in rendering and rendering the plan, elevation, sections and views. (iv) Sketching views of built forms, vegetation, human figures, vehicles etc.
4. Focus on Drafting and Rendering using Different Media, Views, Sketches and Documentation:(i) Enable the students towards presentation techniques and understanding the form by preparing 3D manual study models; (ii) Document the works.
5. **Anthropometry and Ergonomic Studies.**

Pre-requisite Courses: None

Reference Books:

1. "Architects' Data", Neufert, Ernst. Neufert, Peter, 4th Edition, John Wiley & Sons, 2012.
2. "Architecture: Form, Space, and Order", Francis D. K. Ching, John Wiley & Sons, 2012.
3. "Branding and Identity", Design Media Publishing, 2015.
4. "Designs for Small Spaces", Hudson, Jennifer, Laurence King Publication, 2010.
5. "Organic Architecture: Inspired By Nature", Serrats, Marta, Loft Publication, 2010.
6. "Principles of Two Dimensional Design", Wucious Wong, John Wiley & Sons, 1972.
7. "Rendering with Pen and Ink", Gill, Robert W. Thames & Hudson, 2014.
8. "Architectural Renderings: Construction and Design Manual, History and Theory, Studios and Practices", Schillaci, Fabio, Dom Publications, 2009.
9. "Basics Fundamentals of Presentation Freehand Drawing", Afflerbach, Florian, Birkhauser Publications, 2014.
10. "Principles of Design in Architecture", K. W. Smithies, Van Nostrand Reinh, 1981.
11. "Principles of Two-Dimensional Design", Wucius Wong, John Wiley & Sons, 1972.
12. "Sketch Public Buildings: How Architects Conceive Public Buildings" Paredes, Cristina, Loft Pub, 2009.
13. "The Little Book of Creativity", David E Carter, Harper Collins, 2004.
14. "The Sketchbook", Zamora Mola, Francesc, Loft Pub, 2009.

UA18BA102
BUILDING CONSTRUCTION TECHNOLOGY & MATERIALS –I (0-2-2-0-4)

Course Objectives:

- To introduce to the students the architectural construction drawings.
- To introduce the students to various masonry construction practices.
- To introduce the students to various components of a building.
- To expose the students to the basic building materials & their properties.
- To comprehend the structural and aesthetic components of a building.

Course Outcome:

The students by the end of the course will be able to:

- Draft and read architectural drawings using architectural conventions.
- Identify the basic building components of a building and construction methods.
- Use appropriate building materials based on the properties, behavior and applications.
- Understand the techniques involved in building construction.
- Observe and understand innovative details in construction.

Course Content:

1. **Introduction to Drafting and Drafting Aids:** lines, hatches, lettering, scales and proportion, composition.
2. **Brick Masonry, Stone Masonry, Material Study:** (i) basic components of masonry, Stretcher and Header bond, English Bond, Flemish Bond, etc.; (ii) Ashlar masonry, rubble masonry; (iii) stone, brick, aggregate, mortar.
3. **Arches, Lintels & Material Study:** (i) typical arch and its basic components, Ogee arch, semicircular arch, four centered arch; (ii) R.C.C lintel, brick lintel, stone lintel; (iii) sand, fly ash, cement, lime, aggregate.
4. **Sections through Structure:** Typical section through a building and foundations.
5. **Material Study:** Material study of P.C.C, Concrete blocks.

Pre-requisite Courses: None

Reference Books:

1. "Barry's Advanced Construction of Buildings", Stephen Emmitt, John Wiley & Sons, 2014.
2. "Building Construction", Rangwala, Charoter Publishing House, 2015.
3. "Building Construction", William Barr McKay, Vol. 142, Pearson Education, 2013.
4. "Building Construction Illustrated", Francis D. K. Ching, John Wiley & Sons, 2014.
5. "Building Construction: Principles", Practices, and Materials, Glenn M. Hardie, Prentice Hall, 1995.
6. "Construction Technology", R. Chudley, Roger Green, Pearson Education, 2011.
7. "Text Book of Building Construction: Including Engineering Materials", Arora & Bhindra, Dhanpat Rai and Sons, 1984.

UA18BA103
GRAPHICS – I (0-0-4-0-2)

Course Objectives:

- Students will be introduced to the fundamental techniques of graphics, drafting, understanding the different values in drawn lines.
- To allow students to explore and understand the relation of intersection of objects and orthographic projections.
- Students will be introduced to three dimensional representation of solid forms through drafting and models.
- To understand the construction of sections of solids and relation of intersection of objects and their graphic representation.
- Students will be introduced to three dimensional representation of solid forms through drafting and models.

Course Outcome:

The students will be able to:

- Comprehend the significance of universal notations in Architectural Graphics.
- Identify and apply different scales in different contexts.
- Demonstrate the techniques of orthographic projections in drawings.
- The representation of three dimensional forms.
- Graphical presentation skills for effective communication.

Course Content:

1. Introduction to fundamental techniques of graphics, drafting, values in drawn lines, tone, texture, lettering & construction of scales.
2. Introduction of plane geometry and development of solids.
3. Orthographic projection of solids.
4. Understanding sections of solids and intersection of solids.
5. Introduction to three dimensional representations of solid forms. (isometric and axonometric views and models)

Pre-requisite Courses: None

Reference Books:

1. "Architectural Graphics", Ching, Francis D. K., John Wiley & Sons, 1987.
2. "Architectural Graphics", Martin C, Leslie, The Macmillan, 1970.
3. "Drawing and Perceiving", Douglas Cooper, John Wiley & Sons, 2007.
4. "Engineering Drawing", Bhatt, N. D. Charotar Publishing House Pvt. Ltd. 2014.
5. "Engineering Drawing", Gopalkrishna, K. R., 23rd edition, Subhas Stores, 2014.
6. "Geometrical Drawing for Art Students", Morris, I. H. & Jesse, Orient Blackswan, 2004.

UA18BA104
HISTORY OF ART, ARCHITECTURE & DESIGN –I (2-0-0-1-2)

Course Objectives:

- Familiarize the learner with Pre-historic Period.
- Critical appreciation of buildings during different Ancient civilizations.
- Synoptic study of influences of culture and climate on buildings of Ancient civilization.
- Study the influence of climate and culture relating to Indian context.
- Imbibe the learner with Design techniques and characteristics of Greek and Roman civilization.

Course Outcome:

The students will be able to:

- Identify the different periods in history.
- Recognize and appreciate the evolution of civilizations across the world.
- Identify Art, Architecture and Design of the period and its influences.
- Evaluate the various characteristic features of different styles of architecture in Indian history.
- Interpret and appreciate Greek and Roman buildings, materials and construction techniques used by them.

Course Content:

Art, architecture, design & influences leading to a style during the following:

1. Pre historic time and Egyptian civilization.
2. West Asian civilization.
3. Indus valley civilization and development of various styles in India.
4. Greek Period
5. Roman Period

Pre-requisite Courses: None

Reference Books:

1. "A Global History of Architecture", Ching Francis D.K, John Wiley & Sons, 2011.
2. "Architecture of the World", Benedikt Taschen, Stierlin, Henri, 1994.
3. "Indian Architecture: Islamic period", Percy Brown. CBS Publishers & Distributors2002.
4. "Indian Architecture; Buddhist and Hindu Periods", Brown, Percy, CBS Publishers, 2014.
5. "Sir Banister Fletcher's A History of Architecture", Fletcher, Banister, CBS Publishers, 1996.
6. "The Story of Baroque Architecture Zanlungo", Claudia. Tatabra, Daniela, Prestel Publisher, 2012.
7. "The Story of Gothic Architecture", Prina, Francesca. Prestel Publisher, 2011.
8. "The Story of Renaissance Architecture", Servida, Sonia, Prestel Publisher, 2011.

UA18BA105
STRUCTURAL MECHANICS -I (2-0-0-1-2)

Course Objectives:

- Students will be introduced to basic structural elements and materials.
- Students will learn basic concepts of force and force system.
- Identify the types of loads and support systems.
- Learn properties of sections.
- Learn the concept of moment of inertia.

Course Outcome:

The students will be able to:

- Work with different structural elements and materials.
- Analyze the various forces and force systems.
- Identify the loads and solve design problems.
- Calculate the sectional properties of various geometrical sections.
- Find the moment of inertia of various geometrical sections.

Course Content:

1. **Basic structural elements & materials:** (i) introduction to basic structural elements; (ii) basic mechanical properties of materials.
2. **Forces:** (i) Definition of force and classification of system of force; (ii) concurrent coplanar forces, triangle law of forces, parallelogram law of forces, rectangular components, resolution of forces, problems on resolution of forces; (iii) theorem of transmissibility & composition of forces, static of equilibrium conditions, resultant and equilibrant of force system, problems on the above to determine the equilibrant and static equilibrium; (iv) problems on calculation of resultant; (v) moment of a force & condition of equilibrium, non concurrent non parallel forces, lever arm, couple; (vi) Varignon's theorem of moments – derivation & simple problems, problems on non concurrent non parallel forces.
3. **Types of loads:** (i) concentrated load, uniformly distributed load, uniformly varying load; (ii) Types of supports, problems on support reactions for the beams, trusses.
4. **Properties of the section & the definition:** (i) Cross-sectional area, centroid, second moment of area; (ii) Section modulus & radius of gyration of standard areas, derivation of centroid – Square, rectangular, circular & flanged sections; (iii) Problems on the above geometrical figures for centroid – Square, rectangular, circular, Tee & I-sections.
5. **Derivation:** (i) derivation of MI of Square, rectangular, circular about its centroidal axis, Parallel axis theorem & explanation; (ii) problems on MI - Square, rectangular, circular, Hollow circular, hollow rectangular, square sections, Tee section, symmetrical I section and unsymmetrical I section.

Pre-requisite Courses: None

Reference Books:

1. "Engineering Mechanics", S Timoshenko D.H. Young, McGraw-Hill, 1983.
2. "Strength of Materials", R.K. Bansal, Laxmi Publications, 2015.
3. "Structures in Architecture", Salvadori and Heller, Prentice-Hall, Inc, 1964.

UA18BA106
CARPENTRY, MODEL MAKING &CREATIVE WORKSHOP (0-0-4-0-2)

Course Objectives
- To enable students to learn various details in carpentry
- To enable students to learn about different materials for model making.
- To enable the students to understand relation between scale and proportion.
- To enable the students to understand relation between form and space.
- To enable the students to understand various techniques in Ceramics

Course Outcome:
The students will be able to:
- Visualize the various details in carpentry.
- Use different types of materials and its feasibility in model making.
- Visualize the scale and proportion in architecture.
- Visualize the basic relations of form and space.
- Prepare models using various techniques in Ceramics.

Course Content:
1. Introduction to carpentry models.
2. Introduction to different materials. Making basic shapes out of different materials to explore the nature & texture of the materials.
3. Introduction to 3D models.
4. Introduction to scale and proportion through exercises.
5. Introduction to Ceramics.

Pre-requisite Courses: None

Reference Books:

1. "Art of Architectural Model", Akto Busch, Design Pr;1991.
2. "Objet: Creative Idea and Unique Design", Ji-Hyun, Choi. Eun-Ji, Kim. Go-Un, Kim, Archiworld Co. Ltd, 1995.
3. "Objet2: Creative Idea and Unique Design", Ji-Hyun, Choi. Eun-Ji, Kim. Go-Un, Kim, Archiworld Co. Ltd, 1995.
4. "Unfold Paper in Design, Art, Architecture & Industry", Petra Schmidt & Nicola Stattman, Birkhäuser GmbH, 2009

UA18BA107
COMMUNICATION SKILLS (1-0-0-0-1)

Course Objectives:
- To develop effective communication skills, both written and verbal in students.
- To understand what is plagiarism, and how to guard against unintended plagiarism.
- Understanding the reasons for citing sources and learning the different styles of citing sources.
- Improving on presenting and writing skills.
- To develop student's effective reading skills.

Course Outcome:
The students will be able to:
- Communicate effectively through different mediums and presentations.
- Analyze articles and understanding the gist of it.
- Understand how to write papers and cite sources, enabling them to proceed in the direction of research.
- Effectively read and write articles.
- Write reports and prepare documentation.

Course Content:
1. **Introduction to communication:** The need of effective communication, understanding communication cycle, and visual aids of communication.
2. **Writing letters and building your resume:** Basics of letter writing, job application letter, preparing a resume /curriculum vitae and e-mail letters.
3. **Barriers to communication, effective presentation and public speaking skills:** Understanding outside and interpersonal barriers to communication and developing public speaking skills through speech, voice modulation, fluency, pauses etc.
4. **Understanding Plagiarism and Learning the different styles of citing sources**:Learn about plagiarism and how to avoid it, learning to paraphrase. Learning biography style and parenthetical style of citations.
5. **Effective reading and writing skills**:Article review, understanding the gist of authors ideas. Paragraph writing, expansion of ideas, and report writing skills.

Pre-requisite Courses: None

Reference Books:

1. "A Practical English Grammar", A.J. Thomson AV Martine, Oxford University Press, 1987.
2. "Communicative English for Professional Courses", Mudambadithaya G S, Sapna Book House, 2002.
3. "English Conversation Practice", Taylor, Grant, McGraw-Hill, 1967.
4. "Technical Communication Principles and Practice", Meenakshi Raman & Sangeetha Sharma, 3rd Edition, Oxford University Press, 2015.

UA18BA108
SEMINAR/ ACTIVITIES - I (0-0-2-0-1)

Course Objectives:
- To familiarize and expose the students to the design activities
- To provide hands-on experience and exposure to students to actual design practices through lectures, demonstrations etc
- To expose students to latest design methodologies and techniques.
- To create an interface for students between Industry and Academia
- To enhance the students' knowledge on how to compose and analyze space

Course outcome:
The students will be able to:
- Realize the practical aspects of the design process.
- Prepare documentation of the design based demonstrations or lectures.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time design needs.
- Incorporate the knowledge gained during the lecture/ demonstrations/ activity in their drawings/process models.

Course Content:
1. Study of the design processes/models/design considerations/ design approaches
2. Analysis of approaches taken by industry/academic experts
3. Synthesis of data/design models/design considerations
4. Preparation of drawings/conclusions/models/solutions
5. Report

UA18BA109
SITE EXPOSURE I (0-0-4-0-0)

Course Objectives:

- To familiarize and expose the students to the project site & its conditions
- To provide hands-on experience and exposure to actual design practices.
- To expose students to latest design techniques in the industry
- To create an interface for students between Industry and Academia.
- To enhance the student's knowledge on how to compose and analyze space.

Course outcome:

The students will be able to:

- Realize the practical aspects of the design process.
- Prepare documentation of the industry / site visits.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time industry/on site needs.
- Incorporate the knowledge gained during industry visits in their models/portfolio/drawings.

Course Content:

1. Study of the industry site visit and data collection
2. Analysis of data
3. Synthesis of data/design models/design considerations
4. Preparation of drawings/conclusions/models/solutions
5. Report

UA18BA111E
PHOTOGRAPHY & VIDEOGRAPHY (1-0-4-0-3)

Course Objectives:

The students are exposed to:

- The art of Photography.
- The art of Videography.
- Develop an aesthetic sense in students with reference to composing a picture with all its elements such as subject, texture, light, form, movement, space, etc.
- The art of narration through images.
- Group exercices/ Small documentation exercices.Course Outcome:

The students will be able to:

- Demonstrate their skill in photography.
- Demonstrate their skill in videography.
- Compose a picture with all its elements such as subject, texture, light, form, movement, space, etc.
- Demonstrate their skill in art of narration through images.
- Work in groups for projects/ documentation.

Course Content:

1. Brief history of photography,basics of image capturing and visual effects.
2. Brief history of videography.
3. Understanding various techniques of rendering and color schemes.
4. Sketching , visual composition and abstraction.
5. Undertaking group activities / small measured drawing exercises.

Pre-requisite Courses: None

Reference Books:

1. "The Development of Film", Alan Casty, Harcourt Publishers Group, 1973
2. "Photojournalism: The Professionals' Approach", Kenneth Kobre, Focal Press, 1980.
3. "Basic Photography", John Hedgecoe, Au

II SEMESTER B.Arch (2018-23 BATCH)

UA18BA151
DESIGN II (0-6-0-4-9)

Course Objectives:

- To expose the students to the relationship between human feelings and form.
- To train the students in space and form making.
- To introduce to the students the study variables like aesthetics, light, movement, transformation etc.
- To train the students towards perception and visualization by undertaking small projects.
- To train them to prepare drawings and models.

Course Outcome:

The students will be able to:

- Visualize the relationship between human feelings and form.
- Create space and form.
- Understand the design variables.
- Perceive and visualize.
- Represent design through drawing.

Course Content:

1. Relationship between human feelings and form: To create space and form and exhibit through models made of different materials to express the look and feel and explore the relationship between human feelings and form.
2. Study of variables: Study variables of design like aesthetics, light, movement, transformation etc.
3. Transformation: Undertake transformation of solids, coordination of form and function.
4. Introduction of small projects: Concept development, site studies, visualize space and activity, concepts, single line plans and 3D forms, organize space, volumes, massing; make a study model.
5. Presentation & Workshop: (i) Drafting and Rendering of floor plans, elevations and sections and views; (ii) Preparation of a manual model; (iii) Preparation of portfolio of completed design work.

Pre-requisite Courses: UA18BA101

Reference Books:

1. "Branding and identity", Design Media Publishing, 2015.
2. "Designs for Small Spaces", Hudson, Jennifer- Laurance King Publication, 2010.
3. "Design Fundamentals in Architecture", VS Parmar, Somaiya Publications, 1997.
4. "Form Space and Order", Francis D.K Ching, 3rd Edition, John Wiley & Sons, 2012.
5. "From Models to Drawings: Imagination and Representation in Architecture", Frascari, Marco, Hale, Jonathan. Starkey, Bradley, Routledge Publisher, 2007.
6. "Objet: Creative Idea and Unique Design", Ji-Hyun, Choi Eun-Ji, Kim, Go-Un, Kim, Archiworld Co. Ltd., 1995.
7. "Objet2: Creative Idea and Unique Design", Ji-Hyun, Choi. Eun-Ji, Kim Go-Un, Kim, Archiworld Co. Ltd., 1995.

8. "Organic Architecture: Inspired by Nature", Serrats, Marta-, Loft Publication, 2010.
9. "Time Savers Standards for Architectural Design Data", John Hancock, McGraw-Hill, 1997.

UA18BA152
BUILDING CONSTRUCTION TECHNOLOGY & MATERIALS –II (0-2-2-0-4)

Course Objectives:

- To provide the students with information of various components of a building.
- To introduce students to doors and its construction details.
- To introduce students to windows and its construction details.
- To introduce students to construction practices pertaining to staircases**.**
- To help students understand building materials, properties, construction details and application in building

Course Outcome:

The students will be able to:

- Identify the components of a building such as doors, windows, roofing systems, staircase and their construction methods.
- Use appropriate building materials based on the properties, behavior and applications and usage of steel in building.
- Differentiate and compare different types of doors based on materials, use and cost.
- Differentiate and compare different types of windows based on materials, use and cost.
- Identify and compare different types of staircases based on shape and material

Course Content:

1. **Doors:** Introduction to doors and frames, detail study of panel doors with glass and mesh, flush doors, batten ledged and braced doors. Materials- Properties and usage of timber.
2. **Windows:** Introduction to wooden windows – detail study of fixed and sash windows.
3. **Staircase:** Introduction to types of staircase. Detail study of R.C.C waist slab staircase and R.C.C folded plate staircase. Construction of R.C.C pre-cast staircase.
4. **Steel and Composite Staircase:** Study of steel and composite staircases.
5. **Materials:** Role of timber in building industry. Study of steel as construction materials including their characteristic properties, application, etc.

Pre-requisite Courses: None

Reference Books:

1. "Building Construction Illustrated", Francis D K Ching, John Wiley & Sons, 2011.
2. "Building Construction", Mckay, William Barr, Vol. 2 & 3, Pearson, 2013.
3. "Building Construction", Rangwala, Charoter Publishing House, 2015.
4. "Construction of Buildings", Robin Barry, 3rd Edition, Wiley, 1998.
5. "Construction Technology", R Chudley, 5th Edition, Pearson Education, 2011.
6. "Staircases", James W.P Campbell, Michael, Tutton, Routledge, 2014.
7. "Text Book of Building Construction", Arora & Bhindra , Dhanpat Raj, 1988.

UA18BA153
GRAPHICS – II (2-0-2-0-3)

Course Objectives:

- Students will be introduced to the principles, elements and types of perspective drawing-one-point perspective, two-point perspective and three-point perspective.
- To learn the art of drawings perspectives to scale and by using approximate method.
- Learn to draw the sciography of planes and solids.
- To learn the art of graphical presentations and sciography in perspectives to enhance the visual skills.
- To learn the art of rendering using different mediums and textures in their presentation drawings.

Course Outcome:

The students will be able to:

- Draw scaled perspective drawings.
- Draw freehand perspective drawings.
- Understand the play of light and shadow on buildings/ objects.
- Develop skills in graphical presentations including sciography.
- Develop skills in graphical presentations by rendering using various mediums and textures.

Course Content:

1. **One-point Perspective:** Understanding fundamental techniques of One-point perspective.
2. **Two-point Perspective:** Understanding fundamental techniques of Two-point perspective.
3. **Other Types of Views :** Understanding the concept of drawing in worm's / bird's eye view.
4. **Sciography**: Learning about gradations of light, shade and shadow on objects/ forms.
5. **Rendering**: Learning pen and ink illustration techniques to create shade and texture on objects/ forms.

Pre-requisite Courses: None

Reference Books:

1. "An Introduction to Perspective", Ray Smith, D K Publishers, 1999.
2. "Architectural Renderings - Construction and Design Manual", Fabio, Schillaci, Dom Publisher, 2009.
3. "Engineering Drawing", Bhatt, N D, Charotar Publishing House Pvt. Ltd., 2014.
4. "Engineering Drawing (I&II)", K.R. Gopalakrishna,Subhash Stores, 2014.
5. "Rendering with Pen & Ink", Robert Gill, Thames and Hudson, 1992.

UA18BA154
HISTORY OF ART, ARCHITECTURE & DESIGN-II (2-0-0-1-2)

Course Objectives:

- Students will be introduced to the historical timeline of Christian Architecture.
- Exposed to the Art, Architecture and Design of various periods of Christian Architecture.
- Able to study the evolution and design influences.
- Understand the different types of buildings and construction techniqes.
- Critical analysis and documentation of historical styles.
Course Outcome:

The students will be able to:

- Identify the different periods of Christian Architecture through timeline.
- Identify Art, Architecture and Design of the period and its influences.
- Understand the evolution and synthesis of architectural styles.
- Understand the different construction techniques used and their relevance to the present times.
- Documentation and analysis of different architectural styles.

Course Content:

1. **Early Christian Period:** Art, Architecture, Design & influences leading to the style of the period.
2. **Romanesque Period:** Art, Architecture, Design & influences leading to the style of the period.
3. **Gothic Period:** Art, Architecture, Design & influences leading to the style of the period.
4. **Renaissance Period:** Art, Architecture, Design & influences leading to the style of the period.
5. **Revival and modern periods:** Art, Architecture, Design & influences leading to the style of the period.

Pre-requisite Courses: None

Reference Books:

1. "A Global History of Architecture", Ching Francis D.K, John Wiley & Sons, 2011.
2. "Architecture of the World", Benedikt Taschen, Stierlin, Henri, 1994.
3. "Indian Architecture; Buddhist and Hindu Periods", Brown, Percy, CBS Publishers, 2014.
4. "Sir Banister Fletcher's A History of Architecture", Fletcher, Banister, CBS Publishers, 1996.
5. "The Story of Baroque Architecture" Zanlungo, Claudia. Tatabra, Daniela, Prestel Publisher, 2012.
6. "The Story of Gothic Architecture", Prina, Francesca. Prestel Publisher, 2011.
7. "The Story of Renaissance Architecture", Servida, Sonia, Prestel Publisher, 2011.

UA18BA155
STRUCTURAL MECHANICS – II (2-0-0-1-2)

Course Objectives:

- To enable students understand and apply the concepts of stresses, strains, shear force and bending moments while designing.
- Understand various elastic constants and deformation behavior of structural components.
- Apply the concepts of shear stresses and bending moments while designing.
- Understand the state of stress of structural components under complex loading conditions.
- To assist students analyze the failure of design through theories of failures.

Course Outcome:

The students will be able to:

- Explain the mechanical behavior of design materials.
- Analyze the properties of materials and understand the relationship between load (stress) and deformation (strain).
- Design the beam considering the failure occured owing to shear force and bending moments.
- Find the stresses in complex loading crucial for designing.
- Apply failure theories concepts to solve design problems.

Course Content:

1. **Simple stress and strain:** (i)Introduction, Properties of materials: Stress, Strain, Hooke's law, Poisson's ratio, Stress – Strain diagram for structural steel & non ferrous materials; (ii) Principle of superposition & problems.
2. **Elastic constants and elongation of bars:** (i) Total elongation of tapering bar of circular & rectangular sections, elongation due to self weight, problemson above. (ii) Derivation of expression for volumetric strain, elastic constants & relationships among constants and problems on elastic constants.
3. **Shear Force and Bending Moment:** Relationship between loading, shear force & bending moment, shear force & bending moment equations - cantilever beams, simply supported beam and overhanging beams with point load, UDL, moment and problems on above.
4. **Transformation of stress and strain:** Biaxial state of stress, state of stress at a point, stresses on inclined planes, principal planes and stresses, maximum shearing stresses, Mohr's circle for Plane stress, Stresses in Thin cylinder and shells.
5. **Theories of failures:** (i) Various theories of failures, graphical representation of theories of failures in 2D stress system; (ii) Important points from theories of failures used in design.

Pre-requisite Courses: None

References Books:

1. "A Textbook of Strength of Materials", Bansal R.K, Laxmi Publishers, 2007.
2. "Strength of Materials", B.S. Basavarajaiah and P. Mahadevappa, T & F, 2010.
3. "Strength of Materials", Rajput, 4th Edition, S. Chand Publishers, 2007.
4. "Structures in Architecture", Salvadori and Heller, Prentice-Hall, Inc, 1964.

UA18BA156
INTRODUCTION TO COMPUTERS, DIGITAL GRAPHICS & ART (2-0-2-0-3)

Course Objectives:

- To develop skills required in using computers as a tool for design representation.
- To develop skills with 3D visualization & to develop 2D drafting skills with AutoCAD.
- 3D modeling using Google Sketch-Up.
- To learn Presentation techniques using Google Sketch-Up.
- To learn Rendering techniques using Photoshop.

Course Outcome:

The students will be able to:

- Carry out 2D plans in AutoCAD.
- Use sketch-up to create 3D models.
- Use Materials & View Styles to enhance the view of the model.
- Use presentation techniques in sketch-up to communicate design.
- Incorporate Rendering techniques using Photoshop.

Course Content:

1. **Introduce AutoCAD commands to carry out 2D exercises.**
2. **Introduce Sketch-up commands to carry out 3D exercises: (i) User Interface essentials:** View settings, navigations, orbit & save. (ii) **Draw Tools:** Basic shapes using draw tools, Unit setup, push-pull, follow me.

3. **Modify:** Scale, rotate, Copy & Mirror.
   Measurements: Protractor, tape, Divide, array.
4. **Views:** Camera views, Scenes, Walkthrough. **Styles:** Preset styles, face & edge styles.**Material:** Applying colors & Textures, creating new materials. **Shadows**: Shadow & fog settings. **Presentation:** Section planes, orthogonal views, background styles. **Output:** Save as images, Walkthrough as Video file.
5. **Presentation techniques:** using Photoshop to render 2-d drawings.

Pre-requisite Courses: None

Reference Book:

1. "Sketch-up 8 for Dummies", Aidan Chopra, Wiley, 2010

UA18BA157
KANNADA KALI (1-0-0-0-0)
ಕನ್ನಡ ಕಲಿ (1–0–0–0–0)

ಪಠ್ಯಕ್ರಮ ಉದ್ದೇಶಗಳು:

ಪಠ್ಯಕ್ರಮದ ಉದ್ದೇಶ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಕನ್ನಡ ಮಾತನಾಡುವ ಜ್ಞಾನವನ್ನು ಕಲಿಸುವುದು.

ಪಠ್ಯಕ್ರಮದ ಫಲಿತಾಂಶ:

ವಿದ್ಯಾರ್ಥಿಗಳು ದಿನನಿತ್ಯದ ಚಟುವಟಿಕೆಗಳಲ್ಲಿ ಕನ್ನಡವನ್ನು ನಿರರ್ಗಳವಾಗಿ ಬಳಸುವ ಸಾಮರ್ಥ್ಯವನ್ನು ಹೊಂದುವರು.

ಪಠ್ಯಕ್ರಮದ ವಿಷಯಗಳು:

1. ಮೂಲಭೂತ ಸಂಭಾಷಣೆ: ಇಬ್ಬರು ಮತ್ತು ಗುಂಪಿನಲ್ಲಿನ ಸಂಭಾಷಣೆ.
2. ರಚನೆಯ ನಮೂನೆ: ಪದಗಳನ್ನು ಮತ್ತು ವಾಕ್ಯಗಳನ್ನು ರಚಿಸುವುದು.
3. ಭಾಷಾಂತರ: ಕನ್ನಡದಿಂದ ಆಂಗ್ಲ ಭಾಷೆಗೆ – ಆಂಗ್ಲ ಭಾಷೆಯಿಂದ ಕನ್ನಡ ಭಾಷೆಗೆ.
4. ಶಬ್ಧಕೋಶ: ಕನ್ನಡದಲ್ಲಿ ಸರಳವಾದ ಪದಗಳನ್ನು ಕಲಿಯುವುದು.
5. ಅಂಕಿಗಳು: ಅಂಕಿಗಳು ಮತ್ತು ಮೂಲಭೂತ ವ್ಯಾಕರಣ.

ಪೂರ್ವಾಪೇಕ್ಷಿತ: ಏನೂ ಇಲ್ಲ

ಅಧ್ಯಯನ ಮಾಡಬೇಕಾದ ಪುಸ್ತಕಗಳು:

1. "ಕನ್ನಡ ಕಲಿ", ಲಿಂಗದೇವರು ಹಳೆಮನೆ, ಪ್ರಸಾರಾಂಗ ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, 2007

UA18BA158:
SEMINAR/ ACTIVITIES - II (0-0-2-0-1)

Course Objectives:

- To familiarize and expose the students to the design activities
- To provide hands-on experience and exposure to students to actual design practices through lectures, demonstrations etc
- To expose students to latest design methodologies and techniques.
- To create an interface for students between Industry and Academia
- To enhance the students' knowledge on how to compose and analyze space

Course outcome:

The students will be able to:

- Realize the practical aspects of the design process.
- Prepare documentation of the design based demonstrations or lectures.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time design needs.
- Incorporate the knowledge gained during the lecture/ demonstrations/ activity in their drawings/process models

Course Content:

1. Study of the design processes/models/design considerations/ design approaches
2. Analysis of approaches taken by industry/academic experts
3. Synthesis of data/design models/design considerations
4. Preparation of drawings/conclusions/models/solutions
5. Report

UA18BA159:
SITE EXPOSURE - II (0-0-4-0-0)

Course Objectives:

- To familiarize and expose the students to the Project site & its conditions
- To provide hands-on experience and exposure to actual design practices.
- To expose students to latest design techniques in the industry
- To create an interface for students between Industry and Academia.
- To enhance the student's knowledge on how to compose and analyze space.

Course outcome:

The students will be able to:

- Realize the practical aspects of the design process.
- Prepare documentation of the industry / site visits.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time industry/on site needs.
- Incorporate the knowledge gained during industry visits in their models/portfolio/drawings.

Course Content:

1. Study of the industry site visit and data collection
2. Analysis of data
3. Synthesis of data/design models/design considerations
4. Preparation of drawings/conclusions/models/solutions
5. Report

UA18BA121E
APPLIED ART & APPRECIATION (1-0-2-0-2)

Course Objectives:

- Application of Art.
- The meaning of art and its role.
- Appreciation of a work of art.
- Various types of art.
- Relationship of various forms of arts with architecture.

Course Outcome:

The students will be able to:

- Identify the applied arts.
- Visualize the role of art.
- To distinguish between art, craft and architecture.
- Develop a sense of criticism.
- Relate architecture and design to the allied fields of art.

Course Content:

1. **Art:** The meaning and role of art.
2. **Types of Art:** Fine arts, performing arts, visual art, spatial arts, folk arts, commercial arts, industrial arts abstract art, temporal art, pop art, abstract art, digital art, Types of Architecture and design.

3. **Art Criticism:** Types of Criticism, Criticism of works of art, movements and isms in art, impressionism, expressionism, etc.
4. **Art Forms:** Visual Arts: Painting, Photography and Architecture and design, Sculpture and the relationship with architecture and design.
5. **Art Forms:** Performing Arts: Films, Music, Literature and the relationship with architecture.

Pre-requisite Courses: None

Reference Books:

1. "Humanities through the Arts", F. David Martin and Lee A. Jacobus., McGraw-Hill Education, 2014.
2. "Principles of Two Dimensional Design", Wucios Wong, Wiley, 1972.

UA18BA122E
INTRODUCTION TO PRODUCT, INTERACTION & COMMUNICATION DESIGN
(0-0-2-0-1)

Course Objectives:

- To introduce students to product design.
- To introduce students to communication design.
- To introduce students to interaction design.
- Develop skills required tin making prototypes.
- To learn different techniques in presentation.

Course Outcome:

At the end of this course, the student will be able to:

- Appreciate the role of Product, Communication and Interaction design.
- Design and develop products .
- understand the generic design process.
- Identify elements of communication design.
- create brand identity for design company.

Course Content:

1. **Design:** Introduction to Design
2. **Product Design:** Role and importance of Product Design.
3. **Communication Design:** Role and importance of Communication Design.
4. **Interaction Design:** Role and importance of Interaction Design.
5. **Exercises:** Exercises in product, communication and interaction design

Pre-requisite Courses: None

Reference Books:

1. "Innovative Product Design Practice", Carl Liu, CYPI Press, 2013.
2. "Interaction Design: Beyond Human-Computer Interaction", Sharp and Rogers, 2007.
3. "Product Design and Development", Karl Ulrich and Steven Eppinger**s,** Pearson Education, 2009.
4. "Sketching: Drawing Techniques for Product Designers", Roselien Stuer and Koos Eissen, 2007.
5. "The Design of Everyday Things", Don Norman, Books Group Pub, 2014.
6. "The Elements of Graphic Design" Paperback, Alex W. White, 2nd Edition, 2011.
7. "Visual Communication: Images with Messages", Paul Martin Lester, 2002.

BACHELOR OF ARCHITECTURE
(AS PER COUNCIL OF ARCHITECTURE MINIMUM STANDARDS OF ARCHITECTURAL EDUCATION REGULATIONS, 1983)

III SEMESTER B ARCH (2017-22BATCH)

UA17BA201
DESIGN III (6-2-4-7)

Course Objectives:

Students will be introduced to:

- The physical attributes of a site and its response on architectural design.
- Explore the relationship between space making, architectural form, human feelings, context and site conditions.
- Design responding to Social, Cultural and Historical factors.
- Building typologies(small scale public buildings)
- Accepted universal standards relevant to public buildings

Course Outcomes:

The students will be able to:

- Demonstrate the relation between space making, form and human feelings generated.
- Demonstrate work in a given context and site conditions.
- Illustrate the Social, Cultural and Historical factors in their design.
- Understand small scale public building typologies and its relevance to given context.
- Understand and apply the accepted universal standards which are relevant to small scale public buildings.

Course Content:

1. **Introduce students to the physical attributes of a site and context:**
   (i) Various approaches to generate concepts for architectural design.
   (ii) Evolution of conceptual sketches to study models, to understand volumes, massing and develop aesthetic strategies.
2. **Design Concept and Strategy development:**
   (i) Various approaches to generate concepts for architectural design.
   (ii) Evolution of conceptual sketches to study models, to understand volumes, massing and develop aesthetic strategies.
3. **Relationship between the Culture and Architecture:**
   (i) To establish the linkages between culture, arts, symbolism, patterns and forms of a particular region and its manifestation in the architecture.
4. **Design programs for small scale public buildings and similar prototypes:**
   (i) Explore the relationship between spaces, architectural form and human feelings generated using design principles.
   (ii) Scale: monumental scale, human scale.
   (iii) Form guidelines for design, study circulation flow, analyze and interpret data..
5. **Preparation of final portfolio and models.**
   Preparation of floor plans, elevations and sections, reviews and revisions.
   (i) Presentation of 3D views and models using different media.

Pre-requisite Courses: None

Reference Books:

1. ''How Designers Think'', Bryan Lawson, 4thedition, Architectural Press, 2005.
2. ''Time savers standards for architectural design data'', John Hancock, Watson, Donald. Crosbie, Michael J, TMH, 2005.
3. Neufert Architect's data, Bousmaha Baiche & Nicholas Walliman, Blackwell science ltd
4. ''Architecture, form, space and order'', Ching, Francis D K, Wiley Publications, 2005.
5. ''Design in Architecture - Architecture and the human sciences'', Geoffrey Broadbent, John Wiley & Sons, New York, 1981.
6. ''Developments in Design Methodology'', Nigel Cross , John Wiley & Sons, 1984.
7. National Building Code – IS
8. New Metric Handbook – Patricia Tutt and David Adler – The Architectural Press
9. ''Method in Architecture'', Tom Heath, John Wiley & Sons, New York, 1984.

UA17BA202
BUILDING CONSTRUCTION TECHNOLOGY & MATERIALS III (4-0-0-4)

Course Objectives:

Students will be introduced to:

- The fundamental concepts of various types of scaffolding and formworks.
- The fundamental principles of RCC in framed structures.
- The fundamental principles of RCC foundations and columns.
- The fundamental principles of different types of timber trusses.
- An understanding of the basic building materials.

Course Outcome:

The students will be able to:

- Draft and read architectural drawings of a framed structure.
- Identify the basic building components such as footing, column and their construction methods.
- Design different types of timber trusses.
- Use appropriate building materials based on the properties, behavior and applications and identify the particular materials for usage in construction of load bearing buildings.
- Use innovative details in construction.

Course Content:

1. **Scaffolding and formwork:** Materials used and scaffolding methods, its advantages and disadvantages.
2. **RCC Foundation:** RCC footings, Raft foundation, Grillage foundation, Pile foundation.
3. **RCC Column**types, Shapes and Reinforcement details.
4. **Trusses:**Types of Timber roof trusses, Detail study of Lean-to roof, Pitched roof, Mansard roof, King post truss & Queen post truss.
5. **Materialstudy:** Summary of Timber as a material, Types of Roof covering materials, Study of Concrete as construction materials including their composition, characteristic properties, application etc.

Pre-requisite Courses: None

Reference Books:

1. "Barry's Advanced Construction of Buildings", Stephen Emmitt, 2nd Edition, John Wiley & Sons, 2006.
2. "Building Construction", Rangwala, 33rd Edition, Charoter Publishing House, 2015.
3. "Building Construction", William Barr McKay, Vol. 1,- 5th Edition,Vol.2 - 4th edition, Pearson Education, 2013.
4. "Building Construction Illustrated", Francis D. K. Ching, John Wiley & Sons.
5. "Building construction", Sushil Kumar, 20th Edition, 2015.
6. "Engineering materials", Rangawala, 2010.
7. ''Design of concrete mixes'', N Krishna Raju,CBS Publishers & Distributors, 2014.
8. ''Pile Foundation: Design and construction'', Satyendra Mittal, CBS, 2016.

UA17BA203
THEORY OF ARCHITECTURE - I (2-0-0-2)

Course Objectives:

To introduce the students to:

- The theories of Architectural design.
- The principles of compositions.
- Aesthetics in design and materials.
- To acquire individual capabilities necessary for the competant practice of architecture and lifelong learning.
- To stimulate artistic sensitivity and strengthen the power of creativity.

Course Outcome:

Students will be able to:

- Design incorporating the principles of composition.
- Identify aesthetics in design.
- Use the appropriate building materials.
- Analyze and interpret the characteristic features of a composition.
- Experience architecture in psychological and physiological terms.

Course Content:

1. **Introduction to Theory of Architecture and Spatial organization**:
   (i) Organizing principles in design - Axis, Symmetry, Asymmetry, Datum etc.
   (ii) Linear, radial, clustered, Centralized and Grid organizations.
2. **Principles of architectural composition:**
   (i) Unity, Duality, Rhythm, Repetition, Scale, Theory of Proportions.
   (ii) Contrast, Restraint, Repose, Punctuation/Definition, Strength, Accentuation, Gradation, Hierarchy, Balance, Harmony, Vitality, Dynamism, Transformation
3. **Ornamentation, Character/Style in architecture.**
4. **Building Materials:**Stone, Brick, concrete, Timber. Iron & Steel, Glass.
5. **Generation of forms:**Pragmatic, Analogic, Canonic and Iconic.

Pre-requisite Courses: None

Reference Books:

1. ''Architecture, form, space and order'', Ching, Francis D K, 4th Edition, Wiley Publication, 2005.
2. ''Humanities through Arts'', F. David Martin and Lee Jacobus, 9th Edition,McGraw-Hill Education, 2015.
3. ''Principles of design'', Wucius Wong, John Wiley & Sons, 1st Edition, 1993.

UA17BA204
HISTORY OF ART, ARCHITECTURE & DESIGN –III
(2-0-1-2)

Course objectives:

The students will be introduced to:

- Indian Architecture
- Islamic Architecture
- Indo-Saracenic Architecture.
- Comprehend the use of different construction materials.
- Understand the construction techniques and methodology used to build monumental structures.

Course outcome:

The students will be able to:

- Identify the Hindu concepts and style of construction and the influences on the development of architecture.
- Undestand Islamic styles in Indian context and architectural synthesis of both the styles.
- Identify the Indo-Saracenic architectural styles in India, character and influence.
- Differentiate the architectural features of both the styles of architecture.
- acquire knowledge on scale , proportions of monumental structures and construction techniques adopted to build them.

Course Content:

The students will be introduced to:

1. **Art, Architecture of Indian Temple and Secular Architecture under:** Chalukyas, Pallavas, Cholas and Pandyas.
2. **Art, Architecture of Indian Temple and Secular Architecture under:** Rulers of Vijayanagar, Nayaks, Later Chalukyans, Rashtrakutas and Hoysalas.
3. **Art, Architecture of Indian Temple and Secular Architecture under:** Jain Style, Gupta Style, Orissa Style, Central Indian (Khajuraho/Nagara) Style, Western Indian (Mara-Gurjara) Style.
4. **Art, Architecture of Islamic Religious and Secular Architecture under:**
   i) Introduction to Mosque and tomb with terminologies.
   ii) Slave dyanasty, Khilji dynsaty, Tughlaq dyansty, Sayyid and Lodhis.
5. **Art, Architecture of Islamic Religious and Secular Architecture under:**
   i) Provincial styles of Deccan (Gulbarga, Bidar, Bijapur), Jaunpur, Bengal, Punjab and Gujarat.
   ii) Mughal period: Humayun, Akbar, Jahangir, Shah Jahan and Aurangazeb.

Pre-requisite Courses: None

Reference Books:

1. ''History of Architecture'', Banister Fletcher, 20th Edition, Routledge; 1996.
2. ''Indian Architecture – Buddhist and Hindu period'', Percy Brown, 2nd Edition, Read Books, 2010.
3. ''Indian Architecture – Islamic Period'', Percy Brown, Apt Books,1990.
4. ''History of Indian Architecture (Buddhist, Jain & Hindu Period)'', Sharmin Khan, 1st Edition, CBS Publishers & Distributors, 2014.
5. ''Ancient Indian Architecture (From Blossom to Bloom)'', Sanjeev Maheswari and Rajeev Garg, CBS Publishers & Distributors, 2001.
6. ''Master Pieces of Traditional Indian Architecture'', Satish Grover, Om Books, 2004.
7. ''Odisha: An Architectural Odyssey'', Soumyendu Shankar Ray & Kajri Misra, Bloomsbury India, 2016.
8. ''The Royal Palaces of India'', George Michell, Antonio Martinelli, Thames & Hudson, 1999.
9. ''Islamic Architecture in India'', Satish Grover, South Asia Books, 1996.
10. a) ''The Mosques of the Indian Subcontinent'', Fredrick W Bunce, 1stedition, D.K. Print World Ltd., 2008.
    b) ''Royal Palaces, Residences and Pavilions of India'', Fredrick W Bunce,D.K. Print World Ltd., 2005.
    c) ''Monuments of India and the Indianized states'', Fredrick W Bunce, D.K. Print World Ltd., 2008.
    d) ''Islamic Tombs in India'', Fredrick W Bunce, D.K. Printworld Ltd, 2004 .
11. ''History of Architecture in India'', Christopher Tadgell, Phaidon Press, 1994.

UA17BA205
STRUCTURES – I (2-0-1-2)

Course Objectives:

To enable students to :

- Understand the behavior of Beams under simple loading, the stresses developed in beams.
- Familiarize with the deformation in beams due to pure bending.
- Appreciation of shear stresses in beams due to bending.
- Understanding the governing differential equation of elastic curve and its solution.
- Introduction to torsion of circular and hollow shafts.
- Understanding of columns in concept of buckling loads.

Course Outcome:

The students will be able:

- To do analysis of beams under bending load.
- To calculate the deflection of structures under different loading.
- Find the deflection of structures under different loading.
- To calculate the stresses developed in shafts due to torsion.
- To find buckling load induced in columns.

Course Content:

1. **Behavior and Analysis of Beams subjected to Bending:** (i) Deformations in prismatic and symmetric members in pure bending, pure bending theory and assumptions, bending stresses and strains, elastic flexural formulae, elastic section modulus, radius of curvature of neutral surface, modulus of rupture, flexural rigidity, moment of resistance. (ii) Numerical problems covering bending of various types of beam sections.
2. **Shear stresses in beams, shear stress diagram for rectangular and I sections, principal stresses in bending, numerical problems.**
3. **Slope and Deflection in beams:** Differential equation of the elastic curve, slope and deflection of statically determinate beams by method of successive integration, Macaulay's method, moment area method, numerical problems.
4. **Torsion of Circular Shafts and Hollow Shafts:** Introduction, deformations in a circular shaft, angle of twist, shearing strain, shearing stresses in the elastic range, elastic torsion formulae, torsion testing, modulus of rigidity G, polar moment of inertia J, numerical problems, power transmission.
5. **Elastic Stability of Columns:** (i) Introduction, stability of structures, Euler's Formula for pin-ended columns, extension of Euler's formula to columns with other end conditions. (ii)

Limitations of Euler's formula, Rankine's formula, numerical problems.

Pre-requisite Courses: None

Reference Books:

1. "Strength of Materials", R.K. Bansal, Laxmi Publications (P) Ltd., New Delhi, 2015.
2. "Mechanics of Material", Beer, Johnston, Dewolf, Mazurek, 6^{th} Edition, McGraw Hill, 2017.
3. "Basic Structural Analysis", C.S. Reddy, 3^{rd} Edition, McGraw Hill.
4. "Statics and Applied Strength of Materials", Raymond F. Neathery, John Wiley & Sons Inc., 1985

UA17BA206
BUILDING SERVICES I (SURVEYING & LEVELING, WATER SUPPLY & SANITATION)(3-0-0-3)

Course Objectives:

To introduce students to:

- Principles and practice of surveying & leveling.
- To introduce students to major streams of building services like mechanical engineering and plumbing.
- To study water supply and sanitation systems.
- A thorough learning of sanitation systems with different fixtures.
- Creating awareness for conservation of water and different methods of recycling and reusing of waste water.

Course Outcome:

The students will be able to:

- Practical knowledge of surveying and leveling by producing drawings and calculating the levels.
- Theoretical and practical knowledge of water supply inside building complex and site layout.
- Develop a basic design and/or supervise water supply and sanitation systems for a building.
- Integrate water supply and sanitation systems into architectural design.
- Working drawings of water supply systems and storm water drains and calculations of volume of water for domestic purposes.

Course Content:

1. **Introduction to Surveying and Leveling:**
   (i) Surveying – Definition, classification, principles of surveying, character of work, shrunk scale and field work.
   (ii) Leveling- Definition, classification, booking and reduction of levels, longer leveling, errors and contouring.
2. **Introduction to Building Services and its importance:**
   (i) The students will be introduced to the three major streams of building services, mechanical, electrical and plumbing. The importance of proper integration and coordination will be discussed through examples. International standards will be introduced.
   (ii) Introduction to Water and Water Use.
   (iii) Key terms and concepts.
3. **Supply Side Systems:**
   (i) Study of appropriate water treatment methods, standards
   (ii) Water Distribution systems
   (iii) Water metering
   (iv) Domestic water supply systems - layout development
   (v) Fittings and Fixtures
   (vi) Fire Fighting
4. **Sanitation and Disposal:**
   (i) Storm water, Sullage and Sewage, Standards
   (ii) Building level drainage systems - layout development
   (iii) Site level drainage
   (iv) Fittings and Fixtures.
5. **Water Reuse, Recycling and Recharge:**
   (i) Importance of conservation
   (ii) Types of waste water and possible reuse
   (iii) Sewage Treatment Systems/ Water Recycling systems
   (iv) Introduction to ground water and water recharge systems

Pre-requisite Courses: None

Reference Books:

1. "Surveying Vol I" , DR. PC Punmia, Laxmi Publications, 2015
2. "Building Services Engineering", David Chadderton, 6th Edition, Routledge, 2017.
3. "Building Services Handbook", Hall & Greeno, 7th Edition, Routledge, 2013.

UA17BA207
COMPUTERS IN ARCHITECTURE -I (3-0-0-3)

Course Objectives:

To introduce the students to:

- Use computers as a tool for architectural design representation.
- Drawing management & standard practices.
- Creating 3D Views and Walkthroughs for Architectural Presentation.
- Learning techniques of camera , materials and lighting.
- Learning V -Ray features and learning to create realistic use.

Course Outcome:

The students will be able to:

- Make simple models with combination of the tools learnt.
- Modify the standard and extended primitives to create complex objects.
- Create 3D Views and Walkthroughs.
- To create a scene with lights, materials and create perspective views with cameras.
- To create realistic views with V-Ray materials and lights.

Course Content:

1. **Introduction to 3D Software:** The students will be introduced to the basic tools and features.
2. **Architectural Model:** The students will create an architectural model including building and site.
3. **Rendering:** Material and lighting techniques for realistic rendering.
4. **Walkthrough:** A video walkthrough of their building will be developed using the tools taught in the units above.
5. **Presentation:** Presentation of final sheets with 3D views.

Pre-requisite Courses: None

Reference Books:

1. "Rhinoceros for Windows", Robert McNeel & Associates, 2015.
2. "Inside Rhinoceros 5", Ron K.C. Cheng, 2014.
3. "3D Photorealistic Rendering: Interiors & Exteriors with V-Ray and 3ds Max", Jamie Cardoso, 2016.
4. "Autodesk 3ds Max 2017 Complete Reference Guide", Kelly L. Murdock, 2017.

UA17BA208
VACATION ASSIGNMENT/ STUDY TOUR/ SUMMER TERM ASSIGNMENT - I (0-0-0-0)

Course Objectives:
The students are exposed to:

- The place of study tour/ assignment undertaken
- Historical influences towards design solutions.
- Geographic and geological influences towards design solutions.
- Socio-economic, cultural and other factors influences towards design solutions.
- The documentation of the place of visit/ Assignment undertaken.

Course outcome:
The students will be able to:

- Appreciate the influences of History while working towards design solutions.
- Appreciate the influences of geography and geology while working towards design solutions.
- Appreciate the influences of socio-economics of a region while working towards design solutions.
- Appreciate the influences of culture and other factors while working towards design solutions.
- Prepare a documentation of the place of visit.

Course Content:
1. Literature study of a place.
2. Study of any particular Architect of the place/Monuments.
3. Geographical and climatic conditions of the site.
4. Study of drawings.
5. Compilation into a document.

UA17BA209
SEMINAR / ACTIVITIES - III (0-2-0-0)

Course Objectives:
The students are exposed to:

- Various activities
- The significance of Documentation and analysis
- Industry practices and subject experts
- Application of theoretical knowledge in real world scenario
- Interaction with allied professionals

Course outcome:
The students will be able to:

- Carry out different activities.
- Document and prepare models
- Analyze available data and draw inferences
- Realize the significance of architectural theory in practical application
- Appreciate the diligence and dedication required to succeed in the chosen profession

Course Content:
1. Literature study of activity
2. Analysis of activity
3. Synthesis of data and proposals
4. Preparation of drawings/concepts/ conclusions/models
5. Report

UA17BA210
SITE EXPOSURE III (0-6-0-0)

Course Objectives:
The students are exposed to:

- To the site & its conditions.
- Hands on experience and exposure to actual construction practices
- The latest construction techniques
- The interface between industry and academia
- The knowledge on how to compose and analyze space.

Course outcome:
The students will be able to:

- Realize the practical aspects of a construction site.
- Prepare documentation of the site visits.
- Identify to the practical requirements to be considered in projects.
- Interpret & respond to real time on site needs.
- Incorporate the knowledge gained on site, in their drawings.

Course Content:
1. Study of the site and data collection
2. Analysis of the data
3. Synthesis of data and proposals
4. Preparation of drawings/conclusions.
5. Report

UA17BA211:
VERNACULAR DESIGN (2-0-0-2)

Course Objectives:
- To inculcate in the students an appreciation of Vernacular architecture.
- To understand the planning aspects, indigenously available materials & climatic conditions of different geographical areas.
- To understand design as an integrated process.
- To familiarize the sensitivity of built environment to its surroundings and impact on design.
- To understand diverse construction techniques.

Course Outcomes:
The students will be able to:

- Address climatic, cultural , socio-economic, technological and religious influences on built environment.
- Critically appreciate , analyze Vernacular concepts in different geographical areas.
- Understand the pragmatic process of form generation from Vernacular concepts.
- Acquire knowledge of various indigenous construction materials and techniques.
- The students will be able to develop vernacular designs incorporating local planning aspects, materials and details.

Course Content:
1. History and organization of vernacular buildings.
2. Understanding of forms, spatial planning, cultural aspects, symbolism, colour, art, materials of construction and construction techniques.
3. Study of factors that shape the architectural character and render the regional variations of vernacular architecture - geographic, climatic, social, economic, local materials and skills available in the region etc.

4. Study of vernacular architecture of selected building typologies and typical building components such as columns, roofs, windows, doors etc that symbolize a particular religion or community.
5. A critical review of the relevance and application of vernacular ideas in contemporary times.

Pre-requisite Courses: None

Reference Books:

1. ''Invitation to Vernacular Architecture: A Guide to the Study of Ordinary Buildings and Landscapes'', Carter, T., & Cromley, E. C, Knoxville: The Unversity of Tennessee, Press. 2005.
2. ''Traditional buildings of India, Cooper'', I.Thames and Hudson Ltd, London, 1998.
3. ''Encyclopaedia of Vernacular Architecture of the World,Oliver'', P. Cambridge University Press, 1997.
4. ''Architecture of the Indian desert'', Kulbushan Jain & Meenakshi Jain, AADI Centre, 2000.
5. ''The Royal Palaces of India'', George Michell,Thames and Hudson Ltd., London, 1999.
6. ''The Chettiar Heritage'', S Muthiah; Meenakshi Meyappan; Visalakshi Ramaswamy; V Muthuraman,Chettiar Heritage, 2002.
7. ''Encyclopaedia of Vernacular architecture of the World'', Paul Oliver, Cambridge University Press, 1997.
8. ''Havali – Wooden Houses & Mansions of Gujarat'', V.S.Pramar, Mapin Publishing Pvt. Ltd., Ahmedabad, 1990
9. ''The Tradition of Indian architecture – Continuity & Controversy – Change since 1850'', Giles Henry Rupert Tillotson, Yale University Press, 1989.
10. ''House, Form & Culture'', Amos Rapoport, Prentice Hall Inc, 1969.

UA17BA212
CONSERVATION (2-0-0-2)

Course Objectives:

- To inculcate an appreciation of historical and heritage buildings .
- To understand the importance of indigenously available materials and climatic conditions of geographical areas.
- To understand design as an integrated process.
- To familiarize the sensitivity of built environment to its surrounding and impact on its design.
- To emphasize on the students the significance of conservation.

Course Outcome:

The students will be able to:

- Appreciate buildings of historical and heritage importance.
- To appreciate and analyze vernacular concepts and document the same.
- Pragmatic process of form generation from vernacular concepts.
- Acquire knowledge of indigenous construction materials and techniques.
- The students will be able to respond with techniques of conservation.

Course Content:

1. **Introduction:**Definition of conservation, origin, evolution andneed for conservational activities.
2. **Techniques of conservation.**
3. **Role of an architect in conservation program.**
4. **Effect of conservation on a Community:**
   (i) Social, cultural, historical and economical values of conservational projects.
   (ii) Conflict and compatibility between conservation and development - the need to strike abalanceof conservational programs.
5. **Case studies of conservation works which are successful by government and non-governmental agencies.**

Pre-requisite Courses: None

Reference Book:

1. ''Guide to Conservation'', Bernard Fielder, 3rd Edition, Architectural Press, 2003.

IV SEMESTER B.Arch (2017-22 BATCH)

UA17BA251
DESIGN IV (6-2-4-7)

Course Objectives:

Students will be introduced to:

- The concept of community living and interactive spaces in Architectural design .
- The need for privacy, socio-economic determinants.
- Circulation - vehicular and pedestrian circulation .
- Open and built spaces in housing design
- Regulatory controls and approvals.

Course outcome:

The students will be able to:

- Apply community living concept in Architectural design.
- Analyze socio-economic determinants in housing design.
- Understand the significance of open and built space integration.
- Use regulatory controls.
- Effectively design circulation network.

Course Content:

1. Introduction to community living concept.
2. Discussion on Interactive spaces and neighborhood, privacy factors, open spaces and communal spaces.
3. Introduction to major project- Horizontal spread.
4. Introduction to minor project- Vertical spread.
5. Preparation of final portfolio with detailed plans, sections, elevations, views and models.

Pre-requisite Courses: None

Reference Books:

1. 'Time Savers Standards for Architectural Design Data'', John Hancock, Watson, Donald. Crosbie, Michael J, TMH, 2005.
2. ''Architectural Graphics Standards'', Ramsay and Sleeper, 12th Edition, 2016.
3. ''Architects' data'', Neufert, Ernst. Neufert, Peter, 4th Edition, John Wiley & Sons, 2012.

UA17BA252
BUILDING CONSTRUCTION TECHNOLOGY & MATERIALS –IV (4-0-0-4)

Course Objectives:

The students will be introduced to:

- RCC roofing systems.
- Deep foundation construction techniques.
- Details of slab construction for various spanning conditions of structure.
- RCC domes, vaults and pitched roofs
- Different materials used for floor and wall finishes

Course Outcome:

The students will be able to:

- Apply techniques, details and characteristics of RCC slab Construction.
- Apply deep foundation construction techniques.
- Use innovative details in construction.
- Apply RCC domes, vaults and pitched roofs in their designs.
- Apply different materials used for floor and wall finishes.

Course Content:

The students will be introduced to:

1. Introduction to slabs, Column position and centerline drawing, RCC One-way slab, Two-way slab, One-way Continuous slab, Cantilever slabs, Overhangs.
2. Flat Slab, Ribbed Slab, Waffle slab.
3. Filler Slab, Coffered Slab, Precast Slab.
4. Dome, Vaults, Pitched Roof and Lean-to-roof.
5. Materials:Different types of floor finishes, Characteristics and types of Paints, Wall finishes, Internal and External plastering.

Pre-requisite Courses: None

Reference Books:

1. "Building Construction Illustrated", Francis D K Ching , John Wiley & Sons, CBS Publisher,1985.
2. "Building Construction", Makay,William Barry, Vol. 2 & 3, 4th& 5th edition, Pearson, 2013.
3. "Building Construction", Rangwala, 33rd Edition, Charoter Publishing House, 2015.
4. "Construction Of Buildings", Robin Barry, 3rd Edition, Wiley, 1998.
5. "Construction Technology", R Chudley, 2nd Edition, Pearson Education, 2015.
6. ''Plastering'', Sawyer J T, Routledge, 2007.
7. ''Design and construction of Concrete Shell Roofs'', G S Ramaswamy, R.E. Krieger, 1984.
8. ''Cast-in-place Concrete in Tall Building Design and Construction Council on Tall building and Urban Habitat'', L. G. Aycardi, McGraw-Hill, 1992.
9. "Text Book Of Building Construction", Arora & Bhindra , 5th Edition, Dhanpat Raj, 2015.

UA17BA253
THEORY OF ARCHITECTURE II (2-0-0-2)

Course Objectives:

To introduce to the students:

- A broad over view - the evolution of thought and trends, across timeline, of Western Architectural world during Renaissance, Baroque, Neo Classical and Modern periods.
- The ideas and philosophies of architects and their contributions.
- To comprehend the various factors contributing to evolution of architectural theories and their relevance to design development.
- To acquire the individual capabilities necessary for the competent practice of architecture and lifelong learning.
- To stimulate design sensitivity and strengthen the power of creativity.

Course outcome:

Students will be able to :

- Comprehend the evolution of architectural design ideas and philosophies by various architects across different continents.
- Identify the evolution of thoughts and trends across timeline of Western Architecture.
- Contributions of great masters of architecture and application of design grammar in all their buildings.
- Criticize and evaluate buildings.
- Experience architecture in psychological and physiological terms.

Course Content:

1. **Antiquity to 17th century**
   - (i) Introduction - the connection between theories and application in various eras.
   - (ii) Contributions of Vitruvius.
   - (iii) Introduction to Renaissance.
2. **Theories of 18th & 19th centuries**
3. **Modern movement**
4. **Post modernism & De-constructivism**
5. **Academic thoughts and Research orientation**

Pre-requisite Courses: None

Reference Books:

1. ''Architecture, Form, Space and Order'', Ching, Francis D K, Wiley Publications, 2005.
2. ''Design in Architecture'', Geoffrey Broadbent,Wiley-Blackwell, 1977.
3. ''Modern Movements in Architecture'', Charles Jencks, Penguin Books, 1987.

UA17BA254
CLIMATE RESPONSIVE ARCHITECTURE (3-0-1-3)

Course Objectives:

- To expose students to the key concepts of climate responsive design and to expose them to design strategies for sustainability.
- To familiarize students with climatic data and thermal comfort zones.
- To acquaint students with passive design strategies.
- Introduce students to architectural design process in diverse climates.
- To expose them to design strategies for sustainability.

Course Outcomes:

The students will be able to:

- Understand basic influences of various climatic zones.
- Read and analyze climatic data.
- Realize the significance of thermal comfort and its application in the design process.
- Develop climate responsive designs.
- Apply passive design strategies to diverse climates.

Course Content:

1. **Introduction to Climate:**
   Introduction to key concepts:
   - (i) Elements of climate
   - (ii) Major climatic zones of the world
   - (iii) Indian subcontinent
   - (iv) Understanding and representing climate data
   - (v) Thermal comfort & Heat exchange processes
2. **Site level planning: Study of micro climatic influencers. Placement and orientation of building as per climatic influence.**
3. **Space Planning Principles:** Discuss placement of spaces based on climatic response. Heat dissipation/ trapping strategies through architectural space planning.
4. **Building Envelope Design:**
   - (i) Introduction to thermal conduction through envelope including opaque and translucent surfaces. U-Value calculations.

(ii) Ventilation techniques through better envelope design.
(iii) Day lighting maximization.

5. **Basic Strategies:** Students will be introduced to basic climate response strategies for all Indian climatic zones.

Pre-requisite Courses: None

Reference Books:

1. "Manual of Tropical Housing'', Koenigsberger, Universities Press, 1975.
2. "Tropical Architecture'', C.P. Kukreja, McGraw-Hill Inc, 1978.
3. "Climate Responsive Architecture'', Arvind Krishnan, McGraw Hill Education, 1999.
4. "Green Building Illustrated", Francid D.K. Ching, Wiley Pub, 2014.

UA17BA255
STRUCTURES – II (2-0-1-2)

Course Objectives:

Introduce the students to:

- Design Reinforced Concrete Structures with emphasis on Limit State Method.
- Analyze and design basic structural elements.
- Design beams using the limit state method.
- Design columns using the limit state method.
- Design footings using the limit state method.

Course outcome:

The students will be able to:

- Use the basic concept and design methods of RCC structures.
- Design beams using the limit state method.
- Design columns using the limit state method.
- Design footings using the limit state method.
- Conduct overall design of RCC structures.

Course Content:

1. **Design Philosophy** – Concept of Elastic method, ultimate load method and limit state method –Limit State philosophy - IS code provisions – Load and Load combinations – Stress and strain relationship of reinforcing steel and concrete.
2. **Limit state design of Beams** – Analysis and Design of Singly and Doubly reinforced beams and Analysis of T- beam.
3. **Limit state design of Slabs** – Design of one way simply supported and continuous slab. Design of Two way rectangular slab subjected to uniformly distributed load for various boundary conditions, Design of stair case (dog- legged).
4. **Limit state design of column** – Design of short axially loaded RC columns, RC Columns with uniaxial moment.
5. **Limit state design of Footing** – Loads on foundation, types of footing, Design of axially loaded square footing.

Pre-requisite Courses: None

Reference Books:

1. "Reinforced Concrete Design", Unnikrishna Pillai, S., Devadas Menon, Tata McGraw-Hill Publishing Company Ltd., New Delhi. 2006.
2. "Limit State Design of Reinforced Concrete", Varghese, P.C., 2nd Edition, Prentice Hall of India, Pvt. Ltd., New Delhi. 2006.
3. "Design of Reinforced Concrete Structures", Krishna Raju, N., CBS Publishers & Distributors, New Delhi 2010.
4. "Fundamentals of Reinforced Concrete Design", Gambhir M.L., Prentice Hall of India, Pvt. Ltd., New Delhi 2006.

UA17BA256
BUILDING SERVICES II(ELECTRICAL SERVICES & ILLUMINATION) (3-0-0-3)

Course Objectives:

- To introduce students to the application of electrical services in design & construction.
- Study the materials used in electrical services for buildings.
- Electricity and illumination applications used in current architectural practice.
- Comprehensively plan and design the electrical and illumination scheme of a building
- Networking
- Energy conservation

Course Outcome:

The students will be able to:

- Develop a basic design and/or supervise illumination scheme for a building.
- Suggest standard materials used in electricalservices for buildings.
- Develop a basic design and/or supervise electrical systems for a building.
- Develop a basic design and/or supervise networking systems for a building.
- Develop an illumination daylight design contributing to energy conservation.

Course Content:

1. **Introduction to Electrical Systems:**
   (i) The students will be introduced to the key terms in electrical systems.
   (ii) Sources of electricity.
   (iii) Supply and Distribution of electricity from generation to the building level.
   (iv) International standards – wiring, appliances, graphical indication.
2. **Building Electricity Use:**
   (i) Key appliances and their planning.
   (ii) Building level distribution.
   (iii) Field study of wires, cables and conduits.
3. **Illumination:**
   (i) Introduction to day lighting and artificial lighting.
   (ii) Key terms for lighting.
   (iii) International illumination standards.
   (iv) Types of artificial lights and lighting systems.
   (v) Design of day lighting and artificial lighting.
   (vi) Integration of day lighting and artificial lighting.
4. **Networking:**
   (i) Introduction to networking in buildings.
   (ii) Planning for networking - telecommunication.
   (iii) Cables and conduits.
5. **Energy Conservation:**
   (i) Importance of conservation.
   (ii) Introduction to reduction strategies including monitoring.
   (iii) Introduction to renewable energy.
   (iv) Planning considerations for renewable energy.

Pre-requisite Courses: None

Reference Books:

1. ''Electrical Technology'', VH Cotton, Reem Publications Pvt. Ltd. 2011.
2. "Electrical Wiring, Estimation and Costing", by L Uppal, 6th Edition, Khanna Publisher, 2015-16

UA17BA257
COMPUTERS IN ARCHITECTURE –II (2-0-0-2)

Course Objectives:

- To familiarize the students with Software skills and revisiting the Autodesk AUTOCAD software .
- Introduction to the Autodesk REVIT software with using Modifiers and the basics of Tool Box
- Introduction to a major project, a multistory building and introducing them toExtended Modeling Techniques.
- To develop the Contours and topographical setup using REVIT .
- Create and compose a sheet to scale .

Course Outcome:

The students will be able to:

- Draft plans and generate elevations and sections.
- Understand the importance and usage of the REVIT user interface with materials application and rendering details.
- Learn to draw a multistorey apartment with integrating services and understanding the modifiers.
- Work on the contour of topographical site and understand the background and context of their designs.
- Present their work in a template with proper scale and compose their sheet.

Course Content:

1. **Introduction to Revit:**
   Basic modeling techniques will be taught.
2. **Climate Response Analysis:**
   Addition of climatic influencers (weather file) and analysis of day lighting, thermal comfort, shading, etc.
3. **Resource and Cost Loading:**
   Material, costing and estimation will be taught using Revit.
4. **Integration of Services:**
   Students will be introduced to integration of mechanical, electrical and plumbing services in the model.
5. **Construction and Project Management:**
   Students will be taught to produce outputs such as quantity and estimation sheets, cost analysis, project timeline, etc.

Pre-requisite Courses: None

Reference Books:

1. ‘’Mastering Autodesk Revit 2017 for Architecture’’, Eddy Krygiel, John Wiley & Sons, 2016.
2. ‘’Autodesk Revit Architecture 2012’’, Eric Wing, Sybex, 2011.

UA17BA258
SEMINAR / ACTIVITIES - IV (0-2-0-0)

Course Objectives:

The students are exposed to:

- Various activities
- The significance of Documentation and analysis
- Industry practices and subject experts
- Application of theoretical knowledge in real world scenario
- Interaction with allied professionals

Course outcome:

The students will be able to:

- Carry out different activities.
- Document and prepare models
- Analyze available data and draw inferences
- Realize the significance of architectural theory in practical application
- Appreciate the diligence and dedication required to succeed in the chosen profession

Course Content:

1. Literature study of activity.
2. Analysis of activity.
3. Synthesis of data and proposals.
4. Preparation of drawings/concepts/ conclusions/models.
5. Report.

UA17BA259
SITE EXPOSURE IV (0-6-0-0)

Course Objectives:

The students are exposed to:

- To the site & its conditions.
- Hands on experience and exposure to actual construction practices
- The latest construction techniques
- The interface between industry and academia
- The knowledge on how to compose and analyze space.

Course Outcomes:

The students will be able to:

- Realize the practical aspects of a construction site.
- Prepare documentation of the site visits.
- Identify to the practical requirements to be considered in projects.
- Interpret & respond to real time on site needs.
- Incorporate the knowledge gained on site, in their drawings.

Course Content:

1. Study of the site and data collection.
2. Analysis of the data.
3. Synthesis of data and proposals.
4. Preparation of drawings/conclusions.
5. Report.

UA17BA221
ENERGY EFFICIENT DESIGN (2-0-0-2)

Course Objectives:

- To sensitize the students to the concept of energy efficiency and its need in today’s context.
- To introduce basic influencers, principles and systems of energy efficient design.
- To introduce to students social and economic influences of energy efficient design.
- Introduce active and passive strategies.
- Familiarize students with acclaimed sustainable building projects.

Course Outcome:

The students will be able to:

- Understand and appreciate the concepts of energy efficient design.
- Apply energy efficiency in building design.
- Appreciate regional and contextual design.
- Enhance their design using sustainable technology, techniques and principles.
- Apply techniques and principles for designing energy efficient designs.

Course Content:

1. **Introduction to Energy Efficient Design:**
   The students will be introduced to energy efficient building design. They will be sensitized towards the need for sustainable design. The concept of Reduce, Reuse, Recycle and Replenish will be discussed.
2. **Introduction to Influencers – Environmental, Social and Economic:**
   (i) Discuss climatic influencers, such as temperature, humidity, rainfall, sky cover, etc. and corresponding comfort conditions.
   (ii) Briefly discuss various climatic zones of India.
   (iii) Train students to read sun path diagram, wind rose and psychometric chart.
   (iv) Briefly discuss the impact of social and economic sustainability, introducing students to key terms such as durability, cost-efficiency (ROI), lifecycle, carbon footprint etc.
3. **Introduction to Passive and Active Strategies:**
   Students will be introduced to the various passive and active strategies for energy efficient design broadly covering the following areas:
   (i) Thermal comfort
   (ii) Lighting
   (iii) Water Management
   (iv) Waste management
   (v) Renewable Energy
4. **Case Study/ Design:**
   To discuss application of the techniques taught in the previous module, students will be familiarized with acclaimed sustainable building projects.

Pre-requisite Courses: None

Reference Books:

1. 'Manual of Tropical Housing'', Koenigsberger, Universities Press, 1975.
2. "Sustainable Building - Design Manual: Sustainable Building Design Practices", TERI, The Energy and Resources Institute, 2009.
3. "Green Design: From Theory to Practice", Ken Yeang, Black Dog Publisher, 2011.
4. "Building to Suit the Climate: A Handbook", Hausladen, Birkhauser, 2011.
5. ''Green Building Illustrated", Francis D.K. Ching, John Wiley & Sons, 2014.

UA17BA222
MATERIAL EFFICIENT DESIGN (2-0-0-2)

Course Objectives:

To introduce students to

- Material efficiency in design
- The need for resource conservation.
- Reuse, Reduce and Recycling of materials.
- To discuss techniques that can be applied to achieve material efficiency.
- To introduce case study and analysis of a project.

Course Outcomes:

The students will be able to:

- Adopt material efficiency while designing.
- To appreciate need for resource conservation.
- To apply Reuse, Reduce and Recycling of materials.
- To apply techniques to achieve material efficiency.
- Apply various techniques to enhance the resource efficiency of their design at all levels, planning, design, construction and operation.

Course Content:

1. **Introduction to Material Efficiency:**
   The students will be introduced to the concept of material/ resource efficient design, its need and impact on the built environment. They will be briefed about Life Cycle Analysis. A generic process will be discussed.
2. **Reduction in Material:**
   Strategies to reduce material consumption will be discussed for all stages as stated above. These could include:
   (i) Form based reduction.
   (ii) Structural efficiency (AEC, HCB, etc).
   (iii) Design and Construction techniques such as PreFab and Modular Design.
3. **Reuse:** Refurbishment will be discussed in brief. Strategies for reuse and refurbishment will be discussed.
4. **Recycled Material:** The students will be exposed to available recycled material through site visits and market analysis. Application of the same will be discussed through case studies.
5. **Renewable Materials:** Easily replenished materials will be discussed such as mud blocks, bamboo, hempcrete, etc. A tradeoff between aesthetics, cost and durability will be discussed.

Pre-requisite Courses: None

Reference Books:

1. ''Green Building Illustrated", Francis D.K. Ching, John Wiley & Sons, 2014.
2. "Sustainable Materials Without the Hot Air: Making Buildings, Vehicles and Products Efficiently and with Less New Material", Allwood, 2nd Revised Edition, UIT Cambridge; 2015.
3. "Material Revolution. Sustainable and Multi-Purpose Materials for Design and Architecture", Sascha Peters, 2nd Edition, Birkhauser Verlag, 2011.

V SEMESTER B.Arch (2016-21 BATCH)

UA16BA301
DESIGN V (6-2-4-7)

Course Objectives:

The students will be introduced to:

- The need for creating architecture as an envelope for a specific function and the design of public buildings for diverse user groups relevant to any given socio-cultural/ socio economic context.
- The significance of structural and service integration in the architectural design process for optimal building performance and relevance of building materials and construction techniques and climatic factors.
- To understand site planning, zoning and circulation and familiarize them with Statutory bodies and Development regulations.
- The role of visual grammar in built environments.
- Use of technology and digital techniques to enhance design solutions.

Course Outcomes:

The students will be able to:

- Implement the design process relevant to architecture of public buildings.
- Integrate spatial, structural and service modules in building design

- Arrive at Architectural design solutions with reference to local bye laws and statutory regulations.
- Appreciate the significance of visual design parameters in creating built environments
- Effectively communicate architectural drawings through digital techniques.

Course Content:

1. **Discussion on Architecture relevant to public domain**- influencing parameters
2. **Introduction to Major Project**- Hospitality/ Healthcare/ Retail and other such service intensive urban scale projects - Case Study, Site analysis, Concept & Zoning
3. **Design Development of Major project** - Planning, Circulation & Form development, Integration of Services, Structure & Parking
4. **Introduction & Design Development of Minor Project**- projects that explore visual imagery and building identity - Conceptual Planning, Form development and Detailing
5. **Preparation of Final Portfolio** - Site plan, Detailed Plans, Elevations, sections, detailed sketches & Model.

Pre-requisite Courses: None

Reference Books:

1. " Neufert's Architects Data", Wiley-Blackwell; Auflage, 2012 .
2. "Universal Design Handbook", Wolfgang Preiser, Mcgraw Hill Book Co; Auflage ,2010.
3. "Advanced Construction for Buildings", Emitt, Wiley-Blackwell; Auflage , 2018.
4. "Metric Handbook Planning & Design Data, 5th Edition, Taylor & Francis Ltd , 2018.
5. "Healthcare Spaces", Roger Lee, Visual Reference Publications, 2004.
6. "Architecture of Art Museums", Ronnie Self, Routledge; 1 edition, 2014.

UA16BA302
BUILDING CONSTRUCTION TECHNOLOGY & MATERIALS V(4-0-0-4)

Course Objectives:

The students will be introduced to:

- Construction detail of Complex buildings including metal roofing systems
- Detailing of various types of Shell roofs
- Building technology involved in construction of large span structures
- Construction practices for pre engineered buildings
- Properties and architectural application of building materials such as Plastics and water proofing compounds

Course Outcomes:

The students will be able to:

- Identify construction practices relevant to complex building systems.
- Apply construction techniques applicable to shell roofs
- Use appropriate building components for large span structures.
- Integrate pre engineering technology as a construction detail.
- Analyze the properties and application of various Building materials.

Course Content:

1. **Steel Truss**- Construction and detail of Steel trusses for various spans, Tubular and L- angle trusses with lattice girders, north lighting, aluminum sheet and MS cladding and roof fixing details**.**
2. **Detail of shell roof** - Construction methods for Folded plate, Hyperbolic paraboloid, cylindrical roofs
3. **Construction of large span structures**- Introduction to construction of Geodesic dome, space frame, Tensile and Pneumatic structures
4. **Pre-engineered buildings**- Introduction to metal and prefabricated structures & Pre-engineered buildings
5. **Building Material Portfolio** - Study of Plastic as building material, manufacturing process, types and application. Study of Waterproofing materials and techniques in construction.

Pre-requisite Courses: None

Reference Books:

1. "Barry's Advanced Construction of Buildings", Emitt & Gorse, 2nd Edition, Wiley India, Pvt. Ltd., 2006.
2. "Building Construction Illustrated", Francis, D.K. , 4th Edition, Wiley India Pvt. Ltd., 2008.
3. "Building Construction", Mckay, J.K., 4th Edition, Pearson India. 2015.
4. "Construction Technology", Roy Chudley, 2nd Edition, Pearson India. 2014.
5. "Building Construction Illustrated", Francis D K Ching, Wiley, 2014.
6. "60 Design & Construction of Concrete Shell Roofs", G S Ramaswamy, Krieger Pub Co , 1984.

UA16BA303
CONTEMPORARY ARCHITECTURE(2-0-0-2)

Course Objectives:

The students will be introduced to:

- Works of Contemporary Architects in the Indian Context.
- Works of Contemporary Architects in a global setting.
- Critical appreciation of Architectural developments and trends.
- Design thought and application in present day framework.
- Influencing parameters in Architecture as a design and construction discipline.

Course Outcomes:

The students will be able to:

- Identify and appreciate architectural works of Contemporary Indian Architects
- Role of Contemporary architects in shaping Architectural thought.
- Gain a deeper understanding of prevalent architectural processes.
- Analyze application of contemporary architectural ideas in a given context.
- Appraise the factors and parameters that influence architecture on a global scale.

Course Content:

1. **Modern Architecture in India**- Post Independence Era- works of Edwin Lutyen and Le Corbusier, Contemporary

   Architects- Design Thought and works of Charles Correa and B V Doshi, Raj Rewal, Uttam Jain, Achyut Kanvinde.
2. **Modern Architecture in India -** Low cost and vernacular techniques in Architecture- Laurie Baker, Anant Raje, Experimental techniques in Puducherry
3. **GlobalContemporary Design thought**- Design philosophy & works of Richard Meier, Charles Moore, Bernard Tschumi, Geoffrey Bawa. Ideas and works of Frank Gehry, Zaha Hadid. High- Tech Architecture of Sir Norman Foster, Sir Michael Hopkins.

4. **Contemporary Design thought** - Design philosophy & works of Renzo Piano, Santiago Calatrava, Tadao Ando, I.M. Pei, Daniel Leibskind, Rem Koolhas, Coop Himmelb(l)au.
5. **Advances in Architecture**- Architectural trends including Digital Architecture, Blobitecture, Cybertecture, Parametric design, NURBS, Virtual and Augmented Reality.

Pre-requisite Courses: None

Reference Books:

1. "Contemporary Architecture", Morgan, Ann Lee & Taylor Colin , Macmillan, 1984.
2. "Modern Architecture in India", Bahga, Bahga and Bahga , Galgotia Pub. Co.,1993.

UA16BA304
SOCIOLOGY & ECONOMICS(2-0-0-2)

Course Objectives:

The students will be introduced to:

- Nature and Scope of Sociology
- Influences of Social issues on Architecture
- Different types of community living
- Economics in Society
- Economics of Architecture

Course Outcomes:

The students will be able to:

- Identify diverse socio-cultural and socio- economic factors
- Appraise challenges and social issues related to Architecture in Indian context.
- Enlist Diverse Social communities
- Analyze impact of Economy on built environments
- Explore concepts of Urbanization and building economics

Course Content:

1. **Fundamentals of Sociology**- Basic terms in Sociology, Relevance of Sociology in design of Built environments,Influence of Culture in Design, Community Living- Urban and Rural settings
2. **Community Living**- Demography, Migration, impact of Urbanization on transport, infrastructure and urban life, origin of slums, Affordable Housing
3. **Fundamentals of Economics**- Definition and Terms in Economics, Relevant practices in economics of the Construction Industry
4. **Financing Institutions** - Financing agencies, Supply and Demand in real estate
5. **Building costs**- Land values, building life cycle, timelines

Pre-requisite Courses: None

Reference Books:

1. "Urban Housing Form", Jingmin Zhou, Architectural Press , 2005.
2. "Housing & Dwelling", Barbara Miller Lee, Routledge, 2006.
3. "Housing Transformation", Bridget Franklin, Routledge , 2006.

UA16BA305
STRUCTURES- III(2-0-1-2)

Course Objectives:

The student will be introduced to:

- Definitions, Structural concepts, structural forms, structural behavior to various loads and load combinations
- Analysis of elements of Portal Frame Structure System,
- Analysis of elements of Arch and Vault Structure
- Analysis of elements of Dome Structure
- Analysis of elements of Concrete shell Structure

Course Outcomes:

The student will be able to:

- Analyze Structure based on loads and load combinations
- Analyze the structural forms and materials used for elements of Portal Frame Structure System
- Analyze the structural forms and materials used for elements of Arch and Vault Structure
- Analyze the structural forms and materials used for elements of Dome Structure
- Analyze the structural forms and materials used for elements of Concrete Shell Structure.

Course Content:

1. **Analysis of structural loads to satisfy Building Codes and Standards**:Determine thegeneral loads to be considered in the design of the structure, based on the type of occupancyspecified for each area. a) Gravity loading: Dead and Live load calculation based on IS 875 (Part1&2) b) Introduction to seismic loading b) Introduction to seismic loads, snow loads and wind loads based on IS Codes (IS 1893, IS 875 Part 3,4,5)
2. **Analysis of elements of Portal Frame Structure System:** Proportioning of elements of two-dimensional rigid frames that have arigid joint between column and beam. General framing arrangement of Portal frame for 75M X300M building, basic load path and total structural weight calculation.
3. **Analysis of elements of Arch and Vault Structures**: Proportioning of elements of curved structural member spanning twopoints, of masonry, concrete or steel and used as the roofing systems of large span buildings.Proportioning of elements of Arch and Vault arrangement for spanning 75M X 300M building.
4. **Analysis of elements of Dome Structures:** Domes as polar arrays of curved structural systems in masonry,concrete, steel with glass cladding, their structural strength and properties as roofing systems oflarge column-free spans. Proportioning of the elements of dome(s) for spanning 75M X 300M building.
5. **Analysis of elements ofConcrete Shell structure:**Proportioning of elements of double curved surfaces formed from warpedsurface (e.g. hyperbolic parabolic); their properties and strength as light-weight constructionfor column free large spans. Proportioning of Concrete shell roof to spanning 75M X 300M building, and basic load path and total structural weight calculation.

Pre-requisite Courses: None

Reference Books:

1. "Structures", Martin Bechthold, Daniel L Schodek , PHI Learning Private limited, 2013.
2. "Works of Felix Candela", Felix Candela , The Princeton University, 2008.
3. "Works of Frei Otto", Web Resources.
4. "Works of Hassan Fathy", Web Resources.
5. "Works of P.L. Nervi", Web Resources.
6. "Works of Sir Buckminster Fuller", Web Resources.
7. "Building Structures Illustrated", Francis D.K. Ching, 2nd Edition, John Wiley &Sons, 2013.
8. "Building Construction Illustrated", Francis D.K. Ching, 4th Edition, John Wiley & Sons, 2014.

UA16BA306
BUILDING SERVICES- III (HVAC, Lifts & Fire Fighting) (3-0-1-3)

Course Objectives:

The students will be introduced to:

- Role of Mechanical systems in Building Design
- Active climate control in Built Environments through Heating, Mechanical ventilation and Air Conditioning

- Mechanical transport systems in buildings such as Lifts, Escalators and Travelators
- Fire Safety in Buildings- Passive and Active concepts in Fire Fighting
- Compliance with Guidelines as per Building code

Course Outcomes:

The students will be able to:

- Identify the significance of Mechanical systems in Built Environments
- Enlist and specify different types of Heating, Ventilation and Air conditioning
- Plan and design mechanical transport systems as required by the architectural design brief.
- Develop design strategies for passive and active fire fighting.
- Apply mandatory guidelines and rules for service integration in architectural design solutions

Course Content:

1. **Mechanical Ventilation and Introduction to Air Conditioning**- Need for Mechanical Ventilation and types of Ventilation Systems, Introduction to Refrigeration cycles, Load calculations, Air Distribution, Heating systems
2. **Air Conditioning systems** - Types of air conditioning systems- Window, split, cassette type, Centralized air conditioning, water and air cooled chillers, Duct sizes and layout, AHU. Spaces with special requirements
3. **Mechanical Transport systems-** - Elevator types, details of elevator shaft, design considerations for number, layout, capacity and arrangement of lifts in architectural design, lift interiors, Escalators and Travelators- types, location and inclination
4. **Fire Safety & Fire Fighting** - Passive and Active design strategies for fire protection and fire fighting in buildings, fire driveways, refuge areas, travel distances, sprinkler system, fire hydrants, fire resistant materials, with specific emphasis on high rise buildings.
5. **Compliance with regulations**- Service integration and fire safety in buildings in compliance with NBC, ECBC, etc

Pre-requisite Course: None

Reference Books:

1. "Principles of Air Conditioning", V Paul Lang, Delmar Cengage Learning, 1995.
2. "Refrigeration & Air Conditioning Data Hand book" , Manohar Prasad , New Age International, 2nd Edition. 2013.
3. "Heating & Air Conditioning of Buildings", Faber & Keats, Routledge, 2015.
4. "National Building Code of India (NBC) VOL 1 & Vol 2. 2016"; BIS. 2016.
5. "NFPA 101: Life Safety Code", National Fire Protection Association, NFPA, 2017.
6. " IS codes", Part 8 Section 3 and 5 & Part 3 & 4 , BIS.

UA16BA307
LANDSCAPE DESIGN (1-2-0-2)

Course Objectives:

The students will be introduced to:

- Role of open spaces in enhancing building design
- Elements and Principles in Landscape Design
- Aesthetical, Functional and Technical aspects of Landscape design
- Fundamental concepts in Ecology and Sustainable Environments
- Overview of Landscape Conservation

Course Outcomes:

The students will be able to:

- Detail architectural design solutions integrated with Landscape elements
- Apply Landscape design principles in architecture.
- Explore the role of landscape design in diverse architecture projects
- Analyze key factors influencing ecological balance and sustainability
- Appreciate the need for Landscape conservation and propose relevant measures

Course Content:

1. **Introduction to Landscape Design**- Need and Role of Landscape Design, Overview of History of Landscape Design- Eastern and Western philosophies, Types of gardens, Urban and Rural Landscapes
2. **Principles and Elements of Landscape Design** - Site planning principles- Landform, water bodies and Vegetation, Landscape elements- Softscape and Hardscape (Water Bodies, Paving, Garden Structures), Services (Landscape lighting, plumbing & drainage)
3. **Eminent Landscape Architects** - Design Ideology and works of Garret Eckbo, Martha Schwartz, Maya Lin, SWA, Michael Van Valkenburgh, Ravindra Bhan, Shaheer Associates
4. **Ecology, Sustainable environments & Landscape Conservation** - Fundamental concepts of ecology, natural environments and relevant sustainable concepts, Impact of human intervention on the environment, need for environmental protection and Landscape conservation
5. **Landscape Design project**- Design and detail of small Landscape spaces such as Residential Landscape, Courtyards, etc.;

Pre-requisite Course: None

Reference Books:

1. "An Introduction to Landscape Architecture", Laurie, M., Elsevier. 1975.
2. Motloch, J. "Introduction to Landscape Design", John Wiley & Sons, 2001.
3. Holden, R &Liversedge, J. Landscape Architecture: An Introduction", Laurence King Publishing Ltd., 2014.
4. "The course of Landscape Architecture: A History of our Designs on our Natural World", Girot, C., Thames & Hudson, 2016.
5. "Landscape Architecture: A Manual of Site Planning and Design, McGraw-Hill, Simonds, J O., 1997.
6. "Landscape Graphics", Reid Fasla, John Wiley & Sons, 1993.

UA16BA308
VACATION ASSIGNMENT/ STUDY TOUR/ SUMMER TERM ASSIGNMENT - II (0-0-0-0)

Course Objectives:

The students are exposed to:

- Places of Architectural interest
- Diverse Architectural Styles relevant to context
- Ideas and works of Eminent Architects
- Practical application in Architecture
- Significance of Architectural Profession

Course Outcome:

The students will be able to:

- Appreciate the influences of geographical and historical parameters on Architecture.

- Analyze the impact of socio cultural and socio economic factors on design.
- Appreciate the individualistic statements of architects.
- Prepare themselves to industry needs
- Appreciate the significance of the profession

Course Content:

1. Literature study of a place and Data collection
2. Analysis of data
3. Synthesis of data and proposals
4. Preparation of drawings/concepts/conclusions/models
5. Report

UA16BA309
SEMINAR/ ACTIVITIES V (0-2-0-0)

Course Objectives:

The students are exposed to:

- Various activities
- The significance of Documentation and analysis
- Industry practices and subject experts
- Application of theoretical knowledge in real world scenario
- Interaction with allied professionals

Course Outcome:

The students will be able to:

- Carry out different activities.
- Document and prepare models
- Analyze available data and draw inferences
- Realize the significance of architectural theory in practical application
- Appreciate the diligence and dedication required to succeed in the chosen profession

Course Content:

1. Literature study of activity
2. Analysis of activity
3. Synthesis of data and proposals
4. Preparation of drawings/concepts/ conclusions/models
5. Report

UA16BA310
SITE EXPOSURE V (0-6-0-0)

Course Objectives:

The students are exposed to:

- The site & its conditions.
- Hands on experience and exposure to actual construction practices
- The latest construction techniques
- The interface between industry and academia
- The knowledge on how to compose and analyze space.

Course Outcome:

The students will be able to:

- Realize the practical aspects of a construction site.
- Prepare documentation of the site visits.
- Identify the practical requirements to be considered in projects.
- Interpret & respond to real site needs.
- Incorporate the knowledge gained on site, in their drawings.

Course Content:

1. Study of the site and data collection
2. Analysis of the data
3. Synthesis of data and proposals
4. Preparation of drawings/conclusions
5. Report

UA16BA331
FURNITURE DESIGN (2-0-0-2)

Course Objectives:

The students will be introduced to:

- Historical Timeline of Furniture Design
- Principles in Furniture Design
- Significance of anthropometry & ergonomics in Furniture design
- Prototypes, mass production and Bespoke pieces in furniture
- Materials, Specifications & Costing

Course Outcomes:

The students will be able to:

- Appreciate the development of Furniture design through various periods & styles.
- Explore elements of Furniture design
- Apply anthropometry and ergonomic principles in design of furniture
- Explore diverse materials, techniques and costing in Furniture
- Design and detail Furniture Units

Course Content:

1. **Overview of Furniture Design**- Varied concepts in Furniture Design, Brief History of Furniture Design-Different periods and Styles
2. **Principles and Elements of Interior Design** - Furniture types for different functions and spaces - Residential, Office, Institutional, etc, for different activities, outdoor furniture, custom made, mass production.
3. **Materials, techniques and Costing**- Market Survey of Materials and finishes for furniture, manufacturing and fixing details, specification, rate analysis and costing
4. **Eminent Furniture Designers**- Design philosophy and works of Contemporary Furniture Designers
5. **Furniture Design project**- Design and detail of different types of furniture

Pre-requisite Course:None

Reference Books:

1. "Time Saver Standards for building Types", Joseph De Chiara & John Callender, McGraw Hill Ed, 2017.
2. "Neuferts's Standards". Ernst Neufert, Wiley, 2012.
3. "Human Dimension & Interior Space", Julius Paneiro, Watson-Guptill, 1979.

UA16BA332
PRODUCT DESIGN (2-0-0-2)

Course Objectives:

The students will be introduced to:

- Form studies in Product Design
- Materials and techniques in Product Design
- Design process and Creative techniques- manual and digital
- Mock up models and prototyping
- Manufacturing process for diverse products

Course Outcomes:

The students will be able to:

- Explore the design process and techniques through form studies.
- Analyze appropriate materials for different products

- Apply manual and digital skills in designing products
- Design and detail Products based on activity and function
- Develop prototype for the design

Course Content:

1. **Overview of Product Design**- Concepts in Product Design, Brief History of Product Design, critical factors and parameters in designing products for varied functions
2. **Material and Techniques** - Market Survey of Materials and finishes for different products, properties, procurement, application and costing, custom made, mass production, product life cycle
3. **Creative Techniques in Product design**- Design Thinking, design processes, manual and digital creative thinking
4. **Eminent Product Designers**- Design philosophy and works of Contemporary Product Designers
5. **Product Design project**- Design and detail of different types of products

Pre-requisite Course: None

Reference Books:

1. Principles of Form & Design", Wong, John Wiley & Sons , 1993.
2. "Industrial Design", Jim Leslo, Wiley, 2011.
3. "Prototyping & Model Making For Product Design", Bjarki Hallgrimsson, Laurence King Publishing , 2012.

VI SEMESTER B.Arch (2016-21 BATCH)

UA16BA351
DESIGN VI (8-0-4-8)

Course Objectives:

The students will be introduced to:

- Creating Built environments with respect to a specified design programme.
- The significance of planning principles in Campus Design as an Architectural typology
- Diverse intrinsic and extrinsic factors, regulations and bye laws in design of large scale projects.
- Design process relevant to varied public usage and occupancy
- The need for developing an Identity in Architectural design solutions

Course Outcomes:

The students will be able to:

- Implement the design process relevant to Campus Design and Institutional buildings
- Integrate the design programme with the site and spatial requirements, context, zoning, circulation and form development
- Arrive at Architectural design solutions with reference to local bye laws and statutory regulations.
- Appreciate the significance of creating an architectural identity in large scale projects
- Effectively communicate architectural drawings through digital techniques.

Course Content:

1. **Discussion on Architecture relevant to Campus Design and Institutional projects**- influencing parameters
2. **Introduction to Major Project**- Institutional projects, Campus Design - Case Study, Site analysis, Concept & Zoning
3. **Design Development of Major project** - Planning, Circulation and Form development, Linkages, Built and open spaces, Integration of Services, Structure & Parking
4. **Introduction & Design Development of Minor Project**
5. **Preparation of Final Portfolio** - Site plan, Detailed Plans, Elevations, sections, detailed sketches & Model of both projects

Pre-requisite Courses: None

Reference Books:

1. "Neufert's Architects Data", Ernst Neufert, Wiley, 2012.
2. "Universal Design Handbook", Wolfgang Preiser, McGraw-Hill Education, 2010.
3. "Advanced Construction for Buildings", Emitt,Wiley-Blackwell; Auflage , 2018.
4. "Metric Handbook Planning & Design Data, Pamela Buxton 5th Edition, Taylor & Francis Ltd , 2018.
5. "College and Universities Educational Spaces", Sibylle Kramer, Braun , 2010.

UA16BA352
BUILDING CONSTRUCTION TECHNOLOGY & MATERIALS VI(4-0-0-4)

Course Objectives:

The students will be introduced to:

- Structural Glazing as a construction material
- Metal Cladding in facade detail
- Application of UPVC, FRC & PVC in Building Industry
- Steel and Aluminum sliding, folding doors & partitions, Skylights
- Properties and architectural application of Glass as a building material

Course Outcomes:

The students will be able to:

- Identify construction practices relevant to Facade Glazing
- Apply construction techniques and fixing techniques for metal cladding
- Use UPVC, FRC & PVC for appropriate functions in building construction
- Design and detail Sliding and Folding doors, skylights
- Analyze the properties and application of various Building materials.

Course Content:

1. **Structural Glazing**- Fabrication and construction details for curtain wall, structural glazing, spider fittings, frameless glass doors and windows
2. **Metal Cladding** - Construction methods and fixing details for ACP, Aluminum louvres
3. **UPVC, FRC & PVC**- Detail of Doors, windows and partitions, wooden sliding, folding doors
4. **Steel and Aluminum**- Design and detail of Steel and Aluminium Sliding and Folding doors and skylights
5. **BuildingMaterial Portfolio** - Study of Glass as building material, manufacturing process, types and application. Alternative building materials for wall construction

Pre-requisite Courses: None

Reference Books:

1. "Building Construction Illustrated",Francis, D.K., 4th Edition, Wiley India Pvt. Ltd., 2008.
2. "Building Construction Volume 1,", Mackay, J.K., 4th Edition, Pearson India, 2015.
3. "Construction Technology Volume 1," Roy Chudley, 2nd Edition, Pearson India, 2015.
4. " Building Construction", Rangwalla, Charoter Publishing House, 2015.

UA16BA353
ESTIMATION & COSTING (3-0-0-3)

Course Objectives:

The student will be introduced to:

- Specification of Building works as per standard code
- Providing specifications for construction projects
- Quantification of Building materials
- Preparing Bill of Quantities
- Cost estimation for building works

Course Outcomes:

The student will be able to:

- Identify relevant code for cost estimation and specification
- Write specifications for different building materials
- Calculate required quantity of building materials for a given project set.
- Prepare BOQ for construction projects
- Estimate cost of Construction for different types of buildings

Course Content:

1. **Introduction to Building Code**- Introduction to building code and specification as per NBC and ECBC. Estimation methods for various building components
2. **Material Specification**- Specification of different building materials such as brick, cement, glass, steel, etc.; for architectural and structural components, for exterior and interior applications.
3. **Quantity Calculation**- Calculation of quantities for different building types.
4. **Cost Estimation**- Estimating cost based on market survey, rate analysis, detailed specification including materials, labour, transport, supervision, etc.;
5. **Preparing Cost Estimate**- Preparation of Cost estimate for a given drawing set with specification and estimation for project construction.

Pre-requisite Courses: None

Reference Books:

1. "Estimating and Costing" , S K Dutta, S Chand Publishing , 2013.
2. "Estimating", S C Rangwala, CHAROTAR BOOKS DIST , 2009.
4. "Estimating Building Costs", Calin, CRC Press , 2003.
5. "Estimating Construction Costs", Robert L Pennfoy, McGraw-Hill Education, 2013.

UA16BA354
WORKING DRAWING(2-2-0-3)

Course Objectives:

The students will be introduced to:

- Drawing standards and notations for Architectural drawings
- Preparation of Coordinated Drawing set for architectural project inclusive of Structure, Services & Landscape
- 'Good For Construction' drawings for architectural projects
- Detailed drawings for service intensive spaces
- Drawing preparation for Sanction process and Approvals

Course Outcomes:

The students will be able to:

- Apply standard drafting practices and notations in architecture drawings.
- Appreciate the significance of coordination between architecture and allied disciplines
- Enlist stages of project execution from concept to completion
- Prepare detailed 'Good for construction' working drawings
- Prepare detailed drawings with dimensions and specifications for different buildings.

Course Content:

1. **Introduction to Working drawing**- Relevance of working drawings in architectural practice and construction industry
2. **Architectural working drawings**- Preparing working drawings for a given project with reference to structural drawings.
3. **Coordination drawings**- Preparing working drawings for a given project with reference to electrical and plumbing layout.
4. **Detail drawings** - Preparing detailed drawings for Kitchen and toilet inclusive of tiling pattern, fixtures and services.
5. **Overview of Sanction process**- Understanding of sanction process, approvals and different regulatory bodies.

Pre-requisite Courses: None

UA16BA355
STRUCTURES- IV(2-0-1-2)

Course Objectives:

The student will be introduced to:

- High Rise structures and its composition
- Gravity loads to structures
- Seismic and Wind loading
- Lateral Load Resisting System
- Moment resisting frame

Course Outcomes:

The student will be able to:

- Calculate building loads for consideration of Seismic loads, Wind loads and Gravity.
- Calculate dead and live based on IS Codes
- Perform static analysis for seismic and wind loads
- Design buildings for Lateral Loads
- Compose Moment-resisting 2-dimensional frame.

Course Content:

1. **Introduction of High Rise Structures,Introduction to the Structural design Project:** Composition of the elements for a 10 storey building of dimension 30m × 30m [Suggested Dimension], 35 meter height, 10m X 10m column gridand with service core in the central bay. Calculation of building loads load calculationbased on the IS 875 and seismic loads and wind loads and design of gravity and lateralsystems.
2. **Gravity loading**: Dead and Live load calculation based on IS 875 (Part 1)and NBC**.**
3. **Seismic and Wind loading:**Seismic loading calculation based on IS 1893 Code; Static Analysis Procedure.Wind loading calculation based on Indian Standard I.S. 875 (Part 3)**.**
4. **Introduction to Lateral Load Resisting System:** The structural systems of buildings designed to withstand lateral loads caused by wind and seismic activity.
5. **Moment resisting frame:** Composition of the elements of Moment-resisting 2-dimensional frameassemblies of beams and columns, with the beams rigidly connected to the columns. General moment resisting framing arrangement and sizing and design of beams, columns and slabs for 30m X 30m [Suggested Dimension], 35 meter high building, andbasic load path and total structural weight calculation.

Pre-requisite Courses: None

Reference Books:

1. "Structures",Martin Bechthold, Daniel L Schodek, PHI Learning Private Limited, 2014
2. "Building Structures Illustrated", Francis D.K. Ching, 2nd Edition, John Wiley &Sons, 2013.
3. "Building Construction Illustrated", Francis D.K. Ching, 4th Edition, John Wiley & Sons, 2014
4. Indian Standard Codes - IS456-2000, IS-875 (Part I to IV), IS-1893; National Building Codes, SP-34 Steel detailing.

UA16BA356
BUILDING SERVICES- IV (Acoustics)(2-0-1-2)

Course Objectives:

The students will be introduced to:

- Different built environments that require sound control
- Fundamentals of sound and acoustics
- Behaviour of Sound in architectural projects such as auditoriums, seminar halls, theatres, etc
- Acoustical design in buildings
- Appropriate materials and technology for acoustical design

Course Outcomes:

The students will be able to:

- Identify the design parameters necessary for sound control
- Apply properties of sound in designing projects
- Arrive at acoustical design solutions for specific projects
- Propose appropriate materials for acoustic design
- Analyze practical application of acoustic services

Course Content:

1. **Overview of Acoustics** - Properties of Sound, need for acoustical design
2. **Sound in enclosed spaces** - Behaviour of Sound in spaces such as auditoriums, seminar halls, etc
3. **Acoustical Design** - Acoustical Design of different type of enclosed spaces, calculation of reverberation time
4. **Materials & Techniques** - Different types of materials for sound absorption and reflection. Fixing and construction techniques for the same.
5. **Noise pollution**- Control of environmental noise through traffic, industries, etc.

Pre-requisite Course: None

Reference Books:

1. "Building Services Handbook" , Hall & Green ,Routledge , 2013.
2. "Architectural acoustics", David Egan, J. Ross Publishing , 2007.
3. "Theatres And Concert Halls", Birgit Schmolke, Page One, 2011 .

UA16BA357
ENVIRONMENTAL STUDIES (1-0-0-0)

Course Objectives:

The students will be introduced to:

- Fundamentals of Environmental Science
- Relationship between natural and man-made environments
- Issues and challenges in design of built spaces with respect to environmental changes
- Concepts in Bio-mimicry, Renewable Energy systems
- Overview of Urban Ecology and Landscape Urbanism

Course Outcomes:

The students will be able to:

- Employ the fundamental concepts of Environmental science in architectural pursuits.
- Explore the complex relationship between environmental factors
- Explore the role of environmental changes in shaping built spaces
- Apply the principles of Bio-mimicry in Building design
- Integrate principles of Urban Ecology and renewable energy systems in Architecture

Course Content:

1. **Fundamental concepts in Environmental science** - Ecological systems, biotic andabiotic factors, Parametersaffecting the environment at macro and micro level.
2. **Relationship between natural and man-made environments**- Complex relationship between Natural Environments and built environments- design and planning strategies to mitigate ill effects of uncontrolled urban development
3. **Concepts in Bio-mimicry** - Study of natural systems and process and their application in Architectural design
4. **Urban Ecology & Landscape Urbanism** - Principles of landscape Urbanism, significance of integrating landscape and ecology in planning for Urban framework
5. **Renewable Energy systems**- Types of renewable energy systems, application in built environment planning

Pre-requisite Course:None

Reference Books:

1. "Housing Climate Comfort", Martin Evans, Architectural Press, 1980.
2. "Climate Responsive Architecture", Arvind Kishan, Baker and Szokolay, McGraw Hill Edu , 2017.
3. "Green Architecture- Design for a Sustainable Future", Brende and Robert vale,Thames & Hudson Ltd , 1991.
4. "Green Architecture-A guide for Sustainable Design", Michael J Crosbie, Aia Pr ,1995.
5. "Zero Carbon Homes", Jo Williams, 2012.

UA16BA358
SEMINAR/ ACTIVITIES VI (0-2-0-0)

Course Objectives:

The students are exposed to:

- Various activities
- The significance of Documentation and analysis
- Industry practices and subject experts
- Application of theoretical knowledge in real world scenario
- Interaction with allied professionals

Course outcome:

The students will be able to:

- Carry out different activities.
- Document and prepare models
- Analyze available data and draw inferences
- Realize the significance of architectural theory in practical application
- Appreciate the diligence and dedication required to succeed in the chosen profession

Course Content:

1. Literature study of activity
2. Analysis of activity
3. Synthesis of data and proposals
4. Preparation of drawings/concepts/ conclusions/models
5. Report.

UA16BA359
SITE EXPOSURE VI (0-6-0-0)

Course Objectives:

The students are exposed to:

- The site & its conditions.
- Hands on experience and exposure to actual construction practices
- The latest construction techniques
- The interface between industry and academia
- The knowledge of construction materials and its usage.

Course outcome:

The students will be able to:

- Realize the practical aspects of a construction site.
- Prepare documentation of the site visits.
- Identify to the practical requirements to be considered in projects.
- Interpret & respond to real time on site needs.
- Incorporate the knowledge gained on site, in their designs and drawings.

Course Content:

1. Study of the site and data collection
2. Analysis of the data
3. Synthesis of data and proposals
4. Preparation of drawings/conclusions
5. Report.

UA16BA341
ARCHITECTURAL DESIGN WITH STEEL (2-0-0-2)

Course Objectives:

The students will be introduced to:

- Design potential of steel as a building material
- Aesthetic and structural properties
- Best practices using steel as a building material
- Architectural examples using steel as primary building material (Global context)
- Architectural examples using steel as primary building material (Indian context)

Course Outcomes:

The students will be able to:

- Appreciate the limitations and possibilities of steel as a construction material
- Explore use of steel in different building components
- Analyze use of steel in different Building typologies
- Realize application of steel for structural and visual appeal
- Arrive at Design solutions using steel as the primary material

Course Content:

1. **Introduction to steel as a Construction material**- Properties of steel, manufacturing process, types of steel in building construction, costing
2. **Use of steel in different building component**s - Use of steel for structure, cladding, furniture, doors, windows, etc
3. **Analyze use of steel in different Building typologies**- Application of steel in different buildings in traditional and contemporary context.
4. **Notable examples of Architectural Design with steel**- Case Study of Architectural examples with steel as primary building material and innovative design applications
5. **Design project**- Design and detail of a given building type using steel construction

Pre-requisite Course:None

Reference Books:

1. "Detail featuring Steel - Resources, Architecture , Reflection ", Detail; Har/DVD edizione , 2009.
2. "Architecturally Exposed Structural Steel, Terry, Meyer & Boake, Walter De Gruyter Inc , 2012.
3. "Architecture Material & Detail Structure – Metal", Fernando Perez, words and visual press pte ltd, 2016.

UA16BA342
ARCHITECTURAL DESIGN WITH GLASS (2-0-0-2)

Course Objectives:

The students will be introduced to:

- Design potential of glass as a building material
- Aesthetic and structural properties
- Best practices using glass as a building material
- Architectural examples with innovative use of glass (Global context)
- Architectural examples with innovative use of glass (Indian context)

Course Outcomes:

The students will be able to:

- Appreciate the limitations and possibilities of glass as a building material
- Explore use of glass in different building components
- Analyze use of glass in different building typologies
- Realize application of glass for design visual appeal
- Arrive at Design solutions using glass as the primary material.

Course Content:

1. **Introduction to glass as a Construction material**- Properties of glass, manufacturing process, types of glass in building construction, costing
2. **Use of glass in different building component**s - Use of glass for facade, partitions, doors, windows, furniture, etc
3. **Analyze use of glass in different Building typologies**- Application of glass in different buildings in traditional and contemporary context.
4. **Notable examples of Architectural Design with glass** - Case Study of Architectural examples with innovative design applications of glass
5. **Design project**- Design and detail of a given building type using different types of glass

Pre-requisite Course:None

Reference Books:

1. "Architecture Material & Detail Structure- Glass", Russel Brown, Design Media Publishing Ltd, 2015.

BACHELOR OF DESIGN

Program Education Objectives:

- **UA16BD_UG_PEO1** : Train students in contemporary, cutting-edge domains and engineering principles, so as to build capabilities to solve real world problems using Computing, Information and Communication Technology
- **UA16BD_UG_PEO2** : Prepare students for higher education in the best universities across the globe in all related areas of engineering and technologies through strong fundamentals .
- **UA16BD_UG_PEO3** : Instill research culture in students through research assistantships, research oriented projects, sponsored and collaborative research, patronizing publications and presentations.
- **UA16BD_UG_PEO4** : Hone students to develop an ability to innovate efficient solutions , which will have long term impact on the well being of the society.
- **UA16BD_UG_PEO5** : Create professionally superior and ethically strong globally competent employees and entrepreneurs

Program Outcomes:

- **UA16BDPO1** : Engineering Knowledge: Apply the knowledge of Mathematics, Science, Engineering fundamentals and an engineering specialization to the solution of complex engineering problems. (Design Fundamentals)
- **UA16BDPO2** : Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (complex design problems)
- **UA16BDPO3** : Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations. (complex design problems)
- **UA16BDPO4** : Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **UA16BDPO5** : Modern Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. (complex design activities)
- **UA16BDPO6** : The Engineer & Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. (design practice)
- **UA16BDPO7** : Environment & Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. (design solutions)
- **UA16BDPO8** : Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. (design practice)
- **UA16BDPO9** : Individual & team work: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
- **UA16BDPO10** : Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. (design activities).
- **UA16BDPO11** : Project Management & Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. (design projects & principles).
- **UA16BDPO12** : Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

I SEMESTER B. DES (2018-22 BATCH)

UA18BD101:
INTRODUCTION TO MATERIALS (0-2-2-0-4)

Course objectives:

To introduce students to:

- Natural Materials and their properties for design applications
- Synthetic Materials and their properties for design applications
- Thermoplastics and thermosetting plastics and their properties for design applications
- Composite materials and their properties for design applications
- Surface treatments and their properties for design applications

Course Outcomes:

At the end of the course students will be able to:

- Explore a range of natural materials, their properties and visual perception.
- Explore a range of engineered their properties and visual perception.
- Explore a range of composite materials, their properties and visual perception.
- Appreciate the macroscopic view of materials, their usage and its implications.
- Choose appropriate materials for product design.

Course Content:

1. Natural Materials: Study of wood, bamboo, cane, leather, jute, rubber, paper, etc.
2. Synthetic Materials, their properties and usage: rubber, MDF, plywood, ceramics, glass, metals, and their properties.
3. Thermoplastics and thermosetting plastics, their properties and usage.
4. Composite materials, their properties and usage.
5. Surface treatments: Materials used for coating other materials. Surface finish (surface roughness). Macro-view of materials, processing and sustainability.

Pre-requisites Courses: None

Reference Books:

1. "Materials for Design", Chris Lefteri, 1st Edition, Laurence King Publishing Limited, 2014.
2. "Materials and Design", Mike Ashby and Kara Johnson, 3rd Edition, Butterworth-Heinemann, 2014.
3. "Design and Technology", Garratt James, 2nd Edition, Cambridge University Press, UK, 1996.
4. "Industrial Design: Materials and Manufacturing Guide", Jim Lesko, 2nd Edition, John Wiley & Sons, Inc. Hoboken, New Jersey, 2007.

II SEMESTER B. DES (2018-22 BATCH)

UA18BD151:
PROJECTS IN PRODUCT, INTERACTION & COMMUNICATION DESIGN (0-2-2-0-4)

Course Objectives:

- Expose students to aspects of design sketching
- Expose students to rendering ideas
- To introduce students to product design projects
- To introduce students to communication design projects
- To introduce students to interaction design projects

Course Outcome:

At the end of this course, the student will be able to:

- Visualize their ideas through sketches
- Render their ideas using appropriate shading and coloring techniques
- Appreciate the various design processes involved in product design
- Appreciate the various design processes involved in communication design
- Appreciate the various design processes involved in interaction design

Course Content:

1. Exploring different sketching media: graphite pencils, watercolor, acrylic, gel pens, markers and paper for sketching different materials and their textures used in products
2. Representing various product, interaction and communication design elements, giving material thickness, surface texture/ treatment etc
3. Product design and processes
4. Communication design and processes
5. Interaction design and processes

Pre-requisite Courses: None

Reference Books:

1. "Sketching for Designers", Scott Robertson, Design Studio Press , 2013.
2. "Sketching User Experiences: Getting the Design Right and the Right Design, Morgan Kaufman", Bill Buxton, Elsevier, 2007.
3. "How to Render: Fundamentals of Light, Shadow and Reflectivity", Scott Robertson with Thomas Bertling, Design Studio Press, 2012
4. "Interaction Design: Beyond Human-Computer Interaction", Sharp and Rogers, 2007.
5. "Product Design and Development", Karl Ulrich and Steven Eppingers, Pearson Education, 2009.
6. "The Elements of Graphic Design" Alex W. White, 2nd Edition, Paperback, 2011.
7. "Visual Communication: Images with Messages", Paul Martin Lester, 2002.

III SEMESTER B. DES (2017-21 BATCH)

UA17BD201 :
DESIGN HISTORY (3-0-2-3)

Course Objectives:

To introduce students to:

- Various periods of Modern Design History
- Arts, Craft and Machines (1866 - 1914)
- Post World War I and World War II (1945-1960)
- Impact of the World Wars on the evolution of Modern Design
- Social changes and design

Course Outcomes:

The students will be able to:

- Identify products and graphics from different eras of Modern Design
- Differentiate movements which led to mass manufacturing
- Appreciate the role of Entrepreneurship in the growth of design as a global phenomenon
- Relate with social changes with time and design
- Appreciate impact of the World Wars on the evolution of Modern Design

Course Content:

1. Introduction to Modern Design History; Industry, Supply, Demand and Design (1700 - 1865)
2. Arts, Craft and Machines (1866 - 1914)
3. Post World War I (1918 - 1944)
4. Post World War II (1945-1960)
5. Development, Revolts and Movements of Equality (1960 - 2000)

Pre-requisite Courses: None

References:

1. "History of Modern Design", 1st Edition, by Laurence Pu King, Laurence King David Raizman, Prentice Hall PTR, 2003.
2. "Founders of American Industrial Design", Carroll Gantz, McFarland & Company, 2014.
3. "Design Chronicles", Gantz, Carroll FIDSA, Publisher: Schiffer Publishing Ltd, 2005.

UA17BD202:
DESIGN METHODS AND CREATIVITY (4-0-0-4)

Course Objectives:

- To introduce students to
- Design methods to solve various design problems
- Design methods for design in various design contexts
- Patterns of reasoning in design
- Methods for Analysis and Synthesis and their preliminary application
- Methods for Simulation and evaluation, and their preliminary application

Course Outcomes:

At the end of the course the students will be able to

- Appreciate the importance of methods during design
- Choose methods particular to the design stage in question
- Apply methods individually or in groups in the design stage
- Apply techniques in Analysis and Synthesis
- Apply methods for Simulation and evaluation

Course Content:

1. Introduction to design method and design methodology
2. Patterns of reasoning in design. Significance of methods for questioning the status quo and creativity. Methods for understanding user needs, validation and their application
3. Introduction to methods for analysis and their preliminary application
4. Introduction to methods for Synthesis and their preliminary application
5. Introduction to methods for Simulation and evaluation, and their preliminary application

Pre-requisite Courses: None

References:

1. "Design Methods- Seeds of Human Futures", C.J. Jones, Wiley–Interscience, 1989.
2. "Product Design: Fundamentals and Methods", NFM Roozenburg and J Eekels, 1995.
3. "How Designer's Think: The Design Process Demystified", B. Lawson, Architectural Press, 1997.
4. "Product Design and Development", U. T. Karl and S. D. Eppinger, 3rd Ed., Tata McGraw Hill, 2004.
5. "Industrial Design in Engineering – a Marriage of Techniques", C.H. Flurscheim Ed., The Design Council, 1983.
6. "Design of Everyday Things", D. Norman, , Currency Books, New York, 1990.
7. "Usability **Engineering", J. Nielsen, , Morgan Kaufmann, San Francisco, 1993.**

UA17BD203: SEMINAR / ACTIVITIES III (0-2-0-0)

Course Objectives:

To introduce students to:

- Design activities
- Hands-on experience and exposure to actual design practices through lectures, demonstrations etc
- Latest design methodologies and techniques.
- Interactions between Industry and Academia
- Composition and analysis of space

Course outcome:

The students will be able to:

- Realize the practical aspects of the design process.
- Prepare documentation of the design based demonstrations or lectures.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time design needs.
- Incorporate the knowledge gained during the lecture/ demonstrations/ activity in their drawings/process models.

Course Content:

1. Study of the design processes/models/design considerations/ design approaches
2. Analysis of approaches taken by industry/academic experts
3. Synthesis of data/design models/design considerations
4. Preparation of drawings/conclusions/models/solutions
5. Report

UA17BD204: SITE EXPOSURE III (0-6-0-0)

Course Objectives:

- Project site & its conditions
- Hands-on experience and exposure to actual design practices.
- Latest design techniques in the industry
- Interactions between Industry and Academia
- Composition and analysis of space

Course outcome:

The students will be able to:

- Realize the practical aspects of the design process.
- Prepare documentation of the industry / site visits.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time industry/on site needs.
- Incorporate the knowledge gained during industry visits in their models/portfolio/drawings.

Course Content:

1. Study of the industry site visit and data collection
2. Analysis of data
3. Synthesis of data/design models/design considerations
4. Preparation of drawings/conclusions/models/solutions
5. Report

UA17BD206: GRAPHIC DESIGN (6-0-2-6)

Course Objectives:

- To introduce students to the elements and principles of graphic design
- To expose students to raster and vector-based technology
- To expose students to critical thinking and problem solving through graphic design
- To expose students to Typography
- To expose students to Printing & web Design process

Course Outcomes:

The students will be able to:

- Make compositions using elements and principles of graphic design
- Use technology to solve problems through concept development and critical thinking
- Work & understand between Vector & raster based designs
- Bring out the attributes by understanding Typography Principles
- Work & understand between printing & web design

Course Content:

1. Introduction to Graphic Design
2. Exploring Elements of Graphic Design
3. Exploring Principles of Graphic Design
4. Typography
5. Creating images for Print & Web

Pre-requisite Courses: None

References:

1. "Graphic Storytelling and Visual Narrative", Will Eisner Instructional Books, 1996.
2. "How to Use Graphic Design to Sell Things, Explain Things, Make Things Look Better, Make People Laugh, Make People Cry, and (Every Once in a While)",Thames & Hudson Limited, Michael Bierut, 2015.
3. "The Elements of Graphic Design", Alex White, Skyhorse Publishing, 2002.

UA17BD201P: PRODUCT DESIGN AND DEVELOPMENT (6-0-2-6)

Course Objectives:

To introduce students to

- Details of design and development of a technical product in an industrial context
- Interactions of design with other departments in a development cycle
- Product Specification and Industrial Design
- Concept generation, selection and testing
- Product Modelling, Costing and Prototyping

Course Outcomes:

At the end of the course the students will be able to

- Identify the challenges in product development
- Identify characteristics of successful product development
- Appreciate interactions of design with other departments in a development cycle
- Recognize information flows in the product design and development cycle
- Identify the deliverables in each design phase of product design and development cycle

Course Content:

1. Definitions of Product Design, Introduction to Product Development and Processes in Organizations
2. Product Specification and Industrial Design
3. Concept generation, selection and testing
4. Product Modelling, Costing and Prototyping
5. Product Architecture and Development Economics

Pre-requisite Courses: None

References:

1. "Product Design and Development", Ulrich, Karl T., Eppinger, Steven D., McGraw-Hill, 2004
2. "Product Design: Fundamentals and Methods", Roozenburg and Eekels, Publisher: John Wiley & Sons Inc; New edition, 1995
3. "Creating Breakthrough Products: Innovation from Product Planning to Program Approval", Cagan, Jonathan; Vogel, Craig M., Publisher: Financial Times Prentice Hall; 2002
4. "Design Revolution: 100 Products That Empower People", Pilloton, E., Metropolis Books, 2009
5. "Methods for the Systematic Development of New Products", Publisher: Chapman & Hall, 1995

UA17BD202P:
MATERIAL SELECTION AND MANUFACTURING PROCESSES (2-2-0-3)

Course Objectives:

To introduce students to

- Aesthetic and engineering properties of materials in product design
- Material selection for product design
- Subtractive manufacturing processes
- Additive manufacturing processes
- Fabrication processes

Course Outcomes:

At the end of the course the students will be able to

- Appreciate the nature of material selection criteria in product design and the necessity to balance these
- Model aesthetic criteria and basic engineering criteria for material selection
- Select materials from appropriate material selection charts
- Relate Subtractive manufacturing processes with current trends
- Relate Additive manufacturing processeswith current trends

Course Content:

1. Different criteria for material selection across product categories; aesthetic properties of materials and modeling them for selection;
2. Considerations of engineering properties during design of products and modeling them for selection; Introduction to material selection by analysis, synthesis and inspiration
3. Material selection charts and their interpretation
4. Subtractive manufacturing processes across metals, non-metals, composites etc.
5. Additive manufacturing processes across possible materials and fabrication techniques

Pre-requisite Courses: None

References:

1. "Materials and Design: The Art and Science of Material Selection in Product Design", Ashby, Michael; Johnson, Kara, Publisher: Butterworth-Heinemann; 2014.
2. "Materials Selection in Mechanical Design", Ashby, M.F., Pergamon Press, 1992.
3. "Industrial design: Materials and Manufacturing guide", Jim Lesko, 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey 2007.
4. "Polymer Products: Design, Materials and Processing", David H. Morton-Jones, John W Ellis, Chapman and Hall, 2011.
5. "Manufacturing processes for designprofessionals", Thompson R., Thames & Hudson, London, 2007.
6. "Design and Technology", Garratt J., Cambridge University Press, UK, 2004.

UA17BD203P :
FORM STUDIES AND SCULPTING (3-2-2-4)

Course Objectives:

This course introduces students to:

- Abstraction of objects
- Taxonomy of objects
- Metaphor and semantics
- Concept of family of forms
- Sketches to 3D forms using modeling software

Course Outcomes:

At the end of the course the students will be able to

- Identify appropriate metaphors to generate forms for products
- Apply abstraction and product expressions in the context of product form
- Apply theories of object categorization and product semantics
- Apply a generic approach towards digital sculpting
- Render digital prototypes for representing the aesthetic value of design

Course Content:

1. Form generation using abstraction and metaphors in the context of products.
2. Study of product expressions like soft, hard, warm, cold, precise, gross, delicate, strong, fragile, rugged etc. by analyzing in terms of design elements
3. Concept of family of forms; Taxonomy of objects and meaning. Understanding identity from the perspective of design elements and principles. Case studies
4. Creating basic building blocks, curves, surfaces and volumes. Frame and fillet approach to digital sculpting, generating shapes using basic building blocks.
5. Converting sketches to 3D forms using modeling software

Pre-requisite Courses: None

References:

1. "Design and Form", Itten, Johannes;, Publisher: English Edition, Wiley Publications, 1997.
2. "Order and Meaning in Design", Wim Muller, Lemma Publishers - Utrecht - 2001, ISBN 905189705

3. "Women, Fire, and Dangerous Things", Lakoff, G, University of Chicago Press, 1990.
4. "Semantic Turn : New Foundation for Design", Krippendorff, K, Taylor and Francis, 2005.
5. "Semantic Vision in Design : Symposium on Design", Vihma, S (ed), University of Industrial Arts (UIAH), 1990.
6. "Human Categorization", Eleanor Rosch, Warren, Neil, (Ed.), "Advances in Cross-Cultural Psychology 1: 1-72". Academic Press. (Book Chapter), 1977.
7. "Principles of Perceptual Learning and Development", Gibson, E.J, Appleton, New York, 1966.
8. "Learning Design with Alias Studio Tools: A Hands-on Guide to Modeling and Visualization in 3D. Sybex", Beisert, F. T., 2006.

UA17BD211P :
DESIGN MATH (2-0-0-2)

Course Objectives:

To introduce students to:

- Basic mathematical concepts needed during design analysis
- Concepts of Integral
- Working ideas in Matrix Algebra
- Techniques in Optimization
- Matlab

Course Outcomes:

At the end of the course the students will be able to

- Appreciate math in design
- Appreciate form geometrically and the necessity for a mathematical basis to analyze
- Apply mathematical concepts to reduce product geometry into elements for analysis
- ApplyMatrix Algebra to design issues
- ApplyMatlab to design problems

Course Content:

1. Foundations of Calculus-Limits, continuity, derivative, the derivative as rate of change; Applications of the derivative-graphing of functions, maximum/minima problems, related rates, falling bodies; Taylor Series, Non-linear equation-Newton Raphson's Method.
2. Integral-introduction, antiderivatives and infinite integrals, the area between two curves, rules of integration, methods of integration, Applications of Integral, Introduction to Numerical Methods of Integrations- The trapezoidal Rule, Simpson's Rule, Gauss quadrature.
3. Introduction to Matrix Algebra, Matrix operations, systems of equations, Gaussian Elimination, LU Decomposition, Gauss-Siedal Method, Eigenvalues and Eigen Vectors.
4. Optimization- Introduction, One Dimensional Unconstrained Optimization, Linear Programming (LP)-linear programming problem, Problem Modeling, Geometric concepts, Standard form of an LP, The Simplex method, Multi-objective Optimization (concepts)
5. Introduction to Matlab, Matlab Environment, vector and matrices, plotting and graphics, Statistics and an introduction to programming in Matlab, Curve Fitting.

Pre-requisite Courses: None

References:

1. "Higher Engineering Mathematics", B S Grewal, Khanna Publishers, 40th Edition, 2007.
2. "Calculus Demystified", Steven G. Krantz, McGraw Hill, 2011.
3. "Introduction to Matrix Algebra", Autar Kaw, 2nd Edition, 2010.
4. "Optimization Concepts and Applications in Engineering", Ashok D. Belegundu and Tirupathi R. Chandrupatla, Cambridge University Press, 2nd Edition, 2011.
5. "Matlab Demystified", David McMahon, McGraw Hill, 2007.
6. "Getting Started with MATLAB : A Quick Introduction for Scientists and Engineers", Rudra Pratap, Oxford University Press, 2016.

UA17BD212P:
DIGITAL SOLID SCULPTING (2-0-0-2)

Course Objectives:

To introduce students to

- Composing forms out of basic forms
- Composing forms out ofBoolean operations
- Digital solid modeling features for generating parts/components
- Modeling aspects of assembly of parts and components
- Modeling aspects of assembly ofcomponents

Course Outcomes:

The students will be able to

- Model basic forms
- Compose forms using Boolean operations on different form types
- Perform feature additions/subtractions on forms
- Parametric modeling of parts and their assembly
- Parametric modeling of components and their assembly

Course Content:

1. History and evolution of Digital solid sculpting. Introduction to basic object creation; point, line, plane, shape, surface form and interpreting them from a design perspective
2. Modeling of basic forms, Composing forms with single and multiple type of these based on the visual feedback from the renderers or off screen rendered views.
3. Boolean operations and composing forms using one or a combination of operations and interpreting them from the perspective of form composition, transitions, intersections etc.
4. Feature operations on forms composed and their design significance
5. Parametric modeling of parts/components and their assembly.

Pre-requisite Courses: None

References:

1. "CAD/CAM Theory and Practice", Zeid, I. McGraw-Hill Higher Education, 199.1
2. "CADCAM: From Principles to Practice", McMahon, C., & Browne, J. J. Addison-Wesley Longman Publishing Co., Inc., 1993.
3. "CAD Software - History of CAD CAM"- http://www.cadazz.com/cad-software-history.htm

UA17BD201C :
INTRODUCTION TO ANIMATION (3-2-2-4)

Course Objectives:

To introduce students to:

- Animation
- Animation Process
- Different techniques of 2D animation
- Principles of Animation
- Production Process

Course Outcome:
The students will be able to

- Understand Animation
- Understand Production Process
- Work with different stages of Production
- Create animation of different types
- Develop animation using principles of animation

Course Content:
1. Introduction to Animation
2. Production Process
3. Animation Principles and Examples
4. Techniques in 2D Animation
5. Short film : 2D Animation

Pre-requisite Courses: None

References:
1. "Cracking Animation: The Aardman Book of 3-D Animation", Peter Lord, Nick Park, Brian Sibley, 4th Edition, Thames & Hudson, 2015.
2. "Flash Cartoon Animation: Learn from the Pros", Glenn Kirkpatrick and Kevin Peaty, Springer, 2004.
3. "Animation 1: Learn to Animate Cartoons Step by Step", Preston Blair, Walter Foster Publishing, 1980.
4. "The Animator's Survival Kit", Richard E. Williams, 2nd Edition, Faber & Faber, 2009.

UA17BD202C : INTRODUCTION TO FILM MAKING (2-2-1-3)

Course Objectives:
To introduce students to:

- Basic film making and photographic equipments,
- Different roles in film making,
- Photo Journalism
- Documentary skills
- To assist students develop sets and props for film shoot

Course Outcome:
Students will be able to:

- Use film making
- Use photographic equipments,
- Appreciate different roles in film making
- Apply basic techniques used in Photo Journalism
- Make a Documentary

Course Content:
1. Basics of Film Making and film genres - Major genres: Narrative, avant-garde, and other genres.
2. Pre production - Story blocks, scrip writing, casting art makeup wardrobe, planning and scheduling.
3. Case Study 1 (Minor project) - Short movie
4. Indian cinema and Set design - History of Indian cinema and different set designs
5. Major project - Photo and Video Communication

Pre-requisite Courses: None

References:
1. "The Development of Film", Alan Casty, Harcourt Publishers Group, 1973.
2. "Photojournalism: The Professionals' Approach", Kenneth Kobrre, Focal Press, 1980.
3. "Basic Photography", John Hedgecoe, Auoro Books, 1993.
4. "The Art of Dramatic Writing", Lajos Egri, Touchstone, 2004.

UA17BD211C: FASHION COMMUNICATION (2-0-0-2)

Course Objectives:
To introduce students to

- Theory fashion communication
- Practice of fashion communication
- Communication of contemporary fashion concepts through digital media
- Presentation of contemporary fashion concepts through digital media
- Fashion Photography

Course Outcomes:
At the end of the course the students will be able to

- Apply Theory of fashion communication to design projects
- Create a Presentation of contemporary fashion concepts
- Produce a professional fashion communication product like fashion film
- Create a professional fashion communication product like fashion magazine
- Build a professional fashion communication product promotional package.

Course Content:
1. Principles of Fashion
2. Colour harmonies
3. Merchandising
4. Fashion accessories
5. Design and product development

Pre-requisite Courses: None

References:
1. "Elements of Fashion and Apparel Designing", Sumathi G.J., New Age International Pvt. Ltd, 2007.
2. "Inside the Fashion Business", Kitty G Dickerson, Pearson, 2002.
3. "Fashion from Concept to Consumer", Cini Stephens Frings, Pearson, 1982.
4. "Fashion Sketching Book", Bina Abling, Fai Child, Bloomsbury Academic, 2012.
5. "Wardrobe Strategies for Women", Judith Rasband, Delmar, Bloomsbury Academic, 2001.
6. "Fundamentals of Textile and their Care", Susheela Dantygi, Orient Longman Ltd, 1964.

UA17BD212C : PRINTING TECHNOLOGIES (2-0-0-2)

Course Objectives:
To introduce students to:

- Printing Processes
- Printing Techniques
- Paper and surface preparation
- Ink Technology
- Digital methods in printing

Course Outcomes:
At the end of the course the students will be able to

- Appreciate the principles and technical operations in printing, processes and techniques

- Appreciate different types of Paper and Ink Technologies
- Appreciate different types of Ink Technologies
- Apply digital methods in printing
- Prepare paper and surface preparation

Course Content:

1. Introduction to printing processes and technologies
2. Introduction to printing techniques
3. Introduction to paper and surface preparation
4. Introduction to Ink and technology
5. Introduction to digital methods in printing

Pre-requisite Courses: None

References:

1. "Handbook of Print Media", Helmut Kipphan, Springer Berlin Heidelberg, 2014.
2. "Printing technology", J. Michael Adams, Delmar, 2002.
3. "Fabricated: The New World of 3D Printing", Hod Lipson, Melba Kurman, John Wiley & Sons, 2012.

UA17BD201T :
GAME DESIGN (3-2-2-4)

Course Objectives:

To introduce students to

- Concepts of Game Design
- To expose students to the basic tools of game design
- Principles involved in Games for Change
- Game Framework
- Case study in Game Design

Course Outcome:

The students will be able to:

- Design a board game
- Appreciate the Mechanics, Dynamics, Aesthetics Frame work in a game
- Apply Game Design Principles
- Prepare a Game for Change
- Design a Case study -Game for critique

Course Content:

1. Elements of Gaming and history
2. Game Framework - Mechanics, Dynamics, Aesthetics Frame work
3. Games for Change - Psychological, behavioral, and social aspects of games
4. Case study -Game for critique
5. Major Project: Board Game Design

Pre-requisite Courses: None

References:

1. "100 Principles of Game Design", Wendy Despain, New Riders, 2013.
2. "The Art of Game Design: A Book of Lenses (and a deck of lenses)", Jesse Schell, 2nd Edition, CRC Press, 2008.
3. "A Theory of Fun for Game Design", Raph Koster, O'Reilly, 2004.
4. "Rules of Play: Game Design Fundamentals", Katie Salen and Eric Zimmerman, MIT Press, 2003.
5. "The Gamification of Learning and Instruction: Game-Based Methods and Strategies for Training and Education", Karl M. Kapp, Pfeiffer, 2012.
6. "Gamify: How Gamification Motivates People to do extraordinary things", Brian Burke, Taylor and Francis Group, 2014.
7. "The Game Inventor's Guidebook", Brian Tinsman Fundamentals of Game 8. Design, 3rd Edition, Ernest Adams, Krause Publications, 2003.

UA17BD202T:
HUMAN-COMPUTER INTERACTION I (2-2-1-3)

Course Objectives:

To introduce students to:

- A brief history of Human Computer Interaction
- Human factors and its relationship with design and engineering
- To expose students to Early Computing Interfaces
- Methods of Study of Interaction devices
- A Case Study or Major project in HCI

Course Outcome:

The students will be able to:

- Observe Sensory devices in the context of HCI
- Differentiate between HCI and User Interface Studies
- Relate HCI with modern gadgets and developments
- Relate the history of computing gadgets with HCI
- Apply principles of User Centered design in a HCI project

Course Content:

1. A Brief History of HCI
2. Introduction to human factors – Psychology and physiology
3. User Centered Design
4. Study of Interaction devices - Keyboard, pointing devices, etc
5. Case Study or Major project - Design for Environment

Pre-requisite Courses: None

References:

1. "Interface: An Approach to Design", Bonsiepe, Gui, Dawn Barrett (Ed.), Maastricht, Uitgeverij De Balie, 1999.
2. "Experiences in Visual Thinking", McKim, Robert; Publisher: Brooks/Cole Publishing, 1980.
3. "Sketching User Experiences: Getting the D Design Right and the Right Design", Buxton, Bill, Elsevier, 2007.

UA17BD211T :
USER EXPERIENCE STUDIES (2-0-0-2)

Course Objectives:

To introduce students to:

- Theory user experience design
- Sensibilities of user experience design
- Various User profiles and persona
- Different Scenario modeling and task analysis
- Types of Surveys, focus groups, and interviews

Course Outcomes:

At the end of the course the students will be able to

- ApplyProblem solving skills for User Experience studies
- UseContextual inquiry methods in UX Studies
- Utilize profiles and personain UX Studies
- ApplyScenario modelingin UX Studies
- Conduct task analysisin UX Studies

Course Content:

1. Basics and Overview of User Experience
2. Contextual inquiry and wants/needs Assessment
3. User profiles and persona
4. Scenario modeling and task analysis
5. Surveys, focus groups, and interviews

Pre-requisite Courses: None

References:

1. "Observing The User Experience: A practitioner's Guide To user Research", Elizabeth Goodman, Mike Kuniavsky, Andrea Moed, Elsevier, 2005.
2. "Understanding Your Users: A Practical Guide to User", Kuniavsky, M., Elsevier, 2003.
3. "Don't Make Me Think: A Common Sense Approach to Web Usability". Berkeley, John Wiley & Sons,. NY, Krug, S. (2005). CA: New Riders. Morville, P., & Rosenfeld, L. 2007.
4. "Information Architecture for the World Wide Web", Seastopol, O'Reilly Media, CA, ,3rd Edition, , 1988.

UA17BD212T:
SPACE DESIGN (2-0-0-2)

Course Objectives:

To introduce students to:

- Principles of Interaction
- Principles and perception of Space
- Structure of Memory
- Structure of Virtual Spaces and Cognition
- Human Error and Space

Course Outcomes:

At the end of the course the students will be able to:

- Appreciate the principles of interaction design
- Appreciate the Structure of Memory and Space
- Appreciate the role of Human Error and Space
- Apply Human Error and Design in a project
- Apply structures of Virtual Spaces and Design Principles

Course Content:

1. Introduction to Fundamental Principles of Interaction
2. Introduction to the Seven Stages of Action
3. Introduction to Structure of Human Memory
4. Introduction to Human Error and Design
5. Introduction to Virtual Spaces and Design Principles

Pre-requisite Courses: None

References:

1. "Design of Everyday Things", D. Norman, Currency Books, New York, 1990.
2. "Making Sense of Space, The Design and Experience of Virtual Spaces as a Tool for Communication", Iryna Kuksa and Mark Childs, Elsevier, 2014.
3. "Human Dimension & Interior Space", Julius Panero, Watson Guptill Publications, 1979.

IV SEMESTER B. DES (2017-21 BATCH)

UA17BD251:
CONTEMPORARY DESIGN (2-2-0-3)

Course Objectives:

- To introduce students to the evolutionary aspects of contemporary design
- To enable students identify the impact of globalization on product, design
- To enable students identify the impact of globalization interaction design
- To enable students identify the impact of globalization on communication design
- To assist students appreciate the impact of mass production and its impact on sustainability

Course Outcomes:

The students will be able to:

- Recognize the application of the Universalization of Design in current products
- Appreciate impact of globalization on product, design
- Appreciate impact of globalization interaction design
- Appreciate impact of globalization on communication design
- Identify the complexity of social changes and role of visual communication

Course Content:

1. Understanding the term Contemporary Design
2. Emergence of personal aspirations
3. Product Design - Universalization of Design and Aesthetics
4. Interaction Design - Speed, Interface, Interaction and emphasis on productivity
5. Communication Design - Social changes and role of visual communication

Pre-requisite Courses: None

Reference:

1. "Aspects of Contemporary Book Design", Richard Hendel, University of Iowa Press, 2013.
2. "India: Contemporary Design: Fashion, Graphics, Interior", Divia Patel, Roli Books Private, Limited, 2014.

UA17BD252:
SEMINAR/ ACTIVITIES IV (0-2-0-0)

Course Objectives:

To introduce students to:

- Design activities
- Hands-on experience and exposure to actual design practices through lectures, demonstrations etc
- Latest design methodologies and techniques.
- Interactions between Industry and Academia
- Composition and analysis of space

Course outcome:

The students will be able to:

- Realize the practical aspects of the design process.
- Prepare documentation of the design based demonstrations or lectures.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time design needs.
- Incorporate the knowledge gained during the lecture/ demonstrations/ activity in their drawings/process models.

Course Content:

1. Study of the design processes/models/design considerations/ design approaches
2. Analysis of approaches taken by industry/academic experts
3. Synthesis of data/design models/design considerations
4. Preparation of drawings/conclusions/models/solutions
5. Report

UA17BD253:
SITE EXPOSURE IV (0-6-0-0)

Course Objectives:

To introduce students to:

- Project site & its conditions
- Hands-on experience and exposure to actual design practices.

- Latest design techniques in the industry
- Interactions between Industry and Academia
- Composition and analysis of space

Course outcome:

The students will be able to:

- Realize the practical aspects of the design process.
- Prepare documentation of the industry / site visits.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time industry/on site needs.
- Incorporate the knowledge gained during industry visits in their models/portfolio/drawings.

Course Content:

1. Study of the industry site visit and data collection
2. Analysis of data
3. Synthesis of data/design models/design considerations
4. Preparation of drawings/conclusions/models/solutions
5. Report

UA17BD254 :
ADVANCED GRAPHIC DESIGN (6-0-2-6)

Course Objectives:

- To introduce students to various communication theories
- To introduce students to the dynamics of motion graphics
- To enable students to work with typographic hierarchy
- To expose students to the art of storytelling through design and media
- To expose to Design, Media, Storytelling & Narratives

Course Outcomes:

The students will be able to:

- Apply communication theories to visual perception and semiotics through examples
- Produce typographic works which communicate to a diverse audience
- Construct visual narratives through Graphic Designs
- Understand Motion Graphics
- Understand Attributes of Typography

Course Content:

1. Communication Theories and Visual Perception
2. Semiotics
3. Exploring Motion Graphics
4. Advanced Typography
5. Design, Media, Storytelling and Narratives

Pre-requisite Courses: None

References:

1. "UI is Communication: How to Design Intuitive, User Centered Interfaces by Focusing on Effective Communication", Everett McKay, Elsevier, 2013.
2. "Visual Communication: Images with Message", Paul Martin Lester, Cengage, 1994
3. "Bridgman's Complete Guide to Drawing from Life", George B. Bridgman, Sterling Publishing Company, 2009.
4. "Human Motion: Understanding, Modelling, Capture, and Animation", Bodo Rosenhahn (Editor), Reinhard Klette (Editor), Dimitris Metaxas (Editor), Springer, 2010.
5. "Elemental Magic: The Art of Special Effects Animation", Joseph Gilland, Elsevier, 2009.
6. "Face Detection and Gesture Recognition for Human-Computer Interaction", Ming-Hsuan Yang and Narendra Ahuja, Springer Science, 2001 .

UA17BD251P :
ADVANCED DESIGN METHODS AND FORM STUDIES (6-0-2-6)

Course Objectives:

To introduce students to

- Higher level Analysis of a design problem
- Elaborate analysis of a design problem
- Synthesis methods for complex design problems
- Representation of design solution
- Prototyping of design solution

Course Outcomes:

At the end of the course the students will be able to

- Structurally analyze a design problem
- Synthesize for complex design requirements/specifications
- Represent the design outcome using digital tools
- Use Digital sculpting as a method
- Prototype using digital manufacturing techniques

Course Content:

1. Analyzing the Behavioral and societal needs for multi-stakeholder scenario. Analysis for a design problem, Framing the final specifications
2. Ideation for complex requirements using elaborate techniques like TRIZ
3. Form design for the concepts synthesized in unit 2. Product semantics, identity and cultural influence.
4. Digital sculpting of the best three concepts generated in unit 3
5. Presentation, digital rendering of the concepts and rapid prototyping

Pre-requisite Courses: None

References:

1. "The Art of Color: The Subjective Experience and Objective Rationale of Color", Itten, Johannes, Wiley Publications,1997.
2. "Women, Fire, and Dangerous Things", Lakoff, G:, University of Chicago Press, 1990.
3. "Semantic Turn : New Foundation for Design", Krippendorff, K :, Taylor and Francis, 2005.
4. "Semantic Vision in Design : Symposium on Design", Vihma, S (ed):, University of Industrial Arts (UIAH), 1990.
5. "Principles of Perceptual Learning and Development", Gibson, E.J:, Appleton, New York, 1966.
6. "Learning Design with Alias Studio Tools: A Hands-on Guide to Modeling and Visualization in 3D", Beisert, F. T.. Sybex.,2006.

UA17BD252P:
CAE IN PRODUCT DESIGN I (3-2-0-4)

Course Objectives:

To introduce students to:

- Basic concepts in modeling for design analysis
- Computational Modeling-physical problems in Engineering
- Theory of Elasticity and Fundamentals for Finite element methods
- Finite Element Methods in Beams
- Finite Element Methods in Frames

Course Outcomes:

At the end of the course the students will be able to

- reduce product geometry into components/elements for modeling purposes
- reduce product geometry into elements for modeling purposes
- model components for basic analysis
- apply design changes on inferring results from iterative design analysis
- apply FEM for Beams, Trusses and Frames

Course Content:

1. Computational Modeling-physical problems in Engineering, role of CAE (Computer Aided Engineering) in Product Design, computational modeling using the Finite Element Modeling, Approximate vs Actual method, Weighted residual Methods, Variational Method
2. Theory of Elasticity and Fundamentals for Finite element methods
3. FEM for Trusses-Introduction, FEM Equations, Problems and applications
4. FEM for Beam-Introduction, FEM Equations, Problems and applications
5. FEM for Frames - Introduction, FEM Equations for Planar Frames

Pre-requisite Courses: None

References:

1. "Introduction to Finite Elements in Engineering", Tirupathi R Chandrupatla,Ashok D Belegundu, Prentice Hall, 3rd Edition, 2002.
2. "Finite Element Analysis", G Lakshmi Narasaiah, BS Publications, 2008.
3. "Finite Element Analysis", S.S. Bhavikathi, New Age Publishers, 2010.
4. "The Finite Element Method: A Practical Course", G. R. Liu, S. S. Quek, Prentice Hall, 3rd Edition, 2013.
5. "Practical Finite Element Analysis", Nithin S Gokhale, Sanjay S Deshpande, Sanjeev V Bedekar, Finite to Infinite, First Edition, 2008.

UA17BD253P: MECHANISM DESIGN (2-2-0-3)

Course Objectives:

This course introduces students to:

- Basics of structures
- Basics of mechanisms
- Aspects of mechanisms and their cams in the context of products with moving members.
- Displacement and Velocity analysis using graphical methods
- Acceleration analysis using graphical methods

Course Outcomes:

At the end of this course students will be able to

- Relate aspects of mechanisms with the real world
- Differentiate between variants and relate to design issues
- Analyze aspects of four-bar mechanism graphically
- Synthesize simple cams
- Create a model depicting various mechanisms

Course Content:

1. Introduction to mechanisms - links, elements, types of joints/ pairs, degrees of freedom, structure, superstructure and mechanism, analysis versus synthesis in mechanisms
2. Stages in mechanism design, design categories and mechanism parameters, vector representation
3. Displacement and Velocity analysis using graphical methods
4. Acceleration analysis using graphical methods
5. Basic cam and follower types, follower motion types, and cam profiles

Pre-requisite Courses: None

References:

1. "Mechanism Design", Sandor, G.N., and Erdman, A.G., , Prentice Hall India Ltd. New Delhi, 1984.
2. "Kinematics and Dynamics of Machinery", Charles E Wilson and J Peter Sadler, Pearson Publications, 3rd Edition, 2008.
3. "Theory of Machines", S. S. Ratan, Tata Mc Graw-Hill, 4th Edition, 2014.

UA17BD254P: ERGONOMICS (3-2-0-4)

Course Objectives:

To introduce students to

- Human capabilities and limitations
- Human limitations
- Aspects of safety and comfort for a product design
- Aspects of comfort for a product design
- Key concepts in Design for everyone

Course Outcomes:

At the end of the course the students will be able to

- Categorize human capabilities and identify their use during product design
- Categorize limitations and identify their use during product design
- Apply aspects of ergonomics during product design
- Evaluate usability of designed interventions from a human-centric view
- Apply design principles for displays

Course Content:

- History and focus of ergonomics, Ergonomics and its areas of application in the work system, humanizing work, modern ergonomics
- Human capabilities and limitations, Anthropometrical, Physiological, Psycho-social considerations in Ergonomics
- Basic body mechanics, Postural stability and postural adaptation, Risk factors for musculoskeletal disorders in the workplace, behavioral aspects of posture
- Designing for a population of users, Sources of human variability, Anthropometry and its uses in ergonomics, Principles of applied anthropometry for ergonomics in design
- Design for everyone; Design for Seating and Standing work. Principles for the design of visual displays; Auditory displays, Design of controls; Combining displays and controls; Virtual environment.

Pre-requisite Courses: None

References:

1. "Introduction to Ergonomics", R.S Bridger, , McGraw-Hill Inc., 1995
2. "Human Factors in engineering and Design", M. S. Sanders and Ernest J. McCormick:, Sixth Edi., McGraw-Hill International Editions, 1987

3. “Indian Anthropometric Dimensions for Ergonomic Design Practice”, D. Chakrabarti, National Institute of Design, Ahmedabad, 1997
4. “Handbook of Human Factors and Ergonomics”, G. Salvendy (Ed.), John Wiley and Sons, 1997

UA17BD221P : COLOR DESIGN (2-0-0-2)

Course Objectives:

This course introduces students to:

- Qualitative basis of color in design
- Experiential aspects of color in design
- Theories of color for design synthesis
- Key concepts in Colour Mixing
- Key concepts in Theory of Colour Impressions

Course Outcomes:

At the end of the course students will be able to

- Analyze the design context for the use of color
- Create Colour contrasts
- Choose color schemes appropriately given a choice
- Design color schemes
- Create Composition with Colour

Course Content:

1. Colour Physics, Colour Agent and Colour Effect, Concord of Colours, Subjective Timbre
2. Theory of Colour Design, The Twelve part Colour Circle
3. Colour contrasts: Hue, Light-dark, Cold-warm, Complementary, Simultaneous, Saturation, Extension
4. Colour Mixing, Colour sphere and Colour Harmony, Form and Colour, Spatial effects of Colour
5. Theory of Colour Impression and Expression, Composition with Colour

Pre-requisite Courses: None

References:

1. “The Art of Color: The Subjective Experience and Objective Rationale of Color”, Itten, Johannes, John Wiley & Sons; Revised edition, 1961
2. “The Elements of Color: A treatise on the color system of Johannes Itten - English translation from German”, Ernst Van Hagen, Van Nostrand Reinhold Company, 1976.
3. “Understanding Color: An Introduction for Designers”, Linda Holtzschue, 5th Edition, John Wiley & Sons, 2017.
4. “Design and Form”, Itten,: Johannes, Wiley ,1975
5. “Color and Design”, Edited by Marilyn DeLong and Barbara Martinson, Berg Publishers, 2012.

UA17BD222P: DIGITAL SURFACE SCULPTING (2-0-0-2)

Course Objectives:

To introduce students to

- Entry-level expertise in generating digital surface prototypes
- Simulate aesthetic value of design
- Building blocks of surface modeling
- Sketch to surface
- Effective presentations of digital prototypes

Course Outcomes:

The students will be able to

- Understand the parameters that influence the quality in digital surface sculpting
- Understand the industry specific requirements
- Relate best practices for digital surface sculpting
- Use digital sculpting tools, Alias
- Use digital prototypes for representing the aesthetic value of design (Rendering)

Course Content:

1. History and evolution of Digital surface sculpting. Typical surface development process in Industry
2. Building blocks of surface modeling (Curves, Surfaces) and their quality
3. Frame and fillet approach to digital sculpting, generating shapes using basic building blocks
4. Sketch to surface, making it production ready - Drafts, Parting lines etc.
5. Effective presentation of digital prototypes that simulate aesthetic value

Pre-requisite Courses: None

References:

1. “CAD/CAM Theory and Practice”, Zeid, I. McGraw-Hill Higher Education, 1991.
2. “CADCAM: From Principles to Practice”, McMahon, C., & Browne, J. J., Addison-Wesley Longman Publishing Co., Inc. 1993.
3. “CAD software - history of CAD CAM” - http://www.cadazz.com/cad-software-history.htm
4. “Learning design with Alias Studio Tools: A Hands-on Guide to Modeling and Visualization in 3D”, Beisert, F. T., Sybex, 2006.

UA17BD251C : ADVANCED ANIMATION (3-2-2-4)

Course Objectives:

To introduce students to:

- Stop motion & traditional techniques of animation
- Software based 2D Animation
- Computer based 3D animation
- Principles of Animation
- Steps in the production Process

Course Outcomes:

The students will be able to:

- Apply traditional techniques of animation
- Work with Stop motion techniques
- Work with Software based 2D Animation
- Develop animation using 3D techniques
- Understand Animation Production process

Course Content:

1. Introduction to 3D animation
2. Application of Principles in 3D animation
3. Key Features of Production
4. Techniques in 3D Animation
5. Short film : 3D animation

Pre-requisite Courses: None

References:

1. “Cracking Animation: The Aardman Book of 3-D Animation”, 4th Edition, Thames and Hudson, 2015
2. “Flash Cartoon Animation: Learn from the Pros”, Glenn Kirkpatrick and Kevin Peaty, Springer, 2004
3. “The Animator’s Survival Kit”, Richard E. Williams, 2nd Edition, Faber & Faber, 2009

4. “Cracking Animation: The Aardman Book of 3-D Animation”, 4th Edition, Peter Lord, Nick Park, Brian Sibley, Thames & Hudson,2015

UA17BD252C :
WEB DESIGN AND DEVELOPMENT (2-2-1-3)

Course Objectives:

To introduce students to:

- Techniques used in Conceptualization of problems
- Techniques used in design related Research for uncovering needs and wants
- Information architecture
- Information design flow
- Content vs. Information

Course Outcome:

The students will be able to:

- Relate research with web design needs
- Apply Information design to web content
- Create Task flow charts
- Create work flow charts
- Create Develop website

Course Content:

1. Introduction to Web Design - Conceptualize and Research, Basics of Adobe Dreamweaver
2. Information design and content - Structuring content, Using images, Using colors on the web
3. Case study - Analyze and understand E commerce website
4. Minor project - Studio problem to solve and design a fully functional website.
5. Major project - Dream company website Design

Pre-requisite Courses: None

References:

1. “Learning Web Design: A Beginner’s Guide to HTML, CSS, Javascript, and Web Graphics”, Jennifer Niederst Robbins, O’Reilly Media, 2001.
2. “Don’t Make Me Think, Revisited: A Common Sense Approach to Web Usability”, Steve Krug, New Riders, 2005.

UA17BD253C :
FILM STUDIES (3-2-2-4)

Course Objectives:

To introduce students to:

- Film History
- Film Theory
- Film Production Techniques
- Processes involved in Script to Storyboard
- Techniques involved in Camera Composition

Course Outcome:

Students will be able to:

- Prepare a Script
- Prepare a storyboard
- Make a short movie
- Make a advertisement
- Make a documentary clip

Course Content:

1. Film History and Theory
2. Developing Movie Ideas - Ideas and mapping
3. Script to Storyboard
4. Camera Composition with props
5. Production and Major project

Pre-requisite Courses: None

References:

1. “How to Read a Film by James Monaco”, Oxford University Press, 1977.
2. “Major Film Theories”, J.Dudly Andrew, Oxford University Press, 1976.
3. “Film & Media Studies”, Robert Kolker, Wiley, 2008.
4. “Screen Play”, Syd Field, Delta Trade Paperbacks, 2005.

UA17BD221C:
BRAND COMMUNICATION (2-0-1-2)

Course Objectives:

To introduce students to:

- Brand identity systems,
- Branding principles and communication
- Role of technology in creation of brand identity
- Brand strategy and communication
- Key concepts in Brand Architecture

Course Outcomes:

At the end of the course the students will be able to

- Develop a Personal Branding Kit
- Develop a Brand Identity Style Guide
- Identify various methods of creating Branding Identity Products
- Develop Brand Identity using technology
- Develop a Personal Brand Strategy

Course Content:

1. Introduction to principles of Brand Identity, Branding and Communication
2. Introduction to Brand Strategy and Communication
3. Introduction to Brand Standards
4. Introduction to Brand Architecture
5. Introduction to Technology in Brand Communication

Pre-requisite Courses: None

References:

1. “Designing Brand Identity: An Essential Guide for the Whole Branding Team”, Alina Wheeler, John Wiley and Sons, 2003
2. “Do-It-Yourself Brand Design: Make Logos, Ads and Everything In-Between”, Gabrielle Weinman, Createspace Independent Pub, 2014
3. “Zag: The Number One Strategy of High-Performance Brands”, Marty Neumeier , AIGA, 2007

UA17BD222C:
PHOTO JOURNALISM (2-0-1-2)

Course Objectives:

To introduce students to:

- Personal styles
- Photographic philosophy
- Ideas in Photo Journalism
- Research methods in Photo Journalism
- Content generation and photography

Course Outcomes:
At the end of the course the students will be able to

- Relate personal style with standard methods of photojournalism
- Identify personal photographic philosophy with other important styles
- Relate to standard principles of documentary making
- Successfully develop photo documentary
- Create a portfolio presentation

Course Content:
1. Introduction to Photojournalism
2. Case study on content manifestation
3. photographic philosophy
4. Storytelling and narratives
5. Photojournalism Project

Pre-requisite Courses: None

References:

1. "Photojournalism: An Introduction", Fred Parrish, Wadsworth Thomson, 2002.
2. "Modern News Reporting" Warren Carl. Harper and Row, 1944.
3. "Emerging Trends in Journalism", Mudgal, Rahul. Sarup and Sons, 1999
4. "Handbook of Journalism and Mass Communication", Vir Bala Aggarwal and V. S. Gupta, Concept Publishing Company, New Delhi, Second Reprint, 2002 .
5. "Mass Communication: Principles and Concepts", Seema Hasan, CBS Publishers and Distributors Pvt. Ltd., New Delhi, 2010.

UA17BD251T :
ADVANCED GAME DESIGN (2-4-2-4)

Course Objectives:
To introduce students to:

- Principles of Game theory and Strategic Thinking
- Mechanics of Game Design
- Principles involved in Game Interface Design
- Techniques involved in Game for critique
- Principles of Game Architecture

Course Outcome:
The students will be able to:

- Apply Principles of Game theory to a game
- Apply Strategic Thinking techniques to a game
- Appreciate Game Interface Design and differentiate between different interfaces
- Produce Digital Game design
- Crate a 3D model of the game

Course Content:
1. Game theory and Strategic Thinking
2. Level Design and Game Architecture
3. Game Interface Design
4. Case study -
5. Major project: Game Development

Pre-requisite Courses: None

References:

1. "Rules of Play: Game Design Fundamentals", Katie Salen and Eric Zimmerman, MIT Press, 2003.
2. "Gamify: How Gamification Motivates People to do extraordinary things", Brian Burke, Taylor and Francis Group, 2014.
3. "The Gamification of Learning and Instruction: Game-Based Methods and Strategies for Training and Education", Karl M. Kapp, Pfeiffer, 2012.
4. "100 Principles of Game Design", Wendy Despain, New Riders, 2013.
5. "The Art of Game Design: A Book of Lenses (and a deck of lenses)", Jesse Schell, 2nd Edition, CRC Press, 2008.
6. "A Theory of Fun for Game Design", Raph Koster, O'Reilly, 2004.
7. "The Game Inventor's Guidebook", Brian Tinsman Fundamentals of Game 8. Design, 3rd Edition, Ernest Adams, Krause Publications, 2003.

UA17BD252T:
CODING (2-2-1-3)

Course Objectives:
To introduce students to:

- Principles of HTML
- Techniques in Creating an HTML document
- CSS and Style Sheets and Syntax
- CSS and Syntax
- Hyper Text Mark Up Language

Course Outcomes:
The students will be able to:

- Embed social media content into web pages
- Implement and understand how to interpret basic web analytics
- Create a HTML document
- Apply Elements of HTML for a mini-project
- Apply CSS and Syntax for a mini-project

Course Content:
1. Introduction to HTML
2. Elements of HTML
3. Creating an HTML document
4. Introduction to CSS - Style Sheets and Syntax
5. Introduction to Mobile Application - Development Environments

Pre-requisite Courses: None

References:

1. "HTML A Beginner's Guide", Wendy Willard, McGraw Hill, 2009.
2. "HTML 5 in simple steps", Kogent Learning Solutions Inc. Dreamtech Press, 2010.
3. "Cascading Style Sheets: The Definitive Guide", Eric A. Meyer, O'Reilly, 2000.

UA17BD253T :
HUMAN-COMPUTER INTERACTION II (4-0-2-4)

Course Objectives:
To introduce students to

- Interfaces and HCI Studies
- Factors effecting interaction design and HCI
- User Customization for HCI
- Research methods in User Centered Design
- Principles in Universal Design

Course Outcome:
The students will be able to:

- Applyartificial intelligence in current design issues
- ApplyUser Centered Design in current design issues
- Create a *Design for All* mini-project

- ApplyUser Customization to a current design problem
- Design for Universal Products

Course Content:

1. Introduction to artificial intelligence
2. Introduction to User Centered Design
3. Study of User Customization
4. Case Study or Major project - Design for All/Universal Design
5. Interactive art and scientific visualization

Pre-requisite Courses: None

References:

1. "Usability Engineering", Nielson, J., Elsevier, 1993.
2. "Designing Web Usability", Nielson, J., New Riders. Indianapolis 2000.
3. "Usability Inspection Methods", Neilson, J., & Mack, R. L., John Wiley & Sons, New York, 1994.

UA17BD221T : USER INTERFACE STUDIES (2-0-1-2)

Course Objectives:

To introduce students to

- Iterative Interface Design
- User's Mental Models in Interface Design
- Techniques in Systematic interface design
- Evaluation Methods In User Interfaces
- Heuristic evaluation and Interfaces

Course Outcomes:

At the end of the course the students will be able to

- Applyiterative interface design principles
- Applymethods in Systematic interface design
- Use Mental models for interface design
- Apply Heuristic evaluation in a mini project
- Develop Prototype User Interfaces

Course Content:

1. Introduction to iterative interface design
2. Systematic interface design
3. Mental models and interface design
4. Heuristic evaluation
5. Case study and mini project

Pre-requisite Courses: None

References:

1. "Designing with the Mind in Mind", Jeff Johnson, Elsevier, 2010.
2. "UI is Communication", Everett N McKay, Elsevier , 2013.
3. "Simple and Usable Web, Mobile, and Interaction Design", Giles Colborne, New Riders, 2011.

UA17BD222T : COGNITIVE STUDIES (2-0-1-2)

Course Objectives:

To introduce students to

- Cognitive systems,
- Reasoning methods
- Implications and Memory
- Sensory systems and Design
- Cognitive systems, research and applications

Course Outcomes:

At the end of the course the students will be able to

- Apply cognitive abilities with design
- Apply visual perception principles to design
- Relate sensory functions with design
- Develop application for human use with visual feedback
- Develop application for human use with auditory feedback

Course Content:

- Introduction to cognitive abilities
- Elements of Cognitive Design
- Visual perception and auditory
- Application and implication of Cognitive Design
- Case study and mini project

Pre-requisite Courses: None

References:

1. "Cognitive Psychology and its implication", Anderson J R, Worth Publishers, 2014.
2. Handbook of Applied Cognition, edited by Francis T. Durso, John Wiley, 2007.
3. "Mental Models in Cognitive Science ", Alan Garnham, Jane Oakhill (Eds.), Psychology Press, 1996

V SEMESTER B. DES (2016-20 BATCH)

UA16BD301: SEMINAR/ ACTIVITIES V (0-2-0-0)

Course Objectives:

To introduce students to:

- Design activities
- Hands-on experience and exposure to actual design practices through lectures, demonstrations etc
- Latest design methodologies and techniques.
- Interactions between Industry and Academia
- Composition and analysis of space

Course outcome:

The students will be able to:

- Realize the practical aspects of the design process.
- Prepare documentation of the design based demonstrations or lectures.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time design needs.
- Incorporate the knowledge gained during the lecture/ demonstrations/ activity in their drawings/process models.

Course Content:

1. Study of the design processes/models/design considerations/ design approaches
2. Analysis of approaches taken by industry/academic experts
3. Synthesis of data/design models/design considerations
4. Preparation of drawings/conclusions/models/solutions
5. Report

UA16BD302: SITE EXPOSURE V (0-6-0-0)

Course Objectives:

To introduce students to:

- Project site & its conditions
- Hands-on experience and exposure to actual design practices.

- Latest design techniques in the industry
- Interactions between Industry and Academia
- Composition and analysis of space

Course outcome:

The students will be able to:

- Realize the practical aspects of the design process.
- Prepare documentation of the industry / site visits.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time industry/on site needs.
- Incorporate the knowledge gained during industry visits in their models/portfolio/drawings.

Course Content:

- Study of the industry site visit and data collection
- Analysis of data
- Synthesis of data/design models/design considerations
- Preparation of drawings/conclusions/models/solutions
- Report

UA16BD303:
VACATION ASSIGNMENT / STUDY TOUR II (0-0-2-0)

Course Objectives:

To introduce students to:

- Various design activities.
- Significance of documentation and analysis.
- Industry practices and interactions with subject experts.
- Application of theoretical knowledge in real world scenario.
- Professionals from the design field

Course outcome:

The students will be able to:

- Carry out different activities.
- Document / prepare models.
- Analyze available data and draw inferences.
- Realize the significance of architectural theory in practical application
- Appreciate the diligence and dedication required to succeed in the chosen profession.

Course Content:

1. Literature study of the activity
2. Analysis of activity
3. Synthesis of data and proposals
4. Preparation of drawings/concepts/conclusions/models
5. Report

UA16BD301P:
PRODUCT DESIGN PROJECT STUDIO - I (6-0-0-6)

Course Objectives:

To introduce students to:

- the application of design thinking in design project
- application of design methods in design project
- analysis of design trends
- problem analysis and validation
- development of requirement list

Course Outcomes:

At the end of the course the students will be able to

- apply design methods in projects that they seek to pursue
- apply design thinking
- analyze design trends and identify future trends
- validate identified needs and problems
- generation of requirement list for the design project

Course Content:

- Trends Analysis
- Opportunity Identification
- User research
- Needs validation and problems analysis
- Requirement generation

Pre-requisite Courses: None

References:

- “Product Design and Development”, Ulrich, Karl T., Eppinger, Steven D., McGraw-Hill, 2004.
- “Creating Breakthrough Products: Innovation from Product Planning to Program Approval”, Cagan, Jonathan; Vogel, Craig M., Financial Times Prentice Hall,; 2002.
- “About Face 3: The Essentials of Interaction Design”, Alan Cooper, Robert Reimann and David Cronin, 3rd Edition, Jenson Books Inc. ISBN-13: 978-0470084113.
- “Design Thinking for Visual Communication (Basics Design)”, Gavin Ambrose, Fairchild Books, 2 Edition, Paperback, , 2015, ISBN-13: 978-1472572714
- “Launch: Using Design Thinking to Boost Creativity and Bring Out the Maker in Every Student”, John Spencer, A J Juliani, , 2016, Dave Burgess Consulting, Incorporated, Paperback: ISBN-13: 978-0996989541.

UA16BD302P :
PRODUCT PLANNING AND MARKETING MANAGEMENT (2-2-1-3)

Course Objectives:

To introduce students to:

- Different methods to study user needs
- Methods to understand Segmentation and Target market
- aspects of planning product launches
- aspects of planning marketing new products
- frameworks for developing product strategies

Course Outcomes:

At the end of this course students should be able to

- explore and apply methods to understand user needs and behavior
- apply methods to understand market size and segmentation for products
- understand aspects of marketing products
- understand the generation of design briefs
- apply methods for differentiating one’s own products in the market from others existing

Course Content:

1. Corporate strategy for product planning, Management thinking on new products, seeing product as part of the image of the company, Defining companies business, Technology transfer problems, SWOT analysis, Analysis of strength, weakness, opportunities and threat.
2. Brief introduction to assessing of companies financial performance. Study of product life cycle, Monitoring of sale and competition, when to introduce new products. Assessing market potentials for new products, market research, Consumer research and its demographic aspects, setting up a questionnaire for these aspects.

3. Establishing market segment and their dimensions. Assessing competitors share and locating direct and indirect sources to understand this. Assessing competitors marketing approach and strategies.
4. Developing a strategy to introduce new products, Using market gaps as competitive edge, cost considerations and profitability of new products. Developing a product plan and product mix, price policy, positioning the company, product positioning, planning for future position. Evolving a design brief by interlinking with market/product plan.
5. Seeing product design as a part of a scheme to develop brand image, house style, marketing strategy and corporate image. Differentiating product range from each other and from competitor's range. Developing product specifications for different products within the range. Market communication, launching the product, monitoring the market performance.

Pre-requisites:

Course Code: None Course Title: None

References:

1. "Consumer Behaviour", Schiffman and Kanuk, Pearson , 2010.
2. "Marketing management", Kotler Philips, 5th Edition, Prentice Hall, New Delhi, 1984.
3. "New Product Management", Merle Crawford C, McGraw-Hill Higher Educ , 2011.
4. "Marketing Research", Luck, David J., and Rubin, Ronald S., Prentice Hall India Learning Private Ltd, 1987.
5. "Marketing Imagination", Levitt Theodore, Free Press, New York, 1986.

UA16BD303P:
BASIC COMPUTING AND DESIGN (3-2-2-4)

Course Objectives:

To introduce students to:

- Computing in design
- 2D generative design
- 3D generative design
- Application of generative design
- Different constraints in generative design

Course Outcomes:

At the end of the course the students will be able to

- understand and appreciate importance of computing in design
- code to generate 2D geometry
- code to generate 3D geometry
- apply generative design in product design
- interpret constraints to code for generative design

Course Content:

1. Introduction to Computing in Design
2. Concept of Generative Design in 2D
3. Concept of Generative Design in 3D
4. Generative design for product applications
5. Student Project work

Pre-requisite Courses: None

References:

1. "Foundations: The Grasshopper" Third edition:Gil Akos and Ronnie Parsons, Mode Lab, 2014 (http://modelab.is/)
2. "Rhino Python Primer", Skylar Tibbits: SJET (www.sjet.us) www.scriptedbypurpose.net; Arthur van der Harten, Kirkegaard Associates (www.perspectivesketch.com and www.kirkegaard.com) Steve Baer, Robert McNeel & Associates (www.rhino3d.com):http://s3.amazonaws.com/mcneel/misc/docs/en/RhinoPythonPrimerRev3.pdf
3. "Grasshopper Plug-in Help through Rhino 5", (Software)

UA16BD304P:
MECHATRONICS (4-0-1-4)

Course Objectives:

This course introduces students to:

- Various aspects of mechatronic product design approach involving interdisciplinary interaction.
- Mechanical and mechatronic components in design.
- Electro Mechanical actuators and magnetic circuits.
- Different actuation methods and motion control.
- Interfacing of mechanical and electronic systems.

Course Outcomes:

At the end of this course students should be able to

- survey mechanical and mechatronic components from a design requirement perspective
- analyze requirements and select actuators apply automating linkages to get desired motion
- understand drive options and requirements to automate mechanisms
- understand aspects of control and apply in simple mechanisms
- understand interfacing in mechanical and electronic systems.

Course Content:

1. Introduction to Mechatronics – overview of mechatronic products and their functioning.
2. Motion and motion conversion systems; Survey of mechanical components, their selection and assembly for motion conversion requirements; Load analysis for actuator selection
3. Study of Electro-mechanical actuators such as solenoids, Stepper motors, DC and AC motors; Basic magnetic circuit s, magnetic materials and analysis.
4. Basics of Hydraulic and Pneumatic actuation;Study of sensors and transducers for motion control requirements.
5. Study of electronic controllers and drives for mechatronic products; Interfacing of mechanical and electronic systems. Studio assignments and projects

References:

1. "Mechatronics", W. Bolton., Pearson Low Priced Edition, India, 2011
2. "Introduction to Mechatronics and Measurement Systems", Michael B. Histand and David G.Alciatore, WCB McGraw Hill, 2002
3. "DC Motors and Control Systems", Kuo, BC., SRL Publishing Co., 1979.
4. "Step Motors and Control Systems", Kuo, BC., SRL Publishing Co., 1979.

UA16BD305P:
INTRODUCTION TO ELECTRICALS AND ELECTRONICS (2-2-1-3)

Course Objectives:

This course introduces students to:

- the basics of electrical and electronic devices
- familiarizing students to uses and primary applications of electrical and electronic devices.
- different components of electrical and electronic devices
- control of moving components
- basic control logic

Course Outcomes:

At the end of this course students should be able to

- understand the working of basic electrical and electronic devices
- appreciate their uses
- understand and use different components in electronic and electrical devices
- use these devices to control moving components as necessary within simple projects
- build integrated circuits.

Course Content:

1. Basics of Electrical and Electronic devices
2. Switches, relays, their applications and exercises using these
3. Diodes, Transistors, sensors, their applications and exercises using these
4. OpAmps, their applications and exercises using these
5. Timing and Integrated circuits, basic control logic and exercises using these

Pre-requisites:

Course Code: None Course Title: None

References:

1. "Electrical and Electronic Technology", E. Hughes (Revised by J.Hiley, K Brown & I.M Smith), 9th Edition, Pearson Education, 2005.
2. "Electronic Devices and Circuit Theory", Robert. L Boylestad and Louis Nashelsky, 10th Edition, PHI, 2009.
3. "Design and Technology", James Garatt, Cambridge University Press, Low Priced Edition, 2004.

UA16BD331P: FURNITURE DESIGN (2-0-0-2)

Course Objectives:

To introduce students to:

- aspects of product design particular to furniture design
- types of furniture and their design
- various materials used for furniture design
- various fittings and fitments
- different manufacturing processes.

Course Outcomes:

At the end of the course the students will be able to

- understand furniture as product types in particular use contexts
- tailor and apply product design process to furniture
- choose materials for furniture design
- choose fittings and fitments applicable
- choose and design for different manufacturing processes for furniture

Course Content:

- The history of furniture construction; Classification and Characteristics of Furniture
- Furniture Design process: Ergonomics in Furniture
- Innovations in materials; Understanding innovation in contemporary furniture design
- Fittings and assemblage; Conventional and new furniture manufacturing processes
- Ethics and Sustainability

Pre-requisite Courses: None

References:

1. "Furniture Design: An Introduction to Development, Materials and Manufacturing", Stuart Lawson, Laurence King Publishing, 2014.
2. "Furniture Design", Jerzy Smardzewski, Springer Verlag, Springer International Publishing Switzerland, 2015

UA16BD332P: TOY DESIGN (2-0-0-2)

Course Objectives:

To introduce students to:

- aspects of product design particular to toy design
- types of toys and their design
- Design considerations for toy design
- Materials used for toy design
- different manufacturing processes

Course Outcomes:

At the end of the course, the students will be able to

- understand the cultural development of toys
- understand toys as product types in particular use contexts
- tailor and apply product design process to toys
- choose materials specific for toys
- choose and design for different manufacturing processes for toys

Course Content:

1. The history of toy making; classification and characteristics of toys
2. Toy Design process and its varied considerations
3. Toys as integrated systems for play
4. Standards for toys as safe products for different users
5. Ethics and Sustainability

Pre-requisite Courses: None

References:

1. "Homo-Ludens: A Study of the Play Element in Culture", Joan Huizinga,; 1st US - 1st Printing Edition , Beacon Press 1971.
2. http://www.arvindguptatoys.com/toys.html
3. "Toys as Culture", Brian Sutton-Smith, Gardner Press; 1st Edition, January 1, 1986.
4. "Product Design and Development", Ullrich and Eppinger, 6th Edition, Pearson Low-priced Edition, 2014

UA16BD301C: COMMUNICATION DESIGN PROJECT STUDIO I (6-0-2-6)

Course Objectives:

To expose students to:

- 3D modeling techniques with various softwares
- Texturing and Rigging
- Lighting and Rendering
- Advanced graphic design methods
- Methods of building a Communication Design Portfolio

Course Outcomes:

The students will be able to:

- Model organic & inorganic models
- Understand Texturing & Rigging Technique
- Expose the Students to Lighting and Rendering
- Work on Graphic Design Projects
- Make Communication Design Portfolio

Course Content:

1. 3D modeling
2. Texturing & Rigging

3. Lighting & Rendering
4. Graphic Design Project
5. Communication Design Portfolio

Pre-requisite Courses: None

Reference Books:

1. "The Art and Science of Digital Compositing", Ron Brinkmann, Morgan Kaufmann ,2008
2. "Maya 8.0 Character Modeling", Gary Oliveri, Jones & Bartlett Learning , 2006.
3. "Character Modeling with Maya and ZBrush: Professional Polygonal", Jason Patnode, Focal Press; 1 edition 2008.
4. "Maya character creation", Chris Maraffi, New Riders, September 2003.
5. "ZBrush Character Creation: Advanced Digital Sculpting" ,Scott Spencer Paperback, 2011.
6. "ZBrush Characters and Creatures", Kurt Papstein, 3dtotal Publishing , 2015.

UA16BD302C:
3D ANIMATION LAB -I (4-0-1-4)

Course Objectives:

To introduce students to:

- Character Design
- Stop motion Animation
- 2D software based animation
- 3d Character Animation technique
- Steps in the animation process

Course Outcomes:

The students will be able to:

- Demonstrate Character Design Techniques
- Understand Stop motion techniques of Animation
- Student will be able to work with 2D Animation Software's
- Demonstrate the ability to work with 3D Software's
- Create the Character Animation using different Techniques

Course Content:

1. Character Design & Stop motion Animation
2. Software based 2D animation
3. 3D Character Animation
4. 3D Production Pipeline
5. Animation Project-Short film

Pre-requisite Courses: None

Reference Books:

1. "The Art of Stop-motion Animation", Ken A. Priebe,Course Technology PTR; 1 edition 11, 2006.
2. "Stop Motion: Craft Skills for Model Animation," Susannah Shaw, Focal Press; 2 edition April 2008.
3. "Stop-motion Animation: Frame by Frame Film-making with Puppets and Models", Barry JC Purves, Fairchild Books; 2 edition,2004.
4. "Stop Motion Animation: How to Make and Share Creative Videos", Melvyn Ternan, Barron's Educational Series, 2013.
5. "Creating 3-D Animation: The Aardman Book of Filmmaking", Peter Lord, Harry N. Abrams, 1998.
6. "Cracking Animation", Peter Lord, Thames & Hudson; Auflage: New, 2005.
7. "Stop-motion Armature Machining: A Construction Manual", Tom Brierton, McFarland Publishing ,2002.

UA16BD303C:
INFOGRAPHICS - I (2-2-1-3)

Course Objectives :

This course introduces students to:

- Infographics, its importance, types, design principles and techniques.
- Content, Layout, Structure, and Spatial arrangement in infographic design
- Use of Text, Typography, fonts, color, Icons, Images, Diagrams, and Charts in Infographic Design
- Ways to create flow of information and data - Lines, Frames, and white space.
- Mobile Friendly Infographics.

Course Outcome :

At the end of the course, students will be able to

- Understand and apply design principles and techniques of Infographic design.
- Create layout and structure of Infographic with meaningful content.
- Understand and use Non-verbal elements of Infographics.
- Apply different techniques to create desirable flow of information and data in infographic design.
- Understand and create mobile friendly Infographics.

Course Content :

1. **Introduction to Infographics**
   - Understanding the visual Story telling
   - Importance, Types, Design Principles, and techniques for infographic design
2. **Elements of Infographics**
   - Content, Layout, Structure and Spatial arrangement in infographics
3. **Non Verbal Elements of Infographics**
   - Text, Typography, fonts, color, Icons, Images, Diagrams, and Charts in Infographic Design
4. **Flow of information and data**
   - Lines, Frames, and white space techniques for creating flow of information.
   - Data Visualization Interfaces.
5. **Mobile Friendly Infographics**
   - Design Considerations for mobile friendly infographics

Pre- requisites : None

References :

1. "Infographics: The Power of Visual Storytelling", Jason Lankow, Josh Ritchie,John Wiley and Sons, Inc, Hoboken, New Jersey, 2012.
2. "Made to Stick: Why Some Ideas Survive and Others Die (Arrow)", Chip Heath and Dan Heath, Arrow Books, 2008.
3. "The Wall Street Journal Guide to Information Graphics , The Dos and Don'ts of Presenting Data , Facts and Figures", Dona M Wong, W.W. Norton & Company, 2010.
4. "Visual Thinking for Design (Morgan Kaufmann Series in Interactive Technologies)", Colin Ware, Denise E M Penrose, 2008.

UA16BD304C :
VISUAL EFFECTS - I (3-2-2-4)

Course Objectives:

To introduce students to :

- Media ethics, basics of acoustics and fundamentals of acting
- Sound tracks, CGI lighting and VFx for films

- Different techniques of Audio/Video editing
- Editing Techniques
- Compositing Techniques

Course Outcomes:

At the end of the course the students will be able to

- Develop sound and digital composition
- Develop acting roles for sequence and film
- Work with different audio and video softwares
- Work with 3D Software and Editing Softwares.
- Work with dynamics for visual fx and compositing

Course Content:

1. Culture and Media Studies
   a. Media Ethics, Laws & Censorship
2. Sound Engineering and Film Editing
   b. Sequence Analysis, Sound Image Appreciation and study of Acoustics
3. Acting Fundamentals
   c. Drama and Music Appreciation
4. Visual effects and Lighting techniques
   d. CGI Lighting for VFX and Digital Compositing
5. Case Study and Major Project

Pre-requisites:

Course Code: None Course Title: None

References:

1. “The Filmmaker’s Guide to Visual Effects: The Art and Techniques of VFX for Directors, Producers, Editors and Cinematographers”, Eran Dinur, Routledge; 1 ed, 2017.
2. “The VES Handbook of Visual Effects: Industry Standard VFX Practices and Procedures”, Susan Zwerman and Jeffrey A Okun, Focal Press, 2010.
3. “The Bare Bones Camera Course for Film and Video”, Tom Schroeppel and Chuck DeLaney,Tom Schroeppel; 2nd Revised ed 1982
4. “Producing Animation (Focal Press Visual Effects and Animation)”, Catherine Winder and Zahra Dowlatabadi, Focal Press,2001.
5. “The Digitization of Cinematic Visual Effects: Hollywood’s Coming of Age”, Rama Venkatasawmy, Lexington Books , 2012.

UA16BD305C:
PACKAGING AND VISUAL COMMUNICATION(2-2-1-3)

Course Objectives :

This course introduces students to:

- Packaging Design, its importance, history and types of packaging design
- Packaging design Process, design principles, design considerations, and aspects
- Study of Packaging Materials
- Sustainable Packaging, relation between Packaging Design and environment

Course Outcome :

At the end of the course, students will be able to

- Understand what Packaging Design is and appreciate its importance.
- Apply design principles and considerations in Packaging Design Process.
- Apply various techniques and materials for manufacturing and production.
- Understand the importance of sustainable packaging.
- Create innovative packaging designs.

Course Content :

1. **Introduction to Packaging Design**
   - Importance, History and Types of Packaging Design
2. **Packaging Design Process**
   - Design principles, Considerations
   - Aspects - Package design and Label Design
3. **Packaging Materials**
   - Various materials used for packaging, study of structures and techniques for production.
4. **Sustainable Packaging**
   - Impact of packaging on the environment
   - Sustainable approaches towards Packaging Design
5. **Packaging Design Project**
   - Small Project on Packaging Design

Pre- requisites : None

References :

1. “Best Practices for Graphic Designers, Packaging: An Essential Guide for Implementing Effective Package Design Solutions”, Grip, Rockport Publishers, 2014.
2. “Green Your Work: Boost Your Bottom Line While Reducing Your Carbon Footprint”, Kim Carlson, Adams Business, F+W Media Company, 2009.
3. “Material Innovation: Packaging Design, Andrew H. Dent, Leslie Sherr”, Thames & Hudson, 2015.

UA16BD331:
VISUAL ERGONOMICS (2-0-0-2)

Course Objectives :

This course introduces students to:

- The science of Visual ergonomics, and its impact on health and performance of the users
- The working of the complex human visual system and perception
- The environments, which affects the visual system and perception
- Functioning and performance of visual system and ways to maintain comfort and safety
- Design visually ergonomic displays, interfaces.

Course Outcome :

At the end of the course, students will be able to

- Understand visual ergonomics and its impact on health.
- Understand the complex human visual system and perception.
- Understand the visual environment and apply methods to improve it.
- Understand and apply methods to maintain visual comfort and safety.
- Create visually ergonomic designs.

Course Content :

1. **Introduction to Ergonomics**
   - Visual ergonomics, its domains and its influence on health and performance.
2. **The human visual system and perception**
   - Visual Acuity, Color Vision, Depth Perception, Spectacle wear, Ocular health, and Computer Vision Syndrome.
3. **The Visual environment**
   - Lighting- Illumination, Indoor air Quality, Ocular Hazards, Psychosocial factors.

4. **Visual Functions and Performance**
    - Visual comfort and safety, Optical Corrections, ageing vision, visual fatigue.
5. **Visual Displays and Information Design**
    - small projects/exercises on Visual displays.

Pre-requisite : None

References :

1. "Visual Ergonomics Handbook", Jeffrey Anshel, CRC Press, 2005.
2. "Human Factors in Lighting", Peter Robert Boyce, 2nd Edition, CRC Press, 2003
3. "Human Factors in Engg. & Design", Sanders, McGraw Hill Education; 7th Edition, 2013
4. "Handbook of Human Factors in Web Design", Kim-Phuong L. Vu , Robert W. Proctor, CRC Press, 2011

UA16BD332C: ILLUSTRATIONS AND STORYTELLING (2-0-0-2)

Course Objectives:

The Students are exposed to:

- Develop artistic skills in digital & handmaid illustrations
- Provide knowledge in creating composition
- Develop skills in vector and raster based Software's
- Work & understand all the Design aspects
- Develop skills to create 3D based Illustrations

Course Outcomes:

The students will be able to:

- Create Digital & handmaid Illustrations with various methods
- Make Compositions by Applying elements of Design
- Work with various Software's
- Visualize the role of Creative head
- Use 3D techniques in Graphic Art

Course Content:

1 Graphic Illustration methods
2. Elements of Graphic Art
3. Vector & Raster techniques for Illustrations
4. Role of Graphic Designer
5. 3D Illustration techniques

Pre-requisite Courses: None

Reference Books:

1. "Creative Photoshop CS4: Digital Illustration and Art Techniques ", Derek Lea,Routledge , 2017.
2. "Beginner's Guide to Digital Painting in Photoshop: Characters ", Charlie Bowater and Derek Stenning,3dtotal Publishing, 2015.
3. "The Complete Guide to Digital Illustration ", Adam Banks and Steve Caplin, Ilex Press , 2003.
4. "Digital Illustration: A Master Class in Creative Image-making ", Lawrence Zeegen, RotoVision , 2005.
5. "Secrets of Digital Illustration: A Master Class in Commercial Image-making", Lawrence Zeegen, Rotovision, 2007.
6. "Pen and Mouse: Commercial Art and Digital Illustration", Angus Hyland, Watson-Guptill,2001.

UA16BD301T: INTERACTION DESIGN PROJECT STUDIO I(6-0-2-6)

Course Objectives:

This course introduces students to:

- Problem Identification in the domain of Interaction Design
- Design Thinking methodologies and how it could be applied to the domain of Interaction Design
- Suitable research methods and techniques of Data generation and analysis
- Techniques of prototyping for Interaction Design Projects
- Techniques of obtaining user feedback and testing for Interaction Design projects

Course Outcome:

At the end of the course, students will be able to:

- Differentiate and identify the right problems
- Choose suitable design thinking methodologies for the identified problem(s)
- Apply appropriate research methods
- Develop alpha prototypes
- Work with users to generate feedback and conduct testing

Course Content:

1. Introduction to the Interaction Design Project Studio Exploration, Problem Identification
2. Design Thinking Methodologies Choosing appropriate methodologies for the identified problems
3. Research Methods
   Application of suitable research methods to the indentified problems Data generation, Data Analysis
4. Prototyping
   Relooking at the context and data synthesis, Alpha Prototypes
5. Feedback and Testing
   Working with users to obtain feedback, Testing and modification of the prototypes

Pre-requisites : None

References:

1. "Guerrilla UX Research Methods: Thrifty, Fast, and Effective User Experience Research Techniques", Russ Unger and Todd Zaki Warfel, Morgan Kaufmann, 2012.
2. "Design Research, Methods and Perspectives", Brenda Laurel (Ed.), The MIT Press, 2003.
3. "Research for Designers: A Guide to Methods and Practice", Gjoko Muratovski, SAGE Publications Ltd 2015,
4. "Qualitative Inquiry and Research Design: Choosing Among Five Approaches", John W. Creswell, Cheryl N. Poth, Paperback, 2017,
5. "Prototyping: A Practitioner's Guide", Todd Zaki Warfel, Rosenfeld Media , 2011.

UA16BD302T: UI/UX - I (4-0-1-4)

Course Objectives:

To introduce students to

- UX/UI Tools for designing apps
- Conducting primary and secondary research methods for problem statement
- UX Design Tools for creating new apps.
- Information Architecture & Wire framing
- Usability principles

Course Outcomes:

At the end of the course the students will be able to

- Successfully develop application for multi platforms.
- Understand the UX process for application design
- Analyze application using usability principles
- Design information architecture and create prototype.
- understand methods of user data analysis.

Course Content:

1. Introduction to UX/UI
    - Problem Statement - Primary and Secondary Research
2. Research Synthesis & Design Brief
    - Persona & User Scenarios, Use Cases and User Flow
3. Brainstorming & Ideation
    - UX Design Tools and Software
4. Information Architecture & Wire framing
    - Usability constraints and synthesis
5. Case Study and Major Project
    - Portfolio Preparation

Pre-requisites:

Course Code: None Course Title: None

References:

1. “Start with Why”, Simon Sinek, Portfolio, 2011.
2. “The UX Book: Process and Guidelines for Ensuring a Quality User Experience”, Rex Hartson, Pardha Pyla,Morgan Kaufmann ,2012.
3. “Interaction Design: Beyond Human - Computer Interaction”, Preece, Sharp and Rogers, Wiley, 2007.
4. “Measuring the User Experience”, Tullis and Albert, Morgan Kaufmann, 2013.
5. “Research Methods in Human-computer Interaction”, Jonathan Lazar and Jinjuan Heidi Feng, Morgan Kaufmann, 2017.
6. “Handbook of Usability Testing”, Rubin and Chisnell, 2nd Edition, John Wiley & Sons , 2008.
7. “The Challenger Sale”, Matthew Dixon and Brent Adamson, Portfolio ,2013.
8. “Permission Marketing”, Seth Godin, Simon & Schuster, 1999.

UA16BD303T: DESIGNING INTERACTIVE EXPERIENCES(2-2-1-3)

Course Objectives:

This course introduces students to

- Interactive experience and relationship between Human Senses and Interaction
- Interactive Experience Design Styles & Trends
- Interactive experience in the Digital Age
- Tools and Modalities for interactive experience design
- Case study and Exercises to design interactive experience

Course Outcomes :

At the end of the course, students will be able to

- Appreciate the importance of making experiences interactive, and understand the role of human senses’ in creating interactive experiences.
- Understand and appreciate design trends and different styles of interactive experience design.
- Understand the impact of digital age on design of experiences.
- Understand and apply different modalities in creating interactive experiences.
- Design simple interactive experience through a project.

Course Content:

1. Introduction to Interactive experiences
   Role and importance. Relationship between Human Senses, Interface, and Interaction.
2. Interactive Experience Design Styles & Trends
   Flat, Typographic and Vintage Visual Styles, Parallax and Scrolling Animation Navigational Styles
   Connection via Social Media and Internet of Things.
3. Interactive experience in the Digital Age
   Impact of Digital technologies on interaction design
   Human Computer Interaction, Interactive Art
4. Tools and Modalities
   Touch, Beacons & Sensors, Internet of Things, Speech Recognition.
5. Project on interactive experience design
   Case study and project on interactive experience design

Pre- requisites : None

References :

1. “Interdisciplinary Interaction Design: A Visual Guide to Basic Theories, Models and Ideas for Thinking and Designing for Interactive Web Design and Digital Device Experiences”, James Pannafino, Assiduous Publishing, 2012
2. “The Joy of UX: User Experience and Interactive Design for Developers”, David Platt, Mark L Taub, 2016
3. “Designing for Emerging Technologies: UX for Genomics, Robotics, and the Internet of Things”, Jonathan Follett, O’Rielly Media Inc., 2015

UA16BD304T: CUSTOMER EXPERIENCE AND VIRTUAL REALITY (3-2-2-4)

Course Objectives:

To introduce students to

- Challenges of customer experience
- Scenario and persona in customer experience
- Basic concepts of virtual reality
- Tools of virtual reality
- web based VR application

Course Outcomes:

At the end of the course the students will be able to

- Identify and evaluate sources of information in the area of customer experience
- Analyze, improve customer experience
- Understand history of VR
- Use VR for application development
- Understand hardware and platform application tools

Course Content:

1. Customer Experience Strategy
   Voice of the Customer, Customer Insight, and Understanding
2. Experience Design and Improvements
   Designing and transforming an organization
3. Introduction to Virtual Reality
   Hardware and History
4. VR Applications
   The Psychology of VR: the Three Illusions
5. Case Study and Major Project

Pre-requisites:

Course Code: None Course Title: None

References:

1. ‘X: The Experience When Business Meets Design’, Brian Solis, John Wiley & Sons, 2015.
2. ‘Chief Customer Officer 2.0: How to Build Your Customer-Driven Growth Engine’, Jeanne Bliss, Jossey-Bass, 2015.
3. ‘The Ultimate Question 2.0: How Net Promoter Companies Thrive in a Customer-Driven World’, Fred Reichheld, Harvard Business Review Press , 2011.
4. ‘Driven to Delight: Deliver World-Class Customer Experience the Mercedes-Benz Way’, Joseph Michelli, Brilliance Audio , 2015.

5. 'Customer Experience 3.0: High-Profit Strategies in the Age of Techno Service', John A. Goodman, AMACOM , 2014.
6. "Designing Virtual Worlds", Richard Bartle, New Riders, 2003.
7. "The Visionary Position: The Inside Story of the Digital Dreamers Who are Making Virtual Reality a Reality", Fred Moody, Crown Business,199.
8. "Virtual Reality", Howard Rheingold, Simon & Schuster,1992.
9. "Learning Virtual Reality", Tony Parisi, O'Reilly, 2015.

UA16BD305T: RESPONSIVE APPLICATIONS AND CODING (2-2-1-3)

Course Objectives:

This course introduces students to

- Responsive applications in the context of interaction design
- User behavior in the relation of types of screen size
- User behavior in the relation of types of platforms
- Concepts in One Code Base
- Types of Layout and coding methods

Course Outcome :

At the end of the course, students will be able to

- Appreciate responsive application in a mobile first context
- Correlate user behavior with screen size
- Correlate user behavior with platforms
- Apply concepts of One Code Base
- Appreciate types of layout using coding methods

Course Content:

1. Introduction to Responsive Application
   - Reasons and needs for responsive applications
2. Introduction to User behavior and screen size
   - Types of classification of user behavior and screen size
3. User behavior and platform
   - Types of classification of user behavior and platform
4. Introduction to One Code Base
   - Reasons for having a One Code Base
5. Types of layouts and Coding
   - Application of coding to create suitable layouts & protypes

Pre-requisite : None

References :

1. Bootstrap: Responsive Web Development", Jake Spurlock, O'Reilly Media , 2013,
2. "Designing for Performance: Weighing Aesthetics and Speed", Lara Callender Hogan, O'Reilly Media 2014,
3. "Learning AWS.: Design, Build, and Deploy Responsive Applications using AWS Cloud Components", Aurobindo Sarkar and Amit Shah, Packt Publishing Limited , 2018,
4. "Learning RxJava: Reactive, Concurrent, and Responsive Applications, Thomas Nield, Packt Publishing , 2017,
5. "ASP.NET MVC 5 with Bootstrap and Knockout.js: Building Dynamic, Responsive Web Applications", Jamie Munro,O'Reilly Media , 2015
6. "Head First Android Development", Dawn Griffiths, O'Reilly, 2015.

UA16BD332T: DESIGN FOR MULTIMEDIA AND ENVIRONMENT (2-0-0-2)

Course Objectives:

To introduce students to:

- Perspectives of interaction using multimedia
- Design and fabrication in various medias
- Spatial planning in various medias
- Image manipulation in various medias
- Audience and human factors in various medias

Course Outcomes:

The students will be able to:

- Relate exhibition design to generic design process
- Make prototypical experiential spaces
- Make prototypical interior-design environments
- Make prototypical scenography for festivities
- Make prototypical spaces for cultural and theatrical events

Course Content:

1. Introduction to Spatial Planning and Structures
2. Introduction to experiential spaces and design
3. Introduction to Audience and human factors
4. Introduction to Image manipulation in exhibition spaces
5. Case Study - Design, Fabrication to Display

Pre-requisite Courses: None

Reference Books:

1. "Grand Stand 6", Ana Martins, Evan Jehl, Frame Publishers , 2018.
2. "Basics Interior Design", Pam Locker, AVA Publishing, 2010.
3. "The Art of Museum Exhibitions: How Story and Imagination Create Aesthetic Experiences", Leslie Bedford, Routledge, 2014.
4. "Exhibition Art: Graphics and Space Design", Wang Shaoqiang, Promopress, 2016.
5. "Exhibition Design: An Introduction", Philip Hughes, Laurence King Publishing , 2015.

VI SEMESTER B. DES (2016-20 BATCH)

UA16BD351: DESIGN, INNOVATION AND MANAGEMENT (3-2-2-4)

Course Objectives:

To introduce students to

- Broader context of design in organizations and for innovation
- Broader context for innovation
- Design and intellectual property management
- Methods of management in design projects within small teams
- Role of design for driving customer experiences

Course Outcomes:

At the end of the course the students will be able to

- understand the critical role of design and the design process for innovation
- manage design projects within small teams
- search patent databases to estimate novelty
- Conduct patent searches
- Appreciate the role of design for customer driving experiences

Course Content:

1. Significance of design as a process for change and a motivator
2. Importance of the design process for creating novelty
3. Aspects of forming and managing design projects and teams
4. Conducting patent searches and making reports to propose/ establish novelty; understand IP rights and design registration procedures
5. Role of design for driving experiences and corporate/ organizational innovation

Pre-requisite Courses: None

References:

1. "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", , Tim Brown, Harper Business, Hardcover, 2009, ISBN-13: 978-0061766084
2. "Design Thinking: Integrating Innovation, Customer Experience, and Brand Value", Thomas Lockwood, Allworth Press; 1st Edition, 2009, ISBN-13: 978-1581156683
3. "Product Innovation: Leading Change through Integrated Product Development", David L. Rainey, Cambridge University Press, 2011.
4. "Design Management: Using Design to Build Brand Value and Corporate Innovation", Brigitte Borja De Mozota, Allworth Press, 2004.

UA16BD352:
SEMINAR/ ACTIVITIES VI (0-2-0-0)

Course Objectives:

To introduce students to:

- Design activities
- Hands-on experience and exposure to actual design practices through lectures, demonstrations etc
- Latest design methodologies and techniques.
- Interactions between Industry and Academia
- Composition and analysis of space

Course outcome:

The students will be able to:

- Realize the practical aspects of the design process.
- Prepare documentation of the design based demonstrations or lectures.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time design needs.
- Incorporate the knowledge gained during the lecture/ demonstrations/ activity in their drawings/process models.

Course Content:

1. Study of the design processes/models/design considerations/ design approaches
2. Analysis of approaches taken by industry/academic experts
3. Synthesis of data/design models/design considerations
4. Preparation of drawings/conclusions/models/solutions
5. Report

UA16BD353:
SITE EXPOSURE VI (0-6-0-0)

Course Objectives:

To introduce students to:

- Project site & its conditions
- Hands-on experience and exposure to actual design practices.
- Latest design techniques in the industry
- Interactions between Industry and Academia
- Composition and analysis of space

Course outcome:

The students will be able to:

- Realize the practical aspects of the design process.
- Prepare documentation of the industry / site visits.
- Identify and respond to the practical requirements to be considered in design projects .
- Interpret and respond to real time industry/on site needs.
- Incorporate the knowledge gained during industry visits in their models/portfolio/drawings.

Course Content:

1. Study of the industry site visit and data collection
2. Analysis of data
3. Synthesis of data/design models/design considerations
4. Preparation of drawings/conclusions/models/solutions
5. Report

UA16BD351P:
PRODUCT DESIGN PROJECT STUDIO - II (6-0-2-6)

Course Objectives:

To introduce to students to:

- Application of design thinking and methods within a design project
- Development of design specifications
- Application of various ideation techniques
- Evaluation of concepts
- Detail design of the project

Course Outcomes:

At the end of the course the students will be able to

- apply design methods in projects that they seek to pursue
- create design specifications based on the project
- ideate and generate different design concepts
- evaluate the concepts generated and select the final concept
- create embodiment design and details

Course Content:

1. Design Specification
2. Ideation
3. Conceptualization
4. Evaluation and Selection
5. Embodiment Design

Pre-requisite Courses: None

References:

1. "Product Design and Development", Ulrich, Karl T., Eppinger, Steven D., McGraw-Hill, 2004.
2. "Creating Breakthrough Products: Innovation from Product Planning to Program Approval", Cagan, Jonathan; Vogel, Craig M., Financial Times Prentice Hall, 2002.
3. "About Face 3: The Essentials of Interaction Design", Alan Cooper, Robert Reimann and David Cronin, 3rd Edition, Jenson Books Inc. ISBN-13: 978-0470084113
4. "Design Thinking for Visual Communication (Basics Design)", Gavin Ambrose, Fairchild Books, 2nd Edition, Paperback 2015, ISBN-13: 978-1472572714
5. "Launch: Using Design Thinking to Boost Creativity and Bring Out the Maker in Every Student", John Spencer, A J Juliani, Dave Burgess Consulting, Incorporated, Paperback, 2016, ISBN-13: 978-0996989541

UA16BD352P:
VEHICLE DESIGN (4-0-2-4)

Course Objectives:

To introduce to students to:

- Design process specific for vehicles
- Role of narrative in design
- Generation of mission statement and design brief
- Visual DNA in vehicle design
- Development of concept and digital sculpting

Course Outcome:

The students will be able to:

- understand aspects of transportation in terms of mobility and vehicles
- apply a user centric basis for designing vehicle exteriors
- apply aspects of brand identity and evolution to vehicles
- generate concepts and develop digital models
- communicate the design with clients.

Course Content:

1. Defining and verbalizing a vision and setting targets; identify opportunity based on emotional experience
2. Understanding the role of narrative in design;
3. Generating a mission statement; interplay between brand and design brief;
4. Creating a visual DNA based on design brief; selecting key directions and themes
5. Bringing ideas together; Component design; digital sculpting and concept making; communication with internal and external clients

References:

1. "Vehicle Design: Aesthetic Principles in Transportation Design", Jordan Meadows, Routledge, 2017.
2. "Car-Trek: Rickey Martins 50 year Quest to Draw Futuristic Cars", Createspace Independent Publications, 2013.
3. "H-point: The Fundamentals of Car Design & Packaging", 2nd Edition, Design Studio Press, 2014.
4. "How to Draw Cars Like a Pro", 2nd Edition, Thomas et. al. Motorbooks, 2006.
5. "How to Design Cars like a Pro", Tony Lewin et. al. Motorbooks, 2010.

UA16BD353P:
DESIGN FOR MANUFACTURABILITY AND COST (3-0-2-3)

Course Objectives:

To introduce students to:

- Various manufacturing processes
- Manufacturability requirements
- Additive Manufacturing
- Different kinds of costing methods
- Concepts in design for sustainability

Course Outcome:

The students will be able:

- to understand implications of the choice of manufacturing technologies on design
- to design product considering subtracting manufacturability
- to design product considering additive manufacturability
- to design product for manufacturability and to control product cost
- to design for sustainability considerations

Course Content:

1. Review of Manufacturing Processes and manufacturability requirements
2. Design for Subtracting Manufacturing
3. Design for Additive Manufacturing
4. Design for Cost
5. Sustainability considerations

Pre-requisite Courses: None

Reference Books:

1. "Product Design for Manufacture and Assembly", Boothroyd G. and Dewhurst J., CRC Press, 2010.
2. "Design for Manufacturability Handbook", James G Bralla, McGraw Hill Publications, 2004.
3. "Target Costing Market Driven Product Design", Bradford Clifton, Holmdel, Henry M. B. Bird, Robert E. Albano, Marcel Dekker, 2003.

UA16BD354P:
CAE in PRODUCT DESIGN -II (1-4-0-3)

Course Objectives:

To introduce students to:

- Finite element modeling of 2D solids
- Finite element modeling of Plates and shells
- Basic concept of 3D Solids in FEM
- Role of lumped parametric modeling in Computer Aided Analysis.
- Various commercially available meshing and analysis software

Course Outcome:

The students will be able:

- to use 2 D elements for computer aided analysis.
- to understand the basic of plates and shells elements in FEM
- to model structural components using 3D Solids
- to model components using LPM approach
- to use commercially available CAE tools

Course Content:

1. FEM for Two Dimensional Solids
2. FEM for Plates and Shells.
3. FEM for 3D Solids
4. Lumped Parametric Model
5. Modeling techniques and use of commercially available analysis software

Pre-requisite Courses: None

Reference Books:

1. "Introduction to Finite Elements in Engineering", Tirupathi R Chandrupatla, Publisher, Phi Pub, 2009.
2. "Finite Element Analysis", G Lakshmi Narasaiah, BS Publications , 2016.
3. "The Finite Element Method", G.R. Liu, Butterworth-Heinemann, 2013.
4. "Practical Finite Element Analysis", Nithin, Finite To Infinite , 2008.

UA16BD341P:
TRANSPORTATION PLANNING (2-0-0-2)

Course Objectives:

To introduce to students to:

- design process in the context of transportation systems
- transportation planning and travel characteristics
- transportation planning considerations and transit planning
- safety considerations
- management of transportation systems

Course Outcome:

The students will be able:

- to understand various considerations in transportation planning
- to apply design principles in vehicle design drawn from the broader context of transportation
- plan transportation and transits for different transportation systems

- to apply safety considerations while planning
- apply different aspects of transportation system management

Course Content:

- Introduction to Transport Planning; Travel characteristics; land use; urban design and environmental considerations
- Travel demand, evaluation and prioritization
- Planning for parking, bicyclists and pedestrians; Transit planning
- Safety considerations in transportation; public participation and engagement
- Aspects of transportation system management and operations

Reference Books:

1. "Transportation Planning Handbook", Institution of Engineers, Michael D. Meyer, 4th Edition, John Wiley & Sons, 2016.
2. "Sustainable-Transportation-Planning-Tools-for-Creating-Vibrant-Healthy-and-Resilient-Communities", Jeffrey Tumlin, John Wiley & Sons, 2012.

UA16BD342P: PACKAGING DESIGN (2-0-0-2)

Course Objectives:

To introduce to students to :

- history of packaging and contemporary trends
- elements of packaging design.
- packaging design Process, design principles, design considerations, and aspects.
- various materials used in packaging design
- professional practices involving packaging design

Course Outcome:

The students will be able to:

- understand and appreciate the history and importance of packaging design.
- understand different elements involved in packaging design
- apply design processes and considerations specific to packaging design
- evaluate and select materials for packaging
- understand the regulatory issues in professional practice.

Course Content:

1. History of packaging and contemporary trends
2. Defining packaging design
3. Elements of packaging design
4. Packaging Design process
5. Professional practice of packaging design; legal and regulatory issues

References:

1. "Packaging Design: Successful Product Branding from Concept to Shelf", Marianne Rosner Klimchuk and Sandra A. Krasovec, 2nd Edition, John Wiley& Sons, 2012.
2. Packaging Essentials: 100 Design Principles for Creating Packages",Rockport Publishers, 2010.
3. "Structural Packaging_ Design Your Own Boxes and 3D Forms", Paul Jackson-Laurence King Publishing, 2012.

UA16BD351C: COMMUNICATION DESIGN PROJECT STUDIO II (6-0-2-6)

Course Objectives:

To introduce students to:

- 3D film production process
- Software for 3D modeling
- Techniques involved in the usage of 3D/2D software
- Knowledge of making a short film using 3D/2D software's
- Preparation strategies for Design Portfolio

Course Outcomes:

The students will be able to:

- Know to Work with 3D film Production Pipe line
- Demonstrate the ability to work with 3D software's
- Work & Understand Dynamics
- Students will be able to specialize in the advanced concepts of Animation like keying, motion capturing etc.
- Create Design Portfolio

Course Content:

1. 3D Production Pipe line
2. 3D Modeling
3. Dynamics
4. Packaging Design
5. Design Portfolio

Pre-requisite Courses: None

Reference Books:

1. "Maya Studio Projects: Dynamics", Todd Palamar, Sybex , 2009.
2. "MEL Scripting a Character Rig in Maya", New Riders , 2008.
3. "Getting Started in 3D with Maya", Adam Watkins, Focal Press, 2012.
4. "Maya At A Glance", George Maestri, Sybex , 2005.
5. "Maya for Games: Modeling and Texturing Techniques with Maya and Mudbox", Michael Ingrassia,Focal Press , 2008.
6. "Computer Animation Complete: All-in-One: Learn Motion Capture", Rick Parent, Morgan Kaufmann , 2009.
7. "The Mocap Book: A Practical Guide to the Art of Motion Capture", Ricardo Tobon, Foris Force, 2010.
8. "The Animator's Motion Capture Guide: Organizing, Managing, and Editing", Matthew Liverman, Charles River Media, 2004.

UA16BD352C: INFOGRAPHICS - II (3-0-1-3)

Course Objectives :

To introduce students to

- Infographics and considerations for its suitability for Print and Media
- Design Considerations for printing infographics.
- Preparation of files for printing
- Digital and Litho Printing, Variable Data Printing
- Different types of paper used in printing industry and techniques for folding

Course Outcome:

At the end of the course, students will be able to

- Differentiate infographics for printing from that of web or mobile
- Apply different design considerations used in infographics for print
- Prepare files ready for printing for different purposes
- Identify and use appropriate printing techniques according to the type of print required
- Identify different paper types used for printing and apply various folding techniques.

Course Content:

1. Infographics- Suitability for Print and Media
    - Study of difference between infographics for digital use and printing.

2. Printing considerations for infographics
    - Type of Color mode, Limiting number of Colors
    - Font style and sizes, and Cost
    - Ergonomic considerations
3. File Preparation
    - Print size, File format, and Print bleed, trim
    - Image size/resolution- Newspaper, magazine, photography book
4. Printing Techniques
    - Digital and Litho Printing, Variable Data Printing
5. Paper Folding
    - Study of types of paper, and Folding types and Techniques

Pre- requisites : None

Reference Books :

1. "Paper Folding Templates for Print Design Formats, Techniques and Design Considerations for Innovative Paper Folding", Trish Witkowski, HOW books, an Imprint of F+W Media, Inc, 2012.
2. "Handbook of Print Media - Technologies and Production Methods", Kipphan, Helmut (Ed.), Springer-Verlag Berlin Heidelberg, 2006.
3. "Getting It Printed", Eric Kenly, HOW Books, 4th Revised Edition, 2004.
4. "Real World Print Production with Adobe, Creative Cloud", Claudia McCue, Peachpit Press, 2013.

UA16BD353C:
VISUAL EFFECTS - II (2-2-1-3)

Course Objectives:

To introduce students to

- Techniques of Visual Effects (VFX)
- Audio literacy and different forms of narratives
- Technological advancements in the field of film and VFX
- VFXfor broadcast, multimedia and film
- Compositing Techniques

Course Outcomes:

At the end of the course the students will be able to

- Apply techniques of visual effects
- Appreciate different forms of narratives
- Apply process of visual fx created for multimedia, broadcast and film aspects
- Use compositing software and camera tracking, motion tracking, lighting etc.
- Work with different concepts of compositing

Course Content:

- Advanced Visual effects and Lighting techniques
- Narratives, Media Theory and Audio Literacy
- Camera tracking and motion tracking
- Advanced Compositing Techniques
- Visual Fx production Pipe line- Case Study and Major Project

Pre-requisites: None

References:

1. "VFX Fundamentals: Visual Special Effects Using Fusion 8.0", Wallace Jackson, Apress, 2016.
2. "The Visual Effects Producer: Understanding the Art and Business of VFX", Charles Finance and Susan Zwerman, Focal Press , 2009.
3. "Digital Compositing for Film and Video", Steve Wright,Routledge, 2010.
4. "After Effects Apprentice: Real-World Skills for the Aspiring Motion Graphics Artist (Apprentice Series)" , Chris Meyer and Trish Meyer, Routledge , 2016.
5. "GoPro: Professional Guide to Filmmaking [covers the HERO4 and all GoPro cameras]", Bradford Schmidt and Brandon Thompson, Peachpit Press , 2014.

UA16BD354C:
3D ANIMATION Lab -II (3-2-2-4)

Course Objectives

This course introduces students to:

- Back ground painting using Digital media/Handmade & Animatics
- Techniques used in 2D animation softwares relevant for 3D animation
- 3D Character animation techniques
- Motion capturing animation
- Deformers &character facial expressions

Course Outcomes:

The students will be able to:

- Create Background design
- Work with 2D animation techniques
- Work with 3D animation techniques
- Create movements using Motion capturing Animation
- Work with Deformersand create character facial expressions

Course Content:

1. Background Design & 2D Animations
2. 3D Character Animation work flow
3. Motion Capturing Animation
4. Deformers
5. Production Process-Short film

Pre-requisite Courses: None

Reference Books:

1. "Cartoon Character Animation with Maya: Mastering the Art of Exaggerated Animation", Keith Osborn, Fairchild Books , 2015.
2. "Body Language: Advanced 3D Character Rigging", Eric Allen and Kelly L. Murdock, Sybex , 2008.
3. "Animation Methods - Rigging Made Easy: Rig Your First 3D Character in Maya", David Rodriguez, CreateSpace Independent Publishing Platform , 2013.
4. "Animation Methods - Rigging Made Easy: Rig Your First 3D Character in Maya", David Rodriguez, Createspace Independent Publishing Platform , 2013.

UA16BD341C:
APPLIED ERGONOMICS(2-0-0-2)

Course Objectives:

This course introduces students to

- Human interactions with systems
- Task analysis and human centered design
- Principles and applications of anthropometry
- Engineering aspect of Products
- Physical, Cognitive, Occupational and biomechanics aspects

Course Outcome :

At the end of the course, students will be able to

- Appreciate human interactions with systems and equipments
- Apply task analysis
- Apply principles of ergonomics to human centered design

- Apply Engineering aspect of Products to human centered design
- Connect Physical, Cognitive, Occupational and biomechanics aspects to human centered design

Course Content:

1. Introduction to Applied ergonomics
    - human interactions with systems
    - human interactions with equipments
2. Introduction to Tasks
    - Task analysis
    - Human centered design
3. Introduction to Physiology
    - Anthropometry
4. Introduction to Engineering aspect of Products
5. Introduction to Physical, Cognitive, Occupational and biomechanics aspects

Pre-requisite : None

References :

1. "Work Study & Ergonomics", S.K. Sharma and Savita Sharma, S K Kataria and Sons , 2012.
2. "The Design of Everyday Things", Don Norman, Basic Books , 2013.
3. "Office Ergonomics: Ease and Efficiency at Work", Anne D. Kroemer and Karl H.E. Kroemer,CRC Press , 2nd Edition, 2016.
4. "Handbook of Human Factors and Ergonomics Methods", Neville Anthony Stanton and Alan Hedge,CRC Press ,2004.
5. "Ergonomics for Beginners: A Quick Reference Guide", Jan Dul, CRC Press ,3rd Edition, 2017.

UA16BD342C:
STORYBOARDING TECHNIQUES (2-0-0-2)

Course Objectives:

To introduce students to

- Pre-production process & Animacting
- Art of the Storyboarding & Animatics
- Thumbnails for Storyboarding using Camera angles, Movement & Shots
- Softwares to create storyboarding
- Develop skills to creating story board panels for a movie

Course Outcomes:

The students will be able to:

- Work with the Preproduction process for film
- Apply various methods of story boarding & Animatics
- Visualize the storyboard using thumbnails
- Create Story boards using softwares
- Create Storyboard for a movie

Course Content:

1. Preproduction Process & Animacting
2. Storyboarding & Animatics
3. Storyboarding using Vector & Raster-based softwares
4. Visualizing Storyboards
5. Storyboards & Animatics for movie

Pre-requisite Courses: None

Reference Books:

1. "Directing the Story Book", Francis Glebas, Focal Press , 2008.
2. "The Art of the Storyboard: A Filmmaker's Introduction Book", John Hart, Focal Press , 2007.
3. "Storyboards: Motion in Art Book, Mark Simon, Routledge , 2006.
4. "Framed Ink: Drawing and Composition for Visual Storytellers Book", Marcos Mateu-Mestre, Design Studio Press , 2010.
5. "Exploring Storyboarding Book", Wendy Tumminello, Course Technology , 2004.
6. "Prepare to board! Book", Nancy Beiman, Zapdoc, 2006.
7. "Professional Storyboarding: Rules of Thumb Book", Anson Jew, Focal Press, 2012.

UA16BD351T:
INTERACTION DESIGN PROJECT STUDIO II (6-0-2-6)

Course Objectives:

This course introduces students to

- Process of Problem Identification in the domain of Interaction Design
- Rapid prototyping first and then use various Design Thinking methodologies
- Data generation and analysis methods
- Prototyping for Interaction Design Projects
- User feedback and testing for Interaction Design projects

Course Outcome :

At the end of the course, students will be able to

- Differentiate and identify the right problems
- Choose suitable design thinking methodologies for the identified problem(s)
- Apply appropriate research methods
- Develop alpha prototypes
- Work with users to generate feedback and conduct testing

Course Content:

1. **Introduction to the Interaction Design Project Studio II**
    - Exploration
    - Problem Identification and redefinition
2. **Design Thinking Methodologies II**
    - Rapid Prototyping and choosing Design Thinking Methodologies
    - Choosing appropriate methodologies for the identified problems
3. **Research Methods II**
    - Application of suitable research methods to the indentified problems
    - Data generation
    - Data Analysis
4. **Prototyping**
    - Contextual data synthesis
    - Developing alpha prototypes
5. **Feedback and Testing**
    - Working with users to obtain feedback
    - Testing and modification of the prototypes

Pre-requisite : None

References :

1. "Guerrilla UX Research Methods: Thrifty, Fast, and Effective User Experience Research Techniques", Russ Unger and Todd Zaki Warfel, Morgan Kaufmann , 2012.
2. "Design Research, Methods and Perspectives", Brenda Laurel (Ed.), The MIT Press, 2003

3. "Research for Designers: A Guide to Methods and Practice", Gjoko Muratovski, SAGE Publications Ltd , 2015.
4. "Qualitative Inquiry and Research Design: Choosing Among Five Approaches", John W. Creswell and Cheryl N. Poth, SAGE Publications Ltd, 2017.
5. "Prototyping: A Practitioner's Guide", Todd Zaki Warfel, Rosenfeld Media , 2011.

UA16BD352T:
UI/UX - II (2-2-1-3)

Course Objectives:

To introduce students to

- UI guidelines
- Usability testing and evaluation
- Iterative Design and Interface Redesign
- Usability Testing for applications
- User Interfaces evaluation

Course Outcomes:

At the end of the course the students will be able to

- Design and develop UI screens
- Understand the best practices for UI/UX design
- conduct Heuristic analysis
- follow standard User interface practices
- prototype using software

Course Content:

1. Visual Design & UI Guidelines
   UI Design & Prototyping Tools
2. Iterative Design and Interface Redesign
   Std UI Design Practice
3. Usability Testing and UX
   Heuristic analysis
4. UI Design Tools and Software
   Evaluating User Interfaces
5. Case Study and Major Project
   Portfolio Preparation

Pre-requisites:

Course Code: None Course Title: None

References:

1. "Mental Models", Indi Young, Rosenfeld Media, 2013.
2. "Practical Empathy", Indi Young, Rosenfeld Media , 2015.
3. "The Inmates Are Running the Asylum", Alan Cooper, Sams , 2004.
4. "Rocket Surgery Made Easy", Steve Krug, New Riders , 2009.
5. "Designing for the Digital Age", Kim Goodwin, Wiley, 2009.
6. "Delivering Happiness", Tony Hsieh, Grand Central Publishing, 2013.
7. "In-N-Out Burger: A Behind-the-Counter Look at the Fast-Food Chain That Breaks All the Rules", Stacy Perman, HarperBusiness , 2010.

UA16BD353T:
ARTIFICIAL INTELLIGENCE, AUGMENTED REALITY (3-2-2-4)

Course Objectives:

To introduce students to

- Basics of Artificial Intelligence systems
- Basics of Augmented Reality
- Applications of AI / AR
- Basics of Machine learning
- Working of recommendation engine

Course Outcomes:

At the end of the course the students will be able to

- Successfully develop designs enabled with AR
- Understand and appreciate the application of AI
- Appreciate Machine Learning capabilities
- Understand history of AI and AR
- create application enabled with AR

Course Content:

1. **Introducing Augmented Reality**
   characteristics of AR systems and components of an AR architecture
2. **AR application**
   printed media and 3D object
3. **Introduction to AI, history of AI**
   Intelligent agents
4. **Machine Learning: Basic concepts**
   AI applications (Vision/Robotics)
5. **Case Study and Major Project**

Pre-requisites:Nil

References:

1. "Introduction to Artificial Intelligence", Philip C Jackson, Dover Publications , 2013.
2. "Deep Learning (Adaptive Computation and Machine Learning series) ",Ian Good fellow, Yoshua Bengio, & Aaron Courville, MIT Press , 2017.
3. "The Cambridge Handbook of Artificial Intelligence", Keith Frankish, William M. Ramsey, Cambridge University Press, 2014.
4. "Artificial Intelligence: A Modern Approach", Stuart Russell and Peter Norvig, Pearson , 2009.
5. "Augmented Reality: Principles and Practice (Usability)", Dieter Schmalstieg, Tobias Hollerer, Addison-Wesley Professional, 2016.
6. "Fundamentals of Wearable Computers and Augmented Reality", Woodrow Barfield , 2nd Edition, Paperback,CRC Press, 2017.

UA16BD354T:
TECHNLOGY TRENDS AND ANALYSIS (3-0-1-3)

Course Objectives :

To introduce students to

- Interaction design trends
- Prototyping tools trends.
- Various methods for trend analysis and forecasting.
- Various techniques for displaying trends
- Design trend forecasting methods

Course Outcome :

The students will be able to

- Appreciate different interaction design trends and prototyping tools.
- Choose and apply methods for trend analysis.
- Forecast the future trend.
- Apply different methods for displaying trends
- Create designs with lasting relevance.

Course Content :

1. Research Methods and Study of trends in interaction design
    - Micro-mini interactions, hypnotic feedback, Age responsive design, Digital trust design, Failure mapping, User off boarding.
2. Prototyping tools Trends
    - UX Pin, Flinto, Principle, Web Flow, Adobe XD, and Marvel.
3. Trend Analysis and Presentations
    - Audience, Statistics assumptions, cause of trend, parameters that influence the trend, methods of trend analysis.
    - Visual methods for displaying trends.
4. Trend Forecasting and predictions
    - Patterns in time series, forecasting using Patterns
    - Types of forecasting methods - Delphi Technique, Scenario writing, Subjective approach and time series forecasting
5. Designing for tomorrow
    - Guidelines for mapping the recent past to the impending future.
    - Design that maintains lasting relevance

Pre- requisites : None

Reference Books :

1. “Trend Forecaster’s Handbook”, Raymond Martin, Lawrence King Publishing Ltd., 2010.
2. “Thinking about the Future: Guidelines for Strategic Foresight”, Andy Hines and Peter Bishop, Hinesight Edition, 2015
3. “Designing UX: Prototyping”, Ben Coleman and Dan Goodwin, Site Point Pvt. Ltd, 2017
4. “Emerging Research and Trends in Interactivity and the Human-Computer Interface”, Katherine Blashki, Book News Incorporation Portland, 2013

UA16BD341T:
APPLIED ERGONOMICS (2-0-0-2)

Course Objectives:

This course introduces students to

- Human interactions with systems
- Task analysis and human centered design
- Principles and applications of anthropometry
- Engineering aspect of Products
- Physical, Cognitive, Occupational and biomechanics aspects

Course Outcome :

At the end of the course, students will be able to

- Appreciate human interactions with systems and equipments
- Apply task analysis
- Apply principles of ergonomics to human centered design
- Apply Engineering aspect of Products to human centered design
- Connect Physical, Cognitive, Occupational and biomechanics aspects to human centered design

Course Content:

1. **Introduction to Applied Ergonomics**: human interactions with systems, human interactions with equipments
2. **Introduction to Tasks**: - Task analysis - Human centered design
3. **Introduction to Physiology:**Anthropometry
4. **Introduction to Engineering** aspect of Products
5. **Introduction** to Physical, Cognitive, Occupational and biomechanics aspects

Pre-requisite : None

References :

1. “Work Study & Ergonomics”, S.K. Sharma and Savita Sharma, S K Kataria and Sons , 2012.
2. “The Design of Everyday Things”, Don Norman, Basic Books , 2013.
3. “Office Ergonomics: Ease and Efficiency at Work”, Anne D. Kroemer and Karl H.E. Kroemer,CRC Press , 2nd Edition, 2016.
4. “Handbook of Human Factors and Ergonomics Methods”, Neville Anthony Stanton and Alan Hedge,CRC Press ,2004.
5. “Ergonomics for Beginners: A Quick Reference Guide”, Jan Dul, CRC Press ,3rd Edition, 2017.

UA16BD342T:
INTERACTIVE SMART DEVICES (2-0-0-2)

Course Objectives:

This course introduces students to:

- User input and new types of interactions
- 3-D Modelling and device fabrication
- Simple electronic actuation circuits
- Market scope for Interactive Smart Devices
- Applications of Interactive smart devices to business and education

Course Outcome :

At the end of the course, students will be able to:

- Design new types of interactions
- Build and fabricate 3-D models for the interactive smart device
- Build simple electronic actuation circuits
- Appreciate the market scope for Interactive Smart Devices
- Appreciate applications of Interactive smart devices to business and education

Course Content:

1. **Introduction to User Input and New Types of Interactions** : Design of the device prototype
2. **3-D Modelling and Fabricate of the Form of the Device**: Modelling and fabrication techniques
3. **Build Basic Sensing and Actuation Circuits**: Building and construction of the actuation circuits
4. **Describe the Market Opportunity**: Target Audience and size of that market.
5. **Application of Interactive Smart Devices** : Education, Business

Pre-requisite : None

References :

1. “Designing The Internet of Things 2015”, Adrian Mcewen and Hakin Cassimally, Wiley, 2013.
2. “SMART Board Interactive Whiteboard For Dummies”, Radana Dvorak, For Dummie, 2012.
3. “Smart Sensors and Systems: Innovations for Medical, Environmental, and IoT Applications”, 8 November, Chong-Min Kyung and Hiroto Yasuura, Hardcover, 2016.
4. “Smart Design: First International Conference Proceedings”, Philip Breedon, Springer , 2014,
5. “Human-Computer Interaction: Design and Evaluation” , Masaaki Kurosu, 17th International Conference, HCI International 2015, Los Angeles, CA, USA, August 2–7, 2015, Part I (Lecture Notes in Computer Science), 10 July 2015.

FACULTY OF ENGINEERING & TECHNOLOGY

SCHEME OF INSTRUCTION

Programs of Study: B.TECH / M.TECH

Sl. No.	Course Type
1.	Preliminary (PC)
2.	Foundation (FC)
3.	Core (CC)
4.	Elective (EC)
5.	Project / Self learning / Seminar / Internship (PW)
6.	Non credit (NC) (All non credit courses are mandatory)

STRUCTURE OF CURRICULUM

FACULTY OF ENGINEERING – UG PROGRAMS

B.TECH

I / II SEMESTER (2018 – 22 BATCH)

(COMMON TO ALL PROGRAMS OF STUDY)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE18MA101	Engineering Mathematics - I	3	1	1	0	4	FC
2	UE18MA151	Engineering Mathematics – II	3	1	1	0	4	FC
3	UE18CY101	Engineering Chemistry	4	0	0	0	4	FC
4	UE18PH101	Engineering Physics	4	0	0	0	4	FC
5	UE18CS101	Introduction to Computing with Python	4	0	0	0	4	FC
6	UE18CS151	Problem Solving with C	4	0	0	0	4	FC
7	UE18CV101	Engineering Mechanics-Statics	4	0	0	0	4	FC
8	UE18EC101	Basic Electronics Engineering	4	0	0	0	4	FC
9	UE18ME101	Mechanical Engineering Sciences	4	0	0	0	4	FC
10	UE18EE101	Basic Electrical Engineering	4	0	0	0	4	FC
11	UE18BT101	Engineering Biology	2	0	0	0	2	FC
12	UE18CY102	Chemistry Laboratory	0	0	2	0	1	FC
13	UE18PH102	Physics Laboratory	0	0	2	0	1	FC
14	UE18CS102	Introduction to Computing with Python Laboratory	0	0	2	0	1	FC
15	UE18CS152	Problem solving with C Laboratory	0	0	2	0	1	FC
16	UE18ME102	Computer Aided Engineering Graphics	1	0	2	0	2	FC
17	UE18HS101	Constitution of India and Professional Ethics	0	0	0	0	0	NC
18	UE18HS102	Environmental studies	0	0	0	0	0	NC
19	UE18HS103	Technical Communication	0	0	0	0	0	NC
20	UE18HS104	Kannada	0	0	0	0	0	NC
		TOTAL	**41**	**2**	**12**	0	**48**	

B.TECH IN BIOTECHNOLOGY

III SEMESTER (2017-21 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17MA201	Engineering Mathematics -III	3	1	1	0	4	FC
2	UE17BT201	Bioprocess Calculations	4	0	0	0	4	FC
3	UE17BT202	Fluid Mechanics and Mechanical Operations	3	0	2	0	4	CC
4	UE17BT203	Microbiology	4	0	0	0	4	CC
5	UE17BT204	Biochemistry: Biomolecules	4	0	0	0	4	FC
6	UE17BT205	Microbiology Laboratory	0	0	2	0	1	CC
7	UE17BT206	Biochemistry:Biomolecules Laboratory	0	0	2	0	1	FC
8	UE17BT207X	Special Topic	1	0	2	0	2	PW
		TOTAL	**19**	**1**	**9**	**0**	**24**	

IV SEMESTER (2017-21 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17MA251	Linear Algebra and its Applications	3	1	1	0	4	FC
2	UE17BT251	Thermodynamics and Heat Transfer	3	0	2	0	4	FC
3	UE17BT252	Genetics and Molecular Biology	4	0	0	0	4	CC
4	UE17BT253	Biochemistry: Metabolism	4	0	0	0	4	CC
5	UE17BT254	Mass Transfer	4	0	0	0	4	CC
6	UE17BT255	Genetics and Molecular Biology laboratory	0	0	2	0	1	CC
7	UE17BT256	Biochemistry:Metabolism Laboratory	0	0	2	0	1	CC
8	UE17BT257X	Special Topic	1	0	2	0	2	PW
		TOTAL	**19**	**1**	**9**	**0**	**24**	

V SEMESTER (2016-20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE16BT301	Bioprocess Reaction Engineering	**3**	**0**	**2**	**0**	**4**	**CC**
2	UE16BT302	Genetic Engineering and applications	**4**	**0**	**0**	**0**	**4**	**CC**
3	UE16BT303	Bioinformatics	**4**	**0**	**0**	**0**	**4**	**CC**
4	UE16BT304	Genetic Engineering and applications Laboratory	**0**	**0**	**2**	**0**	**1**	**CC**
5	UE16BT305	Bioinformatics Laboratory	**0**	**0**	**2**	**0**	**1**	**CC**
	Elective – 1							
7	UE16BT311	Structural Biology	4	0	0	0	4	EC
8	UE16BT312	Dairy Biotechnology	4	0	0	0	4	EC
9	UE16BT313	Renewable Energy Resources	4	0	0	0	4	EC
10	UE16BT314	Microarray Technology	4	0	0	0	4	EC
11	UE16BT315	Bioanalytical Instrumentation	4	0	0	0	4	EC
12	UE16BT316	Clinical Biochemistry	4	0	0	0	4	EC
	Elective – II							
13	UE16BT321	Microbial Biotechnology	4	0	0	0	4	EC
14	UE16BT322	Human Cytogenetics	4	0	0	0	4	EC
15	UE16BT323	Bioprocess and equipment design	4	0	0	0	4	EC
16	UE16BT324	Neurobiology	4	0	0	0	4	EC
17	UE16BT325	Agricultural Biotechnology	4	0	0	0	4	EC
18	UE16BT326	Human Physiology	4	0	0	0	4	EC
		TOTAL	**19**	**0**	**6**	**0**	**22**	

ELECTIVES TO BE OPTED FOR SPECIALISATION			
Sl. No	**SPECIALISATION**	**ELECTIVE - I**	**ELECTIVE - II**
A	Cellular and Molecular Biology	UE16BT311 UE16BT312	UE16BT321 UE16BT322,324
B	Process Engineering and Computational Biology	UE16BT311,313 UE16BT314	UE16BT323 UE16BT324
C	Medical and Environmental Biotechnology	UE16BT311,315 UE16BT316	UE16BT324,325 UE16BT326

VI SEMESTER (2016-20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE16BT351	Bioprocess Systems Analysis and Control	4	0	0	0	4	CC
2	UE16BT352	Upstream Process Technology	4	0	0	0	4	CC
3	UE16BT353	Immunology	3	0	2	0	4	CC
4	UE16BT354	Bioprocess Systems Analysis and Control Laboratory	0	0	2	0	1	CC
5	UE16BT355	Upstream Process Technology Laboratory	0	0	2	0	1	CC
6	UE16BT356	Special Topic	1	0	2	0	2	PW
	Elective – III							
7	UE16BT331	Molecular Genetics	4	0	0	0	4	EC
8	UE16BT332	Neuroinformatics	4	0	0	0	4	EC
9	UE16BT333	In silico Drug Design	4	0	0	0	4	EC
10	UE16BT334	Computational Biology	4	0	0	0	4	EC
11	UE16BT335	Environmental Biotechnology	4	0	0	0	4	EC
12	UE16BT336	Biosensors	4	0	0	0	4	EC
	Elective – IV							
13	UE16BT341	Microbial rDNA Technology	4	0	0	0	4	EC
14	UE16BT342	Animal Biotechnology	4	0	0	0	4	EC
15	UE16BT343	Reactor Engineering	4	0	0	0	4	EC
16	UE16BT344	Systems Biology	4	0	0	0	4	EC
17	UE16BT345	Health Diagnostics	4	0	0	0	4	EC
17	UE16BT346	Nanobiotechnology	4	0	0	0	4	EC
		TOTAL	**20**	**0**	**8**	**0**	**24**	

ELECTIVES TO BE OPTED FOR SPECIALISATION			
Sl. No	**SPECIALISATION**	**ELECTIVE - III**	**ELECTIVE - IV**
A	Cellular and Molecular Biology	UE16BT331 UE16BT332	UE16BT341 UE16BT342
B	Process Engineering and Computational Biology	UE16BT332,333 UE16BT334	UE16BT343 UE16BT344
C	Medical and Environmental Biotechnology	UE16BT331,333,335 UE16BT336	UE16BT345 UE16BT346

VII SEMESTER (2015-19 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE15BT401	Food Biotechnology	**3**	**0**	**2**	**0**	**4**	**CC**
2	UE15BT402	Downstream Process Technology	**3**	**0**	**2**	**0**	**4**	**CC**
3	UE15BT403	Drug Development and Toxicology	**3**	**0**	**2**	**0**	**4**	**CC**

	Elective – V							
7	UE15BT411	Molecular Genetics	4	0	0	0	4	EC
8	UE15BT412	IPR,Bioethics and biosafety	4	0	0	0	4	EC
9	UE15BT413	Molecular Modeling and Simulation	4	0	0	0	4	EC
10	UE15BT414	Metabolic Engineering	4	0	0	0	4	EC
11	UE15BT415	Forensic Biology	4	0	0	0	4	EC
12	UE15BT416	Environmental Toxicology	4	0	0	0	4	EC
	Elective – VI							
13	UE15BT421	Tissue Engineering	4	0	0	0	4	EC
14	UE15BT422	Plant Biotechnology	4	0	0	0	4	EC
15	UE15BT423	Transport Phenomena	4	0	0	0	4	EC
16	UE15BT424	Neuroinformatics	4	0	0	0	4	EC
17	UE15BT425	Clinical Research and Data Management	4	0	0	0	4	EC
17	UE15BT426	Bioremediation and waste water treatment technology	4	0	0	0	4	EC
19	UE15IE506	Bioprocess Design and Economics	4	0	0	0	4	EC
		TOTAL	17	0	6	0	20	

ELECTIVES TO BE OPTED FOR SPECIALISATION

Sl. No	SPECIALISATION		ELECTIVE - V	ELECTIVE - VI
A	Cellular and Molecular Biology		UE15BT411 UE15BT412	UE15BT421 UE15BT422
B	Process Engineering and Computational Biology		UE15BT413 UE15BT414	UE15BT423 UE15BT424
C	Medical and Environmental Biotechnology		UE15BT415 UE15BT416	UE15BT425 UE15BT426

VIII SEMESTER (2015-19 BATCH)

Sl. No.	Course Code	Course Title	Hours /week				Credits	Course Type
			L	T	P	S		
1	UE15BT451	Biostatistics	2	0	0	0	2	CC
2	UE15BT490	Project Work	0	0	28	0	14	PW
		TOTAL	**2**	**0**	**28**	**0**	**16**	

B.TECH IN COMPUTER SCIENCE AND ENGINEERING

III SEMESTER (2017-21 BATCH)

Sl. No.	Course Code	Course Title	Hours /week				Credits	Course Type
			L	T	P	S		
1	UE17CS201	Digital Design and Computer Organization	4	0	0	0	4	FC
2	UE17CS202*	Data Structures	4	0	0	0	4	CC
3	UE17CS203	Introduction to Data Science	4	0	0	0	4	FC
4	UE17CS204	Web Technologies I	4	0	0	0	4	CC
5	UE17CS205	Discrete Mathematics and Logic	4	0	0	0	4	FC
6	UE17CS206	Digital Design and Computer Organization Laboratory	0	0	2	0	1	FC
7	UE17CS207	Data Structures Laboratory	0	0	2	0	1	CC
8	UE17CS208 X	Special Topic I	0 /2	0	4 /0	0/8	2	PW
9	UE18MA101D	Engineering Mathematics –I(Applicable to Lateral Entry Students)	2	1	0	0	2	FC
		Total	**23/24**	**0**	**4**	**0**	**24/26**	
Note: Prerequisite courses * UE17CS151								

IV SEMESTER (2017-21 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE17MA251	Linear Algebra and Its Applications	4	0	0	0	4	FC
2	UE17CS251*	Design and Analysis of Algorithms	4	0	0	0	4	CC
3	UE17CS252	Data Base Management Systems	4	0	0	0	4	CC
4	UE17CS253	Microprocessor and Computer Architecture	4	0	0	0	4	FC
5	UE17CS254	Theory of Computation	4	0	0	0	4	CC
6	UE17CS255	Design and Analysis of Algorithms Laboratory	0	0	2	0	1	CC
7	UE17CS256	Microprocessor and Computer Architecture Laboratory	0	0	2	0	1	FC
8	UE17CS257 X	Special Topic II	0 /2	0	4 /0	0/8	2	PW
9	UE18MA151D	Engineering Mathematics –II (Applicable to Lateral Entry Students)	2	1	0	0	2	FC
		TOTAL	**22/24**	**0**	**4**	**0**	**24/26**	
Note: Prerequisite courses * UE17CS151								

V SEMESTER (2016-20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE16CS301	Computer Networks	4	0	0	0	4	CC
2	UE16CS302*	Introduction to Operating Systems	4	0	0	0	4	CC
3	UE16CS303	Principles of Programming Languages	4	0	0	0	4	CC
4	UE16CS304	Computer Networks Laboratory	0	0	2	0	1	CC
5	UE16CS305	Introduction to Operating Systems Laboratory	0	0	2	0	1	CC
	Elective - I							
7	UE16CS311**	Advanced Algorithms	4	0	0	0	4	EC
8	UE16CS312$	Advanced Data Base Management Systems	4	0	0	0	4	EC
9	UE16CS313$	Big Data	4	0	0	0	4	EC
10	UE16CS314	Multimedia Computing	4	0	0	0	4	EC
	Elective - II							
13	UE16CS321**	Computer Graphics and Visualization	4	0	0	0	4	EC
14	UE16CS322$$	Data Analytics	4	0	0	0	4	EC
15	UE16CS323$$$	Fuzzy Logic	4	0	0	0	4	EC
16	UE16CS324	Scientific Computing	4	0	0	0	4	EC
17	UE16CS325**	Artificial Intelligence	4	0	0	0	4	EC
		TOTAL	**20**	**0**	**4**	**0**	**22**	
Note: Pre-requisite Courses -- *UE16CS202; **UE16CS251; $UE16CS252; $$UE16CS203; $$$UE16CS205								

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – I	ELECTIVE – II
A	Algorithms & Computing Models	UE16CS311, UE16CS312, UE16CS313, UE16CS314	UE16CS323, UE16CS325
B	Systems & Core Computing	UE16CS312, UE16CS313	UE16CS321
C	Data Science	UE16CS311, UE16CS312, UE16CS313	UE16CS321, UE16CS322, UE16CS323, UE16CS324, UE16CS325

VI SEMESTER (2016-20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE16CS351*	Compiler Design	4	0	0	0	4	CC
2	UE16CS352	Cloud Computing	3	0	0	4	4	CC
3	UE16CS353**	Machine Learning	4	0	0	0	4	CC
4	UE16CS354	Compiler Design Laboratory	0	0	2	0	1	CC
5	UE16CS355	Machine Learning Laboratory	0	0	2	0	1	CC
6	UE16CS356X	Special Topic I	0 /2	0	4 /0	0/8	2	PW
	Elective - III							
7	UE16CS331$	Computer Network Security	4	0	0	0	4	EC
8	UE16CS332	Storage Area Networks	4	0	0	0	4	EC
9	UE16CS333***	Natural Language Processing	4	0	0	0	4	EC
10	UE16CS334$$	Multi Core Computing	4	0	0	0	4	EC
11	UE16CS335	Generic Programming	4	0	0	0	4	EC
12	UE16CS336	Drone Computing	4	0	0	0	4	EC
	Elective - IV							
13	UE16CS341$	Software Defined Networks	4	0	0	0	4	EC
14	UE16CS342	Knowledge Management	4	0	0	0	4	EC
15	UE16CS343#	System Modeling and Simulation	4	0	0	0	4	EC
16	UE16CS344$	Network Management	4	0	0	0	4	EC
17	UE16CS345***	Digital Image Processing	4	0	0	0	4	EC
18	UE16CS346$	Advanced Computer Networks	4	0	0	0	4	EC
19	UE16CS347	Reconfigurable Computing	4	0	0	0	4	EC
		TOTAL	**20**	**0**	**6**	**0**	**23**	**0**

Note: Pre-requisite Courses -- *UE16CS202, UE16CS254; **UE16MA251, UE16CS251; ***UE16CS251; $UE16CS301; $$UE16CS253; #UE16CS203

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – III	ELECTIVE – IV
A.	Algorithms & Computing Models	UE16CS332, UE16CS333, UE16CS335,	UE16CS342, UE16CS345
B.	Systems & Core Computing	UE16CS331, UE16CS332, UE16CS334, UE16CS336,	UE16CS341, UE16CS343, UE16CS344, UE16CS345, UE16CS346, UE16CS347
C.	Data Science	UE16CS333	UE16CS342, UE16CS343

VII SEMESTER (2015-19 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
COMMON TO ALL STUDENTS								
1	UE15CS401	Object Oriented Modeling and Design	4	0	0	0	4	CC
2	UE15CS402	Software Engineering	4	0	0	0	4	CC
3	UE15CS403$	Web Technologies II	4	0	0	0	4	CC
4	UE15CS404	Term Paper	0	0	0	8	2	PW

OPTION I@								
5	UE15CS41X	Elective V	4	0	0	0	4	EC
6	UE15CS42X	Elective VI	4	0	0	0	4	EC
OPTION II@								
7	UE15CS41X	Elective V	4	0	0	0	4	EC
8	UE15CS43X	Research Credits/ MOOC Course	0	0	8/0	0/16	4	PW
OPTION III@								
9	UE15CS41X	Elective VI	4	0	0	0	4	EC
10	UE15CS43X	Research Credits/ MOOC Course	0	0	8/0	0/16	4	PW
	Elective - V							
11	UE15CS405^^	Object Oriented Programming with Java	4	0	0	0	4	FC
12	UE15CS411	Enterprise Resource Planning	4	0	0	0	4	EC
13	UE15CS412*	Algorithms for Information Retrieval	4	0	0	0	4	EC
14	UE15CS413	Content Management	4	0	0	0	4	EC
15	UE15CS414	Computer Vision	4	0	0	0	4	EC
16	UE15CS415**	Advanced Machine Learning	4	0	0	0	4	EC
17	UE15CS416##	Wireless Network Communications	4	0	0	0	4	EC
	Elective - VI							
18	UE15CS421	Information Security	4	0	0	0	4	EC
19	UE15CS422$	Web Services	4	0	0	0	4	EC
20	UE15CS423*	Algorithms for Intelligent Web	4	0	0	0	4	EC
21	UE15CS424**	Social Network Analytics	4	0	0	0	4	EC
22	UE15CS425#	Computer Systems Performance Analysis	4	0	0	0	4	EC
23	UE15CS426*	Design Patterns	4	0	0	0	4	EC
24	UE15CS427	Autonomous Mobile Robotics	4	0	0	0	4	EC
		TOTAL	**20/24**	**0**	**0**	**8**	**22/26**	

^^Applicable to Lateral Entry students only

Note: Pre-requisite Courses -- $UE15CS204; *UE15CS251; **UE15CS353; #UE15CS253; ##UE15CS301

@: Students can choose one of the three given options.

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – V	ELECTIVE – VI
A.	Algorithms & Computing Models	UE15CS411, UE15CS412, UE15CS414, UE15CS415	UE15CS423, UE15CS424, UE15CS426
B.	Systems & Core Computing	UE15CS414 UE15CS416	UE15CS421, UE15CS422, UE15CS425, UE15CS427
C.	Data Science	UE15CS411, UE15CS412, UE15CS413, UE15CS415	UE15CS421, UE15CS423, UE15CS424

VIII SEMESTER (2015-19 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
OPTION 1@								
1	UE15CS490	Project Work	0	0	24	8	14	PW
OPTION II 2@								
2	UE15CS491	Internship	0	0	12	0	6	PW
3	UE15CS492	Project Work	0	0	12	8	8	PW

	Elective - VII							
4	UE15CS452	Introduction to Software Testing	2	0	0	0	2	EC
5	UE15CS453	Introduction to Business	2	0	0	0	2	EC
6	UE15CS454	Research Methodology	2	0	0	0	2	EC
7	UE15CS455	Technical Writing	0	0	0	8	2	EC
		TOTAL	**2/0**	**0**	**24**	**8/16**	**16**	
@: Student should choose one of the two given options.								

B.TECH IN CIVIL ENGINEERING

III SEMESTER (2017-21 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE17MA201	Engineering Mathematics- III	3	0	2	0	4	CC
2	UE17CV201*	Strength of Materials	3	0	2	0	4	CC
3	UE17CV202	Fluid Mechanics	4	0	0	0	4	CC
4	UE17CV203	Geoinformatics	4	0	0	0	4	CC
5	UE17CV204	Construction Materials & Technology	3	0	2	0	4	CC
6	UE17CV205	Building Planning & Drawing	0	0	2	0	1	CC
7	UE17CV206	Survey Practice Laboratory	0	0	2	0	1	CC
8	UE17CV207X	Special Topic	0	0	2	0	1	ST
9	UE18MA101D	Engineering Mathematics –I (Applicable to Lateral Entry Students)	2	0	0	0	2	FC
		TOTAL	**17/19**	**0**	**12**	**0**	**23 /25**	
Note: Prerequisite course: * UE17CV101 Engineering Mechanics								

IV SEMESTER (2017-21 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1.	UE17MA251	Linear Algebra & its Applications	3	0	2	0	4	CC
2.	UE17CV251*	Structural Analysis	3	0	2	0	4	CC
3.	UE17CV252	Hydraulics & Machinery	4	0	0	0	4	CC
4.	UE17CV253	Transportation Engineering- Highway Engineering	4	0	0	0	4	CC
5.	UE17CV254	Concrete Technology	3	0	2	0	4	CC
6.	UE17CV255	Concrete Laboratory	0	0	2	0	1	CC
7.	UE17CV256	Fluid Mechanics & Machinery Laboratory	0	0	2	0	1	CC
8.	UE17CV257X	Special Topic	0	0	2	0	1	ST
9	UE17MA151D	Engineering Mathematics –II (Applicable to Lateral Entry Students)	2	0	0	0	2	FC
		TOTAL	**17/19**	**0**	**12**	**0**	**23 / 25**	
Note: Prerequisite course: * UE17CV101 Engineering Mechanics								

V SEMESTER (2016-20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE16CV301*	Design & Detailing of R C Structures	3	0	2	0	4	CC
2	UE16CV302*	Computational Structural Analysis	4	0	0	0	4	CC
3	UE16CV303	Fundamentals of Geotechnical Engineering	4	0	0	0	4	CC
4	UE16CV304	F M & Fluid Machinery Laboratory	0	0	2	0	1	CC
5	UE16CV305	Computer Aided Structures Laboratory	0	0	2	0	1	CC
6	UE16CV306	Detailing of R C Structures Laboratory	0	0	2	0	1	ST

	Elective - I							
7	UE16CV311	Hydraulics & Machinery	4	0	0	0	4	EC
8	UE16CV312	Numerical Methods in Civil Engineering	4	0	0	0	4	EC
9	UE16CV313	Advanced Concrete Technology	4	0	0	0	4	EC
	Elective - II							
10	UE16CV321	Alternative Building Materials & Technology	4	0	0	0	4	EC
11	UE16CV322	Soft Computing in Civil Engineering	4	0	0	0	4	EC
12	UE16CV323	Advanced Mechanics	4	0	0	0	4	EC
		TOTAL	19	0	8	0	23	

Note: Prerequisite course: *UE16CV201

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – I	ELECTIVE – II
A	Computer Aided Structures	UE16CV311, UE15CV312	UE15CV322
B	Earth Sciences	UE16CV311	UE15CV321, UE15CV323
C	Construction Technology	UE16CV311, UE16CV313	UE15CV321

VI SEMESTER (2016-20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE16CV351	Advanced Geotechnical Engineering	4	0	0	0	4	CC
2	UE16CV352*	Design & Detailing of Steel Structural Elements	3	0	2	0	4	CC
3	UE16CV353	Transportation Engineering- Highway Engineering	4	0	0	0	4	CC
4	UE16CV354	Geotechnical Engineering Laboratory	0	0	2	0	1	CC
5	UE16CV355	Design and Detailing of Hydraulic Structures Laboratory	0	0	2	0	1	CC
6	UE16CV356X	Special Topic	0	0	2	0	1	ST
	Elective - III							
7	UE16CV331	Hydrology And Irrigation Engineering	4	0	0	0	4	EC
8	UE16CV332	Advanced R C C	4	0	0	0	4	EC
9	UE16CV333	Transportation Structures	4	0	0	0	4	EC
	Elective - IV							
10	UE16CV341	Design Of Pre-Stressed Concrete Structures	4	0	0	0	4	EC
11	UE16CV342	Ground Improvement Techniques & Foundation Design	4	0	0	0	4	EC
12	UE16CV343	EIA for Transportation Projects	4	0	0	0	4	EC
		TOTAL	**19**	**0**	**8**	**0**	**23**	

Note: Prerequisite course: *UE16CV201

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl No.	SPECIALIZATION	ELECTIVE – I	ELECTIVE – II
A	Computer Aided Structures	UE16CV331, UE16CV332	UE16CV341
B	Earth Sciences	UE16CV331	UE16CV343/342
C	Construction Technology	UE16CV331, UE16CV333	UE16CV342

VII SEMESTER (2015-19 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE15CV401	Construction Planning and Methods	3	0	0	0	3	CC
2	UE15CV402	Environmental Enginering (Sewage Treatment and Sanitary Engineering) and Environmental Engineering Laboratory	3	0	2	0	4	CC
3	UE15CV403	Transportation Engineering -Railway, Airport. Extensive Survey Project	3	0	2	0	4	CC
4	UE15CV404	Design & detailing of Steel Structures Laboratory	0	0	2	0	1	CC
	Elective - V							
5	UE15CV411	Estimation & Costing	4	0	0	0	4	EC
6	UE15CV412	Numerical Methods in Civil Engineering	4	0	0	0	4	EC
	Elective - VI							
7	UE15CV421	Ground Improvement Techniques & Foundation Design	4	0	0	0	4	EC
8	UE15CV422	Traffic Engineering	4	0	0	0	4	EC
9	UE15CV423	Remedial Engineering	4	0	0	0	4	EC
		TOTAL	**17**	**0**	**6**	**0**	**20**	
Note: Prerequisite course: * UE15CV201								
ELECTIVES TO BE OPTED FOR SPECIALIZATION								

Sl. NO	SPECIALIZATION	ELECTIVE – V	ELECTIVE – VI
A	Computer Aided Structures	UE15CV 411, UE15CV 412	UE15CV421, UE15CV423
B	Earth Sciences	UE15CV 411	UE15CV422
C	Construction Technology	UE15CV411	UE15CV421

VIII SEMESTER (2014-18 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
	UE15CV451	Research Methodology & Experimental Design	2	0	0	0	2	CC
	UE15CV490	Project Work	0	0	0	28	14	PW
		Total	**2**	**0**	**0**	**28**	**16**	

B.TECH IN ELECTRONICS AND COMMUNICATION ENGINEERING

III SEMESTER (2017-21 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE17MA201	Engineering Mathematics III	3	1	1	0	4	FC
2	UE17EC201	Network Analysis and Synthesis	4	0	0	0	4	FC
3	UE17EC202*	Analog Circuit Design	4	0	0	0	4	FC
4	UE17EC203	Digital Circuit Design	4	0	0	0	4	FC
5	UE17EC204	Signals & Systems	4	0	0	0	4	FC
6	UE17EC205	Analog Circuit Design Laboratory	0	0	2	0	1	FC
7	UE17EC206	Digital Circuit Design Laboratory	0	0	2	0	1	FC
8	UE17EC207	Special Topic	2 /0	0	0/02	0/4	2	FC /PW
9	UE18MA101D	Engineering Mathematics –I (Applicable to Lateral Entry Students)	2	1	0	0	2	FC
		TOTAL	**19 / 21**	**1 / 2**	**5/2**	**0/4**	**24/26**	
Note: Prerequisite course: *UE17EC101, UE17EE101								

IV SEMESTER (2017-21 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE17MA251	Linear Algebra	3	1	1	0	4	FC
2	UE17EC251	Control Systems	4	0	0	0	4	CC
3	UE17EC252	Computer Organization	4	0	0	0	4	CC
4	UE17EC253	VLSI	4	0	0	0	4	CC
5	UE17EC254	Electromagnetic Field & Transmission Lines	4	0	0	0	4	CC
6	UE17EC255	Computer Organization Laboratory	0	0	2	0	1	CC
7	UE17EC256	VLSI Laboratory	0	0	2	0	1	CC
8	UE17EC257XX	Special Topic	2	0	0	0	2	EC
9	UE18MA151D	Engineering Mathematics –II (Applicable to Lateral Entry Students)	2	1	0	0	2	FC
		TOTAL	**23 / 25**	**1 / 2**	**5**	**0**	**26 / 28**	

V SEMESTER (2016-20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE16EC301	Communication Engineering	4	0	0	0	4	CC
2	UE16EC302*	Microwave Engineering*	4	0	0	0	4	CC
3	UE16EC303^	VLSI Design^	4	0	0	0	4	CC
5	UE16EC304	Microwave Engineering Laboratory	0	0	2	0	1	CC
6	UE16EC305	VLSI Design Laboratory	0	0	2	0	1	CC
	Elective- I							
7	UE16EC311	Video Engineering	4	0	0	0	4	EC
8	UE16EC312#	Optic Fiber Communication	4	0	0	0	4	EC
9	UE16EC313@	Semiconductor Devices	4	0	0	0	4	EC
10	UE16EC314	Computer Organization	4	0	0	0	4	EC
11	UE16EC315^^	Control Systems	4	0	0	0	4	EC
12	UE16EC316##	Digital Image Processing	4	0	0	0	4	EC
	Elective – II							
13	UE16EC321	Satellite communication	4	0	0	0	4	EC
14	UE16EC322	Wireless communication	4	0	0	0	4	EC
15	UE16EC323	Real Time Operating Systems	4	0	0	0	4	EC
16	UE16EC324$	Testing of VLSI Circuits	4	0	0	0	4	EC
17	UE16EC325&	Fuzzy Systems	4	0	0	0	4	EC
18	UE16EC326&	Artificial Neural Networks	4	0	0	0	4	EC
		TOTAL	**20**	**0**	**4**	**0**	**22**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – I	ELECTIVE – II
A	Communication	UE16EC311, UE16EC312	UE16EC321, UE16EC322
B	VLSI	UE16EC313, UE16EC314	UE16EC323, UE16EC324
C	Signal Processing	UE16EC315, UE16EC316	UE16EC325, UE16EC326

Note: Prerequisite course: *UE16EC254; ^UE16EC202, UE16EC203; #UE16PH101, UE16EC202; @UE16EC202; ^^UE16MA251, UE16EC204; #UE16EC204, #E16EC253; $UE16EC203; &UE16MA251

VI SEMESTER (2016-20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE16EC351	Computer Networks	4	0	0	0	4	CC
2	UE16EC352	Digital Communication	4	0	0	0	4	CC
3	UE16EC353#	Digital System Design #	4	0	0	0	4	CC
4	UE16EC354	Computer Networks Laboratory	0	0	2	0	1	CC
5	UE16EC355	Digital System Design Laboratory	0	0	2	0	1	CC
6	UE16EC356XX	Special Topic	2/0	0	0/2	0	2	EC/PW
	Elective – III							
7	UE16EC331	Spread spectrum communication	4	0	0	0	4	EC
8	UE16EC332	Error Control Coding	4	0	0	0	4	EC
9	UE16EC333#	Digital System Synthesis and Optimization	4	0	0	0	4	EC
10	UE16EC334°	System on Chip Architecture	4	0	0	0	4	EC
11	UE16EC335^	Control Systems	4	0	0	0	4	EC
12	UE16EC336^	Linear Systems	4	0	0	0	4	EC
13	UE16EC337@	Advanced Digital Signal Processing	4	0	0	0	4	EC
	Elective – IV							
14	UE16EC341	Introduction to Cryptography	4	0	0	0	4	EC
15	UE16EC342	Optimization and Its Applications	4	0	0	0	4	EC
16	UE16EC343#	Memory Design and Testing	4	0	0	0	4	EC
17	UE16EC344°	Real Time Embedded Systems	4	0	0	0	4	EC
18	UE16EC345$	Pattern Classification	4	0	0	0	4	EC
19	UE16EC346@	Adaptive Signal Processing	4	0	0	0	4	EC
20	UE16EC347^	Machine Learning	4	0	0	0	4	EC
		TOTAL	**22/6**	**0**	**4/6**	**0**	**24**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – III	ELECTIVE – IV
A	Communication	UE16EC331, UE16EC332	UE16EC341, UE16EC342, UE16EC347
B	VLSI	UE16EC333, UE16EC334	UE16EC342, UE16EC343, UE16EC344
C	Signal Processing	UE16EC335, UE16EC336, UE16EC337	UE16EC342, UE16EC345, UE16EC346, UE16EC347
Note: Prerequisite course: #UE16EC203; ^UE16MA251, UE16EC204; @UE16EC253; $UE16MA251; UE16EC252			

VII SEMESTER (2015-19 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
COMMON TO ALL STUDENTS								
1	UE15EC401o	Fundamentals of Antennaso	4	0	0	0	4	CC
2	UE15EC402	Embedded Systems Design	4	0	0	0	4	CC
3	UE15EC403#	Wireless Communication#	4	0	0	0	4	CC
4	UE15IE406	Technical Communication I (Applicable to Lateral Entry Students)	2	0	0	0	2	EC

	OPTION I							
5	UE15EC41X	Elective V	4	0	0	0	4	EC
6	UE15EC42X	Elective VI	4	0	0	0	4	EC
	OPTION II							
7	UE15EC41X / UE15EC42X	Elective V OR Elective VI	4	0	0	0	4	EC
8	UE15EC431 OR UE15EC432XX	Research project **OR** SWAYAM Course I	0	0	8/0	0/4	4	PW / CC
	Elective - V							
9	UE15EC411@	Wireless Network Design@	4	0	0	0	4	EC
10	UE15EC412@@	Error Control Coding@@	4	0	0	0	4	EC
11	UE15EC413oo	Network Security IIoo	4	0	0	0	4	EC
12	UE15EC414$	Parallel and Distributed Computing$	4	0	0	0	4	EC
13	UE15EC415##	Digital System Synthesis and Optimization##	4	0	0	0	4	EC
14	UE15EC416	Advanced Digital Image Processing	4	0	0	0	4	EC
15	UE15EC417^	Detection and Estimation^	4	0	0	0	4	EC
	Elective – VI							
16	UE15EC421o	Radar Systemso	4	0	0	0	4	EC
17	UE15EC422**	Passive RF and Microwave Circuits**	4	0	0	0	4	EC
18	UE15EC423*	Timing Analysis of Digital Circuits*	4	0	0	0	4	EC
19	UE15EC424&	Verification of VLSI Circuits with System Verilog	4	0	0	0	4	EC
20	UE15EC425&&	Pervasive Computing&	4	0	0	0	4	EC
21	UE15EC426+	Speech Processing	4	0	0	0	4	EC
22	UE15EC427^	Statistical Signal Processing^	4	0	0	0	4	EC
23	UE15EC428++	Adaptive Systems++	4	0	0	0	4	EC
		TOTAL	**20/22**	**0**	**8/0**	**0/4**	**20/22**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – V	ELECTIVE – VI
A	Communication	UE15EC411, UE15EC412, UE15EC413	UE15EC421, UE15EC422
B	VLSI	UE15EC414, UE15EC415	UE15EC423, UE15EC424, UE15EC425
C	Signal Processing	UE15EC416, UE15EC417	UE15EC426, UE15EC427, UE15EC428

Note:
Prerequisite course: oUE15EC204, UE15EC352; #UE15EC254; @UE15EC351; @@UE15MA251, UE15EC312; ooUE15EC341; $UE15EC253; ##UE15EC203; ^UE15EC254, UE15EC302; **UE15EC352; *UE15EC202, UE15EC303; &UE15EC356; +UE15EC302; ++UE15MA251, UE15EC252
Students can choose either Option I or Option II

VIII SEMESTER (2015-19 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
COMMON TO ALL STUDENTS								
1	UE15EC45X	Elective VII	2	0	0	0	2	EC
2	UE15IE441	Technical Communication - II (For Lateral Entry Students)	2	0	0	0	2	EC

	Option I							
3	UE15EC490	Project Work	0	0	28	0	14	PW
	Option II							
4	UE15EC491 **OR** UE15EC461XX and UE15EC462XX	Project Work (8 credits) **OR** SWAYAM Course II and SWAYAM Course III (4 credits each)	0	0	16/0	0/8	8	PW/EC
5	UE15EC492	Industry / International Internship	0	0	10	0	6	PW
		Elective VII						
6	UE15EC452^{+}	RF Wave Propagation^{+}	2	0	0	0	2	EC
7	UE15EC453	Research Methodology	2	0	0	0	2	EC
8	UE15EC454	Engineering Management	2	0	0	0	2	EC
9	UE15EC455^{x}	System Verilog^{x}	2	0	0	0	2	EC
10	UE15EC455^{xx}	Reconfigurable Computing^{xx}	2	0	0	0	2	EC
11	UE15EC457^{v}	Physics & Technology of Semiconductor Nanoscale Devices^{v}	2	0	0	0	2	EC
14	UE15EC458^{++}	Multimedia Communication^{++}	2	0	0	0	2	EC
	UE15EC459^{++}	DSP Architecture^{++}	2	0	0	0	2	EC
		TOTAL	**2/4**	**0**	**44/28**	**0/8**	**16/18**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – VII
1	Communication	UE15EC452, UE15EC453, UE15EC454
2	VLSI	UE15EC453, UE15EC454, UE15EC455, UE15EC456, UE15EC457
3	Signal Processing	UE15EC453, UE15EC454, UE15EC458, UE15EC459

Note:
1. Prerequisite course: $^{+}$UE15EC204; ^{x}UE15EC303, UE15EC353; ^{xx}UE15EC353; ^{v}UE15EC313; $^{++}$UE15EC302
2. Students can choose either Option I or Option II

B.TECH IN ELECTRICAL AND ELECTRONICS ENGINEERING

III SEMESTER (2017-2021 BATCH)

Sl. No.	Course Code	Course Title	Hours / Week				Credits	Course Type
			L	T	P	S		
1	UE17MA201	Engineering Mathematics III	3	1	1	0	4	FC
2	UE17EE201*	Electric Circuit Theory	3	1	0	0	4	FC
3	UE17EE202	Analog Electronic Circuits	4	0	0	0	4	FC
4	UE17EE203	Digital Electronics	4	0	0	0	4	FC
5	UE17EE204#	Electromagnetic Theory	4	0	0	0	4	FC
6	UE17EE205	Analog Electronic Circuits Laboratory	0	0	2	0	1	FC
7	UE17EE206	Digital Electronics Laboratory	0	0	2	0	1	FC
8	UE17EE207X	Special Topic	2	0	0	0	2	PW
9	UE17MA101D	Engineering Mathematics – I (for Lateral Entry Students)	2	1	0	0	2	FC
		TOTAL	**20/22**	**2 / 3**	**5**	**0**	**24/26**	

Note: Prerequisite course: *UE17EE101; #UE17MA101,UE17MA151

IV SEMESTER (2017-2021 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17MA251	Linear Algebra and Its Applications	3	1	1	0	4	FC
2	UE17EE251	Linear Integrated Circuits	4	0	0	0	4	FC
3	UE17EE252	Electrical Machines-I	3	1	0	0	4	CC
4	UE17EE253	Power Electronics	4	0	0	0	4	CC
5	UE17EE254	Generation Transmission and Distribution	3	0	0	4	4	FC
6	UE17EE255	Linear Integrated Circuits Laboratory	0	0	2	0	1	FC
7	UE17EE256	Electrical Machines-I Laboratory	0	0	2	0	1	FC
8	UE17EE257X	Special Topic	2	0	0	0	2	PW
9	UE17MA151D	Engineering Mathematics –II (for Lateral Entry Students)	2	1	0	0	2	FC
		TOTAL	**19/21**	**2/3**	**5**	**4**	**24/26**	

V SEMESTER (2016-20 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE16EE301*	Electrical Machines – II	3	1	0	0	4	CC
2	UE16EE302#	Microcontrollers	4	0	0	0	4	CC
3	UE16EE303	Signals and Systems	3	1	0	0	4	FC
4	UE16EE304	Electrical Machines – II Laboratory	0	0	2	0	1	CC
5	UE16EE305	Microcontrollers Laboratory	0	0	2	0	1	CC
6	**Elective - I**							
	UE16EE311	Power Distribution Systems	4	0	0	0	4	EC
	UE16EE312	Power Station Practice	4	0	0	0	4	EC
	UE16EE313	Solar Photovoltaic Systems	4	0	0	0	4	EC
	UE16EE314	Power Conversion in Renewable Energy Systems	4	0	0	0	4	EC
	UE16EE315	DSD using VHDL	4	0	0	0	4	EC
	UE16EE316	Communication Engineering	4	0	0	0	4	EC
	UE16EE317	Computer Architecture	4	0	0	0	4	EC
7	**Elective - II**							
	UE16EE321	Renewable Energy Sources	4	0	0	0	4	EC
	UE16EE322	Advanced Electromagnetic Theory	4	0	0	0	4	EC
	UE16EE323	Advanced Power Electronics	4	0	0	0	4	EC
	UE16EE324	PWM Converters and Applications	4	0	0	0	4	EC
	UE16EE325	Data Structures and Algorithms	4	0	0	0	4	EC
	UE16EE326	Sensors and Actuators	4	0	0	0	4	EC
		TOTAL	**18/20**	**2**	**5**	**0**	**22/24**	
Note: Prerequisite course: *UE16EE101; #UE16EE203								

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – I	ELECTIVE – II
A	Smart Power Control	UE16EE311, UE16EE312	UE16EE321, UE16EE322
B	Power Electronic Drives and Energy Systems	UE16EE313, UE16EE314	UE16EE323, UE16EE324
C	Embedded Systems	UE16EE315, UE16EE316, UE16EE317	UE16EE325, UE16EE326

VI SEMESTER (2016-20 BATCH)

Sl. No.	Course Code	Course Title	Hours / Week L	T	P	S	Credits	Course Type
1	UE16EE351	Power System Analysis & Stability	4	0	0	0	4	CC
2	UE16EE352	Control Systems	4	0	0	0	4	CC
3	UE16EE353	Digital Signal Processing	3	1	0	0	4	CC
4	UE16EE354	Power System Analysis & Stability Lab	0	0	2	0	1	CC
5	UE16EE355	Digital Signal Processing Lab	0	0	2	0	1	CC
6	UE16EE356X	Special Topic	2	0	0	0	2	PW
7	**Elective - III**							
	UE16EE331	Special Machines	4	0	0	0	4	EC
	UE16EE332	Energy Audit and Demand Side Management	4	0	0	0	4	EC
	UE16EE333	Design of Power Converters	4	0	0	0	4	EC
	UE16EE334	Computer Aided Design of Power Electronic Systems	2	0	4	0	4	EC
	UE16EE335	FPGA Applications using Verilog	4	0	0	0	4	EC
	UE16EE336	Embedded System Design	4	0	0	0	4	EC
	UE16EE337	Advanced Microcontrollers	4	0	0	0	4	EC
	UE16EE338	Data Communications	4	0	0	0	4	EC
8	**Elective - IV**							
	UE16EE341	Wind Electrical Systems	4	0	0	0	4	EC
	UE16EE342	HVDC Transmission	4	0	0	0	4	EC
	UE16EE343	Smart Grid Technologies	4	0	0	0	4	EC
	UE16EE344	PE System Design using ICs	4	0	0	0	4	EC
	UE16EE345	VLSI Design	4	0	0	0	4	EC
	UE16EE346	Introduction to Robotics	4	0	0	0	4	EC
	UE16EE347	Data Acquisition	4	0	0	0	4	EC
		TOTAL	**21/22**	**1**	**4/6**	**0**	**24/26**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – III	ELECTIVE – IV
A	Smart Power Control	UE16EE331, UE16EE332	UE16EE341, UE16EE342
B	Power Electronic Drives and Energy Systems	UE16EE333, UE16EE334	UE16EE343, UE16EE344
C	Embedded Systems	UE16EE335, UE16EE336, UE16EE337, UE16EE338	UE16EE345, UE16EE346, UE16EE347

VII SEMESTER (2015-19 BATCH)

Sl. No.	Course Code	Course Title	Hours / week L	T	P	S	Credits	Course Type
	COMMON TO ALL STUDENTS							
1	UE15EE401	Industrial Drives and Control	4	0	0	0	4	CC
2	UE15EE402	CAPSA	3	1	0	0	4	CC
3	UE15EE403	Switch Gear Protection	3	0	2	0	4	CC
	OPTION I							
4	UE15EE41X	Elective V	4	0	0	0	4	EC
5	UE15EE42X	Elective VI	4	0	0	0	4	EC

	OPTION II							
6	UE15EE42X	Elective VI	4	0	0	0	4	EC
7	UE15EE43X	SWAYAM Online Course*	0	0	0	16	4	EC
	OPTION III							
8	UE15EE42X	Elective VI	4	0	0	0	4	EC
9	UE15EE44X	Research Project*	0	0	04	08	4	PW
	Elective - V							
10	UE15EE411	FACTS	4	0	0	0	4	EC
11	UE15EE412	Power Systems Operation and Control	4	0	0	0	4	EC
12	UE15EE413	DSP in Power Electronic Converters and Drives	4	0	0	0	4	EC
13	UE15EE414	Application of PE in Power Systems	4	0	0	0	4	EC
14	UE15EE415	Modern Control Theory	4	0	0	0	4	EC
15	UE15EE416	Robotics and Automation	4	0	0	0	4	EC
	Elective - VI							
16	UE15EE421	Testing and Commissioning	4	0	0	0	4	EC
17	UE15EE422	Power Quality	4	0	0	0	4	EC
18	UE15EE423	Medical Electronics	4	0	0	0	4	EC
19	UE15EE424	Power Quality Improvement using PE Devices	4	0	0	0	4	EC
20	UE15EE425	Digital Image Processing	4	0	0	0	4	EC
21	UE15EE426	Advanced Instrumentation Systems	4	0	0	0	4	EC
		TOTAL	**18**	**1**	**2/04**	**0/16/8**	**20**	
*Note: Students can choose one of the Options								

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – V	ELECTIVE – VI
A.	Smart Power Control	UE15EE411, UE15EE412	UE15EE421, UE15EE422
B.	Power Electronic Drives and Energy Systems	UE15EE413, UE15EE414	UE15EE423, UE15EE424
C.	Embedded Systems	UE15EE415, UE15EE416	UE15EE425, UE15EE426

VIII SEMESTER (2015-19 BATCH) – OPTION 1

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE15EE490	Project Work	0	0	20/12	16/8	14/8	PW
2	UE15EE491	Industry Internship	0	0	12	0	6	PW
Note: i. Students who opt to carry out **only the Project Work** may work for 28 hours per week and earn total credits of 14 for UE15EE490. ii. Students who opt to carry out **both the Project Work and Industry Internship** may work for 16 hours per week and earn total credits of 8 for UE15EE490, and may work for the Industry as required and earn total credits of 6 for UE15EE491.								
3	UE15EE451	Utilization of Electrical Power	2	0	0	0	2	CC
4	UE15EE452	Simulation of Power Systems	2	0	0	0	2	CC
5	UE15EE453	Illumination Technologies	2	0	0	0	2	CC
6	UE15EE454	Automotive Electronics	2	0	0	0	2	CC
7	UE15EE455	Digital Video Processing	2	0	0	0	2	CC
8	UE15EE456	Real Time Operating Systems	2	0	0	0	2	CC
		TOTAL	**2**	**0**	**0**	**28**	**16**	

B.TECH IN MECHANICAL ENGINEERING

III SEMESTER (2017 -21 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE17MA201	Engineering Mathematics - III	3	0	2	4	4	FC
2	UE17ME201	Material Science and Metallurgy	4	0	0	2	4	CC
3	UE17ME202	Engineering Thermodynamics	3	1	0	4	4	CC
4	UE17ME203*	Mechanics of Solids	3	1	0	4	4	CC
5	UE17ME204	Metal Casting and Welding Processes	4	0	0	2	4	CC
6	UE17ME205	Metal Casting and Welding Laboratory	0	0	2	1	1	CC
7	UE17ME206	Material Testing Laboratory	0	0	2	1	1	CC
8	UE17ME207	Special Topic	2	0	0	2	2	PW
9	UE17MA101D	Engineering Mathematics – I (Applicable to Lateral Entry Students)	2	1	0	0	2	FC
		TOTAL	**19 / 21**	**2 / 3**	**6 / 6**	**20 / 20**	**24 / 26**	
Note: Prerequisite course: * UE17CV101								

IV SEMESTER (2016 -20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE17MA251	Linear Algebra and Its Applications	3	0	2	4	4	FC
2	UE17ME251	Mechanics of Fluids	3	1	0	4	4	CC
3	UE17ME252	Mechanics of Machines and Mechanisms	3	1	0	4	4	CC
4	UE17ME253	Measurement Science and Metrology	4	0	0	4	4	FC
5	UE17ME254	Engineering Mechanics-Dynamics	3	1	0	4	4	CC
6	UE17ME255	Machine Drawing	0	0	2	1	1	CC
7	UE17ME256	Fluid Mechanics and Machines Laboratory	0	0	2	1	1	CC
8	UE17ME257	Special Topic	2	0	0	2	2	PW
9	UE17MA151D	Engineering Mathematics –II (for Lateral Entry Students)	2	0	0	2	2	FC
		TOTAL	**17 / 19**	**3 / 3**	**8 / 8**	**22 / 24**	**24 / 26**	

V SEMESTER (2016 -20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE16ME301	Design of Machine Elements-I	3	1	0	4	4	CC
2	UE16ME302*	Principles of Energy Conversion	3	1	0	4	4	CC
3	UE16ME303	Metal Cutting and Machining Processes	4	0	0	2	4	CC
4	UE16ME304	Machine Shop Practice	0	0	2	1	1	CC
5	UE16ME305	Thermodynamics and IC Engines Laboratory	0	0	2	1	1	CC
	Elective - I							
6	UE16ME311**	Aerospace Structures	3	1	0	4	4	EC
7	UE16ME312	Power Plant Engineering	3	1	0	4	4	EC
8	UE16ME313#	Automotive Systems Engineering	3	1	0	4	4	EC
9	UE16ME314$	Analysis of Mechanisms	3	1	0	4	4	EC
10	UE16ME315	Composite Materials	4	0	0	2	4	EC

	Elective - II								
11	UE16ME321	Principles of Flight	3	1	0	4	4	EC
12	UE16ME322	I C Engines	3	1	0	4	4	EC
13	UE16ME323	Automotive Transmission	3	1	0	4	4	EC
14	UE16ME324**	Theory of Elasticity	3	1	0	4	4	EC
15	UE16ME325	Geometric Dimensioning and Tolerancing	3	1	0	4	4	EC
		Total	**18**	**0**	**6**	**0**	**23**	
Note: Prerequisite course: * UE16ME202; ** UE16ME203; #UE16CV101; $ UE16ME252									

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – I	ELECTIVE – II
A	Aerospace Engineering	UE16ME311, UE16ME312	UE16ME321
B	Thermo-Fluids Engineering	UE16ME312	UE16ME322
C	Automotive Engineering	UE16ME313	UE16ME322, UE16ME323, UE16ME325
D	Design Engineering	UE16ME314	UE16ME324, UE16ME325
E	Manufacturing Science	UE16ME315	UE16ME325

VI SEMESTER (2016 -20 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE16ME351	Design of Machine Elements II	3	1	0	4	4	CC
2	UE16ME352@	Heat Transfer	3	1	0	4	4	CC
3	UE16ME353	Metal Forming Processes	4	0	0	2	4	CC
4	UE16ME354	Dynamics and Design Laboratory	0	0	2	1	1	CC
5	UE16ME355	Heat Transfer Laboratory	0	0	2	1	1	CC
6	UE16ME356	Special Topic	2	0	0	2	2	PW
	Elective - III							
7	UE16ME331	Elements of Space Technology	3	1	0	2	4	EC
8	UE16ME332@	Turbomachines	3	1	0	4	4	EC
9	UE16ME333**	Introduction to Vehicle Dynamics	3	1	0	4	4	EC
10	UE16ME334#	Mechanism Design	3	1	0	4	4	EC
11	UE16ME335	Smart Materials	4	0	0	2	4	EC
12	UE16IE331	Automotive Electronics	3	1	0	4	4	EC
	Elective - IV							
13	UE16ME341$	Introduction to Gas Dynamics	3	1	0	4	4	EC
14	UE16ME342$	Computational Fluid Dynamics	3	1	0	4	4	EC
15	UE16ME343	Hybrid and Fuel Cell Vehicles	3	1	0	4	4	EC
16	UE16ME344 #	Theory of Plasticity	3	1	0	4	4	EC
17	UE16ME345	Additive Manufacturing	4	0	0	2	4	EC
18	UE16ME346	CAD/CAM	4	0	0	2	4	EC
19	UE16IE341	Computational Material Science	3	1	0	4	4	EC
		TOTAL	**22**	**0**	**4**		**24**	
Note: Prerequisite course: ** UE16ME254; #UE16ME203; $ UE16ME251; @UE16ME202								

ELECTIVES TO BE OPTED FOR SPECIALIZATION			
Sl. No.	**SPECIALIZATION**	**ELECTIVE – III**	**ELECTIVE – IV**
A	Aerospace Engineering	UE16ME331	UE16ME341, UE16ME342
B	Thermo-Fluids Engineering	UE16ME332	UE16ME341, UE16ME342
C	Automotive Engineering	UE16ME333	UE16ME342, UE16ME343
D	Design Engineering	UE16ME333, UE16ME334	UE16ME344
E	Manufacturing Science	UE16ME335	UE16ME345, UE16ME346

VII SEMESTER (2015 -19 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE15ME401	Design of Machine Elements II	3	1	0	4	4	CC
2	UE15ME402	Control Engineering	3	1	0	4	4	CC
3	UE15ME403	Finite Element Methods	3	1	0	4	4	CC
4	UE15IE401	Basics of Research Methodology (Lateral Entry Students)	3	0	0	2	3	EC
5	**Elective– V**							
	UE15ME411*	Introduction to Aerodynamics	3	1	0	4	4	EC
	UE15ME412#	Thermal Management of Electronic Packages and Systems	3	1	0	4	4	EC
	UE15ME413	Hydraulics and Pneumatics	4	0	0	2	4	EC
	UE15ME414	Motorcycle Dynamics	3	1	0	4	4	EC
	UE15ME415	Fatigue Analysis	3	1	0	4	4	EC
	UE15ME416	Surface Engineering	4	0	0	2	4	EC
6	**Elective– VI**							
	UE15ME421##	Aircraft Propulsion	3	1	0	4	4	EC
	UE15ME422##	Refrigeration and Air-Conditioning	3	1	0	4	4	EC
	UE15ME423	Vehicle Vibration and Acoustics	3	1	0	4	4	EC
	UE15ME424**	Fracture Mechanics	4	0	0	2	4	EC
	UE15ME425	Fundamentals of Tribology	4	0	0	2	4	EC
	UE15ME426	Product Design and Manufacturing	3	1	0	4	4	EC
		Total	**17**	**0**	**4**	**0**	**22**	
Note: Prerequisite course: * UE15ME251; # UE15ME202; ** UE15ME203; ##UE15ME302								

ELECTIVES TO BE OPTED FOR SPECIALIZATION			
Sl. No.	**Aerospace Engineering**	**UE15ME411**	**UE15ME421**
A	Thermo-Fluids Engineering	UE15ME412	UE15ME421, UE15ME422
B	Automotive Engineering	UE15ME413, UE15ME414	UE15ME423
C	Design Engineering	UE15ME413, UE15ME415	UE15ME424, UE15ME425
D	Manufacturing Science	UE15ME416	UE15ME426
E	Aerospace Engineering	UE15ME411	UE15ME421

VIII SEMESTER (2015 -19 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE15ME490	Project Work	0	0	0	48	14	PW
2	UE15ME451	Non Destructive Testing	2	0	0	2	2	CC
3	UE15ME452	Seminar: Presentation and Communication Skills (Lateral Entry Students)	1	0	0	0	1	PW
		Total	**2**	**0**	**0**	**50**	**16**	

FACULTY OF ENGINEERING – PG PROGRAMS

M. TECH IN BIOTECHNOLOGY

I SEMESTER (2018-20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE18BT501	Applied Microbiology	3	0	2	0	4	CC
2	UE18BT502	Advanced Molecular Biology	3	0	2	0	4	CC
3	UE18BT503	Cell and Microbial Cultivation	3	0	2	0	4	CC
4	UE18BT504	Research Methodology	2	0	0	0	2	CC
Elective – I								
5	UE18BT511	Bioreactor Design and Scale-up	4	0	0	0	4	EC
6	UE18BT512	Protein Engineering	4	0	0	0	4	EC
7	UE18BT513	Algorithms for Biologists	4	0	0	0	4	EC
8	UE18BT514	Environmental Microbiology	4	0	0	0	4	EC
9	UE18BT515	Molecular Pathology	4	0	0	0	4	EC
10	UE18BT516	Cancer Biology	4	0	0	0	4	EC
Elective – II								
11	UE18BT521	Biomolecular Data Analysis	4	0	0	0	4	EC
12	UE18BT522	Environmental Impact Assessment, Policy and Laws	4	0	0	0	4	EC
13	UE18BT523	Environmental Health Chemistry	4	0	0	0	4	EC
14	UE18BT524	Molecular Diagnostics	4	0	0	0	4	EC
		Total	19	0	6	0	22	

ELECTIVES TO BE OPTED FOR SPECIALISATION		
Sl.No.	**SPECIALISATION**	**ELECTIVES**
A	Biomanufacturing	UE18BT511, UE18BT512, UE18BT521
B	Computational Biology	UE18BT512, UE18BT513, UE18BT521
C	Environmental Bioprocesses	UE18BT514, UE18BT522, UE18BT523
D	Medical and Molecular Biosciences	UE18BT515, UE18BT516, UE18BT524

II SEMESTER (2018-20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE18BT551	Advanced Biochemistry	3	0	2	0	4	CC
2	UE18BT552	Advanced Bioinformatics	3	0	2	0	4	CC
3	UE18BT553	Purification and Formulation of Bio-molecules	3	0	2	0	4	CC
4	UE18BT554	IPR & Bio entrepreneurship	2	0	0	0	2	CC

Elective – III								
5	UE18BT531	Operations Research	4	0	0	0	4	EC
6	UE18BT532	Computational Systems Biology	4	0	0	0	4	EC
7	UE18BT533	Next Generation Sequencing	4	0	0	0	4	EC
8	UE18BT534	Environmental Pollution and Monitoring	4	0	0	0	4	EC
Elective – IV								
9	UE18BT531	Design of Experiments	4	0	0	0	4	EC
10	UE18BT532	Applied Biostatistics	4	0	0	0	4	EC
11	UE18BT533	Bioremediation	4	0	0	0	4	EC
12	UE18BT534	Regenerative Medicine	4	0	0	0	4	EC
		Total	**19**	**0**	**6**	**0**	**22**	

ELECTIVES TO BE OPTED FOR SPECIALISATION		
Sl.No.	**SPECIALISATION**	**ELECTIVES**
A	Biomanufacturing	UE18BT531,UE18BT532,UE18BT541
B	Computational Biology	UE18BT532,UE18BT533,UE18BT542
C	Environmental Bioprocesses	UE18BT534,UE18BT542, UE18BT543
D	Medical and Molecular Biosciences	UE18BT533,UE18BT542,UE18BT544

III SEMESTER (2017-19 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE17BT601	Project Phase I	0	0	0	0	16	PW
Elective- V								
2	UE17BT611	Clinical data analytics	2	0	0	0	2	EC
3	UE17BT612	Advanced Genomic's	2	0	0	0	2	EC
4	UE17BT613	Solid waste management	2	0	0	0	2	EC
		Total	2	0	0	0	18	

IV SEMESTER (2017-19 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17BT651	Project Phase II	0	0	0	0	16	PW
Elective- VI								
2	UE17BT631	Quality assurance & Validation	2	0	0	0	2	EC
3	UE17BT632	Metabolomics	2	0	0	0	2	EC
4	UE17BT633	Biosustainability	2	0	0	0	2	EC
		Total	**2**	**0**	**0**	**0**	**18**	

M.TECH IN COMPUTER SCIENCE AND ENGINEERING

I SEMESTER (2018-2020 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE18CS501	Computer Systems for Programmers	4	0	0	0	4	CC
2	UE18CS502	Advanced Data Structures	4	0	0	0	4	CC
3	UE18CS503	Advanced Network Management & Security	4	0	0	0	4	CC
4	UE18CS504	Special Topic - I	2	0	0	0	2	PW/CC

	Elective - I							
5	UE18CS511	Fundamentals of Scalable Computing	3	2	0	0	4	EC
6	UE18CS512	Topics In Storage Area Networks	3	2	0	0	4	EC
7	UE18CS513	Cryptography	3	2	0	0	4	
	Elective II							
8	UE18CS521	Cloud Computing Fundamentals	3	2	0	0	4	EC
9	UE18CS522	Foundations of IoT & Streaming Analysis	3	2	0	0	4	EC
10	UE18CS523	Web Security	3	2	0	0	4	EC
11	UE18CS524	Data Acquisition & Visualization	3	2	0	0	4	EC
12	UE18CS525	Migrating, Developing Cloud Applications	3	2	0	0	4	EC
		Total	**20**	**4**	**0**	**0**	**22**	**-**

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – I	ELECTIVE – II
A	Cloud Computing	UE18CS511, UE18CS512	UE18CS521, UE18CS525
B	Big Data & IoT	UE18CS511, UE18CS512	UE18CS522, UE18CS524, UE18CS525
C	Cyber Security	UE18CS513	UE18CS523

II SEMESTER (2018-2020 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE18CS551	High Performance Computing & Architectures	4	0	0	0	4	CC
2	UE18CS552	Machine Learning techniques	4	0	0	0	4	CC
3	UE18CS553	Advanced Algorithms	4	0	0	0	4	CC
4	UE18CS554	Special Topic-II	2	0	0	0	2	PW/CC
	Elective -III							
5	UE18CS531*	Advanced Big Data Analytics	3	2	0	0	4	EC
6	UE18CS532**	Cloud Storage & No SQL Databases	3	2	0	0	4	EC
7	UE18CS533$	High Performance Cloud & Big Data Systems	3	2	0	0	4	EC
8	UE18CS534$$	Secure Programming	3	2	0	0	4	EC
	Elective -IV							
9	UE18CS541#	Cloud ,Big Data & IOT security	3	2	0	0	4	EC
10	UE18CS542##	Big Data Algorithms	3	2	0	0	4	EC
11	UE18CS543###	Cyber Forensics & IOT Security	3	2	0	0	4	EC
12	UE18CS544@	Server Virtualization	3	2	0	0	4	EC
		Total	20	4	0	0	22	

Note: Prerequisite course - *UE18CS502,*UE18CS511,**UE18CS501,**UE18CS511, **UE18CS521, $UE18CS501, $UE18CS503, $UE18CS511, $$UE18CS502, #UE18CS501, #UE18CS502, #UE18CS511, ##UE18CS502, ###UE18CS501, @UE18CS521

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – III	ELECTIVE – IV
A	Cloud Computing	UE18CS532,UE18CS533 , UE18CS534	UE18CS541, UE18CS544
B	Big Data & IoT	UE18CS531, UE18CS533, UE18CS534	UE18CS541,UE18CS542, UE18CS543
C	Cyber Security	UE18CS534	UE18CS541, UE18CS543

III SEMESTER (2017 – 2019 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17CS601	Project Phase - 1	0	0	24	16	16	PW
	Elective -V							
2	UE17CS611*	Cloud Strategy Planning and Management	2	0	0	0	2	EC
3	UE17CS612#	Data Centre Networking	2	0	0	0	2	EC
4	UE17CS613**	Mobile Application Development in the Cloud	2	0	0	0	2	EC
5	UE17CS614	Software Project Planning and Management	2	0	0	0	2	EC
6	UE17CS615$	Safety and Security for Internet of Things	2	0	0	0	2	EC
7	UE17CS616$$	Design, Specification, and Analysis of Cyber-physical Systems	2	0	0	0	2	EC
8	UE17CS617	Management of IoT	2	0	0	0	2	EC
9	UE17CS618	Advanced Software Testing	2	0	0	0	2	EC
	Total		2	0	0	0	18	-

Note: Prerequisite courses :
UE17CS501, UE17CS502, *UE17CS521; **UE17CS502,UE17CS503,UE17CS521;
$UE17CS502, $UE17CS503, $UE17CS522; $$UE17CS503, $$UE17CS522; #UE17CS503

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – V
A	Cloud Computing	UE17CS611, UE17CS612, UE17CS613, UE17CS614, UE17CS618
B	Cyber Security	UE17CS616, UE17CS617, UE17CS618
C	Big Data & IOT	UE17CS614, UE17CS615, UE17CS616, UE17CS617, UE17CS618

IV SEMESTER (2017 – 2019 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17CS651	Project Phase - II	0	0	24	16	16	PW
	Elective -VI							
2	UE17CS621*	Cloud Security	2	0	0	0	2	EC
3	UE17CS622**	Cloud Computing Future	2	0	0	0	2	EC
4	UE17CS623$	Speech and Natural Language Processing	2	0	0	0	2	EC
5	UE17CS624$$	Topics in Big Data and IoT	2	0	0	0	2	EC
6	UE17CS625	Software Architectures	2	0	0	0	2	EC
7	UE17CS626	Business Fundamentals	2	0	0	0	2	EC
	Total		2	0	**0**	**0**	**18**	-

Note: Prerequisite courses: *UE17CS503; **UE17CS521; $UE17CS552; $$UE17CS531, $$UE17CS522

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE – VI
A	Cloud Computing	UE17CS621, UE17CS622, UE17CS623,UE17CS626
B	Cyber Security	UE17CS621, UE17CS626
C	Big Data & IoT	UE17CS623, UE17CS626,UE17CS624

M.TECH IN CIVIL ENGINEERING (SPECIALIZATION: STRUCTURAL ENGINEERING)

I SEMESTER (2018 – 20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE18CV501	Structural Dynamics	3	2	0	0	4	CC
2	UE18CV502	Continuum Mechanics- Classical & F E Approach	3	2	0	0	4	CC
3	UE18CV503	Computational Structural Mechanics – Classical and FE approach	3	2	0	0	4	CC
4	UE18CV504	Action &Response of Structural systems	2	0	2	0	3	CC
5	UE18CV505	Advanced Optimisation Methods	3	2	0	0	4	CC
6	UE18CV506	Research Methodology &Techniques	2	0	0	0	2	CC
7	UE18CV507	Seminar -1	0	0	0	4	1	
		TOTAL	**16**	**8**	**2**	**4**	**22**	

II SEMESTER (2018 – 20 BATCH)

Sl. No.	Course Code	Course Title	Hours per week				Credits	Course Type
			L	T	P	S		
1	UE18CV551	Advanced Design of RC Structures	3	2	0	0	4	CC
2	UE18CV552	Computer Aided Analysis & Design Laboratory	0	0	2	0	1	FC
3	UE18CV553	Seminar-2	0	0	0	4	1	
4	**Elective I**							
5	UE18CV511	Design of Earthquake Resistant Structures	3	2	0	0	4	EC
6	UE18CV512	Theory of elastic stability	3	2	0	0	4	EC
7	**Elective II**							
8	UE18CV521	Design of Structural Systems for Tall Buildings	3	2	0	0	4	EC
9	UE18CV522	Theory of Plates and Shells	3	2	0	0	4	EC
10	**Elective III**							
11	UE18CV531	Design of Prestressed Concrete Structures	3	2	0	0	4	EC
12	UE18CV532	Design of Bridges	3	2	0	0	4	EC
13	**Elective IV**							
14	UE18CV541	Repair & Rehabilitation of Structures	3	2	0	0	4	EC
15	UE18CV542	Design of Storage Structures	3	2	0	0	4	EC
		TOTAL	**15**	**10**	**2**	**4**	**22**	

M.TECH IN CIVIL ENGINEERING (SPECIALIZATION: COMPUTER AIDED STRUCTURE)

III SEMESTER (2017 – 19 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17CV601	Project Work Phase - I	0	0	24	16	16	PW
2	UE17CV602	Advanced Design of Steel Structures	3	2	0	0	4	CC
3	UE17CV603	Internship	0	0	0	8	2	PW
		TOTAL	**3**	**2**	**24**	**24**	**22**	

IV SEMESTER (2017 – 19 BATCH)

Sl. No.	Course Code	Course Title	Hours/week				Credits	Course Type
			L	T	P	S		
1	UE17CV651	Project Work Phase - II	0	0	24	16	16	PW
2	UE17CV652	Structural Stability Analysis – Classical & FE Approach	3	2	0	0	4	CC
3	UE15IE5653	Seminar	0	0	0	8	2	
		TOTAL	**3**	**2**	**24**	**24**	**22**	

M.TECH IN ELECTRONICS AND COMMUNICATION ENGINEERING

I SEMESTER (2018-20 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE18EC501	Advanced Digital Communication	4	0	0	0	4	CC
2	UE18EC502	Digital VLSI	4	0	0	0	4	CC
3	UE18EC503	Advanced Embedded Systems	4	0	0	0	4	CC
4	UE18EC504	Modern Digital Signal Processing	4	0	0	0	4	CC
5	UE18EC505	Engineering Mathematics	4	0	0	0	4	CC
6	UE18EC506	Research Methodology	2	0	0	0	2	CC
		TOTAL	**22**	**0**	**0**	**0**	**22**	

II SEMESTER (2018-20 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
Elective I								
1	UE18EC511	Advanced Wireless Communication	4	0	0	0	4	EC
2	UE18EC512	Analog Integrated Circuits	4	0	0	0	4	EC
3	UE18EC513	Real Time Embedded Systems	4	0	0	0	4	EC
4	UE18EC514	Image and Video Processing	4	0	0	0	4	EC
Elective II								
5	UE18EC521	Secure Communication	4	0	0	0	4	EC
6	UE18EC522	Advanced Semiconductor Devices	4	0	0	0	4	EC
7	UE18EC523	Speech Processing	4	0	0	0	4	EC
Elective III								
8	UE18EC531	Optical Fiber Communication and Networking	4	0	0	0	4	EC
9	UE18EC532	Testing of VLSI Circuits	4	0	0	0	4	EC
10	UE18EC533	Adaptive Signal Processing	4	0	0	0	4	EC
Elective IV								
11	UE18EC541	Error Control Coding	4	0	0	0	4	EC
12	UE18EC542	Advanced SoC Architecture	4	0	0	0	4	EC
13	UE18EC543	Detection and Estimation	4	0	0	0	4	EC
Elective V								
14	UE18EC551	Wireless Network Architectures	4	0	0	0	4	EC
15	UE18EC552	Heterogeneous computing	4	0	0	0	4	EC
16	UE18EC553	Verification of VLSI Circuits	4	0	0	0	4	EC
17	UE18EC554	Pattern Recognition and Classification	4	0	0	0	4	EC
18	UE18EC561	Mini project	0	0	4	0	2	PW
		TOTAL	**22**	**0**	**0**	**0**	**22**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE- I	ELECTIVE -II	ELECTIVE- III	ELECTIVE- IV	ELECTIVE – V
A	Communication	UE18EC511	UE18EC521	UE18EC531	UE18EC541	UE18EC551
B	VLSI	UE18EC512, UE18EC513	UE18EC522	UE18EC532	UE18EC542	UE18EC552, UE18EC553
C	Signal Processing	UE18EC514	UE18EC523	UE18EC533	UE18EC543	UE18EC554

III SEMESTER (2017-19 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17EC601	Project Phase I	0	0	28	0	16	PW
Elective IX								
2	UE17EC611	Optimization I	2	0	0	0	2	EC
3	UE17EC612	Introduction to Antenna theory	2	0	0	0	2	EC
4	UE17EC613	Selected Topics Reconfigurable Computing	2	0	0	0	2	EC
5	UE17EC614	Artificial Neural Networks	2	0	0	0	2	EC
		Total	**2**	**0**	**28**		**18**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION		
Sl. No.	**SPECIALIZATION**	**ELECTIVE- V**
A	Communication	UE17EC611, UE17EC612
B	VLSI	UE17EC611, UE17EC613
C	Signal Processing	UE17EC611, UE17EC614

IV SEMESTER (2017-19 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17EC651	Project phase II	0	0	28	0	16	PW
Elective X								
2	UE17EC661	Oplimizalion II	2	0	0	0	2	EC
3	UE17EC662	Antenna Design	2	0	0	0	2	EC
4	UE17EC663	VLSI for DSP	2	0	0	0	2	EC
5	UE17EC664	Statistical signal processing	2	0	0	0	2	EC
		Total	**2**	**0**	**28**	0	**18**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION		
Sl. No.	**SPECIALIZATION**	**ELECTIVE- VI**
A	Communication	UE17EC661, UE17EC662
B	VLSI	UE17EC661, UE17EC663
C	Signal Processing	UE17EC661, UE17EC664

M.TECH IN ELECTRICAL AND ELECTRONICS ENGINEERING

I SEMESTER (2018 – 2020 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE18MA501	Applied Mathematics	4	0	0	0	4	CC
2	UE18EE501	Power Quality	4	0	0	0	4	CC
3	UE18EE502	Power Semiconductor Devices	4	0	0	0	4	CC
4	UE18EE503	Microcontrollers and Its Applications	4	0	0	0	4	CC
5	UE18EE504	Applied Soft Computing	4	0	0	0	4	CC
6	UE18EE505	Seminar	0	0	0	8	2	PW
		TOTAL	**20**	**0**	**0**	8	**22**	

II SEMESTER (2018 – 2020 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE18EE561	Seminar	0	0	0	8	2	PW
	ELECTIVE I							
2	UE18EE511	Power Electronic Devices and Converter Technologies	4	0	0	0	4	EC
3	UE18EE512	Embedded System Design	3	0	2	0	4	EC
4	UE18EE513	Renewable Energy Systems	4	0	0	0	4	EC
	ELECTIVE II							
5	UE18EE521	Smart Grid	4	0	0	0	4	EC
6	UE18EE522	Digital Control Systems	3	0	2	0	4	EC
	ELECTIVE III							
7	UE18EE531	Power Electronics in Drives and Energy Systems	4	0	0	0	4	EC
8	UE18EE532	General Processor Architecture	3	0	2	0	4	EC
	ELECTIVE IV							
9	UE18EE541	HVDC Transmission	4	0	0	0	4	EC
10	UE18EE542	VLSI Architecture and Design Methodologies	3	0	2	0	4	EC
	ELECTIVE V							
11	UE18EE551	FACTS Controllers	4	0	0	0	4	EC
12	UE18EE552	FPGA Architecture and Applications	3	0	2	0	4	EC
		TOTAL	**20/15**	**0**	**0/10**	**8**	**22**	

Sl. No.	SPECIALIZATION	ELECTIVES
A	Power Electronic Drives and Energy Systems	UE18EE511, UE18EE521, UE18EE531, UE18EE541, UE18EE551
B	Embedded Systems	UE18EE512, UE18EE522, UE18EE532, UE18EE542, UE18EE552
C	Smart Power Control	UE18EE513,UE18EE521,UE18EE531, UE18EE541, UE18EE551

III SEMESTER (2017 – 2019 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17EE601	Project Work Phase I	0	0	0	32	16	PW
	ELECTIVE VI							
2	UE17EE611	Modeling and Analysis of Electrical Machines	2	0	0	0	2	EC
3	UE17EE612	Power Electronics in Renewable Energy and Transportation Systems	2	0	0	0	2	EC
4	UE17EE613	Digital Signal Processors and its Architecture	2	0	0	0	2	EC
5	UE17EE614	Data Communications	2	0	0	0	2	EC
6	UE17EE615	Power Quality	2	0	0	0	2	EC
7	UE17EE616	Power System Reliability	2	0	0	0	2	EC
		TOTAL	**2**	**0**	**0**	**32**	**18**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVE VI
	Power Electronic Drives and Energy Systems	UE17EE611, UE17EE612
	Embedded Systems	UE17EE613, UE17EE614
	Smart Power Control	UE17EE615, UE17EE616

IV SEMESTER (2017 – 2019 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17EE690	Project Work Phase II	0	0	0	32	16	PW
	ELECTIVE VII							
3	UE17EE621	Modeling, Design and Simulation of Power Electronic Systems	2	0	0	0	2	EC
4	UE17EE622	Controllers for Power Electronic Systems	2	0	0	0	2	EC
5	UE17EE623	Digital Image Processing	2	0	0	0	2	EC
6	UE17EE624	Digital VLSI System Design and its Implementation Using Verilog	2	0	0	0	2	EC
7	UE17EE625	SCADA and DCS	2	0	0	0	2	EC
8	UE17EE626	Restructured Power Systems	2	0	0	0	2	EC
		TOTAL	**2**	**0**	**0**	**32**	**18**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION		
Sl. No.	**SPECIALIZATION**	**ELECTIVE VII**
A.	Power Electronic Drives and Energy Systems	UE17EE621, UE17EE622
B.	Embedded Systems	UE17EE623, UE17EE624
C.	Smart Power Control	UE17EE625, UE17EE626

M.TECH IN MECHANICAL ENGINEERING

I SEMESTER (2018 – 20 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE18ME501	Advanced Engineering Mathematics	3	1	0	4	4	FC
2	UE18ME502	Theory and Design of Mechanical Measurements	3	1	0	4	4	CC
3	UE18ME503	Advanced Finite Element Methods	3	1	0	4	4	CC
4	UE18ME504	Advanced Engineering Materials	3	1	0	4	4	CC
5	UE18ME505	Data Acquisition and Analysis	0	0	4	2	2	FC
6	**Elective 1**							
	UE18ME511	Advanced Computational Fluid Dynamics	3	1	0	4	4	EC
	UE18ME512	Advanced Machine Design	3	1	0	4	4	EC
	UE18ME513	Advanced Metal Forming	3	1	0	4	4	EC
	UE18ME514	Body and Chassis Engineering	3	1	0	4	4	EC
		Total	**15**	**5**	**4**	**22**	**22**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION		
Sl. No.	**SPECIALIZATION**	**ELECTIVES**
	Thermo-Fluids Engineering	UE18ME511
	Manufacturing Science and Engineering	UE18ME512
	Automotive Engineering	UE18ME513
	Machine Design	UE18ME514

II SEMESTER (2018 – 20 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE18ME551	Advanced Computational Techniques for Engineering Applications	0	0	4	4	2	CC

2	**Elective II**							
	UE18ME521	Advanced Thermodynamics	3	1	0	4	4	EC
	UE18ME522	Advanced Foundry Technology	3	1	0	4	4	EC
	UE18ME523	Vehicle Dynamics	3	1	0	4	4	EC
	UE18ME524	Advanced Theory of Vibrations	3	1	0	4	4	EC
3	**Elective III**							
	UE18ME531	Principles of Combustion	3	1	0	4	4	EC
	UE18ME532	Advanced Geometric Dimensioning & Tolerancing	3	1	0	4	4	EC
	UE18ME533	Automotive Drive Train Engineering	3	1	0	4	4	EC
4	**Elective IV**							
	UE18ME541	Convective Heat and Mass Transfer	3	1	0	4	4	EC
	UE18ME542	Advanced Welding Technology	3	1	0	4	4	EC
	UE18ME543	Automotive Noise Vibration and Harshness	3	1	0	4	4	EC
	UE18ME544	Advanced Mechanism Design	3	1	0	4	4	EC
5	**Elective V**							
	UE18ME561	Advanced Fluid Mechanics	3	1	0	4	4	EC
	UE18ME562	Non-Traditional Machining Processes	3	1	0	4	4	EC
	UE18ME563	Vehicle Crashworthiness	3	1	0	4	4	EC
	UE18ME564	Advanced Mechanics of Materials	3	1	0	4	4	EC
6	**Elective VI**							
	UE18ME571	Conduction and Radiation Heat Transfer	3	1	0	4	4	EC
	UE18ME572	Industrial Robotics	3	1	0	4	4	EC
	UE18ME573	Internal Combustion Engines	3	1	0	4	4	EC
	UE18ME574	Experimental Stress Analysis	3	1	0	4	4	EC
		TOTAL	**15**	**5**	**4**	**24**	**20**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No.	SPECIALIZATION	ELECTIVES
A.	Thermo-Fluids Engineering	UE18ME521, UE18ME531, UE18ME541, UE18ME561, UE18ME571
B.	Manufacturing Science and Engineering	UE18ME522, UE18ME532, UE18ME542, UE18ME562, UE18ME572
C.	Automotive Engineering	UE18ME523, UE18ME533, UE18ME543, UE18ME563, UE18ME573
D.	Machine Design	UE18ME524, UE18ME532, UE18ME544, UE18ME564, UE18ME574

III SEMESTER (2017-19 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17ME601	Project Work Phase I	0	0	0	64	16	PW
	Elective - VI							
2	UE17ME611	Analysis & Design of Centrifugal and Axial Flow Compressors	2	0	0	4	2	EC
3	UE17ME612	Boiling, Condensation and Two Phase Flows	2	0	0	4	2	EC
4	UE17ME613	Theory of Metal Cutting	2	0	0	4	2	EC
5	UE17ME614	CIM and Automation	2	0	0	4	2	EC
6	UE17ME615	Vehicle Crashworthiness	2	0	0	4	2	EC
7	UE17ME616	Multi Body Dynamics	2	0	0	4	2	EC
8	UE17ME617	Tribology in Design	2	0	0	4	2	EC
9	UE17ME618	Theory of Rotor Dynamics	2	0	0	4	2	EC
		TOTAL	**2**	**0**	**0**	**68**	**18**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION		
Sl. No.	**SPECIALIZATION**	**ELECTIVES**
A.	Thermo-Fluids Engineering	UE17ME611, UE17ME612
B.	Manufacturing Science and Engineering	UE17ME613, UE17ME614
C.	Automotive Engineering	UE17ME615, UE17ME616
D.	Machine Design	UE17ME617, UE17ME618

IV SEMESTER (2017 – 19 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE17ME651	Project Work Phase II	0	0	0	64	16	PW
	Elective - VII							
2	UE17ME661	Air Conditioning Systems -Analysis & Design	2	0	0	4	2	EC
3	UE17ME662	Analysis & Design of Steam & Gas Turbines	2	0	0	4	2	EC
4	UE17ME663	Advanced Geometric Dimensioning & Tolerancing	2	0	0	4	2	EC
5	UE17ME664	Jigs and Fixtures	2	0	0	4	2	EC
6	UE17ME665	Electric and Hybrid Vehicle Technology	2	0	0	4	2	EC
7	UE17ME666	Automotive Electrical and Electronics Systems	2	0	0	4	2	EC
8	UE17ME667	Advanced Fracture Mechanics	2	0	0	4	2	EC
9	UE17ME668	Machine Tool Design	2	0	0	4	2	EC
		TOTAL	**2**	**0**	**0**	**68**	**18**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION		
Sl. No.	**SPECIALIZATION**	**ELECTIVES**
A.	Thermo-Fluids Engineering	UE17ME661, UE17ME662
B.	Manufacturing Science and Engineering	UE17ME663, UE17ME664
C.	Automotive Engineering	UE17ME663, UE17ME665, UE17ME666
D.	Machine Design	UE17ME663, UE17ME667, UE17ME668

DEPARTMENT OF COMPUTER APPLICATIONS

BACHELOR OF COMPUTER APPLICATIONS

I SEMESTER (2018 – 21 BATCH)

Sl. No.	Course Code	Title of Course	Hours/ Week				Credits	Course Type
			L	T	P	S		
1	UE18BC101	Introduction to Programming using Python	4	0	0	0	4	FC
2	UE18BC102	Discrete Mathematics	3	2	0	0	4	FC
3	UE18BC103	Fundamentals of Computing	3	0	0	0	3	FC
4	UE18BC104	Introduction to Web Design	4	0	0	0	4	FC
5	UE18BC105	Office Productivity	1	0	2	0	2	FC
6	UM18BB105	English	3	0	0	0	3	PC
7	UE18BC106	Introduction to Programming using Python Laboratory	0	0	2	0	1	FC
8	UE18BC107	Introduction to Web Design Laboratory	0	0	2	0	1	FC
9	**Language (Any one of the options listed below)**							
	UM18BB114	Communicative Kannada - 1	0	0	0	0	0	MC
	UM18BB115	Kannada Kali – 1	0	0	0	0	0	MC
	UM18BB116	Kannada Manasu - 1	0	0	0	0	0	MC
10	UE18HS101	Indian Constitution	0	0	0	0	0	MC
		TOTAL	**18**	**2**	**6**	**0**	**22**	

II SEMESTER (2018 – 21 BATCH)

Sl. No.	Course Code	Title of Course	Hours/ Week				Credits	Course Type
			L	T	P	S		
1	UE18BC151	Programming using C	4	0	0	0	4	FC
2	UE18BC152	Data Structures using C	4	0	0	0	4	FC
3	UE18BC153	Digital Logic and Computer Organization	4	0	0	0	4	FC
4	UE18BC154	User Interface Design	4	0	0	0	4	FC
5	UE18BC155	Professional Communication-I	3	0	0	0	3	FC
6	UE18BC156	Aptitude Building-I	1	2	0	0	2	FC
7	UE18BC157	Programming using C Laboratory	0	0	2	0	1	FC
8	UE18BC158	Data Structures using C Laboratory	0	0	2	0	1	FC
9	**Language (Any one of the options listed below)**							
	UM18BB114	Communicative Kannada – 2	0	0	0	0	0	MC
	UM18BB115	Kannada Kali – 2	0	0	0	0	0	MC
	UM18BB116	Kannada Manasu – 2	0	0	0	0	0	MC
10	UE18HS102	Environmental Studies	0	0	0	0	0	MC
		TOTAL	**20**	**2**	**4**	**0**	**23**	

MASTER OF COMPUTER APPLICATIONS

I SEMESTER (2018 – 21 BATCH)

Sl. No.	Course Code	Course Title	Hours/Week				Credits	Course Type
			L	T	P	S		
1.	UE18MC401	Principles of Accounting	2	2	0	0	3	FC
2.	UE18MC402	Mathematical Foundations for Computer Applications	3	2	0	0	4	FC
3.	UE18MC403	Introduction to Linux	3	0	0	0	3	FC
4.	UE18MC404	Problem Solving Techniques	4	0	0	0	4	FC
5.	UE18MC405	Web Technology I	4	0	0	0	4	PC
6.	UE18MC406	Linux Laboratory	0	0	2	0	1	FC
7.	UE18MC407	Problem Solving Laboratory	0	0	2	0	1	FC
8.	UE18MC408	Web Laboratory I	0	0	2	0	1	PC
		TOTAL	**16**	**4**	**6**	**0**	**21**	

II SEMESTER (2018 – 21 BATCH)

Sl. No.	Course Code	Course Title	Hours/Week				Credits	Course Type
			L	T	P	S		
1.	UE18MC451	Operating Systems	2	2	0	0	3	FC
2.	UE18MC452	Object Oriented Programming using Java	4	0	0	0	4	FC
3.	UE18MC453	Data Structures	3	2	0	0	4	FC
4.	UE18MC454	Macro Programming in Spreadsheets	2	2	0	0	3	FC
5.	UE18MC455	Web Technology II	4	0	0	0	4	CC
6.	UE18MC456	Java Programming Laboratory	0	0	2	0	1	FC
7.	UE18MC457	Data Structures Laboratory	0	0	2	0	1	FC
8.	UE18MC458	Web Laboratory II	0	0	2	0	1	CC
		TOTAL	**15**	**6**	**6**	**0**	**21**	

III SEMESTER (2017 – 20 BATCH)

Sl. No.	Course Code	Course Title	Hours/Week				Credits	Course Type
			L	T	P	S		
1.	UE17MC501	Design and Analysis of Algorithms	3	2	0	0	4	CC
2.	UE17MC502	Computer Networks	4	0	0	0	4	CC
3.	UE17MC503	Database Management Systems	4	0	0	0	4	CC
4.	UE17MC504	Design and Analysis of Algorithms Laboratory	0	0	2	0	1	CC
5.	UE17MC505	Computer Networks Laboratory	0	0	2	0	1	CC
6.	UE17MC506	Database Management Systems Laboratory	0	0	2	0	1	CC
	ELECTIVE – I							
7.	UE17MC511	Python Programming	4	0	0	0	4	EC
8.	UE17MC512	Perl Programming	4	0	0	0	4	EC
9.	UE17MC513	Swift Programming	4	0	0	0	4	EC
	ELECTIVE –II							
10.	UE17MC521	Cyber Security	3	0	0	0	3	EC
11.	UE17MC522	Computer Graphics	3	0	0	0	3	EC
12.	UE17MC523	Introduction to Data Science	3	0	0	0	3	EC
13.	UE17MC524	Data Preparation and Analysis	3	0	0	0	3	EC
		Total	**18**	**2**	**6**	**0**	**22**	

ELECTIVES TO BE OPTED FOR SPECIALIZATION

Sl. No	Specialization	Elective
A	Web Technology	UE17MC511, UE17MC512, UE17MC513, UE17MC521, UE17MC522
B	Data Science	UE17MC511, UE17MC512, UE17MC513, UE17MC523, UE17MC524

IV SEMESTER (2017 – 20 BATCH)

Sl. No.	Course Code	Course Title	Hours/Week				Credits	Course Type
			L	T	P	S		
1.	UE17MC551	Software Engineering and Project Management	4	0	0	0	4	CC
2.	UE17MC552	Advanced Computer Networks	4	0	0	0	4	CC
3.	UE17MC553	Java Programming	4	0	0	0	4	CC
4.	UE17MC554	Automation Testing Laboratory	0	0	2	0	1	CC
5.	UE17MC555	Java Programming Laboratory	0	0	2	0	1	CC
6.	UE17MC556	Mini Project Lab	0	0	2	0	1	PW
7.	UE17MC557*	Advanced Application Development	1	2	0	0	2	CC
	ELECTIVE – III							
8.	UE17MC531	IoT Application Development	3	0	0	0	3	EC
9.	UE17MC532	Web Sockets	3	0	0	0	3	EC
10.	UE17MC533	NoSQL	3	0	0	0	3	EC
11.	UE17MC534	Bioinformatics	3	0	0	0	3	EC
	ELECTIVE – IV							
12.	UE17MC541	Web Frameworks	3	0	0	0	3	EC
13.	UE17MC542	CGI Programming	3	0	0	0	3	EC
14.	UE17MC543	Data Analytics	3	0	0	0	3	EC
15.	UE17MC544	Database Administration	3	0	0	0	3	EC
		TOTAL	**18+1***	**2***	**6**	**0**	**21+2***	

Note - * Only for Lateral Entry Students

ELECTIVES TO BE OPTED FOR SPECIALIZATION		
Sl. No	**Specialization**	**Elective**
A	Web Technology	UE17MC531, UE17MC532, UE17MC541, UE17MC542
B	Data Science	UE17MC533, UE17MC534, UE17MC543, UE17MC544

V SEMESTER (2016 – 19 BATCH)

Sl. No.	Course Code	Course Title	Hours/Week				Credits	Course Type
			L	T	P	S		
1.	UC16MC601+	Advanced Java Programming	4	0	0	0	4	CC
2.	UC16MC602	Cloud Computing	4	0	0	0	4	CC
3.	UC16MC603	Unix Shell and System Programming	4	0	0	0	4	CC
4.	UC16MC604	Advanced Java Programming Lab	0	0	2	0	1	CC
5.	UC16MC605	Unix Shell and System Programming Lab	0	0	2	0	1	CC
6.	UC16MC606	Skill Reinforcement Lab	0	0	2	0	1	CC
7.	UC16MC607*	Advanced Application Development	1	2	0	0	2	CC
	Elective – V							
8.	UC16MC611	Web Services	4	0	0	0	4	EC
9.	UC16MC612	Module Development using NginX	4	0	0	0	4	EC
10.	UC16MC613	Advanced DBMS	4	0	0	0	4	EC
11.	UC16MC614	NoSQL2	4	0	0	0	4	EC
12.	UC16MC615	Network Management	4	0	0	0	4	EC
13.	UC16MC616	Storage Area Networks	4	0	0	0	4	EC
	Elective – VI							
14.	UC16MC621	Web Content Management	4	0	0	0	4	EC
15.	UC16MC622	Module Development using Apache	4	0	0	0	4	EC
16.	UC16MC623	Machine Learning	4	0	0	0	4	EC
17.	UC16MC624	Information Retrieval	4	0	0	0	4	EC
18.	UC16MC625	Mobile Computing	4	0	0	0	4	EC
19.	UC16MC626	IoT Application Development	2	0	2	4	4	EC
		TOTAL	**20/21**	**0/2**	**6**	**0**	**23/25**	

Note: + Prerequisite Course UC16MC551

ELECTIVES TO BE OPTED FOR SPECIALIZATION		
Sl. No	**Specialization**	**Elective**
A	Web Technology	UC15MC611, UC15MC612, UC15MC621, UC15MC621
B	Data Science	UC15MC613, UC15MC614, UC15MC623, UC15MC624
C	Computer Networks and Communication	UC15MC615, UC15MC616, UC15MC625, UC15MC626

VI SEMESTER (2016 – 19 BATCH)

Sl. No.	Course Code	Course Title	Hours/Week				Credits	Course Type
			L	T	P	S		
1.	UC16MC651	Project Management and Report Writing	2	0	0	4	3	PC
2.	UC16MC652	Project	0	0	28	0	14	PW
		TOTAL	**2**	**0**	**28**	**0**	**17**	

SCIENCE AND HUMANITIES

UE18MA101:
ENGINEERING MATHEMATICS – I (3-1-1-0-4)

Course Objectives:

The objective of this course is to introduce the basic principles and techniques of Calculus and its engineering applications. It lays the required foundation and skills that can be repeatedly employed in subsequent courses at higher levels. Students will acquire the skills and techniques of :

- Curve characterization in space by computing curvature.
- Apply partial derivatives to study maxima and minima of functions of two variables.
- Computing the Area, Volume, Centroid, Mass and Moment of Inertia using the knowledge of curve tracing and multiple integrals.
- Explicit solutions of ordinary and higher order differential equations.

This course aims at providing hands on experience in using Maxima to perform tracing of standard curves, illustrate differentiability, rectification of curves, surface area and volume of solids of revolution.

Course Outcomes:

- Student completing the first unit of this course would be expected to find angle between two curves and radius of curvature for a given polar curve.
- At the end of second unit student will be able to differentiate function of more than one variable.
- After the completion of third unit student will know to trace the curve and predict its characteristics and will be able to find the Area and Volume using multiple integrals.
- Units IV and V will enable students to learn different analytical methods to solve first and higher order differential equations.
- At the end of this course the student should be able to apply the above mentioned concepts to engineering problems.
- Proficiency in using Maxima for tracing of curves and concepts of calculus .

Course Content:

1. **Differential Calculus -** Cauchy's Mean value theorem, Taylors and Maclaurin's series expansion for one variable. Introduction to polar coordinates. Polar curves, Angle between radius vector and tangent, angle between two curves , Pedal equations, Radius of curvature and its different forms (no derivations). Application problems.

   Self learning component: Higher order derivatives and Leibnitz rule.

2. **Partial Differentiation -** Introduction to partial differentiation, geometrical interpretation, total derivative, chain rule, partial differentiation of composite and implicit functions, Homogeneous functions and Euler's theorem (no proof).Taylor's and Maclaurin's series for two variables, Maxima and Minima for function of two variables. Errors and approximations. Application problems.

3. **Integral Calculus -** Tracing of Cartesian and polar curves. Double Integrals, Change of order of integration, change of variables (polar, spherical and cylindrical coordinates), Triple integrals, Application of multiple integrals- Center of mass and Moment of inertia.

   Self learning Component: Reduction formulae.

4. **Ordinary Differential Equations -** Introduction to Differential equations, Linear and Reducible to Linear (Bernoulli as a particular case), Exact differential equations, Reducible to exact differential equations, Orthogonal trajectories (Cartesian and polar forms). Solution of first order non linear differential equations-equations solvable for p, equations solvable for y, equations solvable for x. Application problems on differential equations.

5. **Higher order differential equations -** Introduction to higher order differential equations, Complementary function and particular integrals of standard functions. Cauchy's and Legendre's differential equations, variation of parameters. Application problems on differential equations.

   Self learning Component: Lagrange's method of undetermined multipliers.

Pre-requisite courses: Nil

Reference Books:

1. "Higher Engineering Mathematics", B V Ramana. Tata McGraw-Hill Education, 23rd print, 2015.
2. "Higher Engineering Mathematics", B.S.Grewal, Khanna Publishers , 43rd Edition, 2015.
3. "Advanced Engineering Mathematics", Erwin Kreyszig, John Wiley & Sons, 9th Edition, 2011.
4. "Engineering Mathematics", Antony Croft & Robert Davison, Pearson, 4th Edition 2013.

Math Lab Modules: (Maxima)

1. Introduction to Maxima.
2. Maxima commands for plotting functions.
3. Maxima commands for derivatives and n^{th} derivatives.
4. n^{th} derivative with Leibnitz rule.
5. Verification of Euler's theorem, its extension and Jacobian.
6. Maxima commands for reduction formula with or without limits.
7. Plotting of standard Cartesian and polar curves using Maxima.
8. Maxima programs for area and volume.
9. Solution of Differential equation using Maxima and plotting the solution.

Pre-requisite courses: Nil

Reference Books:

1. "Engineering and Scientific Computing with Scilab", C. Gomez, Birkhuser Boston, 1999.
2. "Scilab by Example", M. Affouf, CreateSpace Independent Publishing Platform, 2012.
3. "Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB", Vande Wouwer, P. Saucez and C. Vilas, Scientific and Engineering Applications, Springer, 2014.
4. "Scilab", J. Russell and R. Cohn, Book on Demand, 2012.

UE18MA151:
ENGINEERING MATHEMATICS- II (3-1-1-0-4)

Course Objectives:

- The course will help students to develop ability and skills to think quantitatively and analyze problems critically.
- The course also introduces students to Laplace transforms and its application to Engineering problems.
- Helps utilize techniques of vector analysis to solve Engineering application problems.
- Understand and apply the concepts of Fourier series and special functions in real time problems.

Course Outcomes:

A student completing the course would be expected to learn

- At the end of Unit 1 student will be able to understand, analyze and apply the concept of differential operator of vectors , Divergence and curl of a vector and three important theorems Green, Stokes' and Divergence on vector integration.
- Unit 2 will introduce the students to some popular special functions which are of great importance to engineering problems.
- The concepts of Laplace and Inverse Laplace transforms and its applications in solving higher order differential equations.
- After completing unit V the student will be able to identify if there exists a Fourier series expansion for a function which helps them to study the behavior of the given function. Will be able to evaluate special integrals using Parseval's identity. Will be able to find the Fourier series for a given set of numerical data using Harmonic Analysis.

Course Content:

1. **Vector calculus** - Introduction to vectors and vector differentiation. Gradient of a scalar function, Directional derivative, angle between the surfaces. Divergence, Curl, related properties. Vector Integration -Line ,Surface and Volume Integrals. Green's theorem, Stokes' theorem and Gauss divergence theorem (without proof).

   Self learning component: Velocity and Accelerations
2. **Special functions** - Beta-Gamma functions – Definition, properties and graphs. Relation between Beta - Gamma functions and Duplication formula (Statements only). Bessel's differential equation and its general solution.

   Recurrence relations for Jn(x), Generating function for Jn(x), Jacobi series and Bessel's Integral formula. Orthogonality of Bessel funcions.
3. **Laplace transforms** - Introduction to integral transforms, Definition, Laplace transforms of standard functions. Properties of Laplace transform-Linearity, First Shifting, Change of scale property, Multiplication by t^n and division by t. Laplace transforms of derivatives and integrals. Laplace transforms of periodic functions. Unit- step function, unit-impulse function and related properties.

   Self learning component: Proof of Laplace transforms of periodic function.
4. **Inverse Laplace transforms** - Definition, Inverse Laplace transforms of standard functions, various methods of finding inverse Laplace transforms, Convolution theorem. Applications of Laplace transforms - To solve differential equations.

   Self learning component: Proof of convolution theorem.
5. **Fourier series** - Introduction to Fourier series, Dirichlet's conditions, Euler's formulae. Fourier Series of Even and odd functions, half –range Fourier series.Complex form of Fourier series. Parseval's identity, Practical Harmonic Analysis. Application Problems.

Pre-requisite courses: Nil

Reference Books:

1. "Higher Engineering Mathematics", B V Ramana. Tata McGraw-Hill Education, 23rd print ,2015.
2. "Higher Engineering Mathematics", B.S.Grewal, Khanna Publishers, 43rd edition, 2015.
3. "Advanced Engineering Mathematics", Erwin Kreyszig, John Wiley & Sons, 9th Edition, 2011.
4. "Engineering Mathematics", Antony Croft & Robert Davison, Pearson, 4th edition 2013.

Math Lab Modules: (Maxima)

1. Evaluation of Gradient, curl, divergence and directional derivative.
2. Evaluation of line Integral.
3. Evaluation of surface integrals.
4. Evaluation of Volume integral.
5. Evaluation of Beta and Gamma functions.
6. Evaluation of Bessel functions.
7. Evalution of integrals using Green's, Stoke's and divergence theorem.
8. Hormonic analysis of Fourier series using Maxima.

Reference Books:

1. "Engineering and Scientific Computing with Scilab", C. Gomez, Birkhuser Boston, 1999.
2. "Scilab by Example", M. Affouf, CreateSpace Independent Publishing Platform, 2012.
3. "Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB", Vande Wouwer, P. Saucez and C. Vilas, Scientific and Engineering Applications, Springer, 2014.
4. "Scilab", J. Russell and R. Cohn, Book on Demand, 2012.

UE17MA201:
ENGINEERING MATHEMATICS-III (3-1-1-0-4)

Course Objectives:

- In this course, the students will learn differentiation and integration of complex functions and mappings in the complex plane.
- They are introduced to solve Engineering problems using numerical methods and also the same is verified using Scilab.
- They are introduced to Fourier Transforms to stimulate interest in communications, control and signal processing to prepare them for follow up courses in these areas.
- The theory of probability, Statistics and random variables motivates them to use statistical inference in practical data analysis.
- They are also introduced to Partial Differential Equations of different types and their solutions.

Course Outcomes:

At the end of this course, students will be able to

- Construct analytic functions, evaluate line integrals of complex functions and find the image of a region under a conformal mapping.
- Write a program using Scilab and execute interpolation, numerical integration, and solve ordinary differential equations with initial / boundary value conditions.
- Apply fundamental mathematical properties of the Fourier transforms including linearity, shift, symmetry, scaling, modulation and convolution to calculate the Fourier transforms and inverse Fourier transforms. Also find Fourier Sine and Cosine transforms.

- Construct probability distributions of a random variable based on real world situation and use it to compute the mean and variance and analyse the correlation and regression between two sets of data.
- Form a PDE by eliminating arbitrary constants / functions and solve the linear and non-linear PDE's .

Course Content:

1. **Introduction to Complex functions -** Limit , continuity and Derivative of f(z). Analytic functions, Cauchy –Riemann equations in Cartesian and Polar forms , Conformal Mapping: z^2, e^z, $z + a^2 / z$ ($z \neq 0$) & applications. Line integral in complex plane, Cauchy's integral theorem and consequences, Cauchy's integral formula & its generalization, Singularities, poles, Residues. Cauchy's Residue theorem .

   Self Learning Component: Harmonic Functions, Orthogonal trajectories, Milne Thompson Method.

2. **Finite Differences** - Forward and Backward Differences, Newton – Gregory forward and backward interpolation formulae (No derivations), Interpolation with unequal intervals-Lagrange's interpolation formula. Central Difference-Stirling's and Bessel's formulae (all formulae without proof)-Problems. Numerical integration:Simpson's 1/3, 3/8 rule, Weddle's rule (without proof) -Problems. Numerical solution of ordinary differential equations of first order and first degree, modified Euler's method, Runge - Kutta method of fourth order. Predictor and corrector methods (No derivations of formulae).

3. **Definition of Fourier Transform and its inverse -** , Fourier sine and cosine transforms and their nverses, properties of FT, convolution Theorem, Parseval's identity for Fourier Transform, Finite Fourier sine and cosine transforms.

   Self Learning Component: Relation between Fourier and Laplace Transform.

4. **Probability Distributions** - Random Variables, Discrete & Continuous Random variables, probability mass & density functions, Cumulative Distribution, Binomial , Poisson & Normal Distributions, , Correlation & Regression - Definition and Types, Karl Pearson's Coefficient of Correlation, Lines of Regression & Applications.

   Self Learning Component: Curve Fitting by Least Squares method: $y = a + bx + cx^2$, $y = ab^x$,

5. **Partial differential equations -** Formation of Partial differential equations by elimination of arbitrary constants and arbitrary functions of specific functions - Linear PDE's of first order-Lagrange's linear equation, solution of PDE by direct method. Solution of homogeneous linear PDE with constant co-efficients and non homogeneous linear PDE.

   Self Learning Component: Solution of PDE by the method of separation of variables.

Pre-requisite courses: Nil

Reference Books:

1. "Higher Engineering Mathematics", B S Grewal, 43rd Edition , Khanna Publishers,2015
2. "Higher Engineering Mathematics", B.V Ramana, 23rd Reprint 2015; Mc Graw Hill Education (India) Private Limited

Math Lab -III Modules: Scilab

1	Introduction to Scilab
2 -3	Scilab programs on Interpolation with equal intervals (Newton –Gregor forward and backward interpolation formulae)
4 -5	Scilab programs on Interpolation with unequal intervals (Lagrange's interpolation formula & Lagrange's Inverse Interpolation formula.)
6 **-8**	Numerical Integration using Trapezoidal Rule, Simpson's one third rule, Simpson's three eighth's rule and Weddle's rule,
9 -10	Numerical solution of first order Ordinary Differential Equations - Modified Euler's method & Fourth order Runge - Kutta method
11	Lab Test
12 -13	Test Evaluation

UE17MA251
LINEAR ALGEBRA & ITS APPLICATIONS: (3-1-1-0-4)

Course Objectives:

- In this course, students learn to use matrix operations to solve systems of linear equations, and perform operations with matrices to find the inverse of a matrix.
- They are introduced to basic concepts of vector spaces, linear transformations and fundamental subspaces. They also learn orthogonality of vectors & subspaces and Gram Schmidt orthogonalization to produce orthonormal vectors.
- They are also introduced to eigen values & eigen vectors for diagonalization. They are introduced to singular value decomposition which is used to compute Pseudo inverse, Least squares fitting of data, multivariable control and matrix approximation.
- They are introduced with lab concept which helps them to visualize the various concepts of Linear Algebra.

Course Outcomes:

- After completing this course, students will be able to Solve systems of linear equations using matrix transformations and interpret the nature of solutions and visualize consistency of linear system of equations and also compute inverse of a matrix.
- Demonstrate the ability to work within vector spaces and to distill vector space properties and understand the concepts of the four fundamental subspaces, linear span, linear independence , dimension and basis
- Analyze linear transformation as a mapping and calculate its matrix representation with respect to standard and nonstandard bases.
- Understand the concepts of orthogonal vectors and orthogonal subspaces and apply the Gram-Schmidt process to find an orthonormal basis in a subspace
- Find eigen values and eigenvectors of a matrix and to execute the program of finding largest eigen value by power method. Also determine if a matrix is diagonalizable, and if it is, how to diagonalize it.
- Understand the concept of Positive definite matrices and learn Singular Value Decomposition with its applications.

Course Content:

1. **Matrices and Gaussian Elimination** Introduction, The Geometry of Linear Equations, Gaussian Elimination, Singular cases, Elimination Matrices, Triangular factors and Row Exchanges, Inverses and Transposes, Inverse by Gauss -Jordan method.

   Self Learning Component : Algebra of Matrices.

2. **Vector Spaces** Vector Spaces and Subspaces (definitions only) , Linear Independence, Basis and Dimensions, The Four Fundamental Subspaces.

   Self Learning Component : Examples of vector spaces and subspaces, Rank of a matrix.

3. **Linear Transformations and Orthogonality**-Linear Transformations , Orthogonal Vectors and Subspaces, Cosines and Projections onto Lines, Projections and Least Squares.

   Self Learning Component: Inner Products and Cosines.

4. **Orthogonalization , Eigen Values and Eigen Vectors -** Orthogonal Bases, The Gram- Schmidt Orthogonalization, Introduction to Eigen values and Eigen vectors, Power Method to find the Largest Eigen Value, Diagonalization of a Matrix.

   Self Learning Component : Properties of Eigen values and Eigen vectors.

5. **Positive Definite Matrices -** Tests for positive definiteness, Positive Definite Matrices and Least Squares, Semidefinite Matrices, Singular Value Decomposition, Applications of the SVD.

Math Lab – Implementation of the following concepts in SCILAB:

1. Implementation of Gaussian Elimination ,
2. The LU Decomposition,
3. Inverse of a Matrix by the Gauss- Jordan Method,
4. The Span of Column Space of a Matrix,
5. The Four Fundamental Subspaces,
6. Projections by Least Squares,
7. The Gram-Schmidt Orthogonalization,
8. Eigen values and Eigen Vectors of a Matrix,
9. The Largest Eigen Value of a Matrix by the Power Method.

Pre-requisite courses: Nil

Reference Books:

1. "Linear Algebra and its Applications", Gilbert Strang, 4th Edition, Thomson Brooks/ Cole, Second Indian Reprint 2007.
2. "Higher Engineering Mathematics", B S Grewal, 43nd Edition, 2015, Khanna Publishers.

UE18MA101D:
ENGINEERING MATHEMATICS - I
(For Lateral Entry Students) (2-0-0-0-2)

Course Objectives:

The objective of this course is to introduce the basic principles and techniques of Calculus and its engineering applications. It lays the required foundation and skills that can be repeatedly employed in subsequent courses at higher levels. Students will acquire the skills and techniques of:

- Curve characterization in space by computing radius of curvature.
- Apply partial derivatives to study functions of two variables.
- Computing the Area, Volume using multiple integrals.
- Explicit solutions of ordinary and higher order differential equations.

Course Outcomes:

- Student completing the first unit of this course would be expected to find radius of curvature for a given curve and expansion of Taylor's and Maclaurin's series.
- At the end of second unit student will be able to differentiate function of more than one variable .
- After the completion of third unit student will know to find the Area and Volume using multiple integrals.
- Units IV and V will enable students to learn different analytical methods to solve first and higher order differential equations.
- At the end of this course the student should be able to apply the above mentioned concepts to engineering problems.

Course Content:

1. **Differential Calculus -** Cauchy's Mean value theorem,.Taylors and Maclaurin's series expansion for one variable. Radius of curvature and its different forms (no derivations). Application problems.

   Self learning component: Higher order derivatives.

2. **Partial Differentiation -** Introduction to partial differentiation, total derivative, chain rule, partial differentiation of composite and implicit functions, Homogeneous functions and Euler's theorem (no proof).

3. **Integral Calculus -** Introduction to Multiple integrals, Double Integrals, Change of order of integration, change of variables (polar, spherical and cylindrical coordinates), Triple integrals, Application of multiple integrals. 6 Hours

   Self learning Component**:** Reduction formulae.

4. **Ordinary Differential Equations -** Introduction to Differential Equations, Linear and Reducible to Linear (Bernoulli as a particulr case), Exact, Reducible to exact, orthogonal trajectories (Cartesian and polar forms).

5. **Higher order differential equations -** Introduction to higher order differential equations, Complementary function and particular integrals of standard functions. Variation of parameters. Application problems on differential equations.

Pre-requisite courses: Nil

Reference Books:

1. "Higher Engineering Mathematics", B V Ramana. Tata McGraw-Hill Education, 23rd Print , 2015.
2. "Higher Engineering Mathematics", B.S.Grewal, Khanna Publishers , 43rd Edition, 2015.
3. "Advanced Engineering Mathematics", Erwin Kreyszig, John Wiley & Sons, 9th Edition, 2011.
4. "Engineering Mathematics", Antony Croft & Robert Davison, Pearson, 4th edition 2013.

UE18MA151D:
ENGINEERING MATHEMATICS- II
(For Lateral Entry Students) (2-0-0-0-2)

Course Objectives:

- The course will help students to develop ability and skills to think quantitatively and analyze problems critically.
- The course also introduces students to Laplace transforms and its application to Engineering problems.
- Helps utilize techniques of vector analysis to solve Engineering application problems.
- Understand and apply the concepts of Fourier series and special functions in real time problems.

Course outcomes:

A student completing the course would be expected to learn

- The concepts of Laplace and Inverse Laplace transforms and its applications in solving higher order differential equations.
- Unit 3 will introduce the students to some popular special functions which are of great importance to engineering problems.
- After completing unit IV the student will be able to identify if there exists a Fourier series expansion for a function which helps

them to study the behaviour of the given function. Will be able to find the Fourier series for a given set of numerical data using Harmonic Analysis.

- At the end of Unit V student will be able to undersand, analyze and apply the concept of differential operator of vectors , Divergence and curl of a vector and three important theorems Green, Stoke's and Divergence on vector integration.

Course Content:

1. **Laplace transforms -** Definition, Laplace transforms of standard functions. Laplace transforms of derivatives and integrals, Unit- step function, unit-impulse function and related problems.

   Self learning component: Laplace transform of periodic function.
2. **Inverse Laplace transforms -** Definition, Inverse Laplace transforms of standard functions, various methods of finding inverse Laplace transforms. Applications of Laplace transforms to solve differential equations.
3. **Special functions -** Beta-Gamma functions – Definition, properties and graphs. Relation between Beta - Gamma functions. Recurrence relations for $J_n(x)$, Generating function for $J_n(x)$ (no proof) , Jacobi series and Bessel's Integral formula.
4. **Fourier series -** Introduction to Fourier series, Dirichlet's conditions, Euler's formulae. Fourier Series of Even and odd functions, half –range Fourier series, Practical Harmonic Analysis. Related problems.
5. **Vector calculus -** Introduction to vector differentiation. Gradient of a scalar function, Directional derivative. Divergence, Curl and application problems. Green's theorem, Stokes' theorem and Gauss divergence theorem (without proof) and application problems.

Pre-requisite courses: Nil

Reference Books :

1. "Higher Engineering Mathematics", B V Ramana. Tata McGraw-Hill Education, 23rd Print 2015.
2. "Higher Engineering Mathematics", B.S.Grewal, Khanna Publishers , 43rd Edition, 2015.
3. "Advanced Engineering Mathematics", Erwin Kreyszig, John Wiley & Sons, 9th Edition, 2011.
4. "Engineering Mathematics", Antony Croft & Robert Davison, Pearson, 4th edition 2013.

UE18CY101:
ENGINEERING CHEMISTRY (4-0-0-0-4)

Course Objectives:

The Course intends to provide chemical concepts most relevant to engineering students and demonstrate them in an applied context. The student is exposed to the principles required to understand important contemporary topics and applications of these concepts to real world problems . The course will introduce the students to

- Chemistry of various alternate energy sources like batteries, fuel cells and supercapacitors
- Electrochemical phenomenon involved in corrosion and different methods of corrosion control
- Polymer technology and its applications in industry
- Various equilibria in nature like electrochemical equilibria and phase equilibria
- Fundamentals of molecular spectroscopy, nanomaterials and green chemistry.

Course Outcomes:

- Understand and interpret phase equilibria of one and two-component systems.
- Explain different types of spectral transitions within a molecule and evaluate various spectroscopic parameters like bond length and bond strength from given spectra.
- Appreciate the basic principles of electrochemistry, use of different types of electrodes in analysis and evaluate cell potential for different cell reactions.
- Know construction, working and applications of various energy storage devices such as batteries, fuel cells and supercapacitors.
- Understand basic principles of corrosion and apply suitable techniques for corrosion control. Also know the technological importance and processes involved in metal finishing.
- Know the synthesis, structure – property relationship and applications of commercially important polymers and polymer composites. Understand synthesis, properties and applications of nanomaterials. Also learn the principles of green chemistry for a sustainable and eco-friendly world.

Course content :

1. **Molecular spectroscopy** - Interaction of electromagnetic radiation with matter, electromagnetic spectrum, Born – Oppenheimer approximation, Beer-Lambert's law, Microwave spectroscopy- diatomic rigid rotor model and the rotational spectrum. IR spectroscopy- diatomic harmonic oscillator and anharmonic oscillator model, Electronic spectroscopy- Vibrational coarse structure(Progressions), Franck Condon Principle.
2. **Free energy in chemical equilibria** -Chemical Potential, Phase equilibria : Statement of Gibb's phase rule, Derivation of Gibb's phase rule, Phase diagram of one component system- water system, Condensed systems, Phase diagram of two-component system-Pb-Ag system, Fe-C system, Free energy and emf , cell potentials, Nernst Equation, Types of electrodes, Reference electrodes, Concentration cells: types of concentration cells, Ion selective electrodes: Glass Electrode, Numericals based on all concepts.
3. **Energy storage devices -** Batteries: Components of a battery and working; Battery characteristics, Modern batteries- Reserve batteries: Mg –AgCl battery, Zinc Air battery, Li batteries ; Li-ion battery ($LiCoO_2$), Fuel cells: Principle and working, H_2-O_2 fuel cells- alkaline fuel cell, polymer membrane fuel cell, and solid oxide fuel cell, Application in Oxygen sensors, efficiency of fuel cells, Supercapacitors, Ragone plot.

   Self study component: CH_3OH-O_2 fuel cell, fuel cell based Breath Analyser, Hydrogen storage methods.
4. **Corrosion chemistry** - Electro-chemical theory of corrosion, Types of corrosion-Differential metal; Differential aeration; Pitting corrosion ; Stress corrosion (caustic embrittlement), Factors affecting rate of corrosion. Corrosion control: Metal coating – Galvanizing and Tinning, Inorganic Coating – Anodizing and Phosphating, Corrosion inhibitors, Cathodicprotection – Sacrificial Anode and Impressed current method; Anodic protection.
5. **Functional materials and green chemistry** - Polymers: Introduction, Structure- property relationship, Number average molecular weight; Weight average molecular weight; Viscosity average molecular weight, Commercial Polymers: Synthesis, properties and applications of PMMA, Butyl rubber and epoxy resin , Polymer Composites: Synthesis , properties and

applications of Kevlar and Carbon fibres. Conducting polymers- examples, types of doping, mechanism of conduction in doped polyaniline, applications of conducting polymers. Nanomaterials: Introduction, classification, optical properties , synthesis by sol-gel method and chemical vapour deposition and applications. Green Chemistry: Introduction, Twelve principles of green chemistry with examples.

Self study component: Nanoscale materials: Fullerenes, carbon nanotubes, nanowires and dendrimers

Pre-requisite courses: Nil

Reference Books:

1. "Engineering Chemistry", Gadag, R.V. and Nityananda Shetty A., Third Reprint, I.K. International Publishing House, 2011 (Chapter 1,2,3,4,7,9 and 10).
2. "Engineering Chemistry", Jain,P.C. and Monica Jain., Third reprint, Dhanpat Rai Publishing Company(P) Ltd. (Chapter 6 and 35)
3. "Industrial Electrochemistry", Pletcher, D. and Walsh, F.C., Second edition, Blackie Academic and Professional, 1993 (Chapter 8,10,11)

UE18CY102:
CHEMISTRY LABORATORY (0-0-2-0-1)

Course objectives:

The course intends to train students to develop their experimental skills and apply fundamental chemical principles in problems related to chemistry in engineering . The experiments are designed to support the theory lectures and the hands-on experience will thus enhance students' understanding of a topic. The students is exposed to

- Performing volumetric titrations
- Instrumental analysis using conductometer ,potentiometer and colorimeter
- Constructing phase diagrams
- Determining viscosity average molecular weight of polymers

Course outcomes:

- Students will be able to organize, analyse ,interpret and represent data in the form of tables and graphs.
- They will enhance their skills like precision , observation and logical thinking.
- They will be able to plan experiments and appreciate good lab practices.

Experiments:

1. Demonstration of graphical software for plotting graphs
2. Determine cell constant of a conductivity cell and use the cell for conductometric titration.
3. Assemble a cell using glass electrode (ion-selective electrode) and use the cell for pHmetric titration.
4. Assemble a cell for a redox reaction and use the cell for potentiometric titration.
5. Estimate the amount of Copper in a solution by spectro-photometric method.
6. Calculate Viscosity average molecular weight (M_v) of a polymer by viscosity measurements using Mark – Houwink equation.
7. Construct a phase diagram and determine eutectic composition and eutectic temperature for a simple eutectic system using cooling curves.
8. Determine pH, conductivity, total dissolved salts of a given water sample and estimate total hardness of a given water sample
9. Determine COD of a waste water sample
10. Determine the amount of chloride in a given water sample
11. Construction of salt bridge, setting up a Daniel cell and a concentration cell.
12. Drawing chemical structures using CHEMDRAW software.

Pre-requisite courses: Nil

Reference Book:

1. Laboratory Manual prepared by the Department of Science & Humanities, PES University

UE18PH101:
ENGINEERING PHYSICS (4-0-0-0-4)

Course Objectives:

This course in Physics for the first / second semester is oriented to give Engineering students an overview of the basics of current physics. The course enhances the student's analytical skills and problem solving abilities.

The course exposes students to the:

- Basics of the Electromagnetic waves
- Fundamentals of Quantum Mechanics
- Band theory of solids for characterization of metals, semiconductors and insulators.
- Fundamental concepts of LASERs
- Physics of materials – magnetic and dielectric materials with applications

Course Outcomes:

Students completing the course should be able to

- Comprehend the basic ideas of quantum behavior and wave mechanics
- Apply Schrodinger's equation to one dimensional quantum systems, obtain solutions and analyse the outcomes
- Explain density of states, electronic conduction in metals
- Elucidate the principles of LASER systems and explain the working of typical LASER systems
- Classify magnetic materials on the basis of susceptibility and spin and current applications
- Classify dielectrics on the basis of polarization mechanisms, and ferroelectrics for electronic application

Course Content:

1. **Introduction**: Concepts of Electric and Magnetic fields, concepts of polarization in electric fields, Maxwell's equations. Failure of classical mechanics - Black Body Radiation, Atomic Spectra, PE effect, Compton effect

   Self study and assignments: *Derivations of Black body radiation and Compton Effect; Numericals.*

2. **Quantum Mechanics and Simple Quantum Mechanical Systems**: Mathematical representation of quantum mechanical waves; Schrodinger wave equation and solutions to simple systems –free particles, step potentials, barriers, particle in a 1d, 2d and 3d box, finite potential well, LHO. Conceptual discussions on the solutions for a Hydrogen atom

   Self study and assignments*: Step potentials and particle in 2d and 3d box; Numericals.*

3. **Application of Quantum Mechanics to Solids**: Concepts of the quantum free electron. Mathematical representation including density of states and Fermi energy. Electron motion in a periodic potential and formation of band. E-k diagram - metals, semiconductors and insulators

   ***Self study and assignments**: DOS 1d and 2d, periodic potentials; Numericals*

4. **Application of Quantum Mechanics to Electromagnetic Waves**: Black body radiation as an equilibrium state. Interaction of radiation with matter, absorption and emission cross sections, light amplification and threshold condition. Atomic, and semiconductor lasing systems

   ***Self study and assignments**: Emission cross sections and threshold condition; Numericals*

5. **Application of quantum mechanics to Magnetics and Dielectrics**: Atomic origin of magnetic moments, susceptibility classification of magnetic materials, Brillouin function. Dielectric Polarization mechanisms and types of dielectric materials (piezo, ferro and pyro) and their properties with applications.

   ***Self study and assignments**: Brillouin function and application of dielectrics; Numericals*

Pre-requisite Courses: Nil

Reference Books:

1. "Quantum Physics of Atoms Nuclei and Molecules", Robert Eisberg, Robert Resnick, Wiley, 2006.
2. "Quantum Physics", S Gasiorowicz, 3rd Edition, Wiley Publications, 2007
3. "Principles of Quantum Mechanics", R Sankar, Pearson , 2010
4. "Lectures on Physics", Feynman, Leighton and Sands, Vol. 1-3, 13th Reprint, Narosa Publications, 2012
5. "Concepts of Modern Physics", Arthur Beiser, TMH Publication, 6th Edition, 2015

UE18PH102:
PHYSICS LABORATORY (0-0-2-0-1)

Course Objectives:

- The course is designed to give students an insight into the practical experience of the concepts covered in the theory topics (where ever applicable).
- The course incorporates the concept of errors in measurement and their propagation in the course of estimations.
- Students are trained on fundamentals of graphs and linear regression methods for scattered data.
- The experiments cover the properties of a range of materials- metals, semiconductors, ferroelectrics and ferromagnetic.
- Students investigate the properties of Lasers and concepts of polarization of electromagnetic waves.

Course Outcomes:

At the end of the course students should be able to

- Organise an experimental setup to conduct experiments
- Handle basic measuring equipments, multi meters, lux meter, flux meter, travelling microscope
- Handle signal generators, current and voltage power sources
- Collect pertinent data from careful observations
- Present data in appropriate formats
- Analyse data and draw consistent conclusions
- Present the records in standard formats

Experiments

1. Measuring instruments, least counts and error analysis
2. Graphs – least square fit for scattered data
3. Understanding Optical Interference
4. Atomic spectra as a signature of elements
5. Dielectric constant through DC response
6. LCR series resonance – determination of dielectric constant
7. Understanding electrical conduction in metals
8. Understand electrical conduction in Semiconductors
9. Magnetic measurements of ferromagnetic materials
10. Understanding Piezoelectric Resonance
11. Characteristics of LASER
12. Polarisation states of Light with multiple polarisers

Demo experiments: Photo electric effect / Ferromagnetic hysteresis

Activity: Design an application / experiment.

Pre-requisite Courses: Nil

Reference Book:

1. Laboratory manual prepared by Department of Science and Humanities, PES University.

UE18HS101:
CONSTITUTION OF INDIA & PROFESSIONAL ETHICS (0-0-0-0-0)

Course Objectives:

- The course aims to expose students to the basic concepts of the Constitution of India and the pivotal aspects of Professional ethics with the intent of making them aware of their responsibility and accountability as a citizen of the country.

Course Outcomes :

After completion of the course , a student would be able to :

- Interpret the basics of the Constitution of India and its modalities
- Understand the need of fundamental rights and the fundamental duties
- Develop a sense of responsibility by following the Constitution ethos
- Analyse the importance of Constitution in the day to day affairs as a citizen
- Understand the role of Engineers in Environmental issues

Course Content:

1. **Constitution of India** – Three pillars of the Democracy- Legislature, Executive and Judiciary. Constitution of India – Meaning, Historical background, Characteristics of a Federal Constitution. Salient features of the Constitution of India. Preamble Basics of Citizenship. Fundamental Rights (Art.12-13) Basic concept of Right to Equality (Art 14-18) Right to Freedom (Art 19-22) with a special concentration on Right to Life. Fundamental Duties (Art 51-A). Freedom of Trade and Commerce (Art 301-307).
2. **Professional ethics -** Engineering ethics, Personal vs. Business ethics, Ethics and law, Preventive Ethics, Problem solving method, Identifying moral, conceptual and factual issues.

3. **Risk, safety and liability** - Ensuring safety as a duty, estimating risks, acceptable risks, and Engineers' liability for risk. Responsible Engineers. Honesty, Integrity and reliability. Engineers & the environment - Sustainable development, environment, anthropocentric approach to environmental ethics. Global Issues of ethics in the industry and Government.

Pre-requisite courses: Nil

Reference Books:

1. "Constitutional Law – I : Lexis Nexis Quick Reference Guide", Lauv Kumar and Radhika Gupta, Sept 2013.
2. "Quick Reference Guide Q & A Series- Constitutional Law- I", Rosedar SRA, 2nd Edition 2016
3. "Constitutional Law of India", J N Pandey, Central Law Agency, 54rd Edition
4. "Introduction to Constitution of India", D D Basu, Prentice-Hall , 20th edition 2001
5. "Engineering Ethics Concepts and cases", Harris, Pritchard & Rabins, Thomson & Wadswor, 2nd Edition, 2005
6. "Engineering Ethics", Fleddermann C.B Pearson Education, 2nd Edition, 2004
7. "Ethics and the Conduct of Business", John R Boatright, Pearson Education, New Delhi, 2003.
8. "Fundamentals of Ethics for Scientists and Engineers", Edmund G Seebauer and Robert L Barry, Oxford University Press, Oxford, 2001.

UE18HS102:
ENVIRONMENTAL STUDIES (0-0-0-0-0)

Course Objectives:

- Environmental Studies is a multidisciplinary subject. It has been introduced with the objective of exposing the students to the basic concepts of environment – resources, pollution, management and law; and also the current issues endangering life on earth.

Course Outcomes :

A student complete the course would be able to:

- Delineate physical and biological principles that govern natural processes and appreciate the natural environment as a system and how human activities affect the system.
- Interpret environmental resource management and sustainability conflicts from multiple perspectives.
- Analyze and integrate the social and natural sciences to understand diverse environmental and sustainability challenges ranging from local issues to global environments.

Course Content :

1. **Environment**: Basic concepts- Definition; Scope and importance of environmental studies; need for public awareness. Inter-relationship between soil, water and air media of environment. Natural resources: Definition, classification, types, problems due to over-exploitation. Conservation and Management of resources; Sustainable development. Basic concepts of ecosystems, structure and function of ecosystems, energy flow in ecosystems. Basic concepts of bio-diversity, biogeographical classification of India, value of bio- diversity, threats to bio-diversity and conservation.
2. **Energy Resources:** Types of energy: Conventional sources of energy, fossil fuel, Nuclear based, solar, wind, sea-wave energy. Non-conventional sources of energy, Biofuels - biomass, biogas; hydrogen as an alternative future source of energy.
3. **Environmental Pollution:** Land pollution-Sources and effects of land pollution; control measures, methods for the sustainable use of soils for agriculture. Soil erosion through agriculture, deforestation, grazing, salinization and management. Noise pollution :Sources of noise pollution, characteristics of sound, Effects of noise on environment. Control measures. Air pollution :Structure of atmosphere, Atmospheric inversions. Sources and effects on environment and other organisms, Control measures. Automobile pollution and control. Firework and cracker pollution; their hazards; safety and health effects. Bhopal Gas Tragedy, Global warming, ozone layer and acid rain. Water pollution – Sources and effects on environment and other organisms, Control measures.
4. **Disaster Management:** Definition, origin and classification. Natural (Earthquakes, landslides, floods, Cyclones) and Man-made disasters (biological, chemical, nuclear, radiological, explosions) – definition, causes and management and/or mitigation strategies.

   Solid waste management: Origin of domestic solids waste, biomedical wastes, composition and quantity of refuse, collection, transportation storage of refuse. Waste-treatment options, waste processing, recycling of different waste fractions, Solid waste management - Landfilling, composting, leachate and leachate gas containment. Industrial and special wastes, incineration. Solid waste management issues, rules and policies.
5. **Social Issues and Environmental Law:** Population growth, variation among nations, Population explosion, Family welfare programme. Environment and human health, value education, Women and Child Welfare, Role of information technology in Environmental and human health. Environment and pollution laws: World treaties and World conferences on environment. Indian Acts and Rules – Air Act -1981 (Rules 1982, 1983). Water Act – 1974 (Rules 1975), Forest Conservation Act 1980 (Rules 2003).National Forest Policy, 1988; Wildlife (Protection) Act 1972. Environment Protection Act, 1986. Environmental law. Environment and pollution laws

Pre-requisite courses: Nil

Reference Books:

1. "Perspectives in Environmental Studies", Anubha Kaushik and C.P. Kaushik , New Age International Publishers, 4th Edition, 2014.
2. "Environmental Studies: From Crisis to Cure", Rajagopalan, R, Oxford University, 2nd Edition, 2011.
3. "A Textbook of Environmental Studies", D.K. Asthana and Meera Asthana, S. Chand & Company Ltd., 2009.
4. "Environmental Chemistry", A.K. De , New Age International Publishers., 2006.
5. "Environment and Pollution Laws", S.K. Mohanty , Universal Law Publication, 2006.
6. "Fundamental of Ecology", Odum EP, WB Saunders Co. USA., 1971.

BIOTECHNOLOGY

B.TECH IN BIOTECHNOLOGY

Program Educational Objectives

1. To train and prepare students with logical and analytical abilities to identify, analyse and solve biotechnological problems in process and product development
2. To prepare students to apply modern computational, analytical tools and techniques to address biotechnological problems
3. To prepare innovative, entrepreneurial and ethical professionals fit for a globally competitive environment
4. To inculcate students to pursue life long learning as a means of enhancing knowledge based skills and develop good communicative skills for professional advancement
5. To prepare students to adapt in a world of constantly evolving technology, develop interdisciplinary skills to meet diverse career needs - academic, research, industry or entrepreneurship

Program Outcomes

1. **Scholarship of Knowledge** : To apply basic science, mathematics, engineering fundamentals and program core to solve complex biotechnological problems.
2. **Critical Thinking:** Identify , analyze and address complex problems in biotechnology and its associated domains
3. **Problem Solving:** Critical evaluation and analysis of the problem. Design and develop solutions to solve complex biological problems
4. **Research Skill :**Critically analyze existing literature, apply research based knowledge and biotechnological methods including design and conduction of experiments, analysis and interpretation of data to tackle complex biological problems
5. **Modern Tool Usage:** Select and apply current techniques, appropriate skills and modern software tools including prediction and modeling methods on biological databases to identify issues in biomedical problems.
6. **Collaborative and Multidisciplinary work:** Enhance skills and continuously acquire advanced knowledge in Biotechnology and related domains , multidisciplinary and interdisciplinary domains for professional excellence
7. **Project Management and Finance:** Apply engineering and management principles for effective implementation and execution of projects in teams and in individual capacity with emphasis on time, economics and performance.
8. **Communication**: Contribute and communicate effectively with the society confidently, be able to write effective reports and design documents by adhering to the appropriate standards, make effective presentations, give and receive clear instructions
9. **Life-long Learning**: Pursue life-long learning to enhance knowledge and skills for professional advancement and effective communication
10. **Ethical Practices and Social Responsibility:** Assess personal, product and environmental safety, intellectual property and social responsibilities related to modern biotechnological research and development. Identify measures for energy, environment, health, safety and society following ethical principles
11. **Independent and Reflective Learning:** Critically evaluate the outcomes of one's actions and apply self-corrective measures to improve the performance

UE18BT101:
ENGINEERING BIOLOGY (2-0-0-0-2)

Course Objectives:

- To introduce students to modern biology with an emphasis on evolution of biology as a multidisciplinary field.
- To make students aware of application of engineering principles in biology and engineering robust solutions inspired by biological examples.
- This course is designed to convey the basic and essential concepts of biology to provide a framework for designing and improving biological systems in future for better healthcare, better processes, better products and overall better quality of life.

Course Outcomes:

At the end of the course, the student should be able to

- Understand biological mechanisms of living organisms from the perspective of engineers.
- Solve biological problems with engineering tools.
- Apply bio-systems to optimal design in engineering.

Course Content:

1. **Biomimetics :** Introduction to Biology, Biological Unity underlies Biological diversity, Biomolecules: Water,Carbohydrates,Proteins, Lipids and Nucleic acids, Biomimicry: Nature as an engineer, Bio-processes -engineering analogies
2. **Bioenergy** : Plant & Animal cell, Metabolism: Enzymes & Bio-catalysis, Anabolism: Solar to Bioenergy : photosynthesis, Catabolism: Digestion: Breakdown of food, Respiration : Gas exchanges.
3. **Biomechanics:** Bio-fluidics: Blood- Mechanical systems of the heart, Blood pressure, Molecular Motors: rotational motor mechanism in ATP synthesis, Kinesiology: Bio-mechanistic processes involved in movement, Muscle Contraction-relaxation.
4. **Bioelectronics:** Brain as computer: bio-neural networks, Bionic Eye: Mechanism of Vision, Electronic Nose: Bio-olfactory mechanisms, Cardiac and Nerve impulses, Biological Clock, Circadian rhythm.
5. **Biopharma:** Metabolic Disorders, Cancer and diagnostics, Lab on a chip, Bio-Sensors, Telemonitoring, Drug Discovery

Pre-requisite Courses: NONE

Reference Books:

1. "Biology: A global approach", Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M,
   L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson, Global Edition, 10/E, 2014
2. "Lehninger Principles of Biochemistry", David Nelson, Michael Cox, W H Freeman & Company, Seventh Edition, 2017.
3. "Biomimicry: Innovation inspired by Nature", Janine M Benvus, William Morrow Paperbacks, 2002

UE17BT201:
BIOPROCESS CALCULATIONS (4-0-0-0-4)

Course Objectives:

- To gain an understanding of the concepts of basic mathematical tools.
- To understand the methodical problem-solving skills.
- To understand the significance of material & energy balances and to formulate, apply and solve them.

Course Outcomes:

At the end of the course, the student should be able to

- Familiarise with the use of units, physical properties, and the behaviour of gases and liquids.
- Deal with the complexity of larger problems.
- Develop the ability to work independently in any chemical & biochemical industry.

Course Content:

1. **Introduction to Engineering Calculations:** Inter-conversion of units from one system to another**.** Concept of mole and molecule, Composition of mixtures and solutions- Percentage by weight, mole and volume, Density, Specific gravity, Specific volume, Average molecular weight, Temperature, Pressure, Standard conditions and ideal gases.
2. **Material balance without chemical reactions:** General material balance equation for steady and unsteady states. Material balances in Distillation, Absorption, Extraction, Crystallization, Drying, Mixing, and Evaporation Operations.
3. **Material balance involving chemical reactions:** Principles of Stoichiometry. Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, selectivity and related problems. Material balances involving bypass, recycle and purge; Fuels and Combustion: calculations involving Excess air and Air-fuel ratio.
4. **Energy Balance:** General energy balance equation for steady state. Thermo physics and Thermo chemistry: Heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Enthalpy, Standard Heat of formation, standard heat of reaction, Standard heat of combustion and calorific value, Calculation of $D(H_R)$ at elevated temperature. Biochemical equilibrium constants and conversions**.**
5. **Stoichiometry of Microbial Growth and Product Formation:** Introduction, Definitions of specific growth rate and yield**.** Elemental balances and degrees of reduction. Problems on specific rate and yield.

   Case study: Material Balance-Penicillin Production; Energy Balance- Bioreactor.

Pre-requisite Courses: NONE

Reference Books:

1. "Basic Principles and Calculations in Chemical Engineering", David Himmelblau, Prentice Hall of India, Seventh Edition, 2003.
2. "Bioprocess Engineering – Basic Concepts", Michael L Shuler and Fikret Kargi, Prentice Hall of India, Second Edition, 2005.
3. "Process Calculations Stoichiometry", Gavhane KA, Nirali Prakashan, Seventh Edition India, 1989.

UE17BT202:
FLUID MECHANICS AND MECHANICAL OPERATIONS
(3-0-2-0-4)

Course Objectives:

- To gain understanding of the basic properties of fluids, its measurements.
- Differentiate between the various equipments used for mechanical – physical separation process.

Course Outcomes:

At the end of the course, the student should be able to

- Have the knowledge of the properties of fluids & its measurements.
- Solve problems associated with the fluid measurements and solid – liquid separations.
- Have the knowledge of underline theory of solid – liquid separations.

Course Content:

1. **Fundamentals of Fluid Flows:** Introduction, Properties of Fluids, Viscosity, Pressure and its Measurements: Fluid Pressure at a Point, Pascal's law, Pressure variation in a Fluid at Rest, Measurement of Pressure – Simple and Differential Manometers. Types of Fluid Flow. Continuity equation, Equations of Motion, Euler's Equation of Motion and Bernoulli's Equation from Euler's Equation, Flow through circular and non-circular cross sections, Hagen-Poisuille's equation, Losses through pipe and fittings. Turbulent flow, friction factor. Dimensional Analysis: Dimensionless Numbers, Rayleigh's Method, Buckingham's Pi Theorem, Numerical Examples.
2. **Flow Past Immersed Objects and Packed and Fluidized Beds:** Introduction, Force Exerted by a Flowing fluid on a Stationary Body, Drag, and Lift, Expression for Drag and Lift, Drag Coefficient. Flow Past Sphere, Long Cylinder, and Disk. Flow in Packed Beds: Introduction, Laminar Flow in Packed Beds, Turbulent Flow in Packed Beds, Shape Factors, Mixtures of Particles, and Darcy's Empirical Law for Laminar Flow. Flow in Fluidized Beds: Types of Fluidization in Beds, Minimum Velocity and Porosity for Particulate Fluidization, Pressure Drop and Minimum Fluidizing Velocity, Expansion of Fluidized Beds, Minimum Bubbling Velocity, Numerical Examples.
3. **Fluid Flow Measurements:** Introduction, Venturimeter, Orifice meter, Rotameter, Pitot tube, Notches and Weirs. Numerical Examples. Pumps: Developed head, Power requirement, Suction Lift and Cavitation, Reciprocating Pump: Working Principle, Discharge, Work done and Power required, Variation of Velocity and Acceleration in the Suction and Delivery Pipes due to Acceleration of the Piston, Effect of Variation of Velocity on Friction in the Suction and Delivery Pipes, Numerical. Centrifugal pumps: Working Principle and Characteristics Curves.
4. **Mechanical-Physical Separation Processes:** Classification, Filtration in Solid-Liquid Separation: Introduction, Types of filtration Equipments: Bed filters, Plate and frame filters, Leaf filters, Continuous rotary filters: Continuous rotary vacuum-drum filter, Continuous rotary disk filter, Continuous rotary horizontal filter, Filter Media and Filter Aids, Basic theory of filtration: Pressure drop of fluid through filter cake, Specific Cake Resistance. Filtration Equations for Constant-Pressure Filtration, Equations for washing of filter cakes and total cycle time, Equations for continuous filtration, Filtration equations for Constant-Rate Filtration and Numerical Examples. Settling and Sedimentation in particle-fluid separation: Theory of particle movement through a fluid-Derivation of basic equations for rigid spheres, Drag co-efficient for rigid and non rigid spheres. Sedimentation: Mechanisms of Sedimentation, Determination of settling velocity.
5. **Mechanical Operations:** Size Reduction: Criteria for Comminution, Energy and Power Requirements in Comminution, Efficiency, Crushing Laws and Work Index. Equipment for Size Reduction: Jaw Crusher, Gyratory Crusher, Roll Crushers, Hammer Mill Grinders, Revolving Grinding Mills. Sieve Analysis (Differential and Cumulative), and Numerical Examples.

Pre-requisite Courses: NONE

Reference Books:

1. "Transport Processes and Separation Process Principles", Christie John, Geankoplis, Prentice Hall of India, 4th Edition, 2003.

2. "UNIT - Operations of Chemical Engineering", McCabe, Smith, Harriott, Tata McGraw-Hill, Chemical Engineering Series, 6th Edition, 2010.
3. "A Text Book of Fluid Mechanics and Hydraulic Machines", Bansal R. K., Laxmi Publications, Ltd., 9th Edition, 2017.

UE17BT203: MICROBIOLOGY (4-0-0-0-4)

Course Objectives:

- The course is dedicated to gain knowledge of theoretical concepts and principles in microbiology and its applications.
- To understand the essence and importance of microbes in agriculture, environment, medicine and industry.
- To obtain hands on training with microbiological techniques and skills.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the basics and importance of microbiology.
- Apply the learnt concepts through research to solve problems pertaining to biological systems using micro-organisms as model organisms and through microbiological techniques.
- Investigate the applications of microbiology discipline and its impact on the other areas of biology, biotechnology and human welfare.

Course Content:

1. **Basics of Cell Structure:** Discovery of cell, The Cell theory. Ultrastructure of prokaryotic and eukaryotic Cell – (both plant and animal cell). Cell organelles and function: Nucleus, Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, vacuole and Cytoskeletal structures. Structure of biological membrane: Fluid mosaic model.

   Cellular Organization of Life: Cell cycle and cell Division: mitosis and meiosis. Cell Motility: Amoeboid, ciliary and flagellar movements. Special type of cells: nerve cells, blood cells, muscle cells. Over view of cancer biology.
2. **Introduction to Microbiology:** Definition, Scope, Major contributions of microbiologists. Structure and General Characteristics of Microorganisms: Bacteria, algae, Fungi, Protozoa. Microbial taxonomy: five kingdom and eight kingdom classifications, Bacterial diversity: morphological, structural, metabolic, ecological, behavioral, evolutionary and genetic diversities. phylogenetic classification and molecular approaches to bacterial taxonomy.
3. **Microbial Reproduction**: Bacterial reproduction - binary fission. Virology: Structure of viruses and their genetic system. Plant and animal viruses. Life cycle of a bacteriophage - Lytic and lysogenic cycles. Viroids and prions Reproduction in fungi (Yeast). Reproduction in algae (*Spirulina*). Reproduction in protozoans (*Paramecium*).

   Genetic recombination in Bacteria: Transformation, transduction and conjugation.
4. **Techniques in Microbiology:** Microscopy - Light microscope (bright field, dark field, phase contrast, fluorescence microscopes), electron microscopes (TEM and SEM). Sterilization: Different methods of sterilization. Biosafety levels. Pure culture techniques: composition of culture media, enrichment culture technique, Isolation of microbes from soil, air and water. Study of growth curve and factors affecting growth of microorganisms. Measurement of growth. Staining techniques: Principles of staining, Types of stains – simple stains, structural stains and differential stains. Enumeration by direct microscopic count, Pour plate technique, Streak plate. Characterization of bacteria by biochemical tests (IMViC).
5. **Medical Microbiology:** Common diseases caused by microbes. Bacterial diseases of man – Tetanus, Leprosy, Typhoid, Tuberculosis, Cholera. Viral diseases: Hepatitis, Polio. Fungal diseases: Candidiasis. Protozoan diseases: Malaria. (Etiology, transmission and symptoms of the disease).

   Biological Warfare: Weapons of mass destruction.

   Microbial Ecology: Interactions of microorganisms, rhizosphere and phylloplane microflora, mycorrhiza, air and water microflora. Biofertilizers and Bioremediation.

   Food and Industrial Microbiology: Food Microbiology: Microbial spoilage of food and its control, Food borne infections. Microbial Products: Single cell protein, antibiotics.

Pre-requisite Courses: NONE

Reference Books:

1. "Elements of Microbiology", Michael J., Pelczar Jr., Chan E. C. S., Tata McGraw Hill Publishing Co, Ltd, 5th Edition, 2004.
2. "Cell Biology", Powar C.B., Himalaya Publishing House, 2010.
3. "Microbiology", Prescott, Tata McGraw Hill Publication, 8th Edition, 2010.

UE17BT204: BIOCHEMISTRY: BIOMOLECULES (4-0-0-0-4)

Course Objectives:

- The course involves the study of the molecular composition of living cells and the organization of biological molecules within the cells.
- The course focuses on biological macromolecules like proteins, lipids, polysaccharides, and nucleic acids (DNA and RNA).
- The course will concentrate on the structures of these biomolecules, their functions, and the relationship between structure and function.
- The overall goal of this course is for the student to gain knowledge of biochemical concepts and techniques which will be necessary for future scientific endeavors.
- This course aims to develop the key skills required in scientific work which include practical research skills, analytical and presentation skills.

Course Outcomes:

At the end of the course, the student should be able to

- Identify the major types of biomolecules, their chemical characteristics and functions.
- Understand the role of water as a polar solvent and how the aqueous environment influences the behavior of biological macromolecules.
- Understand the role of biomolecules in causing disease, in diagnosis and treatment of disease.
- Develop practical research skills, analytical and presentation skills required in scientific work.

Course Content:

1. **Fundamentals of Biochemistry:** An Introduction to the science of Biochemistry, Biochemical unity underlies biological diversity, Non –covalent interactions-Hydrogen bonds, Vanderwaal's forces, Electrostatic & Hydrophobic interactions. Properties of water, pH and biological Buffers. Stereochemistry: Importance of stereochemistry, Geometric and Optical isomerism. Configuration and conformation, Chirality, Enantiomers, Diastereomers, D & L, and R & S notations. Keto – enol tautomerism, important functional groups in biochemistry, general types of reactions in biochemistry.
2. **Carbohydrates and Lipids:** Introduction, Sources, Classification into mono, di and polysaccharides. Classification of monosac-

charides based on number of C-atoms. Functional groups-Aldoses and Ketoses, Reactions of carbohydrates, Isomerism of carbohydrates, Fischer projections, Haworth structures, pyranose and furanose structures, Anomers, Epimers, Chair and boat conformations. Structure and functions of sugars, homo and heteropolysaccharides, glycoconjugates. Lipids - Introduction, sources, Nomenclature, Classification. Properties and Functions. Essential fatty acids, Eicosanoids, Prostaglandins, Compound lipids (phospholipids and glycolipids, their importance) Steroids: Structure of steroid nucleus, biological role of cholesterol, Amphiphatic nature of lipids and their importance.

3. **Amino acids and Proteins:** Introduction, Classification (protein and non-protein amino acids), Optical isomerism, chemical properties, acid-base properties-polyionic nature, zwitter ions, pKa, and pI. Peptide bond formation: Structure of protein (primary, secondary, tertiary and quaternary). Ramachandran Plot, Classification of proteins, determination of primary structure, sequencing strategies and n-terminal and c-terminal sequencing, automated sequenators. Properties of proteins, denaturation of proteins.
4. **Nucleic acids:** Purines and Pyrimidines: Structure of purine and pyrimidine bases, nucleosides, nucleotides, RNA & DNA (differences), base pairing schemes, Secondary structure of DNA, Watson and Crick model. Different types of DNA. *E-coli* DNA, Histones and its organization, Nucleosome structure, denaturation of DNA. types of RNA: mRNA, rRNA, and tRNA. Structure of RNA, catalytic RNA (ribozymes).
5. **Bioinorganic Chemistry:** Inorganic elements in biological systems, metalloenzymes, Metal complexes as oxygen carriers-hemoglobin and myoglobin, non-porphyrin oxygen carriers-hemeerythrin and hemocyanin, synthetic oxygen carriers, Metallothionenes. Electron transfer proteins-Ferredoxin, Iron-Sulfur clusters, cytochromes, chlorophyll, Biological nitrogen fixation. Metal complexes as drugs.

Pre-requisite Courses: NONE

Reference Books:

1. “Principles of Biochemistry”, Lehninger, Nelson, Cox, W H Freeman & Company, Fourth Edition, 2004.
2. “Biochemistry”, Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, W H Freeman & Company, Fifth Edition, 2002.
3. “Organic Chemistry”, Graham Solomons, Craig B. Frhyle, John Wiley and Sons, Eighth Edition, 2004.

UE17BT205: MICROBIOLOGY LABORATORY (0-0-2-0-1)

Course Objectives:

- The course is dedicated to gain knowledge of theoretical concepts and principles in microbiology and its applications.
- To understand the essence and importance of microbes in agriculture, environment, medicine and industry.
- To obtain hands on training with microbiological techniques and skills**.**

Course Outcomes:

At the end of the course, the student should be able to

- Understand the basics and importance of microbiology.

Experiments:

1. Preparation and sterilization of Culture Media for bacteria and fungi.
2. Isolation of microbes:
   (i) From soil and water by serial dilution and pure culture techniques and
   (ii) From air by plate exposure method.
3. Study of colony characteristics of microbes. Staining Techniques - Simple and Gram staining of bacteria.
4. Endospore staining and Fungal staining by LPCB.
5. Haemocytometry- Counting of cells from yeast suspensions.
6. Determination of size of yeast cells by micrometry.
7. Biochemical tests – IMViC, starch hydrolysis and catalase test.
8. Effect of Antibiotics on bacterial growth by paper disc method.
9. MPN test for analysis of quality of water.

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE17BT206: BIOCHEMISTRY: BIOMOLECULES LABORATORY (0-0-2-0-1)

Course Objectives:

- The overall goal of this course is for the student to gain knowledge of biochemical concepts and techniques which will be necessary for future scientific endeavours.
- This course aims to develop the key skills required in scientific work which include practical research skills, analytical and presentation skills.

Course Outcomes:

At the end of the course, the student should be able to

- Identify the major types of biomolecules, their chemical characteristics and functions.
- Understand the role of water as a polar solvent and how the aqueous environment influences the behaviour of biological macromolecules.
- Understand the role of biomolecules in causing disease, in diagnosis and treatment of disease.
- Develop practical research skills, analytical and presentation skills required in scientific work.

Experiments:

1. Laboratory safety methods
2. Preparation of Laboratory Solutions: Concentration, Expressions and Calculations
3. Preparation of buffers using Henderson – Hassel Balch equation and Measurement of pH using pH meter.
4. Measurement of chlorophyll content in leaf development
5. Qualitative tests for carbohydrates
6. Qualitative tests for lipids and sterols
7. Determination of iodine value of oils/lipids
8. Determination of saponification number
9. Qualitative tests of amino acids and proteins
10. Isolation of casein from milk by isoelectric precipitation

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU

UE17BT251: THERMODYNAMICS AND HEAT TRANSFER(3-0-2-0-4)

Course Objectives:

- Gain an understanding and apply the laws of thermodynamics to solve problems.
- Conceptual design for heat conduction problem.

- Solve problems related to heat conduction and convection.
- Differentiate between different types of heat exchangers.
- Understand radiation.

Course Outcomes:

At the end of the course, the student should be able to

- Differentiate between thermodynamics and heat transfer.
- Apply the three fundamental laws of thermodynamics and solve problems associated with it.
- Solve problems related to phase and chemical reaction equilibria.
- Distinguish conduction, convection and radiation problems and solve it.
- Identify different types of heat exchangers and solve problems associated with it.

Course Content:

1. **Thermodynamics – Zero and First Law:** Definitions & Fundamental Concepts, Equilibrium State and Phase Rule - Steady State, Equilibrium and Phase Rule, Temperature and Zeroth law of Thermodynamics, Heat Reservoirs and Heat Engines, Reversible and Irreversible Processes, First Law of Thermodynamics - First law of Thermodynamics for Cyclic Process, Internal Energy, First Law of Thermodynamics for Non Flow Process, Enthalpy, First Law of Thermodynamics for Flow Process, Heat Capacity, PVT Behaviour and Heat Effects, PVT Behaviour of Pure fluids, Equation of state and the concept of Ideal Gas, Processes involving Ideal Gases, Heat Effects accompanying Chemical Reactions, Effect of Temperature on Standard Heat of Reaction, Temperature of Reaction

   Second and Third Law of Thermodynamics: Second Law of Thermodynamics, Limitations of First Law of Thermodynamics, General statement of Second Law of Thermodynamics, Entropy, The Carnot Principle, Clausius Inequality, Mathematical Statement of the Second Law of Thermodynamics, Entropy and Irreversibility, Third Law of Thermodynamics, Classification of Thermodynamic Properties, Work Function, Gibbs Free Energy, Relationship among Thermodynamic Properties
2. **Phase and Chemical Reaction Equilibria:** Fugacity and Activity, Chemical Potential, Phase Equilibria, Chemical Reaction Equilibria, Reaction Stoichiometry, Criteria of Chemical Reaction Equilibrium, Equilibrium Constant, Equilibrium Constant and Standard Free Energy Change, Effect of Temperature on Equilibr4ium Constant, Effect of Pressure on Equilibrium Constant, Other factors affecting equilibrium constant, Phase Rule for Reacting Systems.
3. **Heat Transfer by Conduction:** Introduction to modes of Heat transfer, Mechanism of Heat transfer, Concepts of Thermal conductivity, Derivation of general conduction equation, flow of heat through a wall, flow of heat through composite wall, single and multilayered cylindrical pipe, single and multilayered spherical pipe, Insulation, Heat loss through the pipe and optimum thickness of insulation, unsteady state h eat transfer: Bodies with negligible internal temperature gradients.
4. **Convective Heat Transfer:** Natural convection- Significance of Grashof number, effect of natural convection in laminar heat flow; Forced convection: overall heat transfer coefficient, individual heat transfer coefficient, Resistance from overall coefficient, fouling factors, Concept of Thermal boundary layer, Heat transfer of forced convection by turbulent flow, empirical equations namely Dittus-Boelter equation, Sieder-Tata equation, Colburn equation, Correction factor for heating and cooling of fluids, significance of prandtl number, flow in non-circular cross sections , heat transfer in condensation of vapours.
5. **Radiation and Heat Transfer Equipments:** Types of Heat exchangers, overall heat transfer co efficient, Log mean temperature difference, heat transfer effectiveness – NTU method, fouling factors, Radiation heat transfer: Thermal radiation, radiation properties, Black body & Kirchhoff's law, radiation intensity, grey body, radiation heat exchange between two parallel infinite grey surfaces- radiation shield: radiation heat exchange between finite surfaces, shape factor for simple geometry, radiation heat exchange in two zone enclosures.

Pre-requisite Courses: NONE

Reference Books:

1. "Heat Transfer- Principles and Applications", Binay K Dutta, PHI, 8th Edition, 2009.
2. "Chemical Engineering Thermodynamics", Rao Y V C, University Press, 2003.
3. "Thermal Science – Essentials of Thermodynamics, Fluid Mechanics and Heat Transfer", Erian A. Baskharone, McGraw Hill Publications, 2012.
4. "Heat Transfer", S P Sukhatme, University Press, 4th Edition, 2008.

UE17BT252:
GENETICS AND MOLECULAR BIOLOGY (4-0-0-0-4)

Course Objectives:

- To discern the basic knowledge of classical genetics- principles of transmission of traits through genotypic changes and effect on phenotypes, by segregation of alleles and their dominance and recessive effects.
- To learn the fundamental concepts that govern a living cell- understanding the central dogma in molecular biology.
- To know the structure, function and formation of vital macromolecules such as nucleic acids and proteins.
- To know the ingenious mechanisms of mutations, transformations, recombination, transposition and oncogenesis.
- To make the student learn practical skills relevant to molecular biology which make them technically stronger.
- To make students understand and appreciate as to how the basic biological phenomena may be useful in applications.

Course Outcomes:

At the end of the course, the student should be able to

- Distinguish between various aspects of genetics and biological phenomena.
- Analyze biological phenomena through practical skills and techniques.
- Identify various components of genomes and protein from data and the student will be able to link. the importance of macromolecules (DNA and proteins) in association with diseases and drugs.

Course Content:

1. **Organization of Chromosomes:** Discovery, morphology and structural Organization: centromere, telomere, chromonema, euchromatin and heterochromatin. Ultra-structure: nucleosome model. Special types of chromosomes; Salivary gland and Lamp brush chromosomes.
2. **Inheritance of Characters:** Mendelian laws of inheritance. Monohybrid cross, dihybrid cross, laws of segregation, independent assortment, Gene interaction: Supplementary; Comb pattern in fowl; Complementary: Flower colour in sweet peas. Multiple alleles: Blood groups in human beings, coat colour in rabbits.

   Sex Determination, Linkage and Population Dynamics: Sex Determination in Plants and animals: Concepts of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types. Linkage and Crossing Over: coupling and repulsion hypothesis; Linkage in maize and Drosophila. Sex-linked disorders: Hemophilia, colour blindness and hypertrichosis. Introduction to Population genetics, Hardy Weinberg Law and its implications.

3. **Replication:** Central dogma; Definition of replication, features, pre-requisites, proteins required, mechanism in prokaryotes - initiation, elongation and termination, types - theta and rolling circle model, mechanism in eukaryotes - initiation, elongation and termination, replication of telomeres, inhibitors of replication.

   Transcription: Definition, differences between replication and transcription, proteins required mechanism in prokaryotes - initiation, elongation and termination, mechanism in eukaryotes - initiation, elongation and termination, post-transcriptional modifications, inhibitors of transcription.

4. **Translation (Protein Synthesis):** Genetic code features, overview of translation, amino acid activation, mechanism of protein synthesis in pro- and eukaryotes - initiation, elongation and termination events, translational inhibitors, post-translational modification of proteins, protein targeting in mitochondria and bacteria.

   Regulation of Gene Expression: Need for regulation, overview of levels of control, types of control – positive and negative, inducible and repressible types, mechanisms of control at transcription level - in prokaryotes - lac operon, lac mutations, trp operon, Differences in control of gene expression in eukaryotes, control at DNA level, control at transcription level - transcription factors and their domains, control at mRNA level, control at protein level with examples, Gene expression regulation mechanism - role of homeotic genes in pattern regulation in Drosophila.

   Genetic Recombination: Mechanism - Holliday model for homologous recombination, methods in bacteria - transformation, transduction - generalized and specialized, site specific recombination of bacteriophage Lambda, Conjugation.

   Mutations: Definition, classification, types of mutagens, mutagenesis, mechanisms of mutation by physical and chemical mutagens.

   DNA Damage and Repair: Definition, types and causes of damage, DNA Repair - types of repair - photoreactivation, alkyl transferases, recombination, mismatch, excision, and SOS.

5. **Transposition and Retro-transposition:** Definition, origin of transposable DNA elements, classification of transposons, mechanism of replicative and non-replicative transposition, consequence of transposition, mechanism of retrotransposition.

   Retroviruses: Introduction, genome organization in retroviruses, molecular mechanism of reverse transcription and integration.

   Oncogenesis: Terminologies, steps in oncogenesis - immortalization, transformation, metastasis, Tumor suppressor genes, Proto-oncogenes and oncogenes, classes of proteins involved in oncogenesis, mechanisms of activation of proto-oncogenes.

Pre-requisite Courses: NONE

Reference Books:

1. "Principles of Biochemistry", Lehninger, David Nelson and Michael M Cox, W H Freeman & Company, 6th Edition, 2013.
2. "Genetics", P K Gupta, Rastogi publications, 4th Edition, 2011.
3. "Genes IX", Lewin Benjamin, Jones and Bartlett Publishers, 9th Edition, 2006.
4. "Essentials of Molecular Biology", Malacinski, George M, David Freifelder, Narosa, Jones and Bartlett Publishers, 4th Edition, 2003.

UE17BT253: BIOCHEMISTRY: METABOLISM (4-0-0-0-4)

Course Objectives:

- To learn the basic concepts of bioenergetics and metabolism.
- How complex systems are governed by the concepts of bioenergetics and metabolism.
- To investigate and analyse biological systems through the concepts of bioenergetics and metabolism.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the metabolism of various macromolecules.
- Correlate the degradative metabolism of various macromolecules to diseases.

Course Content:

1. **Enzymes Classification, Function, Kinetics and Regulation** - Introduction to enzymes, Classification and nomenclature. Specificity of the enzyme action, Cofactors and coenzymes. Fundamentals of enzyme function: active site, activation energy and the reaction coordinate. Lock and Key Model and Induced Fit Hypothesis. Types of Catalytic mechanisms, Michaelis-Menten equation, Briggs Haldane equation, significance of kinetic parameters of K_m and V_{max} and K_{cat}. Analysis of Kinetics Data: Lineweaver Burke, Eadie Hofstee plots, Reversible inhibition, competitive inhibition, uncompetitive and noncompetitive inhibition and irreversible inhibition. Factors affecting enzyme activity (pH, ionic strength, temperature). Enzyme units: IU, katal, specific activity, Turn over number. Allosteric Enzymes, Cooperativity (Sigmoidal Kinetics), MWC and KNF models.
2. **Carbohydrate Metabolism:** Introduction to Metabolism - Catabolism, anabolism, catabolic, anabolic and amphibolic pathways, Metabolism-Compartmentalization, Aerobic and anaerobic pathways: Glycolysis and its regulation, Gluconeogenesis and its regulation.TCA cycle - Regulation, Glyoxylate cycle, amphibolic & anaplerotic reactions. Electron Transport chain, Oxidative phosphorylation, & production of ATP, balance sheet of glucose oxidation, Oxidative stress. Pentose phosphate pathway (HMP shunt) & its regulation, Glycogen metabolism.
3. **Lipid Metabolism:** Biodegradation of fatty acids, beta – oxidations of saturated & unsaturated fatty acids. Ketone bodies, production during starving and diabetes Biosynthesis of fatty acids – Acetyl-CoA carboxylase reaction, Fatty acid synthase complex, biosynthesis of palmitate, energetics, Regulation of fatty acid biosynthesis. Biosynthesis of triacylglycerols, Biosynthesis of cholesterol, regulation of cholesterol formation.
4. **Amino Acid Metabolism:** Overview of amino acid metabolism, fate of NH_4^+ and carbon skeleton. Digestion of proteins through human digestive system, Biodegradation of amino acids – deamination, transamination, decarboxylation, urea cycle including its regulation. Biosynthesis of amino acids, (oxaloacetate family-aspartic acid, asparagine, Methionine, Threonine and Lysine), Disorders of amino acid metabolism (phenylketonuria, alkaptonuria, maple syrup disease, albinism).
5. **Nucleic Acid Metabolism:** Biosynthesis of purines and pyrimidines –origin of ring atoms of Purines, formation of IMP, conversion of IMP to AMP and GMP, Regulation of purine biosynthesis. De novo synthesis of pyrimidine nucleotides, biosynthesis of UTP & CTP, Regulation of pyrimidine biosynthesis. Biodegradation of nucleotides - Production of uric acid and urea. Recycling of purine and pyrimidine nucleotides by salvage pathways. Lesch-Nyhan syndrome and Gout.

Pre-requisite Courses: NONE

Reference Books:

1. "Principles of Biochemistry", Nelson and Cox, W H Freeman & Company, 4th Edition, 2004.
2. "Biochemistry", Pankaja Naik, JP Brothers, 2nd Edition, 2007.
3. "Biochemistry", Satyanarayana U., Chakrapani U., Uppala Author Publishers, 3rd Edition, 2006.

UE17BT254: MASS TRANSFER (4-0-0-0-4)

Course Objectives:

- Learn the principles of liquid – solid, solid- gas, liquid -liquid mass transfer operations.
- To solve problems for liquid – liquid mass transfer operations.
- To differentiate between solid – fluid mass transfer operations.
- To understand and solve problems associated with solid – fluid separation process.

Course Outcomes:

At the end of the course, the student should be able to

- Differentiate the different principles involved in mass transfer operations.
- Solve problems with respect to liquid – liquid, liquid – solid mass transfer operations.
- Design liquid – liquid, liquid – solid mass transfer operations.

Course Content:

1. **Molecular Diffusion in Fluids:** Introduction to Fick's law, Molecular diffusion in gases, Steady state diffusion of A through non-diffusing B, Steady state equimolar counter diffusion, Steady state diffusion in multi component mixture, diffusivity of gases, molecular diffusion for liquids, diffusivity in liquids, application of molecular diffusion, introduction to mass transfer coefficient, mass transfer in laminar flow and turbulent flow, film heat, mass and momentum transfer analogies, Related problems.
2. **Liquid-Liquid Extraction and Leaching:** Introduction, Liquid Equilibria, Choice of Solvent, concept of Equilateral-Triangular Coordinates, Systems of Three Liquids – One Pair Partially Soluble Systems of Three Liquids – Two Pairs Partially Soluble Systems, Stage wise Contact – Single Stage Extraction, Continuous Countercurrent Multistage Extraction, operation of extraction equipment's like rotating disc contactor, packed extraction towers. Leaching Introduction to solid-liquid extraction: Single stage leaching and its equipment's.
3. **Distillation**: Introduction, Vapor-Liquid Equilibria, Pressure-Temperature-Concentration Diagram, Constant Pressure Equilibria concept of relative volatility, Raoult's law, henrys law, azeotropes: Positive Deviations from Ideality, Minimum-boiling mixtures azeotropes Negative Deviations from Ideality, Maximum-boiling mixtures azeotropes, Single Stage Operation – Flash Vaporization, Differential or Simple Distillation steam distillation, derivation of Rayleigh's equation, Continuous Rectification – Binary Systems, Fractionation Operation, Overall Enthalpy Balances, Multistage Tray Towers – Method of McCabe and Thiele method, problems on of McCabe and Thiele method and differential distillation, equipment's for multistage distillation-plate and packed column.
4. **Adsorption and Drying:** Adsorption: Introduction, types of adsorption namely physical and chemical adsorption, adsorption equilibria, adsorption hysteresis curve, effect of temperature, adsorption of solute from dilute solution, Freundlich equation, application of Freundlich equation, Introduction to single stage operation, Related Problems. Drying: Introduction to drying. Concept of moisture content, equilibrium moisture, bound moisture, unbound moisture, free moisture, Drying rate curve, derivation for time of drying curve, Drying equipment operations like rotary dryer, spray dryer, vacuum dryer, fluidized bed dryer.
5. **Evaporation**: Evaporation: Introduction, types of evaporation equipment's & operation methods, overall heat transfer co efficient in evaporators, calculation methods for single effect evaporators, condensers for evaporators, evaporation of biological materials, related problems.

Pre-requisite Courses: NONE

Reference Books:

1. "Principles of Mass Transfer and Separation Processes", Binay K Dutta, PHI Publications, 5th Edition, 2012.
2. "Transport processes and Unit operations", Christie J Geankoplis, PHI Publications, 4th Edition, 2003.

UE17BT255: GENETICS AND MOLECULAR BIOLOGY LABORATORY (0-0-2-0-1)

Course Objectives:

- To provide hands on training in Molecular Biology techniques.
- To impart knowledge on how to connect concept and experiment and applications of Molecular Biology techniques.

Course Outcomes:

At the end of the course, the student should be able to

- Apply the techniques of Molecular Biology to project work related to this area.
- Analyze the merits and demerits of techniques and work towards open ended solutions.

Experiments:

1. Study of polytene chromosomes
2. Isolation of genomic DNA and its quantification
3. Isolation of plasmid DNA
4. Separation of DNA fragments by agarose gel electrophoresis
5. RNA isolation and analysis
6. Restriction digestion of DNA
7. Transformation of *E. coli* cells with foreign DNA
8. Separation of proteins by Sodium Dodecyl Sulphate-Polyacrylamide Gel Electrophoresis (SDS-PAGE)
9. Amplification of DNA by Polymerase Chain Reaction (PCR)
10. RAPD analysis

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE17BT256: BIOCHEMISTRY: METABOLISM LABORATORY (0-0-2-0-1)

Course Objectives:

- To learn the basic concepts of bioenergetics and metabolism.
- How complex systems are governed by the concepts of bioenergetics and metabolism.
- To investigate and analyze biological systems through the concepts of bioenergetics and metabolism.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the metabolism of various macromolecules.
- Correlate the degradative metabolism of various macromolecules to diseases.

Course Content:

1. Estimation of protein by Lowry's method.
2. Determination of specific activity of alpha-amylase.
3. Effect of substrate and inhibitor concentration on enzyme activity.
4. Estimation of Glucose by ortho-toluidine method.
5. Estimation of Urea by Diacetyl Monoxime Method.
6. Estimation of Creatinine by Alkaline picrate method.
7. Estimation of Cholesterol by Zak's method.
8. Estimation of DNA by DPA Method.
9. Estimation of RNA by Orcinol Method.
10. Thermal denaturation of DNA.

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE16BT301:
BIOPROCESS REACTION ENGINEERING (3-0-2-0-4)

Course Objectives:

- Gain an understanding of basic reaction kinetics.
- Interpret reactor data.
- Understand different types of reactors.
- Design reactors for a single reaction and for biochemical reaction systems.
- Understand non-ideal reactors.

Course Outcomes:

At the end of the course, the student should be able to

- Develop fundamental knowledge about bioprocess reaction engineering.
- Design reactors suitable for both chemical as well as biological reactions through engineering knowledge.
- Relate theory with that of design and experiment.
- Use mathematics, chemistry, physics and biology along with analytical and logical reasoning to analyse and solve complex problems.
- Present through oral communication, graphical presentation and written communication and work independently as well as part of a team.

Course Content:

1. **Overview of Chemical Reactions:** Classification of reactions, Variables affecting the rate of reaction, Definition of reaction rate. Simple reactor types, the rate equation, concentration dependent term of a rate equation – single and multiple reactions, elementary and non-elementary reactions, molecularity and order of reaction, rate constant k, representation of elementary reaction, representation of non-elementary reactions, Temperature dependent term of a rate equation – Temperature dependency from Arrhenius' law, Comparison of theories with Arrhenius' law, Activation Energy and Temperature dependency.
2. **Interpretation of Batch Reactor Data:** Constant Volume Batch Reactor, Integral Method of Analysis of Data – General Procedure, Irreversible unimolecular-type first-order reactions, Irreversible bimolecular-type second-order reactions, Irreversible trimolecular-type third-order reactions, empirical rate equations of nth order, Zero order reactions, Overall order of irreversible reactions from Half Life, Fractional Life method, Irreversible reactions in parallel, Irreversible reactions in series, First order reversible reactions, Second order reversible reactions, Differential Method of Analysis of Data, Variable Volume Batch Reactor – Differential method of analysis, integral method of analysis, Zero order reactions, First order reactions, Second order reactions, nth order and other reactions.
3. **Introduction to Reactor Design:** Ideal Reactors for a Single Reaction: Ideal Batch Reactor, Space Time and Space Velocity, Steady State Mixed Flow Reactor, Steady State Plug Flow Reactor, Holding time and Space time for Flow Reactors. Design for Single Reactions: Size Comparison of single reactors – Batch Reactor, Mixed versus Plug Flow reactors (First and Second Order Reactions), Variation of Reactant Ratio for Second Order Reactions, General Graphical Comparison, Multiple Reactor Systems – Plug flow reactors in series and/or in parallel, Equal Size Mixed Flow Reactor in Series – First Order Reactions, Second Order Reactions, Mixed Flow Reactors of Different Sizes in Series – Finding the Conversion in a given system, Determining the Best System for a Given Conversion.
4. **Basics of Non-Ideal Flow:** The Residence Time Distribution (RTD), Role of RTD in mixing in determining of reactor behaviour, E – The age of distribution of fluid, the RTD, Experimental Methods (Nonchemical) for finding E, The Pulse Experiment, The Step Experiment, Relationship between F and E Curves.
5. **Biochemical Reactions:** Microbial Fermentation, Constant Environment Fermentation, Batch Fermenter, Mixed Flow Fermenter, Product Distribution and Fractional Yields, Kinetic expressions – Availability of Food, Effect of harmful wastes, General kinetic expression. Substrate limiting microbial fermentation – Batch and Plug flow fermenters, Finding Monod constants from batch experiment, Mixed flow fermenters – No cells in feed stream, Feed stream containing cells, Optimum operation of fermenters, Product limiting microbial fermentation – Batch and Plug flow fermenters (n=1), mixed flow fermenters (n=1), Fermentation with n not equal to 1 (Poison limiting jkinetics)

Pre-requisite Courses: NONE

Reference Books:

1. "Chemical Reaction Engineering", Octave Levenspeil, John Wiley & Sons, 3rd Edition, 1999.

UE16BT302:
GENETIC ENGINEERING & APPLICATIONS (4-0-0-0-4)

Course Objectives:

- Obtain knowledge and define the basic concepts of genetic engineering.
- Understand the various techniques employed in the field.
- Comprehend the transition from classical genetics to modern genetic engineering.
- Apply the knowledge while using microorganisms, plants and animals for gene expression and cloning.
- Formulate products from biological agents which can be used at an industrial level.

Course Outcomes:

At the end of the course, the student should be able to

- Translate the basic knowledge of genetic engineering to gene transfer techniques.
- Apply the properties of various microbes, plants and animals in gene manipulation instrumentation.
- Analyze the best technique according to ethics to be applied for production of desired genetic product.

Course Content:

1. **Gene Cloning:** Definition, scope and objectives of subject. Components for gene expression. Genetic elements that control expression of genes- promoters (prokaryotic & eukaryotic), strong and weak promoters, proximal promoter elements, operators, enhancers, transcription factors, choice of start and terminator sequences, factors influencing translational efficiency: RB sites, SD sequences, codon bias. Concept of gene cloning. Definition, steps in creating a recombinant DNA.
2. **Tools in Genetic Engineering:** Vectors. Definition of vector DNA, essential features of vectors, types of cloning vectors – for bacteria - plasmids, bacteriophages, cosmids, phagemids; for yeats – yEPs, yIPs, yRPs, YACs; for animal cells - viruses; for plant cells – Ti and Ri plasmids; basic structure, construction and methods by which these vectors are used. Expression vectors – purpose and construction.

   Enzymes: Nucleases – exo- and endonucleases - DNases, restriction endonucleases; RNases. Polymerases – DNA polymerases, reverse transcriptase, RNA polymerase. Ligases – *E.coli* and T4 DNA ligase. Modifying enzymes – alkaline phosphatase, polynucleotide kinase, terminal deoxyribonucleotidyl.
3. **Isolation and Purification of Nucleic Acids:** viral, prokaryotic and eukaryotic DNA and RNA. Staining and quantification of nucleic acids.

   Techniques: Genetransfer Techniques-physical – electroporation, microprojectile, microinjection; chemical – calcium chloride, calcium phosphate mediated delivery, lipofection. Construction of genomic and cDNA libraries. Methods to detect gene/gene product of interest – direct selection, detection by nucleic acid hybridization – colony and plaque hybridization, immune screening, Southern blotting, Northern blotting, Western blotting, Southwestern blotting. In vitro amplification of DNA by polymerase chain reaction (PCR) – principle, applications and variants of PCR technique. In vitro mutagenesis – M13 mediated, PCR mediated. Sequencing of DNA – Sanger's method. Chemical synthesis of DNA. Gene mapping techniques.
4. **Recombinant Microorganisms:** Production of insulin, growth hormone, tissue plasminogen activator, humanized antibodies, monoclonal antibodies, streptokinase, restriction endonucleases.

   Genetic Engineering of Plants: Resistance to - herbicide, pest, stress, frost. Improvement of nutritional quality – essential amino acids (lysine). enhancing sweetness. delayed ripening. Nutraceuticals. Edible vaccines. Plantibodies.

   Transgenic Animals: Mice, cattle, fish. Dolly. Gene therapy – principle, types and applications, stem cells and gene therapy.
5. **Principles of Genomics:** introduction to genomes –mutation and evolution, polymorphism, genome analysis, applications of genomics. Genomics - Genome projects: major genome sequencing projects *E.coli*, *Saccharomyces*, *Arabidopsis*, Human, *Drosophila.* Structural and functional genomics – Basic principles. Bioethics.

Pre-requisite Courses: NONE

Reference Books:

1. "Genetic Engineering", Smita Rastogi and Neelam Pathak, Oxford University Press, 2009.
2. "Gene Cloning & DNA Analysis - An Introduction", Brown T A, Blackwell Science, 5th Edition, 2006.
3. "Molecular Biotechnology: Principles and Applications of Recombinant DNA", Glick, B R, Pasternak. J J, DC ASM Press, 3rd Edition, 2003.

UE16BT303:
BIOINFORMATICS (4-0-0-0-4)

Course Objectives:

- Understand sequencing, the uses of sequencing and Biological resources/ databases.
- Apply online resources and databases to gain access to sequence data and literature information.
- Analyse the major strategies for functional genomics.
- Interpret sequence analysis and similarity search.
- Describe the key concepts for molecular evolution and molecular phylogeny.
- Understand the main approaches to protein structure bioinformatics analysis.

Course Outcomes:

At the end of the course, the student should be able to

- Use bioinformatics tools to search, retrieve and analyze information on literature, sequence and structure relating to nucleic acids and proteins.
- Acquire skills and knowledge necessary to answer biological problems.
- Solve problems using modern bioinformatics tools.

Course Content:

1. **Introduction and Databases:** Aim, scope and role of Bioinformatics in Biotechnology; DNA sequencing, Genomic sequencing, introduction to Next Generation sequencing (NGS), Sequencing cDNA libraries of expressed genes, Submission of sequences to the databases, Sequence accuracy, Computer storage of sequences, Sequence formats, Biological Databases; Information retrieval from Biological Databases.
2. **Sequence Alignment and Scoring Matrices:** Introduction on sequence alignment, Global alignment, Local alignment, Significance of sequence alignment, Dot matrix sequence comparison, Dynamic programming algorithm for sequence alignment, Use of scoring matrices and gap penalties in sequence alignments.
3. **Sequence Analysis and Similarity Search:** Uses of multiple sequence alignments, Scoring multiple sequence alignments, Methods of multiple sequence alignment- progressive and iterative, Hidden Markov models of multiple sequence alignment, Profile analysis, Block analysis, Pattern searching, Motif analysis, Position-specific scoring matrices. Database similarity search, Scoring matrices for similarity searches, FASTA, BLAST.
4. **Phylogeny and Gene Prediction:** Relationship of phylogenetic analysis to sequence alignment, Concept of evolutionary trees, Methods for phylogenetic tree construction, Reliability of phylogenetic predictions. Gene and Promoter prediction, Categories of Gene Prediction Programs, Gene Prediction in Prokaryotes and Eukaryotes, Promoter and Regulatory Element Prediction in Prokaryotes and Eukaryotes, Prediction Algorithms.
5. **Protein Structural Bioinformatics:** Protein Structure Basics, Protein Structure Visualization, Comparison, and Classification, Protein Secondary Structure Prediction, Protein Tertiary Structure Prediction, Protein structure validation.

Pre-requisite Courses: NONE

Reference Books:

1. "Bioinformatics - Sequence and Genome Analysis", David W Mount, Cold Spring Harbor Laboratory, Second Edition, 2004.
2. "Essential Bioinformatics", Jin Xiong, Cambridge University press, First Edition, 2006.
3. "Bioinformatics - A practical Guide to the Analysis of Genes and Proteins", Andreas D, Baxevanis and Francis B.F. Quellette, A John Wiley and Sons, Third Edition, 2005.

UE16BT304: GENETIC ENGINEERING AND APPLICATIONS LABORATORY (0-0-2-0-1)

Course Objectives:

- To provide hands on training in Molecular Biology and Genetic Engineering techniques.
- To impart knowledge on how to connect concept and experiment and applications of Molecular Biology techniques.

Course Outcomes:

At the end of the course, the student should be able to

- Apply the techniques of Genetic engineering and Molecular Biology to project work related to this area.
- Analyze the merits and demerits of techniques and work towards open ended solutions.

Experiments:

1. Isolation of genomic DNA and its quantification
2. Isolation of plasmid DNA
3. Separation of DNA fragments by agarose gel electrophoresis
4. RNA isolation and analysis
5. Restriction digestion of DNA
6. Transformation of E. coli cells with foreign DNA
7. Separation of proteins by Sodium Dodecyl Sulphate-Polyacrylamide Gel Electrophoresis (SDS-PAGE)
8. Amplification of DNA by Polymerase Chain Reaction (PCR)
9. RAPD analysis
10. Tools for primer and probe designing

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE16BT305: BIOINFORMATICS LABORATORY (0-0-2-0-1)

Course Objectives:

- Understand sequencing, the uses of sequencing and Biological resources/ databases.
- Apply online resources and databases to gain access to sequence data and literature information.
- Analyse the major strategies for functional genomics.

Course Outcomes:

At the end of the course, the student should be able to

- Use bioinformatics tools to search, retrieve and analyze information on literature, sequence and structure relating to nucleic acids and proteins.
- Acquire skills and knowledge necessary to answer biological problems.
- Solve problems using modern bioinformatics tools.

Experiments:

1. Literature search using Pubmed.
2. DNA sequence retrieval from databases and Gene Prediction.
3. Primer Design - factors affecting primer design and Restriction mapping.
4. Protein sequence retrieval and Sequence similarity search (BLAST) – Analysis of parameters affecting alignment.
5. Sequence similarity search (FASTA) – Analysis of parameters affecting alignment.
6. Pair wise and Multiple sequence alignment – Analysis of parameters affecting alignment.
7. Phylogenetic analysis – Identification of orthologs/ paralogs and Pattern elucidation in Proteins using PROSITE.
8. PDB Structure retrieval, Visualization and analysis of Protein Ligand interactions.
9. Secondary structure prediction of proteins, Homology modeling and validation of modeled protein.
10. Structure prediction by threading and Superposition Superposition of structures – Calculation of RMSD and analysis.

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE16BT311: STRUCTURAL BIOLOGY (4-0-0-0-4)

Course Objectives

- To extend the student's knowledge gained from Biochemistry and molecular biology to better understand the principle themes of biomolecular principles and functions.
- To give a comprehensive view of structure-function relationships of biological membranes.
- To apply principles of biophysical techniques in elucidating the structure of biomolecules.

Course Outcomes

- Understand the secondary and tertiary forms of proteins/DNA/ RNA
- Link the structure and functional aspects of biological membranes.
- Explore and apply biophysical techniques to determine structures

Course Content:

1. **Introduction to Structural Biology:** Protein Structure and Folding: Importance of structural biology, Discussion of amino acids. Side chains and their interactions. Protein backbone, side chain conformations, Ramachandran plot. Secondary structure: Helix (α, 310, π helices), Beta structures: parallel and antiparallel sheets. Super secondary structures (β bulges, loops and turns). Protein tertiary structures: stabilizing interactions – hydrogen bonding, disulphide bonds, salt bridges, hydrophobic interactions. Denaturing agents, Anfinsen's experiment, Levinthal's paradox. Stages of protein folding, general features and thermodynamic aspects of protein folding. Spontaneous and assisted protein folding, proline cis-trans isomerases, protein disulphide isomerases, molecular chaperones. Protein misfolding and its implications. Proteasomes.
2. **Structure of Nucleic Acids:** General characteristics of nucleic acid structure. Glycosidic bond, Geometries, rotational isomers and ribose puckering. DNA secondary structures: A, B and Z. Properties of circular DNA, Polymorphism and flexibility of DNA, base stacking, Tertiary structure of nucleic acids. Intra-molecular interactions in the double helix. Thermodynamics of melting of double helix. Interaction with small ions, Tertiary structure of tRNA. Structural motifs of RNA: GNRA tetra loop, internal loops, bulges and junctions.
3. **Structure of Bio-membranes:** Structure and composition of membranes. General and conformational properties of cell membranes: micelle, bilayer and liposomes, membrane dynamics, flippases, membrane fusion. Lipid packing and spontaneous curvature. Role of lipids in membrane fusion, lipid domains and rafts in membrane.
4. **Functions of Membranes:** Membrane transport: Passive transport: Diffusion and osmosis, Active transport: Primary

and secondary. ABC transporters, lactose transporter and glucose transporter, aquaporins and ionophores. Ion channels: ligand gated and voltage gated. Membrane potential and action potential. Overview of Signal transduction, G protein coupled receptor.

5. **Analytical Methods: Spectroscopy:** UV-Visible spectrophotometry, Fluorescence spectroscopy, Infrared spectroscopy, Atomic absorption spectroscopy, Flame photometry, Nephelometry, Raman spectroscopy. Biomolecular structure elucidation: X-ray crystallography, NMR, Circular Dichroism and Mass spectroscopy.

Pre-requisite Courses: NONE

Reference Books:

1. "Text book of Structural Biology", Anders Liljas, Lars Liljas, Jure Piskur, Göran Lindblom, Poul Nissen and Morten Kjeldgaard, World Scientific Publications, 2nd Edition, 2009.
2. Lehninger "Principles of Biochemistry", David Nelson and Michael M Cox, W.H. Freeman& company, 6th Edition, 2013.
3. "Biophysical Chemistry: Principles and Techniques", Upadhyay, Upadhyay & Nath, Himalaya Publishing House, Reviewed Edition, 2009.
4. "Methods in Modern Biophysics", Bengt Nolting, Springer, Third Edition, 2009.
5. "Principles and Techniques of Biochemistry and Molecular Biology", Keith Wilson & John Walker, Cambridge University Press, Seventh Edition, 2010.

UE16BT312:
DAIRY BIOTECHNOLOGY (4-0-0-0-4)

Course Objectives:

- To understand the biological components of a dairy industry.
- To obtain knowledge of requirements and various products of a dairy industry.
- To learn modification of microbes and preservations techniques to produce better dairy products.

Course Outcomes:

At the end of the course, the student should be able to

- Apply concepts and knowledge for production of dairy products on a large scale.
- Evaluate methods for various dairy products using modified microbes and enzymes.
- Design low-fat and low-calorie dairy products by modifying traditional methods.

Course Content:

1. **Scope and significance:** Development and impact of biotechnology on food and dairy industry. Microbial rennet and recombinant chymosin, characteristics and application in cheese making; exogenous free and microencapsulated enzymes, immobilized enzymes-their application in accelerated ripening of cheese; enzymatically modified cheeses (EMC) their utilization in various food formulations.
2. **Advanced technologies used in Dairy industry:** Technological requirements of modified micro-organisms for production of cheese and fermented milk products; technological innovations in the development of functional dairy foods with improved nutritional therapeutic and pro-biotic attributes; physiologically active bio-peptides/ nutraceuticals; protein hydrolysates – their physicochemical, therapeutic properties, production and application in food formulations; production of bio-yoghurt, pro-biotic cheese and fermented milks; bifidus factors in infant food formulations.
3. **Application of Enzymes in dairy:** Protein hydrolysates-production, their physicochemical, therapeutic properties, de-bittering and application in food formulations; Enzymatic hydrolysis of lactose for preparation of whey and UF-permeate beverages.
4. **Microbial formulations:** Microbial polysaccharides their properties and applications in foods, production of alcoholic beverages and industrial products from starch; whey and other by-products; bio-sweeteners-types properties and their applications in dairy and food industry.
5. **Processing and preservation:** Bio-preservatives- characteristics and their application in enhancing the shelf life of dairy and food products. Process schedule of heat-desiccated, coagulated and fermented traditional dairy products; process improvement in production of milk sweets. New products based on fruits, vegetables and cereals; application of membrane technology; microwave heating for industrial production of traditional dairy products. Advances in industrial production of ghee, flavour and texture simulation.

Pre-requisite Courses: NONE

Reference Books:

1. "Biotechnology-Theory and Techniques", Chirikjian J. G., Jones and Bartlett Publishers, 1995
2. "Food Science and Food Biotechnology", Gutierrez-Lopez G. F., Barbosa-Conovas G. V., CRC Press, 2003.

UE16BT313:
RENEWABLE ENERGY RESOURCES (4-0-0-0-4)

Course Objectives:

- To describe the principles of renewable energy production from various renewable sources.
- To distinguish between the fossil energy sources and sustainable energy sources.
- To apply the knowledge of solar and wind energy principles to evaluate the performance of energy conversion systems for maximum efficiency.

Course Outcomes:

At the end of the course, the student should be able to

- List and explain the important sources of energy and their key applications.
- Describe the challenges and problems associated with the use of various energy sources.
- Discuss how to utilize local energy resources (renewable and non-renewable) to achieve the sustainable energy system.

Course Content:

1. **An introduction to energy sources:** Energy consumption as a measure of prosperity, world energy futures, brief discussion of conventional energy sources and their availability, non-conventional energy sources. Comparison between conventional and Non-conventional methods, Applications of Non–conventional energy.
2. **Solar energy:** Solar constants, solar radiation earth's surface, solar radiation geometry, solar radiation measurements. Relevant problems on design and analysis.

   Solar energy collectors: Physical principles of conversion of solar radiation into heat – flat plate Collectors, advantages of flat plate collectors, applications, concentration collectors, focusing type, advantages & disadvantages of concentrating type collectors over flat plate collectors.
3. **Solar energy storage:** Requirement of solar energy storage system, solar pond, solar thermal power production. Application

of solar energy: Solar water heating, space heating, brief discussion of Solar electric power generation, photo voltaic system for power generation, applications of solar photo voltaic systems, advantages & disadvantages, solar distillation, solar furnace, solar cooking, solar green house. Relevant problems on design and analysis.

4. **Wind energy:** Basic principles of wind energy conversion, Nature of wind, power in the wind, maximum power wind energy conversion, site selection consideration, basic concepts of WECS, Classification of WECS, advantages & disadvantages of WECS. Application of wind energy. Environmental Aspects, Recent applications and development, relevant problems on design and analysis.
5. **Energy from Bio-mass:** Bio-mass as a renewable source of energy, different types of bio-mass fuels, gas–liquid-solid, bio-mass conversion technologies, Wet-process-dry process, Photosynthesis, Bio-gas generation, factors affecting Bio-digestion, classification of bio-gas plants, continuous & batch types, fixed drum types, & flogging drum types, advantages & disadvantages, Janatha model: KVIC type, gasification of biogas and different types of gasifier. Relevant problems on design and analysis.

Pre-requisite Courses: NONE

Reference books:

1. "Fundamentals of Renewable Energy Resources and Technology", Sanjay Kumar, Kalyani Publishers, 2015.
2. "Renewable Energy Resources", John Twidell, Tony Weir, Routledge, Second edition, 2005.

UE16BT314:
MICROARRAY TECHNOLOGY (4-0-0-0-4)

Course Objectives:

- To provide the students fundamental concepts in micro array technology.
- To enable them to apply these concepts in research.

Course Outcomes:

At the end of the course, the student should be able to

- Analyze gene expression data.

Course Content:

1. **Basics of Microarray:** Introduction to Microarray, Principles for microarray analysis, Nomenclature for microarrays-probe labeling, hybridization, scanning and data analysis, Applications of microarray.
2. **Manufacturing of Microarray slides:** Oligonucleotides as genetic content-printed oligonucleotide arrays, design of oligonucleotides. DNA fragments as genetic contents-sources, preparation, desired properties. preparing RNA samples for microarray analysis. Production methods-oligosynthesis, deposition, spotting methods, slide surface chemistries, critical success factors. Fluorescent labels in microarray.
3. **Labelling for gene expression analysis:** Requirement of Labelling methods, Labelling strategies, Labelling in first strand synthesis, cDNA post labelling, Labelling with RNA amplification, Random prime labelling of DNA, Direct chemical labelling of mRNA. Purification and characterization of labelled probes.
4. **Microarray Hybridization and Fluorescent imaging system:** Microarray hybridization process-Prehybridization, Hybridization-coverslip method, hybridization buffer, probe blocking, probe concentration, hybridization chambers, post hybridization washes. Fluorescent imaging system, scanner system, signal detection and amplification-guidelines for fluorochromes and filters.
5. **Microarray Data Analysis:** Data analysis pipeline, Experimental design, Data pre-processing, Normalization, finding differentially expressed genes, Cluster analysis, Tools and data management. Quality control measures for microarray analysis, Troubleshooting microarray experiments.

Pre-requisite Courses: NONE

Reference Books:

1. "The Microarray Handbook", Amersham Biosciences, 2002.
2. "DNA Microarray Data Analysis", Jarno Tuimala, M.Mina Laine , CSC-Scientific Computing Ltd, 2003

UE16BT315:
BIOANALYTICAL INSTRUMENTATION (4-0-0-0-4)

Course Objectives:

- The course deals with detection and qualitative & quantitative measurement of chemical compounds.
- The course will provide a comprehensive understanding of various techniques used in the analysis of compounds.
- This course aims to develop the key skills required in scientific work which include practical research skills, analytical and presentation skills.

Course Outcomes:

At the end of the course, the student should be able to

- Identify different techniques used both for qualitative analysis and quantification of compounds
- Apply terms relevant to the process of measuring chemical compounds
- Apply techniques for separation and purification of complex mixtures
- Develop practical research skills, analytical and presentation skills required in scientific work

Course Content:

1. **Techniques of biochemical investigations:** Organism studies, organ perfusion, tissue techniques. Sample preparation: Tissue homogenization, sonication. Centrifugation techniques: Introduction, basic principles of sedimentation, preparative centrifugation, analytical centrifugation. Lyophilization.
2. **Chromatographic techniques:** Fundamental principles of chromatography, Paper chromatography, thin-layer chromatography, high performance thin-layer chromatography, adsorption chromatography, gel filtration, ion exchange chromatography, affinity chromatography and High-pressure liquid chromatography**.** Gas chromatography
3. **Spectroscopic techniques:** Introduction, Principles and applications of Spectroscopy, UV-Visible absorption Spectroscopy, Fluorescence Spectroscopy, Flame Photometry, Nephelometry and Atomic Absorption Spectroscopy. Circular dichroism spectroscopy.
4. **Microscopy and Electrophoresis:**

   Microscopy: Light microscope: bright field and dark field microscopy, phase contrast microscopy. Electron microscopy: TEM and SEM.

   Principles of Electrophoresis, Types of Electrophoresis, Paper and gel electrophoresis (PAGE and SDS PAGE), Immunoelectrophoresis, Isoelectric focussing, two-dimensional electrophoresis, capillary electrophoresis, Pulsed field gel electrophoresis.
5. **Spectroscopic techniques for structure and interaction studies:** Infrared and Raman Spectroscopy, NMR spectroscopy, Surface plasmon resonance, Electron paramagnetic resonance, X-Ray crystallography, Circular Dichroism, Mass spectroscopy.

Pre-requisite Courses: NONE

Reference Books:

1. "Methods of Biochemical Analysis: Bioanalytical Instrumentation", Clarence H. Suelter (Editor). Wiley-Blackwell, 1994.
2. "Principles and Techniques of Biochemistry and Molecular Biology", Keith Wilson (Editor), John Walker (Editor), Cambridge University Press, Seventh Edition, 2010.

UE16BT316: CLINICAL BIOCHEMISTRY (4-0-0-0-4)

Course Objectives:

- The course deals with metabolic pathways for carbohydrates, amino acids and lipids and their alterations in disorders.
- The course will provide insight into the clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal disorders.

Course Outcomes:

At the end of the course, the student should be able to

- Identify the biochemical aspects and pathophysiology associated with various disorders of metabolism and inborn errors of metabolism.
- Co relate and assess the clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions.
- Distinguish between the metabolic pathways for carbohydrates, amino acids and lipids.
- Identify the medical problems associated with abnormal levels of metabolites and therapeutic agents used to treat disorders.

Course Content:

1. **Hematology and Hematology disorders**: Blood composition: Blood cells, serum and plasmacontent. Different types of anemias-nutritional and sickle cell anemia. Complete blood count(CBC). Total and differential and platelet counts and their clinical significance. Blood groups, blood group substances, Rhesus factor, nature of blood group antigens and rare blood groups. Hospital-laboratory method of blood grouping and Rh typing. Erythrocyte sedimentation rate (ESR) determination and its importance in the diagnosis of certain diseases.
2. **Enzymes of clinical and diagnostic importance:** Use of enzymes in the diagnosis and monitoring of myocardial infarction, liver diseases and pancreatic diseases. Normal and abnormal serum values of the enzymes and their significance, acid and alkaline phosphatase, SGOT, SGPT, α-amylase, LDH, creatine kinase, troponin T.
3. **Disorders of metabolism:**

   Disorders of Carbohydrate metabolism: Diabetes- aetiology, classification, management, laboratory investigations. GTT, GlycatedHb, Diabetic complications, inborn errors of carbohydrate metabolism -Glycogen storage diseases, Galactosemia, Lactose intolerance, Pentosuria. **Disorders of Lipid metabolism**- Plasma lipoproteins and their functions, Hyperlipoproteinaemia- classification, Primary and secondary, Hypercholesterolemia, Ketosis and its significance.

   Disorders of amino acid and protein metabolism- Inborn errors of amino acid metabolism- PKU, Alkaptonuria, albinism

   Disorders of purine and pyrimidine metabolism-Gout, Lesch-Nyhan syndrome, Xanthuria, Oroticaciduria.
4. **Kidney Profile and Biochemical investigations in kidney diseases**: Assessment of renal function-clearance tests and their importance in assessment of kidney functions. Laboratory investigations of kidney disorders- UTI, kidney stones, Nephritis, Urolithiasis, Dialysis, Uremia, Hyporuricemia, Urine analysis for normal and abnormal constituents, urine microscopy culture and antibiotic sensitivity test. Kidney transplantation and dialysis.
5. **Liver profile and Biochemical investigations in Liver diseases:** Liver diseases: Types of jaundice, molecular basis and biochemical assessment, viral hepatitis, alcoholic hepatitis, cirrhosis. Hepatocellular functions, with special emphasis on its participation in the various detoxification mechanism. Liver function tests (LFT), and their clinical significance in the diagnosis of liver diseases like cirrohosis and jaundice. Gall-bladder stone analysis and its clinical significance. Hepatitis infections.

Pre-requisite Courses: NONE

References Books:

1. "Harpers Biochemistry", Murray R. K., Granner D. K., Mayes P. A., Rodwell V. W., Appleton & Lange, Stanford, Conneticut, Twenty fourth edition, 1996.
2. "Textbook of Biochemistry with clinical correlations", Thomas M. Devlin, Wiley Liss Publishers, Sixth edition, 2006.

UE16BT321: MICROBIAL BIOTECHNOLOGY (4-0-0-0-4)

Course Objectives:

- To learn the basic concepts of microbial cells and their classification.
- To understand the industrial applications of microbial cells and enzymes.
- To obtain knowledge of production of biological agents.

Course Outcomes:

At the end of the course, the student should be able to

- Apply the properties of various microbes in formulation of biological products.
- Formulate methods for strain improvement and scale up of production.
- Analyze effective methods for industrial production of microbial cells and biological products.

Course Content:

1. **Introduction to Microbial Biotechnology:** Scope, techniques and its application. Importance of Microbiology in Human therapeutics, Agriculture, Food Technology & Environmental studies. Microbial Whole cell-bioreporter. Strain improvement techniques Contamination problems in fermentation industry.
2. **Production of industrial microbial products:** SCP-Microorganisms and substrates used for production, nutritional value of SCP, economics of production, merits and demerits of SCP. Microbial enzymes- glucose isomerase, cellulose. Microbial transformations of antibiotics and steroids. Industrial production of distilled alcoholic beverages. Bioremediation- Concept and principles, *in situ* and *ex situ* bioremediation, biosorption and accumulation of heavy metals. Biodegradation of hydrocarbons, crude oil degradation by bacteria, Methanotrophs, Genetic engineering of microbes for bioremediation. Microbiological Degradation of xenobiotics.
3. **The World of Omics:** Introduction to Omics, Genomics, Proteomics, Transcriptomics & Metabolomics, Overview to Data Analysis, Study of Genome Sequencing and Annotation, Genetic, Structural, Somatic Variation. Quantitative Proteomics, Interaction & Organellar Proteomics, Ubiquitome, Phosphoproteomics, Biomarker Analysis, MS Tissue Imaging. Non-Coding RNAs and iCLIP, scRNA, -seq Coding RNA and Bulk Metatranscriptomics, Small RNA, Ribosome Profiling, Assembly and Annotation, Metagenomics, Quality Control: Experimental Design, Methodology, Isotope Labeling, Pulse Chase Measurements, Multiplexing and Barcoding, Using Proteomics to Understand the Metabolome.
4. **Microbial insecticides:** Candidates for developments into microbial insecticides, production of insecticides, evaluating

potential hazards to man and environment, effectiveness, safety, economics, advantages and disadvantages. Production and applications of microbial polysaccharides & polyesters-Xantham gum and Alginate.

5. **Production of recombinant and synthetics vaccines & proteins:** Insulin, Coagulation factors, FSH, Thrombolytic agents, vaccines-Polio vaccines and chicken pox vaccines, vitamins, Antibiotics and therapeutic hormones.

Pre-requisite Courses: NONE

Reference Books:

1. "Microbial Biotechnology". Alexander N Glazer, Hiroshi Nikaido, Cambridge, Second Edition, 2008.
2. "Microbial Biotechnology – Principles and Applications", Lee yuan Kun (Ed.), World Scientific publisher, Third edition, 2004.
3. "Industrial Microbiology". L.E. Casida Jr., New Age International Publisher, Third edition, 2008.
4. "Fermentation Microbiology and Biotechnology", E I Mansi, Bryce, CRC Press, Third edition, 2004.
5. "Industrial Microbiology: An Introduction", Michael Waites, Neil Morgan John Rockey, Gary Higton. Blackwell Publishing, 2001.

UE16BT322: HUMAN CYTOGENETICS (4-0-0-0-4)

Course Objectives:

- Provide background of human Cytogenetics.
- Demonstrate knowledge of chromosomal abnormalities and associated disorders.
- Develop comprehension of traditional and molecular techniques.

Course Outcomes:

At the end of the course, student should be able to

- Demonstrate Knowledge and understanding of methods used to identify and analyze cytogenetic aberrations.
- Develop an understanding of mechanism of disease expression.
- Differentiate between normal and abnormal cytogenetic data.

Course Content:

1. **Scope of Human Cytogenetics**. Ultrastructure of chromosomes, Nomenclature of human chromosomes, Karyotype. Types of chromosomal changes: Numerical and Structural chromosomal aberrations, Constitutive and facultative heterochromatin. Dosage compensation and X-chromosome inactivation.
2. **International system for chromosome nomenclature** [ISCN], Chromosome breakage and rearrangements, Causes of chromosome breaks, Sister Chromatid Exchanges (SCE_s), Chromosome breakage syndromes. Modifications of mitosis. Meiotic abnormalities. Mapping of human chromosomes.
3. **Cancer cytogenetics:** constitutional chromosomal instability and Cancer risk. Chromosomal abnormalities in Leukaemia, Lymphomas and solid tumours. Oncogene amplification, chromosome markers and Cancer. Role of specific chromosomal changes in the diagnosis and monitoring of acquired malignancy.
4. **Molecular cytogenetics:** Principles of Fluorescence in situ hybridization, (FISH), FISH probes. Types of FISH: Q-FISH, T-FISH, GISH, Multiplex FISH (M-FISH) and Spectral karyotyping (SKY). Comparative genomic hybridization [CGH]. Applications of FISH and CGH in molecular diagnostics and basic research.
5. **Genetic disorders** caused by structural chromosomal abnormalities, Martin-Bell syndrome, DiGeorge Syndrome, Cry-du-chat syndrome, Retinoblastoma, Numerical chromosomal abnormalities: Down's Syndrome, Patau Syndrome, Edward Syndrome, Klinefelter Syndrome, Turner Syndrome.

Pre-requisite Courses: NONE

Reference Books:

1. "Human Genetics", Gardner, A., Howell, R. T. and Davies, T. Viva Books Pvt. Ltd., New Delhi, 2008.
2. "Human Chromosomes: Structure, Behavior, and Effects", Eeva Therman, Millard Susman, Springer Study Edition, 1992.
3. "Cytogenetics: Techniques and Applications", Morgan Key (Editor), Callisto Reference, 2015.
4. "The Principles of Clinical Cytogenetics", Steven Gersen, Martha B. Keagle, Humana Press, First edition, 1999.

UE16Bt323: BIOPROCESS AND EQUIPMENT DESIGN (4-0-0-0-4)

Course Objectives:

- To design plant involving all of the engineering aspects involved in the development of either a new, modified, or expanded industrial plant.
- To design a problem with a brief step by step calculation procedure to achieve an accurate design.

Course Outcomes

At the end of the course, the student should be able to

- Design a plant may be related to chemical, biotechnological or pharma related reactors.
- Design the heat exchangers, condensers, agitated vessels, fermentors, DPHE, reboilers, vaporizers, distillation column used in the petroleum refineries or any chemical/ Biochemical plant.

Course Content:

1. **Shell & Tube Heat Exchanger:** Introduction to heat exchanger, Functional Design-Energy balance equation, log mean temperature difference [co current, counter current], Heat transfer coefficients [inside, outside & overall], Area, length, number of tubes, tube sheet diameter, type pitch, diameter of the sheet. Mechanical Design Baffle, thickness of shell, thickness of tube sheet, tie rods, nozzles designs, pressure drop calculations tube side and shell side, detailed drawing of sectional front view of heat exchanger (1-1, 1-2) with tube sheet layout. Schematic Sketch for the above design.

   Double Pipe Heat Exchanger: Introduction to heat exchanger, Functional Design-Energy balance equation, log mean temperature difference [co current, counter current], Heat transfer coefficients [inside, outside & overall], Area, length, number of tubes, diameter of the tubes, no of hair pins, equivalent diameter of the annulus, dirt factor Mechanical Design: thickness of pipe, glands, bends, nozzles designs, pressure drop calculations Schematic Sketch for the above design.
2. **Agitated & Jacketed Vessel:** Height & diameter [based on reactor volume/reactant volume], thickness of the shell-internal and External pressure B-factor (cylindrical, spherical), thickness of the top& bottom cover, Flange calculations-width & thickness of the flange width & thickness of gasket, number of bolts, bolts circle diameter and bolt diameter. Agitator-Diameter of agitator, height of agitator, type of blade and power required [power rating] to run the agitator Design of vessel openings-manholes, drains, and nozzles. Agitated & Jacket calculations- jacketspacing, thickness of vessel. Schematic Sketch for the above design.
3. **Evaporators:** Introduction to evaporators, Functional design-Energy & material balances, length & diameter of the column, Log mean temperature difference, Boiling point elevation, Heat transfer coefficients, area, steam consumption & steam economy, Mechanical Design: thickness of the column, nozzles, pressure drop calculations thickness of the top & bottom cover, flange calculations design of condenser, reflux ratio, Schematic Sketch for the above design.

4. **Distillation of Packed Column:** Functional design-height of the packed column using Number of transfer units and Height transfer unit's concepts, Mass transfer Concepts. Mechanical design- Thickness of shell [cylindrical spherical], thickness of the top & bottom cover, flange calculations-width and thickness of gasket, number of bolts, bolts circle diameter and bolt diameter, diameter of column, top and bottom free space. Nozzle design. Detailed drawing for the above design [showing clearly inlets, outlets, liquid redistributors, packing support, access man way], Schematic Sketch for the above design.
5. **Fermenter Design:** Functional design –Based on the type of bioreactor [Batch reactor, mixed flow reactor] and cell growth kinetics and performance equation determine the volume of the reactor, according to height by diameter ratio determine height and diameter. Mechanical design – Thickness of the shell [cylindrical], thickness of the top & bottom cover, flange calculations-width and thickness of gasket, number of bolts, bolts circle diameter and bolt diameter. Cooling /Heating arrangement reqd.) Length of the tube. Schematic Sketch for the above design

Pre-requisite Courses: NONE

Reference Books:

1. "Process Equipment Design", M.V. Joshi & V.V.Mahajan, PHI, Third Edition, 2004.
2. "Perrys Chemical Engineers handbook", Robert H Perry & Green, McGraw Hill Publications, Seventh Edition.

UE16BT324:
NEUROBIOLOGY (4-0-0-0-4)

Course Objectives:

- Understand organization of nervous system.
- Develop comprehension of synaptic transmission.
- Comprehend the mechanisms of sensory system.

Course Outcomes:

At the end of the course, the student should be able to

- Understand and comprehend nervous system and disorders.
- Have an understanding of sensory system.
- Differentiate between normal and abnormal neurological conditions.

Course Content:

1. **Introduction to neurobiology:** Organization of the nervous system, Cells of nervous system, Types of neuronal cells, Blood Brain Barrier - structural and functional aspects, Developmental neurobiology.
2. **Molecular Neurobiology:** Signal transduction, Receptors, effector system, Cellular neurochemistry, neurotransmitters and receptors, Synaptic transmission and cellular signaling, Synaptic plasticity, Neurotransmitter synthesis and Metabolism, Peptides and growth factors, G-protein Intracellular messengers.
3. **Electrophysiology:** Membrane transport, Diffusion, facilitated transport, Action Potential, Propagation of action potential, Neuronal membrane structure and ion permeability, Resting and action potentials, Structure and properties of ion channels, Role of ion-channels in brain pathology. Measurements in membrane biophysics-voltage and patch clamp techniques. Electroencephalgram.
4. **Neurobiology of senses:** Neurobiology of the gustatory (taste), olfactory (smell), auditory (sound), visual (sight) and somatosensory (touch) systems. Neurobiology of memory. Neurobiology of Pain.
5. **Neurobiology of diseases:** Lysosomal disorders of nervous system, Inherited and Neurodegenerative disorders: Disorders of basal ganglia, Biochemistry of dementia, Mitochondrial dysfunction and bipolar disorder, Peripheral neuropathy.

Pre-requisite Courses: NONE

Reference Books:

1. "Neurobiology", Gordon M. Shepherd, Oxford University Press, Third edition, 1994.
2. "Foundations of Neurobiology", Fred Delcomyn F., W. H. Freeman & Company, First edition, 1998.
3. "Neuroscience", Dale Purves, George J. Augustine, David Fitzpatrick, William C. Hall, Anthony-Samuel LaMantia, Leonard E. White, Sinauer Associates, Inc., Fifth Edition, 2012.
4. "Neurobiology: Molecules, Cells and Systems", Gary G Matthews, Wiley-Blackwell, Second Edition, 2001

UE16BT325:
AGRICULTURAL BIOTECHNOLOGY (4-0-0-0-4)

Course Objectives:

- To understand the gene transfer techniques to produce superior strains of commercial crops.
- To analyse the techniques involved in the commercial production of plants using plant tissue culture techniques.
- To develop the genetic engineering techniques to produce GM Crops with desired traits, value added biofertilizers.
- To evaluate the social, legal issues related to Genetically modified crops.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the skills related to gene transformation to the plants for production of better strains.
- Understand different plant tissue culture technique and optimization of large scale production techniques.
- Evolve superior plant breeds with high economic value.
- Develop plant products for societal benefits.

Course Content:

1. **Concepts in Agricultural biotechnology:** Applications of plant transformation technology for productivity and performance, disease resistance, genes and gene constructs used for viral resistance by coat protein mediated production, bacterial resistance by lysozyme gene and fungal resistance by chitinase and beta glucanase genes. Agrobacterium mediated transformation. Crop improvement to resist adverse soil conditions. Salinity tolerance, drought resistance. Herbicide resistance in commercially important plants. Insecticide resistance through Bt-gene. Integrated pest management. Current status of BT crops in the world. Effect of transgenic crops on environment.
2. **Importance of micropropagation in development of improved crop varieties:** Introduction to plant cell culture. Explant selection, sterilization and inoculation; various media preparations; MS, B5, SH PC L-2; Callus and cell suspension culture; plantregeneration: organogenesis. Somatic embryogenesis; somaclonal variation, its genetic basis and application in crop improvement. Role of tissue culture in rapid clonal propagation, production of pathogen - free plants and "synthetic seeds"; haploid production: advantages and methods. Protoplast technology.
3. **Role of recombinant DNA technology in improving the crop quality:** Antisense RNA technology (ACC synthase gene and polygalacturonase) Delay of softening and ripening of fleshy

fruits by antisense RNA for ACC synthase gene in tomato, banana. Use of antisense RNA technology for extending shelf life of fruits and flowers. Protection of cereals, millets and pulses following harvest using biotechnology. Biotechnology for fortification of agricultural products- Golden rice, transgenic sweet potatoes.

4. **Importance of biofertlilizers in agriculture.** (*Rhizobium, Azatobacter, Mycorrhiza, Frankia* and Blue green algae) current practices and production of biofertilizers.
5. **An overview of Legal and Socio-economic impact of Biotechnology**. Biotechnology & hunger. Ethical issues associated with labelling and consumption of GM foods. Public perception of GM technology. Biosafety management. Cartagena protocol on biosafety. Ethical implication of BT products, public education, Biosafety regulations, experimental protocol approvals, guidelines for research, environmental aspects of BT applications.

Pre-requisite Courses: NONE

Reference Books:

1. "Agricultural Biotechnology", Updesh Purohith, S.S. Publication, Second Edition, 2003.
2. "Biotechnology, Theory and Techniques", Jack.G.Chirkjan, Jones & Bartlett, Vol.5., 2005.
3. "Hand Book of Agriculture", Indian Council of Agricultural Research (ICAR), 2000.

UE16BT326:
HUMAN PHYSIOLOGY (4-0-0-0-4)

Course Objectives:

- To understand the internal environment of human body homeostasis mechanism.
- To provide the basic knowledge of different types of tissues.
- To provide the knowledge of structure and functioning of organ systems of the body.

Course Outcomes:

At the end of the course, the student should be able to

- Classify different types of tissues.
- Differentiate the various organs of the body and their functions.
- Understand the architecture and functioning of organs of the body.
- Understand normal physiological processes of the body.

Course Content:

1. **Cells of the tissue and body:** Introduction to human body. Basic tissue types in the human body. Connective tissue. Cells of immune system. Cells of the integument. Levels of organization. Homeostatic mechanisms.
2. **Digestive, skeletal and muscular system:** Introduction, overview, functional anatomy of digestive system. Digestive glands, enzyme, physiology of digestion and absorption, energy requirements of the body. Disorders.

   Introduction to skeletal system- structure, functions; bone, axial and appendicular skeleton. Structure and function of cartilage. Joints. muscles of limb movement. Bone marrow, bone disorders. Introduction, functions, general properties of muscles. Principal types of muscles. Mechanism of muscle contraction and relaxation. Disorders.

   3.Respiratory and cardiac system: Introduction, functions, structure of respiratory organs. Mechanism of breathing, pulmonary air volumes, gas exchange in lungs. Respiratory quotient, some respiratory disorders.

   Circulatory system: Circulatory fluids-blood and lymph. Cardiac circulation. Disorders of cardiac system.
4. **Excretory and reproductive system:** Introduction, structure and functions of Kidneys. Brief view on other organs involved in excretion. Physiology of excretion. Disorders.

   Reproductive system: male and female reproductive system. Physiology of fertilization. Disorders.
5. **Endocrine and nervous system:** Endocrine system of vertebrates. Overview of Pituitary, pineal, thyroid, adrenal, pancreas, parathyroid, thymus and gonads.

   Introduction to nervous system. Types of neurons. Stimulus, mode of action of nerves. Conduction of nerve impulses, reflex action. Central nervous system-the brain and spinal cord.

Pre-requisite Courses: NONE

Reference Books:

1. "Ross and Wilson Anatomy and Physiology in Health and Illness", Waugh, Elsevier Health – UK, Twelth edition, 2014.
2. "Human Physiology: An Integrated Approach", Silverthorn Pearson Education India; Sixth edition, 2016.
3. "Introduction to human anatomy and Physiology", Solomon, Elsevier Health, Third edition. 2009.

UE16BT351:
BIOPROCESS SYSTEMS ANALYSIS AND CONTROL (4-0-0-0-4)

Course Objectives:

- Have a basic knowledge of open and closed loop systems.
- To identify I and II order open loop system with various inputs.
- To understand different feedback systems and block diagrams.
- To understand different types of control systems along with stability.

Course Outcomes:

At the end of the course, the student should be able to

- Understand linear open loop and closed loop systems.
- Differentiate between I and II order open loop system and with various operations.
- Differentiate problems associated with different feedback system and solve problems associated with block diagrams.
- Compare and contrast different types of control systems and understanding the stability of the systems.

Course Content:

1. **Linear Open-Loop Systems:** Response of First-Order Systems- Mercury in glass thermometer, Physical Examples of First-Order Systems- Liquid level system, Liquid level process with constant flow outlet, Mixing process, Linearization and Conceptual numerical.

   Linear Open-Loop Systems: Response of First-Order Systems in Series-Interacting system, non-interacting systems, generalization of several non-interacting systems in series, Dynamic response to step input for interacting and non-interacting systems
2. **Linear Open-Loop Systems:** Higher-Order Systems- Second order systems with transfer functions, Response of second order system to step and sinusoidal input – Over damped, under damped and critically damped condition of second order system and transportation lag and Conceptual numerical
3. **Linear Closed-Loop Systems:** Final control Element- Block diagram, negative feedback versus positive feedback, Development of block diagram, Measuring element, final control element, mechanisms – control valve.

   Linear Closed-Loop Systems: Controllers – Two position control, proportional control, derivative control, Integral control, P-I ((proportional –Integral) control, P-D (proportional derivative control, P-I-D (proportional-Integral-derivative) control, Standard block diagram symbols, overall transfer function for single loop systems, Overall transfer function for change in set point, Servo and regulatory problems. Transient response of first and second order processes for set point changes and load changes with proportional and Conceptual numerical.

4. **Linear Closed-Loop Systems:** Concept of stability - definition of stability, Routh test for stability, Routh array, Theorems of the routh test, concept of Root Locus (basics), plotting the root locus diagram, Rules for plotting the root locus diagram and Conceptual numerical.
5. **Process Applications:** Advanced Controller - Cascade control, Analysis of Cascade control, Feed forward control, Feedback controller, ratio control, controller tuning, selection of controller modes, criteria for good control, Tuning rules: Ziegler-Nichols Rules(Z-N) and Cohen and coon Rules(C-C).

Pre-requisite Courses: NONE

Reference Books:

1. "Process Systems Analysis and Control", Donald R. Coughanowr, McGraw-Hill International Editions, Second Edition, 1991.
2. "Process Dynamics and Control", Seborg, Edgar, Mellichamp, John Wiley and Sons, 1989.

UE16BT352: UPSTREAM PROCESS TECHNOLOGY (4-0-0-0-4)

Course Objectives:

- The basic concepts of microbial, plant and animal cell culture techniques and bioreactors used for scale-up process of industrially important products.
- Methods of medium formulation, optimization and standardization using novel bioprocess principles.
- Understanding the similarities or differences between traditional and advanced technologies in the product development.
- Knowledge in environmental, societal & market issues to product formation.
- Practical sessions will prepare them to take up lab scale to large-scale production operations independently / in team.

Course Outcomes:

At the end of the course, the student should be able to

- Differentiate the growth conditions of microbial, plant and animal cell types.
- Differentiate working operations of batch, fed-batch and continuous processes for any biopharmaceutical product formation.
- Design / develop the various parameters for product formation by analyzing the end product.
- Differentiate methods of preservation for all cell types.

Course Content:

1. **Isolation of Industrially Important Microorganisms:** Screening techniques, isolation of industrially important microorganisms using mutation theory: isolation using selection of desired characteristics, isolation of microorganism not utilizing the desired character. Selection of induced mutants using feedback control system, isolation of mutants synthesizing improved levels of primary metabolites, isolation methods of auxotrophic mutants by enrichment method. Preservation techniques for microorganisms of industrial use.

   Media Formulation and Optimization: Characteristics of ideal production/ inoculum medium. Types of medium. Major components and its role in the medium. Energy sources, Carbon & Nitrogen sources, Minerals, Growth factors, Buffers, and Metabolic regulators: Precursors, Inhibitors, Inducers and Activators. Oxygen and antifoam ingredients. Medium optimization (Plackett-Burman & Nelson Method)
2. **Sterilization and Inoculum Development:** Principles of sterilization, Medium sterilization, Sterilization of Fermenters, Feeds, air filters and liquid wastes, Filter sterilization of media, air exhaust etc. Development of Inoculum: Development of inoculum in yeast, bacteria and mycelial processes, sporulation on solidified, solid and submerged. Criteria for aseptic transfer of inoculums. Industrial scale-up.
3. **Growth Kinetics and Fermentation:** Principal types of microbial culture, Fermentor configurations, Batch culture, Continuous culture (Chemostat and turbidostat). Feedback systems in a chemostat. Comparison of Batch and Continuous culture in industrial processes and investigative tools. Fed batch culture, Applications of Fed batch cultures & Advantages of Fed batch culture.

   Solid State and Submerged Fermentation: Principle, parameters for the process, advantages and disadvantages, fermenter design -tray, packed bed. Types of Submerged fermentor: Tower fermentor & Deep-jet fermentor.

   Industrial Productions: Enzymes (Protease, Pectinase), antibiotics (Streptomycin), Production of Biopolymers from bacteria, Immobilization of biocatalyst, Immobilized bioreactors and performance application of immobilization.
4. **Basic Techniques in Plant Cell / Tissue Culture:** Introduction to plant tissue culture: fundamentals of plant tissue culture, explants preparation and sterilization. Various media preparations; MS, B5. Micropropagation. Organogenesis, methods of callus culture, single cell culture and suspension culture, somatic embryogenesis. Haploid culture (anther and ovule culture), triploid culture (endosperm culture). Protoplast technology: isolation, fusion and selection of hybrids. Study of bioreactors for plant cells: Bubble column & Air-lift bioreactor. Production of insulin in transgenic plants.
5. **Techniques in Animal Cell Culture:** Introduction to animal cell culture, importance of animal cell culture. Media formulation and types. Primary cell culture (chick embryo culture). Techniques in animal cell culture: types and characteristics of cell lines, preservation and maintenance. Study of bioreactors for animal cells, Microcarriers & T-Flasks.

Pre-requisite Courses: NONE

Reference Books:

1. "Principles of Fermentation Technology", Stanbury and Whitaker, Elsevier Publication, Second Edition, 2009.
2. "Manual of Industrial Microbiology and Biotechnology", Demain and Davies, ASM Press, 2008.
3. "Biotechnology: A Text Book of Microbiology", Wulf Crueger, Annelisese Crueger, Panima Publications, 2005.
4. "Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications", R. Ian Freshney, Sixth Edition, Wiley Blackwell Publications, 2011.
5. "Plant Tissue Culture", Kalyan Kumar De, New Central Book Agency, 1997.

UE16BT353: IMMUNOLOGY (3-0-2-0-4)

Course Objectives:

- The course involves the study of the cells and organs of immune system and to understand mechanisms of innate and adaptive immunity.
- The course will focus on host's immune response to infectious diseases, mechanisms of autoimmunity, transplantation

immunology, pathological consequences of immunodeficiencies and insight to cancer immunology.
- The course will emphasize on immune techniques employing antigen-antibody reactions which are essential for disease diagnosis.
- The overall goal of this course is to provide students with knowledge and understanding of the basic principles of immunology and its applications in Diagnostics, Therapeutics and Research.
- This course aims to develop the key skills required in scientific work which include practical research skills, analytical and presentation skills.

Course Outcomes:

At the end of the course, the student should be able to

- Distinguish the major types of immunity and understand the fundamental cellular processes involved in generating an immune response.
- Understand body's defence mechanisms to combat and prevent infections.
- Apply immune techniques involving antigen-antibody reactions in disease diagnosis and prognosis.
- Develop practical research skills, analytical and presentation skills required in scientific work.

Course Content:

1. **Introduction to Immune System:** Historical development, Innate (non-specific) Immunity, Adaptive (specific) immunity, Passive and active immunity, Cells of Immune System, Organs of Immune System, Antigens. Introduction to Immunoglobulins, Structure and Function of Immunoglobulin types: IgG, IgA, IgE, IgD and IgM, Organization and Expression of Immunoglobulin Genes.
2. **Generation of B-Cells and Humoral Responses:** B-Cell generation, activation and differentiation, antigen - antibody interactions. Polyclonal antibodies and Monoclonal antibodies, Hybridoma technology – role in Immunotoxins, The Complement System, Structure and Function of Major Histocompatibility Complex (MHC).
3. **T-Cell Responses and Immune Effector Mechanisms:** Classification & Structures of T-Cell Receptors, Antigen processing, T-Cell Maturation, activation and differentiation. Signal transduction-Types of receptors and examples. Mechanism of action of G-protein receptor, acetyl choline/nicotine receptor, steroid hormone receptor, tyrosine specific protein kinases. Cytokines – Interferons, interleukins, Cell-Mediated Responses, Leukocyte migration and inflammation, Hypersensitive Reactions.
4. **Immune System In Health And Disease:** Immune response to infections-Bacterial, Viral, Fungal and Parasitic diseases, Immunodeficiencies (AIDS), Autoimmunity - mechanism, types of autoimmune disorders, immunosuppression, Transplantation Immunology – types of grafts (auto, allo, xeno and isografts), organ rejection, Cancer and Immune system. Vaccines.
5. **Immuno techniques:** Antigen – Antibody Reactions, Affinity, Avidity, Cross-Reactivity, Precipitation Reactions, Agglutination Reactions, Radioimmunoassay, Enzyme-linked Immunosorbent Assay, Western Blot, Immunoprecipitations, Immunofluroscence, Flow Cytometry, Fluorescence, Immunoelectron Microscopy.

Pre-requisite Courses: NONE

Reference Books:

1. "Immunology", Richards A Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis Kuby, W.H. Freeman & Co, Fifth Edition, 2003.
2. "Immunology for life Scientists", L. Eales, Wiley & Sons, Second Edition,2006.

UE16BT354:
BIOPROCESS SYSTEMS ANALYSIS AND CONTROL LABORATORY (0-0-2-0-1)

Course Objectives:

- Have a basic knowledge of open and closed loop systems.
- To identify I and II order open loop system with various inputs.
- To understand different feedback systems and block diagrams.
- To understand different types of control systems along with stability.

Course Outcomes:

At the end of the course, the student should be able to

- Understand linear open loop and closed loop systems.
- Differentiate between I and II order open loop system and with various operations.
- Differentiate problems associated with different feedback system and solve problems associated with block diagrams.

Experiments:

1. To Calibrate the Pressure Cell.
2. To calibrate the Thermocouple.
3. To calibrate the Resistance Temperature Detector.
4. To determine the time constant of first order system for step input.
5. To Calibrate the Wheel Flow Meter.
6. To determine the time constant of Interacting System.
7. To determine the time constant of Non-Interacting System.
8. To Control the temperature using Temperature Controller.
9. To Control the flow using Flow Controller.
10. To Control the pressure using Pressure Controller.

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE16BT355:
UPSTREAM PROCESS TECHNOLOGY LABORATORY (0-0-2-0-1)

Course Objectives:

- The basic concepts of microbial, plant and animal cell culture techniques and bioreactors used for scale-up process of industrially important products.
- Methods of medium formulation, optimization and standardization using novel bioprocess principles.
- Understanding the similarities or differences between traditional and advanced technologies in the product development.
- Knowledge in environmental, societal & market issues to product formation.
- Practical sessions will prepare them to take up lab scale to large-scale production operations independently / in team.

Course Outcomes:

At the end of the course, the student should be able to

- Differentiate the growth conditions of microbial, plant and animal cell types.
- Differentiate working operations of batch, fed-batch and continuous processes for any biopharmaceutical product formation.
- Design / develop the various parameters for product formation by analyzing the end product.
- Differentiate methods of preservation for all cell types.

Experiments:

1. Preparation of artificial seeds using axillary buds/zygotic embryos.
2. Callus induction techniques from carrot on MS medium.
3. Extraction and estimation lycopene from tomato.
4. Isolation of plant protoplasts by enzymatic method.
5. Shake flask studies: comparison of yield in synthetic and complex media for citric acid production from *Aspergillus niger.*
6. Qualitative method for estimation of aflatoxins from groundnuts byThin layer chromatography.
7. Penicillin production from *Penicillin chrysogenum* under solid state fermentation and study of its effect using turbidity method.
8. Production of wine and estimation of volatility and acidity.
9. Single cell protein (SCP) production and estimation from yeasts.
10. Primary cell culture (chick embryo).

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE16BT331: MOLECULAR GENETICS (4-0-0-0-4)

Course Objectives:

- Provide comprehensive information on model organisms and their utility in molecular genetics.
- Give an overview of human genome, analysis of genetic data and mapping techniques.
- Develop comprehension of genes involved in cancer and cell death.
- Critical understanding of axis and pattern formation in organisms.
- Apply the principles of gene information in addressing clinical disorders and ELSI issues associated with sharing genetic information.

Course Outcomes:

At the end of the course, the student should be able to

- Comprehend various model organisms.
- Understand regulation of gene expression at various levels.
- Differentiate genetics of normal and cancer cells.
- Explore molecular mechanisms involved in development.
- Analyze ethical aspects of sharing genetic information.

Course Content:

1. **Model Organisms & their Genomes:** Model organisms: Viruses - Lambda Phage, Prokaryotes (*E. coli*); Eukaryotes: *Chlamydomonas reinhardtii, Saccharomyces cerevisiae;* filamentous fungi (*Neurospora*); *Arabidopsis thaliana - Zea mays*, *Drosophila melanogaster; Caenorhabditis elegans; Xenopus laevis; Mus musculus.*
2. **Human Genetics:** The history, organization, goals and value of the Human Genome Project. Genetic and physical mapping of the human genome. Organization of the human genome. Genetic mapping of mendelian characters; Identifying human disease genes; genetic mapping of complex characters; genetic testing in individuals and populations. Extra nuclear inheritance. Molecular pathology of diseases and chromosomal disorders.
3. **Cancer Genetics:** Control of cell cycle, chromosomal instability, Genes involved in cancer: proto-oncogenes, oncogenes, tumor suppressor genes. Gain of function and loss of function mutations. Inherited cancers: breast cancer, colorectal cancer. Multistep evolution of cancer. Apoptosis and cell senescence.
4. **Developmental Genetics:** Basic concepts, Binary switch genes (Myoblast-determining genes; control of eye formation), genetics of embryonic development in *Drosophila;* zygotic genes and segment formation (Gap genes, pair rule genes, segment polarity genes, selector genes; antennapedia type genes in *Xenopus;* flower development in *Arabidopsis thaliana;* Cell-cell interactions in *Caenorhabditis elegans.*
5. **Gene Based Therapeutics:** Gene therapy: Principles, the technology of classical gene therapy. Gene therapy for inherited disorders-SCID, neoplastic disorders and infectious disease-HIV. Therapeutics based on targeted inhibition of gene expression and mutation correction *in vivo*. Gene silencing: RNAi, microRNA therapeutics and Stem cell therapy. Ethical, legal, and social issues *(*ELSI*)* of sharing genetic information.

Pre-requisite Courses: NONE

Reference Books:

1. "Molecular Genetics", Hancock J. T., Viva Books Pvt Ltd, 2008.
2. "Human Molecular Genetics", Tom Strachan, Andrew P Read, Garland Science Publications, Fourth Edition, 2010.

UE16BT332: NEUROINFORMATICS (4-0-0-0-4)

Course Objectives:

- To make students learn about concepts of modeling and simulation of neurons & brain to understand the neurological disorders.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the importance of neuroinformatics in understanding the neurodegenerative disorders.
- Gain knowledge of different applications of neuroinformatics.

Course Content:

1. **Neuron Models and Neural Encoding:** Neuron models - Integrate and Fire model, Multi compartment models and Network Models. Spike Trains and Firing rates, Neural encoding and decoding. Estimating Firing Rates. Synaptic plasticity rules.
2. **Neuroscience Knowledge Management:** Managing knowledge in Neuroscience, Interoperability across Neuroscience databases. Database architectures for Neuroscience applications, XML for data representation and Data model specification.
3. **Computational Neuronal Modeling and Simulation:** Tools and methods for simulation of Neurons and Neural Circuits - Model structure analysis in NEURON, Constructing realistic Neural simulations with GENESIS, Simulators for Neural Networks and Action potentials. Data mining through simulation.
4. **Neuroinformatics in neurodegenerative Disorders:** Information approach to Systems Neurogenetics. Computational models of dementia and Neurological problems, Application of Systems biology approach to the neuroscience.
5. **Neuroinformatics applications:** Visuospatial processing, Visual attention and Spatial neglect. Human Brain Project: Microscale and Macroscale characterization; Brain image Atlases, Databases and Repositories. Basis of Brain mapping; Functional and Cognitive Brain atlas; Interoperable and Federated Brain Map databases.

Pre-requisite Courses: NONE

Reference Books:

1. "Neuroinformatics", Chiquito Joaquim Crasto, Humana Press, 2007.
2. "Neuroinformatics: an overview of the Human Brain Project", Stephen H. Koslow, Michael F. Huerta, Routledge, Psychology Press, 1997.

UE16BT333: INSILICO DRUG DESIGN (4-0-0-0-4)

Course Objectives:

- To make students learn basic concepts of structural features of proteins, the modeling tools and their use in modern biological applications.
- Provides the fundamentals in protein engineering, Molecular modeling, Molecular basis of drug action, Molecular simulation, Molecular mimicry etc. and also ways of applying them in drug designing.
- Learn about concepts of drug design process, methods used for the drug design and role of bioinformatics for more efficient drugs by reducing time, money and labor in drug discovery.

Course Outcomes:

At the end of the course, the student should be able to

- Analyse the structure and construction of proteins by computer-based methods.
- Understand the *in-silico* approaches that can be used together with bioassays for the discovery, design and development of novel small organic lead compounds.
- Apply the basic principles behind different types of drug-receptor interactions (small molecule-protein and protein-protein interactions).

Course Content:

1. **In silico Drug Design:** Generation of Rational Approaches in Drug Design, Molecular Modeling: The Second Generation, Conceptual Frame and Methodology of Molecular Modeling, The Field Currently Covered, Importance of the "Bioactive Conformation", Molecular Mimicry and Structural Similarities, Molecular
Mimicry, Structural Similarities and Superimposition Techniques.
2. **Computer Assisted New Lead Design:** Rational Drug Design and Chemical Intuition, an important key and the Role of the Molecular Model, Limitations of Chemical Intuition Major Milestones, and Future Perspectives. Introduction, Basic Concepts, Molecular Recognition by Receptor and Ligand Design, Active Conformation, Approaches to Discover New Functions, Approaches to
the Cases with known and unknown receptor structure.
3. **Molecular Modeling:** Steps in molecular modeling - Constructing an Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure Generation or Retrieval, Structure Visualization, Conformation Generation, Deriving Bioactive Conformations, Molecule Superposition and Alignment, Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Molecular Interactions: Docking, Calculation of Molecular Properties, Energy Calculations (no derivation),Examples of Small Molecular Modeling Work, Nicotinic Ligands, Sigma Ligands, Antimalarial Agents.
4. **Docking Methods:** Program GREEN Grid: Three - Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three-Dimensional Database Search Approaches, Automated Structure Construction Methods, Structure Construction Methods with known Three-Dimensional Structure of the Receptor, Structure Construction in the case of Unknown Receptor Structure. Scope and Limitations, Points for Consideration in Structure, Construction Methods, Handling of X-Ray Structures of Proteins, Future Perspectives, Types of programs available for molecular modeling-scope and limitations-interpretation of results.
5. **Computer-Assisted Drug Discovery:** The Drug Development Process, Introduction, The Discovery and Development Process, New Lead Discovery Strategies, Composition of Drug Discovery Teams, The Practice of Computer- Assisted Drug Discovery (CADD), Current Practice of CADD in the pharmaceutical Industry, Management Structures of CADD Groups, Contributions and Achievements of CADD Groups, Limitations of CADD Support, Inherent Limitations of CADD Support, State of Current Computational Models, Software and Hardware Constraints.

Pre-requisite Courses: NONE

Reference Books:

1. "Guide Book on molecular Modeling in Drug Design", N Claude Cohen, Academic Press, First edition, 1996.
2. "Introduction to Protein Structure", Branden C and Tooze R, Garland Publishers, Fourth edition, 1993.
3. "Protein Engineering", Moody P.C.E. and A. J. Wilkinson, IRL Press Oxford, Second edition, 1990.

UE16BT334: COMPUTATIONAL BIOLOGY (4-0-0-0-4)

Course Objectives:

- To make students learn applications of algorithms and prediction models in analysing biological data.

Course Outcomes:

At the end of the course, the student should be able to

- Apply knowledge of different algorithms for biological data analysis.
- Understand the applications of algorithms in biological data analysis.

Course Content:

1. **DNA and Protein sequence analysis:** Introduction, scope and applications of Computational biology. Analysis of single DNA sequence: Scanning long repeat, Counting of overlaps. Analysis of Multiple DNA or Protein sequences. Alignment algorithms for two sequences: Gapped global comparisons and Dynamic programming algorithms, substitution matrices.
2. **Patterns, motifs and signals:** Pattern matching - Pattern matching with Consensus sequences. Structural domains and Motifs - Sequence blocks & Profiles, Protein sequence motifs, Protein structural motifs, Clustering and Functional analysis of coordinately regulated genes. Discovering transcriptional regulatory Signals, Ultraconservation in the Human Genome.
3. **Restriction mapping, Map assembly, Sequencing** – Restriction mapping and map assembly, DNA sequencing, Finding signals in DNA - Gibbs sampling, Viterbi algorithm, Hidden Markov Models.
4. **Computational Biology and Cancer research:** Mathematical modeling of tumorigenesis. One hit and two hit stochastic models. Tumor suppressor gene, Microsatellite and Chromosomal instability in sporadic - APC gene, colorectal cancer, point mutation. Chromosome loss, DNA damage and genetic instability - Apoptotic, Fitness landscape. Tissue aging and the development of cancer - Angiogenesis, Checkpoint competence, DNA damage. Basic models of tumor inhibition and promotion. Mechanisms of tumor neovascularization - Cancer and Immune responses.
5. **Computational Immunology:** Introduction to computational immunology; Immunological databases – IMGT – IMGTGENE-DB, – IMGT-HLA, Tools for the prediction binding affinity between peptide, Peptide Binding Prediction – SYFPEITHI, BIMAS, MHC-PRED, Future of computational modeling and prediction systems in clinical immunology.

Pre-requisite Courses: NONE

Reference Books:

1. "Computational Molecular Biology", Pavel Pevzner, The MIT Press, 2000.
2. "Computational Biology of Cancer", Dominik Wodarz, Natalia L. Komarova, World Scientific, 2005.
3. "In silico Immunology", Darren Flower, John Timmis, Springer, 2007.

UE16BT335: ENVIRONMENTAL BIOTECHNOLOGY (4-0-0-0-4)

Course Objectives:

- To impart the student an understanding of different pollutions of environment by air, water and soil.
- To enable an understanding of diverse metabolic capabilities and potential of microorganisms for remediation technologies.
- To provide a platform of knowledge on production of value added products like biofuels, vermicompost and industrial metabolites.
- To emphasize green technology.

Course Outcomes:

At the end of the course, the student should be able to

- Have awareness and understanding of Environmental Pollution.
- Analyze and assess the pollution and anthropogenic activities contributing to pollution in air, water and soil.
- Apply engineered bioremediation strategies to clean up contaminated environment and benefit human society.

Course Content:

1. **Biotechnology and Environmental Protection:** Basic concepts of environment – definition, Xenobiotics, Eco-kinetic and bio-kinetic properties of a xenobiotic, significance of dose, Routes of entry of xenobiotics, Current status of biotechnology in environmental protection-scope of environmental biotechnology.

   Environmental Microbiology: Important environmental micro-organisms, microbial enzymes and their roles, Bioaugmentation, Packaged microorganisms, Biological treatments and impact of pollutants on biotreatment.
2. **Treatment of Waste Waters:** Characteristics of waste waters, methods of removal of solids, Aerobic biological treatment-Activated sludge processes, Rotating Biological Contactors, Lagoons or ponds- Oxidation Ditch and Oxidation Pond, Anaerobic biological treatment- Upflow Anaerobic Sludge Blanket Reactor.

   Removal of Specific Pollutants: Nitrogen, Phosphorous, Hydrocarbons – aliphatic, aromatic, PCB, Pesticides, Heavy metals, treatments of industrial effluents – characteristics, processes and Biological Treatment of Dairy, Distillery, Pharma, Pulp, Petroleum and Tannery Industrial Effluents.
3. **Bioremediation:** Types of bioremediation – natural, pump and treat, Bioremediation of surface soil sludges, Advantages and disadvantages of Bioremediation, Bioventing, Phytoremediation and its types – phytostabilization, phytovolatalization, phhytofiltration. Biotechnoogy of oil spills – case studies.

   Biotechnology for Sustainability: Biomining – processes, Advantages and Disadvantages, Biopesticides – as an alternative to chemical pesticides, Biofilms – formation, significance and examples, Bioindicators – monitoring pollution, principles of bioindicators, examples, biofertilizers – as alternatives to chemical fertilizers.
4. **Biotechniques for Air Pollution and Odour Control:** Introduction, Magnitude of the problem, Deodourization processes – bioscrubbers, biobeds, Biofiltration. Applications – odour measurements. Stack emissions and plume behaviour.
5. **Bioenergy from Wastes:** Biomass for energy production, biogas – biomethanization, biogas from food and other processing industries, fuel alcohol production – bioethanol, biomethanol, biodiesel and biohydrogen. Syngas.

   Novel Methods of Waste Control: Vermitechnology, waste water treatment using aquatic plants, constructed wetland, Root Zone Treatment.

Pre-requisite Courses: NONE

Reference Books:

1. "Environmental Biotechnology (Industrial Pollution Management)", Jogdand S. N., Himalaya Publishing House, 2004.
2. "Environmental Biotechnology: Principles and Applications", Rittmann and McCarty, McGraw Hill Publications, 2001.

UE16BT336: BIOSENSORS (4-0-0-0-4)

Course Objectives:

- To familiarize students with biosensor technology, their application area.
- To enable an understanding of most common sensor principles used today, based on electric, optical, and mechanic principle.
- To impart the student on how biospecific interaction is used for various applications of sensors in different fields.

Course Outcomes:

At the end of the course, the student should be able to

- Acquire knowledge about the biosensors.
- Have the ability to design a biosensor.
- Have the ability to compare different techniques with emphasis on sensitivity and selectivity.

Course Content:

1. **Overview of biosensors:** History, concepts and applications. Bioinstrumentation and bio-electronic devices, Components of biosensor devices and designs. Molecular recognition: Enzymes, Antibodies and DNA. Types of biosensors- Electrochemistry for biosensors, Principles of potentiometry and potentiometric biosensors; amperometry and amperometric biosensors; Voltammetry: principles and techniques; Bio-electrochemistry and direct biosensors, Electrical and Electrochemical Impedance: Principles and Applications. Conductimetric and Impedimetric Biosensors.
2. **Sensors:** Enzyme sensors: affinity sensors: antibodies, oligo-nucleotides, measuring binding in affinity sensors, SPR, quartz crystal microbalance, FRET, Membrane protein sensors: ion channels, receptors, whole cell sensors – bacteria, yeast, mammalian cells, non-biological and bio-mimicry: molecularly imprinted polymers, non-biological organic molecules, electro-chemiluminescence, pH sensors, artificial receptors
3. **Immobilization**: adsorption, encapsulation- (hydro-gel, sol-gel glass, etc.), covalent attachment, diffusion issues. Optical Biosensor, Microlithography for biosensors, FETS and Bio-FETS, MEMS and Bio-MEMS. Lab-on-a-chip: TAS and m-TAS devices, Sensors based on Fiber Optic, Surface Plasmon Resonance (SPR) biosensors, Surface Characterization of Hybrid Bilayer Membrane Sensors, Quartz Crystal Nanogravimetry (QCN) biosensors, quantum dots, magnetic beads, PEBBLE sensors.
4. **Biosensor Arrays and Chemometrics**, Multi-element array biosensors: electronic nose and electronic tongue, Signal Processing and Data Fusion for Biosensors. Measuring complex samples, multi-analyte detection, continuous measurements, reagent less biosensors, implantable sensors, biocompatibility issues.

5. **Applications** of biosensors in Agriculture, food safety, food processing- design criteria and needs. Biomedical sensors: Microfabricated Sensors and the Commercial Development Of the i-Stat Point-Of-Care system, Noninvasive Biosensors in Clinical Analysis. Applications of Biosensor-based instruments; Blood chemistry sensors, sensors for Genetic testing, Physical sensors, Electrical sensors: Electrocardiographs Electroencephalograph etc., Electrosurgical equipments. Applications of biosensors in Bio-security, environmental: state of the field, market potential, unique design criteria and needs, current sensors in use.

Pre-requisite Courses: NONE

Reference Books:

1. "Biosensors", Cooper J M, Oxford publication, 2004.
2. "Bioinstrumentation and Biosensors", Donald L Wise, Marcel Dekker Inc., 1991.

UE16BT341: MICROBIAL rDNA TECHNOLOGY (4-0-0-0-4)

Course Objectives :

- To obtain knowledge of fundamental concepts and recent advances in the field of microbial recombinant technology.
- To understand the techniques involved as an application of the basic concepts.
- To apply the knowledge of gene cloning using microorganisms.

Course Outcomes:

At the end of the course, student should be able to

- Apply the properties of various microbes in gene manipulation.
- Analyze the different methods of microbial gene cloning to obtain desired product.
- Understand the different areas where recombinant DNA technology is used.

Course Content:

1. **Ideal features of cloning vectors** – plasmids and bacteriophages – cloning vectors for E.coli; pBR322, pUC vectors, M13 and other plasmid vectors – Cosmids, Phagemids. high-cloning capacity vectors: single stranded DNA vectors (M13, fd, f1); PACs, BIBACs, Plant Transformation vectors Ti, Ri plasmids, Binary, Conjugate, selection schemes. Restriction mapping and analysis.
2. **DNA modifying enzymes**: Nucleic acid probe preparation; End-Labeling (3'- and 5'-), Random priming and Nick translation using radioactive non-radioactive labeling techniques. Hybridization techniques. PCR based methods for site-directed mutagenesis (Single primer methods viz. Mis-incorporation of mismatched oligos, Over-lap extension), whole plasmid single round PCR, mis-repair of mutant oligonucleotides, selection of mutant (dut/ung E. coli strains for SDM through uracil replacement) DNA fingerprinting – RFLP, RAPD – chromosome walking. Gel retardation assays. DNA footprinting by DNase I, DNA microarray analysis. Evolution in enzymology (Klenow, T7 polymerase, Taq polymerase).
3. **Expression vectors in prokaryotes.** Selectable markers– SV40, Papilloma, Retrovirus, Baculoviral vectors. Gene transfer techniques – Agrobacterial plasmids – Ti plasmid and viral vectors. application. PCR methods and genomics- PCR, Real time-PCR, Inverse PCR, nested PCR, Taqman assay, RACE PCR. Protein Expression Vectors (expression systems for high level protein expression in E.coli, codon usage), protein purification tags, histidine and GST tags, IMAC. E. coli expression vectors-lac, tac and T7 promoter based vectors.
4. **Different strategies for in vitro and in vivo cloning** – Preparation of rDNA, Preparation of cDNA and genomic DNA libraries – screening procedures – gene transfer technologies– Site directed mutagenesis-Methods of nucleic acid sequencing-Sanger's method, Genome sequencing, Self-priming methods, replacement synthesis, Okayama and Berg strategy, use of Adapters/Linkers and methylation for directional cloning. Next generation sequencing methods.
5. **Marker-exchange mutagenesis in bacteria.** Fusion protein-down-stream processing of recombinant proteins-Applications in medicine – Transgenic and knockout animals. Gene therapy-Human therapies – tPA, interferon, antisense molecules. Genetically modified food – bioremediation with recombinant microorganisms– forensic science – genetic diversity – Agriculture, crop improvement – production of biosensors, enzymes – safety guidelines in rDNA research – containment and disposal.

Pre-requisite Courses: NONE

Reference Books:

1. "Gene Cloning and DNA Analysis: An Introduction", T. A. Brown, Blackwell, Sixth Edition, 2010.
2. "Principles of Gene Manipulation and Genomics", Sandy B. Primrose and Richard Twyman, Wiley, 2009.
3. "From Genes to Genomes: Concepts and Applications of DNA Technology", Jeremy W. Dale, Malcolm von Schantz, Nicholas Plant. Wiley-Blackwell, Third Edition, 2011.
4. "Molecular Cloning: A Laboratory Manual", Michael R. Green and Joseph Sambrook, Cold Spring Harbor Press, Fourth Edition, 2012.
5. "GENES XI", Jocelyn E. Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick. Lewin's, Jones & Bartlett Learning, 2012.

UE16BT342: ANIMAL BIOTECHNOLOGY (4-0-0-0-4)

Course Objectives:

- To provide a basic understanding of animal biotechnology and its applications in study of various human diseases and gain knowledge about the live stocks.

Course Outcomes:

At the end of the course, the student should be able to

- Impart knowledge on production of transgenic animals and how to improve the meat and milk production.
- Inculcate the understanding of cell culture technique, significance of its cultivation and its application in the production of valuable products.
- To develop an understanding on basic pattern of animal breeding, controlling characters and disorders.
- Understanding the various strategies in vaccine production and implementation of stem cell research in diagnosing various diseases in human.

Course Content:

1. **Animal Cell Culture:** Introduction, cell culture laboratory-design, layout and maintenance, Equipment and Instrumentation. Methods of sterilization, types of culture media, composition, preparation and metabolic functions of culture media, Role of CO_2, Serum and supplements. Serum and protein free defined media and their applications. Culture and maintenance of primary and established cell lines. Biology of cultured cells, culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, measurement of viability, cytotoxicity, growth parameters.
2. **Stem cells and tissue engineering:** Stem cells, scope, embryonic and adult stem cells, properties, identification, stem cells culture,

techniques and their applications in modern clinical sciences. Tissue engineering, biomaterials used in tissue engineering, three-dimensional culture and transplantation of engineering cells. Tissue engineering of skin, bone and neuronal tissues.

3. **Transgenic animals and cloning:** Scope and methods of obtaining transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases. Animal cloning, methods and their importance with reference to domestic animals. Genes influencing production traits. IVF- technology for livestock and humans. Mitochondiral DNA of farm animals, applications of genome analysis of animal breeds.
4. **Applications:** Applications of Animal biotechnology in poultry, aquaculture and sericulture Industries. Current status of livestock, Improvement of biomass, disease resistant, recombinant vaccines for poultry. Improvement of livestock-pharming products. Pharmaceutical glyco proteins produced by mammalian cells-tissue plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons, Cell culture-based vaccines.
5. **Bioethics:** Bioethics in Biodiversity, ethics of resource management, impact of patenting on biodiversity rich developing countries. Ethical issues associated with consumptions of genetically modified animals and foods. Ethical implication of human genome project, international ethical and legal issues connected with human genome diversity research. Foetal sex determination implications. Genetic studies of ethnic races.

Pre-requisite courses: NONE

Reference Books:

1. "Animal Biotechnology, Comprehensive Biotechnology, First Supplement", Babiuk L.A., Philips J.P, Moo Young M, Pergamon press, New York, 1989.
2. "Animal Cell Culture: Essential Methods", John Davis, Wiley-Blackwell and Sons publisher, First edition, 2011.
3. "Animal Cell Culture: Concept and Application", Bhatt, Sheelendra M., Morgan & Claypool publishers, First edition, 2011.

UE16BT343:
REACTOR ENGINEERING (4-0-0-0-4)

Course Objectives:

- To familiarize with the different types of reactors based on reactions catalyzed by solids, packed bed reactors.
- To understand mass transfer limitation in gas/liquid reaction on solid catalysts, trickle bed reactors, slurry reactors.
- To develop performance equations for different reactor types.
- To get the know-how on the design of reactors for enzyme reactors or fermentors and microbial fermentors.

Course Outcomes:

At the end of the course, the student should be able to

- Identify different phases and its limitations on solid catalyzed reactions.
- Design or develop performance equation for different reactors types using the rate limiting steps.
- Analyze or design reactors for enzyme production or microbial fermentations.

Course Content:

1. **Reactions Catalyzed by Solids:** Introduction, Complications of the rate equation, Contacting patterns for two phase systems, The spectrum of kinetic regimes, The rate equation for surface kinetics, Pore diffusion resistance combined with surface kinetics – Single cylindrical pore (1st order reaction), Porous Catalyst particles, Heat effects during reaction.
2. **Solid Catalyzed Reactions:** Performance equation for reactors containing porous catalyst particles – Plug flow, Mixed flow and Batch, Experimental methods for finding rates, Determining controlling resistances and the rate equation, The Packed Bed Catalytic Reactor: Introduction, Staged Adiabatic Packed Bed Reactors – Different types.
3. **G/L Reactions on Solid Catalysts:** Trickle Beds and Slurry Reactors: The general rate equation, Performance of an excess of component B, Performance of an excess of component A, Which kind of contactor to use.
4. **Biochemical Reaction Systems:** Enzyme Fermentation: Michaelis-Menten Kinetics (M-M Kinetics) – Batch or Plug Flow Fermentor, Mixed Flow Fermentor, Alternative methods for evaluating k and C_M, Inhibition by a foreign substance – Competitive and Non-competitive inhibition, Kinetics of competitive inhibition, How to tell between competitive and non-competitive inhibition from experiment. Microbial Fermentation - Introduction, Constant Environment Fermentation, Batch Fermentor – Qualitative, Mixed Flow Fermentor, Product Distribution and Fractional Yields, Kinetic Expressions – Availability of food, Effect of harmful wastes, General kinetic expression.
5. **Biochemical Reaction Systems:** Substrate-Limiting Microbial Fermentation - Batch or Plug Flow Fermentors, How to find Monod constants from batch experiment, Mixed Flow Fermentors – No Cells in feed stream, Feed stream containing cells, Optimum operation of fermentors.

   Product-Limiting Microbial Fermentation - Batch or Plug Flow Fermentors (n = 1), Mixed Flow Fermentors (n = 1), Fermentation with n not equal to 1 (Poison Limiting Kinetics).

Pre-requisite Courses: NONE

Reference Books:

1. "Chemical Reaction Engineering", Octave Levenspiel, John Wiley and Sons, Third Edition, 1999.
2. "Elements of Chemical Reaction Engineering", Scott Fogler H, Prentice Hall India, Third Edition, 2002.

UE16BT344:
SYSTEMS BIOLOGY (4-0-0-0-4)

Course Objectives:

- To make students learn about concepts of modeling of biological processes and their representation.

Course Outcomes:

At the end of the course, the student should be able to

- Model and simulate various biological processes using bioinformatics tools.
- Understand the importance of modeling and simulation of biological processes.

Course Content:

1. **Introduction to Systems Biology:** Scope, Applications. Concepts, implementation and application. Databases for Systems Biology, Mass Spectrometry and systems Biology.
2. **Modeling Tools:** SBML, MathML, CellML, Petri Nets.
3. **Models and Applications:** Natural Language Processing and Ontology enhanced Biomedical data mining. Integrated Imaging Informatics. Standard platforms and applications - metabolic control analysis, glycolysis, metabolic network, flux balance analysis. Signal Transduction - Jak-Stat pathway, MAP kinase. Modeling of Gene Expression - lac operon. Quasispecies model. Reconstruction of metabolic network from Genome Information.
4. **Integrated Regulatory and Metabolic Models:** Circadian rhythms. Gene Regulatory Networks, attractor, and Boolean

functions. Mapping Genotype – Phenotype relationship in cellular networks.

5. **Multiscale representations of cells and Emerging phenotypes:** Multistability and Multicellurarity, Spatio-Temporal systems biology, Cytomics – from cell state to predictive medicine.Human Interactome.

Pre-requisite courses: NONE

Reference Books:

1. "Computational Systems Biology", Andres Kriete, Roland Eils, Academic Press, 2006.
2. "Systems Biology", Andrzej K. Konopka, CRC Press, 2006.
3. "Systems biology in practice: concepts, implementation and application", Edda Klipp, Wiley-VCH, 2005.

UE16BT345: HEALTH DIAGNOSTICS (4-0-0-0-4)

Course Objectives:

- Demonstrate knowledge of various diseases, causative agents and knowledge of disorders.
- Develop comprehension of traditional and molecular diagnostic techniques.
- Develop approaches to design and device diagnostic procedures.
- Enhance students' knowledge of recent diagnostic techniques.

Course Outcomes:

- At the end of the course, the student should be able to
- Have knowledge and understanding of human pathology and genetic disorders.
- Have an understanding of molecular and immunodiagnostic techniques.
- Differentiate between normal and abnormal diagnostic data.

Course Content:

1. **Diseases and Diagnosis:** Overview of diagnostic tests. In born errors of metabolism (PKU,) Chromosomal disorders: autosomal and sex chromosomal disorders (Down's syndrome, Klinefelter syndrome). Dynamic mutations (trinucleotide expansions in Fragile –X syndrome). Infectious diseases: Bacterial diseases (Tuberculosis), viral diseases (AIDS), fungal diseases (candidiasis) and parasitic diseases (Malaria). Hemoglobinopathies (sickle cell disease, Thalassemia). Neurological disorders(Parkinson's disease), Immunodeficiency diseases (SCID).Metabolic disorders: diabetes mellitus. Occupational diseases: Penumoconiosis.
2. **Molecular Diagnostics:** Karyotyping: banding techniques for detection of chromosomal disorders. Fluorescent in situ hybridization (FISH). Cancer cytogenetics: spectral karyotyping and comparative genomic, hybridization (CGH). DNA diagnostics: PCR based diagnostics; PCR-OLA, ligation chain reaction. Single nucleotide polymorphism and detection techniques. Southern blot-based diagnosis (SCA). Enzymes in clinical diagnosis. Isozyme analysis-alkaline phosphatase, Lipid profiles: HDL, LDL.
3. **Antigen-antibody Reactions:** Antigen antibody interactions. Immunoassay classification: homogenous and heterogenous immunoassay. Recent advances- Liposome immunoassay, flow-injection immunoassay, capillary electrophoresis immunoassays, immonosensors. Signal amplification systems.
4. **Imaging Diagnostics**: Imaging Techniques (Basic Concepts), Invasive and Non- Invasive. Principle and applications of Electrocardiography (ECG), Electroencephalography (EEG), Computerized Tomography (CT), Magnetic Resonance Imaging (MRI), Ultrasound Imaging (US), Positron Emission Tomography (PET).
5. **Advances in Diagnosis:** Biosensors, types of biosensors, Clinical proteomics, Lab-on-a chip, Microarrays and their applications. Bio-MEMs in disease diagnosis. Nanodiagnostic tools. Rapid diagnostic kits.

Pre-requisite Courses: NONE

Reference Books:

1. "Textbook of Clinical Chemistry and Molecular Diagnostics", David Bruns, Edward, Ashwood Carl Burtis, Elsevier, 2006.
2. "Essentials of Diagnostic Microbiology", Lisa Anne Shimeld, Delmar Tho, Cengage Learning, 1999.

UE16BT346: NANOBIOTECHNOLOGY (4-0-0-0-4)

Course Objectives:

- Provide working knowledge of nanotechnology principles and its industry applications.
- Apply key concepts in materials science, chemistry, physics, biology and engineering to the field of nanotechnology.

Course Outcomes:

At the end of the course, the student should be able to

- Design and conduct experiments, as well as to analyze and interpret data related to nanosciences.
- Design a process to meet realistic societal needs relevant to economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
- Identify, formulate, and solve engineering problems.

Course Content:

1. **Introduction: History of Nanotechnology and Nanobiotechnology**: scope and Applications. Introduction and overview of Quantum concepts. Nanomaterials and Nanobiomaterials: Structures and properties of Carbon based, metal based and bionanomaterails: Fullerenes, Bucky Ball, Nanotubes, Quantum Dots, Magnetic, Nano Shells, Dendrimers, Nanocarriers, Nanocrystals, Nanowires, Nanomembranes, hybrid biological/inorganic, protein & DNA based nanostructures. Introduction and overview of first, second and third generation biomaterials.
2. **Characterization of Nanostructures:** UV-Visible spectroscopy, Electron Microscopy-Scanning electron microscopy (SEM), Atomic Force microscopy (AFM), Transmission electron microscopy (TEM), Scanning Probe microscopy (SPM), Scanning tunnel microscopy (STM); Fourier Transform infrared spectroscopy (FTIR); X-ray spectroscopy.
3. **Nano Synthesis and Fabrication:** Introduction & overview of Nanofabrication: Bottom up-self assembly and Top down approaches using processes like Ball milling, Sol-gel Process, Chemical Vapour deposition (CVD). Plasma or flame spraying synthesis, Ion-Bean sculpting electrodeposition and various lithography techniques. Nanolithography and Soft lithography. Green synthesis of nanoparticles, Biomolecule modules for nanofabrication, applications and developments. Nanobiosensors in modern medicine, environmental monitoring and remote sensing.
4. **Application of Nanobiotechnology**: Medical Nanobiotechnology: Diagnostics: Imaging: Benefits and Applications. Nanotherpeutics: cancer treatment – Nanotechnology based chemotherapy (Smart Bomb), Pebbles, wound care products, Implantable materials for vascular interventions, Implantable materials for orthopaedics and dentistry. Active implantable devices and biomics. Nanosurgery. Pharmaceutical Nanobiotechnology: Drug delivery – Nanoparticles used

as drug delivery systems, types of drug loading, drug release (sustained and targeted release mechanism), Biodegradable polymers. Application in the field of Nano Surgery and Tissue Engineering. Molecular Nanotechnology, Biomolecules-nanomaterial adducts in diagnostics, targeted drug delivery.

5. **BioMEMS and NEMS:** Micro & Nano-Electromechanical systems – Fabrication process – choice of materials – advantages and limits of various approaches, Applications, Thermal Radiations, Magnetic, Chemical and Mechanical Transducers –Sensing and Actuators. Nano Safety Issues: Nanotoxicology: Toxicology health effects caused by Nanoparticles, Ethics, Challenges and Future.

Pre-requisite Courses: NONE

Reference Books:

1. "Nanobiotechnology", P.C.Trivedi, Pointer Publishers, 2008.
2. "Introductory Nanobiotechnology", Siddhartha Shriastava, New Central Book Agency, 2013.
3. "Nanobiotechnology", Vedpriya and Rishi kumar, LAP,Lambert Academic Publishing, 2011.

UE15BT401:
FOOD BIOTECHNOLOGY (3-0-2-0-4)

Course Objectives:

- To comprehend the nature of essential food constituents and their influence on organoleptic, physical, chemical and biological properties of food.
- To understand the concept of food spoilage, food analysis, food processing and preservation.
- To obtain knowledge on regulatory compliances related to food production and food safety.

Course Outcomes:

At the end of the course, the student should be able to

- Analyze quality of food.
- Differentiate various preservation techniques.
- Gain knowledge of food processing regulations.

Course Content:

1. **Basic Aspects of Food & Nutrition:** Food constituents-carbohydrates, proteins, lipids, vitamins, minerals, fibers. Antinutritional factors – role in body functions, deficiency. Calorific value of nutrients, digestibility. Basal metabolic rate, recommended daily allowance. Physico-Chemical and Functional Properties of Food Constituents: Colloidal systems in foods. Rheological properties of solids and liquid foods. Functional properties of carbohydrates (starch-gelation), proteins (texturization) and fats (emulsification) in foods.
2. **Food Analysis & Spoilage:** Proximate analysis (carbohydrates, proteins, lipids, crude fiber, vitamins and minerals). Organoleptic analysis (flavour –taste, palatability and aroma). Mechanism of flavour perception; appearance, texture. Food spoilage: Induced by physical factors (water activity, temperature, humidity). Chemical (pH, redox potential, extraneous residues). Biological factors (enzymes, inhibitors, microbial contaminants from various sources). Types of spoilage- pigmentation, curdling, slime, rancidity, putrefaction (off-flavours), gassiness, browning. Food intoxication, food borne infections
3. **Food Preservation and Processing**: Physical methods of preservation – temperature, irradiation, drying, canning, freezing. Equipment for pasteurization and cleaning-in-place (CIP). Chemical methods of preservation – organic acids, salts of organic acids, Gaseous preservatives, pickling. Packaging- types, materials, equipment; Labelling aspect, Edible films, storage –MAS Food additives: Vitamins, minerals, flavoring components, colours.
4. **Fermented food, GM food, Functional food:** Fermented milk products, soya products, cereal products, beverages. Genetically modified foods-cereals and fruits. Functional foods- from cereals, nutraceuticals. Preparation of jams and jellies. Single cell protein, Mushroom extracts.

   Biotechnology of Food industry Waste utilization: Waste generated from agriculture and food processing plants, transformation of wastes to produce enzymes, colours, soluble fibres and essential oils.
5. **Perspectives of Food Industry:** Objectives of food industry. Factors influencing product development, marketing and promotional strategies. Food safety regulations, FDA, FSSAI, ISO. HACCP guidelines. Visit to food industry.

Reference Books

1. Food Biotechnology: Principles and Practice, Joshi V. K. and Singh, R. S. IK International Publishing House Pvt. Ltd., 2012.
2. Modern Food Microbiology, Jay, J. M, OxfoRd CRC Press, Eighth Edition, 2008.
3. Food Science & Nutrition, Sunetra Roday, Oxford University Press, 2007.

Pre-requisite Courses: NONE

Reference Books:

1. "Food Biotechnology: Principles and Practice", Joshi V. K., Singh, R. S., IK International Publishing House Pvt. Ltd., 2012.
2. "Modern Food Microbiology", Jay J. M, OxfoRd CRC Press, Eighth Edition, 2008.
3. "Food Science & Nutrition", Sunetra Roday, Oxford University Press, Second edition, 2007.

Experiments:

1. Determination of viscosity in milk using Viscometer.
2. To check the quality of milk by Methylene blue dye reductase test (MBRT).
3. Enumeration of microbial population from spoiled food substances.
4. Isolation and biochemical characterization of food spoilage microorganisms.
5. Estimation of Vitamin C (Ascorbic acid) from citrus fruits by titration.
6. Food preservation techniques a) Canning b) Chemical preservatives.
7. Quantitative method of carbohydrate estimation in sweet potato and beetroot.
8. Quantitative method of protein estimation in soyabean.
9. Quantitative method of lipid estimation in egg.
10. Test to detect food adulteration in chillies, flour, honey and milk

UE15BT402:
DOWNSTREAM PROCESS TECHNOLOGY (3-0-2-0-4)

Course Objectives:

- Understand the role of downstream processing in Biotechnology industry.
- Demonstrate the major strategies used for purification of bio-molecules like proteins/DNA and other small molecules having commercial importance.
- Interpret different methods of purification and its application in various level of downstream process technology.
- To design a cost-effective method for industrial purification of bio-molecules.

Course Outcomes:

At the end of the course, the student should be able to

- Understand downstream process designing for a cost-effective method of purification of product for industrial scale.
- Design different purification process.

Course Content:

1. **Role of Downstream Processing in Biotechnology:** Role and importance of downstream processing in biotechnological processes. Problems and requirements of by-product purification, Economics and downstream processing in **Biotechnology**: Cost cutting strategies - optimal methods for product recovery. Characteristics of biological mixtures: cells as colloidal systems. Physico-chemical factors to be considered for different products recovery, concentration of cells - physical and chemical characteristics. Process design criteria for various classes of by-products. High volume-low value products e.g. citric acid, ethanol and penicillin and Low volume-high value products e.g. recombinant proteins like insulin, Physico-chemical basis of bioseparation process e.g. Manufacture of citric acid.
2. **Primary Separation and Recovery Processes:** Cell disruption methods for intracellular products, removal of insoluble, biomass (and particulate debris) separation techniques: Flocculation, Sedimentation, Centrifugation, Filtration methods. Product Separation Techniques: Liquid-liquid extraction, distillation and evaporation.
3. **Membrane Science and Technology:** Types of membrane processes, Membrane - based separations (micro and ultra filtration) theory. Design and configuration of membrane separation equipment; applications of microfiltration, ultrafiltration and reverse osmosis. Solute polarization, cake formation in membrane. Ultra filtration - causes of cake formation. Consequences and control measures. Tangential Flow Filtration, Hybrid separation technologies -Dialysis - principle, and applications. Crystallization: principles, process & examples.
4. **Enrichment Operations:** Precipitation with salts, organic solvents - principle and methods. Extractive operations: Aqueous Two-Phase extractions, Supercritical liquid extraction, Process integration, *In-situ* product removal.
5. **Separation Techniques: Chromatography:** Adsorptive chromatographic separation processes: Partition Chromatography, TLC, GC - nor **c**mal and reverse phase. HPLC-Principle and applications, Gel permeation Chromatography and Ion exchange chromatography: Principle, equipment and applications. Membrane chromatography. Electro chromatography - principle. Electrophoretic separations: Native PAGE, SDS-PAGE and capillary electrophoresis - principle and applications, Freeze drying.

Pre-requisite Courses: NONE

Reference Books:

1. "Downstream Process Technology – A New Horizon in Biotechnology", N K Prasad, PHI Learning Pvt. Ltd., New Delhi, 2010.
2. "Bioseparations – Principles and Techniques", Sivasankar, Eastern Economy, Second Edition, 2008.

Experiments:

1. Solid- liquid separation methods: To estimate the rate of sedimentation –*Spirullina*/gram flour etc.
2. Product enrichment operations: Precipitation-fractionation of a protein from yeast by salting out method.
3. Product enrichment operations: To extract amylase enzyme using Two -aqueous phase extraction method.
4. Separation of amino acids / carbohydrates by TLC.
5. Extraction of intracellular enzymes by physical method of cell disruption and measure the enzyme activity of the recovered product.
6. Solid-liquid separation technique by centrifugation and calculate the terminal velocity and residence time of the supernatant.
7. Estimation of citric acid from fermented broth by colorimetric method.
8. Estimation of dry weight using different temperature-Product drying techniques.
9. Recovery process- study of filtration of yeast culture and calculate the specific cake resistance and resistance of the filter medium.
10. Primary separation technique – effect of flocculation in yeast and ethanol assay

UE15BT403:
DRUG DEVELOPMENT AND TOXICOLOGY (3-0-2-0-4)

Course Objectives:

- The course focuses on all aspects of drugs development beginning with their isolation from varied sources, extraction, purification, final formulation and clinical trials.
- The course gives students an overall view on drugs, their mechanism of action, their therapeutic and toxicological effects & their metabolic fate in the human body.
- The course will provide an understanding of dose response, the mechanisms of toxicity and toxicity testing.
- The course also focuses on the ADMET (Absorption, Distribution, Metabolism, Elimination & Toxicity) studies, pharmacokinetic, pharmacodynamic and pharmacogenetic aspects of drug action.
- An insight into the advanced systems of drug delivery will help the student to know the recent trends in drug delivery.
- This course aims to develop the key skills in students required in scientific work which includes practical research skills, analytical and presentation skills.

Course Outcomes:

At the end of the course, the student should be able to

- Acquire knowledge of the processes underlying drug development, the protocols involving preclinical and clinical trials, ethical issues and an awareness of factors influencing the global drug industry.
- Design protocols for isolation of bioactive compounds from natural sources, conduct qualitative analysis and study their pharmacological and toxicological aspects.
- Demonstrate knowledge of the fundamental pharmacokinetic and pharmacodynamic processes in the body, the chemical and cellular basis of biotransformation in drug metabolism and the impact of genomic variation on drug pharmacokinetics and pharmacodynamics.
- Have current information on advanced drug delivery systems.
- Develop practical research skills, analytical and presentation skills required in scientific work.

Course Content:

1. **Sources of New Drugs:** Drug Discovery Process, Sources of drugs: Medicinal plants, animal & microbial sources, Sources of drugs: Organic synthesis. Extraction of bioactive compounds: Physical & chemical extraction methods of bioactive compounds from plants & microbial sources: Purification procedures & Formulation of bioactive compounds; Biosimilars
2. **Basics of Toxicology and Bioassays:** Principles of Toxicology, Types of toxicology studies, Acute & chronic Toxicity, Dose response relationships: Graded, Quantal, Time action curves. Basic concepts of IC_{50}, ED_{50} & LD_{50} , Bioassays types and its

applications in toxicology, Plant assays, Microbial Assays & Animal Cell culture assays, Heavy metals, heavy metal antagonists & treatment of poisoning, Histopathological studies of toxicity with animal organs.

3. **ADME Studies:** Introduction to ADME: Pharmacokinetics and Pharmacodynamics, Routes of drug administration & Dynamics of drug absorption, Membrane Transporters & Drug response, Distribution (Translocation) -Membrane barriers, Bioavailability & drug metabolism – Liver, Storage organs & Elimination, Drug Receptors, Mechanism of drug action, Pharmacogenetics.
4. **Biotransformation:** Introduction to biotransformation, General principles: Receptor sites and translocation factors, Types of Biotransformation: Phase I: Non synthetic –Oxidation, Reduction and Hydrolysis, Mixed Function Oxygenases; Phase II: Synthetic – Conjugation, Antidotes, Biotransformation of drugs: A Case Study (Paracetamol), Biotransformation of xenobiotics (DDT) , Polyaromatic hydrocarbons & DNA adducts
5. **Advanced Drug Delivery Systems:** Traditional drug delivery vs Targeted drug delivery systems Merits & Demerits, Drug delivery systems: Microspheres & microcapsules, vesicles, micelles, Dendrimers as drug carriers, Polymer Therapeutics: Polymer drug conjugates, Polymeric micelles, Liposomes. Transdermal & topical systems for drug delivery: Gel matrix & patch technology,

   Nanotechnology in drug delivery systems: MEMS & NEMS,

   Nanomaterials for drug delivery: Nanoparticles, Nanospheres & Nanocapsules,

   Thin film drug delivery: Oral drug strips, Quantum dots, Acoustic targeted, Neural & Heparin based delivery systems .

Pre-requisite Courses: NONE

Reference Books:

1. "Environmental Biology and Toxicology", P D Sharma, Rastogi Publications, Delhi, 1993.
2. "Manual Pharmacology and Therapeutics", Goodman and Gilman's, McGraw-Hill Education, Second edition, 2015.

Experiments:

1. Isolation of starch from potatoes.
2. Isolation of caffeine from tea leaves.
3. Isolation of pectin from orange peel.
4. Isolation of piperine fron black pepper.
5. Phytochemical analysis.
6. Quality analysis of L-Dopa using TLC.
7. Estimation of IC_{50} of toxic metal inhibitors in an enzyme assay.
8. Search, retrieve and analyze bioactive compounds from PubChem database.
9. Search and retrieve the structure of small bioactive compounds in PubChem database.
10. Evaluation of antibacterial activity of plant extracts.

UE15BT411:
MOLECULAR GENETICS (4-0-0-0-4)

Course Objectives:

- Provide comprehensive information on model organisms and their utility in molecular genetics.
- Give an overview of human genome, analysis of genetic data and mapping techniques.
- Develop comprehension of genes involved in cancer and cell death.
- Critical understanding of axis and pattern formation in organisms.
- Apply the principles of gene information in addressing clinical disorders and ELSI issues associated with sharing genetic information.

Course Outcomes:

At the end of the course, the student should be able to

- Comprehend various model organisms.
- Understand regulation of gene expression at various levels.
- Differentiate genetics of normal and cancer cells.
- Explore molecular mechanisms involved in development.
- Analyze ethical aspects of sharing genetic information.

Course Content:

1. **Model Organisms & their Genomes:** Model organisms: Viruses - Lambda Phage, Prokaryotes (*E. coli*); Eukaryotes: *Chlamydomonas reinhardtii, Saccharomyces cerevisiae;* filamentous fungi (*Neurospora*); *Arabidopsis thaliana - Zea mays*, *Drosophila melanogaster; Caenorhabditis elegans; Xenopus laevis; Mus musculus.*
2. **Human Genetics:** The history, organization, goals and value of the Human Genome Project. Genetic and physical mapping of the human genome. Organization of the human genome. Genetic mapping of mendelian characters; Identifying human disease genes; genetic mapping of complex characters; genetic testing in individuals and populations. Extra nuclear inheritance. Molecular pathology of diseases and chromosomal disorders.
3. **Cancer Genetics:** Control of cell cycle, chromosomal instability, Genes involved in cancer: proto-oncogenes, oncogenes, tumor suppressor genes. Gain of function and loss of function mutations. Inherited cancers: breast cancer, colorectal cancer. Multistep evolution of cancer. Apoptosis and cell senescence.
4. **Developmental Genetics:** Basic concepts, Binary switch genes (Myoblast-determining genes; control of eye formation), genetics of embryonic development in *Drosophila;* zygotic genes and segment formation (Gap genes, pair rule genes, segment polarity genes, selector genes; antennapedia type genes in *Xenopus;* flower development in *Arabidopsis thaliana;* Cell-cell interactions in *Caenorhabditis elegans.*
5. **Gene Based Therapeutics:** Gene therapy: Principles, the technology of classical gene therapy. Gene therapy for inherited disorders-SCID, neoplastic disorders and infectious disease-HIV. Therapeutics based on targeted inhibition of gene expression and mutation correction *in vivo*. Gene silencing: RNAi, microRNA therapeutics and Stem cell therapy. Ethical, legal, and social issues *(*ELSI*)* of sharing genetic information.

Pre-requisite Courses: NONE

Reference Books:

1. "Molecular Genetics", Hancock J. T., Viva Books Pvt Ltd, 2008.
2. "Human Molecular Genetics", Tom Strachan, Andrew P Read, Garland Science Publications, Fourth Edition, 2010.

UE15BT412:
IPR, BIOETHICS AND BIOSAFETY (4-0-0-0-4)

Course Objectives:

- To create IPR consciousness; and familiarize the students about the documentation and administrative procedures relating to IPR in India.
- Understanding, defining and differentiating different types of intellectual properties (IPs) and their roles in contributing to organizational competitiveness.
- Understanding the Framework of Strategic Management of bioethis and Biosafety levels in labs.

Course Outcomes:

At the end of the course, the student should be able to

- Identify different types of Intellectual Properties (IPs), the right of ownership, scope of protection as well as the ways to create and to extract value from IP.

- Recognize the crucial role of IP in organizations of different industrial sectors for the purposes of product and technology development with reference to Biotechnology.
- Identify activities and constitute IP infringements and the remedies available to the IP owner.
- Be familiar with the processes of Bioethics and Biosafety at different levels.

Course Content:

1. **Introduction to Intellectual Property Rights:** Concept of Intellectual Property, Kinds of Intellectual Property: Trademarks, Copyright and related Rights, Industrial Design, Traditional Knowledge, Geographical Indications. Conventions and Treaties Relating to Global Administration of Intellectual Property Rights, IPRs and Information Technology, IPRs and Traditional Knowledge, Intellectual Property Rights in India and world.
2. **Patents, Copyright and Trademarks**: Classification of Patents, Patent Law in India. Patent Office and Authorities, Grant of Patent, Right and Obligation of a Patentee, Infringement of Patents, Patents – International Law, Social Implication of Patents. Copyrights, Copyright Law in India, Registration and terms of Copyright, Copyright infringement, Trademarks – forms of Intellectual Property, Law of trade Marks in India, Trademarks –International Law.
3. **Biotechnology and Intellectual Property Rights:** Patentability of Biotechnology, territorial nature of patents, Legal, social and policy implications of genetic patents, importance of patents in genetic research, IPR protection to Bioinformatics and Genomic databases, implications of genetic patents on human genetic resources. Protection of GMOs IP.
4. **Bioethics and Legal Issues:** Introduction to bioethics, need of bioethics, Public perception related to Biotechnology from developed and developing countries. Legal and socio-economic impacts of biotechnology, issues in use of genetically modified life forms. Ethical issues of Human Genome Project. Social and ethical implication of biological weapons.
5. **Biosafety and Risk Assessment:** Introduction; Historical Background; Levels of biosafety Primary Containment for levels; specific microorganisms; Recommended biosafety levels for Infectious agents and Infected Animals. Biosafety guidelines – NIH and Government of India. Guidelines for research in transgenic organisms. Overview of National Regulations and relevant International Agreements including Cartagena Protocol, GMP and GLP.

Pre-requisite Courses: NONE

Reference Books:

1. “Encyclopaedia of Ethical, Legal and Policy issues in Biotechnology”, Murray T. M., Mehlman M. J., John Wiley & Sons, First edition, 2000.
2. “Biotechnology and Safety Assessment”, Thomas J. A., Fuch R. L., Academic Press, Third edition, 2002.

UE15BT413: MOLECULAR MODELING & SIMULATION (4-0-0-0-4)

Course Objectives:

- To provide the students fundamental concepts of protein structure and molecular mechanics.
- To provide the students the basics of molecular dynamics.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the simulation techniques.
- Analyze and apply the molecular modeling techniques.

Course Content:

1. **Introductory concepts:** Introduction to Molecular Modeling, Introduction to X-Ray crystallography and NMR spectroscopy. Introduction to PDB and 3D Structure data. Protein Structure Hierarchy: Helices, β-Sheets, Supersecondary and Tertiary structure, Folds, Quaternary structure. Protein folding and misfolding.
2. **Foundations of Molecular Modeling:** Quantum mechanics foundations of molecular mechanics, Model and energy formulations. Force Fields- Formulation of the Model and Energy, Normal modes, Bond length potential, Bond angle potential, Torsional potential, Van der Waals potential, Coulomb potential.
3. **Optimization & Energy Minimizations:** Optimization fundamentals, basic algorithmic components, Energy minimization, conformational analysis.
4. **Basics of Molecular Dynamics:** An overview. Molecular dynamics simulation methods-introduction, simple models, molecular dynamics at constant temperature and pressure, solvent effects in molecular dynamics. Monte Carlo simulation methods.
5. **Applications:** Challenges in molecular modeling. Molecular modeling in rational drug design. Modeling a complex environment - Simulation methods for membranes.

Pre-requisite Courses: NONE

Reference Books:

1. “Molecular Modeling Principles and Applications”, Andrew R. Leach, Prentice Hall USA, Second edition, 2001.
2. “Molecular Modeling and Simulation: An Interdisciplinary Guide”, Tamar Schlick, Springer, Second edition, 2010.

UE15BT414: METABOLIC ENGINEERING (4-0-0-0-4)

Course Objectives:

- To provide the students essential concepts and applications of metabolic engineering.

Course Outcomes:

At the end of the course, the student should be able to

- Apply metabolic engineering in research.

Course Content:

1. **Introduction to metabolic engineering:** Central Metabolism: Fueling metabolism, Supply of biomass precursors, Anabolism, Anaplerosis.Coordination of metabolic reactions: Feedback inhibition, Energy charge, Multigene networks.Methods for metabolic characterization: Genome, Transcriptome, Proteome, Metabolome, Fluxome.
2. **Comprehensive models for cellular reactions**: Stochiometry of cellular reactions, Reaction rates, Dynamic mass balance.
3. **Regulation of metabolic pathways:** Regulation of Enzymatic Activity, Regulation of Enzyme concentration, Regulation at whole cell level, Regulation of Metabolic networks.
4. **Metabolic flux analysis**, Sensitivity analysis. Methods for Metabolic Flux Analysis – Metabolite Balancing, Tracer Experiments, MS and NMR in labelling measurement, Applications of metabolic flux analysis.
5. **Metabolic control analysis (MCA)**: Determination of Flux control coefficients, MCA of Linear and Branched pathways. Metabolic design: Gene amplification, Gene-disruption, Randomized and targeted strain development. Metabolic Engineering in Practice: Actual examples from research and industrial biotechnology.

Pre-requisite Courses: NONE

Reference Books:

1. “Metabolic Engineering Principles and Methodologies”, Stephanopoulos G., Aristidou A. and Nielsen J., Academic Press, 1998.
2. “Computational Analysis of Biochemical Systems”, Voit E. O., Cambridge University Press, 2000.

UE15BT415:
FORENSIC BIOLOGY (4-0-0-0-4)

Course Objectives:

- To introduce forensic science concepts with the deliberations on elements of criminalistics such as significance of physical evidence in the practice of forensic science profession.
- To introduce various disciplines of criminalistics such as forensic pathology, anthropology, odontology, engineering, fingerprint science, psychiatry, toxicology and digital forensics.
- To understand profession of forensic biology and its associated dilemma and ethics.

Course Outcomes:

At the end of the course, the student should be able to

- Apply forensic science services and its organization.
- Apply principles, precautions and procedures to conduct crime scene investigations in the light of importance of collection, maintenance and utility of physical evidence including its analysis and presentation.
- Estimate time of death by observation of the body and appreciate fundamentals of different disciplines of forensic biology including practice of ethics governing the profession.

Course Content:

1. **Introduction:** Definition and Scope, Special areas in forensic science; Examination of the dead, living cases; Historical Development of Forensic Sciences: Milestones in the history; Development of Forensic science; The Role of the Forensic Laboratory: Organization of a crime Laboratory services; Typical Sections of the Forensic or Crime Laboratory; Basic services provided by full service crime laboratories; Physical Science unit, Biological unit; Firearms unit; Document Examination unit -function and duties performed by each unit and lab; The process of criminal justice.
2. **Criminalistics:** Criminalistics in forensic science; disciplines in criminalsitics. Crime scene investigation and examination: Collection and evidence chain. Scientific Evidence in Court: Basics of Evidence; Analysis of Evidence, Locard’s Exchange Principle, Types- Testamentary and demonstrative witnesses; Physical evidence: Documentation and Collection of Physical Evidence; Collection techniques; Packaging, transport, preservation, labeling of evidence (chain of custody); Expert unit personnel – Trained evidence collection technician; analytical techniques and duties of analytical technician.
3. **Forensic Biology:** Forensic Pathology: Rigor mortis, Lovor mortis, Algor mortis; Post-mortem examination-medico legal autopsy. Forensic Anthropology; Forensic Entomology; Forensic Odontology; Forensic Engineering, Dactyloscopy: Finger prints - Classification and patterns; Forensic Psychiatry; Forensic toxicology-forensic chemistry with reference to drugs and alcohol; DNA Analysis.
4. **Digital Forensics:** Introduction, Digital cameras forensic imaging, uses of digital imaging, digital videos, scanners, presenting pictures in courtroom, forgery and steganography, Maintaining chain of custody with digital images, advantages and disadvantages of digital forensics. Sampling: Types of sampling in forensic research.
5. **Ethics in Forensics:** Professionalism in forensic science; the importance of professional ethics to science practitioners, Development of a code of conduct; code of ethics for forensic science (with reference to AAFS); Ethical requirement, impact the daily work of a forensic scientist; Ethical dilemmas and their resolution.

Pre-requisite Courses: NONE

Reference Books:

1. “Introduction to Forensic Sciences”, William G. Eckert, Elsevier, Second Edition, 1992.
2. “Encyclopaedia of Forensic Sciences”, Jay Siegel, Geoffrey Knupfer, Pekka Saukko, Elsevier, Second Edition, 2000.

UE15BT416:
ENVIRONMENTAL TOXICOLOGY (4-0-0-0-4)

Course Objectives:

- This course is designed to provide an overview of environmental toxicology, major classes of pollutants, their fate in the environment, their disposition in organisms, and their mechanisms of toxicity.
- It will emphasize on assessing the toxicity of pollutants in biological and environmental systems.

Course Outcomes:

At the end of the course, the student should be able to

- Compare and contrast toxicokinetics and toxicodynamics.
- Explain the potential fate and effects of a contaminant in the environment.
- Know about environmental toxicity testing, risk assessment, radioactivity in the environment, legislation and environmental monitoring.

Course Content:

1. **Historical Review of Human Impact on the Environment:** Development of Pollution, Major environmental pollutants, Effects of pollutants on Ecosystems, Specific examples of environmental toxicants, Toxicity of pesticides, insecticides, heavy metals, radioactive minerals, fluriodes, chemical fertilizers, their sources and entry routes. Transport of toxicants by air and water, an introduction to Food webs, Transport through food chain - bioaccumulation and biomagnification of toxic materials in food chain.
2. **Basic concepts of Eco-toxicology:** Introduction, Principles and scope of ecotoxicology. Types of toxics substances degradable and non-degradable. Factors influencing toxicity, Biochemical basis of toxicity – mechanism of toxicity and receptor mediated events, acute and chronic toxicity, Sigmoid relationships, Threshold limit value, LC50 LD50. Concept of Dosimetry: lethal, sub-lethal & chronic tests, Dose response curves
3. **Environmental Monitoring**: Environmental impact assessment, Methods of monitoring, Sampling, Analytical techniques for detection of environmental toxicants, biomonitoring, programs and parameters of biomonitoring, concept of bioindicator, bioindicator groups and examples, Environmental impacts of pesticides: Physiological and metabolic effects on flora and fauna.
4. **Environmental Toxicity testing:** Toxicology of major pesticides, Evaluation of toxicity, Methods used to assess toxicity of toxic materials. Concepts of Bioassay- types, characteristics. Importance and significance of bioassay, Microbial bioassay for toxicity testing, Bioassay test models and classification. Human toxicology and assessment of risk to humans, types of toxicity testing, Organ toxicity: Hepatotoxicity, Nephrotoxicity,

Pulmonary toxicity, Neurotoxicity with specific toxicant examples and tissue damages caused

5. **Toxicokinetics and Toxicodynamics:** Fate of environmental toxicants, Xenometabolism. Health, Hygiene and Legislation- Epidemiology and health ecology. Epidemiological diseases due to pollution problems., Occupational and industrial health management, Health risk assessment of toxic chemicals. Ecological risk assessment in environmental management, Overview of Environmental legislation, Legislative perspective in ecological risk assessment, Human health risk assessment

Pre-requisite Courses: NONE

Reference books:

1. "Principles of Environmental Toxicology", Shaw I. C., Chadwick J., Taylor&Francis ltd, First edition, 1998.
2. "Environmental biology and Toxicology", Sharma P.D. Rastogi, Lamporary., Rastogi publications, Third edition, 1994.

UE15BT421: TISSUE ENGINEERING (4-0-0-0-4)

Course Objectives:

- To understand various biological factors and extracellular matrix involved in tissue engineering.
- To identify and select various types of biomaterials for tissue engineering.
- To understand the role of tissue microenvironment, scaffold design technology and functionality of bioreactors in tissue engineering.

Course Outcomes:

At the end of the course, the student should be able to

- Analyze role of various biological factors and extracellular matrix for various engineered tissue.
- Solve problems related to various types of biomaterials for tissue engineering.
- Identify particular scaffolding technology and bioreactor environment for particular engineered tissue.

Course Content:

1. **Cell and Tissue Biology: I**ntroduction to tissue engineering. Tissue development and organization. Embryonic and adult Stem cells. Introduction to cell adhesion, Adhesion Receptors, Cell Adhesion to Biomaterials, Measurement of Cell Adhesion, Effect of Biomaterial on Physiological behaviour. Introduction to Cell migration, Characteristics of Mammalian Cell Migration, Regulation of Cell Movement, Cell Migration Assays, Mathematical Models for Cell Migration and Tissue Growth.
2. **Extracellular Matrix:** Introduction, ECM and Functional Integration of Implanted Materials, Basement Membranes and Focal Adhesions, Focal Adhesions as Signalling Complexes, ECM and Skeletal Tissues, Sources of ECM for Tissue Engineering Applications, Properties of ECM, Mining the ECM for Functional Motifs, Functions of ECM Molecules, Polymeric Materials and their Surface Modification, Formation of Gradient Structures.
3. **Tissue engineering of Biomaterials:** Introduction to synthetic polymers, Biodegradable materials vs. permanent materials, Natural biopolymers and hydrogels, Mechanical properties of biomaterials, Surface modification and characterization of polymers, Immune response to biomaterials, In vitro Assessment/biocompatibility/protein adsorption. Polymeric scaffolds for tissue engineering applications.

   Scaffold Design and Fabrication: Tissue Biomechanics, Scaffold design and fabrication, Natural Polymers for Scaffold Fabrication, Synthetic Polymers for Scaffold Fabrication, Scaffold Design Properties.
4. **Drug and Growth Factor Delivery:** Drug delivery, Mechanisms of Drug Delivery, Protein-Drug Properties, Drug Delivery in Tissue Engineering, Introduction to growth factors, Polymer scaffold delivery systems, Polymer hydrogel delivery systems, Polymer microsphere technology.

   Tissue Engineering Bioreactors: Introduction, most common Bioreactors in Tissue Engineering, Cell Seeding in Bioreactors, Bioreactor Applications in Functional Tissues, Design Considerations, Challenges in Bioreactor Technologies.
5. **Tissue Engineering Applications:** Tissue Engineering of Skin, Bone Tissue Engineering, Cartilage Tissue Engineering, Neuronal Tissue Engineering, Cardiovascular Tissue Engineering, Musculoskeletal Tissue Engineering (tendon/ligament/muscle), Adipose Tissue Engineering.

   Regulation of Engineered Tissues: Introduction, FDA Regulation, Regulation of Pharmaceutical / Medical Human Tissue Products in Europe, Regulation of Pharmaceutical /Medical Human Tissue Products in Japan, Other considerations Relevant to Engineered Tissues, Case studies.

Pre-requisite Courses: NONE

Reference Books:

1. **"Tissue Engineering",** John P. Fisher, Mikos A. G., Joseph D. Bronzino, CRC Press, 2007.
2. **"Methods of Tissue Engineering",** Anthony Atala, Lanza P., Academic Press, Elsevier, Second edition, 2006.

UE15BT422: PLANT BIOTECHNOLOGY (4-0-0-0-4)

Course Objectives:

- Provide background of Plant tissue culture.
- Demonstrate knowledge of plant transformation techniques and metabolites production.
- Develop comprehension of agriculture biotechnology.

Course Outcomes:

At the end of the course, student should be able to

- Describe different methods of plant tissue culture
- Demonstrate knowledge and understanding of methods of generation of transgenic plants
- Develop an understanding of regulatory issues associated with GM plants.

Course Content:

1. **Plant tissue culture:** Scope and Importance of plant tissue culture- Media composition and types, hormones and growth regulators, explants for organogenesis, somaclonal variation and cell line selection, production of haploid plants and homozygous lines, Micro propagation, somatic embryogenesis, protoplast culture and somatic hybridization, Selection and maintenance of cell lines, cryopreservation, germplasm collection and conservation.
2. **Plant transformation techniques:** Mechanism of DNA transfer – *Agrobacterium* mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; design of expression vectors; 35S and other promoters, genetic markers, use of reporter genes; viral vectors; Direct gene transfer methods-particle bombardment, electroporation and microinjection methods. Binary vectors, desirable features of plasmid vectors-Molecular markers; RAPD, RFLP, and SCAR
3. **Plant genomics:** *Arabidopsis thaliana* as a model plant. Maize genome project and Rice genome project mRNA profiling – overview of methods and applications to plant improvement. Molecular phenotyping, regulatory networks.

4. **Plant metabolites production**: Plant cell culture for the production useful chemicals and secondary metabolites; pigments, flavanoids, alkaloids, hairy root culture, control mechanism and manipulation of shikimate pathway. Transgenic plants for production of enzymes, biodegradable plastics, therapeutic proteins and edible vaccines. Metabolic engineering for production of secondary metabolites. Bioreactors for Scaling up of Production of Secondary Metabolites.
5. **Agricultural Biotechnology:** Transgenics for tolerance to biotic stresses - Engineering plants for tolerance to insect damage - engineering plants for fungal resistance. Transgenics for biotic stress tolerance, Transgenics for improved protein quality, Transgenics for higher ß-Carotene, Transgenic for edible vaccines.

   Biosafety of GM plants (Major biosafety concerns - Gene flow through pollen, Development of resistance in insects, Bt-transgenic based IPM in cotton, Salient features of the proposed IPM package, Human and Animal health safety issues,

Pre-requisite Courses: NONE

Reference Books:

1. "Plant Biotechnology – the genetic manipulation of plants", Slater. Oxford, Second Edition, 2008.
2. "Plant Biotechnology and Genetics: Principles, Techniques, and Applications", C. Neal Stewart, Jr. (Editor), Wiley-Blackwell; Har/Cdr *edition,* 2008.

UE15BT423: TRANSPORT PHENOMENA (4-0-0-0-4)

Course Objectives:

- To understand and address compact statement of conservation principles, along with the flux expressions, with emphasis on the similarities and differences among the three (momentum, energy and mass) transport processes.
- To predict viscosity and the mechanisms of momentum transport, thermal conductivity and the mechanisms of energy transport and diffusivity and the mechanisms of mass transport.
- To derive shell momentum, energy and mass balances.
- To arrive at expressions for velocity distributions in laminar flow, temperature distributions in solids and laminar flow, and concentration distributions in solids and laminar flow.

Course Outcomes:

At the end of the course, the student should be able to

- Predict and relate properties at molecular scales to macroscopic quantities of velocity, temperature and concentration profiles.
- Distinguish the similarities and differences between momentum, energy and mass transport processes.
- Set up shell balance equations for the momentum, energy and mass balances and arrive at velocity, temperature and concentration profiles.

Course Content:

1. **Viscosity and the Mechanisms of Momentum Transport:** Newton's Law of Viscosity, Problem - Calculation of Momentum Flux, Generalization of Newton's Law of Viscosity, Pressure and Temperature Dependence of Viscosity, Problem – Estimation of Viscosity from Critical Properties, Molecular Theory of Viscosity of Gases at Low Density, Problem – Computation of Viscosity of a Gas Mixture at Low Density, Problem – Prediction of Viscosity of a Gas Mixture at Low Density, Molecular Theory of the Viscosity of Liquids, Problem – Estimation of Viscosity of a Pure Liquid, Viscosity of Suspensions and Emulsions, Convective Momentum Transport.
2. **Thermal Conductivity and the Mechanisms of Energy Transport:** Fourier's Law of Heat Conduction, Problem – Measurement of Thermal Conductivity, Temperature and Pressure Dependence of Thermal Conductivity, Problem – Effect of Pressure on Thermal Conductivity, Theory of Thermal Conductivity of Gases at Low Density, Problem – Computation of the Thermal Conductivity of a Monatomic Gas at Low Density, Estimation of the Thermal Conductivity of a Polyatomic Gas at Low Density, Prediction of the Thermal Conductivity of a Gas Mixture at Low Density, Theory of Thermal Conductivity of Liquids, Problem – Prediction of the Thermal Conductivity of a Liquid, Thermal Conductivity of Solids.

   Diffusivity and the Mechanisms of Mass Transport: Fick's Law of Binary Diffusion, Problem – Diffusion of Helium through Pyrex Glass, Problem – The Equivalence of D_{AB} and D_{BA}, Temperature and Pressure Dependence of Diffusivities, Problem – Estimation of Diffusivity at Low Density, Problem - Estimation of Self-Diffusivity at High Density, Problem – Estimation of Binary Diffusivity at High Density, Theory of Diffusion in Gases at Low Density, Problem – Computation of Mass Diffusivity for Low-Density Monatomic Gases, Theory of Diffusion in Binary Liquids, Problem – Estimation of Liquid Diffusivity, Mass and Molar Transport by Convection, Summary of Mass and Molar Fluxes, The Maxwell-Stefan Equations for Multi-component Diffusion in Gases at Low Density.
3. **Shell Momentum Balances and Velocity Distributions in Laminar Flow:** Shell Momentum Balances and Boundary Conditions, Flow of a Falling Film, Problem – Calculation of Film Velocity, Problem – Falling film with Variable Viscosity, Flow through a Circular Tube, Problem – Determination of Viscosity from Capillary Flow Data, Problem – Compressible flow in a Horizontal Circular Tube, Flow through an annulus, Flow of Two Adjacent Immiscible Fluids, Creeping Flow around a Sphere, Problem – Determination of Viscosity from the Terminal Velocity of a Falling Sphere.
4. **Shell Energy Balances and Temperature Distributions in Solids and Laminar Flow:** Shell Energy Balances, Boundary Conditions, Heat Conduction with an Electrical Heat Source, Problem – Voltage Required for a Given Temperature Rise in a Wire Heated by an Electric Current, Problem – Heated Wire with Specified Heat Transfer Coefficient and Ambient Air Temperature, Heat Conduction with a Nuclear Heat Source, Heat Conduction with a Viscous Heat Source, Heat Conduction with a Chemical Heat Source, Heat Conduction through Composite Walls, Problem – Composite Cylindrical Walls, Heat Conduction in a Cooling Fin, Problem – Error in Thermocouple Measurement, Forced Convection, Free Convection.

   Concentration Distributions in Solids and Laminar Flow: Shell Mass Balances, Boundary Conditions, Diffusion through a Stagnant Gas Film, Problem – Diffusion with a Moving Interface, Problem – Determination of Diffusivity, Problem – Diffusion through a Non-isothermal Spherical Film, Diffusion with a Heterogeneous Chemical Reaction, Problem – Diffusion with a Slow Heterogeneous Reaction, Diffusion with a Homogeneous Chemical Reaction, Problem – Gas Absorption with Chemical Reaction in an Agitated Tank, Diffusion into a Falling Liquid Film (Gas Absorption), Problem – Gas Absorption from Rising Bubbles, Diffusion into a Falling Liquid Film (Solid Dissolution), Diffusion and Chemical Reaction inside a Porous Catalyst.
5. **Equations of Change for Isothermal Systems:** The Equation of Continuity, Problem – Normal Stresses at Solid Surfaces for Incompressible Newtonian Fluids, The Equation of Motion, The Equation of Mechanical Energy, The Equation of Angular Momentum, The Equations of Change in terms of the Substantial Derivative, Problem – The Bernoulli Equation for the Steady Flow of Inviscid Fluids.

Equations of Change for Non-isothermal Systems: The Energy Equation, Special Forms of the Energy Equation, Boussinesq Equation of Motion for Forced and Free Convection.

Equations of Change for Multi-component Systems: The Equations of Continuity for a Multi-component Mixture, Problem – Diffusion, Convection, and Chemical Reaction, Summary of the Multi-component Equations of Change, Summary of the Multi-component Fluxes, Problem – The Partial Molar Enthalpy.

Pre-requisite Courses: NONE

Reference Books:

1. "Transport Phenomena", R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, Wiley Student Edition, Second Edition, 2006.
2. "Transport Processes and Separation Process Principles" (includes unit operations), Christie John, Geankoplis, Prentice Hall of India, Fourth edition, 2003.

UE15BT424: NEUROINFORMATICS (4-0-0-0-4)

Course Objectives:

- To make students learn about concepts of modeling and simulation of neurons and brain to understand the neurological disorders.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the importance of neuroinformatics in understanding the neurodegenerative disorders.
- Gain knowledge of different applications of neuroinformatics.

Course Content:

1. **Neuron Models and Neural Encoding:** Neuron models - Integrate and Fire model, Multi compartment models and Network Models. Spike Trains and Firing rates, Neural encoding and decoding. Estimating Firing Rates. Synaptic plasticity rules.
2. **Neuroscience Knowledge Management:** Managing knowledge in Neuroscience, Interoperability across Neuroscience databases. Database architectures for Neuroscience applications, XML for data representation and Data model specification.
3. **Computational Neuronal Modeling and Simulation:** Tools and methods for simulation of Neurons and Neural Circuits - Model structure analysis in NEURON, Constructing realistic Neural simulations with GENESIS, Simulators for Neural Networks and Action potentials. Data mining through simulation.
4. **Neuroinformatics in neurodegenerative Disorders:** Information approach to Systems Neurogenetics. Computational models of dementia and Neurological problems, Application of Systems biology approach to the neuroscience.
5. **Neuroinformatics applications:** Visuospatial processing, Visual attention and Spatial neglect. Human Brain Project: Microscale and Macroscale characterization; Brain image Atlases, Databases and Repositories. Basis of Brain mapping; Functional and Cognitive Brain atlas; Interoperable and Federated Brain Map databases.

Pre-requisite Courses: NONE

Reference Books:

1. "Neuroinformatics", Chiquito Joaquim Crasto, Humana Press, 2007.
2. "Neuroinformatics: an overview of the Human Brain Project", Stephen H. Koslow, Michael F. Huerta, Routledge, Psychology Press, 1997.

UE15BT425: CLINICAL RESEARCH AND DATA MANAGEMENT (4-0-0-0-4)

Course Objectives:

- To impart knowledge about Clinical Research and services in medical and pharma field.
- To create awareness about Clinical Research and the latest techniques and trends in the industry.

Course Outcomes:

At the end of the course, the student should be able to

- Describe the early studies in patients: dose-finding / proof of concept studies and their impact on drug development plan.
- Outline the clinical trial design (including legal, regulatory, ethical and practical aspects and GCP).
- Describe the principles, procedures and application of data collection and management in clinical trials in terms of GLP.

Course Content:

1. **Clinical research –Introduction:** Past, Present & Future of Clinical Research. Historical Perspective: The Greek and Roman Influence, Middle ages and Renaissance, Seventeenth, Nineteenth Century and Twentieth century and beyond (Nuremberg code, Belmonte report, Thalidomide disaster), Legal issues.
2. **Clinical Trials:** Introduction to Clinical Trials: scope of clinical trial, Designing of clinical trials, clinical trials Phases, Phase I studies; Phase II studies; Phase III/IV studies. Introduction to ethics of Clinical Trials. **Clinical research and the media, Un-anticipated risk in clinical research**. Clinical Trial Design, BA & BE Studies, Clinical Trial Development: Investigator Brochure, Informed Consent Form, Sponsor Monitor & Investigator responsibility, SOP in Clinical Trials, Clinical Trial Monitoring, Role of CRA, QA and QC in Clinical Trials, CRF Design, Clinical Trial Site Management, Pharmacovigilance.
3. **Regulatory Affairs: Ethical Issues in clinical research, ICH-GCP Guidelines I & II, Schedule Y, ICMR guidelines for biomedical research, Regulatory Issues in US, Australia, Japan & Europe (UK), Regulatory Issues in India.**
4. **Data Management:** Overview of clinical data management, Data management plan, Study management: Monitoring process, Coordinating protocol implementation, Internal & external reporting: Data closure, Data storage & archival; Performance Measures: timesheet, clinical monitor, Clinical Trial Management. Quality Assurance & Quality Control, Audits & Assessments/ Inspection in clinical trials, Medical writing.
5. **Clinical Trials Database**; Introduction to Clinical Data Interchange Standards Consortium (CDISC), The Good Clinical Data Management Practices (GCDMP), CRF designing, DB designing & CRF Annotations; Re-engineering the Clinical Data Management Process: formal methods, big bang, HMOs; Data Validation: data integrity, edit checks, Drug development; Ethical considerations, Adverse event coding and reporting, Role and responsibilities of the CRA, CRC & CRO. Case Studies: protocol development with CRO on drug development; disaster recovery plan.

Pre-requisite Courses: NONE

Reference books:

1. "Principle and Practice of Clinical Research", John I. Gallin, Frederick P Ognibene, Elsevier, Third edition, 2012.
2. "Management of data in clinical trials", Eleanor McFadden, John Wiley & Sons, Inc., Second edition, 2007.
3. **"A manager's guide to the design and conduct of clinical trials", Phillip I. Good, John Wiley & Sons, Inc., Second edition, 2006.**

UE15BT426: BIOREMEDIATION AND WASTE WATER TREATMENT TECHNOLOGY (4-0-0-0-4)

Course Objectives:

- Involves understanding of environment, pollution and applications of biotechnology for remediation.
- Involves various bioremediation techniques on environment problems.
- Learn the renewable source of energy generators.

Course Outcomes:

At the end of the course, the student should be able to

- Use the knowledge of pollution and apply the role of microbes in environmental engineering.
- Justify the role of microbes in bioremediation.
- Develop fundamental understanding of Applications of Biotechnology in Environmental related problems

Course Content:

1. **Bioremediation,** biotransformation and biodegradation. Bioremediation, in situ and ex situ bioremediation, constrains and priorities of bioremediation, Evaluating Bioremediation, Bioremediation of VOCs. Biodegradation. Factors affecting on process of biodegradation. Methods in determining biodegradability. Contaminant availability for biodegradation. Xenobiotics, Persistence and biomagnification of xenobiotic molecules. Microbial interactions with xenobiotics. Phase I and Phase II reactions. Cyt P 450 mediated reactions. Use of microbes (bacteria and fungi) and plants in biodegradation and Biotransformation.
2. **Sources of heavy metal pollution**, Microbial interactions with inorganic pollutants Microbial metal resistance, Microbial transformation, accumulation and concentration of metals, Biosorption Biotechnology and heavy metal pollution.
3. **Water pollution monitoring**. Methods of monitoring. Biological methods- Detection methods for DO, BOD, Pathogen monitoring by heterotrophic plate count, multiple tube method, membrane filtration methods, Other emerging techniques such as enzyme detection, hybridization, PCR, gene probe technology etc. Strategies for controlling pathogen transfer. 3. Chemical methods- Detection methods for COD, pH, alkalinity, TSS, TDS, Total organic carbon, oil, grease etc.
4. **Effluent treatment systems**: Sewage and waste water treatments systems. Primary, secondary and tertiary treatments. Measurement of treatment efficiencies. Biological treatments- aerobic versus anaerobic treatments. Environmental pollution control- Bioremediation, Bioaugmentation and Biostimulation. Biofilms in treatment of waste water. Biofilm development and biofilm Kinetics. Aerobic Biofilms. Bioreactors for waste water treatments. Reactors types and design. Reactors in series. Development and optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment.
5. **Biotechnological application of hazardous waste management and management of resources**. Use of microbial systems. Phytoremediation. Waste water treatment using aquatic plants, root zone treatment. Development of new biocatalysts to be applied in waste water biotechnology. Need for management of resources. Role of environmental biotechnology in management of resources. Reclamation of wasteland, biomass production, Biogas and biofuel production. Development of environmentally friendly processes such as integrated waste management.

Pre-requisite Courses: NONE

Reference Books:

1. "Biotreatment Systems", Wise D. L., CRC Press, Volume 3, 1988.
2. "Waste Water Treatment", Datta, Rao, Oxford & IBH Publishing Company, 1979.
3. "Advances in Biotechnological Process", Mizrahi, Wezel, Volume 4, 1988.

UE15IE506: BIOPROCESS DESIGN AND ECONOMICS (4-0-0-0-4)

Course Objectives:

- To understand Biochemical engineering plant design and draw flow diagrams using general design considerations.
- To differentiate between the various capital investments & perform cost analysis.
- To understand the various parts of a financial statement involving depreciation.

Course Outcomes:

At the end of the course, the student should be able to

- Ability to draw flow diagrams for Biochemical engineering plant.
- Ability to solve problems of various capital investments & perform cost analysis.
- Ability to decipher various parts of a financial statement involving depreciation.

Course Content:

1. **Process Design Development:** Introduction Aim, Biochemical engineering plant design, Development of Design Database: Literature Survey & Patent search. Process Creation, Process Design. Process Flow Diagrams; Piping & Instrumentation Diagrams, Vessel & Piping Layout Isometrics, Equipment Design & Specifications**.**
2. **General Design Considerations:** Health & Safety Hazards, Loss Prevention: HAZOP Study, Fault-Tree Analysis, Failure Mode & Effect Analysis, Safety Indexes & Safety Audits, Environmental Protection-Waste Disposal: Types & Waste Treatment, Plant Location, Plant Layout. Plant Operation & Control, Patent Considerations.
3. **Capital Investments:** Introduction to Capital Investment: Fixed Capital Investment, Working Capital, Cash Flow Diagrams & Cumulative Cash Position. Cost Indexes, Method to Estimate the Equipment Cost by Scaling: Application of "six-tenth factor" rule to costs for U – tube heat exchanger & related Problems, Problems on Cost Estimation.
4. **Cost Analysis:** Introduction to Cost Analysis, Factors involved in Project Cost Estimation, Methods employed for estimating Capital Investment. Time Value of Money, Conceptual Numericals. Profitability Analysis.
5. **Depreciation and Financial Statements:** Introduction to Depreciation, Methods employed to calculate Depreciation, Problems on Depreciation. Break Even Analysis & related problems, Replacements & Opportunity Costs, Introduction to Financial Statements, Design of Report, Brief introduction of types of reports.

Pre-requisite Courses: NONE

Reference Books:

1. "Plant Design and Economics for Chemical Engineers", Max S. Peters, Klaus D., Timmerhaus, Ronal E. West, McGraw Hill Education, Fifth Edition, 2003.
2. "Perry's Chemical Engineers Handbook", Robert H Perry, Green, **McGraw Hill Education**, Seventh Edition, 1997.

UE15BT451: BIOSTATISTICS (2-0-0-0-2)

Course Objectives:

- Understand the various basic concepts of statistics.
- Understand the various techniques available to test the hypotheses.
- To indicate the methodology and theory of statistics as applied to biostatistics.

Course Outcomes:

At the end of the course, the student should be able to

- Define and select wide ranges of techniques needed to perform as a statistician.
- Report and summarise the results obtained from various techniques of statistics.
- Apply statistical theory and principles to the planning, execution, control and analysis of biostatistical studies.

Course Content:

1. **Basics of Statistics:** What is Statistics, Importance of statistics, Descriptive and inferential statistics. Sampling, methods of sampling, random sampling methods. Diagrammatic representation of data, graphic representation of data. Measures of central tendency, Measures of dispersion, variables, qualitative variables, quantitative variables. Introduction bivariate data, Pearson's correlation coefficient r, Properties of Pearson's r, computing Pearson's r, line of regression of x and y, angle between the regression lines.
2. **Probability and Distributions:** Introduction, basic concepts, definition of probability, law of addition of probabilities, association law of probability and conditional probability, Bayes theorem and problems. Binomial distribution, Poisson distribution, Normal distribution, Mean, Variance for all the three distributions. Fitting Binomial, Poisson and Normal distributions.
3. **Estimation Theory:** Introduction, theory of estimation, point estimation, Unbiasedness, Consistency, Efficiency, and Sufficiency. Methods of point estimation, Central limit theorem. Sampling distribution of proportion, interval estimation: Interval estimation for large samples, confidence limits for mean, confidence limits for proportion, Problems.
4. **Hypothesis Testing:** Tests of significance, Null hypothesis, alternative hypothesis, types of errors in testing of hypothesis, level of significance, critical region, one tailed and two tailed tests, procedure for testing of Hypothesis. Large sample tests. Sampling of attributes, tests for single proportion, test of significance for difference of proportions. Sampling of variables: Test of significance for a single mean, test of significance for difference of means. Small sample tests. Students t test, test for single mean, t test for difference of means, paired t test for difference of means, chi square test, chi square test of goodness of fit, chi square test for independence of attributes.
5. **ANOVA:** ANOVA Designs, One-Factor ANOVA (Between-Subjects), Two-Factor ANOVA (Between-Subjects), Unequal Sample Sizes. Use of SPSS software to all the tests.

Pre-requisite Courses: NONE

Reference Books:

1. "Fundamentals of Statistics", S. C. Gupta, Himalaya Publishing House, Sixth Edition, 2005.
2. "Fundamentals of Biostatistics", Khan and Khanum, Ukaaz Publications, Second Edition, 2004.
3. "Fundamentals of Mathematical Statistics", S. C. Gupta and V. K. Kapoor, Sultan Chand and
4. Sons, Eleventh Edition, 2002.

M.TECH IN BIOTECHNOLOGY

Program Educational Objectives

1. To acquire in depth knowledge in the field of Biotechnology Engineering with reference to Process Engineering, Cellular and Molecular Biology , Medical and environmental Biotechnology and apply the same to design and innovate in the field of Biotechnology and related domains
2. To train students with good scientific, technical knowledge and skills to comprehend, analyze, design and create novel processes and novel products.
3. To prepare students to excel in research through the latest state-of-art post graduate training and education
4. To foster students to develop contacts and collaborations with leading institutes of learning & research, alumni and industries for professional advancement.
5. To prepare innovative, entrepreneurial and ethical professionals fit for a globally competitive environment.

Program Outcomes

1. **Scholarship of Knowledge** : To acquire fundamental and in depth knowledge in the field of Biotechnology with specialization in Process engineering, Environmental bioprocesses, Computational biology and Medical and molecular biosciences to solve complex biotechnological problems.
2. **Critical Thinking:** Identify , analyze and address complex problems in biotechnology and its associated domains
3. **Problem Solving:** Critical evaluation and analysis of problem involved in process and product development, societal, environmental and health issues. Design and develop solutions to solve complex biological problems
4. **Research Skill :**Critically and independently analyze existing literature, apply research based knowledge , current and advanced biotechnological methods including design and conduction of experiments, analysis and interpretation of data to tackle complex biological problems
5. **Modern Tool Usage:** Select and apply current techniques, appropriate skills and modern software tools including prediction and modeling methods on biological databases to identify issues in biomedical problems.
6. **Collaborative and Multidisciplinary work:** Enhance skills and continuously acquire advanced knowledge in Biotechnology and related domains , multidisciplinary and interdisciplinary domains for professional excellence
7. **Project Management and Finance:** Apply engineering and management principles for effective implementation and execution of complex, high end projects in teams and in individual capacity with emphasis on time, economics and performance.
8. **Communication**: Contribute and communicate effectively with the society confidently, be able to write effective reports and design documents by adhering to the appropriate standards, make effective presentations, give and receive clear instructions
9. **Life-long Learning**: Pursue life-long learning to enhance knowledge and skills for professional advancement and effective communication
10. **Ethical Practices and Social Responsibility:** Assess personal, product and environmental safety, intellectual property and social responsibilities related to modern biotechnological research and development. Identify measures for energy, environment, health, safety and society following ethical principles
11. **Independent and Reflective Learning:** Critically evaluate the outcomes of one's actions and apply self-corrective measures to improve the performance

UE18BT501: APPLIED MICROBIOLOGY (3-0-2-0-4)

Course Objectives:

- To impart the student an understanding the basic knowledge to applied of microbiology in the environment.
- To enable an understanding of diverse metabolic capabilities and potential of microorganisms for the production of industrial metabolites and remediation technologies to control the pollution in the environment.
- To provide a platform of knowledge on microbial interaction with the human life and their control measures
- To emphasize the application of green technology for the society and life.

Course Outcomes:

At the end of the course, the student should be able to

- The student will have awareness and understanding of various fields of Microbiology and its application.
- Will be able to isolate, characterize and understand the industrially important organism and develop the techniques to emphasize the strategy.
- Will also enable the student to apply engineered strategies to provide safe food and clean up contaminated environment and benefit human society.

Course Content:

1. **Introduction to Microbiology & Microbial Diversity:** Scope of microbiology, Major contribution of scientists Landmark achievements in 20th century. Microbial nutrition: Nutritional classification of bacteria, Techniques in Microbiology: Staining, Sterilization & preservation methods.

   Industrial Microbiology: History of fermentation. Kinetics of growth in batch culture, continuous culture fed-batch fermentation. Fermentation process: Inoculum development. Scale- up. Strain improvement techniques. Microbial products: Primary and secondary metabolites. Microbial preparation of Yogurt. Probiotics. Single cell protein. Mushroom cultivation. Solid state fermentation.
2. **Food & Dairy Microbiology:** Importance and significance of microorganisms in food. Factors influencing microbial growth in food –Intrinsic and Extrinsic parameters, Detection and Enumeration of micro-organisms and their products in food. Food borne pathogens. Food spoilage and preservation techniques. Food safety and Quality Management Systems-General principles of food safety risk management, Safe food alternatives (Organic foods), Good agricultural Practices (GAP), HACCP and ISO systems, Food Indicators- Microbiological criteria of foods and their Significance.
3. **Medical Microbiology**: Important developments in medical microbiology: Normal flora of human body (skin, respiratory & nervous). Opportunistic infections. General concepts for clinical specimen collection and biosafety levels. Host-parasite interactions. Epidemiology: Concept of epidemic, endemic and pandemic. Stages of Disease Progression. Modes of transmission; Human defence Mechanisms. Molecular basis of microbial pathogenicity, Immunization. Antimicrobial Agents: Multi-drug Resistance, Generation of antibiotics, Mechanism of Action of antibiotics. Hospital Acquired infection control program &biological waste management program.
4. **Environmental Microbiology & Agricultural Microbiology:** Microbial interaction with the environment and nutrient cycle. Remediation of pollutants. Omics approaches for characterization of environmental microorganisms. Waste water treatment and disinfection. Plant-microbe interaction-Rhisosphere, phyllosphere, phylloplane, Mycorrhiza, Biofertilizers, Biopesticides, Microbial degradation of agricultural waste. Agriculturally important microorganisms. Microbiological analysis of soil as an index of soil fertility.
5. **Marine Microbiology**: Introduction to Microbial Oceanography –marine ecosystem: benthic & littoral zone, saltpan, mangroves & estuarine microbes, microbial loop-marine microbial communities -phytoplankton, protozoa, bacteria, fungi, and virus. Microbes of extreme environments- study of mechanism of extremophiles–halophiles –halorhodopsin –deep sea microbes –microbes of hydrothermal vents. Seafood microbiology -normal genera associated with fish, food spoilage, fish & human pathogens; zoonotics –Brief account on aquaculture pathogens -Vibriosis –shrimp diseases –WSSV –MBV etc. Rapid diagnosis of contamination in seafoods and aquaculture products.

Pre-requisite Courses: NONE

Reference Books:

1. "Microbiology", Michael J.Pelczar, E. C. S. Chan & Noel R Kreig, Tata McGraw Hill International Edition, New Delhi, 5th edition, 2006.
2. "Environmental Microbiology", Grant WD, Long PL, Blackie Glasgow and London, 1981.
3. "Food microbiology," Frazier WC and Westhoff D, TATA McGraw Hill Publishing Company Ltd. New Delhi, 1988.
4. "Medical Microbiology", David Greenwood, Richard CD, Slack, John Forrest Peutherer, ELBS with Churchill Livingstone, 14th edition, 1992.
5. "Handbook of Microbiological Media", Atlas RM,) Parks L.C, CRC Press, London, 1993.

EXPERIMENTS

- Isolation of Actinomycetes. Characterization and identification of desired product formation from the isolated culture.
- Determination of growth curve of *E.coli* and determine the substrate degradation profile.
- Isolation of industrially important microorganism for the microbial processes and improvement of strain for increase yield by mutation study of a desired product.
- Isolation of food borne pathogens (anyone source: dairy, fermented and spoiled foods). Detection and enumeration of isolated organisms by various methods.
- Microbial degradation of dye by adsorption method.
- Recovery of toxic metal ions of an industrial effluent by immobilization of cells.

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE18BT502: ADVANCED MOLECULAR BIOLOGY (3-0-2-0-4)

Course Learning Objectives:

- To understand the structure, function and interaction of vital macromolecules such as nucleic acids and proteins.
- To know the mechanisms of mutations, transformations, recombination and transposition which maintain the genome.
- To understand and appreciate as to how the basic biological phenomena transcends over prokaryotes to eukaryotes.

Course Outcomes:

At the end of the course, the student should be able to

- Analyze biological phenomena through practical skills and techniques.

- Relate the importance of macromolecules (DNA and proteins) in association with complex mechanisms of the cell.
- Understand how the basic biological phenomena may be useful in applications.

Course Content:

1. **Molecules of the Cell and Maintenance of the Genome:** Importance of weak and strong bonds, Activation of precursors in group transfer reactions, Deciphering the genetic code, Proteins linked to DNA. DNA structure, DNA topology, RNA structure, High order chromatin structure and nucleosome assembly, Chemistry of DNA synthesis, Fidelity of replication, Mutability and repair of DNA, Organelle DNA.
2. **Recombination at the Molecular Level:** Models for homologous recombination, Protein machines, Mating-type switching, Genetic consequence of homologous recombination. Site-specific Recombination and Transposition of DNA**:** Conservative site-specific recombination, Biological roles of site-specific recombination, Transposition, transposable elements and their regulation.
3. **Transcription of protein-coding genes:** RNA polymerases for the transcription cycle, Formation of functional mRNA in bacteria and eukaryotes, Spliceosome machinery and splicing pathways, Alternative splicing, Transport of mRNA across nuclear envelope, Cytoplasmic mechanisms of post-transcriptional control.
4. **The Decoding of mRNA:** Processing of pre-mRNA, Stepwise synthesis of proteins on ribosomes, The activities of Lac repressor and CAP, The case of phage λ (layers of regulation), riboswitches and their mechanism of action. RNA editing.
5. **Gene Regulation:** Transcriptional activators, Conserved mechanisms of transcriptional regulation from yeast to mammals, Recruitment of protein complexes to genes by eukaryotic activators, Signal integration and combinatorial control, Gene silencing by epigenetic modification of DNA, Stimulation of translation by miRNAs. Gene Regulation During Development: Molecular biology of *Drosophila* embryogenesis.

Pre-requisite courses: NONE

Reference Books:

1. "Molecular Biology of the Gene", Watson, Baker, Bell, Gann, Levine, Losick, Pearson Benjamin Cummings & CSHL Press, Fifth Edition, 2004.
2. "Molecular Cell Biology", Lodish, Berk, Kaiser, Krieger, Scott, Bretscher, Ploegh, Matsudaira, W.H. Freeman and Company, Sixth Edition, 2008.
3. "Molecular Biology of the Cell", Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, Garland Science, Sixth Edition, 2014.

Experiments:

1. PCR amplification of target gene. Real time PCR
2. Transformation.
3. Expression by IPTG induction.
4. Purification and partial characterization.
5. RAPD

Pre-requisite Courses: NONE

UE18BT503: CELL AND MICROBIAL CULTIVATION (3-0-2-0-4)

Course Learning Objectives:

- To select medium components and optimize it for microbial/cell culture.
- To check cell density/biomass, cell viability and develop the growth curve.
- To carry out strain improvement.
- To produce the bio-molecule of interest.

Course Outcomes:

At the end of the course, the student should be able to

- Design and optimize the medium for microbial/cell culture.
- Improve the strain and generate the growth kinetics.
- At lab scale produce the bio-molecule of interest.

Course Content:

1. **Industrial cell growth and culture media:** Cell culture and types, aseptic handling technique, culture preservation, animal and microbial cell culture media composition, inoculums preparation.
2. **Culture Medium Optimization and Scale-Up for Microbial Fermentations:** Introduction, nutritional requirements, kinetics of microbial growth, microbial growth measurement, bioreactor operations, microbial fermentation and scale-up.
3. **Kinetics and viability of culture:** Cell cycle in bioprocess, cell growth and expression kinetics, cell viability measurement, contamination detection in cell culture, bioprocess and fermentation monitoring.
4. **Industrial cell growth and expression system:** Animal cells, suspension culture, animal cell stability, expression system, kinetics of expression system, insect cell culture, scale-up biotechnological process.
5. **Culture reactor and process design:** Fermenter / bioreactor design, bioreactor scale down, bioreactor scale-up, mammalian cell culture reactor scale-up, mammalian cell bioreactor, sampling and sample handling for process control, expression and secretion of heterologous proteins, gene expression in bacteria, Pichia, mammalian cell. **Case study:** Microbial / animal cell culture.

Pre-requisite Courses: NONE

Reference Books:

1. "Handbook of Industrial Cell Culture", Vinci V.A., Parekh S.R, Springer, 2003.
2. "Upstream Industrial Biotechnology", Michael C. Flickinger, Wiley, Volume 1 & 2, 2013.

Experiments:

1. Medium optimization by stoichiometry for growth and productivity improvement.
2. Strain improvements for maximise the substrate utilization/ product formation.
3. Study of cultured cell density and viability tests.
4. Cell / microbial culture – growth kinetics/ biomass productivity study.
5. Production of bio-molecules in bioreactor.

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE18BT504: RESEARCH METHODOLOGY (2-0-0-0-2)

Course Objectives:

- To understand the objective of research and its characteristics.
- To demonstrate the understanding of various research techniques.
- To understand the significance of hypothesis testing.
- To learn about sampling, materials and methods in research.
- To learn about intellectual property rights.

Course Outcomes:

At the end of the course, the student should be able to

- Articulate the concept of research and various forms of research.
- Discern path of arriving at a problem statement.
- Elucidate hypothesis and methods of carrying out experimentation.
- Design an experiment to carryout research.
- Explain about IPR methods like to protect the results obtained.

Course Content:

1. **Research- Meaning: Why? What:** Meaning, Objectives and Characteristics of research – Scientific Method Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research.
2. **Problem Statement:** Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem. **Literature Survey:** Importance of literature review in defining a problem **- S**urvey of literature - Primary and secondary sources - web as a source - searching the web - Identifying gap areas from literature review; Development of working hypothesis.
3. **Hypothesis:** Testing of hypotheses - Basic concepts, variables, formulation of research; hypothesis. **Sampling, Material and Methods, Discussion:** Sample- Sampling - Types of sampling; Material - Experiments, Data – Basics of Analysis – Tables, graphs; Discussion.
4. **Research Designs:** Need of research design - Important concepts relating to research design; Research design and methods; Research design – Basic Principles; Features of good design; Research Plan.
5. **Intellectual Property Rights:** IPRs- Invention and Creativity-Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs) A brief summary of: Patents, Copyrights, Trademarks.

Pre-requisite Course: NONE

Reference Books:

1. "Research Methodology: Methods & Techniques", Kothari C. R, New Age International (P) Limited, Second Edition, 2004.
2. "Doing Science: Design, Analysis and Communication of Scientific Research", Ivan Valiela, Oxford University Press, 2009.

UE18BT511:
BIOREACTOR DESIGN AND SCALE-UP (4-0-0-0-4)

Course Objectives:

- To develop the knowledge to write material and energy balances and cell/enzyme kinetics.
- To differentiate different types of reactors and to estimate mass transfer in bioreactors.
- To estimate power consumption in bioreactor.
- To gain knowledge of macro-kinetics both at particle and reactor level.

Course Outcomes:

At the end of the course, the student should be able to

- Do material and energy balances.
- Estimate mass transfer and power consumption in bioreactors.
- Differentiate between particle and reactor level Macro-kinetics.

Course Content:

1. **Introduction:** Balances - Elemental Balances, Heat Balance Equations, Total Mass Balances Yield – The linear growth equation, Yield of aerobic and anaerobic systems, Aerobic and anaerobic product formation and biomass production Kinetics – Cell Kinetics, Enzyme Kinetics, Determination of kinetic constants, Environmental Effects Stability – Enzymes structure, stability, inactivation models, thermodynamically controlled inactivation, kinetically controlled inactivation, and stabilization.
2. **Transport Processes:** Flow and flooding, dispersion and coalescence, suspension – Stirred Vessel, Bubble column, Air-lift, Packed Bed, Medium – Viscosity models, rheology data for fermentation liquids, Viscosity measurement methods, Shear in Different Reactors – Stirred Vessel and Bubble column, Shear devices.
3. **Reactor Engineering:** Mixing mechanisms, modelling of mixing, mixing time-data in stirred vessel, bubble columns, air-lift and packed bed, measuring methods for mixing. Hold-up in different reactor types – stirred vessels, bubble columns, air-lifts vessels, measuring methods for hold-up. Mass Transfer Equations, Quantitative relationships, measuring methods for mass transfer. Theory of foam stability, influence of broth and operating parameters, foam destruction methods, measuring methods for foam.
4. **Heat Transfer and Power Consumption:** Heat sources, cooling – general equations, heat-transfer coefficients for fermentation medium for stirred vessel, bubble column, air-lift and packed bed. Quantitative relationships for power consumption in stirred vessel, bubble columns, air-lift and packed bed, power measuring methods, heat production measurement.
5. **Macrokinetics: Particle Level and Reactor Level:** Qualitative consideration, external and internal diffusion limitation, Michaelis - Menten kinetics, estimation of intrinsic kinetic constants. Apparent Stability – Basic equations, Negligible diffusion limitation, diffusion limited kinetics, apparent stabilization by external or internal diffusion limitation, apparent stabilization on the reactor level. Batch Reactor, Fed-Batch Reactor, CSTR, Cascade on n CSTR, plug flow reactor. Process-Engineering – Relationships between parameters: The critical times concept for oxygen and for heat production, Engineering restrictions for design, General design and optimization schemes for fermenters, Cost aspects, general cost estimates.

Pre-requisite Courses: NONE

Reference Books:

1. "Basic Bioreactor Design",Klaas van't Riet, Johannes Tramper, Marcel Dekker Inc., 1991.
2. "Upstream Industrial Biotechnology", Michael C. Flickinger, Wiley, Volume 2, 2013.

UE18BT512:
PROTEIN ENGINEERING (4-0-0-0-4)

Course Learning Objectives:

- To learn the theory and practice of a variety of protein engineering methods.
- To learn specific examples of engineered proteins and their applications.
- Apply this knowledge to critically analyze protein engineering schemes in the current literature.
- Gain the skills to design a basic protein engineering experiment.

Course Outcomes:

At the end of the course, the student should be able to

- Describe rational and combinatorial methods of protein engineering.
- Describe various methods for library construction and engineering a protein / peptide.

- Formulate an original research plan for a specific protein engineering study and describe the advantages and limitations of the proposed research.
- Converse at an advanced level about current key topics of investigation in the field of protein engineering.

Course Content:

1. **Protein structure function dynamics:** Determination of primary/secondary/ tertiary/ quaternary structure of protein, Ramachandran plot, super secondary structures – motif and domain, protein folding and mechanisms, correlation of structure and function (serine protease/ membrane proteins).
2. **Display systems and library construction:** Phage Display systems, Cell surface display systems, cell free display systems, Library construction for protein engineering.
3. **Protein engineering strategies:** Strategies for protein engineering, Random and site directed mutagenesis, various PCR based strategies, Role of low-fidelity enzymes in protein engineering, gene shuffling and directed evolution of proteins, protein backbone changes, antibody engineering.
4. **Design and engineering:** Designing and engineering of synthetic binding proteins using non-antibody scaffold, engineering therapeutic proteins, protein engineering using non-canonical amino acids.
5. **Application in protein engineering:** Combinatorial enzyme engineering, Protein engineered biomaterials, knowledge-based protein design. Case studies.

Pre-requisite Courses: NONE

Reference Books:

1. "Introduction to protein structure", Carl Branden, John Tooze, Garland Sciences, Taylor & Francis Group, Second Edition, 1999.
2. "Protein Engineering in Industrial Biotechnology", Lila Alberghina, Harwood Academic Publishers, 2002.
3. "Protein Engineering and Design", Sheldon J. Park, Jennifer R. Cochran, CRC Press, 2009.

UE18BT513:
ALGORITHMS FOR BIOLOGISTS (4-0-0-0-4)

Course Objectives:

- To provide the students' knowledge on algorithms for analysing biological data.

Course Outcomes:

At the end of the course, the student should be able to

- Implement specific algorithms for analysing biological data.

Course Content:

1. **Algorithms & Complexity:** Molecular Biology primers, Biological algorithms versus computer algorithms, recursive and iterative algorithms, Big-O notation**.**
2. **Exhaustive search and combinatorial pattern matching algorithms:** Restriction mapping, Motif finding, profile, search trees. Repeat finding, Hash tables, Keyword Tress, Suffix Trees, Heuristic similarity search algorithms.
3. **Dynamic programming algorithms:** Sequence comparison, Global sequence alignment, local sequence alignment, gap penalties.
4. **Graph algorithms:** DNA sequencing, shortest superstring problem, SBH as a Hamiltonian path problem, Fragment assembly in DNA sequencing, Protein sequencing and identification.
5. **Clustering & Trees:** Hierarchical clustering, K means Clustering, Evolutionary trees-distance based and character-based tree construction.

Pre-requisite Courses: NONE

Reference Books:

1. "An introduction to Bioinformatics Algorithms", Neil C. Jones, Pavel A. Pevzner, MIT Press, 2004.

UE18BT514:
ENVIRONMENTAL MICROBIOLOGY (4-0-0-0-4)

Course Objectives:

- To provide understanding of environmental microbiology, the functional diversity of microorganisms in the environment in relation to human welfare and ecosystem health.
- To study microbial interactions with pollutants in the environment and the fate of microbial pathogens in the environment.
- To understand and analyse the detection of microbes and their activities in the environment, microbial biogeochemistry, bioremediation and water quality.

Course Outcomes:

At the end of the course, the student should be able to

- Learn the basic principles of environment microbiology and be able to apply these principles to understanding and solving problems in water quality and bioremediation.
- Be familiar with current research in environmental microbiology.
- Read and contextualize current research articles.
- Apply engineered strategies to provide safe food and benefit human society.

Course Content:

1. **Aerobiology:** Air spora in different layers of atmosphere. Aerosol, Nature of aerosol, Sampling devices for collection of air samples. Assessment of air quality and control using principles sedimentation, impaction, impingement, suction, filtration and biocidal control. Importance of air borne microbes, Allergy-causes and detection methods. Aeromicrobiological pathway-launching, transport, deposition. Extramural and intramural aeromicrobiology.
2. **Aquatic Microbiology:** The aquatic environment -major environmental conditions influencing microflora. Distribution of microorganisms in the aquatic environments -freshwater environment, and marine (estuaries, mangroves, deep sea, hydrothermal vent, salt pans, coral reefs) environment. Zonation of water ecosystem, upselling, euthrophication, food chain in aquatic ecosystems. Microbiology of drinking water, water pollution and its types, purification of water for human consumption. Assessment of microbial status in water and waste water (Shot gun sequencing techniques, Biosensors). Wastewater characteristics. Effluent treatment processes (like trickling filter, activated sludge, oxidative pond, anaerobic digestion and chemical disinfection).
3. **Soil Microbiology:** Microbial diversity in soil, Biotic and abiotic interaction, Soil microbes and soil fertility, microorganisms in soil processes- carbon, nitrogen, hydrogen, oxygen and sulphur cycle. Nitrogen fixation: Biochemistry of Nitrogen fixation -mechanism of nitrogenase -hydrogenase. Assay of nitrogen fixation -physiology of legume root nodule, leghaemoglobin -Synthesis, Plant-Microbe interaction, The rhizosphere, Mycorrhizal symbioses, Genetic exchange between communities. Role of microbes in solid waste management.
4. **Diversity in anoxic ecosystem:** Role of methanotrophs in aquatic ecosystem. Methanogens-reduction of carbon monoxide-reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and heavy metals. **Extremophiles:** The domain Archaea, acidophilic, alkalophilic, thermophlic, barophilic

and osmophilic and radiodurant microbes-mechanisms and adaptation. Halophilic-membrane variation-electron transport-application of thermophiles and extremophiles. Extremozymes.

5. **Biodegradation**: Role of microbes in degradation of xenobictic compounds, aromatic and aliphatic carbon compounds, pesticides, plastics. Mode of action, Biodeterioration of wood, paper pulp, pharma effluent. Biosorption, Bioaccumulation of heavy metals, Principle and mechanism, Bioremediation of soil, air and water pollutants by various methods, advantages and disadvantages. Bioleaching of iron, copper, gold and radioactive substances.

Pre-requisite Courses: NONE

Reference Books:

1. “Environmental Microbiology”, Ralph Mitchell, Ji-Dong Gu, Wiley Blackwel, Second Edition, 1996.
2. “Fundamentals of Air Pollution”, Richard W. Boubel, Academic Press, New York, 1994.
3. “Environmental Microbiology”, I. L. Pepper, Charles P. Gerba, Terry J. Gentry, Academic Press, New York, Third Edition, 2015.
4. “Hazardous Waste Management”, Charles A. Wentz, McGraw Hill Publication, 1995.
5. “Environmental Microbiology”, R. M. Maier, I. L. Pepper, C. P. Gerba, Academic Press, New York, Second Edition, 2009.
6. “Introduction to Drug Metabolism”, G. Gordon Gibson, Paul Skett, Nelson Thornes, Third Edition, 2001.

UE18BT515:
MOLECULAR PATHOLOGY (4-0-0-0-4)

Course Objectives:

- To provide an insight to molecular genetics and the molecular basis of diseases
- To provide an in depth understanding of molecular medicine’ and the translational aspects of molecular pathology: molecular diagnostics, molecular assessment, and personalized medicine.
- To critically evaluate the use of molecular techniques in the diagnosis and treatment of disease.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the major forms of disease, their pathology and molecular mechanisms that drive these diseases.
- Design and execute molecular diagnostic tests.

Course Content:

1. **Molecular mechanisms of cell injury, cell death & cellular adaptation:** Introduction to the concept of health and diseases. Acute and chronic disease, epidemic, endemic and pandemic diseases. Different categories of human diseases. Modes of cell death, structural features of necrosis and apoptosis, cellular & molecular mechanisms- Mitochondria, Nucleus, Lysosomes & Endoplasmic reticulum.
2. **Host defense against pathogens:** Leukocyte adhesion, mitigation, activation, pattern recognition, receptors & inflammatory responses, chronic inflammation, acquired immune response, tissue remodeling. Secretion systems: general secretory pathway, two-step secretion, contact dependent secretion, conjugal transfer system and autotransporters. Microbe & hosts-balance of power, pathogenesis strategies.
3. **Molecular mechanisms of enteric pathogenesis:** Shigella: Entry, Induction of macropinocytosis, Invasion of epithelial cells, Intracellular motility and spread, Apoptotic killing of macrophages, Virulence factors involved. *E.coli:* Enterotoxigenic *E.coli* (ETEC), labile & stable toxins, Entero-pathogenic E.coli (EPEC), type III secretion, Cytoskeletal changes, intimate attachment; Enterohaemerrohogic E.coli (EHEC), Mechanism of bloody diarrhea and Hemolytic Uremic Syndrome, Enteroaggregative *E.coli* (EAEC). *Vibrio cholerae*: Cholera toxin, Co-regulated pili, filamentous phage, survival.
4. **Molecular & Cellular pathogenesis of non-enteric pathogens:** Cardiovascular diseases, Haemotostatic & thrombotic diseases, Pulmonary diseases, Liver diseases, kidney diseases, Exocrine & Endocrine diseases, Cancer.
5. **Human genome-implication in human diseases:** Basic concepts of human molecular genetics, overview of human genome project, Biomarkers.

   Molecular mechanisms & Novel therapies: Molecular basis of autoimmune diseases (SLE), Arthritis, Neurological disorders, Immune deficiency diseases (AIDS). Current molecular infectious disease paradigm. Pharmacogenomics & Personalized medicine in treatment of human diseases.

Pre-requisite Courses: NONE

Reference Books:

1. “Cell and Molecular Biology: Concepts and Experiments”, Gerald Karp, Wiley, Fourth Edition, 2005.
2. “Essential concepts in Molecular Pathology”, William Coleman, Gregory Tsongalis, Academic Press, First Edition, 2010.
3. “Molecular Pathology-The Molecular basis of Human Diseases”, William Coleman, Gregory Tsongalis, Academic Press, First Edition, 2009.
4. “Human diseases-a systemic approach”, Elaine Tompary, Jill Raymond, Paul Holdoway, Pearson Education Limited, 2009.
5. “Neurodegenerative diseases-neurobiology, pathogenesis and therapeutics”, M. Flint Beal, Anthony E. Lang, Albert Ludolph, Cambridge Publishers, 2005.

UE18BT516:
CANCER BIOLOGY (4-0-0-0-4)

Course Objectives:

- To provide an insight into the common cellular and molecular mechanisms that are deregulated in cancerous cells and its contribution to cancer.
- Describes the role of gene mutations in the development of cancer and how cancer can be considered as a heritable trait.
- Provides an insight to the role of environmental factors that influence cancer susceptibility.
- Focus on the rationale for both traditional chemotherapies and novel targeted therapeutic approaches and highlight the benefits and limitations of each therapy.

Course Outcomes:

At the end of the course, the student should be able to

- Have a comprehensive overview of the biology and pathology of cancer.
- Understand the role of mutations and environmental factors that cause cancer.
- Compare and contrast the mechanisms by which activation of oncogenes, loss of tumour suppressors, loss of cell cycle check points, and development of faulty DNA repair lead to cancer.
- Compare traditional and targeted therapeutic treatment methods of cancer.
- Compile, critically analyze and evaluate research results and present these both orally and in writing.

Course Content:

1. **Characteristics of human cancer:** Basic Facts about Cancer, Hallmarks of Malignant Diseases, Classification of Human

Cancers, Macroscopic and Microscopic Features of Neoplasms, Grade and Stage of Neoplasms, Tumour Staging.

2. **Causes of cancer:** The Theory of ''Hits'', Chemical Carcinogenesis, Historical Perspectives, Metabolic Activation of Chemical Carcinogens, Tumour Initiation, Promotion, and Progression, Experimental Models for the Study of Carcinogenesis, Irradiation Carcinogenesis, Oxygen Free Radicals, Aging, and Cancer, Genetic Susceptibility and Cancer, Viral Carcinogenesis.
3. **Biochemistry and cell biology of cancer:** Growth Characteristics of Malignant Cells, Changes in Cell Membrane Structure and Function, Modification of Extracellular Matrix Components, Signal Transduction Mechanisms: cancer pathways, Cell Cycle Regulation; molecular players, Angiogenesis, Biochemical Characteristics of Metastatic Tumour Cells, Apoptosis.
4. **Molecular Genetics of cancer and tumour immunology:** Chromatin Structure and Function, Role of Gene Rearrangement, Cancer related genes: Oncogenes (Ras, myc) and tumour suppressor genes (Rb, p53). Hereditary cancers: breast and colorectal cancer. Inflammation and Cancer, Mechanisms of the Immune Response to Cancer, Identification and Characterization of Tumour-Derived Antigenic Peptides.
5. **Diagnosis and treatment of cancer:** Cancer Cytogenetics; Fluorescent *In Situ* Hybridization (FISH), Comparative Genomic Hybridization for diagnosis of cancer, molecular techniques in diagnosis of cancer; PCR, DNA microarray and immunohistochemistry. Imaging diagnosis: PET scanning. Cancer biomarkers, therapies for cancer; Surgery, Pharmacotherapy, radiotherapy, Targeted therapy; immunotherapy and gene therapy.

Pre-requisite Courses: NONE

Reference Books:

1. "Cancer Biology", Raymond W. Ruddon, Oxford University Press, 2007.
2. "The Biology of Cancer", Weinberg R. A., Garland Science, New York, 2007.
3. "Cell and Molecular Biology", Karp G., John Wiley and Sons Inc., New York, 1996.

UE18BT521:
BIOMOLECULAR DATA ANALYSIS (4-0-0-0-4)

Course Objectives:

- To learn the theory and practice proteomics tools for biomolecular data analysis.
- To learn specific methods of proteins data analysis used in industry and their applications.
- Apply this knowledge to critically analyze data generated in protein/ peptide characterization.

Course Outcomes:

At the end of the course, the student should be able to

- Describe various methods used in protein/ peptide analysis.
- Formulate an original research plan for a specific protein/ peptide analysis and describe the advantages and limitations of the proposed research.
- Gain the knowledge of peptide/ protein identification algorithms.

Course Content:

1. **Proteomics and tools of proteomics:** Proteomics and new biology, proteome, Bottom-up and top-down proteomics, overview of analytical proteomics, analytical protein and peptide separations, protein digestion techniques, Protein Determination by UV Absorption
2. **Mass Spectrometry for analysis:** Instruments working principle: MS, MALDI TOF, TOF Mass analyser, ESI Tandem MS, Triple Quadrapole Mass Analyser, Ion-Trap Mass Analyser, Automated Data Acquisition. Case studies.
3. **Peptide identification and analysis:** Peptide mass finger printing over view and analytical approach, complications, software tools, scoring, peptide patterns, Peptide Ion fragmentation in MS-MS, MS-MS spectrum, problems.
4. **Protein identification:** ESI Tandem MS to protein identification, Algorithms and software for tool for identifying proteins from ESI Tandem MS Data (Sequest), Algorithm for Mining Specific Features of Tandem MS Data (SALSA).
5. **Mass spectrometry for the structural characterisation:** MS based approach for the characterisation of the recombinant proteins, purification development, formulation development, analytical method development, confirmation of structure/ product compatibility assessment, Characterisation of protein ligand complex in drug discovery.

Pre-requisite Courses: NONE

Reference Books:

1. "Protein and Peptide Mass Spectrometry in Drug Discovery", Michael L. Gross, Guodong Chen, Birendra Pramanik, John Wiley & Sons Publications, 2012.
2. "Proteins and Proteomics: A Laboratory Manual", Richard Simson, CHSL Press, 2003.
3. "The Protein Protocol Hand Book", John M Walker, Humana Press, 2002.
4. "Protein Mass Spectrometry", Julian Whitelegge, Elsevier, Volume 52, 2009.

UE18BT522:
ENVIRONMENTAL IMPACT ASSESSMENT, POLICY AND LAWS (4-0-0-0-4)

Course Objectives:

- To enable the students, assess, predict and simulate the overall impact of developmental projects.
- To educate the students on the scope, steps involved and various methods related to assessment of environmental impact due to developmental projects.

Course Outcomes:

At the end of the course, the student should be able to

- Develop an understanding of current EIA methods and the techniques and tools used.
- Develop an understanding of current assessment methods and legislation.
- Develop an understanding of current environmental monitoring systems.
- Critically apply the framework of EIA or EMS to relevant situations.
- Apply knowledge acquired to the process of environmental impact modeling and prediction as a design tool with application to a number of case studies.

Course Content:

1. **Fundamentals of Environmental Impact Assessment (EIA)**: Environment Protection Act, 1989- EIA Notifications of 1994, 2006, 2014 and 2016- Definitions, purpose and characteristics of EIA; global evolution of EIA; participants in EIA process, stages of EIA, types of EIA. Environmental inventory. Baseline data on EIA- environmental data, project data and project alternative data. Measurement of impact– physical, social (Social Impact Assessment), economic, natural; Public participation in environmental decision making under 'Public Hearing'; Framework of Environmental Assessment; Description

of environmental setting; environmental impact factors and area consideration. Environmental Impact Statement (EIS) and Environmental Management Plan (EMP).

2. **Environmental Impact Analysis**: Impact identification and methods of impact identification- adhoc method, checklist, matrix, network, overlay and index methods. **EIA Methodologies:** Criteria for selection of EIA methodology; EIA methods; Predictive models for impact assessment. Prediction and assessment of impact on soil and water (ground and surface waters), biological environment, air environment, noise, socio-economic and human health impact., impact evaluation (assessment) and impact mitigation.
3. **Environment Risk Assessment (ERA) and Management in EIA**: Introduction, Basic concepts of Environment Risk Assessment (ERA), Risk assessment and treatment of uncertainty; key steps performing ERA; advantages and limitations of ERA.
4. **Legal control of Environmental pollution in India:**
    a. The Air prevention and control of pollution Act, 1981, amended in 1990.
    b. The Water prevention and control of pollution Act, 1974, amended 1988: CESS Act 1977, amended in 1991.
    c. Municipal solid waste management rules 2016, Municipal solid waste management and handling rules 2000, Construction and Demolition Waste Management Rules,. 2016, Plastic Waste Management Rules 2016, Hazardous waste management rules under The Environment protection Act. 1986, Noise Pollution (Regulation and Control) Rules, 2000.
    d. National Green Tribunal- Functions, Powers, Appeals.
5. **EIA Case Studies:** Environmental impact of industrial development on physical resources, ecological resources, human use values, quality of life values and project sitting; Factors to be considered in making assessment decisions; Guidelines for preparing TORs; management requirement for preparation of EIA for industrial projects; assessment of impacts; treatment plants.

Pre-requisite Courses: NONE

Reference Books:

1. "Environmental Impact Assessment - Practical solutions to recurrent problems", Lawrence D. P., Wiley- Interscience, New Jersey, 2003.
2. "Handbook of Environmental Impact Assessment", Petts J., Vol. I and II, Conwell Science London, 2009.
3. "Environmental Impact Assessment", Canter L.W., McGraw-Hill, New York, 2006.
4. "Environmental Impact Assessment Methodologies", Y. Anjaneyulu, Valli Manickam, B S Publication, Second Edition, 2007.
5. "A Textbook of Environmental Engineering", P. Venugopal Rao, PHI Learning Pvt. Ltd., 2012.

UE18BT523:
ENVIRONMENTAL HEALTH CHEMISTRY (4-0-0-0-4)

Course Objectives:

- Interaction between man and potentially toxic or harmful agents in the environment.
- To understand the methods used to assess human and environmental exposure pathways of environmental pollutants.
- To understand the principles and Concepts in Risk Assessment.
- To prevent environmentally related diseases in the general and occupational environments.

Course Outcomes:

At the end of the course, the student should be able to

- Recognize, assess and have knowledge of control measures for different types of toxic agents of general and occupational environments.
- Have knowledge of human exposure, limit values and standards of environmental pollutants and delineate hazard potential.
- Identify nature of Risk, know the fundamentals of risk assessment and suggest management strategy.

Course Content:

1. **Environmental Health Chemistry:** Definitions and inter-relationships chemicals and health; dose-effect; essential features of environmental health chemistry; pharmacokinetic properties of a chemical compound; eco-kinetic properties of a chemical; environmental fate of chemicals; Environmental factors and stresses – chemical, physical, ergonomic and biological agents. mode of entry of harmful agents – inhalation, skin absorption, ingestion. The Nature of Chemical Hazards and Human Response from Exposure to Chemical Substances; Classification of Chemical Toxicity; Factors Influencing Chemical Toxicity to Humans and Human Response to Chemical Toxicants; Distribution and Storage of Toxicants in the Human Body; Scope of Chemical Hazard Problems: Lead Exposures as an Example.
2. **Human Exposure to Chemicals:** An Overview of Human Contact Sites and Target Organs Most Susceptible to Chemical Exposures; Fundamentals of Human Physiology; Target Organ Toxicity; General Types of Human Exposures; Types of air-borne contaminants; Human Exposures to Airborne Chemical Toxicants; Water Pollution - Exposures to Chemicals in Water; Contaminated Soil Problems and Human Exposures to Chemicals on Land; Human Exposures to Chemicals in Foods; Public Health and Socio-Economic Implications of Chemical Exposure Problems; The General Nature of Human Health Effects from Chemical Exposures; Managing the Chemical Exposure Problem.
3. **Recognition of hazard from environmental chemicals:** Fundamental Principles of Chemical Hazard; health versus physical hazards; fundamental principles of cause and effect; hazards of asphyxiates; indoor air quality; Hazardous properties of metals; industrial solvents and health hazards; hazards of exposure to energy: thermal stress; noise and vibration; ionizing radiation;: 0250403528, 9780250403523, 1981. Jeffrey W. Vincoli, "Basic Guide to Industrial Hygiene", Van Nostrand Reinhold, ISBN: 0-44201960-2, 1995. heat and stress; recognition of biological hazards; understanding ergonomics an overview - ergonomic risk factors.
4. **Evaluation and controlling industrial and environmental pollutants:** General principles of industrial hygiene; occupations and risk and methods of control; Standards and Concept of Threshold Limit Values; Sampling the environment; Types of sampling; Monitoring methods – personal, environmental and biological sampling methods; Hygienic guides; Permissible Exposure Levels; Biological Standards; urine, blood and breath analysis; biological limits; Industrial hygiene sampling and monitoring: objectives air sampling instrumentation and equipment; Personal Protective Equipment.
5. **Principles and Concepts in Risk Assessment and Exposure:** The Nature of Chemical Hazard, Exposure, and Risk; Basis for Measuring risks; Risk Assessment and Nature of Risk Assessments; Qualitative *versus* Quantitative Risk Assessments; Individual *versus* Group Risks; Risk Perception Issues; Risk Acceptability and Risk Tolerance Criteria; The *de Minimis* or 'Acceptable' Risk; General Attributes of Risk Assessment: The Purpose; The Attributes; Risk Assessment *versus* Risk Management; Risk

Assessment as a Diagnostic Tool; Baseline Risk Assessments; Public Health Risk Assessments; Risk Assessment as an Holistic Tool for Environmental and Public Health Management.

Pre-requisite Courses: NONE

Reference Books:

1. "Introduction to Atmospheric Chemistry", Jacob, Princeton University Press, ISBN: 0691001855, 1999.
2. "Public Health Risk Assessment - for Human Exposure to Chemicals", Kofi Asante-Duah, Springer Science + Business Media New York, ISBN 978-94-010-0481-7, 2002.
3. "Environmental Health Chemistry", Jamdes D. McKinney, American Chemical Society, Ann Arbor Science, ISBN: 0250403528, 9780250403523, 1981.
4. "Basic Guide to Industrial Hygiene", Jeffrey W. Vincoli, Van Nostrand Reinhold, ISBN: 0-44201960-2, 1995.

UE18BT524: MOLECULAR DIAGNOSTICS (4-0-0-0-4)

Course Objectives:

- To provide an understanding of molecular basis of diagnosis.
- To sensitize students about the recent advancements in diagnostics.
- To acquaint the students with features of quality assurance and standards.

Course Outcomes:

At the end of the course, the student should be able to

- Describe the concepts in molecular diagnostics that provide the foundation for implementing and adapting new techniques and assays.
- Apply molecular diagnostic techniques in the diagnosis of microbiological, oncological, genetic and other disorders.
- Compare and select appropriate molecular diagnostic methods.

Course Content:

1. **Molecular Diagnostic Technologies:** PCR-Based Methods for Mutation Detection, Alternative Methods for Amplified Nucleic Acid Testing, Electrophoretic Methods for Mutation Detection and DNA Sequencing, Single-Nucleotide Polymorphisms: Testing DNA Variation for Disease Association. Microarray Approaches to Gene Expression Analysis, Methods for Analysis of DNA Methylation.
2. **Other Clinical Diagnostic Technologies:** Flow Cytometry, Medical Cytogenetics, Fluorescence *In Situ* Hybridization, Comparative Genomic Hybridization. Immunohistochemistry, Imaging diagnostics: Ultrasound, Computed Tomography, Magnetic Resonance Imaging, Electrocardiography, Electroencephalography, Positron Emission Tomography.
3. **Applications of Molecular Diagnostics for Human Cancers, infectious diseases and identity-based testing:** Molecular Pathogenesis of Human Cancer, Molecular Genetic Abnormalities in Acute and Chronic Leukemias. Molecular Testing for bacterial diseases, Molecular Diagnosis for viral diseases: HIV-1, Hepatitis C. HLA Typing Using Molecular Methods, Molecular Analysis for Forensic Casework and Parentage Testing, Molecular Assessment of Bone Marrow Transplant Engraftment, The Use of DNA-Based Identity Testing for Specimen Identification.
4. **Applications of Molecular Diagnostics for Genetic Diseases:** An Overview of Molecular Genetics, Genetic Basis of Neurologic and Neuromuscular Diseases, Molecular Mechanisms of Endocrine Disorders, Molecular Pathogenesis of Cardiovascular Disease, Prenatal Genotyping for Identification of Foetuses at Risk, Personalized Medicine.
5. **Quality Assurance and issues for the Clinical Molecular Pathology Laboratory:** Framework for Quality Assurance in Molecular Diagnostics, Verification of Molecular Assays, Standards and Standardization of Molecular Diagnostics Laboratory-Developed Tests in Molecular Diagnostics, Genetic Counselling Considerations in Molecular Diagnosis, Ethical, Social, and Legal Issues Related to Molecular Genetic Testing.

Pre-requisite Courses: NONE

Reference Books:

1. "Molecular Diagnostics - For the Clinical Laboratorian", *Coleman,* William B., Tsongalis, Gregory J., Humana Press, 2006.
2. "Fundamentals of Molecular Diagnostics", Carl A. Burtis, David Bruns, Edward R. Ashwood, Elsevier, 2007.
3. "Molecular Diagnostics: Fundamentals, Methods and Clinical Applications", Lela Buckingham, F.A. Davis Company, 2011.

UE18BT551: ADVANCED BIOCHEMISTRY (3-0-2-0-4)

Course Objectives:

- To provide an insight of bimolecular interactions and their functional and regulatory roles.
- Role of glycosylation at the cellular and molecular level.
- Importance of bioconjugation reactions in detection, diagnosis and targeted drug delivery.

Course Outcomes:

At the end of the course, the student should be able to

- Identify different bimolecular interactions and understand their role in regulation at the cellular and molecular level.
- Understand the role of glycosylation in cellular processes.
- Apply bioconjugation reactions in diagnosis and targeted drug delivery.

Course Content:

1. **Biomolecules and Bimolecular interactions:** Types of biomolecules: Simple and complex carbohydrates, classification and functions. Hierarchal proteins structure; Regulatory enzymes and their role in metabolic pathways. Lipids: classification and functions, Nucleic acids: types and functions. Types of biomolecular interactions and their functional and regulatory roles: carbohydrate- protein (glycoproteins), carbohydrate- lipid (glycolipids) lipid- protein (lipoproteins), nucleic acid- protein (nucleoproteins).
2. **Membrane Biochemistry**: Cell and organelle membranes, physical properties of bilayers, polymorphic phases and molecular shapes exhibited by lipids, effect of lipid composition and modification on viscosity and fluidity, role of cardiolipin and cholesterol, bilayer asymmetry and membrane curvature, lipid heterogeneity, lipid rafts, liposomes and application.
3. **Biochemistry of signaling pathways:** Types of signaling, Signal molecules-hormones, peptide, amino acid derivatives, steroids, ecosanoids, specificity of protein kinases and phosphotases; signal transduction pathways of G- protein linked, ion channel, enzyme linked receptors; intrinsic enzyme/cytokine receptors, second messengers-cAMP, CREB, cGMP, phosphoinositides, arachidonic acid, Ca^{2+} and NO, nuclear signaling and transcriptional activation by phosphorylation cascade.

   Glycosylation and its functional & regulatory role: Types of glycosylation (N, O, C linked glycosylation, glypiation) Role of glycosylation in receptor signalling, recognition and adhesion (cell adhesion molecules), protein folding, chaperons, transport and interaction with lectins.

4. **Cell cycle biochemistry:** Cell Cycle: Cell cycle (entry of cell from G2 to M – phase) Role of M – Cdk, MPF. Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Regulation of M- phase (role of mitogen, survival factor and TGF- β). Role of ubiquitin. Growth factors and cytokines, growth phases and check points of cell cycle (DNA replication and spindle- attachment checkpoint) and their regulation.
5. **Bioconjugation and its applications:** Molecules involved in bioconjugation reactions: biotin, avidin, fluorophores, radioisotopes, PEG and their conjugation to proteins. Common bioconjugation reactions, types of bioconjugation reactions-random and site specific, Bioconjugation reactions using zerolength, homobifunctional, heterobifunctional, trifunctional crosslinkers, cross bridges, Types of nanocarries: Dendrimers, liposomes, quantum dots, nanocapsules, Applications in diagnosis and targeted drug delivery.

Pre-requisite Courses: NONE

Reference Books:

1. "Lehninger Principles of Biochemistry", David L. Nelson, Michael M. Cox, W. H. Freeman & Company, Sixth Edition, 2012.
2. "Biochemistry of Signal Transduction and Regulation", Gerhard Krauss, Wiley-VCH, Third Edition, 2003.
3. "Biochemistry of Lipids, Lipoproteins and Membranes", Dennis E. Vance, Jean E. Vance, Elsevier, Fifth Edition, 2008.

Experiments

1. Liposome preparation
2. Bioconjugation reactions: ELISA
3. Isolation and purification of lectins.
4. Enzyme kinetics
5. Affinity chromatography

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE18BT552:
ADVANCED BIOINFORMATICS (3-0-2-0-4)

Course Objectives:

- To provide the students, knowledge on algorithms for DNA and RNA sequences.
- To provide the students concepts of sequence polymorphisms and predictive methods using sequences.
- To provide students concepts of protein structure prediction, evaluation and comparison.

Course Outcomes:

At the end of the course, the student should be able to

- Predict gene using algorithms from DNA sequences.
- Predict RNA structure.
- Predict, evaluate and compare protein structures.

Course Content:

1. **Algorithms for DNA Sequences:** Introduction, Predictive methods for DNA sequences – Markov Models, Hidden Markov Models and Discriminant Analysis in Gene Prediction, Promoter Analysis – Characterization and Prediction.
2. **Algorithms for RNA Sequences:** RNA Secondary Structure Thermodynamics, Dynamic Programming for RNA Secondary Structure Prediction for single and multiple sequences, Predicting RNA tertiary structure.
3. **Sequence Polymorphisms:** Overview of Evolution and origins of polymorphisms, Types of Polymorphisms, SNP Discovery Methods, Genotyping and Haplotype Map Project.
4. **Predictive Methods using Protein Sequences:** Neural Networks, Predicting Features of Individual Residues, Predicting Function, Hidden Markov Models in Protein Analysis.
5. **Protein Structure Prediction and Analysis:** Protein Structure Determination, Protein Structure Prediction, Evaluation and Comparison.

Pre-requisite Courses: NONE

Reference Books:

1. "Bioinformatics – A Practical Guide to the Analysis of genes and Proteins", Andreas D. Baxevanis, B. F. Francis Oueleette, John Wiley and Sons, Third Edition, 2005.
2. "Bioinformatics – Sequence and Genome Analysis", David W. Mount, Cold Spring Harbor Laboratory, Second Edition, 2004.

Experiments

1. Promoter design and Gene prediction.
2. RNA structure prediction.
3. SNP analysis.
4. Protein analysis-localization, solvent accessibility, transmembrane segments.
5. Protein structure prediction and validation.

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE18BT553:
PURIFICATION AND FORMULATION OF BIOMOLECULES (3-0-2-0-4)

Course Objectives:

- To provide an insight on the processes used to extract recover, purify, analyze and formulate biomolecules.

Course Outcomes:

At the end of the course, the student should be able to

- Describe the principle that underlies the major processes used in purification of biomolecules.
- Perform separation and recover biomolecule.
- Design and execute the processes for the purification and formulation of biomolecules.

Course Content:

1. **Extraction of Biomolecules:** Sample preparation: Tissue homogenization, sonication. Cell disintegration and extraction. Optimization and clarification of extract. DNA, RNA, protein extraction, Conventional methods (Guanidium, alkaline, CTAB) Solid phase nucleic acid extraction, silica matrices, glass, diatomaceous earth, magnetic bead. Protein: Solubility of protein, salting out Precipitation with organic solvents and organic polymers. Affinity precipitation, precipitation by selective denaturation.
2. **Separation and Concentration:** Introduction to bioseparation, Characterization of biomolecules and fermentation broth, Solid-liquid separation and cell disruption. Centrifugation techniques: Introduction, basic principles of sedimentation, Preparative Centrifugation, analytical centrifugation, Ultracentrifugation. Precipitation of prteoin - Theory and methods, dialysis. Liquid-liquid extraction – theory and practice, Aqueous two phase extraction, Solid liquid extraction.

3. **Purification:** Theory of chromatography, Selection of matrices/ resins for chromatography, gel filtration chromatography, Ion-exchange chromatography, hydrophobic interaction chromatography, HPLC, Reverse Phase chromatography, Affinity chromatography – metal, dye. Immunosorbent chromatography, Expanded bed chromatography
4. **Analysis:** Measurement of concentration and activity of purified biomolecules, Purity analysis, Electrophoresis, Immunochemical method. Analytical techniques – Spectroscopy: UV, CD, NMR, MS, Protein arrays, Blotting techniques – Southern, Western, Northern blotting.
5. **Product Formulation:** Freeze-drying, Spray drying, Lyophilization, Crystallization, Stabilization. Case study on purification and formulation of biomolecules.

Pre-requisite Courses: NONE

Reference Books:

1. "Methods of Biochemical Analysis: Bioanalytical Instrumentation", Clarence H. Suelter, Wiley Blackwell, 1994.
2. "Principles and Techniques of Biochemistry and Molecular Biology", Keith Wilson, John Walker, Cambridge University Press, 2010.
3. "Protein Purification: Principles and Practice",Robert K. Scopes, Springer, Third edition, 1994

Experiments:

1. Sample preparation and extraction of molecules.
2. Concentration and precipitation.
3. Purification (Chromatography).
4. Analysis of purity & activity (Spectroscopy, electrophoresis).
5. Formulation / Lyophilization of the product.

Pre-requisite Courses: NONE

Reference Book:

1. Laboratory Manual prepared by Department of Biotechnology, PESU.

UE18BT554:
IPR & BIOENTREPRENEURSHIP (2-0-0-0-2)

Course Learning Objectives:

- To provide an understanding of concepts of IPR, its classification and administration.
- To provide skills for evaluating, articulating, refining, and pitching a new product or service offering, either as a start-up business or a new initiative within an existing firm.
- To acquaint the students the challenges of starting new ventures and enable them to investigate, understand the process of setting up a business.

Course Outcomes:

At the end of the course, the student should be able to

- Understand Entrepreneurship.
- Understand Business Models and Planning for Business and describe the different steps in a business development process.
- Independently formulate a business plan based on a business idea.
- Describe the fundamentals of intellectual property rights and legislation, particularly in the biotechnology industry.

Course Content:

1. **Introduction to Intellectual Property Rights:** Concept of Intellectual Property, Kinds of Intellectual Property, Conventions and Treaties Relating to Global Administration of Intellectual Property Rights, IPRs and Information Technology, IPRs and Traditional Knowledge.
2. **Patents, Copyright and Trademarks:** Classification of Patents, Grant of Patent, Social Implication of Patents. Copyrights, Registration and terms of Copyright, Copyright infringement, Trademarks – forms of Intellectual Property, Laws of trade Marks.
3. **Biotechnology and Intellectual Property Rights:** Patentability of Biotechnology, TRIPS, GATT, Legal, social and policy implications of genetic patents, importance of patents in genetic research, IPR protection to Bioinformatics and Genomic databases, Protection of GMOs IP.
4. **Strategic planning of entrepreneurship:** Introduction to entrepreneurship; Assessment of feasibility of a given venture/ new venture; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks; Statutory and legal requirements for starting a company/ venture; Basics in accounting practices: concepts of balance sheet.
5. **Bio Entrepreneurship:** General introduction to biotech industry, Scope. Trends and key issues in biotechnology industry. Organization, financing, policy, trends, problems and issues in the healthcare, pharmaceutical, Agricultural and other biotech industries.

Pre-requisite Courses: NONE

Reference Books:

1. "Intellectual Property Law", Bently L., Sherman B., Oxford University Press, Fourth Edition, 2014.
2. "Innovation and Entrepreneurship in Biotechnology, an International Perspective: Concepts, Theories and Cases", Damian Hine, John Kapeleris, Edward Elgar Publishing, 2006.

UE18BT531:
OPERATIONS RESEARCH (4-0-0-0-4)

Course Learning Objectives:

- To study the need and importance of Operations Research for rationale decision making for practical problems.
- To obtain knowledge on various methods of formulating real word problems into linear models and to solve them.
- To comprehend in finding the optimal solutions by different methods.

Course Outcomes:

At the end of the course, the student should be able to

- Apply methods of PERT CPM techniques.
- Apply network construction and critical path determination.
- Apply methods for large-scale transportation.

Course Content:

1. **Introduction:** Definition. Scope of Operations Research (OR). Approach and limitations of O.R. Models, Characteristics and phases of O.R,Linear Programming Problems: Mathematical formulation of L.P, Problems and Graphical solution method .
2. **Assignment problems:** Balanced and Unbalanced assignment problems, Maximization assignment problems, travelling salesman problems.

   Transportation problem: Basic feasible solutions by different methods, finding optimal solution, MODI method, Degeneracy, Unbalanced transportation problems, Maximization problems.
3. **Sequencing:** Johnson's algorithm, njobs-2machines, njobs-3, machines and njobs-n machines without passing sequence, 2jobs-n, machines, Graphical solutions.

4. **PERT- CPM Techniques:** Network construction, determining time estimates and critical path, in network analysis, Variance and probability of completing the project, Calculation of different floats, Project duration, Crashing of simple network.
5. **Replacement model:** Replacement of items which fails completely-individual replacement, group replacement. Replacement of items where maintenance cost increases with time and the value of money changes.

Pre-requisite Courses: NONE

Reference Books:

1. "Operation Research", S. D. Sharma, Kedarnath & Co., Eighth Edition, 2003.
2. "Operation Research", Kantiswaroop, P. K. Gupta, Manmohan, S Chand & Co., Ninth Edition, 1999.
3. "Introduction to Pert and CPM", L. S. Srinath, EastWest, Third Edition, 1998.
4. "Scientific Inventory Management", Hospach Buchan, Earnest Koenigberg, McGraw Hill *publications,* 1989.

UE18BT532:
COMPUTATIONAL SYSTEMS BIOLOGY (4-0-0-0-4)

Course Objectives:

- To provide the students concepts of modeling cellular processes as network of interactions.

Course Outcomes:

At the end of the course, the student should be able to

- Use state-of-the-art algorithms in understanding molecular mechanism at system level along with their limitations.

Course Content:

1. **Introduction:** Basic notions for computational models of biochemical systems, networks, data integration, standard and formats for systems biology, model organisms, simulation techniques and tools, data resources, model semantics.
2. **Modeling and analysis of biochemical systems:** Common modeling approaches, ODE models, system equation, stoichiometric matrix, flux cone, elementary flux models and extreme pathways, constraint-based flux optimization, Kinetic models of biochemical networks, reaction kinetics, reaction thermodynamics, mass action kinetics, metabolic control analysis.
3. **Discrete, stochastic and spatial models:** Discrete models- Boolean networks and petri nets; stochastic modeling of biochemical systems, spatial models- compartment models, reaction diffusion systems.
4. **Network structure, dynamics and function:** Structure of biochemical networks, regulation network and network motifs, modularity of gene functions, models for gene expression and regulation.
5. **Model fitting and analysis:** Model fitting, reduction and coupling, variability and uncertainity analysis, robustness mechanism, information transmission in signaling pathways.

Pre-requisite Courses: NONE

Reference Books:

1. "Systems Biology: A Textbook", Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach, Ralf Herwig, Wiley-VCH, Second Edition, 2016.
2. "Computational Systems Biology", Andres Kriete, Roland Eils, Elsevier, Academic Press, Second Edition, 2006.

UE18BT533:
NEXT GENERATION SEQUENCING (4-0-0-0-4)

Course Objectives:

- To learn the theory and practice of a Next Generation Sequencing platforms and analysis tools.
- To learn specific genome assembly algorithms and de-novo assembly of the sequence data.
- Apply the knowledge to critically analyze genome data for biological applications.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the basic knowledge of Next Generation Sequencing platforms.
- Analyze and apply the appropriate tools and techniques to perform high throughput data analysis.
- Design high throughput data analysis tools.

Course Content:

1. **Sequencing platforms:** Introduction to NGS, Chemistry of differences sequencing platforms, Roche/454 FLX, Illumina/ Solexa Genome Analyzer, Applied Biosystems SOLiD system, Helicos Heliscope, Pacific Biosciences/single molecule real time (SMRT) sequencing. Advantages and disadvantages of the platforms, Need of Hybrid platforms. Base calling algorithms, Base quality, phred values, Reads quality checks, Interpretations from quality checks. Adapter and primer contamination. Processing reads using clipping of reads-Advantages and disadvantages of processing of reads.
2. **Genome assembly algorithms:** Alignment of short-reads to reference genome using spaced seed (ELAND, SOAP), index-filtering algorithm (SeqMap), quality-score (RMAP), q-filter algorithm (SHRiMP), FM-index (Bowtie, BWA,SOAP2), suffix tree (MUMmer). Sequence Alignment formats: Sequence Alignment/ Map (SAM) format, Binary Alignment/Map (BAM) format, Tools for conversion (SAMtools), Alignment viewers (IGV, MGAviewer).
3. **De-novo assembly:** Overlap-layout-consensus (OLC) approach (Arachne, Phusion), de Bruijn and Euler path approach (Euler, SOAPdenovo), string graph assembler (SGA), Scaffolding: Supercontig, contig orientation, contig ordering, contig distancing and gap closing using SOAPdenovo, ABySS, OPERA and RACA. Calculation N50 and its importance in assessing assembly, Quality checks for assembly, MIRA, Columbus, Velvet.
4. **Application of R in NGS analysis:** Introduction to Bioconductor, Reading of RNA-seq data (ShortRead, Rsamtools, GenomicRanges), annotation (biomaRt, genomeIntervals), reads coverage and assign counts (IRanges, GenomicFeatures), differential expression (DESeq).
5. **Biological applications of NGS:** Whole-genome sequencing, Exome sequencing, Transcriptome sequencing, Epigenome sequencing, Interactome sequencing, methylome sequencing, chip Sequencing, smallRNA sequencing, RAD Sequencing and RRL sequencing. Big Data analytics - Introduction of Cloud computing, Hadoop architecture. MIKE2.0, Multiple layer architecture, Distributed Parallel architecture, NGS data analysis using Hadoop.

Pre-requisite Courses: NONE

Reference Books:

1. "Next-generation DNA sequencing Informatics", Stuart M. Brown, Cold Spring Harbor Laboratory, 2013.
2. "RNA-seq Data Analysis: A Practical Approach", Eija Korpelainen, Jarno Tuimala, Panu Somervuo, Mikael Huss, Garry Wong, Chapman & Hall/CRC, 2014.

3. "Next generation sequencing: Translation to Clinical Diagnostics", Wong Lee-Jun C., Springer, 2013.
4. "Next-generation genome sequencing: Towards Personalized Medicine", Michal Janitz, Wiley-VCH, 2008.
5. "Next-generation DNA sequencing informatics", Stuart M. Brown, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, 2013.

UE18BT534: ENVIRONMENTAL POLLUTION AND MONITORING (4-0-0-0-4)

Course Objectives:

- To understand environmental pollution and its types.
- To be able to carry out monitoring of pollutants and apply the same in research and practice.

Course Outcomes:

At the end of the course, the student should be able to

- Obtain knowledge on types of pollutants in different form of pollution.
- Understand the scope of Biotechnology in environmental protection.
- Obtain knowledge on principles and technologies of monitoring of persistent organic pollutants.

Course Content:

1. **Environment and pollution:** Concept of Environmental Pollution; Origin of pollution; Classification and nature of Environmental Pollutants; Major sources; Impacts of Environmental Pollution. Environment protection Act: Environmental laws, Environmental policies, Environmental ethics.
2. **Air and noise pollution:** Concept of air Pollution; Major air pollutants and their sources; Meteorological aspects of air pollution; Oxides of nitrogen and sulphur; Particulate matter; Air pollution standards; Indoor and outdoor air pollution; Vehicular air pollution; Air pollution episodes and disasters; Effects of air pollution on human health, animals, plants, material and climate; Formation of fog and photochemical smog and acid rain; Monitoring of air pollution; Control on release of smoke; Gaseous contaminants and odour; Control on release of particulate matter by using different control devices. Noise Pollution: Concept of noise; Sources of noise; Measurement of noise; Religious festival and noise; Standards of noise; Effects of noise on plants, animals and human beings; Control of noise at source; Industrial noise control; Prevention of public noise; Community noise control.
3. **Soil Pollution:** Importance of soil; Concept of soil pollution; Soil acidity, saline and alkaline soil; Causes of soil salinity; Major soil types; Physical, chemical and biological methods of soil reclamation; Different causes of soil degradation; Chemical and metallic pollution of agricultural soil; Mining and soil pollution; Soil pollution and air quality; Control of soil pollution
4. **Water Pollution:** Principal forms of Water Pollutants and their sources; Pollution of stream, lakes and phenomenon of eutrophication; Water pollution monitoring and water quality standards; Ocean pollution – oil pollution; Ground water pollution and its control; Water pollution prevention
5. **Pollution Monitoring:** Methods of monitoring; Biological methods; Detection methods for DO, BOD, Pathogen monitoring; Advanced techniques such as enzyme detection, hybridization, PCR, Gene probe technology etc.; Chemical methods- Detection methods for COD, pH, alkalinity, TSS, TDS, Total organic carbon, oil, grease etc.; Biotechnology for clean environment. Bioindicators and biosensors for detection of pollution.

Pre-requisite Courses: NONE

Reference Books:

1. "Environmental Microbiology", Raina M. Maier, Ian L. Pepper, Charles P. Gerba, Academic Press, 2000.
2. "Wastewater Microbiology", Gabriel Bitton, Wiley-Liss, Second Edition, 1999.
3. "Environmental Biotechnology: Principles and Applications", Bruce Rittman, Perry L. McCarty, McGraw-Hill, Second Edition, 2000.
4. "An Introduction to Environmental Biotechnology", Milton Wainwright, Kluwer Academic Publishers, Boston, 1999.
5. "Environmental Biotechnology: Theory and Application", Evans G. M., Furlong J. C., John Wiley and Sons, 2003.
6. "Biotechnology and Safety Assessment", Thomas J.A., Fuchs R., Academic Press, 2002.

UE18BT541: DESIGN OF EXPERIMENTS (4-0-0-0-4)

Course Objectives:

- To understand the issues and principles of Design of Experiments.
- To review basic statistical concepts in Design of Experiments.
- Concept of Blocking in Design of Experiment Two factor Factorial Design and its extension to the General Factorial Designs.
- To understand concept and application of hypothesis testing in DOE.

Course Outcomes:

At the end of the course, the student should be able to

- Design and optimize an experimental model.
- Implement randomized blocks, Latin square designs and extensions of these.
- Implement confounding and blocking in 2^k designs.
- Understand and implement robust parameter designs of response surface methodologies.

Course Content:

1. **Introduction and Simple Comparative Experiments:** Strategy of experimentation, Typical applications of experimental design, Basic principles, Guidelines for designing experiments, History of statistical design, Using Statistical Techniques in experimentation. Basic Statistical concepts, Sampling and sampling distributions, Inferences about the differences in Means - Randomized Designs, Inferences about the differences in Means – Paired Comparison Designs, Inferences about the Variances of Normal Distributions.
2. **Experiments with a Single Factor:** The Analysis of Variance The analysis of variance, Analysis of the Fixed Effects Model, Model Adequacy Checking, Practical Interpretation of Results, Determining Sample Size, Discovering Dispersion Effects, Non-parametric Methods in the Analysis of Variance.
3. **Randomized Blocks, Latin Squares and Related Designs, Introduction to Factorial Design: T**he Randomized Complete Block Designs, The Latin Square Design, The Graeco-Latin Square Design, Balanced In-complete Block Designs. Definitions and Principles, Advantage of Factorials, The Two-Factor Factorial Design, The General Factorial Design, Fitting Responses and Surfaces, Blocking in a Factorial Design.
4. **The 2^k Factorial Design, Blocking and Confounding in the 2k Factorial Design:** Introduction, The 2^2 Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^k Design, The addition of Centre Points to the 2^k Design. Blocking a Replicated 2^k Factorial Design, Confounding in the 2^k Factorial Design, Confounding the 2^k Factorial Design in Two Blocks, Confounding

the 2^k Factorial Design in Four Blocks, Confounding the 2^k Factorial Design in 2^p Blocks, Partial Confounding.

5. **Fitting Regression Models:** Linear Regression Models, Estimation of Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression Models, Confidence Intervals in Multiple Regression Models, Prediction of New Response Observations, Regression Model Diagnostics, Testing for Lack of Fit.

   Response Surface Methods and Other Approaches to Process Optimization: Introduction to Response Surface Methodology, The Method of Steepest Ascent, Analysis of a Second Order Response Surface, Experimental Designs for Fitting Response Surfaces, Mixture Experiments, Evolutionary Operation, Robust Design.

Pre-requisite Courses: NONE

Reference Books:

1. Douglas C. Montgomery, "Design and Analysis of Experiments", John Wiley and Sons Inc., Eighth Edition, 2001.

UE18BT542:
APPLIED BIOSTATISTICS (4-0-0-0-4)

Course Objectives:

- To provide the students with a broad survey of biostatistical methods and techniques.

Course Outcomes:

At the end of the course, the student should be able to

- Apply appropriate statistical methods to analyze biological data.

Course Content:

1. **Basics & Descriptive Statistics:** Study Design-Randomized controlled studies, Historically controlled studies, crossover studies, factorial design, group allocation studies, randomization, blinding/masking, biases, compliances, cohort studies, case control studies, odds ratio, variables, qualitative data, quantitative variables-measures of location, measures of spread, displaying quantitative variables, log transformation, multivariate data, distribution of statistics-distribution of mean, proportion, variance, standard error.
2. **Statistical inference & Comparison of means:** Point estimation, confidence interval estimation, hypothesis testing, P value, errors, powers and sample size, statistical significance and practical significance, categorical data, binomial distribution and normal approximation to the binomial distribution, tests of association, Pearson's chi- square test, test of independence and homogeneity, Fischer's exact test, The t-Test, F distribution, tests of central tendency-Wilcoxon Signed Rank Test, Mann-Whitney Test, ANOVA, Kruskal-Wallis Test.
3. **Correlation & Regression:** Pearson Correlation coefficient, Spearman Rank correlation coefficient, simple linear regression, assessing the regression model fit, multiple linear regression, logistic regression.
4. **Survival analysis, Bayesian methods, missing data:** Failure time, Life table methods, Kaplan-Meier curves, Bayesian analysis, handling missing data.
5. **Application:** Estimating analytical imprecision, Laboratory quality control strategy, microarray analysis, association methods in human genetics, genome mapping.

Pre-requisite Courses: NONE

Reference Books:

1. "Topics in Biostatistics", Walter T. Ambrosius, Humana Press, 2007.

UE18BT543:
BIOREMEDIATION (4-0-0-0-4)

Course Objectives:

- To understand and apply advanced concepts of microbial ecology, biochemistry and bioremediation on Environment.
- To be able to carry out advanced research and practice in environmental biotechnology.

Course Outcomes:

At the end of the course, the student should be able to

- Obtain knowledge on scope of Biotechnology in environmental protection.
- Obtain knowledge on principles and technologies of removal of persistent organic pollutants mainly by means of the biological , physico-chemical technologies and other innovative technologies.
- Understand Engineering aspects of using microorganisms and plants for the remediation of contaminated soil, sludge and groundwater.

Course Content:

1. **Environment and pollution:** Concept of Environmental Pollution; Origin of pollution; Classification and nature of Environmental Pollutants; Major sources; Impacts of Environmental Pollution.
2. **Bioremediation:** Introduction, constraints and priorities of Bioremediation, Biostimulation , Bioaugmentation, in situ, exsitu, intrinsic & engineered bioremediation; **Solid phase bioremediation** - land farming, prepared beds, soil piles, Phytoremediation. Composting, Bioventing & Biosparging; **Liquid phase bioremediation**- suspended bioreactors, fixed biofilm reactors.
3. **Remediation: Treatment systems:** Microbial systems of bioremediation : Microbial Energy, Microbiology of bioremediation, Genetic modified microbes as bioremediation tools; Process control parameters. Phytoremediation: Phytoextraction,Rhizofiltration, Phytostabilization. Waste water treatment using aquatic plants; Root zone treatment.
4. **Remediation: Industrial Effluent treatment:** Sewage and waste water treatments systems; Primary, secondary and tertiary treatments; Measurement of treatment efficiencies; Bioremediation: Removal of specific pollution. Physicochemical characteristics and treatment strategies for effluent generated by Distillary and fermentation industry; Fertilizers and pesticide manufacturing industries; Dyes and dye intermediate producing industries and textile industries; Paper and pulp industries; Tanneries; Pharmaceuticals; Thermal power plants; Food and dairy industries; Iron and steel industries; Biotechnological application of hazardous waste management of water.
5. **Environmental impacts on agriculture:** Biodegradation of agricultural chemicals; GM crops and their impact on environment; Biological nitrogen fixation; Phosphate solubilization; Biofertilizers; Biological control of insect pests; Role of biopesticides/ insecticides; Biocontrol of plant pathogens; Ecology and IPM (Integrated pest management). Need for management of resources; Role of environmental biotechnology in management of resources; Reclamation of wasteland; Biomass production; Biogas and biofuel production; Development of environmentally friendly processes such as integrated waste management.

Pre-requisite Courses: NONE

Reference Books:

1. "Environmental Microbiology", Raina M. Maier, Ian L. Pepper, Charles P. Gerba, Academic Press, 2000.

2. “Biodegradation and Bioremediation”, Martin Alexander, Academic Press, Second Edition, 1999.
3. “Wastewater Microbiology”, Gabriel Bitton, Wiley-Liss, Second Edition, 1999.
4. “Environmental Biotechnology: Principles and Applications”, Rittman, Perry L. McCarty, McGraw-Hill, Second Edition, 2000.
5. Evans G. M., Furlong J. C., “Environmental Biotechnology: Theory and Application”, John Wiley and Sons, 2003.
6. “Advanced Physicochemical Treatment Processes”, Wang L. K., Hung Y. T., Shammas N. K., Springer, Humana Press, 2008.

UE18BT544: REGENERATIVE MEDICINE (4-0-0-0-4)

Course Objectives:

- To provide an insight into the current knowledge, future potential use and development of regenerative medicine.
- Deal with tools, methods and experimental protocols needed to study and characterize stem cells; as well as the application of stem cells to treat specific human diseases.
- To provide an insight to different kinds of stem cells, tissue engineering and their applications in accelerating the healing process to restore injured or damaged tissues and organs.
- Will focus on clinical applications of stem cell therapies on diseases as well as cell and gene therapy.

Course Outcomes:

At the end of the course, the student should be able to

- Identify different types of stem cells and their specific characteristics.
- Describe methods of applications to replace damaged or destroyed cells including tissue engineering.
- Apply regenerative medicine applications to human diseases.
- Evaluate current theories, methods and techniques within the research field, their practical execution and application.
- Compile, critically analyse and evaluate research results and present these both orally and in writing.

Course Content:

1. **An Introduction to Stem Cells:** Overview of basic and translational research of stem cells. Current perspectives in Regenerative Medicine, Diseases impacted by Regenerative Medicine: Replacement Therapy, Cellular Aspects of Regenerative Medicine. Concept of Stem Cells. Three-Dimensional Cell Culture, Organ Culture, Organotypic Culture. Stem Cells – Basics, Properties and Classification, Types of Stem cells – Hematopoietic Stem Cells, Mesenchymal Stem Cells, Embryonic Stem Cells, Foetal Stem Cells.
2. **Pluripotent stem cells:** Rodent and human embryonic stem cells their derivation, maintenance and applications, Induced pluripotent stem cells from human and other species, their generation and characterisation, Primordial and embryonic germ cells, their origin, properties and applications, Amniotic fluid derived pluripotent stem cells, their isolation and characterisation, Stem cells in extraembryonic lineages.
3. **Stem cells from adult organs**- Characteristics, Isolation, Culture and Characterization protocols: Neurogenesis and neural stem cells, hematopoietic stem cells, cord blood hematopoietic stem cells, retinal stem cells, hair follicle stem cells, vascular progenitors, skeletal muscle stem cells, kidney stem cells, Stem cells in the liver, pancreas, intestines.
4. **In Vitro and In Vivo Synthesis of Tissues and Organs:** Micro-Scale Patterning of Cells and their Environment, Three-Dimensional Scaffolds, Tissue Engineering and Transplantation Techniques, Immunoisolation Techniques, Modes of Cell and Tissue Delivery, Regeneration of Bone and Cartilage, Islet Cell transplantation and Bioartificial Pancreas, Bioprinting of Organs and Tissues.
5. **Applications of Stem cells:** Stem Cells in Gastrointestinal, Liver, Pancreas, Kidney, Heart, Spinal Cord and Lung Regeneration. Stem Cells in Eye Diseases and Disorders Neural stem cells for central nervous system repair. Use of stem cells to treat heart disease, diabetes, muscular dystrophy, Embryonic stem cells in tissue engineering. Regeneration of epidermis from adult keratinocyte stem cells. Application of stem cells to bone regeneration.

Pre-requisite Courses: NONE

Reference Books:

1. “Essential of StemCell Biology”,Lanza, J. Gearhart , Elsevier, Academic Press, 2009.
2. “Essential Stem Cells Methods”, R. Lanza, I. Klimanskaya, Academic Press, 2009.
3. “Principles of Tissue Engineering”, Robert Lanza , Academic Press, Third Edition, 2007.

UE17BT611: CLINICAL DATA ANALYTICS (2-0-0-0-2)

Course Objectives:

- To educate the student on concepts of basic analytics
- To understand the application of data analytics for pharmaceutical discoveries

Course Outcomes:

At the end of the course, the student should be able to

- Understand the role of data analytics in clinical decision support system and pharmaceutical discoveries
- Understand methods and concepts for basic and advanced data analytics

Course Content:

1. **Data sources and basic analytics:** EHR, biomedical signal analysis, biomedical image analysis, sensor data analysis; Genomic data analysis for personalized medicine, NLP and data mining for clinical text.
2. **Advanced data analytics:** Clinical prediction models, temporal data mining, visual analytics, clinicogenomic data integration, information retrieval.
3. **Data analytics for pharmaceutical discoveries:** Data sources, chemical and biological data, interaction prediction methods, multivariate methods.
4. **Clinical decision support system:** Types-Knowledge based, Artificial Neural Networks, Genetic algorithm; Critical and noncritical challenges, Reasoning-Rule based, Probabilistic reasoning, Case based reasoning.
5. **Applications and case studies:** Computer-assisted medical image analysis systems-Diagnosis of diseases, Mobile imaging and analytics for biomedical data.

Pre-requisite Courses: NONE

Reference Books:

1. “Healthcare data analytics”, edited by Chandan K Reddy & Charu C Aggarwal, CRC Press,2015.

UE17BT612: ADVANCED GENOMICS (2-0-0-0-2)

Course Objectives:

- To understand and apply advance concepts of Genomics.
- To develop insights into the current developments in the field of Genomics.

Course Outcomes:

At the end of the course, the student should be able to

- Familiar with the underlying principles and techniques of Genomics.
- Able to relate to the current developments in the field of Genomics

Course content:

1. **Genome analysis:** Nucleotide databases, gene prediction, sequence analysis, ESTs, Next Generation Sequencing.
2. **Functional genomics:** Introduction, forward and reverse genetics, Comparative genomics, transctiptomics, *Helicobacter pylori* functional Genomics.
3. **Epigenetics and epigenomics:** Epigenetic organization, epigenome analysis methods; DNA methylation analysis methods.
4. **Metagenomics:** Metagenome, shotgun metagenome sequencing, Sargasso sea metagenome survey, soil resistome project. Viral metagenomics.
5. **Pharmacogenomics:** Personalized medicine, Pharmacogenetics of enzymes and receptors, Single Nucleotide Polymorphisms and analysis. Cancer Genomics.

Pre-requisite Courses: NONE

Reference Books:

1. "Introduction to Genomics", Arthur Lesk, Oxford University Press, Second edition, 2015.
2. "Discovering Genomics, Proteomics and Bioinformatics", Malcolm Campbell, Pearson Education India, Second edition , 2007.
3. "Introducing Epigenetics: A Graphic Guide", Cath Ennis and Oliver Pugh, Icon Books Limited, 2017.

UE17BT613:
SOLID WASTE MANAGEMENT (2-0-0-0-2)

Course Objectives:

- To study the sources of solid waste and collection.
- To gain perspective into the management of solid waste such as transport, processing and disposal

Course Outcomes:

At the end of the course, the student should be able to

- Identify the different sources of solid waste and its collection.
- Differentiate different methods of transfer, transport, processing and disposal.

Course Content:

1. **Introduction to Environment:** Ecosystem –meaning- Types -Components- Structure – Functions, Levels of organization in nature- Food chain and Trophic structure, Biogeochemical Cycles, Energy flow.Municipal solid waste: Definition - Sources and types of solid waste- composition and its determinants of Solid waste-factors influencing generation-quantity assessment of solid wastes-methods of sampling and characterization.
2. **Collection:** Collection of Solid waste – collection services – collection system, equipments – time and frequency of collection – labour requirement – factors affecting collection – analysis of collection system – collection routes – preparation of master schedules.
3. **Transfer:** Need for transfer operation – transfer stations – types – transport means and methods – location of transport stations - Manpower requirement – collection routes: Transfer stations – selection of location, types & design requirements, operation & maintenance.
4. **Processing:** Techniques – purposes mechanical volume reduction – necessary equipments – chemical volume reduction – incinerators – mechanical size reduction selection of equipments – components separation – methods – drying and dewatering. Recovery of Resources, conversion products and energy recovery – recoverable materials – processing and recovery systems – incineration with heat recovery.
5. **Disposal:** Refuse disposal – various methods – incinerations – principle features of an incinerator – site selection and plant layout of an incinerator - sanitary landfill- methods of operation – advantages and disadvantages of sanitary land fill - site selection – reactions accruing in completed landfills – gas and leachate movement and control – equipments necessary.

Pre-requisite Courses: NONE

Reference Books:

1. "Integrated Solid Waste Management" , George Techobanoglous, McGraw - Hill, 1993
2. "Solid Waste Engineering Principles and Management" Techobanoglous Thiesen Ellasen;, McGraw – Hill, 1997.
3. " Municipal Solid Wastes-Problems & Solutions" R.E.Landrefh and P.A.Rebers, Lewis, 1997.
4. "Solid Waste Management in Developing countries", Blide A.D.& Sundaresan, B.B, INSDOC, 1993.

UE17BT631:
QUALITY ASSURANCE AND VALIDATION (2-0-0-0-2)

Course Objectives:

- To understand the quality assurance and validation of biotechnological products and process.
- To understand and select the testing procedure for quality assurance and validation.

Course Outcomes:

At the end of the course, the students should be able to

- Design a process involved in validation of biotechnological product
- Understand the process of quality assurance and validation
- Knowledge of regulatory issues in biotechnology manufacturing.

Course Content:

1. **Introduction and scope in biotechnology:** Importance, Quality Assurance or Quality Control?, Issues in Biopharmaceutical Processing, Quality Assurance Compliance Programs: - Documentation, SOP, Personnel training, Calibration, maintenance, audit, validation.
2. **Quality Control and Quality Assurance:** Biotechnology Products, Final Product Lot Release: - General Safety Testing, Sterility Testing, Pyrogen Testing, Mycoplasma Testing, DNA Testing, Virus Testing. Process Validation: - Process Parameters, Cell Line Characterization, Virus Removal and Inactivation, DNA and Nucleic Acid Removal. FDA Inspection Guides.
3. **Biotechnology Manufacturing Issues:** Regulation of Biotechnology Products, FDA's Concerns, Strategies for Compliance: - Importance of Planning, Review, Audits.
4. **Validation of Biopharmaceutical Upstream Processes:** Cell Bank Testing and Qualification, Equipment Qualification: - Installation, Operational and Performance Qualification. Validation of Fermentation/Cell Culture Processes: - Raw Material Validation, Process Validation.
5. **Validation of Biopharmaceutical Downstream Processes:** Validation of Downstream Processing: - Process Chemicals and Raw Materials, Column Packing Materials. Performance Qualification of Downstream Processes: - Concurrent versus Prospective validation, Chromatography column packing, column lifetime, and Process robustness. Clearance studies.

Pre-requisite Courses: NONE

Reference Books:

1. "Quality Control Training Manual: Comprehensive Training Guide for API finished pharmaceutical and biotechnologies", Syed Imtiaz Haider and Syed Erfan Asif, CRC Press, 2011.
2. Kenneth E. Avis, Carmen M. Wagner and Vincent L. Wu. "Biotechnology: Quality Assurance and Validation", Volume 4, CRC Press, 1999.
3. "Good Laboratory Practice Regulations", Weinberg S, Vol. 69, Marcel Dekker Series, 2003
4. Quality Assurance Guide by Organization of Pharmaceutical Procedures of India, Vol. I and II, Mumbai, 1996
5. Quality Assurance of Pharmaceuticals- A Compendium of Guidelines and Related materials, Vol. I and II, WHO Publications, 1999

UE17BT632: METABOLOMICS (2-0-0-0-2)

Course Objectives:

- To educate the student on concepts and methods of metabolomic data analysis
- To understand the application of metabolomics in industry, agriculture and disease research
- Understanding of metabolomics to identify new bioactives

Course Outcomes:

At the end of the course, the student should be able to

- Understand the role of metabolomics in industry, agriculture and disease research
- Understand methods to interpret metabolomic data
- Understand role of metabolomics to identify new bioactives

Course Content:

1. **Concepts and methodology:** Chemical challenge of metabolome: structural diversity, controlling rates and levels; Sampling and sample preparation: quencing, obtaining metabolites from biological samples; Analytical tools: Chromatographic system, Mass Spectrometry.
2. **Data analysis and integration:** Online metabolomics databases and pipelines, generic software frameworks, computational methods to interpret and integrate metabolomic data, software techniques for enabling High-Throughput analysis of metabolomic datasets.
3. **Metabolomics to identify new bioactives**: Metabolic pathways as targets for drug screening: Genetic/signaling pathways and Biochemical pathways as targets for drug screening, Measuring extreme pathways – Carbon tracing in tracer-based metabolomics, Extreme pathways as targets for drug screening.
4. **Plant Metabolomics**: Specific challenges in plant metabolomics; Applications of metabolomics approaches in plant research- Phenotyping, Functional genomics, Fluxomics, Metabolic trait analysis.
5. **Applications and case studies:** Yeast Metabolomics: Discovery of new metabolic pathways in *Saccharomyces cerevisiae*; Microbial Metabolomics: Techniques to investigate intracellular metabolite dynamics; Metabolomics in human disease research: Clinical implementation of metabolomics, Comprehensive vs. focused metabolomics.

Pre-requisite Courses: NONE

Reference Books:

1. "Metabolomics", Ute Roessner, InTech, 2012.
2. "Metabolome Analysis -An Introduction", Silas G. Villas-Boas, Ute Roessner,Michael A. E. Hansen, Jorn Smedsgaard and Jens Nielsen, John Wiley & Sons Inc., 2007.

UE17BT633: SUSTAINABLE GREEN TECHNOLOGIES (2-0-0-0-2)

Course Objectives:

- Development of new generation sustainable designers
- Inculcate the skills which are responsible and able in the task of designing environmentally sustainable products
- Understand the merits of environmental sustainable technologies

Course outcomes:

At the end of the course, the student should be able to

- Develop new generation sustainable environmental designs
- Application of skills based on priority to evolve sustainable environmental products to society problems
- Create awareness to bring socioeconomic changes in the society with environmental sustainability

Course Content:

1. **The scope of water management for economic growth of India**. The potential treatment methodologies related to sewage water recycling and applications in irrigation, agro industrial sector. Study of regulations and good practices employed in the recycling process to ensure human and environmental safety.
2. **Study of Environmental Impact Assessment of Waste water recycling plant and simulation analysis.** Environmental Impact Assessment of waste water treatment Plant in respect to sustainability: Visit to a waste water recycling plant and preparation of case study report. Utilization of tools and techniques related to waste water treatment. Development of simulation model related to the unit with respect to its use in agriculture and industry sector.
3. **Biopesticides and Biofertilizers:** Source of Biopesticides: Bacteria, Virus, Fungi, Nematodes, Plant secondary metabolites. The bioprocess involved in the scale up and formulation of biopesticides.

   Source of Biofertilizers: Organic manures, Effective microorganisms like Trichoderma harzianum, Trichoderma viridae, Psuedomonas flurescence formulations. The biotechnological approaches in development of improved commercial formulations and their potentials against target crops.
4. **Biogas as a source of alternative fuel:** Biomethanation using biomass, recent advances in the bioreactor design related to biogas production. Biotechnology in improvising the strains of methanogenic bacteria by symbiotic archaea bacteria. Usage of compression technology to improve the biogas usage to automobiles.
5. **Clean Development Mechanisms (CDM) for Sustainable industrial Development:** The regulatory guide lines related CDM by United Nation Commission on Environment, Benefits to the countries implementing CDM guidelines at the manufacturing sectors. The emission trading impact on the economic development of the country. The recognitions related to start up and other infrastructure projects having inbuilt CDM technologies from National and International regulatory bodies.

Pre-requisite Courses: NONE

Reference Books:

1. "Design for Environmental Sustainability", Carlo Vezzoli, Ezio Manzeni, Springer, Second Edition, 2016.
2. "Environmental Sustainability", Thangavel, Sridevi.K., Springer, First Edition, 2015.

COMPUTER SCIENCE AND ENGINEERING

B.TECH IN COMPUTER SCIENCE AND ENGINEERING

Program Educational Objectives

- Prepare and train students in theoretical foundations to work with cutting edge computing technologies and design solutions to complex engineering problems, making them ready to work in industrial environment.
- Develop all round skills such as team building, inter-personal skills, and leadership qualities in order to effectively communicate with engineering community and with society, at large.
- Promote research culture through internships, research assistantships, research-oriented projects, sponsored and collaborative research and enable them to pursue higher studies in computer science and related fields.
- To inculcate social concern meeting the requirements of prospective employers and to develop an ability to innovate efficient computing solutions for better society.
- Create professionally superior and ethically strong globally competent employees and entrepreneurs.

Program Outcomes

- Apply mathematical and theoretical principles in the modeling and design of high-quality computer-based systems using state-of-the-art computer technology.
- Conduct in-depth study of research literature in the area of Computer Science, analyze problems in order to arrive at substantiated conclusions using first principles of mathematics, and allied sciences.
- Design, implement and evaluate Computer Systems, programs and processes that meet partial/ complete specifications with concern for society, environment and culture.
- Design and conduct experiments, collect data, analyze and interpret the results to investigate complex engineering problems in the field of Computer Science.
- Apply state-of-the-art techniques and modern computer-based tools in prediction, comparison and modeling of complex engineering activities.
- Have sound understanding of professional, legal, security and social issues and responsibilities in engineering actives involving Computer Science.
- Understand societal and environmental concerns and demonstrate responsibility in sustainable development of computer-based solutions.
- Be aware of ethical and professional responsibilities in engineering situations; make informed judgments regarding intellectual property and rights in relation to computer-based solutions in global, economic, environmental and societal contexts.
- Able to function effectively in teams to establish goals, plan tasks, meet deadlines, manage risk and produce high-quality technical solutions.
- Contribute and communicate effectively with the society, be able to write effective reports and design documents by adhering to appropriate standards, make effective presentations, give and receive clear instructions.
- Apply skills in clear communication, responsible teamwork and time management by, for example, managing a team or project and communicating with external stakeholders.
- Recognize the need for and demonstrate an ability to engage in continuing professional development in its broadest sense.

UE18CS101: INTRODUCTION TO COMPUTING USING PYTHON (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Learn basics of computer hardware and programming.
- Learn how to solve a given problem.
- Learn various paradigms of programming.
- Learn Python as a programming language.
- Learn how to combine data structures and functions available in Python to solve problems.

Course Outcomes:

At the end of the course, the student will be able to:

- Outline the process involved in executing a computer program.
- Program effectively using Python programming language.
- Think using different paradigms of programming.

Course Content:

1. **Introduction**: Computational Problem Solving, Limits of Computational Problem Solving, Computer Algorithm, Computer Hardware, Digital Computer, Operating System, Limits of IC Technology, Computer Software, Syntax, Semantics and Program Translation.
2. **Process of Computational Problem Solving**: Introduction to Python Programming Language, Output Function, Variables, Types, id Operators and Expressions, Control Structures, Lists, Dictionaries, Sets, Tuples and Strings.
3. **Functions**: Definition, Call, Positional and Keyword Parameters, Default Parameters, Variable Number of Arguments, Modules - Import Mechanisms, Functional Programming - map, filter, reduce, max, min and lambda functions, List Comprehension.
4. **Object Oriented Programming:** Classes and Objects, Inheritance, Polymorphism, Error Handling and Exceptions - try, except and raise, Exception Propagation.
5. **File Processing:** Reading and Writing Files.

Pre-requisite Courses: None.

Reference Book(s):

1. "Introduction to Computer Science Using Python: A Computational Problem-Solving Focus", Charles Dierbach, John Wiley, 2012.

UE18CS102: INTRODUCTION TO COMPUTING USING PYTHON LABORATORY (0-0-2-0-1)

Course Objectives:

The objective(s) of this course is to,

- Learn basics of computer programming.
- Learn how to solve a given problem.
- Learn to use various paradigms of programming.
- Learn Python as a programming language.
- Learn how to implement data structures and functions available in Python to solve problems.

Course Outcomes:

At the end of the course, the student will be able to:

- Illustrate problem solving using Python programming.

Course Content:

1. UNIX Commands and Utilities.
2. Program to demonstrate Input Output Functions, Operators and Expressions.
3. Program to demonstrate the Usage of Libraries.
4. Program to demonstrate Control Structures.
5. Program to demonstrate Control Structures.
6. Program to demonstrate Lists and Tuples.
7. Program to demonstrate Sets and Dictionaries.
8. Program to demonstrate String Related Operations.
9. Program to demonstrate the Usage of Functions.
10. Program to demonstrate Functional Programming.
11. Program to demonstrate Functional Programming.
12. Program to demonstrate File Handling in Python.

Pre-requisite Courses: None.

Reference Book(s):

1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE18CS151:
PROBLEM SOLVING WITH C (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Learn how to solve common types of computing problems.
- Learn to map problems to programming features of 'C'.
- Understand computer programming and its roles in problem solving.
- Understand and develop well-structured programs using 'C' language.
- Learn the basic data structures through implementation in 'C' language.

Course Outcomes:

At the end of the course, the student will be able to:

- Analyze the given problem and develop an algorithm to solve the problem.
- Optimize the solution given for an existing problem.
- Use 'C' language constructs in the right way.
- Design, develop and test programs written in 'C'.

Course Content:

1. **Counting**: Introduction to Programming, Salient Features of 'C', Program Structure, Variables, Data Types, Operators and Expressions, Control Structures, Input/ Output Functions.
2. **Text Processing and String Manipulation**: Single Character Input and Output, Arrays and Pointers, Strings, String Manipulation.
3. **Prioritized Scheduling**: Functions, Structures and Unions, Dynamic Memory Management, Lists, Priority Queue.
4. **Sorting**: Sorting, Combination of Structures and Arrays and Pointers, Callback, Sorting using Callback.
5. File Handling, Enums, Bit Fields, Storage Class, Qualifiers, Life and Scope, Pre-Processor Directives, Conditional Compilation, Pragmas.

Pre-requisite Courses: None.

Reference Book(s):

1. "How To Solve It By Computer", R G Dromey, Pearson, 2011.
2. "The C Programming Language", Brian Kernighan, Dennis Ritchie, 2nd Edition, Prentice Hall PTR, 1988.

UE18CS152:
PROBLEM SOLVING WITH C LABORATORY (0-0-2-0-1)

Course Objectives:

The objective(s) of this course is to,

- Learn and implement how to solve common types of computing problems.
- Use data types and control structures of 'C'.
- Learn to map problems to programming features of 'C'.
- Learn to write good, portable 'C' programs.

Course Outcomes:

At the end of the course, the student will be able to:

- Analyze a given problem and implement an algorithm to solve the problem.
- Improve upon a solution to a problem.
- Implement the 'C' language constructs in the right way.
- Design, develop and test programs written in 'C'.

Course Content:

1. Program to demonstrate Input, Output Functions and Control Structures.
2. Program to demonstrate Word/ Line/ Character Count in a given input data.
3. Program to demonstrate Operators and Control Structures.
4. Program to demonstrate Character Input and Output.
5. Program to demonstrate Functions, Arrays and Pointers.
6. Program to demonstrate Strings, Pointers using multiple files.
7. Program to demonstrate the use of Multi-Dimensional Arrays.
8. Program to demonstrate the usage of Structures, Array of Structures and Array of Pointers.
9. Program to demonstrate List using multiple files.
10. Program to demonstrate Enumerations.
11. Program to demonstrate File Handling in 'C'.
12. Program to demonstrate File Handling in 'C'.

Pre-requisite Courses: None.

Reference Book(s):

1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE17CS201:
DIGITAL DESIGN AND COMPUTER ORGANIZATION (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Learn to design digital circuits and systems using state-of-the-art Computer-Aided Design (CAD) tools.
- Learn how to represent a digital system using a Hardware Description Language (Verilog HDL) and how to simulate the design.
- By the end of this course, each student would have designed a full basic microprocessor.

Course Outcomes:

At the end of the course, the student will be able to:

- Convert a specification of a small to medium scale digital system into an implementation.
- Hierarchically decompose a complex specification into simpler components.
- Understand concurrency and develop concurrent system specifications and implementations.

Course Content:

1. **Combinational and Sequential Logic Design:** Introduction, Boolean Equations, Karnaugh Maps, Combinational Building Blocks, Synchronous Logic Design.
2. **Digital Building Blocks:** Introduction, Finite State Machines, Parallelism, Arithmetic Circuits, Sequential Building Blocks, Memory Arrays, Logic Arrays.
3. **Architecture:** Introduction, Assembly Language, Machine Language, Programming, Addressing Modes, Compiling, Assembling, Loading.
4. **Microarchitecture:** Introduction, Performance Analysis, Single-Cycle Processor, Multi-Cycle Processor, Pipelined Processor, Advanced Microarchitecture.
5. **Memory Systems:** Introduction, Memory System Performance Analysis, Caches, Virtual Memory, Introduction to I/O Systems.

Pre-requisite Courses: None.

Reference Book(s):

1. "Digital Design", M Morris Mano, Michael D Ciletti, 5th Edition, Pearson.
2. "Computer Organization and Design", David A Patterson, John L Hennessey, 4th Edition, Elsevier.
3. "Digital Design and Computer Architecture", David Money Harris, Sarah L Harris, 2nd Edition, Elsevier.

UE17CS202: DATA STRUCTURES (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Enable the learner with the concepts of recursion and linear data structures viz., Linked Lists, Stacks and Queues.
- Enable the learner with the concepts of non-linear data structures viz., Graphs, Trees, Heaps, Trie and Hashing.
- Hone the learner such that they obtain the ability to compare different implementations of data structures and recognize the advantages and disadvantages of different implementations.
- Inculcate in the learner, the aspects of choosing the appropriate data structure and algorithm design method for a specified application and with the usage of standard libraries.

Course Outcomes:

At the end of the course, the student will be able to:

- Implement fundamental data structures viz., Lists, Stacks, Queues, Linked Lists, Binary Trees from first principles.
- Demonstrate the use of appropriate data structures for a given problem.
- Design and implement solutions to basic practical problems using customized data structures.
- Develop quick and foolproof solutions to practical problems using abstract data types.

Course Content:

1. **Data Structures Overview**: Recursion, Pointers, Programming Practices. **Lists**: Definition, Create, Insert, Delete, Update, Traverse and Position-based Operations, Linked List and Array Implementations, Concatenate, Merge, and Reverse Lists, Doubly-Linked List Implementation and Operations, Circular Lists and Multi-List, Applications of Lists.
2. **Stacks**: Definition, Operations, Implementation using Linked-List and Arrays, Applications of Stacks – Postfix Conversion and Expression Evaluation, Parentheses Balancing. **Queues**: Definition, Operations, Implementation, Applications, Circular Queue, Dequeue.
3. **Graphs:** Definition, Complete Graphs, Regular Graphs, Paths, Connectivity, Euler and Hamilton Graphs, Representation of Graphs - Adjacency/ Cost Matrix, Adjacency Lists, Traversal of Graphs. **Trees**: General Tree Representation, Traversals, Applications. **Binary Trees**: Definition, Properties, Implementation, Traversals, Applications.
4. **Binary Search Tree**: Definition, Implementation, Search, Insert, Delete Operations, Building and Evaluating Binary Expression Tree. **Heap Tree**: Implementation, Insert, Delete, FindMin Operations, Priority Queue using Arrays and Heap.
5. **Tries:** Definition, Implementation, Applications. **Hashing**: Hash Table, Hash Functions, Collision Handling by Open Addressing, Chaining.

Pre-requisite Courses: UE17CS151 – Problem Solving with C.

Reference Book(s):

1. "Data Structures and Program Design in C", Robert Kruse, C L Tondo, Bruce Leung, Shashi Mogalla, PHI, 2nd Edition, 2015.
2. "Data Structures Using C and C++", Tanenbaum, Langsam, Augenstein, Pearson, 2nd Edition, 2015.

UE17CS203: INTRODUCTION TO DATA SCIENCE (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Provide insights about the basic roles of a Data Scientist. Develop a greater understanding of the importance of Data Visualization techniques.
- Develop problem-solving skills.
- Make inferences about the population parameters using sample data.
- Test a hypothesis about the population parameters to draw meaningful conclusions.
- Provide an understanding on the importance and techniques of predicting a relationship between the two sets of data and determine the goodness of fitted model.

Course Outcomes:

At the end of the course, the student will be able to:

- Develop various visualizations of the data in hand and communicate results of analysis effectively (visually and verbally).
- Analyze a real-world problem and solve the same with the knowledge gained from various distributions study.
- Analyze an extremely large data set and perform exploratory data analysis to extract meaningful insights.
- Develop and test a hypothesis about the population parameters to draw meaningful conclusions.
- Fit a regression model to data and use it for prediction.

Course Content:

1. **Introduction to Data Science using Python:** Motivating Examples and Scope. **Sampling:** Sampling Methods, Sampling Errors. **Getting and Analyzing Data:** Reading Files, Need for Data Cleaning and Its Basics, Scraping the Web. **Statistics:** Introduction, Types of Statistics. **Data Visualization and Interpretation:** Histogram, Bar Charts, Line Charts, Scatter Plots, Box Plots, Good vs. Bad Visualization.
2. **Random Variables:** Random Variables, Expectation, Functions of Random Variables. **Probability Distributions:** Brief Overview of Probability Basics, Discrete Distributions (Bernoulli, Binomial, Poisson), Continuous Distributions (Normal), Normal Probability Plots, Student's t Distribution.

3. **Probability Distributions:** Principles of Point Estimation - Mean Squared Error, Maximum Likelihood Estimate, The Central Limit Theorem and Applications. **Confidence Intervals:** Using Simulation to Construct Confidence Intervals, Interval Estimates for Mean of Large and Small Samples, Factors affecting Margin of Error.
4. **Confidence Intervals:** Interval Estimates for Proportion of Large Samples, Confidence Intervals for the Difference between Two Means, Interval Estimates for Paired Data. **Hypothesis and Inference:** Hypothesis Testing for Population Mean and Population Proportion of Large Samples, Relationship between Hypothesis Tests and Confidence Intervals, Large-Sample Tests for the Difference Between Two Means, Errors in Hypothesis Testing.
5. **Hypothesis and Inference:** Power of a Test, Factors Affecting Power of a Test, Distribution Free Tests, Chi-Squared Test. **Simple Linear Regression:** Correlation, Inference on Population Correlation, Building the Regression Model, Predictions using Regression Models, Residual Plots.

Pre-requisite Courses: None.

Reference Book(s):

1. "Statistics for Engineers and Scientists", William Navidi, McGraw Hill Education, India, 3rd Edition, 2013.
2. "Data Science from Scratch", Joel Grus, O'Reilly, 1st Edition, 2015.

UE17CS204: WEB TECHNOLOGIES I (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Teach students HTML and CSS for designing web pages.
- Introduce students to the basics of JavaScript as a programming language.
- Familiarize students with the Document Object Model and enable them to create dynamic web pages that react to user input.
- Teach students about installing and configuring Apache Server and incorporating backend support for their web pages.
- Introduce students to the newer features available as part of the HTML5 standard.
- Familiarize students with jQuery and Bootstrap.

Course Outcomes:

At the end of the course, the student will be able to:

- Design visually appealing websites using HTML and CSS.
- Design solutions for programming questions using JavaScript.
- Create dynamic webpages by manipulating the Document Object Model.
- Setup a web server and host a website with backend support.
- Incorporate the latest HTML5 features in the webpages designed by them with fallback options wherever required.
- Use Bootstrap and jQuery to enhance the functionality of their websites.

Course Content:

1. **Introduction, UI Design and UX :** Internet, WWW, Web Servers and Browsers, URLs, MIME, HTTP, Basic Markup, Images, Hyperlinks, Lists, Tables, Forms, DataList, Canvas, Audio and Video, Geo-Location, Local Storage, Web Workers, Offline Web Applications, Drag and Drop.
2. **JavaScript:** Introduction to Client-Side Scripting, JavaScript Basics, Screen Input and Keyboard Output, Functions, Objects, Inheritance, Hoisting, Arrays, JavaScript Objects, Accessing and Modifying DOM, Events and Event Handlers - Load, Mouse, Synthetic Events, Key and Form Related Events, Event Bubbling, Cookies.
3. **Apache:** httpd Server, Request Response Formats Basics, Configuration, Debugging, .htaccess.
4. **PHP:** Basics, File Handling and System Calls, Strings and Regular Expressions, Arrays, Cookies, Sessions, Functions, Classes, Database Access.
5. **Bootstrap:** Grid Systems, Layout, Tables and Forms, Buttons and Images, Progress Bar, Navigations. **jQuery:** Usage, Selecting DOM Elements, Getting and Setting Attributes, Changing Styles, File Handling and System Calls, Arrays, Cookies, Sessions, Database Access.

Pre-requisite Courses: None.

Reference Book(s):

1. "JavaScript Absolute Beginner's Guide", Kirupa Chinnathambi, 1st Edition, 2017.
2. "Programming the World Wide Web", Robert W Sebesta, Pearson, 7th Edition, 2013.
3. "HTML5 Up and Running", Mark Pilgrim, O'Reilly, 1st Edition, 2012.

UE17CS205: DISCRETE MATHEMATICS AND LOGIC (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Develop logical thinking and its application to computer science with emphasis on the importance of proving statements correctly.
- Introduce fundamental discrete structures like Sets, Functions and Relations.
- Introduce combinatorial objects and counting techniques.
- Draw similarities between Mathematical Induction and Recurrences and use them to design recursive functions.
- Introduce algebraic structures like Groups, Rings and their usage in coding theory.

Course Outcomes:

At the end of the course, the student will be able to:

- Comprehend formal logical arguments.
- Specify and manipulate basic mathematical objects such as Sets, Functions and Relations and will also be able to verify simple mathematical properties that these objects possess.
- Apply basic counting techniques to solve combinatorial problems.
- Design a recursive function by developing a Recurrence and prove its correctness using Mathematical Induction.
- Apply the concepts of algebraic structures in coding theory.

Course Content:

1. **Logic:** Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference.
2. **Sets, Functions and Relations:** Sets and Set Operations, Functions, Relations and Their Properties, Sequences and Summations, Countably Infinite and Uncountably Infinite Sets, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orderings.
3. **Counting:** The Sum and the Product Rules, The Pigeonhole Principle, Permutations and Combinations, Binomial Coefficients, Generalized Permutations and Combinations.
4. **Induction, Recursion and Recurrence Relations:** Mathematical Induction, Strong Induction, Recursive Definitions, Recursive Algorithms, Recurrence Relations, Solving Linear Recurrence Relations.

5. **Algebraic Structures:** The Structure of Algebras, Semi Groups, Monoids and Groups, Homomorphisms, Normal Subgroups and Congruence Relations, Rings, Integral Domains and Fields, Coding Theory, Hamming Codes.

Pre-requisite Courses: None.

Reference Book(s):

1. "Discrete Mathematics and its Applications", Kenneth H Rosen, 7th Edition (Indian adaptation by Kamala Krithivasan), Tata McGraw-Hill, 2011.
2. **"Discrete and Combinatorial Mathematics:** An Applied Introduction", Grimaldi, Ramana, 5th Edition, Pearson, 2011.

UE17CS206: DIGITAL DESIGN AND COMPUTER ORGANIZATION LABORATORY (0-0-2-0-1)

Course Objectives:

The objective(s) of this course is to,

- Explain the elements of digital system abstractions such as digital representations of information, Digital Logic, Boolean Algebra, State Elements and Finite State Machine (FSMs).
- Design simple digital systems based on these digital abstractions, using the "Digital Paradigm" including discrete sampled information.
- Use the "Tools of the Trade" - Basic Instruments, Devices and Design Tools.
- Work in a design team that can propose, design, successfully implement and report on a digital systems project.
- Communicate the purpose and results of a design project in written and oral presentations.

Course Outcomes:

At the end of the course, the student will be able to:

- Achieve knowledge and awareness of various components to design stable digital circuits.
- Analyze and design combinational circuits.
- Design and develop sequential circuits.
- Design and develop a basic microprocessor.
- Translate real world problems into digital logic formulations using Verilog.

Course Content:

1. Implementing Basic Gates and Adder Circuit using Trainer Kit.
2. Verilog Basics - I.
3. Verilog Basics - II and Combinational Design - Adders/ Multiplexers.
4. Designing a basic ALU.
5. Sequential Design - Counters.
6. Sequential Design - Register Files.
7. Sequential Design - FSM.
8. Design of Datapath Unit.
9. HDL Representation of Single-Cycle Processor.
10. Mini Project.
11. Mini Project.
12. Mini Project.
13. Mini Project.

Pre-requisite Courses: None.

Reference Book(s):

1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE17CS207: DATA STRUCTURES LABORATORY (0-0-2-0-1)

Course Objectives:

The objective(s) of this course is to,

- Enable the learner with the concepts of recursion and linear data structures viz., Linked Lists, Stacks and Queues.
- Enable the learner with the concepts of non-linear data structures viz., Graphs, Trees, Heaps, Trie and Hashing.
- Hone the learner such that they obtain the ability to compare different implementations of data structures and recognize the advantages and disadvantages of the different implementations.
- Inculcate in the learner, the aspects of choosing the appropriate data structure and algorithm design method for a specified application and with usage of standard library.

Course Outcomes:

At the end of the course, the student will be able to:

- Implement fundamental data structures viz., Lists, Stacks, Queues, Linked Lists, Binary Trees from first principles.
- Demonstrate the use of appropriate data structures for a given problem.
- Design and implement solutions to basic practical problems using customized data structures.
- Develop quick and foolproof solutions to practical problems using abstract data types.

Course Content:

1. Write a program to perform the following operations using Linked List:
   a) Insert an element at the beginning.
   b) Delete the specified element from the list.
   c) Display elements of the list.
2. Write a program to perform the following operations using Linked List:
   a) Insert an element at a specified position.
   b) Delete the element at the end of the list.
   c) Reverse the nodes in the list.
   d) Display elements of the list.
3. Write a program to perform the following operations using Doubly Linked List:
   a) Insert an element at the beginning.
   b) Delete the specified element from the list.
4. Write a program to perform the following operations using Doubly Linked List:
   a) Insert an element at a specified position.
   b) Delete the element at the end of the list.
5. Create an array or linked list implementation of Stack. Provide PUSH, PEEP (or TOP) and POP methods. Check for:
   a) Overflow
   b) Underflow
   exceptions during these operations.
6. Create an array or linked list implementation of Queue. Provide ENQUEUE, DEQUEUE and FRONT methods. Check for:
   a) Overflow
   b) Underflow
   exceptions during these operations.
7. Covert a given infix expression to postfix expression.
8. Write a 'C' program to perform matching of brackets – parentheses, square and flower brackets.
9. Implement a circular queue CQUEUE and implement ENQUEUE and DEQUEUE functions.

10. Write a ‘C’ program to find the number of connected components in an undirected graph using DFS traversal.
11. Implement a Binary Search Tree and perform the following:
    a) Insert a node.
    b) Preorder Traversal.
    c) Postorder Traversal.
    d) Inorder Traversal.
12. Implement a Binary Search Tree and perform the following:
    a) Find the minimum element in the tree.
    b) Find the maximum element in the tree.
    c) Find the number of nodes in the tree.
    d) Find the number of internal nodes in the tree.
    e) Find the number of external nodes in the tree.
13. Implement a Priority Queue using heap with:
    a) Insert.
    b) Remove Min methods.
14. Construct a dictionary of key-value pairs using Trie and search for a value matching a key.

Pre-requisite Courses: None.

Reference Book(s):

1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE17CS251:
DESIGN AND ANALYSIS OF ALGORITHMS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Learn to design and analyze algorithms with an emphasis on the resource utilization in terms of time and space.
- Learn various techniques in development of algorithms so that the effect of problem size and architecture design on the efficiency of the algorithm is appreciated.
- Learn to prove the correctness of algorithms.

Course Outcomes:

At the end of the course, the student will be able to:

- Identify the design technique used in an algorithm.
- Design an algorithm for a problem in a known design technique.
- Prove the correctness of an algorithm.
- Analyze the resource utilization of an algorithm in terms of time and space.
- Understand the limits of algorithms and the ways to cope with the limitations.

Course Content:

1. **Introduction:** Algorithms, Fundamentals of Algorithmic Problem Solving, Important Problem Types. **Analysis of Algorithm Efficiency:** Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non - Recursive and Recursive Algorithms.
2. **Brute Force:** Sequential Search, Brute Force String Matching, Selection Sort, Bubble Sort, Depth-First Search and Breadth-First Search, Exhaustive Search. **Divide-and-Conquer:** Merge Sort, Quick Sort, Binary Search, Binary Tree Traversals, Multiplication of Large Integers, Strassen’s Matrix Multiplication and Master Theorem.
3. **Decrease-and-Conquer:** Insertion Sort, Topological Sorting, Algorithms for Generating Combinatorial Objects, Decrease-by-a-Constant-Factor Algorithms. **Transform-and-Conquer:** Presorting, Heap Sort, AVL Trees, Red-Black Trees, 2-3 Trees and B Trees.
4. **Space and Time Tradeoffs:** Sorting by Counting, Input Enhancement in String Matching - Horspool’s and Boyer-Moore Algorithms. **Dynamic Programming:** Computing a Binomial Coefficient, The Knapsack Problem and Memory Functions, Warshall’s and Floyd’s Algorithms.
5. **Greedy Technique:** Prim’s Algorithm, Kruskal’s Algorithm, Dijkstra’s Algorithm, Huffman Trees. **Limitations of Algorithm Power:** Lower-Bound Arguments, Decision Trees, P, NP, and NP-Complete Problems. **Coping with the Limitations of Algorithm Power:** Backtracking, Branch-and-Bound.

Pre-requisite Courses: UE17CS151 – Problem Solving with C.

Reference Book(s):

1. “Introduction to the Design and Analysis of Algorithms”, Anany Levitin, 2nd Edition, Pearson Education, 2011 (Updated Version of the Book).
2. “Introduction to Algorithms”, Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, 3rd Edition, Prentice-Hall India, 2009.
3. “Fundamentals of Computer Algorithms”, Horowitz, Sahni, Rajasekaran, 2/e, Universities Press, 2007.
4. “Algorithm Design”, Jon Kleinberg, Eva Tardos, Pearson Education, 2006.

UE17CS252:
DATABASE MANAGEMENT SYSTEMS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Introduce fundamental concepts, terminology and application of databases.
- Teach design concepts and creation of relational databases.
- Teach basic and advanced SQL commands.
- Provide overview of database programming and procedural languages.
- Provide overview of transaction management, database recovery and security.

Course Outcomes:

At the end of the course, the student will be able to:

- Construct an Entity-Relationship (E-R) model from specifications and transform it to a relational model.
- Design databases and apply normalization constraints.
- Construct queries in SQL or Relational Algebra to perform CRUD (Create, Retrieve, Update and Delete) operations on database.
- Understand and apply the concepts of procedural languages.
- Apply the principles of database transaction management, database recovery and security.

Course Content:

1. **Introduction to Database and Conceptual Design using ERD:** Introduction to Databases**,** Conceptual Model**,** Conceptual Design using ERD, Entity, Weak Entity, Relationships, Attributes and Keys, Roles and Constraints, Relational Model, Constraints and Database Schemas, ER to Relational Mapping, Relational Algebra, Unary Operations - SELECT and PROJECT, Set Theory Operations, Binary Relational Operations - JOIN, DIVISION, Aggregate Functions and Grouping.
2. **SQL:** SQL Data Definition, Primary Data Types and Advanced Data Types like CLOB, BLOB, Specifying Constraints in SQL, Basic Retrieval Queries, Insert, Delete, Update and Schema Change Statements in SQL, Advanced SQL Queries, Specifying General Constraints as Assertions and Triggers, Views, Additional Features of SQL, Database Programming, PL/ SQL.

3. **Database Design:** Informal Design Guidelines for Schemas, Functional Dependencies, Inference Rules, Closure, Equivalence, Minimal Cover, Normal Forms Based on Primary Keys (1st, 2nd and 3rd NF), General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form, Properties of Relational Decompositions, Overview of Higher Normal Forms.
4. **DBMS Architecture and Database Security:** Three-Schema Architecture, Data Abstraction and Data Independence, Database Languages and Interfaces, DBMS Modules, Database Security, Access Control.
5. **Transaction Management and Database Security:** ACID Properties, Transactions and Schedules, Serializability and Recoverability, Precedence Graphs, Concurrency, Lock-Based Protocols, 2PL, Strict 2PL Protocols, Timestamp-Based Protocols, Deadlocks - Detection and Prevention, Crash Recovery, Advanced Topics - NoSQL.

Pre-requisite Courses: None.

Reference Book(s):

1. "Fundamentals of Database Systems", Ramez Elamsri, Shamkant B Navathe, Pearson, 7th Edition, 2017.
2. "Database Management Systems", Johannes Gehrke, Raghu Ramakrishnan, McGraw-Hill, 3rd Edition, 2003.
3. "Database Systems: The Complete Book", Garcia-Molina, J D Ullman, Widom, 2nd Edition, Prentice-Hall, 2008.
4. "Database System Concepts", Silberschatz, H Korth, S Sudarshan, 6th Edition, McGraw-Hill, 2010.

UE17CS253: MICROPROCESSOR AND COMPUTER ARCHITECTURE (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Introduce concepts of basic processor architecture and its design.
- Introduce concepts of pipeline architecture and hazards.
- Bring in the study of memory hierarchy, cache memory and its optimizations.
- Introduce multi-core/ many core processor architecture and programming.

Course Outcomes:

At the end of the course, the student will be able to:

- Demonstrate ability to understand the design of different instruction sets like RISC/ CISC and their addressing modes.
- Demonstrate the ability to understand the design of a pipelined processor and its challenges.
- Demonstrate the use of tools to analyse the performance of programs on different architectures.
- Design alternative memory hierarchy layouts and optimizations.
- Demonstrate and appreciate modern trends in architecture such as multicore architectures.

Course Content:

1. **Introduction to Architecture:** Introduction, ISA Classification - RISC and CISC, Memory Addressing, Operands - Types and Size, Instruction Set - Operations, Control Flow, Instruction Encoding, Case Study - ARM/ MIPS/ x86 Processor.
2. **Introduction to Pipeline:** 3 - Stage Pipelining, 5 - Stage Pipelining, Pipeline Hazards - Data, Structural and Branch Hazards, Branch Prediction Mechanisms, Performance Metrics, Trends in Technology, Power and Energy in Integrated Circuits.
3. **Memory Hierarchy:** Mapping Techniques - Fully Associative, Direct Mapped and Set Associative, Cache Performance, Basic Cache Optimizations.
4. **I/O and Interrupts:** Interrupts and Interrupt Handling Mechanisms - Polling and Daisy Chain, PIC, DMA, AMBA and APB Bus.
5. **Advances in Architecture:** Introduction to Parallel Architecture, Amdahl's Law, Gustafson Law, Instruction Level Parallelism, Multi-Core Architecture.

Pre-requisite Courses: None.

Reference Book(s):

1. "Computer Organization and Design", Patterson, Hennessey, 5th Edition, Morgan Kaufmann.
2. "ARM System-on-Chip Architecture", Steve Furber, 2nd Edition, 2015, Pearson India.
3. "Computer Architecture: A Quantitative Approach", Hennessey, Patterson, 5th Edition.

UE17CS254: THEORY OF COMPUTATION (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Teach students to construct basic machines like DFA, NFA which represent Regular Languages.
- To familiarize students to construct Regular Expressions, Regular Grammars and to identify Non – Regular Languages.
- Teach students to identify Context Free Languages, to construct Push Down Automata which represent Context Free Languages, to convert the given grammar to various normal forms and to make use of Membership Algorithm.
- Teach students to understand closure properties of Context Free Languages, to identify Non – Context Free Languages and to construct Turing Machines.
- To familiarize students with concepts like Recursively Enumerable languages, Recursive Languages, PCP and Undecidable Problems.

Course Outcomes:

At the end of the course, the student will be able to:

- Design simple machines like DFA, NFA, convert NFA to DFA and minimize a given DFA.
- Construct regular expressions for different languages, verify that some languages are regular and some are not.
- Analyze the difference between Regular Languages and Context Free Languages, design Push Down automata, construct Context Free Grammars, convert one form of the grammar to other form.
- Enumerate the properties of Context Free Grammars, verify that some languages are context free and some are not, design Turing Machines, and analyze the difference between acceptability and decidability.
- Analyze the difference between Recursive and Recursively Enumerable Languages, Decidable Languages, Turing – Recognizable and Co – Turing – Recognizable, some problems that cannot be solved by Turing Machines, reduce one Undecidable Problem to another, Undecidable Problems for Recursively Enumerable Languages, Post Correspondence Problem, Undecidable Problem for Context – Free Languages.

Course Content:

1. **Introduction**: Computers, Computation, Computability and Languages. **Finite Automata and Regular Languages**: Deterministic Finite Automata, Non – deterministic Finite Automata, Constructing Finite Automata, Equivalence of

Deterministic and Non – deterministic Finite Automata, Minimizing Finite Automata.

2. **Regular Expressions, Regular Grammars and Non–Regular Languages:** Regular Expressions, Equivalence of Regular Expressions, Regular Expressions in Practice, Regular Grammars. **Properties of Regular Languages:** Closure Properties of Regular Languages, Answering Questions about Regular Languages, Pumping Lemma and Identifying Non – Regular Languages.
3. **Context–Free Languages and Grammars:** Introduction to Context – Free Languages and Push –Down Automata, Context – Free Grammars, Parsing and Ambiguity, Conversion to Chomsky and Greibach Normal Forms, A Membership Algorithm for Context – Free Languages.
4. **Properties of Context–Free Languages:** Closure Properties and Questions about Context – Free Languages, Pumping Lemma for Context – Free Languages. **Turing Machines:** The Standard Turing Machine, Constructing Turing Machines, Church – Turing Thesis.
5. **Decidability:** Recursive and Recursively Enumerable Languages, Decidable Languages, Turing –Recognizable and Co – Turing – Recognizable. **Undecidability**: Problems That Cannot Be Solved by Turing Machines, Reducing One Undecidable Problem To Another, Undecidable Problems for Recursively Enumerable Languages, The Post Correspondence Problem, Undecidable Problem for Context – Free Languages.

Pre-requisite Courses: None.

Reference Book(s):

1. "An Introduction to Formal Languages and Automata", Peter Linz, 5th Edition, Jones and Bartlett, New Delhi, India, 2011.
2. "Theory of Computation", Michael Sipser, Cengage Learning, New Delhi, India, 2008.
3. "Introduction to Automata Theory, Languages, and Computation", John E Hopcroft, Rajeev Motwani, Jeffrey D Ullman, 3rd Edition, Pearson Education, New Delhi, India, 2009.
4. "Theory of Computation: A Problem–Solving Approach", Kavi Mahesh, Wiley India, New Delhi, 2012.

UE17CS255: DESIGN AND ANALYSIS OF ALGORITHMS LABORATORY (0-0-2-0-1)

Course Objectives:

The objective(s) of this course is to,

- Design and implement algorithms of Brute Force technique.
- Design and implement algorithms with Divide and Conquer technique.
- Design and implement algorithms with Decrease and Conquer and Transform and conquer techniques.
- Design and implement algorithms with Space and Time Tradeoffs.
- Design and implement optimization algorithms using Dynamic Programming and Greedy technique.

Course Outcomes:

At the end of the course, the student will be able to:

- Design and implement algorithms of Brute Force Technique.
- Design and implement algorithms with Divide and Conquer technique.
- Design and implement algorithms with Decrease and Conquer and Transform and Conquer techniques.
- Design and implement algorithms with Space and Time Tradeoffs.
- Design and implement optimization algorithms using Dynamic Programming and Greedy technique.

Course Content:

1. **Brute Force:** Implementation of Sequential Search Algorithm.
2. **Brute Force:** Implementation of Brute Force String Matching Algorithm.
3. **Brute Force:** Implementation of Selection Sort and Bubble Sort Algorithms.
4. **Brute Force:** Implementation of Depth - First Search and Breadth - First Search Algorithms.
5. **Brute Force:** Exhaustive Search Algorithm for solving the Traveling Salesman Problem.
6. **Divide-and-Conquer:** Implementation of Merge Sort and Binary Search Algorithms.
7. **Divide-and-Conquer:** Implementation of Quick Sort Algorithm.
8. **Decrease-and-Conquer:** Implementation of Insertion Sort Algorithm and Topological Sort.
9. **Transform-and-Conquer:** Implementation of AVL Trees.
10. a) **Transform-and-Conquer:** Implementation of Heap Sort Algorithm.
    b) **Space and Time Tradeoffs:** Implementation of Distribution Counting Sort Algorithm.
11. **Space and Time Tradeoffs:** Implementation of Horspool's Algorithm for String Matching.
12. **Dynamic Programming:** Implementation of Warshall's and Floyd's Algorithms.
13. **Greedy Technique:** Implementation of Dijkstra's Algorithm.

Pre-requisite Courses: None.

Reference Book(s):

1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE17CS256: MICROPROCESSOR AND COMPUTER ARCHITECTURE LABORATORY (0-0-2-0-1)

Course Objectives:

The objective(s) of this course is to,

- Implement assembly language programs and develop strong competencies in contemporary ISAs.
- Develop, edit, compile and debug assembly language programs using present - day simulators.
- Know various addressing modes that are defined in a given instruction set architecture and illustrate how machine language instructions in that architecture identify the operand(s) of each instruction.
- Practice interfacing experiments using various sensors with Arduino board.
- Imbibe the skills of formulation of a complex problem, design a suitable solution using Arduino/ Raspberry Pi processors and demonstrate the end results.

Course Outcomes:

At the end of the course, the student will be able to:

- Inculcate the importance of instruction set architecture and their fundamental concepts using assembly language programming.
- Demonstrate editing, compiling, executing and debugging an assembly language program of a contemporary microprocessor.
- Demonstrate the usage of subroutines and recursion supported by the ISA.
- Imbibe strong assembly language programming skills by implementing solutions to problems using simulators.
- Instilling the idea to formulate a complex problem definition, approach to solve the problem, methodology to apply and implement suitable algorithm and check for the final results.

Course Content:

1. Introduction to Instruction Set – ARM/ x86 Processor and Sample programs using Simulator.
2. Programs on ARM/ x86 using Simulator.
3. Programs on ARM/ x86 using Simulator.
4. Case Study - 3 Stage Pipeline using Simulator.
5. Case Study - 5 Stage Pipeline using Simulator.
6. Case Study - Data Hazards using Simulator - RAW, WAR, WAW.
7. Case Study - Memory Performance Analysis using Simulator.
8. Confirmation of Mini Project Titles and Literature Survey.
9. Mini Project.
10. Mini Project.
11. Mini Project Evaluation.
12. Simple Scalar Simulator, Memory Performance, Simcache.

Pre-requisite Courses: None.

Reference Book(s):

1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE16CS301:
COMPUTER NETWORKS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Impart the core principles of Information Communication Technology, which is an inevitable part of the modern Internet, starting from the layered architecture.
- Teach the principles of Application Layer and introduce sample popular Application Layer protocols - HTTP, DNS.
- Provide an insight into the most widely used Transport Layer protocols - TCP and UDP. Convey dimensions of Network layer, through the Internet Protocol that glues billions of hosts across the globe and associated routing protocols.
- Give an essence of the Data Link Layer, building blocks of Local Area Network and consolidate how all layers are involved to provide a browsing application.
- Provide the experience of use of network tools to imbibe the diagnostic and debugging skills to deal with networking issues.

Course Outcomes:

At the end of the course, the student will be able to:

- Sketch the big picture of complex Internet, in terms of building blocks, organized layered architecture.
- Analyze HTTP, DNS and other protocols and use socket programming.
- Illustrate how reliable communication is achieved on a public internet using TCP and select the right transport protocol for a given application.
- Design subnets, configure routers in simulated environment and analyze IP using a protocol analyzer.
- Demonstrate the role of multiple protocols used in all the layers while running a popular application like browsing.

Course Content:

1. **Introduction to Computer Networks and the Internet:** Building Blocks of Communication Networks and Internet, Elements of Network Edge, Access Networks and Physical Media, Network Core, Concepts of Switching, Layered Architecture - Introduction, List of Responsibility and Functions of Each Layer, Introduction to Network Tools such as Wireshark, nc, ssh.
2. **Application Layer:** Network Application Principles, The Web and HTTP - Overview, HTTP Message Format, Web Caching, Cookies and Authentication, DNS Services, DNS Hierarchy, DNS Records, Socket Programming with TCP and UDP.
3. **Transport Layer:** Introduction to Transport Layer Services, UDP Protocol, Principles of Reliable Data Transfer – Stop-N-Wait Protocol, Sliding Window Concepts – Go Back N Protocol, TCP Features, Header, Connection Management, Flow Control, Error Control and Congestion Control, TCP Streaming vs. UDP Message Oriented Delivery.
4. **Network Layer and Internet Protocol:** IPV4 Datagram Format, Fragmentation, Addressing, Subnet Principles, Forwarding Mechanisms, DHCP, NAT, ICMP, ARP, IP Static Routing, Hierarchical Addressing and Route Aggregation, Longest Prefix Match, Introduction to IPTABLES, Introduction to IPV6.
5. **Link Layer and LAN:** Introduction to Link Layer, Error Detection Principles, CRC, Building Blocks of Local Area Network, LAN Switch - Working Principles, Introduction to MAC Protocols, CSMA/ CD, Retrospective: A Web Page Request Case Study, Introduction to Wireless LAN and WPA/ WPA2 and Access Point.

Pre-requisite Courses: None.

Reference Book(s):

1. "Computer Networking - A Top - Down Approach", James F Kurose, Keith W, Pearson, 6th Edition, 2012.
2. "Computer Networks - A Top - Down Approach", Behrouz A Forouzan, Firouz Mosharraf, Pearson, Special Indian Edition, 2012.

UE16CS302:
INTRODUCTION TO OPERATING SYSTEMS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Provide an understanding on the various components of an Operating System.
- The course focuses on fundamental problems and optimal solutions for resource management in operating systems such as process, disk and memory management.
- The course will introduce design principles and tradeoffs in the design of Operating Systems.
- The course will also introduce the interface for interacting with a contemporary Operating system such as Linux.

Course Outcomes:

At the end of the course, the student will be able to:

- Gain extensive knowledge on principles and modules of Operating Systems.
- Understand the design of various algorithms for scheduling and their relative performance.
- Design pieces of operating systems such as process management, concurrent processes and threads, memory management and virtual memory.
- Use tools and interface of the operating system.
- Explore design tradeoffs in designing various components of an Operating System.

Course Content:

1. **Introduction and CPU:** What Operating Systems Do? **Introduction to Virtualization of Resources:** CPU/ Memory, Concurrency, Persistence, The Process Abstraction, Process States, Description, Control, API (fork()/ exec()). **Scheduling:** Workload Assumptions, Metrics, Types of Scheduling - FIFO, SJF, Response Time, Round Robin, Multi - Level Feedback Queue. **Case Study:** Linux/ Windows/ UNIX Scheduling Algorithms.
2. **Concurrency:** Introduction and Threads, Types of Threads, Multi - Core/ Multi - Threading, Shared Data. **Thread API:** Thread

Creation, Completion, Locks, Condition Variables, Compilation. **Mutual Exclusion and Synchronization:** Software Approaches, Principles of Concurrency, Hardware Support, Semaphores, Message Passing, Readers Writers Problem, pthread Locks. **Deadlocks and Starvation:** Principles of Deadlock, Tools for Detection.

3. **Memory:** Requirements, Partitioning, Paging, Segmentation, Memory API – malloc/ free, Errors. **Virtual Memory**: Hardware and Control Structures, OS Support, Address Translation, Dynamic Relocation, Segmentation, Paging, TLBs, Context Switches, Replacement Policy - LRU, Design Alternatives - Inverted Page Tables, Bigger Pages, Swapping. **Case Study:** Linux/ UNIX Memory Management.
4. **Persistence - I/O Devices:** System Architecture, Canonical Devices/ Protocol – Organization of I/O, CPU Overheads and Interrupts, DMA, OS Design Issues - Device Interaction, Device Driver, Buffering. **Disk Drives:** Performance Parameters - Geometry, I/ O Time Computation, Disk Scheduling Policies, Data Integrity and Protection – Checksum.
5. **File Systems:** File Organization and Access, Directories, Sharing, Security – Access Controls, Record Allocation, Secondary Storage Management. **Case Study:** UNIX/ Windows/ Linux File System. **FS Interface:** Creating/ Reading/ Writing, Random Access, fsync(), Renaming, Hard Links and Symbolic Links, Mounting File Systems. **Security:** Intruders and Malicious Software, Buffer Overflow, OS Hardening, Case Study: UNIX/ Windows.

Pre-requisite Courses: UE16CS202 – Data Structures.

Reference Book(s):

1. “Operating Systems - Internals and Design Principles”, William Stallings, 9th Edition, Pearson, 2018.
2. “Operating Systems: Three Easy Pieces”, Remzi Arpaci-Dusseau, Andrea Arpaci Dusseau, http://pages.cs.wisc.edu/~remzi/OSTEP/
3. “Advanced Programming in the Unix Environment”, Richard Stevens, Stephen A Rago, Pearson, 3rd edition, 2017.
4. “Operating System Concepts”, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, 9th Edition, John Wiley and Sons, 2013.
5. “Operating Systems”, Harvey Deitel, Paul Deitel, David Choffnes, 3rd Edition, Prentice Hall.
6. “Modern Operating Systems”, Andrew S Tannenbaum, 3rd Edition, Pearson.

UE16CS303:
PRINCIPLES OF PROGRAMMING LANGUAGES
(4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Enable students to learn constructs in a language.
- Enable students to design a new construct/ language.
- Enable students to choose appropriate language for real world problem solving, based on the required features.
- Enable students to evaluate various language design features considering the programming paradigm.
- Introduce various paradigms and their support in language design.

Course Outcomes:

At the end of the course, the student will be able to:

- Choose a particular language for problem solving depending on the application domain.
- Analyze and compare programming language concepts.
- Analyze the implementation issues related to a language design.
- Identify the language design features of any language and evaluate them.
- Identify language features required for supporting various paradigms.

Course Content:

1. **Preliminary Concepts:** Reasons for Studying, Concepts of Programming Languages, Programming Domains, Language Evaluation Criteria, Influences on Language Design, Language Categories, Programming Paradigms – Imperative, Object Oriented, Functional Programming, Logic Programming, Programming Language Implementation – Compilation and Virtual Machines, Programming Environments. **Names, Binding, Type Checking and Scopes:** Names, Variables, Binding of Attributes to Variables, Type Bindings, Type Inferencing, Type Checking, Strong Typing.
2. **Type Checking and Scopes** (continued…): Type Equivalence, Scope, Scope and Lifetime, Referencing Environments. **Data types:** Introduction, Primitives, Character, User Defined, Array, Associative, Record, Union, Pointer and Reference Types, Design and Implementation Issues Related to These Types, Names, Variable, Concept of Binding, Type Checking, Strong Typing, Type Compatibility, Named Constants, Variable Initialization. **Expressions and Statements:** Short Circuit Evaluation, Mixed Mode Assignment, Assignment Statements, Cascading Operators.
3. **Control Structures**: Statement Level, Compound Statements, Selection, Iteration, Unconditional Statements, Guarded Commands. **Subprograms and Blocks:** Fundamentals of Subprograms, Scope and Lifetime of Variable, Static and Dynamic Scope, Design Issues of Subprograms and Operations, Local Referencing Environments, Parameter Passing Methods, Overloaded Subprograms, Generic Subprograms, Parameters that are Subprogram Names.
4. **Functions** (continued…)**:** Design Issues for Functions, User Defined Overloaded Operators, Co-Routines and Function Closures. **Abstract Data types:** Abstractions and Encapsulation, Introduction to Data Abstraction, Design Issues, Object Oriented Concepts with Reference to Java and Python.
5. **Exception handling:** Exceptions, Specifications, Exception Propagation. **Logic Programming Language:** Introduction and Overview of Logic Programming, Basic Elements of Prolog, Application of Logic Programming. **Functional Programming Languages:** Introduction, Fundamentals of FPL, Applications of Functional Programming Languages and Exploration of the Features, Comparison of Functional and Imperative Languages.

Pre-requisite Courses: None.

Reference Book(s):

1. “Concepts of Programming Languages”, Robert W Sebesta, Pearson Education, 10th Edition, 2012.
2. “Programming Language Pragmatics”, Michael L Scott, Elsevier, 3rd Edition, 2009.
3. “Programming Languages Design and Implementation”, Pratt, Zelkowitz, Prentice Hall/ Pearson Education, 4th Edition, 2001.

UE16CS304:
COMPUTER NETWORKS LABORATORY (0-0-2-0-1)

Course Objectives:

The objective(s) of this course is to,

- Make familiar with some of the popular software tools being used in the networking industry.
- Facilitate the student to see the packet and sense the protocol in both virtual and real time environment, as a result understand the computer networks domain.

- Impart the principles of architecting a typical network through design, engineering and configuration.
- Develop the skills of analyzing a protocol which would help in troubleshooting a network.
- Create an environment to apply programming knowledge and skills to computer network domain.

Course Outcomes:
At the end of the course, the student will be able to:

- Effectively use the industry standard network simulation tool - CISCO PACKET TRACER and analysis tool - Wireshark.
- Interpret a protocol in terms of syntax, semantics and sequence of actions.
- Design, engineer and test the network in a virtual environment.
- Analyze standard protocols using industry standard protocol analyzer.
- Apply algorithmic approach and coding to implement the principles/ protocols of networking.

Course Content:
1. Study the principle of a switched network using the simulator - CISCO PACKET TRACER.
2. Study the concept of layered architecture using the protocol analyzer - Wireshark.
3. Analyze HTTP protocol in different scenarios.
4. Design and analyze a Domain Name Resolution System.
5. Write a program to create a simple web server - client system using socket programming.
6. Write a program to illustrate reliable data transfer in internet.
7. Analyze Transmission Control Protocol in different scenarios.
8. Analyze the protocols IP, ICMP and DHCP.
9. Design and engineer a router based wide area Network
10. Write a program to illustrate Distance Vector Routing.
11. Simulate a switched LAN and study Spanning Tree Algorithm.

Pre-requisite Courses: None.

Reference Book(s):
1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE16CS305:
INTRODUCTION TO OPERATING SYSTEMS LABORATORY (0-0-2-0-1)

Course Objectives:
The objective(s) of this course is to,

- Teach students the design aspects of operating system.
- Teach process management concepts and techniques.
- Teach memory management concepts.
- Enable students to learn the problems in inter-process communication and the possible solutions.
- Imbibe students with disk scheduling concepts and techniques.

Course Outcomes:
At the end of the course, the student will be able to:

- Write programs to implement the basic functionality of an operating system and its components.
- Write programs to implement the various scheduling algorithms and analyze their performance tradeoffs.
- Implement algorithmic solutions to process synchronization problems.
- Implement algorithmic solutions to handle deadlocks.
- Write programs to implement memory and device management.

Course Content:
Each lab will be of 3 weeks duration and will involve a component of design and a component of analysis.

1. **Objective - Process Management**: Build a shell and execute commands. Include piping and standard I/O redirection. Implement a command to list all the processes on the system and their threads.
   a. Objective:
   i. Demonstrate ability to work with process management system calls like fork(), exec(), pthreads().
   ii. Design and performance tradeoffs between using threads and processes.
   iii. Demonstrate ability to use inter process communication and decide when to use a mutex vs a semaphore.
2. **Objective - Memory Management:** Write a program to allocate memory that pushes another executing process out of memory into swap. Determine how many pages are accessed by the new process. Compute page fault rate.
   a. Objective:
   i. Understand the memory layout of a process/ thread. Map this to types of variables and scope in a program.
   ii. Analyze the paging system using tools to understand scenarios of swapping.
3. **Objective – File Systems and Device Management**: Build a user level file system on a layer of an abstract block device. Design the metadata layout of the file system.
   a. Analysis: Analyze the system fragmentation v/s performance when block size is modified.
4. **Putting It All Together:** Boot Minix and write a new system call into Minix. Modify the default scheduling algorithm for Minix.

Pre-requisite Courses: None.

Reference Book(s):
1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE16CS311:
ADVANCED ALGORITHMS (4-0-0-0-4)

Course Objectives:
The objective(s) of this course is to,

- Understand basics of Recurrences and Amortized Complexity Analysis of Data Structures.
- Understand a few String Matching/ Prediction Algorithms and their applications.
- Understand the design strategy of Dynamic Programming.
- Understand some Polynomial and Number Theoretic Algorithms.
- Learn about Randomized Algorithms.

Course Outcomes:
At the end of the course, the student will be able to:

- Perform Amortized Analysis on complex Data Structures.
- Decide usage of Randomized Algorithms for practical intractable problems.
- Compare and evaluate String Matching Algorithms.
- Apply Number Theoretic concepts in applications like Cryptography.
- Solve complex problems using Dynamic Programming.
- Implement an efficient FFT Algorithm.

Course Content:
1. **Basics of Complexity:** Notations, Randomized Algorithms and Amortized Complexity Analysis.

2. **String Algorithms:** String Matching – Boyer–Moore, Rabin–Karp, Finite Automata and Knuth–Morris–Pratt Algorithms, Suffix Trees - Applications of Suffix Trees, Regular Expression Searches Using Suffix Trees.
3. **Number Theoretic Algorithms**: Modular Arithmetic, RSA Cryptography, Primality Testing and Factorization.
4. **Dynamic Programming**: Elements of Dynamic Programming, Problems - Coin-Row, Rod-Cutting, Matrix-Chain Multiplication, Longest Common Subsequence.
5. **Polynomials and FFT:** Representation of Polynomials, DFT and FFT, Efficient Implementation of FFT.

Pre-requisite Courses: UE16CS251 – Design and Analysis of Algorithms.

Reference Book(s):

1. "Introduction to Algorithms", T H Cormen, C E Leiserson, R L Rivest, C Stein, PHI, 3rd Edition 2009.
2. "The Algorithm Manual", Steven Skiena, Springer, ISBN: 9788184898651.

UE16CS312:
ADVANCED DATABASE MANAGEMENT SYSTEMS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Acquire knowledge on Parallel and Distributed Databases.
- Learn topics of Data Warehousing for solving analytical data processing problems.
- Learn basics of NoSQL Databases and Big Data systems.
- Learn specialized Application Databases.
- Choose the appropriate database and storage technique.

Course Outcomes:

At the end of the course, the student will be able to:

- Analyze issues related to implementing relational database for large datasets.
- Apply Data Warehousing techniques for solving analytical processing requirements.
- Apply Parallel and Distributed Database approach to problems of large databases.
- Select the NoSQL (non-relational database) approach to the "Big Data" problem.
- Apply specialized databases for advanced applications.

Course Content:

1. **Review of Relational Data Model**: Reporting and Analytical Databases, Data Warehousing, OLAP, SQL Analytical Functions, Column Oriented Storage, Introduction to Data Mining.
2. **Parallel and Distributed Databases:** Concepts, Parallel and Distributed Databases and Issues.
3. **Introduction to NoSQL:** Emergence of NoSQL databases, Characteristics of NoSQL, Categories of NoSQL systems, CAP Theorem. **NoSQL Databases:** Document Databases with Example (MongoDB, CouchDB), Column Oriented Databases with Example (Cassandra), Key-Value Stores with Example (Riak, Voldemort), Graph Databases with Example (Neo4J).
4. **Introduction to Big Data:** What is Big Data, Hadoop, HDFS, and Apache Spark.
5. **Specialty Databases:** In-Memory Databases for RDBMS (VoltDB) and Key Value Store (Redis), Time-Series DBMS, Search Engines, Spatial, Temporal, Deductive.

Pre-requisite Courses: UE16CS252 – Database Management Systems.

Reference Book(s):

1. "Database System Concepts", Silberschatz, Korth, Sudarshan, 6th Edition, McGraw Hill, 2013.
2. "Fundamentals of Database Systems", Elmasri, Navathe, 7th Edition, Pearson Education, 2015.
3. "Data Mining: Concepts and Techniques", Jiawei Han, Micheline Kamber, Jian Pei, 3rd Edition, Morgan Kaufmann, 2011.
4. "NoSQL Distilled", Pramod J Sadalage, Martin Fowler, Addison Wesley, 2012.
5. "Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement", Eric Redmond, Jim R Wilson, O'Reilly, 2012.

UE16CS313:
BIG DATA (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Provide an introduction to Big Data.
- Introduce storage technologies for Big Data.
- Introduce computational issues and infrastructure for Big Data.
- Introduce algorithms for processing Big Data.
- Application of Big Data techniques to various real life problems.

Course Outcomes:

At the end of the course, the student will be able to:

- Explore various characteristics of Big Data problems.
- Understand principles and design alternative storage technologies for Big Data.
- Design Big Data applications using available infrastructure for Big Data through practical assignments.
- Apply and differentiate between algorithms for processing Big Data and Normal Algorithms.
- Apply Big Data techniques in real life problems through a group-based project.

Course Content:

1. **Introduction:** Big Data Definition, Challenges and Opportunities with Big Data, Data Intensive Scientific Discovery and the Role of Big Data, History, Map Reduce – Storage (HDFS), Computation Model, Case Study: Google, YARN Introduction, Introduction to Sample Big Data Algorithms – Matrix Multiplication and Page Rank.
2. **Big Data Infrastructures (Compute/ Storage):** Overview of Hadoop Ecosystem, Relational Operators on Map Reduce, Case Study: HIVE, Other storage – Hbase.
3. **In Memory Computation:** Issues with Hadoop, Spark and Scala, Resource Management using Mesos, Complexity of Big Data Algorithms.
4. **Real Time Analysis:** Streaming Analysis Use Cases, Streaming Spark, Storm, Streaming Algorithms, Case Study.
5. **Advanced Analytics on Big Data:** Clustering Algorithms and Collaborative Filtering, Case Study: Mahout/ MLLib/ Tensor Flow/ Watson.

Pre-requisite Courses: UE16CS252 – Database Management Systems.

Reference Book(s):

1. "Hadoop: The Definitive Guide", Tom White, O'Reilly, 4th Edition, 2009.
2. "Big Data Analytics Beyond Hadoop: Real-Time Applications with Storm, Spark and More Hadoop Alternatives", Vijay Srinivasa Agneeswaran, Pearson Education, 2014.

3. "Mining of Massive Datasets", Anand Rajaraman, Jure Leskovec, Jeffrey D Ullman, Cambridge Press, 2014.
4. "Spark: Cluster Computing with Working Sets", Zaharia M, Chowdhury M, Franklin M J, Shekhar S, Stoica I, HotCloud, ACM New York, 2010.
5. "Resilient Distributed Datasets: A Fault-tolerant Abstraction for In-memory Cluster Computing", Zaharia, Matei, et al., Proceedings of the 9th USENIX Conference on Networked Systems Design and Implementation, USENIX Association, 2012.
6. "Learning Spark", Matei Zaharia, Patrick Wendell, Andy Konwinski, Holden Karau., O'Reilly Media, 2015.

UE16CS314:
MULTIMEDIA COMPUTING (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Teach the basic concepts of Multimedia and Hypermedia, World Wide Web and Overview of Multimedia Software Tools and exploring multimedia applications.
- Train students to understand graphics and image data representation, color in image and video and types of video signals and basics of digital audio.
- Teach various text, image and video compression standards.
- Identify the current and future issues related to multimedia technology.
- Identify both theoretical and practical aspects in designing multimedia systems surrounding the emergence of multimedia technologies using contemporary hardware and software technologies.

Course Outcomes:

At the end of the course, the student will be able to:

- Apply different compression techniques depending on the multimedia object streams, interpret the various standards for multimedia communications and their features.
- Demonstrate multimedia and its applications to potential clients.
- Identify and describe the function of the general skill sets in the multimedia industry.
- Identify the basic hardware and software requirements for multimedia development and playback.
- Design and develop applications and exercise proper design choices and meet Quality of Service requirements.

Course Content:

1. **Introduction to Multimedia:** What is Multimedia? Multimedia and Hypermedia, World Wide Web, Overview of Multimedia Software Tools. **Graphics and Image Data Representation:** Graphic/ Image Data Types, Popular File Formats. **Color in Image and Video:** Color Science, Color Models in Images, Color Models in Video.
2. **Fundamental Concepts in Video:** Types of Video Signals, Analog Video, Digital Video. **Basics of Digital Audio:** Digitization of Sound, MIDI: Musical Instruments Digital Interface, Quantization and Transmission of Audio.
3. **Lossless Compression Algorithms:** Introduction, Basics of Information Theory, Run Length Coding, Variable Length Coding, Dictionary Based Coding, Arithmetic Coding, Lossless Image Compression**. Lossy Compression Algorithms:** Introduction, Distortion Measures, The Rate-Distortion Theory, Quantization, Transform Coding, Wavelet Based Coding, Wavelet Packets, Embedded Zero Tree of Wavelet Coefficients, Set Partitioning in Hierarchical Trees.
4. **Image Compression Standards:** The JPEG Standard, The JPEG2000 Standard, The JPEG-LS Standard, Bi-Level Image Compression Standards**. Basic Video Compression Techniques:** Introduction to Video Compression, Video Compression Based on Motion Compensation**,** Search for Motion Vectors, H.261, H.263.
5. **MPEG Video Coding I – MPEG-1 and 2:** Overview, MPEG-1, MPEG-2**. MPEG Video Coding II – MPEG-4, 7 and Beyond:** Overview of MPEG-4, Object-Based Visual Coding in MPEG-4, Synthetic Object Coding in MPEG-4, MPEG-4 Object Types, Profiles and Levels, MPEG-4 Part10/ H.264, MPEG-7, MPEG-21.

Pre-requisite Courses: None.

Reference Book(s):

1. "Fundamentals of Multimedia", Ze-Nian Li, Mark S Drew, Pearson Education Inc., 2004.

UE16CS321:
COMPUTER GRAPHICS AND VISUALIZATION (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Impart the basics of computer graphics, different graphics systems and applications of computer graphics.
- Discuss various algorithms for scan conversion and filling of basic objects and their comparative analysis.
- Introduce the use of geometric transformations on graphics objects and their application in composite form.
- Impart frame extraction with different clipping algorithms and transformation to a graphics display device.
- Introduce projections and visible surface detection techniques for display of 3D scene on 2D screen and rendering of projected objects to naturalize the scene in 2D view.

Course Outcomes:

At the end of the course, the student will be able to:

- Demonstrate the fundamentals of computer graphics and display pipeline systems.
- Be able to draw different 2D objects using scan conversion algorithms and also fill basic objects and perform their comparative analysis.
- Use geometric transformations on graphics 2D objects and demonstrate their application in composite form.
- Be able to extract a 2D object using clipping algorithms and apply transformations to a graphics display system
- Apply graphics in greater depth to more complex courses like Image Processing, Virtual, Augmented Reality, etc.,

Course Content:

1. **Introduction:** Applications of Computer Graphics, A Graphics System, Images - Physical and Synthetic, Imaging Systems, The Synthetic Camera Model, The Programmer's Interface, Graphics Architectures, Programmable Pipelines, Performance Characteristics. **Graphics Programming:** The Sierpinski Gasket, Programming Two Dimensional Applications. **The OpenGL:** The OpenGL API, Primitives and Attributes, Color, Viewing, Control Functions, The Gasket Program, Polygons and Recursion, The Three-Dimensional Gasket, Plotting Implicit Functions.
2. **Implementation:** Basic Implementation Strategies, Four Major Tasks, Clipping, Line-Segment Clipping, Polygon Clipping, Clipping of Other Primitives, Clipping in Three Dimensions, Rasterization, Bresenham's Algorithm, Polygon Rasterization, Hidden-Surface Removal, Anti- Aliasing, Display Considerations.

3. **Geometric Objects and Transformations-I:** Scalars, Points and Vectors, Three-Dimensional Primitives, Coordinate Systems and Frames, Modelling a Colored Cube, Affine Transformations, Rotation, Translation and Scaling.
4. **Geometric Objects and Transformations-II:** Geometric Objects and Transformations, Transformation in Homogeneous Coordinates, Concatenation of Transformations, OpenGL Transformation Matrices, Interfaces to Three Dimensional Applications, Quaternions.
5. **Viewing** : Classical and Computer Viewing, Viewing with a Computer, Positioning of the Camera, Simple Projections, Projections in OpenGL, Introduction to Parallel-Projection Matrices, Perspective-Projection Matrices.

Pre-requisite Courses: UE16CS251 – Design and Analysis of Algorithms.

Reference Book(s):

1. "Interactive Computer Graphics: A Top-Down Approach with OpenGL", Edward Angel, Pearson Education, 5th Edition, 2008.
2. "Computer Graphics Using OpenGL", Francis S Hill Jr., Stephen M Kelley, 3rd Edition, PHI, 2009.
3. "Computer Graphics", James D Foley, Andries Van Dam, Steven K Feiner, John F Hughes, Pearson Education, 1997.
4. "Computer Graphics - OpenGL Version", Donald Hearn, Pauline Baker, Pearson Education, 3rd Edition, 2004.

UE16CS322:
DATA ANALYTICS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Provide an insight into data pre-processing, summarization and visualization techniques.
- Teach the role of data analytics in business decision making.
- Teach model building and validation using various techniques.
- Develop hands-on experience in a relevant project based on real life data.
- Teach the skill of effectively communicating the results of data analytics.

Course Outcomes:

At the end of the course, the student will be able to:

- Perform exploratory data analysis on a given set of data including visualization techniques.
- Build regression models and use them for prediction.
- Analyze data to infer underlying patterns and formulate recommendations.
- Build time series models and use them for prediction.
- Perform text analysis involving classification and clustering.

Course Content:

1. **Exploratory Data Analysis and Visualization:** Introduction, Data Sources, Data Cleaning, Dimensionality Reduction, Data Summarization, Visualization – Graphics and Plotting (R Graphics and Relevant Packages and Maps), Case Studies.
2. **Regression Analysis**: Multiple Regression, Logistic Regression, Case Studies.
3. **Recommendation Systems**: Mining of Association Rules, Other Techniques to Design Recommendation Systems.
4. **Time Series Analysis:** Simple Smoothing, Trend Analysis, Decomposing Time Series, Exponential Smoothing, ARIMA Modelling, Case Studies.
5. **Text Analytics**: Text Processing, Lexical Analysis, Text Classification, Text Clustering, Case Studies.

Pre-requisite Courses: UE16CS203 – Introduction to Data Science.

Reference Book(s):

1. "R for Data Science", Dan Toomey, PACKT Publishing, 2014.
2. "Practical Data Science with R", Nina Zumel, John Mount, Manning Publications, 2014.
3. "Building a Recommendation System with R", Suresh R Gorakala, Michelle Usuelli, PACKT Publishing, 2015.
4. "Learning Predictive Analytics with R", Eric Mayor, PACKT Publishing, 2015.
5. "Data Analysis with Open Source Tools", Philip K Janert, O'Reilly, 2010.
6. "Data Mining: Concepts and Techniques", Jiawei Han, Micheline Kamber, Jian Pei, The Morgan Kaufmann Series in Data Management Systems, 3rd Edition, 2011.

UE16CS323:
FUZZY LOGIC (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Learn about formal methods to represent "vague" and "less" mathematical knowledge.
- Combine some of the traditional design approaches with Fuzzy Logic.
- Exposure to new and exciting applications of "vague" knowledge processing.

Course Outcomes:

At the end of the course, the student will be able to:

- Have a broad knowledge of Fuzzy Logic operations.
- Demonstrate the ability to think critically in making decisions based on Fuzzy Logic.
- Apply a new thinking methodology to real life problems including engineering ones.

Course Content:

1. **Introduction, Classical Sets and Fuzzy Sets:** The Case for Imprecision, A Historical Perspective, The Utility of Fuzzy Systems, Limitations of Fuzzy Systems, The Illusion - Uncertainty and Accuracy, Uncertainty and Information, Fuzzy Sets and Membership, Chance versus Fuzziness, Sets as Points in Hypercube. Classical Sets - Operations on Classical Sets, Properties of Classical (Crisp) Sets, Mapping of Classical Sets to Functions. Fuzzy Sets - Fuzzy Set Operations, Properties of Fuzzy Sets, Alternative Fuzzy Set Operations.
2. **Classical Relations and Fuzzy Relations:** Cartesian Product, Crisp Relations - Cardinality of Crisp Relations, Operations on Crisp Relations, Properties of Crisp Relations, Composition, Fuzzy Relations - Cardinality of Fuzzy Relations, Operations on Fuzzy Relations, Properties of Fuzzy Relations, Fuzzy Cartesian Product and Composition, Non - Interactive Fuzzy Sets, Tolerance and Equivalence Relations - Crisp Equivalence Relation, Crisp Tolerance Relation, Fuzzy Tolerance and Equivalence Relations, Value Assignments - Cosine Amplitude, Max-Min Method, Other Similarity Methods.
3. **Properties of Membership Functions, Fuzzification and Defuzzification:** Features of the Membership Function, Various Forms, Fuzzification, Defuzzification to Crisp Sets, Lambda -Cuts for Fuzzy Sets, Lambda - Cuts for Fuzzy Relations, Defuzzification to Scalars Development of Membership Functions - Membership Value Assignments (Intuition, Inference, Rank Ordering, Neural Networks, Genetic Algorithms), Fuzzy Arithmetic and Extension Principle - Extension Principle - Crisp Functions, Mapping and Relations, Functions of Fuzzy Sets - Extension Principle, Fuzzy Transform (Mapping), Practical Considerations, Fuzzy Arithmetic,

Interval Analysis in Arithmetic, Approximate Methods of Extension - Vertex Method, DSW Algorithm, Restricted DSW Algorithm, Comparisons.

4. **Logic and Fuzzy Systems:** Classical Predicate Logic – Tautologies, Contradictions, Equivalence, Exclusive OR and Neither Exclusive NOR, Logical Proofs, Deductive Inferences, Fuzzy Logic, Approximate Reasoning, Other forms of the Implication Operation. **Fuzzy Systems:** Natural Language, Linguistic Hedges, Rule Based Systems Multiple Conjunctive Antecedents, Multiple Disjunctive Antecedents, Aggregation of Fuzzy Rules, Graphical Techniques of Inference.
5. **Decision Making with Fuzzy Information:** Fuzzy Synthetic Evaluation, Fuzzy Ordering, Non - Transitive Ranking, Preference and Consensus, Multi Objective Decision Making, Fuzzy Bayesian Decision Method, Decision Making under Fuzzy States and Fuzzy Actions. **Fuzzy Classification:** Classification by Equivalence Relations - Crisp Relations, Fuzzy Relations, Cluster Analysis, Cluster Validity, c-Means Clustering - Hard c-Means (HCM), Fuzzy c-Means (FCM), Classification Metric, Hardening the Fuzzy c-Partition, Similarity Relations from Clustering.

Pre-requisite Courses: UE16CS205 - Discrete Mathematics and Logic.

Reference Book(s):

1. "Fuzzy Logic with Engineering Applications", Timothy J Ross, Wiley India, 3rd Edition, 2010.
2. "Fuzzy Sets and Fuzzy Logic: Theory and Applications", George K Klirand, Bo Yuan, Prentice Hall, 1995.
3. "Neural Networks and Fuzzy Systems: A Dynamical System Approach", B Kosko, PHI, 1991.

UE16CS324: SCIENTIFIC COMPUTING (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Formulate and solve engineering problems using numerical techniques.
- Understand mathematical basis for numerical computing.
- Understand inherent errors in numerical computing and deal with them.
- Devise computational algorithms for techniques studied.
- Exposure to software packages for numerical computing.

Course Outcomes:

At the end of the course, the student will be able to:

- Find roots of equations.
- Solve systems of linear algebraic equations.
- Compute derivatives of functions.
- Compute integrals of functions.
- Find numerical solutions to systems of ordinary differential equations.
- Estimate errors for methods used.

Course Content:

1. **Modelling, Problem Solving and Error Analysis**: Using Mathematical Models to Solve Engineering Problems, Floating-Point Representation, Approximations and Round-Off Errors, Truncation Errors and Taylor Series, Case Studies.
2. **Roots of Equations**: Bracketing methods, Open Methods, Roots of Polynomials, Case Studies. **Linear Algebraic Equations**: Gaussian Elimination, Gauss Jordan, Crout, LU Decomposition, Gauss-Siedel Method, Case Studies.
3. **Numerical Differentiation and Integration**: Newton-Coates Integration Formulas, Numerical Integration, Numerical Differentiation, Case Studies.
4. **Interpolation Techniques**: Newtonian Interpolation Techniques, Lagrange Interpolation Techniques. **Curve Fitting:** Linear and Quadratic Curve Fitting.
5. **Ordinary Differential Equations**: Runge-Kutta Methods, Boundary-Value and Eigen value Problems, Case Studies.

Pre-requisite Courses: None.

Reference Book(s):

1. "Numerical Methods for Engineers", Steven C Chapra, Raymond P Canale, McGraw Hill, 6th Edition, 2010.

UE16CS325: ARTIFICIAL INTELLIGENCE (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Provide an introduction to Machine Intelligence, Problem Solving, Heuristic Search.
- Provide an introduction to Game Playing.
- Provide an introduction to various knowledge representation techniques, reasoning, and expert systems.
- Provide an introduction to planning and learning in AI.
- Introduce Understanding, Natural Language Processing and Robotics - Perception and Action.

Course Outcomes:

At the end of the course, the student will be able to:

- Apply various search techniques for solving problems in AI.
- Write programs to play games.
- Apply knowledge representation techniques and build algorithms for reasoning with knowledge.
- Apply planning and learning algorithms to enhance AI problem solving.
- Identify the AI research and problem areas and choose appropriate problem solving methods.

Course Content:

1. **Introduction to Artificial Intelligence:** Origins, Historical Perspective, Successes and Failures. **State Space Search:** AI Problems, Intelligent Agents, State Space Search, Heuristic Search Techniques.
2. **Advanced Search Techniques:** Game Playing - Adversarial Search, Simulated Annealing, Beam Search, Genetic Algorithm, Constraint Satisfaction Problems.
3. **Knowledge Representation using Logic:** Propositional Logic, First Order Predicate Logic, Reasoning, Logic Programming.
4. **Structured KR Techniques:** Semantic Nets and Frames. **Expert Systems:** Rules, Rule Chaining, Rule Based Systems, Rete Algorithm.
5. **Planning:** STRIPS Model, Goal Stack Planning, Hierarchical Planning, Graph Plan. **Introduction to Advanced Topics:** Perception and Action, Learning, Understanding and NLP. **Current Applications in AI**: Robotics, Games.

Pre-requisite Courses: UE16CS251 – Design and Analysis of Algorithms.

Reference Book(s):

1. "A First Course in Artificial Intelligence", Deepak Khemani, McGraw Hill, 1st Edition, 2013.
2. "Artificial Intelligence – A Modern Approach", Stuart Russell, Peter Norvig, Pearson, 3rd Edition (Paperback), 2016.
3. "Artificial Intelligence", E Rich, K Knight, Shivashankar Nair, Tata McGraw Hill, 3rd Edition, 2009.

UE16CS351:
COMPILER DESIGN (4-0-0-0-4)

Course Objectives:
The objective(s) of this course is to,

- Introduce the major concept areas of Language Translation and Compiler Design.
- Develop a greater understanding of the issues involved in programming language design and implementation.
- Provide practical programming skills necessary for constructing a compiler.
- Develop an awareness of the function and complexity of modern compilers.
- Provide an understanding on the importance and techniques of optimizing a code from a compiler's perspective.

Course Outcomes:
At the end of the course, the student will be able to:

- Use the knowledge of patterns, tokens and regex for solving the problems in the field of Data Mining.
- Analyze and design the semantic behavior of a compiler.
- Design and develop the behavior of a construct.
- Design and implement a simple compiler.
- Optimize the performance of a program in terms of speed and space using new code optimization techniques.

Course Content:
1. **Compilers:** The Language Processing System, The Phases of a Compiler, The Grouping of Phases into Passes, Variations in Compiler Models**. Lexical Analysis:** The Role of the Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, Design of a Lexical Analyzer Generator. **Syntax Analysis:** The Role of Parser, Syntax Error Handling, Error-Recovery Strategies. **Top - Down Parsing:** Recursive Descent Parser (RDP) with Backtracking.
2. **Syntax Analysis: Top - Down Parsing -** LL(1) Parser. **Bottom - Up Parsing:** Shift-Reduce Parsing, LR(0), SLR, Viable Prefixes, CLR, LALR.
3. **Syntax – Directed Translation:** Syntax - Directed Definitions (SDDs), Evaluation Orders for SDDs, Applications of Syntax - Directed Translation (SDT), Syntax - Directed Translation Schemes - Postfix Translation Schemes. **Parser Stack Implementation:** Parser Stack Implementation of Postfix SDTs, SDTs with Actions Inside Productions, SDTs for L - Attributed Definitions. **Implementing L - Attributed SDDs**: L - Attributed SDDs and LL Parsing.
4. **Syntax - Directed Translation - Implementing L - Attributed SDDs**: Bottom - Up Parsing. **Intermediate - Code Generation:** Variants of Syntax Trees – Directed Acyclic Graphs for Expressions, Three - Address Code – Addresses and Instructions, Quadruples, Triples, Indirect Triples, SSA Form, Control Flow Graph, **Machine Independent Optimization:** Different Optimizations.
5. **Machine Independent Optimization:** Optimization of Basic Blocks**,** Live-Variable Analysis**. Run - Time Environments:** Storage Organization, Stack Allocation of Space, Access to Non - Local Data on the Stack. **Code Generation:** Issues in the Design of a Code Generator, The Target Language, Addresses in the Target Code, Static Allocation, Stack Allocation, Run - Time Addresses for Names.

Pre-requisite Courses: UE16CS202 – Data Structures, UE16CS254 – Theory of Computation.

Reference Book(s):
1. "Compilers – Principles, Techniques and Tools", Alfred V Aho, Monica S Lam, Ravi Sethi, Jeffery D Ullman, 2nd Edition, Pearson Education, 2009.
2. "Modern Compiler Design", Dick Grune, Kees van Reeuwijk, Henri E Bal, Ceriel J.H. Jacobs, Koen Langendoen, 2nd Edition, 2012.

UE16CS352:
CLOUD COMPUTING (4-0-0-0-4)

Course Objectives:
The objective(s) of this course is to,

- Understand the rationale behind the Cloud Computing revolution.
- Introduce various models of Cloud Computing.
- Understand how to design applications on Cloud and the role of security.
- Understand and design distributed systems for scalability.
- Understand and apply various tradeoffs in designing Cloud architectures.

Course Outcomes:
At the end of the course, the student will be able to:

- Comprehend the technical and business rationale behind Cloud Computing.
- Decide the model of Cloud Computing to use for solving a particular problem.
- Build applications for the Cloud and understand the security implications.
- Apply the fundamentals of distributed systems design to Cloud Computing.
- Apply the concepts learnt in solving a real-life problem in a group setting.

Course Content:
1. **Introduction and Cloud models:** Cloud Computing - Business Perspective, Models - SOA and REST, IaaS Model and Case Study, PaaS Model.
2. **Virtualization Compute:** CPU Virtualization - Hardware/ Software, Lightweight Virtualization – Containers, Micro services.
3. **Storage and Network Virtualization:** CAP Theorem, Object and Block Storage Virtualization, Scaling Storage, Multitenancy, Network Virtualization Architecture.
4. **Resource Allocation and Scheduling:** Algorithms for Allocation of Compute, Storage, Container Orchestration, Fair-Share and Capacity Schedulers.
5. **Distributed Architectures:** Architectures - Peer to Peer, Master Slave, Cluster Coordination, Failure - Availability/ Reliability, SaaS Model, Security in Cloud.

Pre-requisite Courses: None.

Reference Book(s):
1. "Moving to the Cloud: Developing Apps in the New World of Cloud Computing", Dinkar Sitaram and Geetha Manjunath, Syngress 2011.

UE16CS353:
MACHINE LEARNING (4-0-0-0-4)

Course Objectives:
The objective(s) of this course is to,

- Introduce basics of Matrices, Random Variates and Distributions relevant for the study of Machine Learning Techniques.
- Formulate a well - defined Machine Learning problem with clear metrics.
- Familiarize with techniques for Dimensionality Reduction and Computational Efficiency.

- Understand the notions of Hypotheses Space, Hypotheses Structure and Search.
- Become conversant with types of Machine Learning Algorithms, their applicability and Inductive Bias.

Course Outcomes:

At the end of the course, the student will be able to:

- Distinguish categories of Data Attributes, Dimensions, Sample Sizes.
- Acquire a thorough understanding of Supervised, Unsupervised Learning.
- Understand Logistic and Linear Regression and Function Estimation.
- To cluster and classify data.
- Extract rules and associations and provide impactful recommendations from data.
- Decide on the data that matters for the learning problem at hand.

Course Content:

1. **Introduction/ Basics:** Learning Problems, Designing Learning Systems, Perspectives and Issues. **Concept Learning**: Version Spaces and Candidate Elimination Algorithm, Inductive Bias.
2. **Classification and Regression**: Decision Trees, k-Nearest Neighbors, Logistic Regression, Neural Networks and Back Propagation, Support Vector Machines, Boosting (Ada Boost), Linear Regression, Logistic Regression, Tree Based Regression, Instance Based Learning (k-NN)
3. **Stochastic Models:** Bayesian Learning, Genetic Algorithms, Markov Models, Document Similarity and Text Classification.
4. **Unsupervised Learning:** K-means, Hierarchical Clustering - Agglomerative, Divisive, Distance Measures, Density Based Clustering – DBScan, Pattern, Association Rule Mining - Apriori Algorithm, Frequent Pattern - Growth Algorithm.
5. **Dimensionality Reduction and Recent Trends in ML:** Matrices, Properties, Eigen Values, Eigen Vectors**,** Principal Component Analysis, Singular Value Decomposition, Deep Learning – Introduction, CNN, GAN, Reinforcement Learning.

Pre-requisite Courses: UE16MA251 – Linear Algebra, UE16CS251 – Design and Analysis of Algorithms.

Reference Book(s):

1. "Machine Learning", Tom Mitchell, McGraw Hill Education (India), 2013.
2. "Pattern Recognition and Machine Learning", Christopher Bishop, (2nd Printing) Springer, 2011.
3. "Introduction to Machine Learning", Ethem Alpaydin, 1st Edition, PHI Learning, 2017.
4. Appropriate Handouts for Matrices, Random Variates, Recent Trends in ML.

UE16CS354:
COMPILER DESIGN LABORATORY (0-0-2-0-1)

Course Objectives:

The objective(s) of this course is to,

- Deepen the understanding of Compiler Design.
- Develop problem solving ability using programming.
- Develop ability to design and analyze a compiler.

Course Outcomes:

At the end of the course, the student will be able to:

- Acquire the generic skills to design and implement a compiler.
- Analyze practical aspects.

Course Content:

1. Lex to count number of characters, words, newlines and white spaces.
2. Lex for Number Base Conversion.
3. Lex for finding the ASCII values of Escape Sequence character.
4. Lex to remove comment lines.
5. Yacc to validate identifiers.
6. Yacc to validate Context Free Grammars.
7. Yacc to validate Nested IF – ELSE construct.
8. Convert the BNF rules into Yacc form and write code to generate Abstract Syntax Tree.
9. Write a C program for implementing the functionalities of a Predictive Parser.
10. Program to implement semantic rules to calculate the expression that takes an expression with digits, + and * and computes the value.
11. Mini Project.

Pre-requisite Courses: None.

Reference Book(s):

1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE16CS355:
MACHINE LEARNING LABORATORY (0-0-2-0-1)

Course Objectives:

The objective(s) of this course is to,

- To reinforce the Machine Learning Theory and Algorithms by implementations of meaningful problems using Python.

Course Outcomes:

At the end of the course, the student will be able to:

- Distinguish categories of Data Attributes, Dimensions, Sample Sizes.
- Acquire a thorough understanding of Supervised, Unsupervised Learning.
- Understand Logistic and Linear Regression and Function Estimation.
- To cluster and classify data.
- Extract rules and associations and provide impactful recommendations from data.
- Decide on the data that matters for the learning problem at hand.

Course Content:

1. Mini - Project, Batch Formation and Problem Statement Finalization.
2. Construct/ Visualize a Decision Tree using Information Gain (Entropy) attributes on a (at least) 32 - size data set with (at least) 8 – attributes.
3. Implement a Genetic Algorithm based Hand - Written Character Recognition.
4. Implement a 3 Layer Neural Network (32 input, 8 hidden and 4 output neurons) to perform Face Recognition (4 faces) (1st week).
5. Implement a 3 Layer Neural Network (32 input, 8 hidden and 4 output neurons) to perform Face Recognition (4 faces) (2nd week).
6. Mini - Project, Literature Survey and Design Submission.
7. Implement an SVM - Based Binary Classifier for Movie Review Classification. Write your own code for the SMO Algorithm. Use the IMDB Data Set.

8. Implement Naive Bayes Sentiment Analyzer for Document Classification (3 classes atleast).
9. Implement an HMM - Based Emotion Predictor on an audio input (1st week).
10. Implement an HMM - Based Emotion Predictor on an audio input (2nd week).
11. Implement DBSCAN based Clustering on election data to find meaningful clusters.
12. Mini - Project Submission and Evaluation.

Pre-requisite Courses: None.

Reference Book(s):

1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE16CS331:
COMPUTER NETWORK SECURITY (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Provide an overall view of what Computer and Network Security is all about and generate interest in this field to be able to take this as a further specialization area or a career path.
- Introduction of Perimeter Security (Firewall, IDS, IPSEC, VPN), Authentication and Access Management, Cryptography, Malware, Secure Programming, Applications Security, Security and Privacy Policy.

Course Outcomes:

At the end of the course, the student will be able to:

- Choose Cryptography Algorithms based on the application domain of the network.
- Write code to implement various Encryption/ Decryption algorithms.
- Apply Authentication Protocols and Processes.

Course Content:

1. **Overview:** Computer Security Concepts, Requirements, Architecture, Trends, Strategy. **Perimeter Security:** Firewalls, Intrusion Detection, Intrusion Prevention Systems, Honeypots. **User Authentication:** Password, Password - Based, Token - Based, Biometric, Remote User Authentication. **Access Control:** Principles, Access Rights, Discretionary Access Control, UNIX File Access Control, Role Based Access Control. **Internet Authentication Applications:** Kerberos, X.509, PKI, Federated Identity Management.
2. **Human Factors:** Security Awareness, Training and Education, Organization Security Policy, Employment Practices and Policy. **IT Security Management and Risk Assessment:** IT Security Management, Risk Assessment, Analysis of IT Security Controls. **Plans and Procedures:** IT Security Management Implementation, Security Controls, Plan, Implementation of Controls.
3. **Cryptographic Tools:** Confidentiality with Symmetric Encryption, Message Authentication and Hash Functions, Digital Signatures, Random Numbers, Symmetric Encryption. **Message Confidentiality:** DES, AES, Stream Ciphers, Cipher Block Modes of Operation, Key Distribution. **Public Key Cryptography and Message Authentication:** Asymmetric Encryption**,** Secure Hash Functions, HMAC, RSA, Diffie Hellman Algorithm. **Internet Security Protocols:** SSL, TLS, IPSEC, S/ MIME.
4. **Cloud Security:** Cloud Computing Service Models and Layers, Security Issues in Cloud Computing. **Bluetooth Security:** Bluetooth Protocol Stack, Multiple Security Modes. **Mobile Security:** Security Concepts, Requirements, Architecture.
5. **Wireless Network Security:** Wireless Communications and 802.11 WLAN Standards Wireless Protected Access (WPA), IEEE 802.1x, 802.11i/ WPA2, Wireless Network Threats, ZigBee Security, Wireless Mesh Network Security.

Pre-requisite Courses: UE16CS301 – Computer Networks.

Reference Book(s):

1. "Computer Security: Principles and Practice", William Stallings, Lawrie Brown, Indian Edition, Pearson, 2010.

UE16CS332:
STORAGE AREA NETWORKS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Introduce students to the current storage technologies.
- Equip students with an understanding of SAN technologies in Data Centers, SAN architectures, its advantages and complexities.
- Walk through the IO path from an Application to bits and bytes stored in a device with all the related technologies in the path.
- Provide hands on exposure to Cloud Storage and how you would write/ read data there.
- Exposure to SAN applications like Backup, Security and Management aspects of SAN/ NAS.

Course Outcomes:

At the end of the course, the student will be able to:

- Analyze the logical and physical components of a storage infrastructure.
- Design different types of RAID implementations and enumerate their benefits.
- Analyze and walk through the data path from Application to a Disk
- Contrast SCSI, Fiber Channel and iSCSI protocols.
- Analyze benefits of storage virtualization.
- Write an application which would write/ read data from a Cloud Storage.

Course Content:

1. **Introduction to Storage Systems, IO Techniques and Intelligent Disk Systems:** Structured and Unstructured Data, Data Centers, Key Requirements of Data Centers, Storage in Data Centers, Types of Storage (including SDS), Converged Storage, Futures in Storage Technologies, Storage – Centric IT Architecture and Its Advantages, The Physical I/O Path from the CPU to the Storage System. **Introduction to Storage Components:** Disks, Physical Structure of Disks, Categorization of Disk Subsystems, Architecture of a Disk Subsystem, Internal I/O Channels and Their Design Variations, RAID Levels, Availability of Disk Systems.
2. **Storage Protocols - SCSI, FC, iSCSI:** SCSI Basics, Components, Addressing, Protocol and Functioning. **Fiber Channel:** FC Basics, FC Protocol Stack, iSCSI.
3. **SAN and NAS – Components and Hardware and Software Architecture:** Network Attached Storage - Introduction to NAS Hardware and Software Components and Architecture, SAN Hardware and Software Components and Architecture.
4. **Storage Virtualization and Large Storage Systems:** Storage Virtualization, Implementation Considerations, Server, Device and Network Centric Storage Virtualization, Storage Virtualization in Block or File Level, In - Band, Out-Band, IP Storage, Object Storage, Cloud Storage, REST Based Cloud Storage Access. **Illustrations of Cloud Storage:** Google FS, Openstack Swift**,** Amazon S3, MS Azure.

5. **Storage Management and Applications:** SAN and NAS Management, CIM/ WEBEM, SMI-S. **Storage Security:** Security Considerations in Storage, Information Security, Security Methods, Storage Security Technologies and Challenges, Best Practices in Security. **Business Continuity and Storage Applications:** Backup, Recovery and Archival.

Pre-requisite Courses: None.

Reference Book(s):

1. "Storage Networks Explained", Ulf Troppens, Rainer Erkens, Wolfgang Muller, Wiley India, 2013.
2. "Storage Networking Fundamentals – An Introduction to Storage Devices, Subsystems, Applications, Management, and File Systems", Marc Farley, Cisco Press, 2005.
3. "Storage Networks - The Complete Reference", Robert Spalding, Tata McGraw-Hill, 2011.
4. "Storage Area Network Essentials - A Complete Guide to Understanding and Implementing SANs", Richard Barker, Paul Massiglia, Wiley India, 2006.

UE16CS333: NATURAL LANGUAGE PROCESSING (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Expose students to the concepts of n-grams and Language Modelling with n-gram.
- Expose students to the Natural Language Processing pipeline i.e. Morphology, Lexical Analysis, Syntactic Analysis, Semantic Analysis and Discourse.
- Expose students to the Information Extraction problems and end to end Natural Language Generation problems as applications of Natural Language Processing.
- Introduce students to the various Neural Network methods for Natural Language Processing.

Course Outcomes:

At the end of the course, the student will be able to:

- Implement meaningful course or research projects using current Natural Language Processing technology.

Course Content:

1. **Text Normalization, Morphology and Finite State Transducer:** Concept/ Types of Ambiguity in Natural Language Processing, Empirical Laws: Zipf's Law, Heap's Law. **Text Normalization:** Content and Function Words, Type vs. Token, Unix Tools for Crude Tokenization and Normalization, Word Tokenization and Normalization, Lemmatization and Stemming, Sentence Segmentation. **Morphology and Finite State Transducers:** Survey of English Morphology, Finite State Morphological Parsing, Combining FST Lexicon and Rules, Lexicon - Free FST - The Porter Stemmer, Human Morphological Parsing.
2. **N-Grams, Edit Distance and Language Modelling:** n-grams, Evaluating Language Models - Perplexity, Generalization and Zeros, Smoothing - Kneser-Ney Smoothing, Web and Stupid Back Off, Perplexity's Relation to Entropy. **Spelling Correction and Noisy Channel:** Noisy Channel Model, Real World Spelling Error, Minimum Edit Distance Algorithm, Improved Edit Models. **Word Classes and Part-of-Speech (POS) Tagging:** English Word Classes, Penn Tagsets for English, Rule-Based Part-of-Speech Tagging, Transformation-Based Tagging, POS Tagging using Hidden Markov Model, Maximum Entropy Model and Conditional Random Fields, Neural Language Models with Deep Artificial Neural Network.
3. **Parsing:** Context Free Grammar. **Syntactic Parsing:** Ambiguity Presented By Parse Trees, CKY Parsing, Chart Parsing and Earley Parser. **Partial Parsing:** Chunking. **Statistical Parsing:** Probabilistic Context Free Grammar, Probabilistic CKY Parsing of PCFG, Problems with PCFG, Probabilistic Lexicalized PCFG. **Introduction to Dependency Parsing:** Dependency Relations, Dependency Formalisms, Dependency Tree Banks, Evaluating Parsers.
4. **Semantics - Lexical semantics:** Word Senses and Relations Between Word Senses, WordNet: A Database of Lexical Relations, Word Sense Disambiguation - Overview, Supervised Word Sense Disambiguation, WSD - Dictionary and Thesaurus Methods, Semi-Supervised WSD, Unsupervised Word Sense Induction. **Word Similarity or Semantic Relatedness Based On Thesaurus:** Resnik Similarity, Lin Similarity, Jiang-Conrath Distance, Extended Gloss Overlap And Extended Lesk Method. **Lexicons For Sentiment and Affect Extraction:** Available Sentiment Lexicons, Using Wordnet Synonyms And Antonyms - Sentiwordnet, Supervised Learning of Word Sentiments, Using Lexicon For Sentiment Recognition, Lexicons For Emotions And Other Affective States. **Representation Of Meaning:** Computational Desiderata for Representations, Meaning Structure of Language, First Order Predicate Calculus, Some Linguistically Relevant Concepts, Related Representational Approaches, Alternative Approaches To Meaning. **Syntax Driven Semantics:** Syntax-Driven Semantic Analysis, Attachments for a Fragment of English, Integrating Semantic Analysis into the Earley Parser, Idioms and Compositionality, Robust Semantic Analysis. **Co-Reference Resolution and Discourse:** Lappin and Lease Algorithm, Hobbs Algorithm.
5. **Information Retrieval, Natural Language Generation and Neural Network Methods for Natural Language Processing - Information retrieval:** Information Extraction vs. Retrieval, Information Extraction Sub-Problems, Named Entity Recognition - Practical NER Architectures. **Natural Language Generation:** An Architecture, Question Answering System - IR Based Factoid Question Answering, Knowledge Based Question Answering, IBM's Watson, Dialogue System And Chatbot - Rule Based And Corpus Based Chatbots. **Vector Semantics:** Words And Vectors, Pointwise Mutual Information, Measuring Similarity, Using Syntax to Define a Word's Context, Evaluating Vector Models. **Semantics With Dense Vectors:** Dense Vectors via SVD, Distributional Hypothesis, Embedding from Predictions - Skip Gram And CBOW, Properties Of Embedding, Pre-Trained Word Representations - Word2vec And Glove, Limitation Of Distributional Methods. **Neural Network Methods For Natural Language Processing:** CNN and RNN as Feature Extractors, Modeling With Recurrent Neural Network - Sentiment Classification, Part of Speech Tagging, Conditioned Generation By RNN - Encoder-Decoder, Seq2seq Models, Seq2seq Chatbots.

Pre-requisite Courses: UE16CS251 – Design and Analysis of Algorithms.

Reference Book(s):

1. "Speech and Natural Language Processing", Daniel Jurafsky and James H Martin, 3rd Edition Draft, http://web.stanford.edu/~jurafsky/slp3/
2. "Neural Network Methods for Natural Language Processing", Yoav Goldberg, Morgan and Claypool Publishers.
3. "Natural Language Processing with Python – Analyzing text with natural Language Toolkit", Steven Bird, Ewan Klein, and Edward Loper, O'rielly books, https://www.nltk.org/book/
4. "Deep Learning with Python", Francois Chollet, Manning.

UE16CS334: MULTI CORE COMPUTING (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Introduce the factors influencing a program's performance.
- Teach how various factors influencing performance of programs including both hardware and software.
- Use and design appropriate tools to monitor, measure and optimize performance.
- Introduce different programming models to write high performance programs.

Course Outcomes:

At the end of the course, the student will be able to:

- Analyze existing applications for performance bottlenecks.
- Design and debug performance efficient applications.
- Understand and apply design tradeoffs in choosing different models of parallel programming.
- Use tools to aid in creating high performance computing applications.

Course Content:

1. **Introduction to Performance and Architecture:** Introduction to Performance, High Performance Computing Applications, Metrics, Benchmarks, Motivating Example - Overview of Computer Systems and Their Impact on Performance, Types of Architectures, Concurrency and Parallelism, Types of Parallelism, Review of Pipelining. Instruction Level Parallelism - Concepts and Challenges, Data Hazards, Performance Measures, Multiple Issues, Compiler Optimization - Loop Unrolling, Dynamic Scheduling - Examples and Algorithm Bus vs. Interconnection Networks in Processors.
2. **Compiler Optimizations and Performance:** Fusion, Transformations for Performance Enhancement Speculation, Limitations of ILP, Hyperthreading, Thread Level Parallelism, Multithreading Architectural Support, Multi-Cores, Amdahl's law, Gustafson's Law, Introduction to GPU, Parallel Architectures - Shared vs Distributed Memory Architectures.
3. **Threading and OpenMP:** Designing for Threads – Programming Patterns, Data Structure Choice, Reader/ Writer Locks, Deadlocks, OpenMP – Computation of Pi, Parallel, False Sharing, OpenMP - Sections, Locks, Memory Models, Storage Attributes, OpenMP – Synchronization, Critical Section, Atomics, Loop Work-Sharing and Scheduling.
4. **Memory Hierarchy and Optimizations:** Case Study - Intel Core i7 Memory Hierarchy, Memory Consistency Models, Cache Coherence and NUMA and Interconnects.
5. **GPU Computing:** CUDA – Motivating Example, Matrix Multiplication, Examples, CUDA Threads, Blocks and Latency, Recent Trends in Multi/ Many Core Architectures, Putting It All Together – Example Case Study HPC App and Its Optimization.

Pre-requisite Courses: UE16CS253 – Microprocessor and Computer Architecture.

Reference Book(s):

1. "Computer Architecture: A Quantitative Approach", Hennessey, Patterson, 5th Edition.
2. "Computer Systems: A Programmer's Perspective", Randal Bryant, David O'Halloran 2nd Edition, Prentice Hall, 2011.
3. "Programming Massively Parallel Processors: A Hands On Approach", David Kirk, Wen-meiHwu, 2010, Morgan Kaufmann.

UE16CS335: GENERIC PROGRAMMING (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Understand the rationale behind generic programming.
- Understand compile time checks.
- Gain insights into the concept of meta programming.

Course Outcomes:

At the end of the course, the student will be able to:

- Solve programming problems and improve programs using Generic Programming.
- Evaluate Generic Programming methods/ approaches and understand their pros and cons.

Course Content:

1. **Template Functions:** Definition, Instantiation - Implicit and Explicit, Specialization, Type and Non-Type Template Parameter.
2. **Template Class:** Instantiation, Templates and Static Members, Templates and Inheritance, Templates and Composition, Templates and Friends, Template Member Functions, Dependent Type, Default Template Parameter, Nested Templates Traits and Policies, STL Philosophy, Efficiency of Algorithms, Separation of Behavior from Container Classes, Functor and Iterator, Iterator Hierarchy, Adaptors, Examples of Containers and Algorithms.
3. **Template Meta - Programming Overview:** Compile-Time Programming Nature and Limitations of Template Meta-Programming.
4. **Building Blocks:** Values, Functions, Branching, Recursion, Compile-Time "If" Conventions for "Structured" Template Meta Programming.
5. **Generics in Java:** Generic Methods, Constructors, Type Inference, Bounded Type Parameters, Subtyping, Wildcards, Type Erasure, Overview of Generic Collection Classes, Generics in C#, Generic Constraints, Generics and Casting, Inheritance and Generics, Generic Methods, Generic Delegates, Generics and Reflection.

Pre-requisite Courses: None.

Reference Book(s):

1. "C++ Primer", Lippman, Addison-Wesley, 2013.
2. "A tour of C++", Bjarne Stroustrup, Addison-Wesley, 2013.
3. "Templates: The Complete Guide", David Vandevoorde, Nicolai M Josuttis, Addison-Wesley, 2002.
4. "STL Tutorial and Reference", Musser, Derge and Saini, 2nd Edition, Addison-Wesley, 2001.
5. "Java Tutorials", Online Reference Link - https://docs.oracle.com/javase/tutorial/.
6. MSDN for C# generics.

UE16CS336: DRONE COMPUTING (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To enable the students to have hands-on experience with drones/quadcopters.
- To understand the basic principles of flying.
- To write program to fly drones.
- To use mission planners for accomplishing GPS related tasks.
- To enrich the drone computing applications to serve the society.

Course Outcomes:

At the end of the course, the student will be able to:

- Students will be able to fly drones/ quadcopter both using RF controller and semi-autonomously.
- Students will be able to write programs to guide the paths of drones.
- Students will be able to use GPS coordinates to locate positions while flying.
- Students will be able to apply the fundaments of drone computing for their projects.
- Students will be able to innovate workable ideas to address the challenging problems in the society.

Course Content:

1. **Building a Simple Drone:** Introduction to Drones, Types of Drones, Configuration of Flight Controller, Configuration of Receiver Transmitter Control, Assembling Drone Components, Experiments with Simple Flight Paths.
2. **Understanding Control:** Theory of PTD Controller, Experiments Flying with PID, Theory of Electronic Control, Experiments Flying with EC, Analyzing Path Accuracies and Flight, Stability with Experiments.
3. **Path Planning with GPS:** Introduction to GPS, Experiments with GPS Modules, Path Planning with GPS Co-ordinates, Experimenting Path Planning with GPS Co-ordinates, Analyzing Path Accuracies and Flight Stability with Experiments.
4. **Impact of Payload:** Introduction to Payload, Impact of Payload, Maximizing Payload, Experiments with Different Payloads, Analyzing Path Accuracies and Flight Stability with Experiments.
5. **Tracking with Camera:** Introduction to Tracking with Camera, Object Recognition, Obstacle Avoidance, Experiments for Tracking Objects, Analyzing Follow-Up Accuracies and Flight Stability with Experiments.

Pre-requisite Courses: None.

Reference Book(s):

1. "Getting Started with Drones: Build and Customize Your Own Quadcopter", Terry Kilby, Belinda Kilby, Maker Media, Inc, 1st Edition, 6 October 2015.
2. "Make: Drones: Teach an Arduino to Fly", David McGriffy, Maker Media, Inc, 1st Edition, 10 October 2016.
3. "Drone/ UAV Dictionary: Includes 300 Commercial UAV Applications", Dr. Jerry LeMieux, CreateSpace Independent Publishing Platform, 1st Edition, May 9, 2014.

UE16CS341:
SOFTWARE DEFINED NETWORKS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Understand the rationale behind evolution of Software Defined Network technology.
- Understand SDN based managed network services through abstraction of higher-level functionality.
- Understand the architecture of SDN traffic through Control and Data planes.

Course Outcomes:

At the end of the course, the student will be able to:

- Implement SDN approach to design, engineer and manage the networks.
- Configure Network services using SDN with ease, efficiently and remotely monitor QoS.

Course Content:

1. History and evolution of Software Defined Network, SDN Architecture.
2. Control and Data Plane Separation, Control Plane, Network Virtualization, Data Plane.
3. Programming SDNs, Openflow.
4. Verification and Debugging, Use Cases and Looking Forward.
5. Hands-on using simulator Mininet.

Pre-requisite Courses: UE16CS301 – Computer Networks.

Reference Book(s):

1. "Software Defined Networks - Programmability Technologies", Thomas D. Nadeau, Ken Gray -SDN: O'Reilly Media, 2013.
2. "Software Defined Networks - A Comprehensive Approach", Paul Goransson and Chuck Black, Morgan Kaufmann, 2014.

UE16CS342:
KNOWLEDGE MANAGEMENT (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Understand and appreciate the rationale and theory of Knowledge Management.
- Learn various tools for Knowledge Management.
- Understand the significance of Knowledge Management.
- Learn different ways of knowledge creation and transfer.
- Understand the role and implications of technology in the field of Knowledge Management.

Course Outcomes:

At the end of the course, the student will be able to:

- Apply Knowledge Management paradigms in applications like Semantic Web.
- Select and use various tools for effective Knowledge Management.

Course Content:

1. **The Basics:** Working Smarter, Knowledge Management (KM) Myths and Lifecycle, Implications of KM. **Understanding Knowledge**: Definitions, Cognition and KM, Data, Information and Knowledge, Types of Knowledge, Expert Knowledge, Human Thinking and Learning, Implications for KM. **Knowledge Management Systems Lifecycle**: Challenges, Conventional versus KM System Lifecycle, Implications for KM. **KM Strategy**: Economy of Plan, Economy of Change, Economy of Control.
2. **Knowledge Creation and Capture:** Knowledge Creation and Knowledge Architecture, Nonaka's Model, Knowledge Architecture, Implications, Capturing Tacit Knowledge, Knowledge Capture, Evaluating the Expert, Developing a Relationship with Experts, Fuzzy Reasoning and Quality of Knowledge, Interview as a Tool, Guide to a Successful Interview, Rapid Prototyping, Implications.
3. **Design of KM Systems:** Economy of Scope, Economy of Effort, Economy in Deployment, Other Knowledge Capturing Techniques, Onsite Observation, Brain-Storming, Protocol Analysis, Consensus Decision Making, The Repertory Grid, NGT, Delphi Method, Concept Mapping and Black-Boarding, Knowledge Codification, Why Codify, Modes of Knowledge Conversion, How to Codify Knowledge, Codification Tools and Procedures, Knowledge Developer's Skill Set, Implications. **System Testing and Deployment**: Quality and Assurance, Knowledge Testing, Approaches to Logical and User Acceptance Testing, Managing the Test Phase, KM System Deployment, Issues, User Training and Deployment, Post-Implementation Review, Implications, Knowledge Transfer and Sharing - as a Step in a Process, Transfer Methods, Role of Internet, Implications.

4. **Knowledge Transfer in E-World:** The E-World, E-Business, Implications, KM System Tools and Portals – Learning from Data, Data Visualization, Neural Networks as a Learning Model, Association Rules, Classification Types, Implications, Data Mining – Knowing the Unknown, Data Mining and Business Intelligence, Business and Technical Drivers, Data Mining Virtual Cycle and Data Management, Data Mining in Practice, Role of DM in Customer Relationship, Implications. **Knowledge Management Tools and Portals:** Portals - The Basics, Business Challenge, Knowledge Portal.
5. **Technologies, Implications, Ethical, Legal and Managerial Issues:** Knowledge Owners, Legal Issues, Ethical Factor, Improving the Climate, Implications.

Pre-requisite Courses: None.

Reference Book(s):

1. "Knowledge Management", Elias M. Awad and Hassan Ghaziri, Pearson Publications, 2007.
2. "Ten Steps to Maturity in Knowledge Management – Lessons in Economy", J.K. Suresh and Kavi Mahesh, Chandos Publishing, 2006.

UE16CS343:
SYSTEM MODELING AND SIMULATION (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To provide a background to students on the principles of modeling and simulation and expose them to different types of models.
- To train students on the techniques of how to model a scenario using discrete event system models. Expose students to typical applications such as queueing systems and inventory systems.
- To train students to conduct end-to-end simulation experiments and assess the fitness of simulation.
- To expose students to continuous systems and application of continuous simulation to real life systems.
- To expose students to agent-based modeling.

Course Outcomes:

At the end of the course, the student will be able to:

- Student will be able to model a given scenario/ problem and generate inputs to simulate the same and derive simulation table that includes inputs and outputs.
- Student will be able to apply simulation techniques to typical discrete event systems such as queuing systems, inventory systems and reliability of machines.
- Student will be able to generate inputs for simulation using understanding of statistical distributions.
- Student will be able to validate the input models and assess the simulation output relative to real life data.
- Student will be able to model continuous systems using numeric methods.
- Student will be able to apply agent-based modeling techniques.

Course Content:

1. **Introduction to Simulation:** Principles of Modeling and Simulation, Model Taxonomies, Fundamentals of Queuing Theory, Random Variate Generation, Monte Carlo Simulation, Performance Measures of Queuing Systems.
2. **Building Discrete Event Simulation Models:** Managing Event Lists, Queue Disciplines, Priorities, Application to Simulation of Computer Subsystems and Concurrent Processes.
3. **Design of Simulation Experiments:** Generation of Random Numbers, Validation of Random Numbers, Generating Variates, Input Data Analysis to Determine Distributions.
4. **Validation of Simulation and Output Analysis**: Verification and Validation of Simulation Models, Analysis of Simulation Output, Tests of Significance and Design of Experiments, Variance Reduction Techniques.
5. **Continuous System Simulation and Agent Based Simulation:** Modeling Systems using Differential Equations, Principles of Numerical Integration, Numerical Integration Methods, Simulation of Discontinuities (Combined Discrete-Continuous Simulation), Application to Population Ecology and Other Systems, The Need for Agent-Based Simulation, Agent Concepts – Characteristics and Interaction Topologies, Agent-Based Simulation Platforms (Netlogo and Others), Applications Examples.

Pre-requisite Courses: UE16CS203 – Introduction to Data Science

Reference Book(s):

1. "Discrete Event System Simulation", Jerry Banks et al, 5th Edition, Pearson, 2013.
2. "Numerical Methods for Engineers", Steven C Chapra and Raymond P.Canale, 6th Edition, McGraw Hill, 2015.
3. "Simulation with Arena", W David Kelton, 5th Edition, McGraw Hill, 2013.

UE16CS344:
NETWORK MANAGEMENT (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Challenges associated with Network Management (NM).
- Standards related to Network Management.
- Applications related to NM like FCAPS.
- Building of a NM interaction using SNMP.
- Evolving technologies with NM.

Course Outcomes:

At the end of the course, the student will be able to:

- Analyze the challenges associated with Network Management.
- Contrast the different NM architectures and their salient points
- Demonstrate applications associated with NM using some of the Open source tools
- Create a MIB, Manager and Agent using SNMP and demonstrate the basics of NM

Course Content:

1. **Introduction to Network Management**: Introduction, What is Network Management, Element and Network Management Systems, Challenges associated with Managing Networks, Variety and Multi-Vendor Environments, Scale and Complexity, Types of Networks, Network Topologies, Functions and Types, Internet And Network Management; Administrative Entities, Their Autonomy and Responsibilities in Terms of Policies, Data Center Networks. NM – The Big Picture and the Activities/ IT Groups which Support them, NOCs, Network Devices and Services which Need to be Managed, Benefits of Automation, Maturity of Network Management, What are the Expectations from an NMS; In an Element based NMS, Who is Best Suited for Providing a Network Management System to Manage the Components? What should a typical NM system provide, Architectural Approaches of NMS.
2. **Standards based Network Management Models**: IETF and OSI, CIM/WEBEM, Interoperability Models. **Network Element Management**: Functional Grouping of Network Management Activities. **A Review of Network Elements and Services:** Introduction, Network Devices and Network Services, Network Elements and Element Management, Effect of Physical Organization on Management, Examples of Network Elements -

Hardware components like Switches, Cable Modem System, DSL Modem System and DSLAM, IP Router Software Components like Firewall, DNS Server, DHCP Server, Web Server, HTTP Load Balancer.

3. **FCAPS:** The Industry Standard Definition, Organization of Management Software. **Configuration Management:** Introduction, Intuition for Configuration, Configuration and Protocol Layering, Dependencies among Configuration Parameters, Configuration and Temporal Consequences, Configuration and Global Consistency, Configuration and Default Values, Configuration Types and Ways of Keeping the Environment Stable in Terms of Transactions, Rollbacks etc. **Fault Management:** Fault Management Basics, Detection, Correlation, Isolation, Tracking of Faults and Resolution of Faults, Fault detection tools, Benefits of Fault management tools.
4. **Performance Management:** What is Network Performance Management, Network Performance Measures, How Are They Measured, Where Are They Measured, Capacity Planning, QoS. **Accounting Management**: What is Accounting Management, Context of Billing and Accounting in NM, Account Management Architecture and Process, Service Providers - Revenues and The Relationship to Accounting, SLAs, Billing. **Security Management:** Basics of Security, Network Security, Management Goals Related to Security, Common Security Attacks, Security Policies, Risk Assessment, Technologies for Network Security, Security Architecture.
5. **Introduction to Software Defined Network's Relationship to NM**: Autonomic Computing. Simple Network Management Protocol (SNMP): Topics for Writing a MIB, Manager and Agent and Their implementation. Network Management with BYODs, Network Management with Hybrid Cloud Challenges and the Approach.

Pre-requisite Courses: UE16CS301 – Computer Networks.

Reference Book(s):

1. "Automated Network Management Systems", Douglas E Comer, 1st Edition, Addison-Wesley, 2012.
2. "Communications Network Management", Terplan Kornel, 2nd Edition, Prentice Hall, 1991.
3. "SNMP, SNMPv2 and CMIP", William Stallings, Addison-Wesley, 1993.
4. "Network Management Principles and Practice", Mani Subramanian, Pearson Education, 2010.
5. "Network Management Fundamentals", Alexander Clemm, CISCO Press, 2007.
6. "A Practical Approach to WEBEM/CIM Management", Chris Hobbs, CRC Press, 2004.
7. "Advances in Network Management", Jianguo Ding, 2010.
8. Various Articles from Internet, Published Papers.

UE16CS345:
DIGITAL IMAGE PROCESSING (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To understand the image fundamentals (Acquisition, Storage and Viewing).
- To gain an insight to the mathematical transforms necessary for processing of grayscale and binary images.
- To assess the quality of an image and study the application of enhancement techniques in the spatial and frequency domains.
- To understand some types of noise that affects images and study techniques for de-noising and restoration.
- To understand some of the techniques used for processing of 3D color images.
- Introduce the technology of Image Compression.

Course Outcomes:

At the end of the course, the student will be able to:

- Understand image formation and the role human visual system plays in perception of gray and color image data.
- Apply image processing techniques in both the spatial and frequency (Fourier) domains.
- Assess the quality of an image and apply appropriate enhancement techniques.
- Design and evaluate methodologies for image segmentation.
- Conduct an independent study and analysis of feature extraction techniques.
- Design and / or apply algorithms to solve problems pertaining to image processing and analysis.

Course Content:

1. **Introduction:** What is Digital Image Processing (DIP), Examples of Fields That Use DIP, Fundamental Steps in Digital Image Processing, Elements of Visual Perception, Basic Concepts in Sampling and Quantization, Representing Digital Images, Spatial and Gray-Level Resolution, Zooming and Shrinking Digital Images, Some Basic Relationships between Pixels, Linear and Nonlinear Operations.
2. **Image Enhancement in the Spatial Domain:** Some Basic Gray Level Transformations, Histogram Processing, Enhancement using Arithmetic / Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.
3. **Image Enhancement in the Frequency Domain:** Introduction to the Fourier Transform and the Frequency Domain, Smoothing Frequency-Domain Filters, Sharpening Frequency Domain Filters, Homomorphic Filtering
4. **Morphological Image Processing and Segmentation:** Preliminaries, Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms. **Image Segmentation**: Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation.
5. **Color Fundamentals and Basics of Compression**: Color Models, Pseudocolor Image Processing, Basics of Full-Color Image Processing, Color Transformations, Smoothing and Sharpening, Color Segmentation, Noise in Color Images. **Image Compression**: Fundamentals - Image Compression Models, Some encoding techniques.

Pre-requisite Courses: UE16CS251 – Design and Analysis of Algorithms.

Reference Book(s):

1. "Digital Image Processing", Rafael C Gonzalez and Richard E. Woods, Prentice Hall, 4th Edition 2018.
2. "Digital Image Processing and Analysis", Scott E Umbaugh, CRC Press, 2014.
3. "Digital Image Processing", S Jayaraman, S Esakkirajan, T Veerakumar, McGraw Hill Ed. (India) Pvt. Ltd., 2013.
4. "Digital Signal and Image Processing", Tamal Bose, John Wiley, 2003.

UE16CS346:
ADVANCED COMPUTER NETWORKS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Expose the host of factors converging to produce the latest revolution in computer and communication networks.

- Teach the principles of wireless and mobile networking, the inevitable part of modern ubiquitous communication.
- Impart the principles of the technology, which is making a revolution in networking namely Software Defined Networking (SDN).
- Present the eco-system of the technology, that is making our globe smart - Internet of Things (IoT).
- Bring out the significance of various virtualization techniques in modern networks with a focus on Network Function Virtualization (NFV).

Course Outcomes:

At the end of the course, the student will be able to:

- Realize the need for new technologies in computer networks to meet growing needs of IT users.
- Compare and contrast various wireless technologies.
- Innovate ways to design networks using SDN techniques and tools and be able to take up projects.
- Conceptualize the applications of IoT relevant to Indian society and be geared up to take up internship projects in the industry.
- Identify different sub-domains in advanced computer networking, to pursue career or higher studies.

Course Content:

1. **Elements of Modern Networking:** Networking Architecture, Ethernet, Wi-Fi, 4G/ 5G Cellular, Cloud Computing, Internet of Things. **Requirements and Technology:** Types of Network and Internet Traffic, Demand, Big Data, Cloud Computing, Mobile Traffic, Requirements - QOS, QOE, Routing, Congestion Control, SDN and NFV.
2. **Wireless Networks**: Elements of Wireless Network, Types of Wireless Networks, Wi-Fi Network, Mobile Phone Network Architecture, 2G-3G-4G, Mobility Principle.
3. **The Internet of Things:** Scope, Components – Sensors, Actuators, Microcontrollers, Transceivers, RFID IoT architecture and Implementation – ITU-T IoT Reference Model, IoT World Forum Reference Model, CISCO IoT System, SDN Data Plane, OpenFlow Logical Network Device, OpenFlow Protocol, SDN Control Plane, SDN Control Plane Architecture, ITU-T Model.
4. **Software Defined Networks**: Evolving Networking Requirements, The SDN Approach, SDN Data Plane, Control Plane, Application Plane, OpenDaylight, REST, Co-operation and Co-ordination among Controllers, High Availability Clusters, SDN Application Plane Architecture, Network Services Abstraction Layer, Abstractions in SDN.
5. **Virtualization:** Network Function Virtualization - Concepts and Architecture, Background and Motivation for NFV, Virtual Machines, NFV Concepts, Benefits and Requirements, Architecture Network Virtualization, Virtual LANs, Virtual Private Networks.

Pre-requisite Courses: UE16CS301 – Computer Networks.

Reference Book(s):

1. "Computer Networking – A Top-Down Approach", James Kurose, Keith Ross, 7th Edition, Pearson, 2015.
2. "Foundations of Modern Networking", William Stallings, 1st Edition, Addison-Wesley, 2015.

UE16CS347:
RECONFIGURABLE COMPUTING (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Understand the motivation for reconfigurable computing.
- Introduction to internal structure of reconfigurable devices.
- Understand design of accelerator logic.
- Learn industry standard development tools.

Course Outcomes:

At the end of the course, the student will be able to:

- Comprehend the rationale behind reconfigurable computing.
- Build computation structures to accelerate processing.
- Use industry standard tools to implement accelerator logic.
- Design and implement accelerator logic to speed up an application.

Course Content:

1. **Introduction:** Business and Technical Motivations (such as Moore's law challenges and big data computation requirements) for Reconfigurable Computing.
2. **FPGA Architecture:** Architecture and Organization (Logic Blocks, Interconnect, Memory and Arithmetic Blocks) of Modern FPGA (Field Programmable Gate Array) Reconfigurable Devices.
3. **Accelerator Logic**: Design of Logic Structures, Memory Structures and State Machines and Their Implementation using Structural Verilog HDL.
4. **Development Software:** Industry Standard Tools for Compiling, Optimizing, Simulating and Debugging Accelerator Logic.
5. **Applications:** Hands on Programming of Basic Computation Structures and At Least One Application That Performs Much Faster Than Software.

Pre-requisite Courses: None.

Reference Book(s):

1. "Digital System Design with FPGA: Implementation Using Verilog and VHDL", Cem Ünsalan, Bora Tar, 1st Edition, McGraw-Hill Education, 2017.

UE15CS401:
OBJECT ORIENTED MODELING AND DESIGN (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Introduce students to Object Oriented Programming, Object Oriented Analysis and Modeling using the Unified Modeling Language (UML).
- Familiarize them with the models used in UML, including static as well as dynamic (behavioral) models.
- Make students appreciate the importance of system architecture and system design in product development.
- Introduce students to important design principles including GRASP and SOLID.
- Introduce students to Design Patterns and their use in software development.

Course Outcomes:

At the end of the course, the student will be able to:

- Use the concepts of classes and objects in Object Oriented Programming. Use UML to model a complex system by defining actors and use cases.
- Construct Class Models and analyze the dynamics of a system using Activity, Sequence, State and Process models.
- Depict the architecture of a software system by using component and deployment models and design a database based on a class model.
- Use GRASP and SOLID principles in the design of software.
- Apply software design patterns in a variety of situations.

Course Content:

1. **Introduction, Use Cases and Class Models:** Introduction to Object Oriented Programming – OOP Principles, Class Fundamentals, Declaring and Assigning Objects, Reference Variables, Introducing Methods, Constructors and Destructors, Introduction to Modeling, Introduction to UML, Use Case Models, Application to Case Study.
2. **Class Models and Dynamic Models:** Class Modeling, Object Constraint Language, Advanced Class Modeling, Activity Models, Sequence Models, ATM Case Study: Application Class / Interaction Models, State Models, Advanced State Models, Relationship between Class and State Models, Application to Case Study.
3. **System and Class Design:** System Design, Class Design, Implementation Models, Object Oriented Languages, Database Design.
4. **Object Oriented Design Principles:** GRASP (General Responsibility Assignment Software Patterns) and SOLID (Single Responsibility, Open-Closed, Liskov Substitution, Interface Segregation, Dependency Inversion).
5. **Design Patterns:** What Design Patterns Are, How Design Patterns Solve Problems, How to Select a Design Pattern, How to Implement a Design Pattern, Introduction to Widely Used Design Patterns including Creational, Structural, and Behavioural Patterns.

Pre-requisite Courses: None.

Reference Book(s):

1. "Object-Oriented Modeling and Design with UML", Michael R Blaha, James R Rumbaugh, 2nd Edition, Pearson.
2. "The Complete Reference Java2", Herbert Schildt, 5th Edition, TATA McGRAW HILL.
3. "Applying UML and Patterns", Craig Larman, 3rd Edition, Pearson.
4. "The Unified Modeling Language User Guide", Grady Booch, James Rumbaugh and Ivar Jacobso, 2nd Edition, Pearson.
5. "Design Patterns Elements of Reusable Object-Oriented Software", Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, Pearson.
6. "Core Java", Cay S Horstmann, Tenth Edition, Pearson Education, 2016.

UE15CS402:
SOFTWARE ENGINEERING (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Ensure the relevance and need of an engineering approach to software development.
- Learn Software Engineering concepts.
- Expose students to the tools available as part of the Software Development and Product Development Life Cycle.
- Enable the students to practice the principles of Software Product Development.

Course Outcomes:

At the end of the course, the student will be able to:

- Relate to the challenges of Software Development and relate to Software Engineering as a methodical approach for development.
- Use Software Development Life Cycles with an understanding of when and where to use.
- Work through and produce different artifacts expected at each phase of the lifecycle.
- Work on a project plan, track and manage projects.
- Appreciate the importance and usage of quality and metrics in Software Development.

Course Content:

1. **Introduction to Software Engineering:** Understand the Context of Software Engineering, Contrasting System Development, Product Development, Software Products, Project Engineering, Generic Process Framework, Phases in the Development of Software, Product Life Cycle Phases, Roles in Product Development, Product Development Eco-System, Introduction to Software Development Models including Waterfall Model, Incremental Model, Evolutionary Model, Agile Model, etc. **Software Project and Product Management Overview:** Planning a Software Development Project with Overview of Different Aspects of Software Engineering Management and Process Maturities. **Requirements Engineering and Modeling:** Requirements Engineering Tasks, Requirements Documentation / Specification and Management, Requirements Traceability**.**
2. **Software Architecture:** Software Architecture, Software Life Cycle, Architecture Design, Architectural Views, Architectural Styles, The Unified Modeling Language. **Software Design:** Classical Design Methods, Object Oriented Analysis and Design Methods, Design Patterns, Service Orientation - Service Descriptions and Service Communication, Service Oriented Architecture. **Implementation:** Coding Standards and Guidelines, Code Review / Peer Review, Patching and Patch Management.
3. **Change and Build Management:** Elements of a Configuration Management System, Baselines, Repository, SCM Process, Configuration Management Plan, Management of Code Versions, Release Versions, Exposure to Code Management Tools / Build.
4. **Software Testing:** Test Objectives, Testing and the Software Life cycle, Testing Strategies, Verification and Validation, Planning and Documentation, Manual Test Techniques, Coverage Based Test Techniques, Fault Based Test Techniques, Error Based Test Techniques, Comparison of Test Techniques, Test Stages and Estimating Software Reliability.
5. **Software Quality:** Managing Software Quality, A Taxonomy of Quality Attributes, Perspectives on Quality, The Quality System, Software Quality Assurance, The Capability Maturity Model, Personal Software Process. **Other Eng. Topics:** CBSE, Software Metrics, Software Engineering in a Global Environment, Software Estimation, Software Engineering and Hacking, Ethics in Software Engineering. **DevOps:** Introduction, Overview and Component.

Pre-requisite Courses: None.

Reference Book(s):

1. "Software Engineering: Principles and Practice", Hans van Vliet, 3rd Edition, Wiley India, 2010.
2. "Software Engineering: A Practitioner's Approach", Roger S Pressman, 6th Edition, McGraw Hill, 2005.
3. "Software Engineering", International Computer Science Series, Ian Sommerville, 9th Edition, Pearson Education (2009).
4. IEEE SWEBOK and Other Sources from Internet.

UE15CS403:
WEB TECHNOLOGIES II (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Provide an in-depth insight into Asynchronous Communication using AJAX techniques.
- Provide an introduction to challenges involved in improving performance of rich web sites.
- Learn the basics of Web Services and Reverse AJAX techniques.
- Provide an overview of various Server-Side Frameworks for web development.
- Provide a basic overview of non-functional side of the WWW.

Course Outcomes:

At the end of the course, the student will be able to:

- Design Rich Web Applications, with techniques like AJAX, Server-Push, etc.
- Use Node.js as a Server-Side Framework to develop web sites that provide fast and reliable content.
- Develop RESTful Web Services and consume them.
- Develop robust web sites that are immune to malicious web attacks.

Course Content:

1. **AJAX:** Hidden Frames Technique, Image-Based AJAX, Dynamic Script Loading, XMLHttpRequest, Cross-Domain Access (CORS), Maintaining History in AJAX Calls, Fetching Binary Data with XHR. AJAX Patterns – Predictive Fetch, Multi-Stage download, Periodic Refresh and Fallback Patterns, Submission Throttling.
2. **Syndication, Reverse AJAX and Web Services:** RSS / Atom Feeds, JSON and XML, JSON vs XML, XML Based Parsers. **Reverse AJAX:** COMET, HTTP Streaming and Long Poll, iFrames Technique, Using XMLHttpRequest, HTML5 Server Sent Events, Overview of COMET Frameworks, Web Sockets. **Web Services**: Principles of REST, Architecture of SOAP-Based Services, REST vs. SOAP Based Services, Building and Invoking RESTful Web Services using PHP, Hosting Web Services on Cloud, Introduction to Micro Services.
3. **Angular JS:** Introduction, Directives and Controllers, Forms, Inputs and Services, Server Communication with $http, Filters.
4. **Non-Functional Aspects of the Web:** Performance Considerations - Timeouts, Retries, Handling Server Errors, Multiple Requests, The HTTP 1.1 Two Connection Limit, Race Conditions, Caching on Client Side, Compression of Data, Request Management, Scalability. HTTP 2.0 – New Features, HTTP 2.0 vs 1.1. Security – Web Attack Surfaces, Reconnaissance Review, Various Vulnerabilities and Precautions, SQL Injection, XSS, XST, CSRF, HTTP Authentication and its Configuration in Apache.
5. **Server-side Frameworks:** Overview of Popular Server side Frameworks – Ruby on Rails, CodeIgniter, Django, MEAN.IO. **Node.js**: Basics, Callbacks, HTTP Responses, File and Database Access.

Pre-requisite Courses: UE15CS204 – Web Technologies I.

Reference Book(s):

1. "Professional AJAX", Nicholas C Zakas, Jeremy McPeak, Joe Fawcett, 2nd Edition, Wiley Publishing, 2007.
2. "Angular JS Up and Running", Shyam Sheshadri, Brad Green, O Reilly, 1st Edition, 2014.
3. "AJAX: The Complete Reference", Thomas A Powell, McGraw Hill, 2008.
4. Handouts for Web Sockets, HTTP 2.0 protocol, Node.js.

UE15CS404
TERM PAPER (0-0-0-8-2)

Course Objectives:

The objective(s) of this course is to,

- Build the foundation for a student to take up a career in research.
- Learn how to perform a literature survey and record their findings.
- Communicate his work to a larger audience.
- Learn how to work with a group of researchers.

Course Outcomes:

At the end of the course, the student will be able to:

- Demonstrate how to read and summarize research papers.
- Demonstrate the ability to communicate the literature review in a document.
- Demonstrate capability to work in a team.

UE15CS405
OBJECT ORIENTED PROGRAMMING WITH JAVA (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Learn the basics of Object Oriented Programming.
- Learn how to solve different types of computing problems.
- Understand and develop well-structured programs using Java programming language.

Course Outcomes:

At the end of the course, the student will be able to:

- Appreciate the Object Oriented Programming paradigm.
- Develop solutions to problems in problem domain and map them to solution domain.
- Read, write, understand and modify programs in Java.

Course Content:

1. **Java Fundamentals:** Introduction to Programming in Java, Java Language and Java Platform, Program Structure, Translation Process, Simple I/O, Constants, Variables, Type, Mixed Mode Operation, Primitive Types and Reference Types. **Object Based Programming:** Abstraction, Encapsulation, Composition, Class Attributes, Behaviour, Objects, and Methods. **Interface and Implementation**: Instance Fields and Methods, Initialization of Fields, Role of Constructors and Destructors, Garbage Collector, Parameter Passing, Value Type and Reference Type, Overloading of Methods, Scope. **Control Structures**: Selection – if, switch, Looping – while, for, do while, break and continue, Nested Control Structures.
2. **Recursion. Class Attributes and Behaviour:** Difference between Class Methods and Instance Methods, Necessity to Use Class Methods. **Enumerated Data Type:** Class Containing Fixed Number of Objects. **Programming for Safety:** Assertions, Exception Handling, Exception Propagation, Use and Misuse of Exception Mechanism.
3. **Arrays as Abstract Data Type:** Creation, Initialization, Methods on Arrays, Built-In Methods, Higher Order Arrays, **Strings as Abstract Data Type:** Creation, Initialization, Immutability, String Methods. **Composition and Inheritance: "**has a" and "is a" Relationship, LISKOV's Property of Substitution, When to Use and When Not to Use Inheritance, Super and Sub Classes, Polymorphism, Overriding.
4. **Inheritance (Continued):** Concepts of Single Rooted Hierarchy and Interface, Abstract Class in Programming Languages, Object Class in Java. **Composition**: Flexibility of Composition over Inheritance, Examples of Composition and Inheritance. **Package:** Need of Package Concept, User Defined Package, Introduction to Built-In Packages.
5. **Nested Types:** Need for Type within Type, Different Types of Inner Classes, Anonymous Inner Classes, Callback Mechanism. **Persistence:** Reading from Files, Writing into Files, Concept of Serialization. **Introduction to Generics and Collections:** Generic Programming Concepts, Concept of Generic Box, List Interface, Sort and Search.

Pre-requisite Courses: None.

Reference Book(s):

1. "Core Java Volume I – Fundamentals", Cay S Horstmann, Gary Cornell, 9th Edition, Pearson.
2. "Learning Java", Patrick Niemeyer and Daniel Leuck, 4th Edition, O'Reilly.

UE15CS411: ENTERPRISE RESOURCE PLANNING (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To learn the strategic importance of Enterprise Resource Planning systems in industry
- To learn the basics of ERP, the modules of ERP
- To learn the key selection criteria and implementation issues & risks of ERP
- To be aware of ERP related technologies
- To be aware of commercial ERP software.

Course Outcomes:

At the end of the course, the student will be able to:

- Identify typical functionality of ERP sub-systems.
- Apply criteria to select ERP Package
- Apply criteria to select ERP Consulting Partner
- Systematically develop plans for an ERP Implementation project and
- Identify critical success factors and associated risks.

Course Content:

1. **Introduction to Enterprise Resource Planning Systems:** Introduction, Value Chain Framework, Problems with Disintegrated Data in an Organization, Evolution of ERP Systems, Role of ERP Systems in an Organization, Are ERP Systems Different from Traditional Information Systems?, Scope of ERP Systems, General Model of Business and Role of ERP, Major ERP Players, Implementations in India. **Life Cycle of an ERP Implementation Project:** Introduction, Life Cycle of an ERP Project, ERP Project Teams, Implementation Methodologies, Deployment Methods. **Benefits and Cost of an ERP System:** Introduction, Benefits, Cost of an ERP Implementation, Cost-Benefit Analysis.
2. **Change Management:** Introduction, People Issues: Are You Ready for ERP?, Factors that Influence Pre-implementation Attitude, How to Enhance Attitude?, Change Management Strategies to Handle Organizational Issues, Creating a Change Management Strategy to Handle Organizational Issues, Tools for Assessing the Organizational Changes. **Re-Engineering:** Introduction, Processes and their Characteristics, Life Cycle of a BPR Project, Life Cycle of an IT-driven BPR Project, Re-engineering Examples, Case Studies. **Business Process Modelling and Business Modelling**: BPM Introduction, Business Process Hierarchy, Standards for Business Processes and Modelling, Process Modelling Maturity and Multi-Dimensional Modelling, Process Modelling Software, Business Modelling, Integrated Data Modelling.
3. **ERP Functional Modules: Human Capital Management:** Introduction, Human Capital Management Systems, Leading HR Solutions from ERP Vendors, Strategic Vs. Operational HR Processes and HR Outsourcing, Employee Health and Safety. **Financial Management:** Introduction, ERP Financial Application, Financial Modules in Detail. **Procurement and Inventory Management:** Procurement, Inventory Management. **Production Planning and Execution:** Understanding MRP II Concepts, How ERP PP module supports MRP II Processes, Critical Master Data Elements, Managing different Production Scenarios.
4. **ERP Selection:** Introduction, ERP System Selection Team, ERP Solution and Vendor Selection, Information Gathering, Preliminary Filtering, Parameters for ERP Selection, Prepare and Release Request for Proposal (RFP), Gap Analysis, AHP for ERP Selection. **Managing an ERP Project:** Introduction, Success of an ERP System is Multi-dimensional, Critical Success Factors, Risk Associated with an ERP Project, Measuring Performance of ERP System (using Balanced Scorecard).
5. **ERP and Related Technologies:** Introduction, Electronic Data Interchange (EDI), Supply Chain Management (SCM), Customer Relationship Management (CRM), Product Life Cycle Management (PLM), Data Warehousing, Business Intelligence (DW-BI). **Introduction to Commercial ERP Software**: Introduction, Indian Market, SAP, Oracle, Peoplesoft, JD Edwards, MS Dynamics. Implementations in India; Articles and Cases.

Pre-requisite Courses: None.

Reference Book(s):

1. "Enterprise Resource Planning: A Managerial Perspective", Veena Bansal, Pearson Education India, 2013.
2. "Enterprise Resource Planning- Text & Cases", Rajesh Ray, Tata McGraw Hill, New Delhi, 2011.
3. "ERP Demystified", Alexis Leon, McGraw Hill Education, 3rd Ed, 2014.

UE15CS412: ALGORITHMS FOR INFORMATION RETRIEVAL (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Understand the architecture, models and algorithms used in Information Retrieval.
- Understand the basic principles and implementation of Indexing and Search.
- Understand how web search works.
- Understand the use of machine learning in Information Retrieval.
- Become familiar with applications and latest trends in Information Retrieval.

Course Outcomes:

At the end of the course, the student will be able to:

- Implement an efficient index for a document collection.
- Perform searches on a document collection, rank and evaluate results.
- Implement components of a web search system.
- Apply Machine Learning techniques in Information Retrieval Systems.
- Describe modern applications and research trends in Information Retrieval.

Course Content:

1. **Introduction to Information Retrieval:** Background, Architecture and Strategies of Information Retrieval (IR) Systems, IR Models, Boolean and Extended Boolean Models, Dictionary, Vocabulary, Positional Postings, Phrase Queries and Tolerant Retrieval.
2. **Indexing and Vector Space Model:** Algorithms for Indexing and Index Compression, Vector Space Model for Scoring, tf-idf and Variants, Efficient Scoring and Ranking.
3. **Evaluation of IR / Other IR Models:** Performance Measurement, Relevance Feedback, Query Expansion, Other IR Models.
4. **Web Search:** Web Search Basics, Economic Model of Web Search, Search User Experience, Web Crawling and Indices, Link Analysis, The PageRank Algorithm, Building a Complete Search System.
5. **Applications of IR:** Text Classification and Clustering, Snippet Generation, Summarization, Topic Detection and Tracking, Question Answering, Personalization.

Pre-requisite Courses:

UE15CS251 – Design and Analysis of Algorithms.

Reference Book(s):

1. “Introduction to Information Retrieval”, Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, ISBN: 9781107666399, Cambridge University Press, 2009.
2. “Modern Information Retrieval: The Concepts and Technology behind Search”, Ricardo Baeza -Yates and Berthier Ribeiro – Neto, 2nd Edition, ACM Press Books 2011.
3. “Search Engines: Information Retrieval in Practice”**,** Bruce Croft, Donald Metzler and Trevor Strohman, 1st Edition, Addison Wesley, 2009.
4. “Information Retrieval: Implementing and Evaluating Search Engines”, Stephen Buettcher, Charles L A Clarke and Gordon V Carmack, MIT Press, 2010.

UE15CS413: CONTENT MANAGEMENT (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Learn the basic concepts of a Content Management System (CMS) and its components.
- Learn the architecture of a CMS.
- Learn to design components of a CMS.
- Learn relevant tools and technologies – CML, XML.
- Learn to build Collection systems, Management Systems and Publishing systems.

Course Outcomes:

At the end of the course, the student will be able to:

- Identify the fundamental concepts of a CMS and its components.
- Identify the architecture of a CMS.
- Design components of a CMS.
- Identify and study tools and technologies such as CML and XML.
- Build Collection systems, Management systems and Publishing systems.

Course Content:

1. **What is Content:** Defining Data, Information and Content, Content Format, Structure, Functionality is Content. **What is Content Management**: Understanding Content Management, Introducing the Major Parts of a Content Management System, The Roots and Branches of Content Management.
2. **Logical Design of a CMS:** The Wheel of Content Management, Working with Metadata, Catalog Audiences.
3. Designing Publications, Designing Content Components, Accounting for Authors, Accounting for Acquisition Sources.
4. Designing Content Access structures, Designing Workflow and Staffing Models, Building a Content Management System, Content Markup Languages, XML and Content Management, Processing Content.
5. Explore Commercial CMS and Learn Current Trends in CMS (Implementation), Hands on CMS Implementation, Building Collection Systems, Building Management Systems, Building Publishing Systems.

Pre-requisite Courses: None.

Reference Book(s):

1. “Content Management Bible”, Bob Boiko, Wiley India Ltd, 2005.
2. “Enterprise Content Management”, Stephen A Cameron, BCS, 2012.

UE15CS414: COMPUTER VISION (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To create an awareness of the imaging fundamentals in terms of acquisition, storage and display.
- To gain an insight into the mathematical transforms necessary for binary and gray scale images.
- To study the quality of the image and the enhancement of images in spatial and frequency domains.
- To design and evaluate the methods of mathematical morphology and image segmentation.
- To translate the techniques of gray scale images to 3D/color images.

Course Outcomes:

At the end of the course, the student will be able to:

- Identify typical defects in an image and assess a suitable technique for processing the image to mitigate/ remove the defect and enhance the image.
- Design methods to automatically extract regions of interest from each other and the background either in binary, grayscale or color images.
- Extract the gist of any method in literature for processing of images for a particular application and be able to explain this clearly, extending their learning of concepts such as histogram equalization to local/ adaptive histogram equalization and enhancement techniques in the spatial and frequency domains to block processing of images - realized through seminars in class.
- Assess hardware available for acquisition and viewing of images for advantages and limitations and be able to identify a suitable imaging modality for a given application.
- Implement basic techniques using open source tools and take up a problem, conceptualize the solutions and implement in a programming language of their choice - realized through a hands-on workshop, assignment and class project.
- Application of spatial and frequency domain processing for computer vision.

Course Content:

1. **Introduction to Computer Vision:** A Brief History of Computer Vision, The Digital Camera, Point Operators, Linear Filtering, Neighborhood Operators, Basics of Frequency Domain Processing.
2. **Feature Detection and Matching and Segmentation:** Features - Feature Extraction, Binary Object Features, Histogram Features, Color Features, Spectral Image Features, Corner Detection, Scale Invariance, Projections, Segmentation, Points, Lines, Split and Merge, Mean – Shift.
3. **Computational Photography:** Photometric Calibration, High Dynamic Range Imaging, Super Resolution and Blur Removal, Basics of Image Matting and Texture Analysis.
4. **Stereo and 3D Reconstruction**: Stereo - An Introduction, Epipolar Geometry, Sparse and Dense Correspondence, Local Methods, Feature Tracking and Optical Flow.
5. **Recognition:** Object Detection, Face Recognition, Category Recognition, Context and Scene Understanding.

Pre-requisite Courses: None.

Reference Book(s):

1. “Computer Vision: Algorithms and Applications”, Richard Szeliski, 2nd Edition, Springer, 2010.
2. “Computer Vision – A Modern Approach”, Forsythe and Ponce, 2nd Edition, Pearson, 2011.

3. “Dictionary of Computer Vision and Image Processing”, R. B. Fisher, T. P. Breckon, K. Dawson-Howe, A. Fitzgibbon, C. Robertson, E. Trucco, C. K. I. Williams. Chichester, West Sussex : John Wiley & Sons Inc., 2014.

UE15CS415: ADVANCED MACHINE LEARNING (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To impart hands-on knowledge on Advanced Machine Learning Topics.
- Introduce students to programming with TensorFlow and Keras tools.
- Provide in-depth coverage of Support Vector Machines.
- Introduce students to Deep Learning techniques – CNN and RNN.
- Introduce students to Reinforcement Learning and Generative Adversarial Networks.

Course Outcomes:

At the end of the course, the student will be able to:

- Implement Machine Learning techniques with TensorFlow and Keras.
- Solve time-series related problems with RNN.
- Classify real-world data using Support Vector Machines.
- Classify images using CNN.
- Generate data in the form of images using GAN.
- Develop simple game engines using Reinforcement Learning.

Course Content:

1. **TensorFlow and Keras and Reinforcement Learning**: Brief overview of Deep Learning Frameworks. **TensorFlow**: Installation, Creating and Managing Graphs, Lifecycle of a Node Value, Linear Regression, Gradient Descent, Visualizing Graphs using TensorBoard. **Keras**: Installation, Loading Data, Defining and Compiling Models, Fitting and Evaluating Models, Simple Neural Networks’ Implementation, Fine-Tuning Hyperparameters. **Reinforcement Learning**: Learning to Optimize Rewards, Credit Assignment Problem, Temporal Difference Learning and Q-Learning. **Case Study:** Learning to play a simple game using deep Q-learning - implementation.
2. **Support Vector Machines:** A Very Brief Recap of the Support Vector Machine (SVM) Problem, Soft-Margin SVM (Noisy Data), Kernel Functions – Linear, Polynomial, Gaussian, Other Types, The SMO Algorithm, Multi-Class SVMs, Text-Classification, Building Applications.
3. **Recurrent Neural Networks (RNN) and Unsupervised Feature Learning:** Recurrent Neurons, Memory Cells, Static and Dynamic Unrolling through Time, Variable-Length Input-Output Sequences, Training RNNs – Sequence Classifier, Predicting Time Series, Deep RNNs, LSTM Cell and GRU Cell, Text Classification with RNN, RNN Vs Naïve Bayes, Unsupervised Feature Learning – Autoencoders and Variations.
4. **CNN, GAN and Transfer Learning: CNN -** Architecture of CNNs, Filters, Feature Maps, Max-Pool Layers, Other Pooling Types, Case Study: Image Recognition Using CNN – Hands-On Implementation Using Keras. **GAN** - Architecture and Training Methods, Image-Generation, Hands-On Implementation Using Keras. **Transfer Learning** - Motivation, Variations, Use in CNNs.
5. **Paper Review and Implementation:** Selection of two state-of-the-art papers (recent) on deep learning, in depth study of the papers in class and their implementation.

   NOTE: Unit 5 will be part of End-semester Assessment. Questions will be asked on the chosen papers.

Pre-requisite Courses: UE15CS353 – Machine Learning.

Reference Book(s):

1. “Hands-on Machine Learning with Scikit-Learn and TensorFlow”, Aurelien Geron, First Edition, O’REILLY, 2017.
2. “Deep Learning with Keras”, Antonio Gulli and Sujit Pal, Packt Publishing, First Edition, 2017.
3. “Pattern Recognition and Machine Learning”, Christopher Bishop, First Edition, Springer, 2011 (Reprint).
4. Handouts for SVM, Transfer Learning.

UE15CS416: WIRELESS NETWORK COMMUNICATIONS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To provide an overview of Wireless Communication networks area and its applications in communication engineering.
- To appreciate the contribution of Wireless Communication networks to overall technological growth.
- To understand the various terminology, principles, devices, schemes, concepts, algorithms and different methodologies used in Wireless Communication Networks.

Course Outcomes:

At the end of the course, the student will be able to:

- Understand the cellular system design and technical challenges.
- Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling.
- Analyze the design parameters, link design, smart antenna, beam forming and MIMO systems.
- Analyze Multiuser Systems, CDMA, WCDMA network planning and OFDM Concepts.
- Summarize the principles and applications of wireless systems and standards

Course Content:

1. **Overview of Wireless communication:** Cellular Phone Standards, Cellular Evaluation, Wireless Local Loop (WLL) and LMDS, Wireless Local Area Networks (WLANs), Bluetooth and Personal Area Networks (PANs), Overview of WLAN standards (802.1g/n/ac/ad) and channel management. Handover in WLAN network.
2. **Overview of Wireless Communication-II:** Wifi, Wimax (IEEE 806.16a), IoT Wireless -Topologies, Zigbee Wireless Networks and Transceivers, NFC, 6LoWPAN, Tradeoff between Battery, Bandwidth and Distance. **Wireless Channel Models:** Path Loss and Shadowing Models, Millimeter Wave Propagation, Statistical Fading Models, Narrowband Fading, Wideband Fading Models.
3. Design of WLAN in public place e.g. Cafes, hotels, Railway Stations, Airports. **Impact of Fading and ISI on Wireless Performance:** Capacity of Wireless Channels, Digital Modulation and its Performance. **Overview of SOHO Internet Technologies:** DSL, PON, Cable and Satellite.
4. Adaptive Modulation, Multiple Input/ Output Systems (MIMO).
5. **ISI Countermeasures:** Multicarrier Systems and OFDM, Multiuser and Cellular Systems.

Pre-requisite Courses: UE15CS301 – Computer Networks.

Reference Book(s):

1. “Wireless Communication”, Andrea Goldsmith, First Edition, Cambridge University Press.
2. “Fundamentals of Wireless Communication”, David Tse, Pramod Viswanath, First Edition, Cambridge University Press.
3. “Advanced Wireless Communication and Internet: Future Evolving Technologies”, Savo G Glisic, Third Edition, Wiley.

UE15CS421: INFORMATION SECURITY (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Learn the challenges and pitfalls of Software Development and Secure Programming, across the Web, Mobile Devices and IoT.
- Learn the possible attacks and available remedies.
- Learn about security design and testing best practices.

Course Outcomes:

At the end of the course, the student will be able to:

- Understand the security limitations of commonly used Operating Systems, Browsers and Mobile Operating Systems.
- Understand the security limitations of popular programming languages.
- Understand the common security pitfalls in various application development approaches, platforms and how to avoid them.
- Learn how to use some common security testing strategies and Penetration Testing.

Course Content:

1. **Introduction:** Software Threats and Vulnerabilities, OWASP Top 10, SANS Top 25, CVE, etc. Various Type of Attacks like Brute-Force Attacks, DDOS, Phishing, Credentials Misuse, Malware, etc. Significance/ Importance of Secure Coding, Secure Coding Terminology, Secure Coding Principles, Threat Modeling, Secure Coding Resources (Both online and offline).
2. **Secure Software Development and Programming:** Common Operating Systems and Their Security Limitations, Common Programming Languages and Their Security Limitations, Secure Application Development, Database Security, Ransomware, Virus, Malicious Code, Testing and Prevention, Best Practices.
   - **2.1.** C++ Catastrophe, Calls to Delete, Constructors, Lack of Reinitialization, Ignorance of STL, Pointer Initialization, Testing Techniques and Defensive Measures. Catching Exceptions - Overview, Structured Exception Handling, Signal Handling, Failure to Handle Errors Correctly, Yielding Too Much Information, Ignoring Errors, Misinterpreting Errors, Using Useless Return Values, Using Non-Error Return Values. Platform Security - Code Integrity and Code Signing, Secure Boot, Measured Boot and Root of Trust, Security threats from peripherals, e.g., DMA, IOMMU.
   - **2.2.** Vulnerabilities and Exploits like Buffer Overflows, SQL Injection, Insecure Direct Object References, Security Misconfiguration, Sensitive Data Exposure.
3. **Web Application Security Issues:** Challenges, Browser Security, SQL Injection, Cross-Site Scripting, Cross-Site Request Forgery, Session Hijacking, TLS Stripping, Cross-Site Scripting (XSS), Broken Authentication and Session Management.
   - **3.1.** HTTP Security: Overview of HTTP Security, MITM Attacks and Solutions, HTTP Security Headers: CSP (Content-Security-Policy), HSTS (HTTP Strick Transport Security), HPKP (HTTP Protocol Key Pining), X-Frame-Options, X-XSS-Protection, X-Content-Type-options, CORS (Cross Origin Resource Sharing), HTTP/ 2 and Security Challenges, HTTP Security Considerations - Transfer of Sensitive Information and Its Encoding, Privacy Issues and HTTP Authentication.
   - **3.2.** Executing Code with Too Much Privilege, Examples and Defensive Measures, Failure to Protect Stored Data, Weak Access Controls on Stored Data, Weak Encryption of Stored Data, Use of Weak Password-Based Systems, Password Compromise Password, Change Policies, Password Failure Error Display Policies, Retrieval of Forgotten Passwords, Default Passwords and Replay Attacks, Storing Passwords and Alternatives, Password Verifiers Zero Knowledge, Brute-Force Attacks Against Password Verifiers.
4. **Mobile Application Security** - Android and iOS Security, App Security, Secure Boot, Data Exfiltration, Cloud and IoT Application Security.
5. **Countermeasures - Tools, Frameworks, and Services:** Secure Coding Standards, Secure Coding Best Practices/ Patterns, Intercepting Validators, Sanitization, Session Management, Authentication, Encryption, Password Management, Access Control, Error Handling and Logging, File Management, Memory Management, Microsoft Secure Development Process (SDP), Static Analysis Tools, Dynamic Analysis Tools, Web Application Security Frameworks, Java-Based Enterprise Application Security Frameworks, Outsourcing, Vulnerability Tracking.

Pre-requisite Courses: None.

Reference Book(s):

1. "Computer Security – Principles and Practice", Third Edition, William Stallings. Chapters 1, 3, 4, 5, 6, 10, 11, 12, 13, 18, 19, 25, 26.

UE15CS422: WEB SERVICES (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To provide a brief introduction to Service Oriented Architecture.
- To provide a comprehensive introduction to Web Services.
- To impart techniques on building RESTful and SOAP-based Services.
- To educate the student on the security aspects of Web Services.

Course Outcomes:

At the end of the course, the student will be able to:

- Build RESTful Web Services
- Build SOAP based Web Services
- Design RESTful APIs
- Demonstrate basic security mechanisms in Web Services.
- Invoke RESTful and SOAP-based Web Services.

Course Content:

1. **Introduction:** Web Services and SOA, Overview of HTTP, REST.
2. **RESTful Web Services - The Service Side:** RESTful Service as an HTTP Servlet, as a JAX-RS Resource, Generating XML and JSON Responses, Restlet Resources, WebService Provider.
3. **RESTful Web Services - The Client Side:** Clients against Amazon E-Commerce Service, RESTful Clients and WADL Documents, JAX-RS Client API, JSON for Javascript Clients, JSONP and Web Services, jQuery, AJAX Polling.
4. **SOAP-Based Web Services:** SOAP-Based Services, Java Clients, WSDL Service Contract, SOAP-Based Clients against Amazon E-Commerce Services, Asynchronous Clients.
5. **Web Services Security:** Wire-Level Security - Service and Client-Side, HTTPS – Encryption, Decryption, Handshake, etc. in Detail, Container-Managed Security, WS-Security.

Pre-requisite Courses: UE15CS204 – Web Technologies I.

Reference Book(s):

1. "Web Services Up and Running", Martin Kalin, 2nd Edition, O Reilly, 2013.

UE15CS423: ALGORITHMS FOR INTELLIGENT WEB (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To get an understanding of search algorithms.
- To learn recommendation algorithms and their working.

- To get an insight into clustering algorithms.
- To introduce classification algorithms and their use in today's applications.
- To get an idea of different web applications.

Course Outcomes:

At the end of the course, the student will be able to:

- Analyze different search algorithms and make comparison
- Suggest different recommendation algorithms
- Implement various clustering algorithms
- Analyse different intelligent applications
- Effectively use classification algorithms

Course Content:

1. **Introduction and Search Algorithms:** Introduction to Web and Intelligent Web Applications, Examples of Intelligent Web Applications, Intro to AI and Machine Learning, Intro to Search and Information Retrieval, Lucene as a Search Engine, Improving Search Results, Link Analysis and PageRank, Other Search Algorithms, Scalability Issues in Search.
2. **Recommendation Algorithms:** Distance and Similarity, Distance and Similarity, Recommendation algorithms, Types of Recommendations, Workings of Sample Systems, Workings of Sample Systems, Data Normalization and Correlation Coefficients.
3. **Clustering Algorithms:** Introduction to Clustering, Grouping in SQL, Clustering Algorithms, Types of Clustering Algorithms, Example Algorithms, Example Algorithms, Applications of Clustering, Scalability Issues in Clustering.
4. **Classification Algorithms:** Classification Theory, Category Lists, Taxonomy, Folksonomy and Ontology, Classification by Tagging, Automatic Classification and Routing, Types of Classification Algorithms, Hybrid Classifiers, Sample Applications, Practical Issues in Classification.
5. **Intelligent Web Applications:** Design of an Intelligent Web Application, User Requirements, Selecting Algorithms, Data Design, Design for Performance, Architecture of an Intelligent Web Application, Implementation Issues, Summary and Conclusion.

Pre-requisite Courses: UE15CS251 – Design and Analysis of Algorithms.

Reference Book(s):

1. "Algorithms of the Intelligent Web", Haralambos Marmanis, Dmitry Babenko, Manning Publishers, 2011.

UE15CS424: SOCIAL NETWORK ANALYTICS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Provide students background on concept of various types and kinds of Social Networks, their structural properties and related measures
- Train students to observe and measure unique aspects of network formation and growth of social networks
- Enable students to understand social phenomena such as diffusion and cascades.
- Expose students to Strategic Networks, the incentive model for connection formation
- Expose students to Game theory and Games on Networks, concepts related to strategies and optimality

Course Outcomes:

At the end of the course, the student will be able to:

- Model a given scenario/problem as a network, evaluate the type and kind of such a network and measure structural properties of that network.
- Apply algorithms to detect communities and decipher phenomena peculiar to social networks such as small worlds and power laws
- Model a social process such as spread of information and diseases using diffusion model.
- Model and analyze strategic networks and measure network properties.
- Apply Social Network Analysis concepts to variety of real world scenarios by modeling them as games.

Course Content:

1. **Background and Fundamentals of network analysis:** Introduction to Networks and Examples, Ego-centric Networks, Exchange Networks, Graph-Theory, Directions and Weights, Adjacency Matrices, homophily, Tie-strengths and structural holes**.** Representing and Measuring Networks: Degree distribution, diameters, path-lengths, centrality, closures, clustering
2. **Models of Network formation:** Random Networks, Small World, Growing Random Networks, Growth Models, Distribution of expected degrees, Preferential attachment, Fat tails, Power Laws, Fat Tails, Scale-free networks, Affiliation Networks, Cliques and Cores, Cohesion, Communities and Community Detection Algorithms
3. **Implications of Network Structure:** Diffusion through Networks: -The Bass Model, Diffusion in Random networks, Giant Components, Models to study disease and information spreads, Cascades and Contagions, Assortativity, Percolation and Robustness of Networks, Effects of communities and centralities on diffusion
4. **Strategic Networks:** Economic Game Theoretic Models of Network Formation, Connections Model, Pair-wise Stability, Efficient and Pareto-efficient networks, Externalities and Co-author Models, Pair-wise Nash Stability, Complements and Substitutes.
5. **Games on Networks:** Introduction to Games, Reasoning about behavior in a Game, Prisoner's Dilemma, Best response and Dominant Strategies, Nash Equilibrium, Multiple equilibriums: Co-ordination Games, Hawk-Dove Game, Mixed Strategies, Pareto Optimality and Social Optimality**.**

Pre-requisite Courses: UE15CS353 – Machine Learning.

Reference Book(s):

1. "Introduction to Social Network Methods", Robert A Hanneman, University of California Riverside, 2005.
2. "Social and Economic Networks", Mathew O Jackson, Princeton University Press, 2008.
3. "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", D Easley and J Kleinberg, Cambridge University Press, 2010.

UE15CS425: COMPUTER SYSTEMS PERFORMANCE ANALYSIS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Provide students background on the art of system performance evaluation

- Train students to observe workload, workloads selection
- Enable students to understand capacity planning and benchmarking
- Expose students to get hands on experimental analysis and design
- Expose students to different queuing models

Course Outcomes:

At the end of the course, the student will be able to:

- Model a given scenario for analysing the performance evaluation of the system
- apply workload and workload selection criteria for different scenarios
- Model execution monitors and accounting logs
- Model and analyze capacity planning and benchmarking
- Apply queuing models for different scenarios for predicting the performance

Course Content:

1. **Introduction:** The Art of Performance Evaluation, Common Mistakes in Performance Evaluation, A Systematic Approach to Performance Evaluation, Selecting an Evaluation Technique, Selecting Performance Metrics, commonly used Performance Metrics, Utility Classification of Performance Metrics, Setting Performance Requirements.
2. **Workloads, Workload Selection and Characterization:** Types of Workloads, Addition Instructions, Instruction Mixes, Kernels, Synthetic Programs, Application Benchmarks, Popular Benchmarks, Workload Selection - Services Exercised, Level of Detail, Representativeness, Timeliness, Other Considerations in Workload Selection, Workload Characterization Techniques – Terminology, Averaging, Specifying Dispersion, Single Parameter Histograms, Multi Parameter Histograms, Principle Component Analysis, Markov Models, Clustering.
3. **Monitors, Program Execution Monitors and Accounting Logs:** Monitors - Terminology and Classification, Software and Hardware Monitors, Software versus Hardware Monitors, Firmware and Hybrid Monitors, Distributed System Monitors, Program Execution Monitors and Accounting Logs, Program Execution Monitors, Techniques for Improving Program Performance, Accounting Logs, Analysis and Interpretation of Accounting Log Data, Using Accounting Logs to Answer Commonly Asked Questions.
4. **Capacity Planning and Benchmarking:** Steps in Capacity Planning and Management, Problems in Capacity Planning, Common Mistakes in Benchmarking, Benchmarking Games, Load Drivers, Remote-Terminal Emulation, Components of an RTE, Limitations of RTEs.
5. **Experimental Design and Analysis:** Introduction - Terminology, Common Mistakes in Experiments, Types of Experimental Designs, 2k Factorial Designs, Concepts, Computation of Effects, Sign Table Method for Computing Effects, Allocation of Variance, General 2k Factorial Designs, General Full Factorial Designs with k Factors - Model, Analysis of a General Design, Informal Methods.
6. **Queuing Models:** Introduction - Queuing Notation, Rules for all Queues, Little’s Law, Types of Stochastic Process. Analysis of Single Queue - Birth-Death Processes, M/M/1 Queue, M/M/m Queue, M/M/m/B Queue with Finite Buffers, Results for Other M/M/1 Queuing Systems.

Pre-requisite Courses: UE15CS253 – Microprocessor and Computer Architecture.

Reference Book(s):

1. “The Art of Computer Systems Performance Analysis”, Raj Jain, John Wiley and Sons, 2007.
2. “Computer System s Performance Evaluation and Prediction”, Paul J Fortier, Howard E Michel, Elsevier, 2003.
3. “Probability and Statistics with Reliability, Queuing and Computer Science Applications”, Trivedi K S, 2nd Edition, Wiley India, 2001.

UE15CS426:
DESIGN PATTERNS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To impart design principles beyond coding.
- To inculcate good habits in design.
- To make the participants appreciate what to do and what not to do.
- To compare alternate design solutions.
- To appreciate the intricacies of design.

Course Outcomes:

At the end of the course, the student will be able to:

- Separate the interface from implementation in any complex problem.
- Identify the contexts where design patterns can be applied.
- Select where idioms can be applied as opposed to design patterns.
- Identify where not to apply design patterns.
- Reliably refactor a large piece of software.

Course Content:

1. **Design Principle:** Interface and Implementation, Open Closed Principle, Liskov Substitution Principle, Dependency Inversion Principle, Integration Segregation Principle. **Architectural and Package Principles.**
2. **Idioms:** Handle Body Idiom (PIMPL), Reference Counting, Named Constructor Idiom, Telescoping Constructor, Bean Pattern for Construction, Destruction Idiom.
3. **Design Patterns:** GOF Patterns, Constructional Patterns, Structural Patterns, Behavioral Patterns.
4. **Patterns:** Beyond GOF, Persistence, Multi-threading.
5. **Introduction to Anti-patterns and Refactoring.**

Pre-requisite Courses: UE15CS251 – Design and Analysis of Algorithms.

Reference Book(s):

1. “Design Principles and Design Patterns”, Robert C Martin, 2000.
2. “Design Patterns: Elements of Reusable Object-Oriented Software”, Gamma et al, Addison Wesley, 1994
3. “Java Design Patterns”, James W Cooper, Addison Wesley, 2000.
4. “AntiPatterns - The Survival Guide to Software Development Processes”, Alexander Shvets, Online Reference at http://bit.ly/2e4nxzd).

UE15CS427:
AUTONOMOUS MOBILE ROBOTICS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To enable the students to have hands-on experience with mobile robots
- To understand the physics of motion
- To write program to operate mobile robots

- To use mobile robots for accomplishing high level tasks
- To enrich the mobile robotics applications to serve the society

Course Outcomes:

At the end of the course, the student will be able to:

- Operate mobile robots autonomously or/and semi-autonomously
- Write programs to guide the paths of mobile robots
- Perform assigned tasks using mobile robots
- Apply the fundaments of mobile robotics for their projects
- Innovate workable ideas to address the challenging problems in the society.

Course Content:

1. **Introduction and Locomotion:** Introduction to mobile robots (MR), Applications, Key issues in locomotion, Legged mobile robots, Wheeled mobile robots
2. **Kinematics:** MR kinematic models, MR constraints, MR maneuverability, MR workspace, MR control basics
3. **Perception:** Sensor for MR, Representing uncertainty, Error propagation, Feature extraction – range data, Feature extraction – vision
4. **Localization:** Challenges in localization, Map representation, Map-based localization, Other localization methods, Automatic map building
5. **Planning and Navigation:** Path planning, Obstacle avoidance, Navigation architectures, Control localization, Techniques for localizations

Pre-requisite Courses: None.

Reference Book(s):

1. "Introduction to Autonomous Mobile Robots", Roland Siegwart, Illah Nourbakhsh, The MIT press 2004 (eBook is freely available).
2. "Mobile Robotics: Mathematics, Models, and Methods", Alonzo kelly, Cambridge University Press, 2013.
3. "Robot Programming: A Practical Guide to Behavior-Based Robotics", Joe Jones, Daniel Roth, McGraw-Hill Education TAB; 1st Edition, 2004.

UE15CS452:
INTRODUCTION TO SOFTWARE TESTING (2-0-0-0-2)

Course Objectives:

The objective(s) of this course is to,

- Introduce the concepts of Software Quality and types of testing.
- Familiarize with different levels of testing.
- Understand the challenges in test management, test automation.
- Introduction to software testing tools.
- Understand the advances in testing field like cloud and mobile testing.

Course Outcomes:

At the end of the course, the student will be able to:

- Apply the concepts of Quality Engineering.
- Apply proper testing techniques at different phases of development.
- Understand cost of quality.
- Plan, employ and measure proper Quality approaches applied.
- Gain hands-on exposure to few testing tools.

Course Content:

1. **Introduction to Software Quality and Testing:** Introduction to Software Quality - Importance, Philosophy and Concepts, Quality Management, Cost of Quality, SQA, Verification and Validation, Importance of Testing in SDLC and Other New Methods of Software Development Like Agile, SCRUM, etc., Test Lifecycle and Tools and Techniques for Test Life cycle, Modified V Model for Testing Requirements in a Project, Classification of Testing Types Based on Method/ Requirement /Target /Needs, Test Design and Planning.
2. **Unit Testing:** Definition, Test Planning, Methodology, Code Coverage Testing. **White Box Testing:** Definition. **Integration Testing:** Overview, Top-Down Integration, Bottom-Up Integration, System Integration, Scenario Testing. **Black Box Testing:** Definition and Overview, Test Case Design Techniques for Black Box Testing - Specification Based Test Design and Requirements Traceability Matrix, Positive and Negative Testing, Equivalence Partitioning, Boundary Value Analysis, Decision Tables, Advantages and Disadvantages.
3. **System Testing:** Definition, Reason and Overview, Test Case Generation, Static Testing – Manual, Tool Based, Structural Testing – Code Complexity Testing, Advantages and Disadvantages. **Acceptance and Use-Case Testing:** Overview, Types - User Acceptance Testing, Alpha and Beta Testing, Business Vertical, Deployment Testing and Smoke/ Sanity Testing.
4. **Functional System Testing**: Types - Design Verification, Business Vertical, Deployment Testing and Smoke/ Sanity Testing. **Non-Functional Testing:** NFT Overview, Scalability, Reliability and Stress Testing, Performance Testing Overview, Methodology for Performance Testing. **Regression Testing:** Definition, Types of Regression Testing, When and How To Do Regression Testing.
5. **Test Management and Testing Metrics:** Introduction to Test Infrastructure Management, Testing Metrics Overview, Types of Metrics – Project, Progress and Productivity Metrics. **Automated Testing, Defect management:** Overview, Scope of Automation, Design and Architecture of Test Automation Framework, Selecting Testing Tool, Functional Testing Automation Demo / Hands-On, Defect Management, Defect Tracking Tools, Advances in Testing - Virtualization of Test Environments, Cloud Based Testing and Model Based Testing.

Pre-requisite Courses: None.

Reference Book(s):

1. "Software Testing – Principles and Practices", Srinivasan Desikan and Gopalaswamy Ramesh, Pearson, 2006.
2. "Foundations of Software Testing", Aditya Mathur, Pearson, 2008.
3. "Software Testing, A Craftsman's Approach", Paul C Jorgensen, Auerbach, 2008.

UE15CS453:
INTRODUCTION TO BUSINESS (2-0-0-0-2)

Course Objectives:

The objective(s) of this course is to,

- Understand the different types of business ownership.
- Understand how a modern business organization works.
- Understand the importance of marketing and the activities involved in it.
- Understand how a business organization is run and managed.
- Understand the activities required to set up a start-up company.

Course Outcomes:

At the end of the course, the student will be able to:

- Describe the various legal forms of business ownership.
- Explain the functions and working of a business organization.
- Describe the processes involved in product/ services strategy.
- Explain the role of management in a business organization.
- Explain the factors that can make a start-up company successful.

Course Content:

1. **Introduction to Business and Its Terminologies:** Historical Context of How Businesses Evolved into their Present Forms, Family Businesses, Forms of Ownership (Proprietorship, Partnerships and Corporations).
2. **Entrepreneurship and Start-ups: Entrepreneurship** - Meaning, Evolution and Development, Functions of an Entrepreneur. **Start-Ups -** Evolution of Startups, Important Factors In Startups - Idea, Team, Business Model, Funding Options, Timing, Startup Culture, Startup Ecosystems, Startup Environment in India, Case Studies of Successes and Failures.
3. **Business Functions:** Typical Functions of Any Business Organization - Production, Finance, Accounting, Human Resource Management, Research and Development, Sales and Marketing, Importance and Management Aspects of All Functions. Business Reporting - Balance Sheets and Profit/ Loss Accounts and Modern Methods of Business Reporting.
4. **Sales and Marketing:** The Activities for Creating, Communicating, Delivering and Exchanging Offerings That Have Value for Customers, Clients, Partners and Society At Large, Marketing is Used To Create the Customer, To Keep the Customer and To Satisfy the Customer, How To Tailor a Product or Service To A Target Market, Digital Marketing and Its Effect On the Traditional Marketing Methods.
5. **Management:** Setting the Strategy of an Organization and Coordinating the Efforts of its Employees to Accomplish its Objectives Through the Application of Available Resources such as Financial, Natural, Technological and Human Resources.

Pre-requisite Courses: None.

Reference Book(s):

1. "Introduction to Business", Student Edition (McGraw Hill), https://www.amazon.com/Introduction-Business-Student-BROWN-BUSINESS/dp/0078747686
2. "Entrepreneurship Simplified (From Idea to IPO)", Ashok Soota and SR Gopalan, Penguin Random House India, 2016, https://www.flipkart.com/entrepreneurship-simplified-idea-ipo/p/itmemhky2qrg7zqn?pid=9780670088959
3. The single biggest reason why startups succeed | Bill Gross (TED Talk) https://www.youtube.com/watch?v=bNpx7gpSqbY

UE15CS454: RESEARCH METHODOLOGY (2-0-0-0-2)

Course Objectives:

The objective(s) of this course is to,

- Define research and identify the systematic steps to be followed.
- Identify the overall process of designing a research study from inception to its report.
- Impart familiarity with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.

Course Outcomes:

At the end of the course, the student will be able to:

- Understand some basic concepts of research and its methodologies.
- Identify appropriate research topics.
- Select and define appropriate research problem and parameters.
- Prepare a project proposal (to undertake a project).

Course Content:

1. **An Introduction:** Meaning, Objectives and Characteristics of Research, Research Methods Vs. Methodology, Types of Research, Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical, Research process, Criteria of Good Research.
2. **Research Design:** Research Design and Methods, Research Design, Basic Principles - Need of Research Design, Features of Good Design, Important Concepts Relating to Research Design.
3. **Sampling design:** Steps in Sampling Design, Characteristics of a Good Sample Design, Types of Sample Designs, Methods of Data Collection - Collection of Primary Data, Observation Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Difference between Questionnaires and Schedules, Collection of Secondary Data.
4. **Testing of Hypotheses:** Basic Concepts, Procedure for Hypotheses Testing, Flow Diagram for Hypotheses Testing, Important Parametric Test - Chi-Square Test.
5. **Interpretation and Report Writing:** Techniques of Interpretation, Structure and Components of Scientific Reports, Different Steps in the Preparation, Layout, Structure and Language of the Report, Illustrations and Tables, Types of Report, Technical Reports and Thesis.

Pre-requisite Courses: None.

Reference Book(s):

1. "Research Methodology: Methods and Techniques", C R Kothari, Gourav Garg, New Age International Publishers, 3rd Edition, 2014.
2. "Research Methods for Engineers", David V Thiel, Cambridge University Press, 2014.

UE15CS455: TECHNICAL WRITING (2-0-0-0-2)

Course Objectives:

The objective(s) of this course is to,

- Introduce fundamental concepts of technical documents.
- Teach about different types of documentation required – Technical Manuals, User Manuals and Support/ Maintenance Manuals.
- Introduce technologies related to editing – Online Help, In-app help, etc.
- Introduce the art of making effective presentations.

Course Outcomes:

At the end of the course, the student will be able to:

- Perform comprehensive editing, copyediting and proofreading.
- Revise documents for tone, clarity, conciseness and continuity.
- Use technologies related to editing.
- Build on-line and in-app help facilities.

M.TECH IN COMPUTER SCIENCE AND ENGINEERING

Program Educational Objectives:

1. Train and prepare students to be computer science and engineering professions, strong and sound in fundamentals of science and engineering that facilitates innovative skills and strategies to help solve problems of industry and society
2. Prepare students to be conversant in hands-on software design and development skills on a sustained manner
3. Prepare graduates to pursue professional ethics in all their endeavors, adapt well to perform their roles as an individual, team-member, leader and possess good communicative skills that help foster sound inter-personal relationships in their engagement in industry and society

4. To inculcate and engage in research in the field of computer science and engineering field that facilitate publications, promote consulting and industry partnerships
5. To prepare students secure befitting placements in industries, be competent globally both as employees and entrepreneurs

Program Outcomes:

1. **Scholarship of Knowledge** : To acquire in depth knowledge in the field of Computer Science & Engineering with specialization in Cloud Computing, Big data and IOT, Cyber security and apply the same in the design and development of Software and Hardware Systems
2. **Critical Thinking:** Analyze complex problems in Computer Science & Engineering and its associated domains; analyze alternative designs for tradeoffs between various design factors such as power, performance and accuracy.
3. **Problem Solving:** Identify, formulate and critically study the problem, understand the interplay between theory and practice, design and develop efficient algorithms, conduct experiments, analyzing the results and applying the knowledge to different domains by considering social, environmental, economic, and security constraints.
4. **Research Skill :**Critically analyze existing literature in an area of specialization, conduct investigative research to develop innovative methodologies to tackle issues identified and contribute to the development of technological knowledge and intellectual property
5. **Modern Tool Usage:** Apply current techniques, skills and modern computing tools to build and analyze robust, reliable, maintainable, scalable and efficient computing systems
6. **Collaborative and Multidisciplinary work:** Enhance skills and continuously acquire advanced knowledge in Computer Science and Engineering, multidisciplinary and interdisciplinary domains for professional excellence
7. **Project Management and Finance:** Manage and execute complex software engineering projects under economic, time and performance constraints both working in teams and in an individual capacity
8. **Communication**: Contribute and communicate effectively with the society confidently, be able to write effective reports and design documents by adhering to the appropriate standards, make effective presentations, give and receive clear instructions
9. **Life-long Learning**: Engage in lifelong learning with persistent scientific temper for professional advancement and effective communication of the technical information
10. **Ethical Practices and Social Responsibility:** Become a complete professional with high integrity and ethics, with excellent professional conduct and with empathy towards the environmental and contribute to the community for sustainable development of society
11. **Independent and Reflective Learning:** Critically evaluate the outcomes of one's actions and apply self-corrective measures to improve the performance

UE18CS501: COMPUTER SYSTEMS FOR PROGRAMMERS (4-0-0-0-4)

Course Objectives:

- This course introduces the hardware-interface of a program in modern processor architectures.
- This course provides an end - to - end picture in sufficient advanced detail of software and hardware components.

Course outcomes:

At the end of the course the student will be able to

- Trace the execution of a program with respect to modern processor architecture fundamentals.
- Write and debug complex programs.

Course Content:

1. **Introduction to computer systems:** compilation system, processor functioning, caches, storage devices, networks, information storage, number representations. Machine level representation of programs.
2. **Processor architecture:** Instruction set architecture logic design, clocking, pipelining, data hazards, exception handling, Simulators.
3. **Memory Hierarchy:** storage technologies, locality of reference, cache memories. Impact of caches on program performance.
4. **Linking:** compiler drivers, static linking, object files, relocatable object files, symbol tables, symbol resolution, relocation, dynamic linking, shared libraries, loading executable object files, position independent code.
5. **Virtual Memory:** page tables, locality, Address translation, memory mapping, Dynamic memory allocation, Garbage collection, Common memory related bugs.

Prerequisite Courses: None

Reference Books:

1. "Computer Systems: A Programmer's Perspective", Randal Bryant and David O' Halloran, Prentice Hall, 2nd Edition, 2011.
2. Computer Architecture: A Quantitative Approach", Hennessey and Patterson, MK publishers, 5th Edition,2011.

UE18CS502: ADVANCED DATA STRUCTURES (4-0-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Analyze the impact of data structures on algorithms, program design and program performance.
- Understand and apply amortized analysis on data structures, including binary search trees, mergable heaps, and disjoint sets.
- Analyze the applications of static and dynamic trees.
- Design, implement, and use advanced ADTs.
- Analyze state space search techniques like PERT-CPM.

Course Outcomes:

At the end of the course the student will be able to

- Demonstrate the notion of Abstract Data Types (ADT) & Recursive access on them.
- Illustrate the relation between Data Structure operations and Amortized Complexity analysis.
- How to Analyze Iterated Lists and variations thereof.
- Demonstrate tree data structures and how to balance them, for specific access needs.
- Analyze graph representations, Event modeling, Spatial and Temporal relational data

Course Content:

1. **Review of Complexity notations- Amortized Analysis, Review of Abstract Data Types:** concept of interface and implementation, Array as an ADT: Different implementations of Array Implementation. List Data Structure – List Interface& List implementations, Concept of Iterator: Operations on Lists and Arrays – traverse, search, replace, reverse, copy.

2. **List variations:** Stack, Queue, Doubly Ended Queue, Doubly Linked List, skip list, interface and implementation, Multilist: sparse matrices, Binary Counters (Stepanov).
3. **Trees:** Interface and implementation, General purpose tree, binary tree: binary search trees, red-black trees, AVL trees, B trees, B+ trees, B* trees, Prefix and Suffix trees, 2-3 trees, Splay trees.
    - **Heap**: external sorting by merging, priority queue, Binomial heaps, Leftist heaps, Skewed heaps, Fibonacci heaps, Graphs-interface and implementation, adjacency matrix, adjacency list, incidence matrix traversal spanning tree connectivity, isomorphism
4. **Combination of data structures** - State space search techniques, greedy method, branch and bound techniques, PERT and CPM, Introduction to Spatio, Temporal data structures and R-Trees

Prerequisite Courses: None

Reference Books:

1. "Abstract Data Types: Specifications, Implementations, and Applications", Nell Dale, Henry M. Walker, Jones & Bartlett Learning, 1996.
2. "Introduction to Algorithms", T. H Cormen, C E Leiserson, R L Rivest and C Stein, Prentice-Hall of India, 3rd Edition, 2010.
3. "Data Structures and Algorithm Analysis in C++", Mark Allen Weiss, Pearson, 4th Edition, 2014.
4. "Data Structures and Algorithms", Alfred V. Aho, Jeffrey D. Ullman, Pearson, 1983.
5. "Spatial Statistics and Spatio-Temporal Data: Covariance Functions and Directional Properties", Michael Sherman, Wiley, 2010.

UE18CS503: ADVANCED NETWORK MANAGEMENT & SECURITY (4-0-0-0-4)

Course Objectives:

The objective(s) of the course is

- To become familiar with the basics of Computer Networks and various Network Architectures.
- To understand fundamental protocols and network traffic, congestion and resource controlling & allocation.
- To learn and appreciate different types of routing protocols such as RIP, OSPF.
- To learn different types of end to end protocols and to distinguish between streams oriented protocols and byte oriented protocols.
- To get concepts of various end to end protocols.

Course Outcomes:

At the end of the course the student will be able

- To identify and discuss the concepts underlying IPv6 protocol, and their main characteristics and functionality.
- To understand the principles and functionality of mobile IP, explaining its concretization in IPv6.
- To understand the needs of optimization of the mobility mechanisms and description of some extensions that aim to reduce handover latency and requirements from terminals.
- To understand the differences between routing and forwarding.
- To explain and demonstrate convergence procedure using different routing protocols.

Course Content:

1. **Data Communications:** Data Networking, and the Internet, Data Communications and Networking for Today's Enterprise. A Communications Model, Data Communications, Networks, The Internet: An Example Configuration, Protocol Architecture, TCP/IP, and Internet-Based Applications**:** The Need for a Protocol Architecture: The TCP/IP Protocol Architecture, The OSI Model: Standardization within a Protocol Architecture, Traditional Internet-Based Applications, Cellular Wireless Networks -Principles of Cellular Networks - First Generation Analog - Second Generation CDMA - Third Generation Systems.
2. **Internetwork Protocols:** Basic Protocol Functions - Principles of Internetworking - Internet Protocol Operation - Internet Protocol - IPv6 - Virtual Private Networks and IP Security Introduction - The OSI Security Architecture - Security Attacks - Security Services - Security Mechanisms - A Model for Network Security – Standards.
3. **Cryptography:** Symmetric Encryption and Message Confidentiality, Symmetric Encryption Principles - Symmetric Block Encryption Algorithms, Random and Pseudorandom Numbers: Stream -Ciphers and RC4 - Cipher Block Modes of Operation. Public-Key Cryptography and Message Authentication - Approaches to Message Authentication - Secure Hash Functions - Message Authentication Codes - Public Key Cryptography Principles - Public-Key Cryptography Algorithms - Digital Signatures Key Distribution - Symmetric Key Distribution Using Symmetric Encryption - Key Distribution Using Asymmetric Encryption - X.509 Certificates - Public Key Infrastructure.
4. **Network Security Applications:** Transport-Level Security- Web Security Issues - Secure Sockets Layer (SSL) - Transport Layer Security (TLS) – HTTPS - Secure Shell (SSH), Wireless Network Security- Wireless Security - Mobile Device Security - IEEE 802.11 - Wireless LAN Overview, IP Security- IP Security Overview - IP Security Policy - Encapsulating Security Payload - Combining Security Associations - IEEE 802.11i Wireless LAN Security.
5. **System Security:** Malicious Software - Types of Malicious Software - Propagation – Infected Content – Viruses - Propagation – Vulnerability Exploit – Worms - Propagation – Social Engineering – SPAM, Trojans - Payload – System Corruption - Payload – Attack Agent – Zombie, Bots - Payload – Information Theft – Keyloggers, Phishing, Spyware - Payload – Stealthing – Backdoors, Rootkits – Countermeasures - Distributed Denial of Service Attacks Firewalls- The Need for Firewalls - Firewall Characteristics - Types of Firewalls – Firewall Basing - Firewall Location and Configurations, Intruders– Intruders - Intrusion Detection.

Prerequisite Courses: None

Reference Books:

1. "Data and Computer Communications", William Stallings, Pearson, 10th Edition, 2013.
2. "Network Security Essentials Applications and Standards", William Stallings, Pearson, 6th Edition, 2010.

UE18CS511: FUNDAMENTALS OF SCALABLE COMPUTING (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduce the basic principles of computing at scale.
- Introduce the business need and applications for scaling computing
- Introduce examples of scalability from Cloud computing and Big Data and how the two relate to each other.
- Provide practical insights through case studies in scalable computing
- Introduce different programming models.

Course Outcomes:
At the end of the course the student will be able to

- Motivate and explain trade-offs in computing at scale
- Demonstrate development of Cloud/Hadoop applications.
- Evaluate Service-oriented technologies and their potential for business transformation.
- Analyze various cloud programming models and choose the appropriate model for application development
- Demonstrate use of tools for developing applications at scale

Course Content:
1. **Principles of distributed computing:** why distributed computing, models of distributed computing, challenges addressed, communication (REST/SOA), performance, failure and availability, resource allocation.
2. **Introduction to Cloud Computing and IaaS :** Cloud computing models – IaaS, PaaS, SaaS, IaaS overview and programming model, case study and exercises using Amazon/Openstack.
3. **PaaS and SaaS:** PaaS Programming model, case study – Microsoft Azure/IBM Bluemix, SaaS programming model with a case study.
4. **Big data programming models:** Introduction to Big Data, HDFS, MapReduce programming model, YARN architecture
5. **Big Data Algorithms and tradeoffs:** Relational operators, Matrix multiplication, Computational complexity of Hadoop, Introduction to HIVE and HBase and their programming model.

Prerequisite Courses: None

Reference Books:
1. "Moving to the Cloud", Dinkar Sitaram, Geetha Manjunath, Elsevier Publications, 2011.
2. "Hadoop: The Definitive Guide, Tom White", 4th Edition, O'Reilly, 2015
3. Mining of Massive Datasets, Anand Rajaraman, Jure Leskovec, Jerey D. Ullman, 2nd Edition, Cambridge University Press, 2014

UE18CS512:
TOPICS IN STORAGE AREA NETWORKS (3-2-0-0-4)

Course Objectives:
The objective(s) of the course is to

- Introduce students to the current storage technologies.
- Equip students for better appreciation of SAN technology, its advantages, complexities and an idea as to which situations it can be gainfully utilized, its Architecture
- Related technologies like RAID, Virtualization, Network Attached Storage, IP Storage are discussed.
- Expose the Management aspects of SAN/NAS and also address key considerations like Backup, Security.

Course Outcomes:
At the end of the course the student will be able to

- Analyze logical and physical components of a storage infrastructure.
- Design different types of RAID implementations and their benefits.
- Design Fiber Channel protocols.
- Analyze benefits of storage virtualization.
- Demonstrate the benefits of deploying a SAN.

Course Content:
1. **Introduction to storage systems, IO techniques and Intelligent Disk Systems:** Structured and Unstructured Data, Data centers, Key requirements of data centers, Storage – Centric IT Architecture and its advantages. The Physical I/O path from the CPU to the Storage System, Introduction to Storage components: Disks, Physical structure of disks, Categorization of disk subsystems. Architecture of a disk subsystem, Internal I/O channels and their design variations, RAID levels, Availability of Disk Systems
2. **Storage protocols - SCSI, FC, iSCSI:** SCSI Basics, Components, Addressing, Protocol and Functioning, Fiber Channel: FC Basics, FC Protocol Stack. Network Attached Storage: The NAS Architecture, The NAS hardware and Software Architecture. iSCSI
3. **Distributed Storage Systems -** SAN, SAN /NAS convergence, IP Storage, SAN Architecture and Hardware devices**:** Overview, Creating a Network for storage; SAN Hardware Devices.The fibre channel switch; Host Bus Adaptors. Software Components of SAN: The switch's Operating system.
4. **Storage Virtualization and Management:** Storage Virtualization - Definition of Storage virtualization; Implementation Considerations; Storage virtualization on Block or file level. Storage Management, In-band, Out-band, CIM, WEBEM, SMI-S
5. **Storage Security and Applications:** Security considerations: Information Security, Security Methods, Storage Security Technologies, Storage Security Challenges, Fibre Channel SAN Security, NAS Security, Best Practices in Security and others. Storage Applications: Backup, Recovery and Archival

Prerequisite Courses: None

Reference Books:
1. "Storage Networks Explained", Ulf Troppens, Rainer Erkens and Wolfgang Muller, Wiley India, 2013.
2. "Storage Networking Fundamentals – An Introduction to Storage Devices, Subsystems, Applications, Management, and File Systems", Marc Farley, Cisco Press, 2005.
3. "Storage Networks - The Complete Reference", Robert Spalding, Tata McGraw-Hill, 2011.
4. "Storage Area Network Essentials A Complete Guide to Understanding and Implementing SANs", Richard Barker and Paul Massiglia, Wiley India, 2006.

UE18CS513:
CRYPTOGRAPHY (3-2-0-0-4)

Course Objectives:
The objective(s) of the course is to

- Introduce cryptography, the types of attacks it prevents against and the business impact
- Introduce the mathematical foundations required for cryptography
- Analyze the computational complexity of various cryptographic techniques
- Introduce design of various protocols using the cryptographic techniques and the various available tools
- Provide practical assignments to help gain deeper insight into cryptography

Course Outcomes:
At the end of the course the student will be able to

- Appreciate the impact of cyberattacks on the society and the role of cryptography.
- Analyze cryptographic techniques for their soundness using the mathematical foundations
- Apply cryptography to solve real-life problems
- Analyze case-studies on their use of cryptography.
- Design applications/protocols to use cryptography.

Course Content:

1. **History and overview of cryptography:** Basic symmetric-key encryption, One time pad and stream ciphers, perfect secrecy and the one time pad. semantic security and stream ciphers. Block ciphers basic modes of operation: CBC and counter mode, Block cipher abstractions: PRPs and PRFs Pseudo Random Permutations (PRP); Pseudo Random Functions (PRF); security against chosen plaintext attacks (CPA); nonce-based CBC encryption and nonce-based counter mode.
2. **Attacks on block ciphers:** exhaustive search, time-space tradeoffs, differential & linear cryptanalysis, meet in the middle, side channels Message integrity: definition and applications, Collision resistant hashing, Merkle-Damgard and Davies-Meyer. MACs from collision resistance. Case studies: SHA and HMAC Authenticated encryption: security against active attacks
3. **Public key cryptography:** Arithmetic modulo primes, Cryptography using arithmetic modulo primes vanilla key exchange (Diffie-Hellman); the CDH and discrete-log assumptions, Public key encryption semantically secure ElGamal encryption; CCA security , Arithmetic modulo composites, RSA and Rabin functions. how to encrypt with trapdoor permutations
4. **Digital signatures:** definitions and applications, How to sign using RSA, More signature schemes and applications Hash based signatures. certificates, certificate transparency, certificate revocation
5. **Identification protocols:** Password protocols, salts; one time passwords (S/Key and SecurID); challenge response authentication, Authenticated key exchange and SSL/TLS session setup Zero knowledge protocols

Prerequisite Courses: None

Reference Books:

1. "Introduction to Modern Cryptography", J. Katz and Y. Lindell, 2nd Edition, 2014

UE18CS521: CLOUD COMPUTING FUNDAMENTALS (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Provide an overview of the Cloud Computing Fundamentals.
- Understand the business need for using Cloud Computing
- Understand the fundamental concepts of a data center
- Understand various cloud programming models and their relevance
- Through case studies, understand the design principles of cloud computing

Course Outcomes:

At the end of the course the student will be able to

- Demonstrate the business drivers for different cloud computing models
- Apply the fundamental concepts in datacenters to understand the tradeoffs in power, efficiency and cost
- Design system virtualization and outline its role in enabling the cloud computing system model
- Illustrate the fundamental concepts of cloud storage and demonstrate their use in storage systems.
- Analyze various cloud programming models and apply them to solve problems on the cloud

Course Content:

1. **Introduction and review of concepts:** What is Cloud Computing? Data centers, Challenges with Data centers, Components of Data centers. Operating systems concepts review– filesystem stack, storage, virtual memory and page tables, networking
2. **Virtualization:** Business drivers for virtualization, Virtualization, Layering and virtualization, Virtual Machine Monitors, Virtual Machines, Software virtualization – shadow page tables, Hardware support for virtualization – nested page tables
3. **IaaS architecture:** Case study of OpenStack architecture, modules – keystone/cinder/nova, design challenges and patterns. Cloud security, scaling.
4. **PaaS architecture:** Case study – Azure/Bluemix, programming model, Architecture of azure and differences between IaaS/ PaaS, Load Balancer.
5. **SaaS and other models:** Case study – Salesforce.com, multitenancy, Containers and scheduling, Kubernetes.

Prerequisite Courses: None

Reference Books:

1. "Cloud Computing Theory and Practice", Dan C Marinescu, Morgan Kaufmann, 2013.
2. "Moving to the Cloud", Dinkar Sitaram, Geetha Manjunath, Elsevier Publications, 2011.
3. "Cloud Computing Principles and Paradigms", Rajkumar Buyya, James Broberg, Andrzej Goscinski, Willey, 2014

UE18CS522: FOUNDATIONS OF IOT & STREAMING ANALYSIS (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- The objective of the course is to give an overview of the Internet of Things (IOT) and Cyber physical systems.
- Introduce different types of IoT through real-world case studies.
- Introduce an IoT design methodology.
- Introduce how IoT devices are monitored and manage.
- Understand how Big Data analysis can be performed on IoT.

Course Outcomes:

At the end of the course the student will be able to

- Design, define and plan software and hardware requirements comprising an IoT system.
- Demonstrate how to select and design IoT hardware components.
- Demonstrate connectivity to IoT systems to the cloud.
- Perform basic analytics with IoT systems.
- Design and develop an IoT system in a team for a real-world problem.

Course Content:

1. **IoT Introduction:** Defining the Internet of Things, panoramic view of IOT/CPS applications, IoT Applications, IoT solution architecture, IoT Devices and Operating Systems
2. **IoT Technologies**: Processor (Arduino), Sensors, Programming on Arduino/Raspberry Pi, Wireless Technologies, WAN Technologies
3. **IoT Middleware:** Overview, M2M, SCADA, RFID and WSN middleware, Protocols: MQTT, CoAP
4. **Streaming analytics:** Data stream model, Apache Storm – architecture and programming model. Analysis of streams using Storm.
5. **Streaming Techniques:** Sampling algorithms, Estimating number of unique elements in streams, averaging.

Prerequisite Courses: None

Reference Books:

1. "Internet of Things: An Hands On Approach", Vijay Madisetti and Arshdeep Bahga, VPT, 2014.
2. "The Internet of Things in the Cloud: A Middleware Perspective", Honbo Zhou, CRC Press, 2012.
3. "Precision", Principles, Practices and solutions for the Internet of Things", Timothy Chou, McGraw Hill,2016.
4. "Internet of Things", Architecture and Design Principles, Raj Kamal, McGraw Hill, 2017

UE18CS523: WEB SECURITY (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Understand security issues as applicable to web applications.
- Understand server security issues.
- Understand legal issues with security.
- Understand the various tools associated with developing secure web applications.
- Describe the motivation of attackers.

Course Outcomes:

At the end of the course the student will be able to

- Demonstrate fundamental techniques of cryptography.
- Demonstrate the use of tools in developing secure web applications.
- Demonstrate relevant aspects of the correlation between Web Trust and Web Security.
- Analyze the legal issues through case studies in web applications.
- Analyze the motivation of attackers.

Course Content:

1. **Introduction:** The Web Security Landscape, Architecture of the World Wide Web, Cryptography basics. Cryptography and the web, Understanding SSL and TLS
2. **Digital Identification:** Passwords, Biometrics and Digital Signatures. Digital Certificates, CAs and PKI, Web's war on privacy, privacy protecting techniques, privacy protecting Technologies.
3. **Web Server security:** Physical security for servers, Host security for servers, Securing web applications.
4. **Web Server Security:** Deploying SSL server certificates, securing your web service, computer crime Security for content providers: Controlling access to web content, Client-side digital certificates.
5. **Security for content providers:** Pornography, Filtering software, Censorship, privacy policies, legislation, P3P, Digital Payments, Intellectual property and actionable content.

Prerequisite Courses: None

Reference Books:

1. "Web Security, Privacy and Commerce", Simson Garfinkel, Gene Spafford, 2nd Edition, O'Reilly, 2002.

UE18CS524: DATA ACQUISITION AND VISUALIZATION (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Imparts an understanding of the challenges in data acquisition.
- Introduces collection of data from different sources.
- Introduces the need for and the need for data visualization in a Big data Environment.
- The course covers various factors influencing visualization design.
- Introduces tools and expects students to build an end-to-end solution.

Course Outcomes:

At the end of the course the student will be able to

- Demonstrate various means of acquiring data from the environment.
- Choose amongst various visualization techniques on the most appropriate technique for solving a visualization problem.
- Demonstrate visualization of data using standard visualization techniques.
- Demonstrate use of tools.
- Develop an end-to-end acquisition and visualization solution.

Course Content:

1. **Context of Data Visualization:** Understanding the importance of visualization as a discovery tool, bedrock of visualization knowledge, defining data visualization, visualization skills for the masses, the data visualization methodology, visualization design objectives. Identifying Key Factors of visualization, eight hats of data visualization design.
2. **Taxonomy of data visualization methods**: (with implementation and examples for a few important methods using JavaScript, R, D3.js or Processing along with acquisition of Data from the web).
3. **Comparison of Categories**: Dot Plots, Bar Charts, Floating bar (or Gantt chart), Pixelated bar chart, Histogram, Slope graph (or bumps chart or table chart), Radial chart, Glyph chart, Sankey diagram, Area size chart, Small multiples (or trellis chart), Word cloud.
4. **Assessing Part whole relationships**: Pie chart, Stacked bar chart (or stacked column chart),Square pie (or unit chart or waffle chart) , Tree map , Circle packing diagram, Bubble hierarchy, Tree hierarchy. **Showing Change over time**: Line chart , Spark lines, Area chart, Horizon chart, Stacked area chart , Stream graph, Candlestick chart (or box and whiskers plot, OHLC chart) , Barcode chart , Flow map
5. **Plotting connections and relationships**: Scatter plot, Bubble plot, Scatter plot matrix, Heat map (or matrix chart), Parallel sets (or parallel coordinates) , Radial network (or chord diagram), Network diagram (or force-directed/node-link network), **Mapping geo-spatial data**: Choropleth map, Dot plot map, Bubble plot map, Isarithmic map (or contour map or topological map), Particle flow map , Cartogram, Dorling cartogram, Network connection map.

Prerequisite Courses: None

Reference Books:

1. "Data Visualization": A Successful Design Process, Kirk, Andy, Packt Publishing Ltd, 2012.
2. "Interactive Data visualization for the Web ", Murray, Scott, O'Reilly Media, Inc., 2013.
3. Visualizing Data: Exploring and Explaining Data with The Processing Environment, Fry, Ben, O'Reilly Media, Inc., 2007.

UE18CS525: MIGRATING AND DEVELOPING CLOUD APPLICATIONS (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Outline various cloud architecture models.
- Introduce development of cloud-based applications.

- Introduce various challenges of migrating applications to different types of cloud.
- Introduce tools for debugging cloud applications.
- Design principles for developing cloud applications.

Course Outcomes:

At the end of the course the student will be able to

- Analyze and Distinguish amongst various cloud application development models.
- Choose the right model for cloud application development.
- Plan/design on migrating legacy applications to the cloud.
- Develop a cloud-based application for a real world problem.
- Demonstrate the use of tools in developing a cloud application.

Course Content:

1. **Review of Cloud Architecture:** Choosing the Right Cloud Service Model – Use of SaaS, PaaS, IaaS RESTful Services: Challenges of Migrating Legacy Systems to the Cloud.
2. **4D's Migration Methodology:** Discover – Application Dependency Mapping, Base lining Performance, Design – Return on Investment, Technology Refresh, Service Levels, Architecture Design and Models, Infrastructure Design, Application Redesign, Deploy – Types of Migration Deployments.
3. **Implementing Services:** Implementing IaaS - Storage as a Service, Compute as a Service, Cells-as-a-Service, Implementing PaaS - Storage Aspects, Mashups, Implementing Software as a Service – CRM as a Service, Social Computing Services, Document Services.
4. **Paradigms of Developing Cloud Applications:** Scalable Data Storage Techniques, Map Reduce, Rich Internet Applications, Challenges in Cloud: Scaling Computation, Scaling Storage, Multi-Tenancy, and Availability.
5. **Designing Cloud Security:** Security Requirements and Best Practices, Risk Management, Selecting a Cloud Service Provider, Cloud Security Evaluation Frameworks, Managing the Cloud: Managing IaaS, PaaS and SaaS, Cloud-Scale Management Systems.

Prerequisite Courses: None

Reference Books:

1. "Architecting the Cloud: Design Decisions for Cloud Computing Service Models", Michael J. Kavis, Wiley, 2014.
2. "Cloud Computing: From Beginning to End", Ray Rafaels, Paperback Press, 2015.
3. "Moving to the Cloud: Developing Apps in the New World of Cloud Computing", Dinkar Sitaram, Geetha Manjunath , Syngress , 2011.
4. "Cloud Application Architectures – Building Applications and Infrastructure in the Cloud", George Reese, O'Reilly, 2009.

UE18CS551:
HIGH PERFORMANCE COMPUTING & ARCHITECTURE (4-0-0-0-4)

Course Objectives:

The objective(s) of the course is

- To help students in acquiring knowledge on parallel and distributed databases and its applications.
- To understand the basics of intelligent databases and object oriented databases.
- To understand advanced topics of data warehousing and mining and appreciate the research topics in databases.
- To gain insight into decision support, data ware housing and data mining.
- To learn advanced topics such as geographical information systems, genome databases.

Course Outcomes:

At the end of the course the student will be able to

- Identify, describe, and categorize database objects.
- Design and implement advanced queries using Structured Query Language.
- Design, construct and maintain a database and various database objects using procedural language constructs, forms and reports to solve problems.
- Critically analyze and evaluate modeling and development methods/techniques in Object-Relational Databases.
- Analyze the fundamental theories and requirements that influence the design of modern database systems

Course Content:

1. **Understanding performance:** Factors influencing performance, modern architectures, instruction level parallelism, multi-core architectures, hyper threading, massively parallel GPU architectures. Speculative execution: thread level parallelism, data/control dependencies, and Superscalar and VLIW processors. Latency v/s throughput.
2. **Measuring performance:** Tools to measure performance of programs on CPU/GPU, prof, nvprof, methodology of measuring and debugging performance. Compiler Optimizations to achieve performance, understanding program structures, affect on compilers, loop optimizations: unrolling, fusion, transformations. Loop invariant branches/computation.
3. Programming models – task level and data level parallelism. Introduction to high performance computing Problems. Introduction to OpenMP for extracting parallelism on modern processors. Minimizing threading overhead. Advanced concepts – tasks, section, scheduling
4. **Introduction to OpenCL / CUDA** for extracting parallelism on modern GPUs, Kernels, Threads - organization, Assignment, scheduling, synchronization. Warp divergence.
5. **CUDA memories**, Device memory types, reducing global memory traffic. Memory hierarchy and effect on performance, cache organizations, writing cache friendly code. NUMA Architectures: cache consistency. Different consistency models.

Prerequisite Courses: None

Reference Books:

1. "Computer Architecture: A Quantitative Approach", Hennessey and Patterson, Morgan Kaufmann, 5th Edition, 2011.
2. "Computer Systems: A Programmer's Perspective", Randal Bryant and David O'Halloran, Prentice Hall, 2nd Edition, 2011.
3. "Programming Massively Parallel Processors: A Hands on Approach", David Kirk and Wen-meiHwu, Morgan Kaufmann, 2010.

UE18CS552:
MACHINE LEARNING TECHNIQUES (4-0-0-0-4)

Course Objectives:

The objective(s) of the course is

- To understand the basic concepts of learning and decision trees.
- To understand various techniques such as Bayesian techniques, instant based learning, neural networks and genetic algorithms.
- To analyze and understand Bayesian and computational learning.
- To appreciate the instant based learning and learning set of rules.
- To appreciate the analytical learning and reinforced learning methods.

Course Outcomes:

At the end of the course the student will be able to

- Basic knowledge about the key algorithms and theory that form the foundation of machine learning and computational intelligence.

- Identify and apply the appropriate machine learning technique to classification, pattern recognition, optimization and decision problems.
- Compare and contrast different machine learning algorithms.
- Design and implement a basic classification system.
- Analyze and design reinforced and analytical learning algorithms.

Course Content:

1. **Basics of MLT**, Version Spaces and Candidate Elimination Algorithm – Inductive Bias.
2. **Decision Tree learning**: Representation, Algorithm, Hypothesis Space Search, Inductive Bias and Issues.
3. **Regression,** Back propagation, Neural Nets, Support Vector Machines, Bayesian Learning, Bayes Classifiers, Genetic Algorithms.
4. **Instance based Learning**: PAC models, Sample Complexity, Unsupervised Learning: Clustering, Association Analysis, FP-Growth.
5. **Dimensionality Reduction**: Principal Component Analysis and Singular Value Decomposition

Prerequisite Courses: None

Reference Books:

1. "Pattern Recognition and Machine Learning", Christopher Bishop, Springer 2nd Printing, 2011.
2. "Machine Learning in Action", Peter Harrington, Dream Tech Press (India), 2012.
3. "Machine Learning", Tom Mitchell, McGraw Hill Education (India), 2013.

UE18CS553:
ADVANCED ALGORITHMS (4-0-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Understand basics of Recurrences and Amortized Complexity analysis of Data Structures.
- Understand a few string matching/prediction algorithms and their applications.
- Understand Max flow and Graph Centric Tree algorithms.
- Understand Polynomial representations and hence FFT algorithm.
- Understand Number Theoretic algorithms and hence RSA cryptography.

Course Outcomes:

At the end of the course the student will be able to

- Perform Amortized Complexity analysis of complex data structures.
- Design advanced string matching algorithms.
- Design Max flow and other advanced Graph Centric Tree algorithms.
- Design FFT algorithm.
- Design Number Theoretic algorithms

Course Content:

1. **Review of Analysis Techniques**: Growth of Functions: Asymptotic notations; Standard notations and common functions; Recurrences and Solution of Recurrence equations-The substitution method, the recurrence – tree method, the master method; Amortized Analysis: Aggregate, Accounting and Potential Methods.
2. **Graph Algorithms**: Bellman - Ford Algorithm; Single source shortest paths in a DAG; Johnson's Algorithm for sparse graphs; Flow networks and Ford-Fulkerson method; maximum bipartite matching. Polynomials and the FFT: Representation of polynomials; The DFT and FFT; Efficient implementation of FFT.
3. **Number-Theoretic Algorithms**: Elementary notions; GCD; Modular Arithmetic; Solving modular linear equations; The Chinese remainder theorem; Powers of an element; RSA cryptosystem; Primality testing; Integer factorization.
4. **String-Matching Algorithms**: Naïve string Matching; Rabin - Karp algorithm; String matching with finite automata; Knuth-Morris-Pratt algorithm; Boyer – Moore algorithms.
5. **Probabilistic and Randomized Algorithms**: the hiring problem, indicator random variables, randomized algorithms, probabilistic analysis and further uses of indicator random variables.

Prerequisite Courses: None

Reference Books:

1. "Introduction to Algorithms", T. H Cormen, C E Leiserson, R L Rivest and C Stein, Prentice-Hall of India, 3rd Edition, 2010.
2. "Fundamentals of Computer Algorithms", Ellis Horowitz, Sartaj Sahni, S.Rajasekharan, Universities Press, 2nd Edition, 2007.

UE18CS531:
ADVANCED BIG DATA ANALYTICS (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduce alternative techniques to perform big data processing
- Introduce applications of Big Data Processing
- Use tools and techniques to analyze a large data corpus
- Technologies for performing processing at large scale
- Perform a group-based activity to apply tools and techniques learnt to a real world problem.

Course Outcomes:

At the end of the course the student will be able to

- Motivate and explain trade-offs in big data processing technique design and analysis in written and oral form.
- Demonstrate the usage of tools to design Big Data applications.
- Demonstrate development of analytics applications using alternative technologies to Hadoop.
- Demonstrate ability to work in a small team to solve a real world problem with applications to the society
- Communicate the design through a presentation and build a prototype to showcase the design.

Course Content:

1. **Models of computing:** Review of MapReduce, limitations of MapReduce, PageRank, Alternatives to Map Reduce – Iterative, Workflow processing, Graph Processing, In-memory computation.
2. **Spark and Pregel:** Workflow model case study – Apache Spark – RDDs, Scala, Performance advantages, Graph model case study – Pregel/Graph. Computation model.
3. **Machine learning at scale:** Introduction to machine learning. Machine learning with Spark – mllib, Clustering, Collaborative filtering Algorithms applied to Big Data. Case study – Tensorflow, Watson.
4. **Timeseries analysis and Eventshop:** Business applications of timeseries data, challenges/tools to process timeseries data. Searching/Matching algorithms. Visualization of data – Eventshop.
5. **Multimedia - Speech Processing:** Variety in Big data, Business cases for Multimedia-Speech processing. Hidden Markov Models, Case study: Sphinx.

Prerequisite Courses:

UE18CS502 – Advanced Data Structures, UE18CS511- Fundamentals of Scalable Computing.

Reference Books:

1. "Big Data Analytics Beyond Hadoop": Real-Time Applications with Storm, Spark, and More Hadoop Alternatives, Vijay Srinivasa Agneeswaran PhD, 1st Edition, Pearson, 2014
2. "Mining of Massive Datasets", Anand Rajaraman, Jure Leskovec, Jerey D. Ullman, 2nd Edition, Cambridge University Press, 2014

UE18CS532:
CLOUD STORAGE & NoSQL DATABASES (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduce various cloud storage services and architectures.
- Introduce various NoSQL databases and their architectures.
- Introduce design choices of using different services/databases What11 is the objective of this line.
- Real world uses of various NoSQL databases.
- Tools to manage various NoSQL databases.

Course Outcomes:

At the end of the course the student will be able to

- Demonstrate the architecture of various cloud-based storage services and their design.
- Gain hands on experience of using cloud storage.
- Able to develop applications to use different NoSQL databases.
- Analyze and demonstrate a case study.
- Demonstrate capability to understand newer research in the area of cloud storage services.

Course Content:

1. **Storage as a Service:** Amazon Storage Services, Amazon S3 – Getting started, Organizing Data, Administration, Amazon Simple DB – Data Organization and Access, Amazon RDS, EC2 Storage Resources – Elastic Block Service, Instance Storage Windows Azure Storage – SQL Azure, Azure AppFabric, Using Azure Cloud Storage Services, Using persistent stores in Google App Engine.
2. **PAAS Storage Aspects:** Amazon S3, Amazon SimpleDB, IBM SmartCloud, Using IBM Data Studio to Enable Data as a Service (DaaS), Apache Hadoop – Overview, MapReduce, Hadoop Distributed File System, Mashups – Yahoo pipes, Yahoo Query Language.
3. **Cloud Storage Challenges:** Scalability, Security, Reliability and Availability, Scalable Data Storage Techniques: Partitioning – functional decomposition, master-slave replication, sharding.
4. **NoSQL Systems:** Key-Value Stores – Amazon's Dynamo, Redis, MemcacheDB, Column-Oriented Databases - Cassandra, Google's BigTable, HBase, Document Stores -MongoDB, CouchDB, Graph Databases – Neo4j, Performing CRUD operations.
5. **Scaling Storage:** CAP Theorem – Consistency, Availability, and Partitioning-tolerance, Implementing Weak Consistency, Consistency in NoSQL Systems – Hbase, MongoDB, Cassandra.

Prerequisite Courses: UE18CS501 – Advanced Operating Systems, UE18CS511- Fundamentals of Scalable Computing, UE18CS521 – Cloud Computing Fundamentals

Reference Books:

1. "Moving to the Cloud – Developing Apps in the New World of Cloud Computing", Dinkar Sitaram, Geetha Manjunath , Syngress, 2011.
2. "Professional NoSQL", Shashank Tiwari, Wrox Publication, 2011.
3. "NoSQL Databases", Chirstof Strauch, http://www.christof-strauch.de/nosqldbs.pdf,2009
4. "NoSQL Distilled", Pramod J. Sadalage, Martin Fowler, Addison-Wesley, 2012.

UE18CS533:
HIGH PERFORMANCE CLOUD & BIG DATA SYSYTEMS (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduce various distributed models and enabling technologies.
- Deep dive using case studies of cloud/big data systems.
- Tools to develop and debug applications on large scale systems.
- Benchmarks to measure performance on large scale systems.
- Understand the relationship between cloud computing and IoT

Course Outcomes:

At the end of the course the student will be able to

- Demonstrate the architecture of distributed cloud systems and problems related to resource management.
- Design a distributed massively parallel computation application.
- Design interconnection technology and networks for design of cloud computing systems.
- Demonstrate usage of tools to monitor/develop applications for large scale systems.
- Develop an application for a real-life case study.

Course Content:

1. **Distributed System Models and Enabling Technologies**: scalable computing over the internet, Network technologies, and system models for distributed and cloud computing, software environments, performance.
2. **Computer clusters for scalable parallel computing:** clustering for massive parallelism, Compute clusters and MPP architectures, - interconnects, hardware, software and middleware support, Design principles of computer clusters. Case studies: Cray XT5/ IBM Roadrunner.
3. **Virtual machines and virtualization of clusters:** Review of virtualization and tools, Virtualization of CPU/Memory/IO devices, Virtual clusters and resource management. Virtualization for Data Center Automation. Containers and microservices
4. **Cloud Platform Architecture:** Data center design and interconnection networks, Architectural design of compute and storage clouds, Inter cloud resource management.
5. **Ubiquitous clouds and IoT:** Cloud trends in supporting ubiquitous computing, performance of distributed systems and the cloud, enabling technologies for IoT, Innovative IoT applications, Online social and professional networking.

Prerequisite Courses: UE18CS502 – Advanced Data Structures, UE18CS503 – Advanced Network Management & Security, UE18CS511-Fundamentals of Scalable Computing**.**

Reference Books:

1. "Distributed and Cloud Computing: From Parallel Processing to the Internet of Things", Kai Hwang, Jack Dongarra, Geoffrey Fox, Morgan Kaufmann, 2012.

UE18CS534:
SECURE PROGRAMMING (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- The objective of the course is to learn how to write secure code
- It will introduce common problems that lead to exploits in applications.
- Introduce tools to overcome problems.
- Introduce the impact to organization and business due to security lapses.
- Design applications keeping security as a design goal.

Course Outcomes:

At the end of the course the student will be able to

- Assess the security risk in programs
- Analyze and review code to determine potential security flaws
- Apply tools to analyze code for security exploits
- Apply software engineering practices/processes for early identification of flaws
- Apply secure programming practices through a practical exercise.

Course Content:

1. **Overview**: Process description & control: Validating all input & Designing secure programs: Command line and environment variables, File descriptors, names and contents.
2. **Authentication and identity management:** Single-sign on. Declarations and initializations and expressions: Declare objects with appropriate storage durations, Identifier declaration with conflict linkage classifications, Using correct syntax for declaring flexible array member, Avoiding information leakage in structure padding.
3. **Integers and floating points**: Wrapping of unsigned integers, Integer conversions and misrepresented data, Integer overflow and divide by zero errors. Arrays, Strings and Memory Management: Out of bounds subscripts and valid length arrays, Comparing array pointers, Pointer arithmetic for non-array object, scaled integer.
4. **Accessing freed memory:** Freeing dynamically allocated memory, Computing memory allocation for an object. Cryptographic Foibies – random number, passwords, key management issues, creating own cryptographic functions, bit flipping attacks, reusing buffers, Protecting Secret Data – managing secrets in memory.
5. **Socket Security**: Server hijacking, TCP window attacks, Accepting connections, Writing firewall friendly applications, Protecting against DOS attacks.

Prerequisite Courses: UE18CS502 – Advanced Data Structures.

Reference Books:

1. "The CERT C Coding Standard: 98 Rules for Developing Safe, Reliable, and Secure Systems", Robert C. Seacord, Addison Wesley Professional, 2nd Edition*,* 2014.
2. "Secure Programming for Linux and Unix How To, Linux Documentation Project", David Wheeler, Linux Documentation Project (LDP), 2004.
3. "Writing Secure Code", Michael Howard and David LeBlanc, Microsoft Press, 2nd Edition, 2003.
4. "Secure Programming Cookbook for C and C++", John Viega, Matt Messier, O'Reilly Media, 1st Edition, 2003.
5. "Practices for Secure Development of Cloud Applications", Bryan Sullivan - Microsoft, Said Tabet - EMC, Edward Bonver - Symantec, Judith Furlong - EMC, Steve Orrin - Intel, Peleus Uhley - Adobe Systems, Inc, 2013.

UE18CS541:
CLOUD, BIG DATA & IoT SECURITY (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- The objective of this course is to introduce the security and privacy challenges.
- The course will study application of various cryptographic/ security techniques in cloud computing.
- Will introduce risks and threats posed to Big Data.
- Will introduce legal issues with respect cloud security.
- Introduce case studies with respect to IOT.

Course Outcomes:

At the end of the course the student will be able to

- Analyze factors that are critical to implementing security and privacy in the cloud.
- Demonstrate the various threats faced by a cloud computing environment and ways to manage these threats.
- Demonstrate how to develop and test secure code for cloud computing platforms.
- Analyze and demonstrate case-studies involving IOT security.
- Demonstrate cryptographic techniques used in security.

Course Content:

1. **Software Security Fundamentals:** Objectives, Security Services – Authentication, Authorization, Auditing, Accountability. Security Design Principles, Cloud Software Requirements – Secure Development practices, software requirements engineering, security policy implementation.
2. **Applied Cryptography and Intrusion Detection:** Architecture of applied cryptography, One way hash function and integrity, Encryption algorithms and Confidentiality, Digital signature and Authentication (DH, RSA), Intrusion Detection and Information.
3. **Security in cloud:** Introduction, Virtualization and multitenancy, Risk assessment for cloud migration, privacy concerns, Infrastructure security in cloud: Network and Virtualization security, Application security for SaaS, PaaS and IaaS.
4. **Internet of Things Security:** Introduction to IOT, Security and privacy for IOT, Case Study: Smart Home, Smart Grid Network, Modern vehicle, Wearable Computing and BYOD, Mobile Health Care.
5. **Big Data Security:** Securing your big data: Distributed frameworks, Storage, Real-time security, Deploying big data for security: big data for fraud detection, security incident and event management (SIEM), Big data technologies and Risks.

Prerequisite Courses: UE18CS501- Advanced Operating Systems, UE18CS502 – Advanced Data Structures, UE18CS511- Fundamentals of Scalable Computing.

Reference Books:

1. "Securing the cloud: Cloud Computing Security Techniques and Tactics", Vic (J. R.) Winkler, Elsevier, 2011.
2. "Cloud Security and Privacy", Tim Mather, Subra Kumara swamy and Shahed Latif, O'Reilly, 2009.
3. "Cloud Security A Comprehensive Guide to Secure Cloud Computing", Ronald L Krutz, Russell Dean Vines, Wiley, 2010.
4. "Cryptography for Security and Privacy in Cloud Computing", StefanRaas and Daniel Siamanig, Artech house, 2013.

UE18CS542:
BIG DATA ALGORITHMS (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Objective is to understand scenarios where Big Data Algorithms are used.
- Design algorithms for use in Big Data applications.
- Measure the complexity of Big Data Algorithms.
- Using the Map-Reduce paradigm to implement some of the Big Data Algorithms.
- Apply the Big Data Algorithms in real-life problems.

Course Outcomes:

At the end of the course the student will be able to

- Design Algorithms for Big Data.
- Understand and design infrastructure to process these Algorithms.
- Estimate and Measure the complexity of Big Data Algorithms.
- Write and debug implementations of the algorithms.
- Choose algorithms for real-life applications.

Course Content:

1. **Introduction-** map reduce programming, complexity of algorithms, distributed file systems
2. **Map Reduce Algorithms** – Matrix vector, relational algebra, Matrix multiplication, Page Rank, Extensions to Mapreduce, Complexity Models of Map-reduce
3. **Finding Similar Items –** near neighbor search, shingling, similarity preserving summaries, locality sensitive hashing, distance measures,
4. **Mining Data Streams –** stream data model, sampling data, filtering streams, counting distinct elements, counting ones, estimating moments,
5. **Clustering –** Introduction, K-means, clustering for streams, introduction of large-scale machine learning.

Prerequisite Courses: UE18CS502 – Advanced Data Structures, UE18CS511- Fundamentals of Scalable Computing.

Reference Books:

1. "Hadoop: The Definitive Guide", Tom White, 4th Edition, O'Reilly, 2015.
2. "Mining of Massive Datasets", Jure Leskovec, Anand Rajaraman and Jeffrey D Ullman, www.mmds.org, 2014.

UE18CS543: CYBER FORENSICS & IoT SECURITY (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduces fundamentals of cyber forensics and will highlight forensics challenges in cloud computing and IOT.
- Introduce techniques and mechanism to collect and preserve evidence for investigating crimes related to all software layers of IOT – devices, networks and cloud.
- Introduce legal issues with collecting forensics.
- Introduce Tools for collecting evidence.
- Case studies on online investigations.

Course Outcomes:

At the end of the course the student will be able to

- Collect evidence related to various layers in an IOT environment.
- Apply the concepts on real-life cases.
- Demonstrate the usage of tools to collect evidence.
- Analyze the legal/technical issues in collecting evidence.
- Demonstrate an analysis on a case-study.

Course Content:

1. **Scope of forensics:** Skills, type of evidence, importance, history of forensics, Windows – file storage, operating systems boot process, registry.
2. **Handling Wearable devices/ sensors:** vulnerabilities in IoT devices, Mobile Devices – cellular network, base station, SIM card forensics, handset specifications, mobile OS.
3. **Network forensics:** networking devices, wireless networks, protocols, tools, threats. Cloud storage forensics – sky drive, Google Drive, Drop box – remnants of access.
4. **Online investigations**: Documenting investigations – obtaining evidence from service provider**.**
5. **Tools:** Documenting crime scene/evidence, Admissibility of evidence.

Prerequisite Courses: UE18CS501 – Advanced Operating Systems

Reference Books:

1. "Abusing the Internet of Things – Blackouts, Freakouts and Stakeouts", Nitesh Dhanjani, O'Reilly, 2015.
2. "Computer Forensics Practical Guide: Investigating Computer Attacks", Amrit Chhetri, BookTango, 2015.
3. "Cloud Storage Forensics", Darren Quick, Ben Martini, Kim-Kwang Raymond Choo, Elsevier, 2014.
4. "Network Forensics- Tracking Hackers through Cyberspace", Sherri Davidoff, Jonathan Ham, Pearson, 2012.

UE18CS544: SERVER VIRTUALIZATION (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduce the fundamentals of server virtualization.
- Highlight the technology used in different hypervisors.
- Study the different features of different hypervisors.
- In depth study of a hypervisor through case study.
- Tools to develop and debug hypervisors.

Course Outcomes:

At the end of the course the student will be able to

- Analyze design of hypervisor technology.
- Demonstrate the differences between different hypervisors.
- Hands-on experience in hypervisor.
- Demonstrate usage of tools in debugging hypervisors.
- Analyze choice of hypervisor to use.

Course Content:

1. **VMWare Installation & Configuration:** Configuring a Virtual Machine, Gold Builds, and Clones, Advanced Configurations.
2. **Virtual Networking:** Physical-to-Virtual Migrations, Server Consolidation, Cool Tools for a Virtual Infrastructure.
3. **Administering a Virtual Infrastructure:** Best Practices, Gotchas and Common Problems, ESX Server: The Scripted Installation, Native Tools, Scripting and Programming for the Virtual Infrastructure.
4. **Building a VM:** Modifying VMs, Installing and Configuring a Virtual Server, Virtual Machines, Virtual Networks, Virtual Disks.
5. **Introduction to ADS and Virtual Server Migration Tool:** Managing Virtual Server, Migrating Physical Machines, Troubleshooting, Deploying Xen: Demystifying the Installation, The Administrator Console and Other Native Tools, Managing Xen with Third-Party Management Tools, Deploying a Virtual Machine in Xen (Other Hypervisors to be studied are KVM, Docker)

Prerequisite Courses: UE18CS521- Cloud Computing Fundamentals

Reference Books:

1. "The Best Damn Server Virtualization Book Period", Roger Dittner, Syngress; 1st Edition, 2011.
2. "The Definitive Guide to the Xen Hypervisor (Prentice Hall Open Source Software Development)", David Chisnall, Prentice Hall, 2007.
3. "Mastering KVM Virtualization", by Prasad Mukhedkar, PacktPubishing, ASIN B018UCXERK, 2016.
4. http://www.linux-kvm.org/page/Documents#Documentation
5. "Docker Cookbook", SebastienGoasguen, O'Reilly Media, 2015

UE17CS611: CLOUD STRATEGY PLANNING AND MANAGEMENT (2-0-0-0-2)

Course Objectives:

The objective(s) of the course is to

- Provide the students the skills and knowledge required to plan and manage a Cloud Computing strategy within an organization.
- This will enable students to evaluate the strategic value of Cloud Computing in its IT Strategy.
- Introduce IT Governance and Compliance models.
- Introduce tools used in IT governance and administration.
- Use cases and case studies on how cloud computing transforms IT and business.

Course Outcomes:

At the end of the course the student will be able to

- Strategically assess how cloud computing enables IT Transformation and business value in an organization.
- Analyze the role that cloud computing can play in the business process.
- Critically appraise how the incorporation of cloud computing in an IT strategy can deliver on strategic business objectives.
- Evaluate how cloud computing and Service Oriented Architecture (SOA) can deliver business agility.
- Implement IT governance to manage business realization from cloud IT services.

Course Content:

1. **Achieving Business Value from IT Transformation:** Moving to a cloud architecture and strategy to achieve business value. BPM, IS, Porter's Value chain model and BPR as a means of delivering business value, Investigate business strategy models to gain competitive advantage for organizations, SWOT/PEST, Economies of scale, Porter's 3 Strategies and 5 Competitive Forces. also D'Aveni's hyper competition models.
2. **Discuss Roles:** Roles of the strategic IS/IT leaders such as Chief Information Officer (CIO) and the Chief Technology Officer (CTO) in planning and managing IT Strategic development in the organization.
3. **IT Strategy:** Develop an IT strategy to deliver on strategic business objectives in the business strategy. IT Project planning in the areas of ITaaS, SaaS, PaaS and IaaS. Shared services delivered by a Service Oriented Architecture (SOA) in a Private or Public Cloud. Services, Databases and Applications on demand.
4. **The Effect on Enterprise Architecture:** The effect on Enterprise Architecture and its traditional frameworks such as Zachman and The Open Group Architecture Framework (TOGAF). Managing resources (people, process, technology), to realize benefit from Private/Public Cloud IT services (IaaS, PaaS, PRaaS, SaaS), Gartner's 5 pillars of benefit realization.
5. **IT Governance:** IT governance as a service in measuring the delivery of IT Strategy from Cloud IT Services using Sarbannes Oxley (CobiT) and other commonly-used approaches.

Prerequisite Courses: UE17CS501 – Advanced Operating Systems, UE17CS502 – Advanced Data Structures, UE17CS521- Cloud Computing Fundamentals

Reference Books:

1. "Easiest Ever Guide to Strategic IT Planning", Arnold J Cummins, E-Book, https://ebookee.org/dl/Arnold-J-Cummins-Easiest-Ever-Guide-to-Strategic-IT-Planning/
2. "Enterprise Cloud Computing - A Strategy Guide for Business and Technology Leaders", Andy Mulholland, Jon Pyke, Peter Fingar, Meghan Kiffer Press, 2010.
3. "Management Strategies for the Cloud Revolution", Charles Babcock, McGraw Hill, 1st Edition, 2010.
4. "A Quick Start Guide to Cloud Computing: Moving Your Business into the Cloud", Mark I. Williams, Kogan Page Limited, 2010.

UE17CS612: DATA CENTRE NETWORKING (2-0-0-0-2)

Course Objectives:

- The objective of the course is to give an overview of Networking basics and then given an in-depth understanding of Cloud Networking.
- Students will also learn the design considerations and the technologies that are used. They will also get an understanding of the recent trend towards Software Defined Networking.

Course Outcomes:

At the end of the course student will be able to

- Identify the characteristics of a cloud network
- Implement the different technologies and topologies used in cloud and data center

Course Contents:

1. **Cloud networking overview**: Networking basics, cloud data center and networking introduction, characteristics of cloud networking, evolution from mainframes to cloud.
2. **Technology:** Switch fabric technology – fabric architecture overview, fabric topologies, congestion management. Cloud and data center topologies: traditional multitiered, data center network switch types, flat data center networks, rack scale architectures.
3. **Networking** standards, virtualization and networking: ethernet data rate standards, virtual LANs, data center bridging, improving network bandwidth, remote DMA, virtual switching. Network virtualization: Multi-tenant networks, traditional network tunneling protocols, VXLAN, NVGRE, Tunnel Locations. defined networking.
4. **Data center** software background, OpenFlow, Network Function virtualization, SDN Deployment.
5. **High Performance Computing Networks:** HPC System architectures, Multisocket CPU boards, HPC Networking standards.

Prerequisite Courses: UE17CS503 – Advanced Network Management and Security

Reference Books:

1. "Cloud Networking: Understanding Cloud Based Data Center Networks", Greg Lee, Morgan Kaufmann, 2015.
2. "Software Defined Networking: Design and Deployment", Patricia Morreale and James Anderson, CRC Press, 2014

UE17CS613: MOBILE APPLICATION DEVELOPMENT IN THE CLOUD (2-0-0-0-2)

Course Objectives:

The objective(s) of the course is to

- Provide an overview of various mobile development platforms.
- Discuss on how mobile applications interact with the cloud.
- Design mobile applications that use the cloud for both storage and computation.
- Introduction to tools required for mobile application development.
- Introduction of security and synchronization challenges in cloud environments.

Course Outcomes:

At the end of the course the student will be able to

- Demonstrate various mobile development technologies and platforms.
- Develop mobile applications that use the cloud.
- Demonstrate tool-based development and debugging of cloud applications.
- Design security features into development of a cloud application.
- Design an end-to-end cloud application on the mobile.

Course Content:

1. **Overview:** Evolution of Mobile Computing, Mobile Cloud Ecosystem, Mobile Player – Pages, Apps and Widgets, Revisiting role of HTML5, Mobile Development Considerations, Getting Started: Web Kit Browser Engine, nginx Web Server to test Apps on Mobile Devices.
2. **Building a Touch Sensitive Drawing App:** How to Draw on Screen, Drawing in Response to Touch Events, DRY principle, Using Amazon Cloud, Using EC2, Deploying Mobile Web App,
   Building Mobile Web Apps: Installing mobile web apps on iPhone and Android home screens, Use of HTML5 and JQuery.
3. **Building Apps in the Cloud:** Node JavaScript Server and Node APIs, Developing Efficient Storage Algorithms, Designing multi-process architecture, Connecting nginx, Node, and MongoDB, developing web service interface for SimpleDB, Synchronizing local data with remote data.
4. **Working with Amazon S3 service:** Streaming Data efficiently, Understanding OAuth protocol, Designing a Large Scale System, Using memcached server, using consistent hashing algorithm.
5. **Understanding web:** hybrid and native apps, Streaming data onto Amazon S3,Understanding different kinds of cloud development services, publishing apps.

Prerequisite Courses: **UE17CS502** – Advanced Data Structures, UE17CS503 – Advanced Network Management and Security, UE17CS521 – Cloud Computing Fundamentals

Reference Books:

1. **“**Beginning building mobile application development in the cloud”, Richard Rodger,Wiley, 2012.
2. **“**Cloud Computing”, Kris Jamsa, Jones & Bartlett Learning, 2012.
3. **“**Mobile Cloud Computing: Architectures, Algorithms and Applications”, Debashis De, CRC Press, 2015.
4. **“**Advances in Mobile Cloud Computing Systems”, F. Richard Yu, Victor C.M. Leung, CRC Press, 2015.

UE17CS614:
SOFTWARE PROJECT PLANNING AND MANAGEMENT
(2-0-0-0-2)

Course Objectives:

- This course highlights importance of software project management and to formulate strategy in managing projects.
- The course covers cost estimation of a project and risk management with an exposure to the software management metrics.

Course outcomes:

At the end of the course the student will be able to

- Incorporate the process of project management and its application, with practice of key stages of project management.
- Identify the factors that put a project at risk and quantify the likely effect of risk on project timescales.

Course Content:

1. **Metrics:** Introduction, The Metrics Roadmap, A Typical Metrics Strategy, Set Targets and track Them, Understanding and Trying to minimize variability. **Software configuration management:** Introduction, Some Basic Definitions and terminology, the processes and activities of software configuration management.
2. **Risk management:** Introduction, risk management and its importance, Risk management cycle, Risk identification: common tools and techniques. **Project planning and tracking**: Components of Project Planning and Tracking, The “What“ part of a Project Plan, The “What Cost “ Part of a Project Plan.
3. **Software requirements gathering**: Inputs and start criteria for requirements gathering, Dimensions of requirements gathering, Steps to be followed during requirements gathering. **Estimation:** Need for Estimation, The three phases of Estimation.
4. **Design and development phases**: Some differences in our chosen approach, salient features of design, evolving an architecture/ blueprint. **Project management in the testing phase:** Introduction, What is testing?, what are the activities that makeup testing?. **Project management in the maintenance phase:** Introduction, Activities during Maintenance Phase.
5. **Globalization issues in project management:** Evolution of globalization, challenges in building global teams. **Impact of the internet on project management:** Introduction, the effect of internet on project management. **People focused process models:** Growing emphasis on people centric models, people capability maturity model.

Prerequisite Courses: None

Reference Books:

1. “Managing Global Projects”, Ramesh Gopalaswamy, Tata McGraw Hill, 2013.
2. “Managing the Software Process”, Watts Humphrey, Pearson

UE17CS615:
SAFETY AND SECURITY FOR INTERNET OF THINGS
(2-0-0-0-2)

Course Objectives:

The objective(s) of the course is to

- Introduces security issues in the Internet of Things.
- Introduces techniques to examine threats and vulnerabilities in IoT
- Introduces cryptographic methods and security mechanisms for IoT systems and wearable.
- Introduces tools for assessing risk.
- Introduces techniques to perform identity management.

Course Outcomes:

At the end of the course the student will be able to

- Analyze an IoT system for security challenges.
- Demonstrate capability to encrypt/decrypt data in IoT systems.
- Demonstrate usage of tools to asses risk.
- Design security for a wearable IoT system.
- Develop Identity management prototypes.

Course Content:

1. **IoT security challenges and requirements:** Vulnerabilities and Threats for IoT – Attack surface areas, Standards and practices for IoT security – MQTT security, OWASPIoT Security.
2. **Lightweight Cryptosystems for IoT:** block and stream ciphers (PRESENT/Spongent), Hash functions and MAC – (Quark/ Marvin), Asymmetric cryptography (ECC), Digital signatures.
3. **Risk – Assessment and Analysis:** Adaptive Risk management for IOT.
4. **Identity Management:** Authentication and Anonymity.
5. **Security of wearable and implantable Devices:** Security of wearable and implantable body area networks, Distributed

monitoring for adaptive security, Case Studies – electronic lock picking, attacking smart Televisions, exploiting wireless connectivity.

Prerequisite Courses: UE17CS502 – Advanced Data Structures, UE17CS503 – Advanced Network Management and Security, UE17CS522 – Foundations of IoT and Streaming Analysis

Reference Books:

1. "Abusing the Internet of Things – Blackouts, Freakouts and Stakeouts", Nitesh Dhanjani, O'Reilly, 2015.
2. "Security of Things –An Implementers Guide to Cyber-Security for Internet of Things", Ollie Lighthouse, NCC Group, 2014.
3. ."Adaptive Security for the Internet of Things", H Abie, Elsevier, 2015.

UE17CS616:
DESIGN, SPECIFICATION AND ANALYSIS OF CYBER-PHYSICAL SYSTEMS (2-0-0-0-2)

Course Objectives:

The objective(s) of the course is to

- This course introduces the fundamentals of cyber physical systems.
- The course will introduce the different layers of cyber physical systems and the challenges and technologies in each layer.
- Introduces scalable networking for CPS.
- Introduces management of networking devices for CPS.
- Introduces interoperability issues and solutions for CPS.

Course Outcomes:

At the end of the course the student will be able to

- Evaluate the technologies of cyber physical systems.
- Design and implement modules of CPS.
- Demonstrate scalability of the networking infrastructure for CPS.
- Demonstrate management of the network devices.
- Demonstrate interoperability between CPS solutions.

Course Content:

1. **Introduction:** CPS Architecture – Cyber Physical System Design.
2. **CPS Interconnection & QoS**: Cyber Physical Internet – Network QoS in CPS – CPS Security.
3. **Interoperability and communication in CPS**: Heterogeneous networking in CPS.
4. **CPS and heterogeneous mobile computing:** Scalable architectures for heterogeneous environments.
5. **CPS Network Services**: Cyber physical control systems – Cyber physical systems management.

Prerequisite Courses: UE17CS503 – Advanced Network Management and Security, UE17CS522 – Foundations of IoT and Streaming Analysis

Reference Books:

1. "Challenges, Opportunities, and Dimensions of Cyber-Physical Systems", H. Sultana, V. Saritha, P. Krishna, IGI Global, 2014.

UE17CS617:
MANAGEMENT OF IoT (2-0-0-0-2)

Course Objectives:

The objective(s) of the course is to

- Provides a management perspective to an IoT based system environment.
- Introduces Identity management on IoT.
- Imparts an understanding in different individual components of the IoT systems.
- Introduces an IoT based business model.
- Learn about resource management in IoT.

Course Outcomes:

At the end of the course the student will be able to

- Defend the need for IoT system management and its components.
- Manage an IoT system using SNMP, NETCONF, YANG and its identity management.
- Develop Big Data and Process Management in IoT solutions.
- Demonstrate IoT Opportunity Identification and Management.
- Demonstrate resource management in IoT.

Course Content:

1. **Overview of IoT systems and their Usage Scenarios:** Resource management in the IoT, clustering, synchronization and software agents, Understanding the need for system management in an IoT system.
2. **Study Different Mechanisms of IoT System Management:** SNMP, NETCONF and YANG as part of the IoT system management.
3. **Data and Event Management:** Discuss different kinds of data and events that have to be managed in the IoT and managing these to trigger signals and processes.
4. **Identity management:** Identity models in IoT, Identity management and trust in the IoT context, Authentication and Control.
5. **IoT Opportunity Identification and Building Business Plan:** Business model development, Eco-system development, Development of an IoT Business case, Challenges, Risk Identification and Analysis and Building a Business Plan.

Prerequisite Courses: None

Reference Books:

1. "Internet of Things – A Hands on Approach", Arshdeep Bahaga and Vijay Madisetti, Universities Press, 2015.
2. "Identity Management for Internet of Things", Parikshit Narendra Mahalle and Poonam N. Raikar , Rivers Publishers Series in Communications (ISBN 9788793102903), 2015.
3. "Enterprise IoT", Dirk Slama, Frank Puhlmann, Jim Morrish and Rishi Bhatnagar, O'Reilly, 2015.
4. "Resource Management in the Internet of Things": Clustering, Synchronization and Software Agents, Tomas Sanchez Lopez, Alexandra Brintrup, Marc-Andre Isenberg, Jeanette Masfeld, University of Cambridge and Oxford.(Article), 2011.

UE17CS618:
ADVANCED SOFTWARE TESTING (2-0-0-0-2)

Course Objectives:

- The purpose of this course to enable students to understand basics and goals of software testing& techniques
- The course will give an exposure to various tools used for automating the testing process and will have an idea of various methods and evaluation procedures for improving the quality models.

Course outcomes:

At the end of the course the student will be able to

- Assess the specific software testing strategies and methodologies and analyze software measurement criteria.
- Identify, analyze and formulate criteria and specifications appropriate to a given problem
- Compare and contrast available automated support tools and their applications.

Course Content:

1. **Basics of Software testing and examples**- Basic definitions of software testing – Test cases – Identifying test cases – Examples:

Generalized pseudo code- The triangle problem. Decision table-based testing: Decision Tables, Test cases for the triangle problem, Test cases for the Next Date function.

2. **Data Flow testing**: Definition of Use testing, Slice-based testing. **Levels of testing**: Traditional view of testing levels, **Integration Testing:** A closer look at the SATM system. **System testing:** Basic concepts of Threads, requirement specification, Finding threads, **Interaction Testing**: Context of interaction, A taxonomy of interactions.
3. **Issues in object-oriented testing**: Units for object-oriented testing, Implications of composition and encapsulation, inheritance and polymorphism. **Object-oriented integration testing:** UML support for integration testing, MM-paths for object-oriented software.
4. **GUI testing:** The currency conversion program, Unit testing. **Object-Oriented System Testing:** Currency converter UML description. **Exploratory testing:** The context-driven school, Exploring exploratory testing with familiar examples, Exploratory and context-driven testing observations.
5. **Model-based testing:** Testing based on models, appropriate models, Use case-based testing, Commercial tool support for model-based testing. **Test-Driven Development:** Test-Driven code cycles

Prerequisite Courses: None

Reference Books:

1. "Software Testing, A Craftsman's Approach", C Paul C. Jorgensen, Auerbach Publications, 3rd Edition, 2013.
2. "Foundations of Software Testing", Aditya P Mathur, Pearson, 2008.
3. "Software Testing and Analysis – Process, Principles and Techniques", Mauro Pezze, Michal Young, John Wiley & Sons, 2008.

UE17CS621:
CLOUD SECURITY (2-0-0-0-2)

Course Objectives:

The objective(s) of the course is to

- The objective of this course is to introduce the security and privacy challenges in cloud computing.
- The course will study application of various cryptographic/ security techniques in cloud computing.
- Will introduce risks and threats posed to cloud computing.
- Will introduce legal issues with respect cloud security.
- Introduce case studies with respect to cloud security.

Course Outcomes:

At the end of the course the student will be able to

- Analyze factors that are critical to implementing security and privacy in the cloud.
- Demonstrate how to develop and test secure code for cloud computing platforms.
- Demonstrate the various threats faced by a cloud computing environment and ways to manage these threats.
- Analyze and demonstrate case-studies involving cloud security.
- Demonstrate cryptographic techniques used in cloud computing.

Course Content:

1. **Cloud Computing Software Security Fundamentals:** Objectives, Security Services – Authentication, Authorization, Auditing, Accountability. Security Design Principles, Cloud Software Requirements – Secure Development practices, software requirements engineering, security policy implementation.
2. **Secure Cloud Software Testing:** Cloud Computing and Business continuity. Secure remote access.
3. **Risk Issues:** privacy and compliance risks, threats to infrastructure, data and access control. Cloud service provider risks. Virtualization Security Management.
4. **Security Architecture:** Architectural considerations, Identity Management and Access controls, Autonomic Security. Encryption and Key Management, Data Deduplication, Retirement.
5. **Cryptography Fundamentals:** encryption, signatures, Remote data storage – data checking, secure Deduplication, searchable encryption, availability in the cloud. Privacy enhancing encryption.

Prerequisite Courses: UE17CS503 – Advanced Network Management and Security

Reference Books:

1. "Securing the cloud: Cloud Computing Security Techniques and Tactics", Vic (J. R.) Winkler, Elsevier, 2011.
2. "Cloud Security and Privacy", Tim Mather, Subra Kumara Swamy and Shahed Latif, O Reilly, 2009.
3. "Cloud Security A Comprehensive Guide to Secure Cloud Computing", Ronald L Krutz, Russell Dean Vines, Wiley, 2010.
4. "Cryptography for Security and Privacy in Cloud Computing", Stefan Raas and Daniel Siamanig, Artech house, 2013.

UE17CS622:
CLOUD COMPUTING FUTURE (2-0-0-0-2)

Course Objectives:

The objective(s) of the course is to

- The objective of this course is to analyze the future of cloud computing.
- The course will focus on efforts to develop new technology for cloud computing.
- The course will also highlight the challenges driving these efforts.
- Is to equip the students with ability to carry out research in cloud computing.
- Communicate in various cloud computing forums.

Course Outcomes:

At the end of the course the student will be able to

- Demonstrate the limitations of present-day cloud computing technology.
- Demonstrate new technological developments to address these challenges.
- Contribute to one of these efforts.
- Summarize current state of the art in cloud-computing through case studies.
- Demonstrate capability to communicate in real-world forums..

Course Content:

1. **Big Data Management**: Big data management and data cloud, Big data analysis, Discovering and clustering from data mining, Big Data applications, Big data privacy, Cloud Computing in Health Care Introduction, Cloud Computing for Healthcare, Security and Interoperability, Case study
2. **Cloud in Science:** Introduction, Complexity of scientific applications, cloud technologies for science, science clouds, cloud projects for science, operation research as a service, Eservice, Green computing, Introduction, proposition, HiPC, Green Computing
3. **Cloud in Enterprises and Manufacturing:** Introduction, Emergence of cloud Industrialization, Industrial transformation to the cloud, Cloud Manufacturing, Economics and Business Facet of cloud computing. Introduction, Business Model, Economic benefits of moving into the cloud, Spot pricing mechanism, application migration considerations

4. **Standardization:** Introduction, Standards led by the Industry, Open grid forum, SNIA, IETF cloud reference framework Distributed management task force (DMTF), National Institute of Standards and Technology (NIST), The Open Group,The Cloud Standards Customer Council,Open Cloud Consortium,Enterprise and Networking Perspective
5. **Security in the Cloud:** Introduction, Deployment options security, service delivery models security. Security aspects of cloud anatomy, secure cloud computing architecture, cloud security alliance

Prerequisite Courses: UE17CS521 – Cloud Computing Fundamentals

Reference Books:

1. "Pervasive Cloud Computing Technologies: Future Outlooks and Interdisciplinary Perspectives",Lucio Grandinetti (University of Calabria, Italy),Ornella Pisacane (Polytechnic University of Marche, Italy) and Mehdi Sheikhalishahi (University of Calabria, Italy), October 2013, ISBN13: 9781466646834
2. Selected papers in Cloud Computing from latest conferences.

UE17CS623: SPEECH AND NATURAL LANGUAGE PROCESSING (2-0-0-0-2)

Course Objectives:

The objective(s) of the course is to

- Introduce the student to advances in multimedia technologies relevant to Big Data
- Understand the business relevance of speech and natural language technologies
- Introduce the basic models used for processing speech and natural language
- Work with tools to perform speech/natural language processing
- Gain a practical insight into solving these problems

Course Outcomes:

At the end of the course the student will be able to

- Demonstrate the use of speech/natural language processing in solving real-life problems
- Demonstrate the use of tools for performing speech/NLP
- Demonstrate capability to perform analysis and compare various models
- Work in a team to solve related problems
- Communicate the solution to the instructor using a report.

Course Content:

1. **Introduction** - Business relevance, Survey of English Morphology (inflectional and derivational morphology), Finite State Morphological parsing, Porter Stemmer, Word and Sentence Tokenization, Detection and Correction of Spelling Errors, Minimum Edit Distance
2. **Ngrams** – Word Counting in Corpora, Simple (unsmoothed) N-Grams, Training and Test Sets, Evaluating N-Grams. Part of Speech Tagging – English Word Classes, Tagsets for English, Part-of-Speech Tagging
3. **Hidden Markov and Maximum Entropy Models** – Markov Chains, Hidden Markov Model, Likelihood Computation, Decoding, HMM Training, Maximum Entropy Models. Phonetics – Speech Sounds and Phonetic Transcription, Articulatory Phonetics, Phonological Categories and Pronunciation Variation, Acoustic Phonetics and Signals, Automatic Speech Recognition – Speech Recognition Architecture, HMM Applied to Speech, Feature Extraction: MFCC Vectors, Acoustic Likelihood Computation, Lexicon and Language Model, Search and Decoding, Embedded Training, Word Error Rate.
4. **Syntactic Parsing** – Parsing as Search, Ambiguity, Search in the Face of Ambiguity, Dynamic Programming Parsing Methods, Partial Parsing, Statistical Parsing – Probabilistic CFGs, Probabilistic CKY Parsing, Ways to Learn PCFG, Rule Probabilities, Problems with PCFGs, Improving PCFGs, Probabilistic Lexicalized CFGs, Evaluating Parsers.
5. **Lexical Semantics** – Word Senses, Relation between Senses, Wordet: Database of Lexical Relations, Event Participants, Primitive Decomposition, Metaphor, Computational Lexical Semantics – Word Sense Disambiguation, Supervised Word Sense Disambiguation, WSD Evaluation, Minimally Supervised WSD, Word Similarity, Semantic: Role Labeling.

Prerequisite Courses: UE17CS552 – Machine Learning Techniques

Reference Books:

1. "Speech and Language Processing: An Introduction to Natural Language Processing", Daniel Jurafsky and James H. Martin, Prentice Hall, 2009.
2. "Computational Linguistics and Speech Recognition", Dan Jurafsky, James H. Martin, Prentice Hall, 2nd Edition, 2008.
3. "Foundations of Statistical Natural Language Processing", Christopher D. Manning and Hinrich Schütze, MIT Press, 1999.
4. "Natural Language Understanding",James Allen, Benjamin/ Cummings publishing Company, 2ndedition, 1995.
5. "Digital Processing of Speech Signals", Lawrence R. Rabiner, Ronald W. Schafer, Prentice Hall, 1978.

UE17CS624: TOPICS IN BIG DATA AND IoT (2-0-0-0-2)

Course Objectives:

The objective(s) of the course is to

- This course introduces topics of research in the areas of Big Data and IOT.
- The course covers study of papers relevant to current challenges/ solutions in Big Data.
- In depth treatment of one specific topic related to Big Data/IOT.
- Aim of making the student perform independent research in Big Data/IOT.
- Demonstrate the ability to read and summarize relevant literature.

Course Outcomes:

At the end of the course the student will be able to

- Define requirement for problem in Big Data/IOT.
- Demonstrate capability to survey the literature and propose a solution.
- Build a prototype to showcase a solution.
- Present the prototype to different audiences and get feedback on the research.
- Work independently on a problem.

Course Content:

1. **Big Data Management:** The foundations and principles of on-going investigations, and presents an analysis of current challenges and advances related to Big Data management: Big Data Platforms for the Internet of Things, Improving Data and Service Interoperability with Structure, Compliance, Conformance and Context Awareness Big Data Management Systems for the Exploitation of Pervasive Environments. FID False Authentications, Adaptive Pipelined Neural Network Structure in Self-Aware Internet of Things
2. **Spatial Dimensions of Big Data:** Application of Geographical Concepts and Spatial Technology to the Internet of Things, Fog Computing.

3. **IoT Models & Architectures:** Theoretical and state-of-the-art models**,** architectures, e-infrastructures, and algorithms that enable the inter-cooperative and inter-operable nature of the Internet of Things for the purpose of collective and computational intelligence, in the Big Data context
4. **Metadata Management in Smart Grids:** Context-Aware Dynamic Discovery and Configuration of 'Things' in Smart Environments.
5. **Cutting-edge Internet of Things related applications:** Social Networking Analysis, Architecture for Product Traceability in Logistic Applications.

Prerequisite Courses: UE17CS522 – Foundations and IoT and Streaming Analysis, UE17CS531 – Advanced Big Data Analytics,

Reference Books:

1. "Big Data and Internet of Things: a Roadmap for Smart Environments" , Bessis, Nik.. (Ed. Ciprian Dobre) , Springer International Publishing, 2014.
2. "Big Data and the Internet of Things: Enterprise Information Architecture for a New Age", Stackowiak, Robert, Art Licht, VenuMantha, and Louis Nagode, Apress, 2015.

UE17CS625: SOFTWARE ARCHITECTURE (2-0-0-0-2)

Course Objectives:

- This course involves in architect of complex software systems expected in real life scenarios.
- To expose students to issues involved, The scope emphasizes, non-functional requirements/quality attributes that are typically not as well addressed as functional requirements.
- To expose the students to the different architectural views and architecture pattern/styles

Course outcomes:

At the end of the course the student will be able to

- Apply design patterns to programming problems to evolve efficient designs
- Design a software conforming to the various software architecture principles

Course Content:

1. **Introduction:** The Architecture Business Cycle, Software processes and the architecture business cycle. **Software Architecture concepts:** Software Architecture, Architectural Elements. **Viewpoints and Views:** Architectural Views, Benefits of using viewpoints, viewpoint pitfalls, and viewpoints catalog. **Perspectives:** Quality Properties, Applying Perspectives to views.
2. **Role of Software Architect:** Architecture Definition Process, Role of Architect. **Introduction:** What software architecture is and what it is not, other points of view, Architectural patterns, reference models and reference Architectures, Importance of software architecture. **Architectural styles**: Pipes and filters, Data abstraction and Object-oriented organization.
3. **Case Studies:** Keyword in Context; Instrumentation software; Mobile robotics; Cruise control. Introduction**:** Architectural Patterns, Design Patterns and Idioms.
4. **Interactive architecture patterns:** Model-View-Controller, Presentation-Abstraction-Control. **Distributed pattern**: Broker Pattern. **Adaptive patterns:** Microkernel, Reflection. **Design Patterns:** Structural decomposition, Whole-Part Organization of work, Master-Slave, Access Control, and Proxy. **Reading assignment:** J2EE/.NET/SEDA architecture. **Quality attributes:** Functionality and architecture of quality attributes.
5. **Architecture tactics:** Achieving Quality: Introducing tactics; Availability tactics; Modifiability tactics; Performance tactics; Security tactics. **Architectural definition:** Architecture Definition in SDLC designing the architecture. **Architectural documentation:** Views; choosing the relevant views; documenting a view, Documentation across views, Context Diagram, Principles and Traceability.

Prerequisite Courses: None

Reference Books:

1. "Software Architecture in Practice", Len Bass, Paul Clements, Rick Kazman, Pearson Education, 2nd Edition, 2003.
2. "Software Systems Architecture", Nick Rozanski and Eoin Woods, Pearson Education (Indian Edition), (reprint edition), 2009

UE17CS626: BUSINESS FUNDAMENTALS (2-0-0-0-2)

Course Objectives:

The objective of this course is

- Understand the different types of business ownership
- Understand how a modern business organization works
- Understand the importance of marketing and the activities involved in it
- Understand how a business organization is run and managed, and
- Understand the activities required to set up a start-up company

Course Outcomes:

At the end of the course the student will be able to:

- Describe the various legal forms of business ownership.
- Explain the functions and working of a business organization.
- Describe the processes involved in product/services strategy.
- Explain the role of management in a business organization.
- Explain the factors that can make a startup company successful.

Course Content:

1. **Introduction and Legal forms of Business:** Historical context of how businesses evolved into their present forms. Forms of ownership (proprietorship, partnerships, Nonprofit, corporations).
2. **Start-Ups:** Evolution of startups, Important factors in startups: Idea, Team, Business Model, Funding Options, Timing. Startup Culture, Startup ecosystems, Startup environment in India, Case Studies of successes and failures.
3. **Business Functions:** Typical functions of any business organization: Production, Finance, Accounting, Human Resource Management. How the activities of a business are reported - Balance Sheets and Profit/Loss accounts.
4. **Business Functions:** Research and Development, and Marketing, Marketing: The activities, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large. Marketing is used to create the customer, to keep the customer and to satisfy the customer. How to tailor a product or service to a target market. Sales
5. **Management:** Setting the strategy of an organization and coordinating the efforts of its employees or volunteers to accomplish its objectives through the application of available resources, such as financial, natural, technological, and human resources.

Prequisite Courses : None

Text Book :

T1. Introduction to Business, Student Edition (McGraw Hill)

Reference Books :

1. The single biggest reason why startups succeed | Bill Gross (TED Talk)
2. Entrepreneurship Simplified (From Idea to IPO) by Ashok Soota and SR Gopalan, Penguin Random House India, 2016

CIVIL ENGINEERING

BTECH IN CIVIL ENGINEERING

Program Educational Objectives:

1. Our graduates will actively engage in a professional career as a registered civil engineer or pursue advanced study.
2. Our Graduates, guided by the principles of design, development and sustainability engage in providing infrastructure with futuristic societal necessities.
3. Our graduates will comprehend professional practice issues, realize global inter-connectedness; will recognize how civil engineering projects affect society and the environment.

Program Outcomes:

1. **Professional Skills:** Graduates of the program will be capable of operating effectively in a professional environment by demonstrating technical interactive and communication skills; they have an ability to design and conduct experiments, as well as to analyze and interpret data; they will be interactive, understanding and provide solutions to civil engineering problems.
2. **Design skills:** Graduates can design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability, and sustainability.
3. **Continuing education:** Graduates are prepared to pursue professional development with licensure requirements and engage in professional societies and able to take opportunities for advanced education.

UE18CV101: ENGINEERING MECHANICS (4-0-0-0-4)

Course Objectives:

- Learn engineering mechanics concepts required for analysis of structures under static loads and predict the effect of loads.
- Learn to identify an appropriate structural system and represent clearly and completely all the supports and forces acting on the system.
- Learn to isolate a subsystem from all surrounding bodies and develop free-body diagram of the isolated system.
- Apply pertinent mathematical, physical and engineering principles to analyze.
- Solve problems in an organized and coherent manner and elucidate the meaning of the solution in the context of the problem.

Course Outcomes:

- Develop skill to determine resultants and apply conditions of static equilibrium to plane force systems.
- Develop skill to identify and quantify all forces associated with a static frame work.
- Develop skill to identify, formulate and solve engineering problems

Course Content:

1. **Introduction to statics:** Mechanics, Basic Concepts, Scalars and Vectors**, Force Systems-I:** Introduction, Force, Rectangular Components, Moment, Couple, Resultants, Numerical problems
2. **Equilibrium:** Introduction, Equilibrium in Two Dimensions - System Isolation and the Free-Body Diagram, Equilibrium conditions, Numerical problems.
3. **Distributed Forces:** Introduction, Centroids of Areas, Centroids of Composite Bodies and figures, Numerical problems. **Area Moments of Inertia:** Introduction, Definitions, Composite areas, Numerical problems.
4. **Structures:** Introduction, Plane Trusses, Method of Joints, Numerical problems **Beams:** External effects, Numerical problems
5. **Friction:** Introduction, Frictional Phenomena - Types of Friction, Dry Friction, Flexible flat belts, Numerical problems.

Reference Book:

1. "Engineering Mechanics Statics" J.L. Meriam, L.G. Kraige John Wiley & Sons, 7th Edition, Reprint 2014

UE17CV201: STRENGTH OF MATERIALS (3-0-2-0-4)

Course Objectives:

- Study fundamental principles of mechanics of materials and its application to various structural elements. Understand concepts of stress, strain and deformations, determination of stresses and strains in structural material under axial, bending and thermal loads. Understand coordinate transformation of stress and strain, stress invariance, surface stresses and their importance.
- Study concepts of material properties like Young's modulus, shear modulus and Poisson ratio, yield stress, ultimate stress and allowable stress, factor of safety.
- Understand stress analysis concepts, demonstrate ability to perform analysis of beams subjected to a bending moment and shear forces, pressure vessels under internal fluid pressures, predict buckling strength of columns for various end conditions under compressive load conditions and analyze shafts subjected to torsion loading.

Course Outcomes:

- To apply the formal theory of solid mechanics to calculate forces, deflections, moments, stresses, and strains in a wide variety of structural members subjected to tension, compression, torsion, bending, both individually and in combination, including: axially loaded bars, components in pure shear, circular shafts in torsion, beams in bending, trusses.
- To understand the concepts of stress at a point, strain at a point, and the stress-strain relationships for linear, elastic, homogeneous, isotropic materials.
- To determine principal stresses and angles, maximum shearing stresses and angles, and the stresses acting on any arbitrary plane within a structural element.
- To draw Free Body Diagrams (FBD) for rigid bodies, beams, 2-D structures, frames and set up equilibrium equations (i.e. forces and couples) for them.
- To utilize basic properties of materials such as elastic moduli and Poisson's ratio to appropriately to solve problems related to isotropic elasticity.

Course Content:

1. **Concept of stress:** Normal (tensile and compressive) and shear stress, uniform and non-uniform stress distributions, analysis and design concepts, numerical accuracy and sample problems. Components of stress under general loading conditions, yield strength and ultimate strength, ultimate and allowable stress, factor of safety, factors influencing the determination of factor of safety. **Behavior and analysis of axially loaded members:** Load vs. displacement diagram, normal and shearing stresses and strains, stress-strain diagram, true stress vs. true strain diagram, brittle and ductile materials, isotropic materials, Hooke's law: Young's modulus of elasticity, Poisson's ratio. Generalized Hooke's law, dilatation - bulk modulus, shearing strain, shear modulus, relation among E, υ and G, numerical problems. Deflections of axially loaded members. Effect of temperature

loading: coefficient of thermal expansion, thermal and elastic strains, numerical problems.

2. **Concept of Bending Moment and Shear force:** Introduction to different types of transverse loads, supports and beams, bending moment and shearing force, sign conventions, shear force and bending moment diagrams (SFD & BMD), relationship among load, shear and bending moment, numerical problems.
3. **Behavior and Analysis of Beams subjected to Flexure and Shear:** Deformations in prismatic and symmetric members in pure bending, pure bending theory and assumptions, bending stresses and strains, elastic flexural formulae, elastic section modulus, radius of curvature of neutral surface, modulus of rupture, flexural rigidity and numerical problems covering bending of various types of beam sections. Shear stresses in beams, shear stress diagram for rectangular and I sections, numerical problems.
4. **Deflection of Beams:** Introduction, deformation of a beam under transverse loading, equation of the elastic curve, using singularity functions to determine the slope and deflection of a beam (Macaulay's Method), numerical problems. **Elastic Stability of Columns:** Introduction, stability of structures, Euler's Formula for pin-ended columns, extension of Euler's formula to columns with other end conditions. Numerical problems.
5. **Torsion of Circular Shafts:** Introduction, deformations in a circular shaft, angle of twist, shearing strain, shearing stresses in the elastic range, elastic torsion formulae, torsion testing, modulus of rigidity G, polar moment of inertia J, numerical problems. **Principal Stresses and Strains**: Introduction to plane stress problems, principal planes, Mohr's circle of stress, numerical problems.

Lab Component: Tensile test and Compression test on Mild steel, Aluminum, Hardness test on Mild steel, Brass, Aluminum

Prerequisite Courses: UE17CV101- Engineering Mechanics

Reference Books:

1. "Mechanics of Materials (In SI Units)", Ferdinand P Beer, E Russell Johnston Jr., John T DeWolf, David F Mazurek, 6th Edition, Tata McGraw Hill Education (India) Edition 2013.
2. "Mechanics of Materials", James M Gere & Stephen P Timoshenko, 2nd Edition, CBS Publishers & Distributers Private Limited, India, Reprint 2004.
3. "Strength of Materials", S Ramamrutham, Dhanpat Rai Publications, Reprint 2005.
4. "Strength of Materials", I.B. Prasad, 8th Edition, Khanna Publishers, 1989.
5. "Strength of Materials –Elementary Theory and Problems - Part 1", Stephen P Timoshenko, 3rd Edition, CBS Publishers, Reprint 2002.
6. "Strength of Materials –Advanced Theory and Problems - Part 2", Stephen P Timoshenko, 3rd Edition, CBS Publishers, Reprint 2002.
7. "Solid Mechanics", S.M.A. Kazioni, 1st Revised Edition, Tata McGraw Hill, New Delhi, 1988.
8. "Introduction to Mechanics of Solids", E.P. Popov, Prentice Hill of India, New Delhi, 1973.
9. "Mechanics of Solids: An Introduction", S.H. Crandall, N.C. Dahl and T.V. Lardner, McGraw Hill International, Tokyo, 1994
10. "The Testing of Engineering Materials", Davis & Troxell McGraw-Hill Higher Education, 1982.

UE17CV202:
FLUID MECHANICS (4- 0 – 0 – 0 - 4)

Course Objectives:

- Understand fluid mechanics by emphasizing the physics
- Understand principles and equations of fluid mechanics
- By solving the numerous and diverse real – world engineering examples student gets to know how to apply fluid mechanics in engineering practice.
- Understand basic properties of fluids, governing laws and equations of fluid flow, such as Pascal's law, Bernoulli's equation, Kinematics of fluids, Reynold's number, and Darcy-Weisbach equation.
- With this foundation, students are well equipped to learn related theoretical & practical subjects and their applications in the higher semesters.

Course Outcomes:

- Helps the student to apply fluid mechanics knowledge to meteorology, oceanography, hydrology areas.

Course Content:

1. **Introduction & Basic concepts:** Introduction, Applications areas of fluid mechanics, The No-slip condition, classification of fluids flows, Viscous versus inviscid regions of flow, internal and external flow, compressible versus incompressible flow, laminar versus turbulent flow, natural (or unforced) versus forced flow, steady versus unsteady flow, one-,two-, and three-dimensional flows, system and control volume, Importance of dimensions and units, some SI units, Dimensional homogeneity, Unity conversion ratios, numerical problems
2. **Properties of fluids**: introduction, continuum, density and specific gravity, density of ideal gases, vapor pressure and cavitation, compressibility and speed of sound, viscosity, surface tension and capillarity effect, numerical problems. **Pressure and fluid statics**: Pressure at a point, variation of pressure with depth, pressure measurement devices, the barometer, the manometer, other pressure measurement devices, introduction to fluid statics, hydrostatic forces on submerged plane surfaces, special case: submerged rectangular plate, hydrostatic forces on submerged curved surfaces, buoyancy and stability, stability of immersed and floating bodies, numerical problems. **Fluid kinematics:** Lagrangian and Eulerian descriptions, Acceleration field, material derivative; flow patterns and flow visualization, streamlines, pathlines, streaklines, timelines, surface flow visualization techniques, Reynolds transport theorem – statement & application only. numerical problems.
3. **Mass, Bernoulli, and energy equations**: Introduction, Conservation of mass, the linear momentum equation, conservation of energy; conservation of mass, mass and volume flow rates, conservation of mass principle, the Bernoulli equation, derivation, force balance across streamlines, static, dynamic and stagnation pressures, limitations on the use of the Bernoulli equation, hydraulic grade line (HGL) and energy grade line (EGL), applications of the Bernoulli equation; numerical problems, Kinetic energy correction factor, numerical problems. **Momentum analysis of flow systems:** Newton's laws, choosing a control volume, forces acting on control volume, the linear momentum, special cases, momentum-flux correction factor, β, steady flow, steady flow with one inlet and one outlet,
4. **Flow in pipes:** Introduction, Laminar and turbulent flows, Reynold's number, entrance region, Entry lengths, laminar flow in pipes, pressure drop and head loss, inclined pipes, turbulent flow in pipes, turbulent velocity profile, the moody chart, types of fluid flow problems, minor losses, pipe in series and pipe in parallel, flow rate measurement, pitot and pitot-static probes, obstruction flow meters: orifice, venturi, nozzle meters, variable- area flowmeters, (rotameters), ultrasonic flowmeter, other flowmeters, numerical problems, Water hammer, gradual closure of value, sudden closure of value, numerical problems.
5. **Differential analysis of fluid Flow:** Introduction, Conservation of mass – The continuity equation, derivation, alternative form of the continuity equation, special cases of the continuity

equation, the stream function, the stream function in Cartesian coordinates, numerical problems **Flow measuring devices**: Flow through orifices and mouthpieces**,** introduction, classification of orifices, flow through an orifice, hydraulic coefficients, determination of coefficient of velocity, coefficient of discharge, and coefficient of contraction, flow through large orifice, flow through submerged orifice, flow through partially submerged orifices, classification of mouthpieces, numerical problems. Flow over notches and weirs: Introduction, classifications of notches and weirs, discharge over a rectangular notch or weir, discharge over a triangular notch or weir, discharge over a trapezoidal notch or weir, discharge over a broad crested weir, discharge over a ogee weir, discharge over submerged weir, numerical problems

Prerequisites Courses: None

Reference Books:

1. "Essentials of Fluid Mechanics – Fundamental and Applications", John M. Cimbala, Yunus A Cengel, Mcgraw Hill Education (India) Private limited, New Delhi. 2013.
2. "A Text Book on Fluid Mechanics and Hydraulic Machines", Sukumar Pati, First Reprint, Tata McGraw Hill Education (India) Private limited, New Delhi, 2013.

UE17CV203:
GEOINFORMATICS (4-0-0-0-4)

Course Objectives:

- To understand different geometric objects – setting of curves, area & volume calculation.
- To know concepts of electro- magnetic waves, EDM, GPS, remote sensing, photography and usage of computers in surveying.
- To identify basic equipments like Tapes/Chains, Compass, Plane Table, Dumpy Level and Theodolite.

Course Outcomes:

On successfully completing this course students:

- Are able to analyze and solve the problems relating to setting of curves.
- Will be able to operated and collect the required data using total station
- Will be able to analyze the mapping technique
- Are able to apply appropriate surveying data capture technique.

Course Content:

1. **Basic Surveying Techniques:** Definition of surveying, classification of surveys, Basic principles of surveying, map numbering, introduction to instruments - tapes, chains, ranging rods, working principle of optical square, prism square, cross staff, conventional symbols, Meridians and bearings, principle, working and use of - prismatic compass, surveyor's compass, magnetic bearing, true bearings, whole circle bearing and reduced bearing, dip and declination, local attraction, Levelling: Principles, basic definitions and methods of leveling, parts and usage of digital level .Theodolite: temporary adjustments of a transit theodolite, measurement of horizontal angles – method of repetitions and reiterations, measurements of vertical angles, Contouring: Contours and their characteristics, use of contours, grade contours and uses. Areas & Volumes: General methods of determining areas and volumes, Plane Table Surveying: Plane table and accessories, advantages and limitations of plane table survey, methods of plotting – radiation, intersection, basic principle of Trigonometrical Leveling and Tacheometry - tacheometric equation for horizontal line of sight and inclined line of sight in fixed hair method, Beaman stadia arc.
2. **Simple Circular Curves and Compound Curves:** Introduction to curves - simple circular curves, compound and reverse curves, transition curves and vertical curves, parts of curve and usage. Simple circular curves- necessity, types, elements, designation of curves, setting out simple curves by linear methods, setting out curves by Rankine's deflection angle method, Obstacles to location of curves. Compound curves-Elements, Design of compound curves, setting out of compound curves (numerical problems)
3. **Curves, EDM and Total Station:** Reverse Curves - Elements, Reverse curve between two parallel straights (numerical problems on Equal radius and unequal radius), Transition curves-Requirements, Characteristics, Super elevation, Length of Transition curve and related numerical problems. **Electro Magnetic Distance Measurement &Total Station**: Electro Magnetic Distance Measurement: Introduction, electromagnetic waves, modulation, types of EDM instruments - Geodimeter, Tellurometer and Wild Distomat, principle of their working. Total Station – Introduction to electronic theodolite, Salient features of total station, advantages of total station over conventional instruments, types of Total Station, application of total station.
4. **Global Positioning System (GPS):** Introduction, GPS principles, Satellite navigation System, GPS segments - Space segment, Control segment, User segment, GPS satellite signals, Receivers-features, structure, types, consideration in selection of receiver, DGPS- methods, Static and Kinematic DGPS, Application of GPS. **Geographical Information System (GIS):** Definition and components of GIS, four M's, database and data models, Introduction of Remote sensing and GIS, GIS packages and usage of GIS.
5. **Introduction to Remote Sensing:** Definition, Principles of energy interaction in atmosphere and earth surface features, Idealized remote sensing system and real remote sensing system, basic principles of remote sensing, platforms and sensors , imaging Sensor Systems and its applications in satellite systems, image interpretation techniques, visual interpretation, Digital image processing and applications of remote sensing. **Photogrammetry:** Basic concepts of terrestrial photogrammetry and aerial photogrammetry, photo theodolite, horizontal & vertical angles, horizontal position, type of photographs and geometry of aerial photographs and related problems.

Prerequisites Courses: None

Reference Books:

1. "Surveying Volume I", B. C. Punmia, Ashok K Jain, Arun K Jain, 15th Edition, Laxmi Publications, 2005.
2. Surveying Volume II", B. C. Punmia, Ashok K Jain, Arun K Jain, Laxmi Publications, 15th Edition, 2005.
3. "Surveying Volume III", B. C. Punmia, Ashok K Jain, Arun K Jain, 15th Edition, Laxmi Publications, 2005.
4. "Remote Sensing and GIS", M. Anji Reddy, BS Publications/BSP Books, 4th Edition, 2012.
5. Geomatics Engineering, Manoj K Arora and R C Badjatia, Nem Chand and Bros Publishers, 2011
6. "Surveying Theory and Practice", James M. Anderson, McGraw Hill Publication, 7th Edition, 1997.
7. "Fundamentals of Surveying", Milton O. Schimidt, Wong, Thomson, 2nd Edition, 1997.
8. "Fundamentals of Surveying", S.K. Roy, 2nd Edition, Prentice Hall of India, 2006
9. Surveying: volume 2, K.R. Arora, Standard Book House ,2010
10. Surveying: volume 1, K.R. Arora, 16th edition, Standard Book House, 2010
11. Concepts and Techniques of Geographic Information Systems Second Edition, Chor Pang Lo, Albert K. W. Yeung, Pearson, 2016

UE17CV204: CONSTRUCTION MATERIALS & TECHNOLOGY (3-0-2-0-4)

Course Objectives:

- To learn about various materials used in construction
- To know about alternative materials used in industry.
- To learn about various types of foundation.
- To learn about the construction techniques used in industry.
- To know about sustainable construction.

Course Outcomes:

- Knowledge of various materials which are used in the construction field.
- Brief idea of the components of a building structure.

Course Content:

1. **Stones:** Varieties of building stones, qualities of good building stones, dressing of stones, selections and suitability of stones, uses of stones, decay and preservation of stones, quarrying of stones. **Bricks:** Qualities of brick earth, standard specifications for shape, size and properties, testing of bricks. **Alternative materials:** Solid and hollow blocks, stabilized mud blocks, aerated blocks, rammed earth, reinforced brick work.
2. **Cement:** Raw materials, manufacture, types, properties, use of puzzolonic materials such as fly ash, granulated blast furnace slag, rice husk ash as partial replacement, tests on cement. **Fine and Coarse Aggregates:** Properties and uses. M Sand, **Grading of aggregates, tests on aggregates Mortar, Concrete:** materials, preparation, properties and uses. **Reinforcing and Structural Steel:** Types, properties – yield strength, ultimate strength, proof stress, elongation, shapes and uses.
3. **Timber:** Classification of timber, fundamental engineering properties of good timber, defects in timber, seasoning of timber, solar timber seasoning kiln preservation of timber, ply wood and its uses. **Plastics:** Types, constituents of plastic, properties, uses of plastics in building industries. **Paints, Varnishes and Distempers:** Constituents of oil paint, chatacteristics of a good paint, types of paints, painting to wood, steel, iron and wall surfaces. Varnishes- Constituents of varnishes – types of varnishes, method of applying varnishes. Distemper and application to new and old surfaces. Surface preservatives – metallic coating by hot dipping. **Flooring:** Base preparation, Types of flooring, laying details. **Form work:** Economy in form work, material for form work details in RCC columns, beams and floors, slip forming. **Scaffolding, Shoring**
4. **Techniques of Sub Structures Foundations:** Need, concepts of foundation, shallow foundation, depth of excavation, Isolated and combined footings. Pile foundations, bearing, friction, under reamed types, pile caps. **Masonry: Brick Masonry:** Different types of bonds - English, Flemish. Stone masonry types, **Plastering, Pointing Doors, Windows and Ventilators:** Location of doors, size of doors and door frames, types of doors and windows, ventilators. **Roofs:** Different types of roofs and roof coverings, one way, two way slabs - typical sketches.
5. **Sustainable Construction:** Concept**,** Need, embodied energy and CO2 emissions in building materials, recurring and operational energy in buildings, total energy in building life cycle, zero energy and water neutral buildings, green buildings, rating systems – GRIHA (Green Rating for Integrated Habitat Assessment), LEED – India (Indian Green Building Council), points allocation and rating. Construction and Demolition (C & D) waste management – 4 R's Golden rule (Reduce, Reuse, Recycle, Recover) before final disposal. Safety, health and welfare facilities in construction sites.

Lab Component: Tests on Aggregates, Specific Gravity, Sieve Analysis, Bulking of sand.

Prerequisites Courses: None

Reference Books:

1. "Building Construction", B.C. Punmia, Laxmi Publications, New Delhi, 10th Edition, 2007.
2. "Engineering Materials", S.C Rangwala, Charotar Publishing House, Anand, 28th Edition, 1997.
3. "Building Construction", P.C. Varghese. Prentice Hall of India, New Delhi, 2007.
4. "Building Construction", Sushil Kumar, 16th Edition, Standard Publishers & Distributors, New Delhi, 2005.
5. "Building Construction" W B Mackay, Vol 4, Pearson Publications 2013.
6. "Construction Technology", Chudley 4th Edition, Pearson Publications. 2005.
7. "Alternative Building Materials and Technologies", K.S. Jagadish and B.V. Venkatarama Reddy, 1st Edition, New Age International (P) Ltd., 2009.
8. "Construction of Buildings", Barry, 7th Edition, Wiley-Blackwell Publications, April 2014
9. National Building Code, BIS, New Delhi, 2015
10. IGBC Manual, GRIHA Manual, 2010
11. IS CODES: 2185 part 1, 8041-1990, 12330-1988, 12600-1989.

UE17CV205: BUILDING PLANNING & DRAWING (0-0-2-0-1)

Course Objectives:

- Understanding of the power and precision of computer-aided drafting.
- Ability to create 2D representations of 3D objects as plan view, elevations and sections.
- Ability to assemble these drawings in industry-standard plan form and produce plotted hard copies ready for distribution.
- Awareness of architectural drafting with a focus on industry standards.

Course Outcomes:

- Capability to present the ideas, actual planning and construction details, to prepare easily understandable and aesthetic designs.
- Capability to explain and discuss the proposed requirements for a building plan as derived from rough sketches.

Course Content:

General introduction to CAD & drafting using AUTOCAD or similar tools to perform the following:

1. To prepare geometrical drawing of components like - Stepped wall footing, Paneled doors, Glazed windows, Introduction to staircase, types of staircase,
2. Functional design of building, positioning of various components of buildings, orientation of buildings, building standards, governing laws, set back distances and calculation of carpet area, plinth area and floor area ratio.
3. Introduction to foundation marking, Development of plan, elevation, section and schedule of openings from the given line diagram of buildings.

Prerequisites Courses: None

Reference Books:

1. "Building Drawing", M.H.Shah and C.M. Kale, Tata McGraw Hill Publishing Co Ltd., New Delhi, 5th Edition, 2002.
2. "Building Planning, Designing and Scheduling", Gurucharan Singh, Standard Publishers & Distributors, New Delhi, 2006.
3. "National Building Code of India", BIS, New Delhi, 2005.

UE17CV206: SURVEYING PRACTICE (0–0–2–0–1)

Course Objectives:

- Enable the student to capture information using the instruments & environment to avoid possible errors in surveying.
- Enable the student to capture information using Total Station, transfer the same to a computer and map the same using software.
- Use GPS equipments for tracking and locating coordinates
- Student will gain knowledge about the equipments like Tapes/ Chains, Compass, Plane Table, Auto Level, Theodolite and Total Station. Handheld GPS

Course Outcomes:

On successfully completing the coarse students are able to:

- Use surveying instrumentation effectively
- Process and analyze surveying data using appropriate computational and analytical techniques
- Use the data for the design and setting out of engineering works.

Course Content:

1. To set out geometric shape using compass
2. Measurement of horizontal angle using theodolite
3. To determine difference in elevation between two points using auto level by fly levelling
4. Determine distance between two inaccessible points intersection method of plane tabling
5. Introduction and measurement of angles and distances using Mode-A and Mode-B using Total station
6. Stake out co-ordinates of given area
7. To find coordinates of road alignment(curve setting)
8. Traverse using Total Station including orientation
9. Plot coordinates of sloping surface and traverse using softwares
10. Locate coordinates of a given set of points and locate points for a given set of coordinates using GPS
11. Use of GIS Software
12. Foundation marking

Prerequisites Courses: None

Reference Books:

1. Laboratory Manual prepared by Department of Civil Engineering, PESU
2. "Surveying Volume I", B. C. Punmia, Ashok K Jain, Arun K Jain, 15th Edition, Laxmi Publications, 2005.
3. Surveying Volume II", B. C. Punmia, Ashok K Jain, Arun K Jain, Laxmi Publications, 15th Edition, 2005.
4. "Surveying Volume III", B. C. Punmia, Ashok K Jain, Arun K Jain, 15th Edition, Laxmi Publications, 2005.
5. "Remote Sensing and GIS", M. Anji Reddy, BS Publications/BSP Books, 4th Edition, 2012.
6. "Surveying Theory and Practice", James M. Anderson, McGraw Hill Publication, 7th Edition, 1997.
7. "Fundamentals of Surveying", Milton O. Schimidt, Wong, Thomson, 2nd Edition, 1997.
8. "Fundamentals of Surveying", S.K. Roy, 2nd Edition, Prentice Hall of India, 2006.

UE17CV251: STRUCTURAL ANALYSIS (4-0-0-0-4)

Course Objectives:

- To learn the basics of structural analysis
- To understand the different types of loads on structures
- To understand the different types of supports and connections in structures
- To understand the concept of moving load

Course Outcomes:

On completion of this course, students are able to:

- Identify determinate and indeterminate structures
- Obtain displacements and forces in structural members
- Analyze various structures

Course Contents:

1. **Introduction to structural analysis:** Forms of structures, loads and forces: dead loads, imposed loads. **Analysis of Determinate structures:** Equations of equilibrium, sign convention, cables, equation of a cable, horizontal tension, tension in cables supported at different levels, length of cables, effects of change of temperature.
2. **Displacements – Geometric methods:** Deflected shapes, moment area method, conjugate beam method. **Displacements – Energy methods**: Introduction, forms of elastic strain energy, strain energy in members, energy relations: law of conservation of energy, virtual works, Betti's and Maxwell's laws of reciprocal deflections, application of virtual work, deflection of trusses and frames, Castigliano's Theorem I.
3. **Analysis of Indeterminate Structures:** Castiglino's Theorem II (Minimum Strain Energy) – Propped cantilever, fixed beams, theorem of three moments, derivation and application to the analysis of statically indeterminate beams.
4. **Three hinged semi circular and parabolic arches** with supports at same levels and different levels, determination of thrust, shear and bending moment. Analysis of Two hinged semi circular and parabolic arches with supports at same levels and different levels, determination of thrust, shear and bending moment for arches.
5. **Rolling Loads and Influence Lines:** Introduction, Types of moving loads –Concentrated, Single, Pair, Multiple – UDL, longer than span and shorter than span, Influence line diagrams-Reaction, BM, SF, Absolute maximum BM and SF (only for statically determinate beams).

Prerequisites Courses: UE17CV101 Engineering Mechanics

Reference Books:

1. "Basic Structural Analysis", C. S Reddy, Tata McGraw Hill, New Delhi, 3rd Edition, 2012.
2. "Analysis of Structures", Vazirani and Ratwani, 17th Edition, Khanna Publishers, 2012.
3. **"**Structural Analysis", Devadas Menon, Narosa Publishing House, Reprint 2012.
4. **"**Structural Analysis", T.S. Thandavamoorthy**,** Oxford University Press, 2011.
5. "Advanced Structural Analysis", Devadas Menon, Narosa Publishing House, 2012.
6. "Introductory Structural Analysis", C. K. Wang, Prentice Hall, 1981.
7. "Intermediate Structural Analysis", C. K. Wang, Tata McGraw Hill Publishing Co. Ltd., 2011.
8. "Structural Analysis", R.C Coates, M.G Coutie, and F.K Kong, ELBS/Van Nostrand Reinhold, 3rd Edition, Singapore, 1998.

UE17CV252 HYDRAULICS AND MACHINERY (4-0-0-0-4)

Course Objectives:

- This course develops a better understanding of dimensions, dimensional homogeneity, understand how flow in open channels differ from pressurized flow in pipes, learn how flow rates in open channels are measured, learn how to obtain expression for forces exerted by a liquid jet for various vane configurations, become familiar with essentials of hydroelectric power plant and introduction to different turbines, become familiar with components and working principle of centrifugal pumps.

Course Outcomes:

- Student is enabled to model, build prototype, perform suitable tests and report the performance of models encountered in field of hydraulics.
- Student will be able to recognize, evaluate the performance characteristics of turbines and pump.

Course Content:

1. **Dimensional analysis and model studies:** Dimensions and units, dimensional homogeneity, non-dimension of equations, dimensional analysis, Rayleigh's method, the method of repeating variables and the Buckingham's π theorem, model analysis, similitude, geometric, kinematic and dynamic similarities, Forces influencing hydraulic phenomena, inertia, viscous , gravity, pressure, surface tension or capillary, elastic, dimensionless numbers and their consequences in fluid mechanics, Reynolds's, Froude, Euler, mach, Weber, model laws, Reynolds, Froude, Euler, mach, Weber, classifications of models, undistorted, distorted, numerical problems.
2. **Open channel flow:** Classification of open-channel flows, uniform and varied flows, laminar and turbulent flows in channels, Froude number and wave speed, speed of surface waves, specific energy, conservation of mass and energy equations, uniform flow in channels, critical uniform flow, best hydraulic cross sections, rectangular channels, trapezoidal channels, Gradually varied flow, liquid surface profiles in open channels, rapidly varied flow and hydraulic jump, flow control and measurement, underflow gates, overflow gates, flow over a bump with negligible friction, broad-crested weir, sharp-crested weirs, numerical problems**.**
3. **Impact of jets:** Introduction, impulse momentum, force exerted by liquid jet on a stationary: vertical flat plate, inclined flat plate, curved vane, symmetrical curved vane at the centre, symmetrical curved vane tangentially at one of the tips, unsymmetrical curved vane tangentially at one of the tips, hinged plate, force exerted by liquid jet on a moving: flat plate, vertical flat plate, moving inclined flat plate, moving curved vane moving in the direction of jet. Force exerted by a liquid jet striking a series of vanes, introduction to concept of velocity triangle, numerical problems.
4. **Hydraulic Turbines:** Introduction, essential element of hydroelectric power plant, head and efficiencies of hydraulic turbines, hydraulic, volumetric, mechanical, overall, classification of hydraulic turbines. Pelton Wheel, work done and efficiencies of Pelton wheel, working proportions of Pelton wheel, reaction turbine, Francis Turbine, work done and efficiencies of Francis turbine, working proportions of Francis turbine, Kaplan turbine, draft tube theory, cavitations in hydraulic machines, specific speed for hydraulic turbines, characteristic curves of hydraulic turbines, main, operating, constant efficiency curves, governing of turbines, governing of Pelton wheel, numerical problems**.**
5. **Centrifugal pumps:** Introduction, components, working principle, work done, different heads in a pumping system, different efficiencies, manometric, volumetric, mechanical and overall, characteristics of a centrifugal pump, minimum speed for starting, multistage, pumps in series, and parallel, specific speed, characteristic curves, main, operating characteristics curves, constant efficiency curves, cavitations numerical problems.

Pre-requisites Course: None

Reference Books:

1. "Essentials of Fluid Mechanics – Fundamental and Applications", John M. Cimbala, Yunus A Cengel, McGraw Hill Education (India) Private limited, New Delhi, Edition 2013.
2. "A Text Book on Fluid Mechanicsand Hydraulic Machines", Sukumar Pati, Tata McGraw Hill Education (India) Private Limited, New Delhi, First Reprint 2013.
3. **"**A Textbook of Fluid Mechanics and Hydarulic Machines", RK Bansal,Laxmi Publications (P) Ltd., S.I. Units Revised 9th Edition, Bangalore 2013
4. "Schaum's Fluid Mechanics – 2500 Solved Problems", McGraw Hill, Edition, 1989.
5. "Fluid Mechanics", Pijush K. Kundu, Ira .M.Cohen, Academic Press, An Imprint of Elsiever, Edition, 2010
6. "Fluid Mechanics", Streeter, McGraw Hill Education (India) Private Limited, New Delhi, 9th Edition, 7th Reprint, 2013.
7. "Fluid Mechanics and Hydraulic Machines – Problems and Solutions", K. Subramanya, Tata Mcgraw Hill Education, New Delhi, Edition, 2011.
8. "Mechanics of Fluids", Irving, McGraw Hill, Boston, Edition, 2003.

UE17CV253
TRANSPORTATION ENGINEERING – HIGHWAY ENGINEERINGING (4-0-0-0-4)

Course Objective:

- Students will be able to identify different types of highways their development as per the Indian Roads Congress.
- They should be in a position to draw a cross section of a highway indicating the different parts.
- They will be in a position to explain different geometric design as well the materials and their properties used in construction of highway.

Course Outcomes:

- At the end of this course students will be in a position to design the elements of a Highway.
- Able to acquire and apply knowledge of properties of road aggregates in conducting various laboratory tests.
- Capable of remembering the properties and constitution of road binders.

Course Content:

1. **Introduction on Highway Engineering:** Highway engineering, scope of highway engineering, highway classification, factors controlling highway alignment, engineering survey for highway location. **Highway Economics and Finance**: Highway Development in India - Jayakar Committee Recommendations and Realizations, Concepts of Ongoing Highway Development Programmes at National Level, Institutions for Highway Development at National level - Indian Roads Congress, Highway Research Board, National Highway Authority of India, Ministry of Road Transport and Highways (MORTH) and Central Road Research Institute. Methods of Economic Analysis- Motor vehicle operation cost, Highway finance.
2. **Highway Geometric Design – I**: Importance, Terrain classification, Design speed, Factors affecting geometric design, Classification and Cross Section of Urban and Rural Roads (IRC), Highway Cross Sectional Elements – Right of Way, Carriage Way, Camber, Kerbs, Shoulders and Footpaths [IRC Standards].
3. **Highway Geometric Design – II**: Elements of highway, Sight Distance- Restrictions to sight distance- Stopping sight distance- Overtaking sight distance- overtaking zones- Examples on SSD and OSD- Sight distance at intersections, Factors affecting Sight

Distances, PIEV theory, Horizontal alignment-Radius of Curve-Super elevation – Extra widening- Transition curve and its length, setback distance – Examples, Vertical alignment-Gradient-summit and valley curves with examples.

4. **Highway Materials and Construction Practice:** Desirable Properties and Testing of Highway Materials: Soil – California Bearing Ratio Test, Field Density Test - Aggregate - Crushing, Abrasion, Impact Tests, Water absorption, Flakiness and Elongation indices and Stone polishing value test - Bitumen - Penetration, Ductility, Viscosity, Binder content and Softening point Tests. - Construction Practice - Water Bound Macadam Road, Bituminous Road and Cement Concrete Road [as per IRC and MORTH specifications] - Highway Drainage [IRC Recommendations]
5. **Pavements Design**: Pavement types, component parts of flexible and rigid pavements and their functions, design factors, ESWL and its determination-Examples, Flexible pavement- Design of flexible pavements as per IRC;37-2001-Examples, Rigid pavement-Westergaard's equations for load and temperature stresses-Examples- Design of slab thickness only as per IRC:58-2002

Note: Computer Lab using highway geometric design software to be carried out.

Pre-requisites Courses: None

Reference Books:

1. "Highway Engineering", S K Khanna, C E G Justo, A Veeraraghavan, 11h Edition Nemchand Bros, Rookie, 2015.
2. "Highway Engineering",L R Kadiyali , 6th Edition, Khanna Publishers, New Delhi, 2011.
3. "Principles of Pavement Design", E.J. Yoder, 2nd Edition, John Wiley & Sons, Inc. New York, 1975.
4. "Pavement Analysis and Design", Yang H. Huang, Prentice Hall, Edition, 2003.
5. "Principles of Urban Transportation System Planning", Hutchinson, B.G., McGraw-Hill, 1974
6. "Traffic Engineering", McShane W R &Roess R P, Prentice-Hall, NJ, 2010.
7. "Urban Transit: Operations, Planning and Economics", Vukan R. Vuchic, Wiley, 2005.
8. "Transportation Engineering & Planning", C.S. Papacostas, P.D. Prevedouros, Prentice Hall of India Pvt. Ltd, 2006.
9. IRC Standards (IRC 37 - 2001 & IRC 58 -1998)
10. Bureau of Indian Standards (BIS) Publications on Highway Materials Specifications for Road and Bridges, MORTH (India),

UE17CV254:
CONCRETE TECHNOLOGY (3–0–2–0–4)

Course Objectives:

- To learn basic concept of concrete in terms of strength elasticity, creep shrinkage & durability.
- To learn different concrete design methods
- To learn different test on hardened concrete
- To know about latest development in special concrete and concreting techniques.

Course Outcomes:

On completion of this course, students are able to

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of Concrete mix design
- Design and develop analytical skills.
- Summarize the Light Weight concrete, Fiber reinforced concrete and High Performance concrete.

Course Content:

1. **Fresh Concrete:** Workability, Measurement of workability, segregation, bleeding, process of manufacturing of concrete, curing of concrete, finishing of concrete.
2. **Strength of concrete:** Water cement ratio, gel space ratio, accelerated curing test, gain of strength with age, maturity concept of concreteand problems, effect of maximum size of aggregate, relation between compressive strength, bond strength, aggregate cement bond strength, high strength concrete, High performance concrete.
3. **Elasticity, Creep, Shrinkage & Durability of concrete:** Elastic properties of aggregate, creep,Shrinkage.**Durability**: Strength and durability relationship, volume change in concrete, permeability of concrete(Interaction between permeability, volume change& cracking), Factor contributing cracks in concrete, mass concrete, freezing and thawing, transition zone in concrete, chemical action in concrete, sulphate attack, alkali-aggregate reaction, chloride attack, concreting in sea water carbonation.
4. **Concrete mix design:** Concept of mix design ACI Method , IS 10262-2000 Method (Design problems).
5. **Testing of hardened concrete:** Different tests on destructive and non -destructive methods. **Special concrete and concreting methods:** Lightweight concrete, aerated concrete, no fines concrete, high density concrete, fiber reinforced concrete, self compacting concrete geopolymer concrete.

Prerequisites Courses: None

Reference Books:

1. "Concrete Technology", M.S. Shetty, S.Chand and Co., Reprint Edition, 2013.
2. IS10262-2009 Guidelines for Concrete Mix Proportioning.
3. "Properties of Concrete A.M. Neville,", ELBS Edition, Longman Ltd., London
4. "Concrete", P.K. Mehta and P J M Monteiro, Prentice Hall, New Jersey, 2004.
5. "Concrete Technology", M.L .Gambhir, Dhanpat Rai & Sons, New Delhi, 1987.

UE17CV255:
CONCRETE LABORATORY (0-0-2-0-1)

Course Objectives:

- To know about properties of materials used in construction
- To know about the properties of fresh and hardened concrete.
- To know about non destructive test

Course Outcomes:

- On completion of this course, students are able to:
- Understand the basics of Material testing methods and procedures followed in the industry.

Course Content:

1. **Aggregates**: Specific Gravity of Aggregates, Water Absorption Test for Aggregates.
2. **Cement**: Normal Consistency, Setting time, Soundness by Autoclave method, Compression strength test and Air permeability test for fineness, Specific gravity of cement.
3. **Fresh concrete**: Workability – Slump, Compaction factor and Vee-Bee test workability test for SCC.
4. **Hardened concrete**: Mix Design, Compression strength and Split tensile tests. Test on flexural strength of RCC beams, Permeability of concrete. Air permeability test for fineness
5. **Non destructive test**: Ultra Sonic Pulse Velocity Test (PUNDIT) , Rebound hammer test

Prerequisites Courses: None

Reference Books:

1. "Concrete Manual" , M. L. Gambhir , Dhanpat Rai & Sons New Delhi, 1992.
2. IS2386:(Part 1 to part 5) R2016 Methods of testing aggregates for concrete
3. Laboratory Manual prepared by Department of Civil Engineering, PESU.

UE17CV256: FLUID MECHANICS & MACHINERY LABORATORY (0-0-2-0-1)

Course Objectives:

- Fluid mechanics laboratory experiments are setup so that experiments can be performed to compliment the theoretical information taught in the lecture course.

Course Outcome:

- On completion of the course the student will be able to design an experiment further theories encountered in application of hydraulics to Civil Engineering

Course Content:

1. **Flow experiments:** Verification of Bernoulli's equation, Determination of metacentric height, Reynold's number, open channel flow, Determination of major losses in pipes Determination of minor losses in pipes .Calibration of venturimeter .Calibration of Orifice meter. Calibration of notches (90º V Notch, Rectangular).Calibration of Nozzle Meter .
2. **Experiments on fluid machinery:** Performance Analysis of a single stage Centrifugal pump. Performance Analysis of a Multi stage Centrifugal pump. Impact of Jets (Flat vane, Semi-circular Vane). Performance Analysis on a Pelton wheel. Performance Analysis of Francis Turbine. Performance Analysis of Kaplan turbine.

Pre-requisites Course: None

Reference Books:

1. "Experiments in Fluid Mechanics", Sarbjit Singh- PHI Pvt. Ltd., New Delhi, 2009.
2. Laboratory Manual prepared by Department of Civil Engineering, PESU.

UE16CV301: DESIGN AND DETAILING OF RC STRUCTURES (3- 0- 2- 0 -4)

Course Objectives:

- Perform the analysis and design of basic RCC structural elements like beams, slabs, columns, footings and staircases.
- Understand various design philosophies: working stress, ultimate load and limit state methods
- Usage of IS codes of practice to design RCC structures by civil engineers in India

Course Outcomes:

On completion of this course, students are able to:

- Design basic RCC structural elements- Beams, Slabs, Columns and Footings

Course Content:

1. **Methods of Design of Concrete Structures:** Introduction, Working Stress Method, Load Factor Method, Limit State Method, Durability aspects.**Limit State Design:** Introduction, Principles of Limit State Design, Procedure for design for limit states, Characteristic Load and Characteristic Strengths, Partial Safety Factors for Loads and Material Strengths, Stress-Strain Characteristics of Concrete, Stress-Strain Characteristics of reinforcement bars, Summary of Design by Limit State Method. **Theory of Singly Reinforced Members in Bending:** Introduction, Limit State of Collapse by Flexure, Balanced, Under reinforced and Over reinforced Sections, Equivalent Compression Block in Concrete, Determination of Constants k_1 and k_2 for Compression Stress Block, Depth of Neutral Axis of a given Beam, Importance of Limiting x/d Ratios, Calculation of M_u by Strain Compatibility Method, Expression for x/d for given b, d and M_u, Expressions for Lever Arm Depth, Calculation of Steel Area for given b,d and M_u for Depths Larger than the Minimum Required, Guidelines for Choosing Width, Depth and Reinforcement of Beams.
2. **Design & Analysis of Singly Reinforced Beams:** Introduction, Methods of Design and Analysis, Procedure for Analysis of Section by Strain Compatibility (Trial & Error Method), Analysis and Design by Formulae (Method 2), Necessity for Specifying Maximum and Minimum Tension Steel in Beams, Numerical Problems. **Design & Analysis of Doubly Reinforced Beams:** Introduction, Basic Considerations, Action of Doubly Reinforced Beams, Analysis and Design of Doubly Reinforced Beams, Strain Compatibility, Use of Formulae Steel Beam Theory, Numerical Problems.
3. **Design for Shear:** Introduction, Types of Shear Failures, Calculation of Shear Stress, Design Shear Strength in Concrete Beams, Types of Shear Reinforcements, Rules for Minimum Shear Reinforcement, General Procedure for Design of Beams for Shear, Design of Bent-up Bars as Shear Reinforcements, Enhanced Shear Near Supports – Critical Sections for Shear, Detailing of Steel, Numerical Problems. **Design of Flanged Beams:** Introduction, Effective Flange Width, Basis of Design and Analysis of Flanged Beams, T Beam Formulae for Analysis and Design, Minimum and Maximum Steel in Flanged beams, Transverse Reinforcement, Numerical Problems.
4. **Design of One-way Slabs:** Introduction, Design of One-way continuous Slabs with UDL Using Coefficients, Numerical Problems**. Design of Two-Way Slabs:** Introduction, Action of Two-way Slabs, Procedure for Design of Two-way Simply-supported Slabs, Procedure for Design of Two-way Restrained Slabs (with Torsion at Corners) – Numerical Examples**.**
5. **Design of Axially Loaded Short Columns:** Introduction, Short Columns, Unsupported and Effective Length (Height) of Columns, Slenderness Limits for Columns, Checking Accidental Eccentricity, Design of Short Column, Strength of Helical Reinforced Short Column, Placements of Steel in Circular Columns, Detailing of Columns**. Design of Footings:** Introduction, Design Loads for Foundation Design, Basis of Design of Footings, Soil Pressure on Foundations, Conventional Analysis of Foundations Subjected to Vertical Load and Moments, Design of Independent Footings, Minimum Depth and Steel Requirements, Procedure for Design, Detailing of Steel, Design of Rectangular Footings**.**

Prerequisite Courses: UE16CV201 - Strength of Materials

Reference Books:

1. "Limit State Design of Reinforced Concrete", P.C Varghese, 2nd Edition, Prentice Hall of India, 2013.
2. "Design of Reinforced Concrete Structures", N Subramanian, Oxford University Press, 1st Edition, Dec. 2013.
3. "Reinforced Concrete Design", Unnikrishnan Pillai and Devdas Menon, Tata McGraw Hill, 3rd Edition, 2014.
4. "Design of Reinforced Concrete Structures (IS:456-2000)", N. Krishna Raju, CBS Publishers & Distributors Pvt Ltd., 3rd Edition, 2014.
5. IS 456 –2000 Indian Standard Plain & Reinforced concrete Code of Practice

6. SP – 24-1983, Explanatory Handbook on Indian Standard Code of Practice for Plain and Reinforced Concrete (IS 456:1978)
7. SP –16- 1984. Design Aids for Reinforced Concrete to IS 456:1978
8. SP – 34- 1987(Reprint 1999) Hand book on Concrete Reinforcement & Detailing.

UE16CV302: COMPUTATIONAL STRUCTURAL ANALYSIS (4-0-0-0-4)

Course Objectives:

- To learn the different methods of analysis of indeterminate structure
- To learn basic concepts of matrix methods of structural analysis
- To learn basics of structural dynamics

Course Outcomes:

On completion of this course, students are able to:

- Analyze indeterminate structures
- Develop flexibility and stiffness matrix
- Behavior of structure subjected to dynamic load

Course Content:

1. **Slope Deflection Method:** Development of slope and deflection equations, analysis of continuous beams, frames with and without lateral translation of joints.
2. **Moment Distribution Method:** Review of force method and displacement methods of analysis. Introduction, definition of terms – distribution factor, carryover factor, development of method and Analysis of beams and Orthogonal rigid jointed plane frames (sway and non-sway) with kinematic redundancy less than/equal to three. (Members to be axially rigid).
3. **Kani's Method:** Introduction, Basic concept, analysis of continuous beams, beams with overhang and analysis of rigid frames of different geometry – frames without sway and with sway.
4. **Stiffness Matrix Method:** Element and global stiffness matrices, Co-ordinate transformations, Rotation matrix, Transformations of stiffness matrices, load vectors and displacement vectors. Development of stiffness matrix for plane truss element and axially rigid plane framed structural elements and analysis of continuous beams, plane truss and axially rigid plane frames by stiffness matrix method with static indeterminacy ≤ 3.
5. **Introduction to Finite Element Method:** Introduction, Finite element analysis – bars and trusses. Numerical covering bars and trusses (2D)

Prerequisite Courses: UE16CV201 Strength of Materials

Reference Books:

1. "Basic Structural Analysis", C S Reddy, Tata McGraw Hill, New Delhi, 3rd Edition, 2012.
2. "Analysis of Structures", Vazirani and Ratwani, 17th Edition, Khanna Publishers, 2012.
3. "Structural Analysis", T.S. Thandavamoorthy, Oxford University Press, 2011.
4. "Structural Analysis", Devdas Menon, Narosa Publishing House, 2012.
5. "Matrix Methods of Structural Analysis", C K Wang, Tata McGraw Hill Publication, 1970
6. "Comprehensive Structural Analysis", R Vaidyanath, P Perumal, Laxmi Publications, New Delhi, Volume II, 2004.
7. "Structural Dynamics", Mario Paz, CBS Publications, 2012
8. "Structural Analysis", R.C Coates, M.G Coutie and F.K Kong, ELBS/ Van Nostrand Reinhold, 3rd Edition, Singapore, 1998.

UE16CV303 FUNDAMENTALS OF GEO-TECHNICAL ENGINEERING (4-0-0-0-4)

Course objectives:

- To understand fundamentals of geotechnical engineering.
- It helps students understand weathering process of rocks, soil formation, different types of soils, soil structure, basic properties of soils and soil mechanics.
- This course covers soil water, permeability and seepage, compaction of soil, compressibility and consolidation process, shear strength properties of soil.
- This course equips students with problem solving abilities, calculations of basic soil properties, measurement techniques and its practical applications. Finally, with this foundation, students should be well equipped to learn related subjects and their applications in the higher semesters.

Course Outcome:

- On completion of this course the student should be in a position to determine index and Engineering properties of soil by various methods.

Course content:

1. **Introduction:** Definition of soil mechanics, historical review, weathering process,soil formation, types and classification of soils in India, principal types of soil, properties of soil components. Soil Mass and Preliminary definitions: Constituents of soil mass, water content, density and unit weight of soil solids, specific gravity, voids ratio, porosity, degree of saturation, densities and unit weights of soil mass - bulk, dry, saturated & submerged and their inter relationships, density index.
2. **Index Properties of Soil:** Water content determination, specific gravity determination, particle size determination, soil consistency (liquid limit by Casagrande and cone penetration method, plastic limit and shrinkage limit), identification and description of coarse grained and fine-grained soils. Classification of soils: Purpose of soil classification, particle size classification – MIT classification, textural classification. IS classification - plasticity chart and its importance. Soil structure: Soil particles, electrical forces, inter particle forces, particle arrangement in coarse grained soils, clays and composite soils.
3. **Soil water**: Held water: structural water, adsorbed water, capillary water. Free water: Effective and neutral pressures, equilibrium water content, frost action. Permeability and Seepage: Head, gradient and potential, Darcy's law, coefficient of permeability, factors affecting permeability, determination of permeability (laboratory), average permeability of stratified soils, seepage pressure and quick condition.
4. **Compaction of Soil**: Definition, standard and modified Proctor's compaction tests, factors affecting compaction, effect of compaction on soil properties, measurement of field compaction and field compaction methods and control. Compressibility and Consolidation of Soil: Compressibility, compression of laterally confined soil and undisturbed specimen, consolidation, Terzaghi's consolidation theory-assumption and limitations (no derivation), normally consolidated, under consolidated and over consolidated soils, pre-consolidation pressure and its determination by Casagrande's method. Consolidation characteristics of soil (C_c, a_v, m_v and C_v). Consolidation test: determination of consolidation characteristics of soil-compression index and coefficient of consolidation (square root of time fitting method, logarithmic time fitting method).
5. **Shear strength of soil** : Review of Mohr circle, Mohr's strength theory, shear strength of soil, Mohr-coulomb theory, conventional failure envelope, concept of effective stress and

total stress, measurement of shear parameters- direct shear test, unconfined compression test, tri-axial compression test and vane shear test, test under different drainage conditions, concept of pore pressure and pore pressure parameters.

Prerequisite Courses: None

References books:

1. "Soil Engineering; in theory and practice; Fundamentals and general principles", Alam Singh, Vol 1, 4th Edition, CBS Publishers and Distributors Pvt. Ltd., 2012.
2. "Soil Mechanics and Foundation Engineering (Geotechnical Engineering)", Dr. K. R. Arora, 7th Edition, Standard Publishers Distributors, 2011.
3. "Soil Mechanics and Foundation Engineering; Geotechnical Engineering Series".,V.N.S Murthy 4th Edition, UBS Publishers and Distributors, New Delhi, 2012.
4. "Soil Mechanics and Foundations", B.C.Punmia, Ashok Kumar Jain, Arun Kumar Jain 16th Edition, Laxmi Publications, New Delhi, 2005.
5. "Geotechnical Engineering", Braja, M. Das,5th Edition, Thomson Business Information India (P) Ltd., India, 2002.
6. "Foundation Analysis and Design", J.E Bowles5th Edition, McGraw Hill Pub. Co. New York, 1996.
7. "Basic and Applied Soil Mechanics", Gopal Ranjan and A.S.R Rao, New Age International (P) Ltd., New Delhi, 2012.
8. "Geotechnical Engineering", C Venkatrahmaiah, New Age International Publishers, New Delhi, 2011.
9. "Soil Mechanics and Foundation Engineering in SI Units", S.K.Garg, 7th Edition, Khanna Publishers, New Delhi, Reprint 2010.

UE16CV304:
FLUID MECHANICS & MACHINERY LABORATORY
(0-0-2-0-1)

Course Objectives:

- Fluid mechanics laboratory experiments are setup so that experiments can be performed to compliment the theoretical information taught in the lecture course.

Course Outcome:

- On completion of the course the student will be able to design an experiment to further theories encountered in application of hydraulics to Civil Engineering

Course Content:

1. **Flow experiments:** Verification of Bernoulli's equation, Determination of metacentric height, Reynold's number, open channel flow, Determination of major losses in pipes . Determination of minor losses in pipes .Calibration of venturimeter .Calibration of Orifice meter. Calibration of notches (90º V Notch, Rectangular). Calibration of Nozzle Meter .
2. **Experiments on fluid machinery:** Performance Analysis of a single stage Centrifugal pump. Performance Analysis of a Multi stage Centrifugal pump. Impact of Jets (Flat vane, Semi-circular Vane). Performance Analysis on a Pelton wheel. Performance Analysis of Francis Turbine. Performance Analysis of Kaplan turbine.

Pre-requisites Course: None

Reference Books:

1. "Experiments in Fluid Mechanics", Sarbjit Singh- PHI Pvt. Ltd., New Delhi, 2009.
2. Laboratory Manual prepared by Department of Civil Engineering, PESU.

UE16CV305:
COMPUTER AIDED STRUCTURES LABORATORY
(0-0-2-0-1)

Course Objectives:

- Explain importance of commercially available design and analysis software.
- Exposure to commercially available software like ETABS, ANSYS, STAAD PRO, etc
- Perform analysis, design iterations and design optimization

Course Outcomes:

- Use commercial software like STAAD PRO, ETABS, ANSYS etc and perform analysis, design
- Create more robust designs.

Course Contents:

1. Introduction to STAAD Pro.
2. Modelling & Analysis of Determinate Beams
3. Modelling & Analysis of Indeterminate Beams
4. Modelling & Analysis of Frames without sway
5. Modelling & Analysis of Frames with sway
6. Modelling Analysis & Design of R C Framed structures

Prerequisite Courses: None

Reference Books:

1. "Dynamics of Structures", A K Chopra, Pearson Education, Indian Branch Delhi, 5th Edition, 2007.
2. "Basics Structural Analysis", C.S. Reddy, Tata McGraw Hill Education, 3rd Edition, 1994
3. "Earthquake Resistant Design of Structure", S.K Duggal, Oxford University Press, 1st Edition, 2012.
4. "Theory of Structures", S. Ramamrutham and R. Narayan, Dhanpat Rai and Sons, 9th Reprint Edition, 2014.
5. STAAD PRO Laboratory Manual prepared by the Department of Civil Engineering, PESU.

UE16CV311:
HYDRAULICS AND MACHINERY (4-0-0-0-4)

Course Objectives:

- This course develops a better understanding of dimensions, dimensional homogeneity, understand how flow in open channels differ from pressurized flow in pipes, learn how flow rates in open channels are measured, learn how to obtain expression for forces exerted by a liquid jet for various vane configurations, become familiar with essentials of hydroelectric power plant and introduction to different turbines, become familiar with components and working principle of centrifugal pumps.

Course Outcomes:

- Student is enabled to model, build prototype, perform suitable tests and report the performance of models encountered in field of hydraulics.
- Student will be able to recognize, evaluate the performance characteristics of turbines and pump.

Course Content:

1. **Dimensional analysis and model studies:** Dimensions and units, dimensional homogeneity, non-dimension of equations, dimensional analysis, Rayleigh's method, the method of repeating variables and the Buckingham's π theorem, model analysis, similitude, geometric, kinematic and dynamic similarities, Forces influencing hydraulic phenomena, inertia,

viscous , gravity, pressure, surface tension or capillary, elastic, dimensionless numbers and their consequences in fluid mechanics, Reynolds's, Froude, Euler, mach, Weber, model laws, Reynolds, Froude, Euler, mach, Weber, classifications of models, undistorted, distorted, numerical problems.

2. **Open channel flow:** Classification of open-channel flows, uniform and varied flows, laminar and turbulent flows in channels, Froude number and wave speed, speed of surface waves, specific energy, conservation of mass and energy equations, uniform flow in channels, critical uniform flow, best hydraulic cross sections, rectangular channels, trapezoidal channels, Gradually varied flow, liquid surface profiles in open channels, rapidly varied flow and hydraulic jump, flow control and measurement, underflow gates, overflow gates, flow over a bump with negligible friction, broad-crested weir, sharp-crested weirs, numerical problems**.**
3. **Impact of jets:** Introduction, impulse momentum, force exerted by liquid jet on a stationary: vertical flat plate, inclined flat plate, curved vane, symmetrical curved vane at the centre, symmetrical curved vane tangentially at one of the tips, unsymmetrical curved vane tangentially at one of the tips, hinged plate, force exerted by liquid jet on a moving: flat plate, vertical flat plate, moving inclined flat plate, moving curved vane moving in the direction of jet. Force exerted by a liquid jet striking a series of vanes, introduction to concept of velocity triangle, numerical problems.
4. **Hydraulic Turbines:** Introduction, essential element of hydroelectric power plant, head and efficiencies of hydraulic turbines, hydraulic, volumetric, mechanical, overall, classification of hydraulic turbines. Pelton Wheel, work done and efficiencies of Pelton wheel, working proportions of Pelton wheel, reaction turbine, Francis Turbine, work done and efficiencies of Francis turbine, working proportions of Francis turbine, Kaplan turbine, draft tube theory, cavitations in hydraulic machines, specific speed for hydraulic turbines, characteristic curves of hydraulic turbines, main, operating, constant efficiency curves, governing of turbines, governing of Pelton wheel, numerical problems**.**
5. **Centrifugal pumps:** Introduction, components, working principle, work done, different heads in a pumping system, different efficiencies, manometric, volumetric, mechanical and overall, characteristics of a centrifugal pump, minimum speed for starting, multistage, pumps in series, and parallel, specific speed, characteristic curves, main, operating characteristics curves, constant efficiency curves, cavitations numerical problems.

Pre-requisites Course: None

Reference Books:

1. "Essentials of Fluid Mechanics – Fundamental and Applications", John M. Cimbala, Yunus A Cengel, McGraw Hill Education (India) Private limited, New Delhi, Edition 2013.
2. "A Text Book on Fluid Mechanics and Hydraulic Machines", Sukumar Pati, Tata McGraw Hill Education (India) Private Limited, New Delhi, First Reprint 2013.
3. **"**A Textbook of Fluid Mechanics and Hydarulic Machines", RK Bansal, Laxmi Publications (P) Ltd., S.I. Units Revised, 9th Edition, Bangalore 2013.
4. "Schaum's Fluid Mechanics – 2500 Solved Problems", McGraw Hill, 1989.
5. "Fluid Mechanics", Pijush K. Kundu, Ira. M. Cohen, Academic Press, An Imprint of Elsiever, 2010.
6. "Fluid Mechanics", Streeter, McGraw Hill Education (India) Private Limited, New Delhi, 9th Edition, 7th Reprint, 2013.
7. "Fluid Mechanics and Hydraulic Machines – Problems and Solutions", K. Subramanya, Tata Mcgraw Hill Education, New Delhi 2011.
8. "Mechanics of Fluids", Irving, McGraw Hill, Boston, 2003.

UE16CV312:
NUMERICAL METHODS IN CIVIL ENGINEERING
(4-0-0-0-4)

Course Objectives:

- This course intends to provide a broad background to numerical methods common to various branches of civil engineering.
- Apply pertinent mathematical and engineering principles to analyze.
- Solve problems in an organized and coherent manner and elucidate the meaning of the solution in the context of the problem.
- introduce the numerical solution of partial differential equations, after a brief review of canonical partial differential equations

Course Outcomes:

- Develop skill to determine resultants and apply conditions of static equilibrium to plane force systems.
- Develop skill to identify and quantify all forces associated with a static frame work.
- Develop skill to identify, formulate and solve engineering Civil Engineering problems

Course Content:

1. **Introduction to Numerical Methods:** Why study numerical methods, Sources of error in numerical solutions: truncation error, round off error. Order of accuracy - Taylor series expansion. **Direct Solution of Linear systems**: Gauss elimination, Gauss Jordan elimination. Pivoting, inaccuracies due to pivoting. Factorization, Cholesky decomposition. Diagonal dominance, condition number, ill conditioned matrices, **Iterative solution of Linear systems:** Jacobi iteration, Gauss Seidel iteration, Convergence criteria.
2. **Direct Solution of Non-Linear Systems:** Newton Raphson iterations to find roots of a 1D nonlinear equation. Generalization to multiple dimensions. Newton Iterations, Quasi Newton iterations. Local and global minimum, rates of convergence, convergence criteria. **Iterative Solution of Non-Linear systems**: Conjugate gradient. Preconditioning.
3. **Partial Differential Equations**: Introduction to partial differential equations. Definitions & classifications of first and second order equations. Examples of analytical solutions. Method of characteristics.
4. **Numerical Differentiation:** Difference operators (forward, backward and central difference). Stability and accuracy of solutions. Application of finite difference operators to solve initial and boundary value problems.
5. **Introduction to the Finite Element Method as a method to solve partial differential equations:** Strong form of the differential equation. Weak form. Galerkin method: the finite element approximation. Interpolation functions: smoothness, continuity, completeness, Lagrange polynomials. Numerical quadrature: Trapezoidal rule, simpsons rule, Gauss quadrature**.**

Pre-requisites Course: None

Reference Books:

1. "Numerical Methods", D. Dahlquist, and A. Bork, Dan Prentice-Hall, Englewood Cliffs, NJ, 1974.
2. "Numerical Methods for Engineering Problems", N Krishna Raju and Dr. K U Muttu, Macmillan Publishers India Limited, 2000.
3. "The Finite Element Method", T. J. R. Hughes, Prentice Hall, Englewood Cliffs, NJ, 1987.
4. "Green's functions and Boundary Value Problems", I. Stakgold, Wiley, 1998.

UE16CV313
ADVANCED CONSTRUCTION TECHNOLOGY
(4–0–0–0–4)

Course objectives:

- To know about modern techniques used in construction industry.
- To understand about building maintenance

Course outcomes: On successfully completing this course:

- Students are able to analyze problems relating to excavation
- Students are able to analyze the cause for cracks

Course Content:

1. **Pre cast system:** Terms defined : prefabricated building, module, composite members, modular coordination, Advantages and Disadvantages of Prefabrication system ,Types of pre-fabricated building - load bearing wall type - frame type Stages of precasting – preparation and storage of materials - moulding and curing; Pre fabrication methods: individual method, battery form method, tilting mould method , Handling during transport and storage - Handling arrangement - Transport - inside the factory - stacking yard to erection site, Erection works to be carried out - Equipment required.
2. **Deep Excavation:** Definition-Problems encountered in deep excavations-Methods of Timbering-stay bracing, Box sheeting, vertical sheeting, runners and sheet piling-Precaution to be taken during timbering-Dewatering of the foundation trenches-Methods –Pumping, Provision of sumps and side drain cement grouting, freezing process, electro-osmosis process.
3. **Cracks in Buildings:** Cracks in general - horizontal crack in masonry and plaster - vertical cracks at the bearing R.C.C beams or pillars - transverse cracks in R.C.C slab and sunshade-causes and repairs-Cracks in concrete – Types- Intrinsic cracking-structural cracking – plastic cracks -thermal contraction cracks - sulphate attack cracks – alkali aggregate reaction cracks – shrinkage cracks – causes and remedies. Repair techniques: Materials for repair- Epoxy adhesive – injection and mortars – Repair and strengthening of concrete structures by bonded steel plates.
4. **Fire protection in buildings**: Introduction, causes and effects of fire, precautionary measures to minimize dangers of fire factors to be considered, Fire resisting properties of common building material alarm system - protection of openings - common wall stair-floor fire extinguishing arrangement – fire protection systems – types - Emergency exit arrangements - Strong room construction.
5. **Pre-Engineering and composite construction:** Planning of earthquake resistant building, Construction of walls –provision of corner reinforcement, Construction of beams and columns, Base isolation Special Structures.

Prerequisites Courses: None

Reference Books:

1. "Maintenance and Repair of Buildings", R.K.Guha, New Central Book Agency (p) Ltd-Calcutta, 2002.
2. "Construction technology", R. Chudley, 4th Edition, Pearson publication
3. "Building Construction Handbook" R. Chudley (revised by R. Greeno), 3rd edition Longman Group, England, 1999.
4. "Building Construction", S. P Arora, S.P Bindra 2nd Edition, Danpat Rai Publication.
5. "Concrete Technology", M.S. Shetty, 7th Edition S. Chand & Co, New Delhi, 2004.
6. "Fundamentals building construction materials and methods", Edward Allen, Joseph Iona, 6th Edition, Wiley.
7. IS 1893–2002: Criteria for Earthquake Resistant Design of Structures (5th revision).
8. IS4928–1993: Code of practice for Earthquake Resistant Design and Construction of Buildings. (2nd revision).
9. IS 13827–1992: Guidelines for Improving Earthquake Resistance of Low Strength Masonry Building.
10. IS: 3920–1997: Code of practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces.
11. IS: 13935–1993: Guidelines for Repair and Seismic Strengthening.

UE16CV321:
ALTERNATIVE BUILDING MATERIALS AND TECHNOLOGY (4-0-0-0-4)

Course Objectives:

- To learn about different alternative building materials and technology
- To learn basic concepts of structural masonry and cost effectiveness
- To learn about the equipments used in manufacturing alternative materials.

Course Outcomes:

On completion of this course, students are able to:

- Understand the environmental issues created by building materials
- Suggest building materials based on locality, climate and cost effectiveness

Course Content:

1. **Introduction:** Environmental issues concerned to building materials Environmental friendly and cost-effective building technologies. Requirements for building of different climatic regions. **Alternative Building Materials:** Characteristics of different masonry units like Stones, Laterite blocks, Fal-G Blocks, concrete blocks, and Stabilized mud block. Building materials from Agro and Industrial wastes and recycled concrete aggregates.
2. **Alternative Building Technologies:** Alternative for wall construction Types, Construction method, Masonry mortars (type, preparation and properties Alternative roofing systems (concepts), filler slab, composite beam panel roofs, masonry vaults and domes
3. **Structural Masonry:** Compressive strength of masonry elements**,** Factors affecting compressive strength**,** Strength of units, prisms / wallettes and walls**,** Effect of brick work bond on strength**,** Bond strength of masonry: Flexure and shear**,** Elastic properties of masonry materials and masonry IS Code provisions**,** Design of masonry compression elements**,** Concepts in lateral load resistance.
4. **Precast Construction and Pre-Engineered Buildings:** Need and types of precast construction, modular coordination, basic module, planning and design modules and modular grid systems. Precast elements- Hollow Core Slabs, TT, ST, Joists and Planks, Beams and Girders – R, L, I, IT, U shapes, Columns – Single Storey, Multi Storey (continuous), Wall Panels – Solid, Hollow core, Ribbed, Sandwich.Floor-panel connections, Floor to beam connections, beam to column connections, beam to beam connections, column to column connections, column to foundation connections, panel to panel connections, Pre-Engineered buildings.
5. **Steel-Concrete Composite Concepts & RC Monolithic Construction :**Steel concrete Composite - Profiled Sheeting with concrete topping – Details and behavior, Composite beams – Structural behavior – types - effect of construction methods – Shored -unshored, Composite Columns – Filled and Encased, National Building Code Specifications, Monolithic constructions

Pre-requisites Course: None

Reference Books:

1. "Alternative Building Materials and Technologies", K.S. Jagadish and B.V. Venkatarama Reddy, 1st Edition, New Age International (P) Ltd., 2013.
2. "Structural Masonry", Arnold W. Hendry, 2nd Edition" Palgrave Macmillan, 1990.
3. IS 1905-1987, Indian Standard Code of Practice for Structural Use of Unreinforced Masonry, Bureau of Indian Standards.
4. IS 2250-1981, Indian Standard Code of Practice for Preparation and Use of Masonry Mortars, Bureau of Indian Standards.

UE16CV322: SOFT COMPUTING IN CIVIL ENGINEERING (4-0-0-0-4)

Course Objectives:

- Learn various soft computing frame works.
- Understand different soft computing techniques like Neural Networks, Support Vector machines, Genetic Algorithms, Fuzzy Logic.
- Recognize the feasibility of applying a soft computing methodology for a particular problem.
- Effectively use existing software tools to solve real problems using a soft computing approach.

Course Outcomes:

- Apply soft computing techniques to solve civil engineering problems.

Course Content:

1. **Introduction:** What is soft computing?, characteristics of neuro computing and soft computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing in civil engineering.
2. **Artificial Neural Networks (ANN):** What is artificial neural network? human brain, models of a neuron, neural networks viewed as directed graphs, feedback, network architectures, learning processes, learning tasks, application.
3. **Support vector machines (SVM)** What is SVM? optimal hyperplane for linearly separable patterns, optimal hyperplane for non-separable patterns, support vector machine viewed as a Kernel Machine, design of support vector machines, application.
4. **Fuzzy Logic** Introduction, classical sets and fuzzy sets, basic concepts in fuzzy set theory – operations of fuzzy sets, classical relations and fuzzy relations, membership functions and its properties, fuzzy logic principles, fuzzy inference, fuzzy rule-based systems, fuzzification and defuzzification, application.
5. **Genetic Algorithms (GA)**: Introduction, fundamentals, population, fitness function, parent selection, crossover, mutation, survivor selection, termination condition, application.

Prerequisite course: None

Reference books:

1. "Engineering Optimization- Theory and Practice", S S Rao, 4th edition, John Wiley & sons, 2009.
2. "Soft Computing in Water Resources Engineering: ANN, FL and GA", G Tayfur, WIT Press, UK, 2012.
3. "Neural Networks and Learning Machines", S.Haykins, 3rd edition, Prentice Hall of India, 2009.
4. "Fuzzy logic with engineering application", Ross T.J., McGraw Hill International Edition, 1995.
5. "System identification in structural engineering", GF Sirca & H Adeli, Scientia Iranica, A, 19(6), 1355-1364, 2012.
6. "Computational design optimization of concrete mixtures-A review", MA DeRousseau, JR Kasprzyk, WV Srubar, Cement & Concrete Res.- Elsevier, 109, 42-53, 2018.

UE16CV323: ADVANCE MECHANICS (4-0-0-0-4)

Course Objectives:

- The primary purpose of the study of engineering mechanics is to study the capacity to predict the effects of force and motion while carrying out the creative design functions of engineering. This capacity requires more than a mere knowledge of the physical and mathematical principle of mechanics. Also required is the ability to visualize physical configurations in terms of real materials, actual constraints and the practical limitations which govern the behavior of machines and structures. One of the primary objectives in a mechanics course is to help the student this ability to visualize, which is vital to problem formulation.

Course Outcomes:

- Develop skill to determine resultants and apply conditions of static equilibrium to 3 D force systems.
- Develop skill to identify and quantify all forces associated with a static frame work in 3 D.
- Develop skill to identify, formulate and solve engineering problems in 3 D.

Course Content:

1. **Three-dimensional force systems**: Rectangular Components, Moment and Couple, Resultants, Numerical problems.
2. **Equilibrium in Three Dimensions:** Equilibrium Conditions, Numerical problems.
3. **Structures:** Method of sections, Space Trusses, Numerical problems.
4. **Area moment of Inertia:** Products of inertia and rotation of axes, Numerical problems.
5. **Friction:** Wedges, Numerical problems.

Prerequisites Courses: None

Reference Books:

1. "Engineering Mechanics Statics" J.L. Meriam, L.G. Kraige John Wiley & Sons, 7th Edition Inc.

SPECIAL TOPIC

UE16CV306 DETAILING OF RC STRUCTURES (0-0-2-0-1)

Course Objectives:

- Enable the student to detail reinforcement in various RC structural elements.

Course Outcomes:

- On completion of this course, students are able to:
- Sketch reinforcement details of RCC structural elements- Beams, Slabs, Columns and Footings.

Course Content:

1. Necessity and Importance of Detailing.
2. Structural Layout drawings, bar Shapes, bar bending schedule.
3. Detailing of columns and footing.
4. Detailing of Beams with bar bending schedule
5. Detailing one way/ two way slabs with bar bending schedule
6. Detailing isolated columns, Column footings with bar bending schedule

7. Staircase design & detailing- with and without waist slab(doglegged, spanning b/w two landings),Detailing of tread and riser staircases

Pre-requisites Course: None

Reference Books:

1. IS 456 –2000 Indian Standard Plain & Reinforced concrete Code of Practice
2. SP – 34- 1987 (Reprint 1999), Hand book on Concrete Reinforcement & Detailing.
3. "Limit State Design of Reinforced Concrete", P.C Varghese, Prentice Hall of India, 2nd Edition, 2013.
4. "Design of Reinforced Concrete Structures (IS:456-2000), N. Krishna Raju, CBS Publishers & Distributors Pvt. Ltd., 3rd Edition, 2014
5. "Reinforced Concrete Design", Unnikrishnan Pillai and Devdas Menon, Tata McGraw Hill, 3rd Edition, 2013
6. "Design of Reinforced Concrete Structures", N Subramanian, Oxford, IBH, 2009
7. SP –16- 1984. Design Aids for Reinforced Concrete to IS 456:1978

UE16CV351: ADVANCED GEOTECHNICAL ENGINEERING (4-0-0-0-4)

Course objectives:

- This course gives a detailed understanding of Geo-technical engineering.
- It helps students to understand importance of exploration program, stabilization of boreholes, stresses in soils, lateral earth pressure, stability of earth slopes.
- This course also covers topics on bearing capacity, foundation settlement, proportioning shallow and pile foundations and well foundations.

Course outcomes:

- On completion of this course the students should be capable to present report on soil exploration program and various types of stresses acting on soil stratum
- They will be in a position to know the types of earth pressures acting on various structures, practical approach for determination of bearing capacity and foundation settlement analysis.

Course Contents:

1. **Subsurface exploration:** Importance of exploration program, Methods of exploration: Boring, Seismic refraction method of geophysical exploration, Types of samples - undisturbed, disturbed and representative samples, Samplers, sample disturbance, area ratio, Recovery ratio, clearance, Stabilisation of boreholes - Typical bore log. Number and depth of borings for various civil engineering structures, soil exploration report. Standard penetration test and cone penetration test.
2. **Stresses in soils:** Boussinesq's equation for concentrated, circular and rectangular loads. Newmark's chart, Pressure distribution diagrams, Westergaard's equation, Contact pressure. Flownets: Laplace equation (no derivation) assumptions and limitations only, characteristics and uses of flownets, Methods of drawing flownets for Dams and sheet piles. Estimating quantity of seepage and Exit gradient. Determination of phreatic line in earth dams with and without filter. Piping and protective filter.
3. **Lateral earth pressure:** Active and Passive earth pressures, Earth pressure at rest. Rankine's and Coulomb's Earth pressure theories-–assumptions and limitations, Graphical solutions for active earth pressure (cohesion less soil only) – Culmann's and Rebhann's methods, Lateral earth pressure in cohesion less soils, Earth pressure distribution. Stability of earth slopes: Types of slopes, causes and type of failure of slopes. Definition of factor of safety, Stability of infinite slopes, Stability of finite slopes by Method of slices and Friction Circle method, Taylor's stability number, Fellineous method, methods to improve slope stability.
4. **Bearing capacity:** Definitions of ultimate, net and safe bearing capacities, Allowable bearing pressure. Terzaghi's and Brinch Hansen's bearing capacity equations - assumptions and limitations, Bearing capacity of footing subjected to eccentric loading. Effect of ground water table on bearing capacity. Field methods of evaluation of bearing capacity - Plate load test.
5. **Foundation settlement:** Importance and Concept of Settlement Analysis, Immediate, consolidation and Secondary settlements (no derivations, but, computation using relevant formula for Normally Consolidated soils), Tolerance. BIS specifications for total and differential settlements of footings and rafts.

Prerequisite Courses: None

References books:

1. "Soil Engineering; in theory and practice; Fundamentals and general principles", Alam Singh, CBS Publishers and Distributors Pvt. Ltd., Vol 1, 4th Edition 2012.
2. "Soil Mechanics and Foundation Engineering (Geotechnical Engineering)", Dr. K. R. Arora, Standard Publishers Distributors, 7th Edition 2011.
3. "Soil Mechanics and Foundations", B.C.Punmia, Ashok Kumar Jain, Arun Kumar Jain ,Laxmi Publications, New Delhi, 16th Edition, 2005.
4. "Modern Geotechnical Engineering", Alam Singh, CBS Publishers and Distributors Pvt. Ltd., 3rd Edition, 2012.
5. "Soil Mechanics and Foundation Engineering; Geotechnical Engineering Series", V.N.S Murthy, UBS Publishers and Distributors, New Delhi, 4th Edition, 2012.
6. "Geotechnical Engineering", Braja, M. Das, Thomson Business Information India (P) Ltd., India, 5th Edition, 2002.
7. "Foundation Analysis and Design", J.E Bowles, McGraw Hill Pub. Co. New York, 5th Edition 1996.

UE16CV352: DESIGN AND DETAILING OF STEEL STRUCTURAL ELEMENTS (3-0-2-0-4)

Course Objectives:

- Structural steel is a popular material used for construction of buildings, bridges and other structures. In this course properties of steel, behaviour of structural steel elements under various load conditions and design procedures will be discussed.
- Design of tension members, compression members and flexural members subject to axial load, bending load and combined bending and axial load will be studied.
- In addition, simple and eccentric steel connections are also discussed.

Course Outcomes:

- At the end of this course the students will be in a position to select an appropriate structural systems and design.

Course Contents:

1. **Structural Members and Connections:** Structural members – Main, Secondary, Connections, Steel Sections- Rolled, Hollow, Cold formed, Welded Sections, Castellated Beams and Built-up sections. Selection of Sections, Primary Steel Properties, Modes of failure in Members - Yielding, Fracture, Local and Member Buckling. Bolts and Bolting: Types, Sizes and Grades, Bolt Holes, Bolted Shear Failure Mechanisms – Bolt shear, Shear tear out,

Bearing Failure, Net Section Failure, Block Shear, Load transfer in Bearing and Slip critical connections. Welds and Welding: Welding Process, Types, Weld Size, End returns. Strength Limit State and Serviceability limit state, partial safety factors for Loads and Materials as per IS 800, Design Action and Design Strength. Design of Plate connections - Lap, But – Examples (simple connections, eccentric connections).

2. **Analysis and Design of Tension Members:** Structural Systems with tension members, Sections adopted, Failure Modes, Code recommendations for Design Strength and Stiffness requirements. Design Examples- Single and Double Angles, Equal, unequal, Bolted and welded, Lug Angles including block shear failure problem.
3. **Analysis and Design of Compression Members:** Structural Systems with compression members, Modes of failure, Behavior of compression members, Elastic buckling of slender compression members, Sections used for compression members, Effective length of compression members, Design of compression members – Rolled, Angle and Built up compression members: Laced and Battened columns.
4. **Analysis and Design of Flexural Members:** Behaviour of Beams under increasing moment, Fully Plastic Moment, Plastic Section modulus, Plastic Hinge, Shape Factor, Plastic Analysis- Collapse load – Beam Examples. Failure Modes, Section Classification: Plastic, Compact, Semi-Compact and Slender. Design Bending Strength of laterally supported Beams, Shear Yielding, Web buckling, Web Crippling – Design Examples with low shear and high shear.
5. **Design of column bases and caps**: Types of column bases - Slab base, Gusset base. Design of moment resisting base plate, foundation bolts.

Pre-requisites Courses: UE16CV201 - Strength of Materials

Reference Books:

1. "Design of Steel Structures", N Subramanian, Oxford University Press, 2008.
2. "LIMIT State Design of Steel Structures", S K Duggal, McGraw Hill Education (India) Private Limited 2010.
3. "Design of Steel Structures", S. Ramamrutham, Dhanpat Rai Publishing Company (P) Limited 1975.
4. "Design of Steel Structures", Pasala Dayaratnam, S. Chand, Reprint 2013.
5. "Design of Steel Structures", B.C. Punmia, Ashok Kumar Jain, Arun Kr. Jain, Punmia, Firewall Media, 2nd Edition, Reprint 2013.
6. "Design of Steel Structures 1", Ramchandra, Scientific Publishers, 2014.
7. "Indian Standard General Construction in Steel - Code of Practice", IS 800-2007 3rd Revision.
8. "Indian Standard Handbook for Structural Engineers", SP, 6(1), 1964.

UE16CV353: TRANSPORTATION ENGINEERING – HIGHWAY ENGINEERING (4-0-0-0-4)

Course Objectives:

- Students will be able to identify different types of highways their development as per the Indian Roads Congress.
- They should be in a position to draw a cross section of a highway indicating the different parts.
- They will be in a position to explain different geometric design as well the materials and their properties used in construction of highway.

Course Outcomes:

- At the end of this course students will be in a position to design the elements of a Highway.
- Able to acquire and apply knowledge of properties of road aggregates in conducting various laboratory tests.
- Capable of remembering the properties and constitution of road binders.

Course Content:

1. **Introduction on Highway Engineering:** Highway engineering, scope of highway engineering, highway classification, factors controlling highway alignment, engineering survey for highway location. **Highway Economics And Finance**:Highway Development in India - Jayakar Committee Recommendations and Realizations, Concepts of Ongoing Highway Development Programmes at National Level, Institutions for Highway Development at National level - Indian Roads Congress, Highway Research Board, National Highway Authority of India, Ministry of Road Transport and Highways (MORTH) and Central Road Research Institute. Methods of Economic Analysis- Motor vehicle operation cost, Highway finance.
2. **Highway Geometric Design – I**: Importance, Terrain classification, Design speed, Factors affecting geometric design, Classification and Cross Section of Urban and Rural Roads (IRC), Highway Cross Sectional Elements – Right of Way, Carriage Way, Camber, Kerbs, Shoulders and Footpaths [IRC Standards].
3. **Highway Geometric Design – II**: Elements of highway, Sight Distance- Restrictions to sight distance- Stopping sight distance- Overtaking sight distance- overtaking zones- Examples on SSD and OSD- Sight distance at intersections, Factors affecting Sight Distances, PIEV theory, Horizontal alignment-Radius of Curve- Super elevation – Extra widening- Transition curve and its length, setback distance – Examples, Vertical alignment-Gradient- summit and valley curves with examples.
4. **Highway Materials And Construction Practice:** Desirable Properties and Testing of Highway Materials: Soil – California Bearing Ratio Test, Field Density Test - Aggregate - Crushing, Abrasion, Impact Tests, Water absorption, Flakiness and Elongation indices and Stone polishing value test - Bitumen - Penetration, Ductility, Viscosity, Binder content and Softening point Tests. - Construction Practice - Water Bound Macadam Road, Bituminous Road and Cement Concrete Road [as per IRC and MORTH specifications] - Highway Drainage [IRC Recommendations]
5. **Pavements Design**: Pavement types, component parts of flexible and rigid pavements and their functions, design factors, ESWL and its determination-Examples, Flexible pavement- Design of flexible pavements as per IRC;37-2001-Examples, Rigid pavement- Westergaard's equations for load and temperature stresses- Examples- Design of slab thickness only as per IRC:58-2002

Pre-requisites Courses: None

Reference Books:

1. "Highway Engineering", S K Khanna and C E G Justo, 10th Edition Nemchand Bros, Rookie, 2015.
2. " Highway Engineering", L R Kadiyali, 6th Edition, Khanna Publishers, New Delhi, 2011.
3. "Principles of Pavement Design", E.J. Yoder, 2nd Edition, John Wiley & Sons, Inc. New York, 1975.
4. "Pavement Analysis and Design", Yang H. Huang, Prentice Hall, 2003.
5. "Principles of Urban Transportation System Planning", Hutchinson, B.G., McGraw-Hill, 1974
6. "Traffic Engineering", McShane W R & Roess R P, Prentice-Hall, NJ, 2010.

7. "Urban Transit: Operations, Planning and Economics", Vukan R. Vuchic, Wiley, 2005.
8. "Transportation Engineering & Planning", C.S. Papacostas, P.D. Prevedouros, Prentice Hall of India Pvt. Ltd, 2006.
9. IRC Standards (IRC 37 - 2001 & IRC 58 -1998)
10. Bureau of Indian Standards (BIS) Publications on Highway Materials Specifications for Road and Bridges, MORTH (India),

UE16CV354 GEOTECHNICAL ENGINEERING LABORATORY (0-0-2-0-1)

Course Objectives:

- Familiarize students with geotechnical test methods used in the field for soil testing.
- Conduct test efficiently and without sacrificing the quality of results.
- Understand laboratory testing methods and the standard test procedures.

Course outcomes:

- The students will be able to perform reports on soil exploration program.
- They will be in a position to know the practical approach for determination of soil properties.

Course Content:

1. Determination of water content by oven drying method and Pycnometer method.
2. Determination of specific gravity by Pycnometer and density bottle.
3. Determination of grain size distribution by sieve analysis (Mechanical analysis).
4. Determination of Atterberg's limits-Liquid limit, plastic limit and shrinkage limit.
   - Liquid limit (Casagrande and Cone Penetration Methods).
   - Plastic limit.
   - Shrinkage limit.
5. Standard Proctor Test.
6. Determination of In situ density by core cutter and sand replacement methods.
7. Determination of Coefficient of permeability by constant head and variable head methods.
8. Strength Tests.
   - Direct Shear Test. (Sand & Clay)
   - Triaxial Compression Test (undrained).
   - Unconfined Compression Test
9. CBR test on soil.

Pre-requisites Courses: None

Reference books:

1. "Geotechnical engineering lab", Department of Civil Engineering, PESIT
2. Geotechnical Engineering Laboratory Manual, K. Madhavan, 2009.
3. "Soil Engineering; in theory and practice; Fundamentals and general principles", Alam Singh, Vol 1CBS Publishers and Distributors Pvt. Ltd., 4th Edition, 2012.
4. "Modern Geotechnical Engineering", Alam Singh, CBS Publishers and Distributors Pvt. Ltd, 3rd Edition, 2012.
5. "Soil Mechanics and Foundation Engineering (Geotechnical Engineering)", Dr. K. R. Arora, Standard Publishers Distributors, 7th Edition 2011

UE16CV355: DESIGN AND DETAILING OF HYDRAULIC STRUCTURES LAB (0-0-2-0-1)

Course Objectives:

- Design and generation of near field drawings of impounding structures, canal transmission & canal regulatory structures using corresponding design codes.

Course Outcomes:

On completion of this course, students are able to:

- Understand the basics concepts related to design detailing of various hydraulic structures.

Course Content:

1. **Design & drawing of impounding structures:** Tank Surplus Weir. Tank Sluice with tower head
2. **Design & drawing of canal transmission structures:** Canal Drops.
3. **Design & drawing of Canal regulation structures:** Canal head works

Pre-requisites Courses: None

Reference Books:

1. "Design of Minor Irrigation and Canal Structures", C. SathyaNarayana Murthy, Wiley Eastern Limited, New Delhi,1990.
2. "Hydrology - Principles, Analysis and Design", H M Raghunath, New age International 2006.
3. "Irrigation Engineering & Hydraulic Structures", S.K Garg, Khanna Publishers, New Delhi, 2013
4. "Hydraulic Structures & Irrigation Design Drawing", N.Balasubramanya, Tata Mcgraw-Hill Education Pvt.Ltd., New Delhi, 2015.
5. "Irrigation, Water Resources & Water Power Engineering", P.N. Modi, Standard Book House, New Delhi, 2008

UE16CV331 HYDROLOGY AND IRRIGATION ENGINEERING (4-0-0-0-4)

Course Objectives:

- To know the basic concepts in hydrology.
- To study the features of precipitation, rain gauge density, transpiration and infiltration.
- To learn about runoff, estimation, modeling of runoff, and hydrograph.
- To understand estimation, forecasting, control of flood, and concept of Muskingum method.
- To know the basics, necessity, types of irrigation and water requirement of crops.

Course Outcomes:

- get the Knowledge of various processes involved in Hydrologic cycle.
- Knowledge of Hydrographos, river control and training workd, Flood routing.
- Brief Knowledge of irrigation.

Course Content:

1. **INTRODUCTION & PRECIPITATION:** Introduction, Hydrologic cycle (Horton's representation). Water budget equation, Precipitation: Introduction, forms of precipitation, measurement of precipitation, Rainguage network, methods of computing average rainfall, interpolation of missing data, adjustment of missing data by double mass curve method. Depth duration area relationships, Hyetograph and mass curve of rainfall.

2. **LOSSES FROM PRECIPITATION:** Evaporation: Definition, factors affecting, measurement, Estimation using empirical methods evaporation control. Consumptive use, Estimation of consumptive use, Problems. Evapo-transpiration: Definition, factors affecting, measurement, estimation. Infiltration, Measurement of Infiltration, Horton's equation, Numerical problems. **HYDROGRAPHS** Run-off- Process, Catchment characteristics – Factors affecting runoff, estimation, flow-duration curves, Definition of hydrographs, components of hydrographs, unit hydrograph, S-Curve hydrograph, Synthetic Hydrograph, base flow separation, Concepts of Instantaneous unit hydrograph- problems
3. **ESTIMATION OF FLOOD & FLOOD ROUTING:** Definition of flood, factors affecting flood, methods of estimation (envelope curves, empirical formulae, rational method). Flood routing: Introduction to hydrological routing, relationship, of out flow and storage, general storage equation, Muskingum routing method, Problems
4. **IRRIGATION: INTRODUCTION:** Introduction, need for irrigation, advantages and disadvantages of irrigation, Types of irrigation, Techniques of water distribution in farms, Quality of Irrigation water, soil-water-plant relationship, soil moisture. Frequency of irrigation Water requirement of Crops: Introduction, definitions, crop seasons of India, duty, delta, base period, Irrigation efficiencies, Problems
5. **RIVER CONTROL AND TRAINING WORKS:** Importance of rivers and necessity of control, Types of rivers and their characteristics, Classification of rivers, Behaviour of rivers, Control and training of rivers: Objective, Classification, Methods.

Prerequisites Courses: None

Reference Books:

1. "Engineering Hydrology", Subramanya K, 3rd edition, Tata McGraw Hill, New Delhi.
2. "Irrigation Engineering and Hydraulics Structures", S. K. Garg, Khanna Publishers. Delhi.
3. "Hydrology & Soil Conservation Engineering", Ghanshyam Das, PHI Learning Private Ltd., New Delhi- 2009
4. "Hydrology & Water Resources Engineering", Patra K.C, Narosa Book Distributors Pvt. Ltd. New Delhi-2008
5. "Hydrology & Water Resources Engineering"- R.K.Sharma & Sharma, Oxford and Ibh, New Delhi
6. "Irrigation and Water Resources Engineering", G. L. Asawa, New Age International Publishers.
7. "Hydrology for Engineers", Linsley, Pauler and Kohlas, MGHK Publishers, Tokyo (1975),
8. "Irrigation and Water Power Engineering", B.C. Punmia and Pande Lal, Laxmi Publications, New Delhi
9. "A Text Book of Hydrology"- Jayarami Reddy, Laksmi Publications, New Delhi-2007
10. "Irrigation, water Resources and water power Engineering"- P. N. Modi, Standard book house, New Delhi.
11. "Irrigation and Water Power Engineering", Madan Mohan Das, Mimi Das Saikia, PHI Learning Pvt. Ltd. New Delhi 2009 (Ed).
12. "Hydrology-Analysis and Design", Raghunath H.M, New Age international publishers. New Delhi.

UE16CV332:
ADVANCED R C C (4 - 0 -0 – 0 - 4)

Course Objectives:

- To design staircase, combined footings, flat slabs and liquid retaining structures in conformity with established design procedures and Indian Standard codes.
- To design a structural system using the knowledge of designing structural elements of a building.
- To detail the bar bending schedule on a drawing such that the design parameters are all available for incorporation of the drawing.

Course Outcomes:

On completion of this course, students are able to:

- Design RCC structural systems – stair cases, flat slabs, combined footings, retaining walls and liquid retaining structures

Course Content:

1. **Design of Stair Cases:** Introduction, General Notes on Design of Stairs, Design of Stairs Spanning Horizontally, Design of Dog-legged Stair, Design of Stair with Quarter Space Landing, Design of Open Newel Stair with Quarter Space Landing, Design of Staircase with Central Stringer Beam, Tread & Riser staircase, Numerical Problems, Rebar details, Bar bending schedule
2. **Design of Flat Slabs:** Introduction, Components of flat slab construction, Indian code recommendations (IS:456-2000), Direct design method, Equivalent frame method, shear in flat slab, slab reinforcement, openings in flat slab, Numerical Problems, Rebar details, Bar bending schedule
3. **Combined Footings:** Combined rectangular footing, Strap footing, Raft footing, Numerical Problems, Rebar details, Bar bending schedule **Analysis and design of one way slab supported on portal frames**- fixed and hinged- Numerical Problems, Rebar details, bar bending schedule
4. **Design of Retaining Walls:** Introduction, types of retaining walls, active earth pressure – Rankine's theory, passive earth pressure, stability of cantilever retaining wall, design principles of cantilever retaining wall, design of cantilever retaining wall with horizontal backfill, design of cantilever retaining wall with sloping backfill, Design of counter fort retaining wall, Numerical Problems, Rebar details, Bar bending schedule
5. **Design and Detailing of liquid retaining structures:** Ground level reservoir – Rectangular, circular without roof (IS 3370 I-IV)**,** Numerical Problems, Rebar details, Bar bending schedule

Prerequisites Courses: UE15CV201 - Strength of Materials

Reference Books:

1. "Limit State Design of Reinforced Concrete", Ashok Kumar Jain, Arun Kumar Jain, Dr. B C Punmia,Laxmi Publications (P) Ltd, 2013.
2. "Design of Reinforced Concrete Structures", N Subramanian, Oxford, IBH
3. "Design of Reinforced Concrete Structures" S Ramamrutham ,17th Edition, Dhanpat Rai & Sons, 2012.
4. "Reinforced Concrete Design", Unnikrishnan Pillai and Devdas Menon, 3rd Edition, Tata McGraw Hill
5. "Indian Standard Plain & Reinforced concrete Code of Practice", IS 456 – 2000.IS 456 –2000, Bureau of Indian Standards
6. "Hand book on Concrete Reinforcement & Detailing", SP – 34-1987, (Reprint 1999), Bureau of Indian Standards
7. IS 3370 I-IV. Code of practice for concrete structures for the storage of liquids, Bureau of Indian Standards
8. " Explanatory Handbook on Indian Standard Code of Practice for Plain and Reinforced Concrete (IS 456:1978)" SP – 24-1983, Bureau of Indian Standards
9. "Design Aids for Reinforced Concrete to IS 456:1978" , SP –16-1984, Bureau of Indian Standards

UE16CV333:
TRANSPORTATION STRUCTURES (4-0-0-04)

Course Objectives:

- Classify the various transportation structures, explain the principles of design methods and list the steps involved in the design of various transportation structures.

- Identify the input parameters required for design of transportation structures and design and evaluate a transportation structures based on the data given.

Course Outcomes:

After completion of the course the student should be able to

- Decide the selection of transportation structures, list the factors affecting design of various transportation structures and generate the input parameters required for design.
- Summarize the design methodology and arrive at design values for various transportation structures.

Course Content:

1. **Introduction:** Principles of Planning of Elevated Rail Transit System, grade separation structures, pedestrian crossing and sub- ways.
2. **Loads on Bridges:** Dead loads, live loads, dynamic effects of vehicles, longitudinal forces, centrifugal forces, wind loads, earth quake forces, stream flow pressure, load combinations, design examples.
3. **Design of Bridge Slabs:** Longitudinally reinforced deck slabs, transversely reinforced bridge slabs.
4. **Design of Pre-stressed Concrete Bridges:** Design code, design examples.
5. **Design of Box and Slab Culverts:** Design code, design examples.

Prerequisites Courses: None

Reference Books:

1. “Principles of Design of RCC Bridges”, Raina. R.K, Tata McGraw Hill,1999.
2. “Bridge Engineering”, N Krishnaraju, UPD Publishers, New Delhi,2000.
3. “Design of Modern Concrete Highway Bridges”, Conrad P. Heins and Richard A. Lawrie, John Wiley and Sons, 1999.

UE16CV341:
DESIGN OF PRE-STRESSED CONCRETE STRCUTURES (4-0-0-0-4)

Course Objectives:

- Understand the behavior of the Pre-Stressed concrete structural members
- To learn how to analyze and design Pre-Stressed concrete members

Course Outcomes:

On completion of this course, students are able to:

- Design basic PSC elements
- Exposure to IS codes of practice to design Pre-Stressed concrete members

Course content:

1. **Materials:** High strength concrete and steel, Stress-Strain characteristics and properties. Basic principles of prestressing: Fundamentals, Load balancing concept, Stress concept, centre of Thrust. Pre- tensioning and post tensioning systems, tensioning methods and end anchorages. Various losses encountered in pre-tensioning and post tensioning methods, determination of jacking force.
2. **Prestress Analysis:** Pre-tensioned and post-tensioned symmetrical and asymmetrical sections - Permissible stress, design of prestressing force and eccentricity, limiting zone of pre-stressing force cable profile (Rectangular and T-sections only).Cracking Moment, Kern Point and Pressure Line.
3. **Deflections:** Deflection of a pre-stressed member – Short term and long term deflections, Elastic deflections under transfer loads and due to different cable profiles. Deflection limits as per IS 1343. Effect of creep on deflection, load verses deflection curve, methods of reducing deflection**.** Crack width calculation .
4. **Limit state of design:** Flexure - IS Code recommendations – Ultimate flexural strength of sections, Shear - IS Code recommendations, shear resistance of sections, shear reinforcement. Limit state of serviceability – control of deflections and cracking.Design of slabs – one way slab , two way slab.
5. **Design of end blocks:** Transmission of prestress in pretensioned members, transmission length, Development length, Anchorage stress in post-tensioned members. Bearing stress and bursting tensile force-stresses in end blocks-Methods, I.S. Code, provision for the design of end block reinforcement.

Pre-requisites Courses: None

Reference Books:

1. “Pre-stressed Concrete”, N. Krishna Raju, Tata Mc. Graw Publishers, 3rd Edition, 2007.
2. “Pre-stressed Concrete”, P. Dayarathnam, Oxford and IBH Publishing Co, 5th Edition, 1991.
3. “Design of Pre-stressed Concrete Structures”, T.Y. Lin and Ned H. Burns, John Wiley & Sons,New York,1982.
4. ”Pre-stressed Concrete”, G.S. Pandit and S.P. Gupta, CBS Publishers, 1993.
5. IS: 1343: Pre-stressed Concrete - Code of Practice, 1980.

UE16CV342:
GROUND IMPROVEMENT TECHNIQUE AND FOUNDATION DESIGN (4-0-0-0-4)

Course Objectives:

- Basic knowledge on various ground improvement techniques and their suitability for various types of soil conditions.
- The skills of implementation of geotechnical knowledge in field situations.
- Knowledge of reinforcement to soils in the form of geo-textiles and other synthetic materials.

Course Outcomes:

- Student will be able to understand soil dewatering techniques with respect to field conditions.
- Student will be able to understand grouting techniques
- Student will be able to design pile and machine foundations.

Course content:

1. **Ground Improvement Technique:** Definition, Need for Ground Improvement, Objectives of ground improvement, Classification of ground improvement techniques, Factors to be considered in the selection of the best soil improvement technique, Trends in ground Improvement. **Grouting:** Types of grouts – Grouting equipment and machinery Grouting method. **Drainage and Dewatering:** Drainage techniques – Well points – Vacuum and electro osmosis method – Seepage analysis for two-dimensional flow-fully and partially penetrating slots in homogenous deposits (Simple cases only). **Stabilization of soils:** Stabilisation with cement, lime and chemicals – Stabilisation of expansive soils.
2. **Earth Reinforcement:** Concept of reinforcement – Types of reinforcement material – Applications of reinforced earth – use of Geotextiles for filtration, drainage and separation in road and other works.
3. **Foundation Engineering:** Introduction, purpose of foundation, requirements for stable foundation, Classification of foundation, selection of types of foundation.

4. **Deep foundation:** Introduction, design of pile foundation, analysis of single pile under vertical loads, Analysis of under reamed piles under vertical loads, design of pile cap
5. **Special Foundation**: Introduction, pier and cassion foundation, Design of machine foundation.

Prerequisites Courses: None

Reference Books:

1. "Ground Improvement Techniques"- Purushothama Raj P, Laxmi Publications, New Delhi, 1999.
2. "Construction and Geotechnical Method in Foundation Engineering"- Koerner R.M., Mc Graw Hill Pub. Co., New York, 1985
3. "Engineering principles of ground modification"- Manfred Hausmann, Mc Graw Hill Pub. Co., New York, 1990
4. "Methods of treatment of unstable ground"- Bell, F.G, Butterworths, London, 1975.
5. "Expansive soils"- Nelson J.D. and Miller D.J, John Wiley and Sons, 1992.
6. "Soil Stabilization; Principles and Practice"- Ingles. C.G. and Metcalf J.B, Butterworths, London, 1972.

UE16CV343
ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS: (4-0-0-0-4)

COURSE OBJECTIVE:

- To expose the students to the need, methodology, documentation and requirements of environmental and social impact assessment of Transportation Projects.

COURSE OUTCOME:

- Students would have understood the impact of Transportation projects on the environment and are able to develop and implement mitigation measures.
- They will also know about the legal requirements of Environmental Assessment for projects.

Course content:

1. **Introduction**: Environment and its interaction with human activities - Environmental imbalances - Attributes, Impacts, Indicators and Measurements - Concept of Environmental Impact Assessment (EIA), Environmental Impact Statement, Objectives of EIA, Advantages and Limitations of EIA
2. **Environmental Indicators:** Indicators for climate - Indicators for terrestrial subsystems - Indicators for aquatic subsystems - Selection of indicators - Socio-economic indicators - Basic information - Indicators for economy - Social indicators - Indicators for health and nutrition - Cultural indicators - Selection of indicators.
3. **Environmental Impact Assessment for Transportation Projects**: Basic Concepts, Objectives, Transportation Related Environmental Impacts – Vehicular Impacts – Safety & Capacity Impacts – Roadway Impacts – Construction Impacts, Environmental Impact Assessment – Environmental Impact Statement, Environment Audit, Typical case studies
4. **Environmental Issues in Industrial Development**: On-site and Off-site impacts during various stages of industrial development, Long term climatic changes, Greenhouse effect, Industrial effluents and their impact on natural cycle, Environmental impact of Highways, Mining and Energy development.
5. **Social Impact Assessment:** Urban Growth Indicators of Environmental Quality, Energy use, Fuel Economy in Transportation, Energy Efficiency strategies - Land Acquisition- Public Consultation - Cost benefit analysis - Rehabilitation Plans.

Prerequisites Courses: None

Reference Books:

1. "Environmental Impact Assessment", Larry W Canter, McGraw Hill Publishers, 1996.
2. "Introduction to Environmental Impact Assessment", John Glasson, Riki Therivel, Andrew Chadwick, 4th Edition, Routledge, New York, 2012
3. "Transport Policy and Environment" David Banister; Routledge, UK, 2002
4. "The Impact of Environmental Assessment – A Review of World Bank Experience", World Bank; Washington, 1997.
5. "Road and the Environment", World Bank Technical paper no. 363, Washington, 1997.
6. "Scottish Natural Heritage, A handbook on environmental impact assessment", Natural Heritage Management, 4th Edition, www.snh.gov.uk., 2013

UE15CV401:
CONSTRUCTION PLANNING AND METHODS (3-0-0-0-3)

Course Objectives:

- To study and understand the concept of planning, scheduling, costing, resource leveling and use of project information necessary for construction project.
- To study and understand the various types of construction equipments and their applications in construction projects

Course Outcomes:

On successful completion of the course, students should be able to,

- Develop skill to control project schedule, cost and time.
- Develop ability to determine quantity and cost associated with construction equipment
- Develop understanding of construction equipment purchase and replacement techniques

Course Content:

1. **Construction Planning:** Introduction, Definition of a Project, Types of Project Plans, (Time Plan, Manpower Plan, Material Plan, Construction Equipment Plan, Finance Plan), gnatt or bar chart, Work Break Down Structure, Planning Techniques – Terminologies Used (Event and Activity, Dummy Activity, problems on precedence and succeder Network, Precedence, Network Logic, Duration of an Activity, Forward and Backward Pass, Float or Slack Time, Path and Critical Path.
2. **Network Diagram** Preparation of Network Diagram, Performance Evaluation and Review Technique (PERT), Critical Path Method (CPM), Network, The-Line-of Balance (LOB), Network Technique Advantages. Numerical Problems on Critical Path Method, and Precedence Network.
3. **Project Scheduling, Resource Leveling and construction Economics:** Introduction, Resource Leveling, Resource Allocation, Importance of Project Scheduling. Introduction, Time Value of Money, Cash Flow Diagram, Evaluating Alternatives by Equivalence, Present Worth Comparison, Future Worth Comparison, Annual Cost and Worth Comparison. Numerical Problems on Equivalence.
4. **Construction Equipment and Material Management:** Introduction, Classification of Construction Equipments (Earth Work Equipments, Concrete Equipments, Hoisting Equipments, Plant and Equipment Acquisition), Depreciation, Methods of Calculating Depreciation, Numerical Problems on Depreciation. Introduction, Material Procurement Process in Construction Organization, Material Management Functions, Materials Planning, Inventory Management, Inventory-related Cost.

5. **Project Cost and Value Management:** Project Cost Management, Cost Budgeting, Cost Control, Collection of Cost-related Information, Labour Cost, Material Cost, Subcontractor Cost, Overhead Cost, Cost Codes, Cost Statement, Lean construction : Principles of Lean, VSM, Waste Elimination, 5S, Lead Time Reduction, Computer Applications in Scheduling, Resource Levelling, Monitoring, and Reporting: Introduction, Popular Project Management Software, Construction Planning System, , Functions of Project Management Software, Scheduling function, resource management function, Tracking or monitoring function, Reporting function, Additional functions,

Prerequisite Course: None

Reference Books:

1. "Construction Project Management, Theory and Practice", K N Jha, 1st edition, Pearson Publications, 2011.
2. "Construction Project Scheduling", M T Callahan, D G Quackenbush and J E Rowing, McGraw Hill Education, Indian Edition, 2014
3. "Construction Planning, Equipments and Methods", R L Peurifoy, C J Schexnayder, A Sharpia, Seventh Edition, McGraw Hill Education, Indian Edition, 2013.

UE15CV402: ENVIRONMENTAL ENGINEERING (3-0-2-0-4) (SEWAGE TREATMENT AND SANITARY ENGINEERING) & ENVIRONMENTAL ENGINEERING LABORATORY

Course objectives:

- The students at the end of the course will have the ability to understand and design a system or a component involving civil engineering and environmental aspects.
- The student will be able to understand the impact of engineering solutions in a global, economic, environmental, and social context.

Course Outcomes:

Students at the end of the course will have the ability to

- design and conduct experiments, as well as to analyze and interpret data
- identify, formulate, and solve engineering problems
- use the techniques, skills, and modern engineering tools necessary for engineering practice.
- function on multidisciplinary teams
- to meet desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety and sustainability

Course Content:

1. **Introduction:** Sources of water - Sources, considerations, for intake, infiltration galleries, distribution system, requirements, methods and layouts. Run-off estimation - Introduction, Run-off process and peak run-off rate, estimation of run-off, factors affecting run-off. Rational method, Empirical method, Time intensity frequency curves, Time of concentration, significance.
2. **Estimation of Sewage Discharge and Run-off:** Estimating Sewage Discharge - Estimation of sewage discharge, forecasts, effects on the design by the variations in sewage flow; Hydraulic Formulae, Chezy Formula, the Kutter Formula, the Manning Formula, the Crimp and Burges Formula, the Hazen Williams Formula, velocities of gradients. **Sanitation System** - Systems of sanitation; components and types of design of sewerage system; water borne diseases, factors affecting fluctuation, storage capacity, Financing sewerage projects, water demand
3. **Sewers, Construction, Maintenance, Appurtenances:** Sewers - Sewer materials, shapes of sewer pipes, laying and testing of sewer pipes. **Sewer appurtenances** - Man holes, lamp holes, street inlets, Called gullies; catch basins, flush tanks, grease or oil traps, inverted siphons, storm water regulators. **Maintenance of sewers** - Maintenance of sewers, cleaning of sewers, ventilation of sewers. **Pumps for lifting of sewage** - Necessity of pumping, types of pumps, pumping stations
4. **Primary Treatment of Sewage:** Treatment process - Overview of treatment process; classification of treatment methods – primary and secondary **Screening** - Types of Screens and their designs and cleaning; comminutors; disposal of screenings. **Grit removal basins** - Settling of discrete particles (Type I sedimentation); design of sedimentation tanks, grit chambers, Tanks for removing oils and grease - Necessity of skimming tanks, construction and design of tanks in removing oil and grease; skimming tanks; disposal of skimming. **Sedimentation** - Necessity, types and design of sedimentation tanks; coagulation and coagulation tanks, flocculation, disinfection tanks, estimation of disinfectants.
5. **Biological Treatment**: Biological Treatment and design of filter tanks - Introduction to sewage filtration; contact beds, sand filters, trickling filters, sludge digestion – factors affecting sludge digestion, design of sludge digestion tank, sludge disposal by drying. **Septic Tank**: Working principles, designing of soak pits. **Service Reservoirs**: Joints, valves such as sluice valves, air valves, check valves; water meters, pump house – laying and testing of pipe lines

Prerequisite Course: None

Reference Books:

1. "Sewage Disposal and Air Pollution Engineering", Santosh Kumar Garg, Environmental Engineering Vol. II, Khanna Publishers., 2013.
2. "Water Supply and Sanitary Engineering", G.S. Birdie and J.S. Birdie, Dhanpat Rai Publishing Company, 2013.
3. "Waste Water Engineering Treatment and Reuse", Metcalf & Eddy, Fourth Edition, Tata McVraw-Hill Publishing Company Limited, 2005.
4. "Environmental Engineering – A Design Approach", Arcadio P Sincero and Gregoria A Sincerio, PHI Learning Pvt. Ltd., 2010.
5. "Elements of Environmental Science and Engineering", P Meenakshi, PHI Learning Pvt. Ltd., 2012.
6. "Environmental Science and Engineering", J Glynn Henry and Gary W Heinke, Second Edition, PHI Learning Pvt. Ltd., 2012.
7. "Elements of Environmental Engineering", Dr K N Duggal, S Chand and Company Pvt. Ltd, 2013.

LAB COMPONENT

Course Content:

1. Determination of solids in sewage: total solids, suspended solids, dissolved solids, volatile solids, fixed solids, settleable solids.
2. Determination of dissolved oxygen. Determination of BOD.
3. Determination of COD.
4. Determination of percentage of available chlorine in bleaching powder, residual chlorine and chlorine demand.
5. Jar test for optimum dosage of alum; turbidity determination by nephelometer,
6. Presumptive coli form test.
7. Environmental noise intensity measurements using Sound Level Meter.
8. Characterization of solids wastes.

Prerequisite Course: None

Reference Books:

1. Sawyer, Mc. Carty (1994), Chemistry for Environmental Engineering, 4th edition, McGraw-Hill Publishing Company, New Delhi.
2. APHA (2005), Standard Methods for Analysis of water and Waste Water, American Public Health Administration (APHA), USA
3. Manual for Water and Waste water Analysis. NEERI publications.
4. Manual prepared by Department of Civil Engineering, PESIT.
5. IS Code

UE15CV403: TRANSPORTATION ENGINEERING–RAILWAYS, AIRPORT, Extensive survey project (3-0-2-0-4)

Course objectives:

- Introduction to History of Railway engineering, Airport, Tunnel and Harbour Engineering.
- Design of various components of railways.
- Learning different methods involved in tunnelling.
- Classification of harbours and their importance.

Course Outcomes:

On completion of this course the student should be able to

- List and discuss on factors affecting development of railways, harbours, ports and characteristics of waterways.

Course Content:

1. **Railway Engineering:** Introduction**:** Role of railways in transportation, Indian Railways, Selection of Routes, Permanent way and its requirements, Gauges and types, Typical cross sections-single and double line B G track in cutting, embankment and electrified tracks, Coning of wheels and tilting of rails, Rails-Functions-requirements—types and sections Length- defects-wear-creep-welding-joints, creep of rails. **Sleepers and Ballast:** Functions, requirements, Types, Track fitting and fasteners-Dog spike, screw spike and Pandrol clip, Fish plates-bearing plates, Calculation of quantity of materials required for laying a track-Examples, Tractive resistances and hauling capacity with examples
2. **Geometric Design:** Necessity, Safe speed on curves, Cant-cant deficiency-negative cant-safe speed based on various criteria (both for normal and high speed tracks) Transition curve, Gradient and types, grade compensation, Examples on above. **Points and Crossing:** Components of a turnout, Details of Points and Crossing, Design of turnouts with examples (No derivations) types of switches, crossings, track junctions Stations and Types, Types of yards, Signaling-Objects and types of signals, station and yard Equipment-Turn table, Fouling mark, buffer stop, level crossing, track defects, and maintenance.
3. **Airport Engineering:** Introduction**:** Layout of an airport with component parts and functions, Site selection for airport, Aircraft characteristics affecting the design and planning of airport, Airport classification, Runway orientation using wind rose with examples **Runway-** Basic runway length-Corrections and examples, Runway geometrics, Taxiway Factors affecting the layout - geometrics of taxiway-Design of exit taxiway with examples, **Visual aids-** Airport marking – lighting-Instrumental Landing System.
4. **Tunnel Engineering:** Tunnels**:** Advantages and disadvantages, Size and shape of tunnels, Surveying-Transferring centre line, and gradient from surface to inside the tunnel working face, Weisbach triangle-Examples, Tunnelling in rocks-methods, Tunneling methods in soils-Needle beam, Liner plate, Tunnel lining, Tunnel ventilation, vertical shafts, Pilot tunneling, mucking and methods, drilling and drilling pattern.
5. **Harbours:** Harbour classifications, Layout with components, Natural phenomenon affecting the design of harbours - wind, wave and tide, currents, Breakwater-Types Wharf and Quays, Jetties and Piers, Dry dock and wet docks, Slipways, Navigational aids, warehouse and transit-shed.

Prerequisite Course: None

Reference Books:

1. “Railway Engineering”, Saxena& Arora, Dhanpat Rai & Sons New Delhi 7th Reprint Edition 2015-(Unit 1 & Unit 2)
2. “Airport Planning and Design”,Khanna Arora and Jain, Nem Chand Bros Roorkee 6th Edition 2009 – (Unit 3)
3. “Harbour Dock and Tunnel Engineering”, R Srinivasan, Charaotar Publishing House 27th Edition 2015– (Unit 4 & 5)
4. ‘Highway Engineering’, S K Khanna and C E G Justo, 10th edition Nemchand Bros, Roorke 2015.
5. “Railway Track Engineering”, Mundrey, McGraw Hill Publications 3rd edition 2000
6. “Indian Railway Track”, M M Agarwal, Jaico Publications, Bombay 18th revised Edition 2013
7. Indian Railway standard Hardbound- Code of practice for the design of Sub-Structure and Foundations of Bridges
8. Research Design and Standards – Lucknow, ISO-9001 Certified Organization

Extensive Survey Project

An extensive survey training involving investigation and design of the following projects is to be conducted for 1 week (8 days). The student shall submit a project report consisting of designs and drawings.

General instructions, Reconnaissance of the sites and fly levelling to establish bench marks.

NEW TANK PROJECTS:

The work shall consist of

i. Alignment of center line of the proposed bund, Longitudinal and cross sections of the Center line.
ii. Capacity surveys.
iii. Details at Waste weir and sluice points.
iv. Canal alignment.

NOTE:

1) For at least one of the above four works, Total Station should be used.
2) Design of waste weir and canal to be prepared.

RESTORATION OF OLD TANK PROJECT:

The work shall consist of

- Plotting of center line alignment of the existing bund, Longitudinal and cross sections of the Center line.
- Capacity surveys of existing water level, existing sill level, existing top bund level , 1.0 m above existing top bund level, 2.0m existing top bund level
- Details at existing Waste weir and sluice points.
- Existing Canal alignment
- Proposed- centerline, canal alignment, canal alignment

WATER SUPPLY AND SANITARY PROJECT:

Examination of sources of water supply, Calculation of quantity of water required based on existing and projected population. Preparation of village map by any suitable method of surveying (like plane tabling), location of sites for ground level and overhead tanks underground drainage system surveys for laying the sewers.

HIGHWAY PROJECT:

Preliminary and detailed investigations to align a new road (min. 1 to 1.5 km stretch) between two obligatory points. The investigations shall consist of topographic surveying of strip of land for considering alternate routes and for final alignment. Report should justify the selected alignment with details of all geometric designs for traffic and design speed assumed. Drawing shall include key plan initial alignment, final alignment, longitudinal section along final alignment, typical cross sections of road.

Note: All relevant drawings to be prepared using AUTO CAD.

UE15CV404:
DESIGN AND DETAILING OF STEEL STRUCTURES LABORATORY (0-0–2-0- 1)

Course objectives:

- Design and detailing as required in the field using corresponding design codes of different connections in steel structures.

Course outcomes:

- At the end of this course the students will be in a position to select an appropriate structural systems and design.

Course content:

1. Detailing of Bolted and welded Structural Connections: Beam-Column, Beam - Beam, Splices: Beam, Column, Bracket connections.
2. Detailing of Laced and Batten compression members, Slab base, Gusset base.
3. Detailing of Truss members and Joints
4. Detailing of Welded Plate girders with and without stiffeners
5. Design and Detailing of Gantry Girder

Prerequisite Course: None

Reference books:

1. “Design of steel structures”, N Subramanian, Oxford University Press, 2008.
2. “Limit state design of steel structures”, S K Duggal, Mcgraw Hill Education (India) private limited 2010.
3. “Design of steel structures”, S. Ramamrutham, Dhanpat Rai Publishing Company (p) Limited, 1975.
4. “Design of Steel Structures”, Pasala Dayaratnam, S. Chand, reprint 2013.
5. “Design of Steel Structures”, Dr. B.C. Punmia, Ashok Kumar Jain, Arun Kr. Jain, Punmia, Firewall Media,2nd edition, Reprint 2013.
6. “Design of Steel Structures 1”, Ramchandra, Scientific Publishers, 2014.
7. Indian standard General Construction in Steel- Code of Practice, IS 800-2007 3rd revision.
8. Indian standard Handbook for Structural Engineers, SP: 6(1) – 1964.

UE15CV411:
ESTIMATION AND COSTING (4-0-0 -0-4)

Course Objectives:

- To estimate quantities and cost of a structure.
- To understand detailed specification of different components of buildings.
- Student will be able to determine the quantity of earthwork for road construction.
- To analyse the unit rate of different items in building construction.

Course Outcome:

On completion of this course the student should be able to

- Perform estimation, cost analysis and valuation for the given structure.

Course Content:

1. **Introduction**: Purpose of Estimating. **Different Types of Estimates**: Different types of estimates; detailed estimate; Schedule of rates: Substituted items; Recasting of estimate; External services; Prime cost; Day work; Provisional sum; Taking off in Quantity Surveying; Bill of quantities; Sub-work; General abstract of cost; Complete set of estimate. **Approximate Estimate**: Importance of approximate estimate; Purpose of approximate estimate; Approximate methods of estimating buildings; Cost from materials and labour; Approximate cost for Water Supply, Sanitary and Electrification works; Method of preparation approximate estimate for road projects, Bridge, Culvert and Road works.
2. **Method of Building Estimate:** General items of work for building estimate; Principle Units for various items of works; Limits of measurement and degree of accuracy in Estimating; General items of works, Unit of measurement for different items of works and materials; Some simple estimates; Different Methods for estimating Building works. Principle of estimating a single roomed building; two roomed building; Estimate of an underground water tank; Calculation of brickwork for typical figures and finding floor areas. **Estimate of Buildings**: Detailed estimate of a single roomed building; Detailed estimate of a two roomed building; Estimate from line plan; Detailed estimate for a two storied building with comparative cost for different portions.
3. **Water Supply and Sanitary Works**: Method of measurement of water supply and sanitary works based on IS 1200; Estimate of septic tanks; Detailed Estimate of a Manhole. **Bridges and Culverts**: Process of calculations to estimate quantities for Abutment, Wing walls and Return walls of splayed culverts. Estimates for Arch culvert, Slab culvert. **Pavement**: Pavement portion of a Road structure.
4. **Analysis of Rate**: Quantity of materials per unit rate of work; Estimating labour; Task or outturn work; Quantity of material required for different items of works; Rate of materials and labour; plinth Area Rate; Analysis for Manufacturing materials; Analysis for Earthwork Analysis for concrete works; Shuttering and staging; Damp-proof course with cement concrete; Analysis for Brickwork; Analysis for stone masonry; Analysis for roofing; Analysis for plastering. **Contracts:** Definition, essentials of contracts, Types of Engineering contract, their advantages and disadvantages. Definition of terms Tender, Tender form, Tender documents, Tender notice.
5. **Specification**: What is Specification; Necessity of Specification; Types of Specifications; Standard Specification; Special specification; Open specification; Advantages and disadvantages of open specification; General specification; Specifications for Bricks, Cement, Sand, Water, Lime Coarse aggregate and Reinforcement; Earthwork; Cement concrete; Reinforced cement concrete; First class brickwork; Half brick thick partition wall in cement mortar;; Stone masonry; Damp-proof course; Glazed Tiles in skirting and dado; Cement plaster; Wood work; Steel doors and windows; Cement plastering; Cement pointing; White-washing; Colour-washing; Lime punning; Distempering; Glazing; Painting; Varnishing; French polishing; Decorative Water-proof cement coating. **Valuation**: Qualifications and functions of a Valuer; The purposes of valuations; Gross income; Outgoings; Net income; Scrap value; Salvage value, Market value; Factors which affect the value of a property; Book value; Assessed value; Distressed value or Forced sale value; Replacement value; Potential value; Monopoly value; Sentimental value; Speculative value; Accommodation value; Sinking fund; Capitalized value; Essential characteristics of an ideal investment;

Prerequisite Course: None

Reference Books:

1. "Estimating, Costing, & Valuation in Civil Engineering". M.Chakraborti, Calcutta. 25th Edition 2014.
2. "Estimating and Costing in Civil Engineering". B.N. Dutta, UBS Publishers and distributors, New Delhi. 26th Edition December 2008.
3. "Estimating Construction Costs" R.L. Peurifoy & G.D.Oberlender, McGraw-Hill Publication. 5th Edition November 2001.
4. KPWD Schedule of rates for the current year.

UE15CV412: NUMERICAL METHODS IN CIVIL ENGINEERING (4-0-0-0-4)

Course Objectives:

- This course intends to provide a broad background to numerical methods common to various branches of civil engineering.
- Apply pertinent mathematical and engineering principles to analyze.
- Solve problems in an organized and coherent manner and elucidate the meaning of the solution in the context of the problem.
- introduce the numerical solution of partial differential equations, after a brief review of canonical partial differential equations

Course Outcomes:

- Develop skill to determine resultants and apply conditions of static equilibrium to plane force systems.
- Develop skill to identify and quantify all forces associated with a static frame work.
- Develop skill to identify, formulate and solve engineering Civil Engineering problems

Course Content:

1. **Introduction to Numerical Methods:** Why study numerical methods, Sources of error in numerical solutions: truncation error, round off error. Order of accuracy - Taylor series expansion. **Direct Solution of Linear systems**: Gauss elimination, Gauss Jordan elimination. Pivoting, inaccuracies due to pivoting. Factorization, Cholesky decomposition. Diagonal dominance, condition number, ill conditioned matrices, **Iterative solution of Linear systems:** Jacobi iteration, Gauss Seidel iteration, Convergence criteria.
2. **Direct Solution of Non-Linear Systems:** Newton Raphson iterations to find roots of a 1D nonlinear equation. Generalization to multiple dimensions. Newton Iterations, Quasi Newton iterations. Local and global minimum, rates of convergence, convergence criteria. **Iterative Solution of Non-Linear systems**: Conjugate gradient. Preconditioning.
3. **Partial Differential Equations:** Introduction to partial differential equations. Definitions & classifications of first and second order equations. Examples of analytical solutions. Method of characteristics.
4. **Numerical Differentiation:** Difference operators (forward, backward and central difference). Stability and accuracy of solutions. Application of finite difference operators to solve initial and boundary value problems.
5. Introduction to the Finite Element Method **as a method to solve partial differential equations:** Strong form of the differential equation. Weak form. Galerkin method: the finite element approximation. Interpolation functions: smoothness, continuity, completeness, Lagrange polynomials. Numerical quadrature: Trapezoidal rule, simpsons rule, Gauss quadrature**.** .

Pre-requisites Course: None

Reference Books:

1. "Numerical Methods", D. Dahlquist, and A. Bork, Dan Prentice-Hall, Englewood Cliffs, NJ, 1974.
2. "Numerical Methods for Engineering Problems", N Krishna Raju, Dr. K U Muttu, Macmillan Publishers India Limited, 2000.
3. "The Finite Element Method", T. J. R. Hughes, Prentice Hall, Englewood Cliffs, NJ, 1987.
4. "Green's functions and Boundary Value Problems", I. Stakgold, Wiley, 1998.

UE15CV421: GROUND IMPROVEMENT TECHNIQUES AND FOUNDATION DESIGN(4-0-0-0-4)

Course Objectives:

- Basic knowledge on various ground improvement techniques and their suitability for various types of soil conditions.
- The skills of implementation of geotechnical knowledge in field situations.
- Knowledge of reinforcement to soils in the form of geo-textiles and other synthetic materials.

Course Outcomes:

On successfully completing this course:

- Student will be able to understand soil dewatering techniques with respect to field conditions.
- Student will be able to understand grouting techniques
- Student will be able to design pile and machine foundations.

Course Content:

1. **Ground Improvement Technique:** Definition, Need for Ground Improvement, Objectives of ground improvement, Classification of ground improvement techniques, Factors to be considered in the selection of the best soil improvement technique, Trends in ground Improvement. Grouting: Types of grouts – Grouting equipment and machinery – Grouting method
2. **Drainage and Dewatering:** Drainage techniques – Well points – Vacuum and electro osmosis method – Seepage analysis for two-dimensional flow-fully and partially penetrating slots in homogenous deposits (Simple cases only), Stabilisation of Soils: Stabilisation with cement, lime and chemicals, Stabilisation of expansive soils.
3. **Earth Reinforcement**: Concept of reinforcement – Types of reinforcement material – Applications of reinforced earth – use of Geotextiles for filtration, drainage and separation in road and other works. Materials for Repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement, Fiber reinforced concrete.
4. **Foundation Engineering:** Introduction, purpose of foundation, requirements for stable foundation, Classification of foundation, selection of types of foundation. Deep foundation: Introduction, design of pile foundation, analysis of single pile under vertical loads, Analysis of under reamed piles under vertical loads, design of pile cap.
5. **Special Foundation:** Introduction, pier and cassion foundation, Design of machine foundation

Pre-requisites Course: None

Reference Books:

1. "Ground Improvement Techniques"- Purushothama Raj P,Laxmi Publications, New Delhi, 1999.
2. "Construction and Geotechnical Method in Foundation Engineering"- Koerner R.M., Mc Graw Hill Pub. Co., New York, 1985.

3. "Engineering principles of ground modification", Manfred Hausmann, Mc Graw Hill Pub. Co., New York, 1990
4. " Methods of treatment of unstable ground"- Bell, F.G. (1975) Butterworths, London.
5. "Expansive soils"- Nelson J.D. and Miller D.J, John Wiley and Sons, 1992.
6. "Soil Stabilization; Principles and Practice" - Ingles. C.G. and Metcalf J.B, Butterworths, London, 1972.

UE15CV422:
TRAFFIC ENGINEERING (4-0-0-0-4)

Course Objectives:

- Understand fundamental knowledge of traffic engineering, scope and its importance.
- Describe basic techniques for collecting and analysing traffic data, diagnosing problems, designing appropriate remedial treatment, and assessing its effectiveness.
- Apply probabilistic and queuing theory techniques for the analysis of traffic flow situations and emphasis the interaction of flow efficiency and traffic safety.
- Understand and analyse traffic issues including safety, planning, design, operation and control.
- Apply intelligent transport system and its applications in the present traffic scenario.

Course outcomes:

- Understand the human factors and vehicular factors in traffic engineering design.
- Conduct different types of traffic surveys and analysis of collected data using statistical concepts.
- Use an appropriate traffic flow theory and to comprehend the capacity & signalized intersection analysis.
- Understand the basic knowledge of Intelligent Transportation System

Course Content:

1. **Traffic Planning and Characteristics**: Road Characteristics-Road user characteristics, PIEV theory, Vehicle Performance characteristics, Fundamentals of Traffic Flow, Urban Traffic problems in India, Integrated planning of town, country, regional and all urban infrastructures, Sustainable approach- land use & transport and modal integration.
2. **Traffic Surveys**: Traffic Surveys- Speed, journey time and delay surveys, Vehicles Volume Survey including non-motorized transports, Methods and interpretation, Origin Destination Survey, Methods and presentation, Parking Survey, Accident analyses-Methods, interpretation and presentation, Statistical applications in traffic studies and traffic forecasting, Level of service- Concept, applications and significance.
3. **Traffic Design and Visual Aids**: Intersection Design-channelization, Rotary intersection design, Signal design, Coordination of signals, Grade separation, Traffic signs including VMS and road markings, Significant roles of traffic control personnel, Networking pedestrian facilities & cycle tracks.
4. **Traffic Safety and Environment**: Road accidents, Causes, effect, prevention, and cost, Street lighting, Traffic and environment hazards, Air and Noise Pollution, causes, abatement measures, Promotion and integration of public transportation, Promotion of non-motorized transport.
5. **Traffic Management**: Area Traffic Management System, Traffic System Management (TSM) with IRC standards, Traffic Regulatory Measures, Travel Demand Management (TDM), Direct and indirect methods, Congestion and parking pricing, All segregation methods- Coordination among different agencies, Intelligent Transport System for traffic management, enforcement and education.

Pre-requisites Course: None

Reference Books:

1. "Traffic Engineering and Transport Planning", Kadiyali. L.R.Khanna Publishers, Delhi, 2013
2. "Highway Engineering", S K Khanna and CEG Justo and A Veeraragavan, Nem Chand and Bros, 2017
3. "Indian Roads Congress (IRC) Specifications: Guidelines and Special Publications on Traffic Planning of Highway Engineering and Traffic Analysis", Fred L. Mannering, Scott S. Washburn and Walter P.Kilareski, Wiley India Pvt. Ltd., New Delhi, 2011.
4. "Principles of Traffic and Highway Engineering", Garber and Hoel, CENGAGE Learning, New Delhi, 2010.
5. "Guidelines on Low-cost Traffic Management Techniques" for Urban Areas, SP:43-1994, IRC Specification, 1994

UE15CV423:
REMEDIAL ENGINEERING(4-0-0-0-4)

Course objectives:

- To know about various techniques and materials for repair
- To know about various sources causing deterioration in buildings

Course outcomes:

On successfully completing this course:

- Identify buildings showing signs of deterioration and assess the cause or source
- Understand various repair techniques and materials available
- Understand the importance of quality control in construction industry
- Understand importance of protection and maintenance of structures.

Course Content:

1. **Introduction to maintenance**, repair and rehabilitation, distress, deterioration of concrete structures, facets of maintenance, importance of maintenance, need for repairs and upgrading of structures, global scenario of distressed structures, assessment procedure for evaluating a damaged structure, Diagnostic methods & analysis, preliminary investigations, experimental investigations using NDT
2. **Deterioration -types**, signs, causes and symptoms, mechanism of deterioration, factors affecting deterioration like permeability, inadequate durability & micro-structure of concrete. Physical deterioration due to moisture, temperature, shrinkage, freeze-thaw, abrasion, erosion, cavitation, crystallization of salts, Efflorescence, exposure to severe environment like marine exposure. Chemical deterioration due to corrosion of reinforcement (chloride induced, carbonation induced), Alkali-silica reaction, sulphate attack, Acid attack. Deterioration due to water leakage, fire – detection & mitigation of the same. Deterioration due to ageing, inadequate maintenance, Design & construction deficiencies, overloading etc. Visual deterioration of structures- Types of cracks, causes & characteristics of cracking in various structural components like beam, column, slab, masonry walls. Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection.
3. **Materials for Repair:** Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement, Fiber reinforced concrete.

4. **Techniques for Repair And Demolition**-Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings and cathodic protection. Engineered demolition techniques for dilapidated structures – case studies.
5. **Repairs to overcome low member strength,** Deflection, Cracking, Chemical disruption, weathering wear, fire, leakage, marine exposure, engineered demolition techniques for dilapidated structures - case studies

Pre-requisites Course: None

Reference books:

1. "PWD Hand book on Repair and Rehabilitation of RCC Buildings", DG(W), Central Public Works Department, New Delhi, 2002.
2. "Repairs and rehabilitation of Concrete Structures", P. I. Modi & C. N. Patel, PHI Publication, 2016
3. "Concrete Structures Repair Rehabilitation and Retrofitting", J.Bhattacharjee, Books Wagon,2005
4. "Learning from failures – Deficiencies in Design", Raikar R N, Construction and Service R&D Centre (SDCPL), Raikar Bhavan, Bombay,1987.
5. "Concrete microstructure, Properties and materials", P Kumar Mehta and Paulo J.M. Monterio,Mc Graw Hill Pub. Co.4th Edition, 2014
6. "Concrete Technology Theory and Practice", M. S. Shetty, S. Chand and Company, New Delhi, 1992.
7. "Handbook on Nondestructive Testing of Concrete", V. M. Malhotra, Nicholas J. Carino, , 4th Edition 2004
8. "Maintenance and Repair of Civil Structures", B.L. Gupta and Amit Gupta, Standard Publications, 2013.
9. "Concrete Structures, Materials, Maintenance and Repair", Denison Campbell, Allen and Harold Roper, Longman Scientific and Technical UK, 1991.
10. "Deterioration Maintenance and Repair of Structures", Sidney, M. Johnson, Mc Graw Hill Pub., 1965
11. "Concrete Structures, Protection, Repair and Rehabilitation", R. Dodge Woodson, Butterworth-Heinemann, 2009

UE15CV451:
RESEARCH METHODOLOGY AND EXPERIMENTAL DESIGN (2-0-0-0-2)

Course Objectives:

- Introduce students to research, types of research, research process, literature survey and review process, formulate hypothesis and sampling designs;
- Data collection methods, data analysis techniques and interpretation using statistical means;
- Rules of writing reports, thesis, journal articles and project proposals, rules of citation, ethics of research

Course Outcomes:

- Demonstrate knowledge of types of research, research process;
- Perform literature reviews using print and online databases and will be able to formulate hypothesis
- Demonstrate the knowledge of research and sampling designs;
- Demonstrate knowledge of rules of citation, ethics of research;
- Describe rules of writing reports, thesis, journal articles and project proposals.

Course Content:

1. **Foundations of Research**: 1. Meaning, Definition, Characteristics, Objectives, Motivation, utility. Characteristics of scientific method. **Types of Research:** 1. Descriptive vs. Analytical Research 2. Applied vs. Fundamental Research 3. Quantitative vs. Qualitative Research 4. Conceptual vs. Empirical Research. **Research Process:** Formulating the Research Problem **Review of Literature:** 1. What and Why Review of Literature?; Types of review of Literature 2. Technique of reviewing of literature; Characteristics of Good Review of Literature **Hypothesis:** 1. Hypothesis formulation 2. Qualities of a good Hypothesis; Null Hypothesis and Alternative hypothesis
2. **Research Design:** 1. Meaning of Research Design 2 Need for Research Design 3 Features of a Good Design 4. Important Concepts Relating to Research Design 5. Important Experimental Designs Basic Principles of Experimental Designs.
3. **Sampling Design:** 1. Characteristics of a good sample and Criteria of Selecting a Sampling Procedure 2. Characteristics of a Good Sample Design 3. Different Types of sample designs 4. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. 5. Determining size of the sample – Practical considerations in sampling and sample size.
4. **Scientific Report Preparation**: 1. Significance of Report Writing 2. Citation Rules and Methods (In text and end-text citations: MLA and APA Citation) 3. Thesis Writing; Review Paper writing **Article Writing for Journal Publication**: 1. Elements of Scientific Article –Abstract, Key words, introduction, material and methods, 2. Results and Discussion, 3. Summary and Conclusions. Bibliography and References Project Proposal Writing: 1. Approaching a proposal; 2. Criteria for a good grant proposal, Common shortcomings.
5. **Research Ethics:** 1. Tenets of Ethics; What is Research Ethics? Why lecture on Research Ethics? Conducting and reporting of science/engineering 2. Relationship in research groups; Hazards to good scientific practice 3. What is scientific misconduct? **Intellectual property rights: 1.** IPRs- Invention and Creativity-Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs); 2. A brief summary of: Patents, 3. Copyrights, 4. Trademarks.

Prerequisite Courses: None

Reference Books:

1. Research Methodology: Methods & Techniques, C.R. Kothari, 2nd Revised Edition, 2007, New Age International (P) Limited
2. Doing Science: Design, analysis and communication of science research Valielaivan, Oxford University Press, 2009
3. Notes, PowerPoint slides from faculty

MTECH IN CIVIL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES :

1. To effectively utilize computational methods and allied engineering tools in an optimal mode in the domain of structural engineering design and analysis of a wide spectrum of civil structures.
2. To develop innovative methods through critical thinking to resolve complex problems in the field of civil structures.
3. To be proficient in effective communicative skills in the field of structural design by developing oral as well as graphical means and multi-media presentations.

PROGRAM OUTCOMES :

- Be able to solve complex structural engineering problems by the sound fundamental knowledge of science and mathematics.

- Be able to design, analyze civil structures by apt considerations of public health, safety, environmental, social and cultural dimensions.
- Will be able to interpret data and extract information problems of design and plan abating or minimizing them through theoretical experiments and tools.
- Possess adaptability to efficiently contribute as a leader as well as a competent team-member.
- Appreciate and practice with professionalism, follow ethical path and be proficient in oral and technical communication.
- Believe in innovation, and practice life-long learning that augments critically analysis, self-correct, give considered opinions, take appropriate and timely decisions.

UE18CV501:
STRUCTURAL DYNAMICS (3-2-0-0-4)

Course Objectives:

- To possess knowledge about fundamentals of dynamics as applied to civil engineering structures.
- To have basic knowledge of one degree-of-freedom, multi-degree-of-freedom systems and obtain free and forced response of these systems subjected to different dynamic loading.
- Understand free and forced vibration phenomena
- Understand the natural frequencies, mode shapes and damping for a given structural system

Course Outcomes:

- Understanding of basic principles and importance of structural dynamics structures.
- Find out the response of the structures subjected to dynamic loading.
- Determine the natural frequencies and mode shapes for a given system and design to avoid resonance issues and provide necessary damping
- Able to determine the fatigue life loading due to dynamic loads

Course Content:

1. **Undamped single degree-of-freedom system:** degrees of freedom; undamped system; springs in parallel or in series; Newton's laws of motion; free body diagram; D'Alembert's principle; solution of the differential equation of motion; frequency and period; amplitude of motion; summary and problems
2. **Damped single degree-of-freedom system:** viscous damping, equation of motion, critically damped system, overdamped system, undamped system, logarithmic decrement, summary & problems.
3. **Response of one-degree-of-freedom system to harmonic loading & general dynamic loading:** undamped harmonic excitation, damped harmonic excitation, evaluation of damping at resonance. bandwidth method (Half -power) to evaluate damping, equivalent viscous damping, response to support motion, force transmitted to the foundation, seismic instruments, Duhamel's integral- undamped system; Duhamel's integral-undamped system; response by direct integration, solution of the equation of motion. summary, analytical problems, problems
4. **Multi-degree-of-freedom systems:** equations of motion, problem statement, and solution methods: simple system: two-story shear building, general approach for linear systems, static condensation, planar or symmetric-plan systems: ground motion, unsymmetric-plan buildings: ground motion, symmetric-Plan buildings: torsional excitation, problem statement.
5. **Multi-degree-of-freedom systems:** free vibration: systems without damping, natural vibration frequencies and modes, modal and spectral matrices, orthogonality of modes, interpretation of modal orthogonality, normalization of modes, and modal expansion of displacements.

Prerequisite Courses: None

Reference Books:

1. "Structural Dynamics", Mario Paz, Springer, 5th Edition 2014.
2. "Dynamics of Structures", Anil K Chopra, Pearson, Seventeenth Impression, 2015

UE18CV502:
CONTINUUM MECHANICS - CLASSICAL AND FE APPROACH (3-2-0-0-4)

Course Objectives:

- To introduce students to the fundamental concepts of the mechanics of deformable bodies along with state-of-the-art computational methods in civil engineering. The range of material behaviour considered includes: Finite Deformation Elasticity

Course Outcomes:

On successful completion of this course, students are able to

- Ability to apply knowledge of mathematics, science, and engineering by developing the
- Equations of motion for vibratory systems and solving for the free and forced response.
- Formulate, analyze and solve problems in elasticity using classical approach.
- Understand the formulation of and implementation of Isoparametric finite element models for two and three-dimensional deforming bodies
- Use finite element methods for solving continuum mechanics problems.
- Read and Comprehend scientific articles in the field of Computational Mechanics of deformable bodies

Course Content:

1. **Basic Concepts**: Definition of stress and strain at a point, components of stress and strain at a point, strain displacement relations in cartesian co-ordinates, constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases, plane stress, plane strain – Definition.
2. **Two-dimensional problems in Rectangular Coordinates**: Airy's stress function approach to 2-D problems of elasticity. Solution by Polynomials – End Effects, Saint – Venant's Principle – solution of some simple beam problems, including working out of displacement components.
3. **Two - dimensional problems in Polar coordinates**: General equation in Polar coordinates – Strain and displacement relations, equilibrium equations - Stress distribution symmetrical about an axis – Pure bending of curved bars – Displacements for symmetrical stress distributions –Bending of a curved bar by a force at the end – The effect of a small circular hole on stress distribution in a large plate subjected to uni-axial tension and pure shear.
4. **Analysis of Stress and Strain in Three Dimensions**: Introduction – Principal stresses – Determination of the principal stresses and principal planes. – Stress invariants – Determination of the maximum shearing stress- Octahedral stress components, Principal strains – strain invariants.
5. **FE APPROACH**: 2D and 3D Elements - CST, LST, Rectangular family, Tetrahedral and Hexahedra: Shape functions, Element Stiffness matrix, Equivalent Loads, Isoparametric formulation of Triangular and General quadrilateral elements, Axisymmetric elements, Gauss Quadrature.

Prerequisite Courses: None

Reference Books:

1. "Theory of elasticity", Timoshenko and Goodier, McGraw Hill Book Company, III Edition, 1983.
2. "Continuum Mechanics fundamentals", Valliappan.S, Oxford and IBH, 1981
3. "Concepts and Applications of Finite Element Analysis", Robert D Cook et al, 3rd Edition, John Wiley and Sons, New York, 1988
4. "Advanced Mechanics of Solids", Srinath. L.S.Tata McGraw-Hill Publishing Co Ltd, New Delhi, 1987
5. "Finite element procedures in Engineering Analysis", Bathe. K.J, PHI. New Delhi, 1982
6. "The Finite Element Method", Zienkiewicz. O.C, Tata-McGraw-Hill Publishing Company
7. "Finite Element Analysis", Krishnamoorthy C.S, Tata-McGraw-Hill Publishing Company

UE18CV503:
COMPUTATIONAL STRUCTURAL MECHANICS - CLASSICAL AND FE APPROACH (3-2-0-0-4)

Course Objectives:

- To acquire the knowledge of principles of computational structural mechanics.

Course Outcomes:

- Gain knowledge of development of problem solving skills.
- Enhance the analytical skills.

Course Content:

1. **Direct Stiffness Method – Trusses:** Degrees of Static and Kinematic indeterminacies, Concepts of Stiffness and Flexibility, Local and Global Coordinate System, Analysis of indeterminate Trusses, with and without initial strains for different types of boundary conditions such as Fixed, Hinged, Roller, Slider, Elastic (Spring) supports, support settlement.
2. **Direct Stiffness Method** - Continuous Beam, 2D Frames: Analysis of Continuous beams, for different types of boundary conditions such as Fixed, Hinged, Roller, Slider, Elastic (Spring) supports, support settlement. Analysis of Simple 2D Frames with and without sway, Element stiffness matrix for 3D frames and Grids
3. **Basic Concept of Finite Element Method:** Concept of FEM, Formulation using principle of virtual work, Principles minimum potential energy, Method of Weighted Residuals (Galerkin's), Choice of displacement function, Degree of continuity. Generalized and Natural coordinates.
4. **FE Analysis using Bar Elements:** Derivation of Shape Function for Linear and Higher order elements using Inverse and Lagrange Interpolation formula, Element Stiffness matrix Two and Three noded elements. Examples with constant and varying cross sectional area subjected to concentrated loads, distributed body force and surface traction and Initial strains due to temperature. Isoparametric formulation
5. **FE Analysis using Beam Element**: Derivation of Shape Function for two noded beam element, Hermitian Interpolation, Element Stiffness matrix, Consistent Nodal loads,, Concept of Reduced or Lumped Loads, Examples : Cantilever and Simply Supported beams,

Prerequisite Courses: None

Reference Books:

1. "Computational Structural Mechanics", Rajasekaran.S, PHI, New Delhi 2001.
2. "Basic Structural Analysis," Reddy.C.S, TMH, New Delhi 2001
3. "Concepts and Applications of Finite Element Analysis", Robert D Cook et al, 3rd Edition, John Wiley and Sons, New York
4. "Computer Methods of Structural Analysis", Beaufait F.W. et al., Prentice Hall, 1970.2. Weaver.W and Gere.J.H., Matrix Analysis of Framed Structures, Van Nastran, 1980.
5. "Matrix Computer Methods of Structural Analysis", Rubinstein M.F, Prentice-Hall.
6. "Finite element procedures in Engineering Analysis", Bathe.K.J, PHI. New Delhi

UE18CV504:
ACTION AND RESPONSE OF STRUCTURAL SYSTEMS (2-0-2-0-3)

Course Objectives:

- A structural system may be subjected to several combinations of actions when deployed into service.
- Certain important decisions such as, proper identification of structural systems, design actions on them and the recourse to the type of analysis have to be made during the design process.
- The focus of this course is on how to calculate the various design loads and apply them in a commercially available structural analysis software, known as actions, which are required to determine the design forces, known as 'Response" or effects of actions.

Course Outcome:

On successful completion of this course, students are able to

- Understand the importance of appropriate codal provisions.
- Familiarize with procedures for calculating action effects for different types of structures frequently encountered in practice
- Assess the basic need, concepts and procedures of different types of analysis.
- To understand commercially available structural analysis software.

Course Content:

1. **IS 875 PART 1, 2, 4, 5:** Sources, Nature and Magnitude, Probabilistic assessment, Characteristic and Design values. IS 875 PART 1 and 2 code provisions. Load combination rules for design. Estimation of DL and LL on structural elements such as Slab, Beams, Columns, in different types of structural systems, Joint Loads on Trusses, Distributed load on Purlins- Numerical examples. Accidental loads – Impact and collisions, Explosions and Fire. - Numerical examples

   Lab Component: Estimation of DL & LL on Structural elements, verifying the calculated loads by using commercially available structural analysis software.
2. **Wind Load - IS 875 PART 3**: Buildings: Nature and Magnitude, Factors influencing wind loads, Internal and External pressure distribution, Design Wind Speeds and Pressure, Numerical Examples to calculate external and internal pressure for different types of buildings and regions – Flat roof, Pitched Roof, mono slope roof, Hipped roof, Sign board, Water tank on braced and shaft staging, Multi-storey Frames.

   Lab Component: Estimation of wind loads on different buildings, applying the same on the model created using commercially available structural analysis software.
3. **Seismic Loads: IS 1893:** Buildings - Nature and Magnitude, Centre of mass and rigidity, Calculation of Design Seismic Force by Static Analysis Method,

   Lab Component: Estimation of Seismic loads (ESLM) on Structural elements, to know how Seismic loads are applied on the models created using commercially available structural analysis software.

4. **Dynamic Analysis Method:** Location of Centre of Mass, Location of Centre of Stiffness, and Lateral Force Distribution as per code provisions.

   Lab Component: To know how Seismic loads (Dynamic Loads) are applied on the models created using commercially available structural analysis software.

5. **Vehicles Loads as per IRC 6 - 2010 on Road Bridges:** Class 70 R, Class AA, Class A, Class B, Tracked Vehicle, Wheeled Vehicle, Load Combinations, Impact, Wind, Water Currents, Longitudinal Forces: acceleration, breaking and frictional resistance, Centrifugal forces, temperature, Seismic forces, Snow Load, Collision Loads. Load Combinations – Simple Numerical examples

   Lab Component: To understand how Load Combinations are applied on the models created using commercially available structural analysis software.

Prerequisite Courses: None

Reference Books:

1. "An explanatory Handbook on IS 875 (PART 3); Wind Load on Building and Structures", Document No: IITK-GSDMA Wind 07 V1.0 - IITK-GSDMA Project on Building Codes
2. "Explanatory Examples on Indian Seismic Code IS 1893(Part I)", Document No: IITK-GSDMA-EQ21-V2.0 - IITK-GSDMA Project on Building Codes
3. "Code of Proactive for design loads (Other than Earthquake) for Buildings and Structures. IS 875 (Part 1)- 1987 reaffirmed 2003
4. "Code of Practice for design loads (Other than Earthquake) for Buildings and Structures" IS 875 (Part 2)- 1987 reaffirmed 2003
5. "Code of Practice for design loads (Other than Earthquake) for Buildings and Structures" IS 875 (Part 3)- 1987 reaffirmed 2003

UE18CV505: ADVANCED OPTIMIZATION METHODS (3 - 2 - 0 -0- 4)

OBJECTIVES

- Learn Optimization techniques.
- Learn the various soft computing frame works.
- Be familiar with design of various neural networks.
- Be exposed to support vector machines
- Be exposed to self-organizing mapping.
- Be exposed to fuzzy logic and swarm intelligence.

OUTCOME

- Knowledge in advanced optimization techniques helps to solve civil engineering problems

Course Content:

1. **Introduction:** What is Optimization? Classical optimization techniques, modern optimization techniques, what is soft computing? Soft computing constituents, methods in soft computing, supervised and unsupervised learning, hybrid models, MATLAB based applications of soft computing in civil engineering.
2. **Neural Networks:** Concept, biological neural system, evolution of neural network, activation functions, feed forward networks, feedback networks, learning rules – Hebbian, Perceptron learning and Windrow- Hoff, winner-take-all, applications.
3. **Support vector machine:** Linear classifiers, classifier margins, linear SVM mathematically, solving optimization problem, Vapnik-Chervonenkis dimension, soft margin classification, hard margin vs. soft margin, non-linear SVMs, Kernel functions, properties of SVM, applications.
4. **Self-Organizing Maps:** What is SOM, topographic maps, setting up structure of the SOM, components of self-organization, training algorithms of the map, advantages and disadvantages, overview of SOM algorithm, applications.
5. **Fuzzy systems & Swarm intelligence:** Classical sets and fuzzy sets, fuzzy sets operations, fuzzy relations, membership functions, defuzzification, fuzzy rule based systems, Swarm intelligence-ant colonization and particle swarm optimization, applications.

Prerequisite Course: None

Reference Books:

1. "Engineering Optimization- Theory and Practice", S S Rao, 4th Edition, John Wiley & Sons, 2009.
2. "Neural Networks: A Comprehensive Foundation", S. Haykin, 2nd Edition, Prentice Hall of India, 2003.
3. "Neural Networks and Learning Machines", S. Haykin, 3rd Edition, Prentice Hall of India, 2009.
4. "Fuzzy logic with Engineering Application", Ross T.J., McGraw Hill International Edition, 1995.

UE18CV506: RESEARCH METHODOLOGY AND TECHNIQUES (2-0-0-0-2)

Course Objectives:

- Introduce students to research, types of research, research process, literature survey and review process, formulate hypothesis and sampling designs;
- Data collection methods, data analysis techniques and interpretation using statistical means;
- Rules of writing reports, thesis, journal articles and project proposals, rules of citation, ethics of research

Course Outcomes:

- Demonstrate knowledge of types of research, research process;
- Perform literature reviews using print and online databases and will be able to formulate hypothesis
- Demonstrate the knowledge of research and sampling designs;
- Collect data, analyze and interpret using statistical means;
- Demonstrate knowledge of rules of citation, ethics of research;
- Describe rules of writing reports, thesis, journal articles and project proposals.

Course Content:

1. **Foundations of Research**: 1. Meaning, Definition, Characteristics, Objectives, Motivation, utility. 2. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method. **Types of Research:** 1. Descriptive vs. Analytical Research 2. Applied vs. Fundamental Research 3. Quantitative vs. Qualitative Research 4. Conceptual vs. Empirical Research. **Research Process:** 1. Basic Overview 2. Formulating the Research Problem 3. Defining the Research Problem 4. Problem Identification & Formulation 5. Research Question, **Review of Literature:** 1. What and Why Review of Literature?; Types of review of Literature 2. Technique of reviewing of literature; Characteristics of Good Review of Literature **Hypothesis:** 1. Hypothesis formulation 2. Qualities of a good Hypothesis; Null Hypothesis and Alternative hypothesis
2. **Research Design:** 1. Meaning of Research Design 2 Need for Research Design 3 Features of a Good Design 4. Important Concepts Relating to Research Design 5. Important Experimental Designs Basic Principles of Experimental Designs **Sampling Design:** 1. Characteristics of a good sample and Criteria of Selecting a Sampling Procedure 2. Characteristics of a Good Sample Design 3. Different Types of sample designs 4. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. 5. Determining size of the sample – Practical considerations in sampling and sample size.

3. **Data Collection**: 1. Collection of Primary Data 2. Observation Method 3.Interview Method 4. Collection of Data through Questionnaires 5 Case Study Method 6. Collection of Secondary Data **Processing and Analysis of Data:** 1. Processing Operations 2. Statistics in Research 3. Measures of Central Tendency – Descriptive statistics 4. Measures of Dispersion 5. Inferential statistics **Interpretation and Report Writing:** Meaning of Interpretation: 1. Why Interpretation 2. Technique of Interpretation; Precaution in Interpretation
4. **Scientific Report Preparation**: 1. Significance of Report Writing 2. Citation Rules and Methods (In text and end-text citations: MLA and APA Citation) 3. Thesis Writing; Review Paper writing **Article Writing for Journal Publication**: 1. Elements of Scientific Article –Abstract, Key words, introduction, material and methods, 2. Results and Discussion, 3. Summary and Conclusions. Bibliography and References Project Proposal Writing: 1. Approaching a proposal; 2. Criteria for a good grant proposal, Common shortcomings.
5. **Research Ethics:** 1. Tenets of Ethics; What is Research Ethics? Why lecture on Research Ethics? Conducting and reporting of science/engineering 2. Relationship in research groups; Hazards to good scientific practice 3.What is scientific misconduct? **Intellectual property rights: 1.** IPRs- Invention and Creativity-Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs); 2. A brief summary of: Patents, 3. Copyrights, 4. Trademarks

Prerequisite Courses: None

Reference Books:

1. "Research Methodology: Methods & Techniques", C.R. Kothari, 2nd Revised Edition, 2007, New Age International (P) Limited
2. "Doing Science: Design, analysis and communication of science research", Valielaivan, Oxford University Press, 2009
3. Notes, PowerPoint slides from faculty

UE18CV551: ADVANCED DESIGN OF RC STRUCTURES (3-2-0-0-4)

Course Objectives:

- To acquire the knowledge of principles of RC Structural Design,
- To design and detail different types of RC structures,
- To assess the performance of RC structures.

Course Outcomes:

- Gain knowledge of development of problem solving skills.
- Perceive the design principles of RC structures
- Design and enhance the analytical skills.
- Review the principles of Structural Design and detailing
- Comprehend the structural performance.

Course Content:

1. **Deflection of Reinforced Beams and slabs:** Introduction, Short-term deflection of beams and slabs, Calculation of deflection by IS 456, Numerical problems. **Estimation of crack width in reinforced concrete members:** Introduction, Estimation of crack-width in Beams, Mechanism of Flexural cracking, Calculations of crack-widths, Numerical problems.
2. **Yield line method of design of slabs:** General features, Characteristic features of yield lines, Yield moments, Yield line analysis by Virtual work method and Equilibrium method for square, rectangular and circular slabs, Numerical problems. **Design of grid floors:** Introduction, Analysis of Flat Grid floors, Detailing of steel in flat grids, Numerical problems.
3. **Redistribution of moments in reinforced concrete beams:** Introduction, Conditions of Moment Redistribution, Final shape of redistributed bending moment diagram, Moment redistribution for a two-span continuous beam, Advantages and disadvantages of Moment redistribution, Modification of clear distance between bars in beams (for limiting crack width) with redistribution, Moment-curvature relations of reinforced concrete sections, Numerical problems.
4. **Design of Reinforced Concrete Deep Beams & Corbels:** Introduction, Minimum thickness, Steps of designing deep beams, design by IS 456, checking for Local Failures, detailing of deep beams, Analysis of Forces in a Corbels, Design of Procedure of Corbels, and Design of Nibs
5. **Design of Bunkers and Silos:** Introduction, Difference between bunker and silo, Design of square and circular bunkers, Design of Silos.

Prerequisite Courses: None

Reference Books:

1. "Reinforced and Prestressed Concrete", A Park and Paulay, Year
2. "Reinforced Concrete Design", Lin TY and Burns N H, Year
3. "Design of Prestressed Concrete Structures"Kong KF and Evans T H, Year
4. "Advanced Reinforced Concrete Design", P.C. Varghese, Prentice-Hall of India, New Delhi, 2005.
5. "Comprehensive RCC Design", Dr.B.C.Punmia, Ashok Kumar Jain and Arun Kumar Jain, Year
6. "Reinforced Concrete Design", S. Pillai, DevdasMenon- 3/ED 3rd Edition, Year

UE18CV552: COMPUTER AIDED ANALYSIS AND DESIGN LABORATORY (0-0-2-0-1)

Course Objectives:

- Explain importance of commercially available design and analysis software.
- Exposure to commercially available software like STAAD PRO, ETABS, ANSYS, etc
- Perform analysis, design iterations and design optimization

Course Outcomes:

- Use commercial software like ETABS, ANSYS etc and perform analysis, design
- Create more robust designs.

Course Content:

1. Introduction to STAAD Pro.
2. Modelling & Analysis of Determinate Beams
3. Modelling & Analysis of Indeterminate Beams
4. Modelling & Analysis of Frames without sway
5. Modelling & Analysis of Frames with sway
6. Modelling Analysis & Design of R C Framed structures
7. Modelling & Analysis Steel trusses
8. Modelling Analysis & Design of Steel framed structures

Prerequisite Courses: None

Reference Books:

1. "Dynamics of Structures", A K Chopra, Pearson Education, Indian Branch Delhi 5th Edition, 2007.
2. "Basics Structural Analysis", C.S. Reddy, Tata McGraw Hill Education, 3rd Edition, 1994
3. "Earthquake Resistant Design of Structure", S.K Duggal, Oxford University Press, 1st Edition, 2012.
4. "Theory of Structures", S. Ramamrutham and R. Narayan, Dhanpat Rai and Sons, 9th Reprint Edition, 2014.
5. Laboratory Manual prepared by the Department of Civil Engineering, PESU.

UE18CV511: DESIGN OF EARTHQUAKE RESISTANT STRUCTURES (3-2-0-0-4)

Course objectives:

- To evaluate the seismic response of the structures
- To design the reinforced concrete buildings for earthquake resistance.
- To learn principles of structural design and performance of masonry structures
- To design different types of structures and to detail the structures.

Course outcomes:

- Understand the principles of design of masonry structures
- Evaluate the strength and stability of the masonry structures.
- Understand the concepts of earthquake resistance of reinforced concrete buildings.
- Summarize the principles of Structural Design and Detailing.

Course Content:

1. **Consideration of Infill Wall in Seismic Analysis of RC Buildings –** Introduction, Structural and Constructional Aspects of Infills, Failure Mechanism of Infilled Frame, Analysis of Infilled Frames. **Seismic damages in RC Buildings:** Damages to Non-Structural Panel Elements – Damage to Infill Walls, Damage to Exterior Walls.
2. **Step-by-step Procedure for Seismic Analysis of RC Building** – Response Spectrum Method–A, Frame without considering the stiffness of Infills-B, Frame considering the stiffness of Infills, Time History Method.
3. **Earthquake Resistant Design of Shear Wall** – Introduction, Description of Building, Determination of Design Lateral Forces, Design of Shear Wall, Detailing of Reinforcements. **Capacity Based Design – An Approach for Earthquake Resistant Design of Soft Storey RC Buildings** – Introduction, Preliminary Data for (G+3) Plane Frame, Step-by-step Procedure for Capacity Based Design.
4. **Lateral Load Analysis of Masonry Buildings** – Introduction, Procedure for Lateral Load Analysis of Masonry Buildings. **Seismic Analysis and Design of Masonry Buildings** – Introduction, Building Data, Determination of Design Lateral Load, Determination of Wall Rigidities, Determination of Torsional Forces, Determination of Increase in Axial Load due to Overturning, Determination of Pier Loads, Moments and Shear, Design of Shear Walls for Axial Load and Moments, Design of Shear Walls for Shear, Structural Details.
5. **Art of Detailing Earthquake Resistant Structures** – Introduction, Purpose of Reinforcement, Directional changes of Internal Forces, Detailing of Beams, Detailing of Compression Members, Brackets and Corbels.

Prerequisite Courses: None

Reference Books:

1. "Earthquake Resistant Design of Structures", Pankaj Agarwal and Manish Shrikhande, 2nd Edition, Prentice-Hall of India Private Limited, New Delhi, 2006 (Unit 1 to 4).
2. "Reinforced Concrete Structures", Robert Park and Thomas Paulay, Wiley India (P) Ltd, Delhi, 2013.
3. "Indian Standard Criteria for Earthquake Resistant Design of Structures, General Provisions and Buildings (5th revision)", IS 1893 (Part 1), Bureau of Indian Standards, 2002
4. Relevant Indian Standard Code Books.

UE18CV512: THEORY OF ELASTIC STABILITY (3-2-0-0-4)

Course Objectives:

- To introduce the fundamentals of concept of stability, buckling of columns, buckling of beam-columns and frames, buckling of thin rectangular plates, torsional and lateral-torsional buckling.

Course outcomes:

- The students are expected to be able to apply the Theory of Elastic Stability, to study the buckling of beams, columns, frames and plates.

Course Content:

1. **Fundamental Concepts:** Concept stability, instability and bifurcation, different forms of structural instability, analytical approaches of stability analysis. **Beam – column –** Introduction, Differential equations for Beam- columns, Beam – column with concentrated lateral load, several concentrated loads, continuous lateral load, and Bending of a Beam-Column by Couple.
2. **Elastic buckling of bars and frames:** Euler's column formula, alternate form of the differential equation for determining critical Loads, the use of Beam-column theory in calculating critical loads, buckling of frames, buckling of continuous Beams, and buckling of Continuous Beams on elastic support.
3. **Inelastic buckling of bars:** Inelastic bending, Inelastic bending combined with axial load, Inelastic buckling of bars (Fundamental case), and Inelastic buckling of bars with other End conditions.
4. **Torsional buckling:** Introduction, Pure Torsion of Thin–walled bars of open cross section, Non-uniform Torsion of Thin –walled bars of open cross section, Torsional buckling, Buckling by Torsion and Flexure, and Combined Torsional and flexural buckling of bars with continuous elastic supports.
5. **Lateral buckling of beams:** Differential equations for lateral buckling, Lateral buckling of beams in pure bending, Lateral buckling of a cantilever Beam, Lateral buckling of simply supported 'I' beams, Lateral buckling of simply supported Beam of narrow rectangular cross section, and other cases of lateral buckling.

Prerequisite Courses: None

Reference Books:

1. "Theory of Elastic Stability", S.P. Timoshenko and J.M.Gere, McGraw-Hill, 2nd edition, 1961.
2. "Stability of Structures", Ashwini Kumar, Allied Publishers, New Delhi, 1998.
3. "Principles of Stability theory", Alexander Chajes, Prentice- Hall, 1974.
4. "Elastic Stability of Structural Elements", N.G.R. Iyengar, Macmillan India, 2007.

UE18CV521: DESIGN OF STRUCTURAL SYSTEMS FOR TALL BUILDINGS (3-2-0-0-4)

Course Objectives:

- Learn principles of stability of tall buildings
- Design tall structures for earthquake and wind loads
- Evaluate the performance of tall structures for strength and stability.

Course Outcomes:

- Have the Knowledge of design and develop problem solving skills.

- Understand the principles of strength and stability
- Design and develop analytical skills.
- Summarize the behaviour of various structural systems.
- Understand the concepts of P-Delta analysis.

Course Content:

1. **Design Criteria:** Design philosophy, loading, sequential loading, and materials – high performance concrete, fibre reinforced concrete, lightweight concrete, design mixes. Loading and Movement: Gravity loading: Dead and live load, methods of live load reduction, Impact, Gravity loading, Construction loads
2. **Wind Loading**: static and dynamic approach, Analytical and wind tunnel experimentation method. Earthquake loading: Equivalent lateral force, modal analysis, combinations of loading, working stress design, Limit state design, Plastic design.
3. **Behaviour of Various Structural Systems:** Factors affecting growth, Height and structural form; High rise behaviour, Rigid frames, braced frames, in-filled frames, shear walls, coupled shear walls, wall-frames, tubular, cores, Futigger – braced and hybrid mega system.
4. **Analysis and Design:** Modelling for approximate analysis, accurate analysis and reduction techniques, analysis of building as total structural system considering overall integrity and major subsystem interaction, analysis for member forces; drift, computerized general three-dimensional analyses.
5. **Stability of Tall Buildings:** Overall buckling analysis of Frames, Wall frames, Approximate methods, P-Delta analysis, Simultaneous first order and P-Delta analysis, Translational-Torsional Instability, Out-Of-Plum Effects, Stiffness of Members in Stability Calculations, Effects of Foundation Rotation. Design for Differential movement, Creep and Shrinkage Effects, Temperature effects and Fire.

Prerequisite Courses: None

Reference Books:

1. “Structural Analysis and Design of Tall Buildings”, Taranath B.S, McGraw Hill, 2012.
2. “Tall building structures Analysis and Design”-Bryan Stafford Smith &Alexcoull, John Wiley, 2013
3. “Concrete Technology”, M.S. Shetty, S. Chand and Company Ltd, 7th edition, 2013.

UE18CV522:
THEORY OF PLATES AND SHELLS (3-2-0-0-4)

Course Objectives:

- Learn advanced methods in the analysis of plates and shells.
- Focus will be given to the use of general relationships in the solution of mechanics problems. The student will attain knowledge that can be used to analyze and design mechanical systems. Solution to practical problems will be emphasized including integration with finite element analysis.
- Introduce students to the classical structural mechanics approximations of Membrane, Plate and Shell theories.
- Use energy formulations to demonstrate the consistent derivation of approximate boundary conditions and edge effects.
- Demonstrate the approximation of the classical formulations using numerical approximation techniques.

Course Outcomes:

- An ability to apply knowledge of mathematics, science, and engineering related to plate and shell theory.
- An ability to identify, formulate and solve theoretical problems with structural plate and shell elements.
- Ability to use finite element methods in plate and shell analysis and to use plate and shell theory for verification of finite element results.
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Course Content:

1. **Introduction to plates**: Thin and thick plates, small and large deflections. Small deflection theory of thin plates: Kirchhoff’s classical plate theory (KCPT), Reissner–Mindlin thick plate theory, assumptions, moment curvature relations, stress resultants, governing differential equation in Cartesian co-ordinates, various boundary conditions.
2. **Analysis of rectangular plates:** Navier solution for plates with all edges simply supported, loads: distributed loads, point loads and rectangular patch load. Levy’s method: distributed load and line load, plates under distributed edge moments.
3. **Circular Plates:** Analysis of circular plates under axi-symmetric loading, moment curvature relations, governing differential equation in polar co-ordinates, simply supported and fixed edges, distributed load, ring load, analysis of a plate with a central hole.
4. **Introduction to shells:** Classification of shells on geometry, thin shell theory, equations to shell surfaces, stress resultants, strain-displacement relations, compatibility and equilibrium equations. Shells of Revolution: membrane theory, equilibrium equations, strain displacement relations, boundary conditions, cylindrical, conical and spherical shells.
5. **Circular cylindrical shells:** Circular cylindrical shells: Membrane theory: equilibrium equations, strain displacement relations, boundary conditions. Bending Theory: equilibrium equation, strain displacement relations, governing differential equation, and solution for a simply supported cylindrical shell. **Beam theory of cylindrical shells:** Beam theory of cylindrical shells: principles of Lundgren’s beam theory, beam analysis, arch analysis, and application to cylindrical roof shells.

Prerequisite Courses: None

Reference Books:

1. “Theory of Plates and Shells”, Timosheko, S, Woinowsky-Krieger, W, 2nd Edition, McGraw-Hill Co., New York, 1959.
2. “Theory of elastic stability”. Timoshenko S, Gere JM. Mc Graw-Hill, New York, 1961.
3. “Stresses in Plates and Shells”, Ansel C. Ugural, 2nd Edition, McGraw Hill. 1999.
4. “Design and Constructions of Concrete Shell Roofs”, Ramaswamy G.S, CBS Publishers and Distributors, New Delhi, 1986.
5. “Analysis of Concrete Shells”, Chandrashekhara K, 2nd Edition, New Age International, 1995.
6. “Analysis of Plates”, Chandrashekhara K, 2nd Edition, New Age International (P) Limited, 1995.
7. “Theory and analysis of plates - Classical and Numerical methods”, R. Szilard, Prentice Hall, 1994.
8. “Theory and Design of Concrete Shell”, Chatterjee.B.K, Chapman & Hall, New York, 3rd Edition, 1988.
9. NPTEL Notes on plates and shells

UE18CV531:
DESIGN OF PRESTRESSED CONCRETE STRUCTURES (3-2-0-0-4)

Course Objectives:

- Understand different types of prestressing and advantages of prestresssed concrete structures

- Behaviour of the pre-stressed concrete structural members
- Analysis and design pre-stressed concrete members according to latest IS codes of practice

Course Outcomes:

- Ability to design of PSC elements according to latest IS codes of practice
- Ability to analyse and design pre-stressed concrete structures for practical scenarios
- Maintenance and rehabilitation of PSC structures.

Course Content:

1. **Introduction:** History, basic concepts, types of prestressing a system, materials, terminology, advantages and disadvantages of PSC, applications. IS code provision for design of end blocks.
2. **Limit state of design:** Introduction, deflections, serviceability criterion**,** short term deflections of uncracked members, long term deflections, deflections of cracked members, requirement as per IS 1343, flexure, shear, torsion as per IS 1343 provisions.
3. **Prestressed concrete pipes and tanks:** Circular prestressing, types of PSC pipes, analysis and design of PSC pipes and tanks.
4. **Prestressed concrete slabs and grid floors:** Types of floor slabs, design of one-way, two-way, simple flat slabs, analysis and design of PSC grid floors.
5. **Maintenance and rehabilitation of PSC structures:** Maintenance methodology, inspection of structures, cracks in PSC members, remedy, repairs, repairs of girders damaged by collision, restoration of strength of PSC concrete girders, strengthening by externally bonded steel plates.

Prerequisite Courses: None

Reference Books:

1. "Prestressed Concrete", N. Krishna Raju, Tata Mc. Graw Publishers, latest edition..
2. "Prestressed Concrete Structures", Dayaratnam, Oxford and IBH Publishing C., latest edition.
3. "Design of Prestressed Concrete Structures", T.Y.Lin and Ned H. Burns, John Wiley & Sons, New York.
4. IS code 1343- latest version.

UE18CV532:
DESIGN OF BRIDGES (3-2-0-0-4)

Course Objectives:

- Understand the bridge substructures and superstructures
- Understands the different types of bridges
- To learn principles of structural design of bridges
- To detail the bridge structures
- To evaluate performance of the bridge structures.

Course Outcomes:

- Knowledge of design and development of bridges.
- Ability to design bridge substructures and superstructures
- Apply principles of bridge design and detailing of bridges for practical situations

Course Content:

1. **Introduction**: Historical Developments, Investigation for bridges, Classification of Bridges. Standard specifications for Bridges, General Design Considerations.
2. **Box Culvert:** Different Loading Cases IRC Class AA Tracked, Wheeled and Class A Loading, working out the worst combination of loading, Moment Distribution, Calculation of BM & SF, Structural Design of Slab Culvert, with Reinforcement Details.
3. **Slab & T Beam Bridge Design:** Proportioning of Components Analysis of interior Slab & Cantilever Slab Using IRC Class AA Tracked, Wheeled Class A Loading, Structural Design of Slab, with Reinforcement Detail. T Beam Bridge Cross Girder Design: Analysis of Cross Girder for Dead Load & Live Load Using IRC Class AA Tracked, Wheeled Class A Loading A Loads, Structural Design of Beam, with Reinforcement Detail
4. **Prestressed Concrete Bridges:** Introduction about prestressing methods, Pre-Tensioned PSC Bridges, Post-Tensioned PSC Bridges, Design of Post-Tensioned PSC Slab Bridge Deck Slab, Design of Post-Tensioned PSC Tee-Beam and Deck Slab bridge.
5. **Bridge Bearings:** Introduction. Types of bearings. Design of Steel Rocker and Roller bearings. Design of RC Rocker Bearing. Design of Elastomeric Pad bearing. Expansion Joints for Bridge Decks.

Prerequisite Courses: None

Reference Books:

1. "Essentials of Bridge Engineering", D Johnson Victor, Oxford & IBH Publishing Co New Delhi, Year.
2. "Design of Bridges"- N Krishna Raju, Oxford & IBH Publishing Co New Delhi, Year
3. "Essentials of Bridge Engineering", 6th Edition, D. Johnson Victor, Oxford & IBH Publishing Co. Pvt. Ltd., Year
4. "IRC 6 – 1966 Standard Specifications and Code of Practice for Road Bridges", Section II Loads and Stresses, The Indian Road Congress New Delhi, Year
5. "IRC 21 – 1966 Standard Specifications and Code of Practice for Road Bridges", Section III Cement Concrete (Plain and reinforced) The Indian Road Congress New Delhi, Year
6. "IS 456 – 2000 Indian Standard Plain and Reinforced Concrete Code of Practice"- (4th Revision), BIS New Delhi, Year
7. "Barker and Puckett Design of Highway", Bri John, Wiley and Sons, 2007
8. "Design of Concrete Bridges", Vazirani Ratwani, MG Aswani, Khanna Publishers, New Delhi, Year.
9. "Bridge Engineering", Ponnuswamy, Mcgraw Hill Publications, Year.

UE18CV541:
REPAIR & REHABILITATION OF STRUCTURES (3-2-0-0-4)

Course Objectives:

- To make the students to gain the knowledge on quality of concrete, durability aspects, causes of deterioration.
- To assess distress in structures, repairing of structures and demolition procedures.
- To understand the concepts of maintenance.

Course Outcomes:

- Identify and define all the terms and concepts associated with deterioration of concrete structures.
- Carry out the damage assessment and Rapid Visual inspection of a building showing signs of deterioration and thus should be able to detect the possible cause /source of deterioration.
- Develop a knowhow of the Concrete repair industry equipped with variety of repair materials and techniques.
- Describe and apply the importance of quality control in concrete construction and significance of protection maintenance of structures.

Course Content:

1. **Durability and Deterioration of concrete in structures: Physical causes:** Introduction, durability of concrete, causes of distress in concrete structures, physical deterioration due to shrinkage, freeze-thaw, weathering, abrasion, erosion, cavitations,

temperature changes, fire, construction errors, cracking due to construction overloads, cracks due to externally loads, accidental loadings, design errors. **Chemical causes:** carbonation attack, sulphate attack, acid attack, alkali reaction, chloride attack, salt attack, soft water attack, crystallization of salts, sea water attack. **Corrosion:** Basic principle of corrosion, corrosion mechanisms of embedded metal, corrosion process, damages due to corrosion, codal provisions for different exposure conditions, corrosion protection techniques, relative symptoms to causes of distress and deterioration

2. **Damage Assessment:** Destructive testing systems: Introduction, Purpose of assessment, rapid assessment, monitoring, investigation of damage, observation, questioning, damage assessment procedure, visual inspection, testing system of hardened concrete, evaluation of cracks, destructive testing systems, assessment of existing concrete structures, direct load tests, load test on structural systems. Non-destructive testing systems: Introduction, NDT methods, surface hardness methods, ultrasonic pulse velocity method, advanced ultrasonic testing methods, resonant frequency method, dynamic and vibration methods, pulse attenuation methods, pulse echo method, acoustic emission method, recent development on NDT instruments. Semi-destructive testing methods: Introduction, penetration techniques, pullout& pull off test, core sampling test, permeability test, resistivity mapping, carbonation and pH value test, chloride content, abrasion resistance, alkali silica content tests, diagnostic methods for corrosion damage, investigation strategies.
3. **Repair Materials:** Selection and evaluation of materials: Introduction, criteria for selection of repair materials, methodology for the selection of repair materials, classification of repair materials, evaluation test for repair materials. Special repair materials: Introduction, chemical and mineral admixtures, super plasticisers, accelerators, retarders, fly ash, ground granulated blast furnace slag, condensed silica fume, polymeric materials, polymeric repair materials, types of polymer concrete composites, fibre reinforced concrete (FRC) – behavior of steel fibre reinforced concrete, behavior of FRC with other fibres, of application, types of fibres, ferrocement, SIFCON and SIMCON Materials.
4. **Repair and Rehabilitation: Repair of cracks:** Introduction, factors that affect cracking, measures of cracking, stages of concrete repair, durability of concrete repair, durable repair design, durable repair application, evaluation of repairs, types and classification of repairs, methods of repair. **Rehabilitation techniques:** Introduction, replacement mortar, replacement concrete, preplaced aggregate concrete, shotcrete, grouting, injection grouting, resin injection, dry pack and epoxy-bonded dry pack, sprayed concrete, slab jacking technique, tremie concrete, member replacement. **Strengthening techniques:** Introduction, need for strengthening, terms of repair, structural concrete repair, structural repair techniques for reinforced concrete, structure concrete strengthening, jacketing technique, externally bonding technique, externally bonded mild steel plates, strengthening with external reinforcement, short spanning, externally post-tensioning, section enlargement, strengthening by SIMCON.
5. **Maintenance and Demolition: Necessity and classification of maintenance:** Introduction, classification of maintenance, necessity of maintenance, inspection periods, background of maintenance, maintenance processes. Maintenance procedures: building maintenance, steel work maintenance, wood work maintenance, inspection of building, routine building maintenance. Safety in maintenance and demolition: safety in maintenance, construction accidents, safety in building maintenance, demolition management, concrete demolition, modern technology for demolition.

Prerequisite Courses: None

Reference Books:

1. "Deterioration, Maintenance and Repair of Structures", Sidney, M. Johnson, Year
2. "Concrete Structures – Materials, Maintenance and Repair"-Denison Campbell, Allen & Harold Roper, Longman Scientific and Technical, UK, 1991.
3. "Repair of Concrete Structures", R.T. Allen, S.C. Edwards, Blakie and Sons, UK, 1987.
4. "Learning for failure from Deficiencies in Design, Construction and Service", Raiker R.N., R&D Center (SDCPL), Year
5. "Concrete Technology – Theory and Practice", M.S. Shetty, S. Chand and Company, NewDelhi, 1992.
6. "Rehabilitation of Concrete Structures", Dr. B. Vidivelli, 1st Edition Reprint 2015, Standard Publisher Distributors.

UE18CV542:
DESIGN OF STORAGE STRUCTURES (3-2-0-0-4)

Course Objectives:

- To acquire the knowledge of principles of storage structures.
- To design & detail different types of storage structures like silos, water tanks.
- To access the performance of storage structures.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- Design the bunkers and silos.
- Design circular and rectangular water tanks resting on the ground.
- Design underground water tanks, and
- Design elevated water tanks with top dome and Intze tanks with staging.

Course Content:

1. **Design of Bunkers and silos** : Introduction, Janssen's theory, Airy's theory. Design of rectangular bunkers & silos. Design of Circular bunkers and silos
2. **Water tanks – General:** Introduction, Design requirements according to IS 3370; Joints in water tanks. **Design of water tanks resting on ground:** Design of circular tanks with flexible base, Design of rectangular tanks. Design of circular tanks with Rigid joints at base
3. **Design of Underground Water Tanks:** Introduction, earth pressure on tank walls, uplift pressure on the floor of the tank, design of rectangular tanks with L/B < 2; Design of rectangular tanks with L/B > 2.
4. **Design of overhead water tanks -1:** Design of flat base slab for elevated circular tanks; Design of Circular tank with domed bottom and roof.
5. **Design of overhead water tanks -2:** Design of Intze tank, Design of conical shaped tank.

Prerequisite Courses: None

Reference Books

1. "Advanced Reinforced Concrete Structures" H.J. Shah, Vol – II, Charator Publishers, 6th Edition, 2012.
2. "Advanced RCC Design", Bhavikatti S.S, New Age International (P) Ltd. Publishers, New Delhi, 2006.
3. "Comprehensive RCC Designs", B.C. Punmia, Ashok Kumar Jain & Arun Kumar Jain – Lakshmi Publication, 2005.
4. "Advanced Reinforced Concrete Design", N. Krishna Raju, CBS Publishers & Distributors, New Delhi, 2008.

5. “Advanced Reinforced Concrete Design”, P.C. Varghese PHI Pvt. Ltd., New Delhi, 2007.
6. ” Design of Reinforced Concrete Structures”, M.L.Gambhir, PHI Pvt. Ltd., New Delhi, 2008.
7. “Reinforced Concrete, Limit State Design”, Ashok K. Jain, Nem Chand & Bros, Roorkee, 2009.

UE17CV602: ADVANCED DESIGN OF STEEL STRUCTURES (3-2-0-0-4)

Course Objectives:

- To understand the advanced principles of the design of hot-rolled and cold-formed steel structural members.
- To empower the students with advanced knowledge of analysis and design of steel structures and to instil confidence in them in choosing the right kind of element, section, connection for the given situation.

Course Outcomes:

On completion of this course, students are able to

- Understand how to choose the right kind of structural section, hot-rolled and cold-formed steel structures for the given situation.
- Confidently analyse and design columns, beams, beam-columns with suitable structural sections with adequate fire resistance.

Course Content:

1. **Introduction to Laterally Unrestrained Beams:** Lateral Buckling of Beams, Factors affecting lateral stability of beams, codal provisions, Design Approach. Lateral buckling strength of Cantilever beams, continuous beams, beams with continuous and discrete lateral restraints, Mono- symmetric and non-uniform beams – numerical Design Examples
2. **Introduction to Beams subjected to Torsion and Bending:** Shear Centre and Warping, Uniform and Non-Uniform torsion, Concepts, Methods of evaluating the torsional effects, Codal provisions, numerical Design examples for Rolled and built up sections
3. **Beam- Columns in Frames:** Behaviour of Short and Long Beam - Columns, Effects of Slenderness Ratio and Axial Force on Modes of Failure, Biaxial bending, Strength of Beam Columns, Sway and Non-Sway Frames, Strength and Stability of rigid jointed frames, Effective Length of Columns-, Methods in IS 800 – numericals.
4. **Steel Beams with Web Openings:** Shape of the web openings, practical guide lines, and Force distribution and failure patterns, Analysis of beams with perforated thin and thick webs, Design of castellated beams, Vierendeel girders
5. **Cold formed steel sections and Fire resistance:** Techniques and properties, Advantages, Typical profiles, Stiffened and unstiffened elements, Local buckling effects, effective section properties, IS 811 codal provisions- numerical examples, beam design, column design. Fire resistance level, Period of Structural Adequacy, Properties of steel with temperature, Limiting Steel temperature, Protected and unprotected members, Fire resistance ratings- Numerical Examples.

Prerequisite Courses: None

Reference Books:

1. “Design of Steel Structures”, N. Subramanian, Oxford, IBH, 2017
2. “Design of Steel structures”, Duggal.S.K., Mc Graw Hill, 2nd Edition, 2015
3. IS 1641, 1642,1643
4. IS 800: 2007, IS 811
5. INSDAG Teaching Resource Chapter 11 to 20: www.steel-insdag.org

UE17CV652: STRUCTURAL STABILITY ANALYSIS – CLASSICAL AND FE APPROACH (3-2-0-0-4)

Course Objectives:

- To provide a detailed treatment of buckling characteristics of various structural elements, and to present different methods to solve stability problems including integration with finite element procedures.

Course Outcomes:

On completion of this course, students are able to

- Understand the concepts of stability; types of buckling Compute buckling loads of columns; elastic buckling of frames and Plates

Course Content:

1. **Beam column:** Differential equation. Beam column subjected to (i) lateral concentrated load,(ii) several concentrated loads, (iii) continuous lateral load. Application of trigonometric series. Euler’s formulation using fourth order differential equation for pinned-pinned, fixed-fixed, fixed-free and fixed- pinned columns.
2. **Buckling of frames and continuous beams**. Elastic Energy method: Approximate calculation of critical loads for a cantilever. Exact critical load for hinged-hinged column using energy approach. Buckling of bar on elastic foundation. Buckling of cantilever column under distributed loads. Determination of critical loads by successive approximation. Bars with varying cross section. Effect of shear force on critical load. Columns subjected to non-conservative follower and pulsating forces.
3. **Stability analysis by finite element approach:** Derivation of shape functions for a two noded Bernoulli-Euler beam element (lateral and translational dof) –element stiffness and Element geometric stiffness matrices – Assembled stiffness and geometric stiffness matrices for a discretised column with different boundary conditions – Evaluation of critical loads for a discretised (two elements) column (both ends built-in). Algorithm to generate geometric stiffness matrix for four noded and eight noded isoparametric plate elements. Buckling of pin jointed frames (maximum of two active dof)-symmetrical single bay Portal frame.
4. **Buckling of simply supported rectangular plate:** Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge condition along the other two sides- Buckling of a Rectangular Plate Simply Supported along Two opposite sides and uniformly compressed in the Direction Parallel to Those sides.
5. **Buckling of simply supported rectangular plate – Combined effects**: Buckling of a Simply Supported Rectangular Plate under Combined Bending and Compression – Buckling of Rectangular Plates under the Action of Shearing Stresses – Other Cases of Buckling of Rectangular Plates.

Prerequisite Courses: None

Reference Books:

1. “Theory of Elastic Stability”, Stephen P. Timoshenko, James M. Gere, 2nd Edition, McGraw-Hill, New Delhi, 2010
2. “Principles of Structural Stability”, Zeiglar H, Blaisdall Publications, 1968
3. “Concepts and Applications of Finite Element Analysis”, Robert D Cook et al, 3rd Edition, John Wiley and Sons, New York, 2001
4. “Computational Structural Mechanics”, Rajashekaran. S, Prentice-Hall, India,2004
5. “Dynamics of Structures”, Ray W Clough and J Penzien, 2nd Edition, McGraw Hill, New Delhi,1993.

ELECTRONICS AND COMMUNICATION ENGINEERING

B.TECH IN ELECTRONICS AND COMMUNICATION ENGINEERING

Program Educational Objectives:

1. Train and prepare students to be Electronics and Communication engineering professionals, strong and sound in fundamentals of science and engineering that facilitate innovative skills and strategies to help solve problems of industry and society.
2. Facilitate students to be conversant in design, development and implementation skills through application of technologies related to Electronics and Communication, in a sustained manner.
3. Prepare graduates to pursue professional ethics in all their endeavours, adapt well to perform their roles as an individual, team-member, leader and possess good communicative skills that help foster sound inter-personal relationships in their engagement in industry and society.
4. Motivate students in identifying various specialization available in the field of Electronics and Communication engineering and facilitate their further growth in the chosen domain with relevant elective modules.
5. Orient students for graduate studies, pursue research-oriented career, entrepreneurship and secure befitting placements in industries, with required competence.

Program Outcomes

1. **Engineering knowledge:** Apply mathematical and theoretical principles in the modeling and design high-quality electronic systems using state-of-the-art technology.
2. **Problem analysis:** Conduct in-depth study of research literature in the area of Electronics & Communication and analyze problems in order to arrive at substantiated conclusions using first principles of math and allied sciences.
3. **Design/development of solutions:** Design, implement, and evaluate electronic systems and processes that meet partial/complete specifications with concern for society, environment and culture.
4. **Conduct investigations of complex problems:** Design and conduct experiments, collect data, analyze and interpret the results to investigate complex engineering problems
5. **Modern tool usage:** Apply state-of-the-art techniques and modern software and hardware tools in prediction, comparison and modeling of complex engineering activities
6. **The engineer and society:** Have sound understanding of professional, legal, security and social issues and responsibilities in Engineering actives
7. **Environment and sustainability:** Understand Societal and Environmental concerns and demonstrate responsibility in sustainable development of solutions
8. **Ethics:** Be aware of ethical and professional responsibilities in engineering situations; make informed judgments regarding intellectual property and rights in relation to technical solutions in global, economic, environmental, and societal contexts.
9. **Individual and team work:** Able to function effectively in teams to establish goals, plan tasks, meet deadlines, manage risk and produce high-quality technical solutions
10. **Communication:** Contribute and communicate effectively with the society, be able to write effective reports and design documents by adhering to appropriate standards, make effective presentations, give and receive clear instructions
11. **Project management and finance:** Apply skills in clear communication, responsible teamwork and time management by, for example, managing a team or project and communicating with external stakeholders.
12. **Lifelong learning:** Recognize the need for and demonstrate an ability to engage in continuing professional development in its broadest sense

UE18EC101
BASIC ELECTRONICS ENGINEERING (4-0-0-0-4)

Course Objectives:

- Impart understanding of working principles and applications of semiconductor devices in the design of electronic circuits.
- Introduce basic applications like rectifiers, amplifiers and other signal conditioning circuits with emphasis on practical design considerations.
- Provide basic understanding of digital circuits and principles of logic design.
- To enhance the understanding of the topics in the curriculum, specific activities have been designed as conceptual and hands-on aid.

Course Outcomes:

Students completing the course should be able to

1. Analyze and appreciate the working of electronic circuits involving applications of diodes and transistors.
2. Comprehend working of amplifiers.
3. Design simple analog circuits using general purpose op-amp IC 741.
4. Design combinational digital circuits to meet a given specification using digital ICs
5. Develop simple projects based on the different devices studied in this course.

Course Content:

1. **Introduction to electronics and semiconductor diodes:** V-I characteristics of R, L and C, Voltage and current sources, Voltage divider and current divider theorems, KVL and KCL, Thevenin's theorem, Semiconductor diode under forward and reverse bias, Shockley's equation, Zener and Avalanche breakdown, temperature effects, Ideal versus Practical diode, Diode resistances, Diode equivalent circuits, Zener diode characteristics, Series diode configurations.
2. **Semiconductor diode applications:** Block diagram of regulated power supply, Half-wave, Full-wave and bridge rectifier, ripple factor derivations, Peak inverse voltage. Shunt capacitor filter-working, output waveform and ripple factor equation, Zener diode voltage regulator, Basic positive and negative clipper and clamper circuits
3. **Digital Electronics:** Basic gates(review), Boolean Algebra, Boolean laws and theorems, Simplification of Boolean expressions, Universal gates – NAND and NOR, SOP expression, Arithmetic building blocks – Half and Full Adder, Multiplexers, Demultiplexers, RS Flip-Flop – Basic idea, NAND Gate latch, Clocked RS and D Flip-Flops. Types of Registers, Serial in-Serial out shift register using D FF
4. **Transistors:** Transistor construction, transistor operation, Transistor configurations - Common base and common emitter configurations – input and output characteristics. Transistor amplifying action. Depletion-Type and Enhancement-Type MOSFETs, CMOS Inverter; Amplifier basics: Signal amplification, amplifier circuit symbol, voltage gain, current and power gains, decibel gain, non-linear transfer characteristics and biasing, frequency response of amplifers, amplifier bandwidth

5. **Introduction to Operational Amplifiers:** Op-Amp Basics, Ideal voltage transfer curve, Op-Amp parameters and its values for Op-Amp 741 – Input and output offset voltages, Input and output resistances, GBW, CMRR (Definitions and significance only), Ideal Op-amp, Negative feedback. Practical Op-Amp circuits: Inverting Amplifier, Non-inverting Amplifier, Voltage follower, Summing Amplifier, Voltage Subtraction, Integrator, Differentiator, Voltage-to-current converter, Logarithmic and antilogarithmic amplifier, Basic comparator (ZCD).

Pre-requisite Courses: Nil

Reference Books:

1. Robert. L. Boylestad and Louis Nashelsky,"Electronic Devices and circuit theory ", PHI, 10th Edition, 2009.
2. Hayt, Kemmerly and Durblin, "Engineering Circuit Analysis", McGraw Hill, 7th Edition, 2012
3. Albert Paul Malvino, Donald P Leach, Goutamsaha"Digital Principles and applications", 6th Edition, Tata McGraw Hill, 2007.

UE17EC201: NETWORK ANALYSIS AND SYNTHESIS (4-0-0-0-4)

Course Objectives:

- This course aims to familiarize the student with the application of linear algebra, 1st order and 2nd order differential equations to electrical circuit analysis.
- This course aims to make the students synthesize electrical networks from given transfer functions.
- This is an introductory course to the analysis of electrical networks consisting of linear passive and active elements. This course also introduces synthesis of electrical networks from transfer functions.

Course Outcomes:

Students completing the course should be able to

- Understand network conventions and notations
- Apply network theorems to AC and DC electrical circuits
- Analyze the transient behaviour of 1st order and 2nd order AC and DC circuits using time domain analyses and s-domain analyses
- Design and analyze two port networks using various interconnection models
- Synthesize a given network transfer function (RL, RC, LC and RLC)

Course Content:

1. **Conventions and basic analysis:** Reference directions for current and voltage, Active element conventions, Star – Delta transformation, Source Transformations, Kirchhoff s Laws and network equations, Node and mesh analysis, concepts of super node and super mesh, DC and AC networks excited by independent and linearly dependent sources, Concept of Duality, Dot convention for coupled circuits(qualitative treatment only)
2. **Network theorems:** Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power transfer theorem, Reciprocity theorem, Millmann's Theorem, Tellegen's theorem, Problems for DC and AC excitations
3. **Transient characteristics:** Damping and time constants (series and parallel circuits), Time domain analysis: First order and second order DC circuits, Time domain analysis: First order and second order AC circuits, s-domain analysis: First order and second order DC circuits, s-domain analysis: First order and second order AC circuits
4. **Two port networks:** One port networks, z-parameters: open circuit analysis, y-parameters: short circuit analysis, h-parameters and t-parameters, Deriving two port network parameters from one another, Interconnection of two port networks (series, parallel and cascaded)
5. **Network synthesis:** Hurwitz polynomial, Positive real functions, Elementary Synthesis procedures, Properties of R-C impedance functions, Properties of R-L admittance functions, Properties of L-C immittance functions, R-L, R-C, LC, R-L-C: Foster I form, R-L, R-C, L-C, R-L-C: Foster II form, R-L, R-C, L-C, R-L-C: Cauer I form, R-L, R-C, L-C, R-L-C: Cauer II form

Pre-requisite Courses: Nil

Reference Books:

1. "Introductory Circuit Analysis", Robert L. Boylestad, 10th Edition, Prentice Hall, 2002.
2. "Theory and Problems of Basic Circuit Analysis", John O'Malley, 2nd Edition, McGraw Hill, 1992.
3. "Engineering Circuit Analysis", W.H. Hayt, J.E. Kemmerly, S.M. Durbin, 7th Edition, TMH, 2007.
4. "Network Analysis and Synthesis", Franklin F Kuo, 2nd Edition, Wiley India, 2006.
5. "Network Analysis", M.E Van Valkenburg, 3rd Edition, PHI, 2006.

UE17EC202 ANALOG CIRCUIT DESIGN (4-0-0-0-4)

Course Objectives:

- Understand features and applications of Diode
- Design of BJT/ MOSFET amplifiers
- Provide basic understanding of frequency response, multistage amplifiers
- Understand feedback amplifiers and design oscillators
- Design opamp circuits and understand practical problems

Course Outcomes:

Students completing the course should be able to

- Acquire a basic knowledge in solid state electronics including diodes, MOSFET, BJT, and operational amplifier.
- Design and analyze analog electronic circuits using discrete components.
- Analyze the amplitude and frequency responses of common amplification circuits.
- Design, construct and take measurement of various analog circuits to compare experimental results in the laboratory with theoretical analysis

Course Content:

1. **Introduction:** (i) Diode features and applications: Diode capacitances, Reverse recovery time, Clippers, Clampers and Voltage-Multiplier circuits; (ii) Introduction to Amplifiers: Amplifiers, Signal Amplification, voltage gain, expressing gain in decibels, Amplifier power supplies, Amplifier saturation, Circuit models for amplifiers, Frequency response of amplifiers, Classification of amplifiers based on frequency response; (iii) Bipolar Junction Transistors: Analysis of transistor circuits at DC, The transistor as an amplifier, small signal equivalent circuit models
2. **MOS Field Effect Transistors:** Revision of enhancement MOSFET, Depletion type MOSFET, MOSFET circuits at DC, The MOSFET as an amplifier, Biasing in MOS amplifiers, Basic configuration of single stage IC MOS amplifiers (CS, CG, CD), All NMOS amplifier stages; MOS Differential amplifiers, Multistage amplifiers
3. **Frequency response:** Low and high frequency response of Common emitter , common source amplifiers; Common base, Common gate and cascode configurations, Common collector and common emitter cascade, frequency response of the differential amplifier; Output stages and power amplifiers:

Classification of output stages, Class, A, Class B and Class AB output stage , Biasing the class AB circuit, variations in the class AB configuration

4. **Feedback and Oscillators:** The general feedback structure, some properties of negative feedback , The four basic feedback topologies, Series -shunt, series-series, shunt-shunt and shunt series feedback amplifier, determining the loop gain, the stability problem , stability study using Bode plots; Basic principles of sinusoidal oscillators, RC, LC and crystal oscillators
5. **Op amp features and applications:** Inverting integrator, inverting differentiator , instrumentation amplifier, Effect of finite open loop gain and bandwidth on circuit performance, large signal operation of op amp, DC imperfections Generation of square and Triangular waveforms, Monostable multivibrator, IC timers, Nonlinear waveform shaping Circuits, precision rectifier circuits

Pre-requisite Courses: UE17EC101 – Basic Electronics Engineering, UE17EE101 – Basic Electrical Engineering

Reference Books:

1. "Micro Electronics Circuits" , Sedra and Smith, Oxford University Press, 5th Edition, 2007.
2. "Operational Amplifiers and Linear Integrated Circuits", Robert. F. Coughlin and Frederick F. Driscoll, Pearson Education 6th Edition, 2008.
3. "Electronic Devices and Circuit Theory", Robert. L. Boylestad and Louis Nashelsky, 10th Edition, PHI, 2009
4. "Integrated Electronics" ,Jacob Millman, Christos C. Halkias, TMH Publications, 2009
5. "Linear Integrated Circuits",D. Roy Choudhury , Shail B. Jain, 3rd Edition, New Age International Pvt. Limited, 2007.

UE17EC203
DIGITAL CIRCUIT DESIGN (4-0-0-0-4)

Course Objectives:

- To learn Boolean laws and theorems.
- To learn algorithms/methods for minimizing Boolean expressions based on the cost criterion.
- Differentiating between combinational and sequential logic networks.
- Designing with MSI components and Programmable Logic Devices.
- Analysis and design of sequential logic networks

Course Outcomes:

Students completing the course should be able to,

1. Understand of the cost function of a Boolean function and Boolean logic function minimizing algorithms.
2. Analysis of combinational and sequential logic networks.
3. Design of combinational and sequential logic networks.
4. Design of FSM, pattern generator and sequence detector.

Course Content:

1. **Boolean Algebra and Combinational Networks:** Introduction to Boolean functions (Laws, Don't care conditions, Truth Tables), Binary numbers, Number base conversions, Signed Binary Numbers
2. **Simplification of Boolean Expressions:** Formulation of the simplification Problem, criteria for minimality, Prime Implicants and Irredundant Disjunctive Expressions, K-maps upto Five variable, the Quine-McLuskey method of generating prime implicants and prime implicates. Prime implicant/prime implicate tables and irredundant expressions, Prime implicant/ prime implicate table reductions, Variable entered K-maps.
3. **Combinational Logic Modules and their Applications:** Binary adders and subtractor, Carry look ahead adder, decimal adder, Multiplier, Comparators, Decoders, Encoders, Multiplexers (applications only), Programmable logic devices, PROMS, PAL, PLA Devices,
4. **Flip-Flops:** The basic Bistable element, Flip Flops-Truth table, circuit, characteristic equations, state equations, state transition diagrams, Latches-SR latch, Gated SR latch, D Latch, Timing considerations, Master-slave SR Flip-flops (pulse triggered), Master-slave JK Flip-flops (pulse triggered), Edge triggered Flip-flops, Characteristic equations, Sequential Programmable Devices.
5. **Sequential Networks and Logic Families:** Registers, Counters, Ripple Counters, Design of Synchronous & Asynchronous counters; Sequential Networks, Analysis of clocked synchronous sequential networks, Mealy model, Moore model, **FSMs** Introduction to CMOS logic family, Operational characteristics of MOSFET as switch, Structure and operations of CMOS gates (NAND, NOR, NOT), Electrical characteristics of logic gates – logic levels and noise margins, fan-out, propagation delay, transition time, power consumption and power-delay.

Pre-requisite Courses: Nil

Reference Books:

1. "Digital Principles and Design", Donald D. Givone, Tata-McGraw Hill, 2007.
2. "Digtial Design with an Introduction to Verilog HDL" M. Morris Mano Michael D Ciletti, Pearson, 2017.

UE17EC204 :
SIGNALS AND SYSTEMS (4-0-0-0-4)

Course Objectives:

- To familiarise different types of signals and systems typically encountered in Communication engineering
- To expose students to different transformation techniques to apply and analyze different real-life periodic and aperiodic signals to systems (typically LTI).
- To provide valuable insights of complex systems/signals analyzed through different techniques learnt
- To provide sufficient understanding of different types of signals and systems and transformation techniques for future courses in Signal Processing, Image processing and so on.

Course Outcomes:

Students completing the course should be able to,

- Understand and represent signals and perform basic operations on signals.
- Determine Fourier representations for continuous-time and discrete-time signals.
- Understand LTI systems
- Analyze and design signals and systems using transformation techniques.
- Use the unilateral Z transform.
- Apply the Fourier representation properties and z- transform properties to solve problems.

Course Content:

1. **Signals and Systems:** Classification of signals, Continuous-time and discrete-time signals, Transformations of the independent variable, Exponential and sinusoidal signals, The unit impulse and unit step functions, Sa(x)/Sinc functions, Importance of sinc function , Continuous-time and discrete-time systems, Basic system properties. Introduction to Sampling: Sampling theorem, Nyquist criterion.

2. **Linear Time-invariant Systems**: Discrete-time LTI systems: The convolution sum, Continuous-time LTI systems: The convolution integral, Properties of LTI systems, Causal LTI systems described by difference equations (Natural, Forced, and Complete Response)
3. **Representation of Periodic (Continuous time & Discrete-time) signals using Fourier series :** Explanation of Complex Exponentials, Response of LTI systems to complex exponentials, Trigonometric Fourier Series, Fourier series representation of continuous-time periodic signals, Convergence of the Fourier series (brief discussion only), Properties of continuous-time Fourier series (CTFS), Fourier series representation of discrete-time periodic signals, Properties of Discrete-time Fourier series(DTFS)
4. **Continuous-time Fourier Transform: Representation of aperiodic signals:** the continuous-time Fourier transform (CTFT), The Fourier transform for periodic signals, Properties of continuous-time Fourier transform, Fourier transform pairs. The discrete-time Fourier transform: Representation of aperiodic signals: the discrete-time Fourier transform (DTFT), The Fourier transform for discrete periodic signals, Properties of discrete-time Fourier transform, Fourier transform pairs, Duality**.**
5. **Z-transformation:** The Z-transform, The region of convergence (ROC) for the Z-transform, The inverse Z-transform, Properties of the Z-transform, Z-transform pairs, Analysis and characterization of LTI systems using Z-transforms. The unilateral Z-transform and solution of difference equations.

Pre-requisite Courses: Nil

Reference Books:

1. "Signals and Systems", V. Oppenheim and A. S. Willsky and S. H. Nawab, 2nd Edition, Pearson Education, 1996.
2. "Signal Processing and Linear Systems", B. P. Lathi, 1st Indian Edition, Oxford University Press, 2006.
3. "Signals and Systems",Simon Haykin and Barry Van Veen, 2nd Edition, Wiley India, 2004.
4. "Analog and Digital Signal Processing", Ashok Ambardar, Thomas Learning, 1999.

UE17EC205:
ANALOG CIRCUIT DESIGN LABORATORY (0-0-2-0-1)

Course Objectives:

- Under stand features and applications of Diode
- Design of BJT/ MOSFET amplifiers
- Provide basic understanding of frequency response, multistage amplifiers
- Understand feedback amplifiers and design oscillators
- Design opamp circuits and understand practical problems

Course Outcomes:

Students completing the course should be able to

- Acquire a basic knowledge in solid state electronics including diodes, MOSFET, BJT, and operational amplifier.
- Design and analyze analog electronic circuits using discrete components.
- Analyze the amplitude and frequency responses of common amplification circuits.
- Design, construct and take measurement of various analog circuits to compare experimental results in the laboratory with theoretical analysis

Course Content:

1. Clippers / Clampers / voltage multipliers
2. Single stage CS amplifier and verify the voltage gain, frequency response and input/output impedances .
3. Two stage amplifier and voltage series feedback amplifier
4. Inverting, non inverting amplifiers and voltage follower
5. Inverting active integrator and differentiator circuits
6. RC and LC oscillators
7. RC and LC oscillators
8. Precision rectifier circuits
9. Astable and monostable multivibrators
10. Differential amplifiers
11. Class B/AB push -pull amplifiers

Reference Books:

1. Laboratory Manual prepared by Department of Electronics and communication Engineering, PES University.

UE17EC206
DIGITAL CIRCUIT DESIGN LABORATORY (0-0-2-0-1)

Course Objectives:

- To learn Boolean laws and theorems.
- To learn algorithms/methods for minimizing Boolean expressions based on the cost criterion.
- Differentiating between combinational and sequential logic networks.
- Designing digital circuits using Verilog.
- Analysis and design of sequential logic networks

Course Outcomes:

At the end of the course, the student should be able to

- Understand of the cost function of a Boolean function and Boolean logic function minimizing algorithms.
- Analysis of combinational and sequential logic networks.
- Design of combinational and sequential logic networks.
- Design of FSM, pattern generator and sequence detector.

Course Content:

1. Simplification, realization of Boolean expressions using universal logic gates
2. Realization of parallel adder/ Subtractors.
3. Realization of Binary to Gray code conversion and vice versa
4. MUX/DEMUX arithmetic circuits and code converter
5. Realization of One/Two bit comparator and study of 7485 magnitude comparator
6. Use of a) Decoder chip to drive LED display and b) Priority encoder
7. Flip-Flops: (i) JK Master slave (ii) T type and (iii) D type
8. Realization of counters as a sequential circuit and MOD – N counter design
9. SIPO, SISO (Left, Right), PISO, PIPO operations
10. Design and testing of Ring counter/Johnson counter.
11. Design & testing of Sequence generator & Sequence Detection.
12. Open ended experiment

Reference Books:

1. Laboratory manual prepared by Department of Electronics and Communication Engineering, PES University.

UE17EC251:
CONTROL SYSTEMS (4-0-0-0-4)

Course Objectives:

The study of the subject should enable the student to learn:

- Mathematical modeling(transfer functions and state space representation) of simple electrical, mechanical and electromechanical control systems

- The block diagram algebra and signal flow graph analysis.
- Characteristics of the time domain performance of feedback systems.
- Analyze the stability of feedback systems using various systems.
- To design simple compensators in the frequency domain and to design controller and observers in the state-space domain.

Course Outcomes:

Students completing the course should be able to

- Explain basic concepts of control systems, their types & requirements. Identify controllers, their types , features & application
- Apply Laplace transform and state space techniques to model dynamic systems, and convert between these formulations
- Analytically quantify the time and frequency domain behaviour of dynamic systems
- Specify steady state control system requirements, and select prototype controller structures to achieve these requirements
- Formulate dynamic feedback controller design specifications in the frequency domain
- Synthesise feedback controllers using root locus, Nyquist and Bode techniques
- Characterise the behaviour of elementary feedback control systems through simulations.

Course Content:

1. **Mathematical Models of Systems:** Introduction, Differential Equations of Physical Systems, Linear Approximations of Physical Systems, The Laplace Transform, The Transfer Function of Linear Systems, Block Diagram Models, Signal Flow Graph Models. Feedback Control System Characteristics: Open and Closed Loop Control Systems, Sensitivity of Control Systems to Parameter Variations, Control of the Transient Response of Control Systems, Disturbance Signals in a Feedback Control System, Steady State Error
2. **The Performance of Feedback Control Systems:** Introduction, Test Input Signals, Performance of a Second Order System, Effects of a Third Pole and a Zero on the Second Order System Response, The s – Plane Root Location and the Transient Response, The Steady – State Error of Non unity Feedback Systems. The Stability of Linear Feedback Systems: The Concept of Stability, the Routh – Hurwitz Stability Criterion, The Relative Stability of Feedback Control Systems
3. **The Root Locus Method:** Introduction, Concept and the Root Locus technique. Frequency Response methods: Introduction, Frequency Response Plots, Bode Diagram, and Performance Specifications in the Frequency Domain.
4. **Stability in the Frequency Domain:** Introduction, Mapping Contours in the s – Plane, the Nyquist Criterion, Relative Stability and the Nyquist Criterion. The Design of Feedback Control Systems: Introduction, Approaches to System Design, Cascade Compensation Networks, Phase – Lead Design Using the Bode Diagram, System Design Using Integration Networks, Phase-Lag Design Using Bode Diagram.
5. **State Variable Models:** Introduction, the State Variables of a Dynamic System, the State Differential Equation, The Stability of State Variable Systems; The Design of State Variable Feed Back Systems: Introduction, Controllability, Observability, Full-state feedback control design.

Pre-requisite Courses: Nil

Reference Books:

1. “Modern Control Systems”, R.C. Dorf and R.H. Bishop, 11th Edition, Addison-Wesley, 1999.
2. “Control Systems Engineering”, I.J.Nagrath and M.Gopal, 5th Edition, New Age International Publications, 2007.
3. “Modern Control Engineering”, K. Ogata, 5th Edition, Pearson Education Asia, 2010.

UE17EC252:
COMPUTER ORGANIZATION (4-0-0-0-4)

Course Objectives:

- To understand the basic organisation and architecture of computers
- To efficiently design, implement and test various modules
- To provide strong foundation for advanced courses in computer architecture, operating systems subjects, Instruction Level Parallel processors, Parallel computing and distributed computing.

Course outcomes

Students completing the course should be able to

- Design basic computer organisation and architecture based on few case studies.
- Use this knowledge for further advanced courses.
- Write the microprograms for few instructions.
- Understand the concepts of parallel processing and pipelining
- Implement various modules and verify using HDL

Course content:

1. **Introduction:** Basic structure and operational and operational concepts of computers, performance considerations; Different architectures-Harvard Architecture, Von Neumann Architecture, RISC and CISC
2. **Assembly Language**: Instruction format, opcode and data formats, Addressing modes (with respect to 8051) moving data, Logical & Arithmetic Operations, Jump & Call operations
3. **Arithmetic and Logic Unit:** High speed adders, Booth’s algorithm for multiplication, high speed multipliers, division, arithmetic operations on floating point numbers (IEEE std)
4. **Processor Design**: Design of a basic processor, units in a Instruction execution, functional units and their interconnection, hardware for generating internal control signals, microprogramming approach
5. **Input/Output Organization:** Accessing I/O devices, program controlled I/O, Interrupts and supporting software and hardware, DMA, design of interface circuits, commercial bus standards
6. **Memory System:** SRAM cell, DRAM cell, Basic concepts and organization of memory, Hierarchial memory system, cache memory and its operation, Cache memory mapping (Direct, Set Associative and Fully Associative), Cache replacement algorithm(LRU) .

Pre-requisite Courses: Nil

Reference Books:

1. “Computer Organization and Design”, David A,Patterson and John L Hennessy, 4th (ARM) Edition, Morgan Kaufmann, 2010
2. “Computer Organization and Architecture”, Smruthi Ranjan Sarangi, McGraw-Hill, 2015.
3. “Computer organization”, Carl Hamecher, Z Vranesic and Zaky , 5th Edition, McGraw Hill, 2011
4. “Computer Architecture and Organisation”, J.P. Hayes, 2nd Edition, Tata McGraw-Hill, 1988.

UE17EC253: VLSI DESIGN (4-0-0-0-4)

Course Objectives:

- The course aims to provide an understanding of the design of digital circuits at switch-level and basic operations of MOSFET.
- It will familiarize the students with the implementation of digital circuits in Mentor Graphics Tool and also help them verify the RTL schematic by simulation.
- The key focus will be on the design and implementation of RTL schematic of combinational and sequential circuits.

Course Outcomes:

Students completing the course should be able to

- Understand the fundamentals of MOS devices.
- Working principles of CMOS inverter.
- Able to build systems with CMOS devices
- Will have the basic knowledge of timing analysis
- Will have the knowledge of layout diagrams and design rules

Course Content:

1. **MOS Devices & Circuits:** Basic overview of MOS devices in Enhancement and Depletion Mode, Channel length modulation effect, Voltage Transfer Characteristics,V-I Relationship, Aspects of MOS threshold voltage, MOS transistor transconductance & output conductance, CMOS inverter,Estimation of CMOS Inverter Delay,Components of Energy and Power Switching, Short-Circuit and Leakage Components,Noise margin
2. **MOS Circuit Design Process-Fabrication and Layout**: NMOS fabrication, CMOS fabrication, p-well, n-well, twin-tub process,MOS layers,Stick diagrams-MOS design style and CMOS design style, Lambda based design rules, Contact cuts, Layout diagrams, Translation to mask form.
3. **Basic Circuit Concepts and Scaling of MOS Circuits**: Basic circuits concepts and scaling of MOS circuit, sheet resistance, Area capacitance, Delay unit, Inverter delays, Propagation delays, Scaling models, Scaling factors, parameters for scaling.
4. **CMOS Circuit Design Techniques:** Pass transistor, Transmission gate,Static CMOS Circuits, CMOS circuits with ratioed Logic ,Dynamic logic circuits, Demonstration of design techniques with examples of High speed adders: Carry skip, Carry select and carry save adders
5. **Sequential Circuits Design:** Basic Latch and Flip Flop operation, CMOS implementation of the D-latch, Origins of Clock Skew / Jitter and Impact on Performance, Clock Distribution Techniques, Problems on max and min Delay contraints at design level.

Pre-requisite Courses: Nil

Reference Books:

1. "Essentials of VLSI Circuits and Systems", Eshraghian, Kamran, Douglas A. Pucknell, and Sholeh Eshraghian". Prentice-Hall of India, 2005.
2. "Introduction to VLSI Circuits and Systems", Uyemura, John P, 2002.
3. "Digital Integrated Circuits–A Design Perspective", Jan, M. Rabaey, Chandrakasan Anantha, and Nikolic Borivoje, 2003.
4. "CMOS Digital Integrated Circuits", Kang, S.M. and Leblebici, Y, Tata McGraw-Hill Education, 2003.
5. "Principles of CMOS VLSI Design" Weste, Neil HE, and Kamran Eshraghian, Vol. 188, Addison-Wesley, New York, 1985.

UE17EC254: ELECTROMAGNETIC FIELDS AND TRANSMISSION LINES (4-0-0-0-4)

Course Objectives:

- Appreciate the fundamental difference between circuit theory and field theory. Furthermore, understand the difference between time invariant fields and time varying fields and the interdependence between the electric field and magnetic field in the latter case. The last section gives an insight into the behaviour of a circuit when its length is comparable to the wavelength.
- The circuit theory concepts is inadequate for explaining phenomena's like radiation, communication between two walkie-talkies or mobile phones at a distance. Electromagnetic field theory will introduce the concepts and laws of static and time varying electric and magnetic fields and interaction between these two fields which provides an explanation for the above said phenomena.

Course Outcomes:

Students completing the course should be able to

- Calculate the electric field, scalar potential, stored energy, and capacitance associated with simple distributions of charge
- Calculate the magnetic field, stored energy, and inductance for simple distributions of current density.
- Calculate the resistance of simple structures of given conductivity
- Use appropriate Maxwell's equations in integral and differential forms to time-varying field problems.
- Analyze and calculate Basic transmission line parameters.

Course Content:

1. **Vector Algebra and Calculus:** Introduction to coordinate systems and transformation, Cartesian coordinates, circular cylindrical coordinates, spherical coordinates, vector operations in different co-ordinate systems-Divergence, Curl, Gradient
2. **Electrostatics:** Introduction, Coulomb's Law and field intensity, electric fields due to continuous charge distributions, electric flux density, Gauss's Law, Applications of Gauss's Law, Divergence of a vector and Divergence theorem, Electric potential, Gradient of a scalar quantity, Relationship between Electric field and potential, an electric dipole and flux lines, energy density in electrostatic fields; Electric Fields in Material Space: Continuity equation and relaxation time, boundary conditions, Poisson's and Laplace's equation, general procedure for solving Poisson's or Laplace's equation, resistance and capacitance
3. **Magnetostatic Fields:** Introduction, Biot-Savart's Law, Ampere's circuital Law, applications of Ampere's Law, Curl of a vector and Stoke's theorem, magnetic flux density, Maxwell's equation for static fields, magnetic scalar and vector potentials, derivation of Biot-Savart's Law and Ampere's Law, forces due to magnetic fields.
4. **Maxwell's Equations:** Introduction, Faraday's Law, transformer and motional electromotive forces, displacement current, Maxwell's equations in final forms. Time harmonic fields.
5. **Transmission Lines and Impedance Matching:** Introduction, Line inductance and capacitance of a two wire line, Equation of continuity and Kirchoff's current law, equation of voltage and current, transmission line equations and solutions, Coaxial cables, Impedance transformation, reflection coefficient and, standing wave ratio. Impedance matching: quarter wave transformers, stub matching

Pre-requisite Courses: Nil

Reference Books:

1. "Electromagnetic Waves And Radiating Systems", Edward C Jordan, Keith G Balmain, 2nd Edition, PHI, 2005.
2. "Engineering Electromagnetics", William H Hayt Jr, 7th Edition, Tata Mc Graw Hill, 2007.
3. "Microwave Engineering", David M Pozar, 2nd Edition, John Wiley and Sons, 1999.

UE17EC255: COMPUTER ORGANIZATION LABORATORY (0-0-2-0-1)

Course Objectives:

- To understand the basic organisation and architecture of computers
- To efficiently design, implement and test various modules
- To provide strong foundation for advanced courses in computer architecture, operating systems subjects, Instruction Level Parallel processors, Parallel computing and distributed computing.

Course outcomes

Students completing the course should be able to

- Design basic computer organisation and architecture based on few case studies.
- Use this knowledge for further advanced courses.
- Write the microprograms for few instructions.
- Understand the concepts of parallel processing and pipelining
- Implement various modules and verify using HDL

Course Content:

1. Kiel IDE based Assembly Programs
2. Arithmetic Operations
3. Logical Operations
4. Code conversion
5. Sorting
6. Interrupt based Programs
7. Interfacing Programs
8. LCD Interface
9. Keypad Interface
10. DAC Interface
11. ADC Interfacee
12. Motor Interface

Reference Books:

1. Laboratory manual prepared by Department of Electronics and Communication Engineering, PES University.

UE17EC256: VLSI DESIGN LABORATORY (0-0-2-0-1)

Course Objectives:

- The course aims to provide an understanding of the design of digital circuits at switch-level and basic operations of MOSFET.
- It will familiarize the students with the implementation of digital circuits in Mentor Graphics Tool and also help them verify the RTL schematic by simulation.
- The key focus will be on the design and implementation of RTL schematic of combinational and sequential circuits.

Course Outcomes:

- Understand the fundamentals of MOS devices.
- Working principles of CMOS inverter.
- Able to build systems with CMOS devices
- Will have the basic knowledge of timing analysis
- Will have the knowledge of layout diagrams and design rules

Course Content:

1. Simulate FET VI characteristics for PMOS and NMOS
2. Design Inverter in Mentor Graphics using basic layers, PMOS, NMOS
3. Design two input NAND and NOR using PMOS and NMOS transistors
4. Design XOR and XNOR using GDI technique.
5. Implement 4 to 1 Multiplexer using transmission gates.
6. Implement serial and 2 bit parallel adders.
7. Design D,T,JK and Master Slave flip-flops
8. Design asynchronous counter
9. Design of 4 X4 funnel shifter
10. Design a arbitrary synchronous counter (sequence generator)
11. Layout design of a CMOS inverter
12. Layout design of NAND and NOR circuits.

Reference Books:

1. Laboratory manual prepared by Department of Electronics and Communication Engineering, PES University.

UE16EC301: COMMUNICATION ENGINEERING (4-0-0-0-4)

Course Objectives:

- Realize the standard amplitude modulation and performance of analog communication systems.
- Realize different angle modulation techniques.
- Visualize the discretization of the signal.
- Understand the basic concepts of Random Variables.
- Learn the basic concepts of Random process.

Course Outcomes:

Students completing the course should be able to

1. Analyze the performance capabilities of current analog communication systems.
2. Analyze the basic angle modulation techniques.
3. Anayze different sampling methods.
4. Analyze the random variables with respect to communication systems.
5. Analyze the random processes with respect to communication systems.

Course Content:

1. **Amplitude Modulation:** Double Sideband Suppressed Carrier Modulation, Time domain description, Frequency domain description, Generation of DSBSC Waves, Coherent detection of DSBSC Modulated Wave, Costas Loop. Quadrature Carrier Multiplexing; Amplitude Modulation, Time domain description, Frequency domain description, Generation of AM waves, Detection of AM waves; Canonical description of Bandpass Signals and Systems, Single side-band modulation, Time-Domain description, Frequency discrimination method for generating SSB wave, Phase discrimination method for generating an SSB modulated wave, Demodulation of SSB waves.
2. **Angle Modulation:** Angle Modulation, Frequency Modulation, Single tone frequency modulation, spectrum analysis of sinusoidal FM Wave, Properties of FM Waves, Transmission Bandwidth of FM waves, Generation of FM Waves, Demodulation of FM Waves: Balance Frequency Discriminator, Phase Locked loop, Linearized Model. Pre-emphasis and de-emphasis in FM; Superheterodyne receiver.

3. **Sampling:** Sampling Theorem, Quadrature Sampling of Band Pass Signals, Practical aspects of sampling and signal recovery. Sample and Hold circuit for signal recovery, Time Division Multiplexing.
4. **Random Variables:** Review of random variables, Multiple Random Variables: Vector random variables; joint distribution and its properties; joint density and its properties; conditional distribution and density; statistical independence; distribution and density of a sum of random variables; central limit theorem. Expected value of a function of random variables; jointly Gaussian random variables.
5. **Random process:** Random Processes: Stationarity and independence; Ergodicity; correlation functions; Power density spectrum and its properties; relationship between power spectrum and autocorrelation function; cross-power density spectrum and its properties, Gaussian random processes; Random signal response of linear systems; spectral characteristics of system response; spectral factorization; noise bandwidth; bandpass, band-limited and narrow band processes.

Pre-requisite Courses: Nil

Reference Books:

1. "An Introduction to Analog and Digital Communications", Simon Haykin, Wiley Student Edition, Wiley India (P) Ltd. , 2010
2. "Digital Communications", Simon Haykin, Wiley Student Edition, Wiley India (P) Ltd. , 2010.
3. "Probability, Random Variables and Random Signal Principles", Peyton Z. Peebles, Jr., 4^{th} Edition, McGraw-Hill, 2001.

UE16EC302: MICROWAVE ENGINEERING (4-0-0-0-4)

Course Objectives:

- The main objective of the course is to make the students understand the fundamental concept of propagation and wave guiding of electromagnetic wave.
- This course will help the students to apply the basic electromagnetic concepts to design microwave components.

Course Outcomes:

Students completing the course should be able to

1. Solve impedance matching problems
2. Analyze waveguides, eg determine their cutoff frequency, propagating modes and other parameters
3. Analyze cavities, eg determine their resonance frequency and other parameters
4. Design simple microwave circuits
5. Have an understanding of microwave sources

Course Content:

1. **Impedance Matching Using Smith Chart**: Derivation of the Smith Chart contours, single stub matching, double stub matching;
2. **Waveguides and Cavities:** Solutions of wave equations in rectangular co-ordinates, TE and TM modes in Rectangular Waveguides, Poynting vector, Power transmission and Power losses in rectangular waveguides, Excitation of waveguides, Characteristics of Standard rectangular Waveguides, visualization of the fields inside waveguides, Circular waveguides: Solutions of wave equations in cylindrical coordinates, TE and TM modes in circular waveguides. Microwave Cavities: Rectangular and Circular Cavity resonators, Q factor of a cavity resonator;
3. **Microwave Circuits and Components and Microstrip Lines:** Microwave hybrid circuits: Wave guide Tees: E-Plane tee and H-Plane Tee, Magic Tees, Hybrid Rings, S-Matrices of all these components, Waveguide Corners, Bends and twists. Directional couplers: Two–Hole Directional Couplers, S Matrix of a Directional Coupler, Phase Shifter. Microwave Circulators and Isolators. Micro strip Lines, Parallel Strip Lines, Coplanar strip lines, Shielded strip lines, Dispersion relations;
4. **Microwave Tubes:** Klystrons, Reflex Klystrons, TWT, Magnetrons(cylindrical Magnetron oscillators);
5. **Microwave Solid State Devices:** Microwave Diodes: Transfer electron devices: Introduction, GUNN effect diodes – GaAs diode, RWH theory, Modes of operation, Avalanche transit time devices: READ diode, IMPATT diode, Parametric amplifiers, Other diodes: PIN diodes, Schottky barrier diodes.

Pre-requisite Courses: UE16EC254 – Electromagnetic Fields and Transmission Lines

Reference Books:

1. "Microwave Engineering", David M Pozar, 2^{nd} Edition, John Wiley and Sons, 1999.
2. "Microwave Devices and Circuits", Samuel Y. Liao, PHI/Pearson Education, 1990.
3. "Electromagnetic Waves", R.K.Shevgaonkar, 1^{st} Edition, Tata McGraw Hill, 2006.

UE16EC303: VLSI DESIGN (4-0-0-0-4)

Course Objectives:

- The course aims to provide an understanding of the design of digital circuits at switch-level and basic operations of MOSFET.
- It will familiarize the students with the implementation of digital circuits in Mentor Graphics Tool and also help them verify the RTL schematic by simulation.
- The key focus will be on the design and implementation of RTL schematic of combinational and sequential circuits.

Course Outcomes:

Students completing the course should be able to

- Understand the fundamentals of MOS devices.
- Working principles of CMOS inverter.
- Able to build systems with CMOS devices
- Will have the basic knowledge of timing analysis
- Will have the knowledge of layout diagrams and design rules

Course Content:

1. **MOS Devices & Circuits:** Basic overview of MOS devices in Enhancement and Depletion Mode, Channel length modulation effect, Voltage Transfer Characteristics,V-I Relationship, Aspects of MOS threshold voltage, MOS transistor transconductance & output conductance, CMOS inverter,Estimation of CMOS Inverter Delay,Components of Energy and Power Switching, Short-Circuit and Leakage Components,Noise margin
2. **MOS Circuit Design Process-Fabrication and Layout**: NMOS fabrication, CMOS fabrication, p-well, n-well, twin-tub process,MOS layers,Stick diagrams-MOS design style and CMOS design style, Lambda based design rules, Contact cuts, Layout diagrams, Translation to mask form.
3. **Basic Circuit Concepts and Scaling of MOS Circuits**: Basic circuits concepts and scaling of MOS circuit, sheet resistance, Area capacitance, Delay unit, Inverter delays, Propagation delays, Scaling models, Scaling factors, parameters for scaling.
4. **CMOS Circuit Design Techniques:** Pass transistor, Transmission gate,Static CMOS Circuits, CMOS circuits with ratioed Logic ,Dynamic logic circuits, Demonstration of design techniques with examples of High speed adders: Carry skip, Carry select and carry save adders

5. **Sequential Circuits Design:** Basic Latch and Flip Flop operation, CMOS implementation of the D-latch, Origins of Clock Skew / Jitter and Impact on Performance, Clock Distribution Techniques, Problems on max and min Delay contraints at design level.

Pre-requisite Courses: UE16EC202 – Electronic Design and Circuits, UE16EC203 – Logic Design

Reference Books:

1. "Essentials of VLSI Circuits and Systems", Eshraghian, Kamran, Douglas A. Pucknell, and Sholeh Eshraghian". Prentice-Hall of India, 2005.
2. "Introduction to VLSI Circuits and Systems", Uyemura, John P, Publisher, 2002.
3. "Digital Integrated Circuits–A Design Perspective", Jan, M. Rabaey, Chandrakasan Anantha, and Nikolic Borivoje, Publisher, 2003.
4. "CMOS Digital Integrated Circuits", Kang, S.M. and Leblebici, Y, Tata McGraw-Hill Education, 2003.
5. "Principles of CMOS VLSI Design" Weste, Neil HE, and Kamran Eshraghian, Vol. 188, Addison-Wesley, New York, 1985.

UE16EC304:
MICROWAVE ENGINEERING LABORATORY (0-0-2-0-1)

Course Objectives:

- The main objective of the course is to make the students understand the fundamental concept of propagation and wave guiding of electromagnetic wave.
- This course will help the students to apply the basic electromagnetic concepts to design microwave components.

Course Outcomes:

- Solve impedance matching problems
- Analyze waveguides, eg determine their cutoff frequency, propagating modes and other parameters
- Analyze cavities, eg determine their resonance frequency and other parameters
- Design simple microwave circuits
- Have an understanding of microwave sources

Course Content:

1. Determination of modes, transit time, electronic tuning range and sensitivity of Reflex klystron oscillator.
2. Measurement of frequency, wavelength, VSWR and Reflection Coefficient.
3. Determination of V-I curve of Gunn diode and signal frequency.
4. Measurement of beam width, gain and radiation pattern of Horn antenna.
5. Measurement of beam width, gain and radiation pattern of parabola antenna.
6. Determination of Coupling coefficient, insertion loss, directivity, isolation and Scattering matrix coefficients of Directional coupler.
7. Determination of Coupling coefficient, insertion loss, directivity, isolation and Scattering matrix coefficients of magic tee.
8. Determination of Scattering matrix coefficients of Circulator and Isolator.
9. To measure unknown impedance.
10. Determination of Insertion loss, VSWR, and scattering matrix parameters for variable Attenuator.
11. Open ended experiments

Reference Books:

1. Laboratory manual prepared by Department of Electronics and Communication Engineering, PES University.

UE16EC305:
VLSI DESIGN LABORATORY (0-0-2-0-1)

Course Objectives:

- The course aims to provide an understanding of the design of digital circuits at switch-level and basic operations of MOSFET.
- It will familiarize the students with the implementation of digital circuits in Mentor Graphics Tool and also help them verify the RTL schematic by simulation.
- The key focus will be on the design and implementation of RTL schematic of combinational and sequential circuits.

Course Outcomes:

1. Understand the fundamentals of MOS devices.
2. Working principles of CMOS inverter.
3. Able to build systems with CMOS devices
4. Will have the basic knowledge of timing analysis
5. Will have the knowledge of layout diagrams and design rules

Course Content:

1. Simulate FET VI characteristics for PMOS and NMOS
2. Design Inverter in Mentor Graphics using basic layers, PMOS, NMOS
3. Design two input NAND and NOR using PMOS and NMOS transistors
4. Design XOR and XNOR using GDI technique.
5. Implement 4 to 1 Multiplexer using transmission gates.
6. Implement serial and 2 bit parallel adders.
7. Design D,T,JK and Master Slave flip-flops
8. Design asynchronous counter
9. Design of 4 X4 funnel shifter
10. Design a arbitrary synchronous counter (sequence generator)
11. Layout design of a CMOS inverter
12. Layout design of NAND and NOR circuits.

Reference Books:

1. Laboratory manual prepared by Department of Electronics and Communication Engineering, PES University.

UE16EC311:
VIDEO ENGINEERING (4-0-0-0-4)

Course Objectives:

- Study and understandings of the Video Systems and television system and standards
- Detail study of television system including video signals, television signal transmission, television receiver, digital television,
- Study advances in television technology and television standards

Course Outcomes:

Students completing the course should be able to

1. Understand the transmission of video signals and importance of television standards to effectively work with broadcasting applications.
2. Acquire sound knowledge of latest topics in digital video transmission.

Course Content:

1. **Introduction to Television and Video Signals:** Picture Transmission, TV Transmitter, TV Receiver, Synchronization Receiver Controls, Geometric form and Aspect Ratio, Image Continuity, Number of Scanning Lines, Interlaced Scanning, Picture Resolution, Brightness Gradation and Colour Characteristics, Video Signal Dimensions, Horizontal Sync Composition, Vertical Sync Details, Function of Vertical Pulse Train, Scanning Sequence

Details, Perception of Brightness and Colour, Additive and Colour Mixing, Video Signals for Colour Transmission, Luminance Signal (Y) Compatibility, Colour-Difference, Signals Encoding of Colour Difference Signals, Formation of Chrominance, Signal PAL Encoder, Chrominance Signal for Colour Bar Pattern

2. **Television Signal Transmission & Propagation:** Picture Signal Transmission Positive and Negative Modulation Vestigial Sideband Transmission Standard Channel Bandwidth Television Transmitter TV Signal Propagation Interference Suffered by TV Channels TV Broadcast Channels
3. **Television Systems and Standards:** American 525 Line B&W TV system 625 Line Monochrome System NTSC Colour System PAL Colour System French Colour TV System Cable Television Network
4. **Television Receiver:** a) Monochrome Receiver RF Tuner IF subsystem Video Amplifier Sound Section Sync Separation and Processing Deflection Circuits Scanning current in the Yoke DC Power Supplies (b) Colour Receiver Electronic Tuners IF Subsystems Y Signal Channel Chroma Decoder Separation of U and V Colour Phasors Synchronous Demodulators Subcarrier Generation and Control Matrixing for Drive Circuits
5. **Digital Television – Transmission and Reception:** Digital System Hardware Signal Quantization and Encoding Digital Satellite Television Direct-To-Home Satellite Television Digital Terrestrial Television; Advances in TV Technology and Digital Video Standards: HDTV Display Technologies (CRT, LCD, Plasma, LED, Projection) Video Interfaces (Composite, Component, S-Video, DV, SDI, HDMI, DVI) Digitizing Video Chroma Subsampling Basics of Video Compression (MPEG-x, H.26x)

Pre-requisite Courses: Nil

Reference Books:

1. "Modern Television Practice Transmission Reception and Applications", R.R.Gulati, 4th Edition, New Age Publishers, 2011.
2. "Colour Television, Technology, Transmission and Reception", R.R.Gulati, 2nd Edition, New Age International Publishers, 2007.
3. "Audio and Video Systems: Principles, Maintenance and Troubleshooting", R.G.Gupta, 2nd Edition, McGraw Hill Higher Education, 1995.
4. "Audio Video Systems: Principles, Practices and Troubleshooting", S.P.Bali and Rajiv Bali, Khanna Books Publishers, 1999.

UE16EC312:
OPTIC FIBER COMMUNICATION (4-0-0-0-4)

Course Objectives:

- This course provides the basic theory of optical fibers and principle of various components in optical communication system. Student should be able to design the components with specifications for a given fiber optic communication system.
- The sequence of topics takes the student systematically from the underlying principles of components and their interactions with other devices in an optical fiber link, through descriptions of the architectures and performance characteristics of complex optical links.
- By mastering these fundamental topics the student will be prepared not only to contribute to disciplines such as current optical devices, optical communication link, equipment designs but also to understand quickly any further technology developments for future enhanced networks.

Course Outcomes:

At the end of the course, the student should be able to

- Identify the basic elements of optical fiber transmission link and configure optical fiber for various fiber modes.
- Find the different kind of losses, signal distortion in optical wave guides and other signal degradation factors
- Use the various optical source materials, Laser diodes, LED structures and find quantum efficiency
- Apply fiber optical receivers such as PIN , APD diodes and hence improve noise performance in photo detector, receiver operation and configuration
- To use and implement fiber optical network components, variety of networking aspects, FDDI, SONET/SDH and operational principles WDM.

Course Content:

1. **Overview of Optical Fiber Communication:** (i) Motivations for Lightwave Communications, Optical Spectral Bands, Fundamental Data Communication Concepts Network Information Rates, WDM Concepts, Key elements of optical Fiber Systems; (ii) Optical Fibers: Structures, Waveguiding and Fabrication: The Nature of Light, Basic Optical Laws and Definitions, Optical Fiber Modes and Configurations, Mode Theory for Circular Waveguides, Single mode Fibers. Graded- index Fibers, Fiber Materials, Fiber fabrication, Fiber Optic cables; (iii) Optical Networks: Network concepts, Network topologies, SONET / SDH, High speed light wave links, Optical Add/Drop multiplexing, optical switching, WDM Network examples.
2. **Signal Degradation in Optical Fibers:** Attenuation, Signal Distortion in Optical fibers, Characteristics of Single Mode fibers International Standards, Specialty Fibers; Analog links: Overview of Analog links, Carrier to Noise Ratio, Multichannel Transmission Techniques, RF over Fiber, Radio over Fiber links, Microwave Photonics; Digital Links: Point to point links, Link Power Budget, Rise -Time Budget; Nonlinear Effects**:** General overview of Nonlinearities, Effective Length and Area, Stimulated Raman scattering, Stimulated Brillouin scattering, Self Phase modulation, Cross Phase modulation. Four wave mixing FWM mitigation, Wavelength Converters, Solitons;
3. **Transmitters and Receivers:** (i) Optical Sources **-** Review of Semiconductor Physics, Light Emitting diodes, Laser Diodes; Power Launching and Coupling Source to Fiber Power Launching, Lensing schemes for Coupling Improvement, Fiber- to- Fiber joints, LED coupling to Single Mode Fibers, Fiber Splicing, Optical fiber connectors (Qualitative); (ii) Photodetectors: Physical principles of photodiodes, Photodetector Noise, Detector Response Time, Avalanche Multiplication Noise, Structure for InGaAs APDs, Temperature effect on Avalanche gain, Comparison of Photodetectors; (iii) Optical Receiver Operation Fundamental Receiver Operation, Digital Receiver Performance, Eye Diagrams, Coherent Detection, Burst Mode Receivers, Analog Receivers;
4. **WDM Concepts and Components:** Overview of WDM, Passive Optical couplers, Isolators and circulators, Fiber Grating filters, Dielectric thin film filters, Phased array based devices, Diffraction Gratings Active optical components, and Tunable Light sources;
5. **Optical Amplifiers:** Basic applications and types of Optical amplifiers, Semiconductor Optical Amplifiers. Erbium doped fiber amplifiers, Raman Amplifiers, Wideband Optical Amplifiers.

Prerequisite Courses: UE16PH101 – Engineering Physics, UE16EC202 – Electronic Devices and Circuits

Reference Books:

1. "Optical Fiber Communications", Gerd Keiser , 4th Edition, TMH, 2008.
2. "Fiber – Optic Communication Systems", Govind P. Agarwal, 3rd Edition, John Wiley and Sons, 2002.
3. "Optical Fiber Communication", John M. Senior, 2nd Edition, PHI, 1993.

UE16EC313: SEMICONDUCTOR DEVICES (4-0-0-0-4)

Course Objectives:

- This course aims at introducing students to the operational models of semiconductor devices. It will start with an introduction to the physics of crystals, following it up with the energy-band model and the theory of electron-transport and optical properties of semiconductor. The said theoretical understanding will then be used to explain wide range of devices like different types of diodes and transistors along with optical and optoelectronic devices like LED, photo detector, semiconductor LASER, etc.

Course Outcomes

Students completing the course should be able to

- Learn the physics of crystals and semiconductors.
- Acquire knowledge of electron- transport and optical-phenomena in semiconductor.
- Apply the acquired knowledge mentioned above in analysing the operation of semiconductor electronic and optoelectronic devices.
- Be able to design a device against given specifications.

Course Content:

1. **Crystalline Solids and Band Theory:** Introduction to semiconductor and crystal structure, crystal lattice and translational symmetry. Reciprocal lattice and Miller Indices. Lattice planes and fundamental types of lattices, e.g., simple cubic, f.c.c. and b.c.c. and more complex crystal lattices like diamond, Si, Ge and GaAs, Bragg-Equation and determination of crystal structure with X-rays, Band Theory of solids (Schrödinger equation for electrons in a crystal lattice, periodic potential and Bloch Theorem, Kronig-Penney Model – Dirac Comb, band structure), direct and indirect semiconductors, Effective mass approximation (what's the need?), Expression of effective mass for materials with parabolic and linear dispersion, Idea of "holes" and their behaviour, Intrinsic and Extrinsic semiconductors (p and n type).
2. **Charge Carriers in Thermal Equilibrium:** Density of States (DOS), population distribution of charge carriers(Fermi-Dirac statistics and the idea of Fermi level), Electron density in semiconductor and the concept of majority and minority carriers, Effect of magnetic field (Hall Effect) and measurement of majority carrier density.
3. **Steady-State Dynamics of Charge Carriers:** Conductivity in bulk semiconductor: Scattering of charge carriers, relaxation time, how to combine effects of different scattering mechanisms, carrier mobility, drift & diffusion transport – Einstein Relation. Quantum of conductance and the genesis of Ohm's Law in the current era of nanostructures. Carrier generation & recombination (optical absorption & emission). Dependence of conductivity on optical absorption, Charge injection and the idea of Quasi-Fermi level, physics of p-n junction with a brief introduction to transient response of p-n junctions.
4. **Electron Devices:** Brief recapitulation of Bipolar Devices (Junction Diode and BJT – Ebers-Moll Model), Physics of long and short channel MOSFET. Introduction to nanoscale MOSFET (SOI and trigate MOSFETs), SPICE models of MOSFET
5. **Electro-Optic and Photonic Devices:** Photodetector (Photoconductor and Photodiode), LED (Light Emitting Diode). Semiconductor Laser: Physics of stimulated emission in p-n junction, structure and operation of laser diode.

Pre-requisite Courses: UE16EC202 – Electronic Devices and Circuits

Reference Books:

1. "Solid State Electronic Devices", B. G. Streetman and S. K. Banerjee, Prentice-Hall of India, 2006.
2. "Fundamentals of Modern VLSI Devices", Y. Taur and T. H. Ning, Cambridge University Press, 1998.
3. "Semiconductor Device Physics and Design", Umesh K. Mishra and Jasprit Singh, Springer, 2000.

UE16EC314: COMPUTER ORGANIZATION (4-0-0-0-4)

Course Objectives:

- To understand the basic organisation and architecture of computers.
- To efficiently design, implement and test various modules using HDLs.

Course Outcomes:

Students completing the course should be able to

a. Analyze basic computer organisation and architecture based on few case studies.
b. Use this knowledge for further advanced courses.
c. Write the microprograms for few applications
d. Analyze the concepts of parallel processing and pipelining
e. Implement and verify various modules

Course Content:

1. **Introduction:** Evolution of computer, basic structure and operational and operational concepts of computers performance considerations; Instruction set and programs: prerequisites for assembly language programming, addressing modes, instruction set-classification, machine instruction decoding, case study – Intel processor
2. **Input/Output organization:** Accessing I/O devices, program controlled I/O, Interrupts and supporting software and hardware, DMA, design of interface circuits, commercial bus standards
3. **Memory system:** Basic concepts and organization of memory, cache and virtual memory concepts, secondary storage devices
4. **Arithmetic and Logic Unit:** High speed adders, Booth's algorithm for multiplication, high speed multipliers, division, arithmetic operations on floating point numbers (IEEE std) Processing unit-Instruction execution, internal functional units and their interconnection, hardware for generating internal control signals, microprogramming approach
5. **Pipelining:** Concept, various factors affecting the performance and methods of overcoming them, hardware and software implications, influence of pipelining on instruction set design, introduction to superscalar processors

Pre-requisite Courses: Nil

Reference Books:

1. "Computer Organization", Carl Hamecher, Z Vranesic & Zaky, 5th Edition, McGraw Hill, 2011.
2. "Computer Architecture and Organisation", J.P. Hayes, 2nd Edition, Tata McGraw-Hill, 1988.
3. "Computer System Architecture", Morris Mano, 2nd Edition, PHI, 2007.

UE16EC315 : CONTROL SYSTEMS (4-0-0-0-4)

Course Objectives:

The study of the subject should enable the student to learn:

- Mathematical modelling(transfer functions and state space representation) of simple electrical, mechanical and electromechanical control systems

- The block diagram algebra and signal flow graph analysis.
- Characteristics of the time domain performance of feedback systems.
- Analyze the stability of feedback systems using various systems.
- To design simple compensators in the frequency domain and to design controller and observers in the state-space domain.

Course Outcomes:

Students completing the course should be able to

- Explain basic concepts of control systems, their types & requirements. Identify controllers, their types , features & application
- Apply Laplace transform and state space techniques to model dynamic systems, and convert between these formulations
- Analytically quantify the time and frequency domain behaviour of dynamic systems
- Specify steady state control system requirements, and select prototype controller structures to achieve these requirements
- Formulate dynamic feedback controller design specifications in the frequency domain
- Synthesise feedback controllers using root locus, Nyquist and Bode techniques
- Characterise the behaviour of elementary feedback control systems through simulations.

Course Content:

1. **Mathematical Models of Systems:** Introduction, Differential Equations of Physical Systems, Linear Approximations of Physical Systems, The Laplace Transform, The Transfer Function of Linear Systems, Block Diagram Models, Signal Flow Graph Models. Feedback Control System Characteristics: Open and Closed Loop Control Systems, Sensitivity of Control Systems to Parameter Variations, Control of the Transient Response of Control Systems, Disturbance Signals in a Feedback Control System, Steady State Error
2. **The Performance of Feedback Control Systems:** Introduction, Test Input Signals, Performance of a Second Order System, Effects of a Third Pole and a Zero on the Second Order System Response, The s – Plane Root Location and the Transient Response, The Steady – State Error of Non unity Feedback Systems. The Stability of Linear Feedback Systems: The Concept of Stability, the Routh – Hurwitz Stability Criterion, The Relative Stability of Feedback Control Systems
3. **The Root Locus Method:** Introduction, Concept and the Root Locus technique. Frequency Response methods: Introduction, Frequency Response Plots, Bode Diagram, and Performance Specifications in the Frequency Domain.
4. **Stability in the Frequency Domain:** Introduction, Mapping Contours in the s – Plane, the Nyquist Criterion, Relative Stability and the Nyquist Criterion. The Design of Feedback Control Systems: Introduction, Approaches to System Design, Cascade Compensation Networks, Phase – Lead Design Using the Bode Diagram, System Design Using Integration Networks, Phase-Lag Design Using Bode Diagram.
5. **State Variable Models:** Introduction, the State Variables of a Dynamic System, the State Differential Equation, The Stability of State Variable Systems; The Design of State Variable Feed Back Systems: Introduction, Controllability, Observability, Full-state feedback control design.

Pre-requisite Courses: UE16MA251 – Linear Algebra, UE16EC204 – Signals and Systems

Reference Books:

1. “Modern Control Systems”, R.C. Dorf and R.H. Bishop, 11th Edition, Addison-Wesley, 1999.
2. “Control Systems Engineering”, I.J. Nagrath and M. Gopal, 5th Edition, New Age International Publications, 2007.
3. “Modern Control Engineering”, K. Ogata, 5th Edition, Pearson Education Asia, 2010.

UE16EC316 :
DIGITAL IMAGE PROCESSING (4-0-0-0-4)

Course Objectives:

To introduce basic concepts of digital image processing to understand certain important image transforms and image enhancement methods and to familiarize image restoration and color image processing concepts

Course Outcomes:

At the end of the course students should be able to

- Describe the required fundamental transforms.
- Explain the different image processing algorithms.
- Use different techniques in image enhancement and image restoration for improving image quality.
- Investigate the best algorithm for enhancing an image.
- Design image processing algorithms for different applications.

Course Content:

1. **Digital Image Fundamentals:** What is digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception. Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships between Pixels, Linear and Nonlinear operations.
2. **Image Transforms:** 2-D orthogonal and Unitary transforms, 1-D and 2-d DFT, Cosine, Sine, Hadamard, Haar, Slant, Karhunen-loeve, singular value Decomposition.
3. **Image Enhancement in Spatial domain:** Basic Gray Level transformations, histogram processing, Enhancement using ALU operations, Basics of spatial filtering, smoothing spatial filters sharpening spatial filters. Image Enhancement in Frequency domain: Ideal low pass filters, Butterworth low pass filters, Gaussian low pass filters, Sharpening filters, Unsharp masking, High boost filtering, Notch filters, Homomorphic filtering.
4. **Image Filtering and Restoration:** Image observation models, Noise Models, Restoration in the presence of noise only-Spatial Filtering, Periodic noise reduction by frequency domain filtering, inverse and Wiener filtering, least square filters.
5. **Color Image Processing:** Color Fundamentals, Color Models, Pseudocolor Image Processing, Basics of Full-Color Image Processing, Color Transformations, Smoothing and Sharpening, Noise in Color Images.

Pre-requisite Courses: UE16EC204 – Signals and Systems, UE16EC253 – Digital Signal Processing

Reference Books

1. “Fundamentals of Digital Image Processing,’ Anil K Jain, Pearson Education Pvt. Ltd., ,2004.
2. “Digital Image Processing”, R.C.Gonzalez and R.E.Woods, 2nd Edition, Prentice Hall, 2005.
3. ”Digital Image Processing”, William K Pratt, 2nd Edition, Wiley, 1991.

UE16EC321 :
SATELLITE COMMUNICATION (4-0-0-0-4)

Course Objectives:

- The course facilitates an in-depth understanding of modern satellite systems, multiple accesses, modulation and coding techniques.

- Provides learning of VSAT systems, Direct Broadcast Satellite television and installation considerations, Navigation satellites and position determination concepts.
- In this course the basic concepts of satellite communication, satellite systems and satellite design are introduced. The students will also get an exposure to the different kinds of payloads, telemetry and launching techniques.
- Multiple access techniques, navigation techniques, data and video communication techniques are also covered in this course.

Course Outcomes:

At the end of the course, the student should be able to

- Understand satellite applications
- Understand the concepts of navigation, broadcasting TV, VSAT etc
- Get an exposure to various technologies like access technologies, error control coding, link design etc
- Understand the requirements for setting up a ground station
- Install DTH and VSAT antennas.

Course Content:

1. **Introduction:** (i)A brief History of Satellite Communications, the Role and Application of Satellite Communication, Frequency allocations for Satellite Services, Indian satellite scenario and applications; (ii) Orbital mechanics: Kepler's laws, Orbital Mechanics, Satellite Look Angles determination, Slant range determination, Basics of eclipse and Doppler frequency,, Orbital perturbations, Orbital effects in communication systems performance, Radiation and van Allen belts, Launching and positioning, satellite drift and station keeping;
2. **Satellite Link Design:** (i) Basic transmission theory, Noise figure, Sky and system noise temperatures, Design of up and down satellite links, EIRP, G/T, over all C/N, Threshold and Dynamic range, Design examples; (ii) Satellite subsystems: Attitude and orbit control, Telemetry, tracking, and command (TT&C), Power generation, storing and distribution, Communication payloads, Bent pipe and regenerative transponders, Satellite antennas and coverage contours, Reliability and space qualification; (iii) Earth station: Introduction, earth station subsystems. Different types of earth stations; (iv) Error Control for Digital Satellite Links: Channel capacity and error detection and correction coding techniques, Linear block codes, Convolution codes, Concepts of Viterbi decoding, Concepts of Turbo & LDPC coding, Implementation of error detection on satellite links;
3. **Multiple Access:** Space segment access methods, FDMA, TDMA, CDMA, SDMA, Estimation of number of users, Applications;
4. **Direct Broadcast TV & Radio:** Concepts of DTH/ DBS TV, System Design, Link analysis, Master Control Station and Uplink, Installation of DBS TV Antennas;
5. **Satellite Navigation & Global Navigation Satellite System (GNSS):** (i) History of Navigation, Radio and Satellite Navigation, Position Location Principles, Introduction to GPS, GALILEO and GLONOSS, GPS Receivers and Codes, GPS Navigation Message, Signal levels, Timing Accuracy, Receiver Operation, GPS C/A Code Accuracy, Differential GPS, overview of GAGAN, over view of GNSS - Regional Navigation Systems, Indian Regional Navigation system; (ii) VSAT Systems: Introduction, Network Architectures, Star and Mesh networks, Access Control Protocols, VSAT Earth Station configuration, Link analysis for a VSAT Star and Mesh Networks, Concepts of system design, Up link power control;

Prerequisite Courses: Nil

Reference Books:

1. "Satellite Communications", Timothy Pratt, Charles Bostian, Jeremy Allnut, 2nd Edition, John Wiley & Sons, 2002.
2. "Satellite Communication", Dennis Roddy, 4th Edition, TMH, 2006.
3. "Digital Satellite Communication", T.T. Ha, 1st Edition, Cambridge University Press, 2011.
4. "Satellite Communication Systems: Systems Techniques and Technology", Gerard Maral, Michel Bousquet, 5th Edition, John Wilely & Sons, 2009.
5. www.isro.org

UE16EC322
WIRELESS COMMUNICATION (4-0-0-0-4)

Course Objectives:

- This course is an introduction to the design, analysis, and fundamental limits of wireless transmission systems.
- This course will expose the students to the principles behind the working and design of wireless communication systems and technologies.
- Topics covered include: Overview of current wireless systems, path loss and shadowing in a wireless channel, statistical multipath channel models, Capacity of a wireless channel, Diversity, Multiuser DSSS and FHSS systems, Multiuser systems, Cellular systems and infrastructure-based wireless networks, Multicarrier modulation – OFDM and vector coding.

Course Outcomes:

At the end of the course, the student should be able to

- Gain the basic working of current wireless systems
- Determine the Path loss and cell coverage area in wireless systems.
- Understand the narrowband and wideband fading models of statistical multipath channel models.
- Use the techniques to allocate resources among multiple users in wireless systems.
- Understand the basic design principles of cellular systems and channel reuse.
- Determine the maximum data rate that can be transmitted in wireless channels.
- Use the techniques to mitigate the effects of fading in a wireless channel.
- Understand the latest multicarrier techniques like OFDM and vector coding.

Course Content:

1. **Overview of Wireless Communication:** History, Wireless Vision, Technical Issues, Current Wireless Systems, Wireless Spectrum, Standards; Path loss and Shadowing: Radio Wave Propagation, Transmit and Receive signal models, Free-space path loss, Ray tracing, Empherical pathloss models, Simplified path loss model, Outage probability under pathloss shadowing, Cell cover area.
2. **Statistical Multipath:** Statistical Multipath Shadowing Models: Time varying channel impulse response, Narrow band fading models, Wideband fading models;
3. **Spread Spectrum:** Multi-User DSSS systems, Multi-user FHSS systems; Multiuser Systems: Multiuser channels: uplink and downlink, Multiple Access: FDMA, TDMA, CDMA, SDMA, hybrid techniques;
4. **Cellular systems and Infrastructure based wireless networks:** Cellular system fundamentals, channel reuse, SIR and user capacity, Interference reduction techniques, dynamic resource allocation, Fundamentals and rate limits; Capacity of wireless channels: Capacity of AWGN, Capacity of Flat fading models, Capacity Vs Receiver diversity; Diversity: Realization of independent fading paths, Receiver diversity, Transmitter diversity;

5. **Multicarrier Modulation:** Data transmission using multiple carriers, Multicarrier modulation with Overlapping sub channels, Discrete implementation of multicarrier modulation, The DFT and its properties, The cyclic prefix, orthogonal frequency-division Multiplexing, matrix representation of OFDM, vector coding.

Pre-requisite Courses:

Reference Books:

1. "Wireless Communications", Andrea Goldsmith, Cambridge University Press, 2011.
2. "Wireless Communications: Principles and Practices", T. S. Rappaport, 2nd Edition, Prentice Hall, 2002.
3. "Fundamentals of Wireless Communications", David Tse and Pramod Vishwanath, Cambridge University Press, 2009.

UE16EC323: REAL TIME OPERATING SYSTEMS (4-0-0-0-4)

Course Objectives:

The goal of this course is to meet the basics of real time systems and to provide thorough discussion of the fundamentals of Operating system design and to relate these to contemporary design issues and to current directions in the development of operating systems

Course Outcomes:

Students completing the course should be able to

- Use the multitasking techniques in real time systems.
- Use real time scheduling policies in applications.
- Design embedded applications using RTOS.
- To use RTOS software mechanisms

Course Content:

1. **Introduction:** Kernel architecture**,** Real time embedded system, Defining RTOS and its services, Process, PCB, 5 state model, Threads.
2. **IPC** : pipe and fifo**,** semaphore, mutex, event registers and Timers
3. **Scheduling:** scheduler, Types – preemptive and Non preemptive scheduling, RR, SJF, FCFS, Priority.
4. **Memory**: Hierarchical memory system, paging, segmentation, Virtual Memory.
5. **Lab related to free RTX**

Pre-requisite Courses: Nil

Reference Books:

1. "Real-Time Concepts for Embedded Systems" ,Qing Li and Carolyn, CRC Press, 1st Edition, 2003.
2. "Operating System Concepts", Silberschatz, Galvin and Gagne, John Wiley & Sons, 7th Edition, 2005.
3. "Operating Systems: Internals and Design Principles", William Stallings, Prentice Hall International, 5th Edition, 2004.
4. "Computer Architecture and Organisation", J.P. Hayes, 2nd Edition, Tata McGraw-Hill, 1988.

UE16EC324: TESTING OF VLSI CIRCUITS (4-0-0-0-4)

Course Objectives:

- This course aims at demonstrating the concepts of Testing and applying the various test strategies to VLSI circuits.
- The theories of memory testing, scan testing and other topics will be explored.
- This course will cover VLSI testing techniques such as VLSI fault modelling (stuck-at-fault, delay fault), automatic test generation, memory testing, design for testability (DFT).
- VLSI scan testing and built-in self-test (BIST) will also be covered. Students will learn various VLSI testing strategies and how to design a testable VLSI circuit.

Course Outcomes:

Students completing the course should be able to

- Apply various VLSI testing methodologies for any digital circuit.
- Develop fault models, testing strategies for combinational/ sequential circuits and memory circuits.
- Perform delay testing, design for testability (DFT), built-in self-test (BIST) and boundary scan, effectively use the concepts for testing VLSI systems using existing test methodologies, tools and equipment.

Course Content:

1. **Introduction To Testing And Verification:** (i) Introduction to testing, Need for testing, Testing Philosophy, Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends Affecting Tesing Verification and Validation Definitions; (ii) Fault Modeling: Defects, Errors, Faults Functional Versus Structural Testing, Levels of Fault Models, A Glossary of Fault Models, Single Stuck-at Fault, Fault Equivalence, Equivalence of Single Stuck-at Faults Fault Collapsing, Fault Dominance and Checkpoint Theorem;
2. **Combinational Circuit Test Generation:** Algorithms and Representations, Structural vs. Functional Test, Definition of Automatic Test-Pattern Generator, Search Space Abstractions, Algorithm Completeness, ATPG Algebras, Algorithm Types, Redundancy Identification (RID), Testing as a Global Problem, Definitions. Significant Combinational ATPG Algorithms D-Calculus and D-Algorithm, PODEM, FAN;
3. **Delay Test and Memory Test: (i)** Delay Test Problem, Path-Delay Test, Test Generation for Combinational Circuits, Number of Paths in a Circuit, Transition Faults, Delay Test Methodologies, Slow-Clock Combinational Test Enhanced-Scan Test, Normal-Scan Sequential Test, Variable-Clock Non-Scan Sequential Test, Rated-Clock Non-Scan Sequential Test, Practical Considerations in Delay Testing; (ii) RAM Fault Models, Test Algorithm for RAMs, Detection of Pattern Sensitive Faults, BIST Techniques for RAM chips, Test Generation and BIST for Embedded RAMs; (iii) Boundary Scan Standards: Motivation, Purpose of Standard, System Configuration with Boundary Scan TAP Controller and Port;
4. **Sequential Circuit Test Generation:** ATPG for Single-Clock Synchronous Circuits, A Simplified Problem Time-Frame Expansion Method, Use of Nine-Valued Logic, Development of Time-Frame Expansion Methods, Approximate Methods, Implementation of Time-Frame Expansion Methods Complexity of Sequential ATPG, Cycle-Free Circuits, Cyclic Circuits Clock Faults and Multiple-Clock Circuits, Asynchronous Circuits Simulation-Based Sequential, Circuit ATPG, CONTEST Algorithm Genetic Algorithms;
5. **Design For Testability:** Digital DFT And Scan Design: Ad-Hoc DFT Methods, Scan Design, Scan Design Rules, Tests for Scan Circuits, Multiple Scan Registers, Overheads of Scan Design, Physical Design and Timing Verification of Scan, Partial-Scan Design, Variations of Scan; Built-In Self-Test: Random Logic BIST, Definitions BIST Process, BIST Pattern Generation BIST Response Compaction, Built-in Logic Block Observers, Device Level BIST, Test Point Insertion

Pre-requisite Courses: UE16EC203 – Logic Design

Reference Books:

1. "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", M. Bushnell and V. D. Agrawal, Kluwer Academic Publishers, 2000.

2. "Digital Systems Testing and Testable Design", M. Abramovici, M. A. Breuer and A. D. Friedman, IEEE Press, 1990.
3. "Digital Circuit Testing and Testability", P. K. Lala, Academic Press, 1997.

UE16EC325:
FUZZY SYSTEMS (4-0-0-0-4)

Course Objectives:

- Understand the principals of fuzzy systems;
- Design fuzzy systems using various approaches;
- Learn the applications of fuzzy systems in classification, pattern recognition, and control systems

Course Outcomes:

Students completing the course should be able to

- Distinguish between the crisp set and fuzzy set concepts
- Perform mapping of fuzzy sets by a function
- Apply the rules of fuzzy logic for fuzzy control
- Design fuzzy-logic based systems and explore their unique characteristics

Course Content:

1. **Fuzzy Sets, Operations and Relations:** Fuzzy systems; examples; fuzzy sets; basic concepts; operations; fuzzy complement, union, and intersection; averaging operators; fuzzy relations; compositions; extension principle.
2. **Fuzzy Rules and Logic:** Linguistic variables and hedges; fuzzy if-then rules; fuzzy logic; compositional rule; properties of the implication rules; fuzzy rule base; fuzzy inference engine.
3. **Fuzzy Systems:** Fuzzifiers; defuzzifiers; formulas for some classes of fuzzy systems; fuzzy systems as universal approximators; preliminary concepts; design of fuzzy systems; approximation accuracy of the fuzzy system; fuzzy system with second-order approximation accuracy; approximation accuracy of fuzzy systems with maximum defuzzifier.
4. **Design of Fuzzy Systems:** Design of fuzzy systems using a table look-up scheme, gradient descent training, recursive least squares and clustering.
5. **Applications:** Fuzzy Classification: Classification by equivalence relations; cluster analysis; cluster validity; c-means clustering; classification metric; hardening the fuzzy c-partition. Fuzzy Pattern Recognition: Feature analysis; partitions of the feature space; single sample identification; mutlifeature pattern recognition; image processing.

Pre-requisite Courses: UE16MA251 – Linear Algebra

Reference Books:

1. "Fuzzy Logic with Engineering Applications", T. J. Ross, McGraw-Hill International Edition, 1995.
2. "Fuzzy Sets, Uncertainty and Information", G.J. Klir and T.A. Folger , Prentice Hall of India, 2003.
3. "A Course in Fuzzy Systems and Control", L.-X. Wang, Prentice Hall, 1997.

UE16EC326 :
ARTIFICIAL NEURAL NETWORKS (4-0-0-0-4)

Course Objectives:

- Expose the fundamentals of artificial neural networks and learning, and their role in engineering;
- Provide knowledge of supervised learning and unsupervised learning
- Help derive of algorithms for learning.
- Help implement multilayer feedfoward neural networks, radial basis function networks, and recurrent networks

Course Outcomes:

Students completing the course should be able to

- Describe the basic neuronal models
- Explain the different structures of neural networks and learning methodologies
- Use the different structures of neural networks and learning methodologies in applications
- Derive and examine the properties of the learning algorithms
- Evaluate the practical considerations in applying neural networks in applications.

Course Content:

1. **Introduction:** What is a neural network? Human brain; models of a neuron; neural networks as directed graphs; feedback; network architectures; knowledge representation. Linear Neuron: Adaptive filtering problem; unconstrained optimization techniques; linear least-squares filters; least-mean-square algorithm; learning curves; learning rate annealing techniques.
2. **Perceptron: Single Layer:** Perceptron; perceptron convergence theorem; relation between perceptron and Bayes' classifier for a Gaussian environment. Multilayer: Preliminaries; back-propagation algorithm; XOR problem; heuristics for making the BPA perform better; output representation and decision rule; feature detection; back-propagation and differentiation; Hessian matrix; generalization; approximation of functions; cross-validation; network pruning techniques; virtues and limitation of back-propagation learning; accelerated convergence of back-propagation learning; supervised learning as an optimization problem.
3. **Radial-Basis Function Networks:** Cover's theorem on the separability of patterns, interpolation problem, supervised learning as an ill-posed hyersurface reconstruction problem, regularization theory, regularization networks, generalized radial-basis function networks, XOR problem revisited, estimation of the regularization parameter, approximation properties of RBF networks, comparison of RBF networks and multilayer perceptrons; learning strategies.
4. **Learning Processes:** Error-correction learning; memory-based learning; Hebbian learning; competitive learning; Boltzmann learning; credit-assignment problem; learning with and without a teacher. Principal Component Analysis: Some intuitive principles of self-organization; principal components analysis; Hebbian-based maximum eigenfilter; Hebbian-based principal components analysis.
5. **Self-Organizing Maps:** Feature-mapping models; self-organizing map; properties of the feature map; learning vector quantization; Recurrent Networks: Recurrent network architectures; state-space model; nonlinear autoregressive with exogenous inputs model; computational power of recurrent networks; learning algorithms; back-propagation through time; real-time recurrent learning. Applications of Neural Networks in Engineering.

Pre-requisite Courses: UE16MA251 – Linear Algebra

Reference Books:

1. "Neural Networks: A Comprehensive Foundation," S. Haykin, 2nd Edition, Prentice Hall of India, 2003.
2. "Neural Networks and Learning Machines", S. Haykin, 3rd Edition, Prentice Hall of India, 2009.
3. "Applications of Neural Networks", Alan Murray, Springer Science+Business Media, New York. 1995.
4. "Neural Network Design", T. Hagan, H. B. Demuth and M. Beale, Thomson Learning, 2002.
5. "Static and Dynamic Neural Networks: From Fundamentals to Advanced Theory", M. M. Gupta, L. Jin and N. Homma, John Wiley-IEEE Press, 2003.

UE16EC351
COMPUTER NETWORKS (4-0-0-0-4)

Course Objectives:

- The objective of this course is to give the students an in-depth understanding and hands on experience of internet protocols and algorithms.
- This course aims to enable the students to design and analyze simple computer networks.
- The course begins with an introduction to the internet architecture and service models. A top down approach is followed to explain the complex operation of sending data from one host to another.
- The standard application protocols, transmission protocols, networking protocols and MAC layer protocols are covered.

Course Outcomes:

At the end of the course, the student should be able to

- Analyze the internet protocols related to the application layer, transport layer, network layer and link layer
- Design simple computer networks using GNS3 and analyze packet capture using Wireshark
- Implement routing algorithms, client and server socket programs
- Solve numerical problems and logical problems in the design of computer networks
- Apply networking concepts to simple projects in the computer networks

Course Content:

1. **Introduction:** Introduction to internet, ISPs and their hierarchy, Access networks and Physical media, Delays in transmission, circuit and packet switching, core networks, Concept of protocol stack and TCP/IP model, National and international Internet regulatory authorities;
2. **Application layer and Sockets:** Architectures and service models, HTTP, FTP, Mail access protocols (SMTP, POP3 and IMAP), DNS, Peer-to-peer applications (Torrent, DHT and Skype), Introduction to Sockets, Socket programming, Connectionless Transport (UDP sockets), Connection Oriented Transport (TCP sockets)
3. **Transport Layer and Network Layer:** UDP segment structure, TCP segment structure, Reliable data transfer under TCP, Congestion control, Flow control; Internal organisation of a Router, IPv4 Addressing format, CIDR, sub-netting and super-netting, IPv4 Datagram format, Network address translation (NAT), ICMP, IPv6 addressing and datagram format.
4. **Routing**: Dijkstra and Bellman-Ford routing algorithms, RIP, OSPF, BGP, Brief treatment of IS-IS, Brief overview of MPLS, Brief overview of SDN.
5. **Link Layer:** Role and importance of link layer, Error detection and error correction techniques, switching and addressing, Forwarding and filtering, Basic random access techniques, Ethernet: protocol and frame format, Point to Point Protocol (PPP), Virtual Local Area Networking (VLAN);

Prerequisite Course : Nil

Reference Books:

1. "Computer Networking: A Top Down Approach", James F Kurose and Keith W Ross, 6th Edition, Pearson Education, 2013.
2. "Computer Networks", Andrew S. Tanenbaum, 4th Ed., Prentice Hall, 2003.
3. "Telecommunication Networks, Protocols, Modeling and Analysis", Schwartz M, 2nd Edition., Addison-Wesley, 1987.
4. "Data and Computer Communications", William Stallings, 8th Edition, Prentice Hall, 2007.

UE16EC352
DIGITAL COMMUNICATION (4-0-0-0-4)

Course Objectives:

- Understand the PCM system performance.
- Learn the characteristics of different Line Codes.
- Realize the basic concepts of coherent and Non coherent digital modulation techniques.
- Visualize the basic concepts of source coding techiques
- Understand memoryless channels and channel capacity.

Course Outcomes:

Students completing the course should be able to

- Analyze the performance capabilities PCM systems.
- Analyze the Base Band data transmission sysytem.
- Analyze different Digital Modulation Techniques.
- Analyze different source coding techniques
- Analyze the capacity of Memoryless channels.

Course content:

1. **Pulse Code Modulation:** Pulse Code Modulation, Channel noise and error probabilIty, Quantization, Noise and Signal to Noise ratio. Robust Quantization, Differential Pulse Code, Modulation, Delta Modulation, Adaptive Differential Pulse Code Modulation.
2. **Intersymbol Interference and Signal Space Representation:** Discrete PAM Signals, Power spectra of Discrete PAM Signals, Inter Symbol Interference, Nyquist criterion for Distortionless Base band Binary Transmission, Eye diagram, Gram-Schmidt Orthogonalization Procedure, Response of Bank of correlators, to noisy input. Detection of known signals in Noise, Maximum-likelihood, Detector. Correlation Receivers and Matched Filter receiver.
3. **Digital Modulation Techniques:** Digital Modulation Schemes: Coherent Binary PSK, Coherent Binary FSK Coherent Quadrature Phase Shift keying, Minimum Shift Keying, Differential Phase Shift Keying, Quadrature Amplitude Modulation.
4. **Basic Information theory:** Uncertainty Information Theory and Entropy, Source Coding Theorem, Huffman coding.
5. **Channel Capacity:** Discrete Memoryless channels, Mutual Information, Channel Capacity, Channel Coding Theorem, Diffrential entropy and Mutual Information for Continuous Ensembles. Channel Capacity Theorem.

Prerequisite Course : Nil

Reference Books:

1. "Digital Comunications", Simon Haykin, Wiley Student Edition, Wiley India (P) Ltd. , 2010.
2. "Elements of Information Theory," T. M. Cover and J. A. Thomas, Wiley Student Edition, Wiley India (P) Ltd., 2011.

UE16EC353:
DIGITAL SYSTEM DESIGN (4-0-0-0-4)

Course Objectives:

- Understand the different modeling techniques to design digital systems using Verilog HDL.
- Different Modelling Techniques: Gate-Level Modeling, Data-Flow Modeling, RTL, Behavioural Modeling, Write Synthesizable HDL Code, Delay Modeling for different modelling techniques, Writing Simulation Block Program Using Verilog to simulate the Design (Verification).

Course Outcomes:

Students completing the course should be able to

- Understand basics of digital systems, design methodology

- Design combinational and sequential circuits using Verilog
- Write test cases and test benches for given circuits
- Design of digital systems and its verification
- Synthesize and implement the design using FPGA boards

Course Content:

1. **Overview of HDLs, Introduction to Verilog:** Evolution of Computer aided digital design, Emergence of HDLs Typical design flow ,Importance of HDLs , Design Methodologies, Modules, Instances, Components of simulation with examples, Lexical Conventions, Number specifications, Fixed Point and Floating-Point Representation in Verilog, Strings, Identifier and Keywords, Escaped Identifiers Data Types: Nets, Registers, Vectors, Data Types, Arrays, Memories, System Tasks, Compiler Directives, Overriding parameters,
2. **Gate Level Modeling and Delays, Operators, Expressions:** Modules , Ports ,Hierarchical Names- 1, Gate Types Building Circuits with Gates, Gate Delays, Delay Examples, Dataflow modelling: Continuous Assignment, Implicit Continuous Assignment, Implicit Net Declaration, Assignment Delays, Expressions, Operators, Operands , Operator Types, Examples.
3. **Behavioral Modeling:** Structured procedures: initial statement, Structured procedures: always statement (combinatorial), Procedural Assignments Blocking, Non blocking assignments -1, Examples of Blocking, Non blocking assignments , Timing Controls: Delay Based Timing Controls: Event Based Conditional Statements Multiway Branching: Case, Casex, Casez Loops, FSM Examples.
4. **Tasks, Functions, Modeling Techniques:** Sequential and Parallel Blocks, Named Blocks, Nested Blocks,Generate Blocks, Tasks , Functions, Procedural Continuous assignments, Conditional Compilation and execution, Useful System Tasks, Time scales, Timing and Delays: Types of Delay Models, Path delay Modeling, Timing Checks, Delay Back Annotations
5. **Synthesis Concepts:** User-Defined Primitives, UDP basics, Combinational and sequential UDPs, UDP Table Shorthand Symbols, Guidelines for UDP Design, Impact Of Logic Synthesis, Verilog Hdl Synthesis, Synthesis Design Flow, Coding Style For Logic Synthesis, Introduction To Various FPGA Logic Families,Synthesis Design Flow, Coding style for logic synthesis

Pre-requisite Courses: UE16EC203 – Logic Design

Reference Books:

1. ”Verilog HDL - A Guide to Digital Design and Synthesis” Samir Palnitkar, 2nd Edition, Pearson Education, 2003.
2. IEEE Standard Verilog Hardware Description Language 1364-2001.
3. “Digital Design (Verilog): An Embedded Systems Approach Using Verilog”, Peter J Ashenden, Elsevier, 2007.
4. Xilinx Application Notes, [Available]: http://www.xilinx.com/support.html

UE16EC354:
COMPUTER NETWORKS LABORATORY (0-0-2-0-1)

Course Objectives:

- The objective of this course is to give the students an in-depth understanding and hands on experience of internet protocols and algorithms.
- This course aims to enable the students to design and analyze simple computer networks.
- The course begins with an introduction to the internet architecture and service models. A top down approach is followed to explain the complex operation of sending data from one host to another.
- The standard application protocols, transmission protocols, networking protocols and MAC layer protocols are covered.

Course Outcomes:

- Analyze the internet protocols related to the application layer, transport layer, network layer and link layer
- Design and demonstrate simple computer network models using Gns3 emulator
- Implement routing algorithms, client and server socket programs
- Solve numerical problems and logical problems in the design of computer networks
- Apply networking concepts to simple projects in the computer networks

Course Content:

1. Analyze GET and Conditional GET under HTTP using Wireshark
2. Analyze the TCP fragmentation when downloading large files from a web-server using Wireshark
3. Analyze the downloading of embedded objects in a web-page using Wireshark
4. Analyze the DNS query and response using Wireshark
5. Analyze POST method under HTTP using Wireshark
6. Write socket programs for one of the experiments using Python 2.7 or above.
7. Design a simple LAN to demonstrate static addressing and static routing using GNS3
8. Design a network with 4 subnets to demonstrate static addressing and dynamic routing using GNS3
9. Design a 1-hop network to demonstrate dynamic addressing and dynamic routing using GNS3
10. Design a 2-hop network to demonstrate dynamic addressing and dynamic routing using GNS3
11. Design a 2-hop network to demonstrate static and dynamic NAT configurations
12. Open ended experiment

Reference Books:

1. Laboratory Manual prepared by Department of Electronics and Communication Engineering, PES University.

UE16EC355:
DIGITAL SYSTEM DESIGN LABORATORY (0-0-2-0-1)

Course Objectives:

- Understand the different modeling techniques to design digital systems using Verilog HDL.
- Different Modelling Techniques: Gate-Level Modeling, Data-Flow Modeling, RTL, Behavioural Modeling, Write Synthesizable HDL Code, Delay Modeling for different modelling techniques, Writing Simulation Block Program Using Verilog to simulate the Design (Verification).

Course Outcomes:

- Understand basics of digital systems, design methodology
- Design combinational and sequential circuits using Verilog
- Write test cases and test benches for given circuits
- Design of digital systems and its verification
- Synthesize and implement the design using FPGA boards

Course Content:

1. Basic logic gates & Universal Gates (FPGA IMPLEMENTATION).
2. Multiplexor design (4:1) using Parameter construct for variable data bus width (FPGA IMPLEMENTATION).
3. Design of Booth Multiplier and comparing it with Xilinx multiplier.
4. Design of Adder/Subtractor and verification using $random

5. Design of D-Flipflop and D-Latch & implement given block using DFF (FPGA IMPLEMENTATION).
6. Design of Sequence detector in Verilog and differentiate between Mealy and Moore machine implementation
7. Develop a Verilog model of the complex multiplier data path and control path.
8. Design of 4 bit arbitrary sequence counter and implementation on FPGA (FPGA IMPLEMENTATION).
9. Design of a logic block for demonstration of recursive task and `include compiler directive.
10. Design and implementation of simple ALU in WIPRO ULK board and displaying the results using LED interface.
11. Character display using LCD display interface using Spartan 6 in WIPRO ULK board.
12. Design and Write a Verilog model for the controller state machine for the Alarm Clock (FPGA IMPLEMENTATION).

Reference Books:

1. Laboratory Manual prepared by Department of Electronics and Communication Engineering, PES University.

UE16EC331 :
SPREAD SPECTRUM COMMUNICATION (4-0-0-0-4)

Course Objectives:

- To educate students to meet current and future industrial challenges to work in the Telecom Industry.
- This course provides the background for DSSS and FHSS system design, Code generator fundamentals, Performance evaluation of Spread spectrum communications , CDMA standards.

Course Outcomes:

On successful completion of this Course, the students will be able to;

- Generate DSSS and FHSS patterns using trainer kits
- Generate various orthogonal code coding schemes
- Evaluate performance of DSSS, FHSS and CDMA systems
- Design and Implement CDMA

Course Content:

1. **Review of Digital Communication Concepts**: Introduction to direct sequence and frequency hop spread spectrum systems; Hybrid direct sequence/frequency hop spread spectrum. Complex envelope representation of spread spectrum signals;
2. **Spreading codes**: Sequence generator fundamentals, Maximum length sequences. Gold and Kasami codes, Nonlinear Code generators;
3. **DSSS**: Spread spectrum communication system model, Performance of spread spectrum signals in jamming environments; Performance of spread spectrum communication systems with and without forward error correction.
4. **FHSS**: Code generation, Transmitter and receiver design, Performance of FHSS system; Applications of FHSS
5. **Multiple Access Techniques**: Diversity reception in fading channels; Cellular radio concept, FDMA, SDMA, TDMA and CDMA cellular systems. Examples of CDMA cellular systems. Multicarrier CDMA systems. CDMA standards; WCDMA based cellular systems.

Pre-requisite Courses: Nil

Reference Books:

1. "Introduction to Spread Spectrum Communications", R. L. Peterson, R. E. Zeimer and D. E. Borth, Pearson, 1995.
2. "Digital Communication", J. D. Proakis and M. Salehi, McGraw Hill, 2008.
3. "CDMA: Principles of Spread Spectrum Communications", J. Viterbi, Addision Wesley, 1995.
4. "Wireless Communications", Andrea Goldsmith, Cambridge University Press, 2011.

UE16EC332
ERROR CONTROL CODING (4-0-0-0-4)

Course Objectives:

- The course aims to provide an in-depth understanding of the various channel coding and decoding techniques.

Course Outcomes:

Students completing the course should be able to

- Completely understand fundamentals of coding and how they can be applied to design of error control systems.
- Design good codes and of efficient decoding methods

Course Content:

1. **Introduction to Algebra:** Groups, Fields, Binary Field Arithmetic, Construction of Galois Field GF (2m) and its basic properties, Computation using Galois Field GF (2m) Arithmetic, Vector spaces and Matrices.
2. **Linear Block Codes:** Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Error correcting capabilities, Standard array and Syndrome decoding, Decoding circuits, Hamming Codes, Reed – Muller codes, The (24, 12) Golay code, Product codes and Interleaved codes
3. **Cyclic Codes:** (i) Introduction, Generator and Parity check Polynomials, Encoding using Multiplication circuits, Systematic Cyclic codes – Encoding using Feedback shift register circuits, Generator matrix for Cyclic codes, Syndrome computation and Error detection, Meggitt decoder, Error trapping decoding, Cyclic Hamming codes, The (23, 12) Golay code, Shortened cyclic codes; (ii) BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction. Non – binary BCH codes: q – ary Linear Block Codes, Primitive BCH codes over GF (q), Reed – Solomon Codes, Decoding of Non – Binary BCH and RS codes: The Berlekamp - Massey Algorithm, Majority Logic Decodable Codes, One – Step Majority logic decoding, one – step Majority logic decodable Codes, Two – step Majority logic decoding, Multiple – step Majority logic decoding.
4. **Convolutional Codes:** Encoding of Convolutional codes, Structural properties, Distance properties, Viterbi Decoding Algorithm for decoding, Soft – output Viterbi Algorithm, Stack and Fano sequential decoding Algorithms, Majority logic decoding.
5. **Concatenated Codes & Turbo codes:** (i) Single level Concatenated codes, Multilevel Concatenated codes, Soft decision Multistage decoding, Concatenated coding schemes with Convolutional Inner codes, Introduction to Turbo coding and their distance properties, Design of Turbo codes; (ii) Burst – error – correcting codes: Burst and Random error correcting codes, Concept of Inter – leaving, cyclic codes for Burst Error correction – Fire codes, Convolutional codes for Burst Error correction.

Prerequisite Courses: Nil

Reference Books:

1. "Error Control Coding", Shu Lin & Daniel J. Costello, 2nd Edition, Pearson / Prentice Hall, 2004.
2. "Theory and Practice of Error Control Codes", Blahut, Addison Wesley, 1984.

UE16EC633
DIGITAL SYSTEM SYNTHESIS AND OPTIMIZATION

Course Objectives

- Understand the basics of Graph Theory
- Application of Graph theory in Digital circuit synthesis algorithms
- understand synthesis flow of the CAD tools
- Analyse the existing synthesis algorithms.
- Apply synthesis algorithms to the digital circuits

Course Outcomes:

Students completing the course should be able to

- Implement existing synthesis algorithm to synthesize digital circuits.
- Analyse the performance of algorithms for different applications.
- Optimize the algorithm to improve the performance of digital circuits.
- To develop simple algorithm for architectural, logic synthesis of digital circuits.
- Design Simple EDA tool using any high level programming language

Course Content

1. **Introduction to synthesis and optimization:** Circuit Models, synthesis and optimization. Background:Notations, undirected graphs, directed graphs, combinatorial optimization:Introduction to decision and optimization problems, algorithms, tractable and intractable problems. Fundamental algorithms: Linear and Integer Programs : Branch and Bound, Tree cover, greedy scheduling algorithms. Graph optimization problems and algorithms:Dijkstra, Bellman Ford Algorithm. Graph coloring algorithms: Vertex coloring, Leftedge algorithms. Boolean algebra : Boolean functions, representation of Boolean functions using Binary Decision diagram ,ROBDD, ITE operator(only representations and problems) .
2. **Architectural or High Level Synthesis and Optimization:** Schedule Algorithms: Introduction, a model for scheduling problems, Scheduling without resource constraints: ASAP, ALAP, Latency constrained, Scheduling under timing constraints.Scheduling with resource constraints: Integer linear programming Model, List Scheduling,**Hu's Algorithm**, Force directed scheduling, Scheduling Pipe lined circuits:Scheduling with pipelined resources, functional pipelining, loop folding.
3. **Resource Sharing and Cell Library Binding:** Sharing and binding for resource-dominated circuits, sharing and binding for general circuits, concurrent binding and scheduling, resource sharing and binding for pipelined circuits, sharing, **algorithms for library binding**: Covering Algorithms based on structural matching, simple tree based matching, MATCH algorithm, tree based covering, Boolean matching, Rule based library binding, comparisons of Algorithmic and rule based library binding.
4. **Two Level Combinational Logic Optimization:** Logic optimization, principles: Definitions: Multiple output implicant, Multiple output minterm, cover, minimum cover,irredundant cover, prime, essential prime implicant Exact Logic minimization:QM method and Petrick's method. Heuristic Logic Minimization: operators**(Expand,Reduce,Reshape,Irredundant) with examples**, Testability Propertes. logic minimization methods:ESPRESSO: Expand, Reduce, Irredundant, Essentials**(using K Map and problems).**
5. **Logic Level Synthesis and Optimization-Part II:** Sequential Circuit Optimization: Introduction, Sequential circuit optimization using state based models: State minimization for completely specified finite state machines, State minimization for incompletely specified finite state machines, sequential circuit optimization using network models: Introduction to retiming, cycle time minimization using retiming, RETIME_DELAY algorithm.

Pre-requisite Courses: UE16EC203 – Logic Design

Reference Books:

1. "Synthesis and Optimization of Digital Circuits", Giovanni De Micheli, 1st Edition, Tata McGraw-Hill, 2003.
2. "Logic Synthesis", Srinivas Devadas, Abhijit Ghosh , Kurt Keutzer, 1st Edition , Tata McGraw-Hill , 1994.
3. "VLSI Digital Signal Processing Systems- Design and Implementation", Keshab K Parhi, Wiley Publications, 1999.

UE16EC334:
SYSTEM ON CHIP ARCHITECTURE (4-0-0-0-4)

Course Objectives:

- To study the system approach
- To study a System-on-chip (SOC) architecture which is an ensemble of processors, memories, and interconnects tailored to an application domain.
- To customize instruction processor and learn reconfiguration technologies

Course outcomes

Students completing the course should be able to

- Computer system design
- Fundamental ideas and analytical techniques that are applicable to a range of applications and architectures.
- Aware of complementary treatments on embedded software development.
- And electronic system – level design.

Course Content:

1. **Introduction to the System Approach:** System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing; System level interconnection: An approach for SOC Design, System Architecture and Complexity
2. **Processors:** Introduction, Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling; Buffers: minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.
3. **Memory Design for SOC:** Overview of SOC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation, SOC Memory System, Models of Simple Processor – memory interaction.
4. **Interconnect Customization and Configuration:** Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SOC Customization: An overview, Customizing Instruction Processor, Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance- Specific design, Customizable Soft Processor, Reconfiguration - overhead analysis and trade-off analysis on reconfigurable Parallelism.
5. **Application Studies / Case Studies:** SOC Design approach, AES algorithms, Design and evaluation, Image compression – JPEG compression.

Pre-requisite Courses: UE16EC252 – Microcontrollers

Reference Books:

1. "Computer System Design System-on-Chip", Michael J. Flynn and Wayne Luk, Wiely India Pvt. Ltd., 2011.
2. "ARM System on Chip Architecture", Steve Furber, Addison Wesley Professional, 2nd Edition, 2000.
3. "Design of System on a Chip: Devices and Components", Ricardo Reis, Springer, 1st Edition, 2004.

UE16EC335 : CONTROL SYSTEMS (4-0-0-0-4)

Course Objectives:

The study of the subject should enable the student to learn:

- Mathematical modelling (transfer functions and state space representation) of simple electrical, mechanical and electromechanical control systems
- The block diagram algebra and signal flow graph analysis.
- Characteristics of the time domain performance of feedback systems.
- Analyze the stability of feedback systems using various systems.
- To design simple compensators in the frequency domain and to design controller and observers in the state-space domain.

Course Outcomes:

Students completing the course should be able to

- Explain basic concepts of control systems, their types & requirements. Identify controllers, their types , features & application
- Apply Laplace transform and state space techniques to model dynamic systems, and convert between these formulations
- Analytically quantify the time and frequency domain behaviour of dynamic systems
- Specify steady state control system requirements, and select prototype controller structures to achieve these requirements
- Formulate dynamic feedback controller design specifications in the frequency domain
- Synthesise feedback controllers using root locus, Nyquist and Bode techniques
- Characterise the behaviour of elementary feedback control systems through simulations.

Course Content:

1. **Mathematical Models of Systems:** Introduction, Differential Equations of Physical Systems, Linear Approximations of Physical Systems, The Laplace Transform, The Transfer Function of Linear Systems, Block Diagram Models, Signal Flow Graph Models. Feedback Control System Characteristics: Open and Closed Loop Control Systems, Sensitivity of Control Systems to Parameter Variations, Control of the Transient Response of Control Systems, Disturbance Signals in a Feedback Control System, Steady State Error
2. **The Performance of Feedback Control Systems:** Introduction, Test Input Signals, Performance of a Second Order System, Effects of a Third Pole and a Zero on the Second Order System Response, The s – Plane Root Location and the Transient Response, The Steady – State Error of Non unity Feedback Systems. The Stability of Linear Feedback Systems: The Concept of Stability, the Routh – Hurwitz Stability Criterion, The Relative Stability of Feedback Control Systems
3. **The Root Locus Method:** Introduction, Concept and the Root Locus technique. Frequency Response methods: Introduction, Frequency Response Plots, Bode Diagram, and Performance Specifications in the Frequency Domain.
4. **Stability in the Frequency Domain:** Introduction, Mapping Contours in the s – Plane, the Nyquist Criterion, Relative Stability and the Nyquist Criterion. The Design of Feedback Control Systems: Introduction, Approaches to System Design, Cascade Compensation Networks, Phase – Lead Design Using the Bode Diagram, System Design Using Integration Networks, Phase-Lag Design Using Bode Diagram.
5. **State Variable Models:** Introduction, the State Variables of a Dynamic System, the State Differential Equation, The Stability of State Variable Systems; The Design of State Variable Feed Back Systems: Introduction, Controllability, Observability, Full-state feedback control design.

Pre-requisite Courses: UE16MA251-Linear Algebra, UE16EC204-Signals and Systems

Reference Books:

1. "Modern Control systems", R.C. Dorf and R.H. Bishop, 11th Edition, Addison-Wesley, 1999.
2. "Control Systems Engineering", I.J.Nagrath and M.Gopal, 5th Edition, New Age International Publications, 2007.
3. "Modern Control Engineering", K. Ogata, 5th Edition, Pearson Education Asia, 2010.

UE16EC336 : LINEAR SYSTEMS (4-0-0-0-4)

Course Objectives:

- The concepts of state variables and state-space representation for both continuous- and discrete-time linear systems.
- Finding state-variable representations of dynamical systems.
- Stability, controllability, observability and minimality of state-space realisations.
- The design of state-variable feedback controllers, full-order and reduced-order observers, and observer-based compensators.

Course outcomes

Students completing the course should be able to

- Find state-space representations for both continuous- and discrete-time systems.
- Predict the controllability and observability properties of the different canonical forms.
- Compare internal and external stability of dynamical systems.
- Use Lyapunov analysis to investigate the stability of state-space representations of dynamical systems.
- Identify the minimal part of state-space realisations.
- Evaluate the conditions for designing controllers.
- Design state-variable feedback controllers, full-order and reduced-order observers, and observer-based compensators.

Course content:

1. **State-space Descriptions (continuous-time and discrete-time):** Motivation; concept of state; physical systems and state assignment; Canonical forms for SISO linear time-invariant systems; linear time-varying systems; Linearization of nonlinear systems; input-output maps;
2. **Stability of Solutions (continuous-time and discrete-time):** Existence and uniqueness; Properties of state-transition matrix; computation of state-transition matrix (linear time-invariant and linear time-varying); modal decomposition; External stability and internal stability; equilibrium points; Stability in the sense of Lyapunov; Lyapunov equation;
3. **Controllability and Observability (continuous-time and discrete-time):** Linear time-invariant systems: Motivation, controllability and observability, irreducibility, minimality, reachability and

constructability; Transformations among canonical realisations; subspaces; Kalman decomposition; Popov-Belevitch-Hautus tests; effect of sampling. Linear time-varying systems: tests for controllability and observability; Minimum-energy control;

4. **State-variable Feedback (continuous-time and discrete-time):** Motivation; state-variable feedback and modal controllability; Dead-beat control; Quadratic regulator: deterministic and stochastic;
5. **Observers and Compensators (continuous-time and discrete-time):** Asymptotic observers; Dead-beat observers; Kalman filter; Combined observer-controller compensators; Separation principle; Reduced-order observers; Direct transfer-function design.

Pre-requisite Courses: UE16MA251 – Linear Algebra, UE16EC204 – Signals and Systems

Reference Books:

1. "Linear Systems", T. Kailath, Prentice-Hall, 1980.
2. "Modern Control Systems Theory", M. Gopal, New Age International Publishers, 1993.
3. "Linear System Theory and Design", Chi-Tsong Chen, 2nd edition Holt, Rinehart and Winston, 1984.
4. "Linear Systems", Panos J. Antsaklis and Anthony N. Michel, Birkhauser, 2006.
5. "Modern Control Theory", William T. Brogan, 3rd Edition, Prentice-Hall, 1990.
6. "Linear System Theory", Wilson J. Rugh, 2nd Edition, Prentice-Hall, 1996.

UE16EC337 :
ADVANCED DIGITAL SIGNAL PROCESSING (4-0-0-0-4)

Course Objectives:

- This subject involves introduction to the basic principles of DSP. Students will get familiar with the fundamentals of multirate systems such as, interpolation and decimation. Multistage implementation of filters and polyphase decomposition, have been introduced to improve the efficiency of filter design and implementation.
- In filter banks, they will get to learn uniform DFT filter banks, QMF filter banks.
- It will cover the application of filter banks in communication.
- An introduction to paraunitary perfect reconstruction filter banks will also be provided.

Course outcomes

Students completing the course should be able to

- Design and development of digital FIR and IIR filters
- Design of interpolators and decimators
- Design and implementation of filters using multi-stage concept

Course content:

1. **Digital Filters:** Specifications; FIR and IIR filter designs; allpass filters, special types of filters; IIR filters based on allpass filters;
2. **Fundamentals of Multirate Systems:** Basic multirate operations, interconnection of building blocks, polyphase representation, multistage implementation, special filters and filter banks;
3. **QMF Filter Banks:** Errors created in the QMF bank, alias-free QMF system, power symmetric QMF banks;
4. **Maximally Decimated Filter Banks:** M-channel filter banks, polyphase representation, perfect reconstruction systems, alias-free filter banks, tree structured filter banks, transmultiplexers; **Appications**
5. **Paraunitary Perfect Reconstruction Filter Banks:** Lossless transfer matrices, filter bank properties induced by paraunitariness, two channel paraunitary lattice, M-channel FIR paraunitary QMF banks.

Pre-requisite Courses: UE16EC253 – Digital Signal Processing

Reference Books:

1. "Multirate Systems and Filter Banks", P.P. Vaidyanathan, Pearson Education. 2004.
2. "Wavelets and Filter Banks", G. Strang and T. Nguyen, Wellesley-Cambridge. 1996.
3. "Multirate Digital Signal Processing", N.J. Fliege, John Wiley, 2000.
4. "Modern Digital Signal Processing", R. Cristi, Thomson Learning, 2004.

UE16EC341 :
INTRODUCTION TO CRYPTOGRAPHY (4-0-0-0-4)

Course Objectives:

- Understand the different kinds of attacks on information systems, and techniques to prevent them or mitigate their effects.
- To this end, the student is exposed to the design of network security protocols based on standard cryptographic primitives such as symmetric key cryptography, asymmetric key cryptography and one-way hash functions.

Course Outcomes:

At the end of the course, the student should be able to

- Perform a security analysis of an information system to determine the required security attributes.
- Understand different kinds of attacks on information systems, and design techniques to prevent them or mitigate their effects.
- Obtain a basic foundation of aspects of number theory applied to cryptography and information security.
- Understand the internal construction and performance overheads of cryptographic primitives based on Symmetric Key Cryptography (SKC), Asymmetric Key Cryptography (AKC), and One-Way Hash (OWH) functions.
- Design network security protocols using the above cryptographic primitives, and analyse their weaknesses.

Course Content:

1. **Introduction:** Information systems, Attacks on information systems by adversaries. Threat analysis: Adversarial models and Security attributes or security goals. Trade-offs between security and user convenience and user privacy. Notions of trust. Common-sense principles in security design. Introduction to cryptography, cryptanalysis, and steganography;
2. **Number Theory:** Prime numbers, Euclid's greatest common divisor algorithm, Additive inverse and multiplicative inverse, extended Euclid's algorithm, Algebraic structures: Groups, Rings, Fields, Subgroups, Cyclic groups and Cyclic sub-groups Chinese remainder theorem, Euler's theorem, and Fermat's theorem;
3. **Symmetric Key Cryptography (SKC):** Kerckhoff's principle: Key Domain, Entropy of key. Substitution cipher and Transposition cipher, Block ciphers and Stream ciphers. Product ciphers, Shannon's principles of confusion and diffusion, Data Encryption Standard (DES): DES Structure, Multiple DES, DES Security Analysis, Advanced Encryption Standard (AES): Transformations, Key expansion, AES Security analysis. Techniques (ECB, CBC, CFB,OFB, CTR) to use block ciphers to encrypt large files;
4. **One-Way Hash (OWH) Functions:** Characterization of properties one-way hash functions (pre-image resistance, second-preimage resistance and collision-resistance) via birthday theorems; Message authentication via Message Authentication Codes

(MAC): HMAC, NMAC, CMAC. Internal structure of OWH functions: Compression functions, SHA-512, Applications of OWH functions: Message integrity, Password maintenance, Message authentication; Asymmetric Key Cryptography (AKC): Computational hardness of integer factorization and Discrete Logarithm Problem (DLP). RSA crypto-system. El-Gamal crypto-system. Digital Signatures, Digital signature algorithms (RSA, El-Gamal, Schnorr, Digital Signature Algorithm), Digital signatures via One Time Signatures (OTS); Digital Certificate, Certifying Authority (CA), Certificate Revocation List (CRL) Applications of digital signatures, attacks on digital signatures;

5. **Network Security Protocols:** Entity authentication via Smart-cards, Passwords, and Biometrics. Challenge-response protocols, zero-knowledge protocols, 2-factor authentication via One Time Passwords (OTPs), Authenticated Key Exchange Protocols: Diffie-Hellman Key Exchange, Station To Station (STS) protocol, Key Management in the Kerberos system, Secure Sockets Layer (SSL) protocol. Secret splitting techniques; Attacks and Defence mechanisms on Internet-based systems: Topics to be selected by instructor; Systems Security: Topics to be selected by instructor.

Pre-requisite Courses: Nil

Reference Books:

1. "Cryptography and Network Security", Behrouz A. Forouzan and Debdeep Mukhopadhyay, 3rd Edition, Tata McGraw-Hill, 2010.
2. "Computer Networking: A Top Down Approach", James Kurose and Keith Ross, 5th Edition, Pearson, 2012.
3. "Cryptography and Network Security", William Stalling, Pearson Education, 2003.
4. "Cryptography and Network Security", Atul Kahate, TMH, 2003.
5. "A Computational Introduction to Number Theory and Algebra", Cambridge University Press, Victor Shoup, 2005.
6. "Handbook of Applied Cryptography, CRC Press", Alfred Menezes, Paul, Oorschot, and Scott Vanstone, 1996.

UE16EC342
OPTIMIZATION AND ITS APPLICATIONS (4-0-0-0-4)

Course Objectives:

- Introduce the students to a variety of optimization problems using case studies spreading across domains such as communications, smart grids, finance, planning, etc.
- Enabling the students to formulate optimization problems, identify the structure of the problem, apply solution methods and solve the problems using open source optimization software.

Course Outcomes:

At the end of the course, students should be able to

- Understand and identify the structure of various classes of optimization problems
- Formulate and solve optimization problems
- Analyze the structure of the formulation and apply suitable solution method
- Apply decomposition and approximation techniques to optimization problem.
- Run simulations using software such as CVX and CPLEX

Course Content:

1. **Introduction:** Review of linear algebra using geometry, Optimization problem structure, types and complexity, Unconstrained optimization problems: single variable and multivariable solution methods, Introduction to solvers: CVX and CPLEX.
2. **Linear and Integer Programming:** Standard form of LP, structural properties, Simplex method, Duality and Economic interpretation, Formulating and coding LP problems, Integer programming: Structure and Types, Formulating and coding IP problems, Branch and bound methods, Cutting plane method, MINLP to MILP conversion, Benders Decomposition for MIP
3. **Convex Optimization:** Convexity, convex geometry, Convex functions, Lagrangian relaxation and Duality, KKT conditions, Interior point method, Formulating convex problems - examples; Multi-objective problems; Convex relaxations using examples: Semidefinite programming, SOCP, Geometric programming;
4. **Markov Decision Process:** Markov chains and Markov Decision processes, Formulating MDP, Bellman's optimality condition, Finite horizon problems: Dynamic programming, Infinite horizon problems: Value iteration and Policy iteration; Curses of dimensionality and brief overview of ADP
5. **Stochastic Programming:** Deterministic versus stochastic optimization, Basic structure of stochastic linear programs and types of decisions, Two-stage stochastic programming problems, Solution methods: L-shaped method, Sample average approximation and Stochastic decomposition; Brief overview of other types of stochastic programming

Prerequisite Courses: Nil

References:

1. "Linear Algebra", Paul Dawkins, Lamar University, 2007.
2. "Introduction to Applied Optimization", Urmila Diwekar, 2nd Edition, Springer, 2008
3. Stephen Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 7th Edition, 2004.
4. J. F. Benders, "Partitioning Procedures for Solving Mixed-Variables Programming Problems", Computational Management Science, Springer-Verlag, 2005.
5. "Introduction to Stochastic Programming", J. R. Birge and F. Louveaux, Springer Series in Operations Research and Financial Planning, 2nd Edition, 2011.
6. "Approximate Dynamic Programming - II: Algorithms", Warren B. Powell, Wiley Online Library, 2011.
7. Selected journal/conference papers

UE16EC343
MEMORY DESIGN AND TESTING (4-0-0-0-4)

Course Objectives:

- Impart understanding of working principles of conventional semiconductor memories in the design of electronic circuits.
- Introduce various non-conventional memories and their working
- Provide basic understanding of memory faults and testing
- Introduce the concepts of built-in-self test for embedded memories

Course Outcomes:

At the end of the course, students should be able to

- Analyze and comprehend the research work currently being done in this area.
- Design and implement memory arrays using different types of memory cells.
- Implement and develop new testing algorithms
- Develop projects based on the different concepts studied in this course.

Course Content:

1. **Introduction:** Introduction: Overview of semiconductor memory types, Memory array organization; Static RAM: Various

configurations of CMOS SRAM Cell, Read/Write operation of 6-T SRAM Cell; SRAM Peripheral Circuitry: Pre-charge circuitry, Isolation circuitry, Sense Amplifier, Write driver circuit, Decoder circuitry.

2. **Dynamic Random Access Memory:** CAM topology, Binary CAM, Ternary CAM-static and dynamic; DRAM types and operation, DRAM Technology development, DRAM basics - Access and sense operations, Write operation, Opening a row; DRAM Array : The Mbit cell, The DRAM Capacitor - stacked and trench capacitors, The Sense Amplifier – Equilibration and bias circuits, Isolation Devices, Input/Output transistors, Nsense and Psense Amplifiers, Configurations, Operation; High Speed DRAMs: EDO, SDRAM, DDR
3. **Non-volatile memories: ROM:** Cell structure – NAND and NOR Arrays; EPROM: Floating gate EPROM Cell, EEPROM Cell-FLOTOX Technology, EEPROM Architecture; Flash Memory: Cell operation, NOR and NAND Flash; New Memory Cells: FeRAM and MRAM
4. **Memory Testing: Memory Faults:** General Fault Modeling, Read Disturb Fault Model, Precharge Faults, False Write Through, Data Retention Faults, Decoder Faults; Memory Patterns: Zero-one, Exhaustive Test, Walking, Marching and Galloping, Common Array Patterns, Common March Patterns, CAM Patterns
5. **Memory Self Test: BIST Concepts:** The memory boundary, Deterministic BIST, Pseudo-random BIST; BIST and Redundancy-Redundancy types, Hard and Soft Redundancy, Redundancy calculation. BIST using BILBO; Design for Test: Weak Write Test Mode, Bit Line Contact Resistance, PFET Test, Shadow write and Shadow Read; Memory Error Detection and Correction Techniques.

Prerequisite Courses: UE16EC203 – Logic Design

References:

1. "Semiconductor Memories- Technology, Testing and Reliability", Ashok K. Sharma, PHI, 2004.
2. "High Performance Memory Testing: Design Principles, Fault Modeling and Self Test", R.Dean Adams, Kluwer Academic Publishers, 2003.
3. "DRAM Circuit Design: Fundamental and High-Speed Topics",Brent Keeth, R. Jacob Baker, Brian Johnson, Feng Lin 2E, Wiley - IEEE Press, 2007.

UE16EC344
REAL TIME EMBEDDED SYSTEMS (4-0-0-0-4)

Course Objectives:

- The primary goal of this course is to meet the basics of real-time systems
- Enable the students with the knowledge and skills necessary to design and develop embedded applications by means of real-time operating systems.

Course Outcomes:

Students completing the course should be able to

- Use the multitasking techniques in real-time systems.
- Use real time scheduling policies in applications
- Design embedded applications using RTOS.
- Use RTOS software mechanisms
- Identify real time service and estimate the WCET and schedule it

Course Content:

1. **Introduction to Real-Time Embedded Systems:** Brief history of Real Time Systems, A brief history of Embedded Systems; System Resources: Resource Analysis, Real-Time Service Utility, Scheduling Classes, The Cyclic Executive, Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies, Real-Time OS, Thread Safe Reentrant Functions
2. **Processing:** Preemptive Fixed-Priority Policy, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline –Monotonic Policy, Dynamic priority policies; I/O Resources: Worst-case Execution time, Intermediate I/O, Execution efficiency, I/O Architecture.
3. **Distributed Operating Systems:** Topology – Network types – Communication – RPC – Client server model – Distributed file system – Design strategies; (i) Real Time Models And Languages: Event Based – Process Based and Graph based Models – Petrinet Models – Real Time Languages – RTOS Tasks – RT scheduling - Interrupt processing – Synchronization – Control Blocks – Memory Requirements
4. **Memory:** Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash file systems; (i) Multi-resource Services: Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion; (ii) Soft Real-Time Services: Missed Deadlines, QoS, Alternatives to rate monotonic policy, Mixed hard and soft real-time services;
5. **Embedded System Components:** Firmware components, RTOS system software mechanisms, Software application components; High availability and Reliability Design: Reliability and Availability, Similarities and differences, Reliability, Reliable Software, Available Software, Design trade offs, Hierarchical applications for Fail-safe design; Modularizing An Application For Concurrency: Introduction, An Outside-In approach to decomposing applications, Guidelines and recommendations for identifying concurrency, schedulability analysis.

Pre-requisite Courses: UE16EC252 – Microcontrollers

Reference Books:

1. "Real-Time Embedded Systems and Components", Sam Siewert, Cengage Learning India Edition, 2007.
2. "Programming for Embedded Systems", Dreamtech Software Team, John Wiley, India Pvt. Ltd.. 2008.
3. "Real Time Concepts for Embedded Systems", Qing Li and Croline Yao CMP Books, 2011

UE16EC345 :
PATTERN CLASSIFICATION (4-0-0-0-4)

Course Objectives:

- The main objective of this course is to introduce the fundamentals of pattern recognition and classification.
- In this course students will learn about Bayesian decision theory, Maximum likelihood estimation, Hidden Markov Models, some of the non-parametric techniques.
- They will also be introduced to linear discriminant functions and unsupervised learning.

Course Outcomes:

Students completing the course should be able to

- Understand the major concepts and techniques in pattern recognition.
- Acquire abilities to solve problems in specialized application areas such as speech recognition, signal classification, etc.
- Capable of designing pattern recognition systems and QAM

Course Content:

1. **Introduction:** Machine perception; example; pattern recognition systems; the design cycle; learning and adaptation;
2. **Bayesian Decision Theory:** Introduction; Bayesian decision theory – continuous features; minimum-error-rate classification; classifiers, discriminant functions, normal density; discriminant

functions for the normal density; Bayesian decision theory – discrete features; missing and noisy features; Maximum-likelihood and Bayesian Parameters Estimation: Maximum-likelihood estimation; Bayesian estimation; Bayesian parameter estimation: Gaussian case and general theory; problems of dimensionality; component analysis and discriminants; Hidden Markov models;

3. **Non-parametric Techniques:** Density estimation; Parzen windows; kn-nearest-neighbour estimation; nearest-neighbour rule; metrics and nearest-neighbour classification; approximation by series expansions;
4. **Linear Discriminant Functions:** Linear discriminant functions and decision surfaces; generalized linear discriminant functions; two-category linearly separable case; minimizing the perceptron criterion function; relaxation procedures; nonseparable behaviour; minimum squared-error procedures; Ho-Kashyap procedures; linear programming algorithms; support vector machines; multicategory generalizations;
5. **Unsupervised Learning and Clustering:** Mixture densities and identifiability; maximum-likelihood estimates; application to normal mixtures; unsupervised Bayesian learning; data description and clustering; criterion functions for clustering; hierarchical clustering; on-line clustering; component analysis; low-dimensional representation and multidimensional scaling.

Prerequisite Courses: UE16MA251 – Linear Algebra

Reference Books:

1. “Pattern Classification”, Richard O. Duda, Peter E. Hart and David G. Stork, 2nd Edition, John Wiley, 2001.
2. “Pattern Recognition and Image Analysis”, Eart Gose, Richard Johnsonburg and Steve Joust, Prentice-Hall of India, 2003.
3. “Pattern Recognition and Machine Learning”, Christopher M. Bishop, 3rd Edition, Springer, 2007.
4. “Statistical Pattern Recognition”, Andrew R. Webb, 2nd Edition, John Wiley, 2002.

UE16EC346
ADAPTIVE SIGNAL PROCESSING (4-0-0-0-4)

Course Objectives:

- To understand the principles of adaptive systems and its properties;
- To analyze and implement algorithms for adaptations;
- To use adaptive algorithms in important practical situations

Course outcomes

Students completing the course should be able to

- Describe the properties of optimal mean square filters.
- Explain the conditions for stable adaptive algorithms.
- Use the Wiener filter in given applications.
- Apply adaptive algorithms in given applications.
- Characterize and examine the properties of adaptive algorithms.

Course content:

1. **Adaptive Systems:** Definition and Characteristics; areas of application; general properties; open- and closed-loop adaptation; applications of closed-loop adaptation. (i) Adaptive Linear Combiner: General description; input signal and weight vectors; desired response and error; the performance function; gradient and minimum mean-square error; alternative expression of the gradient; decorrelation of error and input components.
2. **Properties of the Quadratic Performance Surface:** Normal form of the input correlation matrix; eigenvalues and eigenvectors of the input correlation matrix; geometrical significance of eigenvectors and eigenvalues; (i) Searching the Performance Surface: Methods of searching the performance surface; basic ideas of gradient search methods; a simple gradient search algorithm and its solution; stability and rate of convergence; the learning curve; gradient search by Newton’s Method; Newton’s Method in multidimensional space; gradient search by the Method of Steepest Descent; comparison of learning curves.
3. **Gradient Estimation and Its Effect on Adaptation:** Gradient component estimation by derivative measurement; the performance penalty; derivative measurements and performance penalties with multiple weights; variance of the gradient estimate; effects on the weight-vector solution; excess mean-square error and time constants; misadjustment; comparative performance of Newton’s and Steepest-Descent Methods; total misadjustment and other practical considerations.
4. **LMS Algorithm:** Derivation of the LMS algorithm; convergence of the weight vector; an example of convergence; learning curve; noise in the weight-vector solution; misadjustment; performance; (i) Other Algorithms: Discrete Kalman filter; normalized and other LMS-based adaptive filters; recursive least squares algorithm.
5. **Applications:** Adaptive Modeling and System Identification: General description; adaptive modeling of a multipath communication channel; adaptive modeling in FIR digital filter synthesis. Adaptive Interference Cancellation: Concept of adaptive noise cancelling; stationary noise-cancelling solutions; effects of signal components in the reference input.

Prerequisite Courses: UE16EC253 – Digital Signal Processing

Reference Books:

1. “Adaptive Signal Processing”, B. Widrow and S. D. Stearns, Pearson Education Asia, 1985.
2. “Statistical Digital Signal Processing and Modeling”, M. H. Hayes, John Wiley, 2002.
3. “Adaptive Filter Theory”, S. Haykin, 4th Edition, Pearson Education Asia, 2002.
4. “Adaptive Signal Processing”, T Adali, S Haykin, Wiley-India, 2010.

UE16EC347
MACHINE LEARNING (4-0-0-0-4)

Course Objectives:

- Develop an appreciation of what is involved in learning from data.
- Understand a range of machine learning algorithms along with their strengths and weakness.
- Understand how to apply machine learning algorithms to solve problems of moderate complexity.
- Ability to formulate machine learning problems for different applications.

Course Outcomes:

Students completing the course should be able to

- Use effective machine learning techniques for various applications.
- Identify the characteristics of datasets and choose appropriate learning models and algorithms.
- Implement practical machine learning algorithms.
- Evaluate learning methods and relate to particular problems.
- Design practical machine learning systems and apply machine learning for their projects.

Course content:

1. **Probability Theory for Pattern Recognition:** Function approximation; review of probability theory (probability,

Bayes' theorem, densities, distributions), model selection, curse of dimensionality, decision theory, information theory, nonparametric methods).

2. **Supervised Learning - A:** Linear models for regression; linear models for classification
3. **Supervised Learning - B:** Neural networks; kernel methods; sparse kernel machines.
4. **Reinforcement Learning:** The bandit problem; Markov decision processes; model-based learning (value iteration, policy iteration); temporal difference learning; eligibility traces.
5. **Learning Automaton:** Environment, automaton (deterministic and stochastic), fixed and variable structure, state and action probabilities, random inputs, feedback connection, norms of behaviour; the two-state automaton

Prerequisite Courses: UE16MA251 – Linear Algebra, UE16EC204 – Signals and Systems

Reference Books:

1. "Pattern Recognition and Machine Learning", Christopher M. Bishop, Springer, 2006.
2. "Machine Learning", Tom M. Mitchell, McGraw Hill, 1997.
3. "Machine Learning: A Probabilistic Perspective", Kevin P. Murphy, MIT Press, 2012.
4. "Introduction to Machine Learning", Ethem Alpaydin , MIT Press, 2004.
5. "Learning Automata: An Introduction", K. S. Narendra and M.A.L. Thathachar, Dover, 2012.
6. "Reinforcement Learning: An Introduction", R.S. Sutton and A. G. Barto, MIT Press, 1998.

UE15EC401:
FUNDAMENTALS OF ANTENNAS (4-0-0-0-4)

Course Objectives:

- This course aims to give an in-depth understanding of the fundamentals of antennas.
- This course is expected to help the students to apply the concepts of antenna design and perform simple experiments.

Course Outcomes:

Students completing the course should be able to

- Get an insight into the fundamentals of antennas.
- Select the appropriate kind antenna from the radiation pattern and other characteristics/specifications.
- Select/design the appropriate kind of dipole and loop antennas for a given application.
- Decide the type of array (linear or 2D) required for a given application. Should also be able to design the front end of an array
- Analyze and design horn antennas and reflector antennas.
- Choose the appropriate kind of feed element of a reflector antenna necessary for a particular application.
- Carry out simple communication link design

Course Content:

1. **Fundamentals of Antenna:** .Introduction, types of antennas, radiation mechanism. Radiation pattern, isotropic, directional and omni directional patterns, Principal patterns, radiation pattern lobes, field regions, radians and steradian. Radiation power density and intensity, directivity and gain, antenna and beam efficiency, half power beam width and bandwidth. Input impedance, Antenna aperture and effective length. Friis transmission equation, Radiation integrals, vector potentials. Relation between vector and scalar potential: Lorentz condition. Solution for inhomogeneous vector potential wave equation. Far field radiation
2. **Thin Dipoles and Loop antennas:** (i) Thin Dipoles: Infinitesimal current element (or Hertzian dipole): radiated fields, power density, radiation resistance, near field region, and intermediate field region, far field region, Small dipole: region separation, far field approximations. Finite length dipole: current distribution, radiated fields, power density, radiation intensity and radiation resistance, directivity, input resistance. Half wavelength dipole; (ii) Loop antennas: Small circular loop- radiated fields, power density and radiation resistance, near field region, far field region, radiation intensity and directivity Circular loop of constant current- radiated fields, power density and radiation resistance, radiation intensity and directivity.
3. **Arrays:** Two element array: pattern multiplication, N' element linear array: Array factor, uniform amplitude and spacing, broadside array, ordinary end fire array, Hansen Woodyard End fire Array, Phased array N element linear array: uniform spacing and non uniform amplitude, Array factor. Rectangular planar array: array factor.
4. **Special Antennas:** Yagi Uda Array, Helical Antennas- Normal and Axial Mode Helix, Log Periodic Dipole Array, Microstrip Antenna; Aperture Antennas: Field Equivalence principle, Sheet Current Distribution in free space, Radiation Pattern as Fourier Transform of Current Distribution,Horn Antennas- Pyramidal Horn, Reflector Antennas- Flatplate Reflector, Corner Reflector, Prime Focus Parabolic Reflector, Cassegrain Reflector.
5. **Electromagnetic Wave Propagation:** Surface Wave Propagation, Wave tilt, Attenuation of surface waves, Space Wave Propagation, Space waves with Directional Antennas, Space wave over spherical earth; Ionosphere Propagation: Structure and Dielectric constant of ionosphere, Group velocity of wave in plasma, Secant Law, Skip Distance, Virtual Height, Attenuation of waves in ionosphere, Maximum usable frequency.

Prerequisite Courses: UE15EC204 – Electromagnetic Field Theory, UE15EC352 – Microwave Engineering

Reference Books:

1. "Antenna Theory Analysis and Design", C.A.Balanis, John Wiley & Sons, 2nd Edition, 2000.
2. "Antennas and Propagation", A.R.Harish and M.Sachidananda, Oxford University Press, 1st Edition, 2007.

UE15EC402:
EMBEDDED SYSTEM DESIGN (4-0-0-0-4)

Course Objectives:

- Develop knowledge and understanding of fundamental embedded systems design paradigms, architectures, possibilities and challenges, both with respect to software and hardware and wide competence from different areas of technology.
- Theoretical knowledge in the areas of real time systems, sensor and measuring systems, and their interdisciplinary nature needed for integrated hardware/software development of embedded systems.
- Ability to analyze a system both as whole and in the included parts, to understand how these parts interact in the functionality and properties of the system.
- To educate students to meet current and future industrial challenges and emerging embedded systems engineering trends.

Course Outcomes:

Students completing the course should be able to

- Design and implement applications on ARM based controllers.
- Write applications in assembly and embedded C

- Develop systems with RTOS features like inter process communication, process synchronization techniques, process scheduling algorithms
- Interface peripherals with standard buses like I2C,SPI, UART,USB and SDIO
- Understand embedded system's hardware components and software tool chain.
- Design an embedded system, Debug and test it

Course Content:

1. **Embedded System components:** Introduction to embedded systems, Overview of Embedded system blocks Physical system -Processor and peripherals Embedded software: Tool chains, Boot loader, Device Drivers, Embedded OS
2. **ARM Processor Fundamentals:** Registers, Current program status register, Pipeline, Exceptions, Interrupts and vector table, core extensions, architecture revisions, ARM Processor families.
3. **Introduction to ARM9 Instruction Set:** Data Processing Instructions, Branch Instructions, Load- store Instructions, software Interrupt Instruction, Program status register Instructions, Loading constants ARM Extensions, conditional execution. Introduction to Thumb Instruction set. Programming examples
4. **Overview of Operating Systems & RTOS:** Introduction-OS Overview, process management-Process, Process control block, Process states (5 State model), Inter Process Communication using LINUX-Pipes, FIFO. Concurrency issues (Race condition, Deadlock, Starvation).Semaphore and Programming examples. Threads-Threads and programming example, Process Scheduling-Basic concepts, Scheduling Criteria, Scheduling Algorithms (FCFS, SJF, RR, Priority Scheduling) , Memory management-Protection, Relocation, Partition (Fixed, Dynamic), Paging, Segmentation. RTOS features. Priority inversion, Priority inheritance and Priority ceiling.
5. **Peripherals:** Overview of Device drivers, I2C, SPI, UART, USB, SDIO overview. Case Study of Embedded Systems with RTOS.

Pre-requisite Courses: UE15CS151 – Problem Solving with C

Reference Books:

1. "ARM System Developer's Guide – Designing and Optimizing System Software", Andrew N Sloss, Dominic Symesand Chris Wright*,* Morgan Kaufmann Publishers, 2004.
2. "ARM System Architecture", Stephen B. Furber, Addison Wesley, 1996.
3. "Operating Systems Internals and Design", William Stallings, Person Prentice Hall, 6th Edition, 2009.
4. "Operating System Concepts", Silberschatz, Galvin and Gagne, Wiley, 8th Edition, 2010.
5. "Introduction to Embedded System", Shibu K.V., Tata McGraw Hill, 2009

UE15EC403:
WIRELESS COMMUNICATION (4-0-0-0-4)

Course Objectives:

- This course is an introduction to the design, analysis, and fundamental limits of wireless transmission systems.
- This course will expose the students to the principles behind the working and design of wireless communication systems and technologies.
- Topics covered include: Overview of current wireless systems, path loss and shadowing in a wireless channel, statistical multipath channel models, Capacity of a wireless channel, Diversity, Multiuser DSSS and FHSS systems, Multiuser systems, Cellular systems and infrastructure-based wireless networks, Multicarrier modulation – OFDM and vector coding.

Course Outcomes:

At the end of the course, the student should be able to

- Gain the basic working of current wireless systems
- Determine the Path loss and cell coverage area in wireless systems.
- Understand the narrowband and wideband fading models of statistical multipath channel models.
- Use the techniques to allocate resources among multiple users in wireless systems.
- Understand the basic design principles of cellular systems and channel reuse.
- Determine the maximum data rate that can be transmitted in wireless channels.
- Use the techniques to mitigate the effects of fading in a wireless channel.
- Understand the latest multicarrier techniques like OFDM and vector coding.

Course Content:

1. **Overview of Wireless Communication:** History, Wireless Vision, Technical Issues, Current Wireless Systems, Wireless Spectrum, Standards; Path loss and Shadowing: Radio Wave Propagation, Transmit and Receive signal models, Free-space path loss, Ray tracing, Empherical pathloss models, Simplified path loss model, Outage probability under pathloss shadowing, Cell cover area.
2. **Statistical Multipath:** Statistical Multipath Shadowing Models: Time varying channel impulse response, Narrow band fading models, Wideband fading models;
3. **Spread Spectrum:** Multi-User DSSS systems, Multi-user FHSS systems; Multiuser Systems: Multiuser channels: uplink and downlink, Multiple Access: FDMA, TDMA, CDMA, SDMA, hybrid techniques;
4. **Cellular systems and Infrastructure based wireless networks:** Cellular system fundamentals, channel reuse, SIR and user capacity, Interference reduction techniques, dynamic resource allocation, Fundamentals and rate limits; Capacity of wireless channels: Capacity of AWGN, Capacity of Flat fading models, Capacity Vs Receiver diversity; Diversity: Realization of independent fading paths, Receiver diversity, Transmitter diversity;
5. **Multicarrier Modulation:** Data transmission using multiple carriers, Multicarrier modulation with Overlapping sub channels, Discrete implementation of multicarrier modulation, The DFT and its properties, The cyclic prefix, orthogonal frequency-division Multiplexing, matrix representation of OFDM, vector coding.

Pre-requisite Courses: UE15EC254 – Probability and Random Process

Reference Books:

1. "Wireless Communications", Andrea Goldsmith, Cambridge University Press, 2011.
2. "Wireless Communications: Principles and Practices", T. S. Rappaport, 2nd Edition, Prentice Hall, 2002.
3. "Fundamentals of Wireless Communications, Cambridge University Press", David Tse and Pramod Vishwanath, 2009.

UE15IE406:
TECHNICAL COMMUNICATION I (2-0-0-0-2)

Course Objectives:

Course Outcomes:

Pre-requisite Courses: Nil

Reference Books:

UE15EC411:
WIRELESS NETWORK DESIGN (4-0-0-0-4)

Course Objectives:

- To provide a broad overview of some advanced wireless networks including their architectures and design issues pertaining to link layer and network layer
- To develop mathematical skills to analyze some of the network design issues
- To develop design fundamentals which can help students to take up projects in wireless networking

Course Outcomes:

Students completing the course should be able to

- Design simple protocols for wireless networks
- Apply link access technique according to the network architecture
- Analyze the design issues in wireless networks
- Develop ideas for pursuing student projects in wireless networking domain

Course Content:

1. **Introduction:** Wireless channel characteristics, Wireless networking fundamentals, Wireless network architectures, Wireless networking standards, Wireless protocols: Link layer, Network layer and Transport layer.
2. **Network Design and Analysis:** Defining system model: Decision variables, constants, objectives and constraints; Simulating data packet arrivals and random variables for various propagation models, Problem formulation/algorithm, Fundamentals of Markov chains, Analysis using Markov chains, Fundamentals of Optimization, Analysis of optimization problems.
3. **Cognitive Radio Networks:** Concepts, Spectrum sensing, Cooperative spectrum sensing, Dynamic spectrum access, Network architectures: Centralized and distributed, multichannel allocation problem, multihop communication, QoS; Design and analysis examples: Sensing allocation problems, scheduling algorithms, MAC protocols
4. **LTE-Advanced and 5G networks:** LTE and LTE-A fundamentals, Radio specifications, Frame format, Load balancing, Carrier aggregation, Coordinated multipoint (CoMP), Device to Device communication, Design and analysis examples: Resource allocation in D2D network; Overview of 5G networks: Cloud RAN, Small scale heterogeneous networks (HetNets), Wireless backhaul networks
5. **Other Ad hoc Networks:** (i) Sensor networks: Applications, Challenges, Network architecture, Link layer and routing issues, (ii) VANETs: Applications, IEEE 802.11p standard, Link layer issues, WAVE specification, Design and analysis examples: MAC protocols for VANETs, (iii) Wireless personal area networks (Bluetooth and Zigbee): PHY, MAC and message format

Prerequisite Courses: UE15EC351 – Computer Networks

Reference Books:

1. “Wireless Communications and Networks”, William Stallings, Prentice Hall, 2nd Edition, 2005.
2. “A Survey of Radio Resource Management for Spectrum Aggregation in LTE-Advanced”, H. Lee et al., IEEE Communications Surveys & Tutorials, 2013.
3. “Uplink Scheduling in LTE and LTE-Advanced: Tutorial, Survey and Evaluation Framework”, N. A-Ali et al., IEEE Communications Surveys & Tutorials, 2013
4. “A Survey on Routing Protocols for Wireless Sensor Networks”, K. Akkaya and M. Younis, Ad hoc Network, Vol. 3, 2005.
5. “Next Generation 5G Wireless Networks: A Comprehensive Survey”, A. Agiwal, A. Roy and N. Saxena, IEEE Communications Surveys & Tutorials, 2016.
6. “A Survey on MAC Protocols in OSA Networks”, T. V. Krishna and A. Das, Computer Networks, Vol. 53, 2009.

UE15EC412:
ERROR CONTROL CODING (4-0-0-0-4)

Course Objectives:

- The course aims to provide an in-depth understanding of the various channel coding and decoding techniques.

Course Outcomes:

Students completing the course should be able to

- Completely understand fundamentals of coding and how they can be applied to design of error control systems.
- Design good codes and of efficient decoding methods

Course Content:

1. **Introduction to Algebra:** Groups, Fields, Binary Field Arithmetic, Construction of Galois Field GF (2m) and its basic properties, Computation using Galois Field GF (2m) Arithmetic, Vector spaces and Matrices.
2. **Linear Block Codes:** Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Error correcting capabilities, Standard array and Syndrome decoding, Decoding circuits, Hamming Codes, Reed – Muller codes, The (24, 12) Golay code, Product codes and Interleaved codes
3. **Cyclic Codes:** (i) Introduction, Generator and Parity check Polynomials, Encoding using Multiplication circuits, Systematic Cyclic codes – Encoding using Feedback shift register circuits, Generator matrix for Cyclic codes, Syndrome computation and Error detection, Meggitt decoder, Error trapping decoding, Cyclic Hamming codes, The (23, 12) Golay code, Shortened cyclic codes; (ii) BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction. Non – binary BCH codes: q – ary Linear Block Codes, Primitive BCH codes over GF (q), Reed – Solomon Codes, Decoding of Non – Binary BCH and RS codes: The Berlekamp - Massey Algorithm, Majority Logic Decodable Codes, One – Step Majority logic decoding, one – step Majority logic decodable Codes, Two – step Majority logic decoding, Multiple – step Majority logic decoding.
4. **Convolutional Codes:** Encoding of Convolutional codes, Structural properties, Distance properties, Viterbi Decoding Algorithm for decoding, Soft – output Viterbi Algorithm, Stack and Fano sequential decoding Algorithms, Majority logic decoding.
5. **Concatenated Codes & Turbo codes:** (i) Single level Concatenated codes, Multilevel Concatenated codes, Soft decision Multistage decoding, Concatenated coding schemes with Convolutional Inner codes, Introduction to Turbo coding and their distance properties, Design of Turbo codes; (ii) Burst – error – correcting codes: Burst and Random error correcting codes, Concept of Inter – leaving, cyclic codes for Burst Error correction – Fire codes, Convolutional codes for Burst Error correction.

Prerequisite Courses: UE15MA251 – Linear Algebra, UE15EC312 – Information Theory and Coding

Reference Books:

1. “Error Control Coding”, Shu Lin & Daniel J. Costello, 2nd Edition, Pearson / Prentice Hall, 2004.
2. “Theory and Practice of Error Control Codes”, Blahut, Addison Wesley, 1984.

UE15EC413: NETWORK SECURITY II (4-0-0-0-4)

Course Objectives:

- This course provides a sound conceptual foundation in the area of Network Security with emphasis on design aspects.
- This course introduces the concepts related to design, build and analysis of simple network security architectures and systems.

Course Outcomes:

Students completing the course should be able to

1. Comprehend system and application design aspects of network security.
2. Analyse network systems through cryptographic, systemic and computational security aspects.
3. Design a framework for verification and assessment of a network system
4. Identify vulnerabilities in a given network.

Course Content:

1. Introduction to Network Security, Systems and Cryptographic approaches: Elements and aspects of Network Security, Network Security Architectures. An overview of types of Security attacks and breaches, Concept of Security services, Associated Security Mechanisms, Models of Network Security, Examples.
2. **Security at the Network/IP level:** IP-level Security, Need, Implications, Mechanisms, Choices, Applications, Examples. Security in IPv4 and IPv6, Trade-offs involved, Points to take-away Virtual Private Networks, Purpose, Types, Principles involved, Applications.
3. **Security at the Transport and Application level:** Need for Application-level and Transport-level security, Mechanisms, Techniques, Applications, Examples. Security for the Web-based Transactions, SSL and TLS Of HTTPS and Secure Shell (SSH) E-mail Security, Need, Mechanisms, Choices, Examples.
4. **Designing secure networks and internetworks:** Basic idea, Process involved, Devices, Positioning, Configuration and Trade-offs, Examples, Firewalls. More on Firewalls, Intrusion Detection Systems and Perimeter Security of Virus, Worms, other malware and Spyware. Security in Clouds: Facts and Myths, Current Status, Emerging trends, Examples Recent Advances in Network Security technology, Emerging trends, Best practices, Take-away points.
5. **Security in the context of E-commerce / m-commerce**: Document interchange, e-Voting Authentication of Remote Users, Issues, Mechanisms, Examples, Kerberos-based security scenarios. Certification Process and Agencies involved. Biometrics in Network and Internet Security, e-Passports, e-VISA and more. Security in Wireless Networks, Basic problems, Issues, Techniques, Examples; Case-Studies on: Firewalls, Intrusion Detection Systems and Perimeter Security, Anti-Virus, Anti-Worms, Anti-Spyware and other Anti-malware systems, State-of-the-art practices in Modern Network and Internetwork Security

Pre-requisite Courses: UE15EC341: Network Security

Reference Books:

1. "Cryptography and Network Security", William Stallings, 6th Edition, Prentice-Hall Inc., 2013.
2. "Applied Cryptography", Bruce Schenier, 2nd Edition, John Wiley & Sons, Singapore, 2011.
3. "Computer Security Handbook Vols. 1 & 2", Seymore Bosworth, M. E. Kabay and Eric Whyne, 5th Edition, John Wiley & Sons, Inc. N.J., 2009.

UE15EC414: PARALLEL AND DISTRIBUTED COMPUTING (4-0-0-0-4)

Course Objectives:

- To give an understanding of parallel computing which is employed in embedded devices, laptops, highend supercomputer, and largescale data centers, to achieve performance and efficiency targets.

Course Outcomes:

Students completing the course should be able to

- Design algorithms for execution in parallel and distributed settings
- Analyze the algorithms for correctness, reliability, security, and performance.
- Understand and account for models, limitations, and fundamental concept
- Apply the fundamental concepts to example systems and algorithms

Course Content:

1. **Introduction:** Scope and issues of parallel and distributed computing. Models Of Parallel Computing: Taxonomy of parallel structures, Control mechanism, Address-Space Organization, Interconnection connection networks: Static and Dynamic interconnection networks, evaluating static interconnection networks, embedding other networks (Linear Array, Mesh, Binary Tree) into a hypercube; Routing mechanisms for static interconnection networks: Store and Forward (SF) Routing; Cut - Theory (CT) Routing; Cost-Performance trade-off; Architectural Models for Parallel Algorithm design.
2. **Basic Communication Operation:** Simple message transfer between two processors; One-to-all broadcast; All-to-all broadcast; Reduction and prefix sums; One-to-all personalized communication; All-to-all personalized communication; circular shift.
3. **Performance and Scalability Of Parallel Systems:** Performance matrices for Parallel systems: Run time, Speed up, Efficiency and Cost; The effect of granularity and data mapping on performance; Scalability of parallel systems; Iso-efficiency metric of scalability;
4. **Models Of Distributed Computing:** Mini computer model; Workstation pool model; Client-server model; Pool of processors model; Hybrid model. Networking And Internetworking: Network technologies and Protocols. Inter process Communication And Remote Procedure Calling: Building blocks; Client-server communication; group communication; Case study: Inter processor communication in UNIX; Design issues in Remote procedure calling; Implementation; Case Studies: SUN and ANSA;
5. **Parallel Computing Algorithms:** Various sorting and searching algorithms, performance metrics for parallel algorithm implementations.

Pre-requisite Courses: UE15EC253 – Microcontrollers

Reference Books:

1. "Introduction to Parallel Computing ", Vipin Kumar, Ananth Grama, Anshul Gupta and George Karypis, Addison Wesley , 2nd Edition, 2003.
2. "Distributed Systems Concepts and Design", George Coulouris, Jean Dollimore and Tim Kindberg, Addison-Wesley, 3rd Edition, 2000.
3. "The Decision and Analysis of Parallel Algorithms", Selim G Akl, Prentice Hall, 1989.

4. “Advanced Computer Architecture: Parallelism, Scalability, Programmability”, Hwang, Kai, 1st Edition, McGraw Hill, 1992.
5. “An Introduction to Parallel Algorithms”, J Jaja, 1st Edition, Addison Wesley, 1992.
6. “Introduction to Parallel Computing”, T G Lewis and H El Rewini, Prentice-Hall, 1992.

UE15EC415:
DIGITAL SYSTEM SYNTHESIS AND OPTIMIZATION (4-0-0-0-4)

Course Objectives:

- Understand the basics of Graph Theory
- Application of Graph theory in Digital circuit synthesis algorithms
- understand synthesis flow of the CAD tools
- Analyse the existing synthesis algorithms.
- Apply synthesis algorithms to the digital circuits

Course Outcomes:

Students completing the course should be able to

1. Implement existing synthesis algorithm to synthesize digital circuits.
2. Analyse the performance of algorithms for different applications.
3. Optimize the algorithm to improve the performance of digital circuits.
4. To develop simple algorithm for architectural, logic synthesis of digital circuits.
5. Design Simple EDA tool using any high level programming language

Course content:

1. **Introduction to Synthesis and Optimization:** Circuit Models, synthesis and optimization. Background: Notations, undirected graphs, directed graphs, combinatorial optimization: Introduction to decision and optimization problems, algorithms, tractable and intractable problems. Fundamental algorithms: Linear and Integer Programs : Branch and Bound, Tree cover, greedy scheduling algorithms. Graph optimization problems and algorithms: Dijkstra, Bellman Ford Algorithm. Graph coloring algorithms: Vertex coloring, Leftedge algorithms. Boolean algebra : Boolean functions, representation of Boolean functions using Binary Decision diagram ,ROBDD, ITE operator(only representations and problems).
2. **Architectural or High Level Synthesis and Optimization:** Schedule Algorithms: Introduction, a model for scheduling problems, Scheduling without resource constraints: ASAP, ALAP, Latency constrained, Scheduling under timing constraints. Scheduling with resource constraints: Integer linear programming Model, List Scheduling,Hu’s Algorithm, Force directed scheduling, Scheduling Pipe lined circuits: Scheduling with pipelined resources, functional pipelining, loop folding.
3. **Resource Sharing and Cell Library Binding:** Sharing and binding for resource-dominated circuits, sharing and binding for general circuits, concurrent binding and scheduling, resource sharing and binding for pipelined circuits, sharing, algorithms for library binding: Covering Algorithms based on structural matching, simple tree based matching, MATCH algorithm, tree based covering, Boolean matching, Rule based library binding, comparisons of Algorithmic and rule based library binding.
4. **Two Level Combinational Logic Optimization:** Logic optimization, principles: Definitions: Multiple output implicant, Multiple output minterm, cover, minimum cover, irredundant cover, prime, essential prime implicant Exact Logic minimization: QM method and Petrick’s method. Heuristic Logic Minimization: operators (Expand, Reduce, Reshape, Irredundant) with examples, Testability Properties; logic minimization methods: ESPRESSO: Expand, Reduce, Irredundant, Essentials (using K Map and problems).
5. **Logic Level Synthesis and Optimization-Part II:** Sequential Circuit Optimization: Introduction, Sequential circuit optimization using state based models: State minimization for completely specified finite state machines, State minimization for incompletely specified finite state machines, ,. sequential circuit optimization using network models: Introduction to retiming, cycle time minimization using retiming, RETIME_DELAY algorithm.

Pre-requisite Courses: UE15EC203 - Logic Design

Reference Books

1. “Synthesis and Optimization of Digital Circuits”, Giovanni De Micheli, 1st Edition, Tata McGraw-Hill, 2003.
2. “Logic Synthesis”, Srinivas Devadas, Abhijit Ghosh and Kurt Keutzer, 1st Edition , Tata McGraw-Hill , 1994.
3. “VLSI Digital Signal Processing Systems- Design and Implementation”, Keshab K Parhi, Wiley Publications, 1999.

UE15EC416:
ADVANCED DIGITAL IMAGE PROCESSING (4-0-0-0-4)

Course Objectives:

- Expose students to advanced concepts of image processing.
- Investigate current representations and methods in image processing such as wavelets and morphology.
- To design and implement algorithms that perform basic image processing operations like filtering of noise and image enhancement
- To design, analyse and implement algorithms for advanced image analysis like image compression, image reconstruction, image segmentation

Course Outcomes:

Students completing the course should be able to

- To compare and use different tools for image analysis in a transformed domain (wavelet vs. Fourier transform).
- To apply the notions learned in the course to practical image processing problems.
- Students are able to apply techniques for image enhancement, filtering and compression.
- Students are able to process and analyze image data.
- Show how higher-level image concepts such as edge detection, segmentation, representation can be implemented and used.

Course Content:

1. **Image Compression:** Fundamentals, Need for image compression, Image Compression models, Elements of Information Theory, Error free compression, Lossy compression, Image Compression Standards.
2. **Morphological Image Processing:** Preliminaries, Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Morphological Algorithms, Extensions to Gray scale Images.
3. **Image Segmentation:** Introduction, Classification of image Segmentation techniques, Region approach-segmentation, Clustering techniques, Segmentation based on thresholding, Water -shed transformation, Edge based segmentation, Classification of edges, Edge detection, Edge Linking, Hough Transform, Shape representation.
4. **Wavelet based image processing:** Introduction, Evolution of wavelet transform, wavelet transform, 2D continuous wavelet transform, Multi resolution analysis, Examples of wavelets, Wavelet based image compression.

5. **Object Recognition:** Introduction, Need for an object-recognition System, Automated Object-recognition Systems, Patterns and Pattern Class, Selection of Measurement Parameters, Relation between Image Processing and Object Recognition, Approaches to object recognition, Baye's Parametric Classification, Neural Network approach to object recognition, Template-Matching based Object Recognition, Applications of Object Recognition.

Pre-requisite Courses: Nil

Reference Books:

1. "Digital Image Processing", R.C.Gonzalez and R.E.Woods, Prentice, Hall, 2nd Edition, 2005.
2. "Digital Image Processing", S Jayaraman, S Esakkirajan and T Veerakumar, Mc Graw Hill, 2009.
3. "Digital Image Compression Techniques", M. Rabbani and P W Jones, SPIE Press, 1991.
4. "A Wavelet Tour of Signal Processing", S Mallat, Academic Press, Second Edition, 1999.

UE15EC417
DETECTION AND ESTIMATION (4-0-0-0-4)

Course Objectives:

- To understand the basics of binary hypothesis testing leading to signal detection theory with Neyman-Pearson and Bayesian approaches.
- To understand the fundamentals of single- and multi-parameter estimation theory with deterministic and Bayesian philosophies.

Course Outcomes:

Students completing the course should be able to

1. Representation of Random signals.
2. Apply hypotheses test.
3. Detection and estimation of Signal with Gaussian noise.
4. Detection and estimation of Signal withnonwhite Gaussian noise.
5. Design of Kalman-Bucy liner filter and optimum linear filters.

Course Content:

1. **Classical Estimation I:** Minimum variance unbiased estimation of scalar and vector parameters. Cramer-Rao lower bound, efficient estimator.Linear model. Best linear unbiased estimator (BLUE).
2. **Classical Estimation II:** Maximum likelihood estimation (MLE), properties of MLE, numerical determination of the MLE. Lease squares estimation.
3. **Bayesian Estimation:** Introduction, maximum a Posteriori (MAP) and minimum mean square error (MMSE) estimation. Linear MMSE estimation. Signal waveform estimation: Wiener filtering. Kalman filters.
4. **Detection Theory I:** Introduction, hypothesis testing, likelihood ratio test, Neyman-Pearson theorem, Bayes risk. Detection of deterministic signals in Gaussian noise, matched filters.
5. **Detection Theory II:** Detection of random signals in Gaussian noise. Composite hypothesis testing: Bayesian approach, generalized likelihood ratio test. Detection of signals with unknown parameters. Signal detection in non-Gaussian noise.

Pre-requisite Courses: UE15EC254 – Probability and Random Process, UE15EC302 – Digital Signal Processing

Reference Books:

1. "Fundamentals of Statistical Signal Processing. Volume I: Estimation Theory", S. M. Kay, Dorling Kindersley (India), New Delhi, 2010.
2. "Fundamentals of Statistical Signal Processing. Volume II: Detection Theory", S. M. Kay, Prentice-Hall, Upper Saddle River, New Jersey, USA, 1998.
3. "Detection, Estimation and Modulation Theory, Part I", H. L. Van Trees, John Wiley, USA, 2001.

UE15EC421:
RADAR SYSTEMS (4-0-0-0-4)

Course Objectives:

- Introduction to radar systems, basic principle of working with simple block diagram and range equation
- MTI and Pulse Doppler radar and tracking radar.
- Detection of signals at the receiver in the presence of noise using probability density function and various detection criteria.
- Using matched filter for improving SNR.
- Introduction to clutter, concepts of land clutter, sea and weather clutter and methods to reject the clutter.
- Functions of receiver, different types of antenna and design principle, duplexer and displays.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the basic functioning of the radar
- Understand the application and hardware of different radars like the moving target indicator and the Doppler radar
- Determine the signal to noise ratio and the thresholding required for detection
- Understand the effect of clutter
- Understand the application and hardware of the heterodyne radar system.

Course Content:

1. **Introduction to Radars:** Basic radar, Radar block diagram, radar frequencies, applications of radar, the origins of radar. Radar equation: Radar range equation, radar cross section of targets, System losses;
2. **MTI and PULSE Doppler Radar:** Introduction to Doppler and MTI radar, delay line cancellers, Digital MTI processing, Moving Target detector, Pulse Doppler radar. Tracking radars: Introduction, Monopulse tracking, Conical scan and sequential lobing, tracking in range;
3. **Detection of Signals in Noise:** Detection of signals in noise, receiver noise and SNR, probabilities of detection and false alarm, transmitted power, pulse repetition frequency Matched filter receiver, detection criteria, Detectors, Automatic detection;
4. **Radar Clutter:** Introduction, Surface clutter, land clutter, sea clutter;
5. **Radar Reception:** The radar super heterodyne receiver, receiver noise figure, radar antenna, Functions of radar antenna, reflector antenna, Electronically steered phased array antenna, Duplexers and receiver protectors, radar displays.

Pre-requisite Courses: UE15EC204 – Electromagnetic Field and Transmission Lines, UE15EC352 – Microwave Engineering

Reference Books:

1. "Introduction to Radar Systems", Merrill I. Skolnik, Tata Mc Graw Hill Publication, 3rd Edition, 2002.
2. "Radar Principles", Peyton Z. Peebles, JR, A, Wiley – Interscience Publications, 1998.
3. "Radar Handbook", Merrill I. Skolnik, McGraw Hill, 2nd Edition, 1990.

UE15EC422:
PASSIVE RF AND MICROWAVE CIRCUITS (4-0-0-0-4)

Course Objectives:

- Impart an understanding of analysis of microwave networks using scattering parameters & transmission parameters, and analysis of periodic structures.
- Introduce basic concepts of impedance matching and tuning with quarter wave transformers,
- Impart basic knowledge in the design of microwave filters using image parameters method & insertion loss method, and in the design of coupled line filters & resonator filters.

Course Outcomes:

Upon successful completion of the course, the students will be able to;

- Get an insight into microwave network analysis and impedance matching
- Understand techniques in impedance matching and tuning the microwave networks
- Design microwave filters using image parameters method and insertion loss method
- Design microwave filters using filter transformations.
- Analyse microwave devices involving periodic structures

Course Content:

1. **Microwave Network Analysis:** Even and odd properties of driving point impedance and reflection coefficient. Impedance, admittance, scattering and transmission matrices. T and Pi equivalent circuits for two port networks.
2. **Impedance Matching and Tuning Networks:** The quarter wave transformer. The theory of small reflections – single-section and multisection transformers. Design of Binomial and Chebyshev multisection matching transformers.
3. **Microwave Filters:** Filter design by image parameter method – image impedances and transfer functions. Filter design by insertion loss method – characterization by power loss ratio, maximally flat low-pass, equal-ripple low-pass, and linear phase low-pass filter prototypes.
4. **Filter transformations and implementations:** Impedance and frequency scaling, bandpass and bandstop transformations. Filter implementations using Richard's transformation, Kuroda's identities, impedance and admittance inverters.
5. **Periodic Structures:** Analysis of infinite periodic structures, terminated periodic structures; k-β diagrams and wave velocities.

Pre-requisite Courses: UE15EC352 – Microwave Engineering

Reference Books:

1. "Microwave Engineering", David M. Pozar, 3rd Edition, Wiley, 2005.
2. "Foundations for Microwave Engineering", R.E. Collin, 2nd Edition, Wiley India, 2009.

UE15EC423:
TIMING ANALYSIS OF DIGITAL CIRCUITS (4-0-0-0-4)

Course Objectives:

- To learn the need and applications of timing analysis in various stages of a VLSI design.
- To learn methods for timing analysis of combinational and sequential digital circuits.
- To learn timing models in cell and interconnects and differentiating the two and their applicability in timing analysis.
- Analysis of the timing parameters and constraints.
- To learn cross talk and noise analysis

Course outcomes

Students completing the course should be able to,

- Analyze the given digital circuit for timing in pre-silicon and post-silicon design levels.
- Analysis of effects of cross talk and glitches and their significance in timing analysis.
- Able to write and apply the timing constraints and analyze the design simulations using SDC on CAD tools.

Course content:

1. **Introduction to Timing Analysis***: Basics of STA, STA at different design phases, Limitation of STA, Power and reliability considerations of STA, STA Concepts: CMOS Logic Design, Modeling of CMOS Cells, Switching Waveform, Propagation Delay, Slew of a Waveform, Skew between Signals, Timing Arcs and Unateness, Min and Max Timing Paths, Clock Domains, Operating Conditions. (Introduction to SDC through Tcl)
2. **Timing models for Standard cell library***: Pin Capacitance, Timing Modeling, Timing Models - Combinational Cells, Timing Models - Sequential Cells, State-Dependent Models, Interface Timing Model for a Black Box, Advanced Timing Modeling
3. **Interconnect Parasitics***: RLC for Interconnect, Wireload Models, Representation of Extracted Parasitics, Representing Coupling Capacitances, Hierarchical Methodology, Reducing Parasitics for Critical Nets, Delay Calculation: Delay Calculation Basics, Delay Calculation with Interconnect, Cell Delay using Effective Capacitance, Interconnect Delay, Slew Merging, Different Slew Thresholds, Different Voltage Domains, Path Delay Calculation, Slack Calculation
4. **Cross talk and noise***: Crosstalk Glitch Analysis, Crosstalk Delay Analysis, Timing Verification Using Crosstalk delay, Configuring the STA Environment*: Introduction to STA Environment, Specifying Clocks, Generated Clocks, Constraining Input Paths, Constraining Output Paths, Timing Path Groups
5. **Timing Verification***: Setup Timing Check, Hold Timing Check, Multicycle Paths, False Paths, Half-Cycle Paths, Removal Timing Check, Recovery Timing Check, Timing across Clock Domains, Examples and case studies.

Pre-requisites: UE15EC303 – VLSI Design, UE15EC202 – Electronic Devices and Circuits

Reference Books:

1. "Static timing Analysis for Nanometer Designs- A Practical Approach", J Bhaskar Rakesh Chadha, 1st Edition, Springer, 2009 .
2. "Constraining Designs for Synthesis and Timing Analysis-A practical Guide to Synopsys design constraints", Sridhar Gangadharan and Sanjay Churiwala, 1st Edition, Springer, 2013.
3. "Timing", Sachin Sapatnekar, First Edition, Kluwer Academic publishers, 2004.

UE15EC424
VERIFICATION OF VLSI CIRCUITS WITH SYSTEM VERILOG (4-0-0-0-4)

Course Objectives:

- This course provides an insight into the design criteria for combinational circuits, memories, processors and I/O devices.
- This course introduces the concepts of writing test cases and test benches using assertions for digital circuit design using system Verilog.
- This course introduces the verification constructs and coverage models

Course outcomes

Students completing the course should be able to

- Write code and simulate any digital function in system Verilog.
- Know the difference between synthesizable and non-synthesizable code.
- Learn good coding techniques as per current industrial practices.
- Design a framework for verification and write verification scenarios for given design
- Apply constrained random verification techniques and assertions to verify the design
- Techniques to measure and modify the functional coverage
- Apply assertions to verify the system design.

Course content:

1. **Basics of Verification:** Difference between ASIC verification and ASIC testing, Verification basics, Testbenches, Layered Organization of Testbenches. Importance of hardware verification languages and methodologies; Basic constructs of System Verilog: System Verilog data types, enhanced literal numbers syntax, 4-state and 2-state types, typedefs, enum, struct data type, Type parameters, $unit and $root. Packages, strings, static and dynamic type casting, Random number generation. loops and jumps in system verilog, introduction to different always blocks, systemverilog enhancements to tasks and functions, systemverilog priority and unique modifiers for case and if statements, 'time scale, systemverilog timeunit and time precision.
2. **Structs, Unions, Packed and Unpacked Arrays, Semaphores and Mailboxes:** Structs and its assignments, packed and unpacked arrays, array indexing, structs and packed structs, Unions and packed unions, dynamic arrays and methods, foreach loop, associative arrays and methods, queues and concatenation operations, queue methods, semaphores and methods, mailboxes and methods, bounded and unbounded mailboxes.
3. **Class and Randomization:** System verilog class basics, class declaration, class members and methods, class handles, class object construction, super and this keywords, object handles, user defined constructors, class extension and inheritance, chaining new() constructors, overriding class methods, extending class methods, local and protected keywords, constrained random variables, directed vs random testing, rand and randc class data types, randomize-randomizing class variables, random case, built-in-randomization methods, random sequence and examples.
4. **Interfaces, Program block, and clocking:** Interface overview, generic interfaces, interfaces vs records, how interfaces work, requirements of good interface, interface, constructs, interface mode ports, Fundamental test bench construction, program blocks, program block interaction with modules, final blocks, Test bench, stimulus/Verification vector timing strategies. Clocking blocks, clocking skews, clocking block scheduling, fork-join processes; Constrained Random variables, Coverage, Methods and interfaces: Randomization constraints, simple and multi-statement constraints, constraint distribution and set membership, constraint distribution operators, external constraints, cover groups, cover points, cover point bins and labels, cross coverage, cover group options, coverage capabilities. Virtual class, why to use virtual class, virtual class methods and restrictions, polymorphism using virtual methods, pure virtual methods, pure constraints, passing type parameters, virtual interfaces.
5. **System Verilog assertions :** Assertion definition, assertion benefits, system Verilog assertion types, immediate assertions, concurrent assertions, assert and cover properties and labels, overlapping and non-overlapping implications, edge testing functions, sequences, Vacuous success, property styles, System Verilog assertion system functions, Assertion severity tasks, assertion and coverage example of an FSM design; System Verilog Assertions for Memory Controllers: Sample System - Memory controller, CPU - AHB Interface Operation, Memory controller operation, SDRAM Verification, SDRAM Assertions, SRAM/FLASH Verification, SRAM/FLASH Assertions, DDR-SDRAM Verification, DDR-SDRAM Assertions.

Prerequisites: UE15EC356 Digital System Design using HDL

Reference Books:

1. "System Verilog for verification- A guide to learning the Test bench language features" Christian B Spear, ,3rd Edition , Springer Publications, 2012.
2. "System Verilog Assertions", Vijaya Raghavan, 1st Edition, Springer Publications, 2005.
3. "System Verilog for Design", Sutherland, 1st Edition, Springer Publications, 2006.

UE15EC425
PERVASIVE COMPUTING (4-0-0-0-4)

Course Objectives:

- To introduce the characteristics, basic concepts and systems issues in mobile and pervasive computing
- To illustrate architecture and protocols in pervasive computing and to identify the trends and latest development of the technologies in the area
- To give practical experience in the area through the design and execution of a modest research project
- To design successful mobile and pervasive computing applications and services
- To evaluate critical design tradeoffs associated with different mobile technologies, architectures, interfaces and business models and how they impact the usability, security, privacy and commercial viability of mobile and pervasive computing services and applications

Course Outcomes:

Students completing the course should be able to

- Analyze and compare the performance of different data dissemination techniques and algorithms for mobile real -time applications
- Analyze the performance of different sensor data management and routing algorithms for sensor networks

Course Content:

1. **Architecture:** Relationship of Wireless Computing, Ubiquitous Computing, Internet Computing. Related ideas: Ambient Computing, Elements of Pervasive architecture, Requirements of computational infrastructure, Failure management. General issues: security, performance, dependability, Web architectures, Local networks, Store and forward, Multi-network architectures (e.g. Wireless LAN to LAN to Internet, hand held synchronized to PC to LAN).
2. **Devices Technology:** Device and network technologies, Devices categories, Devices characteristic Heterogeneity and Interoperability, Mobile Agents, device management, Compaq iPAQ, 3G devices, Palm Tungsten, WindowsCE devices, Symbian devices, J2ME-enabled devices.
3. **Sensor Networks and RFIDS:** Introduction to Sensor networks, Types of sensor networks, Berkeley Motes, Sensor network organization, Sensor network routing mechanisms, Platforms for Wireless sensor networks, Sensor Node Architecture, Sensor Network Architecture; (i) RFID: Introduction, transponder and

reader architecture, Types of tags and readers, Frequencies of operation, Selection criteria for RFID systems, Information processing in the transponder and reader, Fundamental operating principles, Antennas for RFIDs.

4. **Local Area and Wide Area Wireless Technologies:** Local area wireless networks: IEEE 802.11 technologies, Mobile IP, Infrared technologies, Bluetooth networks (OBEX Protocol), Messaging Systems, Personal Area Networks, Network Management, Quality of Service, Wireless protocols. Establishing wide area wireless networks: Concept and structure of cell, Call establishment and maintenance, Channel management, Frequency Assignment techniques, Difference from a wired network
5. **Protocols and Applications:** Networking protocols, Packet switched protocols, Routing Protocols for Sensor Networks, Data Centric Protocols, Hierarchical Protocols, Location-based Protocols, Multimedia Messaging Service (MMS) Protocols, Wireless Application Protocol (WAP). Applications: Mobile access to patient information in a hospital, sales support, retailing, services support, tracking applications.

Pre-requisite Courses: UE15EC351 – Computer Networks

Reference Books:

1. "Pervasive Computing", Burkhardt, Henn, Hepper, Rintdorff and Schaeck, Addison Wesley, 2001.
2. "Fundamentals of Mobile and Pervasive Computing", F. Adelstein, S.K.S. Gupta, The McGraw-Hill, 2005.
3. "Pervasive Computing: Technology and Architecture of Mobile Internet Applications", Jochen Burkhardt, Horst Henn, Stefan Hepper, Klaus Rindtorff, Thomas Schack, Addison-Wesley, 2002.
4. "Pervasive Computing", Uwe Hansmann, L. Merk, M. Nicklous, T. Stober, U. Hansmann, Springer Professional Computing, Springer Verlag, 2003.

UE15EC426:
SPEECH PROCESSING (4-0-0-0-4)

Course Objectives:

- It gives an insight into the fundamentals of processing speech by representing the information by various analysis methods.
- Aims at building a system that recognizes speech.

Course Outcomes:

Students completing the course should be able to

- Understand human speech production mechanism
- Represent information by analysis of signal by Short time Fourier analysis , linear prediction and homomorphic processing of signals
- Device an algorithm to differentiate speech and silence , pitch and formants in speech signals.
- Design a simple isolated word recognizer based on hidden Markov models

Course Content:

1. **Mechanics of Speech:** Speech production: Mechanism of speech production, Acoustic phonetics - Digital models for speech signals - Representations of speech waveform: Sampling speech signals, basics of quantization, delta modulation, and Differential PCM - Auditory perception: psycho acoustics.
2. **Time Domain Models for Speech Processing:** Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech vs silence discrimination using energy & zero crossings, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function
3. **Frequency Domain Methods for Speech Processing: Short Time Fourier Analysis:** Linear Filtering interpretation, Filter bank summation method, Overlap addition method, Design of digital filter banks, Implementation using FFT, Spectrographic displays, Pitch detection, Analysis by synthesis, Analysis synthesis systems.
4. **Homomorphic Speech Processing:** Homomorphic systems for convolution, Complex cepstrum, Mel Frequency Cepstral Coefficients Pitch detection, Formant estimation, Homomorphic vocoder.
5. **Linear Predictive Coding of Speech:** Basic principles of linear predictive analysis, Solution of LPC equations, Prediction error signal, Frequency domain interpretation; Speech Recognition: Introduction, Speech recognition, Signal processing and analysis methods, Pattern comparison techniques, Hidden Markov Models, Isolated digit recognizer.

Prerequisites: UE15EC302 – Digital Signal Processing

Reference Books:

1. "Digital Processing of Speech Signals", L. R. Rabiner and R. W. Schafer, Pearson Education (Asia) Pvt. Ltd., 2004.
2. "Discrete-time Speech Signal Processing: Principles and Practice", Thomas F. Quatieri, Pearson Education (Singapore) Pvt. Ltd., 2002.
3. "Speech Communications: Human and Machine", D. O'Shaughnessy, Universities Press, 2001.
4. "Fundamentals of Speech Recognition", L. R. Rabiner and B. Juang, Pearson Education (Asia) Pvt. Ltd., 2004.
5. "Discrete-Time Processing of Speech Signals", J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis, IEEE Press, 2000.

UE15EC427
STATISTICAL SIGNAL PROCESSING (4-0-0-0-4)

Course Objectives:

- The main objective of this course is to introduce the fundamentals of statistical signal processing.
- To understand the basics of random process and signal modelling. To understand advanced filtering techniques which are adaptive in nature.
- To familiarise different approaches of spectrum estimation and basics of array processing.

Course Outcomes:

Students completing the course should be able to

- Compare the parametric and non-parametric methods of spectrum estimation
- Analyze the signal modelling techniques
- Implement Weiner filter and adaptive filters to suit specific requirements for specific applications.
- Analyze array processing methods

Course Content:

1. **Discrete-time Random Processes:** Random variables and processes, filtering random processes, spectral factorization, ARMA, AR and MA and harmonic processes.
2. **Signal Modeling:** Least squares method, Pade approximation, Prony's method, finite data records, stochastic models. Levinson-Durbin recursion.
3. **Wiener Filters:** FIR and IIR Wiener filters; discrete Kalman filter. **Adaptive Filters:** FIR adaptive filters (steepest descent and LMS)
4. **Spectrum Estimation:** Nonparametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation.

5. **Array Processing:** Array fundamentals, beamforming, optimum array processing, performance considerations, adaptive beamforming, linearly constrained minimum-variance beamformers, sidelobe cancellers, angle estimation, space-time adaptive processing.

Prerequisites: UE15EC254 – Probability and Random Process, UE15EC302 – Digital Signal Processing

Reference Books:

1. "Statistical Digital Signal Processing and Modeling", Monson H. Hayes, John Wiley & Sons (Asia) Pvt. Ltd., 2002.
2. "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing", Dimitris G. Manolakis, Vinay K. Ingle, and Stephen M. Kogon, McGraw-Hill International Edition, 2000.
3. "Algorithms for Statistical Signal Processing", J.G. Proakis, C.M. Rader, F. Ling, C.L. Nikias, M. Moonen and I.K. Proudler, Pearson Education (Asia) Pvt.. Ltd, 2002.
4. "Adaptive Signal Processing", Bernard Widrow and Samuel D. Stearns, Pearson Education (Asia) Pvt. Ltd., 2001.
5. "Adaptive Filters", Simon Haykin, Pearson Education (Asia) Pvt. Ltd, 4th Edition, 2002.

UE15EC428
ADAPTIVE SYSTEMS (4-0-0-1-4)

Course Objectives:

- Understand the concepts of adaptive systems.
- Provide knowledge of stability of dynamical systems.
- Ability to design stable adaptive laws for unknown dynamical systems

Course Outcomes:

Students completing the course should be able to

- Describe and identify the structures of adaptive systems.
- Predict the stability of simple adaptive systems.
- Use Lyapunov stability analysis for stable adaptive systems.
- Derive adaptive laws for stable adaptive systems.
- Design adaptive observers.
- Develop adaptive controllers.

Course Content:

1. **Systems Theory:** State-space representations; adaptive systems; direct and indirect control; model reference adaptive systems and self-tuning regulators; stable adaptive systems; applications.
2. **Stability Theory:** Linear systems; Lyapunov stability; positive-real functions; Kalman-Yakubovich lemma; input-output stability; stability of adaptive systems; other stability concepts.
3. **Simple Adaptive Systems:** Algebraic systems; dynamical systems; state variables accessible.
4. **Adaptive Observers:** Luenberger observer; adaptive observers; design of adaptive observers.
5. **Control Problem:** Adaptive control of plants with relative degree unity; adaptive control of plants with relative degree greater than or equal to 2. Comments on the proof of global stability, the control problem and the controller structure. Combined direct and indirect approach. Relaxation of assumptions; Notion of persistent excitation

Prerequisites: UE15MA251 – Linear Algebra; UE15EC252 - Signals and Systems

Reference Books:

1. "Stable Adaptive Systems", K.S. Narendra and A.M. Annaswamy (1989), Prentice Hall (Dover), 2005.
2. "Adaptive Control: Stability, Convergence and Robustness", S. Sastry and M. Bodson, Prentice-Hall., 1989.
3. "Adaptive Control Tutorial", P. Ioannaou and B. Fidan SIAM., 2006.
4. "Ádaptive Control", K. Astrom 2nd Edition, Pearson Education., 1995.

UE15IE441:
TECHNICAL COMMUNICATION II (2-0-0-0-2)

Course Objectives:

Course Outcomes:

Pre-requisite Courses: Nil

Reference Books:

UE15EC451:
RF WAVE PROPAGATION (2-0-0-0-2)

Course Objectives:

- Understand the significance of the effect of the environment on a propagation link
- Develop skills to analyze skywave propagation
- Get an overview of some of the statistical models of propagation

Course outcomes

Students completing the course should be able to

- Analyze the effect of the vertical and horizontal polarization on the reflection from the ground
- Analyze the effect of surface impedance and elliptical polarization on a surface wave link
- Determine path losses
- Analyze skywave propagation links

Course Content:

1. **Mobile Radio Propagation- Large Scale Path Loss:** Introduction to radio wave propagation, free space propagation model, relating power to electric field, the three basic propagation mechanism, reflection: reflection from dielectrics, Brewster angle, ground reflection (two ray model)
2. **Diffraction** – Fresnel zone geometry, knife edge diffraction model, multiple knife edge diffraction, scattering – radar cross section model,
3. **Surface Wave:** Polarization, Surface wave propagation, wave tilt.
4. **Ionosphereic propagation:** Structure of ionosphere, dielectric constant of the ionosphere, group velocity of a wave in plasma, wave propagation through the ionosphere – skip distance, virtual height, maximum usable frequency, dielectric constant of magnetized plasma.
5. **Practical Link Budget Design Using Path Loss Models:** Log distance path loss model, log normal shadowing, determination of percentage coverage area, outdoor propagation models-Longley Rice model, Durkin's model.

Pre-requisite Courses: UE15EC204 – Electromagnetic Field Theory

Reference Books:

1. "Wireless Communications Principles and Practice", T.S.Rappaport, Prentice Hall of India, 2nd Edition, 2005.
2. "Electromagnetic Waves", R.K.Shevgaonkar, Tata McGraw Hill, 2008.

UE15EC452:
RESEARCH METHODOLOGY (2-0-0-0-2)

Course Objectives:

- To introduce the concept of research methodologies, problem identification and formulation for the students.

- Improve the paper writing skill using different software for technical writing.

Course Outcomes:

Students completing the course should be able to

1. Understand and apply basic research methods including research design and interpretation.
2. Comprehend variety of research methods, including survey research, case studies, comparative analysis, and the use of documentary/primary sources.
3. Understand the ethical issues in research project.
4. Prepare for and present a conference paper/poster at a national/ international conference.
5. Apply different software for preparation of dissertation report.

Course Content:

1. **Foundations of Research:** Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process.
2. **Problem Identification & Formulation:** Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis – Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance. Literature Survey
3. **Research Design :** (i) Concept and Importance in Research – Features of a good research design – Exploratory Research Design , Descriptive Research Designs. Experimental Design, Qualitative and Quantitative Research, Problems in measurement in research – Validity and Reliability.
4. **Paper Writing**: Layout of a Research Paper, Journals in electronics and communication, Impact factor of Journals, when and where to publish, Ethical issues related to publishing, Plagiarism and Self – Plagiarism.
5. **Use of Tools / Techniques for Research:** methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office , Software for detection of Plagiarism.

Pre-requisite Courses: Nil

Reference Books:

1. "Business Research Methods", Donald Cooper & Pamela Schindler , 10th Edition, McGraw Hill, 2008.
2. "Business Research Methods", Alan Bryman & Emma Bell, 2nd Edition, Oxford University Press, 2007.
3. "Research Methodology: Methods and Techniques", C. R. Kothari, 2nd Edition, New Age International Publishers, 2004.

UE15EC453:
ENGINEERING MANAGEMENT (2-0-0-0-2)

Course Objectives:

- To combines the application of practice of management to the practice of engineering skills and techniques involved in the management of engineering activities in operation, research, design and projects
- To understand ethical and business behaviours in engineering organizations, and to change management techniques

Course Outcomes:

Students completing the course should be able to

1. Perform tasks in an organization related to organizing, planning, and controlling project and process activities;
2. Analyze the factors that affect changes in the work environment, and be aware of the approaches in implementing change in an organization;
3. Judge ethical and business behaviors in engineering organizations in a fast-changing business environment.

Course Content:

1. **Engineering and Management:-** Engineering - origin, Management –Definition, management levels, management skills, managerial roles, Functions of managers, Management is Art or Science. Engineering management - synthesis
2. **Planning , Forecasting , Decision making**:- Nature of planning, The foundation for planning- Vision, purpose, mission, strategic planning, strategic management of Technology, Goals & objectives, MBO & MBE. Planning concepts. Forecasting- quantitative & qualitative methods, Technological forecasting, Strategies for managing Technology. Nature of Decision Making. Tools for decision making- under certainty, risk, uncertainty.
3. **Organizing,Human aspects of organizing, Motivating & Leading Technical people :**- Nature of organizing,Traditional organizational theory-Departmentation, span of control, Impact of the information revolution Authority & Power, Delegation. Motivation- various theories, Leadership-Nature, traits, approaches, styles. Motivating and Leading Technical Professionals.
4. **Managing the Research Function and Engineering Design:-** Protection of Ideas-patents, trade marks, copy rights, trade secrets, Creativity, Making R&D organization successful**,** Nature of Engineering Design, Systems Engineering/New Product Development, Design Review, Designing for reliability, Other "Ilites" in design
5. **Project Planning, acquisition and organization**: - The characteristics of a project, the project proposal process, project planning tools, types of Contracts. The project organization, the project manager**,** motivating project performance, Controlling cost & schedule

Pre-requisite Courses: Nil

Reference Books:

1. "Managing Engineering and Technology", Babcock and Morse PHI, 3rd Edition, 2004.
2. "Management-A Competency based Approach", Hellriegel, Jackson and Slocum**,** 9th Edition Thomson South Western, 2001.
3. "Management", Harold Koontz and Heinz Weir Rich, 9th Edition, McGraw Hill,2010
4. "Principles of Management ", P.C Tripathi and P.N. Reddy, 4th Edition, McGraw Hill, 2008.

UE15EC454 :
SYSTEM VERILOG (2-0-0-0-2)

Course Objectives:

- Understand the concepts and syntax of time-based assertions.
- Apply the System Verilog assertions in the verification of protocols and system designs

Course Outcomes:

Students completing the course should be able to

1. Write code and simulate any digital function in system Verilog Assertions.
2. Write code as per current industrial practices.
3. Apply verification techniques to verify the system design.

Course Content:

1. **Introduction to SVA:** What is an Assertion? Why use SystemVerilog Assertions (SVA)? SystemVerilog Scheduling SVA

Terminology, different tuples of assertions, different types of sequences, SVA checker and usage, operators, SVA constructs and properties. SVA for functional coverage

2. **SVA Simulation Methodology:** A sample system under verification, Block level verification, System level verification, Functional coverage, SVA for transaction log creation, SVA for FPGA Prototyping
3. **SVA for Protocol Interface:** PCI - A Brief Introduction, A sample PCI Read transaction, A sample PCI Write transaction A sample PCI System, Scenario I - Master DUT Device , PCI Master assertions , Scenario 2 - Target DUT Device, PCI Target assertions, Scenario 3 - System level assertions; PCI Arbiter assertions; Implementation of case studies using SVA.

Prerequisite Courses:UE15EC303 – VLSI Design, UE15EC353 – Digital System Design Using HDL

Reference Books:

1. "System Verilog Assertions, System Verilog Assertions", Vijaya Raghavan, 1st Edition, Springer Publications, 2005.
2. "System Verilog for Verification- A Guide to Learning the Testbench Language Features", Christian B Spear, 3rd Edition, Springer Publications, 2012.
3. "System Verilog for Design", Sutherland, 1st Edition, Springer Publications, 2006.

UE15EC455:
RECONFIGURABLE COMPUTING (2-0-0-0-2)

Course Objectives:

- To introduce to the basic concepts of computing and the issues in system design.
- To bring in the significance of reconfigurable computing which helps in addressing some of the issues of system design like resource and timing constraint.
- To illustrate architectures and computing models and to identify the trends and latest development of the technologies in the area.
- To study various technological algorithms

Course Outcomes:

Students completing the course should be able to

1. Know the strengths of Reconfiguration factors to be considered in building reconfiguration systems
2. Build reconfigurable system
3. Apply reconfiguration concepts while building systems to address resource constraints, area constraint etc
4. Architecture development

Course Content:

1. **Device Architecture:** Logic—The Computational Fabric, The Array and Interconnect, Extending Logic Configuration; Reconfigurable Computing Architectures: Reconfigurable Processing Fabric Architectures, RPF Integration into Traditional Computing Systems
2. **Reconfigurable Computing Systems:** PAM, VCC, and Splash, Small-scale Reconfigurable Systems, Reconfigurable Supercomputing; Reconfiguration Management: Configuration Architectures, Managing the Reconfiguration Process, Reducing Configuration Transfer Time
3. **Compute Models and System Architectures:** Compute Models, System Architectures; Programming FPGA Applications in VHDL: VHDL Programming; Technology Mapping: Structural Mapping Algorithms, Integrated Mapping Algorithms, Mapping Algorithms for Heterogeneous Resources

Pre-requisite Courses: UE15EC353 – Digital System Design Using HDL

Reference Books:

1. "Reconfigurable Computing", Scout Hauck and Andre Dehon, Elsevier, 2008.
2. "Partial Reconfiguration on FPGAs Architectures", Dirk Koch, Tools and Applications, Springer, 2013.
3. "Multicore Technology: Architecture, Reconfiguration and Modeling", Muhammad Yasir Qadri, Stephen J. Sangwine, CRC Press, 2014.

UE15EC456:
PHYSICS & TECHNOLOGY OF SEMICONDUCTOR NANOSCALE DEVICES (2-0-0-0-2)

Course Objectives:

- Concepts of classical physics are inadequate for explaining the properties of semiconductor structures of ultra-small dimensions. This course intends to introduce students to the fascinating world of man-made quantum-scale structures and their application in electronic and optoelectronic devices.

Course Outcomes:

Students completing the course should be able to

- Understand different types of semiconductor nanoscale structures with introduction to their fabrication processes.
- Learn both semiclassical and quantum mechanical models for electronic transport and optical properties of nanoscale semiconductor structures.
- Learn application of the said concepts in building nanoscale electronic and optical devices.
- Be able to design nanostructures with given physical properties using the physics and the computational techniques learnt in this course.

Course Content:

1. **Semiconductor Heterostructure:** Evolution of nanoscale/ quantum semiconductor devices; Growth techniques of heterostructures: Molecular Beam Epitaxy (MBE), Nanolithography; Band-offset of heterostructures: Theoretical model & experimental methods; Lattice mismatched structures – Strained-layers; Electron States: Effective-mass approximation, quantum particle in a box, energy levels of electrons & holes in unstrained and strained layer heterostructures; Formation of subbands, k.p method; Density of states for bulk (3D), 2D, 1D and 0D
2. **Electronic Transport in Nanosystems:** Boltzmann Transport Theory and the solution of Boltzmann Transport Equation (BTE) for 2DEG; Carrier Scattering Processes in bulk and in 2DEG (Two-Dimensional Electron Gas) - phonon and interface roughness scattering, Scattering Rate for 2DEG, collision integral for 2DEG , Fermi's Golden Rule; Mobility; High-field Velocity of 2DEG : Theory and experimental results; Ballistic Transport and resistance of ultra-small (molecular) interconnects
3. **Optical Interaction Phenomena:** Physics of intersubband transitions; Scattering-induced broadening of photoluminescence spectrum
4. **Nanoscale Electronic Devices:** Nanoscale Field Effect Transistors, FinFET; High Electron Mobility Transistor; Resonant Tunneling & Quantum Interference Devices: Theory of Resonant Tunneling, Microwave and Millimeter-Wave Resonant-Tunneling Devices, Resonant Tunneling Superlattice Devices: Physics and Circuits
5. **Nanoscale Optical and Optoelectronic Devices:** QW lasers, detectors, modulators and switches;

Pre-requisite Courses: UE15EC313 – Semiconductor Devices

Reference Books:

1. "Introduction to Nanoelectronics", Marc Baldo, MIT OCW Publication, 2011.
2. "Electronic Transport in Mesoscopic Systems", Supriyo Datta, Cambridge University Press, 1995.
3. "Physics of Quantum Well Devices", B. R. Nag, Kluwer Academic, 2002.
4. "Physics of Quantum Electron Devices", F. Capasso (Ed.), Springer-Verlag, 1990.
5. "Fundamentals of Modern VLSI Devices", Y. Taur and T.H. Ning, Cambridge University Press, 2009.
6. "Quantum Wells, Wires and Dots", Paul Harrison, 2nd Edition, John Wiley & Sons, 2005.
7. "Introduction to Mesoscopic Physics", Y. Imry, Oxford University Press, 1997.

UE15EC457: MULTIMEDIA COMMUNICATION (2-0-0-0-2)

Course Objectives:

- To learn the multimedia communication standards and compression techniques.
- To understand Video Compression Techniques.
- To learn the Coding Techniques used in real time Communication.

Course Outcomes:

Students completing the course should be able to

- Explain needs of multimedia processing.
- List multimedia standards for audio, video and image.
- State the properties of different media streams; compare and contrast different multicast protocol
- Develop coding for video Compression.
- Apply lossy or loss less compression Technique for real time signals.

Course Content:

1. **Multimedia Communications:** Introduction, multimedia information representation, multimedia networks, multimedia applications, media types, communication modes, network types, multipoint conferencing, network QoS application QoS.
2. **Multimedia Information Representation:** Introduction, digital principles, text, images, audio, video**.**
3. **Text And Image Compression:** Introduction, compression principles, text compression, image compression
4. **Audio And Video Compression:** Introduction, audio compression, DPCM, ADPCM, APC, LPC, video compression, video compression principles, H.261, H.263, MPEG, MPEG-1, MPEG-2, and MPEG-4.
5. **Multimedia Information Networks:** Introduction, LANs, Ethernet, Token ring, Bridges, FDDI High-speed LANs, LAN protocol.

Prerequisite Courses:UE15EC302 – Digital Signal Processing

Reference Books:

1. "Multimedia Communications: Applications, Networks, Protocols, and Standards", Fred Halsall, Addison Wesley, 1st Edition, 2000.
2. "Multimedia Information Networking", Nalin K. Sharda, PHI, 2003.
3. "Multimedia Fundamentals: Vol 1 – Media Coding and Content Processing", Ralf Steinmetz, Klara Narstedt, Pearson Education, 2004.
4. "Multimedia Systems Design", Prabhat K. Andleigh, Kiran Thakrar, PHI, 2004.
5. "Fundamentals of Multimedia", Ze-Nian Li and Mark S. Drew, Pearson Education, 2004.

UE14EC458: DSP ARCHITECTURE (2-0-0-0-2)

Course Objectives:

- To understand the architecture of a digital signal processor
- To learn some programming issues in fixed -point and floating point digital signal processor
- To learn real -time implementation of a digital signal processor

Course Outcomes:

Students completing the course should be able to

- Understand the architecture of floating and fixed point Processor
- To Programme DSP TMS320C5X Processor
- Apply the Concepts of floating point Processor in real time Applications
- Design a real-time signal processing algorithms using the latest DSP processor.
- Design of Filters for real time Signals.

Course Content:

1. **Fundamentals of Programmable DSP's:** Multiplier and Multiplier Accumulator, Modified Bus structure and Memory Access in PDSPs, Multiple accesses Memory, Pipelining, Special Addressing Mode, on chip peripherals.
2. **TMS320C5X Processor:** Bus Structure, Internal Architecture, Assembly level syntax, Addressing Modes, Assembly language Instructions, Some Programs in C5X Processor
3. **TMS320C3X Processor:** Overview of C3X Devices, internal architecture, CPU, Addressing modes, Assembly language Instructions
4. **Application Programs in C3X:** Example Programs, Convolution, Processing real time sequence.
5. **Advanced Processors:** Architecture of TMS320C54X: Bus Structure, CPU, Multiplier, Barrel Shifter, MAC Unit, Pipe line operation.

Pre-requisite Courses: UE15EC302 – Digital Signal Processing

Reference Books:

1. "Digital Signal Processors", B Venkataramani and M Bhaskar, TMH, 2002.
2. "Digital Signal Processing", Avatar Singh and S Srinivasan, Thomson Learning, 2004.
3. "Digital Signal Processors: Architectures, Implementations, and Applications", Kuo S M, Gan W S , Prentice Hall, 2005.
4. "Digital Signal Processing A Practical Approach", Ifeachor E. C., Jervis B.W., 2 Edition,, Pearson Education, 2002.
5. "Digital Signal Processing and Applications with the C6713 and C6416 DSK", Rulph Chassaing, A John Wiley and Sons Inc. 2005.

M.TECH IN ELECTRONICS AND COMMUNICATION ENGINEERING

Program Educational Objectives

1. Train and prepare students to be Electronics and Communication engineering professionals; strong and sound in fundamentals of science and engineering that facilitate innovative skills and strategies to help solve problems of industry and society.
2. Facilitate students to be conversant in design, development and implementation skills through application of technologies related to Electronics and Communication engineering, in a sustained manner.
3. Prepare graduates to pursue professional ethics in all their endeavours, adapt well to perform their roles as an individual, team-member, leader and possess good communicative skills that help foster sound inter-personal relationships in their engagement in industry and society.
4. To inculcate and engage in research in the field of Electronics and Communication engineering that facilitate publications, promote consulting and industry partnerships.
5. To prepare students secure befitting placements in industries, be competent globally both as employees and entrepreneurs in their chosen areas of specialization.

Program Outcomes:

1. **Scholarship of Knowledge:** To acquire in depth knowledge in the field of Electronics and Communication Engineering with specialization in VLSI and Embedded Systems,Signal Processing and Communication and apply the same in the design and development of Software and Hardware Systems
2. **Critical Thinking:** Analyze complex problems in Electronics Communication & Engineering and its associated domains; analyze alternative designs for trade-offs between various design factors such as power, performance and accuracy.
3. **Problem Solving:** Identify, formulate and critically study the problem, understand the interplay between theory and practice, design and develop efficient algorithms, conduct experiments, analyzing the results and applying the knowledge to different domains by considering social, environmental, economic, and security constraints.
4. **Research Skill:** Critically analyze existing literature in an area of specialization, conduct investigative research to develop innovative methodologies to tackle issues identified and contribute to the development of technological knowledge and intellectual property.
5. **Modern Tool Usage:** Apply current techniques, skills and modern computing tools to build and analyze robust, reliable, maintainable, scalable and efficient computing systems
6. **Collaborative and Multidisciplinary work:** Enhance skills and continuously acquire advanced knowledge in Electronics and Communication Engineering, multi and inter disciplinary domains for professional excellence.
7. **Project Management and Finance:** Manage and execute complex software/Hardware engineering projects under economic, time and performance constraints both working in teams and in an individual capacity.
8. **Communication**: Contribute and communicate effectively with the society confidently, be able to write effective reports and design documents by adhering to the appropriate standards, make effective presentations, give and receive clear instructions
9. **Life-long Learning**: Engage in lifelong learning with persistent scientific temper for professional advancement and effective communication of the technical information.
10. **Ethical Practices and Social Responsibility:** Become a complete professional with high integrity and ethics, with excellent professional conduct and with empathy towards the environmental and contribute to the community for sustainable development of society
11. **Independent and Reflective Learning:** Critically evaluate the outcomes of one's actions and apply self corrective measures to improve the performance.

UE18EC501
ADVANCED DIGITAL COMMUNICATION (4-0-0-0-4)

Course Objectives:

This course will expose the students to the digital communication coding, including signal design, modulation methods, demodulation methods, and spectral characteristics of digitally modulated signals. Students will learn concepts of Digital Communications through fading Multipath channels

Course Outcomes:

At the end of the course, the student should be able to

- Understand the concepts of advanced digital communication systems.
- Apply different modulation schemes to baseband signals.
- Analyze the characteristics of M-ary Bandpass Modulated signals.
- Analyze the digital modulated wave in various fading Channels

Course Contents:

1. **Source Coding**: Coding Techniques for Analog sources: Temporal Waveform Coding, Spectral Waveform coding, Model based Source Coding. Coding for Discrete sources: Coding for discrete memory less sources, discrete stationary sources, Lempel-Ziv Algorithm.
2. **Characterization of Communication Signals and Systems:** Representation of Band pass signals and systems, Signal space representation, Representation of digitally modulated signals, spectral characteristics of digitally Modulated signals.
3. **Baseband Modulation and demodulation** : Spectral Attributes of PCM Waveform Bits per PCM Word and Bits per Symbol, M-ary Pulse Modulation Waveforms Correlative Coding, Detection of Binary Signals in Gaussian Noise, Intersymbol Interference, Linear Equalization.
4. **Bandpass modulation and Demodulation:** Digital Band Pass Modulation Techniques, Detection of Signals in Gaussian Noise, Coherent and non Coherent Detection, Error Performance for Binary Systems, M-ary Signaling and Performance, Symbol Error Performance for M-ary Systems (M> 2)
5. **Digital Communications through Fading Multipath Channels:** Characterization of fading multipath channels, effect of signal characteristics, Diversity techniques, Digital Signalling over a frequency selective slowly fading channel.

Prerequisites: Nil

Reference Books:

1. "Digital Communications: Fundamentals & Applications", Bernard Sklar and Dorling Kindersley, Prentice Hall, 2009.
2. "Digital Communications" , John G Proakis , McGraw Hill, 4^{th} Edition, 2001.
3. "Digital Communication Systems Using Matlab & Simulink", David Silage, Bookstand Publishing, 2009.
4. "Digital Communication Systems", Simon Haykin, Wiley Student Edition, 2013.

UE18EC502
DIGITAL VLSI (4-0-0-0-4)

Course Objectives:

- The course aims to provide an understanding of the design of digital circuits at switch-level and various design parameters associated with these circuits.
- It will familiarize the students with the implementation of digital circuits in Mentor Graphics Tool and also help them verify the RTL schematic by simulation.
- The key focus will be on the different design techniques used for the implementation of combinational and sequential circuits and the design trade-offs.
- The course also gives an introduction to the design of semiconductor memories.

Course Outcomes:

Students completing the course should be able to

- Understand the fundamentals of MOS devices.
- Working principles of CMOS circuits.
- Able to build systems with CMOS devices
- Will have the basic knowledge of timing analysis
- Will have the knowledge of layout diagrams and design rules

Course content:

1. **MOS Devices & Circuits:** VLSI Design flow (full-custom and semi-custom), VI characteristics of MOS transistor, Transconductance and output conductance, CMOS inverter, estimation of CMOS inverter delay,Components of Energy and Power Switching, Short-Circuit and Leakage Components, Noise margin, transistor sizing, second order effects. CMOS fabrication : p-well, n-well, twin-tub process.
2. **MOS Circuit Design Process:** MOS layers, Layout diagrams: MOS design style and CMOS design style, Lambda based design rules, Contact cuts, Basic circuits concepts : sheet resistance, Area capacitance, Delay unit, Inverter delays, Propagation delays,
3. **CMOS Circuit Design Techniques:** Static CMOS Circuits: Pass transistor, Transmission gate, Complementary CMOS, CMOS circuits with ratioed Logic, Dynamic logic circuits, Noise Margins, propagation delay and power dissipation consideration for various design techniques, Issues with dynamic logic circuit design technique. Concepts of Logical Efforts and its application in design.
4. **Semiconductor Memories:** Memory Classification, Memory Architectures and Building Blocks, ROM: NOR ROM array, NAND ROM array, RAM: Dynamic Random Access memory: DRAM Cell types, DRAM Operation modes, Static Random Access Memory: 6T SRAM cell – Read and Write operation, Design of Row and Column Decoders.
5. **Analysis of Sequential Circuits:** Basic Latch and Flip Flop operation, Introduction to pipelining, Origins of Clock Skew / Jitter and Impact on Performance, Problems on max and min Delay constraints at design level. Scaling of MOS Circuits: Scaling models, Scaling factors, parameters for scaling.

Prerequisites: Nil

Reference Books:

1. “Digital Integrated Circuits–A Design Perspective”, Jan, M. Rabaey, Chandrakasan Anantha, and Nikolic Borivoje, Pearson, 2nd Edition., 2003.
2. “CMOS digital integrated Circuits”, Kang, S.M. and Leblebici, Y, Tata McGraw-Hill Education, 3rd Ed., 2003.
3. “Introduction to VLSI Circuits and Systems”, Uyemura, John P, Wiley, 2002.
4. “CMOS VLSI design – A circuits and Systems Perspective”, Neil Weste and David Harris, Pearson/Addison-Wesley, 3rd Edition, 2005.

UE18EC503
ADVANCED EMBEDDED SYSTEMS (4-0-0-0-4)

Course Objectives:

- To educate students to meet current and future industrial challenges and emerging embedded systems engineering trends.

Course Outcomes:

At the end of the course, the student should be able to

- Design and implement applications on ARM based controllers.
- Write applications in assembly and embedded C.
- Develop systems with RTOS features like inter process communication, process synchronization techniques, process scheduling algorithms.
- Interface peripherals with standard buses like I2C,SPI, UART and USB.
- Understand embedded system’s hardware components and software tool chain.
- Design an embedded system, debug and test it.

Course Contents:

1. **Typical Embedded systems:** Core of the embedded system, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other system Components;
2. **Characteristics and quality attributes of Embedded systems:** Hardware-software co-design and program modeling: Fundamental Issues in Hardware-Software Co-design, Computational Models in embedded design, Introduction to Unified modeling language, Hardware software trade off; Embedded firmware design and development: Embedded firmware design approaches, Embedded development Languages; Advanced Memories: non-blocking cache memories; memory protection, translation, and virtualization; and memory synchronization, consistency, and coherence
3. **ARM -32 bit Microcontroller:** Architecture of ARM Cortex M3 – General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Register, Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M0, Exceptions Programming, Advanced Programming Features, Memory Protection, Debug Architecture;
4. **Real Time Operating system(RTOS) based Embedded system design:** operating system basics, Types of OS, Tasks , processes, threads, Multi-processing and Multi-tasking, Task Scheduling, threads, processing and scheduling, putting them together; Task communication, task synchronization, Device drivers, How to choose an RTOS; Communication Interfaces: I2C bus,SPI bus ,USB bus ,UART and CAN bus
5. **The Embedded system development Environment:** the Integrated development environment (IDE), Types of files generated on cross compilation, disassembler/Decompilers, Emulators and debugging, target hardware debugging, Boundary scan; Case study of Embedded systems: Two cases

Prerequisites: Nil

Reference Books:

1. “Introduction to Embedded Systems”, K.V. Shibu, TMH Education Pvt. Ltd. 2009.

2. “Embedded Systems- A Contemporary Design Tool”, James K. Peckol, John Wiley, 2008.
3. “Computer Architecture: A Quantitative Approach”, J. L. Hennessy and D. A. Patterson, 5th Edition, Morgan Kaufmann, 2012.

UE18EC504
MODERN DIGITAL SIGNAL PROCESSING (4-0-0-0-4)

Course Objectives:

- Digital signal processing and analysis is a major field in the current era of engineering, applications ranging from mobile, wireless, satellite communications, acoustics, forensic sciences, biomedical, imaging, speech, space-science and many more.
- In this course, students are introduced to advanced digital signal processing which involves multirate signal processing and their applications in signal processing as well as communication systems.
- This course also covers the relevant background theory for understanding and designing multirate systems.

Course Outcomes:

Students completing the course should be able to

- Analyse and process signals in the discrete domain.
- Design FIR and IIR filters to suit specific requirements for specific applications.
- Designing filters in multiple stages to reduce computational complexity
- Understand the applications of multirate systems and filter banks
- Designing M-channel quadrature mirror filters
- A good understanding of Wavelet Transform and its relation to multirate filter banks

Course Content:

1. **Review of Signals and Systems:** Signals, Systems and Processing, Classification of Signals**,** The Concept of Frequency in Continuous-Time and Discrete-Time Signals**,** Analog-to-Digital and Digital-to-Analog Conversion; Discrete Fourier transform, its properties and applications; Frequency-Domain Sampling: The Discrete Fourier Transform**,** Properties of the DFT**,** Linear Filtering Methods Based on the DFT**;**
2. **Design of digital filters:** General Considerations, Design of FIR Filters, Design of IIR Filters from Analog Filters, Frequency Transformations;
3. **Multirate Digital Signal Processing** : Introduction, EL Decimation by a factor ‘D’, Interpolation by a factor ‘I’, Sampling rate Conversion by a factor ‘I/D’, implementation of Sampling rate conversion, Multistage implementation of Sampling rate conversion, Sampling rate conversion of Band Pass Signals, Sampling rate conversion by an arbitrary factor, Applications of Multirate Signal Processing;
4. **DFT Filter Banks and Transmultiplexers**: Digital Filter Banks, Two-channel quadrature Mirror filter bank, M-channel QMF bank, transmultiplexers and Application of transmultiplexers in communications Modulation;
5. **Introduction to Time Frequency Expansion:** Introduction, The STFT, The Gabor Transform, The Wavelet Transform and its relation to Multirate Filter Banks

Prerequisites: Nil

Reference Books:

1. “Digital Signal Processing”, Proakis and Manolakis, 4th Edition, Prentice Hall, 1996.
2. “Modern Digital Signal Processing”, Roberto Cristi, Cengage Publishers (Erstwhile Thompson Publications), India, 2003.
3. “Multirate Systems and Filter Banks”, P. P. Vaidyanathan, Pearson Education, Inc., 1993.
4. “Digital Signal Processing: A Computer Based Approach”, S.K. Mitra, 3rd Edition, Tata McGraw Hill, India, 2007.

UE17EC505
ENGINEERING MATHEMATICS (4-0-0-0-4)

Course Objectives:

The course will help students to develop skills and ability to think and analyze problems critically. The recap on Fourier and Laplace’s Transforms would aid them in various domains of communication, control and signal processing. Introduction of the matrix operations to solve systems of linear equations and perform various operations. The course also gives an introduction to the vector spaces, linear transformation and fundamental subspace , orthogonality of vectors & subspaces, eigen values and eigen vectors for diagonalization.

Course Outcomes:

Students would be able to:

1. Formulate problems into a mathematical form, analyze and obtain solutions.
2. Apply fundamental mathematical properties to calculate Fourier and Inverse Fourier Transforms.
3. Solve systems of linear equations using matrix transformations and interpret the nature of solutions.
4. Skill to work in vector spaces and understand the concept of the four vector spaces.
5. Analyze linear transformation as a mapping and calculate matrix representation .
6. Understand the concepts of orthogonal vectors and subspaces.
7. Find eigen value and eigen vectors of a matrix.

Course Content:

1. **Fourier Transforms:** Fourier Integral Theorem , Fourier Sine and cosine integrals, Definitions of Fourier Transform and its inverse, Fourier sine and cosine transforms and their inverses, properties- linearity, FT of derivatives, Fourier sine and cosine transform of derivatives, convolution Theorem (no proof), Finite Fourier sine and cosine transforms; Self Learning Component: Parseval’s identity for Fourier Transforms (no proof);
2. **Laplace’s Transforms:** Definition, Transfomation of standard functions, periodic functions, Laplace’s Transforms of Derivatives and Integrals, unit step and unit impulse functions. Inverse Laplace’s Transforms: Definition, Inverse Laplace’s Transforms of standard functions, Different methods of finding Inverse Laplace’s Transforms, Convolution Theorem, Application of Laplace’s Transform to solve differential equations.
3. **Matrices and Gaussian Elimination:** Introduction, Geometry of linear equations , Gaussian Elimination, Triangular factors & Row exchanges, Inverses and transposes; Inverse by Gauss Jordan Method. Self Learning Component: Matrix notation and multiplication;
4. **Vector Spaces:** Vector spaces, subspaces (only definitions), Linear independence, basis and dimension, the four fundamental subspaces; Self Learning Component: Pivot variables & Free variables,
5. **Linear transformations & Orthogonality:** Linear transformations, Orthogonal vectors & subspaces, cosines, projections & least squares; Self Learning Component: Projections onto lines.

Orthogonalization, Eigen Values and Eigen Vectors: Orthogonal bases and Gram- Schmidt Orthogonalization, Introduction to Eigen values & Eigen vectors, Diagonalization of a matrix; Self Learning Component: Single Value Decomposition and Applications

Reference Books:

1. "Higher Engineering Mathematics" , B.S. Grewal, 42nd Edition Khanna Publishers, 2005.
2. "Higher Engineering Mathematics" , B.V. Ramana , McGraw Hill Education (India) Pvt. Ltd., 19th Reprint , 2013
3. "Linear Algebra and its Applications", G. Strang, Thomson Brooks/Cole, 4th Edition, 2nd Indian Reprint, 2007.

UE18EC506
RESEARCH METHODOLOGY (2-0-0-0-2)

Course Objectives:

- To give the concept of research methodologies, problem identification and formulation for the students.
- Improve the paper writing skill using different software for technical writing.

Course Outcomes:

Students completing the course should be able to

- Understand and apply basic research methods including research design, data analysis, and interpretation.
- Comprehend variety of research methods, including survey research, case studies, comparative analysis, and the use of documentary/primary sources.
- Understand the ethical issues in research project.
- Prepare for and present a conference paper/poster at a national/ international conference.
- Apply different software for preparation dissertation report and to perform plagiarism check.

Course Content:

1. **Foundations of Research:** Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process.
2. **Problem Identification & Formulation:** Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis – Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance, Literature Survey.
3. **Research Design:** (i) Concept and Importance in Research – Features of a good research design – Exploratory Research Design, Descriptive Research Designs, Experimental Design, Qualitative and Quantitative Research, Measurement: Concept of measurement –what is measured? Problems in measurement in research – Validity and Reliability.
4. **Paper Writing**: Layout of a Research Paper, Journals in electronics and communication, Impact factor of Journals, when and where to publish Ethical issues related to publishing, Plagiarism and Self – Plagiarism.
5. **Use of Tools / Techniques for Research:** methods to search required information effectively, Reference Management Software like Zotero/Mendeley, LaTeX/MS Office, Software for detection of Plagiarism.

Prerequisites: Nil

Reference Books:

1. "Research Methodology: Methods and Techniques", C. R. Kothari , New Age International Publications, 1985.
2. "Research Methodology", R. Panneerselvam, PHI Learning , 2004.

UE18EC511
ADVANCED WIRELESS COMMUNICATIONS (4-0-0-0-4)

Course Objectives:

- The chief objective is to introduce the advanced concepts in modern wireless communication.
- It provides an overview of OFDM & MIMO techniques, 3G and 4G systems and standards.

Course Outcomes:

At the send of the course, students should be able to

- Understand the basic concepts of wireless communications.
- Understand different factors relating to performance of wireless links.
- Understand the 3G and 4G networks.
- Develop research problems in next generation networks.

Course Content:

1. **Wireless Communication Models :** Ray-tracing models and shadowing, Fast Fading Wireless Channel Modeling, Rayleigh/ Ricean Fading Channels, Power Delay profile, RMS Delay Spread, Coherence Bandwidth,, Flat and Frequency fading, Capacity in Frequency selective channels, Concept of Diversity – Frequency, Time, Space (Brief discussion only)
2. **Concept of OFDM:** Introduction to OFDM, Multicarrier Modulation and Cyclic Prefix, Channel model and SNR performance, OFDM Issues – PAPR, Frequency and Timing Offset Issues.
3. **Concept of Multi-Input Multi-Output (MIMO) Systems:** Introduction to MIMO, MIMO Channel Capacity, SVD and Eigenmodes of the MIMO Channel, MIMO Spatial Multiplexing, Alamouti Scheme
4. **Ultra Wide Band :** UWB Definition and Features, UWB Wireless Channels, UWB Data Modulation, Uniform Pulse Train, Bit-Error Rate Performance of UWB.
5. **Wide Area Networks:** 3G networks - Physical layer and link layer profile and Standards, 4G networks - LTE-Advanced – Physical layer and link layer profile and standards.

Prerequisites: Nil

Reference Books:

1. "Wireless Communications," Goldsmith, Cambridge University Press, 2005.
2. "Fundamentals of Wireless Communication," D. Tse and P. Viswanath, CUP, 2005.
3. "MIMO-OFDM Wireless Communication with MATLAB," Y. S. Cho, J. Kim, W. Y. Yang, and C.-G. Kang, Wiley, 2010.

UE18EC512
ANALOG INTEGRATED CIRCUITS (4-0-0-0-4)

Course Objectives:

- At the end of the course students would understand the theoretical models of MOSFET and would be able to analyse and design a CMOS analog circuit against given specifications and implement the same using CAD tools.

Course Outcomes:

Students completing the course should be able to

- Analyse the performance capabilities of current digital communication systems.
- Analyse the Band pass analog and digital modulation and demodulation
- Develop a solution to overcome errors in baseband transmission.
- Analyse the performance of different types of equalizers used in receiver communication systems in mitigating the ISI effects.
- Analyse the performance of Digital modulation Techniques such as ASK, PSK, QPSK and QAM

Course Content:

1. **Overview of the physics of MOS and Single Stage Amplifiers:** Formation of inversion layer, drain-current equation, pinch-off, MOS I/V characteristics and channel length modulation, MOSFET small-signal model of single stage amplifiers such as CS, CG, source follower and cascode with resistive, current-source and MOSFET load, Frequency response and noise analysis of single stage amplifier stages
2. **Differential Amplifier**: Short overview of basic differential pair, Common mode response, Differential pair with MOSFET loads, Gilbert cell with explanation and application
3. **Passive and Active Current Mirrors**: Overview of basic current mirror, Cascode mirrors with advantages and limitations, Active Current Mirrors, Current mirrors for low-voltage application
4. **Operational Amplifiers:** One and two-stage op-amp, Gain boosting - application of cascode, folded cascode and and active-cascode stages, Common mode feedback, Slew Rate and ICMR,CMRR and PSRR – definition and analysis, Frequency compensation – Need and techniques, Design technique with a hands-on example
5. **Phase-Locked Loop:** Fundamentals of type-I and type-II PLLs, Design of a PLL with an example.

Prerequisites: Nil

Reference Books:

1. "Design of Analog CMOS Integrated Circuits", Behzad Razavi, India Edition, TMH, 2002.
2. "Analysis and Design of Analog Integrated Circuits", Paul R. Gray, P.J. Hurst, S.H. Lewis and R.G. Meyer, , 4th Edition, John Wiley & Sons 2001,
3. "CMOS Analog Circuit Design", Phillip E. Allen and Douglas R. Holberg, 2nd Edition, Oxford University Press 2002.

UE18EC513
REAL TIME EMBEDDED SYSTEMS (4-0-0-0-4)

Course Objectives:

- The primary goal of this course is to meet the basics of real-time systems and enable the students with the knowledge and skills necessary to design and develop embedded applications by means of real-time operating systems.

Course outcomes

Students completing the course should be able to

1. Use the multitasking techniques in real-time systems.
2. Use real time scheduling policies in applications
3. Design embedded applications using RTOS.
4. Use RTOS software mechanisms
5. Identify real time service and estimate the WCET and schedule it

Course content:

- **Introduction to Real-Time Embedded Systems:** Brief history of Real Time Systems, A brief history of Embedded Systems; System Resources: Resource Analysis, Real-Time Service Utility, Scheduling Classes, The Cyclic Executive, Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies, Real-Time OS, Thread Safe Reentrant Functions
- **Processing:** Preemptive Fixed-Priority Policy, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline –Monotonic Policy, Dynamic priority policies; I/O Resources: Worst-case Execution time, Intermediate I/O, Execution efficiency, I/O Architecture.
- **Distributed Operating Systems:** Topology – Network types – Communication – RPC – Client server model – Distributed file system – Design strategies; (i) Real Time Models And Languages: Event Based – Process Based and Graph based Models – Petrinet Models – Real Time Languages – RTOS Tasks – RT scheduling - Interrupt processing – Synchronization – Control Blocks – Memory Requirements
- **Memory:** Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash file systems; (i) Multi-resource Services: Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion; (ii) Soft Real-Time Services: Missed Deadlines, QoS, Alternatives to rate monotonic policy, Mixed hard and soft real-time services;
- **Embedded System Components:** Firmware components, RTOS system software mechanisms, Software application components; High availability and Reliability Design: Reliability and Availability, Similarities and differences, Reliability, Reliable Software, Available Software, Design trade offs, Hierarchical applications for Fail-safe design; Modularizing An Application For Concurrency: Introduction, An Outside-In approach to decomposing applications, Guidelines and recommendations for identifying concurrency, schedulability analysis.

Pre-requisites: Nil

Reference Books:

1. "Real-Time Embedded Systems and Components", Sam Siewert, Cengage Learning India Edition, 2007.
2. "Programming for Embedded Systems", Dreamtech Software Team, Jhon Wiley, India Pvt. Ltd., 2008.
3. "Real Time Concepts for Embedded Systems", Qing Li and Croline Yao CMP Books, India Edition, 2011.

UE18EC514
IMAGE AND VIDEO PROCESSING (4-0-0-0-4)

Course Objectives:

This course will establish the advanced concepts and techniques for processing the images on a computer or processors

Course Outcomes:

Students completing the course should be able to

- Analyze general terminology of digital image processing.
- Examine various types of images, intensity transformations and special filtering.
- Evaluate the methodologies for image filtering and restoration.
- Implement data compression algorithms and evaluate methodologies for video processing.

Course Content:

1. **Introduction:** 2D systems, Mathematical preliminaries – Fourier Transform, Z Transform, Optical & Modulation transfer function, Matrix theory, spectral density function.

2. **Image Perception:** Light, Luminance, Brightness, Contrast, MTF of the visual system, Visibility function, Color representation, Chromaticity diagram, Color coordinate systems, Color vision model, Temporal properties of vision. Image Transforms, Introduction,2D-orthogonal and unitary transforms, Properties of unitary transforms, DFT, DCT, DST, Hadamard, Haar, Slant, KLT, SVD transform.
3. **Image Enhancement:** Point operations, Histogram modelling, spatial operations, Transform operations, Image filtering & restoration, Image observation models, Inverse &Wiener filtering, Fourier Domain filters, Least squares filters.
4. **Image analysis & Computer Vision:** Spatial feature extraction, Transform features, Edge detection, Boundary Extraction, Boundary representation, Image segmentation, Classification Techniques, Image data compression, Introduction,Pixel-coding,Predictive techniques, Transform coding.
5. **Video processing:** Fundamental Concepts in Video – Types of video signals, Analog video, Digital video, Color models in video, Video Compression Techniques – Motion compensation, Search for motion vectors, H.261,H.263,H.264, MPEG .

Prerequisites: Nil

Reference Books:

1. Fundamentals of Digital Image Processing", Anil K Jain, Pearson Education Pvt. Ltd. Prentice Hall of India, 2004
2. "Fundamentals of Multimedia", Z. Li and M.S. Drew, Pearson Education Pvt. Ltd, 2004.
3. R.C.Gonzalez and R.E.Woods, "Digital Image Processing", Prentice Hall, 2nd Edition, 2005.
4. "Digital Image Processing", M.Tekalp, Prentice Hall, USA, 1995.

UE18EC521
SECURE COMMUNICATIONS (4-0-0-0-4)

Course Objectives:

- The course aims to provide an in-depth understanding of the various algorithms used for network security and data security.
- Upon completion of this course, the student will have sound knowledge in the mathematical background of communication by secure means.
- In this course, the students will learn various types of secure communications relating to cryptography and water marking.

Course Outcomes:

At the end of the course, students should be able to

- Understand the basic concepts of data security and network security.
- Design algorithms for encryption and decryption.
- Implement digital watermarking in the spatial domain and frequency domain.

Course Content:

1. **Introduction:** Data security and network security. Cryptography and watermarking Rings and fields, Homomorphism, Euclidean domains, Principal Ideal Domains, Unique Factorization Domains, Field extensions, Splitting fields, Divisibility, Euler theorem, Chinese Remainder Theorem, Primality;
2. **Cryptography Algorithms:** Basic encryption techniques, Concept of cryptanalysis, Shannon's theory, Perfect secrecy, Block ciphers, Cryptographic algorithms - Features of DES, Stream ciphers, Pseudo random sequence generators, linear complexity, Non-linear combination of LFSRs, Boolean functions;
3. **Cryptography Systems:** Private key and Public key cryptosystems, One way functions , Discrete log problem, Factorization problem, RSA encryption, Diffie Hellmann key exchange, Message authentication and hash functions, Digital signatures, Secret sharing, features of visual cryptography, other applications of cryptography;
4. **Elliptic Curves, Basic Theory :** Weirstrass equation, Group law, Point at Infinity, Elliptic curves over finite fields, Discrete logarithm problem on EC, Elliptic curve cryptography, Diffie Hellmann key exchange over EC, Elgamal encryption over EC – ECDSA;
5. **Watermarking:** Watermarking in spatial domain, Additive methods, spread spectrum based methods, Information theoretic approach for watermarking, Watermarking in frequency domain, Based on Discrete cosine transform, Discrete Wavelet transform and Contourlet transform, different methods - Comparison between frequency domain and spatial domain methods

Prerequisite Courses: Nil

Reference Books:

1. "Cryptography -Theory and Practice", Douglas A. Stinson, 3rd Edition, CRC Press Company, 2005.
2. "Elliptic Curves: Number Theory and Cryptography", Lawrence C. Washington, 2nd Edition, CRC Press, 2008.
3. "Primality and Cryptography", Evangelos Kranakis, John Wiley & Sons, 1986.
4. "Analysis and Design of Stream Ciphers", Rainer A. Ruppel, Springer Verlag, 1986.
5. "Digital Watermarking and Steganography", Ingemar Cox, Matthew Miller, Jeffrey Bloom, Jessica Fridrich, Ton Kalker, Second Edition, Morgan Kaufman, 2007.
6. "Fundamentals of Digital Image Watermarking", Fernando Perez Gonzalez, Sviatoslav Voloshynovskiy, John Wiley & Sons, 2009.

UE18EC522
ADVANCED SEMICONDUCTOR DEVICES (4-0-0-0-4)

Course Objectives:

- At the end of the course students would understand the fundamentals of semiconductors and their usage in electronic and optoelectronic devices and be able to design devices against a given specification

Course Outcomes:

Students completing the course should be able to

- Appreciate the physics of crystals and semiconductors.
- Understand the fundamentals of electron transport and optical phenomena in semiconductors.
- Understand in detail the fundamentals of semiconductor electronic and optoelectronic devices.
- Be able to design a device against a given specification.

Course content:

1. **Crystalline Solids and Band Theory:** Introduction to semiconductor and crystal structure, crystal lattice and translational symmetry. Reciprocal lattice and Miller Indices. Lattice planes and fundamental types of lattices, e.g., simple cubic, f.c.c. and b.c.c. and more complex crystal lattices like diamond, Si, Ge and GaAs, Bragg-Equation and determination of crystal structure with X-rays. Band Theory of solids (Schrödinger equation for electrons in a crystal lattice, periodic potential and Bloch The-

orem, Kronig-Penney Model – Dirac Comb, band structure), direct and indirect semiconductors, Effective mass approximation (what's the need?), expression of effective mass for materials with parabolic and linear dispersion, Idea of "holes" and their behaviour, intrinsic and extrinsic semiconductors (p and n type), Heterostructures and charge confinement.

2. **Charge Carriers in Thermal Equilibrium:** Density of States (DOS) in 3D, 2D, 1D and 0D, population distribution of charge carriers (Fermi-Dirac statistics and the idea of Fermi level. Electron density in semiconductor and the concept of majority and minority carriers, Transport and optical phenomena in different levels of confinement and their device usage, Effect of magnetic field (Hall Effect) and measurement of majority carrier density.
3. **Steady-State Dynamics of Charge Carriers:** Conductivity in bulk semiconductor: Scattering of charge carriers, relaxation time, how to combine effects of different scattering mechanisms, carrier mobility, drift & diffusion transport – Einstein Relation. Quantum of conductance and the genesis of Ohm's Law in the current era of nanostructures. Carrier generation & recombination (optical absorption & emission). Dependence of conductivity on optical absorption. Charge injection and the idea of Quasi-Fermi level, physics of p-n junction with a brief introduction to transient response of p-n junctions.
4. **Electron Devices:** Brief recapitulation of Bipolar Devices (Junction Diode and BJT – Ebers-Moll Model), Physics of long and short channel MOSFET. Introduction to nanoscale MOSFET (SOI and trigate MOSFETs), SPICE models of MOSFET, brief introduction to quantum-well electron devices;
5. **Electro-Optic and Photonic Devices:** Photodetector (Photoconductor and Photodiode), LED (Light Emitting Diode). Semiconductor Laser: Physics of stimulated emission in p-n junction, structure and operation of laser diode, brief introduction to quantum-well optical devices

Prerequisites: Nil

Reference Books:

1. "Solid State Electronic Devices", B. G. Streetman and S. K. Banerjee, Prentice-Hall of India, 2006.
2. "Fundamentals of Modern VLSI Devices",. Taur and T. H. Ning, Cambridge University Press, 1998.
3. "Semiconductor Device Physics and Design", Umesh K. Mishra and Jasprit Singh, Springer, 2008.
4. "Physics of Quantum Well Devices", B. R. Nag, Kluwer Academic, 2002.
6. "Physics of Quantum Electron Devices", F. Capasso (Ed.), Springer-Verlag, 1990.

UE18EC523
SPEECH PROCESSING (4-0-0-0-4)

Course Objectives:

- To teach students basics of speech signal processing, analysis and modeling of speech signals driven by ever demanding applications to cater present needs.
- To provide an understanding of discrete-time speech signal processing techniques that are motivated by speech model building,
- Introduce applications such as speech modification, speech enhancement, speech coding, speech recognition, biometrics etc.,
- To show students how signal processing algorithms are driven by both time and frequency-domain representations of speech production, as well as by aspects of speech perception.

Course outcomes

Students completing the course should be able to

- Characterize speech signal in relation to production and hearing of speech by humans.
- Design few basic algorithms for speech analysis
- Construct/develop speech recognition, synthesis and coding and
- Illustrate practical aspects of speech algorithms implementation.
- Design a simple system for speech processing (speech activity detector, recognizer of limited number of isolated words).

Course content:

1. **Speech Production and Acoustic Phonetics:** Anatomy and Physiology of Speech Organs; Articulatory phonetics; Acoustic phonetics; Acoustic theory of speech production, Lossless tube models, and Digital models for speech signals; Coarticulation and Prosody; Hearing and Speech perception: Sound Perception; Response of the ear to complex Stimuli; Perceptually important Features of Speech signals; Models of Speech Perception; Vowel Perception and consonant perception; Duration and phonemic cue; Intonation and other aspects of speech perception;
2. **Time Domain Models for Speech Processing:** Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech vs. silence discrimination, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Median smoothing; Short time Fourier analysis and synthesis: Linear Filtering interpretation, Filter bank summation method, Overlap addition method, Design of digital filter banks, Implementation using FFT, Spectrographic displays, Pitch detection, Frequency-Domain Pitch period estimation, Analysis by synthesis, Analysis synthesis systems;
3. **Analysis and Synthesis of Pole-Zero Speech Models:** All-pole modeling of Deterministic Signals; Linear prediction analysis of Stochastic speech sounds; Basic principles of linear predictive analysis, Solution of LPC equations, Prediction error signal, Frequency domain interpretation, Relation between the various speech parameters, Synthesis based on all-pole modeling, Pole-zero estimation; decomposition of Glottal Flow Derivatives;
4. **Homomorphic Signal Processing :** Homomorphic systems for convolution, Complex cepstrum of speech like sequences, spectral-root Homomorphic filtering; Short-time Homomorphic analysis of periodic sequences, Short-time speech analysis/ synthesis using Homomorphic processing, Contrasting Linear prediction and Homomorphic filtering, Pitch detection, Formant estimation, and Homomorphic vocoder;
5. **Speech Synthesis and Recognition:** Principles of speech synthesis, Synthesizer methods, Synthesis of intonation. Automatic Speech Recognition: Introduction, Speech recognition vs. Speaker recognition, Signal processing and analysis methods, Pattern comparison techniques, Hidden Markov Models.

Pre-requisites: Nil

Reference Books:

1. "Discrete-time Speech Signal Processing: Principles and Practice", Thomas F. Quatieri, Pearson Education (Singapore) Pvt. Ltd., 2002.
2. "Speech Communications: Human and Machine", D. O'Shaughnessy, Universities Press, 2001.
3. "Digital Processing of Speech Signals", L. R. Rabiner and R. W. Schafer, Pearson Education (Asia) Pte. Ltd., 2004.

4. "Fundamentals of Speech Recognition", L. R. Rabiner and B. Juang, Pearson Education (Asia) Pvt. Ltd., 2004.
5. "Discrete-Time Processing of Speech Signals",J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis, IEEE Press, 2000.

UE18EC531
OPTICAL FIBER COMMUNICATION AND NETWORKING (4-0-0-0-4)

Course Objectives:

- Student should be able to design the components with specifications for a given fiber optic communication system.
- Students will be prepared not only to contribute to disciplines such as current optical devices, optical communication link, equipment designs but also to understand quickly any further technology developments for future enhanced networks.

Course Outcomes:

At the end of the course, students should be able to

- Identify the basic elements of optical fiber transmission link and configure optical fiber for various fiber modes.
- Find the different kind of losses, signal distortion in optical wave guides and other signal degradation factors
- Use the various optical source materials, Laser diodes, LED structures and find quantum efficiency
- Apply fiber optical receivers such as PIN, APD diodes and hence improve noise performance in photo detector, receiver operation and configuration.
- To use and implement fiber optical network components, variety of networking aspects, FDDI, SONET/SDH and operational principles WDM.

Course Content:

1. **Overview of Optical Fiber Communication:** (i) Motivations for Lightwave Communications, Optical Spectral Bands, Fundamental Data Communication Concepts Network Information Rates, WDM Concepts, Key elements of optical Fiber Systems; (ii) Optical Fibers.
2. **Optical Sources :** Review of Semiconductor Physics, Light Emitting diodes, Laser Diodes; Power Launching and Coupling Source to Fiber Power Launching, Lensing schemes for Coupling Improvement, Fiber- to- Fiber joints, LED coupling to Single Mode Fibers, Fiber Splicing, Optical fiber connectors (Qualitative); Photodetectors Physical principles of photodiodes, Photodetector Noise, Detector Response Time, Avalanche Multiplication Noise, Structure for InGaAs APDs, Temperature effect on Avalanche gain, Comparison of Photodetectors.
3. **Optical Receiver Operation:** Fundamental Receiver Operation, Digital Receiver Performance, Eye Diagrams, Coherent Detection, Burst Mode Receivers, Analog Receivers; Digital Links Point to point links, Link Power Budget, Rise -Time Budget; Analog links – Overview of Analog links, Carrier to Noise Ratio, Multichannel Transmission Techniques, RF over Fiber, Radio over Fiber links, Microwave Photonics.
4. **WDM Concepts and Components:** Overview of WDM, Passive Optical couplers, Isolators and circulators, Fiber Grating filters, Dielectric thin film filters, Phased array based devices, Diffraction Gratings Active optical components, and Tunable Light sources.
5. **Optical Amplifiers:** Basic applications and types of Optical amplifiers, Semiconductor Optical Amplifiers. Erbium doped fiber amplifiers, Raman Amplifiers, Wideband Optical Amplifiers; Nonlinear Effects General overview of Nonlinearities, Effective Length and Area, Stimulated Raman scattering, Stimulated Brillouin scattering, Self Phase modulation, Cross Phase modulation. Four wave mixing FWM mitigation, Wavelength Converters, Solitons; Optical Networks: Network concepts, Network topologies, SONET / SDH, High speed light wave links, Optical Add/Drop multiplexing, optical switching, WDM Network examples

Pre-requisites: Nil

Reference Books:

1. "Optical Fiber Communications", Gerd Keiser, 4th Edition, TMH, 2008.
2. "Fiber – Optic Communication Systems", Govind P. Agarwal, 3rd Edition, John Wiley & Sons, 2002.
3. "Optical Fiber Communication: Principles and Practices", John M. Senior, 2nd Edition, PHI, 1993.

UE18EC532
TESTING OF VLSI CIRCUITS (4-0-0-0-4)

Course Objectives:

- This course aims at demonstrating the concepts of testing and applying the various test strategies to VLSI circuits. The course targets those engineers who upon graduation engage in electronic hardware design, testing or manufacturing projects.
- The course also gives a good foundation for students intending to continue their research in the area of testing.

Course Outcomes:

Students completing the course should be able to

- Apply various VLSI testing methodologies for any digital circuit.
- Develop fault models, testing strategies for combinational/ sequential circuits.
- Analyse and develop test for delay faults in the digital circuits
- Develop fault models and testing strategies for analog circuits
- Effectively use the concepts for testing VLSI systems using existing test methodologies, tools and equipment.

Course content:

1. **Introduction to Testing:** Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends Affecting Testing, Types of Testing; Fault Modeling: Defects, Errors, Faults, Functional Versus Structural Testing, Levels of Fault Models, Single Stuck-at Fault, Fault Equivalence, Equivalence of Single Stuck-at Faults, Fault Collapsing, Fault Dominance and Checkpoint Theorem
2. **Combinational Circuit Test Generation:** Algorithms and Representations, Structural vs. Functional Test, Definition of Automatic Test-Pattern Generator, ATPG Algebras, Redundancy Identification (RID), Testing as a Global Problem, Definitions, D-Calculus and D-Algorithm. PODEM and FAN algorithms
3. **Sequential Circuit Test Generation:** ATPG for Single-Clock Synchronous Circuits ,Time-Frame Expansion Method, Use of Nine-Valued Logic, Implementation of Time-Frame Expansion Methods, Complexity of Sequential ATPG, Cycle-Free Circuits, Cyclic Circuits ,Clock Faults and Multiple-Clock Circuits, Asynchronous Circuits, Simulation-Based Sequential Circuit ATPG: CONTEST Algorithm.
4. **Delay Test:** Delay Test Problem, Path-Delay Test, Transition Faults, Delay Test Methodologies, Slow-Clock Combinational Test, Enhanced-Scan Test, Normal-Scan Sequential Test, Variable-Clock Non-Scan Sequential Test, Rated-Clock Non-scan Sequential Test
5. **Model-based Analog and Mixed -Signal Testability:** Analog Testing difficulties, Analog Fault Models, Levels of Abstaraction,

Types of Analog Testing, Analog Fault Simulation, Motivation, DC Fault simulation of Nonlinear Circuits,Linear Analog Circuit AC Fault Simulation, Analog Automatic Test-Pattern Generation, ATPG Using Sensitivites, ATPG using Signal Flow Graphs

Reference Books:

1. "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits" M. Bushnell and V. D. Agrawal, Kluwer Academic Publishers, 2000.
2. "Digital Systems Testing and Testable Design" M. Abramovici, M. A. Breuer and A. D. Friedman, IEEE Press, 1990.
3. "Digital Circuit Testing and Testability", P. K. Lala,, Academic Press, 1997.

UE18EC533
ADAPTIVE SIGNAL PROCESSING (4-0-0-0-4)

Course Objectives:

- To understand the principles of adaptive systems and its properties;
- To analyze and implement algorithms for adaptations;
- To use adaptive algorithms in important practical situations

Course Outcomes:

Students completing the course should be able to

- Describe the properties of optimal mean square filters.
- Explain the conditions for stable adaptive algorithms.
- Use the Wiener filter in given applications.
- Apply adaptive algorithms in given applications.
- Characterize and examine the properties of adaptive algorithms.

Course content:

1. **Adaptive Systems:** Definition and Characteristics; areas of application; general properties; open- and closed-loop adaptation; applications of closed-loop adaptation; Adaptive Linear Combiner: General description; input signal and weight vectors; desired response and error; the performance function; gradient and minimum mean-square error; alternative expression of the gradient; decorrelation of error and input components.
2. **Properties of the Quadratic Performance Surface:** Normal form of the input correlation matrix; eigenvalues and eigenvectors of the input correlation matrix; geometrical significance of eigenvectors and eigenvalues.
3. **Searching the Performance Surface:** Methods of searching the performance surface; basic ideas of gradient search methods; a simple gradient search algorithm and its solution; stability and rate of convergence; the learning curve; gradient search by Newton's Method; Newton's Method in multidimensional space; gradient search by the Method of Steepest Descent; comparison of learning curves.
4. **Gradient Estimation and Its Effect on Adaptation:** Gradient component estimation by derivative measurement; the performance penalty; derivative measurements and performance penalties with multiple weights; variance of the gradient estimate; effects on the weight-vector solution; excess mean-square error and time constants; misadjustment; comparative performance of Newton's and Steepest-Descent Methods; total misadjustment and other practical considerations.
5. **LMS Algorithm:** Derivation of the LMS algorithm; convergence of the weight vector; an example of convergence; learning curve; noise in the weight-vector solution; misadjustment; performance; Other Algorithms: Discrete Kalman filter; normalized and other LMS-based adaptive filters; recursive least squares algorithm. Applications: Adaptive Modeling and System Identification, Adaptive Interference Cancellation etc

Pre-requisites: Nil

Reference Books:

1. " Adaptive Signal Processing", B. Widrow and S. D. Stearns, Pearson Education Asia, 1985.
2. "Statistical Digital Signal Processing and Modeling", M. H. Hayes, John Wiley, 2002.
3. 'Adaptive Filter Theory", S. Haykin, (), 4^{th} edition, Pearson Education Asia. 2002.
4. "Adaptive Signal Processing", T Adali, S Haykin , Wiley-India, 2010.

UE18EC541
ERROR CONTROL CODING (4-0-0-0-4)

Course objectives

- The course aims to provide an in-depth understanding of the various channel coding and decoding techniques and also provides insight into data security.
- Understand the concepts of detecting and correcting the errors during data transmission.

Course Outcomes:

At the end of the course, students should be able to

- Completely analyse the data to be fed for modulation after channel encoding.
- Design of error correcting codes for efficient Transmission.

Course content

1. **Linear Block Codes:** Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Error correcting capabilities, Standard array and Syndrome decoding, Decoding circuits, Hamming Codes, Reed – Muller codes, The (24, 12) Golay code, Product codes and Interleaved codes
2. **Cyclic codes:** (i) Introduction, Generator and Parity check Polynomials, Encoding using Multiplication circuits, Systematic Cyclic codes – Encoding using Feedback shift register circuits, Generator matrix for Cyclic codes, Syndrome computation and Error detection, Meggitt decoder, Error trapping decoding, Cyclic Hamming codes, The (23, 12) Golay code, Shortened cyclic codes;
3. **BCH codes:** Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction. Non – binary BCH codes: q – ary Linear Block Codes, Primitive BCH codes over GF (q), Reed – Solomon Codes, Decoding of Non – Binary BCH and RS codes: The Berlekamp - Massey Algorithm, Majority Logic Decodable Codes, One – Step Majority logic decoding.
4. **Convolutional codes:** Encoding of Convolutional codes, Structural properties, Distance properties, Viterbi Decoding Algorithm for decoding, Soft – output Viterbi Algorithm.
5. **Concatenated codes & turbo codes:** (i) Single level Concatenated codes, Multilevel Concatenated codes, Soft decision Multistage decoding, Concatenated coding schemes with Convolutional Inner codes, Introduction to Turbo coding and their distance properties, Design of Turbo codes; (ii) Burst – error – correcting codes: Burst and Random error correcting codes, Concept of Inter – leaving, cyclic codes for Burst Error correction – Fire codes, Convolutional codes for Burst Error correction.

Prerequisites: Nil

Reference Books:

1. "Error Control Coding", Shu Lin & Daniel J. Costello, Second Edition, Pearson / Prentice Hall, 2004.
2. "Theory and Practice of Error Control Codes", Blahut, Addison Wesley, 1984.

UE18EC542
ADVANCED SOC ARCHITECTURE (4-0-0-0-4)

Course Objectives:

- To study a System - on - chip (SOC) architecture which is an ensemble of processors, memories, and interconnects tailored to an application domain.
- To Customize Instruction Processor and learn Reconfiguration Technologies

Course outcomes:

Students completing the course should be able to

- Perform computer system design
- Fundamental ideas and analytical techniques that are applicable to a range of applications and architectures.
- Aware of complementary treatments on embedded software development and electronic system – level design.

Course Content:

1. **Introduction to the System Approach:** System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing, System level interconnection, An approach for SOC Design, System Architecture and Complexity.
2. **Chip Basics:** Time, Area, Power, Reliability, and Configurability, Introduction : Design Trade-Offs , Requirements and Specifica-tions, Cycle Time Defining a Cycle Optimum Pipeline Perfor-mance, Die Area and Cost , Ideal and Practical Scaling, Power Area–Time–Power Trade-Offs in Processor Design, Reliability, Configurability, Area Estimate of Reconfigurable Device
3. **Processors:** Introduction , Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling; Buffers: minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors;
4. **Memory Design for SOC:** Overview of SOC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation , SOC Memory System, Models of Simple Processor – memory interaction.;
5. **Interconnect Customization and Configuration:** Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses , Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. (i) SOC Customization: An overview, Customizing Instruction Processor, Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance- Specific design, Customizable Soft Processor, Reconfiguration - overhead analysis and trade-off analysis on reconfigurable Parallelism; (ii) Application Studies / Case Studies: SOC Design approach, AES algorithms, Design and evaluation, Image compression – JPEG compression; Introduction to Network on Chip

Prerequisites: Nil

Reference Books:

1. "Computer System Design System-on-Chip", Michael J. Flynn and Wayne Luk, Wiely India Pvt. Ltd., 2011.
2. "ARM System on Chip Architecture", Steve Furber, 2nd Edition, Addison Wesley Professional. 2000.
3. "Design of System on a Chip: Devices and Components", Ricardo Reis, 1st Edition,, Springer, 2004.

UE18EC543
DETECTION AND ESTIMATION (4-0-0-0-4)

Course Objectives:

- To understand the basics of binary hypothesis testing leading to signal detection theory with Neyman-Pearson and Bayesian approaches.
- To understand the fundamentals of single- and multi-parameter estimation theory with deterministic and Bayesian philosophies.

Course Outcomes:

Students completing the course should be able to

- Representation of Random signals.
- Apply hypotheses test.
- Detection and estimation of Signal with Gaussian noise.
- Detection and estimation of Signal with nonwhite Gaussian noise.
- Design of Kalman-Bucy liner filter and optimum linear filters.

Course content:

1. **Classical Detection and Estimation Theory:** Introduction, simple binary hypothesis tests, M Hypotheses, estimation theory, composite hypotheses, general Gaussian problem, performance bounds and approximations.
2. **Representations of Random Processes:** Introduction, orthogonal representations, random process characterization, homogenous integral equations and eigen functions, periodic processes, spectral decomposition, vector random processes.
3. **Detection of Signals: (Estimation of Signal Parameters):** Introduction, detection and estimation in white Gaussian noise, detection and estimation in nonwhite Gaussian noise, signals with unwanted parameters, multiple channels, multiple parameter estimation.
4. **Estimation of Continuous Waveforms:** Introduction, derivation of estimator equations, a lower bound on the mean-square estimation error, multidimensional waveform estimation, nonrandom waveform estimation.
5. **Linear Estimation:** Properties of optimum processors, realizable linear filters, Kalman-Bucy filters, fundamental role of optimum linear filters.

Prerequisites: Nil

Reference Books:

1. "Detection, Estimation, and Modulation Theory, Part I", H. L. Van Trees, John Wiley & Sons, USA. 2001.
2. "Introduction to Statistical Signal Processing with Applications", M.D. Srinath, P.K. Rajasekaran and R. Viswanathan,, Pearson Education (Asia) Pte. Ltd. /Prentice Hall of India, 2003.
3. "Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory", S. M. Kay, Prentice Hall, USA, 1993.
4. "Fundamentals of Statistical Signal Processing Volume II: Detection Theory", S. M. Kay, Prentice Hall, USA. 1998.

UE18EC551
WIRELESS NETWORK ARCHITECTURES (4-0-0-0-4)

Course Objectives:

- Understanding the concept of wireless media.
- Understanding the concept of wireless networks.
- Making the students capable of addressing the design issues and exploring various emerging protocols for wireless networks.
- To know about 4G networks

Course Outcomes:

Students completing the course should be able to

- Analyze the frequency spectrum for wireless communication systems and how to improve performance of wireless communication systems.
- Distinguish between various wireless standards.
- Distinguish between various diversity techniques for wireless systems.

Course content:

1. **Review of Fundamentals of Wireless Communication and Networks:** Wireless communication channel specifications, Wireless communication systems, Wireless networks, Switching technology, Communication problems, Wireless network issues and standards;
2. **Wireless Body Area Networks:** Properties, Network architectures, Components, Technologies, Design issues, Protocols and applications;
3. **Wireless personal area networks:** Architectures, Components, Requirements, Technologies and protocols, DECT, Bluetooth and Zigbee
4. **4G networks:** LTE-A
5. **Wireless Ad-hoc Networks:** Mobile ad-hoc networks, Sensor network, Mesh networks, VANETs, Research issues in Wireless networks

Prerequisites: Nil

Reference Books:

1. "Wireless and Mobile Network Concepts and Protocols", S. S. Manvi, and M. S. Kakkasageri, 1st Edition, Wiley, 2010.
2. Wireless Communications and Networks, William Stallings, 2nd Edition, Prentice Hall, 2005.
3. "Principles of Wireless Network: A Unified Approach", P. Kaveh, Krishnamurthy, PHI, 2006.
4. "Wireless Communication And Network: 3G and Beyond", Iti Saha Mitra , McGraw Hill, 2009.
5. "Handbook of Wireless Networks and Mobile Computing", Ivan Stojmenovic, Wiley, 2009.
6. "Wireless Network", P. Nicopolitidis, M. S. Obaidat, G. I. Papadimitriou and A. S. Pomportsis., Wiley, 2009.
7. "Wireless and Mobile Network Architectures", Yi-Bing Lin, Imrich Chlamtac, Wiley, 2009.
8. "Introduction to Wireless Telecommunication Systems and Networks", Mullet, Cengage, 2009.

UE18EC552
HETEROGENEOUS COMPUTING (4-0-0-0-4)

Course Objectives:

- Introduce concepts, languages, techniques, and patterns for programming heterogeneous, parallel processors.
- To introduce the concept of data parallel execution models, memory models for managing locality
- To compare multicore with multithreading
- Simulation of memory model and super scalar execution-SIMD and Vector Processing-Multi-core CPU-GPU Architecture on OPENCL

Course Outcomes:

Students completing the course should be able to

- Implementation of hardware based speculation algorithm.
- To demonstrate the implementation of parallel code using OpenCL.

Course Content:

1. **Introduction:** Fundamentals, SuperScalar Processor Design, Introduction to Multicore Architecture – Chip Multiprocessing, Multiprocessors-SIMD-MIMD-Challenges in parallel processing, homogeneous Vs heterogeneous design , SMP – Multicore Vs Multithreading
2. **Shared memory architectures**: Cache Memory – Cache Coherency Protocols, Design of Levels of Caches – Programming for Multilcore architecture, Multicore programming model – message passing model – OpenMP and MPI programming
3. **Exploiting ILP:** Software scheduling-Loop, Unrolling-Loop Transformation, Dynamic Scheduling, Hardware Based speculation, Branch Prediction
4. I**ntroduction to Opencl**: OpenCL SDK kit-Platform and Devices-Execution Environment-Memory model-Writing kernel- Matrix Multiplication example. OPENCL DEVICE ARCHITECTURE: Super scalar execution-SIMD and Vector Processing-Multi-core CPU-GPU Architecture-APU 12 IT2013 SRM (E&T);
5. **C Programming for Linux** Graphic Processing Units – GPU Vs CPU – Accelerated Processing Unit , openCL overview – parallel programming – code template – interoperability – parallel algorithms – task and data decomposition – CPU to GPU communication

Prerequisites: Nil

Reference Books:

1. "Computer Organization and Design: The Hardware/Software Interface", David A. Patterson and John L. Hennessy, Elsevier. ISBN: 978- 0-12-374493-7, 2011.
2. "Parallel Computer Architecture", D. E. Culler and J. P. Singh and A. Gupta, Morgan- Kaufmann publishers, ISBN: 978- 1-55860-343-1, 1998.
3. "Heterogeneous computing with Open CL", Benedict R. Gaster and Lee Howe, Elsevier Publishers, ISBN: 978-0-12-387766-6, 2012.

UE18EC553
VERIFICATION OF VLSI CIRCUITS (4-0-0-0-4)

Course Objectives:

- This course aims at familiarizing the students with importance of verification
- Provide an understanding of the various terms associated with verification. System verilog assertions, simulation based verification, verification plan and methodology – for digital circuits.
- This course also focuses on SOC verification using SVA.

Course Outcomes:

Students completing the course should be able to

- Perform code coverage analysis
- Use different simulators to perform verification-based simulation
- Prepare a verification plan and verify designs successfully.
- Plan verification for SOC components and interfaces

Course Content

1. **Importance of Design Verification:** What is verification? What is a test bench? The importance of verification, Reconvergence model, Formal verification, Equivalence checking, Model checking, Functional verification; Verification Tools: Linting tools: Limitations of linting tools, linting verilog source code, code reviews, Code coverage, Functional Coverage. Verification Languages, Assertions, Stimulus and response, Event based simulation, cycle based simulation.
2. **Simulation methodology:** System-Level Verification, SOC Hardware RTL Verification, SOC Software Verification, Netlist Verification, Physical Verification, Device Test, RTL Verification using Verilog; Static Timing Verification: Concept of static timing analysis. Cross talk and noise. Limitations of STA. slew of a wave form, Skew between the signals, Timing arcs and uniteness, Min and Max timing paths, clock domains, operating conditions, critical path analysis, false paths, Timing models; A sample system under verification, Block level verification, System level verification, Functional coverage, SVA for transaction log creation, SVA for FPGA Prototyping
3. **System Verilog Assertion For Protocol Interface:** PCI - A Brief Introduction, A sample PCI Read transaction, A sample PCI Write transaction A sample PCI System, Scenario I - Master DUT Device, PCI Master assertions, Scenario 2 - Target DUT Device, PCI Target assertions, Scenario 3 - System level assertions PCI Arbiter assertions; Implementation of case studies using SVA.
4. **The verification plan:** The role of verification plan: specifying the verification plan, defining the first success. Levels of verification: unit level verification, reusable components verification, System level verification, board level verification, verifying strategies, verifying responses. Verifying strategies, verifying responses.
5. **Stimulus and Response:** Reference Signals, Simple Stimulus, Simple Output, Complex Stimulus, Bus-Functional Models, Layered Bus-Functional Models, Response Monitors, Transaction-Level Interface, Self-Checking Testbenches, Directed Stimulus Random Stimulus. Case studies: SOC verification (Hands on session)

Prerequisites: Nil

Reference Books:

1. "Writing Testbenches using SystemVerilog", Janick Bergeron, 2nd Edition, Springer, 2006.
2. "Static Timing Analysis for Nanometer Designs A Practical Approach", Jayaram Bhasker, Rakesh Chadha, Springer Publications, 2009.
3. "System-On-Chip Verification: Methodologies and Techniques", Prakash Rashinkar, Peter Paterson and Leena Singh, Kluwer Academic Publishers, 2002.
4. "System Verilog Assertions" Vijay Raghavan, 1st Edition, Springer Publications, 2005.

UE18EC554
PATTERN RECOGNITION AND CLASSIFICATION (4-0-0-0-4)

Course Objectives:

- The main objective of this course is to introduce the fundamentals of pattern recognition and classification.
- In this course students will learn about Bayesian decision theory, Maximum likelihood estimation, Hidden Markov Models, some of the non-parametric techniques.
- They will also be introduced to linear discriminant functions and unsupervised learning.

Course Outcomes:

Students completing the course should be able to

- Understand the major concepts and techniques in pattern recognition.
- Acquire abilities to solve problems in specialized application areas such as speech recognition, signal classification, etc.
- Capable of designing pattern recognition systems and QAM

Course Content:

1. **An Introduction to Pattern Recognition Systems.** Design of Pattern Recognition Systems using Bayesian Decision Theory**.**
2. **Study of Parametric Techniques for Pattern Recognition Systems using Examples.** Includes Maximum-likelihood and Bayesian Parameter Estimation. PCA, FDA and MDA. Hidden Markov Models.
3. **Study of Non-parametric Techniques for Pattern Recognition Systems using Examples.** Includes Density estimation using Parzen windows and k_n-nearest-neighbour estimation. Design of classifiers using Probabilistic Neural Network architecture and Nearest-neighbour rule. An overview on metrics. Density approximation using series expansions**.**
4. **Study of Linear Discriminant Functions for Pattern Recognition Systems.** Includes Perceptron Learning, Criterion functions, relaxation procedures, Minimum squared error procedures and Ho-Kashyap procedure.
5. **An introduction to Support Vector Machines; (i)** Study of Unsupervised Learning techniques for Pattern Recognition Systems: Includes criterion functions for clustering. Examples using k-Means Clustering, Fuzzy K-means clustering, Hierarchical clustering, On-line clustering, Nearest Neighbour clustering. Low-dimensional representation and multi-dimensional scaling**.**

Prerequisites: Nil

Reference Books:

1. "Pattern Classification" Richard O. Duda, Peter E. Hart and David G. Stork, 2nd Edition, John Wiley, 2001
2. "Pattern Recognition and Image Analysis," Eart Gose, Richard Johnsonburg and Steve Joust, Prentice-Hall of India, 2003.
3. "Pattern Recognition and Machine Learning," Christopher M. Bishop, 3rd Edition, Springer, 2007.
4. "Statistical Pattern Recognition," Andrew R. Webb, 2nd Edition, John Wiley, 2002.

UE17EC611
OPTIMIZATION I (2-0-0-0-2)

Course Objectives:

- Introduce the students to a variety of optimization problems using case studies spreading domains such as communications, smart grids, finance, planning, etc.
- Enabling the students to formulate optimization problems, identify the structure of the problem, apply solution methods and solve the problems using open source optimization software.

Course Outcomes:

At the end of the course, students should be able to

- Understand and identify the structure of various classes of optimization problems
- Formulate and solve optimization problems
- Analyze the structure of the formulation and apply suitable solution method
- Apply decomposition and approximation techniques to optimization problem.
- Run simulations using software such as CVX and CPLEX

Course Content:

1. **Introduction:** Review of linear algebra using geometry, Optimization problem structure, types and complexity, System design
2. **Unconstrained optimization problems:** single variable and multivariable solution methods, Introduction to solvers: CVX and CPLEX.
3. **Linear Programming:** Standard form of LP, structural properties, Simplex method, Duality and Economic interpretation, Formulating and coding LP problems
4. **Integer programming:** Structure and Types, Formulating and coding IP problems, Branch and bound methods, Cutting plane method, MINLP to MILP conversion, Benders Decomposition for MIP
5. **Case studies:** Coding using CVX

Prerequisite Courses: Nil

Reference Books:

1. "Linear Algebra", Paul Dawkins, Lamar University, 2007.
2. "Introduction to Applied Optimization", Urmila Diwekar, 2nd edition, Springer, 2008
3. "Convex Optimization", Stephen Boyd and L. Vandenberghe, Cambridge University Press, 7th Edition, 2004.
4. "Partitioning Procedures for Solving Mixed-Variables Programming Problems, Computational Management Science", J. F. Benders, Springer-Verlag, 2005.

UE17EC612:
INTRODUCTION TO ANTENNA THEORY (2-0-0-0-2)

Course Objectives:

- This course aims to give an in-depth understanding of antenna arrays, travelling wave antennas, and aperture antennas. This course will enable the students to choose proper antenna to the desired specifications and design the antennas.

Course Outcomes:

At the end of the course, students should be able to

1. Solve problems in uniformly and non uniformly excited arrays incorporating the mutual coupling.
2. Analyze and design aperture antennas like offset feed parabolic reflectors and dual reflectors.
3. Analyze and design broadband antennas.

Course Content:

1. **Arrays:** Nonuniformly excited equally spaced linear arrays, Mutual coupling, Multidimensional arrays, Phased arrays, Feeding techniques, Perspectives on Arrays.
2. **Travelling wave antennas:** Helical antennas, Biconical antennas Sleeve antennas, and Principles of frequency independent antennas, Spiral antennas, and Log - periodic antennas;
3. **Aperture antennas:** Techniques for evaluating gain, Reflector antennas - Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, Offset parabolic reflectors,
4. **Dual reflector antennas:** Gain calculations for reflector antennas, Feed antennas for reflectors, FiECS representations,
5. **Matching the feed to the reflector:** General feed model, Feed antennas used in practice.

Prerequisites: Nil

Reference Books:

1. "Antenna Theory and Design", Warren.L.Stuzman and Gary.A.Thiele, John Wiley and Sons, 3rd Edition, 2012.
2. "Antenna Theory Analysis and Design", C. A. Balanis, John Wiley, 2nd Edition, 1997.

UE17EC613
SELECTED TOPICS IN RECONFIGURABLE COMPUTING (2-0-0-0-2)

Course Objectives:

- To introduce to the basic concepts of computing and the issues in system design.
- To bring in the significance of reconfigurable computing which helps in addressing some of the issues of system design like resource and timing constraint.
- To illustrate architectures and computing models and to identify the trends and latest development of the technologies in the area.
- To study various technological algorithms

Course Outcomes:

Students completing the course should be able to

- Know the strengths of reconfiguration
- Understand the factors to be considered in building reconfiguration systems
- Build reconfigurable system
- Apply reconfiguration concepts while building systems to address resource constraints, area constraint etc
- Understand architecture development

Course Content:

1. **Device Architecture:** Logic—The Computational Fabric, The Array and Interconnect, Extending Logic Configuration; (i) Reconfigurable Computing Architectures: Reconfigurable Processing Fabric Architectures, RPF Integration into Traditional Computing Systems
2. **Reconfigurable Computing Systems:** PAM, VCC, and Splash, Small-scale Reconfigurable Systems, Reconfigurable Supercomputing; (i) Reconfiguration Management: Configuration Architectures, Managing the Reconfiguration Process, Reducing Configuration Transfer Time
3. **Compute Models and System Architectures:** Compute Models, System Architectures;
4. **Programming FPGA Applications in VHDL:** VHDL Programming
5. **Technology Mapping:** Structural Mapping Algorithms, Integrated Mapping Algorithms, Mapping Algorithms for Heterogeneous Resources

Prerequisites: Nil

Reference Books:

1. “Reconfigurable Computing”, Scout Hauck and Andre Dehon, Elsevier, 2008.
2. “Partial Reconfiguration on FPGAs Architectures, Tools and Applications”, Dirk Koch, Springer, 2013.
3. “Multicore Technology: Architecture, Reconfiguration, and Modeling”, Muhammad Yasir Qadri, Stephen J. Sangwine, CRC Press, 2014.

UE17EC614
ARTIFICIAL NEURAL NETWORK (2-0-0-0-2)

Course Objectives:

- To introduce artificial neural networks, evolutional computation and fuzzy systems.
- To make them understand the supervised and unsupervised neural networks.

Course Outcomes:

Students completing the course should be able to

- Analyse and compare the supervised and unsupervised neural networks.

Course Content:

1. **Introduction:** The Artificial Neuron: Calculating the net input signal, activation functions, artificial neuron geometry, artificial neuron learning;
2. **Supervised Learning Neural Networks:** Neural network types, supervised learning rules, functioning of hidden units, ensemble neural networks;
3. **Unsupervised Learning Neural Networks:** Background, Hebbian learning rule, principal component learning rule, learning vector quantizer-I, self -organizing feature maps;
4. **Radial Basis Function Networks:** Learning vector quantizer- II, radial basis function neural networks.
5. **Case studies:** Supervised and unsupervised learning

Prerequisites: Nil

Reference Books:

1. “Neural Networks: A Comprehensive Foundation,” S. Haykin, 2nd Edition, Prentice Hall of India, 2003.
2. “Neural Networks and Learning Machines”, S. Haykin, 3rd Edition, Prentice Hall of India, 2009.
3. “Applications of Neural Networks”, Alan Murray, Springer Science+Business Media, New York. 1995.

UE17EC661
OPTIMIZATION II (2-0-0-0-2)

Course Objectives:

- Introduce the students to a variety of optimization problems using case studies spreading domains such as communications, smart grids, finance, planning, etc.
- Enabling the students to formulate optimization problems, identify the structure of the problem, apply solution methods and solve the problems using open source optimization software.

Course Outcomes:

At the end of the course, students should be able to

- Understand and identify the structure of various classes of optimization problems
- Formulate and solve optimization problems
- Analyze the structure of the formulation and apply suitable solution method
- Apply decomposition and approximation techniques to optimization problem.
- Run simulations using software such as CVX and CPLEX

Course Content:

1. **Convex Optimization:** Convexity, convex geometry, Convex functions, Lagrangian relaxation and Duality, KKT conditions, Interior point method, Formulating convex problems - examples; Multi-objective problems;
2. **Convex Relaxations using Examples:** Semidefinite programming, SOCP, Geometric programming;
3. **Stochastic Programming (SP):** Deterministic versus stochastic optimization, Basic structure of SP and types of decisions, Two-stage stochastic programming, Solution method: L-shaped method
4. **Monte Carlo Methods and Other SP Types:** Sample average approximation, Stochastic decomposition; Brief overview of other SP formulations
5. **Case studies:** Examples from Commuication

Prerequisite Courses:

UE17EC611 – Optimization I

Reference Books:

1. “Approximate Dynamic Programming - II: Algorithms”, Warren B. Powell, Wiley Online Library, 2011.
2. “Introduction to Stochastic Programming”, J. R. Birge and F. Louveaux, Springer Series in Operations Research and Financial Planning, 2nd edition, 2011.
3. “Stochastic Programming,” Peter Kall and Stein W. Wallace, 2nd Edition, John Wiley & Sons, 2003.

UE17EC662:
ANTENNA DESIGN (2-0-0-0-2)

Course Objectives:

- This course aims to give an in-depth understanding of antennas and also advanced topics such as antenna synthesis and computational electromagnetic and this course will enable the students to apply the concepts of computational electromagnetics in antenna design.

Course Outcomes:

At the end of the course, students should be able to

- Understand the advanced topics in antenna design.
- Solve problems on antenna synthesis and solve problems by applying the method of moments.

Course Content:

1. **Antenna Synthesis**: Formulation of the synthesis problem, Synthesis principles, Line sources shaped beam synthesis, Linear array shaped beam synthesis, Fourier series, Woodward - Lawson sampling method,

2. **Comparison of shaped beam synthesis methods:** low sidelobe narrow main beam synthesis methods, Dolph Chebyshev linear array, Taylor line source method.
3. **Computational Electromagnetics:** Introduction of the methods moments, Pocklington's integral equation
4. **Integral equation and Kirchhoff's networking equations:** Source modeling weighted residual formulations and computational consideration,
5. **Calculations:** Calculation of antenna and scatter characteristics.

Prerequisites:

UE17EC612 – Introduction to Antenna Theory

Reference Books:

1. "Antenna Theory and Design", Warren.L.Stuzman and Gary.A.Thiele, John Wiley and Sons, 3rd Edition, 2012.
2. "Antenna Theory Analysis and Design", C. A. Balanis, John Wiley, 2nd Edition, 1997.

UE17EC663:
VLSI FOR DSP (2-0-0-0-2)

Course Objectives:

To expose to the basic concepts in digital processing system design with emphasis on the digital filter design and related algorithmic and implementation issues. Specifically, focus will be on FIR, IIR Filters classical and optimized design techniques, issues related to finite word length and advantage of specific structures for implementation.

Course Outcomes:

Students completing the course should be able to

1. Acquired knowledge about DSP algorithms, its DFG representation, pipelining and parallel processing approaches.
2. Ability to acquire knowledge about retiming techniques, unfolding ,folding and register minimization path problems.
3. Ability to understand the concepts of systolic architecture and its methodology.
4. Ability to have knowledge about different methods of convolutions.
5. Acquired knowledge on concepts of algorithmic strength reduction.

Course Content:

1. **Introduction to DSP systems:** Typical DSP Algorithms**,** DSP Application, Representations of DSP Algorithms**,** Iteration Bounds: Data flow graph Representations**,** Loop bound and Iteration bound**,** Algorithms for Computing Iteration Bound**,** Iteration Bound of multi rate data flow graphs**,** Pipelining and parallel processing **,**Pipelining of FIR Digital Filters**,** Parallel processing**,** Pipelining and parallel processing for low power
2. **Retiming**: Definition and Properties, Solving Systems of Inequalities, Retiming Techniques different methods
3. **Unfolding and folding:** Unfolding An Algorithm for Unfolding, Properties Of Unfolding, Critical path, Unfolding And Retiming, Folding transformation, Register minimization techniques, Register minimization techniques in folded architectures
4. **Application of Unfolding Systolic architecture design**: Systolic array design Methodology, FIR systolic array, Selection of Scheduling Vector, Matrix-Matrix Multiplication and 2D systolic Array Design, Systolic Design for space representation containing Delays
5. **Fast convolution Algorithms**: Cook-Toom Algorithm, Winograd Algorithm, Iterated convolution, Cyclic Convolution, Design of fast convolution Algorithm by Inspection, Algorithmic strength reduction in filters

Prerequisites: Nil

Reference Books:

1. "VLSI Digital Signal Processing Systems, Design and Implementation", Keshab K. Parthi, Wiley, Inter Science, 1999.
2. "Analog VLSI Signal and Information Processing", Mohammed Ismail and Terri Fiez, McGraw-Hill, 1994.
3. "VLSI and Modern Signal Processing", S.Y. Kung, H.J. White House, T. Kailath Prentice Hall, 1985.
4. "Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing", Jose E. France, Yannis Tsividis, , Prentice Hall, 1994.

UE17EC664
STATISTICAL SIGNAL PROCESSING (2-0-0-0-2)

Course Objectives:

- The main objective of this course is to introduce the fundamentals of statistical signal processing.
- To understand the basics of random process and signal modelling. To understand advanced filtering techniques which are adaptive in nature.

Course Outcomes:

Students completing the course should be able to

1. Analyze the signal modelling techniques
2. Implement Weiner filter and adaptive filters to suit specific requirements for specific applications.

Course Content:

1. **Random Processes:** Random variables, random processes, filtering random processes, spectral factorization, special types of random processes.
2. **Signal Modeling:** Least squares method, Padé approximation, Prony's method, finite data records, stochastic models.
3. **Levinson Recursion:** Levinson-Durbin recursion; Levinson recursion.
4. **Filtering:** Wiener Filtering: FIR and IIR Wiener filters, Discrete Kalman filter; Adaptive Filtering: FIR
5. **Adaptive filters:** adaptive recursive filters, recursive least squares.

Prerequisites: Nil

Reference Books:

1. "Statistical Digital Signal Processing and Modeling", Monson H. Hayes, John Wiley & Sons (Asia) Pvt. Ltd., 2002.
2. "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing", Dimitris G. Manolakis, Vinay K. Ingle, and Stephen M. Kogon, McGraw-Hill International Edition, 2000.
3. "Algorithms for Statistical Signal Processing", J.G. Proakis, C.M. Rader, F. Ling, C.L. Nikias, M. Moonen and I.K. Proudler, Pearson Education (Asia) Pvt.. Ltd, 2002.
4. "Adaptive Signal Processing", Bernard Widrow and Samuel D. Stearns, Pearson Education (Asia) Pvt. Ltd., 2001.
5. "Adaptive Filters", Simon Haykin, Pearson Education (Asia) Pvt. Ltd, 4th Edition, 2002.

ELECTRICAL AND ELECTRONICS ENGINEERING

B.TECH IN ELECTRICAL AND ELECTRONICS ENGINEERING

Program Educational Objectives:

1. Provide students with the knowledge of Basic Electrical and Electronics Engineering concepts so as to acquire the necessary skills for analysis and synthesis of problems in generation, transmission and distribution,
2. Prepare students to identify, analyze and solve complex problems related to industry and research by applying knowledge in Mathematics, Physical Sciences and Engineering Concepts
3. Train students to design, implement, install and commission an industrial real time system,
4. Support students to pursue their career in Industrial and Government organizations, with professional competence to handle critical situations and meet deadlines, and
5. Develop students' ability to communicate effectively, maintain professional ethics, work with team and engage with life-long learning.

Program Outcomes

1. Ability to apply the knowledge of Mathematics, Basic sciences and Engineering in all aspects of Electrical and Electronics Engineering
2. Ability to analyse and solve and to prepare formal technical plans leading to solutions for Electrical and Electronics systems
3. Broad knowledge in the field of Electrical and Electronics Engineering and methods of applying them to define, design, and develop solutions to practical problems
4. Ability to assess the feasibility, applicability, optimality and future scope of power networks and apparatus
5. Ability to apply the techniques of using appropriate tools to investigate, analyze, design, simulate and complete systems involving power controls and drives, smart controls and embedded systems
6. Appreciation of professional, social and environmental issues
7. Understanding of impact of deployment of renewable energy sources, controllers and power systems to environment and society
8. Understanding of the professional ethical practices as applicable to Electrical and Electronics Engineering
9. Ability to work in a team and comprehend his/her scope of work, deliverables and issues in which help is needed by other members of the team
10. Ability to participate and succeed in competitive examinations
11. Ability to develop skills in project management issues

UE18EE101:
BASIC ELECTRICAL ENGINEERING (4-0-0-0-4)

Course Objectives:

- Explain the concepts of electric circuits and its analysis
- Impart knowledge on solving circuits using network theorems
- To brief the phasors and phasor diagrams of single phase AC circuits
- Analysis of three phase circuits
- Illustrate the working principle, construction of DC machines, AC Machines & transformer
- Convey the phenomenon of Electrical Installations

Course Outcomes:

At the end of the course the students will:

- Become adept at applying series-parallel reductions, star delta transformation, mesh analysis, principle of superposition and Thevenin equivalent circuits.
- Understand the role and behaviour of Resistance, Inductance and Capacitance with reference to AC circuits in series and parallel combination.
- Understand the voltage and current relations in three phase star and delta interconnections.
- Understand the construction and characteristics of DC machines, AC machines and transformers.
- Appreciate the basic concepts of Switch gear, Earthing and Energy Consumption.

Course Content:

1. **DC Circuits**: Definitions, Ohm's law, series and parallel circuits, Star - Delta transformation. Kirchhoff's laws, Mesh analysis, Superposition theorem, Thevenin's theorem.
2. **Single Phase AC Circuits:** Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), Power factor improvement.
3. **Three Phase Balanced Systems:** Three phase balanced circuits, voltage and current relations in star and delta connections, Measurement of power and power factor using two wattmeter method.
4. **Electrical Machines:** Electromagnetic Induction, Faraday's Law, Lenz's law, Self and Mutual Induced EMF's. DC machines – Construction, Working and EMF equation of a DC generator, Construction, Working and Torque equation of a DC motor, AC Machines - Construction and working of a three-phase induction motor, Single phase transformer – Construction, Working and EMF equation of a Single phase transformer, Simple numerical, Losses and efficiency in machines.
5. **Electrical Installations:** Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Elementary calculations for energy consumption.

Prerequisite Course: None

Reference Books:

1. "Basic Electrical Engineering", D. P. Kothari and I. J. Nagrath, Tata McGraw Hill, 2010.
2. "Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 9th Edition, Pearson Education, 2005.
3. "Basic Electrical Engineering", D. C. Kulshreshta, 1st Edition, Tata-McGraw-Hill, 2009
4. "Basic Electrical Engineering", V N Mittle and Arvind Mittle, 2nd Edition, Tata- McGraw-Hill, 2006.

UE17EE201:
ELECTRIC CIRCUIT THEORY (3-1-0-0-4)

Course Objectives:

- Develop an understanding of the fundamental theorems of electric circuits.
- Understand transient analysis of RLC circuits.
- Develop the ability to apply circuit analysis to DC and AC circuits.
- Interpret the definition of Laplace transform and calculate the Laplace transform of functions

- Gain knowledge on set of two-port parameters, measurements, relationship between set of two-port parameters.
- Synthesize procedures for elements of reliability theory and one port networks

Course Outcomes

Upon successful completion of this course, students should be able to:

- Use network techniques, like node analysis and loop analysis, to write equations for large linear circuits.
- Apply Thevenin and Norton theorems to analyze and design for maximum power transfer.
- Apply the concept of linearity and the associated technique of superposition to circuits and networks.
- Apply phasor analysis to AC circuits in sinusoidal steady state and analyze the frequency response of circuits containing inductors and capacitors.
- Apply the Laplace transform to linear circuits and systems and analyze simple two-port circuit

Course Content:

1. **Review of electric circuit concepts**: Super node, Super mesh, Linearity & Superposition, Source transformations, Thevenin's & Norton's equivalent circuits, Maximum power transfer theorem. Duality. Dot convention for coupled circuits.
2. **Initial conditions and transient analysis in networks:** Geometrical interpretation of derivatives, Transient Analysis of RL, RC and RLC circuits for DC excitation.
3. **Laplace transformation:** Basic theorems of Laplace transformation, Partial Fraction Expansion, Heaviside Expansion Theorem, Inverse Laplace transform, Examples. Transform of Signals. Basic Signals**,** Waveform synthesis.
4. **Network functions:** Ports, Network functions, Poles & zeros; Restrictions on pole & zero locations for driving point functions. Two port parameters: Relationship of two port variables, Open circuit, Short circuit, Hybrid and Transmission parameters, Relationship between parameter sets.
5. **Elements of realizability theory:** Causality and stability, Hurwitz polynomial, positive real functions, elementary synthesis procedures. Synthesis of one port networks: Properties - LC immittance functions, RL impedances and RC admittances. Synthesis - LC driving point immittances, RC impedances, RL admittances.

Prerequisite Course: UE17EE101 – Basic Electrical Engineering

Reference Books

1. "Network Analysis", M.E Van Valkenburg, 3rd Edition Prentice Hall of India, 1980.
2. "Engineering Circuit Analysis", W.H. Hayt, J.E. Kemmerly, S.M. Durbin, 8th Edition, McGraw-Hill Book Company Inc., 1971.
3. "Network Analysis and Synthesis", Franklin F Kuo, Wiley Toppan, 2nd Edition, Wiley International, 1966.

UE17EE202:
ANALOG ELECTRONIC CIRCUITS (4-0-0-0-4)

Course Objectives:

- To understand the role of diodes and transistors in electronics applications
- To explore the construction and characteristics of diodes, BJTs, FETs, MOSFETs, and JFETs
- To apply MOSFET and BJT large-signal and small-signal device models
- To analyze large-signal and small-signal characteristics of single-stage amplifiers
- To analyze, simulate, and design power amplifiers

Course Outcomes

As an outcome of completing this course, students should be able to

- Understand the use of operational amplifiers as "black box" gain elements in feedback systems
- Methods of biasing transistors & Design of simple amplifier circuits
- Mid – band analysis of amplifier circuits using small - signal equivalent circuits to determine gain input impedance and output impedance
- Method of calculating cutoff frequencies and to determine bandwidth
- Apply principles of Class A, B, and AB power amplifiers

Course Content:

1. **Basics of diode & transistor:** Diode Equivalent Circuit, Diode applications, Overview of DC biasing of BJT
2. **BJT AC analysis**: Amplification in AC domain, BJT transistor modeling, CE Configuration, CC configuration. Approximate Hybrid Equivalent Model, Complete hybrid equivalent model.
3. **FET amplifiers:** Construction and Characteristics of JFETs, FET parameters, Depletion type MOSFET (Construction and V-I Characteristics for P and N channel), Enhancement type MOSFET (Construction and V-I Characteristics for P and N channel). FET biasing, voltage divider bias for JFET, voltage divider bias for D-MOSFET and E-MOSFET. FET AC Analysis: JFET Small Signal Model, JFET AC Equivalent Circuit, Fixed-bias, Self-bias, Voltage-divider Configuration, D-MOSFET and E-MOSFET – Voltage Divider Configuration.
4. **BJT & JFET frequency response:** logarithms, decibels, low frequency analysis, low frequency response, miller effect capacitance, high frequency response
5. **Power amplifiers:** Definition and amplifier types, Series-fed class A amplifier, Class-B amplifier, Class-B amplifier, Class-C amplifier.

Prerequisite Course: None

Reference Books:

1. "Electronic Devices and Circuit Theory", Robert L. Boylestead, Louis Nashelsky, Pearson Education Inc., 9th Edition, 2006.
2. "Electronics Devices and Circuits – An Introduction", Allen Mottershead, PHI Publications, 2010.
3. NPTEL Lectures, Dr. Chitralekha Mahanta.
4. https://www.youtube.com/playlist?list=PL350612601E2DBFDE
5. "Circuits and Electronics Course", Prof. Anant Agarwal https://www.edx.org/course/circuits-electronics-mitx-6-002x-0

UE17EE203:
DIGITAL ELECTRONICS (4-0-0-0-4)

Course Objectives:

- To understand the basic postulates of Boolean algebra
- To describe the correlation between Boolean expressions
- To understand and solve the methods for simplifying Boolean expressions
- To outline the formal procedures for the analysis and design of combinational circuits and sequential circuits
- To summarize the concept of flip flops, sequential networks and their applications

Course Outcomes

As an outcome of completing this course, students should be able to

- Apply the principles of Boolean algebra to manipulate and minimize logic expressions;
- Use K-maps to minimize and optimize two-level logic functions up to 5 variables

- Understand the operation of latches, flip-flops, counters, registers, and register transfers;
- Design combinational circuits using decoders, ROM and transmission gates;
- Understand the operation of state-of-the-art components to design and build complex digital systems, such as memories, PLA, PALs and programmable logic devices (such as FPGAs)

Course Content:

1. **Boolean Algebra & Combinational Networks:** Boolean formulae and functions, Canonical formulae, Manipulations, Incomplete Boolean functions and don't care conditions, Definition of combinational logic, truth tables, deriving switching equations.
2. **Simplification of Boolean Expressions:** Criteria for minimality, Prime implicants and irredundant disjunctive expressions, Karnaugh maps, Five-variable maps, Quine-McLuskey method, Prime implicant/prime implicate tables and irredundant expressions, Prime implicant/prime implicate table reductions, Decimal method for obtaining prime implicants /implicates, Variable entered K-maps.
3. **Combinational Logic Modules and their Applications:** Carry look ahead adder, decimal adder, Comparators, Decoders, Encoders, Multiplexers, Programmable logic devices, PROMS, PAL, PLA devices.
4. **Flip-Flops and Applications:** Latches, Pulse triggered and edge triggered flip-flops, Registers, Counters, Binary ripple counters, Synchronous binary counters, Counters based on shift registers, Design of synchronous counters.
5. **Synchronous Sequential Networks:** Structure, operation, analysis and modeling of clocked synchronous sequential networks.

Prerequisite Course: None

Reference Books:

1. "Digital Principles and Design", Donald D. Givone, Tata-McGraw Hill, 2007.
2. "Digital Logic Applications & Design", John M Yarbrough, Cengage Learning, 2008.
3. "Logic Design", Sudhakar Samuel, Sanguine Technical Publishers, 2006.

UE17EE204:
ELECTROMAGNETIC THEORY (4-0-0-0-4)

Course Objectives:

- To appreciate the theory of vector analysis
- To understand the concepts of electrostatics, electrical potential, energy density and their applications
- To analyze the concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications
- To explore Biot-Savart's Law, Ampere's Law, Faraday's laws, and Maxwell's equations
- To understand the concepts of electromagnetic waves and Poynting vector

Course Outcomes

At the end of the course the students will be able to

- Learn how to apply Cartesian coordinates, cylindrical coordinates, spherical coordinates,
- Become adept at using Divergence of a vector and Divergence theorem
- Calculate relationship between Electric field and potential, an electric dipole and flux lines, Energy density in electrostatic fields.
- Apply continuity equation and relaxation time, boundary conditions, Poisson's and Laplace's equation in various contexts and problems,
- Calculate magnetic fields and flux density from magneto static laws
- Differentiate between magnetic scalar and vector potentials
- Calculate forces due to magnetic fields, magnetic torque and moment, a magnetic dipole
- Describe magnetization in materials and apply magnetic boundary conditions to various contexts and problems
- Calculate transformer and motional electromotive forces, displacement current
- Calculate wave propagation constants in lossy dielectrics, lossless dielectrics, good conductors and free space
- Calculate reflection and transmission coefficients for a plane wave impinging at an interface at normal incidence
- Justify that the FOUR Maxwell equations are sufficient to describe all of electromagnetic phenomena with appropriate boundary conditions.

Course Content:

1. **Vector Analysis:** Review of coordinate systems and transformations, Cartesian coordinates, cylindrical coordinates, spherical coordinates, Divergence of a vector and Divergence theorem, Gradient of a scalar quantity, Curl of a vector and Stoke's theorem
2. **Electrostatics:** Coulomb's Law and Field intensity, Electric flux density, Gauss's Law, Electric potential, Relationship between Electric field and potential, an electric dipole and flux lines, Energy density in electrostatic fields. Maxwell equations for electrostatics.

   Electric Fields in Material Space: Polarization, electric susceptibility, dielectric constant, Relation between flux density and electric field in materials, boundary conditions, Poisson's and Laplace's equation, resistance and capacitance of parallel plate, cylindrical and spherical. Continuity equation and relaxation time.
3. **Magnetostatics:** Biot-Savart's Law and its applications. Ampere's circuital Law and its applications, Coaxial conductors, Solenoid and toroid, magnetic flux density, Maxwell's equation for static fields, magnetic scalar and vector potentials.
4. **Magnetic Forces, Torque and Magnetic Materials:** Forces due to magnetic fields, magnetic torque and moment, a magnetic dipole, magnetization in materials, magnetic boundary conditions, inductors and inductances, magnetic energy. Faraday's Law, transformer and motional electromotive forces, displacement current, Maxwell's equations for time varying fields, Time harmonic fields.
5. **Electromagnetic Wave Propagation:** Wave equation, Solution of wave equation in 1-d, wave propagation in lossy dielectrics, plane waves in lossless dielectrics, plane waves in free space, plane waves in good conductors, power and Poynting vector, reflection of a plane wave at normal incidence – reflection and transmission coefficients.

Prerequisite Course: UE17MA101 – Engineering Mathematics I, UE17MA151 – Engineering Mathematics II

Reference Books:

1. "Principles of Electromagnetics", Matthew N.O. Sadiku, 4th Edition, Oxford University Press, 2011.
2. "Electromagnetic Waves and Radiating Systems", Edward C Jordan, Keith G Balmain, 2nd Edition, PHI, 2005.
3. "Engineering Electromagnetics", William H Hayt Jr., 7th Edition, Tata Mc Graw Hill, 2007.

4. "Introduction to Electromagnetic Fields", Clayton R. Paul, Kath W. Whites, Syed A Nasar, 2nd Revised Edition, TMH, 2007.
5. "Electromagnetics - Schaum's Outlines", J.A. Edminister, 2nd Edition, Tata Mc Graw Hill, 2006.

UE17EE205: ANALOG ELECTRONIC CIRCUITS LABORATORY (0-0-2-0-1)

Course Objectives:

- Design electronic solutions to meet specified requirements of clippers, clampers, and Voltage Multiplier Circuits.
- Analyze the performance characteristics and frequency response of single stage BJT Amplifiers
- Analyze the performance characteristics and frequency response of JFET Amplifiers
- Analyze the performance characteristics of Class A and Class AB Amplifiers and determine the amplification factor
- Observe the frequency response of Multistage amplifier

Course Outcomes:

At the end of the course the student will be able to

- Identify and describe operation of semiconductor devices.
- Analyze where and how analog components are used.
- Locate and select analog devices using component specifications based on circuit requirements.
- Construct operational circuits using analog devices.
- Select and demonstrate the use of appropriate test equipment to analyze circuit operation.
- Using appropriate troubleshooting techniques evaluate circuit performance applying suitable repair methods.
- Identify and demonstrate safe workplace practices

Course Content:

1. Diode Clippers
2. Diode Clampers
3. Diode Voltage Multiplier Circuits
4. Characteristics of single stage BJT Amplifiers (input impedance, output impedance, voltage gain)
5. Frequency response of single stage BJT Amplifier
6. JFET V-I characteristics
7. Voltage Divider Biasing – JFET
8. Frequency Response of JFET Amplifier
9. Class A Amplifier
10. Class A Amplifier with transformer coupled load
11. Class B push-pull Amplifiers
12. Frequency response of Multistage amplifier
13. Open ended experiment

Prerequisite Course: None

Reference Books:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PESU.

UE17EE206: DIGITAL ELECTRONICS LABORATORY (0-0-2-0-1)

Course Objectives:

- Use and apply logic gates to realize Boolean expressions.
- Analyze code conversions.
- Analyze the behavior of MUX/DEMUX using 74153, 74139.
- Verify the truth table of Truth table of JK Master Slave, T and D flip-flops.
- Observe the Shift left, Shift right, SIPO, SISO, PISO, PIPO operations using 74HS95.
- Analyze and test the behavior of Ring counter /Johnson counter and sequence generator.

Course Outcomes:

At the end of the course the student will be able to

- Understand the relationships between combination logic and Boolean algebra, and between sequential logic and finite state machines
- Be able to design and minimize combinational logic
- Appreciate tradeoffs in complexity and speed of combinational designs
- Understand how state can be stored in a digital logic circuit
- know how to design a simple finite state machine from a specification and be able to implement this in gates and edge triggered flip-flops
- Understand how to use MOSFETs to build digital logic circuits
- Understand the effect of finite load capacitance on the performance of digital logic circuits

Course Content:

1. Simplification, realization of Boolean expressions using logic universal gates
2. Realization of parallel adder/ Subtractors using 7483 chip
3. BCD to Excess-3 code conversion and vice versa
4. Realization of Binary to Gray code conversion and vice versa
5. MUX/DEMUX – use of 74153, 74139 for arithmetic circuits and code converter
6. Realization of One/Two-bit comparator and study of 7485 magnitude comparator
7. Use of a) Decoder chip to drive LED display and b) Priority encoder
8. Truth table verification of Flip-Flops: (i) JK Master slave (ii) T type and (iii) D type
9. Realization of 3-bit counters, MOD – N counter design (7476, 7490), Ring counter and Johnson counter.
10. Shift left; Shift right, SIPO, SISO, PISO, PIPO operations using 74HS95.
11. Design and testing of Sequence generator
12. Open Ended Experiment

Prerequisite Course: None

Reference Books:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PESU.

UE17EE207X: SPECIAL TOPIC UE17EE251: LINEAR INTEGRATED CIRCUITS (4-0-0-0-4)

Course Objectives:

- Gain knowledge on feedback concepts and difference amplifiers
- Understand the basic building blocks of linear integrated circuits.
- Study characteristics; realize circuits; design using Op-amp ICs
- Analyze and design linear and non-linear applications of operational amplifiers
- Study internal functional blocks and the applications of special ICs like Timers, PLL circuits, Regulator Circuits, ADCs and DACs
- Understand the theory and applications of analog multipliers and PLL
- To teach the theory and design of oscillators

Course Outcomes:

At the end of the course the students will:

- Learn how to employ feedback & obtain closed loop
- Become adept at using various methods of voltage control, current control for electronic circuits
- Appreciate the consequences of open loop & closed loop control with respect to stability
- Gain an intuitive understanding of the importance each block of operational amplifier
- Advantages of op-amp using in differential mode.
- Learn the primitive concepts of op-amp
- Possess an ability to understand the off-set voltage, input bias current & total off-set voltage in op-amp
- Know the fundamental concepts op-amp parameters
- Understand the role and behavior of op-amp with its basic parameters.
- The main application of op-amp as a instrumentation amplifier will be analyzed
- Understand the how to make voltage to current & current to voltage conversion
- Explain the principle of operation of active filters
- Use of active filters in almost all circuits & their advantages compare to only passive filters.
- Specialized analog ICs will be understood clearly to implement on practical circuit
- Know about different IC regulators which are used in voltage regulators.
- DAC & ADC working which are main parts of microprocessor/ microcontroller.
- Different oscillator circuit using different amplifier devices will be understood.

Course Content:

1. **Feedback and difference amplifiers:** Feedback concepts, Feedback connection types, Difference amplifier, Constant current source, Input resistance, Active load, Level translator, Output stage.
2. **Basics of operational amplifiers**: Voltage-series feedback amplifier, Voltage-shunt feedback amplifier, The practical op-amp: Input offset voltage, Input bias current, Input offset current, Total output Offset voltage, Thermal drift. Effect of variation in power supply voltages on offset voltage, Change in input offset voltage and input offset current with time, Noise, Common mode configuration and common mode rejection ratio, Frequency response – slew rate.
3. **Applications of operational amplifiers**: Instrumentation amplifier, Voltage to current converter, Current to voltage converter, Integrator, Differentiator, Active filters, Comparators, Zero crossing detector, Schmitt trigger.
4. **Specialized IC applications:** The 555 timer: the 555 as a mono-stable, astable multivibrator and its applications. Phase-Locked loops, IC Voltage regulators, 723 general purpose regulator, switching regulator, A/D and D/A converters and specifications.
5. **Oscillators:** Oscillator operation, Phase-shift oscillator, Wein-bridge oscillator, Tuned oscillator circuit, Crystal oscillator, Design of oscillator using op – amp, BJT and JFET.

Prerequisite Course: None

Reference Books:

1. "Electronic Devices and Circuit Theory", Boylestead, Louis Nashelsky, 9th Edition, PHI Publication, 2006.
2. "Op-amps and Linear Integrated Circuits", Ramakant A. Gayakwad, 4th Edition Pearson Education, 1992.
3. "Linear Integrated Circuits", D. Roy Choudhury, Shail Jain, New Age International (P) Ltd., 2003.

UE17EE252:
ELECTRICAL MACHINES - I (3-1-0-0-4)

Course Objectives:

- Familiarize and study the constructional details, principle of operation, expressions for generated voltage and torque of DC machines
- Predict performance characteristics and gain knowledge on speed control techniques of DC motors
- Estimate the various losses taking place in D.C. machines and to study the different testing methods
- Study the working principles of single phase transformers and three phase transformers
- Appreciate the testing procedures of transformers
- Formulate and solve problems related to DC machines, single phase transformers and three phase transformers

Course Outcomes

At the end of the course the students will:

- Learn how to employ excitation circuit for DC generator
- Become adept at using various methods of reducing the armature reaction
- Understand the different types of generator behaviours with their V-I characteristics
- Gain an intuitive understanding of the importance of DC machine.
- Develop the capability to analyze the concepts and applications different types of DC machines
- Learn the primitive concepts of different types of speed control & necessity of speed control
- Possess an ability to understand the differences between different types of motors.
- Know the fundamental concepts of single phase transformer & types based on construction
- Understand the working of transformer with & without load
- Learn how to draw equivalent circuits of transformer with respect to primary / secondary
- Learn about parallel operation of single phase transformer & its requirements
- Understand the differences between single phase and three phase transformers
- Explain the principle different types of connections of three phase transformers & their comparisons
- Understand why auto transformer (variac) is much used in industries.

Course Content:

1. **DC Generators:** Principle of operation, Armature windings, circuit model of a DC machine, generating mode and motoring modes, Armature reaction in generators, methods of excitation, magnetization characteristics, self excitation, characteristics of generators, compound generators, comparison of V-I characteristics of DC generators.
2. **DC Motors:** Principle of operation, Torque equation, Characteristics of DC motors, torque and efficiency, speed control.
3. **Testing of DC Machines:** Swinburne's test, Hopkinson's test, retardation test, field's test, Ward Leonard method.
4. **Single Phase Transformers:** Construction, emf equation of transformer, concept of leakage flux and leakage reactance, operation of transformer under no load and onload with phasor diagrams, equivalent circuit of transformer efficiency and regulation. Testing of transformer- phasing out, polarity test, DC resistance test, OC and SC tests, back-to-back (Sumpner's) test. Parallel operation of two single phase transformers.

5. **Three Phase Transformer:** Connections of transformers, auto transformers, principle, equivalent circuit, No load and on load tap changers.

Prerequisite Course: None

Reference Books:

1. "Electrical Machines", I.J.Nagrath & D.P. Kothari, TMH Publication, 2004.
2. "Electrical Technology", Cotton, H, Pitman, 1924.
3. "Performance and Design of AC Machines", Say, M. G., ELBS, 1995.
4. "Problems in Electrical Engineering: With Answers", Smith, S. P., CBS, 1954.

UE17EE253:
POWER ELECTRONICS (4-0-0-0-4)

Course Objectives:

- To describe the role of Power semiconductor devices in power electronics
- To understand the operation of thyristors and their characteristics with commutation techniques
- To learn the basic concepts of operation of DC choppers
- To analyze and synthesize pulse width modulated inverters, controlled rectifiers and AC voltage controllers
- To Learn the role of Power Electronics in utility-related applications

Course Outcomes

At the end of the course the students will be able to:

- Learn how to differentiate between electronic device & power Electronics device
- Become adept at using various power electronic devices for different applications
- Understand the different types of power electronic switching devices with their switching speed
- Gain an intuitive understanding of the importance power electronic devices
- Develop the capability to analyze the concepts and protection circuits for different types power electronic devices
- Learn the primitive concepts of series & parallel connection of SCRs
- Possess an ability to understand the differences between different types commutation circuits for SCR
- Know the fundamental concepts of DC-DC converter(chopper)
- Understand the working of buck, boost & buck-boost chopper
- Learn how SMPS is more efficient than linear power supply
- Learn about importance of inverter & its principle of operation
- Understand the differences between single phase and three phase inverter
- Control techniques of output of inverters
- Controlled different rectifier circuits using SCRs
- Comparison of different types of controlled rectifiers with respect to output power requirements
- How converter con be used to control ac devices either by using anti-parallel connection of thyristors/TRIAC.

Course Content:

1. **Power devices:** Power semiconductor Devices, Control characteristics of power devices, types of power electronic circuits. Thyristors: Thyristor characteristics, two transistor model of thyristor, Thyristor turn-on di/dt protection, dv/dt protection, thyristor turn-off, thyristor types - phase-controlled thyristors, fast-switching thyristors, GTOs, TRIACs,RCTs,SITHs and LASCR, Series and parallel operation.
2. **Thyristor commutation techniques:** Natural Commutation, Forced Commutation, impulse commutation, resonant pulse commutation, complementary commutation. DC Choppers: Step-Down operation, Step-up operation, switch mode regulators.
3. **Pulse-width-modulated inverters:** Principle of operation, single-phase bridge inverters, three-phase inverters-180-degree and 120-degree conduction, voltage control of single-phase inverters – single, multiple and sinusoidal PWM, phase-displacement control.
4. **Controlled rectifiers:** Principle of phase-Controlled converter operation, Single-phase semi converters, Single-phase full converters, single – phase dual converters, three-phase full converters with RL load, power factor improvements- extinction angle control.
5. **AC voltage controllers:** Principle of on-off control, principle of phase control, single-phase bidirectional controllers with resistive loads, Single-Phase Controllers with inductive loads.

Prerequisite Course: None

Reference Books:

1. "Power Electronics Devices", M. H Rashid, 3rd Edition Pearson Education, 2003.
2. "Power Electronics", M.D.Singh & Khanchandani K.B., 2nd Edition, Tata McGraw Hill, 2006.
3. "Power Electronics, Converters, Applications and Design", Ned Mohan, John Wiley and Sons, 2002.
4. "Power Electronics", Bimbhra, P. S., Khanna Publishers, 2012.

UE17EE254:
GENERATION, TRANSMISSION AND DISTRIBUTION SYSTEMS (3-0-0-4-4)

Course Objectives:

At the end of the course the student will be able to:

- Understand the working of some of different types of power generation systems namely thermal, nuclear, and gas plants.
- Gain knowledge on the primary renewable energy resources namely hydro, solar and wind energy systems
- To learn the usage of passive elements in various Power Transmission Systems
- To understand the factors affecting Insulators and also in Under Ground cables.
- To calculate the various parameters in Distribution System.

Course Outcomes

Upon completion of the course the students would be able to:

- Explain different methods of electric power generation at power generation plants
- Explain the science of energy conversion from various schemes
- Describe the significance of various components of power generation plants
- Describe the importance of power generation from renewable sustainably
- Apply power system fundamentals to the design of a system that meet specific needs.
- Design a power system solution based on the problem requirements and realistic Constraints.
- Develop a major design experience in power a system that prepares them for engineering practice.

Course Content:

1. **Non-Renewable Energy Sources:** Thermal Power Plants: Main parts & working, Fuels, Fuel Handling, Combustion and Combustion equipment, Ash disposal, & Dust Collection, Draught Systems, Types of Boilers and their characteristics, Feed Water, steam turbines, alternators, Layout and Control. Nuclear Power Plants: Nuclear Reactions, Nuclear Materials Feasibility of nuclear power station, main parts of reactor and their functions, coolant cycles, reactor control, nuclear reactor classification – Boiling water, Pressurized water, CANDU reactor, Breeder Reactor. Gas Turbine Power Plants: Typical GT power plant: components of a gas turbine plants, Open and Close Cycle Gas Turbine Plants, Methods to improve thermal efficiency of a gas turbine plant, Fuels for gas turbine plants; Different arrangement of components; Plant layout, advantages of gas turbine plants over steam plants.
2. **Renewable Energy Sources:** Hydroelectric Energy: Factors for selection of site; Hydrology, classification of hydroelectric plants, Types of Turbines, governing of turbines, Power station structure, Layout and Control. Solar Energy: Introduction, Solar Constant, Solar Radiation at the Earth's surface, Solar Radiation Measurements. Thermal electric conversion, Electric power conversion; The PV cell, Module and array, equivalent electrical circuit, open circuit and short circuit current, I-V and P-V curves, PV system components; Wind Energy: Introduction, Wind Speed and Power Relations, Wind speed measurements, Site and turbine selection. Wind Power System – System Components, Variable speed operation, Applications - Interconnected System, Safety Systems, and Environmental impact.
3. **Constants of Overhead Transmission Lines:** Inductance of a conductor due to internal flux, Inductance of a conductor due to external flux, Inductance of a single phase two wire line, Inductance of composite conductor lines- self and mutual GMDs, Inductance of three-phase lines (single circuit), Inductance of three phase lines with more than one circuit (double circuit). Potential difference between two points due to a charge, capacitance of two-wire line, potential difference between two conductors of a group of charged conductors, capacitance of three-phase lines (single circuit), charging current due to capacitance, capacitance of three phase line with more than one circuit (double circuit), skin effect and proximity effect.
4. **Performance of Transmission Lines:** Short Line- Regulation, General Network constants, ABCD constants for short line, Medium Lines- General Network constants for medium lines, Long Lines- Long line equation, Evaluation of ABCD constants Surge Impedance and surge loading of transmission lines, Ferranti Effect, Equivalent T and π networks of a long line, Power transmission in a short line.
5. **Overhead Line Insulators:** Introduction, Insulator Materials, Types, Potential distribution over a string of suspension insulators, Methods of Increasing the string efficiency. Underground cables - Introduction, types of cables, Insulation in cables, Armouring and covering of cables, Insulation resistance of cables, stress in Insulation and capacitance, Sheathing in cables, Use of Inter-sheaths, Capacitance grading. Power distribution systems: dc systems- Introduction, Radial and ring main systems, Different types of distributors, AC distribution - AC Distributor with concentrated loads.

Prerequisite Course: None

Reference Books:

1. "A text book on Power System Engineering", A Chakrabarti, M L Soni, P V Gupta, Dhanpat Rai and Co., New Delhi, 2010.
2. "Wind and Solar Power Systems", Mukund R. Patel, CRC Press, 1999.
3. "Elements of Power System Analysis", W D Stevenson, Mc Graw Hill, 1975
4. "Electric Power", S L Uppal, Khanna Publishers, 2007.
5. "Electric Power Systems", C L Wadhwa, New Age International, 2009.
6. "Electric Power Generation, Transmission and Distribution", S N Singh, PHI, 2010.
7. "Non-Conventional Sources of Energy", Rai, G. D, 4th Edition, Khanna Publishers, New Delhi, 2007.
8. "Fundamentals of Renewable Energy Systems", Mukherjee. D, and Chakrabarti. S, New Age International Publishers, 2005.
9. nptel.ac.in/video.php?subjectId=108102047
10. freevideolectures.com › Electrical Engineering › IIT Delhi

UE17EE255: LINEAR INTEGRATED CIRCUITS LABORATORY (0-0-2-0-1)

Course Objectives:

- To design and construct oscillator circuits.
- To analyze and design various applications of Op-Amp.
- To design and test the characteristics of astable and Mono-stable multivibrator.
- To test the performance of voltage regulators.

Course Outcomes

At the end of the course the students will be able to:

- Learn how to construct low frequency oscillator using op-amp
- Learn to construct wein bridge oscillator to produce sinusoidal wave form at 1 KHz
- Construct practical oscillator circuit to produce very high frequency
- Construct circuit using versatile IC 555
- Develop the laboratory circuit to learn about voltage regulator
- Learn & construct applications of op-amp as ADC and DAC
- Learn to analyse the feedback circuit

Course Content:

1. RC Phase-shift Oscillator
2. Wein-bridge Oscillator
3. Schmitt Trigger
4. A/D Converter
5. 555 – Mono-stable multivibrator
6. 555 – Astable multivibrator
7. Voltage Regulators : IC 7805 and 7905
8. D/A converter – R-2R Ladder network
9. Op-amp Integrator
10. Op-amp Differentiator
11. Op-amp Active filters: 1st order / 2nd order Low-pass and High-pass Butterworth filter
12. Band-pass filter
13. Open ended experiment

Prerequisite Course: None

Reference Books:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PESU

UE17EE256:
ELECTRICAL MACHINES - I LABORATORY (0-0-2-0-1)

Course Objectives:

- Rig up circuits for testing a given machine
- Analyze the performance of different types of DC generators
- Determine the characteristic curves of DC motor
- Conduct performance tests such as Swinburne's Test and Hopkinson's Test
- Control the speed of DC motor by different methods
- Obtain the performance characteristics of 1 phase transformers and 3 phase transformers.

Course Outcomes

At the end of the course the students will:

- Learn how to connect D.C shunt & compound generator for load characteristics
- Learn to construct circuit connection of DC motor to get speed-torque & efficiency characteristics
- Construct practical circuit of transformer parallel operation
- Construct circuit for Hopkison's test
- Develop the laboratory circuit to control speed of DC motor
- Learn & construct to find constant losses & copper loss of transformer
- Learn & construct circuit for scott connection.

Course Content:

1. Load characteristics of a D.C. shunt and compound generator.
2. Load test on a DC motor- determination of speed-torque and BHP-efficiency characteristics.
3. Swinburne's Test.
4. Hopkinson's Test.
5. Fields test on series motors.
6. Retardation test- electrical braking method.
7. Speed control of DC motor by armature voltage control and flux control.
8. Ward Leonard method of speed control of D.C. motor.
9. OC and SC test on single phase transformer & predetermination of efficiency & regulation.
10. Sumpner's test.
11. Parallel operation of two dissimilar (different kVA) 1-phase transformers.
12. Polarity test & connection of 3 phase transformers in star – delta and determination of efficiency & regulation under balanced UPF load.
13. Scott connection- for balanced and unbalanced two phases UPF loads.

UE17EE257X:
SPECIAL TOPIC (2-0-0-0-2)
UE16EE301:
ELECTRICAL MACHINES – II (3-1-0-0-4)

Course Objectives:

- Introduce students to the various types of AC electric motors and AC generators introduce students to the operating principles, methods of starting and area of applications of synchronous and induction machines
- Introduce students to the operating principles, methods of starting of three phase induction motors.
- To study the application of double revolving field theory for single phase induction motor
- To study the effect of load at different power factors, methods of predetermination of regulation for non-salient and salient pole generators.

Course Outcomes:

At the end of the course the students will be able to-

- Understand the construction and principle of operation of induction machines and synchronous machines.
- Evaluate performance characteristics of induction machine and synchronous machines
- Predetermine the performance of cylindrical pole synchronous machine by oc and sc test
- Analyse the effects of excitation and mechanical input on the operation of synchronous machine

Course Content:

1. **Three Phase Induction Motors:** Construction, slip and frequency of rotor currents, rotor mmf and torque production, equivalent circuit model, power across air-gap, torque and power output, torque-slip characteristics, generating and braking modes, maximum(breakdown) torque, starting torque, maximum power output
2. **Tests to Determine Circuit-Model Parameters**: No-load test & blocked rotor test, approximate circuit model, circle diagram, starting of 3-phase induction motors, speed control of induction motors.
3. **Single Phase Induction Motor:** Principle, pulsating field as two rotating fields, rotor with respect to two rotating fields, torque-speed characteristics, split phase motor, construction and operation principle, capacitor start motor.
4. **Synchronous Machines**: Basic synchronous machine model, circuit model, vector diagram of a synchronous generator, OC and SC tests, voltage regulation, calculation of regulation by the synchronous impedance method, Determination of X_d and X_q of a salient ploe synchronous machine.
5. **Tests on Synchronous Machines**: Short-circuit ratio (SCR), Potier method, nature of armature reaction in a synchronous generator, synchronizing to infinite bus-bars, power angle characteristics, phasor diagrams. Synchronous Motors: Principle of operation, "V" and inverted "V" curves of a synchronous motor, phasor diagram of a synchronous motor.

Prerequisite Course: UE16EE101 – Basic Electrical Engineering

Reference Books:

1. "Electric Machines", Kothari, D. P. & Nagrath, I. J., Tata McGraw-Hill Education, 2010.
2. "Theory and Problems of Electrical Machines", D.P Kothari, I.J. Nagrath Kothari, Tata McGraw-Hill Publishing Company, 1992.
3. "Performance and Design of AC Machines", Say, M. G., ELBS, 1995.
4. "Problems in Electrical Engineering: With Answers", Smith, S. P., CBS, 2003.

UE16EE302:
MICROCONTROLLERS (4-0-0-0-4)

Course Objectives:

Systems that work based on processor/microcontroller program execution are referred as mostly embedded systems. They all have associated peripherals that are interfaced with the microprocessor/ microcontroller. This course helps to:

- Understand the architecture of 8051 microcontroller and 8085 microprocessor
- Programming model and instruction supported by 8051 microcontroller

- Able to work with assembly as well as embedded 'C' programming
- Learn different aspects of programming and is a good build up towards embedded system

Course Outcomes:

At the end of the course the students will be able to:

- Write assembly level and C programs for 8051 microcontroller
- Interface peripherals like ADC, DAC which enables interfaces to sensors and actuators
- General purpose inputs and outputs and interface with LCD
- Write interrupt based programs
- Develop a complete microprocessor based system
- Understand the concepts of system programming using the cross-assemblers and cross-compiler

Course Content:

1. **Introduction to INTEL 8051 Microcontroller:** 8051 Microcontroller family, Block diagram, Architecture, features, pin description of the 8051, memory organization, register banks, PSW, SFRs, Addressing Modes, RISC & CISC CPU Architectures, Harvard & Von-Neumann CPU architecture, Microprocessor and Microcontroller
2. **Instruction Set of 8051:** Data transfer instructions, Arithmetic and Logical Instructions, Branch control instructions, Bit oriented instructions, Application Programs: Incrementing, Decrementing, Addition, Subtraction, Multiplication and Division, Decimal Arithmetic, sorting programs, delay calculations
3. **8051 programming in 'C':** Data types and time delays in 8051, I/O programming, Logic operations, Data conversion programs, Accessing code ROM ROM space, Input /output port structures of 8051; 8051Timer / Counter Programming in assembly and C: Programming 8051 Timers, Counter Programming, programming timers 0 and 1.
4. **Serial Communication and Interrupt programming**: 8051 Interrupts, Interrupt Priority in the 8051, Programming Timer Interrupts, Programming External Hardware Interrupts, Basics of Serial Communication, 8051 Connections to RS-232, 8051 Serial port Programming in assembly and in C. Programming the Serial Communication Interrupts
5. **8051 Interfacing and Applications:** Interfacing 8051 to LCD, Keyboard interface and Programming, External memory interfacing: memory address decoding, interfacing 8031/51 with external ROM, 8051 data memory space, Interfacing of ADC, DAC, Sensors, Stepper motor.

Prerequisite Course: UE16EE203 – Digital Electronics

Reference Books:

1. "The 8051 Micro controller Architecture Programming & Application", Kenneth J Ayala, 3rd Edition, Thomson Learning, 2004.
2. "The 8051 Microcontroller And embedded Systems- Using Assembly and C", Muhammad Ali Mazidi, Janice Gillispie Mazidi & Roolin D McKinlay, 2nd Edition, Pearson Education. 2007.
3. "The 8051 Microcontroller Architecture, Programming & Application", Myke Predko, Tata McGraw Hill, 1999.

UE16EE303:
SIGNALS AND SYSTEMS (3-1-0-0-4)

Course Objectives:

- Demonstrate an understanding of the fundamental properties of linear systems, by explaining the properties to others
- Use linear systems tools, especially transform analysis and convolution, to analyze and predict the behavior of linear systems
- Appreciate the use of Fourier analysis to understand the various frequency components in a non- sinusoidal signal.
- Appreciate the use of Fourier series & transform and generalized Z – transform techniques to understand its usage in analyzing power & energy signals. .
- Gain an appreciation for the importance of linear systems in mathematical analysis of systems.

Course Outcomes::

At the end of the course the students will be able to:

- Explain the importance of classification of signals and systems.
- Explain the importance of superposition in the analysis of linear systems
- Explain the role of convolution in the analysis of linear time invariant systems, and use convolution to determine the response of linear systems to arbitrary inputs
- Demonstrate an understanding of causal systems described by difference equation and by explaining determine zero state & forced response.
- Demonstrate the role of Fourier series to find frequency components of periodic signal or sequence.
- Demonstrate the role of Fourier transform to find frequency components of aperiodic signal or sequence.
- Demonstrate an understanding of the relationship between the stability and causality of systems and the region of convergence of their Z transforms, by correctly explaining the relationship, and using the relationship to determine the stability and causality of systems

Course Content:

1. **Signals and Systems:** Classification of signals, Transformations of the independent variable, The unit impulse and unit step functions, Basic system properties.
2. **Linear Time-Invariant Systems:** Discrete-time LTI systems - convolution sum, Continuous-time LTI systems - convolution integral, Properties, difference equations.
3. **Fourier Series Representation of Periodic Signals:** Response of LTI systems to complex exponentials, Fourier series representation of continuous-time periodic signals, Convergence of the Fourier series, Properties of continuous-time Fourier series, Fourier series representation of discrete-time periodic signals.
4. **The Continuous-Time Fourier Transform:** Representation of aperiodic signals, The Fourier transform for periodic signals, Properties of continuous-time Fourier transform, Fourier transform pairs. **The Discrete-Time Fourier Transform:** Representation of aperiodic signals, The Fourier transform for discrete periodic signals, Properties of discrete-time Fourier transform, Fourier transform pairs, Duality.
5. **Frequency Response of LTI Systems:** Magnitude and Phase response, Distortion less & Linear Phase Systems, Group delay & Phase delay. **The Z- Transform:** The Z-transform, region of convergence, inverse Z-transform, Properties, Analysis and characterization of LTI systems using Z- transforms. The unilateral Z-transform and solution of difference equations.

Prerequisite Course: None

Reference Books:

1. "Signals and Systems", Oppenheim, A V, Willsky A S, Nawab S H, Pearson, 2014.
2. "Signal Processing and Linear Systems", Latni B, Oxford University Press, USA, 1998.
3. "Signals and Systems", Haykin S & Van Veen B, John Wiley & Sons, 2007.
4. "Analog and Digital Signal Processing (Vol. 1)", Ambardar A, PWS Publishing Company, 1995.

UE16EE311:
POWER DISTRIBUTION SYSTEMS (4-0-0-0-4)

Course Objectives:

- To give an overview of the function of an electrical power distribution in an electric power system.
- To derive the tools for distribution analysis.
- To have the wider knowledge on planning and design of a distribution infrastructure.

Course Outcomes:

At the end of the course the students will be able to:

- Characterize the electric load on a feeder or a substation
- Evaluate transformer performance in terms of voltage regulation and efficiency under various load conditions
- Design the layout of a substation under specified constraints
- Design primary and secondary distribution system
- Estimate the voltage profile and losses on a feeder
- Analyze the voltage regulation problem and present remedial methods
- Conduct simple reliability and protection studies of distribution systems
- Assess power quality problems and solutions in distribution systems
- Evaluate the impact of distributed renewable resources on distribution system operation.

Course Content

1. **Distribution System Planning and Design**: Distribution system planning Short term planning, Long term planning, dynamic planning, Sub-transmission and substation design. Sub-transmission networks configurations, Substation bus schemes, Distribution substations ratings, Service areas calculations, Substation application curves.
2. **Distributed Generations Systems**: Distributed Generation Standards, DG potential, Definitions and terminologies; current status and future trends, Technical and economical impacts of DG Technologies, DG from renewable energy sources, DG from non-renewable energy sources.
3. **Distributed Generation Evaluation**: Distributed generation applications, Operating Modes, Base load; peaking; peak shaving and emergency power, Isolated, momentary parallel and grid connection.
4. **Distribution System Reliability Analysis**: Primary and secondary system design considerations Primary circuit configurations, Primary feeder loading, secondary networks design Economic design of secondary's, Unbalance loads and voltage considerations.
5. **Distribution System Automation and Control**: Distribution system performance and operation Distribution automation and control, Voltage drop calculation for distribution networks, Power loss Calculation, Application of capacitors to distribution systems, Application of voltage regulators to distribution systems.

Prerequisite Course: None

Reference Books:

1. "Electrical Distribution Engineering", Anthony J. Pansini, CRC Press, 2005.
2. "Distributed Power Generation Planning and Evaluation", H Lee Willis, CRC Press, 2000.
3. "Electric Power Distribution Automation Protection and Control", James A Momoh, CRC Press, 2007.
4. "Power distribution engineering: fundamentals and applications", James J. Burke, CRC Press, 2004.
5. "Electric Power Distribution", Pabla, McGraw-Hill, 2005.

UE16EE312:
POWER STATION PRACTICE (4-0-0-0-4)

Course Objectives:

- Introduce the students to typical layout of a substation
- Understand the factors affecting the cost of generation
- Understand the factors deciding the load demand and the economies of cost of generation and tariff
- Gain knowledge on the primary renewable energy resources namely solar, wind geothermal, tidal and ocean thermal energy.

Course Outcomes:

At the end of the course, the student will be able to-

- Appreciate the layout and operation of a substation
- Optimize the cost of generation and calculation of tariff
- Understand the load demand and the concept of power factor improvement
- Gauge the future energy demand and use the non-conventional resources
- Comprehend the role of private sectors in energy management

Course Content:

1. **Sub-Stations Layout**: Types of substations, bus-bar arrangements, and typical layout of substation.
2. **Power Plant Economics and Tariffs**: Load curve, load duration curve, different factors related to plants and consumers, Cost of electrical energy, depreciation, generation cost, effect of Load factor on unit cost. Fixed and operating cost of different plants, role of load diversity in power system economy. Objectives and forms of Tariff; Causes and effects of low power factor, advantages of power factor improvement, different methods for power factor improvements.
3. **Economic Operation of Power Systems**: Characteristics of steam and hydro-plants, Constraints in operation, Economic load scheduling of thermal plants Neglecting and considering transmission Losses, Penalty factor, loss coefficients, Incremental transmission loss. Hydrothermal Scheduling.
4. **Non-Conventional Energy Sources**: Power Crisis, future energy demand, role of Private sectors in energy management, MHD generation: Working principle, open and closed cycles, MHD systems, advantages, parameters governing power output. Solar power plant: Conversion of solar heat to electricity, Solar energy collectors, Photovoltaic cell, power generation, future prospects of solar energy use.
5. **Wind Energy**: Windmills, power output with combined operation of wind turbine generation and isolated generating system, technical choices& economic size. Geothermal Energy: Earth energy, heat extraction, vapor turbine cycle, difficulties & disadvantages, Tidal energy: Tidal phenomenon, tidal barrage, tidal power Schemes. Ocean Thermal Energy: Introduction, energy conversion, problems.

Prerequisite Course: None

Reference Books:

1. "Generation of Electrical Energy", B.R. Gupta, S. Chand Publications, 2009.
2. "A text book on Power System Engg.", Soni, Gupta & Bhatnagar, Dhanpat Rai & Co. (p) Ltd., 2000.
3. "Elements of Power System Analysis", W. D. Stevenson, McGraw Hill, 1975.
4. "Electrical Power", S. L. Uppal, Khanna Publishers, 1988.

UE16EE313: SOLAR PHOTOVOLTAIC SYSTEMS (4-0-0-0-4)

Course Objectives:

- To explain basics of solar photovoltaic systems.
- To know in depth of its types and design of various PV-interconnected systems

Course Outcomes:

- To explain basics of solar photovoltaic systems.
- To know in depth of its types and design of various PV-interconnected systems.

Course Content:

1. **Photovoltaic Basics**: Structure and working of Solar Cells, Electrical properties and Behaviour of Solar Cells - Cell properties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays - Basics of Load Estimation.
2. **Stand Alone PV Systems**: Schematics, Components, Batteries, Charge Conditioners - Balance of system components for DC and/or AC Applications
3. **Grid Connected PV Systems**: Schematics, Components, Charge Conditioners, Interface Components - Balance of system Components - PV System in Buildings.
4. **Hybrid Systems**: Solar, Biomass, Wind, Diesel Hybrid systems - Comparison and selection criteria for a given application.
5. **Design of PV Systems**: Radiation and load data - Design of System Components for different PV Applications - Sizing and Reliability

Prerequisite Course: None

Reference Books:

1. "Solar Photovoltaic Fundamentals, Technologies and Applications", C S Solanki, PHI Learning Pvt. Ltd., 2011.
2. "Green, Solar Cells Operating Principles, Technology, and System Applications", Martin A., Prentice-Hall, 2008.
3. "The Physics of Solar Cells", Nelson, J., Imperial College Press, 2003.
4. "Solar Electricit", Thomas Markvart, John Wiley and Sons, 2001.
5. "Applied Photovoltaics", Stuart R. Wenham, Martin A. Green, Muriel E. Watt, Richard Corkish (Editors), Earthscan, 2008.
6. "The Solar Electricity Handbook", Michael Boxwell, Code Green Publishing, UK, 2009.
7. "Solar Power Your Home for Dummies", Rik DeGunther, Wiley Publishing Inc, 2008.
8. "Photovoltaic's: Design and Installation Manual", Solar Energy International, 2011.

UE16EE314: POWER CONVERSION IN RENEWABLE ENERGY SYSTEMS (4-0-0-0-4)

Course Objectives:

- To introduce the students to the different renewable and non-conventional sources of energy
- To familiarize the students with the different types of primary converters that change the available energy into a more useful form, and their performance characteristics
- To highlight the need for further conversion process using secondary converters to match the output of the primary converter to the requirements of the load.
- To teach the students about energy storage devices and the energy transfer mechanisms
- To introduce complete energy conversion systems with their control algorithms with examples of different source-load combinations

Course Outcomes:

At the end of the course the student will be able to

- Choose the appropriate converters to match the load to the renewable energy source
- Estimate the energy available from a given source and design appropriate conversion systems
- Utilize the optimal energy storage device to hold excess energy and design converters to transfer and extract energy to and from the storage device

Course Content:

1. **Renewable and Non-conventional energy sources**: Nature of source availability and sizing of system. Solar, wind, biomass, geothermal, micro-hydel, tidal power. Means of harnessing directly and through primary power converters. Direct utilization - heat exchangers and illumination systems
2. **Primary Converters:** Photovoltaic cells, turbines, types and characteristics. Maximum power point and performance curves. Sizing and power ratings. Examples of direct utilization of primary converter output.
3. **Secondary converters:** Load requirements and need for secondary converters. Electrical machines, Power electronic converters, characteristics and control. DC-DC converters, DC-AC converters, unidirectional and bidirectional operation.
4. **Energy Storage Devices:** Batteries, types and charge discharge profiles, basic chemistry and charging systems. Charge controllers. Energy storage devices and applications. Storage devices as revenue generators – TOU pricing and its economics. V2G systems and pumped storage plants.
5. **Renewable and Non-conventional Energy Systems**. Solar PV, wind, hydel system examples. Design, sizing and control. Grid connected and distributed generation systems.

Prerequisite Course: None

Reference Books:

1. "Non-conventional Energy Sources", Rai G D, Khanna Publishers, 1993.
2. "Power Electronics Handbook", Rashid M H., Academic Press, 3rd Edition, 2011.
3. "Power Electronics: Converters, Applications and Design", Ned Mohan, Undeland and Robbins, Wiley India, 2011.

UE16EE315: DSD USING VHDL (4-0-0-0-4)

Course Objectives:

- Design of Digital systems using Hardware Description Language
- Building Individual component of Computer Such as ALU, RAM, Registers.
- Basic design issues of Combinational and Sequential Circuits.
- Discussion of VHDL Test benches and how they are used to verify functionality.

Course Outcomes:

After completion of the course, the student will be able to

- Design of combinational functional blocks (e.g. decoders, multiplexers, adder, multipliers, etc.)
- Design of sequential functional blocks (e.g. registers, counters, etc.)
- Design of Memory elements
- Building simple and pipelined datapaths (ALU, register file and their interconnection paths)

- Sequencing and control - hardwired control and micropro-grammed control
- Single-cycle computer, multi-cycle computer, a pipelined computer design

Course Content:

1. **Introduction to VHDL:** VHDL terms, Describing hardware in VHDL, types of modeling, entity, architectures, concurrent signal assignment, event scheduling, and statement concurrency.
2. **Basic language elements and modeling:** Structural designs, sequential behavior, variables, signals and constants, arrays, VHDL operators, process statements, process declarative region, process statement part, and process execution. VHDL description of combinational networks.
3. **Behavioural Modeling and Sequential Modeling:** Introduction to behavioural modeling, transport versus inertial delay, simulation deltas, drivers, driver creation, bad multiple driver model, Generics, Generate statements.
4. **Sequential processing**: process statement, sensitivity list, signal assignment versus variable assignment, sequential statements. Modeling flip flops using VHDL, modeling a sequential machine.
5. **Subprograms and Packages**: VHDL function, VHDL procedures, packages and libraries. Digital design with SM charts: State machine charts, derivation of SM charts, realization of SM charts. Design Examples.

Prerequisite Course: None

Reference Books:

1. “VHDL”, Douglas L Perry. Tata McGraw-Hill, 2002.
2. “Digital System Design Using VHDL”, Charles H Roth, Jr., Cengage Learning, India Edition, 2nd Edition, 2008.

UE16EE316:
COMMUNICATION ENGINEERING (4-0-0-0-4)

Course Objectives:

- To introduce students to various modulation and demodulation techniques of analog communication.
- To analyze different parameters of analog communication techniques.
- To study pulse modulation and demodulation.

Course Outcomes:

At the end of the course the student will be able to

- Use different modulation and demodulation techniques used in analog communication
- Identify and solve basic communication problems
- Analyze transmitter and receiver circuits
- Compare and contrast design issues, advantages, disadvantages and limitations of analog communication systems

Course Content:

1. **Introduction:** Historical Review, Elements of an Electrical Communication System, Communication Channel and their Characteristics, Mathematical Models for Communication Channels.
2. **Review of Signals and Systems:** Review of Fourier Transform, Rayleigh’s Energy Theorem, the inverse relationship between time and frequency, Dirac Delta Function, transformation of signals through Linear systems, Paley-Wiener Criterion, Hilbert transform, Band Pass signals, Transmission of Band Pass signals, Phase and group delay.
3. **Analog Signals Transmission and Reception:** Introduction, Amplitude Modulation, Double side Band Suppressed carrier Amplitude Modulation, Single side band Amplitude Modulation, Vestigial side band Modulation, Implementation of AM Modulators and De-Modulators, Frequency division Multiplexing, Angular Modulation, representation of FM and PM signals, Spectral Characteristic of Angular Modulated Signals, Implementation of Angle Modulators and De-Modulators, AM Radio Broadcasting, FM Radio Broadcasting.
4. **Effect of Noise on Analog communication System:** Effect of Noise on AM, Effect of Noise on DSB-SCM, Effect of Noise on SSB-AM, Carrier Phase Estimation with Phase Locked loop, Effect of Noise on Angle Modulation, Threshold Effect in Angle Modulation, Pre-emphasis and De-emphasis in FM.
5. **Pulse modulation:** Introduction, sampling process, pulse amplitude modulation (PAM), PPM, PWM, PDM, TDM, bandwidth-noise trade-off, Nyquist sampling theorem.

Prerequisite Course: None

Reference Books:

1. “Communication systems”, Haykin, Simon, John Wiley & Sons, Edition, 2008.
2. “Principles of communication systems”, Taub, Herbert, and Donald L. Schilling, McGraw-Hill Higher Education, Edition, 1986.
3. “Communication systems engineering”, Proakis, John G., et al., Vol. 2. New Jersey: Prentice Hall, 1994.

UE16EE317:
COMPUTER ARCHITECTURE (4-0-0-0-4)

Course Objectives:

- To conceptualize the basics of organizational and architectural issues of a digital computer.
- To analyze performance issues in processor and memory design of a digital computer.
- To understand various data transfer techniques in digital computer.
- To analyze processor performance improvement using instruction level parallelism

Course Outcomes:

At the end of the course, the student will be able to:

- Understand basic structure of computer.
- Perform computer arithmetic operations.
- Understand control unit operations.
- Design memory organization that uses banks for different word size operations.
- Understand the concept of cache mapping techniques.
- Understand the concept of I/O organization.

Course Content:

1. **Introduction:** Generations of architecture, fundamental concepts of design methodologies, basic organization of computer
2. **Processor Design:** Basic organization, instruction set, ALU organization, fixed-point and Floating-point arithmetic
3. **Controller Design:** Basic concepts, design of hardwired control and micro-programmed control units
4. **Memory Organization:** Basic organization, virtual memory, memory hierarchical structure, paging and segmentation concept, memory interleaving, cache & associative memories
5. **Peripheral processing & devices:** I/O accessing and data transfer techniques, I/O channel and processor, I/O management

Prerequisite Course: None

Reference Books:

1. “Computer Organization and Design MIPS Edition: The Hardware/Software Interface”, Patterson, David A., and John L. Hennessy, Newnes, Edition, 2013.

2. "Computer organization", Hamacher, V. Carl, et al., Vol. 3. McGraw-Hill, 1996.
3. "Computer Architecture and Organization", J. P. Hayes, AHA Hafez, Edition, 1988.
4. "Computer organization and architecture: designing for performance", Stallings, William. Pearson Education India, Edition, 2003.
5. "Computer systems design and architecture", Heuring, Vincent P., Harry Frederick Jordan, and Miles Murdocca, Addison-Wesley, Edition, 1997.

UE16EE321:
RENEWABLE ENERGY SOURCES (4-0-0-0-4)

Course Objectives:

- To demonstrate an understanding of key concepts in renewable energy technology
- To evaluate and compare renewable technologies
- To understand schemes of power generation in renewable
- To be aware of applications of various electrical systems to renewable energy sources

Course Outcomes

At the end of the course the students will be able to

- Explain the main sources of energy under renewable sources
- Compare different storage solutions with stress on types of batteries
- Compare different windmills and rotors
- Explain interconnected and hybrid systems
- Apply various generation schemes and compare various generators for renewable energy technologies

Course Content:

1. **Energy Sources:** Energy Consumption as Measure of Prosperity, Renewable Energy Sources, and its Prospects. Means of harnessing directly and through primary power converters. Direct utilization- heat exchangers and illumination systems.
2. **Energy Storage:** Battery, types, equivalent electrical circuit, performance characteristics, lead- acid battery, battery design, battery charging, charging regulators. Storage devices as revenue generators – TOU pricing and its economics. V2G systems and pumped storage plants
3. **Wind Energy:** Multi-blade Water pumping windmills, High Speed Propeller type Wind machines, The Savonius rotor, The Darrieus rotor, Power Speed Characteristics and Torque Speed characteristics. Generating Systems, Applications of Wind Energy, Interconnected System, Hybrid systems, Safety Systems, Environmental aspects.
4. **Grid Connected and Self Excited Induction Generator Operation:** **C**onstant voltage, constant frequency generation, reactive power compensation, variable voltage, variable frequency generation, effect of wind generator on the network.
5. **Generation Schemes with Variable Speed Turbines:** Classification of schemes, operating area, induction generators, doubly fed induction generator, wound field synchronous generators, the permanent magnet generators.

Prerequisite Course: None

Reference Books:

1. "Wind and Solar Power Systems: Design, Analysis and Operation", Mukund R. Patel, CRC Taylor & Francis, 2nd Edition, 2006.
2. "Wind Electrical Systems", S. N. Bhadra, D. Kastha, S. Banerjee, Oxford University Press, 2013.
3. "Non-Conventional Sources of Energy", Rai, G. D., Khanna Publishers, 4th Edition, New Delhi, 2007.
4. "Fundamentals of Renewable Energy Systems", Mukherjee D, Chakrabarti S, New Age International Publishers, 2005.
5. "Non-Conventional Energy Resources", Khan B H, TMH, New Delhi, 2006.

UE16EE322:
ADVANCED ELECTROMAGNETIC THEORY (4-0-0-0-4)

Course Objectives:

At the end of the course the student is expected to:

- Understand the methods of solving Laplace and Poisson equations analytically and numerically using different methods
- Understand the required level of mathematics – concepts of linear algebra, rules of tensor algebra to express laws and constitutive equations of electromagnetics
- Analyze the electro, magnetic and optical properties of materials using matrices and tensors
- Set up and solve the problem of propagation of electromagnetic waves in bounded media and waveguides

Course Outcomes

At the end of the course the students will be able to:

- solve boundary value problems in electrostatics
- adept in applying Laplace and Fourier transform methods to solve partial differential equations
- master the properties of matrices and determinants, including eigenvalues and eigenvectors
- express physical quantities using tensors and manipulate them
- know the contexts in which tensors are applied to study electromagnetic phenomena
- classify different modes of wave transmission such as TE, TM, TEM modes in waveguides
- solve equations of electromagnetic numerically
- differentiate between different methods to solve electromagnetic equations – finite difference, moments and finite element methods

Course Content:

1. **Laplace Equation and its Solutions:** Maxwell Equations (review), Laplace equation in one, two, and three dimensions; Boundary conditions and Uniqueness Theorems, Separation of variables; Laplace and Fourier transforms to solve Laplace equations.
2. **Matrix Algebra:** Vector Spaces, Algebraic Operations, Special Matrices, Invariants of a matrix, Inverse matrix, Inverse transformations, Orthogonal and Unitary matrices, Rotational Matrices, Pauli Spin Matrices, Dirac Matrices, Transformations of vectors. Eigen values, Diagonalization of a matrix, Bilinear and Quadratic forms, Hermitian form.

   Introduction to Tensors: Occurrence, Notation and Conventions, Contravariant and Covariant vector, Tensors of second rank, Algebra of Tensors.
3. **Electric Fields in Anisotropic Media:** Relations between D, E and P in a parallel plate condenser, energy of a polarized crystal, force and couple on a crystal in an electric field. Electrostatic field in a homogeneous anistotropic dielectric, Pyroelectricity, Ferroelectricity.
4. **Wave Guides:** Basic waveguide operation, Rectangular waveguides, TM and TE modes, Wave propagation in the guide, Transmission and attenuation, Optical fiber as a waveguide.
5. **Fundamentals of Computational Electromagnetics:** The finite difference method, 1-D and 2-D boundary value problems; the moment method, 1-D problems; finite element method, finite element discretisation, governing equations, solutions using iteration and band matrix methods.

Prerequisite Course: None

Reference Books:

1. "Introduction to Electrodynamics", David J Griffiths, Pearson Education, 3rd Edition, 1999.
2. "Advanced Engineering Mathematics" Erwin Kreysig, John Wiley & Sons, 10th Edition,1988.
3. "Matrices and Tensors in Physics", A W Joshi, New Age International Publishers, 3rd Edition, 1995.
4. "Physical properties of Crystals - Their representation by Tensors and Matrices", J F Nye, Oxford Science Publications, 1985.
5. "Principles of Electromagnetics", Mathew N Sadiku, Oxford Universities Press, 4th Edition, 2007.
6. "Engineering Electromagnetics", William H Hayt Jr., Tata Mc Graw Hill, 7th Edition, 2007.
7. 'Electromagnetic Wave Theory for Boundary-Value Problems – An Advanced Course on Analytical Methods", H J Eom, Springer Verlag, 2004.
8. "Electromagnetic Waves and Radiating Systems", Edward C Jordan, Keith G Balmain, PHI, 2nd Edition, 2005.
9. "Schaum's Outlines on Electromagnetics" J.A. Edminister, Tata Mc Graw Hill, 4th Edition, 2014.
10. "Fundamentals of Electromagnetics with Matlab", Karl E Lonngren, Sava V Savov, Prentice-Hall India, 2005.
11. "Linear Algebra and Its Applications" – Gilbert Strang, Academic Press, 1976

UE16EE323:
ADVANCED POWER ELECTRONICS (4-0-0-0-4)

Course Objectives:

- Various topologies of switched-mode regulators
- Concepts of switched inverters
- Various techniques of control of these converters

Course Outcomes:

At the end of the course the students will be able to:

- Select an appropriate power semiconductor device based on desired specifications.
- Design a power converter for the required application
- Able to understand control of Electrical Motors through converters

Course Content

1. **DC-DC switched mode converter topologies**: Buck, boost, buck-boost, and Cuk converters Full bridge converter. DC-DC converter-detailed theory, working principles, modes of operation, with detailed circuits and waveforms, applications, merits and demerits, design principle, boundary value numericals.
2. **DC-AC switched mode inverters**: Single-phase inverter, three phase inverters. SPWM inverter - theory, working principles, modes of operation, applications, merits and demerits, design principle, numericals. (introduction to Gate Drives)
3. **Resonant converters**: zero voltage and zero current switching, resonant switch converters; design working, principle, numericals.
4. **High frequency inductor and transformers**: Design principle and numericals, Power conditions and uninterruptible power supplies, solar power based bidirectional inverter- Design principle operation and numericals.
5. **Induction motor control**: Various types, V/F control, vector control, controller realization, Design and working principles - numericals.

Prerequisite Course: None

Reference Books:

1. "Power Electronics: Converters, Applications, and Design", Mohan N., & Undeland T. M., John Wiley & Sons, 2007.
2. "Power Electronics", Lander C. W., McGraw-Hill, Inc., 1987.
3. "Power Electronics and AC Drives", Bose. B. K., Prentice Hall, 1986.
4. "Power Electronics Devices", Dubey G.K. & Asarbada. K., Tata McGraw Hill, 1983.
5. "Power Electronics: Circuits, Devices, and Applications", Rashid. M. H., Pearson Education India, 2003.

UE16EE324:
PWM CONVERTERS AND APPLICATIONS (4-0-0-0-4)

Course Objectives:

- To familiarize the student with different converter topologies
- To introduce different voltage control techniques for inverters
- To highlight the drawbacks of practical converters with regard to power losses and voltage regulation
- To familiarize the student with modeling of different power converters
- To make the student understand the detrimental effects of power converters on the utility line, and ways to overcome them

Course Outcomes:

At the end of the course the students will be able to:

- Analyse the voltage output of converters
- Understand the different modulation techniques used for voltage control of inverters
- Calculate the losses in practical converters
- Model the different PWM converters and estimate their performance
- Design converters that produce minimal distortion on the utility lines

Course Content:

1. **AC/DC Power Conversion:** Overview of applications of voltage source converters. Single phase and three phase-controlled rectifiers: Analysis of voltage output: Average and AC values, harmonic content.
2. **DC/AC Power Conversion:** Single phase inverter: Voltage control methods, Pulse width modulation techniques for three-phase Inverter: Sinusoidal PWM, bus clamping PWM, space vector based PWM, advanced PWM techniques. Selective harmonic elimination. Generation of reference voltages, Harmonics in output voltage, Over-modulation and six step operations.
3. **Switching losses and effects of dead time:** Practical devices in converters, calculation of switching and conduction losses. Need for dead time and its affect on output voltage. Compensation for dead time.
4. **Elements of power conversion system modeling:** Dynamic model of PWM converters; constant V/F induction motor drives; Basics of dynamic modeling of induction motors.
5. **Harmonics and mitigation:** Converters as sources of harmonics on utility line. Displacement and distortion power factor. Mitigation of harmonics using power converters. Line-side converters with power factor compensation, reactive power compensation, harmonic current compensation.

Prerequisite Course: None

Reference Books:

1. "Power Electronics: Converter, Applications and Design", Mohan, Undeland and Robbins, Wiley India, 2011.

2. “Fundamentals of Power Electronics”, Erickson RW, Chapman Hall, 1997.
3. “Power Electronics- Principles and Applications”, Joseph Vithyathil, TMH, 2011.

UE16EE325: DATA STRUCTURES AND ALGORITHMS (4-0-0-0-4)

Course Objectives:

- To cover practical aspects of C programming
- To act as a bridge towards application aspects of programming
- To give students hands on experience on algorithms
- To get students to apply algorithmic concepts to real life problems

Course Outcomes:

- Students should be able to choose right data structures & algorithms for real life problems
- Students will get hands on experience on algorithm development
- Students will get experience on applications
- Students will get good ability to apply algorithmic concepts to real problems

Course Content

1. **Fundamental of algorithms & C programming:** Introduction to Data Structures, Algorithms, Pseudo code representation, Efficiency of an algorithm, Analysis of Algorithm and Asymptotic Analysis. C Fundamentals, C Program Structure, Preprocessor, C Constants, Data types, User defined data types, declaring storage types, Derived data types, Arrays, Structure, C tokens, C keywords, Operators and expressions, Formatted input & output, Decision making and branching. Top Down modular programming, Function types
2. **Basic data structures & dynamic memory allocation**: Pointers, Pointer expressions, Pointer increments and scale factor, Static and dynamic memory allocation, Linked list, Creating linked list, Basic operations on Linked list, singly linked lists and doubly linked lists and list traversals. Circular lists.
3. **Stacks & Queues**: Data types, Definition of data structure, Abstract Data Types, Stacks, Application of stacks Recursion, -Array Based and Linked list-based stack implementation, Infix, Prefix and Postfix representation of expressions, Queues, Array and Linked list-based implementation of Queues, Double ended queues, Circular lists, Applications of queues
4. **Hashing & Binary trees**: Dictionaries, The Dictionary ADT, Dictionary Implementation using Arrays, Linked lists, Hash Table, Collision resolution, Hash Maps, compression maps, Binary search and Linear Search, Trees, Binary trees, Applications of Binary trees, ADT’s for Trees and Binary Trees. Tree Traversals. Binary Search Trees (BST), BST Sort
5. **Sorting & Graph Theory**: Sorting, Insertion Sort, Selection Sort, Bubble sort, Quick Sort, Merge Sort, Priority Queues, Binary Heaps, Building Heaps, Applications of Heaps, Heap Sort, Graphs, Applications of Graphs, Graph Terminology, Spanning tree, Graph ADT, Graph Representation using edge lists, Adjacency lists and Adjacency Matrix, BFS and DFS traversal of Graphs.

Prerequisite Course: None

Reference Books:

1. “Programming in ANSI C”, E Balgurusamy, Tata McGraw Hill, 2007.
2. “Data Structures, A Pseudocode Approach with C”, Richard F Gilberg & Behrouz A Forouzan, Cenage Learning, 2005

UE16EE326: SENSORS AND ACTUATORS (4-0-0-0-4)

Course Objectives:

- Understand static and dynamic characteristics of measurement systems.
- Study various types of sensors.
- Study different types of actuators and their usage.
- Study State-of-the-art digital and semiconductor sensors.

Course Outcomes:

Upon completion of the course the student will be able to

- Explain fundamental physical and technical base of sensors and actuators
- Describe basic laws and phenomena that define behaviour of sensors and actuators
- Analyze various premises, approaches, procedures and results related to sensors and actuators
- Create analytical design and development solutions for sensors and actuators

Course Content:

1. **INTRODUCTION TO MEASUREMENT SYSTEMS**: General concepts and terminology, measurement systems, sensor classification, general input-output configuration, methods of correction, performance characteristics: static characteristics of measurement systems, accuracy, precision, sensitivity, other characteristics: linearity, resolution, systematic errors, random errors, dynamic characteristics of measurement systems: zero-order, first-order, and second-order measurement systems and response.
2. **RESISTIVE AND REACTIVE SENSORS**: Resistive sensors: potentiometers, strain gages, resistive temperature detectors, magneto resistors, light-dependent resistors, Signal conditioning for resistive sensors: Wheatstone bridge, sensor bridge calibration and compensation, Instrumentation amplifiers, sources of interference and interference reduction, Reactance variation and electromagnetic sensors, capacitive sensors, differential, inductive sensors, linear variable differential transformers (LVDT), magneto elastic sensors, hall effect sensors, Signal conditioning for reactance-based sensors & application to the LVDT.
3. **SELF-GENERATING SENSORS**: Self-generating sensors: thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors, Signal conditioning for self-generating sensors: chopper and low-drift amplifiers, offset and drifts amplifiers, electrometer amplifiers, charge amplifiers, noise in amplifiers.
4. **ACTUATORS DRIVE CHARACTERISTICS AND APPLICATIONS**: Relays, Solenoid drive, Stepper Motors, Voice-Coil actuators, Servo Motors, DC motors and motor control, 4-to-20 mA Drive, Hydraulic actuators, variable transformers: synchros, resolvers, Inductosyn, resolver-to-digital and digital-to-resolver converters.
5. **DIGITAL SENSORS AND SEMICONDUCTOR DEVICE SENSORS**: Digital sensors: position encoders, variable frequency sensors – quartz digital thermometer, vibrating wire strain gages, vibrating cylinder sensors, saw sensors, digital flow meters, Sensors based on semiconductor junctions: thermometers based on semiconductor junctions, magneto diodes and magneto transistors, photodiodes and phototransistors, sensors based on MOSFET transistors, CCD imaging sensors , ultrasonic sensors, fiber-optic sensors.

Prerequisite Course: None

Reference Books:

1. "Sensors and Actuators in Mechatronics Design and Applications" Andrzej M. Pawlak, CRC Press, 2006.
2. "Process Control Instrumentation Technology", D. Johnson, John Wiley and Sons, 1999.
3. "Sensors and Transducers", D.Patranabis, TMH 2003.
4. "Measurement System: Applications and Design", E.O. Doeblin, McGraw Hill publications, 2007.
5. "Introduction to Sensors for ranging and imaging", Graham Brooker, The Institution of Engineering and Technology, 2009.
6. "Instrument Transducers – An Introduction to Their Performance and Design", Herman K.P. Neubrat, Oxford University Press, 1963.
7. "Sensors and Transducers", Ian Sinclair, Elsevier, 3rd Edition, 2011.
8. "Sensor Technology Handbook", Jon Wilson, Elsevier, 2004.
9. "PC Interfacing and Data acquisition", Kevin James, Elsevier, 2011.
10. "Sensors and Signal Conditioning", Ramon Pallás Areny, John G. Webster, 2nd Edition, John Wiley and Sons, 2000.
11. "Sensors and Actuators: Control System Instrumentation", Clarence W. de Silva, CRC Press, 2007.

UE16EE304:
ELECTRICAL MACHINES – II LABORATORY (0-0-2-0-1)

Course Objectives:

- To prepare the students to have a basic knowledge of induction motors.
- To prepare the students to have a basic knowledge of alternators.
- To know about an induction generator

Course Outcomes:

At the end of the course the students will be able to:

- Identify various parts of a electrical machine.
- Conduct open circuit and blocked rotor test on 3 phase induction motor.
- Conduct experiments on Ac Machines to find the characteristics.
- Calculate torque and speed of given Induction Machine.
- Ability to perform test on synchronous Machine to find Direct and quadrature axis reactance.

Course Content:

1. Load Test on 3- Φ Induction Motor by Indirect Loading-Performance Evaluation
2. Load Test on 3- Φ Induction Motor by Direct loading- Performance Evaluation
3. Speed control of 3-Φ induction motor-Stator Voltage Control & Rotor Resistance Control
4. Separation of Iron loss, friction & windage loss of 3-Φ induction motor
5. Load test on 1-Φ Induction Motor
6. Circle diagram of 3-Φ induction motor-performance evaluation
7. Slip test on Alternator
8. Voltage regulation of alternator by EMF and MMF methods
9. Voltage regulation of alternator by ZPF method
10. Synchronization of Alternator to Infinite bus bars

Prerequisite Course: None

Reference Books:

1. Laboratory manual prepared by Department of Electrical and Electronics Engineering, PESU.

UE16EE305:
MICROCONTROLLERS LABORATORY (0-0-2-0-1)

Course Objectives:

This course is to provide hands-on experience on the theoretical concepts studied in the theory counterpart of this course. It helps to:

- Understand coding, hardware interfaces and hence develop ability to design and validate
- Get acquainted with 8051 microcontroller kit but the learning can be applied to any other micro-controller and kits
- Explore to extend it with more functionality so that the same can be useful for the future microcontroller based projects
- Able to work with assembly as well as embedded 'C' Programming with an integrated tool chain that includes cross assembler and compiler

Course Outcomes:

At the end of the course the students will be able to do the following with the 8051 microcontroller kit with the concepts that can be applied to any other similar micro-controllers:

- Write Arithmetic Logical Programs (ALP) using simple arithmetic and logical operations
- Interface inputs using General purpose inputs and outputs, ADCs
- Interface outputs like LCD
- Interface and control DC motor and stepper motor
- Interface DAC to generate different waveforms
- Write interrupt based programs
- Able to use integrated development environment that includes compile/link build cycle using cross-compiler tools, debugger etc.

List of Experiments

1. Data transfer programs: Data block movement with an without overlap, Data block interchange
2. Arithmetic instructions program: Adding, multiplying, subtracting numbers
3. Programs on counters: Up and down hex and BCD counters
4. Programs on Boolean and logical instructions (bit manipulation)
5. Programs on conditional CALL &RETURN
6. Programs on code conversion: Hex to decimal, decimal to hex, Conversions to ASCII numbers
7. Serial Data Communication
8. Programs on generating delay
9. Simple calculator and Hex keyboard interface
10. Alphanumeric LCD panel & Hex keypad input
11. External ADC & temperature control
12. Different waveform generation: Generate triangular, square, ramp, sine waves
13. Stepper and DC motor controls

Prerequisite Course: None

Reference Books:

1. Laboratory manual prepared by Department of Electrical and Electronics Engineering, PESU.

UE16EE306:
PROGRAMMING WITH C (2-0-0-0-2)

(Applicable to students admitted through Lateral Entry Scheme)

Course Objectives:

- Introduction to C Programming language

- Learn background knowledge including memory management, pointers, pre-processor and macros
- Become a better programmer instead of doing 'quick and dirty' programs

Course outcome:

By the end of this course, you should be able to:

- Understand and use the basic programming constructs of C
- Manipulate various C datatypes, such as arrays, strings, and pointers
- Use different data structures and create/update basic data files
- Use memory appropriately, including proper allocation/ deallocation procedures
- Apply functional approaches to software problems in C and design programs involving decision structures, loops and functions
- Isolate and fix common errors in C programs
- Write small-scale C programs using the above skills

Course Content:

1. Introduction with simple program – Types, Operators and Expressions.
2. Control Flow – Coding conventions.
3. Input and Output – Functions and Program Structure, Programs
4. Pointers and Arrays – Structures – Programming Exercise 1
5. External and standard library-Dynamic memory - Programming Exercise 2

Prerequisite Courses: None

Reference Books:

1. "The C Programming Language", Kernighan, Brian, and Dennis Ritchie, 2nd ed., Upper Saddle River, NJ: Prentice Hall, 1988.
2. http://www.freebookcentre.net/Language/Free-C-Programming-Books-Download-1.htm

UE16EE351:
POWER SYSTEM ANALYSIS & STABILITY (4-0-0-0-4)

Course Objectives:

- To represent power systems using single line diagram and per unit system.
- To have knowledge of faults to analyze the stability of power system.
- To select power system apparatus – Circuit breakers
- To study power system stability.

Course Outcomes:

At the end of the course the students will be able to:

- Represent power system in per unit.
- Learn the symmetrical component tool.
- Learn to represent the power system components in symmetrical component network.
- Analyze balanced and unbalanced faults in power system
- Judge the stability of power system.

Course Content:

1. **Per Unit Representation**: Representation of Power system Components, Single line Diagram: Circuit models of Transmission line, Synchronous machines, Transformer and load. Impedance and Reactance diagram of power systems. Per unit system, Per unit impedance diagram of power system.
2. **Symmetrical Components**: Symmetrical components. Application to power system. Analysis of unbalanced loads under balanced 3- phase supply, neutral shift. Resolution of unbalanced phasors into their symmetrical components. Phase shift of symmetrical components in transformer bank. Power in terms of symmetrical components.
3. **Sequence Impedance Network Representation**: Sequence impedances and sequence networks. Sequence impedance representation of power system elements: alternator, transformer and transmission line. Representation of power system networks in positive, negative and zero sequence.
4. **Symmetrical and Unsymmetrical Faults**: Unsymmetrical faults: S-L-G, L-L, D-L-G faults on an unloaded alternator with and without fault impedance. Unsymmetrical faults on a power system with and without fault impedance. Symmetrical 3 Phase faults: Short- Circuit currents and the reactance of synchronous machines, short circuit on an unloaded transmission lines.
5. **Power System Stability Studies:** Steady state and transient stability. Rotor dynamics and the swing equation. Power angle equation. Equal-area criterion of stability and its application.

Prerequisite Course: None

Reference Books:

1. "Elements of Power System Analysis", Stevenson, W. D., 2nd Edition, McGraw-Hill, 1982.
2. "Modern Power System Analysis", Kothari, D. P., & Nagrath, I. J., Tata McGraw-Hill Education, 2003.
3. "Power System Analysis", Saadat H., McGraw-Hill Publications, 1999.

UE16EE352:
CONTROL SYSTEMS (3-1-0-0-4)

Course Objectives:

- To develop the theoretical aspects of Control systems and feedbacks.
- To develop state models for dynamic systems and perform steady state analysis
- To study the concepts of root locus and stability
- To understand the frequency response analysis and specifications of control systems with transfer function.
- To perform stability analysis in frequency domain

Course Outcomes:

At the end of the course the students will be able to:

- Represent a system using block diagram and signal flow graphs
- Analyze the performance metrics of second order systems
- Perform stability analysis using Routh-Hurwitz stability criterion
- Analyze and design a control system using the Root Locus method
- Understand the performance and analyze the stability of a system in frequency domain
- Design feedback control systems

Course Content:

1. **Mathematical Models of Systems:** Differential Equations of Physical Systems Linear Approximations of Physical Systems; The Laplace Transform; The Transfer Function of Linear Systems; Block Diagram Models; Signal Flow Graph Models. Feedback Control System Characteristics: Open and Closed Loop Control Systems; Sensitivity of Control Systems to Parameter Variations; Control of the Transient Response of Control Systems; Disturbance Signals in a Feedback Control System; Cost of feedback.
2. **State Variable Models:** The State Variables of a Dynamic System; The State Differential Equation; Signal Flow Graph State Models; Transfer function from the state equation; The Time Response and the State Transition Matrix.

The Performance of Feedback Control Systems: Test Input Signals; Performance of a second-order system; Effects of a third pole and a zero on the second-order System Response; Estimation of the Damping Ratio; The s-plane root location and the Transient Response; steady-state errors of unity and non-unity feedback systems.

3. **The Stability of Linear Feedback Systems:** Concept of stability; Routh–Hurwitz stability criterion; relative stability of feedback control systems; stability of state variable systems. The Root Locus Method: Concept, Procedure, Design utilizing the Root Locus method.
4. **Frequency Response Methods:** The Bode Diagram; Frequency Response Measurements; Performance specification in the frequency domain. Stability in the Frequency Domain: Mapping Contours in the s-plane; The Nyquist Criterion; Relative Stability and the Nyquist Criterion; Time-Domain Performance Criteria Specified in the frequency Domain; System Bandwidth.
5. **The Design of Feedback Control Systems:** System Design; Cascade Compensation Networks, Phase-lead and phase-lag design using Bode diagram, P, PI, PID controllers.

   The Design of State Variable Feed Back Systems: Controllability; Observability; pole-placement using state variable feedback; Ackermann's formula.

Prerequisite Course: None

Reference books

1. "Modern Control Systems", Dorf, Richard C., and Robert H. Bishop, Pearson, 2011.
2. "Control Systems Engineering", Nagrath. I. J., New Age International, 2006.
3. "Modern Control Engineering", Ogata K & Yang Y., Pearson Education Asia, 1970.
4. "Automatic Control Systems", B C Kuo, Prentice Hall, 1981.

UE16EE353:
DIGITAL SIGNAL PROCESSING (3-1-0-0-4)

Course Objectives:

- To understand a easy method of analyzing discrete signals on digital hardware using mathematical tool called DFT & IDFT.
- To understand how a program can be developed with less number of computations to compute DFT & IDFT.
- To understand standard procedure of designing all types of Analog Filter.
- To understand mapping techniques of transforming s plane to z plane so that analog filter is digitized without elaborate mathematics.
- To understand how to design Finite impulse response filters by window method and frequency sampling method.

Course Outcomes:

At the end of the course the students will be able to:

- Explain the importance of properties of DFT & IDFT to reduce the number of computations required in implementation.
- Appreciate signal flow graph of computing DFT & IDFT and use it to develop program or see how quickly DFT or IDFT are computed.
- Explain the ideal & practical frequency response of different filters to know frequency specifications of fitters.
- Explain the difference between Infinite impulse & Finite impulse response filters and difficulty of designing analog FIR filters.
- Explain how Analog Butterworth & Chebyshev filters are designed fro the given frequency specifications.
- Explain mapping of s plane to z plane by different methods and see efficacy of techniques.
- Explain the process of designing digital filters by mapping methods.
- Explain the importance of window functions in the design of FIR filters.
- Explain how frequency sampling is used to design a FIR filter for given specifications.

Course Content:

1. **Discrete Fourier Transforms (DFT):** Frequency domain sampling and reconstruction of discrete signals, DFT as a linear transformation, properties of DFT.
2. **Fast Fourier Transform (FFT):** Direct computation of DFT, need for FFT, Radix-2 FFT algorithm for computation of DFT and IDFT: decimation-in-time and decimation-in-frequency algorithms. Use of DFT in linear filtering: overlap-save and overlap-add methods.
3. **Analog Filter Design:** Design of Butterworth and Chebyshev filters, analog to analog frequency, transformations. Time and frequency domain aspects of ideal and non-ideal filters, linear phase
4. **Design of IIR Filters from Analog Filters:** Mapping of transfer function: Approximation of derivative: backward difference and bilinear transformation, impulse invariance, matched z-transform, verification for stability and linearity during mapping. Realization of IIR filters.
5. **Design of FIR Filters:** Introduction to FIR filters, design of FIR filters using window functions, Hilbert transformer and differentiator, FIR design using frequency sampling technique. Realization of FIR filters.

Prerequisite Course: None

Reference books:

1. "Digital Signal Processing: Principles, Algorithms, and Applications", Proakis John G., & Manolakis Dimitris G., Prentice Hall, 2007.
2. "Digital Signal Processing", Ludeman, L. C., Addison-Wesley Longman Publishing Co., Inc.. 1986.
3. "Digital Signal Processing: a computer-based approach,"Mitra S. K., & Kuo Y., (Vol. 2). New York: McGraw-Hill, 2006.
4. "Discrete-time signal processing", Oppenheim A. V., Schafer R. W., & Buck J. R., (Vol. 2). Englewood Cliffs, NJ: Prentice hall, 1989.
5. "Analog and Digital Signal Processing", Ambardar A., (Vol. 1). PWS Publishing Company, 1995.

UE16EE331:
SPECIAL MACHINES (4-0-0-0-4)

Course Objectives:

- Introduce students to the various types of special electric motors
- Introduce students to the operating principles, of special motors.
- To study the applications of these motors
- To study the performance characteristics of these motors
- To study the speed control of these motors

Course Outcomes:

At the end of the course the students will be able to:

- Differentiate between a PMDC motor and a BLDC motor.
- Will be able to explain the working principle of a d.c servo motor.
- Will be able to obtain open loop transfer function of d.c servo motor.
- Will be able to explain different methods of speed control of universal motors
- Will be able to select a suitable motor for a particular application

Course Content:

1. **Permanent Magnet D.C Motors (PMDC):** Construction, Principle of working, Torque equation and equivalent circuit, Performance characteristics, Moving coil motors, printed circuit motors, Disc motors shell type PMDC motors - Applications.

   Brush less D.C Motors: Classification, Construction, Electronic Commutation, of operation, BLDC square wave motor, Control of BLDC motor, microprocessor-based control of BLDC motor, Sensor less control, Applications.
2. **D.C Servo Motors**: Construction, principle of operation, voltage equation, characteristics, transfer function, control. A.C Servo Motors: Construction and Working, principle of operation, Analysis, Transfer functions.
3. **A.C Series Motor and Universal Motors**: Construction, principle of working, e.m.f and torque equation, phasor diagrams. Torque – speed characteristics. Universal motors - Types and construction, principle of operation, speed control of universal motors.
4. **Stepper Motors**: Step angle, types, variable reluctance stepper motor, permanent magnet stepper motors, Hybrid stepper motor, single phase stepper motor, disc magnet stepper motor, claw tooth cam stack permanent magnet stepper motor, applications.
5. **Linear Induction Motor**: Construction of linear Induction Motors, Thrust equation, performance equations based on current sheet concepts, Goodness factor, Equivalent circuit of linear induction motor, Characteristics of linear induction motor, certain design aspects of linear induction motor, control of linear induction motor.

Prerequisite Course: None

Reference Books:

1. "Special Electrical Machines", E.G. Janardhana, PHI, 2014.
2. "Special Electrical Machines", K. Venkatratnam, University Press, 2008.

UE16EE332:
ENERGY AUDIT AND DEMAND SIDE MANAGEMENT (3-0-0-4-4)

Course Objectives:

- To understand importance of energy audit and energy management
- Capacity to understand and analyze energy economic issues in India & real property depreciation
- To acquire skills for energy modeling, planning and to know energy security issues
- To upgrade knowledge on cost of energy, various tariff and applications of load control

Course Outcomes:

- Enhanced knowledge in energy cost, tariff and audit calculations
- Ability to do case studies on energy audit & management on plants leads to corresponding calculations

Course Content:

1. **Energy Management**: Definition & Objectives of Energy Management, Energy Audit: Types and Methodology, Energy Audit Reporting Format, Understanding Energy Costs, Benchmarking and Energy Performance, Matching Energy Usage to Requirement, Maximizing System Efficiency, Fuel and Energy Substitution, Energy Audit Instruments
2. The time value of money, Developing cash flow models, Payback Analysis, Tax Considerations, Energy Efficiency Equipment & Real Property Depreciation, Impact of fuel inflation on life-cycle costing
3. **Energy Modeling & Planning:** A conceptual framework for energy planning, Energy futures, Basic components of a typical planning methodology, Mathematical models for electricity planning, Electricity planning in general.
4. **Security:** Energy security, Issues in supply security, Policies & issues in demand security, Load curve & basic terms, Cost of electrical energy, Need for electrical energy conservation – methods, Energy auditing, PF improvement, Concept of distributed generation, Deregulation. Numerics in above topics
5. **Demand Side Management**: Scope of demand side management, Evolution, DSM planning & implementation, Load management as a DSM strategy, Applications of load control, End use energy conservation, Tariff options for DSM, Customer acceptance & implementation issues.

Prerequisite Course: None

Reference Books

1. "Fundamentals of Energy Engineering", Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey, 1984
2. "Energy Management", ISTE – Working Professionals Learning Project- AICTE Project – First Edition, 2011.
3. "Generation & Utilization of Electrical Energy", S Sivanagaraju, M Balasubba Reddy, and D Srilatha, Pearson Publication, 2010.
4. "Generation of Electrical Energy", B R Gupta, S Chand Publications, 2011.
5. "Energy Management Handbook", Wayne C. Turner, John Wiley and Sons, 2007
6. "Hand Book of Energy Engineering", Albert Thumann, & D Paul Mehta, 7th Edition, CRC Press Publications, 2012.
7. https://beeindia.gov.in/sites/default/files/1Ch3.pdf

UE16EE333:
DESIGN OF POWER CONVERTERS (2-0-4-0-4)

Course Objectives:

- Implementation of power electronic converters in a practical sense involves several challenges in component selection and design, thermal and EMI issues and control problems.
- Since implementation of practical power electronic circuits is a challenge to students, a hands-on course is needed. This can be achieved by having laboratory sessions that involve comprehensive practical implementation of circuits discussed and designed in the theory classes.
- The four credits are divided over two hours of theory and four hours of hands on lab-work per week.

Course Outcomes:

At the end of the course, the students will be able to

- Design optimal gate driver circuits for different power semiconductor switches
- Understand the need for protection of power electronic devices and provide solutions
- Design and implement practical power electronic systems
- Design systems that operate safely over a specified operating ambient temperature range by suitable design of cooling systems
- To manufacture power converter systems that meet global specifications for EMI

Course Content:

1. **Switching Characteristics of Power Devices**: Turn OFF and turn ON process. Switching and conduction losses and the reduction of losses. Snubber circuits and their design. Soft switching topologies.
2. **Drive Circuits for High and Low Side Devices**: Tailoring switching characteristics by appropriate driver circuits. Bootstrap, charge

pump, Pulse transformer and opto-coupler drive circuits and their design

Protection Circuits: Over-voltage and over-current: causes, prevention and protection circuits for power devices. Pulse by pulse current limiting and latched

3. **Controllers for Switching Power Converters**: PWM Integrated circuits, Digital controllers, Closed loop controller design-analog and digital. Simulation of closed-loop controlled converters
4. **Thermal Design**: Heat dissipation through conduction, convection and radiation. Cooling systems for power converters. Thermal resistance of heat-sinks. Calculating thermal losses and design and selection of heat sinks.
5. **Electromagnetic Interference and Compatibility**: EMI issues with power electronic converters and their mitigation. Capacitive, inductive and electromagnetic coupling, EMI Shielding. EMC standards. PCB layout issues for power electronic controller circuits.

Laboratory sessions: Hands-on sessions where practical validation of theoretical concepts is carried out along with design and implementation of all the concepts on any one converter as part of a course project.

Prerequisite Course: None

Reference Books:

1. "Power Electronics: Converters, Applications, and Design", Ned Mohan,Tore M. Undeland and William P. Robbins, John Wiley & Sons, 2007.
2. "Switch Mode Power Supplies: A handbook", Keith Billings and Taylor Morey, McGraw-Hill, 2011.
3. "Understanding Thermal Dissipation and Design of a Heatsink", Seshasayee Nikhil, Texas Instruments, Dallas, 2011. ww.ti.com/lit/an/slva462/slva462.pdf
4. "Electromagnetic Compatibility Engineering", Henry W Ott., John Wiley & Sons, 2011.

UE16EE334:
COMPUTER AIDED DESIGN OF PE SYSTEMS (4-0-0-0-4)

Course Objectives:

- To introduce the students to computer-based simulation of power electronic systems
- To convey the different simulation techniques used
- To teach the modelling and simulation of different devices and circuits comprised of them

Course Outcomes:

At the end of the course the students will be able to:

- Model power electronic systems competently
- Understand and apply the different simulation techniques
- Perform simulation of practical systems and analyze the Outcomes

Course Content:

1. **Introduction**: Importance of simulation – General purpose circuit analysis – Methods of analysis of power electronic systems – Review of power electronic devices and circuits.
2. **Advanced techniques in simulation:** Analysis of power electronic systems in a sequential manner – coupled and decoupled systems – Various algorithms for computing steady state solution in power electronic systems – Future trends in computer simulation.
3. **Modelling of power electronic devices:** AC sweep and DC sweep analysis – Transients and the time domain analysis – Fourier series and harmonic components – BJT, FET, MOSFET and its model- Amplifiers and Oscillator – Non-linear devices.
4. **Simulation of circuits:** Schematic capture and libraries, time domain analysis. System level integration and analysis, Monte Carlo analysis, Sensitivity/stress analysis, Fourier analysis.
5. **Modelling and simulation examples:** Simulation of Converters, Choppers, Inverters, AC voltage controllers, and Cyclo-converters feeding R, R-L, and R-L-E loads – computation of performance parameters: harmonics, power factor, angle of overlap.

Prerequisite Course: None

Reference Books:

1. "Simulation of Power Electronic Circuits using pSPICE", Rashid, M., PHI, 2006.
2. "Computer Aided Analysis of Power Electronic Systems", Rajagopalan, V. Marcell–Dekker Inc., 1987.
3. "Microsim, Pspice and Circuit Analysis", John Keown Prentice Hall Inc., 1998

UE16EE335:
FPGA APPLICATIONS USING VERILOG (2-0-4-0-4)

Course Objectives:

- To understand the Design and coding of Combinational and Sequential Circuits using verilog and implementation using FPGA.
- Learn the ability to Design, Simulation and Synthesis of Digital Circuits using Verilog
- To provide the students insight of design of Memories for different applications and its implementations using FPGA.

Course Outcomes:

At the end of the course the student will be able to:

- Design and Code Modules like Multiplexer, Demultiplexer, Full Adder, Magnitude Comparator, Modules using both Full Adder and Magnitude Comparator and its implementation on FPGA kits (Spartran 3/6).
- Design and Model the Flip-flops, Registers, Counters, Monoshot, Parallel to Serial Converter, Pattern Sequence Detector using Verilog and its implementation on FPGA (Spartran 3/6).
- Learn RTL Coding Guidelines for Design and get insight of Simulation and Hardware results of above modules.
- Design on Chip Dual Address ROM, Single Address ROM, On Chip Dual RAM and External Memory controller for different applications.

Course Content:

1. **Introduction to FPGA and Design of Combinational Circuits Using Verilog:** Introduction to FPGA**,** Different FPGA Kits and its concepts, Introduction to Hardware Design Language, Design of Combinational Circuits, Realization of Basic Gates, Shift Operations, Realization of Multiplexer, Demultiplexer, Full Adder, Magnitude Comparator, Design Example Using an Adder and a Magnitude Comparator. Simulation and implementation steps using FPGA
2. **Design of Sequential Circuits Using Verilog:** Modeling of Sequential Circuits, Realization of a D Flip-flop, Realization of Registers, Realization of a Counter, Realization of a Non-retriggerable Monoshot, Verilog Coding of a Shift Register, Realization of a Parallel to Serial Converter, Realization of a Model State Machine, Pattern Sequence Detector, Coding organization. Simulation and Implementation steps using FPGA.
3. **RTL Coding Guidelines & Test Bench and Simulation of Design:** RTL Coding Style, Modeling a Test Bench, Test Bench for Combinational Circuits, Test Bench for Sequential Circuits, VLSI Design Flow, Design Methodology, Simulation Using Xilinx ISE

Tool, Simulation Results of Combinational Circuits and Sequential Circuits.

4. **Synthesis of Designs, Place and Route:** Synthesis, Features of Synthesis Tool, Analysis of Design Examples Using Synplify Tool, Viewing Verilog Code as RTL Schematic Circuit Diagrams, Optimization Effected in Synopsys Full and Parallel Cases, Xilinx Place and Route, Place and Route and Back Annotation Using Xilinx Project Navigator.
5. **Design of Memories:** On-chip Dual Address ROM Design, Single Address ROM Design, On-Chip Dual RAM Design, External Memory Controller Design, Simulation, Synthesis, Place and route results of all Memories.

Prerequisite Courses: None

Reference Books

1. "Digital VLSI System Design", Dr. Seetharaman Ramachandran, Springer, 2007.
2. "Digital Logic Design using Verilog", Taraate, Vaibhav, Springer, 2016.
3. "Verilog HDL A Guide to Digital Design and Synthesis", Samir Palnitkar, 2nd Edition, Prentice Hall Professional, 2003.

UE16EE336: EMBEDDED SYSTEM DESIGN (4-0-0-0-4)

Course Objectives:

- To cover product design aspects from processor selection to software architecture
- To cover choice of processor architectures & selecting right architecture for particular embedded application
- To cover choice of IC technologies for Embedded applications
- To cover one specific advanced processor architecture
- To cover different software architectures & pros & cons
- To cover fundamentals of RTOS & its configurations

Course Outcomes:

At the end of the course the student will be able to:

- Select right processor for a given application taking into account the metrics involved
- Work with memories, optimizing depending on availability and type
- Select appropriate software architecture for an application
- Recognize the constraints in different software architectures especially in applications where interrupts are involved, and devise means to overcome the problems
- Design an ROTS incorporating the basic services and manage interrupts

Course Content:

1. **Overview of embedded Systems**: Embedded system design challenges, Common design metrics and optimizing them. Survey of different embedded systems design methodologies, trade-offs. Custom single purpose processors. Design of custom single purpose processors. RT Level design and optimizing the design. General & standard single purpose peripherals. General purpose processors, Timers/counters, UART, PWM, LCD, Keypad controllers, stepper motor control, ADC/DAC.
2. **Memory**: Introduction, Memory write ability and storage performance, common memory types, Composing Memory, Memory Hierarchy, Memory Management Unit, Advanced Memories
3. **ARM Architecture**: Processor Architecture and organization, Abstraction in Hardware, Instruction set Design, RISC and CISC Processors, ARM Architecture, ARM Assembly Language Programming
4. **Interrupts**: Basics- Shared Data Problem-Interrupt Latency, Survey of Software Architectures, Round Robin, Round Robin with interrupts – Function Queues, Scheduling- RTOS Architecture
5. **RTOS Fundamentals:** Tasks – States – Data – Semaphores and shared data – Operating systems Services – Message Queues – Mail Boxes – Timers – Events – Memory Management – Interrupts in an RTOS environment.

Prerequisite Courses: None

Reference Books

1. "Embedded System Design: Unified Hardware/software Introduction", Frank Vahi & Tony Givargies, John Wiley & Sons Inc, 2002.
2. "An embedded Software Primer", David E Simon, Pearson Education, 2005.
3. "ARM System-On-Chip Architecture", Steve Furber, Pearson Education, 2007

UE16EE337: ADVANCED MICROCONTROLLERS (4-0-0-0-4)

Course Objectives:

- To understand the need of microcontroller in development of various projects
- To learn ARM based microcontroller architecture and interfaces
- To get an overview of the system peripherals that cover bus structure, memory map, timers and much more
- To get a hands-on of a microcontroller development tool chain
- To develop programs that interact with different inputs and outputs and hence build applications

Course Outcomes:

At the end of the course the students will be able to:

- To identify the software and hardware components of the system to meet the system requirements (Create)
- Gain knowledge of architectural aspects, interfacing and programming details of microcontroller (Understand)
- Realise software implementation for programming peripherals with all needed elements and structure (Apply)
- Get development environment set-up and use it for ARM microcontroller (Re member/Knowledge)
- Review interrupt mechanisms (Remember/Knowledge)
- Understand the UART interface that enables communication via serial port (Apply)
- Use data bus and other lines to control and communicate with LCD module (Apply)
- Build a sensing system making use of ADC along with interrupt and LCD (Evaluate)

Course Content:

1. **ARM Embedded Systems and Design Philosophy:** Processor fundamentals – Introduction to ARM instruction set – Thumb instruction set – Understanding specifics of ARM microcontroller: architecture overview, memory and memory map
2. **System initialisation and start up code:** Firmware and bootloader – High level C constructs – Basics of efficient C programming as applied to microcontroller –- Compiler – Assembler – Linker/ Locator – Binary download formats – Debugging - Emulators – Logic Analyser
3. **Interrupts**: Interrupt controller, HW interrupt, SW interrupt - Exception handling – GPIO - ADC-DAC-UART – Study of temperature sensor
4. **Peripherals**: Timers-Watch dog timers- PWM- RTC - Serial communication concepts I2C and SPI- Study of motors (stepper,

DC, servo) – Open & Close loop controls - PWM, Proportional and PID

5. **Introduction of DSP in ARM:** Representing signal, FFT etc., Study of the Sensors: Touch, Proximity sensor, Sound sensors, ultra-sonic sensors, accelerometers.

Prerequisite Courses: None

Reference Books:

1. "ARM System Developer's Guide: Designing and Optimizing System Software", Sloss. A., Symes.D, & Wright C., Morgan Kaufmann, 2004.
2. "ARM System-on-Chip Architecture", Furber S. B., Pearson Education, 2000.
3. "ARM Assembly Language: Fundamentals and Techniques", Hohl. W., & Hinds. C., CRC Press, 2014.
4. "The Definitive Guide to the ARM Cortex-M3", Yiu J., Newnes, 2009.
5. "Embedded C", Pont M.J., Addison-Wesley Longman Publishing Co., 2002.
6. "Programming Embedded Systems in C and C++", Barr M., O'Reilly Media, 1999.
7. "The C Programming Language", Kernighan B. W., & Ritchie D. M., Englewood Cliffs: Prentice-Hall, 1988.
8. User's Manual and Data Sheets of ARM chip set based that development board uses.
9. LPC21xx Data sheet
10. LPC21xx User manual
11. Definitive guide for the ARM chip set. (ARM-Cortex M3)
12. http://infocenter.arm.com/help/index.jsp

UE16EE338: DATA COMMUNICATIONS (4-0-0-0-4)

Course Objectives:

- To discuss the digital data communication techniques
- Gain knowledge on basic concepts of data communication layers, protocols and performance
- Understand a few representative protocols and network components
- To introduce the functions of different layers from deployed examples
- To introduce standards employed in computer networking
- To introduce the fundamentals of security in data communication

Course Outcomes:

At the end of the course the students will be able to:

- Describe the hardware and software commonly used in data communications
- Analyse the services and features of various layers of data networks
- Design, implement and analyze simple networks that need data communication.
- Analyze the features and operations of application protocols like TCP/UDP, FTP, HTTP etc.
- Have read a couple of published papers and appreciate the contemporary issues and solution in area of data communication

Course Content:

1. **Introduction to Data Communications**: Data Communication system components, Networks models, Protocols and Standards, Physical layer and media: Analog and Digital signals, Transmission impairment, Data rate limits and performance, Digital Transmission using coding schemes, Analog to digital conversion, Transmission modes, Digital to Analog conversion using shift keying, Analog to Analog conversions using modulation, Multiplexing and spectrum, Switching: Circuit switching, Datagram networks, Telephone network, Cable TV networks
2. **Data Link Layer**: Error Detection and Correction, Data link control: Framing, Flow and error control, Noiseless and Noisy channel, Stop-and-wait ARQ, Go-Back-N ARQ, Selective Repeat ARQ, HDLC and configuration, transfer modes and control, Point to Point Protocol – Multiple Access: Random Access, Controller Access and Channelisation, Wireless LAN: IEEE802.11, Bluetooth.
3. **Network and Transport Layer**: Delivery, Forwarding and Routing, Network Layer protocols, Transport layer: Process to Process delivery, UDP, TCP, Congestion control, QoS
4. **Presentation layer** – Translation – Encryption / Decryption, Substitution and transposition Ciphers, Data Encryption Standards (DES), Public key cryptography, Authentication.
5. **Application layer**: Domain Name System (DNS), Electronic Mail, File Transfer, WWW and HTTP.

Prerequisite Course: None

Reference Books:

1. "Data Communications and Networking", Behrouz A. Forouzan, Tata McGraw-Hill, 4th Edition, 2007.
2. "Computer Networks", A. S. Tannenbum, D. Wetherall, Prentice Hall, Pearson, 5th Edition, 2011.
3. "Data and Computer Communications', William Stallings, Prentice Hall, Pearson, 8th Edition, 2007.
4. "Data Communications and Networking", White, Cengage Learning, 2008.

UE16EE341: WIND ELECTRICAL SYSTEMS (4-0-0-0-4)

Course Objectives:

- To learn the design and control principles of Wind turbine
- To understand the concepts of fixed speed and variable speed, wind energy conversion systems
- To analyze the grid integration issues.

Course Outcomes:

At the end of the course the students will be able to:

- Understand the schemes used for WECS
- Have a knowledge on fixed speed systems and variable speed systems
- Gain knowledge on Grid connected Systems

Course Content:

1. **Introduction**: Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient- Sabinin‟s theory-Aerodynamics of Wind turbine
2. **Wind Turbines**: HAWT-VAWT-Power developed - Thrust-Efficiency-Rotor selection -Rotor design considerations-Tip speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.
3. **Fixed Speed Systems**: Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model Generator model for Steady state and Transient stability analysis.
4. **Variable Speed Systems**: Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed

generators modeling - Variable speed variable frequency schemes.

5. **Grid Connected Systems**: Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

Prerequisite Courses: None

Reference Books

1. "Wind Electrical Sytems", S.N.Bhadra, D.Kastha, & S.Banerjee, Oxford University Press, 2010.
2. "Wind Energy Conversion Systems", L.L.Freris, Prentice Hall, 1990.
3. "Variable Speed Generators", Ion Boldea, Taylor & Francis group, 2006.
4. "The Generation of Electricity by Wind Power", E.W.Golding, Redwood Burn Ltd., Trowbridge, 1976.
5. "Wind Energy Technology", N. Jenkins, John Wiley & Sons, 1997.
6. "Grid Integration of WECS", S.Heir, Wiley and Sons, 1998.

UE16EE342: HVDC TRANSMISSION (4-0-0-0-4)

Course Objectives:

- To understand the concept of DC power transmission and comparison with AC Power transmission.
- To study about the HVDC system control.
- To analyze harmonics and design of filters.
- To model and analysis the DC system under steady state.

Course Outcomes:

Upon completion of the course the student should be able to

- Discuss modern trends in HVDC Transmission and its application
- To deal with the importance of HVDC Transmission and HVDC Converters
- Discus complete analysis of harmonics & filters for HVDC Systems
- To deal with power control of HVDC system

Course Content:

1. **HVDC Transmission:** Power transmission technology, Comparison of AC and DC transmission, Limitations, Description, Planning for HVDC transmission, Modern trends.
2. **HVDC Converters:** Review of single phase and three phase converters, Pulse number, Choice of converter configuration, Simplified analysis of 6 pulse converter, Characteristics of a twelve-pulse converter, power flow in HVDC links.
3. **Harmonics in HVDC Systems:** Harmonic study, Generation of harmonics by converters, Characteristics harmonics on the DC side, Non-characteristic harmonics.
4. **Filters in HVDC System:** Harmonic model and equivalent circuit, Use of filters, Filter configuration, AC and DC filters, power line communication and noise, Active filters and its applications.
5. **Multi-terminal HVDC Systems:** Types of MTDC Systems, Paralleling of converters, Control of power in MTDC, Modeling of HVDC system.

Prerequisite Courses: None

Reference Books:

1. "HVDC Transmission", S Kamakshaiah, V Kamaraju, Tata Mc-Graw Hill Education Private Limited, New Delhi, 2011.
2. "HVDC Power Transmission Systems: Technology and System Interactions", Padiyar K. R., New Age International, 1990.

UE16EE343: SMART GRID TECHNOLOGIES (4-0-0-0-4)

Course Objectives

- To Study and understand concept of Smart Grid technologies and its need for present trend
- To familiarize the Smart meters, WAM, PMU's and Advanced metering infrastructure
- To familiarize the high performance computing for Smart Grid applications such as WAN, HAN & cloud compounding

Course Outcomes

At the end of the course, the student will be able to:

- Understand the need for smart grid, concept of self healing grid
- Understand the technology involved in smart grid
- Have a knowledge on Smart Meters, Advanced Metering infrastructure drivers and protocols, Phasor Measurement Unit, and Intelligent Electronic Devices
- Appreciate smart grid applications namely Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols

Course Content:

1. **Introduction**: Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, characteristics of smart grid, challenges and benefits.
2. **Smart Grid Technologies:** Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).
3. **Smart Meters and Advanced Metering Infrastructure**: Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.
4. **Power Quality Management in Smart Grid**: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.
5. **High Performance Computing for Smart Grid Applications**: Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

Prerequisite Courses: None

Reference Books:

1. "Smart Grid: Infrastructure, Technology and Solutions", Stuart Borlase, CRC Press, 2012.
2. "Smart Grid: Technology and Applications", Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley, 2012.
3. "Smart Grids", Nouredine Hadjsaid and J C Sabonnadiere, Wiley Publications, 2012

UE16EE344: PE SYSTEM DESIGN USING ICS (4-0-0-0-4)

Course Objectives

- To introduce the ICs used for regulator control and PWM control.
- To introduce transducers for sensing

- To introduce protection circuits and low power integrated power modules
- To introduce programmable Digital control ICs for power electronic systems

Course Outcomes:

At the end of the course, the student will be able to:

- Design measurement systems to sense voltage, current, speed etc.
- Use commercially available controllers to design power converter systems
- Design circuits to protect and drive semiconductor switches for optimal operation
- Design a complete power electronic system based on analog or digital controllers
- Work with a variety of programmable controller/processor types

Course Content:

1. **Measurement of thyristorised systems**: Measurement techniques for voltages, current, power, power factor in power electronic circuits, other recording and analysis of waveforms, sensing of speed, Switching Regulator Control Circuits -isolation techniques of switching regulator systems, PWM systems.
2. **Commercial PWM control ICs and their applications**: TL 494 PWM Control IC, UC 1840 Programmable off line PWM controller, UC 1524 PWM control IC, UC 1846 current mode control IC, UC 1852 resonant mode power supply controller.
3. **Drive and Protection circuits**: Introduction, Opto-couplers, self-biased techniques used in primary side of reference power supplies, Soft/Start in switching power supplies, current limit circuits, over voltage protection. IPMs for low and medium power circuits
4. **Programmable logic controllers (PLC)**: Basic configuration of a PLC, Programming and PLC, program modification, power converter control using PLCs.
5. **Digital controllers for power electronics:** Introduction, DSP controllers for drives. Analog to Digital converters, sampling. Essentials of digital control. FPGA and PSoC controllers.

Prerequisite Courses: None

Reference Books

1. "Thyristorised Power Controllers", G. K. Dubey, S. R. Doradla, A. Johsi, and R. M. K. Sinha, 2nd Edition, New Age International, 2010.
2. "High Frequency Switching Power Supplies", Chryssis, 2nd Edition, MGH, 1989.
3. Unitrode application notes: http://www.smps.us/Unitrode.html
4. Texas instruments\Spartan application note

UE16EE345: VLSI DESIGN (4-0-0-0-4)

Course Objectives:

- To understand and develop CMOS VLSI circuits for Digital data path subsystems.
- To learn concepts related to semiconductor device physics with special emphasis on the MOSFET.
- To understand the basic Planar Silicon CMOS Fabrication Process, electrical properties of MOSFETs, lambda-based design rules and scaling process in the fabrication, digital VLSI circuit design based on CMOS technology, CMOS logic and VLSI integrated circuit layout techniques.
- To implement and learn the practical aspects EDA tool-based simulation exercises will help students.
- To implement the VLSI LOGIC CIRCUITS following the DRC rules.
- To learn timing analysis concept during simulation.

Course Outcomes:

At the end of the course the students will be able to:

- Identify, different CMOS circuit design along with merits and demerits.
- Adopt the Design rules in the Circuit Design.
- Carry out delay calculations for given circuit.
- Design and improve the performance of Digital Data path sub systems.
- Design simple feedback control systems using Root Locus technique.
- Design sequential Circuits considering the timing constraints

Course Content:

1. **MOS Devices & Circuits:** Moore's Law, Basic MOS Transistors, Enhancement & depletion mode action, V-I Relationship, Aspects of MOS threshold voltage, MOS transistor transconductance & output conductance, MOS transistor figure of merits, pass transistor, NMOS inverter, Pullup to Pull down ratio for NMOS inverter chain, alternative forms of pull up, CMOS inverter, Noise Margin, Some characteristics of npn bipolar transistors, latch up in CMOS circuits
2. **Integrated System Fabrication:** NMOS fabrication, CMOS fabrication, p- well, n-well, twin- tub process, MOS layers, stick diagrams, n-MOS design style and CMOS design style, Lambda based design rules, contact cuts, double metal MOS process rules, layout diagrams, symbolic diagrams, translation to mask form.
3. **Basic circuits**: Concepts and scaling of MOS circuits, sheet resistance, area capacitance, delay unit, inverter delays, propagation delays, scaling models, scaling factors, parameters for scaling, limitations of scaling.
4. **Logic Circuits I**: Multiplexers, Binary decoders, Equality detector and comparator, priority encoder, bit adder circuits, ripple carry adders, carry look ahead adders, High speed adders and multipliers.
5. **Logic Circuits II**: Sequencing static circuit, max-min delay constraints, time borrowing, clock skew, circuit design of latches and flip flops, counters, shifters.

Prerequisite Courses: None

Reference Books:

1. "Basic VLSI design", Pucknell D. A., & Eshraghian, K. Prentice-Hall Inc, 1994.
2. "Introduction to VLSI circuits and systems", Uyemura J. P., John Wiley, 2002.
3. "CMOS VLSI design. A circuits and systems perspective", Weste. N., Harris. D. & Banerjee. A., Pearson Education India, 2005.
4. "Principles of CMOS VLSI Design–A system perspective", Weste Neil. H. E. & Eshraghian. K., Pearson Education (Asia) Pvt. Ltd., 2000.
5. "Introduction to VLSI design", Mead. C. & Conway. L., Addison Wesley, 1980.

UE16EE346: INTRODUCTION TO ROBOTICS (4-0-0-0-4)

Course Objectives:

- To get an introduction to robotics in the perspective of design and analysis
- To be able to realise the embedded software part of robotics to sense and control using microcontroller.

Course outcome:

At the end of the course the students will be able to:

- Understand various parts of the robots and basics of mathematical modelling needed
- Understand and design interfaces for sensors and actuators from hardware and software perspective
- Understand different aspects of microcontroller programming used in robots
- Able to design and control robots for a specific application

Course content:

1. **Introduction to Robotics**: Robotic Components and Terms – Robot Mechanisms – Matrix Representations – Homogeneous Transformation Matrices. Microcontroller Application to Robotics – Type of Motors and Interfaces.
   Hands-on:
   - Building a mobile robot with chassis with DC motor interface
   - Develop software module for controlling the robot directions
2. **Kinematics – Position Analysis and Motor controls:** Representation of Transformations – Inverse Transformation Matrices – Forward and Inverse Kinematics – DH Representation, Motor Interfaces – Timers – PWM – JoyStick Interface - BlueTooth Communication
   Hands-on:
   - Develop speed controls to robot using PWM
   - Develop wireless communication using Joystick and Bluetooth
3. **Sensors and Differential Motions and Velocities:** Velocity Kinematics – Jacobian – Differential Changes and Changes between frames – Differential Motions – Langrangian Formulation – Robot Equation, Sensors(Position Sensors, Velocity Sensors,, Infra-Red and Ultrasound) Interfaces to Microcontroller for Robotics for object detection, line following and get feedback for speed and position
   Hands-on:
   - Develop Obstacle detection and line following application
   - Solve the Kitchen puzzle Line following
4. Trajectory Planning
   Trajectory Planning - Path Vs trajectory – Joint-space Vs Cartesian-space descriptions – Basics of trajectory planning – Joint-space trajectory planning – Cartesian-space trajectories
   Microcontroller Interfaces to location and mapping
   Hands-on:
   - Develop Sensor Interface module to get the location
   - Develop application for location and mapping
5. Robot Motion Control
   Open loop and Close loop controls – Position Control - PID Controls and Realisation in System
   Hands-on:
   - Develop PID control in robotic hardware and software and make measurements and graphically represent the control parameters by getting inputs wirelessly

Prerequisite Courses: None

Reference Books:

1. “Introduction to robotics: analysis, systems, applications”, Niku, S. B., New Jersey: Prentice Hall, 2001.
2. “Introduction to Autonomous Mobile robots”, Roland Siegwart, Illah R. NourBaksh, New Jersey: Prentice Hall, 2001.
3. “Introduction to robotics: mechanics and control”, Craig, J. J., Pearson Prentice Hall, 2005.

UE16EE347:
DATA ACQUISITION SYSTEMS (4-0-0-0-4)

Course Objectives:

- To provide a basic knowledge of DAQ Concepts
- To expose the students to DAQ hardware
- To understand the working of communication bus
- To design DAQ systems and develop software for DAQ systems

Course Outcomes:

At the end of the course the students will be able to:

- Understand the fundamentals of data acquisition, configuration, characteristics and specifications of various components used in DAS
- Recognize various interfacing issues of ADC’s and DAC’s to a microprocessor/PC
- Study the operating principles of communication bus standards
- Understand the design of DAQs and software
- Implement DAQ software through communication bus standards

Course Content:

1. **Fundamentals of Data Acquisition Systems**: Fundamental Concepts – Sensors and Transducers – DAQ Hardware – DAQ Software – Parameters of DAQ Systems.
2. **DAQ Hardware**: Plug in DAQ Systems, Signal Conditioning, A/D and D/A Converters, Digital Signal Processing, Microprocessor and Microcontrollers, Amplifier, Multiplexer/Demultiplexer, Power management, Timing System, Filtering, Memory Board, Bus Interface.
3. **Communication Bus**: USB, Firewire, Serial Communications, Wireless, Ethernet, Bluetooth, GSM for DAQ Systems, PCI, PCI Express, Standard VME.
4. **DAQ Design and Software**: Functional Design of High speed computer based DAQ Systems, Portable DAQ Systems, Design Guidelines. Software for DAQ – LabVIEW, Android for DAQ, Design of Firmware, Implementation of software for DAQ systems via VME Bus.
5. **Smart DAQ Systems**: General Description of MAX1329, Complete DAQ

Reference Books:

1. “Data acquisition systems”, Di Paolo Emilio, M., Springer, 2013.

UE16EE354:
POWER SYSTEM ANALYSIS & STABILITY LAB (0-0-2-0-1)

Course Objectives:

- To learn about the regulation and efficiency of transmission lines.
- To have knowledge of Inductance and capacitance and sag calculation for lines.
- To learn about the complex power of a three phase load.
- To study about the various types of faults on an unloaded generator.

Course Outcomes:

At the end of the course the students will be able to:

- Calculate the efficiency, regulation of short, medium and long lines.
- Formulate the series and shunt parameters as well as sag of a line.
- Calculate complex power using symmetrical component tool for a 3 phase load.
- Learn to calculate the various types of fault currents on an unloaded generator.

Course Content:

1. ABCD constants, efficiency & regulation of medium length transmission line using PI representation
2. ABCD constants, efficiency & regulation of medium length transmission line using T representation
3. Parameter calculations of long lines with nominal PI representation
4. Parameter calculations of long lines with nominal T representation
5. Evaluation of inductance of overhead transmission line constants for 3 phase single circuit configuration
6. Evaluation of inductance of overhead transmission line constants for 3 phase single circuit configuration
7. Evaluation of Capacitance of overhead transmission line constants for 3 phase double circuit configuration
8. Evaluation of capacitance of overhead transmission line constants for 3 phase single circuit configuration
9. Mechanical design of overhead conductors (sag calculation)
10. Complex power calculation for a Y –connected unbalanced load.
11. Complex power calculation for a Δ - connected unbalanced load.
12. Fault current & line voltages calculations for a SLG fault on an unloaded generators
13. Fault current & line voltages calculations for a LL fault on an unloaded generators
14. Fault current & line voltages calculations for a DLG fault on an unloaded generators

Prerequisite Course: None

Reference Books:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PESU.

UE16EE355:
DIGITAL SIGNAL PROCESSING LAB (0-0-2-0-1)

Course Objectives:

- Understand sampling theorem to write a code both in time & frequency domain
- Underground types of correlation and its implementation to verify its properties.
- Understand DFT and coding to obtain DFT & its inverse for a given sequence.
- Underground circular convolution and implement it in both time and frequency domain.
- Understand IIR filters and develop code to implement it for given specifications
- Underground FIR filters and develop code to implement it for given specifications.
- Understand how to use DSP processor and implement simple code on it.

Course Outcomes:

At the end of the course the students will be able to:

- Learn coding to verify sampling theorem in both domains.
- Learn coding to implement correlation, circular convolution and N – point DFT & IDFT and verify results.
- Learn to implement IIR & FIR filters and see how the frequency response changes as specification changes.
- Learn to implement code on DSP processor.

PART A: CODING Using OCTAVE/ SCILAB/MAT LAB

1. Verification of sampling theorem.
2. Cross & Autocorrelation of a given sequence and verification of its properties
3. Circular convolution of two given sequences without using built – in function
4. Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum and to compute IDFT.
5. Linear & circular convolution of two sequences using DFT and IDFT.
6. Linear filtering of long sequence data by Overlap save & add techniques.
7. Design and implementation of IIR analog filter to meet given specifications.
8. Design and implementation of IIR digital filter to meet given specifications
9. Design and implementation of FIR digital filter using non-adjustable windows to meet given specifications

PART B. LIST OF EXPERIMENTS USING DSP PROCESSOR

1. Linear & circular convolution of two given sequences.
2. Computation of N- Point DFT & IDFT of a given sequence
3. Impulse response of first order and second order system

UE16EE356X:
SPECIAL TOPIC (2-0-0-0-2)
UE15EE401:
Industrial Drives & Control (4-0-0-0-4)

Course Objectives

- To understand steady state operation and transient dynamics of a motor load system.
- To study and analyze the operation of the phase-controlled converter/chopper fed dc drive, both qualitatively and quantitatively.
- To analyze and design the current and speed controllers for a closed loop solid state DC motor drives.
- To study and understand the operation and performance of AC motor drives.

Course Outcomes:

At the end of the course, the students will be able to

- Understand the dynamics of electrical drives and design drives with required time response
- Select suitable power converters to supply the chosen motor
- Apply control theory to design controllers for the drive systems
- Compare the performance characteristics of induction motors and synchronous motor for drive applications
- Design a complete drive system for a given application

Course Content:

1. **Drive Characteristics:** Introduction, Dynamics of Electrical Drives
2. **Converter / Chopper Fed DC Motor Drive:** Steady state analysis.
3. **Design of Controllers for DC Drives:** Transfer functions ,Design of controllers, converter selection and characteristics.
4. **Induction Motor Drives:** Voltage-Fed Inverter Control, Current Fed Inverter Control, Rotor Resistance Control.
5. **Synchronous Motor Drives:** Variable speed drives, modes of operation

Prerequisite Courses: None

Reference Books

1. "Fundamentals of Electrical Drives", Gopal K.Dubey, Narosa Publishing House, 2001.
2. "Electric Motor & Drives: Modeling, Analysis and Control", R.Krishnan, Prentice Hall of India, 2001.
3. "Modern Power Electronics and AC Drives", Bimal K.Bose, Pearson Education, 2002.

4. “Electrical Machines and Drives System”, John Hindmarsh and Alasdain Renfrew, Elsevier 2012.
5. “Thyristor Control of Electric Drives”, Vedam Subramanyam, Tata McGraw Hill, 2007.
6. “A First Course on Electrical Drives”, S.K.Pillai, Wiley Eastern Limited, 1993.
7. “Electric Drives”, N.K.De., P.K.SEN, Prentice Hall of India, 2012.

UE15EE402: COMPUTER AIDED POWER SYSTEM ANALYSIS (3-1-0-0-4)

Course Objectives:

- Optimal planning, operation and control of large scale systems require advanced computer-based techniques.
- To understand economic operation of thermal Units.
- To study transient stability of power systems.
- To have a good perspective of power systems analysis.
- To have an active knowledge of various numerical techniques that can be applied to the solution of large interconnected system.

Course Outcomes:

At the end of the course the students will be able to:

- Understand the importance of bus admittance matrix.
- Analyze any given load flow problems.
- Model the speed governor, generator- load and control the same.
- Judiciously decide the units to be in operation for the most optimum dispatch.
- Judge the stability of an SMIB system during a large disturbance.

Course Content:

1. **Graph Theory and Bus admittance/Impedance Matrix**: Basics of Graph Theory, Y-Bus by inspection Method, Primitive admittance matrix, Y-Bus by singular transformation, Algorithm for formation of Bus impedance for single phase system.
2. **Load Flow Studies**: Introduction to Load flow studies, Static load flow equations, Types of buses, Approximate method of load flow solution, Guass-Siedel iterative method using Y bus including PV bus, acceleration of convergence, Newton Raphson method of load Flow solution, Fast decoupled load flow method. Problems based on GS and NR and FDLF methods.
3. **Load Frequency Control**: Introduction to Load frequency control, Turbine speed governing system modeling, Block diagram representation of single area, steady state and dynamic response, Two area load frequency control(block diagram derivation and no problems).
4. **Economic Load Dispatch**: Introduction to Economic Load Dispatch, fuel cost and incremental fuel cost curve and equations, Optimal distribution of loads between Units within a plant without losses, Transmission loss as a function of plant generation, determination of loss co-efficient, Economic load dispatch considering the losses, penalty factor.
5. **Transient Stability Studies**: Introduction to Transient stability studies in an SMIB and multi-machine power system, Numerical solution of differential equations modified Euler’s method, Runge-Kutta 4th order method, Milne’s’ Predictor – Corrector method, Swing equation, Representation of synchronous machine for transient stability studies, load representation, Network performance equation, Solution techniques (for all the 3 methods)with flowcharts and problems.

Prerequisite Courses: None

Reference Books:

1. “Computer Techniques in Power System Analysis”, Pai M. A., Tata Mcgraw Hill, 2006.
2. “Modern Power System Analysis”, Nagrath I.J. and Kothari D.P., 3rd Edition, Tata McGraw – Hill, 2006.
3. “Computer Methods in Power System Analysis”, Stagg G. W. and El-Abiad, A. H., McGraw-Hill, 1968.
4. “Power system Analysis”, Saadat H., TMH, 2002.
5. “Computer Techniques and Models in Power Systems”, Rao K. U., I. K. International, 2007.
6. “Advanced Power System and Dynamics”, Singh, L. P., 5th Edition, New Age International Publications, 2007.

UE15EE403: SWITCHGEAR AND PROTECTION (3-0-2-0-4)

Course Objectives:

- To discuss the causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
- To understand the problems associated with circuit interruption by a circuit breaker.
- To discuss various types of circuit breakers, their comparative merits and testing.
- To understand the characteristics and functions of relays and protection schemes
- To understand various equipment protection like transformer, generator, motor, protection of bus bars, transmission lines, instrument transformer and applications.

Course Outcomes:

At the end of the course the students will be able to:

- Design the relevant protection systems for the main elements of a power system.
- Analyze with over current, differential, and ratio protection devices and their application in a coordinated protection scheme.

Course Content:

1. **Fuses**: Principle of operation, definitions, fuse element material, HV and LV fuses, selection of fuse, advantages and disadvantages of fuse. PRINCIPLE OF CIRCUIT BREAKERS: Introduction, principles of operation of a CB, current zero interruption theories, certain terms associated with circuit breaking, Interruption of capacitive currents, interruption of low inductive current chopping, resistance switching.
2. **Circuits Breakers**: Types of HT and LT circuit breakers: Miniature CB, Residual Current Detector, Air CB low oil or minimum oil circuit breaker, air blast breakers, sulphur hexafluoride circuit breakers, vacuum interrupters, Circuit breaker ratings.
3. **Protective Relaying**: Introduction, basic requirements of protective relaying: Electromagnetic relays, Induction relays, Non-directional over-current or earth leakage (induction type) relay, Directional relay, Differential relay – principle of operation, Current differential relay, bias characteristics, Opposed voltage differential scheme, Negative sequence relay.
4. **Distance Relays:** Distance relay – Impedance relay, admittance relay, reactance relay, classification of distance relays. Operating characteristics of Distance Relays. Three stage protection of lines. Carrier current protection of lines.
5. **Protection Schemes:** Protection Schemes: Protection of Alternators, rotor fault protection and Stator Fault Protection. Induction motor protection – protection against overloads, locked rotor, stalling, single phasing, loss of load, unbalanced supply and short circuits. Transformer Protection - Differential

protection for transformers, Harmonic restraint, Over current and restricted earth fault protection, balanced earth fault protection, frame leakage protection, Buchholz relay

Experiential Learning:

1. Fuse, MCB and Electromechanical Overcurrent Relay
2. Microprocessor based Overcurrent Relay
3. Microprocessor based Over voltage and Under voltage Relay
4. Motor Protection
5. NPS, Generator Protection

Prerequisite Courses: None

Reference Books:

1. "A Text Book on Power System Engineering", Chakrabarti. A., Soni M. L., Gupta P. V., &Bhatnagar U. S., Dhanpat Rai & Co, 2001.
2. "Switchgear Protection and Power Systems: Theory, Practice and Solved Problems", Rao S. S., Khanna Publishers, 1999.
3. "Handbook of Switchgears", Bhel E., Tata McGraw-Hill Education, 2005.
4. "Power System Protection and Switchgear", Ram B., Tata McGraw-Hill Education, 2011.
5. "Power System Protection and Switchgear", Oza, Bhuvanesh A., N. C. Nair, Rashesh P. Mehta, and Vijay H. Makwana, Tata Mc-Graw Hill, 2010.

UE14EE411:
FLEXIBLE AC TRANSMISSION (4-0-0-0-4)

Course Objectives:

- To understand the concept of power system compensation by Flexible AC transmission Controllers (FACTS)
- To study about the various FACTS controllers.
- To study about the role of FACTS controllers to enhance controllability and power transfer capability in ac system.
- To model and analyze the various FACTS controllers

Course Outcomes:

Upon completion of the course the student should be able to

- Explain the importance of FACTS controllers for performance enhancement of the power system.
- Develop basic mathematical models for these controllers
- Analyze the impact of various components associated with these controllers on power system performance

Course Content:

1. **Facts, Concepts and general system configuration**: Transmission, interconnection, flow of power in AC system, power flow and dynamic stability consideration of a transmission line interconnection, relative importance of controllable parameters, basic types of FACTs controllers, shunt, series, combined shunt and series connected controllers.
2. **Power semiconductor devices**: Types of high power devices, principle of high power devices characteristics and requirements, power device material, Diode, MOSFET, Gate turn off thyristor (GTO) , Emitter turn off thyristor (ETO) & integrated gate commuted thyristor (GCT & IGCT).
3. **Voltage sourced converters and Current sourced converters**: Basic concepts, Single - phase full wave bridge converter operation, square wave voltage harmonics for a single phase, Three - phase full wave bridge converter. Self and line commutated current source converter: basic concepts, three phase full wave diode rectifier, and thyristor based converter with rectifier and inverter operation, current sourced versus voltage source converter.
4. **Static shunt compensator**: Static shunt compensator SVC and STATCOM: objective of shunt compensation, methods of controllable Var generation, variable impedance type static var generators, the regulation slope, transient stability enhancement, Var reserve control , comparison between SVC and STATCOM.
5. **Static series compensators GCSC, TSSC, TCSC and SSSC**: Objectives of series compensation; variable impedance type of series compensators, switching converter type series compensators.

Prerequisite Courses: None

Reference Books:

1. "Understanding Facts", Hingorani N. G., & Gyugyi L., IEEE press, 2000.
2. "FACTS Controllers in Power Transmission and Distribution", Padiyar K. R., New Age International, 2007.

UE15EE412:
POWER SYSTEM OPERATION AND CONTROL
(4-0-0-0-4)

Course_Objectives:

- To gain the knowledge of modeling of different equipments of generating system
- To understand hydrothermal scheduling techniques and maintenance scheduling.
- To get the insight of load frequency control and its modeling
- To study the concept of voltage control using compensation devices
- To understand the role of energy control centre, SCADA, EMS functions and power system security states.

Course Outcomes:

After completion of the course, the student will be able to

- Design algorithms for economic operation of Power Systems, Hydrothermal scheduling.
- Apply the Optimization Techniques to solve for financial benefits of Power System.
- Analyze the Economic Dispatch Problem and Unit Commitment in Thermal Power Plant.
- Formulate the multi objective economic dispatch problem and solve the same using evolutionary techniques.
- Create and Solve Power System Problems using simulation Software and interpret the results.

Course Content:

1. **Introduction**: Modeling of Turbine, Generator, Governor and Excitation System, Hydrothermal Coordination - Hydrothermal scheduling problems, the short term hydrothermal scheduling problem, short term hydro-scheduling-A gradient approach, pumped storage hydroplants, and dynamic programming solution to the hydrothermal scheduling problems. Factors considered in maintenance scheduling for generating units, turbines, boilers – Introduction to maintenance scheduling using mathematical programming.
2. **Voltage Stability:** Reactive Power Flow and Voltage Collapse, Mathematical Formulation of Voltage Stability Problem, Voltage Stability Analysis, Prevention of Voltage Collapse, State of the Art, Future Trends and Challenges. Compensation in power systems: Loading capability, Load compensation, Line compensation, Series compensation, Shunt Compensation
3. **UNIT Commitment**: methods-priority lists method, dynamic programming method, constraints, spinning reserve, and examples.

4. **Multiobjective and Evolutionary Techniques for Generation Scheduling**: Multiobjective Optimization, The surrogate Worth Trade-off Approach, Weighting Method. Genetic Algorithm Solution Methodology for Economic Dispatch of thermal units.
5. **System Security**: classification of security states, factors affecting power system security, contingency analysis. SCADA system - Data acquisition, Data transmission & telemetry.

Prerequisite Courses: None

Reference Books

1. "Power System Operation and Control", Sivanagaraju S., & Sreenivasan G., Pearson Education, 2010.
2. "Power Generation, Operation, and Control", Wood A., & Wollenberg B., 2nd ed. Wiley India, 2009.
3. "Modern Power System Analysis", Kothari D., & Nagrath J., 3rd ed., Tata McGraw-Hill Publishing Company, 2008.
4. "Power System Optimization", Kothari D., & Dhillon J., Prentice-Hall India, 2006.

UE15EE413: DSP IN POWER ELECTRONIC CONVERTERS AND DRIVES (4-0-0-0-4)

Course Objectives

- To understand essentially of components/circuits and to employ for digital controllers
- To study and analyze the various techniques in digital system qualitatively and quantitatively.
- To analyze and develop the DC-DC converter and drive systems by standard DSP

Course Outcomes:

- Ability to understand, design, and apply suitable digital controller for given power electronic converter as well as electrical drive

Course Content:

1. **Introduction and Digital Concepts:** Power Electronics Systems, Digital Control Circuits for Power Electronics Systems, Analog Versus Digital Control Circuit, Causal and Noncausal Circuits, LTI Discrete-Time Circuits, Digital Filters, Hard Real-Time Control Systems, Sampling Rate, Simultaneous Sampling, 8 Number of Bits, Multirate Control Circuits, Active Power Filters, Digital Class D Power Amplifiers.
2. **Analog Signals Conditioning and Discretization:** Analog Input, Galvanic Isolation, Common Mode Voltage, Current Measurements, Comparison of Current Sensing Techniques, Analog Signal Sampling Rate, Signal Quantization, Acquisition Time, A/D Converters Suitable for Power Electronics Control Circuits
3. **DSP Based DC-DC Converter & Drives:** Converter structure, CCM, DCM, Controlling B-B Converter, Principle of Hybrid Stepper Motor – Operation, Stepper motor drive system & its implementation in DSP, Principle of BLDC Motor, Motor control system, Implementation in DSP
4. **DSP based Clarke's/Park's and SVPWM**: Clarke's Transformation, Park's Transformation, Field Oriented Control Transformation, Introduction, Principle of constant V/f control of IM, SVPWM technique, DSP Implementation
5. **PMSM & Vector Control of IM**: Principle of PMSM, PMSM Control System, Implementation in DSP, Introduction to 3-Ph IM basic theory, Reference frame theory, Field oriented control. Control Strategies: Torque angle control, Unity power factor control

Prerequisite Courses: None

Reference Books

1. "Digital Signal Processing in Power Electronics Control Circuits", Sozański, Krzysztof, Springer, 2013.
2. "DSP-based electromechanical motion control", Toliyat, Hamid A., and Steven G. Campbell, CRC press, 2003.
3. "Digital power electronics and applications", Luo, Fang Lin, Hong Ye, and Muhammad H. Rashid, Elsevier, 2010.
4. "Digital control of electrical drives", Vukosavic, Slobodan N, Springer Science & Business Media, 2007.

UE15EE414: APPLICATION OF POWER ELECTRONICS TO POWER SYSTEMS (4-0-0-0-4)

Course Objectives:

- To enlighten the student about the intricacies of the power system, its stability and control
- To describe the different compensating systems to ensure stability
- To describe harmonic mitigation techniques to preserve integrity of the grid

Course Outcomes:

At the end of the course the students will be able to:

- Analyze the behavior of an interconnected transmission system and calculate the power flows
- Utilize FACTS to improve power system performance
- Determine the stability limits of the system and design suitable compensators

Course Content:

1. **General System Considerations and FACTS**: Transmission Interconnections, Flow of Power in an AC System, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, principles of series and shunt compensation, Basic Types of FACTS Controllers, Benefits from FACTS, Application of FACTS.
2. **Shunt Compensators**: Objectives of Shunt Compensation, Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, improvement of Transient Stability, Power Oscillation Damping, Static VAR Compensators, SVC and STATCOM, The regulation Slope, Transfer Function and dynamic Performance, Transient Stability, Enhancement and Power Oscillation Damping
3. **Series Compensators**: Objectives of Series Compensation, concept of series capacitive compensation, voltage stability, improvement of transient stability, power oscillation damping, GTO thyristor controlled series capacitor, Thyristor controlled series capacitor, SSSC.
4. **Combined Compensators**: Introduction, Unified power flow controller, basic operating principles, independent real and reactive power flow control, and control structure, basic control system for P and Q control.
5. **Mitigation of Harmonics**: Power quality problems, harmonics, harmonic creating loads, harmonic power flow, and mitigation of harmonics, filters, passive filters, active filters, shunt, series and hybrid filters.

Prerequisite Courses: None

Reference Books:

1. "Understanding Facts", Hingorani N. G., & Gyugyi, L., IEEE Press, 2000.
2. "Electrical power systems quality", Dugan R. C., McGranaghan M. F., & Beaty H.W., McGraw-Hill, 2001.
3. "Flexible AC transmission systems (FACTS)", Song Y. H., & Johns A., IET, 1999.

UE15EE415:
MODERN CONTROL THEORY (4-0-0-0-4)

Course Objectives

- To understand concept of state, state variable and develop state models for physical systems.
- To know computation of eigen values, and eigen Vectors
- To evaluate State Transition Matrix.
- To understand concept of controllability and observability.
- To understand , analyze the design of observer and controller.
- To analyse stability in the sense of Liapunov

Course Outcomes:

At the end of the course, student will be able to:

- Determine the state model for electrical, mechanical and electromechanical systems
- Solve the state equations by different methods
- Analyze and synthesis the controllability and observability of the system
- Design the controller and observer
- Understand concepts of stability of linear and nonlinear systems

Course Content:

1. **State Variable Analysis**: Introduction, Concept of State, State Variables and State Model, State Modeling of Linear systems, Linearization of state equation. State models for linear continuous and discrete time systems: State space representation using Physical variables, Phase variables and Canonical variables, Derivation of Transfer Function from State Model.
2. **Linear Algebra Concepts**: Eigen values, Eigen Vectors, Generalized Eigen Vectors.Solution of State Equation for linear continuous and discrete time systems: State Transition Matrix and its Properties. Computation of State transition matrix using Laplace Transformation, Power series Method, Cayley Hamilton Method.
3. **Concept of Controllability and Observability**: Methods of determination of Controllability and Observability, Derivation of CCF, OCF, DCF, JCF form.

   Pole placement Techniques: transformation to CCF, transformation to OCF, Stability improvements by state feedback, Necessary and sufficient conditions for arbitrary pole placement, Determination of value of K using transformation technique, Ackermann formula, direct substitution method.
4. **State Observer**: Definitions of Full order, Minimum order, Reduced order observer Design of State Observer. Reduced order observer design, Dual systems, relation between K and Ke.

   Design of Full order Observer: Design of Full order Observer using Ackermann formula, direct substitution method, transformation technique.
5. **Liapunov stability Analysis**: Liapunov function, direct method of Liapunov and the linear system. Construction of Liapunov functions for non-linear system by Krasovskii's method.

Prerequisite Courses: None

Reference Books:

1. "Modern Control System Theory", M.Gopal, New Age International (P) Ltd. Publishers, 2nd Edition, 1993, Reprint 2007.
2. "Modern Control Engineering", K. Ogata, Pearson Education International (PHI), 4th Edition, 2002

UE14EE416:
ROBOTICS AND AUTOMATION (4-0-0-0-4)

Course Objectives

- To provide comprehensive knowledge of robotics and their application areas
- To understand robotics in the perspective of design, analysis and control

Course Outcomes:

At the end of the course the students will be able to:

- Understand the various parts of robots and their applications
- Appreciate the various kinematics and inverse kinematics of robots
- Comprehend the Euler, Lagrangian formulation of Robot dynamics.
- Know the trajectory planning for robot.
- Design and control robots and design for certain specific applications

Course Content:

1. **Introduction to Robotics**: History of Robots – Classifications – Various fields of Robotics – Actuators – Sensors – Manipulators – End effectors – Application areas – Robot programming languages.
2. **Robot Kinematics**: Matrix representation – Homogeneous transformation – DH representation of standard robots – Inverse kinematics.
3. **Robot Dynamics**: Velocity kinematics – Jacobian and inverse Jacobian – Lagrangian formulation – Eulers Lagrangian formulation – Robot equation of motion.
4. **Trajectory Planning**: Introduction – Path Vs trajectory – Joint-space Vs Cartesian-space descriptions – Basics of trajectory planning – Joint-space trajectory planning – Cartesian-space trajectories.
5. **Control and Application of Robotics**: Linear control of robot manipulation – Second-order systems – trajectory following control – Modeling and control of single joint – Architecture of industrial robotic controllers – Robot applications.

Prerequisite Courses: None

Reference books:

1. "Introduction to Robotics: Analysis, Systems, Applications", Niku S. B., New Jersey: Prentice Hall, 2001.
2. "Introduction to Robotics: Mechanics and Control ", Craig J. J., Upper Saddle River: Pearson Prentice Hall, 2005.

UE15EE421:
TESTING AND COMMISSIONING (4-0-0-0-4)

Course Objectives

- To provide an understanding of the standards and procedures to be followed in starting up an electrical system
- To impart knowledge on the various tests to be conducted on a system before it can be commisioned
- To teach the students about the characteristics and testing of generators and motors and selection of the approprite machine for an application
- To provide a comprehensive undersanding of the different switchgear used in an electrical system and their testing

Course Outcomes:

At the end of this course the students will be able to

- Understand the role of Electrical Acceptance Testing, Commissioning and Start-up of Electrical Power Distribution Systems.
- Independently commision an electrical system adhering to the prescribed standards and after following due processes
- Select a generator or motor of the correct specifications in a given situation and commision it after carrying out all the performance and safety tests
- Install, test and maintain switchgear required for a given application

Course Content:

1. **Introduction**: Construction and Parts, Accessories and Fitments, Safety Devices, Terms and Definitions, Temperature classification of Insulation, Methods of cooling, Permissible loading, OLTC and OCTC, Conservator and Breather, Routine and Type Tests, Special tests, Drying Out, Commissioning Tests. Rotating Electrical Machines-Degree of Protection, Cooling Systems, Enclosures.
2. **Synchronous Machines:** Rating, Specifications, Routine Tests and Performance Tests- IR value, DC Resistance, Dielectric Tests, OCC, SCC, Sudden 3 ph SC test, Slip test, Voltage Recovery Test, L-L sustained SC test, Negative Phase Sequence, Vibration, Noise Measurement.
3. **Commissioning of Synchronous Generator**: Unit Commissioning, Starting, Synchronizing, Loading, Reactance and Time Constants.
4. **Induction Motors**: Selection of Induction Motors, Routine Tests and Type Tests- IR, DC resistance, Open circuit voltage test, no-load test-light running, Locked Rotor test, starting test, load test, temperature rise test, measurement of slip, insulation test, vibration test, noise measurement. Installation and Commissioning of Induction Motors, Drying out of Electrical Rotating Machines.
5. **Switch Gear:** Standards, types, specification, Tests on High voltage AC CB Tests on LV AC CB, Selection of CBs, Installation of Switchgear, Filling of SF6 gas.

Prerequisite Courses: None

Reference Books

"Testing commissioning operation and maintenance of electrical equipments", S Rao, Kanna Publishers, 2004.

UE15EE422:
POWER QUALITY (4-0-0-0-4)

Course Objectives

- Introduction to custom power and study of factors governing power quality.
- Study of power factor compensation techniques with power electronic devices and active harmonic filtering.
- Introduction to wiring and grounding methods and particular standards related to them.

Course Outcomes:

At the end of the course student will be able to:

- Adequately trained to work for improvement and betterment of power quality.
- Monitor power quality and improvement.
- Take up prospective research assignments.

Course Content:

1. **Power Quality:** overview of power quality phenomena -Basic terminologies–Power Quality Issues–Causes for reduction in Power Quality—Power Quality Standards and indices, Voltage sags-Causes of voltage sags – magnitude & duration of voltage sags – effect on drives and peripherals –monitoring & mitigation of voltage sags. Interruptions- Origin of Long & Short interruptions– influence on various equipment's –monitoring & mitigation of interruptions. Harmonics-important harmonic introducing devices-SMPS-Three phase power converters-arcing devices- storable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.
2. **Power Factor Improvement:** Passive Compensation- Passive Filtering- Harmonic resonance- Impedance Scan Analysis - Active Power Factor Corrected Single Phase Front End-Control Methods for Single Phase APFC-Three Phase APFC and
3. **Control Techniques:** PFC Based on Bilateral Single Phase and Three Phase Converter-static var compensators-SVC and STATCOM
4. **Active Harmonic Filtering:** Shunt Injection Filter for single phase, three-phase three-wire and three-phase four-wire systems-d-q domain control of three phase shunt active filters-UPS-constant voltage transformers- series active power filtering techniques for harmonic cancellation and isolation. Dynamic Voltage Restorers for sag swell and flicker problems. Grounding and wiring-introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-solutions to grounding and wiring problems
5. **Distributed Generation and Power Quality:** Resurgence of DG, DG Technologies, Interface to the Utility System, Power Quality Issues, Operating Conflicts, DG on Distribution Networks, Siting DG Distributed Generation, Interconnection Standards

Prerequisite Courses: None

Reference Books:

1. "Electrical power system quality", Roger C.Dugan, Mark F. Mc Granghan, Suryasantoso, H. Wayne Beaty, Second Edition, McGraw Hill Pub, 1996.
2. "Electric Power Quality", G.T. Heydt, Starsina Circle Publications, 1991
3. "Power System Quality Assessment", J. Arrillaga, John Wiley, 2000.
4. "Power system Harmonic Analysis", J. Arrillaga, B.C.Smith, N.R. Watson & A. R . Wood, Wiley, 1997.
5. "Electric Power quality control techniques", Wilson E Kazibwe, Musoke H Sendaula, Van Nostrand Reinhold, New York, 1993.

UE15EE423:
MEDICAL ELECTRONICS (4-0-0-0-4)

Course Objectives

- To study the methods of recording various biopotentials
- To study how to measure biochemical and various physiological information
- To understand the working of units which will help to restore normal functioning
- To understand the use of radiation for diagnostic and therapy
- To understand the need and technique of electrical safety in Hospitals

Course Outcomes:

At the end of the course the students will be able to:

- Understand the application of electronics in bio-potential recording
- Understand the working and operation of various bio-chemical measurement instruments
- Have a knowledge on bio-telemetry
- Appreciate equipments used in radiation therapy
- Be aware of the recent trends in medical instrumentation

Course Content

1. **Electro-Physiology and Bio-Potential Recording**: The origin of Bio-potentials; biopotential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, EOG, lead systems and recording methods, typical waveforms and signal characteristics.
2. **Bio-Chemical and Non Electrical Parameter Measurement**: PH, PO2, PCO2, PHCO3, Electrophoresis, colorimeter, photometer, Auto analyzer, Blood flow meter, cardiac output, respiratory measurement, Blood pressure, temperature, pulse, Blood cell counters.

3. **Assist Devices and Bio-Telemetry**: Cardiac pacemakers, DC Defibrillator, Telemetry principles, frequency selection, Bio-telemetry, radio-pill and tele-stimulation.
4. **Radiological Equipments**: Ionizing radiation, Diagnostic x-ray equipments, use of Radio Isotope in diagnosis, Radiation Therapy.
5. **Recent Trends in Medical Instrumentation**: Thermograph, endoscopy unit, Laser in medicine, Diathermy units, Electrical safety in medical equipment.

Prerequisite Courses: None

Reference Books:

1. "Biomedical instrumentation and measurement", Cromwell, Leslie, Fred J. Weibell, and Erich Pfeiffer., PHI Pvt., 2006.
2. "Handbook of biomedical instrumentation", Khandpur, Raghbir Singh, Tata McGraw-Hill Education, 1994.
3. "Biomedical Instrumentation", Anandanatarajan, R. PHI Learning, 2009.
4. "Introduction to biomedical equipment technology", Carr, Joseph J., and John Michael Brown, Prentice Hall, 2001.

UE15EE424:
POWER QUALITY IMPROVEMENT USING POWER ELECTRONIC DEVICES (4-0-0-0-4)

Course Objectives:

- To familiarize with power quality problems and measurements.
- To study the impact of and on the device and different mitigation techniques.
- To learn about the sources of harmonics, various power quality problems and corresponding remedial measures through filtering and static controller, advanced multi-level converters

Course Outcomes:

At the end of the course the students will be able to:

- Comprehend concept of Power Quality & it's issues for various electrical systems
- Understand effects of power quality on electrical apparatus
- Know different power quality improvement techniques and devices

Course Content:

1. **Power Quality**: concepts and definition, Power quality and voltage quality, Power quality standards, General classes of power quality problems, CBEMA and ITI Curves, Power quality terms, Power frequency variations
2. **Non-linear Loads**: Single phase static and rotating AC/DC converters, Three phase static AC/DC converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speed drives.
3. **Measurement and Analysis Methods**: Voltage, Current, Power and Energy measurements, power factor measurements and definitions, event recorders, Measurement Error - Analysis: Analysis in the periodic steady state, Time domain methods Frequency domain methods: Laplace's, Fourier and Hartley transform - The Walsh Transform - Wavelet Transform.
4. **Analysis and Conventional Mitigation Methods**: Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion. On-line extraction of fundamental sequence components from measured samples _ Harmonic Indices - Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI) - Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, closed loop balancing current balancing, Harmonic reduction, Voltage sag reduction.
5. **Power Quality Improvement**: Utility-Customer interface -Harmonic filters: passive, Active and hybrid filters - Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC -control strategies: P~Q theory, Synchronous detection method. Custom power park -Status of application of custom power devices.

Prerequisite Courses: None

Reference Books:

1. "Power Quality Enhancement Using Custom Power Devices", Ghosh A., & Ledwich G., Springer Science & Business Media, 2012.
2. "Electric Power Quality", Heydt G. T., Stars in a circle publications, 1991.
3. "Electrical Power Systems Quality", Dugan R. C., McGranaghan M. F., & Beaty H.W., McGraw-Hill, 2001.
4. "Power Electronic Converter Harmonics: Multipulse Methodsfor Clean Power", Paice D. A., New York, IEEE Press, 1996.
5. "Power System Quality Assessment", Arrillaga J., Watson N. R., & Chen S., Wiley, 2000.

UE15EE425:
DIGITAL IMAGE PROCESSING (4-0-0-0-4)

Course Objectives:

- Describe and explain basic principles of digital image processing;
- Design and implement algorithms that perform basic image processing (e.g., noise removal and image enhancement);
- Design and implement algorithms for advanced image analysis (e.g., morphological image processing & image segmentation) ;
- Assess the performance of image processing algorithms and systems.

Course Outcomes:

After completion of the course, the student will be able to

- Write programs using matlab language for digital manipulation of images; image acquisition; preprocessing; segmentation; fourier domain processing;
- Learn and understand the image enhancement in the spatial domain.
- Learn and understand the image enhancement in the frequency domain.
- Understand the image restoration, compression, segmentation.
- Be able to design, code and test digital image processing applications using matlab language.

Course Content:

1. **Introduction**: Examples of fields that use digital image processing, Fundamental steps in digital image processing, components of image processing system. Digital Image Fundamentals: Light and the Electromagnetic Spectrum, Image sensing and Acquisition, A simple image formation model, Image sampling and Quantization, basic relationships between pixels.
2. **Image enhancement in the spatial domain**: Basic gray-level transformation, histogram processing, enhancement using arithmetic and logic operators, basic spatial filtering, smoothing and sharpening spatial filters, combining the spatial enhancement methods. Image enhancement in the frequency domain: Introduction to the Fourier transform and the frequency domain, smoothing and sharpening frequency-domain filters, homomorphic filtering, Implementation.

3. **Image restoration**: A model of the image degradation/restoration process, noise models, restoration in the presence of noise–only spatial filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the degradation function, Inverse Filtering, Weiner filtering, Constrained least squares filtering.
4. **Image Compression:** Types of redundancies, Encoder-Decoder model, Lossy and Lossless compression, Entropy of an information source, Variable Length Coding,Huffman Coding, Arithmetic Coding, LZW coding, Transform coding, Sub-image size selection, blocking artifacts, DCT implementation using FFT, Run length coding, Bit-plane encoding, Bit-allocation, Zonal Coding, Threshold Coding, JPEG,Lossless predictive coding, Lossy predictive coding, Motion Compensation. Wavelet based Image Compression: Expansion of functions, Multi-resolution analysis, Scaling functions, MRA refinement equation, Wavelet series expansion, Discrete Wavelet Transform (DWT), Continuous Wavelet Transform, Fast Wavelet Transform, 2-D wavelet Transform, JPEG-2000 encoding, Digital Image Watermarking.
5. **Morphological Image Processing**: Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphologic algorithms. Image Segmentation: Detection of discontinuous, edge linking and boundary detection, thresholding, region–based segmentation, segmentation by Morphological Watersheds.

Prerequisite Courses: None

Reference books:

1. “Digital Image Processing”, Gonzalez R., & Woods R., 2nd Edition, Pearson Education, and Dorling Kindersley, 2008.
2. “Digital Image Processing using MATLAB”, Rafael C. Gonzalez, Richard E. Woods and Steven L. Eddins, Pearson Education, 2004.
3. “Image Processing, Analysis, and Machine Vision”, Milan Sonka, Vaclav Hlavac and Roger Boyle, PWS Publishing, 1999.

UE15EE426:
ADVANCED INSTRUMENTATION SYSTEMS (4-0-0-0-4)

Course Objectives:

- To understand the need for measurements and instruments
- To accentuate the need for industrial communication and their standards
- To appreciate the operation and working of Smart instruments

Course Outcomes:

At the end of the course the students will be able to:

- Understand the importance and application of instrumentation systems in process industries
- Appreciate the functions of optic and laser instrumentation
- Know the working of industrial communication standards
- Understand the applications of smart instruments

Course Content:

1. **Industrial Instrumentation**: Pressure measurement – Passive and active electrical pressure transducers, Principles of piezo electric manometers - Measurement of low pressure - Ionization gauge-McLeod gauge - radioactive vacuum gauge - High pressure measurement using air - pressure balance method - Dynamic accuracy of pressure measuring systems - Temperature measurement – Thermal expansion methods, thermoelectric sensors - electrical resistance sensors - digital thermometer, radiation thermometer - Dynamic response of temperature sensors.
2. **Optic and Laser Instrumentation**: Fiber optic sensors - Intrinsic & extrinsic type - Characteristics and laser generation - Types of lasers - Laser for measurement of distance and length – velocity - acceleration – Calculation of power requirements of laser for material processing.
3. **Industrial Networks**: PROFIBUS PA/DP/FMS and FF – Profibus - Introduction, Profibus protocol stack, Profibus Communication model - Communication objects - System operation, Troubleshooting – Foundation field bus versus Profibus.
4. **Industrial Standards**: RS – 232- RS – 485 - ISO-OSI model – EIA 232 interface standard – EIA 485 interface standard – EIA 422 interface standard - 20mA current loop – Serial interface converters -Modbus- Data Highway - HART Protocols.
5. **Smart Instrumentation**: Introduction to Intelligent sensors – smart sensors for temperature and pressure – Smart transmitters for measurement of differential pressure, flow and temperature-self diagnosis and remote calibration features.

Prerequisite Courses: None

Reference Books

1. “A Course in Electrical and Electronic Measurements and Instrumentation”, A.K. Shawney, Dhanpat Rai & Company, 2014.
2. “Process Control Modeling and Simulation”, Wayne Becquette, Pearson International Studies, 2003.
3. “Chemical Process Modeling and Computer Simulation”, Amiya K. Jana, Second Edition, PHI, 2011.
4. “Measurement and Instrumentation -Theory & Application”, A.S.Morris, R.Lengari, Elsevier, 2011.
5. “Data Communication for Instrumentation and Control”, John Park, Steve Mackay, E.Wright, Elsevier, 2003.

UE15EE451:
UTILIZATION OF ELECTRICAL POWER (2-0-0-0-2)

Course Objectives:

- This course gives a comprehensive idea in utilization of electrical power such as electric heating, electric welding and illumination, electric traction, refrigeration, air conditioning and domestic appliances.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- Identify a heating/ welding scheme for a given application.
- Maintain/ Trouble shoot various lamps and fittings in use.
- Figure-out the different schemes of traction schemes and its main components.
- Identify the research opportunities in Electric Utilization industry.

Course Content:

1. **Illumination** – Introduction; Laws of Luminance; Lighting Schemes – Diffusing and Reflecting schemes, Requirements of good lighting, Types and Design of Lighting Schemes, Method of lighting calculations, Calculation of illumination; Street Lighting, Factory Lighting, Flood Lighting.
2. **Electric Heating** – Methods of Electric heating – Arc heating, Induction heating, Dielectric heating, Infrared heating.

   Electric Welding – Welding Processes, Resistance Electric Welding, Electric Arc Welding.
3. **Refrigeration and Air conditioning** – Introduction, Refrigeration Systems, COP, Standard Rating, Domestic Refrigerator, Water Coolers, Refrigerants.

   Air-Conditioning Systems – Introduction, Classification, Load estimation, Air conditioning of theaters.
4. **Domestic Appliances**: Washing Machines - Function – Types – Semi and Fully Automatic – Top and Front loading – washing technique – working cycle – construction and working of washing

machine – comparison of Top and front loading machines – Problems and Remedies.

Vacuum Cleaner - Function – Principle – Main components – features – types - working – accessories - Filters – Repairing.

Water Heaters & Coffee makers - Water Heater – Function – Types – Electric Kettle – Immersion water heater – Construction and working – storage water heaters – Non pressure type – pressure type – construction and working – repairs & remedies – Coffee maker – types – construction and working of percolator type.

5. **Electric Traction** – Traction Systems, Different Systems of Traction, Systems of Railway Electrification, Electric Traction Systems – Power Supply, A C Locomotive, Tramways, Trolley bus

   Train movement and Energy Consumption – Types of railway services, Speed-Time curves for train movement, Crest speed, Average speed, Schedule speed, Mechanism of train movement, Tractive effort, Power output, Energy output.

Prerequisite Courses: None

Reference Books:

"Utilization of Electrical Power", R.K.Rajput, Firewall Media, 2006.

UE15EE452:
SIMULATION OF POWER SYSTEM COMPONENTS (2-0-0-0-2)

Course Objectives:

- This course will enable the students to develop simulation models for electrical systems and implement controllers and compensators for systems based on system performance.
- The student should be able to utilize the potential of MATLAB as simulation and design tool.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- Develop simulation models for various power system components and other electrical systems
- Use MATLAB and SIMULINK to design and analyze simple systems.

Course Content:

1. Simulation of transmission lines and determination of line constants.
   a. Simulation of transmission lines to determine ABCD parameters.
2. Analysis of different types of faults in the power system.
3. Relay model with MATLAB/SIMULINK.
4. Learning PSAT toolbox (available freely on waterloo site) and using for stability studies
5. Load flow analysis with FACTS devices

Prerequisite Courses: None

Reference Books:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PESU.

UE15EE453:
ILLUMINATION TECHNOLOGIES (2-0-0-0-2)

Course Objectives:

- This course is designed with the objective of giving students an insight to the concepts of light and vision.
- The different sources of light, luminaries and lighting control schemes will be covered in this course.

Course Outcomes:

Upon successful completion of this course, students will be able to:

- Understand the physics involved in light and vision
- Get a knowledge on light sources and luminaries
- Appreciate the artificial illumination design techniques

Course Content:

1. **Light & Vision**: Electromagnetic spectrum – visible spectrum, visual process Rods and Cones – their distribution and importance, Photopic, Scotopic & Mesopic visions, colour vision
2. **Light Sources**: Principle of Operation, Luminous Efficacy, Lamp Life and Color Characteristics of Tungsten Halogen, Fluorescent High pressure Mercury & Sodium Vapour Lamps Environmental Effects of Light sources- New Lamp Developments. – Electronic Ballast
3. **Luminaires**: Definition — optical characteristics of light control elements- C.I.E Classification- Luminous Intensity distribution measurements using Goniophotometer.
4. **Artificial illumination design Techniques**: Quantity and Quality of Illuminance - Lumen method of calculations – IES glare index computation method
5. **Lighting Controls**: Manual Control- Automatic Control- Time Switch- Occupancy sensors-Daylight sensors-Dimming- Reduced Voltage – Energy Conservation measures in Illumination Systems.

Prerequisite Courses: None

Reference Books:

1. "The IESNA lighting handbook: reference & application", Rea Mark Stanley, Illuminating Engineering Society of North America Publisher, 2011.
2. "Light Sources: Technologies & Applications", Spiros Kitsinelis, CRC Press, 2010.
3. "Lamps & Lighting", M.A. Cayless & A.M. Marsdon, Oxford & IBH publishing company, 1996.
4. "Applied Illumination Engineering", Jack L Lindsey, Fairmont Press INC., 1997.

UE15EE454:
AUTOMOTIVE ELECTRONICS (2-0-0-0-2)

Course Objectives:

- Modern day automobiles are increasingly controlled by complex electronic systems. In fact there are several independent embedded controllers to manage different systems in the automobile.
- In addition traditional electrical systems for ignition, battery management and illumination exist.
- The increased complexity means that a comprehensive understanding requires a comprehensive knowledge in electrical engineering to design and troubleshoot automobile electrical systems.
- Thus this course is relevant in an electrical engineering curriculm and is one of growing importance as vehicle control systems and regulatory requirements are continually evolving.

Course Outcomes:

At the end of the course, the student will be able to:

- Design charging, ignition and control systems for automobiles
- Comprehend the working princviples of the different sensors and actuators in a vehicle.
- Understand the working of different electrical components in an automobile and troubleshoot problems
- Design the illumination and climate control systems.

Course Content:

1. **Charging System:** Generation of direct current. Shunt generator characteristics. Armature reaction. Third brush regulation. Cut-out. Voltage & current regulators. Compensated voltage regulator alternators principle & constructional aspects and bridge benefits.
2. **Ignition Systems:** Types, Construction & working of battery coil and magneto ignition systems. Relative merits, Centrifugal and vacuum advance mechanisms, types and construction of spark plugs, electronic ignition systems.
3. **Lighting System & Accessories:** Insulated & earth return systems. Positive & negative earth systems. Details of head light & side light. Headlight dazzling & preventive methods. Electrical fuel-pump, Speedometer, Fuel, oil & temperature gauges, Horn, Wiper system, Trafficator.
4. **Automotive Electronics**: Current trends in modern automobiles Open and close loop systems-Components for electronic engine management. Electronic management of chassis system. Vehicle motion control.
5. **Sensors and Actuators**: Basic sensor arrangement, Types of sensors such as-Oxygen sensors, Crank angle position sensors-Fuel metering/vehicle speed sensor and detonation sensor-Altitude sensor, flow sensor. Throttle position sensors. Solenoids, stepper motors, and relays

Prerequisite Courses: None

Reference Books:

1. "Modern Electrical Equipment of Automobiles", Judge. A.W., Chapman & Hall, London, 1992.
2. "Automobile Electrical Equipment", Young. A.P., & Griffiths. L., English Language Book Society & New Press, 1990.
3. "Storage Batteries", Vinal. G.W., John Wiley & Sons Inc., New York, 1985.
4. "Automobile Electrical Equipment", Crouse. W.H., McGraw Hill Book Co Inc., New York, 1980.
5. "Electrical ignition Equipment", Spreadbury. F.G., Constable & Co. Ltd., London 1962.
6. "Automotive Electrical Equipment", Kholi. P.L., Tata McGraw-Hill Co. Ltd. New Delhi, 1975.
7. "Automotive Hand Book", Robert Bosch, Bently Publishers, 1997.
8. "Understanding Automotive Electronics", William B. Ribbens, 5th Edition, Butterworth, Heinemann Woburn, 1998.
9. "Automotive Computers and Control System", Tom Weather Jr and Cland C. Hunter, Prentice Hall Inc., New Jersey, 1991.

UE15EE455:
DIGITAL VIDEO PROCESSING (2-0-0-0-2)

Course Objectives:

- To understand the Arithmetic Design concepts and coding using Verilog.
- Learn the ability to Develop and Verify the algorithms using High level Language
- To provide the students insight of design and analysis of architecture.

Course Outcomes:

At the end of the course the student will be able to:

- Design and Code Serial Adder, Parallel Signed Adder, Multiplier, DCTQ- IQIDCT, PCI Bus Arbiter etc for any FPGA based projects for video processing applications.
- Model the DCTQ Processor for different Video processing applications.

Course Content:

1. **Arithmetic Circuit Designs:** Digital Pipelining, Partitioning of a Design, Partition of Data Width, Partition of Functionality, Signed Adder Design, Signed Serial Adder, Parallel Signed Adder Design, Multiplier Design and Verilog Code for Multiplier Design.
2. **Development of Algorithms and Verification Using High Level Languages:** 2D-Discrete Cosine Transform and Quantization, Algorithm for Parallel Matrix Multiplication for DCTQ, Verification of DCTQ –I QIDCT
3. **Processes with Fixed Pruning Level Control** Using Matlab, Automatic Quality Control Scheme for Image, Algorithm for Assessing Image Quality, Automatic Pruning Level Control Incorporated,
4. **Assessment of Direction** of Motion of Image, Results and Discussions of FOSS Motion Estimation Algorithm.
5. **Architectural Design:** Architecture of Discrete Cosine Transform and Quantization, Architecture of a Video Encoder Using Automatic Quality Control Scheme and DCTQ Processor, The Automatic Quality Controller, Architecture for the FOSS Motion Estimation Processor.

Prerequisite Courses: None

Reference Books:

1. "Digital VLSI System Design", Dr. Seetharaman Ramachandran, Springer, 2007.
2. "Digital Logic Design using Verilog", Taraate & Vaibbhav, Springer, 2016.
3. "A Verilog HDL Primer", J. Bhasker, Star Galaxy Publishing, 1999.

UE15EE456:
REAL TIME OPERATING SYSTEMS (2-0-0-0-2)

Course Objectives:

- To learn fundamental concepts of RTOS
- To learn how real time concepts are modeled in a RTOS
- To understand and appreciate on how example RTOS have deployed.

Course outcome:

- Develop small-scale portable applications using RTOS
- Practical introduction to real-time development tools
- To be able to get a hands-on one commercially used RTOS
- Able to compare functionalities in commercial OS, application development using RTOS

Course content:

1. **Overview of RTOS – 1:** Defining an RTOS, Scheduler, Objects and Services, Key Characteristics – Tasks and Task states – Task Management
2. **Inter-task communication**: Semaphores – Shared data – Message queues – Mail boxes and pipes – Timer and Timer Services
3. **Overview of RTOS – 2:** Memory Management – Exceptions and Interrupts – Semaphores and Queues
4. **Scheduling problem**: classification, worst case execution time (WCET), static and dynamic scheduling – Multithreaded Pre-emptive scheduler – Synchronization and Communication – Deadlocks
5. **Real Time Models:** Event Based – Process Based and Graph based Models – Real Time Languages – RTOS Tasks – RT scheduling – Interrupt processing – Synchronization – Control Blocks – Memory Requirements.

Prerequisite Courses: None

Reference Books:

1. "Operating System Concepts," Silberschatz,Galvin,Gagne, 6th Edition, John Wiley, 2003.
2. "Operating Systems-A Design Oriented approach", Charles Crowley, McGraw Hill, 1997.
3. "Embedded Systems – Architecture, Programming and Design", Raj Kamal, Tata McGra Hill, 2006.
4. "Building Embedded Linux System", Karim Yaghmour, O'Reilly, 2003.
5. "Learning Android", Marko Gargenta, O'Reilly, 2011.
6. "Real Time Systems – Design for distributed Embedded Applications", Herma K., Kluwer Academic, 1997.
7. "Real Time Systems", C.M. Krishna, Kang, G.Shin, McGraw Hill, 1997.
8. "An Introduction to Real Time Systems", Raymond J.A.Bhur, Donald L.Bailey, PHI, 1999.
9. "Advanced Concepts in Operating System", Mukesh Sighal and N G Shi McGraw Hill, 2000
10. "Operating Systems, A Concept-Based Approach", D.M.Dhamdhere, TMH, 2008.
11. "Real–Time systems – Design Principles for distributed Embedded Applications", Hermann Kopetz, Second Edition, Springer 2011.
12. "Linux for embedded and real time applications", Doug Abbott, Elsevier Science, 2003.
13. Micro C OS II Reference Manual.
14. Keil Real Time Library Documentation.

M.TECH IN ELECTRICAL AND ELECTRONICS ENGINEERING

Program Educational Objectives

1. Enable demonstration of peer-recognized expertise together with the ability to articulate that expertise and apply it for contemporary problem solving in the analysis, design, and evaluation of electrical and electronic devices and systems
2. Inculcate study of literature and engage in research in the field of Electrical and Electronics Engineering that facilitate publications, promote consulting and industry partnerships
3. Prepare students to engage in engineering profession, to meet universal standards of competency by contributing to the ethical, creative and innovative practices of engineering
4. Develop mindset of graduates to exhibit sustained learning and adapt themselves, as an individual and as a team, to constantly changing field through graduate work and self-study
5. Encourage, by example, graduates to pursue professional ethics in all their endeavors, and to build good communicative skills that help foster sound inter-personal relationships in their engagement in industry and society.

Program Outcomes:

i. Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
ii. Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context
iii. Identify, formulate and critically study the problem, understand the interplay between theory and practice, design and develop systems considering hardware and software decomposition, conduct experiments, analyzing the results and applying the knowledge to different domains by considering social, environmental, economic, and security constraints
iv. Critically analyze existing literature in an area of specialization, conduct investigative research to develop innovative methodologies to tackle issues identified and contribute to the development of technological knowledge and intellectual property.
v. Apply current techniques, skills and modern computing tools to build and analyze robust, reliable, maintainable, scalable and efficient computing systems
vi. Enhance skills and continuously acquire advanced knowledge in Electrical and Electronics Engineering, multidisciplinary and interdisciplinary domains for professional excellence
vii. Manage and execute engineering projects under economic, time and performance constraints both working in teams and in an individual capacity.
viii. Contribute and communicate effectively with the society confidently, be able to write effective reports and design documents by adhering to the appropriate standards, make effective presentations, give and receive clear instructions
ix. Engage in lifelong learning with persistent scientific temper for professional advancement and effective communication of the technical information
x. Become a complete professional with high integrity and ethics, with excellent professional conduct and with empathy towards the environmental and contribute to the community for sustainable development of society
xi. Critically evaluate the Outcomes of one's actions and apply self corrective measures to improve the performance

UE18EE501: POWER QUALITY (4-0-0-0-4)

Course Objectives:

- To study the production of voltages sags, overvoltage and harmonics and methods of control. To study various methods of power quality monitoring.

Course Outcomes:

At the end of this course students would be able to

- Understand the basic concepts of power quality and various causes of power quality issues in power system.
- Understand the various sources of sag and its mitigation methods
- Understand sources of over voltages and how to implement computer analysis power quality issues
- Understand the effect of harmonics on various loads and its mitigation techniques
- Understand the various power quality monitoring devices

Course Content:

1. **Introduction to Power Quality:** Terms and definitions: Overloading – under voltage – over voltage. Concepts of transients – short duration variations such as interruption – long duration variation such as sustained interruption. Sags and swells – voltage sag – voltage swell – voltage imbalance – voltage fluctuation – power frequency variations. International standards of power quality. Computer Business Equipment Manufacturers Associations (CBEMA) curve.
2. **Voltage Sags and Interruptions:** Sources of sags and interruptions – estimating voltage sag performance. Thevenin's equivalent source – analysis and calculation of various faulted condition. Voltage sags due to induction motor starting. Estimation of the sag severity – mitigation of voltage sags, active series compensators. Static transfer switches and fast transfer switches.

3. **Overvoltages**: Sources of over voltages – Capacitor switching – lightning – Ferro resonance. Mitigation of voltage swells – surge arresters – low pass filters – power conditioners. Lightning protection – shielding – line arresters – protection of transformers and cables. An introduction to computer analysis tools for transients, PSCAD and EMTP.
4. **Harmonics**: Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics – Harmonics Vs transients. Effect of harmonics – harmonic distortion – voltage and current distortion – harmonic indices – inter harmonics – resonance. Harmonic distortion evaluation – devices for controlling harmonic distortion – passive and active filters. IEEE and IEC standards.
5. **Power Quality Monitoring**: Monitoring considerations – monitoring and diagnostic techniques for various power quality problems – modeling of power quality (harmonics and voltage sag) problems by mathematical simulation tools – power line disturbance analyzer – quality measurement equipment – harmonic / spectrum analyzer – flicker meters – disturbance analyzer. Applications of expert systems for power quality monitoring.

Prerequisite Courses: None

Reference Books:

1. "Electric Power System Quality", Dugan, R. C., McGranaghan, M. F., Santoso, S., & Beaty, H. W., McGraw Hill Education, 3rd Edition, 2012.
2. "Electric Power Quality", Heydt, G. T., Stars in Circle Publications, 1991.
3. Bollen, M. H. "Understanding Power Quality Problems (Vol. 3)", IEEE Press, New York, 2000.
4. "Power System Quality Assessment", Arrillaga, J., Watson, N. R., & Chen, S., Wiley, 2000.
5. PSCAD User Manual, Manitoba Research Center, 2005.

UE18EE502:
POWER SEMICONDUCTOR DEVICES (4-0-0-0-4)

Course Objectives:

- To familiarize with structures, operations of various semiconductor devices
- To analyse dynamic characteristics and to estimate power loss of devices
- To design biasing & protection circuits for various power semiconductor devices
- To get familiarity with quadrant switch realization and hence to identify suitable semiconductor device for various converter topologies

Course Outcomes:

At the end of the course the students will acquire ability to:

- Identify suitable device/s for specific applications for wide range of power
- Calculate and estimate the total losses of device to compute performance of converter
- Design and develop biasing and snubber circuits of devices based on power specification
- To analyze circuit behaviour and select suitable semiconductor switch for various applications

Course Content:

Introduction to Power Electronics & Interdisciplinary nature of Power electronics

1. **Semiconductor devices:** Classification of Power Semiconductor Device, Diodes – structure & I-V characteristics, breakdown voltage – Non-punch through, punch-through, switching characteristics. Schottky Diodes: structure, principle of operation, Ohmic contacts
2. **Thyristor**: Basic structure, I-V characteristics, two transistor analogy, switching characteristics, di/dt & dv/dt limitations, methods of improving di/dt & dv/dt ratings, data sheet rating

   Parameter list for SCRs, TRIACs, AC switches, and DIACS

   Transistor: structure, static characteristics, dynamic characteristics, second breakdown, safe operating areas, data sheet rating & terminology

   BJT base drive circuits – turn on/off control, proportional base control & anti-saturation control and isolation of gate & base drive - *Numericals*
3. **MOSFET -** operating principle, Static, dynamic characteristics, Voltage breakdown, n-state conduction losses, safe operating area of MOSFET Data sheet ratings

   Gate drive circuit for MOSFET & numericals,

   GTO & IGBT: Static, dynamic characteristics, Overcurrent protection of GTO, IGBT device limits & SOAs' Gate drive requirements for an MOSFET or an IGBT (Gate Drive Ics).

   Switching power loss calculation & numerical.
4. **Emerging Devices:** *In brief* - Field controlled thyristor, MOS controlled thyristor, SiC and GaAs devices in brief. **Snubber circuits:** for diodes, thyristors, transistors.
5. **Switch Realization:** Switch Applications, single/two/four quadrant switches, Synchrounous Rectifier (Power MOSFET) Temperature Rise – Use of Heat Sinks and numerics, Heat sinks in BJT, MOSFET, Thermal-electrical equivalents, thermal equivalent circuit

Prerequisite Course: None

Reference Books:

1. "Power Electronics, Converters, Applications and Design", Ned Mohan, John Wiley and Sons, 2002.
2. "Power Electronics Devices", M. H Rashid, 3rd Edition Pearson Education, 2003.
3. "Fundamentals of power electronics", Erickson, Robert W, and Dragan Maksimovic, Springer Science & Business Media, 2007.
4. "Power electronics: principles and applications", Vithayathil, Joseph, Tata McGraw-Hill Education, 1995.
5. http://www.st.com/content/ccc/resource/technical/document/application_note/ea/24/b1/42/31/ca/4d/66/CD00183570.pdf/files/CD00183570.pdf/jcr:content/translations/en.CD00183570.pdf
6. http://www.swarthmore.edu/NatSci/echeeve1/Class/e12Code/HEAT-NOTE.pdf

UE18EE503:
MICROCONTROLLERS AND ITS APPLICATIONS (4-0-0-0-4)

Course Objectives:

- Understand the need of microcontroller in development of various projects
- Introduce the outline of the ARM based microcontroller architecture and interfaces
- Get an overview of the system peripherals that cover bus structure, memory map, timers and much more
- Get a hands-on of a microcontroller development tool chain
- How to write programs that interact with other devices and hence build applications

Course Outcomes:

At the end of the course the student will be able to:

- Identify the software and hardware components of the system needed to meet the system needs
- Gain knowledge of architectural aspects, interfacing and programming details for microcontroller
- Interface various I/O devices like stepper motor and other peripherals
- Model in the software implementation with all needed elements and structure with mini-projects
- Gain a good hands-on one of the commercially available development environment to perform the tasks end to end able to analyze real time examples

Course Content:

1. **ARM Embedded Systems and Design Philosophy**: Processor fundamentals – Introduction to ARM instruction set – Thumb instruction set – Understanding specifics of ARM microcontroller: architecture overview, memory and memory map
2. **System Modeling and start up code**: Firmware and boot loader – High level C constructs – Basics of efficient C programming as applied to microcontroller –- Compiler – Assembler – Linker/ Locator – Binary download formats – Debugging – Emulators – Logic Analyser
3. **Interrupt controller, HW interrupt, SW interrupt**: Exception handling- GPIO-ADC-DAC-UART, Timers-Watch dog Timers: PWM- RTC – Serial communication concepts I2C and SPI- Discussions on mini-projects – Coding conventions and tips. Study of Input and output devices : LED and LCD display – App1: Build an application that samples inputs, displays on LCD and has a serial communication
4. **Study of motors (stepper, DC, servo)**: Open & Close loop controls: PWM, Proportional and PID –App2: Build an application to control motor – simple speed control, PID control etc.
5. **Introduction of DSP in ARM**: Representing signal, FFT etc – App3: Building a Spectrum Analyser. Study of the Sensors: Touch, Proximity sensor, Sound sensors, ultra-sonic sensors, temperature sensor, accelerometers. Application: Building a system that detect sounds and take certain actions Mini-project presentation/discussions.

Prerequisite Course: None

Reference Books:

1. "ARM System Developer's Guide: Designing and Optimizing System Software", Sloss, A., Symes, D., & Wright, C., Morgan Kaufmann, 2004.
2. "ARM System-on-chip Architecture", Furber, S. B., Pearson Education, 2000.
3. LPC21xx Data sheet http://www.nxp.com/documents/data_sheet/LPC2101_02_03.pdf
4. LPC21xx User manual http://www.nxp.com/documents/user_manual/UM10161.pdf
5. "Embedded C", Pont, M. J., Addison-Wesley Longman Publishing Co., Inc., 2002.
6. "Programming Embedded Systems in C and C++", Barr, M., O'Reilly Media, Inc., 1999.
7. "Embedded C Programming: Techniques and Applications of C and Pic MCUS", Siegesmund, Imprint Newnes, 2014.
8. "The C Programming Language (Vol. 2)", Kernighan, B. W., & Ritchie, D. M., Englewood Cliffs: Prentice-Hall, 1988.

UE18EE504:
APPLIED SOFT COMPUTING (4-0-0-0-4)

Course Objectives:

- To expose the students to the concepts of feed forward neural networks.
- To provide adequate knowledge about feedback neural networks
- To provide adequate knowledge about fuzzy and neuro-fuzzy systems
- To provide comprehensive knowledge of fuzzy logic control to real time systems.

Course Outcomes:

At the end of the course the student will be able to:

- Understand and apply Soft Computing techniques to problems related to control systems.

Course Content:

1. **ARTIFICIAL NEURAL NETWORKS (ANN)**: Review of basic concepts of Artificial Neural Nets – Architecture of learning algorithm – MLP Architecture: Back Propagation Algorithm – Radial Basis Function Nets(RBF) – Kohonen Self-Organizing Nets – support vector machines and reinforcement learning.
2. **NEURAL NETWORKS BASED CONTROL**: Non Linear optimization - Representation of nonlinear Systems – Nonlinear system identification and monitoring with Artificial Neural Networks – Modeling and control of nonlinear system using ANN - Adaptive neuro controller – case studies.
3. **FUZZY LOGIC**: Basics of Fuzzy sets - Fuzzy operations- Fuzzy Relations – Fuzzification – Defuzzification -Linguistic Hedges – Model based fuzzy control : Fuzzy rule for modeling and control- Mamdani fuzzy rule systems - Takagi-Sugeno-Kang fuzzy rule systems – rule extraction from neural networks.
4. **FUZZY LOGIC BASED CONTROL**: Development of membership functions – Modeling of fuzzy nonlinear systems using fuzzy models (Mamdani and Sugeno) - Design of fuzzy logic controller – Adaptive fuzzy systems – case studies.
5. **NEURO-FUZZY BASED CONTROL**: Adaptive Neuro-Fuzzy systems - Neuro-Fuzzy control for nonlinear systems- Neuro-Fuzzy identification of sub systems - optimization of membership function and rule base using genetic algorithm and particle swarm optimization – adaptive backthrough control -case studies.

Prerequisite Course: None

Reference Books:

1. "Fundamentals of Neural Networks, Architecture, Algorithms and Applications", Laurene V Fausett, Pearson Education, 2011.
2. "Fuzzy Logic with Engineering Applications", Timothy J Ross, Wiley India Pvt. Ltd, 2011.
3. "Learning and Soft Computing, Support Vector Machines, Neural Networks and Fuzzy Logic Models", Kecman V, Pearson Education, New Delhi, 2004.
4. "Fuzzy logic intelligence control and information", Yen J and Langari R, Pearson Education, New Delhi, 2003.
5. "Advanced Fuzzy systems Design & Applications", Jin Y, Springer, New Delhi, 2010.

UE18EE511: POWER ELECTRONIC DEVICES AND CONVERTER TECHNOLOGIES (4-0-0-0-4)

Course Objectives:

- To understand the basic electrical characteristics and ratings of power semiconductor devices
- To provide students the insight useful for understanding semiconductor devices, gate drive circuits, and applications
- To understand and acquire knowledge about various power converters
- To prepare the students to analyze and synthesis different power converter topologies

Course Outcomes:

At the end of the course, the student will be able to

- Analyze & utilize semiconductor devices for various applications
- Understand and utilize the basic gating circuits for devices
- Make use of various power converters in commercial and industrial applications.
- Identify and analyze PWM inverters for various power requirements of consumer applications

Course Content:

1. **Semiconductor Devices:** Static characteristics, typical ratings and applications of the power BJT, MOSFET, IGBT, GTO, MCT, and SiC diode & SiC MOSFET. Switching characteristics and switching losses of BJT, MOSFET and IGBT – di/dt & dv/dt limitations, Base and gate drive requirements and circuits for BJT, MOSFET, IGBT.
2. **Line Commutated Converters:** Phase control, single phase semi-converter & fully controlled converter, three phase semi-controlled & fully controlled converter – R & R-L load. Single-phase dual converters, power factor improvement methods, effect of source inductance, single phase series converters, twelve pulse converter and design of converter circuits with problems.
3. **DC-AC Converters:** Principle of operation, performance parameters, single phase bridge inverters and three phase inverters. Voltage control of single phase and three phase inverters, Current source Inverters and Variable DC link Inverter.
4. **DC-DC Converters:** Principle of operation of step-down, step-up converters, and Buck-Boost converter, with problems – Only CCM operation. Four quadrant chopper, Cuk Converter.
5. **AC-AC Voltage Controllers:** Introduction, Principle of On-Off Control and Phase control. 1-phase and 3-phase controllers feeding R load & R-L loads with problems

Prerequisite Course: None

Reference Books:

1. “Power Electronics: Converters, Applications, and Design”, Mohan, N., & Undeland, T. M., John Wiley & Sons, 2007.
2. “Power Electronics: Circuits, Devices, and Applications”, Rashid, M. H., Pearson Education India, 2003.
3. “Power Electronics Essentials and Applications”, Umanand, L., 1st Edition, New York, NY, Wiley Publishers, 2009.
4. “Fundamentals of Power Electronics”, Erickson, R. W., & Maksimovic, D., Springer Science & Business Media, 2007.

UE18EE512: EMBEDDED SYSTEM DESIGN (4-0-0-0-4)

Course Objectives:

- Understand the fundamental building blocks of Embedded System
- Learn the fundamental RTOS.
- Study the interfaces for the processor communication
- Get familiarity of the development using commercial software tools
- Discussion of Application development using interfacing

Course Outcomes:

At the end of the course, the student will be able to:

- Identify the software and components of the system needed to meet the desired needs
- Realise the software implementation with all needed elements and structure
- Get a good hands-on one of the commercially available development environment to perform the tasks end to end
- Able to analyse real time examples

Course Content:

1. **Introduction**: Overview of embedded systems. Embedded system design challenges, Common design metrics and optimizing them. Survey of different embedded systems design methodologies, trade offs. Custom single purpose processors. Design of custom single purpose processors. RT Level design and optimizing the design.
2. **General & Standard Single Purpose Peripherals**. General purpose processors, Timers/counters, UART, PWM, LCD, Keypad controllers, stepper motor control, ADC/DAC. **Memory**: Introduction, Memory write ability and storage performance, common memory types, Composing Memory, Memory Hierarchy, Memory Management Unit, Advanced Memories
3. **Processor Architecture and Organization**, Abstraction in Hardware, Instruction set Design,RISC and CISC Processors, ARM Architecture, ARM Assembly Language Programming
4. **Interrupts**: Basics- Shared Data Problem-Interrupt Latency, Survey of Software Architectures, Round Robin, Round Robin with interrupts – Function Queues, Scheduling- RTOS Architecture
5. **Introduction to RTOS**: Tasks – States – Data – Semaphores and shared data – Operating systems Services – Message Queues – Mail Boxes – Timers – Events – Memory Management – Interrpts in an RTOS environment.

Prerequisite Course: None

Reference Books:

1. “Embedded System Design: A Unified Hardware/software Introduction, Vol. 4”, Vahid, Frank, and Tony Givargis, John Wiley & Sons, New York, 2002.
2. “An Embedded Software Primer, Vol. 1”, Simon, David E, Addison-Wesley Professional, 1999.
3. “ARM System-on-chip Architecture”, Furber, Stephen Bo, Pearson Education, 2000.

UE18EE513: RENEWABLE ENERGY SYSTEMS (4-0-0-0-4)

Course Objectives:

- To understand the different types of renewable energy sources
- To have a knowledge on the applications of renewable energy sources
- To comprehend the environmental impacts of renewable energy systems

Course Outcomes:

At the end of the course the student will be able to:

- Understand the principles of solar PV systems and the applications

- Understand the dynamics of WECS and applications of wind energy
- Appreciate the resources from biomass and their classification
- Realize the concept of Biophotolysis and fuel cells
- Understand the concept of energy generation from Ocean, and geothermal energy.

Course Content:

1. **Solar Energy** - Solar radiation its measurements and prediction – solar thermal flat plate collectors concentrating collectors – applications – heating, cooling, desalination, power generation, drying, cooking etc – principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications: battery charger, domestic lighting, street lighting, and water pumping, power generation schemes.
2. **Wind Energy –** Atmospheric circulations – classification – factors influencing wind – wind shear – turbulence – wind speed monitoring – Betz limit – Aerodynamics of wind turbine rotor site selection – wind resource assessment – wind energy conversion devices – classification, characteristics, applications. Hybrid systems – safety and environmental aspects.
3. **Bio-energy** – Biomass resources and their classification – chemical constituents and physicochemical characteristics of biomass – Biomass conversion processes – Thermo chemical conversion: direct combustion, gasification, pyrolysis and liquefaction – biochemical conversion: anaerobic digestion, alcohol production from biomass – chemical conversion process: hydrolysis and hydrogenation. Biogas – generation – types of biogas Plants- applications
4. **Hydrogen and Fuel Cells** – Thermodynamics and electrochemical principles – basic design, types, and applications – production methods – Biophotolysis: Hydrogen generation from algae biological pathways – Storage gaseous, cryogenic and metal hydride and transportation. Fuel cell – principle of working- various types – construction and applications.
5. **Other Types of Energy** – Ocean energy resources – principles of ocean thermal energy conversion systems – ocean thermal power plants – principles of ocean wave energy conversion and tidal energy conversion – hydropower – site selection, construction, environmental issues – geothermal energy – types of geothermal energy sites, site selection, and geothermal power plants.

Prerequisite Courses: None

Reference Books:

1. “Solar Energy: Principles of Thermal Collection and Storage”, Sukhatme, K., & Sukhatme, S. P., Tata McGraw-Hill Education, 1996.
2. “Renewable Energy Resources”, Twidell, J., & Weir, T. Routledge, 2015.
3. “Principles of Solar Engineering”, Kreith, F., & Kreider, J. F., Hemisphere Publishing Corporation,Washington, DC,1978
4. “Renewable Energy: Power for a Sustainable Future. Energy”, Kaygusuz, K., Exploration & Exploitation, 19(6), 603-626, 2001
5. “Alternative Energy Sources”, Veziroglu, T.N., Vol 5 and 6, McGraw-Hill, 1990.
6. “Biochemical and Photosynthetic Aspects of Energy Production”, San Pietro, A. (Ed.), Elsevier, 2012
7. “Thermochemical Processing of Biomass In Thermochemical Processing of Biomass”, Bridgewater, A. V., Butterworths, 1984
8. “Fuel Cells: Theory and Application”, Hart, A. B., & Womack, G. J., Chapman & Hall, 1967.
9. “Biogas Technology: A Practical Handbook”, Khandelwal, K. C., & Mahdi, S. S., Tata McGraw-Hill, 1988.

UE18EE521: SMART GRID (4-0-0-0-4)

Course Objectives:

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications

Course Outcomes:

At the end of the course, the student will be able to:

- Understand the need for smart grid, concept of self healing grid
- Understand the technology involved in smart grid
- Have a knowledge on Smart Meters, Advanced Metering infrastructure drivers and protocols, Phasor Measurement Unit, and Intelligent Electronic Devices
- Manage power quality issues in Smart Grid
- Appreciate smart grid applications namely Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols

Course Content:

1. **Introduction to Smart Grid**: Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.
2. **Smart Grid Technologies**: Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).
3. **Smart meters and Advanced Metering Infrastructure**: Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.
4. **Power Quality Management in Smart Grid**: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.
5. **High Performance Computing For Smart Grid Applications**: Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

Prerequisite Course: None

Reference Books:

1. “Smart Grid Technologies: Communication Technologies and Standards, Vol. 7, No. 4”, Vehbi C. Güngör, DilanSahin, TaskinKocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, IEEE Transactions on Industrial Informatics, 2011.

2. "Smart Grid : Infrastructure, Technology and Solutions", Stuart Borlase, CRC Press. 2012.
3. "Smart Grid: Technology and Applications", Wiley Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, 2012.

UE18EE522: DIGITAL CONTROL SYSTEMS (4-0-0-0-4)

Course Objectives:

- To introduce the fundamental concepts, principles and application of digital control system analysis and design to the postgraduate students.

Course Outcomes:

At the end of the course, the student will be able to:

- Understand the techniques applicable to analyze the Discrete Data systems
- Appreciate the compensation techniques
- Implement State Variable Modeling to various engineering applications

Course Content:

1. Structure of a computer controlled system. Review of Z-transform. Computation of time response of Discrete Data system. Bilinear Transformation. W-plane, prewarping, inverse transformation.
2. Design of discrete controllers. Z-domain compensation, w-plane compensation, state variable feed back deadbeat controller, sampled data version of PID controllers.
3. Effect of Data Digitization.
4. Effect of finite word size, limit cycle determination.
5. State Variable Analysis of Digital Control Systems.

Prerequisite Course: None

Reference Books:

1. "Digital control engineering", Gopal, Madan, New Age International, 1988.
2. "Digital Control Systems, Holt, Rinehart and Winston", Kuo, Benjamin C. Inc., New York 1980.
3. "Analysis and synthesis of sampled-data control systems", Kuo, Benjamin C. Prentice Hall, 1963.
4. "Digital control system analysis and design", Phillips, Charles L., and H. Troy Nagle, Prentice Hall Press, 2007.

UE18EE531: POWER ELECTRONICS IN DRIVES AND ENERGY SYSTEMS (4-0-0-0-4)

Course Objectives:

- To design a closed loop controller for DC motor
- To design a closed loop controller for induction motors
- To design a utility interactive converter for power electronic interface to the grid

Course Outcomes:

At the end of the course, the student will be able to

- Design a simple open loop control for DC and induction motors
- Control a motor drive by designing a closed loop controller
- Enable power transfer to grid from a variety of renewable energy sources

Course Content:

1. **Phase, Current & Speed Controlled DC Drive**: Three-phase controlled converter, control circuit, control modeling of three phase converter – Steady state analysis of three phase converter control DC motor drive – Two quadrant, Three phase converter controlled DC motor drive – DC motor and load, converter. Current and speed controllers – Current and speed feedback – Design of controllers – Current and speed controllers – Motor equations – filter in the sped feed back loop speed controller – current reference generator – current controller and flow chart for simulation – Harmonics and associated problems – sixth harmonics torque.
2. **Chopper Controlled DC Motor Drives & Simulation**: Steady state analysis of chopper controlled DC motor drives – rating of the devices – Pulsating torque. Closed loop operation: Speed controlled drive system – current control loop – pulse width modulated current controller – hysteresis current controller – modeling of current controller – design of current controller. Simulation of DC Motor Drives: Dynamic simulations of the speed controlled DC motor drives – Speed feedback speed controller – command current generator – current controller.
3. **Stator Side Control of Induction Drives**: Scalar control – Voltage fed inverter control – Open loop volts/Hz control – speed control slip regulation – speed control with torque and flux control – current controlled voltage fed inverter drive – current – fed inverter control – Independent current and frequency control – Speed and flux control in Current –Fed inverter drive – Volts/Hz control of Current –fed inverter drive – Efficiency optimization control by flux program. Rotor Side Conrol of Induction Drives: Slip power recovery drives – Static Kramer Drive – Phasor diagram – Torque expression – speed control of Kramer Drive – Static Scheribus Drive – modes of operation.
4. **Vector control of Induction Motor Drives**: Principles of Vector control – Vector control methods – Direct methods of vector control – Indirect methods of vector control – Adaptive control principles – Self tuning regulator Model referencing control.
5. **Control of utility interactive inverters**: Grid connected renewable energy systems. Synchronizing of inverters. PLL types. Vector control of grid connected single phase and three phase inverters. Reference signal generation, control of power flow.

Prerequisite Course: None

Reference Books:

1. "Fundamentals of Electrical Drives", Dubey, G. K., CRC Press, 2002.
2. "Power Electronics and Motor Drives: Advances and Trends", Bose B. K., Academic Press, 2010.
3. "Power Electronics and Motor Control", Shepherd W., Hulley, L. N., & Liang, D. T. W, Cambridge University Press, 1995.
4. "Power Electronics: Circuits, Devices, and Applications", Rashid M. H., Pearson Education India, 2003.
5. "Power Semiconductor Drives", Dewan S. B., Slemon G. R., & Straughen A., Wiley-Interscience, 1984.

UE18EE532: GENERAL PROCESSOR ARCHITECTURE (3-0-2-0-4)

Course Objectives:

- To describe computer architecture concepts and mechanisms related to the design of modern processors, memories, and networks and explain how these concepts and mechanisms interact.

- To Apply this understanding to new computer architecture design problems within the context of balancing application requirements against technology constraints; more specifically, quantitatively assess a design's execution time in cycles and qualitatively assess a design's cycle time, area, and energy.
- To Evaluate various design alternatives and make a compelling quantitative and/or qualitative argument for why one design is superior to the other approaches

Course Outcomes:

At the end of the course the student will be able to:

- Suggest alternate processor architectures for specific applications
- Do comparative analysis of different architectures & choose right architecture for specific applications
- Architect a solution for a given problem.

Course Content:

1. **Fundamental Processors**: instruction set architecture; single-cycle processors; hardwired vs. microcoded FSM processors; pipelined processors; resolving structural, data and control hazards; analyzing processor performance.
2. **Fundamental Memories**: memory technology; direct-mapped vs. associative caches; write-through vs write-back caches; single-cycle, FSM, pipelined caches; analyzing memory performance
3. **Fundamental Networks**: single-cycle global crossbars; arbitration; traffic patterns; torus and butterfly topologies; routing algorithms; channel and router microarchitecture; analyzing network performance
4. **Advanced Processors**: superscalar execution, out-of-order execution, register renaming, memory disambiguation, branch prediction, speculative execution; multithreaded, VLIW, and SIMD processors
5. **Advanced Memories**: non-blocking cache memories; memory protection, translation, and virtualization; and memory synchronization, consistency, and coherence

Prerequisite Course: None

Reference Books:

1. "Computer Architecture: A Quantitative Approach", J. L. Hennessy and D. A. Patterson, 5th Edition, Morgan Kaufmann, 2012.
2. "Digital Design and Computer Architecture", D. M. Harris and S. L. Harris, 2nd Edition, Morgan Kaufmann, 2012.

UE18EE541:
HVDC TRANSMISSION (4-0-0-0-4)

Course Objectives:

- To know modern transmission systems using HVDC
- To study converters, and the control of converters used in HVDC
- To understand the concept of harmonics and reduction using filters
- To study power flow analysis and stability analysis

Course Outcomes:

At the end of the course the student will be able to

- Learn the planning of HVDC transmission, and understand the modern trends in DC transmission
- Appreciate the choice of converter and study the configuration
- Analyse the converter in two and three, and three and four valve conduction modes, along with the LCC bridge characteristics
- Analyse the operation of Capacitor Commutated and voltage source converters.
- Learn the strategies used to Control Converters such as, firing angle control, current and extinction angle control, Starting and stopping of Dc link, Power control, Frequency control, Reactive power control, and Tap changer control
- Understand the faults that occur in converters and adapt suitable methods to protect them
- Gain a knowledge on reactive power control
- Learn the concept of harmonics generation and design AC and DC filters to eliminate the harmonics
- Analyze the concept of power flow with VSC based HVDC system.
- Analyze the voltage stability in asynchronous AC/DC system

Course Content:

1. **DC Power Transmission Technology:** Introduction – comparison of AC and DC transmission – application of DC transmission – classifications of DC transmission system – Planning for HVDC transmission – modern trends in DC transmission – DC breakers – cables, VSC based HVDC. Comparison of line commutated converter (LCC) link and voltage source converter (VSC) link.
2. **Analysis of HVDC converters and HVDC system control:** Pulse number, choice of converter configuration – simplified analysis of Graetz circuit – converter bridge characteristics – characteristics of a twelve pulse converter- detailed analysis of converters. General principles of DC link control – converter control characteristics – System control hierarchy – firing angle control – Current and extinction angle control – generation of harmonics and filtering – power control – higher level controllers.
3. **Multiterminal DC systems and harmonics:** Introduction – potential applications of MTDC systems – types of MTDC systems – control and protection of MTDC systems – study of MTDC systems- parallel operation of AC and DC transmission. Harmonics on AC and DC sides – filters
4. **Power flow analysis in AC/DC systems:** Per unit system for DC quantities – modeling of DC links – solution of DC load flow – solution of AC-DC power flow – case studies.
5. **Stability analysis of HVDC systems:** Introduction – system simulation tools – modeling of HVDC systems for digital dynamic simulation – dynamic interaction between DC and AC systems.– inclusion of HVDC model in small signal stability (SSS) algorithm – inclusion of HVDC model in transient stability algorithm and voltage stability analysis.

Prerequisite Course: None

Reference Books:

1. "HVDC Power Transmission Systems: Technology and System Interactions", Padiyar, K. R., New Age International, 1990.
2. "High Voltage Direct Current Transmission (No. 29)", Arrillaga, J., IET – Technology and Engineering, 1998.
3. "Power System Stability and Control (Vol. 7)", Kundur, P. N. J. Balu, & M. G. Lauby (Eds.), McGraw-Hill, New York 1994.
4. "Power Transmission by Direct Current", Uhlmann, E., Springer Science & Business Media, 2012.
5. "HVDC Transmission: Power Conversion Applications in Power Systems", Kim, C. K., Sood, V. K., Jang, G. S., Lim, S. J., & Lee, S. J., John Wiley & Sons, 2009.
6. "Flexible Power Transmission: The HVDC Options", Arrillaga, J., Liu, Y. H., & Watson, N. R., John Wiley & Sons, 2007.

UE18EE542:
VLSI ARCHITECTURE AND DESIGN METHODOLOGIES (3-0-2-0-4)

Course Objectives:

- To understand the basic construction, design, synthesis and simulation of logic devices using VLSI design methodologies.

Course Outcomes:

- To give an insight to the students about the significance of CMOS technology and fabrication process.
- To teach the importance and architectural features of programmable logic devices.
- To introduce the ASIC construction and design algorithms
- To teach the basic analog VLSI design techniques.
- To study the Logic synthesis and simulation of digital system with Verilog HDL.

Course Content:

1. **CMOS Design:** Overview of digital VLSI design Methodologies-Logic design with CMOS-transmission gate circuits-Clocked CMOS-dynamic CMOS circuits, Bi-CMOS circuits- Layout diagram, Stick diagram-IC fabrications – Trends in IC technology.
2. **Programmable Logic Devices:** Programming Techniques-Anti fuse-SRAM-EPROM and EEPROM technology – Re- Programmable Devices Architecture- Function blocks, I/O blocks,Interconnects, Xilinx- XC9500,Cool Runner – XC-4000,XC5200, SPARTAN, Virtex – Altera MAX 7000-Flex 10Kstratix.
3. **Basic Construction, Floor Planning, Placement and Routing:** System partition – FPGA partitioning – Partitioning methods-floor planning – placementphysical design flow – global routing – detailed routing – special routing- circuit extraction – DRC.**Analog VLSI Design: Introduction to analog VLSI- Design of** CMOS 2stage-3 stage Op-Amp – High Speed and High frequency op-amps-Super MOS-Analog primitive cells-realization of neural networks.
4. **Logic Synthesis and Simulation:** Overview of digital design **with Verilog HDL, h**ierarchical odeling concepts, modules and port definitions, gate level odeling, data flow odeling, behavioural odeling, task & functions, Verilog and logic synthesis-simulation-Design examples,Ripple carry Adders, Carry Look ahead adders, Multiplier, ALU, Shift Registers, Multiplexer, Comparator, Test Bench.

Prerequisite Course: None

Reference Books:

1. M.J.S Smith, "Application Specific Integrated Circuits", Addition Wesley Longman Inc., 1997.
2. "Essentials of VLSI Circuits and System", Kamran Eshraghian, Douglas A. Pucknell and Sholeh Eshraghian, Prentice Hall India, 2005.
3. "Modern VLSI Design", Wayne Wolf, Prentice Hall India, 2006.
4. "Analog VLSI Signal and Information Processing", Mohamed Ismail, Terri Fiez, McGraw Hill International,1994.
5. "VeriLog HDL, A Design Guide to Digital and Synthesis", Samir Palnitkar, 2nd Edition,Pearson, 2005.
6. "Chip Design for Submicron VLSI cmos Layout and Simulation", John P. Uyemera, Cengage Learning India Edition, 2011.

UE18EE551:
FACTS CONTROLLERS (4-0-0-0-4)

Course Objectives:

- To introduce the reactive power control techniques
- To educate on static VAR compensators and their applications
- To provide knowledge on Thyristor controlled series capacitors
- To educate on STATCOM devices
- To provide knowledge on FACTS controllers

Course Outcomes:

At the end of the course, the student will be able to:

- Compare various types of FACT controller.
- Design STATIC VAR compensation to power system.
- Design Series compensation to power system using thyristors and GTOs
- Identify appropriate power devices and converter topologies for implementation of FACTS controller.
- Understand the coordination between the FACTS controllers

Course Content:

1. **Introduction**: Review of basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission linePassive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.
2. **Static var Compensator (SVC)**: Configuration of SVC- voltage regulation by SVC- Modelling of SVC for load flow analysis-Modelling of SVC for stability studies-Design of SVC to regulate the mid-point voltage of a SMIB system- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.
3. **Thyristor and GTO Thyristor Controlled Series Capacitors (TCSC and GCSC)**: Concepts of Controlled Series Compensation – Operation of TCSC and GCSC- Analysis of TCSC-GCSC – Modelling of TCSC and GCSC for load flow studies- modeling TCSC and GCSC for stability studied- Applications of TCSC and GCSC.
4. **Voltage Source Converter based Facts Controllers**: Static synchronous compensator(STATCOM)- Static synchronous series compensator(SSSC)- Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC- Modeling of STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline power flow controllers(UPFC and IPFC)-Modeling of UPFC and IPFC for load flow and transient stability studies- Applications.
5. **Controllers and their co-Ordination**: FACTS Controller interactions – SVC–SVC interaction – co-ordination of multiple controllers using linear control techniques – Quantitative treatment of control coordination.

Prerequisite Course: None

Reference Books

1. **"**Thyristor-based FACTS Controllers for Electrical Transmission Systems", Mathur, R. M., & Varma, R. K., John Wiley & Sons, 2002.
2. "FACTS Controllers in Power Transmission and Distribution", K. R.Padiyar, New Age International (P) Ltd., Publishers, New Delhi, 2008.
3. "Flexible AC Transmission System", A.T.John, Institution of Electrical and Electronic Engineers (IEEE), 1999.
4. "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Narain G.Hingorani, Laszio. Gyugyl, IEEE Press, NY, 2000.
5. **"**HVDC and FACTS Controllers: Applications of Static Converters in Power Systems", Sood, V. K., Springer Science & Business Media, 2004.

UE18EE552:
FPGA ARCHITECTURE AND APPLICATIONS (3-0-2-0-4)

Course Objectives:

- Familiarization of various complex programmable logic devices of different family.
- To study Field programmable gate arrays and realization techniques
- Learning Different case studies using one hot case method.

Course Outcomes:

At the end of the course the student will be able to:

- Will be able to learn PLDs, FPGA design and architecture.
- Should be able to understand different types of arrays.
- FSM and different FSM techniques like petrinets and different case studies.

Course Content:

1. **Programmable Logic**: ROM, PLA, PAL, PLD, PGA – Features, programming and applications usingcomplex programmable logic devices Altera series – Max 5000/7000 series and Altera FLEX logic –10000 series CPLD, AMD's – CPLD (Mach 1 to 5); Cypres FLASH 370 Device Technology, Lattice pLSI's Architectures – 3000 Series – Speed Performance and in system programmability.
2. **FPGAs:** Field Programmable Gate Arrays – Logic blocks, routing architecture, Design flow,Technology Mapping jfor FPGAs, Case studies – Xilinx XC4000 & ALTERA's FLEX 8000/10000 FPGAs: AT & T – ORCA's (Optimized Reconfigurable Cell Array): ACTEL's – ACT-1,2,3 and their speed performance.
3. **Finite State Machines (FSM):** Top Down Design – State Transition Table, state assignments for FPGAs. Problem of initial state assignment for one hot encoding. Derivations of state machinecharges. Realization of state machine charts with a PAL. Alternative realization for state machine chart suing microprogramming. Linked state machines. One – Hot state machine, Petrinetes for state machines – basic concepts, properties. Extended petrinetes for parallel controllers. Finite State Machine – Case Study, Meta Stability, Synchronization.
4. **FSM Architectures and Systems Level Design:** Architectures centered around non-registered PLDs.State machine designs centered around shift registers. One – Hot design method. Use of ASMs in One– Hot design. K Application of One – Hot method. System level design – controller, data path and functional partition.
5. **Digital Front End Digital Design Tools for FPGAs & ASICs:** Using Mentor Graphics EDA Tool ("FPGA Advantage") – Design Flow Using FPGAs – Guidelines and Case Studies of parallel adder cell, paraller adder sequential circuits, counters, multiplexers, parallel controllers.

Prerequisite Course: None

Reference Books:

1. "Digital Design Using Field Programmable Gate Array", P. K. Chan & S. Mourad, Prentice Hall, 1994.
2. "Field Programmable Gate Array Technology", S.Trimberger, Kluwer Academic Publications, 1994.
3. "Field Programmable Gate Arrays", J. Old Field, R.Dorf, John Wiley & Sons, New York, 1995.

UE17EE611:
MODELING AND ANALYSIS OF ELECTRICAL MACHINES (2-0-0-0-2)

Course Objectives:

- To arrive at the models for different electrical machines
- To analyse machine behavior for different inputs
- To simulate the developed models in software and verify machine behavior
- To apply the models as part of a larger system

Course Outcomes:

At the end of the course, the student will be able to

- Model different electrical machines based on their mathematical equations
- Simulate the models developed in a software environment and predict machine behavior
- Be able to apply the knowledge gained, in designing controllers
- Use the knowledge as a basis for experimental work on larger systems

Course Content:

1. **Transformer Modeling:** Introduction, single phase transformer model, three phase transformer connections, per phase analysis, normal systems, per unit normalization, per unit three phase quantities, change of base, per unit analysis.Regulating transformers for voltage and phase-angle control.Auto-transformers and special transformers, transmission lines.

   Generalised machine modeling: Speed and transformer e.m.fs. Kron's primitive machine: voltage, current and torque equations. Basic two pole machine representation of commutator machines, 3-phase synchronous machine with and without damper bar and 3-phase induction machine.

   DC Machine modeling: Mathematical model of separately excited DC motor-steady state and transient state analysis, sudden application of inertia load, transfer function of separately excited DC motor, mathematical model of dc series motor, shunt motor, linearization techniques for small perturbations.
2. **Reference Frame Theory:** Real time model of a two phase induction machine, transformation to obtain constant matrices, three-phase to two-phase transformation, power equivalence.
3. **Dynamic Modeling of Three Phase Induction Machine:** Generalized model in arbitrary frame, electromagnetic torque, deviation of commonly used induction motor models-stator reference frames model, rotor reference frames model, synchronously rotating reference frames model, equations in flux linkages, per unit model.

   Small Signal Equations of the Induction Machine: Derivation of small signal equations of induction machine, space phasor model, DQ flux linkages model derivation, control principle of the induction motor.
4. **Modeling of Synchronous Machines:** Introduction, voltage equations and torque equation in machine variables, stator voltage equations in arbitrary and rotor reference frame variables, Park's equations, torque equations in substitute variables, rotor angle and angle between rotors, per unit system, analysis of steady state operation.
5. **Dynamic Analysis of Synchronous Machines:** Dynamic performance during sudden change in input torque and during a 3-phase fault at the machine terminals, approximate transient

torque versus rotor angle characteristics, comparison of actual and approximate transient torque-angle characteristics during a sudden change in input torque; first swing transient stability limit, comparison of actual and approximate transient torque-angle characteristics during a 3-phase fault at the machine terminals, critical clearing time, equal area criterion

Prerequisite Course: None

Reference Books:

1. "Generalized Theory of Electrical Machines", P.S.Bimbra, 5th Edition, Khanna Publications, 1995.
2. "Electric Motor Drives – Modeling, Analysis & Control", R. Krishnan, PHI Learning Private Ltd., 2009.
3. "Analysis of Electrical Machinery and Drive Systems", P.C. Krause, Oleg Wasyncżuk, Scott D.Sudhoff, 2nd Edition, Wiley (India), 2010.
4. "Power System Analysis", Arthur R Bergen and Vijay Vittal, 2nd Edition, Pearson, 2009.
5. "Power System Stability and Control", Prabha Kundur, TMH, 2010.
6. "Dynamic Simulation of Electric Machinery using Matlab / Simulink", Chee-MunOng, Prentice Hall, 1998.

UE17EE612: POWER ELECTRONICS IN RENEWABLE ENERGY AND TRANSPORTATION SYSTEMS (2-0-0-0-2)

Course Objectives:

- To learn the state of the art global expertise on power electronics and its application in transportation, renewable energy and different industrial applications
- To learn and understand the existing technology and future trends of suitable converters in renewable energy and transportation

Course Outcomes:

- Ability to identify the challenging practical projects in research of renewable energy
- Ability to identify and design suitable converters based on the market and industry demand
- Capacity to analyze and examine the control aspects in renewable energy systems
- Ability to differentiate various electric vehicles and charging infrastructure systems in transportation application

Course Content:

1. **Challenges of the Current Energy Scenario & the Power Electronics Contribution:** Introduction, Energy Transmission and Distribution Systems, Renewable Energy Systems, Transportation Systems, Energy Storage Systems.
2. **A New Class of Power Converters for Renewable Energy and Transportation:** Introduction, Hard Switching ac-Link Universal Power Converter, Soft Switching ac-link, Universal Power Converter, Principle of Operation of the Soft Switching ac-Link Universal Power Converter, Design Procedure, Analysis, Applications.
3. **High Power Electronics: Key Technology for Wind Turbines& Photovoltaic Energy Conversion Systems:** Introduction, Development of Wind Power Generation, Wind Power Conversion, Power Converters for Wind Turbines, Power Semiconductors for Wind Power Converter, Controls and Grid Requirements for Modern Wind Turbines, Emerging Reliability Issues for Wind Power System, Power Curves and Maximum Power Point of PV Systems, Grid-Connected PV System Configurations, Control of Grid-Connected PV Systems, Recent Developments in Multilevel Inverter-Based PV Systems.
4. **Controllability Analysis of Renewable Energy Systems:** Introduction, Zero Dynamics of the Nonlinear System, Controllability of Wind Turbine Connected through L Filter to the Grid, Controllability of Wind Turbine Connected through LCL Filter to the Grid, Controllability and Stability Analysis of PV System Connected to Current Source Inverter, Conclusions.
5. **Electric and Plug-In Hybrid Electric Vehicles:** Introduction, Electric, Hybrid Electric and Plug-In Hybrid Electric Vehicle Topologies, EV and PHEV Charging Infrastructures, Power Electronics for EV and PHEV Charging Infrastructure , Vehicle-to-Grid (V2G) and Vehicle-to-Home (V2H) Concepts, Power Electronics for PEV, Charging.

Prerequisite Course: None

Reference Books:

1. "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications", Abu-Rub, H., Malinowski, M., & Al-Haddad, K., John Wiley & Sons, 2014.
2. "Advanced Electric Drive Vehicles", Emadi, A. (Ed.), CRC Press, 2014.

UE17EE613: DIGITAL SIGNAL PROCESSORS AND ITS ARCHITECTURE (2-0-0-0-2)

Course Objectives:

- To impart the knowledge of basic DSP filters and number systems to be used different types of A/D, D /A conversion errors.
- To gain concepts of digital signal processing techniques, implementation of DSP & FFT algorithms and also to learn about interfacing of serial & parallel communication devices to the processor.

Course Outcomes:

At the end of the course the student will be able to:

- Comprehend the knowledge & concepts of digital signal processing techniques, basic building blocks, and implementation of DSP & FFT algorithms.
- Programme the DSP TMS320 series PROCESSOR and decimation interpolation filters, adaptive filters.
- Learn about interfacing of memory and I/O devices to the processor.

Course Content:

1. **Introduction**: Introduction, Digital signal-processing system, The sampling process, Discrete time sequences. Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear time-invariant systems, Digital filters, Decimation and interpolation, Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/ A Conversion Errors.
2. **Architectures for Programmable DSP Devices**: Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Hardware looping, Interrupts, Stacks, Relative Branch support, Pipelining and Performance, Pipeline Depth, Interlocking, Branching effects, Interrupt effects, Pipeline Programming models.

3. **Programmable Digital Signal Processors**: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320 series DSPs, Data Addressing modes of TMS320 series Processors, Memory space of TMS320 series Processors, Program Control, TMS320 series instructions and Programming, On-Chip Peripherals, Interrupts of TMS320 series processors, Pipeline Operation of TMS320 series Processors.
4. **Implementations of Basic DSP Algorithms**: The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit Reversed index generation, An 8-Point FFT implementation on the TMS320 series, Computation of the signal spectrum.
5. **Interfacing Memory and I/O Peripherals to Programmable DSP Devices**: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA). A Multichannel buffered serial port (McBSP), McBSP Programming, a CODEC interface circuit, CODEC programming, A CODEC-DSP interface example.

Prerequisite Course: None

Reference Books:

1. "Digital Signal Processing", Avtar Singh and S. Srinivasan, Thomson Publications, 2004.
2. "DSP Processor Fundamentals, Architectures & Features", Phil Lapsley, Jeff Bier, Amit Shoham, Edward A. Lee, S. Chand & Co., 2000
3. "Digital Signal Processors, Architecture, Programming and Applications", B. Venkata Ramani and M. Bhaskar, TMH. 2004.
4. "Digital Signal Processing", Jonatham Stein, John Wiley, 2000.

UE17EE614: DATA COMMUNICATIONS (2-0-0-0-2)

Course Objectives:

- To discuss the digital data communication techniques
- Gain knowledge on basic concepts of data communication layers, protocols and performance
- Understand a few representative protocols and network components
- To introduce the functions of different layers from deployed examples
- To introduce standards employed in computer networking
- To introduce the fundamentals of security in data communication

Course Outcomes:

At the end of the course the students will be able to:

- Describe the hardware and software commonly used in data communications
- Analyse the services and features of various layers of data networks
- Design, implement and analyze simple networks that need data communication.
- Analyze the features and operations of application protocols like TCP/UDP, FTP, HTTP etc.
- Have read a couple of published papers and appreciate the contemporary issues and solution in area of data communication

Course Content:

1. **Introduction to Data Communications**: Data Communication system components, Networks models, Protocols and Standards, Physical layer and media: Analog and Digital signals, Transmission impairment, Data rate limits and performance, Digital Transmission using coding schemes, Analog to digital conversion, Transmission modes, Digital to Analog conversion using shift keying, Analog to Analog conversions using modulation, Multiplexing and spectrum, Switching: Circuit switching, Datagram networks, Telephone network, Cable TV networks
2. **Data Link Layer**: Error Detection and Correction, Data link control: Framing, Flow and error control, Noiseless and Noisy channel, Stop-and-wait ARQ, Go-Back-N ARQ, Selective Repeat ARQ, HDLC and configuration, transfer modes and control, Point to Point Protocol – Multiple Access: Random Access, Controller Access and Channelisation, Wireless LAN: IEEE802.11, Bluetooth.
3. **Network and Transport Layer**: Delivery, Forwarding and Routing, Network Layer protocols, Transport layer: Process to Process delivery, UDP, TCP, Congestion control, QoS
4. **Presentation layer** – Translation – Encryption / Decryption, Substitution and transposition Ciphers, Data Encryption Standards (DES), Public key cryptography, Authentication.
5. **Application layer**: Domain Name System (DNS), Electronic Mail, File Transfer, WWW and HTTP

Prerequisite Course: None

Reference Books:

1. "Data Communications and Networking", Behrouz A. Forouzan, Tata McGraw-Hill, 4th Edition, 2007.
2. "Computer Networks", A. S. Tannenbum, D. Wetherall, Prentice Hall, Pearson 5th Edition, 2011.
3. "Data and Computer Communications', William Stallings, Prentice Hall, Pearson, 8th Edition, 2007.
4. "Data Communications and Networking", White, Cengage Learning, 2008.

UE17EE615: POWER QUALITY (2-0-0-0-2)

Course Objectives:

- To study the production of voltages sags, overvoltage and harmonics and methods of control. To study various methods of power quality monitoring.

Course Outcomes:

At the end of this course students would be able to

- Understand the basic concepts of power quality and various causes of power quality issues in power system.
- Understand the various sources of sag and its mitigation methods
- Understand sources of over voltages and how to implement computer analysis power quality issues
- Understand the effect of harmonics on various loads and its mitigation techniques
- Understand the various power quality monitoring devices

Course Content:

1. **Introduction to Power Quality:** Terms and definitions: Overloading – under voltage – over voltage. Concepts of transients – short duration variations such as interruption – long duration variation such as sustained interruption. Sags and swells – voltage sag – voltage swell – voltage imbalance –

voltage fluctuation – power frequency variations. International standards of power quality. Computer Business Equipment Manufacturers Associations (CBEMA) curve.

2. **Voltage Sags and Interruptions:** Sources of sags and interruptions – estimating voltage sag performance. Thevenin's equivalent source – analysis and calculation of various faulted condition. Voltage sags due to induction motor starting. Estimation of the sag severity – mitigation of voltage sags, active series compensators. Static transfer switches and fast transfer switches.
3. **Overvoltages**: Sources of over voltages – Capacitor switching – lightning – Ferro resonance. Mitigation of voltage swells – surge arresters – low pass filters – power conditioners. Lightning protection – shielding – line arresters – protection of transformers and cables. An introduction to computer analysis tools for transients, PSCAD and EMTP.
4. **Harmonics**: Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics – Harmonics Vs transients. Effect of harmonics – harmonic distortion – voltage and current distortion – harmonic indices – inter harmonics – resonance. Harmonic distortion evaluation – devices for controlling harmonic distortion – passive and active filters. IEEE and IEC standards.
5. **Power Quality Monitoring**: Monitoring considerations – monitoring and diagnostic techniques for various power quality problems – modeling of power quality (harmonics and voltage sag) problems by mathematical simulation tools – power line disturbance analyzer – quality measurement equipment – harmonic / spectrum analyzer – flicker meters – disturbance analyzer. Applications of expert systems for power quality monitoring.

Prerequisite Courses: None

Reference Books:

1. "Electric Power System Quality", Dugan, R. C., McGranaghan, M. F., Santoso, S., & Beaty, H. W., McGraw Hill Education, 3rd Edition, 2012.
2. "Electric Power Quality", Heydt, G. T., Stars in Circle Publications, 1991.
3. Bollen, M. H. "Understanding Power Quality Problems (Vol. 3)", IEEE Press, New York, 2000.
4. "Power System Quality Assessment", Arrillaga, J., Watson, N. R., & Chen, S., Wiley, 2000.
5. PSCAD User Manual, Manitoba Research Center, 2005.

UE17EE616:
POWER SYSTEM RELIABILITY (2-0-0-0-2)

Course Objectives:

- Understand the reliability processes and reliability measures
- To perform reliability analysis of Generators and transmission systems models through analytical ways
- To learn system modes of failures through reliability study

Course Outcomes:

At the end of the course the student will be able to:

- Acquire the skills to perform reliability analysis of the power system such as generators, transmission lines etc.
- Introduce the Objectives of Load forecasting
- Study the fundamentals of Generation system, transmission system and Distribution system reliability analysis
- Illustrate the basic concepts of Expansion planning

Course Content:

1. **Load Forecasting:** Objectives of forecasting – Load growth patterns and their importance in planning – Load forecasting Based on discounted multiple regression technique-Weather sensitive load forecasting-Determination of annual forecasting-Use of AI in load forecasting.
2. **Generation System Reliability Analysis:** Probabilistic generation and load models- Determination of LOLP and expected value of demand not served –Determination of reliability of ISO and interconnected generation systems.
3. **Transmission System Reliability Analysis:** Deterministic contingency analysis-probabilistic load flow-Fuzzy load flow probabilistic transmission system reliability analysis-Determination of reliability indices like LOLP and expected value of demand not served.
4. **Expansion Planning:** Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.
5. **Distribution System Planning Overview:** Introduction, sub transmission lines and distribution substations-Design primary and secondary systems-distribution system protection and coordination of protective devices.

Prerequisite Courses: None

Reference Books

1. "Reliability Evaluation of Engineering Systems" Billinton, R., & Allan, R. N., Plenum Press, New York, 1992 (pp. 155-173).
2. "Power System Planning", Sullivan, R. L, Tata McGraw Hill Publishing, 1977.
3. "Modern Power System Planning", Wang, X., & McDonald, J. R., McGraw-Hill Companies, 1994.
4. "Electric Power Distribution System Engineering", Gönen, T., (p. 46Á). New York: McGraw-Hill, 1986.

UE17EE621:
MODELING, DESIGN AND SIMULATION OF POWER ELECTRONIC SYSTEMS (2-0-0-0-2)

Course Objectives:

- To arrive at the models for various power converters
- To learn the design aspects of digital controllers
- To design & simulate closed loop power electronic systems

Course Outcomes:

At the end of the course, the student will be able to

- Model power converters based on their mathematical equations.
- Gain better insight into digital controller design
- Design & simulate closed loop power electronic systems

Course Content:

1. **Computer Simulation of Power Electronic Converters and Systems:** Challenges in computer simulation, simulation process, Types of analysis, mechanics of simulation, circuit-oriented simulators, equation solvers, comparison of circuit oriented simulators and equation solvers.
2. **Modelling of Systems:** Input-Output relations, differential equations and linearization, state space representation, transfer function representation, modeling of an armature controlled DC Motor, poles and zeros circuit averaging method of modelling approach for switched power electronic circuits.

3. **Digital Controller Design:** Controller design techniques, Bode diagram method, PID controller, design, root locus method, state space method. Tracker, controller design, controlling voltage, controlling current.
4. **Discrete Computation Essentials:** Numeric formats, fixed –point numeric format, floating –point numeric format, tracking the base point in the fixed point system, addition of numbers, subtraction of numbers, multiplication of numbers, normalization and scaling, multiplication algorithm, arithmetic algorithm reciprocal, square root, reciprocal of square root, sine and cosine exponential, logarithm.
5. **Design & Simulation of Closed Loop Systems**: Closed loop control of buck, boost & buck-boost converters using analog & digital controllers.

Reference Books:

1. "Power Electronics: Converters, Applications, and Design", Mohan, N., & Undeland, T. M., John Wiley & Sons, 2007.
2. "Power Electronics Essentials and Applications", Umanand, L., 1st Edition, New York, NY, Wiley Publishers, 2009.
3. "Fundamentals of Power Electronics", Erickson, R. W., & Maksimovic, D. Springer Science & Business Media, 2007.

UE17EE622: CONTROLLERS FOR POWER ELECTRONIC SYSTEMS (2-0-0-0-2)

Course Objectives:

- To introduce the Ics used for regulator control and PWM control.
- To introduce transducers for sensing
- To introduce protection circuits and low power integrated power modules
- To introduce programmable Digital control Ics for power electronic systems

Course Outcomes:

At the end of the course, the student will be able to:

- Design measurement systems to sense voltage, current, speed etc.
- Design a complete power electronic system based on analog or digital controllers
- Work with a variety of programmable controller/processor types

Course Content:

1. **Transducers in Power Electronics**: Measurement techniques for voltages, current, power, power factor in power electronic circuits, other recording and analysis of waveforms, sensing of speed, Switching Regulator Control Circuits –isolation techniques of switching regulator systems, PWM systems.
2. **Commercial PWM Control ICS and Their Applications**: TL 494 PWM Control IC, UC 1840 Programmable off line PWM controller, UC 1524 PWM control IC, UC 1846 current mode control IC, UC 1852 resonant mode power supply controller.
3. **Drive and Protection Circuits**: Introduction, Opto-couplers, self-biased techniques used in primary side of reference power supplies, Soft/Start in switching power supplies, current limit circuits, over voltage protection. IPMs for low and medium power circuits
4. **Programmable Logic Controllers (PLC)**: Basic configuration of a PLC, Programming and PLC, program modification, power converter control using PLCs.
5. **Digital Controllers for Power Electronics:** Introduction, DSP controllers for drives. Analog to Digital converters, sampling. Essentials of digital control. FPGA and PsoC controllers.

Prerequisite Course: None

Reference Books:

1. "Thyristorised Power Controllers", G. K. Dubey, S. R. Doradla, A. Johsi, and R. M. K. Sinha, 2nd Edition, New Age International, 2010.
2. Chryssis, "High Frequency Switching Power Supplies", 2nd Edition, MGH, 1989.
3. Unitrode Application notes: http://www.smps.us/Unitrode.html
4. "Texas Instruments\Spartan Application Notes.

UE17EE623: DIGITAL IMAGE PROCESSING (2-0-0-0-2)

Course Objectives:

- To introduce techniques and tools for digital image processing.
- To introduce image analysis techniques in the form of image segmentation.
- To develop on-hand experience in applying tools to process images.
- To develop engineering skills and intuitive understanding of the tools used in Image Processing.

Course Outcomes:

At the end of the course, the student will be able to

- Describe different modalities and current techniques in image acquisition
- Describe how digital images are represented and stored efficiently depending on the desired quality, color depth, dynamics
- Use the mathematical principles of digital image enhancement
- Describe and apply the concepts of feature detection and contour finding algorithms.
- Analyze the constraints in image processing when dealing with larger data sets (efficient storage and compression schemes)

Course Content:

1. **Introduction**: Examples of fields that use digital image processing, fundamental steps in digital image processing, components of image processing system. Digital Image Fundamentals: Light and the Electromagnetic Spectrum, Image sensing and Acquisition, A simple image formation model, Image sampling and Quantization, basic relationships between pixels.
2. **Image enhancement in the spatial domain**: Basic gray-level transformation, histogram processing, enhancement using arithmetic and logic operations, basics of spatial filtering, smoothing and sharpening spatial filters, combining the spatial enhancement methods. Image enhancement in the frequency domain Introduction to the Fourier transform and the frequency domain, Smoothing and sharpening frequency-domain filters, homomorphic filtering, Implementation.
3. **Image restoration**: A model of the image degradation/ restoration process, noise models, restoration in the presence of noise–only spatial filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the degradation function, Inverse Filtering, Weiner filtering, Constrained least squares filtering. Image Compression Types of redundancies, Encoder-Decoder

model, Lossy and Lossless compression, Entropy of an information source, Variable Length Coding,Huffman Coding, Arithmetic Coding, LZW coding, Transform coding, Sub-image size selection, blocking artifacts, DCT implementation using FFT, Run length coding, Bit-plane encoding, Bit-allocation, Zonal Coding, Threshold Coding, JPEG,Lossless predictive coding, Lossy predictive coding, Motion Compensation.

4. **Wavelet based Image Compression:** Expansion of functions, Multi-resolution analysis, Scaling functions, MRA refinement equation, Wavelet series expansion, Discrete Wavelet Transform (DWT), Continuous Wavelet Transform, Fast Wavelet Transform, 2-D wavelet Transform, JPEG-2000 encoding, Digital Image Watermarking.
5. **Morphological Image Processing:** Preliminaries, Dilation and Erosion, Opening and closing, hit or miss transformation, basic morphologic algorithms. Image Segmentation Detection of discontinuous, edge linking and boundary detection, thresholding, region–based segmentation, segmentation by Morphological Watersheds.

Prerequisite Course: None

Reference Book:

1. "Digital Image Processing", Gonzalez, R. C.,Pearson Education India, 2009.

UE17EE624: DIGITAL VLSI SYSTEM DESIGN AND ITS IMPLEMENTATION USING VERILOG (2-0-0-0-2)

Course Objectives:

1. To understand the Arithmetic Design concepts and coding using verilog.
2. Learn the ability to Develop and Verify the algorithms using High level Language
3. To provide the students insight of design and analysis of architecture.
4. Get an Hands on of FPGA in Implementation of some architectures and applications.

Course Outcomes:

At the end of the course the student will be able to:

1. Design and Code Serial Adder, Parallel Signed Adder, Multiplier, DCTQ- IQIDCT, PCI Bus Arbiter etc for any FPGA based projects.
2. Model the DCTQ Processor for different applications.
3. Implement Traffic Light Controller and Real Time Clock using FPGA.

Course Content:

1. **Arithmetic Circuit Designs:** Digital Pipelining, Partitioning of a Design, Partition of Data Width, Partition of Functionality, Signed Adder Design, Signed Serial Adder, Parallel Signed Adder Design, Multiplier Design and Verilog Code for Multiplier Design.
2. **Development of Algorithms and Verification Using High Level Languages:** 2D-Discrete Cosine Transform and Quantization, Algorithm for Parallel Matrix Multiplication for DCTQ, Verification of DCTQ –I QIDCT Processes with Fixed Pruning Level Control Using Matlab, Automatic Quality Control Scheme for Image, Algorithm for Assessing Image Quality, Automatic Pruning Level Control Incorporated, Assessment of Direction of Motion of Image, Results and Discussions of FOSS Motion Estimation Algorithm.
3. **Architectural Design:** Architecture of Discrete Cosine Transform and Quantization, Architecture of a Video Encoder Using Automatic Quality Control Scheme and DCTQ Processor, The Automatic Quality Controller, Architecture for the FOSS Motion Estimation Processor.
4. **Project Design:** PCI Bus Arbiter, Design of PCI Arbiter, Verilog Code for PCI Arbiter Design, Test Bench for the Functional Testing of PCI Arbiter, Simulation Results, Synthesis Results for PCI Arbiter, Design of the DCTQ Processor,
5. **Hardware Implementations Using FPGA and I/O Boards:** FPGA Board Features, Features of Digital Input/output Board, Problem on Some FPGA Boards and Its Solution, Verilog Code to Solve the Malfunctioning of System Using XC4000 Series FPGA Boards.

   Traffic Light Controller Design: Verilog RTL Code, Test bench, Simulation, synthesis test results and Hard ware set up for Traffic Light Controller.

   Real Time Clock Design: Verilog RTL Code, Test bench, Simulation, synthesis test results and Hard ware set up for Real Time Clock.

Prerequisite Course: None

Reference Books

1. "Digital VLSI System Design", Dr. Seetharaman Ramachandran, Springer, 2007.
2. "Digital Logic Design using Verilog", Taraate & Vaibbhav, Springer, 2016.
3. "A Verilog HDL Primer", J. Bhasker, Star Galaxy Publishing, 1999.

UE17EE625: SCADA AND DCS (2-0-0-0-2)

Course Objectives:

- To deal with the communication protocols and control of power systems using EMS.
- To introduce the role of Computers and Communication in Electrical Power Engineering
- To provide an introductory knowledge on Energy Management, and power system automation using DCS and SCADA.

Course Outcomes:

At the end of the course, the student will be able to

- Understand the need for energy management and apply energy management programs
- Appreciate the need for Automation systems and its working
- Understand PLCs and DCS
- Analyse the importance of SCADA in power systems

Course Content:

1. **Energy Management System:** The Need for Energy Management, Energy Basics for Energy Managers, Designing an Energy Management Program, Starting an Energy Management Program, Energy Management Centers and their Functions, Architectures.
2. **Automation systems**: Automation systems and its advantages, Components of process control systems, Single loop control, Centralized control, Distributed control systems, Open systems, SCADA systems. Types of data available, Data communication components and protocols.

3. **Distributed Control Systems (DCS):** Programmable Logic Controllers (PLC) Functional description, PLC Vs DCS systems, DCS architecture, Local control units, dedicated card controllers, Unit Operations controllers, DCS multiplexers, DCS system integration, Automation Standards, salient features. SCADA master station configurations, hardware and software components, Communication systems, Human Machine interface. SCADA application functions, Intelligent Electronic devices.
4. **Supervisory Control and Data Acquisition**: Introduction to Supervisory Control and Data Acquisition. SCADA Functional requirements and Components. General features, Functions and Applications, Benefits. Configurations of SCADA, RTU (Remote Terminal Units) Connections.
5. **SCADA in Power System**: SCADA in Power System Automation. SCADA Communication requirements. Practical PLC, DCS and SCADA applications

Prerequisite Courses: None

Reference Books:

1. "Guide to Energy Management", Capehart, B. L., Turner, W. C., & Kennedy, W. J., The Fairmont Press Inc., 2006.
2. "Instrumentation in the Processing Industries", Lipták, B. G., Chilton Book Company. 1973.
3. "Fundamentals of Supervisory Systems", IEEE Tutorial, 1991.
4. "Programmable Logic Controllers: Principles and Applications", Webb, J. W., & Reis, R. A., Prentice Hall PTR, 1998.

UE17EE626: RESTRUCTURED POWER SYSTEMS (2-0-0-0-2)

Course Objectives:

- To understand the issues in electric utilities restructuring
- To know the electric utility markets in the US
- To understand the functionality of OASIS
- To understand the concepts involved in energy trading and pricing

Course Outcomes:

At the end of the course, the student will be able to

- Analyse the restructuring models and understand the market operations
- Understand the utility markets in California and New York
- Understand the functionality, architecture and implementation of OASIS
- Analyse the need for energy trading and portfolio management
- Have a knowledge on Volatility, Risk and Forecasting with respect to energy pricing

Course Content:

1. **Overview of Key Issues in Electric Utilities Restructuring**: Restructuring Models: PoolCo Model, Bilateral Contracts Model, Hybrid Model - Independent System Operator (ISO): The Role of ISO - Power Exchange(PX): Market Clearing Price (MCP) - Market operations: Day-ahead and Hour-Ahead Markets, Elastic and Inelastic Markets - Market Power - Stranded costs - Transmission Pricing: Contract Path Method, The MW-Mile Method - Congestion Pricing: Congestion Pricing Methods, Transmission Rights - Management of Inter Zonal/Intra Zonal Congestion: Solution procedure, Formulation of Inter-Zonal Congestion Sub problem, Formulation of Intra-Zonal Congestion Sub problem.
2. **Electric Utility Markets in the United States**: California Markets: ISO, Generation, Power Exchange, Scheduling Cocoordinator, UDCs, Retailers and Customers, Day-ahead and Hour-Ahead Markets, Block forwards Market, Transmission Congestion Contracts (TCCs) - New York Market: Market operations - PJM interconnection - Ercot ISO - New England ISO - Midwest ISO: MISO's Functions, Transmission Management, Transmission System Security, Congestion Management, Ancillary Services Coordination, Maintenance Schedule Coordination - Summary of functions of U.S. ISOs.
3. **OASIS: Open Access Same-Time Information System**: FERC order 889 - Structure of OASIS: Functionality and Architecture of OASIS - Implementation of OASIS Phases: Phase 1, Phase 1-A, Phase 2 - Posting of information: Types of information available on OASIS, Information requirement of OASIS, Users of OASIS - Transfer Capability on OASIS: Definitions, Transfer Capability Issues, ATC Calculation, TTC Calculation, TRM Calculation, CBM Calculation - Transmission Services - Methodologies to Calculate ATC - Experiences with OASIS in some Restructuring Models: PJM OASIS, ERCOT OASIS.
4. **Electric Energy Trading**: Essence of Electric Energy Trading - Energy Trading Framework: The Qualifying factors - Derivative Instruments of Energy Trading: Forward Contracts, Futures Contracts, Options, Swaps, Applications of Derivatives in Electric Energy Trading - Portfolio Management: Effect of Positions on Risk Management - Energy Trading Hubs - Brokers in Electricity Trading - Green Power Trading.
5. **Electricity Pricing - Volatility, Risk and Forecasting**: Electricity Price Volatility: Factors in Volatility, Measuring Volatility - Electricity Price Indexes: Case Study for Volatility of Prices in California, Basis Risk - Challenges to Electricity Pricing: Pricing Models, Reliable Forward Curves - Construction of Forward Price Curves: Time frame for Price Curves, Types of Forward Price Curves – Short-term Price Forecasting: Factors Impacting Electricity Price, Forecasting Methods, Analyzing Forecasting Errors, Practical Data Study.

Prerequisite Courses: None

Reference Books:

1. "Restructured Electrical Power Systems Operation, Trading and Volatility," Mohammad Shahidehpour and Muwaffaq Almoush, Marcel Dekkar, Inc, 2001.
2. "Deregulation of Electric Utilities", G.Zaccour, Kluwer Academic Publishers, 1998.
3. "Power Systems Restructuring: Engineering and Economics", M. Illic, F.Galiana and L.Fink, Kluwer Academic Publishers, 2000.
4. "Power System Restructuring and Deregulation: Trading, Performance and Information Technology", Loi Lei Lai (Ed.), John Wiley and Sons Ltd., 2001.
5. "Operation of Restructured Power Systems", K. Bhattacharaya, M.H.J.Bollen and J.E.Daader, Kluwer Academic Publishers, 2001.
6. "Spot Pricing of Electricity", F.C.Schweppe, M.C.Caramanis, R.D.Tabors and R.E.Bohn, Kluwer Academic Publishers, 2002.
7. "Applied Mathematics for Restructured Electric Power Systems: Optimization, Control and Computational Intelligence", J.H.Chow F.F. Wu and J.A. Momoh (Eds.), Springer 2004.

MECHANICAL ENGINEERING

B.TECH IN MECHANICAL ENGINEERING

Program Education Objectives

1. Provide students a sound knowledge of fundamentals in Mechanical Engineering and inculcate lifelong learning traits to solve real life engineering problems.
2. Develop problem solving capabilities in students to arrive at sustainable solutions to problems in mechanical engineering and allied areas with a concern for society and environment.
3. Motivate students to be ethically strong, professionally superior and acquire competence to work in a team and lead as well as become a successful entrepreneur.
4. Train students to effectively communicate in verbal and written technical information to engineering community and public in general
5. Motivate students to pursue higher education in mechanical engineering and allied areas in the top universities of the world to become globally competent.

Program Outcomes

1. **Engineering knowledge:** Apply the knowledge of mathematics, science and engineering fundamentals to solve complex problems in mechanical engineering and allied disciplines.
2. **Problem analysis:** Identify, formulate, collate research data and analyze mechanical engineering problems/issues/challenges to reach a viable solution by using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design and develop solutions to mechanical engineering problems; design mechanical system components and/or processes to meet specific customer needs considering public health and safety, cultural, societal and environmental aspects.
4. **Conduct investigations of complex problems:** Conduct investigations using fundamental engineering concepts, review of literature, experimentation, modeling and simulation techniques to analyze and interpret data to provide valid solutions.
5. **Modern tool usage:** Apply modern computing tools and techniques to model and simulate/analyze mechanical engineering problems with a clear knowledge of the assumptions and limitations involved.
6. **The engineer and society:** Apply engineering knowledge and skills to develop sustainable solutions by understanding their impact on society and environment and the effect of mechanical engineering solutions on legal, cultural, social, public health and safety aspects
7. **Environment and sustainability:** Analyze critically the impact of professional engineering solutions on the environment and demonstrate the knowledge of sustainable development.
8. **Ethics:** Attain professionally superior and ethically strong global outlook with an understanding of social responsibilities, awareness of relevant regulatory requirements and norms of engineering practice.
9. **Individual and team work:** Demonstrate an understanding of team work as a member or leader and contribute constructively towards achieving desired goals in diverse and multi-disciplinary teams.
10. **Communication:** Communicate confidently and effectively regarding mechanical engineering activities with the engineering community as well as society in general, in terms of presentations, group discussions and technical report writing adhering to appropriate standards; demonstrate an ability to give and receive clear instructions.
11. **Project management and finance:** Demonstrate ability to apply the principles of project and finance management to efficiently manage and execute mechanical engineering projects, including multi-disciplinary perspectives, while working individually as well as in teams.
12. **Life-long learning:** Demonstrate an ability to engage in life-long learning, self-sufficiently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

UE18ME101: MECHANICAL ENGINEERING SCIENCES (4-0-0-0-4)

Course Objectives:

- To enable the student to learn about the various sources of energy and how it is produced as electricity in a power plant.
- To introduce the laws of thermodynamics and teach fundamental concepts of energy conversion systems
- To introduce the concept of power transmission in machines - belt, gear and chain drives and enable them to understand the engineering treatment of such power transmission drives
- To introduce the properties and mechanical behavior of common engineering materials, concepts of stresses and strains and to equip them with the necessary skills and knowledge to solve simple problems of engineering importance
- To enable students to learn and appreciate various manufacturing processes such as casting, forming and welding and working principles of machine tools and metal cutting operations

Course Outcomes:

At the end of the course, the student will be able to

- Explain the various sources of energy and elucidate on the basic layout of power plants
- State the I and II Laws of Thermodynamics and explain the working principles of internal combustion engines, steam turbines and refrigeration plants
- Explain the working principles of power transmission systems and apply this understanding to solve simple problems
- Explain the mechanical behavior of important engineering materials, solve problems of engineering importance on simple stresses and strains
- Elucidate the various manufacturing processes and explain the working principles of machine tools and metal cutting operations

Course Content:

- **Energy:** Sources and Generation: energy & its sources – conventional & non-conventional, brief introduction to power generation and power plants
- **Thermal Energy Systems:** concepts of heat and work; laws of thermodynamics and their applications, working principles of IC engines, steam turbines, refrigeration
- **Power Transmission:** introduction, gear drives, types of gears, velocity ratio, gear trains, chain drives, belt drives
- **Engineering Materials:** classification, concepts of simple stresses and strains, mechanical properties of engineering materials, mechanical testing.
- **Manufacturing Processes, Machine Tools and Metal Cutting Operations:** principles of metal casting, joining and forming: working principles of machine tools; metal cutting operations - turning, facing, boring, thread cutting, drilling, milling, grinding

Prerequisite Course: None

Reference Books:

1. “Basic Mechanical Engineering”, Pravin Kumar, Pearson, 2013
2. “An Introduction to Mechanical Engineering – Part I”, Michael Clifford, Richard Brooks, Alan Howe, Andrew Kennedy, Stewart McWilliam, Stephen Pickering, Paul Shayer and Phillip Shipway, Hodder Education, 2009
3. “An Introduction to Mechanical Engineering – Part II”, Michael Clifford, Richard Brooks, Kwing – So Choi, Donald Giddings, Alan Howe, Thomas Hyde, Arthur Jones and Edward Williams, Hodder Education, 2010
4. “An Introduction to Mechanical Engineering”, J Wickert and K Lewis, Cengage Learning, Third Edition, 2013

UE18ME102:
ENGINEERING GRAPHICS (1-0-2-0-2)

Course Objectives:

- To introduce the concept of engineering drawing as a language and enable students to learn about the software tool to make engineering drawings
- To enable the student to learn about the concepts and principles of orthographic projections, development of lateral surfaces and isometric projection of simple solids

Course Outcomes:

At the end of the course, the student will be able to

- Use the software tool to make engineering drawings in addition to being able to do it on paper using geometric instruments
- Draw solutions, manually as well as using the software tool, to problems on
  - Orthographic projection of points, lines, planes and simple solids
  - Parallel line and radial line development of lateral surfaces of simple solids
  - Isometric projection of simple solids

Course Content:

1. Introduction to free hand sketching and Solid Edge – commands
2. Dimensioning
3. Geometrical constructions
4. Orthographic projections
5. Projection of Points and Lines
6. Projection of plane surfaces
7. Projections of Solids
8. Development of Surfaces
9. Isometric Projections

Prerequisite Course: None

Reference Books:

1. “Engineering Graphics”, K. R. Gopalakrishna, Subhas Publications, 2012.
2. Engineering Drawing, N.D.Bhatt, Charotar Publishing House, 46th Edition, 2003.
3. “Fundamental of Engineering Drawing”, Luzadder and Duff, Prentice hall of India Pvt Ltd. 11th Edition, 2001.
4. “Engineering Graphics”, Jolhe, McGraw-Hill Publications, 2007.

UE17ME201:
MATERIAL SCIENCE AND METALLURGY (4-0-0-2-4)

Course Objectives:

- To introduce the basic concepts of crystal structure, its different types and defects
- To enable the student to visualize lattice atomic diffusion
- To familiarize the students with mechanical behavior of metals, different types of mechanical testing and fracture behavior of metals
- To enable the students to understand solid and liquid phase reactions and phase diagrams, under equilibrium and non-equilibrium conditions
- To provide an overview of different types of heat treatment processes of ferrous, non-ferrous metals and learn about polymers, ceramics composites and nanomaterials

Course Outcomes:

At the end of the course, the student will be able to

- Explain the importance of materials for various applications
- Identify and analyze the various crystal structures and defects responsible for change in the material properties and explain the process of diffusion, its types and mechanisms
- Identify different phases in iron-carbon diagram for steels and cast-iron and non equilibrium phases
- Use the phase diagrams effectively to identify the phase-state of the material for a given temperature condition
- Select the best heat treatment process based on application and identify the composition, properties and application of various ferrous, non-ferrous, polymer, ceramic, composite and nanomaterials

Course Content:

1. **Lattice, Unit cell, Basis and crystal structure:** Unit cell, Space lattice, Bravais Lattices, Miller indicesin cubic and hexagonal structures, Crystal Imperfections, Atomic Diffusion: Fick’s laws of diffusion
2. **Mechanical Properties and Behavior:** deformations, Tensile test, Plastic deformation, Hardness of Materials, Strain rate effects and Impact testing, Fatigue and Creep
3. **Solid Solutions and Phase Equilibrium:** Solid solutions, Rules governing formation of solid solutions, Phase diagrams, Lever rule, Nonferrous Phase Diagrams, Al-Si, Al-Cu, Cu-Zn Phase diagrams
4. **Iron Carbon Equilibrium Diagram:** Phases in the Fe-C system, Invariant reactions, critical temperatures, Microstructures, The TTT diagram; **Heat Treatment of Steels:** Annealing, Normalizing, Hardening, Tempering, Martempering, Austempering, Surface hardening; **Hardenability of Steels:** Hardenability concept – Jominy End Quench test, effect of alloying elements
5. **Engineering Alloys (Ferrous& Non-Ferrous):** Properties and uses of Carbon steels, Steel designation as per AISI designation; Properties and uses of Cast Irons, Properties and uses of light alloys; Properties and uses of Copper and its alloys; **Ceramic and Polymeric Materials; Composites and Nanomaterials**

Prerequisite Course: None

Reference Books:

1. “The Science and Engineering of Materials ”, Donald R Askeland and Pradeep, P. Phule, Cengage Learning, Sixth |Edition, 2010.
2. “Materials Science and Engineering: An Introduction”, William D. Callister, Jr., John Wiley & Sons, Eighth Edition, 2009.
3. “Characterization of Materials”, Volumes 1 and 2, John Wiley & Sons, New Jersey, 2003
4. “Introduction to Nanotechnology” Charles P. Porte, Frank Owens, Wiley Publishing Company, 2007

UE17ME202:
ENGINEERING THERMODYNAMICS (3-1-0-4-4)

Course Objectives:

- To introduce the fundamental concepts, terms and terminologies involved in thermodynamics.
- To enable students to understand and apply the laws of thermodynamics and the concepts of available energy and availability (exergy) to solve engineering problems.
- To train the students to use charts, tables and equations used in solving engineering problems related to thermodynamics.

Course Outcomes:

At the end of the course, the student will be able to

- Apply fundamental thermodynamic concepts to classify systems as open, closed and isolated and apply the zeroth law of thermodynamics to solve problems
- Apply the 1st and 2nd laws of thermodynamics and the concept of entropy to solve engineering problems involving closed and open systems by making proper assumptions
- Analyze closed and open systems using the concepts of available energy and availability (exergy)
- Apply thermodynamic concepts to describe the performance of individual components of a system (e.g. power plant, a jet engine etc) and relate that information to the overall performance of the entire system
- Analyze different processes involving gases, gas mixtures and pure substances using charts, tables and equations

Course Content:

1. **Introduction:** concept of temperature; zeroth law of thermodynamics; Work and Heat Transfer.
2. **First Law of Thermodynamics:** first law for a closed system-isolated-open system- analysis of steady and unsteady flow systems
3. **Second Law of Thermodynamics:** limitations of first law; Kelvin-Planck and Clausius statements of second law; reversibility and causes of irreversibility; corollaries of second law
4. **Entropy and Availability:** Clausius inequality (Clausius theorem), Entropy generation in closed and open systems; Tds relations, Isentropic process; availability analysis for closed and open systems
5. **Properties of Gases, Gas Mixtures and Pure Substances:** Dalton's law and Gibb's law; state diagrams for a pure substance.

Prerequisite Course: None

Reference Books:

1. "Fundamentals of Thermodynamics", Claus Borgnakke and Richard E Sonntag, Wiley Student Edition, 2010
2. "Thermodynamics - An Engineering Approach", Yunus A Cengel & Michael Boles, 7th Edition, TMH publishing Co. Ltd., 2011
3. "Engineering Thermodynamics", P.K.Nag, TMH publishing Co. Ltd., 2008

UE17ME203:
MECHANICS OF SOLIDS (4-0-0-0-4)

Course Objectives:

To enable the students to

- Acquire fundamental understanding of the behavior of components used in machines
- Develop skills to help them model and analyze the behavior of machine components subjected to various loading support conditions based on equilibrium principles
- Understand the concepts of stress and strain in materials and to understand various terminologies associated such as tensile strength, factor of safety, yield stress and many more
- Understand the concepts of shear force/bending moment deflection in beams
- Understand the concepts of torsion and its application to design of shafts
- Understand the concepts of column loading and its effect due to buckling

Course Outcomes:

At the end of the course, the student should be able to

- Display a good understanding of the behavior of components used in machines
- Demonstrate the required skill sets needed to model and analyze the behavior of machine components subjected to various loading support conditions based on equilibrium principles
- Use the concepts of stress and strain in materials and apply the understanding of various terminologies associated such as tensile strength, factor of safety, yield stress and many more in solving simple numerical problems
- Demonstrate a thorough understand of the concepts related shear force/bending moment deflection in beams, torsion and its application to design of shafts
- Apply their understanding of buckling of beams demonstrate their ability to analyze buckling of simple beams subject to simple boundary and loading conditions understand the concepts of column loading and its effect due to buckling

Course Content:

1. **Axial Loading:** Stress and Strain, stress-strain diagram, Hooke's law, deformation statically indeterminate problems, Multiaxial loading; **Thermal Stresses**
2. **Columns:** Stability, Euler's Formula, Empirical formula; **Torsion:** Deformations in a Circular Shaft, Stresses in the Elastic Range, Design of Transmission Shafts; **Energy Methods:** Strain Energy, Energy for normal and shearing stresses
3. **Transformation of Stress and Strain:** Transformation of plane stress, Principal Stresses, Maximum Shearing Stress, Mohr's Circle for Plane Stress; **Pressure Vessels:** Stresses in Thin and Thick-Walled Pressure Vessels.
4. **Analysis and Design of Beams for Bending:** Shear and Bending-Moment Diagrams; **Pure Bending:** Deformation in a Symmetric Member in pure Bending, Stresses and Deformations in the Elastic Range
5. **Shearing Stress in Beams:** Determining shearing stress in a beam, shear stress distribution in beam cross sections; **Deflection of Beams:** Deformation of a Beam under Transverse Loading, Elastic Curve, Singularity Functions, Area moment method.

Prerequisite Course: UE16CV101: Engineering Mechanics

Reference Books:

1. "Mechanics of Materials (In SI Units)", Ferdinand P Beer, E Russell Johnston, Jr John T DeWolf, TATA McGraw-Hill, Special Indian Edition, 3rd Edition, 2009.
2. "Mechanics of Materials", James M. Gere, Barry J. Goodno, Cengage Learning, 8th Edition, 2012
3. "Strength of Materials", S Ramamrutham, Dhanpat Rai Publications, Reprint 2005.
4. "Strength of Materials", I.B. Prasad, Khanna Publishers, 8th Edition 1989.

UE17ME204:
METAL CASTING & WELDING PROCESSES (4-0-0-2-4)

Course Objectives:

- To enable students to understand the basic concepts of foundry practices, specifically metal casting and metal melting practices
- To train students to analyze a given job for designing appropriate pattern and gating system and also to see if special casting methods are required
- To introduce the students to basic concepts of welding and discuss different types of welding processes

Course Outcomes:

At the end of the course, the student will be able to

- Apply the process of sand casting and customize it for a given material type and application or use special casting methods if necessary
- Design appropriate type of pattern, gating system and select the right molding and core materials by analyzing the part to be cast
- Apply the knowledge of different types of melting furnaces to select appropriate method of metal melting
- Differentiate between various types of welding operations and justify its use for a given application
- select and apply appropriate type of welding process after analyzing various factors associated with the joining operation

Course Content:

1. **Introduction to Manufacturing:** Manufacturing Process, casting. Foundry, Patterns and Pattern Making, Molding and Core Sands
2. **Gating System:** Principles. Design of gating system Defects, Turbulence, Design criteria for pouring basin, sprue, runner and gates.
3. **Melting furnaces and Practices:** types of furnaces, crucible furnace, Electric furnaces; **Cupola-** construction and zones; **Ladle Metallurgy:** degassing techniques, gas scavenging, desulphurization, liquid metal cleanliness and inoculation.
4. **Special casting methods:** Permanent mould casting, Centrifugal casting, Investment casting, Continuous casting. Shell moulding. Plaster mould casting, anitioch process and squeeze casting.
5. **Welding and allied processes:** welding processes and concept, Special welding

Prerequisite Course: None

Reference Books:

1. "Principles of Metal Casting", Richard W. Heine, Carl R. Loper Jr and Philip C, Rosenthal, Tata McGraw-Hill Publication, Second Edition, 2001.
2. "A Text book of Foundry Technology", O P Khanna, Dhanpat Rai Publications, 1996.
3. "A course in Workshop Technology, Volume – I, Manufacturing processes", B.S. Raghuwanshi, Dhanpat Rai & Co. (P) Ltd publishers, 2005.
4. "Welding and Welding Technology", by Richard L. Little, Tata McGraw-Hill Publication, Thirty Seventh Reprint, 2009.

UE17ME206:
MATERIAL TESTING LABORATORY (0-0-2-1-1)

Course Objectives:

- To train the students to use UTM for mechanical testing of specimen under varying load conditions
- To train the students to use various machines to determine hardness, wear resistance, rigidity modulus and impact strength
- To enable the students to understand material characterization and use of non-destructive methods of testing

Course Outcomes:

At the end of the course, the student will be able to

- Determine the elastic properties of materials using UTM and torsion testing machine
- Determine the impact strength of a material using Izod and Charpy tests
- Evaluate surface properties of materials using wear and hardness testing machines
- Evaluate microstructure of different materials using the metallurgical microscope
- Identify defects using non-destructive testing methods

Course Content:

1. Tensile test on metallic specimen using Universal Testing Machine
2. Shear test on metallic specimen using Universal Testing Machine
3. Compression test on metallic specimen using Universal Testing Machine
4. Izod impact test on metal specimen
5. Charpy impact test on metal specimen
6. To study wear characteristics of ferrous and non-ferrous materials for different parameters
7. Torsion test on metallic specimen
8. Brinell, Rockwell and Vickers' Hardness test
9. Identification of microstructures of different engineering materials
10. Bending test on metallic and non-metallic specimens
11. Fatigue test
12. Non-destructive test experiments like ultrasonic flaw detection, magnetic crack detection, dye penetration testing, to study the defects of cast and welded specimens

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by the Department of Mechanical Engineering, PESU.

UE17ME205:
METAL CASTING AND WELDING LABORATORY (0-0-2-1-1)

Course Objectives:

- To familiarize and train students in performing various tests to analyse the properties of moulding and core sand materials
- Demonstrate to the students the various sand casting methods using different types of patterns
- To train the students in the use of various welding and soldering equipment
- To train the students in hot & cold forging practices

Course Outcomes:

At the end of the course, the student will be able to

- Test moulding and core sand properties for its concurrence with a given sand casting application
- Use varieties of foundry tools and equipments
- Select appropriate type of pattern, carefully prepare gating system around it and prepare sand mould for a given job
- Apply various welding practices to fabricate simple jobs
- Perform simple hot and cold forging operations

Course Content:

1. Compression strength test
2. Permeability test
3. Shear strength test
4. Tensile strength test
5. Grain fineness number
6. Clay content test
7. Core Hardness and Mould hardness tests
8. Use of foundry tools and other equipment
9. Foundry model with split pattern
10. Foundry model with solid pattern
11. Foundry model (Hand Cut Model) – can be removed from course content
12. Preparation of one casting using Aluminum (demonstration)
13. Use of welding tools and other equipment
14. Welding Model 1 – BUTT joint by Electric Arc Welding (DC / AC)
15. Welding Model 2 – T joint / L joint by Electric Arc welding
16. Welding Model 3 – Lap Joint by Resistance Spot Welding
17. Welding Model 4 – Resistance Roller Seam Welding
18. MIG Welding demonstration
19. Cold forging – Model 1
20. Hot forging – Model 2

Prerequisite Course: None

Reference Material:

1. Laboratory Manual prepared by the Department of Mechanical Engineering, PESU

UE17ME251: MECHANICS OF FLUIDS (3-1-0-4-4)

Course Objectives:

- To introduce the students to fundamental concepts, terms and terminologies involved in fluid mechanics
- To enable the students to understand and apply the various contributive laws and concepts to solve fluid engineering problems.
- To familiarise the students with measurement and visualisation of fluid flow types, kinematics, and its analysis
- To introduce the students to real world machinery incorporating fluid flow, its performance and the efficiency determining factors

Course Outcomes:

At the end of the course, the student will be able to

- Explain the meaning and significance of fluid properties and solve related problems and analyze and solve problems on fluid pressure and related measurement devices
- Analyze the various types of fluid motion and its stability based on the fundamental laws and forces affecting fluid flow
- Visualize different types of fluid flow, and compare them based on kinematic flow descriptions and analyze how mass and momentum is conserved in various situations based on Bernoulli's & Newton's laws
- Analyze flow through closed conduits and determine energy loss for turbulent and laminar flows
- Apply the concepts of dimensional analysis and non-dimensionalisation and use Buckingham's Pi theorem to obtain expressions for various fluid flow situations; analyze the principles of flow over bodies; explain the working principles of hydraulic turbines and pumps

Course Content:

1. **Fluids Properties:** Introduction; Fluid Statics: Fluid pressure and its measurement; Hydrostatic Forces on Submerged Surfaces; Buoyancy and Stability.
2. **Fluid Kinematics:** Lagrangian and Eulerian Descriptions; Flow Visualization; Plots of fluid flow data; Types of Motion, Vorticity and Rotationality; Reynolds Transport Theorem.
3. **Mass, Bernoulli Equations and Momentum Analysis:** Conservation of Mass; Mechanical energy and Efficiency; The Bernoulli equation; Momentum Analysis, Newton's Laws and Conservation of Momentum;
4. **Flow In Pipes:** Laminar and Turbulent Flows: The Entrance Region; Piping Networks; Flow rate and Velocity Measurement
5. **Dimensional Analysis:** Method of Repeating Variables and Buckingham π Theorem; **Flow Over Bodies:** Lift and Drag; **Turbomachinery:** Working Principles of Hydraulic Turbines and Pumps; **Introduction to compressible flow**

Prerequisite Course: None

Reference Books:

1. "Fluid Mechanics – Fundamental and Applications", Yunus A.Cengel, John M.Cimbala, Tata McGraw-Hill Publishing Co. Ltd. 2006.
2. "Fluid Mechanics" (In SI units), Frank M White, McGraw-Hill Publication, Seventh Edition, 2011.

UE17ME252: MECHANICS OF MACHINES & MECHANISMS (3-1-0-4-4)

Course Objectives:

- To enable students to appreciate the working of mechanical machines and mechanisms
- To enable students to analyze gyroscopes, flywheels and governors to solve important engineering problems.
- To enable students to understand how balancing is carried out theoretically in single and multi-cylinder engines.
- To enable students to develop a sound understanding of various terminologies related to gears and solve engineering problems involving gear trains

Course Outcomes:

At the end of the course, the student will be able to

- Calculate friction in different types of threads, bearings and clutches
- Calculate hoop stresses in flywheels and effect of fluctuating speeds
- Calculate the effect of gyroscopic couples on ships, aeroplanes and 2-wheelers and balance different types of engines
- Apply the concepts of sensitiveness and isochronisms in the analysis of governors
- Explain the classification of gears, related terminologies and solve problems
- Apply the knowledge of velocity ratio to analyze and design different types of gear trains

Course Content:

1. **Introduction:** Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion, Kinematic chain; Kinematic Chains and Inversions; slider crank chain; Mechanisms; Velocity and Acceleration diagrams for 4 bar and slider mechanism
2. **Cams:** Types of Cams, Types of followers, Motion of follower-SHM, Constant Acceleration and deceleration, Constant Velocity and cycloidal, Layout of cam profiles-Problems.

3. **Flywheels:** T-M diagrams, Fly Wheels: Types of flywheels, Hoop stress, Fluctuation of speed and energy, Coefficient of Fluctuation of Energy, Coefficient of Fluctuation of Speed. Problems on applications of flywheels. punching presses.
4. **Gyroscope:** Vectorial representation of angular motion. Gyroscopic Couple; Governors: Types, Force analysis, Controlling force, stability, sensitiveness, isochronisms, effort and power.
5. **Balancing:** Static and Dynamic Balancing, Balancing several rotating and reciprocating masses in different planes

Prerequisite Course: None

Reference Books:

1. "Theory of Machines", S S Rattan, Tata McGraw-Hill, Fourth Edition, 2014.
2. "Kinematics of Machines", Shigley, Oxford, Fourth Edition, 2014.

UE17ME253: MEASUREMENT SCIENCE AND METROLOGY (4-0-0-4-4)

Course Objectives:

- To introduce the significance and fundamentals concepts of measurements
- To enable the students to understand the process of calibration of instruments, types of sensors, transducers, strain gauges and the role of standards for universal acceptability
- To introduce the working of various measuring instruments for measurement and fundamentals of GD & T
- To train the students to identify and describe various types of comparators and form measurement systems.

Course Outcomes:

At the end of the course, the student will be able to

- Elucidate the basic concepts of measurement and evaluate different types of errors associated
- Explain the basic methods of measurement for various quantities like strain, force, torque and the working principles of different types of measuring instruments
- Apply the concepts of limit, fits and tolerances in solving numerical problems
- Differentiate between different types of gauges used in checking dimensions of components
- Describe the working principles of form measuring instruments

Course Content:

1. **Introduction to Measurements:** Generalized measuring system, types of input quantities, errors, uncertainty analysis; **Standards of Length:** calibration, Slip gauges-Wringing phenomena, Indian Standards (M-87, M-112) **Transducers** - Transfer efficiency, primary and secondary transducers; **Intermediate modifying devices:** Mechanical and Electrical systems; **Terminating Devices**
2. **Measurement of Strain, Force and Torque**: Strain gauges, Force measurement, Torque measurement; **Pressure Measurement and Temperature Measurement.**
3. **Fundamentals of Geometrical Dimensioning and Tolerancing systems:** Tolerance, Specification in assembly, Principle of inter changeability and selective assembly limits of size, Standards, Gauges
4. **Comparators:** Introduction, Characteristics, classification of comparators, Mechanical comparators, Optical Comparators, Electric and Electronic Comparators - principles, LVDT; Pneumatic Comparators, back pressure gauges, Solex air gauge.
5. **Form measurements:** Angular measurements, Screw thread and Gear measurements, Tool makers microscope, Profile projector, Gear terminology—Gear tooth vernier caliper.
6. **Hands-on exercises:** Exercises on Calibration of Pressure Gauge, Thermocouples, Linear Variable Differential Transformer (LVDT), Load Cell, Resistance Thermister and Thermometer, diaphragm type Strain Gauge; Measurement of screw thread parameters, angle, alignment, using comparator, Measurement of gear tooth profile, surface roughness

Prerequisite Course: None

Reference Books:

1. "Mechanical Measurements", Thomas Beckwith, Marangoni and Lienhard, Pearson Publication, Sixth Edition, 2010.
2. "Mechanical Measurements and Instrumentation", R K Jain, S K Kataria and Sons, 2012
3. "Mechanical Measurements and Control Engineering", D S Kumar, Metropolitan Book Company Pvt. Ltd., 1979

UE17ME254: ENGINEERING MECHANICS – DYNAMICS (3-1-0-4-4)

Course Objectives:

- To teach students the basic concepts of mass moment of inertia and evaluating them for objects of simple shapes
- To help students analyze the kinematics of particles having rectilinear and curvilinear motion, including motion of constrained connected particles
- To equip the students with necessary skills and knowledge to develop equations of motion of particles using Newton's laws of motion in order to analyze the kinetics of particles having rectilinear and curvilinear motion
- To help students to appreciate and apply important and crucial concepts of work, energy, impulse and momentum in analyzing particle motion
- To teach students, the analysis of plane kinematics and kinetics of rigid bodies by helping them understand and apply concepts and methods related to pure rotation, absolute motion and relative velocity

Course Outcomes:

At the end of the course, the student will be able to

- Elucidate the basic concepts of mass moment of inertia and evaluate them for objects of simple shapes
- Analyze the kinematics of particles having rectilinear and curvilinear motion, including motion of constrained connected particles and solve simple related engineering problems
- Develop equations of motion of particles using Newton's laws of motion in order to analyze the kinetics of particles having rectilinear and curvilinear motion and solve simple related engineering problems
- Apply important and crucial concepts of work, energy, impulse and momentum in analyzing particle motion and solve simple related engineering problems
- Analyze plane kinematics of rigid bodies by understanding and applying concepts and methods related to pure rotation, absolute motion and relative velocity and solve simple related engineering problems

Course Content:

1. **Mass Moment of Inertia:** moment of inertia, Radius of gyration, transfer theorems, Composite bodies; **Kinematics of particles: Particle motion; Rectilinear motion: Velocity** and Acceleration, Graphical interpretations, Analytical integration

2. **Plane curvilinear motion:** velocity, acceleration, visualization of motion; Rectangular coordinates; Normal and tangential coordinates; **Polar coordinates:** time derivatives of the unit vectors, velocity and acceleration, geometric interpretation, circular motion; **Relative motion (Translating axes):** Choice of co-ordinate system, vector representation, Constrained Motion of Connected Particles
3. **Kinetics of Particles-1:** Newton's second law; Equations of motion, free-body diagram; Rectilinear motion; **Curvilinear motion:** Rectangular co-ordinates, Normal and tangential co-ordinates, Polar coordinates
4. **Work and energy:** kinetic energy Work and Curvilinear motion, principle, power, efficiency; **Potential energy:** work-energy equation, conservative force fields; **Impulse and momentum:** linear impulse and linear momentum, principle, conservation of linear momentum
5. **Plane Kinematics of Rigid bodies:** Rigid body assumption; plane motion of a rigid body; Rotation; **Absolute Motion; Relative velocity** due to rotation; **Plane Kinetics of Rigid Bodies:** General Equations of Motion, Translation Fixed-Axis Rotation, General Plane Motion

Prerequisite Course: None

Reference Books:

1. "Engineering Mechanics: Dynamics", J. L. Meriam, L. G. Kraige, Wiley India, 8th Edition, 2017.
2. "Engineering Mechanics: Dynamics", R.C Hibbeler, 14th Edition, Pearson Prentice Hall, 2016.

UE17ME255:
MACHINE DRAWING (0-0-2-1-1)

Course Objectives:

- To discuss the need for machine drawing and introduce the concept of orthogonal views: 1st Angle and 3rd Angle Projection
- To train the students to efficiently use modeling software and project orthographic views of planar and 2D objects
- To train the students to assemble 2D parts of an object on the modeling software and to project sectional views of the same

Course Outcomes:

At the end of the course, the student will be able to

- Apply the concepts of 1st and 3rd angle projection to project 2D and 3D objects using the drawing tool on CAD software
- Read and interpret engineering drawings of a given job
- Use part modeling tool in CAD software to model 2D parts to exact dimensions and contours
- Use drafting tool in CAD software to project various sectional and orthographic views of a 2D modeled object

Course Content:

1. Introduction to CAD Tools
2. Isometric projection. Single and combination of solids
3. Sectional views of solids, like prism and pyramids.
4. Orthographic view of machine parts
5. Orthographic view of machine parts with section
6. Thread forms, Bolts and Nut
7. Rivets and Riveted Joints - Single Riveted, Double Riveted joint
8. Cotter and Pin Joints
9. Couplings

Prerequisite Course: None

Reference Books:

1. "Machine Drawing", N D Bhat, Charotar Publishing House, 49th Edition ,2014
2. "Machine Drawing", K.R. Gopalakrishna, Subhas Publications, 5th Edition, 2003.
3. "A Text Book of Engineering Graphics", K.R. Goplakrishna, Subhas Publications, First Edition, 2003.

UE17ME256:
FLUID MECHANICS & MACHINES LABORATORY (0-0-2-1-1)

Course Objectives:

- To develop in students, the basic skills required to conduct experiments in the area of Fluid Mechanics and Turbomachines
- To enable the students to conduct experiments on and analyse - flow measurement, flow losses and performance of equipment

Course Outcomes:

At the end of the course, the student will be able to

- Calibrate various flow measuring devices and analyze the losses that happen in pipe flow
- Evaluate the performance of blowers, pumps and turbines by conducting various tests

Course Content:

A: Flow Experiments

1. Calibration of flow measuring devices:
    - Orifice meter
    - Venturimeter
    - Notches – V and rectangular
    - Nozzle meter
2. Determination various losses for flow in pipes:
    - Losses due to friction (Major losses)
    - Minor losses in pipe flow

B: Experiments on Fluid Machinery

Performance test of

- Air blower
- Single stage centrifugal pump
- Double stage centrifugal pump
- Reciprocating Pump
- Pelton wheel
- Francis turbine
- Kaplan turbine

Prerequisite Course: None

Reference Books:s

1. Laboratory Manual prepared by the Department of Mechanical Engineering, PESU

UE16ME301:
DESIGN OF MACHINE ELEMENTS – I (3-1-0-4-4)

Course objectives

- To understand the basic concepts of design of machine elements as per design standards, codes.
- To design mechanical members subjected to simple static load, combined load and impact conditions.
- To demonstrate the design of members subjected to Fatigue loading using various standards by problem solving capabilities.

- To understand the basic concepts of design of curved beams.
- To design shafts as per ASME standards subjected to fluctuating and combined loads.
- To design Riveted joints and welded joints to demonstrate the ability to estimate the joint efficiency for various applications by using problem solving activities.

Course Outcomes:

At the end of the course students will be able to,

- Demonstrate the design problem solving procedure for various elements under various loading conditions
- Estimate the size of shafts for various applications
- Estimate the size of threaded fasteners for different applications
- Design riveted joint for both boiler joint and structural joint.
- Demonstrate the capability to use Design Data book for design of various machine elements

Course Content:

1. **Design for Static Strength:** Design considerations, codes, standards, Theories of failure; Members under combined loads; Design for Impact Strength, Instantaneous stress due to axial, bending and torsional loading, Stresses in curved beam, closed rings and links.
2. **Design for Fatigue Strength:** Stress concentration, S-N diagram, fatigue, Endurance limit; Modifying factors, size effect, surface effect, stress concentration effects; Fluctuating stresses, Fatigue strength under fluctuating stresses, Goodman and Soderberg relationship.
3. **Design of Shafts and Couplings:** Torsion of shafts, design for strength and rigidity, ASME and BIS codes for design of transmission shafting, shafts under fluctuating and combined loads; Design for rigid flange coupling and bushed– pin flexible couplings.
4. **Fasteners:** Stresses in Threaded Fasteners, Initial Tension, Design of Threaded Fasteners under Static, Dynamic and Impact loads, Design of Eccentrically loaded Bolted Joints; chanics of Power Screw, Stresses in Power Screws, Efficiency and Self-locking, Design of Power Screw.
5. **Design of Riveted Joints:** Types of Rivets, failures of riveted joints, Joint Efficiency, Boiler Joints, Tank and Structural Joints, Riveted Brackets; **Welded Joints**–Types, Strength of butt and fillet welds, eccentrically loaded welded joints.

Prerequisite Course: None

Reference Books:

1. “Design of Machine Design Elements”, by V B Bhandari, Tata Mc Graw Hill, 3rd edition, 2010
2. Schaum’s outlines “Machine Design” by Hall, Holowenko and Laughlin. The McGraw-Hill companies, First Edition, 2008.
3. Maleev & Hartman’s “Machine Design” O P Grover, CBS Publishers & Distribution, New Delhi, Fifth Edition, 2001
4. “Mechanical Engineering Design (SI Units)”, by Joseph E Shigley, C R Misshke, R G Budynas and K J Nisbett, Tata McGraw Hill, 8th Edition, 2008

Design Data Hand Books:

1. Design Data Hand Book, Dr. K Mahadevan & Dr. K Balaveera Reddy, CBS Publication – 4th edition, 2013

UE16ME302: PRINCIPLES OF ENERGY CONVERSION (3-1-0-4-4)

Course Objectives:

- To help the students to understand the application of engineering thermodynamics in various appliances and mechanisms
- To help the students evaluate the performance characteristics of various real world thermodynamic applications
- To introduce the students to the principles of turbomachinery & the basic analysis of the expansion and compression processes
- To help the students to appreciate the energy exchange characteristics that take place in turbo machines

Course Outcomes:

At the end of the course, the student will be able to

- Analyze a vapor power cycle given a set of operational parameters and constraints, and determine cycle efficiency, its power output, and required heat input
- Modify and improve the overall cycle efficiency for the steam power cycle
- Optimize a vapor refrigeration system based on the given requirements and constraints
- Acquire the skills to make availability analysis and determine second law efficiencies for different types of thermodynamic systems
- Explain the principles of turbo machinery, application of laws of thermodynamics to turbo machines, dimensional analysis and performance characteristics and apply the same to solve problems.

Course Content:

1. **Reciprocating Compressors:** Classification; work done in a single stage compressor; efficiency; p-v diagram for an actual compressor and diagram factor; multistage compressor; **Testing of IC Engines:** performance parameters of IC engines and measurement; **Thermodynamics of combustion:** Fuels analysis; Combustion Equations; Combustion with Air – theoretical air, Air - Fuel Ratio, Orsat Analyzer**;** Enthalpy of Formation; First Law analysis
2. **Vapour Power Cycles:** Classification; Analysis of simple Rankine cycle and modified Rankine cycles; Deviation of practical vapour power cycles from ideal cycles; Binary Vapour cycle.; process heat and by-product power; efficiencies of steam power plant; Organic Rankine Cycle
3. **Gas Power Cycles:** Analysis of Carnot gas power cycle, air-standard Otto, Diesel and Dual combustion cycles and their comparison; Analysis of simple GT cycle; Analysis of practical gas turbine cycles; Analysis of Jet Propulsion cycles like turboprop and turbojet engine cycles.
4. **Refrigeration Cycles:** Carnot Refrigeration cycle; Gas refrigeration cycles; Mechanical vapour compression cycles – analysis of an ideal vapour compression cycle and practical vapour compression cycles; absorption refrigeration systems**; Air-conditioning:** Terminologies; analysis of various psychrometric processes
5. **Principles of Turbomachinery**: Positive-Displacement machines and Turbomachines; I and II law of thermodynamics applied to Turbomachines; Performance Characteristics and Dimensional Analysis**; Flow Through Nozzles and Blade Passages:** Steady flow; Isentropic Expansion; Area changes in One-Dimensional Isentropic Flow; Effects of Friction in Flow Passages; Flow of wet steam through nozzles; Diffusers**.**

Prerequisite Course: UE16ME202 – Engineering Thermodynamics

Reference Books:

1. “Basic & Applied Thermodynamics”, P.K. Nag, Tata – McGraw-Hill Co., Fifth Edition, 2002.
2. “An Introduction to Energy Conversion Volume III – Turbomachinery”, Vedanth Kadambi and Manohar Prasad, New Age International Publishers, New Delhi, 2nd Edition, 2011.
3. “Principles of Turbomachinery”, D.G. Shepherd, The Macmillan Company, New York, First Edition, 1956.

UE16ME303:
METAL CUTTING AND MACHINING PROCESSES
(4-0-0-2-4)

Course Objectives:

- To teach the students the force analysis in orthogonal cutting, mechanics of chip formation and related concepts, along with the parameters affecting it and stress and strain in chips
- To teach students about cutting tool types, parameters and materials, and their effects on production cost and tool life.
- To enable students to appreciate experimental cutting force measurement method
- To illumine the students regarding different lathe and drilling operations, their related calculations, along with twist drill nomenclature
- To teach important shaping and milling operations, their related calculations involving cutting speed and feed, machining time, along with different indexing methods
- To teach students the various grinding operations and parameters, along with types of abrasives

Course Outcomes:

At the end of this course, the students would be able to

- Appreciate force analysis in orthogonal cutting and force calculation methods involved in mechanics of chip formation, along with knowing chip types and related parameters
- Explain about different cutting tool types, parameters and materials, and their effects on production cost and tool life
- Elucidate various lathe and drilling operations, visualize and understand twist drill nomenclature and carry out simple related calculations
- Explain about different shaping and milling operations, their related calculations involving cutting speed and feed, machining time, along with different indexing methods know different grinding types, operations and appreciate the use of different abrasive materials
- Explain various aspects of grinding operation and also the basic process of non-traditional machining

Course Content:

1. **Basics of Metal Cutting Tool:** Orthogonal and Oblique Cutting, Cutting Tools, Tool Geometry, Chips, Work Done in Cutting, Earnst-Merchant Metal Cutting Theorem, Sources of Heat in Metal Cutting
2. **Economics of Metal Cutting Tool:** Tool Failure, Mechanism of Wear, Tool Life, Cutting Tool Materials, Machinability, Economics of metal cutting, Measurement of cutting forces.
3. **Machine Tools:** Lathe and Drilling Machines, types, Specification, Description and functions, parts, Accessories and attachment, operations
4. **Grinding:** types, Specification, Description and functions, parts, Accessories and attachment, operations, Machines, Wheels, Abrasives
5. **Non Traditional Machining:** Process, Applications, Classification

Prerequisite Course: None

Reference Books:

1. "Production Technology", HMT, Tata McGraw-Hill, 9th Reprint, 1999
2. "All About Machine Tools", Heinrich Gerling, New Age International (P) Limited Publishers, 4th Edition, 2014.
3. "Fundamentals of Tool Design", Frank. W. Wilson (Editor), ASTME, Prentice-Hall of India, New Delhi, Third Edition, 1990.
4. "New Technology", Amitabha Bhattacharyya, The Institute of Engineers (India), First Edition, 1972.

UE16ME304:
MACHINE SHOP PRACTICE (0-0-2-1-1)

Course Objectives:

- To help the students learn about the working of Metal Cutting Machines such as Engine Lathe, Milling Machine, Drilling Machine, Shaping Machine and Surface Grinding
- To help the student understand the various cutting tools, cutting tool materials and cutting parameters used during metal cutting operations.
- To help the student know about the different types of chips

Course Outcomes:

At the end of the course, the student will be able to

- Operate engine lathe, milling machine (horizontal and vertical milling machines), shaping machine and drilling machine
- Read a 2D drawing and convert it into a component and measure the same using various instruments to see that the manufactured component adheres to the 2D drawing specification both in terms of geometrical and dimensional accuracy.
- Perform machining operations such as plain turning, taper turning, thread cutting, knurling etc on an engine lathe and make models of given geometry
- Perform machining operations such as gear cutting and slot milling using vertical and horizontal milling machine, drilling and allied operations using drilling machine
- Perform machining operations such as flat and slot shaping operations using shaping machine

Course Content:

1. MODEL 1 – Plain Turning and Step Turning
2. MODEL 2 – Taper Turning and Knurling
3. MODEL 3 – Thread Cutting, Grooving
4. MODEL 4 – Facing, Chamfering
5. MODEL 5 – Drilling using Lathe Machine
6. MODEL 6 – Eccentric Turning
7. MODEL 7 - Gear Cutting on Milling Machine
8. MODEL 8 – Rectangular Slot Milling
9. MODEL 9 – Drilling & Allied Operations
10. MODEL 10 – Milling, Honing Shaping and Superfinishing
11. MODEL 11 – Demonstration of Flattening of surface using a grinding machine

Prerequisite Course: None

Reference Material:

1. Laboratory Manual prepared by the Department of Mechanical Engineering, PESU

UE16ME305:
THERMODYNAMICS & IC ENGINES LABORATORY
(0-0-2-1-1)

Course Objectives:

- To help the students to understand the application of engineering thermodynamics in various appliances and mechanisms
- To help the students evaluate the performance characteristics of various real world thermodynamic applications

Course Outcomes:

At the end of the course, the student will be able to

- Develop basic skills required to conduct experiments in the area of thermodynamics and internal combustion engines

- analyze experimentally
  - calorific value of fuels
  - viscosity of oils
  - performance tests on internal combustion engines and 2-stage air compressor

Course Content:

PART A

1. Flash and Fire point of lubricating oils - Pensky Martin's apparatus.
2. Calorific value fuels – Boy's Gas Calorimeter
3. Viscosity of oils - Redwoods Viscometer
4. Viscosity of oils – Saybolts Viscometer
5. Torsional Viscometer
6. Valve timing diagram of an I.C. engine
7. Calorific value using Bomb's calorimeter

PART B

1. Performance characteristics and Heat Balance sheet for 4-stroke Diesel engine coupled to rope brake dynamometer.
2. Performance characteristics of 4-stroke Petrol engine coupled to Alternator
3. Performance characteristics of Variable Compression Ratio engine
4. Performance characteristics of 2-stroke Petrol engine coupled to rope brake dynamometer
5. Performance characteristics of two-stage reciprocating air compressor
6. To conduct performance test on a Vapour Compression Refrigeration Plant
7. To conduct performance tests on an Air Conditioning Unit

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by the Department of Mechanical Engineering, PESU

UE16ME311:
AEROSPACE STRUCTURES (3-1-0-4-4)

Course Objectives:

- To introduce students to aerospace Structures, various loads and their effects on the aerospace structures
- To familiarize students with the concepts of stress analysis of aerospace structures.
- To impart understanding of various joining methods employed in the field of aerospace structures.

Course Outcomes:

At the end of this course, the student will be able to

- Elucidate on various classifications of aerospace structures
- Explain different design and analysis techniques employed
- Analyze various components of aerospace structures and corresponding modes of failure.
- Explain various techniques of joining and fitting employed for aerospace structures.

Course Content:

1. **Introduction:** Primary structures, secondary structures, design, loads, configuration, design and analysis techniques, Structures and Loads: Categories, Fundamentals, Material Selection, Analysis
2. **Introduction to Aircraft stress analysis:** wing, fuselage, ribs and frames- stress analysis
3. **Strength of structure elements and composite materials-I:** Combined stress, theory of yield and ultimate failure, strength of columns, round, streamline, oval and square tubing, flat sheet
4. **Strength of structure elements and composite materials-II:** Crippling strength, column strength, Buckling strength of monocoque cylinders, Ultimate strength of stiffened curved sheet structures, Design of beams.
5. **Connections and Design Details:** Fittings and connections, bolted and riveted, welded, important details in structural design of aircrafts

Prerequisite Course: UE16ME203 – Mechanics of Solids

Reference Books:

1. "Analysis and Design of Flight Vehicle structures", Bruhn, S.R., the University of Michigan, Jacobs, First Revised Edition, 1973.
2. "Aircraft Design: A Conceptual Approach", Daniel P. Raymer, AIAA Educational Series, Fifth Edition, 2013.

UE16ME312:
POWER PLANT ENGINEERING (3-1-0-4-4)

Course Objectives:

- To introduce the students to various types of power generation methods, generators and fuels used
- To teach the students in detail the construction model of a steam generator along with its accessories and design of chimneys and cooling towers
- To introduce the students to diesel and gas turbine power plants; various components and performance
- To teach the students about hydroelectric and nuclear power plants; various components and performance
- To introduce the students to the analysis of related driving factors for the installation of a power plant

Course Outcomes:

At the end of the course, the student will be able to

- Explain the various currently used methods of power generation and their functioning and debate on the currently used power generating plants and their accessories with regard to their principle of working, advantages/disadvantages, and their limitations.
- Design the chimneys and cooling tower required based on the various performance parameters
- Analyse the various types of diesel and gas turbine power plants and various components used in its performance
- Design optimal power production taking into consideration a hydro-thermal mix and constituent performance factors
- Analyse the operating characteristics and economics of power plant installation based on the cost of production and equipments used

Course Content:

1. **Introduction to Steam power Plants:** Fuels, Equipments, Oil burners. Pulverized fuel firing systems, Coal and ash handling, High pressure steam generators
2. **Steam generator accessories:** Super heaters, Economizers, Air pre heaters and re heaters, Chimneys and Cooling Towers, Calculations, condensers, feed water heaters.
3. **Diesel engine power plants:** Centrifuges, oil heaters, intake and exhaust systems, Super Charging; Gas turbine power plants: Components, fuels, accessories.
4. **Hydro Electric Power Plants:** Hydrological cycle and graphs components; Nuclear Power Plants: Fundamentals, Components, Types, Radiation hazards and control

5. **hoice of site for power station:** Load estimation, capacity factor, use factor, diversity factor, demand factor; Economic analysis of Power Plants

Prerequisite Course: None

Reference Books:

1. "Power Plant Technology", El Wakil, Tata McGraw-Hill International Edition, 2001.
2. "Power Plant Engineering", P.K.Nag, TMH, Third Edition, 2008.

UE16ME313: AUTOMOTIVE SYSTEMS ENGINEERING (3-1-0-4-4)

Course Objectives:

- To introduce vehicle chassis structure
- To broaden the understanding of components of transmission systems
- To introduce automotive suspension systems
- To broaden the importance of conventional and advanced braking systems
- To introduce steering systems

Course Outcomes:

At the end of the course, the student will be able to

- Elucidate the importance of vehicle frame
- Determine steering systems
- Identify suitable braking systems
- Construct automotive suspension systems
- Design a suitable transmission system

Course Content:

1. **Chassis and Body Layout:** Types of chassis layout, Classification of vehicle layout, Integrated body construction, BIW type and corresponding design parameters, Vehicle interior system, Pillar trims, head roofs.
2. **Front Axle and Steering System:** Types of front axles, construction details, materials, front wheel geometry, conditions for true rolling motion of wheels, steering geometry, steering systems, constructional details, steering gear boxes.
3. **Drive Line:** driving thrust and torque reactions, Hotchkiss drive, torque tube drive and radius rods, propeller shaft, universal joints, front wheel drive, final drives, differential principle, construction details, rear axles, loads acting on rear axles, rear axle housing, multi axle vehicles.
4. **Suspension System:** Need, types, suspension springs, constructional details and characteristics of leaf, coil and torsion bar springs, independent suspension, rubber suspension, pneumatic suspension, hydro-elastic suspension, shock absorbers
5. **Braking System:** Classification, drum brakes and disc brakes, constructional details, theory of braking, concept of dual brake system, parking brake, material, hydraulic system, vacuum assisted system, air brake system, antilock braking, retarded engine brakes, eddy retarders.

Prerequisite Course: UE16CV101 – Engineering Mechanics

Reference Books:

1. "Automotive Chassis & Body", P. L. Kohli, Papyrus Publishing House, New. Delhi, First Edition, 2010
2. "The Automotive Chassis: Engineering Principles", JörnsenReimpell, Helmut Stoll and Jürgen W. Betzler Butterworth-Heinemann, Oxford – 2001
3. "The Automotive Body, Volume I: Components Design", Morello,Rosti Rossini,Pia and Tonoli
4. "Mechanics of Road Vehicles", Steed W,Illiffe Books Ltd., London, First Edition, 1960.

UE16ME314: ANALYSIS OF MECHANISMS (3-1-0-4-4)

Course Objectives:

- Understand the fundamentals of the theory of kinematics and dynamics of machines.
- Understand techniques for studying motion of machines and their components.
- Develop ability to perform position, velocity, acceleration and force analysis on linkages and machines.

Course Outcomes:

At the end of the course, the student will be able to:

- Distinguish kinematic and kinetic motion and identify the basic relations between distance, time, velocity, and acceleration.
- Apply vector mechanics as a tool for solving kinematic problems.
- Use graphical and analytic methods to study the motion of a planar mechanism.
- Develop analytical equations describing the relative position, velocity and acceleration of all moving links.
- Identify all reaction and inertia forces on the links.

Course Content:

1. **Mechanism design philosophy:** Seven stages in mechanism design, Mechanism synthesis process, Design categories and mechanism parameters, troubleshooting;
2. **Introduction to kinematics:** Four-bar linkages, Slider-crank Mechanisms, Kinematic diagrams, Degree of freedom (DOF), Analysis versus synthesis; **Motion in mechanisms.**
3. **Displacement Analysis–** Plane motion of a particle and a rigid body, Position analysis; **Velocity Analysis**: Method of velocity difference, Velocity analysis.
4. **Acceleration analysis:** Method of acceleration difference, Method of normal component, Coriolis component of acceleration; Graphical methods for mechanism analysis; Analytical method for acceleration analysis.
5. **Force analysis: Static and inertia forces**, Force of friction; Poles, Pole triangles, Image poles, Opposite pole quadrilateral; Pole force analysis, Inertia forces analysis, Balancing of Slider crank mechanisms.
6. **Curvature theory:** Fixed and Moving Centrodes, Velocities, Accelerations, Inflection Points and the Inflection Circle, Acceleration Field, Return Circle, Bobillier's construction, Crunode points, Burmester's circle point, Ball's point

Prerequisite Course:

UE16ME252 – Mechanics of Machines and Mechanisms

Reference Books:

1. "Mechanism Design", Sandor and Erdman, Prentice Hall, Fourth Edition, 2001.
2. "Kinematics Analysis and Synthesis", Jack Kimbrell, McGraw Hill, First Illustrated Edition, 1991.
3. "Advanced Mechanism Design", Sandor and Erdman, Prentice Hall, First Edition, 1988.

UE16ME315: COMPOSITE MATERIALS (4-0-0-2-4)

Course Objectives:

- To introduce the need to innovate newer materials which have enhanced properties to suit with conventional materials
- To introduce the students to composite materials and focus on the type of reinforcement, types of matrices
- To enable the students to understand different processing and fabrication techniques of composite materials especially with respect to fiber components
- To introduce different reinforcement and matrix materials for various applications

Course Outcomes:

At the end of the course, the student will be able to

- Explain the differences between conventional materials, alloys, composite materials and hybrid composites with respect to their structure and composition
- Illustrate differences between various reinforcement materials, matrix materials along with their applications.
- Explain fabrication techniques of various polymer matrix composites
- Apply the knowledge of polymer and metal matrix composites to suit a specific application
- Explain various powder and liquid metallurgy techniques

Course Content:

1. **Introduction to composite materials:** Definition, Classification, Evaluation of four elastic moduli – Rule of mixture, Macro mechanics of a lamina: Hooke's law for orthographic lamina, Laminate code, Failure criterion.
2. **Manufacturing of Polymer Matrix Composites:** Open and closed mould processing, Hand layup & spray up processing, Bag moulding and Filament winding, Pultrusion, Pulforming, Thermoforming, Injection moulding, Blow moulding
3. **Fabrication of Composites:** Cutting, machining, drilling, mechanical fastening & adhesive Bonding, joining methods
4. **Application and developments:** Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment - future potential of composites
5. **Metal matrix composites:** Reinforcement materials, types, Characteristics & Selection, base Metals selection, applications. Powder metallurgy, liquid metallurgy techniques, applications of Metal matrix composites

Prerequisite Course: None

Reference Books:

1. "Composite Materials Handbook", Mel Schwartz, McGraw-Hill Book Company, 2nd Edition, 1992.
2. "Mechanics of Composite Materials", Autar K.Kaw, CRC Press New York, Second Edition, 2006.

UE16ME321: PRINCIPLES OF FLIGHT (3-1-0-4-4)

Course Objectives:

- To enable students to apply basic aerodynamic and stability aspects of atmospheric flight with respect to general airplanes and helicopters
- To help students understand the basic aspects of space flight

Course Outcomes:

At the end of the course the students will be able to

- Articulate on the broad principles behind the working of various kinds of flight vehicles – aircraft, helicopter, rocket, satellite etc and explain basic aerodynamic concepts associated with low speed (incompressible) flows
- Discern the characteristics of aerofoils and wings, control surfaces and high lift devices etc, taking fixed wing aircraft as specific example
- Emphasize on basic elements of aircraft performance including level flight, turning flight, take off and landing etc and explain important principles of stability and control of an aircraft
- Explain broad features of helicopter flight
- Present the basic features of space flight like ascent flight with rockets, orbital flight, earth and planetary entry etc and present some features about the directions in which aerospace engineering is advancing

Course Content:

1. **Basic Concepts:** Types of flight vehicles, factors affecting atmospheric flight, Elements of Compressible Flow: shock waves, Prandtl - Meyer expansion waves.
2. **Basic Aircraft:** Fixed Wing Aircraft, role of control surfaces and high lift devices, compressibility effects, Elements Of Aircraft Propulsion; Basic Helicopter Aerodynamics
3. **Elements of Aircraft Performance:** Axis system, translational motion in the plane of symmetry, unaccelerated flight, V-n diagram, supersonic aircraft
4. **Principles of Stability and Control:** Static & dynamic, moments on the airplane, stick fixed and stick free static stability, directional static stability, lateral static stability
5. **Principles of Space Flight:** states of Space flight, Orbital Flight; Earth and Planetary Entry; Uninhabited Aerial Vehicles, Micro air vehicles, Hypersonic vehicles

Prerequisite Course: None

Reference Books:

1. "Introduction to Flight", John D Anderson, Tata McGraw Hill, 5th Edition, 2007
2. "Elements of gas turbine propulsion", Jack D. Mattingly, McGraw Hill, Indian Reprint, First Edition, 2005
3. "Rocket propulsion elements", George P. Sutton and Oscar Biblarz, Wiley India Pvt. Ltd., 7th Edition, 2011
4. "Basic Helicopter Aerodynamics", J Seddon, BSP Professional Books, Oxford, Third Edition, 2011.

UE16ME322: I C ENGINES (3-1-0-4-4)

Course Objectives:

- To introduce the students to the various cycles that describe the working of an IC Engine
- To enable the students to compare and contrast between the working of an SI and CI engine
- To help the students understand the importance of cooling and tail-pipe emissions

Course Outcomes:

At the end of the course, the student will be able to

- Differentiate the various cycles based on the different governing factors and explain the various components necessary for proper and efficient combustion of fuel in an SI engine
- Analyze the types of combustion process in SI engines and also debate on parameters that give rise to knocking

- Discuss on the combustion process in a CI engine and analyse the influence of fuel injection and chamber design
- Emphasize on the requirement of cooling and the analyse the heat transfer mechanisms playing a vital role in efficient cooling
- Explain the type of emission and methods for its controls in IC Engines

Course Content:

1. **Introduction:** Engine nomenclature, Four Stroke and Two Stroke Engines, S.I. and C.I. Engines, Combustion; Thermodynamics, thermochemistry & physics of combustion;
2. **Fuel air cycles and Actual cycles:** Deviation from air-standard cycles; Effect of losses, Chemical dissociation, Comparison of air standard and fuel air cycles, Actual cycles
3. **Combustion in S.I. Engines:** mixture requirements, carburetor, Fuel Injection and Injectors; Stages of Combustion in S.I. Engine, Effect of engine Variables, Abnormal Combustion, Knocking, Surface ignition. S.I. Engine Combustion Chamber design principles, Types; Alternate Fuels
4. **Combustion in C.I. Engines:** Diesel injection systems. Injectors; Swirl and squish. Stages of Combustion in CI. Engines. Physical and Chemical delay, Diesel Knock, C.I. Engine Combustion Chambers, Direct injection and indirect injection chambers; Alternate Fuels
5. **Engine Cooling:** Piston and cylinder temperature distribution, engine heat transfer, Air cooling and Liquid cooling, Radiator; Engine testing and Performance Evaluation; **Tail pipe engine emission and Control:** Major pollutants from S.I. Engines and C.I. Engines, Effect of Engine Variable on tail pipe emissions. Euro I, II, III norms. Emission control; Modern developments in I.C. Engines

Prerequisite Course: None

Reference Books:

1. "Internal Combustion Engine Fundamentals", John B. Heywood, McGraw Hill Education; First edition (Indian), 2017
2. "Fundamentals of Internal Combustion Engine", H.N.Gupta, PHI Learning Pvt. Ltd., Second Edition, 2013.
3. "Internal Combustion Engines", V. Ganesan, Tata McGraw-Hill, Second Edition, 2003.

UE16ME323:
AUTOMOTIVE TRANSMISSION (3-1-0-4-4)

Course Objectives:

- To teach the students for the need for transmission and transmission elements.
- To help the students to understand the principles of different types of clutches.
- To help the students to understand different types of gearboxes and their design principles.
- To teach the students to important concepts of automatic transmissions and its working principles
- To help the students for understanding the concepts of final drive components.

Course Outcomes:

At the end of the course, students will be able to

- Articulate the concepts of automotive transmission and illustrate the importance of traction diagram and apply that concept to get drawbar pull
- Design a gearbox for the given requirement by applying the desired concepts.
- Apply the concepts of various types of clutches and calculate the forces acting on them
- Analyse the need for different types of final drive configurations
- Differentiate between geometric and progressive gear steps and their application

Course Content:

1. **Vehicle Power train system** layout and components, functions, requirements profile, Interrelations; **Power Required for Propulsion** Various Resistances to Motion of the Automobile, Traction, tractive effort, performance curves, acceleration gradeability, drawbarpull
2. **Matching engine and transmission:** condition diagram, Ideal transmission and engine- transmission matching, Total ratio and overall gear ratio;**Manual Transmission:** Types of gear boxes, gear synchronization and engagement, selector mechanism, lubrication of gear box, transfer box, gear box trouble shooting
3. **Moving-Off Elements:** Dry Clutches, one-way clutches (Over running clutch), Wet Clutches, Dual Clutches, Hydrodynamic Clutches, Torque Converters, Engine and Torque Converter Working Together, Trilok converter, Engine and Trilok converter working together
4. **Automatic Transmissions** Epicyclic or planetary gear trains, automatic transmission, transmission shift and drive line features, driving and holding devices, automatic transmission fluid, transmission seals, continuously variable transmissions
5. **Final Drives** Propeller shaft and drive, Universal Joints, double Hooke type CV joint, Rear wheel drive arrangements, Rear Axle Final- drive, the differential, practical determination of the gear box and rear axle ratios, front wheel drive and four wheel drive

Prerequisite Course: None

Reference Books:

1. "Automotive Transmissions: Fundamentals, Selection, Design and Application", Gisbert Lechner, Harald Naunheimer, Springer-Verlag Berlin Heidelberg, New York, 2nd Edition, 2011
2. "Automobile Mechanics", Dr. N.K. Giri, Khanna Publications, New Delhi, India, First Edition, 2014
3. "Automobile Engineering Vol-1", Dr. Kirpal Singh, Standard Publication, New Delhi, First Edition, 2012
4. "The Motor Vehicle", T. K. Garrett, K Newton, W. Steeds, Butterworth Heinemann, India, Thirteenth Edition, 2004

UE16ME324:
THEORY OF ELASTICITY (4-0-0-0-4)

Course Objectives:

- To teach students the mathematical procedure required to compute and graphically represent stresses and strains for a body under given loading condition
- To help students understand generalized Hooke's law and different boundary conditions
- To teach students to apply concept of plane stress and plane strain to solve simple related problems
- To enable students to use stress function to solve simple 2D problems in rectilinear and polar coordinates
- To help students analyze torsion of shafts

Course Outcomes:

At the end of the course, the student will be able to

- Compute 3 - dimensional stress and strain components, principal stresses and strains
- Explain Mohr's circle construction, various boundary conditions and generalized Hooke's law
- Apply the concepts of plane stress and plane strain conditions to important related problems

- Use Airy's stress function to solve 2- dimensional problems in rectilinear and polar coordinates
- Illustrate the analytical development necessary to analyze torsion of shafts of circular and generalized cross-sections such as elliptic and triangular

Course Content:

1. **Introduction to Elasticity:** Equilibrium equations, Mohr's diagram, boundary conditions, Generalized Hooke's law, methods of solution of elasticity problems
2. **wo dimensional problems:** Airy's Stress function and its use, Bending of a narrow cantilever beam of rectangular cross-section under edge load.
3. **General equation**: Cylindrical Co-ordinates, Stresses in an infinite plate, stress concentration, stresses in rotating discs and cylinders
4. **Torsion**: Prismatic bars, Torsion of Circular, elliptical and triangular bars, membrane analogy, torsion of thin open sections and thin tubes.
5. **Uniqueness Theorem:** Uniqueness theorem, Principle of super position, reciprocal theorem, Saint Venant's Principle, Thermo elastic stress strain relations, Equations of equilibrium, strain-displacement relations, Temperature symmetrical about center

Prerequisite Course: UE15ME203 – Mechanics of Solids

Reference Books:

1. "Advance Mechanics of Solids", L S Srinath, Tata McGraw-Hill, 3rd Edition, 2009.
2. "Theory and Elasticity", S. P. Timoshenko & J N Goodier, McGraw-Hill International, 3rd Edition, 1972.

UE16ME325: GEOMETRIC DIMENSIONING& TOLERANCING (4-0-0-2-4)

Course Objectives:

- To teach students concept of limits, fits and tolerances with an outlook towards international standards, G D & T symbols and related topics and also help them apply these concepts to solve simple numerical problems
- To teach students about G D & T rules and their applications through examples and problems
- To equip students with the necessary understanding of the concept and types of datum, its different forms, their use and application and apply their collective learning to solve simple problems
- To teach students positional tolerances and help them recognize that positional tolerance concepts helps make manufacturing easier and cheaper
- To teach students concentricity and symmetry concepts and help them see how they are useful in precise manufacturing of components having high speed rotation
- To help students understand and apply profile tolerances for highly complicated components used in automotive and aerospace industries

Course Outcomes:

At the end of the course, the student will be able to

- Explain the drawing with G D & T symbols and rules
- Apply bonus tolerances and virtual conditions to make manufacturing easy.
- Define datum, through which interpretation between designer, manufacturer and apply positional tolerances, by virtue of which manufacturing would be easier and cheaper
- Apply concentricity and symmetry for highly précised aerospace component
- Explain and apply profile tolerances for highly complicated components used in automotive and aerospace industries

Course Content:

1. **Fundamentals:** Limits, Fits and Tolerances as per IS2102 and 919, introduction to GD&T, 14 Symbols, feature and feature of size differences, actual mating envelop and modifiers.
2. **Rule of G D & T:** Rule 1, 2, 3, 4 and 5, Boundary condition, virtual boundary, outer and inner boundary, application to gauges, bonus tolerances its use and applications
3. **Datum and its application:** benefits of Datum, Implied Datum, Demerits of Implied Datum, Datum Feature, Inclined Datum feature, Datum axis and Datum center plane, Datum Targets.
4. **Form and Orientation Tolerances:** Flatness, Straightness, Circularity, Cylindricity, Perpendicularity, angularity and parallelism, Zone of tolerance, measurements, Orientation, Orientation applied to MMC and RFS
5. **Tolerance of Position, Runout, Concentricity Symmetry and Profile:** Concentricity Symmetry, Run out and Profile tolerance

Prerequisite Course: None

Reference Books*:*

1. "Fundamentals of Geometric Dimensioning and Tolerancing", Alex Krulikowski, University of Michigan, Delmar Cengage Learning, 3rd Edition, 2012.
2. "Geometric Dimensioning and Tolerancing-Applications, Analysis & Measurement", J. Madows, Standards media, First Edition, 1995.

UE16ME351: DESIGN OF MACHINE ELEMENTS – II (3-1-0-4-4)

Course Objectives:

- To enable students to design important machine elements such as springs, brakes, flexible power transmission elements such as belts, ropes and chain drives
- To enable students to design different gears as per AGMA standards
- To help students in understanding and learn about different lubrication mechanism, design different types of journal bearings as per ASME Standards and select ball and roller bearings from the standard design catalogue

Course Outcomes:

- At the end of the course, the student will be able to
- Design helical and leaf springs
- Design mechanical power transmission members such as belt drives, rope drives & chain drives depending on various applications
- Design spur, helical, bevel and worm gears subjected to static, dynamic & wear load conditions as per AGMA standards
- Explain the mechanism of lubrication, list different lubricants and their properties and, design journal bearings.
- Select ball and roller bearings from the manufacturer's catalogue for the required application

Course Content:

1. **Design of Springs:** Types of Springs, stresses in springs, equalized stresses. Energy stored in springs
2. **Design of Belt, Rope & Chain Drives:** Selection of open & cross flat belts, V-Belts, Wire ropes, chain drive; **Design of Brakes:** Block brakes, Band brakes, self-locking brakes.

3. **Design of Spur Gears:** Force analysis, Stresses in gear tooth, Lewis equation and form factor, Wear Strength of gear tooth, dynamic load; **Design of Helical Gears:** Kinematics, Formative no. Of teeth**,** Force analysis, Beam strength of helical gear tooth, Design for strength, dynamic and wear load
4. **Design of Bevel Gears:** Kinematics, formative no. Of teeth**,** Force analysis, Beam strength of Bevel gear tooth, Design for strength, dynamic and wear load; **Design of Worm and Worm Gear Drive:** Kinematics, Force Analysis, AGMA proportions, AGMA rating, Thermal Capacity, Design for strength and wear load.
5. **Lubrication & Bearings:** Mechanisms of Lubrication, Petroff's equation, heat generated, heat dissipation, bearing materials, lubricants and properties, Boyd and Raimondi charts; **Ball & Roller Bearings**: Bearing Life, equivalent bearing load, selection of bearings, Bearings for cyclic loads and speeds.

Prerequisite Course: None

Reference Books:

1. "Design of Machine Design Elements" by V B Bhandari, Tata McGraw Hill, FourthEdition, 2017.
2. "Mechanical Engineering Design (SI Units)", by J E Shigley, C R Misshke, R G Budynas and K J Nisbett, Tata McGraw Hill, Eighth Edition, 2008.
3. "Design of Machine Design Elements" by C S Sharma and Kamlesh Purohit PHI, Tenth Printing, 2015.
4. "Design Data Handbook for Mechanical Engineers" by K Mahadevan and K Balaveera Reddy, CBS Publishers and Distributors, Fourth Edition, 2013.

UE16ME352:
HEAT TRANSFER (3-1-0-4-4)

Course Objectives:

- To introduce the students to various engineering correlations of heat transfer analysis and thermal design of engineering components and systems.
- To introduce the students to the three types of heat transfer and its characterization using the basic equations and boundary conditions
- To help the students evaluate the heat transfer process parameters and use various methods to solve related engineering problems

Course Outcomes:

At the end of the course, the student will be able to

- Define conduction, convection and radiation heat transfer applied to engineering systems.
- Compute the conduction heat transfer across different geometries, based on various constraints and boundary conditions and use finite different methods to solve problems related to conduction heat transfer
- Pedict the thermal response of engineering systems to energy transfer mechanisms for transient and steady state situations and employ various charts and correlation tables for solving transient heat conduction problems
- Analyze the flow of heat over bodies with respect to convection mechanism and solve various engineering problems related to hydrodynamically or thermally developed flow and analyze and calculate the heat transfer characteristics based on forced or free convection
- Debate on boiling and condensation processes and also on heat exchangers and their working and apply the various laws to calculate the heat transfer characteristics of radiation and the various determining factors

Course Content:

1. **Mechanisms of Heat Transfer:** Conduction Basic Equations and Boundary Conditions; One Dimensional Steady State Conduction.
2. **Transient Conduction:** Lumped system analysis; transient conduction analysis; Finite Difference Methods for Conduction: steady state conduction; Explicit finite difference equations; Implicit Scheme
3. **Convection:** Basic concepts for flow over bodies; flow through duct; turbulence; Forced convection for flow inside ducts: COUETTE flow, flow over bodies
4. **Free convection:** Dimensionless parameters; Correlations; Boiling & Condensation: Nusselt's theory; correlations for determining heat transfer coefficient
5. **Heat Exchangers:** Classification of heat exchangers; overall heat transfer coefficient; Radiation Heat Transfer Among Surfaces in a Non-Participating Medium: associated laws; Hottel's Cross string formula

Prerequisite Course: UE16ME202 – Engineering Thermodynamic**s**

Reference Books:

1. "Heat and Mass Transfer: Fundamentals and Applications", Cengel, Yunus A. and Ghajar, Afshin J., McGraw-Hill, 5th Edition, Special Indian Edition, 2016.
2. "Heat Transfer – A basic Approach", M. Necati Ozisik, McGraw-Hill International Edition, 1985.
3. "Fundamentals of Heat & Mass Transfer", Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, K. N. Seetharamu, T. R. Seetharam, Wiley India Publication, Edition, 2013.

UE16ME353:
METAL FORMING PROCESSES (4-0-0-2-4)

Course Objectives:

- To introduce to the students the concepts of hot and cold forming and discuss the effects of temperature, metallurgical structure, speed of deformation and friction on forming operation
- To introduce to the students the classification, process, principles and equipments involved in forging, rolling, extrusion, drawing and sheet metal forming operations
- To familiarize the students with the defects and stresses involved in various metal forming operations and enable students to understand the specific areas of application of each forming operations

Course Outcomes:

At the end of the course, the student will be able to

- Understand the plastic flow in metals and factors that influence the properties of formed products
- Analyze various aspects of metal forming operation and make necessary adjustments to the process to minimize the adverse effects of various factors
- Analyze in detail the forging, rolling, extrusion drawing and sheet metal forming operations with respect to operation, stresses involved, identification of defects and identify forming operation for a given application

Course Content:

1. **Fundamentals of Metal working:** Classification; Mechanics of Metal working ; Temperature in Metal working ; Metallurgical structure; Deformation zone geometry; Workability; Residual stress; Experimental techniques for Metal working processes; Computer Aided Manufacturing.
2. **Forging:** Classification; equipment ; Types, Calculations; Powder Metallurgy forging; Residual stresses

3. **Rolling:** Classification; Rolling of Bars and shapes; Forces and geometric relationships Simplified analysis of Rolling load; defects in Rolled products.
4. **Extrusion and Drawing:** Classification; equipment; Types, Deformation, lubrication and defects in Extrusion; Extrusion of Tubing; Production of seamless pipe and tubing Rod and Wire drawing processes; Tube drawing processes; Residual stresses in Rods, Wires and Tubes..
5. **Sheet Metal Forming:** Forming methods; Shearing and Blanking; Bending ; Stretch forming; Deep drawing; Forming limit criteria; Defects in formed products; Press work.

Prerequisite Course: None

Reference Book:

1. "Mechanical Metallurgy", George E Dieter, McGraw Hill Book Company, SI Metric Edition, 1988.
2. "Metal Forming Processes", Surendra Kumar, New Age Intrantyional Publishers, First Edition, 2006.

UE16ME354:
DYNAMICS AND DESIGN LABORATORY (0-0-2-0-1)

Course Objectives:

- To enable students to practically determine principal stresses & strains in structural members and thin pressure vessels
- To enable students to balance rotating masses in different planes and reciprocating masses
- To help students in understanding the process of determining the pressure distribution in journal bearing
- To teach students to estimate the gyroscopic effect on disc
- To enable students to practically determine performance characteristics of the porter Hartnell governor

Course Outcomes:

At the end of the course, the student will be able to

- Determine principal stresses & strain in thin pressure vessel and part subjected combined both bending and torsion
- Identify performance characteristics of the porter Hartnell governor
- Perform static & dynamic balancing of rotating masses in different planes and reciprocating masses
- Determine the pressure distribution in journal bearing
- Understand the development of gyroscopic effect on disc and calculate its moment of inertia

Course Content:

1. Determination of performance characteristics of the porter governor.
2. Determination of Controlling force, Spring force and Characteristic curves of the Hartnell Governor
3. Determination of magnitude and direction of Principal stresses in thin pressure vessel & comparison with analytical estimate.
4. Determination of principal stresses and strains in a member subjected to combined bending and torsion
5. Static and Dynamic Balancing of a shaft carrying several masses of unknown unbalance in different planes.
6. Determination of mass moment of inertia of a plane disc using a Gyroscope & comparison with analytical estimate
7. Determination of pressure distribution in journal bearing
8. Torque Analysis of Epicyclic Gear Train Arrangement
9. Dynamic balancing of reciprocating masses
10. Study of follower motion of for the given cam and to determine displacement, velocity and acceleration.

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by the Department of Mechanical Engineering, PESU.

UE16ME355:
HEAT TRANSFER LABORATORY (0-0-2-0-1)

Course Objectives:

- To develop basic skills required to conduct experiments in the area of heat transfer
- To help the students to understand the process of heat transfer in various appliances and mechanisms
- To help the students implement the theoretical knowledge harnessed through lectures evaluate the performance characteristics of various real world applications

Course Outcomes:

At the end of the course, the student will be able to conduct experiments on and analyse:

- Conduction – steady state and transient
- Convection – free and forced
- Radiation heat transfer
- Use of extended surfaces
- Heat exchangers

Course Content:

1. To determine the thermal conductivity of the given metal rod.
2. To determine (i) overall thermal conductance and (ii) contact resistance for a plane composite wall.
3. To determine the transient temperature distribution in a sphere exposed to (i) air and (ii) water and compare with theoretical predictions.
4. To determine the efficiency of the pin fin and compare it with the theoretical value when (i) the fin is exposed to still air (ii) when the fin is exposed to air moving with a certain velocity.
5. To propose a correlation for finding heat transfer coefficient for free convection
6. To determine local and average heat transfer coefficients for flow through a circular tube subjected to uniform wall heat flux.
7. To determine the mean temperature difference and effectiveness of a (i) a parallel flow heat exchanger and (ii) counter flow heat exchanger and compare the theoretical values.
8. To determine the film wise condensation heat transfer coefficient for a vertical surface and compare with theoretical predictions.
9. To verify Stefan Boltzman Law of radiation (Determination of Stefan Boltzman constant).
10. To determine the emissivity of the given surface.

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by the Department of Mechanical Engineering, PESU.

UE16ME331:
ELEMENTS OF SPACE TECHNOLOGY (3-1-0-4-4)

Course Objectives:

- Introduce the students to various Satellite systems, launch vehicle configuration, appropriate orbits and trajectories along with an overview of the related mechanics for orbit calculations
- Expose them to the various satellite subsystems and its design, various aerospace materials presently used and its space quality and reliability

Course Outcomes:

At the end of the course, the student will be able to

- Articulate on the difference between various satellite systems, the orbits attained by the satellites and the various trajectories used to reach those orbits
- Apply Newton's laws and various orbital parameters to perform orbital and velocity calculations for launching satellites/ spacecrafts
- Explain about the launch sequence, the various stabilisation methods, angles and orbital effects that the satellite undergoes while launching
- Recognise the importance of each satellite subsystem and articulate on its design and role on the satellite system as a whole
- Explain about the various types of aerospace materials used and their choice based on the material characteristics

Course Content:

1. **Introduction to Satellites:** Space environment and its effects on satellites, Low Earth Orbit and Geo Synchronous Satellites, communication – domestic and international, future trends, satellite types
2. **Satellite orbit and Trajectories:** Principles, Newton's laws, Orbital Parameters, velocity and orbit calculations, eccentricity, distance from earth, sun synchronization and related mechanics
3. **Satellite Launch and launch vehicles:** Launch sequence, satellite stabilization, orbital effects, launch vehicle, look angles, earth coverage and ground tracking
4. **Design Considerations of the major subsystems of satellites:** Major subsystems of satellites, space qualification and reliability
5. **Space structures and materials:** Construction and Structural Layout, Flight Envelope and V-N Diagrams, Geodesic Construction, Aerospace Materials, Metallic and Non-Metallic aerospace materials

Prerequisite Course: None

Reference Book:

1. "Understanding Space: An Introduction to Astronautics", McGraw-Hill Inc., 1994
2. "Satellite Technologies, Principles and Applications", A K Maini, Varsha Agrawal, John Wiley and Sons, 2011.

UE16ME332:
TURBOMACHINES (3-1-0-4-4)

Course Objectives:

- To introduce the students to the principles of turbomachinery and the basic analysis of the expansion and compression processes
- To help the students to appreciate the energy exchange characteristics that take place in turbo machines
- To introduce various types of turbines, blowers and pumps and the evaluation of their performance characteristics

Course Outcomes:

At the end of the course, the student will be able to

- Explain the principles of turbo machinery, application of laws of thermodynamics to turbo machines, dimensional analysis and performance characteristics and apply the same to solve problems.
- Derive on the Euler's Turbine equation and to be able to draw velocity triangles at inlet and exit for different situations, for all types of turbo machines; apply the same towards solving problems
- Discern the principles of pumps, fans, compressors & turbines and the impulse, reaction utilization factor etc. in turbines
- Draw velocity triangles for impulse and reactions steam turbines and use the same for solving numerical problems.
- Explain the design of steam and gas turbines and evaluate the performance of the same

Course Content:

1. **Review of Energy Transfer in Turbo machines:** Turbo Machine; Classification; Efficiency; Dimensionless parameters; Specific speed; The Euler Turbine Equation; Impulse and Reaction Turbines; Utilization factor; Compressors and Pumps.
2. **Steam Turbines:** The steam turbine; Impulse staging; Velocity and Pressure compounding; Effects of blade and nozzle losses; Reaction staging; Reheat factor; Losses; radial equilibrium; Performance characteristics of steam turbines.
3. **Gas Turbines:** The Brayton cycle; components and materials; Reheat factor; Losses; Aerodynamic and thermal design; cooling methods; Component matching and Performance Evaluation of Gas Turbines: Performance characteristics; Equilibrium Running diagram, Performance evaluation, operating line; General matching procedures; Transient operation
4. **Centrifugal Compressors:** Essential parts; Principle of operation, Blade shape and velocity triangles; Analysis of flow, Performance parameters; Losses; compressor characteristics; Surging and Choking; Diffuser; Volute casing; Axial flow compressors: Geometry and working principle; Stage velocity triangles; work done factor; Enthalpy Entropy diagram for a stage; performance characteristics and analysis.
5. **Hydraulic Turbines:** Hydraulic power utilization; Classification; The Pelton wheel; Francis and Deriaz turbines; Kaplan turbines; Application of aero foil theory to Propeller blades; Centrifugal and axial flow pumps: The centrifugal pump; Power output and efficiencies.

Prerequisite Course: UE15EME202 – Engineering Thermodynamics

Reference Books:

1. "An Introduction to Energy Conversion Volume III-Turbomachinery", Vedanth Karambi and Manohar Prasad, New Age International Publishers, Second edition, 2011.
2. "Gas Turbines", V.Ganesan, Tata McGraw-Hill Publishing Company Limited, Third Edition, 2010.
3. "Turbomachinery Design and Theory**",** Rama S.R. Gorla and Aijaz A. Khan, Marcell Decker Incop.,USA, First Edition,2003

UE14ME333:
INTRODUCTION TO VEHICLE DYNAMICS (3-1-0-4-4)

Course Objectives:

- Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline
- Application of established engineering methods to automotive design and analysis
- In-depth understanding of specialist bodies of knowledge within the engineering discipline
- Familiarization with modeling and analysis methods
- Familiarization of the vehicle dynamics terminology

Course Outcomes:

At the end of the course, the student will be able to

- Calculate dynamic wheel loads as influenced by accelerations, grades, aerodynamics and towed vehicles
- Predict the traction and power limited acceleration performance of the vehicles

- Estimate aerodynamic and rolling resistance forces exerted on the vehicle and their implications on fuel economy
- Compute fundamental braking response attributes and Estimate brake system balance and brake proportioning
- Determine understeer properties based on tyre, suspension and steering system properties
- Evaluate low-frequency vehicle vibration in relation to the ride comfort criterion

Course Content:

1. **Introduction:** Review of Rigid Body Dynamics, Vehicle dynamics Terminology, Vehicle Co-ordinate Systems, Vehicle inertia properties; **Forward vehicle dynamics:** Axle loads of vehicle and vehicle/trailer combinations.
2. **Tyre Mechanics:** Terminology, Elastic Band Model for longitudinal slip, Simple model for lateral slip, combined longitudinal/lateral slip (friction ellipse), Magic Formula; **Vehicle Aerodynamics:** Aerodynamic forces and Moments, Total road loads.
3. **Longitudinal Dynamics of Road Vehicles:** Acceleration Performance, Braking Performance.
4. **Handling Characteristics of Road Vehicles:** steering geometry, Handling Characteristics of a two-axle vehicles, Steady-State response to steering input, Testing of handling characteristics; Transient Response Characteristics Road Vehicles, Criteria for Directional Stability.
5. **Ride Characteristics of Road Vehicles:** Ride excitation sources, Human response to vehicle vibration, Vehicle ride models, Road profile roughness and modeling, Evaluation of vehicle vibration in relation to the ride comfort criterion.

Prerequisite Course: UE16ME254 - Engineering Mechanics - Dynamics

Reference Books:

1. "Theory of Ground Vehicles", J. Y. Wong, John Willey & Sons NY, Third Edition, 2001
2. "Fundamental of Vehicle Dynamics", Thomas D. Gillespie, Society of Automotive Engineers International, USA, First Edition, 1992.
3. "Vehicle Dynamics: Theory and Applications", Reza N. Jazar**,** Springer, Second edition, 2014.

UE16ME334: MECHANISM DESIGN (3-1-0-4-4)

Course Objectives:

- To teach the students basic concepts related mechanism inversions, force and torque analysis, degrees of freedom for joints, equivalent and unique mechanism
- To help students understand the fundamentals of number analysis needed for mechanism analysis
- To teach the students important concepts and methods employed in linkage synthesis and motion generation
- To help students understand the graphical methods and important concepts related to coupler curves
- To teach Freudenstein's and Bloch method of analytical mechanism synthesis

Course Outcomes:

At the end of the course, the student will be able to

- Explain basic concepts related mechanism inversions, force and torque analysis, degrees of freedom for joints, equivalent and unique mechanism
- Appreciate the fundamentals of number analysis needed for mechanism analysis
- Apply concepts and methods employed in linkage synthesis and motion generation
- Employ graphical methods and coupler curves in mechanism analysis
- Use Freudenstein's and Bloch method for mechanism synthesis

Course Content:

1. **Planar Mechanisms and Geometry of Motion:** Basic concepts, Grashoff's law, Transmission of torque and force in mechanisms, Mobility, Equivalent mechanisms, Unique mechanisms; Number Synthesis.
2. **Synthesis of Linkages:** Function generation, Path generation and body guidance, Precision positions, Structural error, Chebychev spacing; Motion Generation: Poles and relative poles, Relative poles of 4-bar and slider crank mechanisms.
3. **Graphical Methods of Dimensional Synthesis:** Two position synthesis of crank and rocker mechanisms, three position synthesis, four position synthesis, Overlay method.
4. **Coupler Curves:** Equation of coupler curves, Synthesis for path generation, Graphical synthesis for path generation, Robert-Chebyshev theorem, Coupler curves from 5-bar mechanisms
5. **Analytical Methods of Dimensional Synthesis:** Freudenstein's equation for 4-bar mechanism and slider crank mechanism, Bloch's method of synthesis.

Prerequisite Course: UE16ME203 – Mechanics of Solids

Reference Books:

1. "Theory of Machines & Mechanism", John Joseph Uicker, G R Pennock, Joseph Edward Shigley, Oxford University Press, 3rd Edition, 2003.
2. "Mechanism & Machine Theory", A G Ambekar, PHI Learning Pvt. Ltd., First Edition, 2007.
3. "Kinematics, Dynamics & Design of Machinery", K J Waldron, G L Kinzel, Wiley India, Second Edition, 2007.
4. "Advanced Mechanism Design: Analysis and Synthesis Volume II", Sandoor and Arthur G Erdman, PHI, Second Edition, 2006.
5. "Kinematics & Dynamics of Machinery", Charles E Wilson and J Peter Sadler, Pearson Publications, Third Edition, 2008.

UE16ME335: SMART MATERIALS (4-0-0-2-4)

Course Objectives:

- To help students acquire a broad overview of the field of smart materials and smart systems
- To teach the underlying principles in smart materials
- To teach the material science involved in Smart materials
- To adapt smart materials in Industrial applications

Course Outcomes:

At the end of the course, the student will be able to

- Discern the physical principles underlying the behavior of smart materials.
- Interpret basic principles and mechanisms of the stimuli-response for the smart materials and systems
- Develop an insight into the practical applications of smart materials

Course Content:

1. **Intelligent and Smart Materials:** Background, Primitive functions, Intelligence inherent in materials, Materials inherently harmonizing with humanity; Background to smart systems, Actuator materials, Sensing technologies, Micro-sensors, Intelligent systems, Hybrid smart materials.
2. **Smart structural systems and Piezoelectric materials:** Passive sensory smart structures, Reactor actuator-based smart

structures, Active sensing and reactive smart structures, smart skins, Aero-elastic tailoring of aero-foils;

3. **Piezoelectric materials and Shape memory Alloys:** Piezoelectric materials, Piezoelectricity, Industrial Piezoelectric materials, smart materials featuring Piezoelectric systems; shape memory alloys, pseudo elasticity, phase transformations; shape memory plastics.
4. **Electro-rheological and Magneto- rheological Fluids:** Suspensions and electro-rheological fluids, The electro-rheological phenomenon, Charge migration mechanism for the dispersed phase, electro-rheological fluid actuators; Principles of MR fluids, Types of Magneto Rheological fluids, Applications of electro-rheological and Magneto Rheological fluids.
5. **Fiber – Optic sensors:** Fiber optic sensors, light propagation in an optical fiber, embedding optical fibers in fibrous polymeric thermo-sets, Fiber-optic strain sensors

Prerequisite Course: None

Reference Books:

1. "Smart Materials and Structures", M. V. Gandhi and B. D Thompson, Chapman and Hall, London, First Edition, 1992.
2. "Smart Structures: Analysis and Design", A. V. Srinivasan, Cambridge University Press, Cambridge; New York, First Edition, 2001.

UE16IE331:
AUTOMOTIVE ELECTRONICS (3-1-0-4-4)

Course Objective:

- To broaden the importance of vehicle intelligence system
- Introduce students to the electronic systems on board an automobile through multidisciplinary training
- To develop an understanding of the challenges that automotive environment presents to system designer,
- To present an overview of the future technologies in automotive field
- To create awareness with the automotive designer about the impact that electronic systems have on mechanical design, to inculcate in students the principles of mechatronics system design

Course Outcome:

At the end of the course, the student will be able to

- Design intelligence vehicle safety systems
- Explain the concepts of embedded systems and related OS
- Analyse various electronics systems like sensors, fuel injection system, ECU
- Design and development of engine management systems
- Elucidate different protocols available for automotive embedded systems.

Course Content:

1. **Automotive Electricals and Electronics:** Automotive Mechanical Systems: Vehicle Systems: Power Train System, Transmission System, Braking System (Drum, Disc, Hydraulic, Pneumatic), Steering System; Electronics in Automotive Systems; Basic electrical components and operation in an automobile
2. **Introduction to Embedded Systems & Operating system in Embedded Environment:** Components, embedded board; **OS:** purpose, RTOS, Scheduler, Interrupt, multi-tasking, Task synchronization, Inter-task communication.
3. **Integrate Development Environment:** HW / SW configuration, Booting reconfiguration, Managing IDE, debugging, PC based debugger
4. **Embedded System in Automotive Applications: Engine management; Body electronics**; Software calibration using engine and vehicle dynamometers, Automated Driving.
5. **Embedded System Communication Protocols:** control networking, – Communication protocols, Vehicle communication protocols, CAN, LIN, FLEXRAY, MOST, KWP2000. Automotive Embedded Security

Prerequisite Course: None

Reference Books:

1. BOSCH Automotive Handbook, Sixth Edition, 2004.
2. "Automobile Electrical and Electronic Systems", Denton.T, Butterworth Heinmann, 4th Edition, 2012.
3. "Automotive Electronic and Computer Controlled Ignition Systems", Knowles.D, Prentice Hall, First Edition, 1988.
4. "Automotive Electronic Systems", William T.M, Butterworth Heinmann, First Edition, 1987.
5. "Automotive Software Engineering – Principles, Processes, Methods and Tools", Joerg Schaeuffele, Thomas Zurawka, SAE International, Second Revised Edition, 2016.
6. "µC/OS-II Real Time Kernel", Jean J.Labrosse, R&D Publishers, Second Editions, First Edition, 1999.
7. "Automotive Electronics Handbook", Ronald K.J, McGraw Hill Professional, First Edition, 1999.
8. "Automotive Embedded System Handbook", Nicholas Navit, CRC Press, Ninth Edition, 2009.
9. "Automotive SW Engineering", Jorg Schauffer, SAE Publications, First Edition, 2005.

UE16ME341:
INTRODUCTION TO GAS DYNAMICS (3-1-0-4-4)

Course Objectives:

- Introduce the students to the isentropic flows, stagnation properties and the importance of compressible flows
- To teach students the essential concepts of normal shocks, oblique shocks and prandtl-meyer expansion waves.
- To provide students with a firm understanding of fanno and rayleigh flows.
- Introduce students to the measurements involved in gas dynamics.

Course Outcomes:

At the end of the course, the student will be able to

- Apply the conservative equations for the compressible flows and determine the thermodynamics properties across the normal and oblique shock waves.
- Calculate the Prandtl-Meyer flow properties and wave angles
- Find the thermodynamic and flow variables for one-dimensional converging-diverging nozzle flows with various pressure ratios
- Compute the effects of heat addition and friction on compressible flows
- Employ the principles of measurements on compressible flows

Course Content:

1. **Fundamentals of Compressible Flow:** Isentropic Flow, Sonic Velocity, Mach number and its Significance, Regions of Flow, Effect of Mach Number, Energy Equation.
2. **Varying Area Isentropic Flows and Normal Shocks:** Critical Speed of Sound, Critical Flow Area and Choking, Development of Shock Wave, Hugoniot Equation, Thermodynamic and Flow Properties

3. **Oblique Shocks and Expansion Waves:** Oblique Shock Formation and Relations, Governing Equation of Prandtl-Meyer Flow, Prandtl Meyer Function, Prandtl Meyer Expansion Fan.
4. **Fanno and Rayleigh Flows:** Introduction, Governing Equations, Flow in Constant Area Duct with Friction, Friction Choking, Thermal Choking, Hypersonic Flow.
5. **Measurements in Gas Dynamics:** Pressure, Temperature and Velocity measurements, Techniques of Flow Visualization in Compressible Flows

Prerequisite Course: UE16ME251 – Mechanics of Fluids

Reference Books:

1. "Applied Gas Dynamics", E Rathakrishnan, Wiley, First Edition, 2010.
2. "Modern Compressible Flow", J D Anderson, McGraw-Hill, Third Edition, 2002.

UE16ME342:
COMPUTATIONAL FLUID DYNAMICS (3-1-0-4-4)

Course Objectives:

- To help students develop sound understanding of 1D computations by finite difference method (FDM), finite element method (FEM) and finite volume method (FVM) and expose them to the types boundary conditions
- To teach the basic governing equations of CFD, different finite difference schemes and access the accuracy of FD solution
- To teach the students different solution methodologies for FD equations and also stability analysis

Course Outcomes:

At the end of the course, the student will be able to

- Discern the concepts of 1D computations by finite difference method (FDM), finite element method (FEM), finite volume method (FVM) and types of boundary conditions
- Explain and derive basic governing equations of CFD and employ different finite difference schemes
- Assess the accuracy of FD solution
- Elucidate different solution methodologies used for solving and hyperbolic, parabolic and elliptic governing equations
- Perform stability analysis for FD equations

Course Content:

1. **Introduction:** One-dimensional computations by finite difference methods; One-dimensional computations by finite element methods; One-dimensional computations by finite volume methods; Boundary conditions – Neumann and Dirichlet boundary conditions
2. **Governing Equations for CFD:** Governing equations of fluid flow and heat transfer, equation of state, Navier-Stokes equations for a Newtonian fluid, general transport equations, fluid flow equations
3. **The Finite Volume Method for Diffusion Problems:** one, two and three -dimensional steady state diffusion; **Finite Volume Method for Convection-Diffusion Problems**: Steady one-dimensional convection and diffusion, differencing scheme, power law scheme, higher order differencing scheme for convection-diffusion problems.
4. **Solution Algorithms for Pressure-Velocity Coupling in steady flows and Discretised Equations:** the staggered grid, the momentum equations, SIMPLE, SIMPLER, SIMPLEC and PISO algorithm, general comments on the algorithms, Tri-diagonal matrix algorithm
5. **Finite Volume Method for Unsteady Flows:** One-dimensional unsteady heat conduction, Explicit scheme, Crank-Nicolson Scheme, fully implicit scheme, Discretization of transient convection-diffusion equation. Solution procedures for unsteady flow calculations

Prerequisite Course: UE16ME251 – Mechanics of Fluids

Reference Books:

1. "Computational Fluid Dynamics", T.J.Chung, Cambridge University Press, 1st South Asian Edition, 2003.
2. "Computational Fluid Dynamics – A Practical Approach", Jiyuan Tu, Guan Heng Yeoh and Chaoqun Liu, Butterworth- Heineman, Third Edition, 2008.
3. "Computational Fluid Dynamics", John D Anderson, McGraw-Hill International Edition, 1995.

UE16ME343:
HYBRID AND FUEL CELL VEHICLES (3-1-0-4-4)

Course Objectives:

- To provide essential knowledge on alternative propulsion systems for ground vehicles.
- To enable the students to understand the working of Hybrid electric vehicles
- To teach students the underlying concepts of fuel cell technology.
- To enable the students to understand the operating principles, design of electric vehicle subsystems.

Course Outcomes:

At the end of the course, the student will be able to

- Articulate current trends pertaining sustainable mobility requirements and solution techniques through automotive research
- Elucidate on advanced knowledge on electric and hybrid electric vehicle configurations,
- Appreciate the necessity of on-board energy storage systems
- Discern the concepts of electric machines and their control for automotive applications
- Simulate and optimize electric vehicle subsystems.

Course Content:

1. **Vehicle Mechanics,** Roadway Fundamentals, Vehicle Kinetics, Propulsion Power, Tire-Road Force Mechanics, Propulsion system design, **Types of Electric Vehicles – EV Architecture**
2. **Hybrid Electric Vehicles,** Types of Hybrids, Series and Parallel HEV's, Series-Parallel Combination, Complex HEV, IC Engines, Reciprocating Engines, Gas Turbine Engine, Emission control systems, Vehicle Fuel Economy, Design of HEV
3. **Electric Machines and their Controllers,** The 'Brushed' DC Electric Motor, DC Regulation and Voltage Conversion, Brushless Electric Motors, Motor Cooling, Efficiency, Size and Mass, Electrical Machines for Hybrid Vehicle
4. **Energy Storages, Lead**-Acid Batteries, Nickel-based Batteries, Nickel/Iron System, Nickel/Cadmium System, Nickel–Metal Hydride (Ni–MH)Battery, Lithium-Based Batteries, Lithium–Polymer (Li–P) Battery, Lithium-Ion (Li-Ion) Battery, Ultracapacitors, Ultrahigh-Speed Flywheels.
5. **Fuel Cell Vehicles,** Operating Principles, Fuel Cell Technologies, Proton Exchange Membrane Fuel Cells, Alkaline Fuel Cells, Phosphoric Acid Fuel Cells, Molten Carbonate Fuel Cells, Solid Oxide Fuel Cells, Direct Methanol Fuel Cells, Non-hydrogen Fuel Cells.

Prerequisite Course: None

Reference Books:

1. "Electric and Hybrid Vehicles Design Fundamentals", Iqbal Husain, CRC Press, Washington D. C., Second Edition, 2005
2. "Electric Vehicle Technology Explained", James Larminie, John Lowry, John Wiley & Sons, Ltd., New York, Second Edition, 2012
3. "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", Mehrdad Ehsani, Ali Emadi, CRC Press, Washington D. C., Second Edition, 2005
4. "Fuel Cell Systems Explained", Larminie, J. and Dicks, A., John Wiley & Sons, Ltd., New York, Third Edition, 2001.
5. "Recent Trends in Fuel cell Science and Technology", Basu S, Anamaya Publishers, New Delhi., First Edition, 2007.
6. "Fuel Cells Principles and Applications", Viswanathan B, Aulice Scibioh M, Universities Press (India) Pvt Ltd., Hyderabad, First Edition, 2006.

UE16ME344: THEORY OF PLASTICITY (3-1-0-4-4)

Course Objectives:

- Know the main physical features of elasto-plastic deformations and their engineering implications
- To have a good understanding of how to describe elasto-plastic behavior, including yield limit, loading-unloading phenomena and different failure criteria.
- To provide students the essential concepts of strain hardening and subsequent yield, flow rule for plastic flow
- To teach students the plasticity theory of bending of beams and torsion of rods

Course Outcomes:

At the end of the course, the student will be able to

- Employ the main principles of the theory of plasticity for large deformations
- Derive and apply equations in the theory of plasticity for large deformations and apply established plasticity models in the analysis of structures
- Give an account of the fundamental concepts of lines of discontinuity and planes of discontinuity including strains in lines of discontinuity
- Use the plastic stress strain relations, criteria of yielding and flow rule for plastic flow.
- Do the stress analysis for the members subjected to plastic bending and plastic torsion.

Course Content:

1. **Fundamental of Elasticity:** Plastic Deformation of Metals: Crystalline structure in metals, mechanism of plastic deformation, factors affecting plastic deformation, Luder's cubes.
2. **Cubical Dilation, True Stress and Strain:** Strain tensor, principal strain, plane strain, spherical and deviator strain, octahedral strain and representative strain, Stress Strain Relations: empirical equations, theories of plastic flow, St. Venant's theory of plastic flow
3. **Yield Criteria:** Von Mises and Tresca criteria, Geometrical representation, experimental evidence for yield criteria, energy required to change the shape with basic principle problems
4. **Slip Line Field Theory:** Basic equations for incompressible two-dimensional flows, continuity equations, stresses in conditions of plain strain, Geometry and properties of slip line field, construction of slip line nets
5. **Bending of Beams:** Non-linear stress strain curve, shear stress distribution, residual stresses in plastic bending, Torsion of Bars: plastic torsion of a circular bar, elastic work hardening of material, residual stresses

Prerequisite Course: UE16ME203 – Mechanics of Solids

Reference Books:

1. "Theory of Plasticity", Chakraborty, Elsevier, 3rd Edition, 2006.
2. "Engineering Plasticity", W. Johnson and P. B. Mellor D Van N.O Strand Co. Ltd, First Edition, 2000.
3. "Basic Engineering Plasticity", DWA Rees, Elsevier, 1st Edition, 2006.
4. "Theory of Plasticity", L. S. Srinath, TMH, Third Edition, 2009

UE16ME345: ADDITIVE MANUFACTURING (4-0-0-2-4)

Course Objectives:

- To introduce and provide core knowledge of the fundamentals of 3D printing Technologies, various processes and applications
- To enable students to develop better intuition of Technical characteristics in variety of 3D Printing processes.
- To help the students understand the process of developing geometric model and visualizing in RP machines.
- To enable the students to develop an appreciation for the factors limiting accuracy and surface finish of RP models and employ subsequent correction factors.

Course Outcomes:

At the end of the course, the student will be able to

- Eexplain the basics of the current state of the art of 3D printing and its industry and applications of rapid prototyping
- Differentiate between the different processes of 3D printing along with SLS and SGC principle, preparation for and applications
- Explain the working of different 3D printings technologies and machines
- Discern applications of different indirect and direct rapid tolling
- Identify the various sources of errors and recognize the applications of the concepts learnt through a case study

Course Content:

1. **Introduction:** 3D printing Technology, History, Need for the compression in product development, Survey of application. Growth of 3D industry, 3DP information system and Work flow.
2. **3D Printing Processes:** Process, Data preparation, data files, machine details, Application, Types of machine, Principle of operation, process parameters
3. **Technical characteristics and Applications**: Functional models, Principle of Concept Modellers, Machine Details.
4. **Indirect and Direct methods of 3D printing Tooling:** Indirect and Direct Rapid Tooling, Overview of Solid view, magics, mimics, magic communicator.
5. **3D Printing process Optimization:** Factors influencing accuracy, data preparation errors, Part building errors, Error in finishing, influence of build orientation, Recent developments in RP technology. Case study, Applications of RPT

Prerequisite Course: None

Reference Books:

1. "Rapid Manufacturing", D.T.Pham, S.S Dimov, Springer, London, First Edition, 2001.
2. "Rapid prototyping and manufacturing", Paul F. Jacobs, ASME Press, First Edition, 1996.

UE16ME346:
CAD/CAM (4-0-0-2-4)

Course Objectives:

The general objectives of the course are to enable the students to

- Understand the basic fundamentals of computer aided design and manufacturing.
- To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc.
- To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication.
- To learn the part programming, importance of computer aided process planning

Course Outcomes:

At the end of the course the students shall be able to:

- Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces and solid, and the technique of transformation of geometric entities using transformation matrix.
- Describe the use of CAPP for the product development.

Course Content:

1. **Design Processes**: Design criteria, Alternative solutions; **Drafting Techniques; Geometric Modelling:** Wireframe entities, Interpolation and Approximation curves, parametric and non-parametric representation of a circle and helix curves, splines, NURBS.
2. **Surface Modeling:** Analytic surfaces, synthetic surfaces, **Solid Modeling:** C - rep and B - rep approaches; **2D Transformations:** Translation, Scaling and Rotation about arbitrary point, Shearing and Reflection, Homogeneous representation, concatenation.
3. **CAD Database and Data Exchange:** CAD Database and |Structure; **Numerical Control Machine Tools:** Features and elements, types, Canned cycles, Tool length and cutter radius compensation
4. **Computer aided process planning:** Retrieval CAPP system, Generative CAPP system, Benefits of CAPP, Manual and computer aided part programming (APT) for simple components. Programming with MACROS.
5. **Computer Numerical Control:** CNC, DNC and Adaptive control systems. Typical configurations and relative features. Machining centers, FANUC, SINUMERIC controllers. CNC Programming.

Prerequisite Course: None

References:

1. "CAD/CAM Principles and Applications", Chennakeshava. Alavala, McGraw Hill, First Edition, 2004.
2. "CAD/CAM, Theory and Practice", Ibrahim Zeid, McGraw-Hill Inc. New York, First Edition, 2011.
3. "CAD/CAM", Grover, MP and Zimmers E.W, Prentice Hall of India, Indian Edition, 1989.
4. "CAD/CAM: Principles and Applications", Rao, PN, Tata McGraw Hill, Second Edition, New Delhi, 2004.
5. "Computer Control of Manufacturing Systems", Yoram Koren, McGraw Hill Int, New York, Indian Edition, 1994.
6. "Computer Aided Manufacturing", Elanchezhian. C. Sunder Selwyn. T. Shanmuga Sunder, G, Laxmi Publications (P) Ltd., Second Edition, New Delhi, 2007.

UE16IE341:
COMPUTATIONAL MATERIAL SCIENCE (3-1-0-4-4)

Course Objectives:

- The aim of the course is to familiarize the students with knowledge of computer simulations and numerical methods in Materials Science.

Course Outcomes:

At the end of the course the student will be able to

- Analyze eigenvalue problems in quantum mechanical systems
- Calculate the band structure of a periodic solid within the tight binding framework
- Calculate the electronic structure of nanomaterials
- Calculate phononic band structure of periodic solids
- Solve the electronic and phononic structure of functional materials using ab-initio density functional theory based computational software.

Course Content:

1. **Introduction**: Crystalline and non-crystalline structures. Metals, Semiconductors, Ceramics and Glasses. Superconductors, Nanomaterials, Advanced magnetic materials, Energy materials for batteries, fuel cells and photovoltaics.
2. **Linear vector spaces**: Postulates of Quantum Mechanics. Harmonic Oscillator. Central Potential. Bloch's theorem. Tight Binding method. Electronic Density of States in Solids.
3. **Applications** of the tight-binding method to understand the electronic structure of novel materials: Metals and Semiconductors, Graphene, Carbon nanotubes. Electronic Structure of Thin Films within the tight-binding framework. Real-space tight-binding electronic structure calculations for finite systems: Metallic and Semiconducting Nanoparticles.
4. **Ion-Ion interactions**: The Classical Equations of Motion. Normal Coordinates: Phonons. Energy Content of the Lattice Vibrations: Specific Heat. Calculation of Phonon Dispersion relations. The Density of States. Acoustic and Optical Branch.
5. **Use of computational software** to solve problems in Materials science. Project Completion and Presentation: Report writing; Brief presentation of work and Quiz

Prerequisite Course: None

References Books:

1. "Introduction to Solid State Physics", Charles Kittel. Wiley Publishers, Eighth Edition, 2012.
2. "Introduction to Quantum Mechanics", David J. Griffiths, Pearson Publishers, Third Edition, 2005.
3. "Solid State Physics", M. S. Dresselhaus – Lecture Notes, Second Edition, 2005.
4. "Introduction to Solid-State Theory", O. Madelung, Springer-Verlag, First Edition,1978.
5. "Quantum Theory of the Solid State", Joseph Callaway, Academic Press, Second Edition, 1974.

UE15ME401:
DESIGN OF MACHINE ELEMENTS – II (3-1-0-4-4)

Course Objectives:

- To enable students to design important machine elements such as springs, brakes, flexible power transmission elements such as belts, ropes and chain drives

- To enable students to design different gears as per AGMA standards
- To help students in understanding and learn about different lubrication mechanism, design different types of journal bearings as per ASME Standards and select ball and roller bearings from the standard design catalogue

Course Outcomes:

At the end of the course, the student will be able to

- Design helical and leaf springs
- Design mechanical power transmission members such as belt drives, rope drives & chain drives depending on various applications
- Design spur, helical, bevel and worm gears subjected to static, dynamic & wear load conditions as per AGMA standards
- Explain the mechanism of lubrication, list different lubricants and their properties and, design journal bearings.
- select ball and roller bearings from the manufacturer's catalogue for the required application

Course Content:

1. **Design of Springs:** Types of Springs, stresses in springs, equalized stresses. Energy stored in springs
2. **Design of Belt, Rope & Chain Drives:** Selection of open & cross flat belts, V-Belts, Wire ropes, chain drive; **Design of Brakes:** Block brakes, Band brakes, self-locking brakes.
3. **Design of Spur Gears:** Force analysis, Stresses in gear tooth, Lewis equation and form factor, Wear Strength of gear tooth, dynamic load; **Design of Helical Gears:** Kinematics, Formative no. Of teeth**,** Force analysis, Beam strength of helical gear tooth, Design for strength, dynamic and wear load
4. **Design of Bevel Gears:** Kinematics, formative no. Of teeth**,** Force analysis, Beam strength of Bevel gear tooth, Design for strength, dynamic and wear load; **Design of Worm and Worm Gear Drive:** Kinematics, Force Analysis, AGMA proportions, AGMA rating, Thermal Capacity, Design for strength and wear load.
5. **Lubrication & Bearings:** Mechanisms of Lubrication, Petroff's equation, heat generated, heat dissipation, bearing materials, lubricants and properties, Boyd and Raimondi charts; Ball & Roller Bearings: Bearing Life, equivalent bearing load, selection of bearings, Bearings for cyclic loads and speeds.

Prerequisite Course: None

Reference Books:

1. "Design of Machine Design Elements" by V B Bhandari, Tata McGraw Hill, FourthEdition, 2017.
2. "Mechanical Engineering Design (SI Units)", by J E Shigley, C R Misshke, R G Budynas and K J Nisbett, Tata McGraw Hill, Eighth Edition, 2008.
3. "Design of Machine Design Elements" by C S Sharma and Kamlesh Purohit PHI, Tenth Printing, 2015.
4. "Design Data Handbook for Mechanical Engineers" by K Mahadevan and K Balaveera Reddy, CBS Publishers and Distributors, Fourth Edition, 2013.

UE15ME402:
CONTROL ENGINEERING (3-1-0-4-4)

Course Objectives:

- Mathematical Modeling, of mechanical and electromechanical control systems
- Characteristics and performance of feedback systems: transient and steady state response of lower order systems
- Stability analysis of feedback systems using Routh- Hurwitz criterion, root locus method, stability in frequency domain using polar plots, bode plots, performance specifications
- Basic concepts of digital control systems.

Course Outcomes:

At the end of the course, the student will be able to

- Solve problems on open and closed loop control systems with feedback and derive mason's gain formula and block diagram reduction
- Solve problems related to engineering application involving mechanical systems and models of thermal and hydraulic systems
- Solve problems on transient and steady state response system with different inputs
- Derive routh – hurtiwizen criterion and sketch root loci, bode-nyquest plots
- Identify different control systems, solve problems and predict controllability and observability for space state problems.

Coruse Content:

1. **Automatic Control Systems:** automatic controls, control systems, feedback, ideal control system; **Mathematical Modeling:** Laplace transforms, Transfer functions, Mechanical systems, Electrical Analog of mechanical systems, thermal and hydraulic systems; **Block diagrams and signal flow graphs:** Mason's gain formula.
2. **System response:** Transient & Steady state response analysis, Standard test inputs, system response to unit step, ramp inputs, concept of time constant, speed of response. Steady State Error, Static and Dynamic Error Constants. System stability, Routh-Hurwitz Criterion.
3. **Stability, R-H criterion, Root Locus:** The root locus concept, Guidelines for sketching root loci, Selected illustrative root loci.
4. **Frequency response –Polar, Nyquist, Bode Diagrams:** Polar plots, Nyquist Stability Criterion, Stability analysis, Relative stability concepts, Phase and gain margin, M&N circles; **Frequency response analysis using Bode plots:** Bode attenuation diagrams, Stability Analysis using Bode plots, Simplified Bode Diagrams.
5. **Introduction to P-I-D controllers:** Types of controllers; **Analysis of control systems in state space:** state concepts, state-space representation of transfer-function systems, controllability and observability; **Digital control systems**

   Hands-on exercises: Experiments on Free vibration of spring mass system both damped and undamped, torsional vibrations both damped and undamped, Whirling of shaft, Spring-mass system (Pendulum type), Transmissibility ratio, Base Excitation, Impulse Response of a Cantilever Beam, Simulation of a typical first order & second order system and determination of step response of the system, frequency response of second order, impulse response, ramp response & sinusoidal input response of the second order system, root locus plot for the given open loop transfer function G(s) H (s), Determine the closed loop poles that have the varying damping ratio, Find the gain value K at this point, gain margin and Phase margin for a given transfer function by drawing Bode plots, Nyquist plot and Introduction - Problems on Simulink

Prerequisite Course: None

Reference Books:

1. "Modern Control Engineering", Katsuhiko Ogata, Pearson Education, 2004.
2. "Control systems Principles and Design", M. Gopla, TMH, Third Edition, 2008.

3. "Feedback Control Systems", Joseph DiStefano, Schaum's Series, Second Edition, 2001.
4. "Control systems", I.J. Nagarath & M. Gopal, Newage International Publishers, First Edition, 2002.

UE15ME403: FINITE ELEMENT METHODS (3-1-0-4-4)

Course Objectives:

- To enable students with the necessary mathematical & theoretical tools, and skills required to analyze a wide range of two-dimensional, real-world, structural and thermal problems using finite element methodology

Course Outcomes:

At the end of the course, the student will be able to

- Analyze a wide range two-dimensional field problem using finite element techniques
- Apply FEM techniques and solve problems involving heat transfer by conduction
- Apply FEM techniques and solve problems involving structural and solid mechanics
- Use higher order elements in FEM and solve problems

Course Content:

1. **Introduction:** computational methods, finite difference and finite volume methods, direct stiffness method; Integral Formulation for Numerical Solution; Method of weighted residuals; Potential Energy Formulations; principle of virtual work; Elements; Coordinate Systems
2. **Two-Dimensional Field Problems:** Governing Differential Equations; Integral Equations; Element Matrices; Torsion; General Theory; Twisting of a Square Bar; Shear Stress Components; Flow of an Ideal Fluid; Potential Formulation; Groundwater Flow; Flow Around a Cylinder; Regional Aquifer; Electric and Magnetic field problems.
3. **Heat Transfer by Conduction**: Fin; The Composite Walls; Long Two-Dimensional Bodies; Boundary Conditions; axi-symmetric Field Problems; The Differential Equation; axi symmetric Elements, Galerkin's Method; Element Matrices
4. **Structural and Solid Mechanics:** The Axial Force Member; The Truss Element; A Beam Element; A Plane Frame Element: The Element Matrices; Two-dimensional stress analysis; Stress, Strain, and Hooke's Law; The Strain Displacement Equations; Two Dimensional Elasticity: Plane Stress and Plane Strain; axi symmetric stress analysis; Surface Loads.
5. **Higher Order Elements:** Iso-parametric elements; higher order elements; Element Matrices; Numerical Integration Techniques; Rectangular elements; Quadrilateral Regions; Triangular Regions; Pre and Post processing; commercially available FEM packages, Error analysis.

   Hands-on exercises: Exercises based on analysis of heat transfer, thermo-fluids and structural problems using concepts of FEM

Prerequisite Course:

UE16MA251 - Linear Algebra and Its Applications

Reference Books:

1. "Applied Finite Element Analysis", L.J.Segerlind, John Wiley and Sons, 2nd Edition, 1984.
2. "Applied Finite Element Analysis", G.Ramamurthy, I.K.International Publishing House, Second Edition, 2009.

UE15ME411: INTRODUCTION TO AERODYNAMICS (3-1-0-4-4)

Course objectives:

- To present students the theoretical aerodynamics with basic numerical applications of potential flow
- To provide students with an understanding of how an airfoil produces lift, and the effect of airfoil camber and angle of attack on the pressure distribution about an airfoil
- To introduce students the classical thin airfoil theory and Prandtl's lifting line theory for the case of wings
- To teach students the essentials fundamental concepts of high speed aerodynamics

Course outcomes:

At the end of the course students will be able to

- Use the superposition principle to build simple potential flows
- Apply airfoil theory to predict airfoil performance
- Explain the effects of camber, angle of attack and thickness on the aerodynamic characteristics of an airfoil
- Compute the performance parameters of wings using Prandtl lifting line theory
- Appreciate the importance of compressibility and compute the thermodynamics properties in high speed aerodynamics

Course Content:

1. **Aerodynamics - Fundamental Principles and Equations:** Review of Integral and Vector Calculus, Continuity Equation, Momentum Equation, Euler Equation, Bernoulli's Equation, Laminar and Turbulent Flows, Reynolds Number, Boundary Layer, Equations Governing the Boundary Layer, Navier-Stokes equations.
2. **Fundamentals of Inviscid Incompressible Flows**: Circulation and Vorticity, Green's Lemma and Stoke's Theorem, Kelvin's Theorem, Streamline, Stream Function, Irrotational Flow, Potential Function, Equipotential Lines, Elementary Flows; flow over a Cylinder, The Kutta-Joukowski
3. **Incompressible flows over airfoils**: Airfoil Nomenclature, Airfoil Characteristics, The Kutta Condition, Kelvin's Circulation Theorem and the Starting Vortex, Classical Thin Airfoil Theory, Symmetric Airfoil, Cambered Airfoil, Aerodynamics Center, Pressure Distribution, Flow Separation over Airfoils.
4. **Incompressible Flow over Finite Wings**: The Vortex Filaments, the Biot-Savart Law, Helmholtz's Theorem, Prandtl's Classical Lifting-Line Theory and its limitations. Infinite vs. Finite wing, Wing Tip Vortices, Induced Drag, Basic Experimental Concepts for Incompressible Flows.
5. **High Speed Aerodynamics on wings:** Linearized Supersonic Flow, Swept Wings and Delta Wings, Basic Ideas of Hypersonic Flow, Basic Experimental Techniques for High Speed Flows, compressibility correction

Prerequisite Course: UE16ME251 – Mechanics of Fluids

Reference Books:

1. "Fundamentals of Aerodynamics", Anderson, J. D., McGraw-Hill Education, Fifth Edition, 2010.
2. "Aerodynamics for Engineers", Bertin, J. J., Cummings, R. M., Pearson Education Limited, Sixth Edition, 2014.
3. "Theoretical Aerodynamics", Milne Thomson, L.H., Macmillan, First Edition, 1985.
4. "Aerodynamics for Engineering students", Houghton, E.L., and Caruthers, N.B., Edward Arnold Publishers Ltd., London, Seventh Edition, 2010.
5. "Aerodynamics", Clancey, L J., Pitman, First Edition, 1986.

UE15ME412: THERMAL MANAGEMENT IN ELECTRONIC PACKAGES AND SYSTEMS (3-1-0-4-4)

Course Objectives:

- To introduce the students to semiconductor technology and the importance of thermal management in electronics
- To introduce the students to the various thermal transfer process and properties of the surfaces affecting the thermal management
- To introduce the students to advanced cooling methodologies and thermal design
- To introduces them to computer simulations for solution of real world thermal management problems

Course Outcomes

At the end of the course, the student will be able to

- Explain the need for thermal management in electronic components, devices and systems and use the fundamentals of heat transfer mechanisms to design efficient cooling of electronics components and systems.
- Illustrate the usefulness of the concept of thermal resistance
- Carry out a first order analysis of heat transfer from an electronic package and system
- Debate on introduction of advanced cooling technologies
- Analyze the components and systems using commercial packages

Course Content:

1. **Introduction:** Semiconductor Technology Trends. Temperature –Dependent Failures, Importance of heat transfer in electronics. Thermal design process. Heat Transfer mechanisms; **Microelectronic packages and Thermal Resistance network:** packaging. Package thermal resistance network-series and parallel. Thermal contact resistance, Thermal interface materials, Spreading thermal resistance, Thermal resistance of printed circuit boards including thermal vias
2. **Heat Conduction Equation-Fins and Heat sinks Radiation Heat Transfer:** General heat Conduction equation. Boundary and initial conditions. Steady state, Transient heat, Micro scale heat conduction. Fin equation, Heat sinks, Blackbody radiation, Radiation heat transfer from plate-fin heat sinks
3. **Convective Heat Transfer**: Velocity and thermal boundary layer. Friction coefficient, Heat transfer coefficient. External and Internal flows, Natural convection heat transfer
4. **Advanced Cooling Technologies.** Experimental Techniques and Thermal design: Heat pipes, Heat pipe selection and modeling, Jet impingement on flat surfaces and heat sinks, Liquid immersion cooling, Thermo-syphons, Loop heat pipes, Thermoelectric coolers, piezoelectric fans, Electro hydrodynamic flow, Synthetic Jets, Single phase and two-phase flow micro channels- Thermal design.
5. **Computer Simulation and Thermal Design:** Heat transfer and fluid flow equations, Finite difference, Finite volume and Finite element methods, Solution of one and two-dimensional conduction problems, Fluid flow and energy equations. Laminar and turbulent flows, Case studies from electronic packages, boards and systems.

Prerequisite Course: UE15ME302 – Principles of Energy Conversion

Reference Books:

1. "Heat Transfer-Thermal Management in Electronics", Shabany Younes CRC Press, First Edition, 2010.
2. "Fundamentals of Thermal Management", Avram Bar Cohen, Abhay Watwe and KN Seetharamu. Chapter 6 in the book Fundamentals of Microsystems Packaging", Rao R. Tummala, McGraw-Hill, Second Edition, 2001
3. "Cooling of Electronic Equipment". Chapter in the book "Introduction to Thermodynamics and Heat Transfer", Y A Cengel, McGraw-Hill, First Edition, 1997.
4. "Cooling Technologies for Electronic Equipment", D S Steinberg, John Wiley, First Edition, 1980.
5. "Thermal Analysis and Control of Electronic Equipment", A D Kraus and A Bar Cohen, McGraw-Hill, Hemisphere, Second Edition, 1983
6. "Thermal Computations for Electronic Equipment", G N Ellison, Van Nostrand Reinhold, First Edition, 1984.

UE14ME413: HYDRAULICS AND PNEUMATICS (4-0-0-2-4)

Course Objectives:

- To introduce the students to fundamental concepts and principles of hydraulic power, its transmission and various components necessary
- To enable the students to use various deterministic factors and relations to solve engineering problems
- To introduce the students to control methods, circuits and appliances
- To introduce the students fundamental principles and working of Pneumatic Systems

Course Outcomes

At the end of the course the student will be able to

- Apply fluid mechanics and governing laws to hydraulic & pneumatic systems
- Classify and compare the characteristics of the various application level components and thus select different components used in hydraulic systems
- Learn about the functions of control components in hydraulic & pneumatic systems
- Design and analyze simple hydraulic circuits and explain methods use in maintenance of hydraulic systems
- Differentiate between the hydraulic and pneumatic systems along with an understanding of the actuators, motors and control valves

Course Content:

1. **Introduction to Hydraulic Power:** Application of Pascal's law, Structure of Hydraulic control systems, Working Oil Medium, Contamination and Control, The source of Hydraulic Power, Types of pumps, specifications, efficiencies
2. **Hydraulic Cylinders:** cylinder force, power and speed; Hydraulic Motors:, motor types, motors torque, speed, power and efficiency
3. **Control Components in Hydraulic Systems**: directional control valves, pressure control valves, flow control valves.
4. **Hydraulic Circuits:** Control of single and double acting hydraulic cylinder, hydraulic cylinder sequencing circuits, Hydraulic press circuits. Speed control of hydraulic cylinder, Intensifiers, Accumulators, contamination and filtration
5. **Pneumatic Systems:** Structure of systems, Choices of working medium, characteristics of compressed air, Pneumatic actuators, Pneumatic cylinders, motors, control valves; Air Preparation and Distribution.

Prerequisite Course: None

Reference Books:

1. "Fluid Power with Applications", A Esposito, Prentice Hall, Sixth Edition,2003
2. "Introduction to Fluid Power", James L. Johnson, Delmar Thomson Learning, Eswar Press, First Edition, 2003
3. "Pneumatics and Hydraulics", Andrew Parr, Jaico Publishing Co., Third Edition, 2009.

UE15ME414: MOTORCYLE DYNAMICS (3-1-0-4-4)

Course Objectives:

- Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline
- Application of established engineering methods to automotive design and analysis
- In-depth understanding of specialist bodies of knowledge within the engineering discipline
- Familiarization with modeling and analysis methods
- Familiarization of the Motor Cycle dynamics terminology

Course Outcomes:

At the end of the course, the student will be able to

- Predict the effect of various parameters on the kinematics of motorcycles
- Estimate aerodynamic and rolling resistance forces exerted on the vehicle and their implications on fuel economy
- Predict the traction and wheeling limited acceleration performance of the motor cycles
- Compute fundamental braking response attributes and Estimate brake system balance and brake proportioning
- Determine Directional stability of the motorcycle under the influence Gyroscopic effects generated by the yaw motion and roll motion
- Evaluate the various Modes of Motorcycle Vibration in straight running and cornering

Course Content:

1. **Kinematics of Motorcycles:** motorcycles, geometry, trail, steering mechanism, pitch, Rear wheel contact point, Front wheel camber angle, effect of tyre size on the rear frame yaw; **Motorcycle Tires:** Contact forces and Moments of contact between the tire and the road, combined lateral and longitudinal forces, Vibration modes of the tires.
2. **Rectilinear Motion of Motorcycles:** Resistance forces, The center of gravity and the moments of inertia, Motorcycle equilibrium, Motorcycle in translatory rectilinear motion, Wheeling, Braking,
3. **Steady Turning:** Motorcycle roll, roll angle, turn, steering ratio, Linearized model of the motorcycle on a turn
4. **In -Plane Dynamics:** Preliminary considerations, Suspension, Models with one degree of freedom, Two degrees of freedom model, Four degrees of freedom model; **Motorcycle Trim:** Motorcycle trim in steady state motion, curve, accelerated motion, the braking action.
5. **Motorcycle Vibration Modes and Stability:** Capsize, Weave, Wobble, Combined model for weave and wobble, Motorcycle multi body model; **Motorcycle Maneuverability and Handling:** Directional stability, Gyroscopic effects, Motorcycle equilibrium, Slow and fast entering in a turn, The optimal maneuver method, Handling tests.

Prerequisite Course: None

Reference Books:

1. "Motorcycle Dynamics", Vittore Cossalter, Lulu.com Publishers, Second English Edition 2006.
2. "Motorcycle Handling and Chassis Design, the art & science", Toney Foale, Second Edition, SAE, 2002.
3. "Motorcycle Design and Technology**",** Gaetano Cocco, Motorbooks International, First Edition, 2004

UE15ME415: FATIGUE ANALYSIS (3-1-0-4-4)

Course Objectives:

- To teach students the basics of fatigue behaviour, physical aspects of fatigue and designing and testing for fatigue
- To make them understand use of various mathematical relations involved in fatigue analysis
- To teach students the theories and concepts involving fracture mechanics

Course Outcomes:

At the end of the course the student will be able to

- Explain s-n curves and estimate stress concentration factors and fatigue strength of given material
- estimate different types of fatigue statistically by employing various theories of fatigue
- Explain different phases of the fatigue crack and elucidate on fatigue fracture surfaces
- Estimate various parameters for fatigue fracture analysis
- Calculate the fatigue life of a given component under descried set of conditions

Course Content:

1. **Fatigue of structures:** S.N. curves, endurance limits, mean stress, goodman, gerber and soderberg relations and diagrams, notches and stress concentrations and stress concentration factors, notched S.N. curves, fatigue of composite materials.
2. **Statistical aspects of fatigue behaviour:** low cycle and high cycle fatigue, coffin – manson's relation, transition life, cyclic strain hardening and softening, analysis of load histories, cycle counting techniques,cumulative damage, theories.
3. **Fatigue analysis using stress/strainlife (sn/€n) curves:** stress concentrations, analysis of variable amplitude stress histories, applicability of sn curves
4. **Fatigue analysis from finite element models:** analysing linear elastic model with single applied load history- with multiple load history, analysing sequence of data sets, frequency domain finite element analysis
5. **Fatigue design and testing:** safe life and fail-safe design philosophies – importance of fracture mechanics in aerospace structures – application to composite materials and structures.

Prerequisite Course: None

References:

1. "Metal Fatigue in Engineering", Ralph Stevens, Ali Fatemi, Robert.R.Stevens, Henry. O. Fucs, Wiley, Interscience, Second edition, 2000.
2. "Mechanics of Fracture." Vol – I, Sih C.G., Sijthoff and W Noordhoff International Publishing Co., Netherlands, First Edition, 1989.
3. "Fundamentals of Fracture Mechanics," Knott, J.F., Butterworth & Co., Ltd., London, First Edition, 1983.
4. 'Introduction to Fracture Mechanics', Kare Hellan, McGraw Hill, Singapore, First Edition, 1985.

UE15ME416:
SURFACE ENGINEERING (4-0-0-2-4)

Course Objectives:

- To introduce the students to metallurgical concepts of surfacing
- To enable the student to understand different types of coating techniques used
- To discuss the factors and variables that influence the properties of coating and surfacing
- To provide an overview about types of heat treatment methods used in various industrial applications

Course Outcomes:

At the end of the course, the student will be able to

- Appreciate the necessity of surface coating and heat treatment in various fields of applications
- Apply the knowledge in selecting suitable coating and heat treatment method for a given material
- Illustrate how surface treatments brings about an improvement of properties as compared with the base metal
- Identify improved methods for surface treatment to enhance the resistance towards corrosion as compared to the base metals

Course Content:

1. **Introduction to Surface engineering:** Surface modification, effect on material properties, Surface wear mechanisms, Preparation of Substrate for Surface Processing
2. **Surface Modifications:** Physical Vapour Deposition, Chemical Vapour Deposition, Ion Implantation Methods, Coating for High Temperature Performance.
3. **Electrochemical and Spark Discharge Processes:** Plasma Coating Methods, Organic and Powder Coatings, Thermal Barrier Coating.
4. **Advanced Electron Beam Techniques:** Laser Surface Processing, Coating on Plastics.
5. **Application of various Methods:** Comparison of Solar induced Surface Transformation of Materials (SISTM) in processing of Electronic Materials with Other Direct Energy Methods

Prerequisite Course: None

Reference Books:

1. "Thermal Spray Coating- New Material, Processes and Application", Frank Lang, ASM Metals handbook, First Edition, 2004.
2. "Thin Film Deposition", K. Chopra, L. Malhotra, McGraw Hill, First Edition, 2000.

UE15ME421:
AIRCRAFT PROPULSION (3-1-0-4-4)

Course objectives:

- To introduce various types of airbreathing engines and review the basics of gas dynamics.
- To understand the performance of jet engines through thermodynamic cycle analysis.
- To appreciate the complexity of flowfield through compressor, turbine, inlet, nozzle and combustor of a jet engine.
- To understand the performance and components of chemical rocket engines.

Course outcomes:

At the end of the course, the student will be able to

- Understand various types of airbreathing engines and associated gas dynamics.
- Perform thermodynamic cycle analysis calculations of various types of jet engines.
- Understand the aerodynamics and heat transfer of flow through a compressor and turbine. Perform velocity triangle calculations.
- Understand the aerodynamics of flow through inlet and nozzle. Appreciate the basics of combustion and components of combustion chamber.
- Evaluate the performance of chemical rocket engines. Understand the components of solid and liquid rocket engines.

Course Content:

1. **Introduction & Gas dynamics:** Types of airbreathing engines. Review of gas dynamics: static and stagnation property, normal shock, oblique shock, expansion fan.
2. **Jet engine performance:** Thrust and efficiency of jet engine, component efficiencies, turbojet and turbofan engine thermodynamic cycle analysis.
3. **Jet engine components (Turbomachinery):** Compressor operating line and performance map, velocity triangles, diffusion factor, types of stall, surge, transonic compressor, radial equilibrium, multi-stage compressor starting problem. Turbine velocity triangles, review of convection heat transfer, turbine blade cooling methods.
4. **Jet engine components (Inlet, nozzle, combustor):** Subsonic diffuser, types of supersonic inlet. Converging diverging nozzle. Thermodynamics and chemical kinetics of combustion, flame speed, flame stabilization, components of combustion chamber, liner cooling, pattern factor, afterburner.
5. **Rocket engines:** Types of chemical rocket engines, thrust and efficiency, thrust coefficient, characteristic velocity. Liquid rocket combustion chamber, thrust chamber cooling. Solid rocket combustor, grain configuration, chamber pressure and burn surface area. Types of rocket nozzles.

Prerequisite Course: UE15ME302 – Principles of Energy Conversion

Reference Books:

1. "Aircraft Propulsion", S Farokhi, Wiley, Second Edition, 2014.
2. "Elements of Propulsion: Gas Turbines & Rockets", J D Mattingly & K M Boyer, AIAA Education Series, Second Edition, 2016.

UE15ME422:
REFRIGERATION AND AIR-CONDITIONING (3-1-0-4-4)

Course Objectives:

- To introduce students to the concepts of refrigeration and air conditioning and the underlying principles
- To help students understand various systems involved in the process of refrigeration and air conditioning

Course Outcomes:

At the end of the course, student will be able to

- Explain and classify refrigeration cycles and refrigerants
- Explain components involved in the refrigeration and air conditioning, their construction and operation characteristics
- Demonstrate selection and balancing of system and components

Course content:

1. **Refrigeration Cycles & Refrigerants:** Vapor Compression Refrigeration Cycle-Simple saturated vapor compression Refrigeration cycle, Thermodynamic analysis of the above. Refrigerant Classification, Designation, Alternate Refrigerants, Global Warming Potential & Ozone Depleting Potential aspects.
2. **System Components:** Refrigerant Compressors - Reciprocating Open & Hermetic type, Screw Compressors and Scroll Compressors - Construction and Operation characteristics,

Evaporators - DX coil, Flooded type Chillers Expansion devices - Automatic Expansion Valves, Capillary Tubes & Thermostatic Expansion Valves Condensing Units and Cooling Towers

3. **Cycling Controls and System Balancing:** Pressure and Temperature controls, Range and Differential settings, Selection and balancing of system components - Graphical method
4. **Psychrometry:** Moist air behavior, Psychrometric chart, Different Psychrometric process analysis
5. **Air Conditioning:** Summer and Winter Air-conditioning, Cooling Load Calculations, Air Distribution Patterns, Dynamic and Frictional Losses in Air Ducts, Equal Friction Method, Fan Characteristics in Duct Systems.

Prerequisite Course: UE15ME302 – Principles of Energy Conversion

Reference Books:

1. “Refrigeration & Air Conditioning”, W.F.Stocker and J.W.Jones, McGraw Hill Book Company, First Edition, 1982

UE15ME423: VEHICLE VIBRATION AND ACOUSTICS (3-1-0-4-4)

Course Objectives:

- To train the students to design aspects for noise, vibration and harshness in cars.
- To familiarize the students with the most dominant sources of noise and vibration in cars and its measuring instruments.
- To enable the students to get a knowledge on sound fields and room acoustics
- To enable the students to understand the critical design issues and their relations for noise, vibration and harshness, in particular the aspects of objective and subjective design
- To enable the students to know the working principle of vibration measuring instruments

Course Outcomes:

At the end of the course, the student will be able to

- Discern the sound generation mechanisms and measurement and explain different sound fields and its properties
- Elucidate on the different sound measuring microphones and methods of measuring sound pressure level and sound power level
- Explain the sources of noise and vibration in automobiles and its control by using dampers and vibration absorbers
- Articulate about modal analysis by FEM and experimental method
- Illustrate the construction and working principle of vibration measuring instruments

Course Content:

1. **Introduction to NVH:** NVH and its role in automotive design and development; Vehicle Vibrations, mathematical models, linear and torsional system characteristics and response, coordinate coupling, generalized coordinates and modal analysis.
2. **Sources of Vehicle vibration:** vibration sources; Control strategies; Human response, harshness; subjective and objective evaluation; **Vibration Isolation and Control:** damping, isolation and absorption; design of a Vibration Absorbers, Active Vibration Control.
3. **Fundamentals of sound**: Vehicle noise generation mechanism, Acoustic variables, attributes of sound, Decibel scale, Wave equation, sound fields, Measures of sound, human hearing Loudness; Weighting networks, Leq and various noise metrics for road noises.
4. **Noise and Vibration measurements and instrumentation:** Measuring instruments, Sound spectra, acoustic testing chambers, Sound power measurement from Sound pressure, Modal analysis, Transducers and Accelerometers, Excitation sources.
5. **Sound fields and Room Acoustics:** Characterizing sound sources; losses; **Vehicle Interior and Exterior noise:** Internal noise sources; sound package solution to reduce the interior noise; Exterior noise sources in vehicles; Tyre noise.

Prerequisite Course: None

Reference Books:

1. “Engineering Noise Control: Theory and Practice”, Bies D A and Hansen C H, Spon Press, Taylor & Francis, NY, USA, Fourth Edition, 2003.
2. “Vehicle Noise & Vibration Refinement”, Xu Wang (Ed.), Elsevier Publishing Limited, First Edition, 2010.
3. “Vehicle Refinement – Controlling Noise & Vibration in Road Vehicles”, Mathew Harrison, Elsevier Publication, First Edition, 2004.

UE15ME424: FRACTURE MECHANICS (4-0-0-2-4)

Course Objectives:

- To enable students to understand the important terminologies and concepts related to mechanics of fracture in metals
- To enable students understand the analytical treatment of stress and strain fields near a crack tip and
- To enable students to solve problems in linear elastic fracture mechanics and elastic plastic fracture mechanics
- To enable students to apply the concepts of fracture mechanics in fatigue loading situations

Course Outcomes:

At the end of the course, the student will be able to

- Explain stable and unstable crack growth in materials with different plastic deformation capabilities
- Analyze the problem of crack growth behavior in the elastic regime and the elastic – plastic regime
- Estimate fatigue life of critical components
- Carry out safety assessment of engineering components

Course Content:

1. **Introduction to Fracture Mechanics:** Concept of stress state, Modes of fracture, Design philosophies, Griffith criterion, Energy release rate, Crack growth, R-curve, Critical energy release rate.
2. **Stress and displacement fields around a crack:** Stress and displacement fields around a crack, Stress Intensity Factor and its relation to Energy release rate, Test methods to determine K_{IC}
3. **Anelastic plastic deformation at the crack:** Effective crack length – approximate approach, Irwin’s approach, Dugdale approach.
4. **Elastic-Plastic analysis:** J integral and Crack Tip opening displacement
5. **Fatigue crack initiation and propagation:** Laws, effect of overload, crack closure, Fatigue life estimation – constant amplitude and variable fatigue loading cases

Prerequisite Course: UE15ME203 – Mechanics of Solids

Reference book:

1. “Elements of Fracture Mechanics”, Prashant Kumar, Tata McGraw-Hill Education, First Edition, 2009.
2. “Fracture Mechanics: Fundamentals and Applications”, T. L. Anderson, CRC Press, Third Edition, 2005.

UE15ME425: FUNDAMENTALS OF TRIBOLOGY (3-1-0-4-4)

Course Objectives:

- Deal with fundamentals of surface contact and topologies.
- Describe and model engineering surfaces, understand popular surface contact theories
- Understand modes of friction, wear, lubrication and adhesion.

Course Outcomes:

At the end of the course, the student will be able to

- Model a rough engineering surface and explain
- Explain Hertz contact and rough surface contact.
- Explain about theoretical background about processes in tribological system, mechanisms and forms of interaction of friction surfaces.
- Elucidate on adhesion theories and the effect of adhesion on friction and wear.
- Explain application of the friction/lubrication mechanisms to the practical engineering problems.

Course Content:

1. **Materials and surfaces:** Tribology; Solid structure and properties, Disorders in Solid Structures, Elastic and Plastic Deformation, Fracture and Fatigue, Time–Dependent Viscoelastic/Viscoplastic Deformation; Surfaces, Surface parameters
2. **Contacts:** Analysis of Contacts, Stress distribution, Displacements due to loading, Hertzian and non-Hertzian contacts, Rough surfaces in contact, Deformation mode, Thermal effects; Adhesion
3. **Friction:** Friction, Plastic interaction of surface asperities, Ploughing effect, Elastic hysteresis losses, Solid–Solid Contact, Liquid-Mediated Contact, Friction of Materials; Rolling, Tyre-road contacts.
4. **Wear:** Wear, Mechanisms, Wear Debris, Wear of Materials, Indentation cracking, Factors affecting wear, Experimental considerations, Wear control, Application of wear in design, Characteristics of friction induced vibrations.
5. **Lubrication:** Lubricants, Measurement of viscosity, Lubricating oils, Greases; Lubrication, Viscous Flow and Reynolds Equation, Hydrostatic Lubrication, Hydrodynamic Lubrication, Elasto-hydrodynamic Lubrication.

Prerequisite Course: None

Reference Books:

1. "Introduction to Tribology", Bharat Bhushan, John Wiley & Sons, First Edition, 2002.
2. "Principles of Tribology", Halling, J. (Ed), Macmillan, First Edition, 1975.

UE15ME426: PRODUCT DESIGN AND MANUFACTURING (4-0-0-2-4)

Course Objectives:

- To introduce the concept of product design, various product design practices and changes in its perspective through time
- To discuss various factors considered in product design and the design with respect to production
- To introduce the concept of product life cycle, economics of product design and modern approaches to product design

Course Outcomes:

At the end of the course, the student will be able to

- Appreciate various practices and methods of product design.
- Emphasize on implications of product and system design in manufacturing and improve manufacturing competitiveness
- Discern the economical impact on product design
- Assess the life cycle of a product
- Get an insight into modern approaches of product design

Course Content:

1. **Introduction to product design:** Definition, design by evolution, innovation, morphology of design; Product Design Practice in industry: product strategies, the S's of standardization, Renard series.
2. **Review of strength, stiffness and rigidity considerations in product design:** Principal stress trajectories, criteria and objectives of design, material toughness, production process
3. **Design for production—metal parts:** Producibility requirements in the design of machine components, Designing with plastic, rubber, ceramics and wood
4. **Life cycle of a product**: Life cycle management -automating information flow -work flows-Creation of work flow templates -life cycle -work flow integration -case studies.
5. **Economic factors influencing design:** Modern approaches to product design: Change management, Concurrent design and Quality Function Deployment (QFD).

Prerequisite Course: None

Reference Book:

1. "Product Design and Manufacturing", Chitale A K and Gupta R C, PHI, Second Edition, 2002.

UE15ME452: NON – DESTRUCTIVE TESTING (2-0-0-2-2)

Course Objectives

- To introduce to the students the application and need of destructive and non-destructive testing methods
- To introduce to the students various destructive and non-destructive testing methods
- To make the students understand the difference between various NDT methods to aid them in selecting appropriate NDT method

Course Outcomes:

At the end of the course, the student will be able to

- Explain the basic principles of various non-destructive techniques available for testing of engineering components.
- select useful NDT method or a combination of NDT methods for a given application
- Illustrate several ways of comparing the selected NDT method
- Explain the common NDT methods namely- visual, liquid penetrant, magnetic, ultrasonic, eddy current and radiography inspection techniques

Course Content:

1. **Visual Inspection and Liquid Penetrant Testing:** Visual Inspection: Basic procedure, Visual inspection without aids, Optical aids used for visual inspection; Liquid Penetrant Testing: developers, Penetration time, Inspection, Post – emulsifiable fluorescent penetrant system, Advanced LPT techniques.
2. **Magnetic Particle Testing and Eddy current testing:** Magnetic Particle Testing: Magnetization method, Magnetizing current, Inspection of weldments, Automated equipment for specific applications, Demagnetization after inspection, Methods of demagnetization, advances in Magnetic particle testing; Eddy current testing :Basic principle, Instrumentation for ECT, Inspection of welds.

3. **Ultrasonic testing:** Characteristics of Ultrasonic waves, Types of ultrasonic waves, Generation of ultrasonic waves and types of transducers, Construction of probes, Ultrasonic flaw detector
4. **Radiography testing:** principle, Geometric factors in Radiography, X Radiography, Gamma Rays, Penetrameters, Industrial X ray films, Film viewers, Radiographic defect evaluation.
5. **Leak, Acoustic Emission and Thermography Testing:** Leak testing: Pressure tests, Halogen leak detector; Acoustic emission technique: Principle of Acoustic technique, On-line monitoring of welds by acoustic emission, experimental set-up and advantages of AET monitoring of welds; Thermography testing: Basic principle, detectors and equipment, techniques and applications.

Prerequisite Course: None

Reference Book:

1. "A Textbook on Practical Non-Destructive Testing", Baldev Raj, T. Jayakumar, M. Thavasimuthu, Second Edition, Narosa Publishing House, New Delhi 2002.

M.TECH IN MECHANICAL ENGINEERING

PROGRAM EDUCATION OBJECTIVES

1. Train students to acquire in-depth knowledge in the frontier areas of mechanical engineering and associated domains with an ability to amalgamate existing and new knowledge.
2. Develop problem solving and critical reasoning ability in students so as to arrive at sustainable solutions to intricate problems in mechanical engineering and associated domains.
3. Prepare students for higher education and research by providing the framework for gaining multidisciplinary knowledge through research assistantships, projects and internships
4. Train students to acquire professional and intellectual integrity and understand the importance of ethical practices in professional and personal life
5. Train students to communicate technical information effectively to the cognoscenti and general public alike, in spoken as well as written formats

PROGRAM OUTCOMES

1. **Scholarship of Knowledge:** Obtain wide-ranging knowledge in the field of Mechanical Engineering with specialization in Thermo-fluids Engineering, Machine Design, Manufacturing Engineering and Automobile Engineering, with an ability to distinguish, assess, investigate and synthesize existing and new information, and assimilate the same for enhancement of knowledge.
2. **Critical Thinking:** Investigate complex problems in Mechanical Engineering critically and apply independent judgment for obtaining vital information for conducting research
3. **Problem Solving:** Hypothesize and solve problems in mechanical engineering through creative and original approach and develop critical reasoning ability to estimate a wide range of possible solutions and arrive at the most feasible and optimal solution considering safety, public health, cultural, societal and environmental factors.
4. **Research Skill:** Conduct experiments, obtain, analyse and interpret data using proper techniques and tools; obtain information through review of literature and conduct of experiments related to unknown problems in the frontiers of mechanical engineering; demonstrate higher order thinking and contribute to the development of scientific/technological knowledge in the different domains associated with mechanical engineering.
5. **Modern Tool Usage:** Demonstrate an ability to apply modern computing tools and techniques, to model and analyze complex problems in mechanical engineering with a clear knowledge of the limitations involved.
6. **Collaborative and Multidisciplinary work:** Demonstrate an understanding of group dynamics and contribute positively to collaborative and multidisciplinary research with an ability to make
7. Decisions based on rational analysis, to achieve common goals.
8. **Project Management and Finance:** Demonstrate an ability to apply the principles of project and finance management to efficiently manage and execute mechanical engineering projects, including multidisciplinary perspectives, while working individually as well as in groups.
9. **Communication:** Communicate confidently and effectively regarding complex mechanical engineering activities with the engineering community as well as general society both in terms of making oral presentations as well as documenting and writing technical reports, adhering to appropriate standards; demonstrate an ability to give and receive clear instructions
10. **Life-long Learning**: Demonstrate an ability to engage in life-long learning, self-sufficiently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously
11. **Ethical Practices and Social Responsibility:** Attain professionally superior and ethically strong global outlook with an understanding of social responsibility, concern for the environment and be able to contribute to the community for sustainable development of society
12. **Independent and Reflective Learning:** Demonstrate self-awareness and an ability to learn from mistakes made and take suitable corrective action to improve as an engineer and individual.

UE18ME501: ADVANCED ENGINEERING MATHEMATICS (3-1-0-4-4)

Course Objectives:

- To teach students various mathematical techniques involving series analysis, differential equations, complex functions etc.
- To make students understand the application of the mathematical techniques in the analysis of engineering problems

Course Outcomes:

At the end of the course, the student will be able to

- Use the concepts of fourier series and transforms to solve a given function
- Solve given ordinary differential equation using various methods
- Employ series and various functions to solve ordinary differential equations
- Elucidate the concept of complex numbers to analyse problems of calculus

Course Content:

1. **Fourier Series and Transforms:** Fourier Series; Different Periods and Finite Domains; Fourier Series with Complex Exponentials; Fourier Transforms; Discrete Fourier Transforms; Multivariate Fourier Series.
2. **Methods of Solving Ordinary Differential Equations:** Linear First-Order Differential Equations; Linearly Independent Solutions and the Wronskian; Variable Substitution; Heaviside, Dirac, and Laplace; Laplace Transforms; Green's Functions
3. **Partial Differential Equations:** Normal Modes; Separation of Variables; Inhomogeneous Boundary Conditions; The Method of Eigen function Expansion; The Method of Fourier Transforms and Laplace Transforms

4. **Special Functions and ODE Series Solutions:** Solving Differential Equations with Power Series; Legendre Polynomials; The Method of Frobenius; Bessel Functions; Sturm-Liouville Theory and Series Expansions; The Quantum Harmonic Oscillator and Ladder Operators.
5. **Calculus with Complex Numbers:** Functions of Complex Numbers; Derivatives, Analytic Functions, and Laplace's Equation; Contour Integration; Complex Power Series; Mapping Curves and Regions

Prerequisite Course: None

Reference Books:

1. "Mathematical Methods in Engineering and Physics", Gary N. Felder, Kenny M. Felder, John Wiley, First Edition, 2016.
2. "Advance Engineering Mathematics", Erwin Kreyzig, Tenth Edition, Wiley, International Student Version, 2011.

UE18ME502: THEORY AND DESIGN FOR MECHANICAL MEASUREMENTS (3-1-0-4-4)

Course Objectives:

- To introduce measurement errors and methods of describing them, so that measured data is interpreted properly.
- To introduce about the basic operation of transducers for strain, acceleration, pressure, temperature, and fluid flow measurement
- To enable the students to select and assemble the components of basic analog and digital data acquisition systems
- To enable the students to appreciate the various flow measurement and visualization techniques
- To enable the students to appreciate the working of different sensors, actuators and controls

Course Outcomes:

At the end of the course, the student will be able to

- Explain different types of error that may occur in interpreting the experimental data
- Explain the different types of experimental flow measurement and visualization techniques and their working principles
- Explain the principles of temperature measurements
- Discern the concepts behind various electrical & pressure measurement devices
- Explain the purpose and need for using different sensors, actuators and controls

Course Content:

1. **Basic Concepts of Measurement Methods:** Introduction, General Measurement System, Experimental Test Plan, Calibration, Standards, Presenting Data **Static and Dynamic Characteristics of Signals:** Input/ Output Signal Concepts, Signal Analysis, Signal Amplitude and Frequency, Fourier Transform and the Frequency Spectrum, Problems
2. **Measurement System Behaviour** Transfer Functions, Phase Linearity, Multiple-Function Inputs, Coupled Systems, **Uncertainty Analysis:** Measurement Errors, Design-Stage Uncertainty Analysis, Non-symmetrical Systematic Uncertainty Interval, Problems
3. **Analog Electrical Devices and Measurements:** Analog Devices, Analog Signal Conditioning: Amplifiers, Filters, Grounds, Shielding, **Sampling, Digital Devices, and Data Acquisition**
4. **Temperature Measurements:** Thermometry Based on Thermal Expansion, Electrical Resistance Thermometry, Radiative Temperature Measurements, **Pressure and Velocity Measurements:** Pressure Concepts, Pressure Reference Instruments, Pressure Transducers, Calibration, Pressure Measurements in Moving Fluids, Design and Installation
5. **Flow Measurements:** Historical Background, Flow Rate Concepts, Volume Flow Rate through Velocity Flow Meter Calibration and Standards, **Mechatronics:** Introduction, Sensors, Actuators and Controls

Prerequisite Course: None

Reference Books:

1. Richard S. Figliola, Donald E. Beasley, "Theory and Design for Mechanical Measurements", 6th Edition, Willey Publications, 2015
2. Ernest Doebelin, Dhanesh Manik, "Doebelin's Measurement systems", 6th Edition, Tata MC Graw Hill Education Private Limited, New Delhi, 2011
3. J. P. Holman, "Experimental Methods for Engineers", 8th Edition, MC Graw Hill Publications, 2012.
4. S.P.Venkateshan, "Mechanical Measurements", 2nd Edition, John Wiley and Sons Limited, 2015

UE18ME503: ADVANCED FINITE ELEMENT METHODS (3-1-0-4-4)

Course Objectives:

- To teach formulation of different types of finite elements
- To enable students to understand and appreciate the use of approximate and energy methods
- To teach numerical integration, linearity and geometric and material non-linearity
- To provide exposure to important solution techniques and aspects of meshing
- To explain the finite element treatment of dynamic vibration analysis problems

Course Outcomes:

At the end of the course, the student will be able to

- Apply weighted residual method and Ritz method to approximate the solutions of simple problems and develop finite element formulations for bar and beam elements using linear and quadratic shape functions, and use them in simple heat transfer problems
- Formulate and use iso-parametric, axi-symmetric, serendipity, h- and p- elements and use natural co-ordinate systems and apply virtual work and energy methods to solve simple 1-D and 2D problems
- Apply the Lagrangian interpolation polynomials and numerical integration techniques in FEM for solving problems
- Differentiate between linearity and non-linearity and choose the solution scheme appropriately, free and mapped meshing and analyse simple dynamic analysis problems
- Exercise FEM to analyze transient field problems

Course Content:

1. **Fundamentals of Finite Element Methods:** Introduction, Discrete Systems, Differential Equations Governing Discrete Systems, Virtual Work Principle.
2. **Finite Element Analysis of 2D Problems:** Triangular & Quadrilateral Elements, Quasi-Harmonic Equations, Iso-Parametric Elements & Numerical Integration, Introduction to the 3D Method
3. **Finite Element Analysis of Plates and Shells:** Classical Plate Theory, Shear Deformation Plate Theory, Shell Elements.

4. **Finite Element Analysis of Composite Laminates:** Introduction, Classical Laminated Plate Theory, First Order Shear Deformation Theory, Computational Aspects, Continuum Formulation.
5. **Non-linear FEA:** Material & Geometrical Non-linearity, Plasticity, Non-linear Field Problem, Convection-Diffusion Equation, Large Displacements and Structural Instability, Errors in FEA

Prerequisite Course: None

Reference Books:

1. "The Finite Element Method: Its Basis & Fundamentals", Zienkiewicz O.C, Taylor.R.L & Zhu,J.Z, Butterworth-Heinemann (An imprint of Elsevier), First Printed in India, 2007.
2. "Introduction to Finite Element Method", Reddy, J.N., Oxford University Press, Fourth Edition, 2008.
3. "Fundamental Finite Element Analysis and Applications", Bhatti, M. A., John Wiley & Sons, First Edition, 2005.
4. "Concepts and Applications of Finite Element Analysis", Cook, R. D., Malkus, D. S., Plesha, M. E., and Witt, R. J. Wiley Student Edition, Fourth Edition, First Reprint 2007.
5. "The Finite Element Method in Engineering", Rao, S. S., Butterworth-Heinemann (An Imprint of Elsevier), Published by Elsevier India Pvt. Ltd., Sixth Edition, 2007.

UE18ME504:
ADVANCED ENGINEERING MATERIALS (3-1-0-4-4)

Course Objectives:

- To enable students to understand the metallurgical concepts and characterization of advanced materials
- To enable students to understand specific applications of advanced materials
- To enable students to understand the factors and variables influencing the properties of advanced materials

Course Outcomes:

At the end of the course, the student will be able to

- Select appropriate material for specific area of application and explain metallurgical characteristics and applications of various advanced materials like polymers, ceramics, and composites.
- Identify ceramic materials for various applications and discern the concepts of manufacturing fibre reinforced composites (FRC) and sandwich structures
- Elucidate the corrosion mechanism and protection against corrosion

Course Content:

1. **Aerospace materials:** Metallurgical characteristics of alloys of Aluminum, Magnesium and Beryllium, Copper Nickel and Cobalt and Titanium Alloys, Refractory and Precious metals
2. **Polymers:** Classification, Structure-property relationships, Polymerization, Thermoplastics, Elastomers, Thermosetts, Adhesives, Polymer Processing and Recycling.
3. **Ceramic Materials:** Applications, Properties and processing, Methods of making Sintered and Glass ceramics, Inorganic Glasses, Clay products, Refractories, Other ceramic materials.
4. **Advanced Composite Materials:** dispersion strengthened composites; particulate composites; fiber reinforced composites; Manufacturing fibers and composites
5. **Smart structural systems**: Background to smart systems, Actuator materials, Sensing technologies, Micro-sensors, Intelligent systems, Hybrid smart materials, Passive sensory smart structures, Reactor actuator-based smart structures, Active sensing and reactive smart structures

Prerequisite Course: None

Reference Books:

1. "The Science and Engineering of Materials", Askeland, Fulay, Wright and Balani, Cengage Learning India, Sixth Edition, 2012.
2. "Mechanics of composite materials", Rober M. Jones, Taylor & Francis, First Edition, 1984.
3. "Selection of Materials", ASM Metals Hand book Vol. 1, First Edition, 1990.
4. "Smart Materials and Structures", M. V. Gandhi and B. D Thompson, Chapman and Hall, London, First Edition, 1992.

UE18ME505:
DATA ACQUISITION AND ANALYSIS (0-0-4-2-2)

Course Objectives:

- To train the students about image processing techniques.
- To train the students on data analysis.
- To enable the students to evaluate behavioural characteristics of mechanical systems.
- To help the students in technical documentation.

Course Outcomes:

At the end of the course, the student will be able to

- Determine phase portraits using image processing.
- Analyze a continuous system subjected to free vibration.
- Analyze indents using microscopy.
- Obtain temperature distribution under conduction and convection conditions.
- Implement Data acquisition and data analysis.
- Choose necessary electronics for experimental measurements.

Course Content:

1. **Experiments, Mathematics**, **Measurements**, **Introduction to electronics**
2. **Introduction to lumped modelling**, **Technical documentation** - Introduction to LATEX.
3. **Design of Experiments** - Cause and effect; Data representation and interpretation; State space description and numerical experiments; Error bar, scatter bar and curve fitting;
4. **Analysis of experimental data:** Introduction; Causes and Types of Experimental Errors Uncertainty Analysis; Statistical Analysis of Experimental Data; Probability Distributions;
5. **Fundamentals of** - Image processing; Theory of large numbers; Analog-to-digital conversion; Operational modal analysis, Microscopy techniques; Goal seek function, Analysis of trend lines

List of Experiments:

1. Damped simple pendulum – behaviour study using image processing.
2. First passage failure analysis.
3. Free vibration of a cantilever beam.
4. Random data analysis.
5. Micro indentation using various indenter tips.
6. Campbell diagrams for a rotor.
7. Heat transfer from a fin experiment.
8. Regression analysis.

9. Op-amps – Adder, Subtractor, Differentiator, Integrator.
10. R-L-C circuit – Frequency sweep and response.

Prerequisite Course: None

Reference Material

1. “Experimental Methods for Engineers”, J. P. Holman, Eighth Edition, MC Graw Hill Publications, 2012.
2. Lab Manual prepared by the Department of Mechanical Engineering PESU.

UE18ME511:
ADVANCED COMPUTATIONAL FLUID DYNAMICS (3-1-0-4-4)

Course Objective:

- To introduce and provide core knowledge of the fundamentals of CFD, the various methods and analysis techniques
- To enable students to develop a better intuition of fluid mechanics with a variety of flow situations (turbulent, laminar) and develop in-house Matlab / C program codes to solve Navier-Stokes equation
- To help the students understand the process of developing a geometrical model of flow, applying boundary conditions, specifying solution parameters, and visualizing and analyzing results
- To enable the students to develop an appreciation for the factors limiting the accuracy of CFD solutions and employment of subsequent correction factors

Course Outcomes:

At the end of the course, the student will be able to

- Explain the major theories, approaches and methodologies used and compare, contrast, apply appropriate PDES and other system of equations defining flow dynamics
- Use and apply various schemes for the improvement of accuracy
- Appraise the importance of finite difference and iterative solution methods in solving real-time engineering problems
- Apply the various explicit and implicit schemes, predictor-corrector methods and examine second order non-linear problems
- Utilize skills developed in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modeling etc.) and analyse real world engineering designs

Course Content:

1. **Introduction:** Historical background; One-dimensional computations by Finite difference methods, finite element methods and finite volume methods; Boundary conditions
2. **Governing Equations for CFD:** Governing equations, equation of state, Navier-Stokes equations for a Newtonian fluid, general transport equations, classification of fluid flow equations. **The Finite Volume Method for Diffusion**
3. **Finite Volume Method for Convection-Diffusion Problems:** convection and diffusion, the central differencing scheme, discretisation schemes
4. **Solution Algorithms for Pressure-Velocity Coupling in steady flows and discretised Equations:** staggered grid, the momentum equations, SIMPLE, SIMPLER, SIMPLEC and PISO algorithm, general comments on the algorithms, Tri-diagonal matrix algorithm
5. **Finite Volume Method for Unsteady Flows:** One-dimensional unsteady heat conduction, Explicit scheme, Crank-Nicolson Scheme, fully implicit scheme, Discretization of transient convection-diffusion equation

Prerequisite Course: None

Reference Books:

1. “Computational Fluid Dynamics”, John D Anderson, McGraw Hill International Edition, 1995.
2. “Computational Fluid Dynamics”, T.J.Chung, Cambridge University Press, First South Asian Edition, 2003.
3. “An Introduction to Computational Fluid Dynamics - The Finite Volume Method”, H K Versteeg & W Malalasekera, Longman Scientific and Technical, First Edition, 1995.

UE18ME512:
ADVANCED MACHINE DESIGN (3-1-0-4-4)

Course Objectives:

- To enable students understand basic mechanical design procedure
- To enable students to understand and use different failure theories in the design machine components
- To enable students to design a component for fatigue and cyclic loading.
- To enable students to estimate life using strain-life, stress-life and LEFM approaches
- To enable students to understand the concepts of surface failure

Course Outcomes:

At the end of the course, the student will be able to

- Use failure theories to solve problems of engineering importance and articulate about fatigue aspects of machine design
- Explain S-N curves of different materials, factors influencing it, apply the procedure of fatigue life estimation using S-N approach and also to use it for notched membranes, use strain-life and stress-life approach by considering various effecting factors
- Use LEFM concepts in estimating life of a machine component and understand, differentiate between and use Neuber’s rule and Glinka’s rule
- Develop understanding of spectrum loads, cumulative damage and theories concerning it, damage fraction and accumulation and thereby quantify damage
- Articulate different surface failures due to factors such as wear and contact and surface fatigue strength

Course Content:

1. **Introduction:** Modes of mechanical failure, High cycle and low cycle fatigue, Fatigue design models, methods &criteria, Fatigue testing, Fatigue fracture features and mechanisms.
2. **Stress-Life (S-N) Approach:** S-N curves, General behavior, influencing factors, Fatigue life estimation, Strain-Life Approach, test methods, Cyclic stress-strain behavior, Life estimation
3. **LEFM concepts:** Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Notches and their effects, application of crack growth
4. **Fatigue from Variable Amplitude Loading:** Spectrum loads and cumulative damage, Damage quantification, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.
5. **Surface Failure:** Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength.

Prerequisite Course: None

Reference Books:

1. "Metal Fatigue in Engineering", Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, John Willey New York, Second Edition, 2001.
2. "Failure of Materials in Mechanical Design", Jack. A. Collins, John Willey, New York, Second Edition, 1992.
3. "Machine Design", Robert L. Norton, Pearson Education India, Second Edition, 2000.
4. "Fatigue of Materials", S. Suresh, Cambridge University Press, Second Edition, 1998.
5. "Fundamentals of Metal Fatigue Analysis", Julie A Benantine, Prentice Hall,First Edition, 1990.
6. "Fatigue and Fracture", ASM Hand Book, Vol 19, First Edition, 2002.

UE18ME513:
ADVANCED METAL FORMING (3-1-0-4-4)

Course Objectives:

- To introduce to the students the concepts of hot and cold forming and discuss the effects of temperature, metallurgical structure, speed of deformation and friction on forming operation
- To introduce to the students the classification, process, principles and equipments involved in forging, rolling, extrusion, drawing and sheet metal forming operations
- To familiarize the students with the defects and stresses involved in various metal forming operations
- To discuss with the students the specific areas of application of each forming operations

Course Outcomes:

At the end of the course, the student will be able to

- Explain the plastic flow in metals and factors that influence the properties of formed products
- Analyze various aspects of metal forming operation and make necessary adjustments to the process to minimize the adverse effects of various factors
- Identify specific type of forming operation for a given application and recommend the appropriate equipments needed
- Analyze in detail the forging, rolling, extrusion and drawing operations with respect to operation, stresses involved and identification of defects
- Articulate on the forming methods with respect to sheet metal forming and concepts of other operations associated with it

Course Content:

1. **Introduction to Forming Metal:** Basics of metal forming, Effect of temperature, Metallurgical structure, speed of deformation, Friction in forming operation
2. **Forging:** Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging defects. Residual stresses in forging
3. **Rolling:** Classification, forces and geometrical relationships in rolling, Variables in Rolling: Deformation in rolling, Defects and residual stresses in rolled products, Torque and horsepower
4. **Extrusion:** Classification, Extrusion equipment, variables, Deformation, defects, work done; Drawing: Principles, variables, Residual stresses, Defects
5. **Sheet Metal Forming:** Forming methods, Defects in formed products; Press working: Common press working processes, tooling and Press fundamentals, materials, safety considerations

Prerequisite Course: None

Reference Books:

1. "Mechanical Metallurgy", Dieter G.E., Mc Graw Hill Publications, Third Edition, 1988.
2. "Principles of Metal Working", R.Rowe, Amold London, First Edition, 1965.
3. "ASM Metals Handbook on Metal Working", ASM International, First Edition, 2006.
4. "Manufacturing Engineering Handbook", Hwaiyu Geng, McGraw-Hill Professional, Second Edition, 2015.

UE18ME514:
BODY AND CHASSIS DESIGN (3-1-0-4-4)

Course Objectives:

- To introduce the students to the construction of a vehicle body
- To enable the students to know about commercial vehicle body details
- To teach the students about materials and mechanisms used in vehicle body construction and the concepts of design and construction of the external body of vehicles
- To teach the students about steering system and suspension mechanism

Course Outcomes:

At the end of the course, the student will be able to

- Explain the methods improving driver's visibility and discern the layout of bus body, its classifications and frame constructions with regulations
- Discern complete design and construction of light commercial vehicles and select materials for vehicle body construction
- Appraise different loads acting to the vehicle and its safe design testing according to the regulations
- Explain steering kinematics in two wheel and all wheel steering vehicles having two or more than two axles
- Explain the different suspension systems and wheel alignment

Course Content:

1. **Steering Dynamics:** Kinematics Steering, Multiple Axle vehicles, Vehicle with Trailer, Steering Mechanisms, Optimization, Trailer - Truck Kinematics; **Suspension Mechanisms:** Solid Axle Suspension, Independent Suspension, Suspension Requirements, Kinematics Requirements, Dynamic Requirements, Caster Theory,
2. **Car Body Details:** Types, visibility, regulations, safety design, constructional details, Classification of coach work; **Bus Body Details:** Types, Bus body lay out, Constructional details, Regulations.
3. **Commercial Vehicle Details:** Types, Light commercial vehicle body types, Dimensions of driver's seat relation to controls - Drivers cab design.
4. **Body Materials, Trim, Mechanisms:** Steel sheet, timber, plastic, GRP, properties of materials - Corrosion - Anticorrosion methods - Scalation of paint and painting process, Body trim items, Body mechanisms.
5. **Body Loads and Design of Vehicle Bodies:** Idealized structure, structural surface, shear panel method, loads in car; **Design of Vehicle Bodies:** Vehicle Layout design, safety, Load distribution

on vehicle structure, stress analysis under bending and torsion, stress analysis in integral bus body, Design of chassis frame, Recent safety measures, Testing of body.

Prerequisite Course: None

Reference Books:

1. "Vehicle Body Engineering", Pawloski J., Business Books Ltd. First Edition, 1969.
2. "The Automotive Chassis: Engineering Principles", Reimpell J., Butterworth & Co., Second Edition, 2001.
3. "Vehicle Body Layout and Analysis", John Fenton, Mechanical Engg. Publications Ltd. London, First Edition, 1982
4. "Body Construction and Design", Giles J. G., Illife Books, Butterworth & Co., First Edition, 1971.

UE18ME551:
ADVANCED COMPUTATIONAL TECHNIQUES FOR ENGINEERING APPLICATIONS (0-0-4-4-2)

Course Objectives:

- To educate the students about various important computational techniques and related concepts
- To expose students to advanced level usage of MATLAB in data visualization, solving differential equations, curve fitting, etc
- To expose the students to basics of engineering optimization
- To help students understand the method in which MATLAB is used to solve simple problems of engineering and academic significance

Course Outcomes:

At the end of the course, the student will be able to

- Apply important computational techniques and concepts such as polynomial types and representations, error propagation and related terminologies, etc to solve engineering problems, solve 1D wave and heat equation in MatLab
- Express the working of algorithm for Delauney triangulation, convex hulls, splines and Voronoi polygons, and at the same time recognize their application areas and perform data visualization of given equations
- Fit polynomial curve fit equations to give data, perform symbolic differentiation and integration, solve differential equations numerically and symbolically, etc
- Explain the basics of engineering optimization, Hessian matrix and its use, etc
- Employ ode23 to solve the fundamental differential equation of mechanical vibrations

Course Content:

1. **Applied Computational Techniques**: Polynomials and functions; Error analysis; Introduction to three types of PDE and Boundary conditions; Finite difference method; Delaunay triangulation, Voronoi polygon, Convex hull, Splines, Introduction to tensor calculus, Introduction to the theory of finite state machines, Eigen value calculations
2. **Advanced Computations Using MATLAB, SIMULINK and STATEFLOW - 1**: MatLab basics, Techniques for writing fast MATLAB codes; Advanced graphics techniques; Cell arrays and Structures; Array sorting; Curve fitting; Solving ODE; Symbolic integration and differentiation
3. **Advanced Computations Using MATLAB, SIMULINK and STATEFLOW – 2**: Data and file handling; Numerical integration, interpolation, Cubic splines, Delaunay triangulation, Voronoi polygons and convex hulls, Random number generation, Model based development in SIMULINK, solving differential equations in SIMULINK, simple STATEFLOW application
4. **Classical Optimization Techniques**: Basic terminologies, Single-variable optimization, Multi-variable optimization with no, equality and inequality constraints, Hessian matrix and its use, Simple numerical examples of optimization
5. **Applied Computation Using MATLAB**: Solution to $m\ddot{q} + c\dot{q} + q = F_0 \sin\omega t$ $m\ddot{q} + c\dot{q} + q = F_0 \sin\omega t$ using ode23; Simulation of a ball under free fall; Path of a bullet with air resistance considered; Solving 1D wave equation in MATLAB; Solving 1D heat equation in MATLAB; double and triple pendulum analysis in SIMULINK, quarter car model analysis in SIMULINK, STATEFLOW examples.

Prerequisite Course: None

Reference Books:

1. "Numerical methods using MATLAB", John H Mathews and Kurtis D Fink, PHI Private Limited, Fourth Edition, 2004.
2. "Mastering MATLAB 7", Duane Hanselman and Bruce Littlefield, Pearson education, Second Edition, 2008.
3. "Engineering optimization", Singeresu S Rao, New age publications, Third Edition, 1996.

UE18ME521:
ADVANCED THERMODYNAMICS (3-1-0-4-4)

Course Objectives:

- To instill an appreciation for the fundamentals and practical applications of classical thermodynamics and their relevance to the problems of humankind
- To provide the student with experience in applying thermodynamic principles to predict physical phenomena and to solve engineering problems
- To encompass a wider and detailed analysis of thermodynamic concepts

Course Outcomes:

At the end of the course, the student will be able to

- Demonstrate knowledge and understanding of theoretical and practical constraints of the fundamental laws that govern the thermodynamic principles and distinguish with detailed understanding, the basic concepts such as thermodynamic temperature, equilibrium and reversibility
- Articulate on the concepts of availability, exergy, and exergy equilibrium equations and inspect the various thermodynamic process and properties of special systems on basis of chemical thermodynamics
- Develop potent technologies for improving the performance of power generation and refrigeration
- Determine operating conditions for thermodynamic cycles in order to optimize power or efficiency
- Design machines for improved efficiency using thermodynamic reasoning

Course Content:

1. **First Law for Closed and Open Systems:** Work &Heat Transfer; Energy Change; Second Law for Closed and Open Systems; Entropy Maximum and Energy Minimum Principles; Entropy;
2. **Lost Available Work:** Non-flow Processes; Steady-Flow Processes; Mechanisms of Entropy Generation or Exergy Destruction; Exergy Analysis: Non flow and Flow Systems

3. **Single-Phase Systems:** Thermodynamic properties & partial molal properties; Ideal & real gas mixtures; Multiphase systems: Energy minimum principle; Chemically Reactive Systems
4. **Power Generation:** Size constraint; External and internal irreversibilities; Steam and Gas Turbine Power Plants; Combined Power Plants; Entropy-Generation: Irreversibilities;
5. **Refrigeration:** Joule–Thomson Expansion; Brayton Cycle; Liquefaction; Magnetic Refrigeration; Irreversible Thermodynamics: Linearized Relations; Mass Diffusion

Prerequisite Course: None

Reference Books:

1. "Advanced Engineering Thermodynamics", Adrian Bejan, John Wiley, Third Edition, 2006.
2. "Advanced Thermodynamics Engineering", Kalyan Annamalai, Ishwar Kanwar Puri, CRC Press, Second Edition, 2002.
3. "Advanced Thermodynamics for Engineers", D. E. Winterbone, Butterworth-Heinemann, Second Edition, 1997.
4. "Exergy: Energy, Environment, and Sustainable Development", İbrahim Dinçer, Marc A. Rosen, Elsevier, Second Edition, 2007.

UE18ME522:
ADVANCED FOUNDRY TECHNOLOGY (3-1-0-4-4)

Course Objectives:

- To introduce the students to foundry metallurgy and concept of solidification of metals interpretation and use of cooling curves
- To enable the students to understand the design aspects of casting, riser and gating system
- To familiarize the students about advanced melting techniques and control of casting quality in cast iron foundry (grey cast iron, ductile iron and malleable iron)
- To introduce the students to different alloy foundry practices
- To discuss the need and importance of mechanization and modernization of foundry (robotic applications)

Course Outcomes:

At the end of the course, the student will be able to

- Apprehend the importance of foundry in designing new casted products.
- Design proper riser and gated system for the given casting
- Explain solidification of advanced alloys, interpretation of cooling curves, solidification process and microstructure evaluation
- Select melting and molding techniques for a particular alloy
- Use computer and robot technology in foundry processes to meet desired needs

Course Content:

1. **Solidification of Casting:** Solidification of metals, Homogenous & heterogeneous nucleation; Principles of casting and risering: Gating system, Components, Design of gating system &riser
2. **Design of Casting:** Factors, Design consideration in pattern making, moulding techniques and core making and assembly. Cooling stresses and hot spots in casting
3. **Furnace Technology:** Construction and operation, Heat treatment furnaces; Casting Quality Control: Casting defects and factors responsible, Inspection and testing methods, Quality control, Salvaging
4. **Casting Practice:** Steel Casting Practice; Aluminium Foundry Practice; Copper Alloy **Foundry Practice:** General characteristics, Melting and casting , Gating and risering.
5. **Special Casting processes**: Process Principles of Flask less Moulding, Vacuum Casting, Rheo casting, Mechanization of Foundries

Prerequisite Course: None

Reference Books:

1. "Principles of Metal Casting", Heine and Rosenthal, Tata McGraw-Hill Publishing, Second Edition, 2001.
2. "Foundry Technology", Beelely, P.R and Sons, Butterworth Publications, Second Edition, 2001.
3. ASME Hand Book on Casting Processes, First Edition, 2008.
4. "A Text Book of Foundry Technology", O. P. Khanna and M. Lal, Dhanpatrai Publications (P) Ltd., First Edition, 1999.

UE18ME523:
VEHICLE DYNAMICS (3-1-0-4-4)

Course Objectives:

- To introduce students to the basics of vehicle dynamics and its influence on the vehicle handling characteristics
- To enable students to understand the performance characteristics of tires, acceleration and braking performance of a vehicle
- To enable students to understand aerodynamic characteristics of vehicles, handling characteristics of road vehicles.
- To enable students to evaluate the handling characteristics of road and off-road vehicles

Course Outcomes:

At the end of the course, the student will be able to

- Perform response analysis under various boundary conditions and develop mathematical representations of quarter car, half car and full car model
- Explain the working of various vibration measuring instruments
- Determine the natural frequencies and mode shapes for free and forced vibration under damped and un-damped condition
- Discern the effects of slip angles and rolling resistance on tyre forces
- Perform response analysis for different steering conditions on steady state handling characteristics for road and off-road vehicles and also to understand various concepts and topics in acceleration and braking performance

Course Content:

1. **Introduction:** Review of Rigid Body Dynamics, Simulation Framework and tools, Co-ordinate Systems, inertia, Euler angles and Transformation; Forward vehicle dynamics, inclined and banked roads under static and dynamic conditions.
2. **Tyre Dynamics**: Terminology, Construction, Longitudinal Properties and Lateral Properties, Rolling Resistance, Performance of Tyres, Ride Properties, Empirical Tyre Models. Vehicle Aerodynamics: Aerodynamic forces and Moments, Total road loads.
3. **Performance Characteristics of Road Vehicles:** Traction and Power, Transverse weight shift, Simple IC Engine modeling, Acceleration Performance, Braking Performance, Antilock Brake system.
4. **Handling Characteristics of Road Vehicles:** Low speed maneuverability, Steering geometry, Steady state cornering, Steady-State response to steering input, Testing of handling characteristics, Transient response characteristics, Criteria for directional stability.
5. **Ride Characteristics of Road Vehicles:** Stationary oscillations theory, Road models, Ride excitation sources, Human response

to vehicle vibration, Vehicle ride models, Ride comfort criterion, Suspension Characteristics: Ride versus Handling.

Prerequisite Course: None

Reference Books:

1. “Theory of Ground Vehicles”, J. Y. Wong, John Willey& Sons NY, Fourth Edition, 2001.
2. “Vehicle Dynamics: Theory and Applications”, Reza N. Jazar, Springer Verlag, Taylor & Francis Group, CRC Press, Third Edition, 2012.
3. “Fundamentals of Vehicle Dynamics”, T D Gillespie, SAE, First Edition, 1992.
4. “Tyres, Suspension, and Handling”, John C. Dixon, Society of Automotive Engineers Inc, Second Edition, 1996.
5. “Tyre and Vehicle Dynamics”, Hans B. Pacejka, Butterworth-Heinemann Ltd., Second Revised Edition, 2005.
6. “Motor Vehicle Dynamics: Modeling and Simulation”, Giancarlo Genta, World Scientific Publishing Co., Singapore, First Edition, 1997.
7. “Aerodynamics of Road Vehicles”, Hucho W. H., SAE, Fourth Revised Edition, 1998.

UE18ME524: ADVANCED THEORY OF VIBRATIONS (3-1-0-4-4)

Course Objectives:

- To teach the modeling of mechanical systems using equations of motion
- To explain free and forced vibration response analysis of single DOF systems
- To expose the concepts of 2-DOF systems, vibration isolation and different vibration control strategies
- To help the students develop the concept of dynamic vibration absorber and its applications
- To provide the students with the necessary understandings about concepts and significance of natural frequencies and mode shapes
- To make student familiar with transient vibration and continuous system

Course Outcomes:

At the end of the course, the student will be able to

- Develop mathematical models for damped, un-damped, free and forced (harmonic) behaviour of single and two DOF systems and list sources of vibration, apply the concept of vibration isolation and explain the use of vibration testing instruments
- Physically interpret the system response to arbitrary and non-harmonic excitations and model transient vibration and impact loading, calculate critical speeds of shaft and apply co-ordinate coupling and principal co-ordinates in solving 2-DOF problems and explain the mathematical formulation of MDOF systems
- Develop flexibility and stiffness matrices and calculate Eigen values and vectors for a MDOF system
- Explain basics of vibration control and vibration severity standards, analyze dynamic and damped vibration absorbers and perform static and dynamic balancing
- Apply cumulative knowledge in testing for resonance and mode shapes and system identification

Course Content:

1. **Vibration Basics:** Single and Multiple Degree of Freedom Systems, Energy Methods: Lagrange’s Equations, Hamilton’s principle, Mode shape expansions; Eigen value problems of Vibrations and Stability
2. **Introduction to Continuous Systems:** Hyperbolic equations of second order type, Vibration of strings, Longitudinal Vibrations of Bars, Transverse Vibration of beams, Effect of Rotary inertia and shear deformation, Vibration of Plates
3. **Transient Vibration:** Impulse excitation, arbitrary excitation, Base excitation, Laplace transform formulation, drop test, Pulse excitation, shock response analysis.
4. **Random Vibration:** Introduction, Random vibration of a SDOF system, White Noise process, Response of SDOF system, Kanai-Tajmi Model for Earth quake loads, **Failure of Random vibrating systems:** Level crossings problem, First Passage time, Narrow Band and Broad Band Random process
5. **Finite element techniques applied to Vibration problems:** FEA formulation for Bars, Beams and composite plates; **Modal testing:** Introduction, MAC

Prerequisite Course: None

Reference Books:

1. “Random Vibrations: Theory and Practice”, Paul Wirsching, Thomas L Paez and Keith Ortiz, 2nd Edition, Dover Publications,2006
2. “Elements of Vibration analysis”, Leonard Meirovitch, 2nd Edition, Tata McGraw Hill, 1986

UE18ME531: PRINCIPLES OF COMBUSTION (3-1-0-4-4)

Course Objectives:

- To expose the students to fundamental thermodynamic principles and get a detailed insight into the temperatures and heat generated during combustion
- To entail a better understanding of the chemical and physical characteristics of combustion, reaction processes, flame & flame front and analysis of propagation characteristics
- To introduce the students to the real-time appliances where analyses of combustion is paramount in its success

Course Outcomes:

At the end of the course, the student will be able to

- Analyze the principles of combustion and gain knowledge about the various modes and scope of its application
- Diagnose the application parameters to be analyzed, measured and effectively controlled for proper combustion and explain the complementary roles of measurements, modeling and scaling in understanding combustion, and in solving industrial problems
- Articulate on the physics and chemistry of combustion (chemical kinetics and transport phenomena) and the fundamental laws
- Evaluate the type of flame and the various schemes of dynamics
- Contribute to the community in terms of providing a safe healthy environment by analyzing the emissions of various appliances

Course Content:

1. **Introduction**: Combustion, Applications of combustion; Theoretical & Actual combustion processes; Various combustion mode, Scope of combustion; Types of fuel and oxidizers
2. **Thermodynamics properties and Laws:** Thermo-chemistry; Chemical equilibrium; Calculation of heat of formation & heat of combustion; First law analysis of reacting systems
3. **Combustion:** Chemistry – Basic Reaction & Global kinetics; Reactions; Physics – Laws of transport phenomena; Conservations Equations; Transport in Turbulent Flow

4. **Flame:** Flame Structure; Flame &propagation; Deflagration; Detonations; Ignition and Igniter; Premixed Flame; Effects of chemical & physical variables on Burning velocity; Diffusion Flame
5. **Combustion Appliances & Emissions:** Gas burners; Pulverized system of firing; Chemical emission from combustion; Quantification of emission; Emission control methods.

Prerequisite Course: None

Reference Books:

1. "Fundamentals of Combustion", D. P. Mishra, Prentice Hall of India, New Delhi, First Edition, 2008.
2. "Engine Emissions: Pollutant Formation and Advances in Control Technology", B. P. Pundir, Narosa Publishing House, New Delhi, First Edition, 2007.
3. "Principles of Combustion", Kuo K. K, John Wiley and Sons, Second Edition, 2005.
4. "Fundamentals of combustion", Strehlow R, McGraw Hill Book Company, First Edition, 1984.
5. "Combustion", Irvin Glassman, Academic Press, Second Edition, 1993.
6. "Fuels Combustion and Furnaces", John Griswold, McGraw-Hill Book Company Inc. First Edition, 1946.
7. "Fuels and Combustion", Samir Sarkar, Universities Press, Third Edition, 2009.

UE18ME532: ADVANCED GEOMETRIC DIMENSIONING & TOLERANCING (3-1-0-4-4)

Course Objectives:

- To help the student the importance and application of geometric dimensioning in production of a component
- To teach student the fundamental concepts of GD & T practiced at industrial level
- To introduce the student to various standards pertaining to GD&T

Course Outcomes:

At the end of the course, the student will be able to

- Read technical drawing having G D &T symbols and understand G D &T rules, apply bonus tolerances and virtual conditions to make manufacturing easy
- Define datum, through which interpretation between designer, manufacturer and measurement could be well understood
- Apply positional tolerances, by virtue of which manufacturing would be easier and cheaper
- Apply concentricity and symmetry principles to realize manufacturing of highly prECise aerospace components
- Apply profile tolerances for highly complicated components used in automotive and aerospace industries

Course Content:

1. **Limits, Fits and Tolerances:** IS2102 and 919, Specified and Non-Specified Tolerances. G D & T – 14 Symbols
2. **Rule of G D & T**: Rules 1, 2, 3, 4 and 5 of G D & T, Boundary condition, application to gauges, bonus tolerances its uses
3. **Datum and its application**: Implied Datum, Datum applied to RFS and MMC and Targets, orientation and measurements
4. **Form Tolerances and its applications:** Straightness Tolerance,, Flatness Tolerance, Circularity, Cylindricity - its application, control and its Measurements.
5. **Advanced Location Tolerance**: Positional Tolerance, Multiple single segment TOP control, Concentricity, Symmetry and Run out and its measurements.
6. **Introduction to Stack up analysis:** Part and assembly Stacks using coordinate dimensions, Part Stack using positional and profile tolerances

Prerequisite Course: None

Reference Books:

1. "Fundamentals of Geometric Dimensioning and Tolerancing", Dr. Alex Krulikowski, University of Michigan, Third Edition, 2014.
2. "Geometric Dimensioning and Tolerancing", James. D. Meadows, CRC Press, First Edition, 2010.
3. "Geometric Dimensioning and Tolerancing", David A. Madsen, Goodheart-Willcox Publishers, Ninth Edition, 2010.

UE18ME533: AUTOMOTIVE DRIVE TRAIN ENGINEERING (3-1-0-4-4)

Course Objectives:

- To enable students to understand the basics of automotive transmission, its layout, performance features and latest design trends
- To introduce the students to start-up devices, clutches and torque converters, and also in the design and choice of transmission system and the determining factors
- To introduce the students to the various types of transmission systems and its layout; gear shifting mechanisms and sychronisers
- To teach the students about the automatic transmission and design of necessary gear ratios and clutch engagement schedule

Course Outcomes:

At the end of the course, the student will be able to

- Apply various load profiles, direction of rotation and transmission ratio to solve the kinematical relations of power trains
- Design appropriate transmission matching the engine based on the gear ratio, incorporating geometrical and progressive gear steps
- Compare and contrast on the various start-up devices presently used and also evaluate and analyse the performance characteristics of torque converters and design manual transmission giving weightage to the power flows and incorporating synchronisers
- Appraise on the various types of automatic transmission and the level of automation, car CVT's and the torque analysis in shifting process-hot and evaluate differential and final drives, considering internal friction and performance limits
- Design and select various transmission elements like slip joint, universal joint, dead & live axle, constant velocity joint and bearings

Course Content:

1. **Overview of Vehicle Power trains System:** Classification, Power train layout, Functions of Vehicle Transmissions, Fundamental Performance Features; **Matching engine and transmission:** Power Requirement, Road loads and axle loads, Vehicle Performance, Fuel Consumption, Total ratio and overall gear ratio, Selecting the powertrain ratio.
2. **Moving-Off Elements:** Dry Clutches, one way clutches (Over running clutch), Wet Clutches, Dual Clutches, Hydrodynamic Clutches, Torque Converters, Engine and Torque Converter Working Together, Trilok converter.

3. **Manual Transmissions:** Manual Transmission Layouts and Components, Basic gear box construction, Transmission Power Flows, **Gear shifting mechanisms:** mechanisms Classification, synchronizers.
4. **Automatic Transmissions:** Level of automation, Gear shift mode, stepped and Continuously Variable Transmissions, Dual Clutch Transmission, epicyclical gear boxes, Car CVTS.
5. **Differential and final drives:** differential theory, Self-locking differential, and final drives. Differential gears, differential locks and locking differentials, Design of slip joint.

Prerequisite Course: None

Reference Books:

1. "Automotive Transmissions: Fundamentals, Selection, Design and Application", Gisbert Lechner, Harald Naunheimer, Springer-Verlag Berlin Heidelberg, New York, First Edition, 1999.
2. "Design Practices: Passenger Car Automatic Transmissions"**,** Warrendale, AE-18, SAE, Fourth Edition, 2012.
3. "Handbook of Automotive Power Train and Chassis Design"**,** J. Fenton, Professional Engineering Publishing, London, First Edition, 1998.
4. "Gears and Transmissions, Vol. 4"**,** J.G. Giles, Automotive Technology series, Butterworth, London, First Edition, 1969.
5. "The Motor Vehicle", K. Newton, W.Steeds and T.K.Garret, Butterworth Heinemann, India, Thirteenth Edition, 2004
6. Clutches and Brakes: Design and Selection", William C. Orthwein, Marcel Dekker Inc., Second Edition, New York, Second Edition, 2004.

UE18ME541:
CONVECTIVE HEAT AND MASS TRANSFER (3-1-0-4-4)

Course Objectives:

- Identify mechanism of convective heat transfer and its relative importance
- Formulate conservation (continuity, momentum and heat) relations
- Determine non-dimensional parameters by scaling analysis
- Apply similarity concepts to proceed for exact and approximate solutions
- Distinguish between external and internal boundary layer flows
- Distinguish between natural and forced convections
- Distinguish between laminar and turbulent flows in terms of heat transfer

Course Outcomes:

At the end of the course, the student will be able to

- Prepare a mathematical model for any physical problem involving convective heat and mass transfer
- Account for the consequence of convective heat transfer in thermal analyses of engineering systems.
- Evaluate heat transfer and mass transfer coefficients for natural and forced convection for flow through and over surfaces

Course Content:

1. **Basic Concepts:** Convective heat transfer; Important factors; **Differential Formulations of the Basic Laws:** Forced convection and free convection; Laminar flow and turbulent flow; Law of conservation of mass, momentum and energy; **Exact Solutions of Governing Equations**
2. **Boundary layer Flow: Application to External Flow** The boundary layer concept; Qualitative description; Mathematical simplifications; Solutions; **Approximate Solutions of Boundary Layer Equations; Heat Transfer in Flows through Surfaces** Analytic and numerical solutions determination of heat transfer coefficient and Nusselt number-
3. **Heat Transfer in Flows Through Surfaces (continued)** Fully developed region for tubes; Nusselt number; Graetz solution; **Free Convection;** Governing equations; laminar free convection; similarity transformation; free convection from inclined plates; Integral method for free convection
4. **Condensation and Boling** film wise and drop wise condensation; Nusselt's theory; wavy flow; Turbulent flow; condensation; regimes of pool boiling; flow boiling; **Mass Transfer**; Analogy between heat and mass transfer; mass convection relations; simultaneous heat and mass transfer
5. **Fundamentals of Turbulent Flows**; mean motion and fluctuations; apparent turbulent stresses; energy distribution in turbulent streams; Theoretical assumptions for calculation of turbulent flows; Turbulent flow through pipes; Turbulent flow over a flat plate

Prerequisite Course: None

Reference Books:

1. "Heat Convection", Latif M. Jiji, Springer-Verlag, Berlin Heidelberg, Second Edition, 2006.
2. "Heat transfer-A basic approach", M. Necati Ozisik, McGraw-Hill International Edition, 1985.
3. "Boundary Layer Theory", Hermann Schlichting, McGraw Hill Indian Edition, 2014.

UE18ME542:
ADVANCED WELDING TECHNOLOGY (3-1-0-4-4)

Course Objectives:

- To enable students to understand the concept of distortion in joints, the stresses involved around it and how to avoid them
- To familiarize and make students understand the advanced welding processes and hardfacing operations
- To introduce the concept of welding of plastics, issues associated with it and various methods of welding plastics
- To familiarize students with the nomenclature, symbols, methods of inspection and quality control practices used in welding

Course Outcomes:

At the end of the course, the student will be able to

- Identify the presence of distortions in a weld and analyze the stresses involved and recommend methods to avoid them
- Explain the process and application of various advanced welding processes and hardfacing operations
- Articulate the issues involved in welding of plastics and apply theoretical knowledge of edge preparation to specific methods of joining plastics
- Select appropriate method of inspection for given type of weld and required quality
- Apply theoretical knowledge of quality control in welding to assess the quality of a weld and recommend remedies for non-concurrence

Course Content:

1. **Distortion:** occurrence, different types and methods to avoid distortion. Stresses in Joint Design.
2. **Advanced welding processes:** Electro Slag Welding, Electron Beam Welding, Plasma arc Welding, Laser Beam Welding,

Explosion Welding, Diffusion Welding, Ultrasonic Welding, Friction welding and Thermit welding.

3. **Hardfacing;** Cladding, overlaying and surfacing of Dissimilar Materials, methods, metallurgical characteristics, bonding mechanisms; Welding of Plastics; issues, edge preparation, Joining methods
4. **Inspection of Welds:** Destructive and Non-Destructive; Welding Symbols, Representing the welds, Basic weld symbols, Location of Weld, Supplementary symbols, Dimensions of welds
5. **Quality Control in Welding**: Introduction, Quality assurance v/s Quality control, Weld quality, Discontinuities in welds, their causes and remedies, and Quality conflicts.

Prerequisite Course: None

Reference Books:

1. "Welding and Welding Technology", Richard Little, McGraw Hill, First Edition, 1973.
2. "AWS Welding Engineering Handbook", American Welding Society, First Edition, 1982.
3. "Welding Technology", O.P. Khanna, Dhanpat Rai Publications, First Edition, 2zzz012.

UE18ME543: AUTOMOTIVE NOISE VIBRATION AND HARSHNESS (3-1-0-4-4)

Course Objectives:

- To train the students to design aspects for noise, vibration and harshness in cars.
- To familiarize the students with the most dominant sources of noise and vibration in cars and its measuring instruments.
- To enable the students to get a knowledge on sound fields and room acoustics
- To enable the students to understand the critical design issues and their relations for noise, vibration and harshness, in particular the aspects of objective and subjective design
- To enable the students to know the working principle of vibration measuring instruments

Course Outcomes:

At the end of the course, the student will be able to

- Discern the sound generation mechanisms and measurement and explain different sound fields and its properties
- Elucidate on the different sound measuring microphones and methods of measuring sound pressure level and sound power level
- Explain the sources of noise and vibration in automobiles and its control by using dampers and vibration absorbers
- Articulate about modal analysis by FEM and experimental method
- Illustrate the construction and working principle of vibration measuring instruments

Course Content:

1. **Vibration Analysis**: Mathematical models, Formulating the equations, Formulating the equations of motion for characteristics and response, Continuous systems.
2. **Sources of Vibration:** Power Train and Engine, Driveline, Chassis and Suspension, Control Strategies, Vibration Isolation and control, Damping of Vibration, Vibration absorbers.
3. **Vibration Control:** Vibration Isolation, Dynamic Vibration Absorbers, Viscoelastic interlayer
4. **Fundamentals of Acoustics:** Vehicle Noise sound generation mechanisms, Measurement of sound, Sound Intensity and sound pressure levels
5. **Vehicle Noise:** Measurement of sound, Human Hearings, Loudness, Waterplot, Sound Spectra, Order analysis. ATV Methods; **Vibration measurement and instrumentation:** Modal parameter (natural frequency, mode shape and damping) estimation

Prerequisite Course: None

Reference Books:

1. "Fundamentals of Acoustics", Lawrence.E. Kinsler, Austin R Frey, Alan B Coppens, John Wiley and Sons, Third Edition, 2000
2. "Noise and Vibration Control", M.L. Munjal, IISc Press, First Edition, 2013
3. "Elements of Vibration analysis", Leonard Meirovitch, The McGraw Hill, Second Edition, 1975
4. "Vehicle Refinement – Controlling Noise and Vibration in Road Vehicles", Mathew Harrison, Elsevier Publication, First Edition, 2004

UE18ME544: ADVANCED MECHANISM DESIGN (3-1-0-4-4)

Course objectives

- To include dynamics considerations in the design of mechanisms for engineering applications
- Provide theoretical background for basic and advanced kinematics and synthesis of mechanisms to achieve desired motion.
- To enable students to acquire fundamental understanding of basics of mechanism motions.

Course outcomes

At the end of the course, the student will be able to

- Distinguish kinematic and kinetic motion and identify the basic relations between distance, time, velocity, and acceleration.
- Apply vector mechanics as a tool for solving kinematic problems.
- Create a schematic drawing of a real-world mechanism.
- Determine the degrees-of-freedom (mobility) of a mechanism.
- Use graphical and analytic methods to study the motion of a planar mechanism.

Course content:

1. **Principles of Dynamics:** laws of motion, Virtual work, Energy and momentum, Work and kinetic energy, Equilibrium and stability, Generalized coordinates, forces and momentum; Lagrange's equation from D'Alembert's principles.
2. **Planar Mechanisms and Geometry of Motion:**classification of links and pairs; Mechanisms, Machine and Inversions; Grashof's Law; Transmission of torque and force; Mobility, Degree of freedom (DOF), Grüebler criterion; DOF permitted by turning and sliding; Equivalent mechanisms.
3. **Kinematic Analysis:** Displacement analysis; Velocity analysis, Mechanical advantage, Acceleration analysis,Klein's construction**.**
4. **Graphical Dimensional Synthesis:** Function generation, Path generation and Body guidance; Precision positions, Structural error, Chebychev spacing; 2,3,4-position synthesis, Overlay method, Coupler curve synthesis.
5. **Analytical Dimensional Synthesis:** Freudenstein's equation for 4-bar mechanism and slider-crank mechanism; Loop closure equation, Bloch's method of synthesi**s.**

Prerequisite Course: None

Reference Books:

1. "Classical Dynamics", Greenwood, Prentice Hall of India, First Edition,1988.
2. "Theory of Mechanism and Mechanism", Ghosh and Mallick, East West Press, Second Edition, 2007.
3. "Mechanism design: Analysis and synthesis", Sandor and Erdman, Prentice Hall, Fourth Edition, 1984
4. "Machines and Mechanisms", David H. Myszka, Pearson Education, Fourth Edition, 2005.

UE18ME561: ADVANCED FLUID MECHANICS (3-1-0-4-4)

Course Objectives:

- To introduce the students to fundamental concepts of fluid mechanics, various 2D and 3D stream equations, boundary conditions and constitutive laws
- To enable the students to understand and analyze inviscid, irrotational flows and various types of fluid motion and its stability based on the fundamental laws and forces affecting fluid flow
- To educate them about the governing equations, boundary layer conditions, constitutive parameters and solution schemes

Course Outcomes:

At the end of the course, the student will be able to

- Visualize different types of fluid flow, and compare them based on the various models of fluids
- Discern the concept of mass and momentum conservation based on Bernoulli's & Newton's laws and its applications
- Evaluate the stream & potential functions and articulate on the flow parameters and analyze viscous flow including laminar and turbulent flow to solve real-world engineering problems
- Analyze flow over solid bodies for solving real-world engineering problems involving turbomachines, hydraulic pumps and turbines
- Appraise the stability factor of fluid flows and obtain phenomenological observations after applying standardized solution models

Course Content:

1. **Fundamentals:** Equations for Newtonian fluids, Boundary conditions, Vorticity and circulation, the work-energy equation, Non-Newtonian fluids; Inviscid irrotational flows
2. **Singularity distribution methods:** Forces acting on a translating sphere, Added mass and the Lagally theorem, Theorems for irrotational flow; Irrotational Two-Dimensional Flows
3. **Exact solutions of the Navier-Stokes equations:** Solutions to the steady and unsteady flows Navier-Stokes equations when convective acceleration is absent
4. **The Boundary Layer Approximation:** Integral form of the boundary layer equation, Transformations for non-similar boundary layer solutions; Low Reynolds number
5. **Flow stability:** Turbulence and transition to turbulence, Statistical approach: one-point averaging, turbulent models

Prerequisite Course: None

Reference Books:

1. "Advanced Fluid Mechanics", William Graebel, Elsevier, First Edition,2007.
2. "Engineering Fluid Mechanics", P.A. Aswatha Narayana & K.N.Seetharamu, Narosa publications, First Edition, 2005.
3. "Advanced Fluid Mechanics", K.Muralidhar and G Biswas, Narosa publication, Second Edition, 1996.
4. "Introduction to Fluid Dynamics - Principles of Analysis & Design", Midleman, John Wiley and Sons, First Edition, 1998.

UE17ME562: NON-TRADITIONAL MACHINING PROCESSES (3-1-0-4-4)

Course Objectives:

- To enable students to understand the important concepts related to Non-Traditional machining
- To enable students to understand the use of non-conventional machining processes for critical applications
- To enable students to understand process variables and understand the selection of Non-Traditional machining.

Course Outcomes:

At the end of the course, the student will be able to

- Explain importance and need for non-traditional machining processes
- Differentiate between various forms of non-traditional machining methods
- Explain intricate methodology involved in NTM processes
- Choose appropriate NTM process based on the requirement and also assess advantages and disadvantages of the same

Course Content:

1. **Introduction:** Non-traditional machining processes, selection and c1assification; Mechanical process: Ultrasonic Machining, Theories of mechanics, Abrasive Jet Machining
2. **Thermal Metal Removal Process:** Electric discharge machining Principle of operation – mechanism Analysis, Applications.
3. **Electro Chemical and Chemical Processes:** Electro chemical machining (ECM) Classification, principle, parameters of the processes, dynamics, Tool Design, Electro Chemical Grinding
4. **Chemical Machining:** Types, Maskants-Etchenes; Plasma arc machining: Generation of plasma and equipment, Mechanism of metal removal, PAN parameters; Electron Beam Machining, Equipment, Theory of EBM
5. **Laser Beam Machining (LBM):** Generation, Equipment &machining procedure; Ion Beam machining: Mechanism, equipment-process characteristics applications; High Velocity Forming

Prerequisite Course: None

Reference Books:

1. "New Technology", Bhattacharya, Institution of Engineers, India, First Edition,1973
2. "Production Technology", HMT, Tata Mc Graw Hill, First Edition, 1980, Reprint 2008.
3. "Modern Machining Process", P.C Pandy & H.S. Shan, Tata McGraw Hill, 1980.
4. "Metals Hand Book", ASM - Vol-3, First Edition, 1980.
5. "Modern Manufacturing Method", Adithan, New Age International (P) Limited, First Edition, 2007.
6. "Modern Machining Processes", P.K. Mishra, Narosa Publishing House, New Delhi, First Edition, 2007.

UE18ME563: VEHICLE CRASHWORTHINESS (3-1-0-4-4)

Course Objectives:

- To enable the student to understand the vehicle crashworthiness and various occupant safety system being incorporated in the automotive vehicle.
- To enable the student to learn about fundamentals of crash analysis and characterization
- To enable the student to understand concepts of occupant safety

Course Outcomes:

At the end of the course, the student will be able to

- Explain various regulations related to crash analysis and elucidate the requirements of crashworthiness and modeling
- Emphasize on characterization of the crash pulses based on crash phenomenon
- Explain various techniques being used in the safety of the occupants in automotive vehicle such as air bags, seatbelt and abs
- Model the crash testing based on type of crash according to the regulation.
- Articulate about various models employed for safety of the automobile occupants during the possible crash and illustrate multi-body algorithms and optimizing them

Course Content:

1. **Introduction:** Motor Vehicle Safety, Crashworthiness model requirements, and tests, Current Design Practice, Designing for Crash Energy Management.
2. **Vehicle Collision Models:** Impulsive models, Second approximation models, Motion after the Collision with locked wheels and free wheels,
3. **Crash Pulse Characterization:** Introduction, Moment-Area Method, Pulse Approximations with Zero and Non-Zero Initial Deceleration.
4. **Vehicle Impact Modeling Impact and Excitation:** Rigid Barrier and Hyge Sled Tests, Vehicle and Sled/Unbelted Occupant Impact Kinematics, Vehicle and Occupant Transient Kinematics
5. **Occupant Safety:** Effect of impact forces on humans, Designing for human safety, Safety systems, The Multi-Body Method for Crash Analyses

Prerequisite Course: None

Reference Books:

1. "Vehicle Crashworthiness and Occupant Protection", Paul Du Bois, Clifford C. Chou and others, American Iron and Steel Institute, First Edition, 2000.
2. "Vehicle Crash Mechanics", Huang, M., CRC Press, First Edition, 2002.

UE18ME564: ADVANCED MECHANICS OF MATERIALS (3-1-0-4-4)

Course Objectives:

- To enable students acquire knowledge about fundamental concepts of elasticity
- To equip students with necessary knowledge and skills to analyze unsymmetrical bending
- To enable students to calculate deflections and stresses in curved beam and rectangular plates
- To help students acquire required understanding, knowledge and skills to analyze torsion of non-circular cross sections
- To enable students to evaluate the stresses in rotating members and provide a sound understanding of contact stresses and its mathematical treatment

Course Outcomes:

At the end of the course, the student will be able to

- Explain fundamental concepts, laws, mathematical developments and formulations of theory of elasticity
- Locate shear center for various thin sections and analyze shear flows
- Calculate deflection, stresses and kern area in beams under non-symmetrical loading and analyze stresses and deflections in flat plates under pure bending, uniformly loaded load and in curved members such as chain links and crane hooks
- Apply St. Venant's theory, elastic membrane analogy and Prandtl's stress function and analyze for torsional stresses in hollow thin walled tubes
- Analyze stresses in rotating members and illustrate contact stresses (for point and line contacts) and its mathematical treatment within the context of theory of elasticity

Course Content:

1. **Elasticity:** General equations of elasticity, differential equations of equilibrium, generalized hook's law, St. Venant's principle, Airy's stress function. Energy methods
2. **Shear Centre and Unsymmetrical Bending:** Location of shear center for various thin sections - shear flows. Stresses and Deflections in beams under unsymmetrical loading, kern of a section.
3. **Stresses in Flat Plates and Curved Members:** Circumference and radial stresses, deflections, curved beam with restrained ends - closed ring subjected to concentrated load and uniform Solution of rectangular plates
4. **Torsion of Non-circular Sections:** Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy - Prandtl's stress function - torsional stress in hollow thin walled tubes
5. **Stresses in Rotating Members and Contact Stresses:** Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress- deflection of bodies in point and line contact applications.

Prerequisite Course: None

Reference Books:

1. "Advanced Mechanics of Materials", Arthur P Boresi, Richard J. Schmidt, John Wiley, Sixth Edition, 2002.
2. "Advanced Mechanics of Solids", Srinath L S, Tata McGraw-Hill, Fourth Edition, 1992.
3. "Theory of Elasticity", Timoshenko and Goodier, McGraw-Hill India Education Pvt. Ltd., Third Edition, 2010.
4. "Advanced Mechanics of Materials", Robert D. Cook, Warren C. Young, McMillan Publication Company, Second Edition, 1985.
5. "Strength of Materials", G H Ryder, Macmillan India Ltd, Third Edition, 2007.
6. "Applied Mechanics of Solids", Allan F. Bower, CRC press, Special Indian Edition, First Edition, 2012.
7. "Theory of Isotropic/Orthotropic Elasticity", K Baskar and T K Varadan, Ane Books Pvt. Ltd., New Delhi, First Edition, 2009.

UE18ME571: CONDUCTION AND RADIATION HEAT TRANSFER (3-1-0-4-4)

Course Objectives:

- Apply scientific and engineering principles to analyze and design aspects of engineering systems that relate to conduction and radiation heat transfer;
- Use appropriate analytical and computational tools to investigate conduction and radiation heat transfer;
- Interpret results of investigations related to conduction and radiation heat transfer and thermal design;
- Recognize the broad technological and historical context of where heat transfer is important.

Course Outcomes:

At the end of the course, the student will be able to

- Analyze problems involving steady state heat conduction in simple geometries.
- Develop solutions for transient heat conduction in simple geometries.
- Obtain numerical solutions for conduction heat transfer problems.
- Calculate radiation heat exchange in enclosures using radiosity-matrix method
- Formulate radiation problems in radiation in participating media.

Course Content:

1. **Lumped, Integral, and Differential Formulations**: Statement of general laws, Lumped formulation, Integral formulation, Differential formulation, Statement of particular laws, Equation of conduction. Initial and boundary conditions
2. **Steady One-Dimensional Problems, Bessel Functions**: Composite structures, Principle of superposition, Heterogeneous solids, Bessel functions, **Steady Two- and Three-Dimensional Problems Separation of Variables** Orthogonal Functions, Fourier series, Separation of variables, Non-homogeneity
3. **Separation of Variables. Unsteady Problems, Orthogonal Functions:** Multidimensional problems, Time-dependent boundary conditions, Duhamel's super-position integral, **Steady Periodic Problems. Complex Temperature**
4. **Variational Formulation**. **Solution by Approximate Profiles** Steady one-dimensional problems, Steady two-dimensional problems, Kantorovich method, Kantorovich method extended, Moving Heat Source Problems, Phase change problems
5. **Radiation Heat Transfer:** Review of basic concepts and basic laws of radiation, shape factors and shape factor algebra; radiation in enclosures using radiosity-matrix method in non-participating media. Introduction to radiation in participating media.

Prerequisite Course: None

Reference Books:

1. "Conduction Heat Transfer", V.Arpaci, Addison Wesley Press, First Edition, 1966
2. "Heat Conduction",M.Necati Ozisik, John Wiley &sons, 2nd Edition,1993.
3. "Heat Conduction", Jiji, Latif M., Springer, Second Edition, 2000.
4. "Thermal Radiation Heat Transfer", John R. Howell, M. Pinar Menguc, and Robert Siegel Taylor and Francis, Sixth Edition, 2015

UE18ME572: INDUSTRIAL ROBOTICS (3-1-0-4-4)

Course Objectives:

- To familiarize student with fundamental concepts of robot anatomy and drive systems.
- To familiarize the students with the kinematics and construction of robot's arm.
- To provide knowledge about various driving system and sensors with their applications in different areas
- To enhance students' knowledge with robot programming methods and languages of robot

Course Outcomes:

At the end of the course, the student will be able to

- Elucidate on the brief history of robots, anatomy of different type of robots and their applications in respective fields
- Select the suitable end effectors for different purposes of application and their design concepts
- Analyse the degrees of freedom and kinematic motions of robot
- Write programs and employ various programming languages of robots to facilitate different motions in the robot
- Explain the principles of various sensors and their applications in robots

Course Content:

1. **Fundamentals**: Robot, Robot anatomy – Co-ordinate systems, work envelope, types and classification, Specifications Speed of motion, pay load, robot parts and their functions
2. **End effectors:** Grippers, Selection and design considerations;
3. **Robot Drive Systems:** Pneumatic, Hydraulic, Mechanical & Electrical drives; Salient features and applications
4. **Sensors:** Principles and applications, Structured, Lighting approach, Time of flight range finders, Laser range meters, Proximity sensors (Types)
5. **Machine Vision:** Camera, frame grabber, sensing and digitizing image, Inspection, identification, visual serving and navigation.
6. **Robot Kinematics:** Robot as Mechanisms, Matrix representation, Representation of Transformations, Forward kinematics; Robot Programming, languages

Prerequisite Course: None

Reference Books:

1. "Introduction to Robotics", John J. Craig, Pearson Education, Third Edition, 2008.
2. "Introduction to Robotics Analysis, Systems Applications", J Saeed b. Niku, John Wiley and Sons, Second Edition, 2003.

UE18ME573: INTERNAL COMBUSTION ENGINES (3-1-0-4-4)

Course Objective:

- To broaden the understanding of engine working and its subsystems
- To enhance the knowledge about the fuel supply system of SI engines
- To understand the working of different fuel supply systems used in CI engines
- To broaden the understanding of the combustion phenomenon in engines
- To enhance the fundamental knowledge about the charging systems and different combustion chambers of engines

Course Outcome

At the end of the course, the student will be able to

- Explain the working of engines and engine performance
- Explain different fuel systems of SI engines
- Explain the working of CI engine fuel supply system
- Describe the basic difference between combustion in SI engines and CI engines
- Elucidate the fundamental behind charge induction systems, combustion chambers and its importance

Course Content:

1. **Engine Basics:** Engine construction and operation, Classification, – Operating cycles; Engine Subsystems: Ignition system, Cooling systems, Lubricating systems, Performance Testing of engines
2. **Fuel Supply Systems – SI engines:** Mixture requirements, Theory of carburetion, Carburetor; Petrol injection systems, types, Components, Injection, TBI, D-Jetronic, LJetronic, K-Jetronic, KE-Jetronic systems and Gasoline Direct Injection(GDI) systems
3. **Fuel Supply Systems – CI engines:** Functional requirements, Components, Injector Nozzle control and Injection types; Common Rail systems, Injectors, Advance Injection Systems.
4. **Air Induction systems and Combustion Chambers:** Charge Motion, Charging Systems, Boost control; Combustion Chambers: Requirements, Design considerations, Types.
5. **Combustion in Engines:** Types of combustion – Combustion in SI engines; Factors affecting knocking Combustion in CI engines; Spray Characteristics; Abnormal Combustion.

Prerequisite Course: None

Reference Book:s

1. 'Internal Combustion Engine Fundamentals', J.B. Heywood, McGraw Hill Book Co., Second Edition, 1988.
2. 'Internal Combustion Engines', V. Ganesan, McGraw Hill Book Co, Fourth Edition, 2010

UE18ME574:
EXPERIMENTAL STRESS ANALYSIS (3-1-0-4-4)

Course Objectives:

- To teach students the need for different types of experimental stress analysis
- To enable the students to learn the working principle of various measuring instruments
- To help students to acquire sound understanding of basic terminologies and concepts in photo-elasticity, and also the working principles and laws involved
- To introduce to the students, Moiré methods and technique of brittle coating, holography and the principle behind their working
- To enable the students to understand and learn various non-destructive testing methods

Course Outcomes:

At the end of the course, the student will be able to

- Explain the principle of measurements along with various measuring instruments, their application, advantages and disadvantages and articulate about the need and principle of NDT techniques
- Analyze Rosette arrangement of strain gauges and develop expressions to calculate principal strains
- Discern photo-elasticity, polarization of light and meaning of different fringe patterns as applied to stress distribution in the member
- Articulate about compensation and separation techniques needed to quantify the fringe patterns and the technique of three-dimensional photo-elasticity
- Explain the principle of brittle coating, holography and Moire technique and use them

Course Content:

1. **Measurements and Extensometer:** Basic principles, Accuracy, Sensitivity and range, Mechanical, Optical, Acoustical and Electrical extensometers, their uses, advantages and disadvantages
2. **Electrical resistance and strain gauges:** Types and uses, Materials for strain gauge, Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits, strain indicators.
3. **Photoelasticity:** 2D photo elasticity, Concept of light–photoelastic effects, stress optic law, Fringe pattern, Compensation &separation techniques, Photoelastic materials, 3D photoelasticity
4. **Brittle Coating and Moiré Methods:** Introduction to Moiré techniques, brittle coating methods and holography
5. **Non – Destructive Testing:** Fundamentals of NDT, Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique

Prerequisite Course: None

Reference Books:

1. "Experimental Stress Analysis", Dally, J W, and Riley, W.F., McGraw-Hill Inc., New York, Fourth edition, 2005.
2. "Experimental Stress Analysis", Srinath, L S, Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., Tata McGraw-Hill, New Delhi, First Edition, 1984.
3. "Hand book of Experimental Stress Analysis", Hetyenyi, M., John Wiley and Sons Inc., New York, First Edition, 1972.
4. "Acoustic Emission in Acoustics and Vibration Progress", Pollock A A, Ed. Stephens R W B., Chapman and Hall, First Edition, 1993.

UE17ME611:
ANALYSIS & DESIGN OF CENTRIFUGAL AND AXIAL FLOW COMPRESSORS (2-0-0-4-2)

Course Objectives:

- To introduce the students to gas turbines, turbomachinery and corresponding thermodynamic analysis especially the energy transfer between a fluid and a rotor
- To invoke in students an understanding on the aerothermodynamics of turbomachines, compressibility, pressure gradients and various losses
- To familiarise the students to the radial equilibrium theory, small stage efficiencies and working and performance of axial and centrifugal compressors and pumps

Course Outcomes:

At the end of the course, the student will be able to

- Analyse the energy transfer in a gas turbine or in general a turbomachine, construct velocity diagrams, and analyse the system based on the frames of references, Flow and airfoil angles, stages of reaction, invariant thermophysical properties, deviation angles etc
- Elucidate on the assumptions, implications or radial equilibrium equation and subsequent simplifications required and derive the polytropic efficiency of multistage compressors and turbines

- Aanalyse the axial flow compressors and explicate on the various stages and the real flow effects and various start-up problems
- Discuss and debate on centrifugal compressor thermodynamics, components, performance consequences, losses and efficiencies, volute design, performance related variables in propulsion systems and post processing works required
- Enunciate clearly the performance and build characteristics of centrifugal and axial flow pumps along with dimensional analysis of compressible and incompressible flow in turbines and pumps

Course Content:

1. **Gas Turbine Engines:** Gas Generator; Multispool arrangement, Turbomachinery Nomenclature, Energy transfer Between a Fluid and a Rotor
2. **Aerothermodynamics of Turbomachines:** Energy Conservation law; Nozzle and Diffuser like airfoil cascades; Fanno flow relationships; Exhaust diffusers; Momentum thickness.
3. **Radial Equilibrium theory:** Derivation of polytropic efficiency; Multistage compressors and turbines; Axial flow compressors: Real flow effects; Off-design characteristics
4. **Centrifugal Compressors:** 1D approach to volute design; Multiple staging; Impeller/stator flow interaction; Turbine-Compressor Matching, Propulsion system performance
5. **Centrifugal pumps:** Types, losses, efficiencies and characteristics, Muschel curves; Pumps in series & parallel; Axial flow pumps; Dimensional Analysis, Specific speed

Prerequisite Course: None

Reference Books:

1. “Principles of Turbomachinery in Air Breathing Engines”, Erian A Baskhaarone, Cambridge University Press, First Edition, 2006.
2. “An Introduction to Energy Conversion –Volume III Turbomachinery”, V.Kadambi and Manohar Prasad, New Age International, Second Edition, 2011.

UE17ME612:
BOILING, CONDENSATION & TWO-PHASE FLOWS (2-0-0-4-2)

Course Objectives:

- To introduce the students to boiling, condensation and the various muti phase flows
- To familiarize the students to the separated and homogenous flows and the velocity concentration profiles, wave and interfacial phenomena

Course Outcomes:

At the end of the course, the student will be able to

- Aarticulate on multiphase flow and the various analyses performed on various flow regimes and
- Recognize the difference between homogeneous and separated flow and discern the various equations related to momentum and energy
- Analyse the flow regimes using the drift-flux model and introduce the corrections to simple theory of two-phase flow and unsteady flows along with differential analysis of velocity profiles
- Perform analysis of 1D wave continuity in single phase flows, dynamic wave in homogeneous compressible fluids, and discuss on the various shock waves
- Articulate on suspended particles in fluids, stability of unsteady flow and batch sedimentation and friction characteristics-advantages

Course Content:

1. **Introductory concepts:** multi-phase flow; analysis, correlations; Flow regimes; Homogeneous Flow; Separated Flow
2. **The Drift- flux Model:** Gravity dominated flow regimes;

   Velocity & Concentration Profiles: Differential analysis;

   One-Dimensional Waves: Continuity waves, Incompressible 2-component flow
3. **Interfacial Phenomena:** boundary conditions

   Suspension of Particles in Fluids: Particulate fluidization, Flow in particle dispersions; Batch sedimentation; Unsteady flow with particle-particle forces
4. **Bubbly Flow:** Bubble formation; Flow of a bubbly mixture without wall shear; Unsteady flow; Slug Flow; General theory
5. **Annular Flow:** Flooding; vertical upwards cocurrent annular flow; Drop Flow; Single-drop formation; 1D vertical flow without wall friction.

Prerequisite Course: None

Reference Books:

1. “One Dimensional Two Phase Flow”, G.B.Wallis, McGraw-Hill Co., First Edition, 1969.
2. “Two-Phase Flow in Pipe Lines and Heat Exchangers”, D.Chisholm, George Godwin, First Edition, 1983.
3. “Convective Boiling & Condensation”, J.G.Collier, McGraw-Hill Book Co., First Edition, 1996.
4. “Fundamentals of Multi Phase Flows”, Christopher E Brennen, Cambridge University Press, First Edition, 2005.

UE17ME613:
THEORY OF METAL CUTTING (2-0-0-4-2)

Course Objectives:

- To familiarize student with fundamental concepts of cutting tool nomenclature and cutting forces
- To introduce the students about the importance of heat distribution and thermal aspects of machining
- To impart knowledge on mechanisms of tool wear and factors effecting the life of the cutting tool
- To educate students on optimization and failure analysis of a cutting tool

Course Outcomes:

At the end of the course, the student will be able to

- Analyze and differentiate between various types of cutting forces in performing different machining operations
- Explain cutting tool materials, tool wear, temperature in metal cutting and the theory of chip formation in machining process
- Select the appropriate cutting tool material, cutting speed and cutting fluids to reduce temperature distribution during machining
- Develop the methods of working for minimizing the total machining cost by selecting optimized cutting process parameters

Course Content:

1. **Mechanics of Metal Cutting:** Mechanics of Metal Cutting, Mechanism of chip formation, Orthogonal & Oblique cutting, Merchant circle diagram, Theory of Lee & Shaffer, Factors affecting forces & power
2. **Geometry of Cutting Tools:** Single point and multi point cutting, Nomenclature, Tool Materials, Characteristics, types, air, water, oil hardening of tools and applications.
3. **Measurement of Cutting Forces:** Dynamometers, Calibration of dynamometers

Tool Life: Tool wear, Tool failure, tool life equations, effect of process parameters on tool life, tool life tests, Machinability index

4. **Thermal Aspects in Metal Cutting:** Heat sources in metal cutting, temperature in chip formation; Cutting Fluids: Basic actions, properties, selection, application and filtration
5. **Economics of Machining:** Elements of total production cost, optimum cutting speed and tool life for minimum cost and maximum production & optimum cutting speed

Prerequisite Course: None

Reference Books:

1. "Metal Cutting Principles", M.C. Shaw, Oxford Publication, Second Edition, 1985.
2. "Metal Cutting", V.C.Venkatesh & S.Chandrasekharan, Prentice Hall India, First Edition, 1991.

UE17ME614: CIM AND AUTOMATION (2-0-0-4-2)

Course Objectives:

- Introduce to students the significance of computer integrated manufacturing in the design and manufacture for a range of components and products
- To train the students to use preparatory functions to prepare part program for performing different operations in machining centers
- To discuss the need of the computers in the area of manufacturing to reduce manual processing and linking computers to all the manufacturing machines and increase the productivity
- To study the importance of engineering design, and modeling techniques towards flow lines, robotics, numerical control and the integration of computer control and usage in manufacturing

Course Outcomes:

At the end of the course, the student will be able to

- Apply concepts discerned for design, modeling, analysis, process planning and assembly purpose
- Simulate industrial robotics and material handling systems and apply material requirements planning for inventory control in production systems
- Generate manual/automated part programs for a given part to be machined on NC/CNC system.
- Design components of automated production, methods and use the different types of transfer mechanism deployment for storage buffers in automated production line

Course Content:

1. **Production Development through CIM:** Product cycle & Production development cycle, CAD/CAM & CIM, Computer Process Monitoring, Computer Aided Quality Control
2. **Computerized Manufacturing planning systems:** Shop floor control & automatic identification; Computer Network for manufacturing & future automated factor
3. **Analysis of Automated Flow Lines:** Design for automated assembly, Analysis of assembly machine.
4. **Material Handling Systems:** Material functions, Analysis of material handling systems, Design of system, Interfacing handling & storage with manufacturing
5. **Automated Material Handling Storage:** Conveyor system, automated guided vehicle systems, automated storage/retrieval systems, caroused storage systems work in process storage.

Prerequisite Course: None

Reference Books:

1. "CAD/CAM", Zimmers & Grover, PHI, First Edition, 2008.
2. "CAD/CAM/CIM", P.Radhakrishna, New Age International (P) Ltd. Publishers, Second Edition, 2000.
3. "Automation, Production systems & Computer Aided Manufacturing", M.P. Grover, Prentice Hall, First Edition, 1984.
4. "CAD/CAM", Zeid, McGraw-Hill, Second Edition, 2005.
5. "CAD/CAM", P.N.Rao, TMH, Second Edition, 2004.
6. "Robotics for Engineering", Koren.Y, McGraw-Hill, First Edition, 1985.

UE16ME615: VEHICLE CRASHWORTHINESS (2-0-0-4-2)

Course Objectives:

- To enable the student to understand the vehicle crashworthiness and various oecupant safety system being incorporated in the automotive vehicle.
- To enable the student to learn about fundamentals of crash analysis and characterization
- To enable the student to understand concepts of oecupant safety

Course Outcomes:

At the end of the course, the student will be able to

- Explain various regulations related to crash analysis and elucidate the requirements of crashworthiness and modeling
- Emphasize on characterization of the crash pulses based on crash phenomenon
- Explain various techniques being used in the safety of the occupants in automotive vehicle such as air bags, seatbelt and abs
- Model the crash testing based on type of crash according to the regulation.
- Articulate about various models employed for safety of the automobile occupants during the possible crash and illustrate multi-body algorithms and optimizing them

Course Content:

1. **Introduction:** Motor Vehicle Safety, Crashworthiness model requirements, and tests, Current Design Practice, Designing for Crash Energy Management.
2. **Vehicle Collision Models:** Impulsive models, Second approximation models, Motion after the Collision with locked wheels and free wheels,
3. **Crash Pulse Characterization:** Introduction, Moment-Area Method, Pulse Approximations with Zero and Non-Zero Initial Deceleration.
4. **Vehicle Impact Modeling Impact and Excitation:** Rigid Barrier and Hyge Sled Tests, Vehicle and Sled/Unbelted Occupant Impact Kinematics, Vehicle and Occupant Transient Kinematics
5. **Occupant Safety:** Effect of impact forces on humans, Designing for human safety, Safety systems, The Multi-Body Method for Crash Analyses

Prerequisite Course: None

Reference Books:

1. "Vehicle Crashworthiness and Occupant Protection", Paul Du Bois, Clifford C. Chou and others, American Iron and Steel Institute, First Edition, 2000.
2. "Vehicle Crash Mechanics", Huang, M., CRC Press, First Edition, 2002.

UE17ME616: MULTI-BODY DYNAMICS (2-0-0-4-4)

Course Objectives:

- To teach student applications of engineering dynamics for kinematic simulation of automobile and related engineering systems.
- To enable the students to learn various software to analyze multi-body dynamics of an automotive system.

Course Outcomes:

At the end of the course, the student will be able to

- Elucidate the concepts of rigid body dynamics to apply in automobile problems
- Apply various mathematical methods involved in analysis of multi-body dynamics problems
- Illustrate optimization of multi-body dynamic systems with the help of related software.
- Solve for conservative and non-conservative forces in spring, dampers and bushings

Course Content:

1. **Introduction:** MBD, Kinematics of free bodies, Position, velocity, acceleration, transformation matrices, Euler & Cardan angles, Kinematic equations of rotation.
2. **Conservative and non-conservative force and torque elements:** Spring, damper, force elements with inner dynamics, Constraint forces, Impacts, Play and dry friction
3. **Rigid Body and Kinematic Constraints:** Newton- Euler equations, Inertia tensor, SSID of multi-body systems, Constraints functions, DoF, Jacobian, joints and linkages
4. **Structure and functionality of multi- body codes:** Kinematics equilibrium points (static), dynamics, inverse dynamics.
5. **Analysis:** Linearization, modal analysis, and optimization, Usage of Software such as MSC ADAMS for multi body dynamics simulation for automotive system.

Prerequisite Course: None

Reference Books:

1. “Computer-Aided Mechanical Systems”, Nikravesh. P.E., Prentice Hall, First Edition, 1988.
2. “Computational Methods for Multibody Dynamics”, Amirouche, F.M.L, Prentice-Hall, First Edition, 1992.
3. “Computer-Aided Kinematics and Dynamics of Mechanical Systems”, Haug, E.J., Volume I: Basic Methods, Allyn and Bacon, First Edition, 1989.
4. “Multibody Dynamics”, Huston, R.L., Butterworth- Heinemann, First Edition, 1990.
5. “Dynamics of Multibody Systems”, Roberson, R.E. and Schwertassek, R., Springer-Verlag, First Edition, 1988.
6. “Multibody System Handbook”, Schiehlen, W.O., Springer-Verlag, First Edition, 1990.
7. “Dynamics of Multibody Systems”, Shabana, A.A., Wiley, First Edition, 1989.
8. MSC ADAMS user Manual, Simcompanion, First Edition,2017.

UE17ME617: TRIBOLOGY IN DESIGN (2-0-0-4-2)

Course Objectives:

- Introduce students to the various types of friction and frictional properties of materials
- Teach students the types of wear, theoretical wear models and topography measurements
- Familiarize the students the concept of lubrication and types of lubricants
- Teach students the theory of hydrodynamic, hydrostatic and elasto-hydrodynamic lubrication

Course Outcomes:

At the end of the course, the student will be able to

- Apply the basic theories of friction, wear and lubrication to predictions about the frictional behavior of commonly encountered sliding interfaces
- Use the theory of lubrication and compute the performance parameters for different types of bearings
- Explain the importance of contact stresses for various types of contacts
- Apply the fundamental principles of high contact stresses (Hertz stresses) and Elasto-hydrodynamic lubrication in rolling bearings

Course Content:

1. **Surface Interaction and Friction:** Topography of Surfaces and its features, Properties and measurement, Adhesive Theory of Sliding and Rolling Friction, Friction properties, Friction in extreme conditions
2. **Wear and Surface Treatment:** Types and Mechanism of of wear, Laws of wear, Theoretical wear models, Wear of Metals and Non-metals, Surface treatment, Surface Topography measurements, Laser methods, Instrumentation
3. **Lubricants and Lubrication Regimes:** Physical properties, Additives and selection, Various standards, Dry &marginally lubricated contacts, Hydro static & Hydrodynamic lubrication.
4. **Theory of Hydrodynamic and Hydrostatic Lubrication:** 1 & 2D Reynolds equation and Sommerfeld boundary conditions, Squeeze film effects, Thermal considerations, Stiffness considerations, Flow restrictors
5. **High Pressure Contacts and Elasto-Hydrodynamic Lubrication:** Rolling contacts of Elastic solids, Contact stresses, Spherical and cylindrical contacts, Fatigue, Oil film effects, Rolling bearings, Stresses and deflections, Traction drives

Prerequisite Course: None

Reference Books:

1. “Friction and Wear of materials”, Rabinowicz.E, John Willey &Sons, UK, Second Edition, 1995.
2. “Basic Lubrication Theory”, Cameron, A, Ellis Herward Ltd., UK, First Edition, 1981.
3. “Principles of Tribology”, Halling, J. (Editor), Macmillian, First Edition, 1984.
4. “Engineering Tribology”, Williams J.A., Oxford Univ. Press, First Edition, 1994.
5. “Fundamentals of Tribology”, S.K.Basu, S.N.Sengupta & B.B.Ahuja, Prentice Hall of India Pvt. Ltd., New Delhi, First Edition, 2005.
6. “Engineering Tribology”, G.W.Stachowiak & A.W .Batchelor, Butterworth-Heinemann, UK, First Edition, Reprint 2005.

UE17ME618: THEORY OF ROTOR DYNAMICS (2-0-0-4-2)

Course Objectives:

- To expose the students to a brief introduction to free and forced vibrations of SDOF mechanical systems and teach the Laval-Jeffcott rotor model, its parameters, analysis and applications
- To teach the numerical and analytical methods of treating rotating machinery shafts
- To help students in the determination of and differentiation between natural frequencies and modes as applied to a rotor system

- To teach students develop a dynamic rotor model, help them perform orbital analysis and interpret cascade plots and Campbell diagram
- To help students understand the mathematical treatment of the effect of bearings, concept of hydrodynamic instability and design configurations
- To teach the students rigid and flexible rotor balancing in single and multiple plane and help them understand use of influence co-efficient

Course Outcomes:

At the end of the course, the student will be able to

- Explain Laval-Jeffcott rotor model, its parameters, analysis and applications
- Treat rotating machinery shafts using numerical and analytical methods
- Determine and differentiate between natural frequencies and modes of rotor system
- Develop a dynamic rotor model, perform orbital analysis and interpret cascade plots and Campbell diagram
- Mathematically treat the effect of bearings on rotor dynamics, explain their understanding of the concept of hydrodynamic instability and design configurations
- Balance rigid and flexible rotor in single and multiple plane
- explain the use of influence co-efficient

Course Content:

1. **Torsional Vibrations of Rotating Machinery:** Modeling of rotating machinery, Holzer method; Rotor-bearing systems: Evolution of rotating machinery, Rotor-bearing dynamics, Rotor precession, Modeling the rotor, Evolution of rotor design philosophy and Historical perspective
2. **Simple rotors in rigid bearings:** rotor models, Equations of motion, Steady state response, Gravity loading, Effect of shaft bow, Rotor precession in rigid bearings, asymmetric rotors.
3. **Simple rotors in flexible bearings:** Symmetric rotors in flexible bearings, Symmetric rotors in fluid film bearings, Unbalance response, Stability of precession motion
4. **Rotor dynamic analysis:** Undamped critical speeds, Effect of support flexibility, Critical speed map, Influence of stator inertia, bearing models, Equations of damped motion, Eigenvalue problem of damped rotor systems, Campbell diagrams, Orbits and precession mode shapes, Peak response critical speeds, Stability analysis, Simulation examples, Planar modes of precession
5. **Balancing of Rotors:** The mass unbalance, Single plane balancing, Vector balancing, Influence coefficient method, Three-trial-mass method, Two-plane balancing, Influence coefficient method, Resolution into static and couple unbalance, Unbalance tolerances, Permissible residual unbalance, Balance quality grades, Classification of rigid rotors, Multi-plane flexible rotor balancing, Balancing in N+2 planes, Modal balancing

Prerequisite Course: None

Reference Books:

1. Dynamics of Machinery I, II and II, Printech, Mircea Rades, Universitatea Politechnica Bucuresti
2. “Rotor Dynamics”, J S Rao, New Age International Publishers, 3rd Edition, New Delhi, 2011.
3. “Vibration Problems in Engineering, S Timoshenko”, D H Young and W. Weaver, John Wiley, 5th Edition, 1990.
4. “Introduction to Dynamics of Rotor, Bearing Systems”, W J Chen and J E Gunter, Trafford Publishing Ltd, 2005.
5. “Vibratory Condition Monitoring of Machines”, J S Rao, Narosa Publishing House, 2000.

UE17ME661:
AIR CONDITIONING SYSTEMS (ANALYSIS & DESIGN)
(2-0-0-4-2)

Course Objectives:

- To introduce the students to the fundamental concepts of HVAC and methodologies used in system selection comprising of various components and heat recovery and storage
- To enable the students to understand the various conditioning processes, the comfort quality attained using a HVAC unit
- To elucidate on the basic heat transfer modes on building structures heat sources and various losses
- To guide the students and help them understand the solar radiation and the calculate the different cooling and heating loads required
- To guide them through energy calculations & building simulations and air distribution systems

Course Outcomes:

At the end of the course, the student will be able to

- Formulate an effective HVAC system giving consideration to the correct choice of components and distribution systems, discuss in detail the psychological considerations, comfort indices and contaminants involved and suggest various control mechanisms for humidity and contaminants
- Analyse the various outdoor/ indoor designs, fundamental heat loss both losses as well as infiltration and generate computational calculations of heating loads
- Apply the concepts of the solar angles, irradiation, heat gained through fenestrations and obtain appropriate energy calculations and heat balance methods
- Employ simulation methodologies to test out energy heat balance calculations
- Debate on the various types of air distribution system designs, including their performance, selection, testing and general sizing

Course Content:

1. **Introduction to HVAC units:** Fundamental physical concepts; Air Conditioning Systems: System selection & arrangement, HVAC components and distribution systems
2. **Moist air Properties & Conditioning Processes and parameters:** Space Air Conditioning; Indoor Environmental Quality: Humidity; & Contaminant control;
3. **Heat Transmission in Building Structures:** Space Heating Load; Solar Radiation: Thermal radiation; heat gain through fenestrations; energy calculations
4. **Cooling Load:** Heat gain, Cooling load and heat extraction rate; Calculation and design conditions; Fenestration; Radiant time series method and its implementation; Supply air quantities
5. **Energy Calculations & Building Simulation:** Comprehensive simulation methods; Energy calculation tools; Space Air Diffusion: Behavior of Jets; Air-distribution system design

Prerequisite Course: None

Reference Books:

1. “Heating, Ventilating and Air Conditioning: Analysis and Design”, Faye C. McQuiston, Jerald D Parker & Jeffry D Spitler, John Wiley & Sons, Sixth Edition, 2005.
2. “HVAC Systems Design Handbook”, Roger W. Haines & Lewis Wilson, McGraw-Hill Co., Fourth Edition, 2003.
3. “Refrigeration & Air Conditioning”, C.P.Arora, Tata McGraw-Hill Publishing co., Second Edition, 2000.

UE17ME662: ANALYSIS & DESIGN OF STEAM & GAS TURBINES (2-0-0-4-2)

Course Objectives:

- To expose the students to the various nuances revolving around Steam and gas turbines and its construction, performance and evaluation

Course Outcomes:

At the end of the course, the student will be able to

- Explicate on the fundamentals of Steam Turbine construction, its blades and other components
- Appraise on the damping concepts available, the vibration behavior and the evaluation of the design reliability
- Analyze the preliminary design process of gas turbines and determine the stage design using simplified approach
- Determine the incidence and deviation angles, airfoil-cascade geometry variables understanding the geometrical discontinuities and tip-clearance effects
- Analyze the Reynolds number effects, various other parameters that affect the performance and derive empirical correlations for design

Course Content:

1. Steam Turbines: Introduction; Performance Fundamentals and Blade Loading Determination; Construction of Blades and Attachments
2. Damping Concepts as applicable to turbine blades: Vibration Behavior of Bladed disk System; Evaluation Concepts for Vibration; Reliability Evaluation for Blade Design
3. Gas Turbines: Stage Definition; Preliminary design process; Simplified approach for stage design; Incidence and deviation angles; Detailed design of airfoil cascades
4. Gas Turbine Blades: Airfoil-cascade geometry variables; airfoil aerodynamic loading; performance-controlling variables; suction side flow diffusion; location of front stagnation point; trailing edge thickness
5. Empirical correlations for design: Stacking of the vane and blade airfoil sections; supersonic stator option; hot to cold dimension conversion; cooling flow extraction and path of delivery

Prerequisite Course: None

Reference Books:

1. “Steam Turbines Design, Application, and Re-Rating”, Heinz Bloch, Murari Singh, McGraw-Hill Co., 2008.
2. “Blade Design and Analysis for Steam Turbines”, Murari P.Singh, George Lucas, McGraw-Hill Co., 2011.
3. “Principles of Turbomachinery in Air Breathing Engines”, E.A., Baskharone, Cambridge University Press, 2006.
4. “An Introduction to Energy Conversion, Volume III-Turbomachinery”, Vedanth Kadambi and Manohar Prasad, New Age International (P) Ltd. Publishers, Second Edition, 2011

UE17ME663: ADVANCED GEOMETRIC DIMENSIONING & TOLERANCING (2-0-0-4-2)

Course Objectives:

- To help the student the importance and application of geometric dimensioning in production of a component
- To teach student the fundamental concepts of GD & T practiced at industrial level
- To introduce the student to various standards pertaining to GD&T

Course Outcomes:

At the end of the course, the student will be able to

- Read technical drawing having G D &T symbols and understand G D &T rules, apply bonus tolerances and virtual conditions to make manufacturing easy
- Define datum, through which interpretation between designer, manufacturer and measurement could be well understood
- Aapply positional tolerances, by virtue of which manufacturing would be easier and cheaper
- Apply concentricity and symmetry principles to realize manufacturing of highly precise aerospace components
- Apply profile tolerances for highly complicated components used in automotive and aerospace industries

Course Content:

1. **Limits, Fits and Tolerances:** IS2102 and 919, Specified and Non-Specified Tolerances. G D & T – 14 Symbols
2. **Rule of G D & T:** Rules 1, 2, 3, 4 and 5 of G D & T, Boundary condition, application to gauges, bonus tolerances its uses
3. **Datum and its application:** Implied Datum, Datum applied to RFS and MMC and Targets, orientation and measurements
4. **Form Tolerances and its applications:** Straightness Tolerance, Flatness Tolerance, Circularity, Cylindricity - its application, control and its Measurements.
5. **Advanced Location Tolerance:** Positional Tolerance, Multiple single segment TOP control, Concentricity, Symmetry and Run out and its measurements.

   Introduction to Stack up analysis: Part and assembly Stacks using coordinate dimensions, Part Stack using positional and profile tolerances

Prerequisite Course: None

Reference Books:

1. “Fundamentals of Geometric Dimensioning and Tolerancing”, Dr. Alex Krulikowski, University of Michigan, Third Edition, 2014.
2. “Geometric Dimensioning and Tolerancing”, James. D. Meadows, CRC Press, First Edition, 2010.
3. “Geometric Dimensioning and Tolerancing”, David A. Madsen, Goodheart-Willcox Publishers, Ninth Edition, 2010.

UE17ME664: JIGS AND FIXTURES (2-0-0-4-2)

Course Objectives:

- To enable students to understand the important concepts in Jigs and Fixtures.
- To enable students to have basic knowledge in locating and clamping devices.
- To enable students to understand the Design of fixtures

Course Outcomes:

At the end of the course, the student will be able to

- explain the concepts involved in limits, fits and tolerance
- explain basic concepts involved in design and mounting of varieties of jigs and fixtures.
- describe various materials involved in production of jigs and fixtures.
- use various kinds of jigs and fixtures practically
- elucidate various economical considerations regarding selection and mounting of jigs and fixtures

Course Content:

1. **Introduction:** Limit, Fits, &tolerance as per IS2102 & 919 - 4, Introduction to Jigs & Fixture

2. **Principles of location:** Locating from plane surface, Locating from circular surfaces-Radial locators-use of Diamond pins-Locating by Nesting Locating of Irregular Surfaces.
3. **Principles of clamping:** Strap clamps, Cam type clamps, Latch Type clamps, Toggle type clamps, Wedge Type clamps, Rack & Pinion Type Clamps, Hydraulic type clamps.
4. **Design of Jigs:** Type of Drill jig, Types of jigs, General consideration in Designing of Drill jigs & Accessories
5. **Drill Jig Bushing:** Types of Bushes, Materials, Design of Fixture, Economics of Fixture, Types of Fixture, Simple Design of Jigs & Fixture

Prerequisite Course: None

Reference Books:

1. "Fundamentals of Tool Design", ASTME, Prentice-Hall, First Edition, 1962.
2. "Tool Design", Cyrill Donaldson, Tata McGraw-Hill Publications, Special Indian Edition, 2012.

UE17ME665:
ELECTRIC AND HYBRID VEHICLE TECHNOLOGY (2-0-0-4-2)

Course Objectives:

- To enable students to understand the fundamental principles behind Electric and Hybrid Vehicles
- To enable students to understand basics of electrical propulsion systems and various sources of power for the electric vehicles
- To enable students to learn about fundamentals of motors for electric vehicles and their performance characteristics

Course Outcomes:

At the end of the course, the student will be able to

- articulate current trends pertaining sustainable mobility requirements and solution techniques through automotive research
- elucidate on advanced knowledge on electric and hybrid electric vehicle configurations
- explain various underlying concepts of propulsion of electric vehicles and also different possible sources of energy for electric and hybrid vehicles.
- discuss on various methods of storing electricity
- explain working and performance of motors involved in electric vehicles

Course Content:

1. **Introduction:** Electric Bicycles, some Uses for the Electric-Powered Bicycle, Examples of Electric Bicycles, Laws and Regulations Governing Electric Bicycles
2. **Fundamentals of Electrical Propulsion:** Introduction, Mathematical Model of Bicycle Performance, Cheetah-A Superfast Bicycle, Segway Scooter
3. **Sources of Electrical Power:** Electric Bicycle, Requirements of Batteries, Bicycles Requirements, Selection Uncertainties, Battery Types, Components, and Performance
4. **Battery Charging:** Functions of Battery Chargers, Battery Characteristics, Applicability of Commercial Fuel Gauges to Electric Bicycles, Recoverable Energy, Solar Panel Chargers
5. **Motors and Motor Controllers:** Fundamental Principles, Propulsion, Gear Ratio; Measurement of Performance: Efficiency, Sources of Error Finding Coefficient of Drag, Measuring Battery Characteristics

Prerequisite Course: None

Reference Book:

1. "Electric Bikes – a guide to design and use", William C. Morchin Henryoman, IEEE, John Wiley & Sons, Inc., Hoboken, New Jersey, First Edition, 2006

UE17ME666:
AUTOMOTIVE ELECTRICAL AND ELECTRONICS SYSTEMS (2-0-0-4-2)

Course Objectives:

- To enable the student to understand the principles of automotive electronics
- To enable the student to understand the operational principles of storage battery
- To introduce to student s different vehicle electric and electronic systems
- To broaden students' knowledge of the importance of vehicle intelligence and safety systems

Course Outcomes:

At the end of the course, the student will be able to

- analyze various electronics systems like sensors, fuel injection system, ECU
- design of intelligence vehicle systems
- design vehicle safety systems
- identify different safety systems and its role in automobiles

Course Content:

1. **Storage Battery:** Principle of lead acid cells, plates and their characteristics, electrolyte, methods of charging, defects and remedies, Recycling Process
2. **Charging and Lighting System:** D.C. Generators and Alternators their Characteristics, Electro-mechanical and electronic regulators, Wiring Requirements, Static and Dynamic Bending lights
3. **Ignition systems and Engine Management Systems:** Ignition fundamentals, solid state ignition systems, combined ignition and fuel management systems. Exhaust emission control, Digital control techniques, complete vehicle control systems, Artificial intelligence
4. **Chassis Electrical systems:** ABS, Types, Active suspension, Traction control, Electronic control of automatic transmission, Microprocessor And Microcomputer controlled
5. **Electronic Accessories:** Warning & alarm instruments, Wind shield wiper, instrument wiring system & electromagnetic interference suppression, wiring circuits for instruments and MIL.

Prerequisite Course: None

Reference Books:

1. "Automotive Electrical and Electronics", Tom Denton, SAE, Fourth Edition, 2000.
2. "Modern Electrical Equipment of Automobiles", Judge AW, Chapman and Hall, London, First Edition, 1992.
3. "Understanding Automotive Electronics", William B. Ribbens, Butterworth Heinemann, Fifth Edition, 1998.
4. "Automobile Electrical Equipment", Young. A.P, & Griffiths. L, English Language Book Society & New Press, Third Edition, 1990.
5. Bosch, Automotive Hand Book, SAE, Eighth Edition, 2011.
6. "Storage Batteries", Vinal. G.W., John Wiley & Sons inc., New York, Third Edition, 1985.
7. "Automobile Electrical Equipment", Crouse W.H., McGraw Hill Book Co Inc., New York, First Edition, 1980.

8. "Electrical Ignition Equipment", Spreadbury F.G, Constable & Co Ltd., London, First Edition, 1962.
9. "Automotive Computers and Digital Instrumentation", Robert N Brady, Prentice Hall, Eagle Wood Cliffs, New Jersey, First Edition, 1988.
10. "Automotive Electrical Equipment", Kohli P L., Tata McGraw Hill Publishing Co., Delhi, Edition, First 2004.

UE16ME667: ADVANCED FRACTURE MECHANICS (2-0-0-4-2)

Course Objectives:

- To enable students to understand advanced concepts related to mechanics of fracture in materials and to teach them analytical treatment of crack tip stress and strain fields
- To equip students to develop required conceptual and mathematical skills to solve problems in linear elastic fracture mechanics (lefm) and elastic plastic fracture mechanics (epfm)
- To teach concept of stress intensity factor and its determination using different methods
- To help students understand important concepts such as j-integral and crack tip opening displacement (ctod) and teach different jic test methods
- To teach the application of concepts related to failure assessment diagrams
- To expose the students to failure assessment methods and ASME reference curves
- To teach application of LEFM to fatigue problems

Course Outcomes:

At the end of the course, the student will be able to

- apply advanced fracture mechanics concepts and analyse crack tip stress and strain fields
- solve problems in linear elastic fracture mechanics (LEFM) and elastic plastic fracture mechanics (EPFM)
- explain stress intensity factor and its determination
- explain j-integral and crack tip opening displacement (CTOD), their applications and also about different jic test methods
- apply and use failure assessment diagrams, failure assessment methods and ASME reference curves and apply LEFM to solve fatigue problems

Course Content:

1. **Fundamental aspects:** Structural design and failure analysis, evolution of structural design, Crack growth &resistance, Modes of fracture, Stress Intensity Factor, Toughness
2. **Determination of Stress Intensity Factor:** Photo-elasticity, numerical and FEM methods, Crack tip plasticity, Plane stress and strain effects on plasticity
3. **Elastic-Plastic Fracture Mechanics:** J-integral, Crack Tip Opening Displacement (CTOD), equivalence between CTOD and J. JIC test methods,
4. **ASME:** Reference curves, Failure assessment diagrams, J Estimation Scheme, J Based Failure assessment diagrams, PD 6493 approach
5. **LEFM for Fatigue loading:** Fatigue life estimation, Life estimation Softwares (NASGRO and AFGROW), Application of Fracture Mechanics to Creep and Stress corrosion

Prerequisite Course: None

Reference books:

1. "Elements of Fracture Mechanics", Prashant Kumar, Tata McGraw-Hill Education, First Edition, 2009.
2. "Fracture Mechanics: Fundamentals and Applications", T. L. Anderson, CRC Press, Third Edition, 2005.
3. "Fracture Mechanics - Theory and Applications", Majid Mirzaei, TMU, First Edition, 2015.

UE17ME668: MACHINE TOOL DESIGN (2-0-0-4-2)

Course Objectives:

- To familiarize students with different tool design and tool making practices
- To teach various tooling materials and tool heat treatment
- To educate students about design of tools for inspection and gauging
- To teach various locating and clamping methods
- To teach the design of drill jigs, fixtures and press-working tools
- To teach design of sheet metal bending, forming and drawing dies
- To help students understand tool design for joining processes and tooling for casting

Course Outcomes:

At the end of the course, the student will be able to

- explain various tooling materials and related tool heat treatment
- design tools for inspection and gauging
- explain various locating and clamping methods, design drill jigs, fixtures and press-working tools
- design sheet metal bending, forming and drawing dies
- explain tool design for joining processes and tooling for casting

Course Content:

1. **Tool design methods:** Procedure, drafting and design techniques; Boring practice, Installation of drilling, punch and die bushings, EDM, Tracer and duplicating mills, Low melting tool materials.
2. **Tooling Materials and Design:** Materials properties, metallic & non-metallic tooling materials, Heat treatment and tool design, Cutting tools, Selection of carbide tools &determining insert thickness
3. **Design of tools for inspection:** Work piece quality criteria, principles of gauging, types &their applications, Tolerances, Selection of material, Locating methods and devices used
4. **Design of Drill Jigs:** Types of drill jigs, Drill bushings, Methods of construction, Drill jigs and modem manufacturing.

   Design of Fixtures: Types of fixtures, Design of Press working Tools, Die design, Evolution of blanking and progressive blanking.
5. **Design of Sheet Metal Bending, Forming and Drawing Dies:** Forming and Drawing Dies, Evolution, Types and its selection, Tool Design for Joining Processes, Tooling for physical joining processes, and sand casting

Prerequisite Course: None

Reference Books:

1. "Tool Design", Cyril Donaldson, GH LECian and VC Goold, TMH Publishing Co Ltd., New Delhi, Third Edition,2000.
2. "Fundamentals of Tool Design", ASTME, PHI (P) Ltd., New Delhi, First Edition, 1983.
3. "Cutting Tool Design", Rodin, Mir Publications, First Edition, 1968.
4. "Metal cutting & Tool Design", Arshinov, Mir Publishers, Moscow, First Edition, 1970.
5. "Press working of metals", Hinman, McGraw-Hill, First Edition, 1950.

BACHELOR OF COMPUTER APPLICATIONS

Programme Educational Objectives:

1. Graduates will have sound academic base from which an advanced career in Computer Applications can be developed.
2. Graduates will be employed in the industry as Mobile Application Developers, Multimedia Designer, System Administrator, Software Developer and Tester.
3. Graduates will be able to develop and customize solutions for Small & Medium Enterprises.

Program Outcomes:

The Program enables the student to

1. Learn IT Languages and Technologies so that the real life problems can be addressed to.
2. Sharpen their Programming Skills.
3. Understand and differentiate various types and of data structures and Utilise the same in development of Computer Programs
4. Discharge the role of a System Administrator / Database Administrator / Application Developer
5. Demonstrate Professional Communications and Aptitude Skills
6. Apply Software Project Planning and Management Techniques.

UE18BC101: INTRODUCTION TO PROGRAMMING USING PYTHON (4-0-0-0-4)

Course Objectives:

- Learn how to solve common types of computing problems.
- Learn various paradigms of programming
- Learn Python as a programming language
- Learn how to combine data structures and functions available in Python to solve problems

Course outcomes:

Upon successful completion of the course, a student will be able to:

- Analyze a given problem and develop an algorithm to solve the problem
- Improve upon a solution to a problem
- Program effectively using the Python language
- Think using different paradigms of programming

Course Content:

1. **Introduction:** Computation Problem Solving-Limits of Computational Problem Solving - Computer Algorithm - Computer Hardware - Digital Computer - Operating System- Limits of IC technology - Computer Software - Syntax, semantics and program translation.

   Introduction to Python Programming Language - Concept of a library - Interactive session First program in Python - Program Structure - Running a program
2. **Values, Variables and Data types:** Integer Values, Variables and Assignment, Control Codes within Strings, User Input , Controlling the print Function, Variable scope and binding, Data types: String, float, numbers, list, set, dictionary, tuple.

   Operators and Expressions: Operators: Arithmetic operators, Bitwise operators, Boolean operators, Logical operators, Operator Precedence, Expressions, comments, Errors: Syntax Errors, Run-time Errors, Logic Errors, Examples.
3. **Conditional Execution:** The Simple if Statement, The if/else, Compound Boolean Expressions, Nested Conditionals, Multi-way Decision Statements , Conditional Expressions, Errors in Conditional Statements

   Iteration: The while Statement, Definite Loops vs. Indefinite Loops, for Statement, Nested Loops, Abnormal Loop Termination, The break statement, The continue Statement, Infinite, Iteration Examples
4. **Lists:** Using Lists, List Assignment and Equivalence, List Bounds, Basic list operations, indexing, slicing and matrixes, Built-in list functions and methods, List examples.
5. **Using Functions and Writing Functions:** Introduction to Using Functions, Standard Mathematical Functions, The eval Function, time, Random Numbers, Writing Functions, Function Basics, Using Functions, Main Function, Parameter Passing, and Function Examples.

Reference Books:

1. “How To Solve It By Computer”, R.G. Dromey, , Pearson.2011
2. “Learning To Program with Python”, Richard L. Halterman, 2011.
3. “Computer Science Using Python: A Computational Problem-Solving Focus”, Charles Dierbach (2012), Introduction John Wiley.

UE18BC102: DISCRETE MATHEMATICS (3-2-0-0-4)

Course Learning Objectives

- To provide foundation for the development of advanced mathematical concepts used in Computer Science.
- To communicate mathematical ideas in both written and oral form for a variety of audience.

Course Outcomes:

After this course, the student will be able to

- Develop a greater understanding of the breadth of mathematics and provide familiarity with concepts, structures and algorithms that are essential in the field of Computer Science and Applied Mathematics.
- Get foundation for the courses like Fundamentals of Computer Organization, DBMS, Data Structures, Analysis of Algorithms, Theory of Computation, Cryptography, Artificial Intelligence etc.

Course Content:

1. **Basic Structures: Sets and Sequences:** Sets and Subsets, Operations on Sets, Venn Diagrams, Algebraic Properties of Set Operations, Addition Principle, Computer Representation of Sets and Subsets, Sequences, Strings and Regular Expressions
2. **Number Theory:** Properties of Integers, Greatest Common Divisor and Least Common Multiple, Prime Numbers, Representation of Integers, Matrices, Transpose and Powers of Matrices, Matrix Arithmetic, Boolean Matrix Operations
3. **Logic, Proofs, Relations and Functions:** positions and Logical Operations, Conditional Statements, Quantifiers, Methods of Proof, Mathematical Induction Product Sets and Partitions, Representing Relations, Properties of Relations, Closure of Relations, Equivalence Relations, Functions, Special Types of Functions, Inverse Functions and Compositions of Functions
4. **Order Relations and Structures:** Partially Ordered Sets, Hasse Diagram, Topological Sorting, Extremal Elements of Partially Ordered Sets, Lattices, Properties of Lattices, Special Types of Lattices
5. **Graph Theory** : Graphs, Graph Terminologies, Graph Representations, Subgraphs and Quotient Graphs, Euler Paths and Circuits, Hamiltonian Paths and Circuits, Trees, Properties of Trees, Applications of Trees – Binary Search Trees, Tree Traversals

References:

1. “Discrete Mathematical Structures”, Kolman, Busby and Ross, Prentice-Hall of India, 5th Edition, 2004

2. “Discrete Mathematics & its Applications with Combinatorics and Graph Theory”, Kenneth H Rosen, McGraw-Hill, 7th Edition, 2012
3. Discrete & Combinatorial Mathematics, An Applied Introduction”, Ralph P Grimaldi, B.V.Ramana, Pearson Education, 5th Edition, 2011
4. “Discrete Mathematics”, D. S. Malik, M. K. Sen, Cengage Learning, 2009

UE18BC103:
FUNDAMENTALS OF COMPUTING (3-0-0-0-3)

Course Learning Objectives

- To introduce the basics of computers and the related functionalities in detail.

Course Outcomes:

After this course, the student will be able to

- Apply the fundamental concepts and explain the different terminologies in computing.

Course Content:

1. **Introducing Computer System:** The Computer Defined, Computers for Individual Users, Computers for Organizations, Computers in Society. Importance of Computer, The Parts of a Computer System, The Information Processing Cycle, Essential Computer Hardware-Processing Devices, Memory Devices, Input and output Devices, Storage Devices, System Software, Application Software, Computer Data
2. **Interacting with Computer:** The Keyboard and Mouse-The Standard Keyboard Layout, The Mouse, Variants of the Mouse, Devices for the Hand, Optical Input Devices, Audio-Visual Input devices. Printing-Commonly used Printers, High-Quality Printers
3. **Processing Data:** Overview, How Computers Represent Data, How Computers Process Data-CPU, Machine Cycles, Memory, Factors Affecting Processing Speed, Registers, Memory and Computing Power, The Computer’s Internal Clock, The Bus, Cache Memory, A Look Inside the Processor, Microcomputer Processors, Comparing Processors
4. **Storing Data:** Categorizing Storage Devices, Magnetic Storage Devices, Optical Storage Devices, Solid State Storage Devices, Smart Cards, Solid - State Disks
5. **Operating System, Networking Basics and Database Management:** The Purpose of Operating System, Types of Operating Systems, providing a User Interface, Running Programs Overview, The Uses of a Network, Common Types of Networks, Hybrid Networks, How Networks are Structured, DBMS-overview, Databases and Database Management Systems, Working with a Database

Reference Books:

1. “Introduction to Computers”, PETER NORTON, TATA McGraw Hill, 6th Edition
2. “Fundamentals of Computers”, V. Rajaraman, PHI Publication, 5th Edition

UE18BC104:
INTRODUCTION TO WEB DESIGN (4-0-0-0-4)

Course Objectives:

- To learn the concepts of basic and advanced HTML pages using style sheets and scripting languages.

Course Outcomes:

After this course, the student will be able to

- Plan, manage and maintain a web page.
- Understand the role and responsibilities of a web-designer.

Course Content:

1. **Fundamentals of WEB:** Internet, WWW, Web Browsers and Web Servers, URLs, MIME, HTTP, Security, The Web Programmers Toolbox**;** Evolution of the Web, Internet Applications, Networks, TCP/IP, Higher Level Protocols, Important Components of the Web, Web Search Engines, Application Servers
2. **Introduction to XHTML:** Origins and Evolution of HTML and XHTML, Basic Syntax, Standard XHTML Document Structure, Basic Text Markup, Images, Hypertext Links, Lists, Tables, Forms, Frames, Syntactic Differences between HTML and XHTML, Overview of HTML5
3. **Cascading Style Sheets:** Introduction, Levels of Style Sheets, Style Specification Formats, Selector Forms, Property Value Forms, Font Properties, List Properties, Color, Alignment of Text, The Box Model, Background Images, The <span> and <div> tags, Conflict Resolution, Overview of CSS3
4. **JavaScript:** Overview of JavaScript, Object Orientation and JavaScript, Syntactic Characteristics, Primitives, Operations, and Expressions, Screen Output and Keyboard Input, Control Statements, Object Creation and Modification, Arrays, Functions, Constructors, Pattern Matching using Regular Expressions, Errors in Scripts, Examples
5. **Dynamic Documents with Javascript:** The Javascript Execution Environment, The Document Object Model, Element Access in Javascript, Events and Event Handling, Handling Events from the Body Elements, Button Elements, Text Box and Password Elements, The DOM 2 Event Model, The Navigator Object, DOM Tree Traversal and Modification

   Introduction to Dynamic Documents, Positioning Elements, Moving Elements, Element Visibility, Changing Colors and Fonts, Dynamic Content, Stacking Elements, Locating the Mouse Cursor, Reacting to a Mouse Click, Slow Movement of Elements, Dragging and Dropping Elements

References Books:

1. “Programming the World Wide Web”, Robert W. Sebesta, 4th Edition, Pearson education, 2012
2. “Web Technology Theory and Practice”, M. Srinivasan, Pearson Education, 2012.
3. http://www.w3schools.com/html/html5_intro.asp
4. http://www.tutorialspoint.com/html5/html5_syntax.htm
5. http://www.w3schools.com/css/css3_intro.asp
6. http://www.css3files.com/ Unit III
7. “Web Programming Building Internet Applications”, Chris Bates, 3rd Edition, Wiley India, 2009
8. “WEB Technologies”, Uttam K Roy, First Edition, Oxford university Press, 2012
9. http://www.w3schools.com/html/default.asp
10. http://www.w3schools.com/css/default.asp
11. http://www.w3schools.com/js/default.asp

UE18BC105:
OFFICE PRODUCTIVITY (1-0-2-0-2)

Course Objectives:

- To learn all the features and functionality provided by Office Package for effective creation and design of documents.

Course Outcomes:

After this course, the student will be able to

- Demonstrate the basic and advanced knowledge of formatting techniques and presentation styles in word, spreadsheet and presentations.

Course Content:

1. **Common Office Features:** Introduction to MS Office / Libre Office / Google Drive and its Applications, Navigating in MS Office / Libre Office / Google Drive, Mastering Fundamental Operation in (all 3 flavor) Document
2. **Common Office Features:** Paragraph group options, Find and replace, Smart art, word art and clip art, Creation of Links, Creation of tables, Header and footer, Sorting, Page Background, Header and footer, Mail Merge
3. **Mastering Spreadsheet:** Excel Worksheets and Workbooks**,** Essential Worksheet and Cell Range Operations, Formulae and Functions, Charts
4. **Persuading and Informing with PowerPoint:** First Look at PowerPoint 2010, Creating a Presentation Slides including Text, Tables and Charts, Using SmartArt Diagrams, Clip Art and Pictures, Animation Effects, Transitions and Support Materials, Preparing and Delivering a Live Presentation
5. **Sharing and Collaboration:** SharePoint and SkyDrive, SharePoint WorkSpace, Save to Web (SkyDrive), Video conferencing tools.

Reference Books:

1. "Microsoft Office 2010 Bible", John Walkenbach, Herb Tyson, Micheal R Groh, Wiley, 2011.
2. "Practical Open Source Office – Libre Office and Apache OpenOffice", Donna Mulder, June Jamrich Parsons, Dan Oja, Course Technology, 2012.
3. "Google Apps" – Missing Manual, O'Reilly & Associates Inc, 2008.

OFFICE PRODUCTIVITY APPLICATIONS LABORATORY

1. Word Processing
2. Mail Merge
3. Excel (All possible Operation with Example)
4. Usage of formulas in spreadsheets (With a real time example)
5. Presentation Slides (PPT with all Basic Functions and Animations)

UM18BB105:
ENGLISH (3-0-0-0-3)

Course Objectives:

- To develop practical communication skills of students in areas of conversation making, vocabulary development, reading, creative writing and role play through literary work like Prose, Poetry, Short Stories, Biography and Speech.

Course Outcomes:

At the end of the course, the student should be able to

- Read & Visualize text of an expository/ descriptive/ narrative nature; to identify salient points, deduce meanings of words, recognize text organization (e.g. sequence of tenses, sequence of ideas), skim for gist and scan for specific information.
- Compose an answer to a typical question using key words keeping in view length and relationship between ideas as required by key words effectively within the time allotted.
- Pronounce, pause and lay emphasis correctly, describe, explain, narrate, and be an active participant in Group Discussions effectively.

Course Content:

1. **Road Not Taken- Robert Frost;** In Sahayadri Hills, a Lesson in Humility – Sudha Narayana Murthy; Personal Introduction Expansions – Proverbs / Idioms
2. **The Story of the Inexperienced Ghost - HG Wells**; Hillary Rodham Clinton's address at the U.N. 4th World Conference on Women Plenary Session - delivered on 5^{th} September 1995, Beijing, China; Writing and Delivering a speech (Vote of Thanks / Inaugural / Commemorative).
3. **Homecoming – Rajagopal Parthasarathy;** His Return – Perceval Wilde; Translation work of a poem / speech/ story from regional literature.
4. **The Blue Carbuncle - Sir Arthur Conan Doyle**; Little Girls Are Wiser Than Men – Lev Nikolayevich Tolstoy; Brochure / Leaflet Preparation
5. **Because I Could Not Stop For Death – Emily Dickinson**; Vaman Srinivas Kudva – A Biography of one of the Founding Directors of Syndicate Bank; Film: Viewing and Reviewing

Reference Books:

1. "Study material" prepared by Department of BBA, PESU.

UE18BC106:
INTRODUCTION TO PROGRAMMING USING PYTHON LAB (0-0-2-0-1)

Course Objectives:

- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries

Course Outcomes:

Upon completion of the course, students will be able to:

- Write, test, and debug simple Python programs.
- Implement Python programs with decision statements and loops.
- Develop Python programs using user defined functions.
- Use Python lists, tuples, dictionaries for representing compound data.

Course Contents:

1. Basic Syntax
2. Data types
3. Operators
4. Decision Making
5. Loops
6. Numbers

Reference Books:

1. "Learning to program with Python", Richard L. Halterman, 2011.
2. http://www.tutorialspoint.com/python

UE18BC107:
INTRODUCTION TO WEB DESIGN LABORATORY (0-0-2-0-1)

Course Objectives:

- To understand, analyze and apply the role languages like HTML, CSS, XHTMLin the workings of web and web applications.

Course Outcomes:

Upon completion of the course, students will be able to:

- Create a static website using HTML , XHTML & CSS

Course Content:

1. Develop one XHTML document for a web page of a favorite National Leader. Design the web page with an attractive background color, text color and background image, suitable headings and horizontal rules.
2. Write an XHTML document with an example of Table format to print your Telephone Bill.
3. Write the Frameset tags and Frame tags for the following frameset.

<table>
<tr><td>Physics.html</td><td rowspan="2">Welcome.html</td><td>Maths. html</td></tr>
<tr><td>Chemistry.html</td><td rowspan="2">Computer.html</td></tr>
<tr><td>Biology.html</td><td rowspan="2">Heading.html</td></tr>
<tr><td>Zoology.html</td><td>Account.html</td></tr>
</table>

4. Develop and demonstrate the usage of inline and external style sheet using CSS.
5. Write an HTML code for designing the subscription form of mail account in the E-mail website with appropriate fields. Use different CSS styling for make the page attractive
6. Write a JavaScript code to find factorial of N. (Use recursive function).
7. Develop and demonstrate a XHTML document using JavaScript that displays random numbers (integers).
8. Develop and demonstrate, using JavaScript script, a XHTML document that collects the USN (the valid format is: A digit from 1 to 4 followed by two upper-case characters followed by two digits followed by three upper-case characters followed by two digits; no embedded spaces allowed) of the user. Event handler must be included for the form element that collects this information to validate the input. Messages in the alert windows must be produced when errors are detected.
9. Create a page with dynamic effects. Write the code to include layers and basic animation.
10. Create a web page using two image files, which switch between one another as the mouse pointer moves over the images. Use the onMouseOver and onMouseOut event handlers.

UE18BC151: PROGRAMMING USING C (4-0-0-0-4)

Course objectives:

- Learn data types and control structures of C
- Learn to map problems to programming features of C
- Learn to write good portable C programs

Course outcomes:

Upon successful completion of the course, a student will be able to:

- Use the 'C' language constructs in the right way
- Design, develop and test programs written in 'C'

Course Content:

1. **C Basics:** C character set, Identifiers and keywords, Data types, constants, variables and arrays declarations, expressions statements, symbolic constants, compound statements, arithmetic operators, unary operators, relational and logical operators, assignment operators, conditional operators.

   C Constructs: If statement, if..else statement, if..else if…else statement, while statement, do while statement, for statement, switch statement, nested control statement, break operator, continue operator, comma operator, goto statement.
2. **Array Concepts, C Functions:** Functions: declaration, definition & scope, recursion, call by value, call by reference. Storage Classes: automatic, external (global), static & registers.

   String manipulation functions and other standard library functions from stdio.h, stdlib.h, conio.h, ctype.h, math.h, string.h, process.h
3. **Pointers, structures and unions:** Pointers - Introduction, understanding pointers, accessing the address of variable, declaring pointer variables, initialization of a pointer, accessing a variable through its pointer, arrays as pointers, array & pointer relationship, pointer arithmetic, dynamic memory allocation, pointers to functions, array of pointers to functions. Structures and unions- Introduction, definition of structure, declaring structure variable, accessing structure members, unions, enums.

   Dynamic Memory Allocations - malloc, calloc, realloc, free - malloc Vs calloc - Heap Memory - Stack Memory – Pitfalls - Dangling Pointers - DMA – Errors - Best Practices for malloc() & free() - DMA – Unspecified Behaviour
4. **Operators :** Bitwise Operations - Bitwise Vs Logical Operations - sizeof() operator - Pitfalls/Issues with sizeof() usage - Pointer Increment & Scaling

   Preprocessor: # include statements - Multiple Inclusion of a Header File? - Preprocessor – #define statements - Preprocessor – Conditional Compilation - Preprocessor – Nested Macros - Preprocessor – Multiline Macros - Preprocessor – Stringizer - Preprocessor – Token Concatenation - Preprocessor – Useful Directives - Conditional Directives for Debugging - Where Macros are Heavily Used - Practical Examples of Macros - Macros Pitfalls - Macros Vs Enums - Inline Functions - Macros Vs Inline - Inline Recursive Functions - - Command Line Argument - Environment Variables in C Programs - Recursion Example - Recursion Vs Iteration
5. **File Management:** Files & Streams - Streams Buffers - IO Buffers – Line Vs Full Vs No-Buffers - Setting & Flushing Buffers - File Access - File Access Modes - Sequential Vs Random Access - Concept of File Offsets - File Operation Errors - End-of-File Condition? - Return Values and Error Values - Character Based File I/O - Line Based File I/O - Formatted File I/O - Block File I/O - Dangerous – gets() Vs fgets() - File Random Access Methods

Reference Books:

1. "The C Programming Language", Kernighan, D. Ritchie, Pearson Education, 2nd Edition, 2015.
2. "Programming in C", Ashok N. Kamthane, Pearson Education, 2nd Edition, 2011.
3. "Programming in ANSI C", E. BalaGuruswamy, Mcgraw Higher Ed, 7th Edition, 2016.
4. "C the Complete Reference", Herbert Schildt, Tata McGraw Hill, 4th Edition, 2000.
5. "Let us C", Yashwant Kanetkar, BPB Publications, 15th edition, 2016.

UE18BC152: DATA STRUCTURES USING C (4-0-0-0-4)

Course objectives:

- To introduce the concepts of data structures and its significance in solving problems.
- To design a new data structure rather than its practitioners.

Course outcomes:

After this course, the student will be able to

- Develop a greater understanding of the importance of data storage
- Design and implement a new data structure.

Course Content:

1. **Introduction to data structures:** Introduction to data structures, types of data structures, data structure operations; arrays: Introduction, types of arrays, representation of one-dimensional array in memory, array traversal, insertion and deletion, representation of multi-dimensional array in memory, realizing matrices using two-dimensional arrays, matrix operations.
2. **Sorting and Searching Techniques:** Bubble Sort, Selection Sort, Quick Sort, Insertion Sort, Linear Search, Binary Search
3. **Stacks and queues:** Stacks- Introduction, stack operations, stack implementation. Queues-Introduction, queues- basic concepts, queue operations, queue implementation, circular queues, priority queues, double ended queues.
4. **Lists:** Linked list - Introduction, linked list basic concept, linked list implementation, types of linked lists, circular linked list, double linked list.
5. **Graphs and trees:** Graph - Introduction, basic concepts, graph technology

   Trees: introduction, basic concepts, binary tree representation, binary tree traversal, binary search tree, tree variants.

Reference Books:

1. "Programming In ANSI C", E Balaguruswamy, 4th edition, McGraw Hill Education India, 2007
2. "Data Structures Using C", E Balaguruswamy, 2nd reprint, McGraw Hill Education India, 2013
3. "Let us C", Yashwant Kanetkar, BPB Publications,15thedition, 2016.
4. "Data structures through C", Yashwant Kanetkar,, 2nd Edition, BPB Publications, 2009

UE18BC153:
DIGITAL LOGIC AND COMPUTER ORGANIZATION (4-0-0-0-4)

Course Learning Objective:

- To provide an overview of computer hardware and software, understanding of the basic structure and operation of a digital computer.

Course Outcome:

After this course, the student will be able to

- Learn the various components and their interconnection, design and architecture of digital computer.

Course Content:

1. **Binary System and Logic Gates:** Binary Numbers, Number Base Conversion, Octal and Hexadecimal Numbers, Complements, Binary Codes, Binary Storage and Registers, Binary Logic. Boolean Algebra-basic Definition, Axiomatic Definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms, Other Logic Operations, Digital Logic Gates
2. **Simplification of Boolean Functions and Combinational Logic:** The Map Method, Two- and Three- Variable Maps, Product of Sums Simplification, Don't Care Conditions, Adders, Subtractors, Binary Parallel Adder, Decimal Adder
3. **Sequential Logic and Registers, Basic Structure of Computer and Machine Instructions:** Introduction, Flip-Flops, Triggering of Flip-Flops, Registers, Shift Registers Functional Units, Basic Operational Concepts, Bus Structures, Software, Performance, Memory Location and Addresses, Memory Operation, Instruction and Instruction Sequencing, Addressing Modes
4. **Input/Output organization:** Accessing I/O Devices, Interrupts, Direct Memory Access, Interface Circuits
5. **The Memory system:** Basic Concepts, Semiconductor RAM Memories - Internal organization of Memory Chips, Static Memories, Read-Only Memories - ROM, PROM, EPROM, EEPROM, Flash Memory, Cache Memory, Virtual Memory

References Books:

1. "Digital Logic and Computer Design", M. Morris Mano, Pearson, 1/e, 2016
2. "Computer Organization", Carl Hamacher, Zvonko Vranesic, Safwat Zaky, TATA McGraw Hill, 5th edition, 2002.
3. "Digital Principles and Applications", Donald P Leach, Albert Paul Malvino, Goutam Saha, Mc Graw Hill, 7th Edition, 2010
4. "Computer Architecture and Organization", John P. Hayes, Tata McGraw Hill, 3rd Edition, 2012

UE18BC154:
USER INTERFACE DESIGN (4-0-0-0-4)

Course Objectives:

- To provide the basic knowledge to develop high-quality user interfaces for interactive systems such as mobiles, ATMs and computer systems.
- To encourage greater attention to usability issues and to promote further scientific study of human computer interaction.

Course Outcome:

After this course, the student will be able to

- Analyze the various existing interactive systems
- Design and develop high-quality user interfaces for interactive systems

Course Content:

1. **The Human and the Computer:** Introduction, Input Output Channels, Human Memory, Emotion, Individual Differences, Psychology and the Design of the Inter System Text Entry Devices, Positioning Pointing and Drawing, Display Devices, Devices for Virtual Reality and 3D Interaction
2. **The Interaction and its Design Basics:** Introduction, Models of Interaction, Frameworks and HCI, Ergonomics, Interaction Styles, Interactivity, the Context of Interaction What is Design? The Process of Design, Scenarios, Navigation Design, Screen Design and Layout, Interaction and Prototyping
3. **Design Rules and Managing Design Process:** Introduction, Principles to Support Usability, Standards, Guidelines, Golden Rules and Heurstics, HCI Patterns, Organizational Design to Support Usability, The Four Pillars of Design, Development methodologies
4. **Evaluating Interface Designs, Direct Manipulation and Virtual Environments:**

   Introduction, Expert Reviews, Usability Testing and Laboratories, Survey Instruments, Acceptance Tests, Evaluation during Active use, Examples of Direct Manipulation, 3D Interfaces, Teleoperation, Virtual and Augmented Reality
5. **Menu Selection, Form Fill-in and Dialog Boxes:** Introduction, Task Related Menu Organization, Single Menus, Combination of Multiple Menus, Content Organization, Data Entry with Menus
6. **Balancing Function and Fashion:** Introduction, Error Messages, Non-Anthropomorphic Design, Display Design, Web Page Design, Window Design, Color

Reference Books:

1. "Human-Computer Interaction", Janet Finaly, Gregory D Abowd, Russell Beale, Pearson, 3rd Edition, 2011
2. "Designing the User Interface", Ben Shneiderman, Catherine Plaisant Pearson, 5th Edition, 2013

UE18BC155:
PROFESSIONAL COMMUNICATION - I (3-0-0-0-3)

Course Objectives:

- To provide foundation in English for the development of students communication
- The subject will help the students to enhance listening, speaking and writing skills.
- To get acquainted with writing various types and styles of professional letters.
- To provide insight on group discussion, interview, drafting CV and resumes.

Course Outcomes:

After this course, the student will be able to

- Students will be able to communicate appropriately with proper grammar usage.
- Students will be able to enhance communication skills that integrate written, verbal and technical communication.

- Enable students to prepare CVs and be well versed with personnel correspondence
- Develop an understanding of the different elements of communication

Course Content:

1. **Communication:** Definition - objectives of communication, importance of communication means and modes – process - principles. Essentials of effective communication. Classification of communication. Barriers to communication, Ways to overcome barriers. Etiquettes of communication.
2. **Effective Listening:** Listening - Art of listening – Principles of listening, types of listening, Process of listening - guidelines for effective listening, types of listeners – difference between hearing and listening, qualities for a good listener.
3. **Effective Speaking:** Introduction, principles of effective oral communication; vocal control; pronunciation and physical behavior; techniques of effective speech. Interpersonal communication; Group discussion - Definition, process, guidelines and evaluation. Interview, Types of interview; Techniques of interview. Power-point presentations – ways to make presentations effective.
4. **Business, Office Correspondence:** Trade communication - Trade enquiries, quotations, tenders, placing orders, complaints, claims and adjustments and follow-up, Sales Letters, circular letters, banking and insurance communication. Email etiquettes
5. **Personal Correspondence:** Office communication - internal memos, office circulars. Secretarial Correspondence: Board meetings, letters to shareholders and debenture holders, to Registrar of Companies. Notice, agenda, minutes of meetings. Personal Correspondence: Preparation of curriculum vitae, job application, appointment letters, interview letters.

References Books:

1. "Technical Communication - Principles and Practice", Meenakshi Raman, & Sangeta Sharma, Oxford University Press, 2nd Edition, 2011
2. "Business Correspondence and Report Writing", R.C. Sharma & Krishna Mohan. Tata McGraw Hill Publishing Company Limited, 4th Edition, 2011.
3. "Business Communication", K.K. Sinha, Galgotia Publishing Co., Karol Bagh, New Delhi, 4th Edition,2012.
4. "Business communication", Urmila Rai, Himalayas Publishing House, 2nd Edition, 2013

UE18BC156:
APTITUDE BUILDING-I (1-2-0-0-2)

Course Objectives:

- Students will be able to critically evaluate various real-life situations by resorting to Analysis of key issues and factors.
- Students will be able to read between the lines and understand various language structures.
- Students will be able to demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions.

Course Outcomes:

After this course, the student will be able to

- Formulate the problem quantitatively and use appropriate arithmetical, and/or statistical methods to solve the problem.
- Recall Formulae for competitive exams.
- Demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions.
- Interpret quantitative information (i.e., formulas, graphs, tables, models, and schematics) and draw implications from them.
- Critically evaluate various real-life situations by resorting to analysis of key issues and factors.

Course Content:

1. **Quantitative Ability:** Numbers, H.C.F. and L.C.M. of numbers, Simplification, Decimal Fractions - Square roots and Cube roots, Average, Problems on Age and Numbers: Surds and Indices, Percentage, Profit and Loss, Ratio and Proportion
2. **Application Problems:** Partnership, Time and Work, Pipes and Cisterns - Time and Distance, Problems on Trains, Boats and Streams - Allegation or Mixture, Logarithms, Stocks and Shares- Simple Interest, Compound Interest
3. **Geometry:** Area, Volume and Surface area, Races and Games of skill - Clocks, Heights and Distances- Calendar, Permutations and Combinations, True Discount, Probability - Odd man out and Series, Banker's discount - Tabulation, Bar graphs, Pie graphs and Line graphs.
4. **Reasoning:** Character Puzzles, Series Completion, Venn Diagrams - Seating Arrangement, Blood Relation Test - Logical Sequence of Words, Classification, Verification of Truth.
5. **Data Interpretation:** Cause and Effect, Data Sufficiency, Syllogism - Analogy, Arithmetic Reasoning, Direction Sense Test

Reference Books:

1. "Quantitative Aptitude", Dr. R.S. Aggarwal, S.Chand Publication, New Delhi, 2017.
2. "Quantitative Aptitude for Competitive Examinations", Abhijit Guha, 6th Edition, 2016.
3. "A Modern Approach to Verbal & Non-Verbal Reasoning", Dr. R.S Agarwal, S.Chand Publication, New Delhi, 2018.
4. "How to Prepare for Logical Reasoning for the CAT", Arun Sharma, Tata McGraw Hill, 2017.

UE18BC157:
PROGRAMMING USING C LAB (0-0-2-0-2)

Course Objective:

To impart proficiency in the concepts of C programming.

Course Outcome:

At the end of the course the student should be able to

1. Clearly analyze the concepts and problem definition.
2. Incorporate their knowledge for implementation.

Course Contents:

1. Basics of C – declaration, definition, arrays
2. Loops – if-else, for, while and nested loops
3. Functions – pass by value, pass by reference
4. Structures and unions.
5. Pointers - declaration, definition
6. Pointers and arrays.
7. Pointers and functions
8. Advanced pointers
9. Structures and unions using pointers
10. File handling functions

UE18BC158 :
DATA STRUCTURES USING C (0-0-2-0-2)

Course Objective:

To impart proficiency in the concepts of data structures through C programming.

Course Outcome:

At the end of the course the student should be able to

1. Clearly analyze the different data structures.
2. Incorporate their knowledge for implementation.

Course Contents:

1. Sorting & Searching Techniques
2. Stack and queue using arrays.
3. Linked list operations.
4. Stack and queue using linked lists.
5. Trees using arrays and linked lists.
6. Traverse binary trees.
7. Graphs using arrays and linked list.

MASTER OF COMPUTER APPLICATIONS

Programme Educational Objectives:

- Innovation & Entrepreneurship: To produce graduates who will be vibrant professional expertise through demonstration of good analytical, design and implementation skills either in industry or entrepreneurial pursuit.
- Competent Professional Practitioner: To produce graduates who will be successful professionals in industry, government, academia or research and thrive to pursue life-long learning to fulfil their goals.
- Leadership and Teamwork: To prepare graduates who will achieve peer-recognition as an individual or in a team.

Program Outcomes:

- Foundation/Strengthening the core: Acquire in-depth computational knowledge and mathematics with an ability to abstract and conceptualize models from defined problems and requirements
- Problem Solving Skill: Identify, formulate, conduct literature survey and solve complex computing problems through analysis as well as provide optimal solutions
- Design, Development of Applications: Design and evaluate solutions for complex problems, components or processes that meet specified needs after considering public health and safety, cultural, societal, and environmental factors
- Conduct investigations of complex problems: Conduct literature survey to analyze and extract information relevant to unfamiliar problems and synthesize information to provide valid conclusions and interpret data by applying appropriate research methods, tools and design experiments
- Modern Tool Usage: Create, select, adapt and apply appropriate techniques, resources and modern IT tools to complex computing system activities, with an understanding of the limitations
- Professional Ethics: Understand and commit to professional ethics and cyber regulations, responsibilities, and norms of professional computing practices
- Individual and Team Work: Function effectively as an individual, as a member or leader in diverse teams in multidisciplinary environments
- Communication Efficacy: Understand and communicate effectively with the computing community and with society at large, regarding complex computing systems activities confidently and effectively by writing effective reports and design documentations by adhering to appropriate standards, make effective presentations and give / receive clear instructions
- Life-long Learning: Engage in lifelong learning independently for continual development to improve knowledge and competence as a computing professional
- Project management and finance: Demonstrate knowledge and understanding of management principles and apply these to multidisciplinary software development as a team member and manage projects efficiently as a leader considering economical and financial factors
- Integrating Solutions/Modules in the context of Emerging Technologies: Integrate and apply efficiently the contemporary IT tools to all Computer Applications
- Innovation and Entrepreneurship: Identify a timely opportunity for entrepreneurship and use innovation to pursue and create value addition for the betterment of the individual and society at large

UE18MC401:
PRINCIPLES OF ACCOUNTING (2-2-0-0-3)

Course Objectives:

- To understand the basic concepts and standards underlying financial accounting systems.
- To analyze and interpret the results enabling to find out what has happened, to look into future by providing the guidelines for making wise decisions to achieve the corporate objectives.

Course Outcomes:

At the end of the course, the student should be able to

- Maintain the cash accounts through the Cash Book and to find out the cash balance and to find out the cash balance on any particular day.
- To construct basic financial accounting statements – income statement, balance sheet, cash flow statement and understand their interpretation

Course Content:

1. **Fundamentals of Financial Accounting:** Introduction to Accounting, Meaning of Accounting, Journal, Ledger, Subsidiary books, Preparation of Trial Balance, Preparation of Trading Account, Preparation of Profit and Loss Account.
2. **Financial Statement and its Analysis:** Preparation of Balance Sheet, Meaning of Financial Statements, Nature of Financial Statements, Significance of Financial Statements, Analysis and Interpretation of Financial Statements, Types of Financial Analysis, Common size statement analysis of income statements and balance sheets, Comparative statement analysis of income statements and balance sheets
3. **Management Accounting:** Emergence of Management Accounting, Definition of Management Accounting, Need, Nature and Characteristics of Management Accounting, Functions and Scope of Management Accounting, Importance of Management Accounting, Management Accounting Vs. Cost Accounting, Management and Cost Accounting Vs. Financial Accounting, Introduction to budgets , Meaning and Definition of Budget, Budget and Budgetary control, Organization for budgetary control- Budget Centre, Organization chart, Budget committee, Budget Manual, Budget Period, Principal Budgeting Factor, Budget Officer, Objectives of budgeting and budgetary control
4. **Budget and Budgetary control:** Classification of budgets, Preparation of Sales Budget, Preparation of Production Budget, Preparation of Cash Budget, Preparation of Master Budget, Fixed Budget, Flexible Budget, Advantages of Budgetary control system, Limitations of Budgetary control system
5. **Fund Flow and Cash Flow Analysis:** Introduction to Funds, Sources of funds, Applications of funds, Statement of changes in working capital, Fund flow statement, Cash from operating activities, cash from investing activities, Cash from financing activities, Cash flow statement, Illustrations

Prerequisite Course: None

Reference Books:

1. "Accounting for Management", S N Maheshwari, S K Maheshwari, Sharad K Maheshwari, Vikas Publications, 2nd Edition, 2011
2. "Financial Management", I M Pandey, Vikas Publications, 10th Edition, 2013
3. "Financial Accounting for Management", N Ramachandran, Ram Kumar Kakani, Tata McGraw Hill, Reprint, 2008
4. "Accounting for Managers", MadeGowda J, Himalaya Publishing House, Reprint, 2012

UE18MC402: MATHEMATICAL FOUNDATIONS FOR COMPUTER APPLICATIONS (3-2-0-0-4)

Course Objectives:

- To apply fundamental counting algorithms to solve applied problems, particularly those found in the area of computer science.
- To develop the ability to understand and create mathematical arguments.

Course Outcomes:

At the end of this course, the student will be able to

- Acquire the problem-solving skills needed in subsequent courses and professional work.
- Formulate problems precisely and solve by applying formal proof techniques.

Course Content:

1. **Set Theory and Properties of Integers:** Sets and Subsets, Set Operations and the Laws of Set Theory, Counting and Venn Diagrams, Principles of Inclusion and Exclusion, Integers and Algorithms, The Well-Ordering Principle: Mathematical Induction.
2. **Counting Principles:** The Rules of Sum and Product, Permutations, Combinations, Combinations with Repetition, The Pigeonhole Principle.
3. **Fundamentals of Logic and Proofs:** Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Rules of Inference, Introduction to Proofs, Normal Forms.
4. **Relations and Functions:** Cartesian Products and Relations, Relations and their Properties, Representing Relations, Closure of Relations, Equivalence Relations, Partial Orderings. Functions: Plain and One-to-One, Onto Functions, Special functions, Function Composition and Inverse Functions.
5. **Graph Theory and its Applications:** Graphs and Graph Models, Some Special Types of Graphs, Representing Graphs, Connectivity, Euler and Hamilton Paths. Introduction to Trees, Applications of Trees

Prerequisite Course: None

Reference Books:

1. "Discrete & Combinatorial Mathematics, An Applied Introduction", Ralph P Grimaldi, B.V. Ramana, Pearson Education, 5th Edition, 2011

   (Chapter 3 (3.1, 3.2, 3.3), 4 (4.1); 1 (1.1, 1.2, 1.3(Excluding Binomial Theorem), 1.4); 5 (5.1, 5.2, 5.3, 5.4, 5.6), 7 (7.1, 7.2, 7.3, 7.4))
2. "Discrete Mathematics and its Applications with Combinatorics and Graph Theory", Kenneth H Rosen, McGraw-Hill, 7th Edition, 2012

   (Chapter 2 (2.1, 2.2), 3 (3.6), 4 (4.1), 6 (6.5); 5 (5.1, 5.2, 5.3); 1 (1.1, 1.2, 1.3, 1.5, 1.6, 1.7); 7 (7.1, 7.2, 7.3, 7.4, 7.5, 7.6); 8 (8.1, 8.2, 8.3, 8.4, 8.5), 9 (9.1, 9.2))
3. "Discrete Mathematics with Proof", Eric Gossett, John Wiley and Sons, 2nd Edition, 2010
4. "Discrete Mathematical Structures", Kolman, Busby and Ross, Prentice-Hall of India, 4th Edition, 2004.

UE18MC403: INTRODUCTION TO LINUX (3-0-0-0-3)

Course Objectives:

- To have basic understanding on Linux Operating System.
- To learn how to manage and administer the system.

Course Outcomes:

After this course, the student will be able to

- Administer the system.
- Automate system tasks.

Course Content:

1. **Introduction to Linux:** Linux- History, User Interface, Future, Properties, Linux Flavors. Quick start- Logging in, Activating User Interface, Logging Out, Absolute Basics, Getting Help.
2. **Files and File System**: General overview of the Linux File System, Orientation in the File System, Manipulating Files, File Security.
3. **Processes:** Processes inside out, Boot process, init and Shutdown, Managing Processes, Scheduling processes.
4. **I/O redirection and Text Editors:** I/O redirection - Simple redirection, Advanced redirection features, Filters, Text editors, Using the Vim editor, Linux in the office.
5. **House Keeping and Backup:** House-keeping - Text Environment, Graphical Environment, Region specific settings, installing new software, Printing files, Backup - Moving data to your backup devices, Encryption.

Prerequisite Course: None

Reference Books:

1. "Introduction to Linux", Machtelt Garrels, 3rd Edition, Fultus Books, 2010.

   (Chapter 1 (1.1-1.5), 2 (2.1-2.4); 3 (3.1-3.5); 4 (4.1- 4.4); 5 (5.1-5.3), 6 (6.1-6.3); 7 (7.1-7.5), 8(8.1), 9(9.2, 9.4))
2. "The Linux Command Line: A Complete Introduction", William E. Jr. Shotts, William Pollock, 2012.
3. "Introduction to Linux: A Hands-on Guide", Machtelt Garrells, Walton Yantis, Texas State Technical College Publishing, 2009

UC18MC404: PROBLEM SOLVING TECHNIQUES (4-0-0-0-4)

Course Objectives:

- To provide knowledge of problem solving and how a computer program works to solve the problem
- To explore the basic syntax and semantics of programming languages.

Course Outcomes:

At the end of the course, the student should be able to

- Solve the problems using correct semantics.
- Develop understanding of critical evaluation of existing and future programming languages.

Course Content:

1. **Overview of Problem Solving, Procedural Programming:** Problem Solving, Aspect, Top-Down Design, Implementation of Algorithms, Program Verification, An Overview of C, Expressions - The Basic Data Types, Modifying the Basic Types, Identifier

Names, Variables, The Four C Scopes, Type Qualifiers, Storage Class Specifiers, Variable Initializations, Constants.

2. **Console I/O & Preprocessor:** Reading and Writing Characters, Reading and Writing Strings, Formatted Console I/O, printf() – printing characters, numbers, displaying address, %n specifier, format modifiers, minimum field width specifier, precision specifier, justifying output, handling other data types, * and # modifiers, scanf() – format specifiers, inputting numbers, unsigned integers, inputting address, %n specifier, using a scanset, discarding unwanted white space, non-white space characters in control string, format modifiers, suppressing input; The Preprocessor and Comments- The Preprocessor, #define, #error, #include, Conditional Compilation directives, #undef, Using defined, #line, #pragma, The # and ## Preprocessor Operators, Predefined Macro Names, Comments.
3. **Operators and Statements:** Operators, Expressions - Order of Evaluation, Type Conversion in Expressions, Casts, Spacing and Parenthesis; True and False in C, Selection Statements, Iteration Statements, Jump Statements, Expressions Statements, Block Statements.
4. **Arrays, Strings and Pointers:** Arrays – Single-Dimension Arrays, Generating a Pointer to an Array, Passing Single-Dimension Arrays to Functions, Strings, Two-Dimensional Arrays, Multidimensional Arrays, Array Initialization, Variable- Length Arrays; Pointers – What Are Pointers?, Pointer Variables, The Pointer Operators, Pointer Expressions, Pointers and Arrays, Multiple Indirection, Initializing Pointers, Indexing Pointers, Pointers to Functions, C's Dynamic Allocation Functions, Problems with Pointers.
5. **Functions and User-defined Data Types:** Functions – The General Form of a Function, Understanding the Scope of a Function, Function Arguments, argc and argv, What does main() return, The return Statement, Recursion, Function Prototypes; Structures, Unions, Enumerations, typedef – Structures, Arrays of structures, Passing Structures to Functions, Structure Pointers, Arrays and Structures within Structures, Unions, Bit Fields, Enumerations, typedef.

Prerequisite Course: None

Reference Books:

1. "The Complete Reference C", Herbert Schildt, Tata McGraw-Hill, 4th Edition, 2000

   (Chapter 1, 2 (till Page 39); 8, 10; 2 (from Page 40), 3; 4, 5; 6 (till Page 169), 7 (excluding page 200- 201))
2. "How to Solve it by Computer", RI G Droomey, Pearson, 2011.

   (Chapter1(till Page 28))
3. " Programming with C", Byron Gottfried, Schaum's Outlines, Tata McGraw-Hill Publishing, 2nd Edition, 2009.

UE18MC405:
WEB TECHNOLOGY-I (4-0-0-0-4)

Course Objectives:

- To understand the concepts and architecture of the World Wide Web.
- To practice mark-up and embedded dynamic scripting on client-side Internet Programming

Course Outcomes:

At the end of the course, the student should be able to

- Acquire knowledge World Wide Web and explore mark-up languages features
- Design and create interactive web pages using scripting languages.

Course Content:

1. **Fundamentals of WEB and HTML5:** Internet, WWW, Web Browsers and Web Servers, URLs, MIME, HTTP, Security, The Web Programmer's Toolbox, HTML5: Introduction, Support, Elements, Forms, Semantics, Migration, Style Guide, HTML Graphics – Canvas, SVG, HTML Media-Video and Audio files, HTML Plug-ins, YouTube
2. **CSS2:** Introduction, Levels of Style Sheets, Style Specification Formats, Selector Forms, Property Value Forms, Font Properties, List Properties, Color, Alignment of Text, The Box Model, Background Images, The <span> and <div> Tags, Conflict Resolution
3. **JavaScript Basics:** Overview of JavaScript, Object Orientation and JavaScript, Syntactic Characteristics, Primitives, Operations and Expressions, Screen Output and Keyboard Input, Control Statements, Object Creation and Modification, Arrays, Functions, Constructors, Pattern Matching Using Regular Expressions, Errors in Scripts
4. **JavaScript DOM Elements:** The JavaScript Execution Environment, The Document Object Model, Element Access in JavaScript, Events and Event Handling, Handling Events from Body Elements, Button Elements, Text Box and Password Element, The DOM 2 Event Model, The Navigator Object, DOM Tree Traversal and Modification
5. **JavaScript Dynamic Documents:** Introduction to dynamic documents, Positioning elements, Moving elements, Element visibility, Changing Colors and Fonts, Dynamic Content, Stacking Elements, Locating the Mouse Cursor, Reacting to a Mouse Click, Slow Movement of Elements, Dragging and Dropping Elements

Prerequisite Course: None

Reference Books:

1. "Programming the World Wide Web", Robert W. Sebesta, Pearson Education, 4th Edition, 2012.

   (Chapter 1 (1.1-1.9); 3 (3.1-3.13); 4 (4.1-4.14); 5 (5.1-5.10); 6 (6.1-6.11))
2. "HTML5 & CSS3 All-In-One for Dummies", Andy Harris, 3rd Edition, 2013
3. "Web Technology – Theory and Practice", M. Srinivasan, Pearson, 1st Impression
4. "WEB Technologies, Oxford University Press", Uttam K Roy, 1st Edition, 2012
5. http://www.w3schools.com/html/
6. http://www.tutorialspoint.com/html/
7. http://www.w3schools.com/css/

UE18MC406:
LINUX LABARAOTORY (0-0-2-0-1)

Course Objectives:

- To familiarize students with the Linux environment
- To manage and administer the system

Course Outcomes:

After completion of the course students will be able to

- Work confidently in Linux environment
- Master the basics of Linux administration
- Write simple shell scripts

Course Content:

1. Getting Started with Technology
2. Basic Utilities
3. File System Orientation and Manipulating Files
4. File Security

5. Process and Scheduling
6. I/O Redirection and Text Editors
7. Shell Environment
8. Graphical Environment
9. Shell scripts
10. Backup
11. Encryption
12. Final test

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UE18MC407: PROBLEM SOLVING LABORATORY (0-0-2-0-1)

Course Objectives:

- To explore the basic syntax and semantics of programming languages.
- To develop the ability to design solutions for problems

Course Outcomes:

At the end of the course, the student should be able to

- Solve the problems using correct semantics.
- Develop understanding of critical evaluation of existing and future programming languages.

Course Content:

1. Getting Started with Technology
   Programs based on
2. I/O Commands - printf and scanf, Preprocessor Commands
3. Expressions – Mathematical and Character
4. Decisions
5. Loops
6. Arrays
7. Strings
8. Pointers
9. Functions
10. Structures and Unions
11. Lab Test

Prerequisite Course: None

Reference Book

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UE18MC408: WEB LABORATORY 1 (0-0-2-0-1)

Course Objectives:

- To learn the technology required for World Wide Web
- To develop the ability to design front end for web applications

Course Outcomes:

At the end of the course, the student should be able to

- Acquire knowledge World Wide Web and explore mark-up language features.
- Design and create interactive web pages using scripting languages

Course Content:

1. Getting into Technology (HTML basic tags)
   Programs based on
2. Nesting semantic and non-semantic elements.
3. Elements and style with CSS2.
4. Elements in HTML5
5. Form inputs and attributes in HTML5(Mandatory& Optional)
6. Canvas (Drawing Rectangle, Circle, arc)
7. SVG (Line draw, Shapes drawing)
8. JavaScript
9. Final Lab Test

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UE18MC451: OPERATING SYSTEMS (4-0-0-0-4)

Course Objectives:

- To have a general understanding of structure of modern computers.
- To understand the fundamental concepts and algorithms used in operating systems.

Course Outcomes:

After this course, the student will be able to

- Describe, contrast and compare differing structures of operating systems.
- Understand and analyse theory and implementation of processes, scheduling, physical and virtual memory, I/O and files.

Course Content:

1. **Introduction to Operating Systems and its Structure:** What Operating System Do? - Computer System Organization, Operating System Structure, Operating System Operations, Special-Purpose Systems, Computing Environments, Operating-System Services, User-Operating System Interfaces, System Calls, Types of System Calls, System Programs, Operating System Structure.
2. **Process Management and Process Scheduling:** Process Management - Process Concept, Process Scheduling, Operations on Processes, Interprocess Communication; Process Scheduling - Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple Processor Scheduling, Algorithm Evaluation.
3. **Process Coordination – Synchronization and Deadlocks:** Synchronization - Background, The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classic Problems of Synchronization, Monitors; Deadlocks - System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.
4. **Memory Management:** Strategies - Background, Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation; Virtual-Memory Management - Background, Demand Paging, Page Replacement, Allocation of Frames, Thrashing.
5. **Storage Management, Protection and Security:** File System - File Concept, Access Methods, Directory and Disk Structure; Secondary-Storage Structure - Disk Structure, Disk Scheduling; Protection and Security – Introduction, Goals of Protection, Principles of Protection.

Prerequisite Course: None

Reference Books:

1. "Operating System concepts", A. Silberschatz, P. Galvin, G. Gagne, Wiley-India, 8th Edition 2009.

(Chapter 1 (1.1, 1.2, 1.4, 1.5, 1.11, 1.12), 2(2.1-2.5, 2.7); 3(3.1-3.4), 5(5.1 - 5.3, 5.5, 5.7); 6 (6.1-6.7), 7(7.1- 7.7); 8 (8.1-8.6), 9(9.1-9.2, 9.4-9.6); 10 (10.1-10.3), 12(12.2, 12.4), 14(14.1-14.2))

2. "Operating Systems-A Concept based Approach", D.M. Dhamdhere, Tata McGraw-Hill, 3rd Edition, 2012.
3. "Operating Systems-Internals and Design Principles", William Stallings, Pearson, 6th Edition, 2012.

UE18MC452: JAVA PROGRAMMING (4-0-0-0-4)

Course Objectives:

- To introduce the pure object-oriented concepts through Java programming.
- To enable a detailed insight into the Java programming concepts such as creating classes, Methods, Interfaces, Packages, Multithreaded Environment, String handling, Enumerations, Creating small Swing application.

Course Outcomes:

After this course, the student will be able to

- Apply the object-oriented concepts through Java language.
- Develop solution for a real problem using Java programming.

Course Content:

1. **Java Programming Fundamentals:** Object-Oriented Programming, Java Development Kit, Data types, Operators, Java's Primitive Types, Literals, Variables, Short-Circuit Logical Operators, Shorthand Assignments, Type Conversion in Assignments, Cast, Operator Precedence, Expressions, Program control statements, Input Characters, if Statement and flavors, Switch Statement.
2. **Classes, Objects and Methods:** Class, Reference Variables and Assignment, Methods, Parameters, Constructors, new, Garbage Collection and Finalizers, this, Arrays, Array References, length Member, For-Each Style for Loop, Strings, Command-Line Arguments, Bitwise Operators, The ? Operator, Methods and Classes, Method Overloading, Overloading Constructors, Nested and Inner Classes.
3. **Interfaces and Packages, Multithreaded Programming:** Interfaces & Packages, Nested Interfaces, Packages and Member Access, Importing Packages, Multithreaded Programming, Thread Class, Runnable Interface, Thread Priorities, Synchronization, Synchronized Methods, Thread Communication Using notify(), wait() and notifyAll().
4. **Inheritance and Exception Handling:** Inheritance, Member Access, Constructors, using super to Call Superclass Constructors, Members, Multilevel Hierarchy, Superclass References and Subclass Objects, Method Overriding, Abstract Classes, final, Object class., Exception Handling, Multiple catch Clauses, Catching Subclass Exceptions, finally, throws, Java's Built-in Exceptions, New Exception Features Added by JDK7.
5. **String Handling, Enumeration and Annotations, Swing Fundamentals:** String Handling, String Constructors, length(), String Comparison, indexOf(), lastIndexOf(), Enumeration and Annotations, Constructors, Methods, Instance Variables, java.lang, Primitive Type Wrappers, Math Class, Runtime, System and Object Class, java.util, Locale Class, Date and Time, Scanner Class, Swing, Components and Containers.

Prerequisite Course: None

Reference Books:

1. "Java Fundamentals – A Comprehensive Introduction", Herbert Schildt and Dale Skrien, McGraw Hill, 1st Edition, 2013.
2. "The Complete Reference Java2", Herbert Schildt, Tata McGraw Hill, 7th Edition, 2006.
3. "Core Java 2 - Volume 1", Cay S Horstmann, Gary Cornell, Pearson Education, 7th Edition, 2005.

UC18MC453: DATA STRUCTURES (3-2-0-0-4)

Course Objectives:

- To introduce the concepts of data structures and its significance in solving problems.
- To design a new data structure as per storage requirements.

Course Outcomes:

At the end of this course, the student will be able to

- Develop a greater understanding of the importance of data storage
- Design and implement a new Data Structures.

Course Content:

1. **Introduction to Data Structures:** Information and meaning – Data Types in C, Abstract Data Types, Sequences as Value Definition, An ADT for varying length Character Strings, Arrays in C, The Array as an ADT, Using 1-Dimensional Arrays, Implementing 1-Dimensional Arrays, Arrays as Parameters, 2-Dimensional Arrays, Multi-Dimensional Arrays.
2. **Stacks:** Primitive Operations, Representing Stacks in C-Implementing the Push and Pop Operations, An Example - Infix, Prefix, Postfix expressions, evaluating a Postfix Expression, Converting an expression from infix to postfix; Recursion -Recursive Definition and processes - Multiplication of Natural numbers, The Fibonacci sequence, Tower of Hanoi
3. **Queues:** The Queue and its sequential representation – The Queue as an Abstract Data Type, C Implementation of Queues, The Priority Queue, Array Implementation of a Priority Queue, Circular Queue Using Dynamically Allocated Arrays
4. **Lists:** Linked List- Inserting and Removing from a List, linked implementation of stacks, The getnode and freenode operations, Linked implementation of queues, The Linked List as Data Structure, Examples of List operations, Array Implementation of lists, Linked List using Dynamic variables, Other List Structures, Doubly Linked List, Primitive operations on Circular List, The Stack as a circular list, The Queue as a circular list.
5. **Graphs and Trees:** The Graph Abstract Data Type, Graph Representations; Introduction, Terminologies, Representation of Trees, Binary Trees, Binary Tree Representations, Operations of Binary Trees, Applications of Binary Trees, Binary Tree Representations, Implicit array Representation of Binary Trees, Binary Tree Traversals in C, Inorder Traversal, Preorder Traversal, Postorder Traversal, Threaded Binary Trees, Trees and Their Applications, C Representation of Trees, General Expressions as Trees, Tree Searching, Binary Search Trees Insertion into a BST, Deletion from a BST.

Prerequisite Course: None

Reference Books:

1. "Data Structures Using C", Aaron M. Tanenbaum, Yedidyah Langsam, Moshe J. Augenstein, Pearson Education, 2nd Edition, 2007
   Chapter 1 (1-2, 13-54); 2 (77-108) , 3 (117-134, 142-146); 4 (174-184); 4 (186- 200, 203-218, 228-239); 5 (249-277, 305-314, 401-407).
2. "Fundamentals of Data Structures in C", Horowitz, Sahani, Anderson-Freed, Universities Press, 2nd Edition, 2011
   (Chapter 3 (Pg. 114-120); 6 (Pg. 265-275), 5 (Pg. 191-205))
3. "Data Structure Using C", A.K. Sharma, Pearson Education India, 2011

UE18MC454:
MACRO PROGRAMMING IN SPREADSHEETS (2-0-2-0-3)

Course Objectives:

- To provide knowledge of macros and its uses
- To explore the basic syntax and semantics of macro programming.

Course Outcome:

At the end of the course, the student should be able to

- Create macros
- Develop understanding of areas of usage of macros.

Course Content:

1. **Introduction:** Getting started with IDE and toolbar, VBA Programming Variables, Option Explicit, Libraries, Operations on Variables
2. **Conditional Logic, Programming Loops:** If Statements, Else, Elseif Statements, Conditional Operators, Logical Operators, Select Case, For Loops, For Each Loops, Cells, Do Loop
3. **Arrays, Functions:** Arrays and Loops, Multidimensional arrays, Arrays and Split functions, Subroutines, passing values to subroutines, String Functions, Worksheet functions, Message Box, Set Keyword
4. **VBA, Text Files, User Forms:** Opening a text file, closing a Text File, User form buttons, launching user forms, adding new tabs, Customize ribbon
5. **VBA – Picture Viewer, Charts:** Excel Picture Viewer, Design the user form, option and command buttons, Photo Tab, Form Initialize event, textbox data, Image Box, Chart Sheets, Embedded Charts, Chart Constants

Prerequisite Course: None

Reference Books:

1. https://www.excel-easy.com/vba/
2. http://www.homeandlearn.org/index.html
3. https://www.guru99.com/vba-tutorial.html
4. https://www.tutorialspoint.com/vba/index.htm

UE18MC453:
WEB TECHNOLOGY-II (4-0-0-0-4)

Course Objectives:

- To provide knowledge of how a client scripting language and server scripting language differs.
- To explore the basic syntax and semantics of scripting languages enabling the students to design web pages.

Course Outcomes:

At the end of the course, the student should be able to

- Develop real world web application with effective user interface and works with sessions and storing and retrieving in database.

Course Content:

1. **CSS3:** Basics: Working with elements – Display and Visibility, Grouping and Nesting, Selectors, Box Model, Backgrounds and Borders, Image Values and Replaced Content, Floating, Pseudo- Classes/Pseudo-Elements, Working with Transforms, Text Effects,2D/3D Transformations, Animations in CSS
2. **PHP-Basics:** Introduction, Installing PHP, Basic Syntax, PHP Variables, Echo/Print, PHP Data Types, PHP Strings, PHP Constants, PHP Expressions, PHP Operators, PHP Control Structures, PHP Loops, PHP Functions, Arguments, References, Return Values, Variable Scope, Pass by Value & Pass by references PHP, PHP Associative Arrays, Array Iteration, Sorting, PHP Multi-Dimensional Arrays, PHP Superglobals
3. **PHP Forms and Files:** Form Handling, Form Validation, Form Required, URL /Email, PHP GET, PHP POST, Complete, PHP Date and Time, Pattern Matching, PHP Include, PHP Directory, PHP Error, PHP File system and operations
4. **Advanced PHP:** PHP Cookies, Sessions, Filter, Filter Advances, Error Handling, Exceptions, PHP Timezones, PHP Simple XML, PHP Mail, FTP, HTTP, MySQLi, Math, Libxml, Zip, Connecting and fetching and storing data with MySQL Database,
5. **Introduction of Laravel:** Installing Laravel, General framework overview: routes, controllers, views and models, Adding view, Creating Your First Model, DB Seeding, Querying a DB, More Complex Queries, Scopes, Adding Method and Route for Unpublished Articles, HTML Helpers, Adding new Articles to DB, HTML Forms, Edit and Save, View

Prerequisite Course: None

Reference Books:

1. "HTML5 & CSS3 All-In-One for Dummies", Andy Harris, 3rd Edition, 2013
2. "The Joy of PHP Programming: A Beginner's Guide", Alan Forbes
3. "Learning Laravel 5-Building Practical Applications", Nathan Wu, 5th Edition
4. https://www.udemy.com/laravel-5-tutorial-for-beginners/
5. https://www.parthpatel.net/laravel-tutorial-for-beginner-5-4/

UE18MC456:
JAVA PROGRAMMING LAB (0-0-2-0-1)

Course Objectives:

- To introduce the pure object-oriented concepts through Java programming.
- To enable a detailed insight into the Java programming concepts such as creating classes, Methods, Interfaces, Packages, Multithreaded Environment, String handling, Enumerations, Creating small Swing application.

Course Outcomes:

After this course, the student will be able to

- Apply the object-oriented concepts through Java language.
- Develop solution for a real problem using Java programming.

Course Content:

1. Getting started with Technology
   Programs based on
2. Loops
3. Method and constructor Overloading
4. Arrays
5. Interfaces and Packages
6. Multithreading
7. Inheritance
8. Exception Handling
9. Strings
10. Enumeration
11. Lab Test

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UE18MC457:
DATA STRUCTURES LAB (0-0-2-0-1)

Course Objectives:

- To introduce the concepts of data structures and its significance in solving problems.
- To design and implement a new data structure as per storage requirements.

Course Outcomes:

After this course, the student will be able to

- Develop a greater understanding of the importance of data storage
- Design and implement a new Data Structures as per need

Course Content:

1. Getting started with Technology
   Programs based on
2. Arrays
3. Stacks
4. Application of Stacks
5. Recursion
6. Queues
7. Single Linked List
8. Doubly Linked List
9. Circular Linked List
10. Trees and Applications
11. Lab Test

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UE18MC458:
WEB LABORATORY -II (0-0-2-0-1)

Course Objectives:

- To learn the technology required for World Wide Web
- To develop the ability to design front end for web applications

Course Outcomes:

At the end of the course, the student should be able to

- Acquire knowledge World Wide Web and explore style and scripting features.
- Design and create interactive web pages using scripting languages

Course Content:

1. Getting Started with technology
   Programs based on
2. Transformation
3. Conversion
4. Escape Sequence
5. String and Number Input
6. Built-in functions
7. Constants, Global, Operators
8. Control Structure, Loops
9. Functions
10. Arrays
11. File System
12. Cookies and Sessions
13. Filters
14. Database
15. Lab Test

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UE17MC501:
DESIGN AND ANALYSIS OF ALGORITHMS (3-2-0-0-4)

Course Objectives:

- To introduce the general tools and techniques to analyze and design computer algorithms.
- To equip the students with mathematical preliminaries required to analyze and design computer algorithms.

Course Outcomes:

At the end of the course, the student should be able to

- Implement and analyze good principles of algorithm design and estimate their worst-case and average-case behavior
- Analyze data structures and its implementation

Course Content:

1. **Introduction, Analysis Framework and Brute Force Method:** What is an Algorithm?, Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-Recursive and Recursive Algorithms; Brute Force - Selection Sort and Bubble Sort, Sequential Search and Brute-Force String Matching.
2. **Greedy Technique and Dynamic Programming:** Greedy Technique - Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees; Dynamic Programming - Computing a Binomial Coefficient, Warshall's and Floyd's Algorithms, The Knapsack Problem and Memory Functions.
3. **Divide-and-Conquer, Decrease-and-Conquer:** Divide-and-Conquer - Merge Sort, Quick Sort, Binary Search, Multiplication of L arge Integers and Strassen's Matrix Multiplication; Decrease-and-Conquer - Insertion Sort, Depth-First Search and Breadth-First Search, Topological Sorting, Algorithms for Generating Combinatorial Objects.
4. **Transform-and-Conquer, Space and Time Tradeoffs:** Transform-and-Conquer - Presorting, Heaps and Heapsort; Space and Time Tradeoffs - Sorting by Counting, Input Enhancement in String Matching, Hashing.
5. **Limitations of Algorithm Power and Coping with them:** Decision Trees, *P, NP* and *NP* – Complete Problems; Backtracking – n-Queens Problem, Hamiltonian Circuit Problem, Subset-Sum Problem, Branch-and-Bound – Assignment Problem, Knapsack Problem, Traveling Salesman Problem, Approximation Algorithms for *NP*-Hard Problems.

Prerequisite Course: None

Reference Books:

1. "Introduction to Design and Analysis of Algorithms", Anany Levitin, Pearson Education, 2nd Edition, 2009
   (Chapter 1 (1.1), 2(2.1- 2.4), 3(3.1, 3.2); 9 (9.1 - 9.4), 8(8.1, 8.2, 8.4); 4 (4.1- 4.3, 4.5), 5 (5.1-5.4); 6 (6.1, 6.4), 7(7.1-7.3); 11 (11.1 - 11.3), 12 (12.1- 12.3))
2. "Introduction to Algorithms", Coremen T.H., Leiserson C. E., Rivest R. L., PHI, 1998.
3. "Fundamentals of Computer Algorithms", Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, Universities Press, 2nd Edition, 2008

UE17MC502:
COMPUTER NETWORKS (4-0-0-0-4)

Course Objectives:

- To understand the fundamental concepts of computer networking.
- To understand the design and implementation of layered architecture.
- To familiarize the basic protocols used in computer networks.

Course Outcomes:

At the end of the course, the student should be able to

- Analyze various networking protocols.
- Comprehend Inter Domain and Intra Domain Routing.
- Classify the functionality of each of the layers of the TCP/IP protocol suite.

Course Content:

1. **Computer Networks and the Internet:** Overview of the Internet, The Network Edge, The Network Core, Delay Loss and Throughput in Packet Switched Networks, Protocol Layering.
2. **Application Layer:** Introduction, Client- Server Paradigm, Standard Client- Server Applications – www and HTTP, FTP, DNS Peer-to-Peer Paradigm- P2P Networks, Socket Interface Programming.
3. **Transport Layer:** Introduction and Transport Layer Services, Multiplexing and Demultiplexing, User Datagram Protocol - UDP, Transmission Control Protocol - TCP.
4. **Network Layer:** Introduction – Network Layer Services, Packet Switching, Virtual circuit and Datagram Networks, Network Layer Protocols, Routing Algorithms, Routing in the Internet
5. **The Link Layer and Local Area Networks:** Link Layer: Introduction and services, Error Detection and Correction Techniques, Link Layer Addressing and ARP, Ethernet, Link Layer Switches.

Prerequisite Course: None

Reference Books:

1. "Computer Networking- A Top down Approach", James F. Kurose, Keith W. Rose, 5th Edition, Pearson 2012.
   (Chapter 1(1.2, 1.3, 1.4); 3(3.1, 3.2); 4 (4.1, 4.2, 4.5, 4.6); 5(5.1, 5.2, 5.4, 5.5, 5.6))
2. "Computer Networks – A Top down Approach", Behrouz A Forouzan, Special Indian Edition, McGrawHill, 2013.
   (Chapter 1 (1.1, 1.2); 2 (2.1, 2.2, 2.3-2.3.1, 2.3.2, 2.3.6, 2.4- 2.4.1, 2.5); 3(3.1, 3.3, 3.4- 3.4.1, 3.4.2, 3.4.3, 3.4.4, 3.4.7, 3.4.8); 4(4.1- 4.1.1, 4.1.2, 4.2))
3. "Computer Networks", Andrew S. Tannenbaum, 5th Edition, Pearson Education, 2013.
4. "Data Communication and Computer Networks", Prakash C. Gupta, 2nd Edition, PHI, 2014.

UE17MC503:
DATABASE MANAGEMENT SYSTEMS (4-0-0-0-4)

Course Objectives:

- To provide comprehensive introduction to Database Management Systems from several perspectives.
- To introduce the methods for designing a database, querying using SQL & PL/SQL used in modern databases.

Course Outcomes:

At the end of the course, the student should be able to

- Correlate relational database theory with relational database management system.
- Apply data modeling concepts and their applications in design and construct a typical enterprise database.

Course Content:

1. **Overview of database systems and Introduction to database design:** File Systems versus a DBMS, Advantages of a DBMS, Describing and Storing Data in a DBMS-The Relational Model, Levels of Abstraction in a DBMS, Data Independence, Structure of a DBMS. Database Design and ER Diagrams, Entities, Attributes, and Entity Sets, Relationships and Relationship Sets, Additional Features of the ER Model - Key Constraints, Participation Constraints, Weak Entities, Class Hierarchies, Aggregation.
2. **The Relational Model:** Introduction to the Relational Model, Creating and Modifying Relations Using SQL, Integrity Constraints over Relations - Key Constraints, Foreign Key Constraints, General Constraints, Enforcing Integrity Constraints- Transactions and Constraints, Querying Relational Data, Logical Database Design: ER to Relational - Entity Sets to Tables, Relationship Sets (without Constraints) to Tables. Introduction to Views.
3. **Relational Algebra, Schema Refinement and Normal Forms:** Relational Algebra-- Selection and Projection, Set Operations, Renaming, Joins, Division; Introduction to Schema Refinement -- Problems Caused by Redundancy, Decompositions, Problems Related to Decomposition, Functional Dependencies; Normal Forms-- Boyce-Codd Normal Form, Third Normal Form.
4. **Introduction to PL/SQL:** Advantages of PL/SQL, The Generic PL/SQL Block, The Character set, Literals, Data Types, Variables, Constants, LOB Types, Logical Comparisons, Control Structures- conditional, Iterative, Sequential; Cursors-Types-Implicit, Explicit, Cursor for loops, parameterized cursors; Procedures verses Functions- Creating Stored Procedures, Creating a Functions; Database Triggers-Introduction, Use of Database Triggers, Database Triggers V/S Procedures.
5. **Tree-Structured Indexing and Hash-Based Indexing:** Indexed Sequential Access Method (ISAM), B+ Trees: A Dynamic Index Structure, Search, Insert, Delete. Static Hashing, Extendible Hashing, Linear Hashing, Extendible vs. Linear Hashing.

Prerequisite Course: None

Reference Books:

1. "Database Management Systems", Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill, 3rd Edition, 2003.
   (Chapter 1 (1.3-1.5,1.8), 2(2.1-2.4); 3 (3.1-3.6); 4 (4.2), 19 (19.1,19.2,19.4); 10 (10.2-10.6), 11(11.1-11.4))
2. "SQL, PL/SQL The Programming Language of Oracle", Ivan Bayross, BPB Publications, 4th Edition, 2009.
   (Chapter 15, 16, 18)
3. "Fundamentals of Database Management Systems", Ramez Elmasri and Shamkant B. Navathe, Pearson Publications, 5th Edition, 2008.
4. "Data base System Concepts", Silberschatz, Korth and Sudharshan, Mc-GrawHill, 5th Edition, 2006.

UE17MC504:
DESIGN AND ANALYSIS OF ALGORITHMS LABORATORY (0-0-2-0-1)

Course Objectives:

- To introduce the general tools and techniques to analyze and design computer algorithms.
- To equip the students with mathematical preliminaries required to analyze and design computer algorithms.

Course Outcomes:

At the end of the course, the student should be able to

- Implement and analyze good principles of algorithm design and estimate their worst-case and average-case behavior
- Analyze various data structures and its implementation.

Course Content:

For all the exercises implement the algorithm for n elements and determine the time taken to implement. Repeat the experiment for different values of n and plot a graph of time taken versus n.

1. Getting started with Technology
   Programs based on
2. Brute Force
3. Backtracking
4. Greedy Method
5. Dynamic Programming
6. Divide and Conquer
7. Decrease and Conquer
8. Transform and Conquer
9. Input Enhancement
10. Branch and Bound
11. Lab Test

Prerequisite Course: None

Reference Book

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UE17MC505:
COMPUTER NETWORKS LABORATORY (0-0-2-0-1)

Course Objectives:

- To introduce the tools used to understand the working of Computer Networks.
- To understand the layered architecture of building Computer Networks.
- Cultivate analytical skills using the captured trace files from live internet

Course Outcomes:

After this course, the student will be able to

- Analyze the working of Computer Networks.
- Build a small workable network using the hardware elements like, systems, switches and cables.

Course Content:

1. Getting started with Technology, Working with Packet Tracer, Wireshark Analyzer
2. Studying www and HTTP Protocol
3. DNS Protocol
4. DHCP Protocol
5. Addressing and Routing
6. Dynamic Routing
7. Analyze application layer protocols
8. Analyze network layer protocols
9. Analyze transport layer protocols
10. Address Resolution Protocol
11. Lab Test

Prerequisite Course: None

Reference Book

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UE17MC506:
DATABASE MANAGEMENT SYSTEMS LABORATORY (0-0-2-0-1)

Course Objectives:

- To provide a strong formal foundation on the relational model of data.

Course Outcomes:

At the end of the course, the student should be able to

- Populate and query a database using SQL statements.
- Write PL/SQL blocks including stored procedures, stored functions, cursors and triggers.

Course Content:

1. Getting started with technology
2. DDL, DML, DCL, TCL commands.
3. DDL commands with integrity constraints like primary key, foreign key etc.
4. Simple SQL Queries.
5. Complex SQL Queries.
6. Joins, Views
7. PL/SQL Blocks
8. Cursors
9. Functions, Procedures
10. Triggers
11. Lab Test

Prerequisite Course: None

Reference Books

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UE17MC511:
PYTHON PROGRAMMING (3-2-0-0-4)

Course Objectives:

- To provide knowledge of how a client scripting language and server scripting language differs.
- To explore the basic syntax and semantics of python to enable the students to design web pages.

Course Outcomes:

At the end of the course, the student should be able to

- Develop real world web application with effective user interface and works with sessions and storing and retrieving in database.

Course Content:

1. **Python Basics:** Variables, Identifiers, Variable Types, Statements, Assignments, Expressions, Lists, Operators.
2. **Python Procedural:** Conditions, Loops, Lists, Strings, Multi-dimensional lists, Tuples, Functions, Recursive Functions, Exception Handling, Mapping, Filtering and Reduction, Lambda Functions, List Comprehensions, Mapping, Filtering and Reduction, Lambda Functions.
3. **Python Object-Oriented:** Definition and defining a class, Constructor, Destructor, self and del keywords, Access to Attributes and Methods, geattr and hasattr attributes, Data Attributes and Class Attributes, Data Hiding, Inheritance, Static Member, Regular Expressions: Defining Regular Expressions and String Processing.
4. **Python Data Science:** Introduction, NumPy, NumPy Array, Subsetting NumPy Arrays, Side effects, Basic Statistics, Pandas, Basic Plots with matplotlib, Dictionary to Dataframe, CSV to Dataframe

5. **Python GUI:** Tk window and buttons, Tk menubar, Tk widgets, Tk messagebox, Tk file dialogs, Tk dropdown menu

Prerequisite Course: None

Reference Books:

1. "Exploring Python", Timothy A. Budd, Tata McGraw-Hill, 2011. Unit I, II, III, IV
2. "Python 3 Web Development", Jason Lengstorf, APRESS
3. http://www.tutorialspoint.com/python/python_gui_programming.htm
4. https://www.codecademy.com/python-beginner-en-KAgt5/
5. https://docs.python.org/2/tutorial/
6. https://pythonspot.com/gui/
7. https://www.python-course.eu/python_tkinter.php

UE17MC512: PERL PROGRAMMING (4-0-0-0-4)

Course Objectives:

- To provide knowledge of how a client scripting language and server scripting language differs.
- To explore the basic syntax and semantics of scripting languages enabling the students to design web pages.

Course Outcomes:

At the end of the course, the student should be able to

- Develop real world web application with effective user interface and works with sessions and storing and retrieving in database.

Course Content:

1. **Perl – Introduction:** Working with simple values, Lists and Hashes, Loops and Decisions, Regular Expressions, Files and Data - predefined file handles such as STDIN, STDOUT, STDERR, DATA, ARGV, ARGVOUT
2. **Perl-Debugging and Subroutines:** Built-in Perl Debugger, Command Syntax, Syntax Errors, Time Errors, Single-Stepping through a Script, executing to Breakpoints, Setting Global Watches, Strict Error Checking, addresses of variables, Global Variables and Local variables, Create subroutines, Include a subroutine, Pass file handles, Argument handling, Aliasing, Anonymous subroutines, Closures, Prototypes, Recursion, menu driven program to demonstrate the usage of subroutines and hashes
3. **PERL-Packages and Modules:** Perl library file, Perl package, Create a Perl module and call it from a script, Use packages and modules to organize, reuse and export program code. Use vs Require, Package variables, finding modules, installing modules, Exporting, Naming conventions, BEGIN and END blocks, INIT, CHECK, and UNITCHECK Blocks, Reporting errors within modules, Carp function, Cluck function, Croak function, Confess function
4. **Advanced Perl:** References, Modules, Object-Oriented Perl, Perl and Database, Introduction to CGI
5. **Catalyst:** Introduction, Catalyst Basics, Basic CRUD, Authentication, Authorization, Debugging, Testing, Advanced CRUD

Prerequisite Course: None

Reference Books:

1. "Beginning Perl", Simon Cozens, Wrox Press, 1st Edition, 2005
2. "The Definitive Guide to Catalyst: Writing Extensible, Scalable and Maintainable Perl-Based Web Applications (Expert's Voice in Web Development)", Kieren Diment, Matt S. Trout, Eden Cardim, Jay Kuri, Springer, 2009

UE17MC513: SWIFT PROGRAMMING (4-0-0-0-4)

Course Objectives:

- To provide knowledge of client and server scripting languages.
- To explore the basic syntax and semantics of scripting languages enabling the students to design web pages.

Course Outcomes:

At the end of the course, the student should be able to

- Develop real world web application with effective user interface and work with sessions while storing and retrieving data from database.

Course Content:

1. **Introduction to Swift:** Introduction, Printing a line of text, My first program, Environment, Arithmetic overflow checking, Variables, Constants, Operators, Decision Making, Loops, Strings, Characters, Arrays, Dictionaries.
2. **Swift Classes and Methods:** Functions, Closures, Enumerations, Structures, Classes, Properties, Methods, Tuples, Scope, Parameters, Recursion, Nested Functions.
3. **Arrays, Closures and Dictionary:** Introduction to arrays, closures, Array methods filter, passing arrays to functions, Multidimensional arrays, Variadic parameters, declaring Dictionary, Key-value pairs, building Dynamic Dictionary, Hash tables.
4. **Structures and Inheritance:** Structures, Enumerations, Inheritance, Access Modifiers, Case Studies, Additional protocol features, Operator overloading and Subscripts.
5. **Swift App Development:** Technologies overview, building UI, Interface builder, Class ViewController.

Prerequisite Course: None

Reference Books:

1. "Swift for Programmers", Paul Deitel, Harvey Deitel, 1st Edition, 2015.
   (Chapter 2 (Pg 20 – 32), 4 (Pg 48 – 69); 3 (Pg 33 – 46), 5 (Pg 70 – 93); 6 (Pg 96 – 128), 7 (Pg 132 – 154); 9 (Pg 195 – 210), 10 (Pg 215 – 246), 12 (Pg 265 – 286); 13 (Pg 288 – 317))
2. "Learn Cocoa Touch for iOS", Jeff Kelley, 2012.

UE17MC521: CYBER SECURITY (3-0-0-0-3)

Course Objectives:

- To learn how to Safeguard national critical information infrastructure (CII)
- To learn how to Respond to, resolve, and recover from cyber incidents and attacks through timely information sharing, collaboration, and action.

Course Outcomes:

At the end of the course, the student should be able to

- Establish a legal and regulatory framework to enable a safe and vibrant cyberspace
- Develop foster culture of cyber security that promotes safe and appropriate use of cyberspace
- Develop and cultivate national cyber security capabilities counselling

Course Content:

1. **Cybercrime and Cyber** offenses: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA

2000, A global Perspective on cybercrimes, How criminal plan the attacks, Social Eng., Cyber fraud vs. Cybercrime Cyber stalking, Cybercafe and Cybercrimes, Botnets, Attack vector, Cloud computing

2. **Cybercrime: Mobile and Wireless Devices:** Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops
3. **Cybercrime Tools and methods:** Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft), Case Study.
4. **Computer Forensics:** Historical Background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyberforensics and Digital Evidance, Forensics Analysis of Email, Digital Forensics Lifecycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation, Setting of a Computer Forensics Laboratory: Understanding the Requirements, Computer Forensics and Steganography, Relevance of the OSI 7 Layer Model to the Computer Forensics and Social Networking Sites: The Security/Privacy Threats, Forensics Auditing, Anti Forensics.
5. **Cybersecurity-The Legal Perspectives:** Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft), Why do we need Cyberlaw: The Indian Context, The Indian IT Act, Digital Signature and the Indian IT Act, Amendments to the Indian IT Act, Cybercrime and Punishment, Cyberlaw, Technology and Students: Indian Scenario

Prerequisite Course: None

Reference Books:

1. "Cyber Security", Nina Godbole, Sunit Belapure, Wiley India, New Delhi, 2011.
2. "Information Systems Security", Nina Godbole, Wiley India, New Delhi, 2017.
3. "Cyber Security & Global Information Assurance", Kennetch J. Knapp, Information Science Publishing, 2009.
4. "Cryptography and Network Security", William Stallings, Pearson Publication, 2005.
5. "Cyber Security", Avantika Yadav, Narosa Publishing, 2017.
6. "Hacking Secrets", Sai Satish, Srinivasa Rao, Srujana Raju, Aditya Gupta, IndianServers.com, 2013.
7. https://courses.edx.org

UE17MC522: COMPUTER GRAPHICS (3-0-0-3)

Course Objectives:

- Understand basics and importance of visual communications.
- emphasize basic theoretical tools to engage with the various forms of visual culture.

Course Outcomes:

After this course, the student should be able to

- Understand 2D graphics, 3D graphics and algorithms, concepts and techniques.
- Use a current graphics API (OpenGL).

Course Content:

1. **Overview of Computer Graphics System:** Introduction to Computer Graphics, Graphs and Charts, Computer-Aided Design, Virtual-Reality Environments, Data Visualizations, Image Processing, Graphical User Interfaces, Video Display Devices-Refresh Cathode-Ray Tubes, Raster-Scan Displays, Random-Scan Displays, Three- Dimensional Viewing Devices, Input Devices, Graphics Software.
2. **Graphics Output Primitives and Attributes:** Introduction to Open GL, Coordinate Reference Frames, specifying a Two-Dimensional world coordinate reference frame in Open GL, Open GL point and line functions, Line drawing algorithms, Circle generating algorithms, Ellipse-generating algorithms, Fill-area primitives, Polygon fill areas, OpenGL polygon fill area functions
3. **Geometric Transformations:** Basic two-dimensional geometric transformations, Matrix representations and Homogeneous coordinates, Inverse transformations, Two-dimensional composite transformations, Three-dimensional Translation, Rotation and Scaling, Affine transformations, OpenGL geometric-transformation functions.
4. **Two and three-Dimensional Viewing:** The two-dimensional viewing Pipeline, The Clipping window, Normalization and view port transformations, Clipping algorithms, Two-dimensional point clipping, Two-dimensional line clipping, Polygon fill-area clipping; Overview of three-dimensional viewing concepts, The Three-dimensional viewing pipeline, Three-dimensional viewing-coordinate parameters, Transformation from world to viewing coordinates, Projection transformations, Orthogonal projections, Perspective projections, The Viewport transformation and three-dimensional screen coordinates.
5. **Curves and Computer Animation:** Bezier spline curves, Raster methods for computer animation, Design of animation sequences, traditional animation techniques, General computer animation functions, Computer animation Languages, Key frame Systems, Motion specifications, OpenGL Animation Procedures.

Prerequisite Course: None

Reference Books:

1. "Computer Graphics with Open GL", Donald Hearn, M.Pauline Baker, Pearson 3rd Edition 2013.
   (Chapter 1(1.1-1.9), 2 (2.1, 2.4,2.7,2.8); 2 (2.9), 3 (3.1-3.5, 3.9, 3.10, 3.14-3.16), 4(4.13,4.14); 5 (5.1-5.5, 5.10-5.12, 5.16,5.17); 6 (6.1-6.3, 6.5-6.10), 7 (7.1-7.6,7.8,7.9) 8 (8.10), 13(13.1-13.7,13.10))
2. "Interactive Computer Graphics – A top down approach using OpenGL", Edward Angel, Pearson, 5th Edition, 2002.
3. "Computer Graphics", Cengage Learning by Peter Shirley, Steve Marschner Indian Edition 2009.

UE17MC523: INTRODUCTION TO DATA SCIENCE (3-0-0-0-3)

Course Objectives:

- To make them understand the importance of data and data analysis for business environment
- To introduce the basics of statistics and how it is applied for data analysis.

Course Outcomes:

At the end of the course, the student should be able to

- Identify the role of data scientist in a business firm
- Effectively use tools to perform data analysis as part of data science.

Course Content:

1. **Introduction to Data Science:** What is Data Science? Where does data comes from? Working with Data at Scale, Making Data tell its story, Data Scientists. Facets of data, The Data Science Process; Introduction to Data handling - Formulas and Functions, Filtering and Sorting, Formulas for Locating and Pulling Values, Inserting Charts, Using Pivot Tables.
2. **Univariate Descriptive Statistics:** Statistics, Variables and data, getting to know R and R Studio, Data Visualization, Graphs and distribution shapes, Measures of Center and Spread, The Normal distribution, Z-Scores.
3. **Bivariate Distributions:** The Scatter Plot, Correlation, Contingency Tables, Conditional Probability, Examining independence.
4. **Linear, Exponential and Logistic Function models:** Function, least squares, linear function – regression, exponential data, logs, logistic function model, picking a good mode.
5. **Hypothesis Testing:** Hypothesis, Errors in Testing, Alpha and Critical values, t-test, Chi-square test, ANOVA.

Prerequisite Course: None

Reference Books:

1. "What is Data Science?", Mike Loukides, O'Reilly Media Inc, 2014.
2. "Introducing Data Science", Amo D.B. Meysman, Mohammed Ali Davy Cielen, Wiley India, 2015.
3. https://www.edx.org/course/foundations-data-analysis-part-1-utaustinx-ut-7-11x-0
4. https://www.edx.org/course/foundations-data-analysis-part-2
5. "Machine Learning using R", Karthik Ramasubramaniam, Abhishek Singh, Apress Publishing, 2017.
   (Chapter 4)
6. "Think Stats: Exploratory Data Analysis", Allen B. Downey, O'Reilly, 2nd Edition, 2015.
7. "Statistics - An Introduction Using R", Micheal J Crawley, 2nd Edition, John Wiley and Sons, 2015.
8. "R Programming for Data Science", Roger D. Peng, Lean Publishing, 2014.

UE17MC524:
DATA PREPARATION AND ANALYSIS (3-0-0-0-3)

Course Objectives:

- To make them understand the importance of data and data cleaning for data analysis
- To get acquainted with data preprocessing and statistical analysis on the dataset.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the mathematical methods behind the data cleaning process and clean any given dataset
- Effectively use tools to perform data analysis on the cleaned data.

Course Content:

1. **Data and Data Preparation:** Data - Data, Variables, Organization of Data, Describing Data by Tables and Graphs: Qualitative Variables, Quantitative Variables; Data Preparation - Overview, Data Integration, Data Cleaning, Data Normalization.
2. **Dealing with Missing Values and noisy data:** Introduction, Assumptions and Missing Data Mechanisms, Simple Approaches to Missing Data. Identifying Noise, Types of Noise Data, Noise Filtering at Data Level.
3. **Data Reduction and Discretization:** Data Reduction, The curse of Dimensionality. Discretization: Perspectives and Background, Properties and Taxonomy, Experimental Comparative Analysis.
4. **Data Analysis Using Spreadsheets:** Introduction to Data handling-Moving Quickly with Control buttons, Copying Formulas and Data Quickly, Formulas for Locating and Pulling Values, Inserting Charts, Merge Data, Filtering and Sorting, Using Pivot Tables, Using Array Formulas.
5. **R Statistical Data Analysis:** Overview of R: Installing, Operators, Printing Values, Basic Data Types, Control Structures, Functions, Packages, Running R Code. Getting Data into R: Reading Data, Cleaning up Data, Exploratory Data Analysis: Summary statistics, Getting Sense of Data Distribution, Outlier Detection.

Prerequisite Course: None

Reference Books:

1. "Basics of Statistics", Jarkko Isotolo, www.mv.helsinki.fi/home/jmisotal/BoS.pdf.
   (Chapter 2(2.1-2.2), 3(3.1-3.2))
2. "Data Preprocessing in Data Mining", Salvador García, Julián Luengo, Francisco Herrera, Springer, 2014.
   (Chapter 3(3.1-3.4); 4(4.1-4.3), 5(5.1-5.3); 6(6.1-6.2), 9(9.1-9.4))
3. "Data Smart: Using Data Science to Transform Information into Insight", John W. Foreman, John Wiley and sons, 2013.
   (Chapter 1)
4. "Beginning Data Science with R", Manas A. Pathak, Springer, 2014.
   (Chapter 2, 3, 5)
5. "R Programming for Data Science", Roger D. Peng, Lean Publishing, 2014.
6. "Clean Data", Megan Squire, Packt Publishing, 2015.

UE17MC551:
SOFTWARE ENGINEERING AND PROJECT MANAGEMENT (4-0-0-0-4)

Course Objectives:

- To understand the complete Software Development Life Cycle and the different methodologies used.
- To understand the development process standards followed for software projects according to the IT industries.
- To understand about the fundamental principles of software project management like planning, organizing, evaluation and cost estimation

Course Outcomes:

At the end of the course, the student should be able to

- Develop the software projects or prototypes by understanding the Requirements.
- Plan for the project deadlines along with the resources available and type of tasks to be carried out.
- Develop increased awareness in Project Scheduling, tracking, Risk analysis and Project Cost Estimation

Course Content:

1. **Software Engineering and Software Process:** Software and Software Engineering - The Nature of Software, Software Engineering, The Software Process, Software Engineering Practice, Software Myths; Process Models - A Generic Process Model, Process Assessment and Improvement, Prescriptive Process Models, Specialized Process Models, The Unified Process.
2. **Agile-Development and Requirements Engineering, Requirements Modeling:** What Is Agility? Agility and the Cost

of Change, What Is an Agile Process? Extreme Programming (XP), other agile process models; Understanding Requirements - Requirements Engineering, Establishing the Groundwork, Eliciting Requirements, Developing Use Cases, Building the Requirements Model; Requirements Modeling Strategies, Flow-Oriented Modeling, Creating a Behavioral Model, Patterns for Requirements Modeling.

3. **Design Engineering:** Design Concepts - Design within the Context of Software Engineering, The Design Process, Design Concepts, The Design Model; Architectural Design - Software Architecture, Architectural Genres, Architectural Styles, Architectural Design.
4. **Software Project Management Framework:** Introduction to Software Project Management - Why is Software Project Management important?, What is a Project, Software Projects versus other types of Projects, Contract Management and Technical Project Management, Activities covered by Software Project Management; An Overview of Project Planning (Step-wise Approach) - Introduction to Step-wise Project Planning, Step 0: Select Project, Step 1: Identify Project Scope and Objectives, Step 2: Identify Project Infrastructure, Step 3: Analyze Project Characteristics, Step 4: Identify Project Products and activities, Step 5: Estimate Effort for each activity, Step 6: Identify activity risks, Step 7: Allocate Resources, Step 8: Review/Publicize Plan, Step 9 and 10: Execute Plan/Lower-levels of Planning; Project Evaluation - Introduction, A Business Case, Project Portfolio Management, Evaluation of Individual Projects, Cost benefit evaluation techniques, Risk evaluation.
5. **Activity Planning:** Introduction, The Objectives of Activity Planning, When to plan, Project Schedules, Projects and activities, Sequencing and Scheduling activities, Network Planning Models, Formulating the Network Model, Adding the time dimensions, The Forward Pass, The Backward Pass, Identifying the Critical Path, Activity Float, Shortening the Project Duration, Identifying the critical activities, Activity-on-Arrow Networks

Prerequisite Course: None

Reference Books:

1. "Software Engineering – A Practitioner's Approach", Roger S Pressman, Tata McGraw Hill, 7th Edition, 2010.

   (Chapter 1(1.1- 1.6 Page: 3-21), 2 (2.1 – 2.5 Page: 31- 53); 3(3.1-3.5 Page: 67- 89), 5(5.1 -5.5 Page: 120 – 138), 7(7.1 -7.4 Page: 186 – 199); 8(8.1 – 8.4 Page: 216-238), 9(9.1 – 9.4 Page: 242-260))
2. "Software Project Management", Bob Hughes, Mike Coterell and Rajib Mall, TMH, 5th Edition, 2011

   (Chapter 1 (1.1 – 1.6 Page: 1 – 6), 3 (3.1 – 3.11 Page:47 – 66), 2 (2.1 – 2.6 Page: 21-35); 6 (6.1 – 6.16 Page: 126-146))

UE17MC552: ADVANCED COMPUTER NETWORKS (4-0-0-0-4)

Course Objectives:

- To understand the design and implementation of wired and wireless LANs
- To familiarize with group communication in the internetwork and next generation networking protocol

Course Outcomes:

At the end of the course, the student should be able to

- Analyze the functionalities of different Wired and wireless LANs.
- Be exposed to the Congestion Control and QoS issues
- Be familiar with the different multicast routing protocols and IPv6

Course Content:

1. **Review of Network Models, Switching and Ethernet:** Internet History, Standards and Administration, Protocol Layering, TCP/IP Protocol Suite, Review of Switching – Introduction, Structure of a Switch, Standard Ethernet
2. **SONET, Wireless and Mobile Networks:** SONET: Architecture, SONET Layers, SONET Frames, STS Multiplexing, SONET Networks, Virtual Tributaries. Wireless Networks: Introduction, Wireless links and Network Characteristics, IEEE 802.11 Project, Cellular Internet Access, Mobility Management Principles, Mobile IP, Managing Mobility in Cellular Networks.
3. **Routing and Next Generation IP:** Routing Algorithms, Routing in the Internet, Multicast Routing: Introduction, Multicasting Basics, Intra-domain Multicast Protocols, Inter-domain Multicast Protocols, IGMP. Next Generation IP: IPv6 Addressing, IPv6 Protocol, ICMPv6, Transition from IPv4 to IPv6.
4. **SCTP, Congestion Control and Quality of Service:** Network Layer Performance. SCTP: Services, Features, Packet Format, An SCTP Association, Flow Control, Error Control. Congestion: Congestion Control to improve the Performance of Networks, Principles of Congestion Control, TCP Congestion Control. Quality of Service: Data-Flow Characteristics, Flow Control to Improve QoS, Integrated Services, Differentiated Services;
5. **Security in Computer Networks:** What is Network Security?, Principles of Cryptography, Message Integrity, Securing E-Mail, Securing TCP connections, Network-Layer Security: IPSec and VPN, Operational Security: Firewalls and IDS

Prerequisite Course: None

Reference Books:

1. "Data Communications and Networking", Behrouz A Forouzan, 5th Edition, McGrawHill, 2012.

   (Chapter 1(1.4, 1.5), 2 (2.1, 2.2), 8(8.1, 8.4), 13 (13.2); 14(14.3), 15 (15.1, 15.2); 21(21.1, 21.2, 21.3, 21.4, 21.5), 22 (22.1, 22.2, 22.3, 22.4); 18 (18.3), 24 (24.4), 30 (30.1, 30.2, 30.3, 30.4))
2. "Computer Networking- a Top down Approach", James F. Kurose, Keith W.Ross, 5th Edition, Pearson 2012.

   (Chapter 6 (6.1, 6.2, 6.4, 6.5, 6.6, 6.7); 4 (4.5, 4.6); 3 (3.6, 3.7); 8 (8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.8))
3. "Computer Networks", Andrew S. Tannenbaum, 5th Edition, Pearson Education, 2013.
4. "Computer Networks - A Top Down Approach", Behrouz A Forouzan, Special Indian Edition

UE17MC553: JAVA PROGRAMMING (4-0-0-0-4)

Course Objectives:

- To introduce the pure object-oriented concepts through Java programming.
- To enable a detailed insight into the Java programming concepts such as creating classes, Methods, Interfaces, Packages, Multithreaded Environment, String handling, Enumerations, Creating small Swing application.

Course Outcomes:

After this course, the student will be able to

- Apply the object-oriented concepts through Java language.
- Develop solution for a real problem using Java programming.

Course Content:

1. **Java Programming Fundamentals:** Object-Oriented Programming, Java Development Kit, Data types, Operators, Java's Primitive Types, Literals, Variables, Short-Circuit Logical Operators, Shorthand Assignments, Type Conversion in Assignments, Cast, Operator Precedence, Expressions, Program control statements, Input Characters, if Statement and flavors, Switch Statement.
2. **Classes, Objects and Methods:** Class, Reference Variables and Assignment, Methods, Parameters, Constructors, new, Garbage Collection and Finalizers, this, Arrays, Array References, length

Member, For-Each Style for Loop, Strings, Command-Line Arguments, Bitwise Operators, The ? Operator, Methods and Classes, Method Overloading, Overloading Constructors, Nested and Inner Classes.

3. **Inheritance and Exception Handling:** Inheritance, Member Access, Constructors, using super to Call Superclass Constructors, Members, Multilevel Hierarchy, Superclass References and Subclass Objects, Method Overriding, Abstract Classes, final, Object class., Exception Handling, Multiple catch Clauses, Catching Subclass Exceptions, finally, throws, Java's Built-in Exceptions.
4. **Interfaces and Packages, Multithreaded Programming:** Interfaces & Packages, Nested Interfaces, Packages and Member Access, Importing Packages, Multithreaded Programming, Thread Class, Runnable Interface, Thread Priorities, Synchronization, Synchronized Methods, Thread Communication Using notify(), wait() and notifyAll().
5. **String Handling, Enumeration, Collections:** String Handling, String Constructors, length(), String Comparison, indexOf(), lastIndexOf(), Enumeration, Constructors, Methods, Instance Variables, exploring java.lang: Primitive Type Wrappers, Math Class, Runtime, System and Object Class, exploring java.util: Locale Class, Date and Time. Collection.

Prerequisite Course: None

Reference Books:

1. "Java Fundamentals – A Comprehensive Introduction", Herbert Schildt and Dale Skrien, McGraw Hill, 1st Edition, 2013.
   (Chapter 1(1.5 – 1.7 page 12 to 17), 2(2.1 – 2.4 page 37 to 47, 2.6 – 2.15 page 50 to 62), 3(3.1 – 3.6 page 68 to 77); 4(4.1 – 4.7 page 108 to 128, 4.10 -4.11 page 132 to 136), 5 (5.1 – 5.10 page 141 to 181), 6 (6.1 – 6.6 page 187 to 203, 6.9- 6.10 page 220 to 228); 7 (7.1- 7.14 page 234 to 273), 10 (10.1 – 10.12 page 318 to 336); 8(8.1 – 8.8 page 277 to 294), 9 (9.1 – 9.3 page 299 to 308), 12 (12.1- 12.10 page 398 to 420); 22(22.1-22.9 page 737 to 761), 13(13.1- 13.6 page 434 to 448), 23(23.1 – 23.9 page 765 to 788), 24 (24.1 – 24.3 page 797 to 806), 25 (25.1 – 25.5 page 840 to 871))
2. Herbert Schildt, "The Complete Reference Java2", Tata McGraw Hill, 7th Edition, 2006.
3. "Core Java 2 - Volume 1", Cay S Horstmann, Gary Cornell, Pearson Education, 7th Edition, 2005.

UE17MC554: AUTOMATION TESTING LAB (0-0-2-0-1)

Course Objectives:

- To introduce various approaches, techniques, technologies, and methodologies used in software testing.
- To provide hands-on in few automation testing tools.

Course Outcomes:

At the end of the course, the student should be able to

- Analyze different approaches to software testing and select optimal solutions for different situations and projects.
- Perform automation testing in real projects.

Course Content:

1. Getting started with Technology
   Programs based on
2. Debug C programs
3. Debug C++ programs
4. Test cases for equivalence class testing, boundary value testing
5. Test cases for decision-based testing, dataflow testing
6. Test cases for path testing
7. Webpage testing using Selenium
8. Selenium Locators
9. Selenium with decisions and loops
10. Lab Test

Prerequisite Course: None

Reference Book

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UE17MC555: JAVA PROGRAMMING LAB (0-0-2-0-1)

Course Objectives:

- To introduce the pure object-oriented concepts through Java programming.
- To enable a detailed insight into the Java programming concepts such as creating classes, Methods, Interfaces, Packages, Multithreaded Environment, String handling, Enumerations, Creating small Swing application.

Course Outcomes:

After this course, the student will be able to

- Apply the object-oriented concepts through Java language.
- Develop solution for a real problem using Java programming.

Course Content:

1. Getting started with Technology
   Programs based on
2. Loops
3. Method and constructor Overloading
4. Arrays
5. Interfaces and Packages
6. Multithreading
7. Inheritance
8. Exception Handling
9. Strings
10. Enumeration
11. Lab Test

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UE17MC557: E-Commerce Development using Magneto (1-2-0-0-2)

Course Objectives:

- To provide knowledge of different core functionality of Magento customization techniques.
- To provide knowledge of application of Magento like manage online sales, invoicing and shipment

Course Outcomes:

At the end of the course, the student should be able to

- Develop a complete E-commerce application with modern functionalities.

Course Content:

1. **E-Commerce – Introduction to Magento:** What is E-commerce? Types of E-commerce in real world, Different E-Commerce Platform, Top websites developed using Magento, what is

Magento? Why to use Magento? Version, Features, Advantages and Disadvantages of Magento, Installation steps for Magento, System Requirements for in installation, Need Of composer, Magento Architecture and Framework, Block diagram, Magento Folder Structure, Magento Design Concepts and Terminology with scenarios, Global-Website-Store methodology, Planning for multiple stores, Magento2 Components

2. **Managing Store:** Setting up Magento stores, Contact, Design Settings, Strategies for backups and security, Configure Magento Webstore, Basic Configuration- Store Admin, Store Details; Storefront Branding, Catalogs and categories, Products, Product Attributes, Products Import, Quantity, Category Management Special Prices, Orders. Managing products to the customer, Types of product, Related products, up-sells, and cross-sells, Importing and exporting products
3. **Designs and Themes and Role Management:** User and Role Management, Customer Group Management, The Magento theme structure, Creative translations, using theme variants, Customizing design themes, Content menu, Content Elements
4. **Marketing Menu and Revenue Generation:** Shopping tools, Promotions, Communications, SEO & Search, The sales process, Point of Purchase, Order Management, Payment methods, Shipping methods, Configuring sales tax rules, Outgoing e-mails, Modules, Shipping Modules.
5. **Report and Managing Non-product Content:** Report Menu, Report Types, Marketing automation, The Magento content management system - Pages, Static blocks, Widgets, Principles of customizing layouts, Operation of store and System, Electronic payment system, Credit Card, Debit Card, Digital Signature, Cryptography, BFS

Prerequisite Course: None

Reference Books:

1. "Mastering Magento", Bret Williams, Packt Publishing, May 2012.
2. https://magento.com/resources/technical
3. "Cyber Security", Ankita Yadav, Narosa Publishing, 2017.

UE17MC531:
IoT Applications Development (2-0-2-0-3)

Course Objectives:

- To develop an understanding of IoT Technology and Cyber-Physical systems.
- To explore the vast spectrum of IoT Applications and gain an appreciation of the building blocks of IoT.

Course Outcomes:

At the end of the course, the student should be able to

- Identify issues and design challenges in IoT Applications
- Select appropriate hardware and software components for IoT Applications

Course Content:

1. **Introduction to IoT:** Introduction to Internet of Things (IoT), IoT enabling technologies and IoT levels**,** Domain specific applications of IoT, Network Services, Cloud.
2. **IoT & M2M:** IoT and M2M, IoT platforms design methodology, Introduction to IoT Network (SDN, N/w Function Virtualisation), and Cloud Services, Basics of IOT System Management.
3. **IoT Physical Devices & Endpoints:** Introduction to IoT Physical End-points and Platforms, Familiarity with Aurdino, Familiarity with Raspberry Pi, Raspberry Pi Architecture, OS & Programming, Raspberry Pi I/O Interfaces, Communication interfaces.
4. **Python Programming with Raspberry Pi:** Python Programming with Raspberry Pi, Working with Sensors, Working with Aurdino, Case study on Home Intrusion Detection, IoT with Cloud
5. **IoT Cloud Offerings:** IoT Physical Servers & Cloud Offerings, Cloud Storage models and Communication API's, WebServer for IoT, Python Web Application Framework (Django), Designing a RESTful web API, IoT Application Case Study.

Lab Component

1. Familiarity with Aurdino
2. Exploring the different components of Aurdino
3. Familiarity with Raspberry Pi
4. Exploring the different components of Raspberry pi
5. Mini Project
6. Project Demonstration

Prerequisite Course: None

Reference Books:

1. "Internet of Things: A Hands-on Approach", ArshdeepBahga, Vijay Madisetti, Universities Press, 2015
   (Chapter 1 (Pg. 19 – 44), 2 (Pg. 47 – 62); 3 (Pg. 65 – 73), 4 (Pg. 79 – 91); 7 (Pg. 153 – 168); 9 (Pg. 171 – 188, 217 – 278))
2. "Programming the RaspberryPi: Getting Started with Python", Simon Monk, McGrawHill, 2nd Ed, 2017
3. http://forefront.io/a/beginners-guide-to-arduino
4. https://www.arduino.cc/en/Tutorial/HomePage

UE17MC532:
WEB SOCKETS (3-0-0-0-3)

Course Objectives:

- To build strong expertise in Web Sockets
- To Implement front end and back end scenarios using Web Sockets.

Course Outcomes:

At the end of the course, the student should be able to

- Use the knowledge of web sockets in developing desktop-like applications in browser without resorting to methods that exhaust server-side resources.
- Create web applications that communicate between server and client in a bi-directional way without any hacks.

Course Content:

1. **Introduction, WebSocket APIs:** Introduction, WebSocket URIs, WebSocket APIs: Initializing, Stock Example UI, WebSocket Events: Open, Message, Error, PING/PONG, Close, WebSocket Methods: Send,Close, WebSocket Attributes: readyState, bufferedAmount, protocol, Stock Example Server, Testing for WebSocket Support.
2. **Bi-directional Chat:** Long Polling, Writing a basic chat, WebSocket Client, Client Identity, Events and Notifications, The Server, The Client, Example; WebSocket Compatibility - SockJS - SockJS Chat Server, SockJS Chat Client, Socket.IO: Adobe Flash Socket, Connecting, Socket.IO Chat Server, Socket.IO.Chat Client, Pusher.com: Channels, Events, Pusher Chat Server, Pusher Chat Client, Reverse Proxy
3. **WebSocket Security:** TLS and WebSocket: Generating a self-signed certificate, Installing on Linux, Setting up WebSocket over TLS, WebSocket over TLS example, Origin-based Security Model: ClickJacking, X-Frame-Options for frame busting, Denial of Service (DOS), Frame masking, Validating Clients: Setting up dependencies and inits, Listening for web requests, WebSocket Server.
4. **Debugging Tools:** The handshake: The Server, The Client, Download and Configure ZAP, WebSocket Secure to the rescue,

Validating the handshake, Inspecting Frames: Masked Payloads, Closing Connection.

5. **WebSocket Protocol:** HTTP 0.9 – The web is born, HTTP 1.0 and 1.1, WebSocket Open Handshake: Sec-WebSocket-Key and Sec-WebSocket-Accept, Websocket HTTP Headers, WebSocket Frame: Fin Bit, Frame Opcodes: Masking, Length, Fragmentation, WebSocket Close Handshake, WebSocket SubProtocols, WebSocket Extensions, Alternate Server Implementations

Prerequisite Course: None

Reference Books:

1. "WebSocket: Light Weight Client-Server Communications", Andrew Lombardi, O'Reilly, 2nd Edition, 2015.
   (Chapter 2 (Pg 9-21); 3 (Pg 23-34), 5 (Pg 61-77); 6 (Pg 79-92); 7 (Pg 95-110); 8 (Pg 113-124))
2. http://blog.teamtreehouse.com/an-introduction-to-websockets

UE17MC533: NoSQL (3-0-0-0-3)

Course Objectives:

- To provide comprehensive introduction to NoSQL from several perspectives.
- To introduce the methods for designing a database, query languages used in document-based databases.

Course Outcomes:

At the end of the course, the student should be able to

- Differentiate NoSQL with SQL.
- Apply data modeling concepts and their applications in design and construct a typical enterprise large database.

Course Content:

1. **Introduction:** Context and History, What is NoSQL? CAP Theorem, BASE vs. ACID, Types of NoSQL, Data Models, When we should use NoSQL? Comparison of Relational Databases to NoSQL, SQL vs. NoSQL, Storage Architecture
2. **MongoDB and CRUD Operations:** Overview, Features of MongoDB, Architecture, Installation, Basics of CRUD operations in MongoDB, Create, Retrieve, Update Delete operations in detail
3. **Replication in MongoDB:** Replication concepts, Replication in Single Machine, Replication in Multiple Machine
4. **Sharding:** Sharding Concepts, Sharding in testing environment, Sharding in deployment architecture.
5. **PyMongo:** Python Driver (PyMongo), Making a Connection with MongoClient, Getting database and collection, Insert, Update, Delete, Replace, Bulk-insert

Prerequisite Course: None

References:

3. https://www.mongodb.org/
4. http://www.tutorialspoint.com/mongodb/
5. "MongoDB: The Definitive Guide", Kristina Chodorow, O'Reilly Media, 2nd Edition, 2013.

UE17MC534: BIOINFORMATICS (3-0-0-0-3)

Course Objectives:

- To understand sequencing, the uses of sequencing and Biological resources/databases.
- To apply online resources/databases to gain access to sequence data and information.

Course Outcomes:

At the end of the course, Students should be able to:

- Use Bioinformatics tools to search, retrieve and analyze information on literature, sequence the structure relating to nucleic acids and proteins.
- Solve problems using modern bioinformatical tools.

Course Content:

1. **Introduction to Bioinformatics, Information Search and Data Retrieval:** Introduction, Historical overview and Definition, Bioinformatics Applications, Major databases in Bioinformatics, Data Management and Analysis, Molecular Biology and Bioinformatics, Introduction to Information Search, Tools for Web Search, Data Retrieval Tools, Data Mining and Biological databases.
2. **Genome Analysis and Gene Mapping, Alignment of Pair of Sequences :** Introduction, Genome Analysis, Genome Mapping, The sequence Assembly problem, Genetic Mapping and Linkage Analysis, Physical Maps, Cloning the Entire Genome, Genome Sequencing, Applications of Genetic Maps, Sequence Assembly tools, The Human Genome Project (HGP); Introduction to Alignment of Pair of Sequences, Biological Motivation of Alignment Problems, Methods of Sequence of Alignments, Using Scoring Matrices, Measuring Sequence Detection Efficiency.
3. **Profiles and Hidden Markov Models, Gene Identification and Prediction, Gene Expressions and Micro Arrays:** Introduction to Profiles, Using Profiles, Hidden Markov Models (HMMs); Basis of Gene Prediction, Pattern Recognition, Gene Prediction Methods, Other Gene Prediction Tools; Working with DNA Micro Arrays, Clustering Gene Expression Profiles, Data Sources and Tools for Microarray Analysis, Applications of MicroArray Technology.
4. **Alignment of Multiple Sequences and Phylogenetic Analysis, Tools for Similarity Search and Sequence Alignment:** Introduction of Alignment of Multiple Sequences, Methods of Multiple Sequence Alignment, Evaluating Multiple Alignments, Applications of Multiple Alignments, Phylogenetic Analysis, Methods of Phylogenetic Analysis, Tree Evaluation, Problems in Phylogenetic Analysis, Automated Tools for Phylogenetic Analysis; Introduction to tools, Working with FASTA, Working with BLAST, Filtering and Gappad Blast; Using R Tool to visualise and analyse sequence data-Installing Bioconductor R Package, DNA Sequence Statistics, Using R for Bioinformatics.
5. **Applications and Commercial aspects of Bioinformatics:** Introduction to Drug Discovery, Areas influencing Drug Discovery, Important parameters in Drug Discovery, Drug Discovery Technologies, Target Discovery strategy, Strategy to identify possible drug targets; Computer Aided Drug Design: Introduction to Drug Design, Drug Design Approaches, Computer-aided Drug Design Methods.

Prerequisite Course: None

Reference Books:

1. "Bioinformatics Methods and Applications- Genomics, Proteomics and Drug Discovery", S.C. Rastogi, N. Mendiratta, Parag Rastogi, PHI Learning Private Ltd, 3rd Edition, 2009.
   (Chapter 1(1,.1-1.5), 2(2.1-2.4); 3(3.1-3.12), 4(4.1-4.5); 7(7.1-7.3), 8(8.1-8.5), 9(9.1-9.5); 5(5.1-5.9), 6(6.1-6.5); 14(14.1-14.5), 15(15.1-15.4), 21(21.1-21.14))
2. "A Little Book of R for Bioinformatics, Release 0.1", Avril Coghlan, Wellcome Trust Sanger Institute, Cambridge, 2017.
3. "Cloud Computing: A Practical Approach for Learning and Implementation", Srinivasan A & Suresh J, Pearson Education, 2014.
4. "Cloud Computing: Implementation, Management, and Security", John W. Rittinghouse, James F. Ransome, CRC Press, 2010.

5. "Cloud Computing, A Practical Approach", Toby Velte, Anthony Velte, Robert Elsenpeter, TMH, 2009.
6. "Cloud Computing – Insights into New-Era Infrastructure", Kumar Saurabh, Wiley India, 2011.

UE17MC541: WEB FRAMEWORKS (3-0-0-0-3)

Course Objectives:

- To learn how to work different frameworks for website application.
- To explore the basic syntax and semantics of different frameworks.

Course Outcomes:

At the end of the course, the student should be able to

- Develop a web application using Bootstrap and AngularJS Framework.
- Design web pages using Django Framework

Course Content:

1. **jQuery:** Introduction, jQuery library, need of jQuery, Adding jQuery to web page, Download and use jQuery, Advantage of use jQuery, Syntax of jQuery, Ready event, Element selector, using separate file, jQuery Events, jQuey Effects, Animation, stop method, jQueryChaining, jQuery-Ajax, Load method, Ajax Get, Set, Add, Remove, Dimension and Post method, Manipulating CSS, noConflict method, jQuery Traversing, Siblings and jQuery Filtering
2. **Bootstrap:** Introduction- Responsive Design and use, Get Bootstrap and syntax, CSS style Specification-Grid, Typography, Contextual Classes, Tables, Image shapes, Reusable components-Jubotron, Page Header, Wells, Alerts, Buttons, Badges /Labels, Glyphicon, Dropdown Header, Progress bars, Breadcrumbs Pagnitation, Tabs / Pills, Collapse, Navbar, JavaScript Plugins – Carosual, Modal & Tooltip, Popover, Themes
3. **Introduction to AngularJS:** Introduction, Environment Setup, MVC Architecture, Expression, Modules, Directives, Model, Controllers, Scopes, Includes, pristine, switch, class
4. **AngularJS Server:** Server Programming, Services, Http, Filters, Tables, Select, SQL, DOM, Events, Forms Validation, response-objects
5. **Introduction to Django:** Introduction, Django – High Level, MTV framework, Installing Django, Projects vs. Apps, Creating a Django Project, Creating an App inside the project, Create a view, URL Dispatcher, Defining and Using Models, Using Models, Templates and Form Processing, Setting Up the Database using Django admin.

Prerequisite Course: None

Reference Books:

1. "jQuery Cookbook", Cody Lindley, O'Reilly Media, 2009
2. "Bootstrap Essentials", Snig Bhaumik, Packt publishing, 2015
3. "AngularJS", Brad Greene, Shyam Seshadri, O'Reilly Media, 1st Edition, 2013.
4. http://dgangoproject.com
5. http://dgagogirls.org
6. http://dgngobook.com

UE17MC542: CGI PROGRAMMING (3-0-0-3)

Course Objectives:

- Understand the meaning of CGI and the Hypertext Transfer Protocol
- Know how to generate simple web pages using Perl
- Understand how to accept and process data from web forms using the CGI module
- Understand security issues pertaining to CGI programming and how to avoid security problems
- Recognize and use a number of Perl modules for purposes related to CGI programming

Course Outcomes:

At the end of the course, the student should be able to

- Have a practical knowledge on CGI programming
- Implement multimedia web documents

Course Content:

1. **Introduction to CGI:** Definition of CGI, Introduction to HTTP, Terminology, HTTP Methods, GET, HEAD, POST, what is needed to run Perl CGI programs.
2. **Generating web pages with Perl:** The CGI directory, CGI.pm. Making CGI programming a breeze, That header thing Quoting and roll-your-own quotes, HTML output, HTML tags with CGI.pm, Faking tags with CGI.pm, Running CGI program, Debugging your CGI programs, Failing gracefully with CGI::Carp, Cookies, Environment variables
3. **HTML forms and CGI.pm:** A quick look at HTML forms, The FORM element, printing your form with CGI.pm, CGI.pm FORM defaults, Form input fields and CGI.pm, TEXT, HIDDEN, PASSWORD, CHECKBOX, CHECKBOX GROUP, SELECT, SUBMIT
4. **Accepting and processing form input and Security issues:** CGI Parameters, Calling param() in context , Where this hurts , Debugging with the CGI.pm module's offline mode, Building a GET string, Data validation, Multi-form "Wizard" interface , File upload, Authentication and access control for CGI scripts, HTTP authentication, Access control, Secure HTTP.
5. **Splitting HTML and code with HTML::Template:** What is HTML:Template ,The Template Explained, Conventions ,Simple Template Fields, Escaping in template fields, Conditionals, Looping constructs, Including files, Using Template Objects, Binding simple parameters, Binding complex parameters

Prerequisite Course: None

Reference Books:

1. "CGI Programming with Perl", Kirrily Robert, Paul Fenwick, and Jacinta Richardson, Perl Training Australia, 2001-2004

UC17MC543: DATA ANALYTICS (3-0-0-0-3)

Course Objectives

- To understand the raw materials database and data warehouse to mine them to extract knowledge out of it.
- To understand the concepts of Association Rule Mining, Classification and Clustering and applying various algorithms to different datasets.

Course Outcomes

At the end of the course, the student should be able to

- Mine the patterns from the dataset.
- Classify the records, groups the objects/records and predict the class label of datasets.

Course Content:

1. **Data Mining and Data Mining from Business Perspective:** Data Mining - Introduction, Main reasons for Growth of Data Mining Research, New Applications, Trends that effect Data Mining, Data Mining from Business Perspective – Introduction, Evolution of

Data Mining Systems, Knowledge Discovery Process, Data Mining Supporting Technologies Overview, Data Mining Techniques.

2. **Data Types and Preprocessing:** Data Types, Input and Output of DM Algorithms – Introduction, Instances and Features, Different Types of Features, Concept Learning and Concept Description, Output of Data Mining – Knowledge Representation, Preprocessing - Introduction, Steps in Preprocessing, Discretization, Feature Extraction, Selection and Construction, Missing Data and Methodological Techniques for dealing it.
3. **Algorithms for Classification and Regression:** Introduction, Naïve Bayes, Multiple Regression Analysis, Logistic Regression, k-Nearest Neighbour Classification, Evolutionary Computing and Genetic Algorithms.
4. **Association Rule Mining and Correlation Analysis:** Association Rule Mining- Introduction, Automatic Discovery of Association Rules in Transaction Databases, The Apriori Algorithm, Shortcomings, Correlation Analysis- From Association Analysis to Correlation Analysis, Lift.
5. **Cluster Analysis:** Introduction, Partitional Clustering, k-medoids, Modern Clustering Methods.

Prerequisite Course: None

Reference Books:

1. "Insight in Data Mining – Theory and Practical", K. P. Soman, Shyam Diwakar, V. Ajay, Eastern Economy Edition, 7th Printing, 2014
2. "Machine Learning using R", Karthik Ramasubramaniam, Abhishek Singh, Apress Publishing, 2017
3. "Data Mining Concepts and Techniques", Jaiwei Han and Micheline Kamber, Elsevier, Second Edition, 1999.
4. "Introduction to Data Mining", Pang-Ning Tan, Vipin Kumar, Michael Steinbach, Pearson Publication, 1st Impression, 2012
5. "Introduction to Data Mining with Case Studies", G. K. Gupta, PHI, 3rd Edition, 2014

UE17MC544:
DATABASE ADMINISTRATION (3-0-0-0-3)

Course Objectives:

- To understand the tasks of a database administrator
- To Demonstrate how to implement and configure a database environment

Course Outcomes:

At the end of the course, the student should be able to

- Manage and optimize schemas, tables, indexes, and views
- Create logins, configure permissions, assign roles and perform other essential security tasks

Course Content:

1. **Introduction to Database Administration:** Why Learn Database Administration, Management Discipline of Database Administration, DBA Tasks, Database, Data and System Administration, DBA Tasks, Types of DBAs, Staffing considerations, Multiplatform DBA Issues, Production versus Test, The impact of newer technology on DBA.
2. **Performing basic server administration:** Installing and configuring DBMS, DBMS Environments, Database performance Design, Designing Indexes, Hashing, Clustering, different kinds of tables, Server Logs
3. **Managing users and controlling access:** Creating and modifying user accounts, creating and using roles, granting and revoking privileges, managing user groups with profiles, Profiles, Managing users, managing privileges, managing roles, querying role information.
4. **Performing maintenance, backup and recovery:** Brief overview of Tuning methodology, General tuning concepts, Database backup, restoration and recovery, Types of failure in oracle environment, defining a backup and recovery strategy, Testing the backup and recovery plan
5. **Replicating data:** Configuring Replication, Replication Implementation, Partitioning Types, Partitioning Management, Partition Pruning, Partition Selection.

Prerequisite Course: None

Reference Books:

1. "Database Administration: The Complete Guide to DBA Practices and Procedures", Craig Mullins, Addison-Wesley, Second Edition, 2002.
2. "MySQL for Database Administrators", Ed 4 NEW, Oracle University.
3. "Microsoft SQL Server 2012 Administrator's Pocket Consultant", William R. Stanek (Microsoft Press).
4. "Database Systems", C.J. Date, Addison Wesley, 2000
5. "Introduction to Oracle 9i SQL", Chip Dawes, Biju Thomas, BPB, 2002
6. "Oracle 9i DBA Fundamental I", Bob Bryla, Biju Thomas, BPB, 2002
7. "Oracle 9i DBA Fundamental I", Doug Stums, Matthew Weshan, BPB, 2002
8. "Oracle 9i Performance Tuning", Joseph C. Johnson, BPB, 2002.

UC16MC601:
ADVANCED JAVA PROGRAMMING (4-0-0-0-4)

Course Objectives:

- To learn advanced concepts of Java
- To provide the knowledge of using J2EE (Java 2 Enterprise Edition) APIs.

Course Outcomes:

At the end of the course, the student should be able to

- Apply the advance Java concepts to build dynamic web applications
- Understand the basics to start developing MVC architecture-based applications using Spring frameworks

Course Content:

1. **JDBC:** Talking to Database, Immediate Solution, Essential JDBC program, Using Prepared Statement Object, Interactive SQL Tool, JDBC in Action – Result Sets, Batch updates, Mapping, Basic JDBC data types, Advanced JDBC data types, Immediate Solutions
2. **Servlets:** Servlet Structure, Servlet Packaging, Servlet's Lifecycle, Single Thread model interface, Handling Client Request: Form Data, Handling Client Request: HTTP Request Headers, Generating Server Response: HTTP Response Headers, Handling Cookies, Session Tracking
3. **JSP:** Overview of JSP Technology, Need of JSP, Benefits of JSP, Advantages of JSP, Basic Syntax, Invoking Java Code with JSP Scripting Elements – creating Template Text, Invoking Java Code from JSP, Limiting Java Code in JSP, Using JSP expressions, Comparing Servlets to JSP, Writing Script lets, using Scriplets to make parts of jsp conditional, using Declarations, declaration example
4. **Annotations and Java Beans:** Creating Packages, Interfaces, JAR files and Annotations, New java. Lang Sub Package, Built-in Annotations, Working with Java Beans, Introspection, Customizers, Creating a Java Bean, Creating a Bean Manifest File, Creating a Bean JAR file, Using a new Bean, Adding controls to Beans, Giving a bean properties, Design Patterns for Properties,

Simple Properties, Design Pattern for Events, Creating Bound Properties, Giving a Bean Methods, Giving a Bean an Icon, Creating a Bean Info Class, Persistence, The JavaBeans API

5. **Introduction to Spring Framework:** Springing into Action - Simplifying Java development, Containing your beans, Surveying the Spring landscape - Spring Modules, The Spring Portfolio, Wiring Beans – Declaring Beans, Injecting into bean properties, Using Spring's Java-based configuration, Building web applications with Spring MVC - Getting started with Spring MVC, Writing a basic controller, Handling controller input, Processing forms, Handling file uploads

Prerequisite Course: UC16MC551

Reference Books

1. "Core Servlets and Java Server Pages", Marty Hall and Larry Brown, Sun Microsystems Inc., 2nd Edition, 2004.
   (Chapter 3(Pg. 66-86), 4 (Pg. 94-123), 5 (Pg. 146- 170), 7 (Pg. 194 – 217), 8 (Pg. 228-255), 9 (Pg. 262- 292); 10 (Pg. 302-308, 314-317), 11(Pg. 318-340), 12(Pg. 352-354, 362-370), 14 (Pg. 398-430))
2. "Java 6 Programming Black Book", DreamTech Press, 2012.
   (Chapter 29 (Pg. 1309 – 1386), 30 (Pg. 1349 – 1369); 27 (Pg. 1249 – 1257), 28 (Pg. 1273 – 1304))
3. "Spring in Action", Craig Walls, Manning, 3rd Edition, 2011.
   (Chapter 1(1.1, 1.2, 1.3) (Pg. 4-23), Chapter 2 (2.1, 2.2) (Pg. 30-46), 3 (3.4) (Pg. 80-82), 7 (7.1, 7.2, 7.3, 7.4, and 7.5) (Pg. 164 – 197))
4. "Java 6 Programming Black Book", DreamTech Press, New Edition, 2009.
5. "Struts: The Complete Reference", James Holmes and Herbert Scheldt, McGraw Hill, Illustrated Edition, 2004

UC16MC602:
CLOUD COMPUTING (4-0-0-0-4)

Course Objectives:

- To introduce the broad perceptive of cloud architecture and model.
- To be familiar with the lead players in cloud.

Course Outcomes:

After this course, the student will be able to

- Manage cloud applications
- Develop and deploy applications in the cloud
- Apply different cloud programming model as per need

Course Content:

1. **Introduction:** Evolution of the web, Future evolution, Cloud Computing, Cloud Deployment models, Business drivers for cloud computing, Cloud technologies. Setting up your AWS account; Designing Cloud Applications: Design principles, emerging cloud-based application architectures.
2. **Infrastructure as a Service:** Compute as a service: Amazon Elastic Compute Cloud (EC2), Setting up a web server; Storage as a service: Amazon simple storage services (s3), Amazon simple DB, Amazon relational database service; Managing IaaS: EC2 Management, Amazon cloud watch
3. **Platform as a Service:** Understanding app engine, using the cloud console, setting app engine services, coding your app, working with images, style sheets and other static files, incorporating HTML templates, uploading and deploying your app, implementing cloud storage, setting up a custom domain.
4. **Software as a Service:** Email communication over the cloud, CRM as a service, Task Management – calendar, Schedules, Document services – word-processing, presentation, spread sheet, databases, Social Computing Services, Designing Multi-tenancy, Managing SaaS.
5. **Cloud Security and Related Technologies:** Analytics on Cloud, Cloud Security requirements and best practices, Risk management, Security design patterns, Legal and Regulatory issues.

Prerequisite Course: None

Reference Books:

1. "Moving to the cloud", Dinkar Sitaram & Geetha Manjunath, Elsevier Publications, 2011.
   (Chapter 1 - 4, 7-9)
2. "Learning AWS", Aurobindo Sarkar & Amit shah, Packt Publishing, 2nd Edition, 2018.
   (Chapter 1)
3. https://www.lynda.com/Google-App-Engine-tutorials/Google-App-Engine-Essential-Training/194134-2.html
4. "Cloud Computing: A Practical Approach for Learning and Implementation", Srinivasan A & Suresh J, Pearson Education, 2014.
5. "Cloud Computing: Implementation, Management, and Security", John W. Rittinghouse, James F. Ransome, CRC Press, 2010.
6. "Cloud Computing, A Practical Approach", Toby Velte, Anthony Velte, Robert Elsenpeter, TMH, 2009.
7. "Cloud Computing – Insights into New-Era Infrastructure", Kumar Saurabh, Wiley India, 2011.

UC16MC603:
UNIX SHELL AND SYSTEM PROGRAMMING (4-0-0-0-4)

Course Objectives:

- To have basic understanding on UNIX kernel structure and system calls pertained to file and interprocess communication
- To learn on essentials of shell programming and use of system calls in scripting

Course Outcomes:

After this course, the student will be able to

- Write simple Shell programs and manipulate system processes using shell scripting
- Automate many system tasks which may be a part of complex system and apply system calls to manipulate system resources

Course Content:

1. **UNIX Standardization and Implementation:** Introduction - Unix, Unix Architecture, General commands, Handling ordinary Files, Basic File attributes, Unix Standardization, Relationship of standards and Implementations, Limits, Features Test Macros.
2. **Shell Programming:** Shell Scripts, read : Makin Scripts Interactive , Using Command Line Arguments, exit and Exit Status of Command, The Logical Operators && and | | - Conditional Execution, The if Conditional, Using test and [ ] to Evaluate Expressions, The Case Conditional, expr : Computation and String Handling, $0: Calling a Script by Different Names, while: Looping, for: Looping with a List, set and shift: Manipulating Positional Parameters, The Here Document (<<), trap: Interrupting a Program, Debugging Shell scripts with set –x, Sample Validation and Data Entry Scripts, Arrays and Functions.
3. **Filters:** Simple Filters - The Sample Database, pr: Paginating Files, head: Displaying the Beginning of a File, tail: Displaying the End of a File, cut: Splitting a File Vertically, paste: Pasting Files, sort: Ordering a File, uniq: Locate Repeated and Non-repeated Lines, tr: Translating Characters; Filters Using Regular Expressions - grep: Searching for a pattern, Basic Regular Expressions(BRE)- An

Introduction, Extended Regular Expressions (ERE) and egrep, sed: The Stream Editor, Line Addressing, Using Multiple Instructions (-e and –f), Context Addressing, Writing Selected Lines to a File (w), Text Editing, Substitution(s), Basic Regular Expressions Revisited; Awk - Syntax of an awk program statement, Structure of an awk script, operational mechanism for awk, variables, records, fields and special variables, Addressing: Line and Context addressing, patterns, operators, sample Input Files, Simple awk programs.

4. **File System Calls:** File I/O - Introduction, File Descriptors, open Function, creat Function, close Function, lseek Function, read Function, write Function; Files and Directories - Introduction, stat, fstat, and lstat Functions, File types, Set-User-ID and Set-Group-ID, File Access Permissions, Ownership of New Files and Directories, access Function, umask Function, Chmod and fchmod Functions, File size, File Systems, link , unlink , remove and rename Functions , Symbolic Links , symlink and readlink Functions, utime Function, mkdir and rmdir Functions. Reading Directories, chdir , fchdir and getcwd Functions.
5. **Process Control and Relationships:** Process Control - Introduction, Process Identifiers, fork, vfork, exit, wait, waitpid, waitid, wait3, wait4 Functions, Race Conditions, exec Functions, Changing User IDs and Group IDs; Interprocess Communication - Introduction, Pipes, popen and pclose Functions, Coprocesses, FIFO.

Prerequisite Course: None

Reference Books:

1. “Advanced Programming in the UNIX Environment”, W. Richard Stevens and Stephen A. Rago, Pearson Education, 2nd Edition, 2011.
   (Chapter 1(1.1 – 1.2), 2(2.2, 2.4 -2.5, 2.7); 3(3.1 – 3.8), 4(4.1 – 4.9, 4.12, 4.14 – 4.17, 4.19 - 4.22); 8(8.1 – 8.11), 15(15.1 – 15.6))
2. “UNIX Concepts and Applications”, Sumitabha Das, Tata McGraw-Hill, 3rd Edition, 2008.
   (Chapter 6(6.1 – 6.12), 7(7.1-7.7); 16(16.1 -16.17); 14(14.1 – 14.10), 15(15.1 to 15.11), 21(21.1 -21.9))
3. “Unix System Programming Using C++”, Terrence Chan, Prentice Hall India, Illustrated Edition, 1997.
4. “Introduction to Unix & Shell Programming”, Venkateshmurthy, Pearson Education, 2006.

UC16MC604: ADVANCED JAVA PROGRAMMING LABORATORY (0-0-2-0-1)

Course Objectives:

- To learn advanced concepts of Java
- To provide the knowledge of using J2EE (Java 2 Enterprise Edition) APIs.

Course Outcomes:

At the end of the course, the student should be able to

- Apply the advance Java concepts to build dynamic web applications
- Understand the basics to start developing MVC architecture based applications using Spring frameworks

Course Content:

1. Getting started with Technology
   Programs based on
2. Interaction with Database – insert, update, delete and search
3. Servlets
4. Cookies
5. Session Handling
6. JSP
7. HTML, JSP and Servlet Interaction
8. Java Beans
9. Lab Test

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UC16MC605: UNIX SHELL & SYSTEM PROGRAMMING LAB (0-0-2-0-1)

Course Objectives:

- To learn the fundamentals of shell scripting/programming
- To provide an introduction to system-level programming

Course Outcomes:

After completion of the course, the student will be able to

- Write shell scripts to automate various tasks
- Write C/C++ programs that use the UNIX system call interface

Course Content:

1. Getting started with Technology
2. Basic Utilities and File Permissions
3. POSIX Limit Check, Feature Test Macros
4. Interactive and Non-Interactive shell scripts
5. Control Structures
6. Arrays and Functions
7. Grep, Sed, Awk
8. File System Calls
9. Directory System Calls
10. Internal Test
11. Processes, Race Condition
12. Zombie Process
13. Lab Test

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UC16MC606: SKILLS REINFORCEMENT LAB (0-0-2-0-1)

Course Objectives:

- To apply the skills in resolving real world problem statements through technology.
- To get hands-on experience by involving with industry projects.

Course Outcomes:

After completion of the course, the student will be able to

- Able to analyse and apply logic for a specific problem statement.
- Able to get expertise in technical skills development - accurately and timely.
- Confident to work independently and also in a team.

Course Content:

1. Technical Aptitude in C programming language
2. Technical Expertise in C programming language
3. Technical applications of Data Structures
4. Writing efficient programs
5. Technical Interview Q&A

6. Group Discussion
7. Mock Test
8. Team Work

Prerequisite Course: None

Reference Book:

1. Laboratory Manual prepared by Department of Computer Applications, PESU.

UC16MC607:
ADVANCED APPLICATION DEVELOPMENT (1-2-0-0-2)

Course Objectives:

- To provide knowledge of different core functionality of Magento customization techniques.
- To provide knowledge of application of Magento like manage online sales, invoicing and shipment

Course Outcomes:

At the end of the course, the student should be able to

- Develop a complete E-commerce application with modern functionalities.

Course Content:

1. **E-Commerce – Introduction to Magento:** What is E-commerce? Types of E-commerce in real world, Different E-Commerce Platform, Top websites developed using Magento, what is Magento? Why to use Magento? Version, Features, Advantages and Disadvantages of Magento, Installation steps for Magento, System Requirements for in installation, Need Of composer, Magento Architecture and Framework, Block diagram, Magento Folder Structure, Magento Design Concepts and Terminology with scenarios, Global-Website-Store methodology, Planning for multiple stores, Magento2 Components,
2. **Managing Store:** Setting up Magento stores, Contact, Enabling SSL, Design Settings, Strategies for backups and security, Configure Magento Webstore, Basic Configuration- Store Admin, Store Details, Storefront Branding, Catalogs and categories, Products, Product Attributes, Products Import, Quantity, Category Management Special Prices, Orders. Managing products to the customer, Types of product, Related products, up-sells, and cross-sells, Importing and exporting products
3. **Designs and Themes and Role Management:** User and Role Management, Customer Group Management, The Magento theme structure, Creative translations, using theme variants, Customizing design themes, Content menu, Content Elements
4. **Marketing Menu and Revenue Generation:** Shopping tools, Promotions, Communications, SEO & Search, The sales process, Point of Purchase, Order Management, Payment methods, Shipping methods, Configuring sales tax rules, Outgoing e-mails, Modules, Shipping Modules.
5. **Report and Managing Non-product Content:** Report Menu, Report Types, Marketing automation, The Magento content management system - Pages, Static blocks, Widgets, Principles of customizing layouts, Operation of store and System, Electronic payment system, Credit Card, Debit Card, Digital Signature, Cryptography, BFS

Prerequisite Course: None

References:

1. "Mastering Magento", Bret Williams, Packt Publishing, May 2012.
2. https://magento.com/resources/technical
3. "Cyber Security", Ankita Yadav, Narosa Publishing, 2017.

UC16MC611:
WEB SERVICES (4-0-0-0-4)

Course Objectives:

- To learn how to allow normally incompatible applications to inter-operate over the Web regardless of language, platform, or operating system.
- To learn how to allow for business processes to be made available over the Internet using Web Services.

Course Outcomes:

At the end of the course, the student should be able to

- Develop a small web application using major components of web services like SOAP, WSDL and UDDI.
- Provide students with a "big-picture" perspective to enable you to understand the scope and extent of web services, while also providing students with enough nuts and bolts and sample code to start writing your own services.

Course Content:

1. **Introduction to Web Services:** Overview: What Are Web Services? History Web Services Technology, Java and Web Services Application Scenarios, Implementation Scenarios, Benefits of Web Services, A Word about Standards, Service-Oriented Architecture, SOA Entities, SOA Characteristics
2. **XML and Remote Procedure Call:** What is XML?, Validation of XML Data, Advanced XML, Document Constraining, XML-RPC- Overview, Why XML-RPC?, XML-RPC Technical overview, Developing with XML-RPC, Beyond Simple Calls, RPC and Messaging- Synchronous Web Services, Asynchronous Web Services, Remote Procedure Call and Messaging
3. **SOAP and REST:** SOAP The Case for SOAP What Does SOAP Define? SOAP Message Structure, SOAP Message Elements SOAP Processing Model SOAP, Installing Apache SOAP, Deploying SOAP Services, The TcpTunnelGui Tool, RESTful Web Service, Objectives of this RESTful Web Service, Example, URI Mapping, A simple RESTful base class, RESTful Web Service Client, Web Service Controller, Web Service XML Output, JSON Output, API
4. **WSDL and UDDI:** WSDL Describing a Web Service, Describing Functional Characteristics of Services WSDL 1.2, UDDI Discovering Web Services Categorizing Services, Identifiers Business Entity Relationships UDDI's SOAP Interfaces UDDI and SOAP/WSDL Relationships
5. **Transaction Management and Security:** Transaction Management – Concepts, A Transaction Model for Web Services, New Transaction Specifications, Security Considerations for Web Services, Web Services Security Initiatives, XML Digital Signatures, Apache XML Security, XML Encryption, Security Assertions Markup Language, Web Services Security Assertions

Prerequisite Course: None

Reference Books:

1. "Java Web Services Architecture", James McGovern, Sameer Tyagi, Micheal Stevens, and Sunil Mathew, Elsevier, 2008.
   (Chapter 1 (Pg. 4-32), 2(Pg. 35-61); 5(Pg. 133-174); 6(Pg. 177-199); 14(Pg. 583-617), 15(Pg. 621-658))
2. http://phppot.com/php/php-restful-web-service/
3. https://www.phpclasses.org/package/7071-PHP-Implement-REST-based-Web-services.html
4. "Web Services Essentials", Ethan Cerami, O'Reilly Media, February 2002.
   (Chapter 2(Pg. 29-46); Chapter 3(Pg. 65- 83)) .
5. "Web Services and the Data Revolution", Frank P Coyle, Pearson, 2002.
6. "Developing Enterprise Web Services – An Architect's Guide", Sandeep Chatterjee, James Webber, Pearson, 2nd Edition, 2005.

7. "Web Services: Concepts, Architectures and Applications", Gustavo Alonso, Fabio Casati, Harumi Kuno, Vijay Machiraju, Springer International Edition, 2004.

UC16MC612: MODULE DEVELOPMENT USING NGINX (4-0-0-0-4)

Course Objectives:

- To learn how to allow Dynamic Modules Development
- To learn how to manage server by changing plugins

Course Outcomes:

At the end of the course, the student should be able to

- Develop and Serve static content, Proxy connections to upstream servers and Route connections

Course Content:

1. **Introduction and Installation and Configuration:** Installing NGINX using a package manager, Installing NGINX from source, preparing a build environment, Compiling from source, Configuring for web or mail service, a mail proxy, specify paths, Enabling various modules, Disabling unused modules, Finding and installing third-party modules.
2. **The Basic Configuration:** Format, NGINX global configuration parameters, Global configuration directives, Using include files, The HTTP server section Client directives, HTTP client directives File I/O directives, HTTP file I/O directives, Hash directives, HTTP hash directives, Socket directives, HTTP socket directives, Sample configuration, The virtual server section listen parameters, Locations – where, when, and how, Location modifiers, Location-only directives, The mail server section Mail module directives, Mail SSL directives, Full sample configuration.
3. **Using the Mail Module:** Basic proxy service and POP3 service with IMAP service and SMTP service, Using SSL/TLS Complete mail example, Authentication service, Combining with Memcached, Interpreting log files Operating system limits 4., NGINX as a Reverse Proxy
4. **Introduction to reverse proxying:** The proxy module Legacy servers with cookies, The upstream module Keepalive connections, Load-balancing algorithms, Types of upstream servers, Single upstream server, Multiple upstream servers, Non-HTTP upstream servers, Memcached upstream servers FastCGI upstream servers SCGI upstream servers uWSGI upstream servers Converting an "if"-fy configuration to a more modern interpretation Using error documents to handle upstream problems Determining the client's real IP address
5. **Nginx Web Server Administration:** Server Side Includes directives, Server Side Includes commands, Decision-making in NGINX, Perl module directives, creating a secure link, generating images, Image filter directives, Tracking website visitors, UserID module directives, Preventing inadvertent code execution

Prerequisite Course: None

Reference Books:

1. "Nginx: From Beginner to Pro", Rahul Soni, 1st Edition, APress Publication, 2016.
2. "Mastering NGINX", Dimitri Aivaliotis, 2nd Edition, PACKET Publication, 2016.

UC16MC613: ADVANCED DBMS (4-0-0-0-4)

Course Objectives:

- To provide comprehensive introduction to Database Management Systems from several perspectives.
- To introduce the methods for designing a database, query languages used in modern databases as well as the theoretical query languages these languages are based on.

Course Outcomes:

At the end of the course, the student should be able to

- Correlate relational database theory with relational database management system.
- Apply data modeling concepts and their applications in design and construct a typical enterprise database.

Course Content:

1. **Query Optimization:** Query Execution Algorithms, Heuristics in Query Execution, Cost Estimation in Query Execution, Semantic Query Optimization.
2. **Indexing – Trees & Hashing:** Intuition for Tree Indexes, Indexed Sequential Access Method (ISAM), B+ tree – Search, Insert, Delete, Indexing- Primary, Secondary, Multi-Level; Hash-Based Indexing: Static Hashing, Extendible Hashing, Linear Hashing, Extendible VS Linear Hashing.
3. **Transaction Management and Concurrency Control:** The ACID Properties, Transactions and Schedules, Concurrent Execution of Transactions, Lock-based Concurrency Control, Transaction Support in SQL, Introduction to Crash Recovery; Concurrency Control - 2PL, Serializability and Recoverability, Introduction to Lock Management, Lock Conversions, Dealing with Dead locks, Specialized Lock Techniques.
4. **PL/SQL:** Data Types, Variables, Constants, Operators, Conditions, Iterations, Strings, Arrays, Cursors, Records
5. **PL/SQL-Advanced:** Functions, Procedures, Exception Handling, Triggers, Packages, Transactions, Object Oriented Programming

Prerequisite Course: None

Reference Books:

1. "Fundamentals of Database Management Systems", Ramez Elmasri and Shamkant B. Navathe, Pearson Publications, 5th Edition, 2008.
   (Chapter 15(Pg: 554-Pg: 585))
2. "Database Management Systems", Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill, 3rd Edition, 2003.
   (Chapter 10(Pg: 339-Pg: 356), 11(Pg: 371-Pg: 385), 16 (Pg: 520-Pg: 533, Pg: 535-Pg: 536, Pg: 540-Pg: 543))
3. "Data base System Concepts", Silberschatz, Korth and Sudharshan, Mc-GrawHill, 5th Edition, 2006.
4. "SQL, PL/SQL- The Programming Language of Oracle", Ivan Bayross, BPB Publications, 4th Edition, 2009.
   (Chapter 15(Pg: 322-Pg: 326), 16(Pg: 334-348), 18(Pg: 379-Pg: 397))

UC16MC614: NoSQL2 (4-0-0-0-4)

Course Objectives:

- To provide comprehensive introduction to NoSQL from several perspectives.
- To introduce the methods for designing a database, query languages used in document based databases.

Course Outcomes:

At the end of the course, the student should be able to

- Differentiate NoSQL with SQL.
- Apply data modeling concepts and their applications in design and construct a typical enterprise large database.

Course Content:

1. **Introduction to Cassandra:** Cassandra – Introduction, Architecture, Data Model, Installation
2. **Cassandra – cqlsh, Shell Commands:** Using Cassandra shell – start the shell, execute commands – data shell commands, data definition commands, data manipulation commands, clauses
3. **Cassandra – Keyspace, Table, CRUD Operations:** Creating keyspace, Replication, Using keyspace, Alter keyspace, Delete keyspace, create table. Alter table, drop table, truncate table, create index, drop index, batch
4. **Cassandra – CRUD Operations, Datatypes:** Create, Update, Read, Delete Data, CQL Datatypes, CQL Collections, User defined Datatypes
5. **Python with Cassandra:** Python Driver, Making a Connection with Cassandra, Getting database and collection, Insert, Update, Delete, Replace, Querying one and more than one document, Range Queries Data Aggregation

Prerequisite Course: None

References:

1. http://cassandra.apache.org/
2. http://www.tutorialspoint.com/cassandra/
3. "Learning Apache Cassandra", Sandeep Yarabarla, Packt, 2nd Edition, 2017.

UC16MC615:
NETWORK MANAGEMENT (4-0-0-0-4)

Course Objectives:

- To understand general concepts and architecture in Network Management and SNMP.
- To understand the features of SNMP protocol and the major changes in different versions of the protocol.
- To introduce the MPLS technology and applications of Network Management.

Course Outcomes:

At the end of the course, the student should be able to

- Analyze the need for security in network monitoring and control.
- Configure basic network management system on a network and manage the network using basic tools.

Course Content:

1. **Network Management Overview:** Data and Telecommunication Network, Distributed Computing Environment, TCP/IP based Network, Communication Protocols Standards, Networks Systems and Services, Network Management Goals, Organization and Functions, Network Management Architecture and Organization, Network Management Perspectives, NMS Platform.
2. **Basic Foundation of Network Management and SNMPv1:** Network Management Standards, Network Management Models, Organizational Model, Information Model, Communication Model. Abstract Syntax Notation One: ASN.1, Encoding Structure, Macros, SNMPV1, SNMP Model, Organization Model, System Overview, SMI and MIB, SNMP Communication Model, Functional Model.
3. **SNMPv2 and SNMPv3:** SNMPv2 System Architecture, SNMPv2 structure of Management information, SNMPv3 Key features, Architecture, SNMPv3 Applications, Security, SNMPv3 User Based Security Model, Access Control.
4. **Network Management Tools, Systems and MPLS:** System Utilities for Management, Network Statistics Measurement Systems, MIB Engineering, MPLS Network Technology, MPLS OAM Management.
5. **Network Management Applications:** Configuration Management, Fault Management, Performance Management, Event Correlation Techniques, Security Management, Accounting Management, Report Management, Policy Based management, Service Level Management.

Prerequisite Course: None

Reference Books:

1. "Network Management Principles and Practice", Mani Subramanian, 2nd Edition, Pearson Publication, 2012.
   (Chapter 1(Pg. 3 – 47); 3(Pg. 95 – 123), 4(Pg. 128-163), 5(Pg. 184 – 203); 6(Pg. 206 – 231), 7(Pg. 254 – 278); 9(Pg. 308 – 324), 12(Pg. 477 – 486); 10(Pg. 401 – 444))
2. "Internetworking with TCP/IP, Principles, Protocols, and Architectures", Comer, Douglas M., Volume 1, 4th Edition, Prentice Hall, 2000.
3. "Network Management: Concepts and Practice, A Hands-on Approach", Bourke, Richard J., Pearson Education, Inc., 2004.
4. "Network Management Fundamentals", Clemn, A., Cisco Press, 2007.

UC16MC616:
STORAGE AREA NETWORKS (4-0-0-0-4)

Course Objectives:

- To offer guidance on Storage Area Networks.
- To understand the working of Storage Management, Security, Types of Storage, Backup and Recovery.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the benefits of Storage Area and its advantages.
- Understand the impact of SAN on business dependent on IT infrastructure.

Course Content:

1. **Introduction to Information Storage and Management, Storage System Environment:** Information Storage, Evolution of Storage Technology and Architecture, Data Center Infrastructure, Key Challenges in Managing Information, Information Lifecycle Components of Storage System Environment, Disk Drive Components, Disk Drive Performance, Fundamental Laws Governing Disk Performance, Logical Components of the Host, Application Requirements and Disk Performance; Data Protection, Intelligent Storage system - Implementation of RAID, RAID Array Components, RAID Levels, RAID Comparison, RAID Impact on Disk Performance, Hot Spares Components of an Intelligent Storage System, Intelligent Storage Array
2. **Direct-Attached Storage, SCSI, and Storage Area Networks:** Types of DAS, DAS Benefits and Limitations, Disk Drive Interfaces, Introduction to Parallel SCSI, Overview of Fibre Channel, The SAN and Its Evolution, Components of SAN, FC Connectivity, Fibre Channel Ports, Fibre Channel Architecture, Zoning, Fibre Channel Login Types, FC Topologies; NAS, IP SAN - General – Purpose Service vs. NAS Devices, Benefits of NAS, NAS File I / O, Components of NAS, NAS Implementations, NAS File-Sharing Protocols, NAS I/O Operations, Factors Affecting NAS Performance and Availability. iSCSI, FCIP.
3. **Content-Addressed Storage, Storage Virtualization:** Fixed Content and Archives, Types of Archive, Features and Benefits of CAS, CAS Architecture, Object Storage and Retrieval in CAS, CAS Examples. Forms of Virtualization, SNIA Storage Virtualization Taxonomy, Storage Virtualizations Configurations, Storage Virtualization Challenges, Types of Storage Virtualization; Business Continuity, Backup and Recovery - Information Availability, BC Terminology, BC Planning Lifecycle, Failure Analysis, Business Impact Analysis, BC Technology Solutions. Backup Purpose, Backup Considerations, Backup Granularity,

Recovery Considerations, Backup Methods, Backup Process, Backup and restore Operations, Backup Topologies, Backup in NAS Environments, Backup Technologies.

4. **Local Replication, Remote Replication:** Source and Target, Uses of Local Replicas, Data Consistency, Local Replication Technologies, Restore and Restart Considerations, Creating Multiple Replicas, Management Interface, Modes of Remote Replication, Remote Replication Technologies, Network Infrastructure.
5. **Securing the Storage Infrastructure, Managing the Storage Infrastructure:** Storage Security Framework, Risk Triad, Storage Security Domains, Security Implementations in Storage Networking Monitoring the Storage Infrastructure, Storage Management Activities, Storage Infrastructure Management Challenges, Developing an Ideal Solution.

Prerequisite Course: None

Reference Books:

1. "Information Storage and Management", G. Somasundaram, Alok Shrivastava (Editors), EMC Education Services, Wiley- India, 2009.
   (Chapter :1,2,3 & 4 (Pg. 3 – 72); 2 (Pg. 40-43), 5 (Pg. 95 – 118); 8: (Pg. 187 – 189), 5 (Pg. 122-124), 9 (Pg. 202 – 213), 10 (Pg. 226 – 242); 11 (Pg. 263 – 284); 14 (Pg. 333 – 346), 15 (Pg. 366 – 386)
2. "Storage Networks Explained", Ulf Troppens, Rainer Erkens and Wolfgang Muller, Wiley India, 2003.
3. "Storage Networks - The Complete Reference", Rebert Spalding, Tata McGraw Hill, 2003.
4. "Storage Area Networks Essentials A Complete Guide to Understanding and Implementing SANs", Richard Barker and Paul Massiglia, Wiley India, 2002.

UC16MC621:
WEB CONTENT MANAGEMENT (4-0-0-0-4)

Course Objectives:

- To understand and explore methods, tools and applications for content management.
- To understand the knowledge cycle: acquisition, storing, application and maintenance
- To understand key terms about semantic web, knowledge management and content management

Course Outcomes:

At the end of the course, the student should be able to

- Create projects using CMS learning tools like Wordpress and Moodle.
- Understand the role of content management technologies to acquire, organize and present web content.

Course Content:

1. **Content Management System:** Understanding Content Management - Definition, CM is Distributing Business Value, a Balance of Organizational Forces, the Combination of Content-Related Disciplines, Collection, Management, and Publishing, a Computer Infrastructure, The Content Management Industry, CMS overview, The Collection system, The Management System, The Publishing System
2. **Joomla:** Installing Joomla, Exploring the Admin Interface, Content creation using the CAM model, Content customization: images, video, audio, tags, formats, etc., Adding and displaying menus, Linking menus to articles and other feature, Finding and adding Joomla extensions, Must have extensions for any Joomla site, Adding and setting up 2 "big" extensions (choose blog, calendar, image gallery, Paypal-based shopping cart, or portfolio. Other extensions on approval) Creating customized Joomla templates, Modifying Joomla CSS and HTML parameters, Tweaking the Joomla backend, Mobile considerations**, User management and permissions**
3. **Basics of Wordpress:** What Is WordPress? WordPress.com vs. WordPress.org, WordPress Login, Exploring the WordPress Dashboard, Using the WordPress Admin Bar, Exploring WordPress Settings, WordPress Posts vs. Pages, Creating a WordPress Post, Adding Links in WordPress, Adding Images to Posts & Pages, Using the WordPress Media Library, WordPress Posts, Scheduling WordPress Posts, WordPress Categories & Tags, Creating a WordPress Page, Applying a WordPress Page Template
4. **Expertise in Wordpress:** What are WordPress Plugins? Installing WordPress Plugins, Install a WordPress Theme, Using WordPress Widgets, Creating a Custom Menu in WordPress, Managing Comments in WordPress, Creating Users in WordPress, Search Engine Optimization (SEO) & WordPress, WordPress Security, Building own plugins, Uploading and fetching new pluging
5. **Moodle:** Copyright and Licensing, Creating a new course, Course page and Blocks, Working with Text Editor, Label resource, Folder Resource, Book Resource, URL Resource, Assignment activity, Chat activity, Choice activity, Forum activity, Quiz Activity, Activity Log and Reports, Backup and restore a course.

Prerequisite Course: None

Reference Books:

1. "Content Management Bible", Bob Boiko, Willy Publishing, 2nd Edition, 2005.
   (Chapter 6 (Pg. 65-84), 7 (Pg. 85-112))
2. "Getting Started with Wordpress", iThems Media, 2015.
   ((Pg. 6-50); (Pg. 51-99))
3. "How to Moodle Manual", Course Creator Essential, 2015.
   ((Pg. 1 – 57), (Pg. 61 – 99, 122 -149, 156 – 161))

UC16MC622:
MODULE DEVELOPMENT USING APACHE (3-0-0-0-3)

Course Objectives:

- To provide comprehensive introduction to write Apache modules for different purposes.
- To understand the Apache architecture and API working environment.

Course Outcomes:

At the end of the course, the student should be able to

- Develop C and Perl modules which run on Apache Webserver.
- Develop the Apache modules for Apache webserver on which developers are working

Course Content:

1. **Applications Development with Apache:** A brief history of Apache Web Server, Apache Software Foundation, The Apache Development Process, Apache and Intellectual Property, Interactive Online Forums, Conferences, Websites.
2. **The Apache Platform Architecture:** Overview, Two-Phase Operation: Start-up Phase, Operational-Phase, Shutdown, Multi-Processing modules: Why MPMs, The Unix-Family MPMs, Working with MPMs and Operating Systems, Basic Concepts and Structures, Apache Configuration Basics, Request Processing in Apache.
3. **Programming Techniques and Caveats:** Apache Coding Conventions, Managing Module Data, Communication Between Modules, Thread-Safe Programming issues, Managing Persistent Data, Cross-Platform Programming Issues, Cross-MPM Programming Issues, Secure Programming Issues.

4. **Writing a Content Generator:** The Hello World Module: The Module skeleton, return values, The Handler Field, The Complete Module, Using the request_rec object, The Request, the Response and the Environment: Module I/O, Reading Form Data, The Default Handler.
5. **Request Processing Cycle and Meta Handlers:** HTTP: The HTTP Protocol, Anatomy of a HTTP Request, Request Processing in Apache, Diverting a Request: The Internal Redirect, Gathering Information: Sub-requests, Developing a Module.

Prerequisite Course: None

Reference Books:

1. "The Apache Modules Book: Application Development with Apache", Nick Kew, Prentice Hall Publications, 1st Edition, 2015.
   (Chapter 1 (Pg. 1- 19); 2 (Pg. 21 - 51); 4 (Pg. 85 - 122); 5(Pg. 124 - 148); 6(Pg. 151 - 174))

UC16MC623: MACHINE LEARNING (4-0-0-0-4)

Course Objectives:

- Understand the basics underlying machine learning.
- Understand a range of machine learning algorithms along with their strengths and weaknesses.

Course Outcomes:

At the end of the course, the student will be able to

- Formulate machine learning problems corresponding to different applications.
- Apply machine learning algorithms to solve problems of varied complexity.

Course Content:

1. **Machine Learning:** Understanding the evolution, Probability and Statistics, Machine Learning Process Flow. Machine Learning Types, Groups of machine learning algorithms, Real world datasets.
2. **Support Vector Machines & Decision Trees:** Regression Analysis, Correlation Analysis, Support Vector Machines: Linear SVM, Binary SVM, Multi-Class SVM; Decision Trees - Types of Decision Trees, Decision measures, Decision Tree Learning Methods, Ensemble Trees.
3. **Artificial Neural Networks:** Human cognitive learning, perceptron, sigmoid neuron, NN architecture, supervised Vs Unsupervised Neural Nets, Neural Network Learning Algorithms, Feed forward back propagation, Deep Learning
4. **Text Mining:** Introduction, Text Summarization, TF-IDF, POS tagging, Word cloud, Text Analysis.
5. **Model Evaluation:** Introduction, objectives, population stability index, model evaluation for continuous output, model evaluation for discrete output, probabilistic techniques, kappa error metric.

Prerequisite Course: None

Reference Books:

1. "Machine Learning using R", Karthik Ramasubramaniam, Abhishek Singh, Apress Publishing, 2017.
   (Chapter1(1.1, 1.2, 1.4), 6(6.1-6.3, 6.6, 6.7, 6.11, 6.12); 7(7.2-7.8)
2. "Introduction to Data Mining", Pang-Ning Tan, Vipin Kumar, Michael Steinbach, Pearson Publication, 1st Impression, 2012.
3. "Introduction to Data Mining with Case Studies", G. K. Gupta, PHI, 3rd Edition, 2014.
4. "Machine Learning with R", Brett Lantz, Packt Publishing, 2013.

UC16MC624: INFORMATION RETRIEVAL (4-0-0-0-4)

Course Objectives:

- To learn basics of data representation, storage, organization and access to data and information retrieval.
- To learn different retrieval algorithms and its taxonomy
- To equip with sound skills to solve computational search problems

Course Outcomes:

After this course, the student will be able to

- Evaluate information retrieval algorithms and account on difficulties in evaluation
- Apply the concept of indexing, vocabulary, normalization and dictionary in information retrieval

Course Content:

1. **Boolean retrieval:** An example information retrieval problem, A first take at building an inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval; The term vocabulary and postings lists - Document delineation and character sequence decoding, determining the vocabulary of terms, faster postings list intersection via skip pointers, Positional postings and phrase queries.
2. **Dictionaries and tolerant retrieval:** Search structures for dictionaries, Wildcard queries, Spelling correction, Phonetic correction; Index construction - Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing with implementation of Indexing.
3. **Index compression:** Statistical properties of terms in information retrieval, Dictionary compression; Scoring, term weighting and the vector space model: Parametric and zone indexes, Term frequency and weighting, vector space model for scoring.
4. **Text classification and Naive Bayes:** The text classification problem, Naive Bayes text classification, The Bernoulli model, Properties of Naive Bayes, Feature selection- Mutual information, X^2 Feature selection, Frequency-based feature selection hands-on for Naive Bayes classifier; Vector space classification - Document representations and measures of relatedness in vector spaces, Rocchio classification, k nearest neighbor-Time complexity and optimality of K-n; Support vector machines and machine learning on document - Support vector machines: The linearly separable case, Implementation of SVM with a case study.
5. **Web search basics:** Background and history, Web characteristics, Advertising as the economic model, The search user experience, Index size and estimation, Near-duplicates and shingling, References and further reading; Web crawling and indexes - Overview, Crawling, Distributing indexes, Connectivity servers, References and further reading. Hands-on crawlers.

Prerequisite Course: None

Reference Books:

1. "An Introduction to Information Retrieval", Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, Cambridge University Press, 2009.
   (Chapter 1(1.1 - 1.5), 2(2.1 - 2.4.3); 3 (3.1 - 3.4), 4(4.1 - 4.4); 5 (5.1 - 5.2.2), 6(6.1 - 6.3.3); 13(13.1 – 13.5.3), 14(14.1 – 14.3.1), 15(15.1); 19(19.1 – 19.7), 20(20.1 - 20.5))
2. "Modern Information Retrieval", Recardo Baeza-Yates and Berthier Ribeiro-Neto, Pearson Education, 4th Impression, 2009.
3. http://www.dcs.gla.ac.uk/Keith/Preface.html

UC16MC625: MOBILE COMPUTING (4-0-0-0-4)

Course Objectives:

- To introduce various technologies that form the foundation of mobile computing
- To understand how mobile computing help businesses to use information in an effective way
- To understand the security issues in mobile computing

Course Outcomes:

At the end of the course, the student should be able to

- Understand the service aspects of mobile applications which could be able to provide information anywhere, anytime and over any device.
- Understand the working of mobile communication technologies

Course Content:

1. **Introduction and Architecture of Mobile Computing:** Introduction to Mobile Computing, Dialogue Control, Networks, Middleware and Gateways, Application and Services, Developing Mobile Computing Applications, Security in Mobile Computing, Standards and Standards Bodies; History of Internet, Internet the Ubiquitous Network, Architecture for Mobile Computing, Three Tier Architecture, Design Considerations for Mobile Computing, Mobile Computing through Internet, Making Existing Applications Mobile Enabled.
2. **GSM, SMS and GPRS:** GSM Architecture and Entities, Call Routing in GSM, PLMN Interfaces, GSM Addresses and Identifiers, Network Aspects in GSM, Mobility Management, GSM Frequency Allocation; Mobile Computing over SMS, Short Message Service, Value Added Services Through SMS; GPRS – Introduction, GPRS & Packet Data Networks, GPRS Architecture and Operations, Data Services in GPRS, Applications and Limitations of GPRS, Billing and Charging in GPRS.
3. **Mobile Technologies – CDMA and 3G, BLUETOOTH, RFID and WiMAX:** CDMA and 3G – Introduction, Spread Spectrum Technology, IS-95, CDMA versus GSM, Wireless Data, Third Generation Networks, Applications on 3G; Bluetooth, RFID and WiMAX technologies.
4. **Mobile Client:** Client programming – Introduction, Moving beyond the Desktop, Mobile Phones – overview, features, PDA, Design Considerations for handheld devices; Mobile IP – working, Discovery, Registration, Tunneling, Cellular IP, Mobile IP with IPv6.
5. **Security Issues in Mobile Computing:** Introduction, Information Security, Security Techniques and Algorithms, security Protocols, Public Key Infrastructure, Trust, Security Models, Security Frameworks for Mobile Environments.

Prerequisite Course: None

Reference Books:

1. "Mobile Computing – Technology, Applications and Service Creation", Asoke Talukder, Hasan Ahmed and Roopa R Yavagal, 2nd Edition, Mc Graw Hill, 2017.

   (Chapter 1 (1.3 - 1.11), 2 (2.2 - 2.8); 5 (5.1 – 5.9), 6 (6.1 – 6.3), 7 (7.1 – 7.8); 9, 4 (4.1 – 4.4); 12 (12.1 – 12.7), 4 (4.5); 20)
2. "Mobile and Wireless Design Essentials", Martyn Mallick, Willy India, 2003.
3. "Wireless Communications and Networks, 3G and Beyond", Iti Saha Misra, Tata McGraw-Hill, 2009
4. "Mobile Computing", Raj Kamal, Oxford University Press, 2007.

UC16MC626: IOT APPLICATIONS DEVELOPMENT (2-0-2-4-4)

Course Objectives:

- To develop an understanding of IoT Technology and Cyber-Physical systems.
- To explore the vast spectrum of IoT Applications and gain an appreciation of the building blocks of IoT.

Course Outcomes:

At the end of the course, the student should be able to

- Identify issues and design challenges in IoT Applications
- Select appropriate hardware and software components for IoT Applications

Course Contents:

1. **Introduction to IoT:** Introduction to Internet of Things (IoT), IoT enabling technologies and IoT levels**,** Domain specific applications of IoT, Network Services, Cloud.
2. **IoT & M2M:** IoT and M2M, IoT platforms design methodology, Introduction to IoT Network (SDN, N/w Function Virtualisation), and Cloud Services, Basics of IOT System Management.
3. **IoT Physical Devices & Endpoints:** Introduction to IoT Physical End-points and Platforms, Familiarity with Aurdino, Familiarity with Raspberry Pi, Raspberry Pi Architecture, OS & Programming, Raspberry Pi I/O Interfaces, Communication interfaces.
4. **Python Programming with Raspberry Pi:** Python Programming with Raspberry Pi, Working with Sensors, Working with Aurdino, Case study on Home Intrusion Detection, IoT with Cloud
5. **IoT Cloud Offerings:** IoT Physical Servers & Cloud Offerings, Cloud Storage models and Communication API's, Web Server for IoT, Python Web Application Framework (Django), Designing a RESTful web API, IoT Application Case Study.

Prerequisite Course: None

Reference Books:

1. "Internet of Things: A Hands-on Approach", Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015

   (Chapter 1 (Pg. 19 – 44), 2 (Pg. 47 – 62); 3 (Pg. 65 – 73), 4 (Pg. 79 – 91); 7 (Pg. 153 – 168); 9 (Pg. 171 – 188, 217 – 278))
2. "Programming the RaspberryPi: Getting Started with Python", Simon Monk, McGrawHill, 2nd Edition, 2017
3. http://forefront.io/a/beginners-guide-to-arduino
4. https://www.arduino.cc/en/Tutorial/HomePage

UC16MC651: PROJECT MANAGEMENT AND REPORT WRITING (2-0-0-0-2)

Course Objectives:

- To understand about the fundamental principles of software project management like planning, organizing, evaluation and cost estimation
- To inculcate the art of report writing and project documentation skills

Course Outcomes:

At the end of the course, the student should be able to

- Develop increased awareness in Project Scheduling, tracking, Risk analysis and Project Cost Estimation
- Understand the Report writing techniques and standards

Course Content:

1. **Software Project Management Framework:** Why is Software Project Management important?, What is a Project, Software Projects versus other types of Projects, Contract Management and Technical Project Management, Activities covered by Software Project Management; An Overview of Project Planning (Step-wise Approach) - Introduction to Step-wise Project Planning, Step 0: Select Project, Step 1: Identify Project Scope and Objectives, Step 2: Identify Project Infrastructure, Step 3: Analyze Project Characteristics, Step 4: Identify Project Products and activities, Step 5: Estimate Effort for each activity, Step 6: Identify activity risks, Step 7: Allocate Resources, Step 8: Review/ Publicize Plan, Step 9 and 10: Execute Plan/Lower-levels of Planning; Project Evaluation - Introduction, Business Case, Project Portfolio Management, Evaluation of Individual Projects, Cost benefit evaluation techniques – Risk evaluation.
2. **Activity Planning:** Introduction, The Objectives of Activity Planning, When to plan, Project Schedules, Projects and activities, Sequencing and Scheduling activities, Network Planning Models, Formulating the Network Model, Adding the time dimensions, The Forward Pass, The Backward Pass, Identifying the Critical Path, Activity Float, Shortening the Project Duration, Identifying the critical activities, Activity-on-Arrow Networks
3. **Managing People and Organizing Teams:** Introduction, Understanding behavior, Organizational behaviour: A background, Selecting the right person for the job, Instruction in the best methods – Motivation – The Oldman – Hackman job characteristics model, Working in groups, Becoming a team, Decision making, Leadership, organizational structures, Stress, Health and safety.
4. **Monitoring and Control:** Introduction, Creating the framework, Collecting the data, Visualizing Progress, Cost Monitoring, Earned Value, Prioritizing monitoring, Getting project back to target, Change control.
5. **Report Writing:** Understanding the context of the project, Avoiding unnecessary reporting, Why Report, How much detail to include, Format of Reports, Doing the Report, Reporting Style, Plagiarism and Referencing, Ordering and Content, Accreditation, Final Year Project Reporting Guidelines.

Prerequisite Course: None

Reference Books:

1. Bob Hughes, Mike Coterell and Rajib Mall, Software Project Management, TMH, 5th Edition, 2011.
   (Chapter 1 (1.1 – 1.6), 2 (2.1 – 2.6) 3 (3.1 – 3.11); 6 (6.1 – 6.16); 11(11.1 – 11.14), 12 (12.1 -2.4, 12.9); 9 (9.1-9.11))
2. http://www.cs.bham.ac.uk/~pxc/proj/ProjectReport.pdf
3. https://newton.ex.ac.uk/handbook/PHY/forms/WLB010919-4.pdf
4. Guidelines for preparation of thesis / dissertations / reports, University of Mumbai, 2009.

FACULTY OF MANAGEMENT, ECONOMICS & COMMERCE

SCHEME OF INSTRUCTION

Programs of Study: BBA, BBA-HEM, MBA

Sl. No.	Course Type
1.	Preliminary (PC)
2.	Foundation (FC)
3.	Core (CC)
4.	Elective (EC)
5.	Project / Self learning / Seminar / Internship (PW)
6.	Non credit (NC) (All non credit courses are mandatory)

STRUCTURE OF CURRICULUM

UG PROGRAMS

BACHELOR OF BUSINESS ADMINISTRATION (BBA)

I SEMESTER (2018 – 2021 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UM18BB101	Communication for Managers	3	0	0	0	3	PC
2	Language (Any one of the options listed below)							
	UM18BB102	Kannada	3	0	0	0	3	PC
	UM18BB103	Hindi	3	0	0	0	3	PC
	UM18BB104	Sanskrit	3	0	0	0	3	PC
	UM18BB105	English	3	0	0	0	3	PC
	UM18BB106	French	3	0	0	0	3	PC
3	UM18BB107	Fundamentals of Accounting	3	0	0	0	3	FC
4	UM18BB108	Quantitative Methods for Business - I	4	0	0	0	4	FC
5	UM18BB109	Organizational Behaviour	3	0	0	0	3	FC
6	UM18BB110	Management Theory & Practice	3	0	0	0	3	FC
7.	UM18BB111	English Language Lab	0	0	2	0	1	PC
8	UM18BB112	Accounts Lab – 1	0	0	2	0	1	FC
9	UM18BB113	German Language Level -1	0	0	0	0	0	NC
10	UM18BB114	Communicative Kannada - 1	0	0	0	0	0	NC
11	UM18BB115	Kannada Kali – 1	0	0	0	0	0	NC
12	UM18BB116	Kannada Manasu - 1	0	0	0	0	0	NC
		TOTAL	**19**	**0**	**4**	**0**	**21**	

II SEMESTER (2018 – 2021 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UM18BB151	Business Economics	3	0	0	0	3	FC
2	UM18BB152	Quantitative Methods for Business - II	4	0	0	0	4	FC
3	UM18BB153	Digital Transformation Strategy	3	0	0	0	3	FC
4	UM18BB154	Corporate Accounting	3	0	0	0	3	CC
5	UM18BB155	Production & Operations Management	3	0	0	0	3	CC
6	UM18BB156	Marketing Management	3	0	0	0	3	CC
7	UM18BB157	Computer Lab	0	0	2	0	1	PC
8	UM18BB158	Accounts Lab - 2	0	0	2	0	1	FC
9	UM18BB159	German Language Level -2	0	0	0	0	0	NC
10	UM18BB160	Communicative Kannada - 2	0	0	0	0	0	NC
11	UM18BB161	Kannada Kali – 2	0	0	0	0	0	NC
12	UM18BB162	Kannada Manasu - 2	0	0	0	0	0	NC
		TOTAL	**19**	**0**	**4**	**0**	**21**	

III SEMESTER (2017- 2020 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UM17BB201	International Business	3	0	0	0	3	FC
2	UM17BB202	Entrepreneurship Development	4	0	0	0	4	CC
3	UM17BB203	Cost Accounting	4	0	0	0	4	CC
4	UM17BB204	Management of Human Capital	3	0	0	0	3	FC
5	UM17BB205	Financial Management	3	0	0	0	3	CC
6	UM17BB206	Business Regulations	4	0	0	0	4	CC
7	UM17BB207	HCM Lab	0	0	2	0	1	PC
8	UM17BB208	FM Lab	0	0	2	0	1	FC
9	UM17BB209	German Language Level -3	0	0	0	0	0	AC
10	UE17HS101	Constitution of India & Professional Ethics	0	0	0	0	0	NC
11	UM17BB210	Communicative Kannada - 3	0	0	0	0	0	NC
12	UM17BB211	Kannada Kali – 3	0	0	0	0	0	NC
13	UM17BB212	Kannada Manasu - 3	0	0	0	0	0	NC
		TOTAL	**21**	**0**	**4**	**0**	**23**	

IV SEMESTER (2017- 2020 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
	General Management							
1	UM17BB251	Taxation - 1	4	0	0	0	4	CC
2	UM17BB252	Digital Marketing	3	0	0	0	3	CC
3	UM17BB253	Project Management	3	0	0	0	3	CC
4	UM17BB254	Supply Chain Management	3	0	0	0	3	
5	UM17BB255	DM Lab	0	0	2	0	1	PC
6	UM17BB256	PM Lab	0	0	2	0	1	FC
7	UM17BB257	German Language Level -3	0	0	0	0	0	AC
8	UM17BB273	Communicative Kannada - 4	0	0	0	0	0	NC
9	UM17BB274	Kannada Kali – 4	0	0	0	0	0	NC
10	UM17BB275	Kannada Manasu - 4	0	0	0	0	0	NC
11	UE17HS102	Environmental Studies	0	0	0	0	0	NC
	Marketing Specialization (Any two)							
12	UM17BB258	Sales Management	4	0	0	0	4	EC
13	UM17BB259	Consumer Behaviour	4	0	0	0	4	EC
14	UM17BB260	Brand Management	4	0	0	0	4	EC
	Finance Specialization (Any two)							
15	UM17BB261	Financial Markets & Institutions	4	0	0	0	4	EC
16	UM17BB262	Investment & Portfolio Management	4	0	0	0	4	EC
17	UM17BB263	Strategic Financial Management	4	0	0	0	4	EC
	HCM Specialization (Any two)							
18	UM17BB264	Innovations in HR practice	4	0	0	0	4	EC
19	UM17BB265	Strategic HCM	4	0	0	0	4	EC
20	UM17BB266	Organisational Change & Development	4	0	0	0	4	EC
	IB Specialization (Any two)							
21	UM17BB267	Foreign Trade Policy	4	0	0	0	4	EC
22	UM17BB268	Global Business Environment	4	0	0	0	4	EC
23	UM17BB269	Global Marketing	4	0	0	0	4	EC
	Family Business & EDP Specialization (Any two)							
24	UM17BB270	Essentials of Family Business Mgmt	4	0	0	0	4	EC
25	UM17BB271	Managing Innovations	4	0	0	0	4	EC
26	UM17BB272	Social Entrepreneurship & Management	4	0	0	0	0	EC
		TOTAL	**21**	**0**	**4**	**0**	**23**	

V SEMESTER (2016-19 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
	General Management							
1.	UM16BB301	Research Methods	3	1	0	0	4	FC
2.	UM16BB302	Business Information System	3	1	0	0	4	FC
3.	UM16BB303	Advance Spread Sheet Practical	0	0	2	0	1	FC
4.	UM16BB304	Visual Communication Practical	0	0	2	0	1	CC
5.	UM16BB305	German Language Level – 4	0	0	0	0	0	AC
	Marketing Management							
6.	UM16BB306	Advertising & Media Management	2	1	0	0	3	CC
7.	UM16BB307	Retail Management	2	1	0	0	3	EC
	UM16BB308	Supply Chain Management	2	1	0	0	3	EC
	International Business Management							
8.	UM16BB309	International Logistics Management	3	1	0	0	4	CC
9.	UM16BB310	Global Business Environment	3	1	0	0	4	EC
	UM16BB311	Global HCM	3	1	0	0	4	EC
	Finance							
10.	UM16BB312	Business Taxation	3	1	0	0	4	CC
11.	UM16BB313	Financial Derivatives & Commodities	3	1	0	0	4	EC
	UM16BB314	Bank Management	3	1	0	0	4	EC
	Human Capital Management							
12.	UM16BB315	Management of Employee Relations	3	1	0	0	4	CC
13.	UM16BB316	Labour Laws	3	1	0	0	4	EC
	UM16BB317	Strategic Human Capital Management	3	1	0	0	4	EC
		TOTAL	**16**	**6**	**4**	**0**	**24**	

VI SEMESTER (2016-19 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1.	UM16BB351	E-Commerce	2	0	0	0	2	CC
2.	UM16BB352	Society and Value System	2	0	0	0	2	CC
3.	UM16BB353	Project Work	0	0	8	16	8	PW
		TOTAL	**4**	**0**	**8**	**16**	**12**	

BACHELOR OF BUSINESS ADMINISTRATION – HOSPITALITY AND EVENT MANAGEMENT (BBA-HEM)

I SEMESTER (2018 - 21 Batch)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	**Language(Anyone of the options listed below)**							
	UM18BH101	Hindi	2	0	0	0	2	PC
	UM18BH102	English	2	0	0	0	2	PC
2	UM18BH103	**French (or)**	2	0	0	0	2	PC
	UM18BH104	**German**	2	0	0	0	2	PC
3	UM18BH105	Fundamentals of Culinary arts	2	1	0	0	3	FC
4	UM18BH106	Fundamentals of Food and Beverage Service	3	0	0	0	3	FC
5	UM18BH107	Fundamentals of Front office	3	0	0	0	3	FC
6	UM18BH108	Fundamentals of Accommodation Operations	3	0	0	0	3	FC
7	UM18BH109	Fundamentals of Events operations	2	0	0	0	2	FC
8	UM18BH110	Fundamentals Of Culinary Arts Practical	0	0	4	0	2	FC
9	UM18BH111	Fundamentals Of Food And Beverage Service Practical	0	0	2	0	1	FC
10	UM18BH112	Fundamentals Of Front Office Practical	0	0	2	0	1	FC
11	UM18BH113	Fundamentals Of Accommodation Operations Practical	0	0	2	0	1	FC
12	UM18BH114	Fundamentals Of Events Practical	0	0	2	0	1	FC
13	UE18HS101	Constitution Of India & Professional Ethics	0	0	0	0	0	NC
		TOTAL	**18**		**12**	**0**	**24**	
*1 hour of tutorial will be done in the regular class								

II SEMESTER (2018 - 21 Batch)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UM18BH151	Hospitality Accounting	2	1	0	0	3	FC
2	UM18BH152	Patisserie And Confectionery	3	0	0	0	3	FC
3	UM18BH153	Beverage, Brew & Wine Studies	3	0	0	0	3	FC
4	UM18BH154	Accommodation Operations	3	0	0	0	3	FC
5	UM18BH155	Event Operations	3	0	0	0	3	FC
6	UM18BH156	Management Of Services	3	0	0	0	3	FC
7	UM18BH157	Patisserie And Confectionery – Practical	0	0	4	0	2	FC
8	UM18BH158	Beverage, Brew And Wine Studies - Practical	0	0	2	0	1	FC
9	UM18BH159	Front Office Operations (Ids) - Practical	0	0	2	0	1	FC
10	UM18BH160	Accommodation Operations - Practical	0	0	2	0	1	FC
11	UM18BH161	Event Operations Practical	0	0	2	0	1	FC
12	UE18HS102	Environmental Studies	0	0	0	0	0	NC
		TOTAL	**17**	**1**	**12**	**0**	**24**	
*1 hour of tutorial will be done in the regular class								

III SEMESTER (2017 – 20 Batch)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1.	UM17BH201	Industry Exposure Training – Hospitality Industry	0	0	0	54	12	PW
		TOTAL	**0**	**0**	**0**	**54**	**12**	

IV SEMESTER (2017-20 Batch)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UM17BH251	Food Culture & Sustainability	3	0	0	0	3	CC
2	UM17BH252	Distilled Beverages	3	0	0	0	3	CC
3	UM17BH253	Front Office Management	3	0	0	0	3	CC
4	UM17BH254	Accommodations Aesthetics	2	1	0	0	3	CC
5	UM17BH255	Event Management	3	0	0	0	3	CC
6	UM17BH256	Research Methodology	4	0	0	0	4	CC
7	UM17BH257	Event Management Practical	0	0	2	0	1	CC
8	**Elective – I**							
	UM17BH258	Culinary Operations Practical	0	0	4	0	2	EC
	UM17BH259	Distilled Beverages Practical	0	0	4	0	2	EC
	UM17BH260	Front Office Management Practical	0	0	4	0	2	EC
	UM17BH261	Accommodation Aesthetics Practical	0	0	4	0	2	EC
		TOTAL	**18**	**1**	**6**	**0**	**22**	
* 1 hour of tutorial will be done in the regular class								

Summer Term (2017-20 Batch)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
	UM17BH262	Event Internship	0	0	0	54	8	PW
		TOTAL	**0**	**0**	**0**	**54**	**8**	

V SEMESTER (2016-19)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UM16BH301	Culinary Operations – II*	3	0	0	0	3	CC
2	UM16BH302	Food & Beverage Management**	4	0	0	0	4	CC
3	UM16BH303	Front Office Management #	2	1*	0	0	3	CC
4	UM16BH304	Event Management$	3	0	0	0	3	CC
5	**Elective**							
	UM16BH305	Management of services	3	0	0	0	3	EC
	UM16BH306	International Hospitality Management	3	0	0	0	3	EC
6	UM16BH307	Culinary Operations – II - Practical	0	0	4	0	2	CC
7	UM16BH308	Food & Beverage Management - Practical	0	0	4	0	2	CC
8	UM16BH309	Rooms Division Management Practical	0	0	4	0	2	CC
		TOTAL	**17**	**0**	**12**	**0**	**22**	
Note: Prerequisite course - *UM16BH251; **UM16BH252; # UM16BH253; $UM16BH255 ***1 Hour of tutorial will be done in the regular class**								

VI SEMESTER (2016-19 Batch)

Sl. No.	Course Code	Course Title	Hours / week L	T	P	S	Credits	Course Type
1	UM16BH351	Entrepreneurship Development	3	0	0	0	3	CC
2	UM16BH352	Hospitality Marketing	3	0	0	0	3	CC
3	UM16BH353	Hospitality Financial Management	2	0	0	0	2	CC
4	UM16BH354	Human Resource Management	3	0	0	0	3	CC
5	UM16BH355	Specialization Internship	0	0	0	26	3	PW
6	**ELECTIVE - II**							
	UM16BH311	Managing a coffee shop kitchen	0	2	4	0	3	EC
	UM16BH312	Managing a Food Service Outlet	0	2	4	0	3	EC
	UM16BH313	Managing a Training Hotel	0	2	4	0	3	EC
	UM16BH314	Managing a Training Hotel's Rooms	0	2	4	0	3	EC
7	**ELECTIVE - III**							
	UM16BH321	Advance Culinary Operations Practical	0	0	8	0	4	CC
	UM16BH322	Managing Food and Beverage service	0	0	8	0	4	CC
	UM16BH323	Hotel Front Office Management	0	0	8	0	4	CC
	UM16BH324	Accommodation operations and Management	0	0	8	0	4	CC
	UM16BH325	Managing Events Practical	0	0	8	0	4	CC
		TOTAL	**11**	**0**	**14**	**26**	**21**	

ELECTIVES TO BE OPTED FOR SPECIALISATION

Sl. No.	Specialization	Elective – II	Elective –III
A	**Culinary Arts**	UM16BH311	UM16BH321
B	**Food and Beverage Service**	UM16BH312	UM16BH322
C	**Front Office Management**	UM16BH313	UM16BH323
D	**Accommodation Operations**	UM16BH314	UM16BH324
E	**Event Management**	UM16BH314	UM16BH325

PG PROGRAMS

MASTERS IN BUSINESS ADMINISTRATION (MBA)

I Semester (2018 – 20 BATCH)

Sl. No.	Course Code	Course Title	Hours / week L	T	P	*S	Credits	Course Type
1	UM18MB501	Accounting for Managers	2	1	2	2	4	FC
2	UM18MB502	Quantitative Methods – I	2	1	2	2	4	FC
3	UM18MB503	Managing Organization	2	1	0	2	3	CC
4	UM18MB504	Managerial Economics	2	1	0	2	3	FC
5	UM18MB505	Marketing Management	2	1	0	2	3	CC
6	UM18MB506	Leadership	2	1	0	2	3	CC
7	UM18MB507	Mathematics for Management	0	1	0	2	1	FC
8	UM18MB508	Financial Accounting	0	1	0	2	1	FC
9	UM18MB509	Spreadsheet Modeling	0	1	0	2	1	FC
		TOTAL	**12**	**9**	**4**	**18**	**23**	

Note: * 2 Hrs of self study will be given to the students in each course.

II Semester (2018 – 20 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	*S		
1	UM18MB551	Strategic Management	2	1	2	2	4	CC
2	UM18MB552	Corporate Finance	2	1	2	2	4	CC
3	UM18MB553	International Business	2	1	0	2	3	CC
4	UM18MB554	Digital Transformation	2	1	0	2	3	CC
5	UM18MB555	Research Methods	2	1	0	2	3	CC
6	UM18MB556	Strategic Human Resource Management	2	1	0	2	3	CC
7	UM18MB557	Finance	0	1	0	2	1	FC
8	UM18MB558	Quantitative Methods – II	0	1	0	2	1	FC
9	UM18MB559	Management Communication	0	1	0	2	1	FC
		TOTAL	**12**	**9**	**4**	**18**	**23**	
Note: * 2 Hrs of self study will be given to the students in each course.								

Summer Term Courses (2017 – 19 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	*S		
	Choice Based Credit System (Any one)							
I	**Group – 1**							
1	UM17MB570	IIT/NISM/IUP Residential Program	2	2	0	4	4	EC
2	UM17MB571	Supply Chain Management	2	2	0	4	4	EC
3	UM17MB572	Financial Econometrics	2	2	0	4	4	EC
4	UM17MB573	Design Thinking	2	2	0	4	4	EC
5	UM17MB574	Product Management	2	2	0	4	4	EC
6	UM17MB575	Advertising & Marketing Communications	2	2	0	4	4	EC
7	UM17MB576	Digital Transformation	2	2	0	4	4	EC
8	UM17MB577	Personal growth & Interpersonal Effectiveness	2	2	0	4	4	EC
9	UM17MB578	Financial Products and Services	2	2	0	4	4	EC
		TOTAL	**2**	**2**	**0**	**4**	**4**	
II	**Group – 2**							
10	UM17MB590	Strategic Management	2	1	2	2	4	CC
11	UM17MB591	Sales and Distribution Management	2	2	0	4	4	CC
III	**Group – 3**							
12	UM17MB592	International Taxation – 1	2	2	0	4	4	CC
13	UM17MB593	International Taxation – 2	2	2	0	4	4	CC
		TOTAL	**6**	**5/6**	**0/2**	**10/8**	**12**	
	Note: 1. * 2 or 4 Hrs of self study will be given to the students in each course. 2. Summer Term – For backlog students							

III Semester (2017 – 19 Batch)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	*S		
	Business Analytics (Any Four)							
1	UM17MB601	Data Management	2	1	0	2	3	EC
2	UM17MB602	Introduction to Statistics with R	2	1	0	2	3	EC
3	UM17MB603	Predictive Analytics	2	1	0	2	3	EC
4	UM17MB604	Social Media Analytics	2	1	0	2	3	EC
5	UM17MB605	Data Visualization	2	1	0	2	3	EC
	Capital Markets (Any Four)							
1	UM17MB606$	Capital Market Operations	2	1	0	2	3	EC
2	UM17MB607$	Fundamentals of Technical Analysis	2	1	0	2	3	EC
3	UM17MB608$	Mutual Funds and Fixed Income Securities	2	1	0	2	3	EC
4	UM17MB609$	Wealth Management	2	1	0	2	3	EC
5	UM17MB614#	Financial Derivatives	2	1	0	2	3	EC
6	UM17MB615#	International Financial Management	2	1	0	2	3	EC
	Finance (Any Four)							
1	UM17MB610$	Advanced Corporate Finance	2	1	0	2	3	EC
2	UM17MB611$	Investment Management	2	1	0	2	3	EC
3	UM17MB612$	Corporate Taxation	2	1	0	2	3	EC
4	UM17MB613$	Corporate Valuation	2	1	0	2	3	EC
5	UM17MB614#	Financial Derivatives	2	1	0	2	3	EC
6	UM17MB615#	International Financial Management	2	1	0	2	3	EC
	Human Capital Management (Any Four)							
1	UM17MB616	Developing an Entrepreneurial Mindset	2	1	0	2	3	EC
2	UM17MB617	Building Startups	2	1	0	2	3	EC
3	UM17MB618	Intellectual Capital and Innovation	2	1	0	2	3	EC
4	UM17MB619	Talent Acquisition	2	1	0	2	3	EC
5	UM17MB620	Talent Development and Retention	2	1	0	2	3	EC
6	UM17MB621	Compensation and Reward Management	2	1	0	2	3	EC
	Marketing (Any Four)							
1	UM17MB622	Digital Marketing	2	1	0	2	3	EC
2	UM17MB623˜	Brand Management	2	1	0	2	3	EC
3	UM17MB624˜	Retail Marketing	2	1	0	2	3	EC
4	UM17MB625˜	Services Marketing	2	1	0	2	3	EC
5	UM17MB626˜	Marketing Strategy	2	1	0	2	3	EC
6	UM17MB627˜	Selling Today	2	1	0	2	3	EC
		TOTAL	**8**	**4**	**0**	**8**	**12**	

1. * 2 Hrs of self study will be given to the students in each course.
2. Prerequisite Courses:
   a. $ UM17MB503 – Accounting for Managers and UM17MB555 – Corporate Finance
   b. ˜ UM17MB554 – Marketing Management
3. # Common course for Finance and Capital Market Specialization
4. Out of four specialization courses, two courses are offered in III and two in IV Semester

IV Semester (2017 – 19 Batch)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UM17MB651	Internship	0	0	16	0	8	PW
2	UM17MB652	Project Work	0	0	16	0	8	PW
		TOTAL	**0**	**0**	**32**	**0**	**16**	
	Note: Internship and project work are carried out during III & IV Semester							

MASTERS IN APPLIED ECONOMICS [M.Sc. (Applied Economics)]

III SEMESTER (2017 – 2019 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S*		
	UM17AE601	Frontiers of International Economics	3	0	0	0	3	CC
	UM17AE602	Internship	0	0	8	0	4	PW
	UM17AE603	Review of Dissertation	0	0	0	20	5	PW
	UM17MB602	Introduction to Statistics Using R	2	1	0	2	3	CC
	UM17MB611	Investment Management	2	1	0	2	3	CC
	UM18MB507	Mathematics for Management	0	1	0	2	1	FC
	UM18MB509	Spreadsheet Modeling	0	1	0	2	1	FC
		TOTAL	**7**	**4**	**8**	**28**	**20**	
	Note: *2 Hrs. of self-study							

IV SEMESTER (2017 – 2019 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S*		
	UM17AE651	Public Economics	3	0	0	0	3	CC
	UM17AE652	Defense of Dissertation	0	0	0	16	4	PW
	UM17MB603	Predictive Analytics	2	1	0	2	3	CC
	UM17MB615	International Financial Management	2	1	0	2	3	CC
	UM18MB552	Corporate Finance	2	1	2	2	4	CC
	UM18MB558	Quantitative Methods – II	0	1	0	2	1	FC
	UM18MB557	Finance	0	1	0	2	1	FC
	UM18MB559	Management Communication	0	1	0	2	1	FC
		TOTAL	**9**	**6**	**2**	**28**	**20**	
	Note: *2 Hrs. of self-study Internship and Project are carried out during III & IV Semesters							

BACHELOR OF BUSINESS ADMINISTRATION (BBA)

Program Education Objectives (PEO's)

- Graduates will be adept in concepts of management.
- Graduates will be capable of pursuing entrepreneurship.
- Graduates will acquire necessary managerial competence to take up higher responsibilities in organizations.

Program Outcomes (POs):

- To understand the basic concepts of management principles.
- To communicate business information effectively.
- To recognize a business problem and identify the appropriate source of business solutions.
- To apply knowledge & tools of basic mathematics, business accounting, economics, marketing, human resource management, finance & global business to solve business problems.
- To demonstrate abilities in conflict resolution & decision making.
- To demonstrate agility & adaptability to dynamic business environment through continuous learning.
- To demonstrate professionalism, uphold ethical values and contribute to the society.

UM18BB101:
COMMUNICATION FOR MANAGERS (3-0-0-0-3)

Course Objectives:

- To understand the fundamental principles of effective business communication and their practical applications in the current business practices.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the communication process
- Practically carry out business communication
- Deliver public speeches and make presentation.
- Participate and conduct meetings effectively

Course Contents:

1. **Elements of Communication:** Meaning – Importance – Objective and principles of communication, types of communication-communication process, impediments of effective communication, the cross cultural dimensions of Business communication, Business and social etiquettes.
2. **Verbal and Non-Verbal communication:** Attributes of oral and written communication, channels of oral communication, channels of written communication, Non-verbal communication, types of NVC, listening – types..
3. **Art of Public Speaking and Interview techniques:** Speech and presentation, Principles of effective speech and presentation – speech of introduction of a speaker – speech of vote of thanks – occasional speech –theme speech- Interview-Importance of interview – art of conducting and giving interviews –types of interview, Resume drafting.
4. **Instruments of Business Communication:** Inquiries, Circulars, Quotations, Orders, Acknowledgments, Complaints, Claims and adjustments, banking correspondence, Sales letters, Memos, Covering letter, Interview letters, leave letter.
5. **Meetings:** Meaning, Importance, Minutes of Meeting, E-Meetings, Participating and conducting group discussions, Brain Storming and its benefits, report writing.

Prerequisite Course: None

Reference Books:

1. "Communication", Rayudu C S, Himalaya Publishing House, New Delhi, 10th Edition, 2012.
2. "Excellence in Business Communication", Thill J V and Bovee G L, Mc-Graw Hill, New York, 1993.
3. "The Essence of Effective Communication", Ludlow, R & Panton, F, Prentice Hall Publishers, 1998.
4. "Effective Communication", Adair. J, Pan McMillan, 2003.
5. "Business Communication from Process to Product", Bowman, J P and Brachaw P P, Dryden Press, Chicago, 1987.
6. "Business Communication", Meenakshi Raman & Prakash Singh, Oxford Publisher, 2012.
7. "Business Communication", Kaul, New Delhi, Prentice Hall, 2010.
8. "Business Communication: The Real World and Your Career", Senguin, J, Allied Publishers, New Delhi, 2012.
9. "Basic Communication Skills for Technology", Rutherford J, Andre, Pearson Education, Noida, 2012.
10. "Essentials of Business Communication", Rajendra Paul, Korlahalli, J S, Sultan Chand & Sons, New Delhi, 2011.

UM18BB102:
KANNADA (3-0-0-0-3)

Course Objectives:

- To enlighten the students with period based Kannada Literature and impart skills in reading, listening, comprehending complex texts and communication.

Course Outcomes:

At the end of the course, the student should be able to

- Read and visualize text of an expository/ descriptive/ narrative nature; to identify salient points, deduce meanings of words, and recognize text organization.
- Interpret details, comprehend and evaluate ideas and characters.
- Get an insight of different media related communication and Kannada software
- Carry on one to one and group communication in Kannada effectively.

Course Contents:

- ಪ್ರಾಚೀನ ಸಾಹಿತ್ಯ – ವಚನಗಳು
- ಈ ಭಾಗದಲ್ಲಿ ವಚನ ಸಾಹಿತ್ಯದ ಪ್ರಮುಖ ವಚನಕಾರರ ಒಟ್ಟು 8 ವಚನಗಳ್ಳಿದ್ದು, ಹಳೆಗನ್ನಡ ಸಾಹಿತ್ಯ ಪರಿಚಯ ಕೂಡ ಇಲ್ಲಿರುತ್ತದೆ.
- ಮಧ್ಯಕಾಲೀನ ಸಾಹಿತ್ಯ – ಕುಮಾರವ್ಯಾಸ ಭಾರತ
- ಈ ವಿಭಾಗದಲ್ಲಿ ಕುಮಾರವ್ಯಾಸ ಭಾರತದ ಉತ್ತರಕುಮಾರ ಪ್ರಸಂಗದಆಯ್ದ 30 ಷಟ್ಪದಿಗಳಿರುತ್ತವೆ,
- ಹೊಸಗನ್ನಡ ಸಾಹಿತ್ಯ – ಕಥೆ & ಕವನ
- ಈ ವಿಭಾಗದಲ್ಲಿ ಹೊಸಗನ್ನಡದ 03 ಕಥೆಗಳು ಹಾಗು ಒಂದು ಕವನ ಇರುತ್ತದೆ
- ಹಚ್ಚಗನ್ನಡದ 02 ಪ್ರಬಂಧಗಳು ಇರುತ್ತವೆ. ಈ ವಿಭಾಗದಲ್ಲಿ
- ಈ ವಿಭಾಗದಲ್ಲಿ ಸಂವಹನ – ವ್ಯಾಖ್ಯಾನ, ಮಹತ್ವ, ಕಾರ್ಯಗಳು. ಸಮೂಹ ಸಂವಹನದ ಲಕ್ಷಣಗಳು, ವಿವಿಧ ಮಾಧ್ಯಮಗಳ ಪರಿಚಯ – ಪತ್ರಿಕೆ, ದೂರದರ್ಶನ, ರೇಡಿಯೋ, ಚಲನಚಿತ್ರ, ದೂರವಾಣಿ, ಅಂತರ್ಜಾಲ. ಕನ್ನಡ ಸಾಫ್ಟ್‌ವೇರ್ – ಪರಿಚಯ ಹಾಗು ಕರ್ನಾಟಕದಲ್ಲಿ ಆ ಉದ್ಯಮ ಬೆಳೆದ ವಿವರಇರುತ್ತದೆ.

Prerequisite Course: None

Reference Books:

- ಸಾಹಿತ್ಯಸಿಂಚನ – ಸಂ. ಡಾ.ಆನಂದರಾಮುಪಾಧ್ಯಾ – ಪಿ.ಇ.ಎಸ್ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು.
- ಸಂವಹನ ಕೌಶಲ್ಯ – ಸಂ. ಡಾ . ಬಿ.ಗಂಗಾಧರ – ಬೆಂಗಳೂರು ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು

UM18BB103: HINDI (3-0-0-0-3)

Course Objectives:

- To enlighten with literary work both prose and poetry of some leading authors and train the students in Hindi grammar.

Course Outcomes:

At the end of the course, the student should be able to

- Read and visualize text of an expository/ descriptive/ narrative nature; to identify salient points, deduce meanings of words, and recognize text organization.
- Interpret details, comprehend and evaluate ideas and characters.
- Recognize the grammatical accuracy of the content and correct if necessary.

Course Contents:

1. 'कफन' – प्रेमचन्द :दलितग्रामीणजीवनकोचित्रितकरनेवालीकथा
2. 'धर्ती का स्वर्ग' – विष्णुप्रभाकर :लेखककोकश्मीरकीयात्रा
3. पर हुए अनुभवों का चित्र
4. 'समय पर मिलनेवाले' – हरिशंकरपरसाई :हास्यव्यंग्यजीवनचित्रण
   - (i) कुरुक्षेत्र (1–9 पदमात्र) – रामधारीसिंहदिनकरमहाभारतकेयुद्धकेबाद पितामहभीष्मसेदुखीयुधिष्ठिरकोदियेजानेवालेउपदेशोंकावर्णन
   - (ii) आँसू (1–9 पदमात्र) – जयशंकरप्रसाद : कविकेजीवनकादु:खपूर्ण चित्रण– प्रकृतिकेसाथतुलना

     व्याकरण – सन्धि परिभाषाऔरभेद

Prerequisite Course: None

Reference Books:

1. "Hindi Literature in Modern Days", Dr.Srinivas Sharma, Lok Bharathi Prakashan, Allahabad, 2014.
2. "Indian Poetry", Dr. Suresh Agarwal Radha Krishna Prakashan, New Delhi, 2010.

UM18BB104: SANSKRIT (3-0-0-0-3)

Course Objectives:

- To train the students in Sanskrit language by enlightening with literary work both prose and poetry of some leading authors and train the students in letter writing.

Course Outcomes:

At the end of the course, the student should be able to

- Read and visualize text of an expository/ descriptive/ narrative nature; to identify salient points, deduce meanings of words, and recognize text organization.
- Interpret details, comprehend and evaluate ideas and characters.
- Compose typical letters

Course Contents:

1. हितोपदेशः (मित्रलाभः – नारायणपण्डितविरचितम्)– Selection of stories from Hitopadesa of NarayanaPandita (First 25 shlokas to be taught)
2. रघुवंशम् (पञ्चमःसर्गः – महाकविकालिदासविरचितम्) – V Canto of Raghuvamsham written by Kalidasa (long with introduction(Peetike) 50 shlokas)
3. दूतवाक्यम् (भासविरचितम्) Drama portion of Dutavakyam written by Bhasa
4. अपठितावबोधनम् Unread passages in Sanskrit for comprehension.

Prerequisite Course: None

Reference Books:

1. "Hitopadesa of Narayana Pandita", Pandit Rameshwar Bhat, Chaukhamba Sanskrit Pratisthan, New Delhi, 2017.
2. "Raghuvansham of Kalidasa", Dr. Shrikrishnamani Tripathi, Chaukhamba Sanskrit Pratisthan, New Delhi, 2017.

UM18BB105: ENGLISH (3-0-0-0-3)

Course Objectives:

- To develop practical communication skills of students in areas of conversation making, vocabulary development, reading, creative writing and role play through literary work like Prose, Poetry, Short Stories, Biography and Speech.

Course Outcomes:

At the end of the course, the student should be able to

- Read & Visualize text of an expository/ descriptive/ narrative nature; to identify salient points, deduce meanings of words, recognize text organization (e.g. sequence of tenses, sequence of ideas), skim for gist and scan for specific information.
- Compose an answer to a typical question using key words keeping in view length and relationship between ideas as required by key words effectively within the time allotted.
- Pronounce, pause and lay emphasis correctly, describe, explain, narrate, and be an active participant in Group Discussions effectively.

Course Content:

- **Road Not Taken- Robert Frost;** In Sahayadri Hills, a Lesson in Humility – Sudha Narayana Murthy; Personal Introduction Expansions – Proverbs / Idioms
- **The Story of the Inexperienced Ghost - HG Wells**; Hillary Rodham Clinton's address at the U.N. 4th World Conference on Women Plenary Session - delivered on 5th September 1995, Beijing, China; Writing and Delivering a speech (Vote of Thanks / Inaugural / Commemorative).
- **Homecoming – Rajagopal Parthasarathy;** His Return – Perceval Wilde; Translation work of a poem / speech/ story from regional literature.
- **The Blue Carbuncle - Sir Arthur Conan Doyle**; Little Girls Are Wiser Than Men – Lev Nikolayevich Tolstoy; Brochure / Leaflet Preparation
- **Because I Could Not Stop For Death – Emily Dickinson**; Vaman Srinivas Kudva – A Biography of one of the Founding Directors of Syndicate Bank; Film: Viewing and Reviewing

Prerequisite Course: None

Reference Books:

1. "Robert Frost: The Road Not Taken" Robinson, Katherine, Poetry Foundation, Princeton University Press, 2016.
2. "The Story of the Inexperienced Ghost", H G Wells, Independently Published, 2017.
3. www.americanrhetoric.com/top100specchesall.html.

UM18BB106: FRENCH (3-0-0-0-3)

Course Objectives:

To enable the students of Business administration to acquire basic skill to communicate in French in a professional environment along with the knowledge of grammar.

Course Outcomes:

At the end of the course, the student should be able to

- Understand and apply basic skills in written and spoken French.
- Communicate oral and written mastery of the language.

Course Content:

1. **Termes conversationnels français**: initiateurs de conversation et phrases conversationnelles, Conversations entre amis, Conversation téléphonique et étiquette, Comment dire merci et

désolé, salutations communes et au revoir, auto-introduction. **Numéros français et lettres:** Alphabets et sa prononciation, Numéros 1 à 100, nombres ordinaux. **Heure française, jours, mois et saisons :** Heures de la journée en français, Journées françaises de la semaine, Parler de l'heure en français, Mois français de l'année et leurs abréviations, Saisons françaises

2. **Décrire les personnes en français :** Émotions françaises, Décrivez les personnes et l'apparence, Famille française, Description de la personnalité française, Parties du corps, Visage et tête, Honorifiques français.**Vêtements français :** Vêtements pour hommes, Vêtements pour femmes, vêtements pour enfants, couleurs
3. **Expressions françaises et salutations spéciales** :Plaisanteries françaises, Phrases pour les touristes, Noël, nouvel an et voeux d'anniversaire, Félicitations et meilleurs vœux, Vacances françaises.
4. **Expressions générales françaises :** Loisirs et activités en français, santé et bien-être, Voyage, les professions
5. **Expressions commerciales françaises:**Emplois en français, Termes bancaires français, Vocabulaire des affaires en français, Termes informatiques français, Vocabulaire de bureau, termes de fournitures de bureau (grammaire dans l'utilisation de pronoms, noms, articles, verbes et conjugaisons de verbes, construction de phrases)

Prerequisite Course: None

Reference Books:

1. Sylvie POISSON – QUINTON et al., FESTIVAL I., CLE International / Sejer2005 Régine Mériéux,YvesLoiseau, Connexions, Didier, Paris , 2005.
2. Annie Monnerie-Goarin, Evelyne Siréjols,,Champion, CLE International, Paris ,2007

UM18BB107: FUNDAMENTALS OF ACCOUNTING (3-0-0-0-3)

Course Objectives:

- The objective of the course is to strengthen the fundamentals of accounting and provide strong foundation for other accounting courses. The course will intensify knowledge on all the basic components by using double entry book keeping perspective.

Course Outcomes:

At the end of the course, the student should be able to:

- Describe the fundamental accounting concepts, Conventions, terminologies, importance, functions, objectives and Standards
- Prepare books of entry, subsidiary books, bank reconciliation statement, depreciation accounts and Final accounts using double entry bookkeeping.
- Identify and rectify the errors present in books of entry and subsidiary books

Course Contents:

1. **Introduction to Accounting:** Introduction – meaning and definitions – accounting theories – functions of accounting – users of accounting information –concepts and conventions- accounting equation - GAAP-IND AS – accounting cycle. Book keeping- double entry system and single entry system of book keeping – classification of accounts – golden rules for accounting rules of debit and credit under English system and American system.
2. **Books of Entry and Rectification of Error**: Book of Prime entry – meaning – objectives – advantages of journal –journalizing – journal entry - recording problems on journal entry- Book of secondary entry -meaning – features –distinction between journal and ledger-posting- steps involved in posting of entries from journal to ledger – balancing of accounts - verification of arithmetical accuracy - trial balance. Rectification of errors **-** meaning – kinds of accounting errors –need for rectification of errors - suspense account – rectification of error with or without suspense account
3. **Subsidiary Books:** Meaning – significance -types – purchase book, sales book-purchase return book- sales return book- bills receivable book-bills payable book- journal proper. **Cash Book -** meaning of cash book - types of cash book- single column cash book- two column cash book – three column cash book- petty cash book.
4. **Bank Reconciliation Statement:** Meaning – reasons for differences in bank balance between two sets of balances - preparation of bank reconciliation statement. **Depreciation Accounting:** Objectives- Causes of Depreciation- Need for Providing Depreciation- Basic Elements of Depreciation- Methods of calculating depreciation- Straight Line Method- Diminishing Balance Method- Annuity Method
5. **Final Accounts of Proprietary Concern:** Concept of final accounts - concept of profit/loss - preparation of various accounts and statements –problems on final accounts of a sole proprietor.

Prerequisite Course: None

Reference Books:

1. "Fundamentals of Accounting", S P Jain and K L Narang, Kalyani Publishers, 2012.
2. "Financial Accounting", S N Maheshwari, Suneel K Maheshwari, Sharad K Maheshwari, 5th Edition, Vikas Publishers, 2012.
3. "Accounting for Management", Jawaharlal, Himalaya Publishing House, 2012,
4. "Fundamentals of Accounting", Anil Kumar, V. Rajesh, B. Mariyappa, 2nd Revised Edition, Himalaya Publishing House, 2013.
5. "Fundamentals of Accounts", B.S. Raman, Mangalore Publishers, 2012.

UM18BB108: QUANTITATIVE METHODS FOR BUSINESS - I (4-0-0-0-4)

Course Objectives:

- The course aims at equipping the students with an understanding of basic mathematical techniques, concepts and methods of decision making, in order to facilitate managerial decision making.

Course Outcomes

At the end of the course, the student should be able to:

- Understand concepts of commercial arithmetic like simple interest, compound interest and annuity.
- Define basic terms in the area of business calculus.
- Enable the students to construct the constraints and the objective function for a linear programming problem from everyday life.
- Construct mathematical models for real world problems.
- Apply the mathematical tools in business models.

Course Contents:

1. **Matrices & Determinants**: Matrices- Addition, Multiplication, Determinants, Cramer's Rule. Solution system of linear equations.
2. **Commercial Arithmetic**- Ratios & Proportions, Simple Interest, Compound Interest, Annuities.
3. **Introduction to Probability**: Probability distributions – Meaning,

Discrete & Continuous probability functions – binomial, Poisson, normal distribution.

4. **Differential calculus**- Limits, Differentiation, derivative of function of one variable, constant of a function, sum of function, product of two functions, quotient of two functions, Business application of differentiation to commerce and Economics- Revenue function, Cost function- Profit function, Break-even point.
5. **Linear Programming problems**-Definition- Linear Programming problem –Formulation-Solution by graphical method- Simplex method- minimization and maximization problems.

Reference Books:

1. "Quantitative methods for Business – I", G.K. Ranganath and Narasimha Rao, Himalaya Publications, 2015.
2. "Business Mathematics", Dorairaj S N, United Publisher, 2012.
3. D.C. Sanchethi and V.K. Kapoor, "Business Mathematics", Himalaya Publications, 2011.
4. "Mathematics for Business and Economics", J.D. Gupta, P.K. Gupta & ManMohan, Tata McGraw Hill Publishing Company Limited, 2014.
5. Anderson, David R, Sweeney, Dennis J., Williams, Thomas A., "Quantitative methods for Business", Cengage learning 10th edition, New Delhi, 2006.

UM18BB109:
ORGANIZATIONAL BEHAVIOUR (3-0-0-0-3)

Course Objectives:

- The objective of the course is to provide students with a better understanding of behavioural processes and thereby enable them to adapt to the changing practices so that they may function more effectively in their roles as managers of human resources.

Course Outcomes:

At the end of the course, the student should be able to:

- Define and explain how people behave based on their personality, attitude, perception, learning & motivation
- Identify and describe psychological characteristics and organizational conditions that are important at work place.
- Apply key concepts, theories and how they can relate them towards achieving organizational effectiveness.
- Develop leadership qualities in them to take initiatives in the work place.

Course Contents:

1. **Organizational Behaviour:** Introduction-Organizational behaviour – nature and scope, contribution from other disciplines, basic organization behaviour model and Framework of OB.
2. **Personality:** Definition, concepts of personality, determinants of personality, theories of personality – Erickson's Eight development stages, Freudian theory, Jungian theory and Trait theory. Values**-** Importance, Types of values- Allport Values, Rokeach Values.
3. **Attitude and Learning:** Attitude**-** Meaning, characteristics, components and formation of attitudes, relation between attitude and behaviour- Cognitive dissonance theory, measuring of attitudes, changing attitude. **Learning**- Meaning of learning, learning process, learning theory of organizational behaviour - Classical, Operant conditioning, cognitive, observation.
4. **Perception and Group Behaviour:** Perception - Meaning and definition of perception, factors influencing perception, understanding perception and judgment- attribution theory, perception errors. Group Behaviour- Meaning, Types of groups in the organization, functions of groups.
5. **Leadership and Motivation:** Leadership- Concept, Importance, Leader vs Manager, leadership style, Leadership theories – Ohio State University studies, Managerial grid, Fidler's Contingency model, Path goal theory. Motivation- Meaning, Theories of motivation- Maslow's hierarchy of needs, two factor theory, Alderfer's ERG Theory, McGregor Theory X and Y Process Theory.

Prerequisite Course: None

Reference Books:

1. "Organizational Behavior", Stephen P. Robins, Timothy A. Judge, Neharika Vohra, 15th Edition, PHI Learning / Pearson Education, 2013.
2. "Organizational Behaviour - Text, Cases and Games", Aswathappa. K., Himalaya Publication, 2010.
3. "Organizational Behaviour - Text and Case", Singh. K, Pearson Education, New Delhi, 2012.
4. "Organizational Behavior", Fred Luthans, 11th Edition, Mc-Graw Hill, 2001.
5. "Organizational Behaviour", Robbins. S. P, Judge, T. A., & Vohra, N, Pearson Education Asia, 2011.
6. "Principles of Organizational Behaviour", Fincham, Robin, Rhodes, Peter, Oxford University Press, 2011

UM18BB110:
MANAGEMENT THEORY AND PRACTICE (3-0-0-0-3)

Course Objectives:

- The objective of the course is to facilitate the students in understanding the functions and responsibilities of a manager, provide them tools and techniques to be used in the performance of manager's job; enable them to analyse and understand the environment of the organization.

Course Outcomes:

At the end of the course, the student should be able to

- Elucidate the concepts of Management and discuss its relevance in an Organization
- Explain the basic facts and procedures required for managing an organization effectively.
- Analyse general management principles in practical business situation.
- Suggest Planning, Organizing, Staffing, Directing and controlling process in a typical business environment

Course Contents:

1. **Introduction to Management:** Introduction, meaning and features, importance of management, scope of management, Levels of management, principles of management social responsibility of management.
2. **Planning:** Meaning, nature of planning, planning process, objectives of planning, principles of planning, types of plans – (objective, procedure, program, budget, strategy, MBO, MBE. Decision Making, Importance, steps and types.
3. **Organizing:** Meaning, natures and purpose of organization, types of organizations. Departmentation – meaning, basis, centralization and decentralization. Authority and responsibility span of control, factors influencing span of control.
4. **Staffing & Directing:** Meaning, Nature and importance of staffing, recruitment, sources of recruitment, selection and process. **Directing:** Meaning and nature of directing, principles of effective direction, coordination, techniques of effective coordination, cooperation.

5. **Controlling:** Meaning, process, features, importance, and prerequisites of good control system. Control techniques, budgetary control & Non – budgetary control.

Prerequisite Course: None

Reference Books:

1. "Management Process", Appannaiah & Reddy Himalaya Publications, 2013.
2. "Management Process", Sharma and Shahi K. Gupta, Kalyani Publications, 2013.
3. "Essentials of Management", Harold Koontz and Heinz Weihrich, Tata McGraw-Hill, 2002.
4. "Principles of Management", George R Terry and Stephen G. Franklin, AITBS, New Delhi, 2002.

UM18BB111: ENGLISH LANGUAGE LAB (0-0-2-0-1)

Course Objectives:

- The objective of the course is to inspire the students in identifying and amplifying their strengths as communicators.

Course Outcomes:

At the end of the course, the student should be able to

- Evaluate and apply various communication components to real life situations.
- Deliver effective business presentations.

Course Contents:

1. Reading Comprehension and Error Correction
2. Theatre
3. Presentations
4. Art of Public Speaking
5. Group discussion
6. Letter of application with CV
7. Mock interview
8. Verbal Aptitude

Prerequisite Course: None

Reference Books:

1. Rayudu C S, Communication, 10th Edition, Himalaya Publishing House, New Delhi, 2012.
2. Rajendra Paul, Korlahalli, J S. Essentials of Business Communication, Sultan Chand & Sons, New Delhi, 2011.

UM18BB112 ACCOUNTS PRACTICAL- 1 (0-0-2-0-1)

Course Objective:

The objective of the course is to understand the basic concepts and nuances of Financial Accounting using the accounting software- Tally. The course also aims to equip the students with a strong foundation of the essential rudiments of the Accounting software and help them develop a managerial perspective towards the same.

Course Outcome:

At the end of the course, the student should be able to:

- Create company in Tally
- pass accounting entries in Tally
- Prepare bank reconciliation in Tally
- Prepare Financial statements in Tally

Course Content

1. **Creating a Company –Tally :** Altering and Deleting Company
2. **Masters – Ledgers :** Understanding Ledgers- Creating Ledgers- Creating Multiple Ledgers- Altering and Deleting Ledgers
3. **Masters – Groups :** Understanding Groups- Creating Groups- Altering and Deleting Groups
4. **Payment Voucher :** Understanding Default Vouchers- Payment in Double Entry Mode
5. **Receipt Voucher :** Understanding Receipt Vouchers
6. **Day Book :** Understanding Day Book Reports- Altering and Deleting Transactions
7. **Contra and Journal Voucher :** Understanding Contra for Banking
8. **Bank Reconciliation :** Understanding Bank Reconciliation
9. **Financial reports :** Trial balance, Profit and loss account, Balance sheet

Reference Books:

1. Laboratory Manual material prepared by Department of BBA, PESU

UM18BB113: GERMAN LANGUAGE LEVEL – I (0-0-0-0-0)

Course Objectives:

- The objectives of the course it to introduce German language who are unfamiliar with the language at school. This course aims to provide beginning students with a practical basic command of the language

Course Outcomes:

At the end of the course students are be able to:

- Engage in basic conversations about most common everyday situations and write simple notes and phrases.
- Use and understand a wide range of vocabulary items from the skill areas covered in class.

Introduction to German Language

1. Mein name ist… (My name is ….)

   Activities - Greet people & say goodbye, How to say who you are, How to ask people where they come from and where they live,
2. Mir geht's gut…
   a. (I am fine ……)

      Activities - How to ask people how they are? How to say how you are…, How to say which cities & countries, people come from….,
3. Wieschreibt man das?

   (How do you write that?)
4. Language points/Grammar: Verb endings, How to count from 0 – 100, How to spell names and words, How to talk about us and them, SprechenSiedeutsch….(You speak German …), How to say what languages you, speak and ask others what they speak, How to say whether you are working or studying, How to say what Nationality you are..,
5. In der Stadt….. (In town….) How to talk about places in towns and cities, How to count from 101 upwards
6. Arbeit und stadium…. (Work & Study……) the verb to be (sein), Plural forms of Nouns, Audio, and Vocabulary - Expression

Prerequisite Course: None

Reference Books:

1. Laboratory Manual material prepared by Department of BBA, PESU

UM18BB114:
COMMUNICATIVE KANNADA – I (0-0-0-0-0)

Course Objective:

- To get basic knowledge in Kannada language, to speak in Kannada language & get communication skills.

Course outcomes:

At the end of the course, the student should be able to

- Understand the communication process in Kannada
- Practice the communication process in Kannada

Course Contents:

Learn the spoken Kannada Language in the class room.

1. Salutation
2. Personal pronouns
3. Possessive forms
4. Interrogative words
5. Relative nouns

Prerequisite Course: None

Reference Books:

1. ಪ್ರೌಢಶಾಲಾ ಕನ್ನಡ ವ್ಯಾಕರಣ ಮತ್ತು ವಾಕ್ಯರಚನೆ – ಸಿ.ಎಸ್. ಬನಶಂಕರಯ್ಯ
2. ಕನ್ನಡಕಲಿ – ಲಿಂಗದೇವರ ಹಳೆಮನೆ – ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ.

UM18BB115:
KANNADA KALI – I (0-0-0-0-0)

Course Objective:

To impart skills in reading, listening, comprehending complex texts and communication

Course Outcomes:

At the end of the course, the student should be able to

- Get an insight of different media related communication and Kannada
- Carry on one to one and group communication in Kannada effectively.

Course Contents:

1. Introducing each other - conversation
2. Introducing each other – conversation, structure pattern
3. structure pattern, Exercise
4. Enquiring about Room – Exercise and Vocabulary
5. Communication skills in Kannada & Business Kannada

Prerequisite Course: None

Reference Books:

1. ಕನ್ನಡ ಕಲಿ, ಸಂ.ಲಂಗದೇವರು ಹಳೆಮನೆ – ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ
2. ಸಂವಹನ ಕೌಶಲ್ಯ – ಸಂ.ಡಾ.ಗಂಗಾಧರ – ಬೆಂಗಳೂರು ವಿಸ್ವವಿದ್ಯಾಲಯ

UM18BB116:
KANNADA MANASU – I (0-0-0-0-0)

Course Objective:

To enlighten the students with Kannada literature & impart skills in reading listening comprehending complex text and communication

Course Outcomes:

At the end of the course, the student should be able to

- Read and visualize text of an expository/ descriptive/ narrative nature; to identify salient points, deduce meanings of words, and recognize text organization.

Course Contents:

1. ಶ್ರಾವಣ : ದ.ರಾ.ಬೇಂದ್ರೆ
2. ಡಾ. ವಿಶ್ವೇಶ್ವರಯ್ಯ : ಎ.ಎನ್.ಮೂರ್ತಿರಾವ್
3. ದೋಣಿ ಹರಿಗೋಲುಗಳಲ್ಲಿ: ಶಿವರಾಮಕಾರಂತ
4. ಅಣ್ಣಪ್ಪನ ರೇಷ್ಮೆ ಕಾಯಿಲೆ : ಕುವೆಂಪು
5. ಸಂವಹನದ ವ್ಯಾಖ್ಯಾನ, ಮಹತ್ವ, ಕಾರ್ಯಗಳು. ಸಮೂಹ ಸಂವಹನದ ಲಕ್ಷಣಗಳು ಮತ್ತು ವ್ಯಾವಹಾರಿಕ ಕನ್ನಡ

Prerequisite Course: None

Reference Books:

1. ಕನ್ನಡ ಮನಸು : ಸಂ. ಡಾ. ಎಚ್.ಜೆ.ಅಶ್ವತ್ಥಗೌಡ, ಪ್ರಕಾಶಕರು: ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ
2. ಸಂವಹನ ಕೌಶಲ್ಯ – ಸಂ.ಡಾ.ಗಂಗಾಧರ – ಬೆಂಗಳೂರು ವಿಸ್ವವಿದ್ಯಾಲಯ

UM18BB151:
BUSINESS ECONOMICS (3-0-0-0-3)

Course objectives:

- The objective of the course is to enable the students understand the micro economic concepts of demand-supply-pricing-cost and market structures which influence business decisions. Its scope includes enabling the student to apply quantitative economic concepts in day to day managerial decision making.

Course Outcomes:

- At the end of the course, the student should be able to
- Define & understand the basic concept of Business economics.
- Describe & illustrate the factors affecting Demand, Supply, and Production& Price in an economy
- Classify the different types of Market structure in an economy
- Explain the concepts of National Income & Policies of RBI.

Course Contents:

1. **Business Economics:** Meaning - Nature - Roles and responsibilities of a business economist. Concept of demand - its determinants. The law of demand - exceptions to the law of demand, shifts in demand. Basic of Supply & its law.
2. **Concept of utility:** The law of diminishing marginal utility - its defects - Indifference curve and its properties.
3. **Elasticity of Demand:** Definition, measurement of elasticity of demand – price; income; and cross elasticity of demand. Arc; point and total outlay methods.
4. **Production Function:** The law of variable proportions – Basic cost concepts - Total Cost - fixed costs - variable costs. Average and Marginal cost - their relationship. Revenue concepts – Total, Average and Marginal revenue. Relationship between marginal cost and marginal revenue.
5. **Market Structures:** Meaning and types - perfect monopoly, monopolistic competition and equilibrium level of output - through Iso - quants and Iso - Costs with the help of revenue and costs. Break Even Analysis. **National Income Accounting**: Basic Concepts GDP, NNP, PI, DI, PCI. Business cycle - meaning and definition - phases of a trade cycle - Monetary and Fiscal Policies - meaning and instruments.

Prerequisite Course: None

Reference Books:

1. "Managerial Economics", Suma Damodaran, Oxford University Press, 2012.
2. "Managerial Economics", M L Jhingan & J K Stephen, Vrinda Publications (P) Ltd. 2012.
3. "Managerial Economics", Dominic Salvatore, Oxford University Press, 2012.

4. "Mathematics for Economics and Finance - Methods and Modelling", Martin Anthony & Norman Biggs, Cambridge University Press, 2012.
5. "Managerial Economics", H.L. Ahuja, S. Chand and Company Ltd., 2013
6. "Macro Economics", Paul A. Samuelson, William D. Nordhaus, McGraw-Hill Education. 2013.
7. "Operations Research Theory and Applications", J.K Sharma, Trinity Press, 2013.
8. "Principles of Macroeconomics", N Gregory Mankiw, Cengage Learning, 2012.

UM18BB152: QUANTITATIVE METHODS FOR BUSINESS - II (4-0-0-0-4)

Course Objectives:

- The course provides a statistical foundation for the various quantitative techniques that are used in Managerial Decision-Making and to develop quantitative aptitude among management students.

Course Outcomes:

At the end of the course, the student should be able to

- Appreciate the utility of central tendency, dispersion, correlation, regression time series and index number, probability distributions
- Understand concepts & procedures of Business Statistics.
- Apply Statistical concepts& procedures in Business.
- Develop analytical skills among students.

Course Contents:

1. **Background and basic concepts:** Introduction – Definition of Statistics – Functions – Scope – Limitations. **Diagrammatic and graphic representation:** Introduction – Significance – Difference between diagrams and graphs – Types of diagrams and graphs.
2. **Measures of Central Tendency and Dispersion:** Introduction – Types of averages – Arithmetic mean (Simple and weighted) – Median – Mode-Range – Quartile deviation – mean deviation – standard deviation – coefficient of variation – Measures of Skewness: Meaning of Skewness - Symmetrical & Skewed Distributions- Measures of Skewness - Absolute and Relative Measures of Skewness – Karl Pearson's Coefficient of Skewness and Bowley‟s Coefficient of Skewness
3. **Correlation and regression analysis:** Meaning – Types – probable error – Karl Pearson's coefficient of correlation – rank correlation (excluding vicariate and multiple correlation); Regression - Meaning - Definition – regression equations.
4. **Time Series and Index Numbers:** Meaning and components – Computation of trend values by moving average and least square method. Classification – Construction of index numbers – methods of constructing index numbers – simple aggregative method – weighted aggregative method – Fishers ideal method including time & factor reversibility tests – Consumer price index numbers.
5. **Testing of Hypotheis:** Sampling distribution – Test for Single mean, Proportion, Difference of means (Large & Small samples), Test for single variance & equality of variance, Chi – Square test for goodness of fit.

Prerequisite Course: None

Reference Books:

1. "Business Statistics", B G Sathyaprasad & Chikkodi. Himalaya Publishing House, 2011.
2. "Business Statistics: An Applied Orientation", P.K. Viswanathan, Pearson Education.2003.
3. "Fundamentals of Business Statistics", David Anderson, Thomas Arthur Williams, International Edition, 6th Revised Edition, South-Western College Publishing, 2011.
4. "Fundamentals of Statistics", S P Gupta & V K Kapoor, Sultan Chand Publisher, 2014.
5. "Business Statistics", Aggarwal S L, Kalyani Publisher, New Delhi, 2013.

UM18BB153: DIGITAL TRANSFORMATION STRATEGY (3-0-0-0-3)

Course Objectives:

This course attempts to make students understand the different dimensions of Digital transformation, and the associated strategies.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the importance of strategy in digital transformations.
- Gain an appreciation for the new technologies and the concomitant business models that are disrupting incumbent organizations.
- Develop digital strategies for both incumbent and attacker organizations leveraging digital technologies and business models.
- Generate ideas for executable business.

Course Contents:

1. **Understanding Digital Transformation**: Introduction to Digital Transformations, nexus of scale, scope and speed, understanding Innovation adoption and disruptive innovations, Digital Matrix.
2. **Phases of Transformation**: Social Technologies, Experimentation at the Edge, e-Business and Cloud Computing, Collision at the Core, reinvention at the root.
3. Building Leadership Capabilities, Understanding Big Data and Analytics, Understanding IoT Technologies, Understanding Indian Digital Giants.
4. Winning Moves, Orchestrate and Participate across Ecosystems ,Collaborate to co-Create New Capabilities, Amplify Your Human Talent with Powerful Machines, Understanding Global Giants
5. Prepare and Drive Digital Transformation, Understanding Indian Context and Your Theory of Digital Adaptation.

Prerequisite Course: None

Reference Books:

1. "The Digital Matrix: New Rules for Business Transformation through Technology", Venkatraman, Venkat,. Penguin Random House India, 2017.
2. "A Leading Digital: Turning Technology into Business Transformation"Westerman, George, Bonnet, D. and McAfee, Harvard Business Press, 2014.
3. "Diffusion of Innovations", Rogers, Everett M, Simon and Schuster, 2010.
4. "Digital to the Core: Remastering Leadership for Your Industry, Your Enterprise, and Yourself", Raskino, M., Waller, G., Routledge, 2015.

UM18BB154 CORPORATE ACCOUNTING (3-0-0-0-3)

Course Objectives:

- The objective of the course is to gain knowledge and insights into, the preparation of various accounts of Joint stock companies, the valuation of goodwill and shares and the recent trends in accounting

Course Outcomes:

At the end of the course, the student should be able to

- Illustrate the methods in which the joint stock companies issue, redeem, convert and underwrite the shares and debentures.
- Prepare the final accounts of large concerns.
- Calculate an estimate of the value of goodwill and shares
- Explain the recent trends in accounting

Course Contents:

1. **Underwriting of Shares** – Initial Public offering- Issue of Equity Shares and debentures- Underwriting- Meaning- Underwriting Commission- Underwriter- Functions- Advantages of Underwriting- Types of Underwriting- Marked Application and unmarked applications- Problems.
2. **Final Accounts of Companies**: Preparation of income statement and Balance sheet-Operating Income- Cost of goods sold- Operating expenses- Finance cost-Dividend and appropriation- share capital-Reserves and surplus-Secured loan- Fixed assets-Current assets and advances- Current liabilities and provisions- Fictitious Assets- depreciation and amortization- Problems
3. **Valuation of Goodwill:** Meaning of goodwill, nature of goodwill, factors affecting goodwill, methods of calculating goodwill- Average profit Method, Super profit method, Capitalisation Method- Problems
4. **Valuation of Shares:** Meaning, need for valuation, factors affecting valuation, methods of valuation, intrinsic value method, yield method, earning capacity method, fair value method- Problems.
5. **Recent Developments in Accounting & Accounting Standards:** Indian accounting standards, Human Resource Accounting – Environmental Accounting – Social Responsibility Accounting. Accounting Standards - their role in company accounts. IFRS and US GAAP – brief overview, Differences between Indian standards, US GAAP and IFRS, IND-AS.

Prerequisite Course: None

Reference Books:

1. "Corporate Accounting", Maheshwari, S N Maheshwari, S K, Vikas Publishing House, 2016.
2. "Corporate Accounting", P.C Tulsan, Tata Mc Graw Hill, 2012.
3. "Advanced Accountancy", S. N. Maheshwari, Vol 2, Vikas Publishing House, 2011.
4. "International Financial Reporting System", Taxman Edition, 2014.
5. "Students Guide to Accounting Standards" (CA/CMA Final) Edition, 2014
6. "Taxman's Accounting: CA Intermediate (IPCC)", D.G Sharma, 2nd Edition CA, 2014.

UM18BB155: PRODUCTION & OPERATIONS MANAGEMENT (3-0-0-0-3)

Course Objectives:

- The objective of the course is to familiarize the students with concepts and practice of production and operations management in materials handling, operation research techniques, quality management, production planning and decision making in an industry.

Course Outcome:

At the end of the course, the student should be able to

- Recognize the different types of automation and also identify the advantages & disadvantages.
- Describe, explain & choose the best process for production.
- Understand the material management & apply of techniques for material management
- Understand the basic concept of production, inventory management and quality management
- Inculcate basic thinking and decision making relating to production and operations management

Course Contents:

1. **Production Management:** Introduction, meaning & definition, classification, objectives and scope of production and operation management. **Production Planning & Control:** Introduction, meaning & definition, objectives of production planning, Factors determining the production planning procedure, production control, Factors determining the production control, Capacity, Capacity planning, Aggregate planning and RCCP, Scheduling and its associated activities.
2. **Inventory Management:** Meaning & definition, purchasing, selection of suppliers, inventory management, material handling principles and practices, economic consideration, criteria for selection of materials handling equipment, standardization, codifications, simplification, inventory control, techniques of inventory control – ABC analysis, VED analysis, JIT, EOQ, FSN analysis.
3. **Method Engineering:** Concepts of standard time, method study, ergonomics, charts and diagrams, work measurements. **Automation**: introduction, meaning and definition, need, types, advantages and disadvantages.
4. **Transportation & Assignment Problems**: General structure- Methods of finding Initial basic feasible solution- North-West corner rule, Matrix minima method, Vogels approximation method. Test for optimality. Assignment problems-General structure, problems on maximization & minimization.
5. **Basics of Quality Control:** Statistical quality control, quality management, control charts & operating characteristics curves, acceptance sampling procedures, quality circles, meaning of ISO & TQM.Maintenance & waste management: Modern scientific maintenance methods.

Prerequisite Course: None

Reference Books:

1. "Production & Operations Management", Ashwathappa. K and Sridhar Bhatt, Himalaya Publishing House, 2012.
2. "Modern Production & Operations Management", Sarin Buffa, Wiley India Pvt. Ltd., 2011.
3. "Production & Operations Management", Victory E Sower, Michael J Sovie, MCB Ltd., 2012.
4. "Operations Research", N K Tiwari, Shishir K Shandilya, PHI Learning Pvt Ltd., 2009.
5. "Operations Research - Problems & Solutions", JK Sharma, Macmillan India Limited. 2010.

UM18BB156 MARKETING MANAGEMENT (3-0-0-0-3)

Course Objectives:

To develop an understanding of conceptual frame work of marketing management, service operations & its applications in Business.

Course Outcomes:

At the end of the course, the student should be able to

- Understand & explain concepts in marketing.
- Apply knowledge of key marketing concepts in an integrated manner
- Assess & develop marketing plans

Course Contents:

1. **Introduction to Marketing:** Introduction- Nature, scope, Importance, Definition of Marketing, Evolution of Marketing, Core Marketing concepts, Functions of Marketing, Marketing Management,
2. **Market Segmentation, Targeting And Positioning:** Meaning of segmentation, Bases of segmentation, Requisites of sound market segmentation, Target marketing, Positioning
3. **Product Decisions**: Product- Product Mix decisions, Product Line decisions, Classification of products, Levels of product, Product differentiation, Product life cycle, New product development,
4. **Pricing, Promotion and Distribution Decisions:** Pricing- Meaning, objectives, Factors influencing pricing policy, Methods of Pricin**g.** Promotion- Meaning and significance of promotion, Tools of promotion. Physical Distribution- Meaning, Factors affecting choice of channels, Types of channels of distribution.
5. **Recent Trends in Marketing:** E-Business, M-Business, concept marketing, relationship marketing, Event Marketing, Emotional marketing, Buzz marketing, Digital Marketing, Social Media Marketing, E-Tailing.

Prerequisite Course: None

Reference Books:

1. "Marketing Management," Philip Kotler, Kevin Keller, 14th Edition, Pearson Publications, 2014.
2. "Marketing Management", K. Karunakaran, 2nd Revised Edition, Himalaya Publishing House, 2013.
3. "Marketing Management", Mohammed Umair Skyward Publishers, 2013.

UM18BB157
COMPUTER LAB (0-0-2-0-1)

Course Objectives:

- The objective of the course is to introduce the concepts of computer fundamental & their applications for the efficient use of office technology in a business environment.

Course Outcomes:

At the end of the course, the student should be able to

- Demonstrate the basic technicalities of creating Word documents for office use.
- Create and design a spreadsheet for general office usage.
- Demonstrate the basic technicalities of creating a PowerPoint presentation.
- Demonstrate the practices in data & files management

Course Contents:

1. **Create a Word Document: Save (new folder), open and rename it:** Format the paragraphs; Change font size and style; Find and replace words; Page setup for printing; Cut, copy and paste options; Inserting bullets and numbering and formatting; Inserting Excel charts in word document; Importing and exporting data among MS office suites; Hide and unhide ruler; Change the various indents; Undo and redo operation; Spell checking ; Observe the difference between various views in the document; Insert page break, special symbols, Header – footer, date, time, text box, and pictures; Insert page border and text border; Study column options; Insert another document in the current document; Create autocorrect and auto-text entries; Insert line containing subscript and superscript; Enter text in tabular form to study various types of tabs; Insert different comments and background for different paragraphs. Change the text directions; create a label and envelop; Different letters using letter wizard
2. **Create Tables and Perform**: Inserting a table; Adding, deleting rows and columns; Table properties and auto format feature; Sorting a table; Drawing a table; Split and merge cells Converting tables to text and vice versa. **Perform the following operations using Mail-Merge**: Write a general letter using word formatting; Make a list of 20 students having USN, Name & Address; Create 20 letter of above students using Mail Merge
3. **Create a Worksheet:** Store the information of students containing, Sl. No, Name, Reg.no, Date of Birth, Fee paid, Marks in 5 Subjects, Total, Percentage, Class; Enter Details of 5 Students; Enter the serial number using series fill option; Calculate the Total, Percent and Class of all the students using functions; Format the Date of Birth to display in various formats; Insert new column after Reg.no; Insert rows to enter some more students information; Format the cells and range and in various format
4. **Using the Above-created Worksheet, Perform the Following Operations:** Sort the Worksheet using multiple fields; Show the percentage of all the students using Bar graph; Format the above graph (use various options like legends, data; Calculate the average percentage of different combination and illustrate it with Pie chart; Extract the details of students using auto filter feature; Find the name of the student who has scored highest and lowest total
5. **Create and Save Power Point presentation and perform the following operations:** Creating and Saving a new presentation using Auto Content wizard and Template; Editing and Formatting Text in a Presentation and working with Drawing Objects; Inserting Pictures, Slides, Sound, Date and Timings, Slide Number, Charts and Tables; Formatting Presentation by Setting Background, Applying Design Template and Other features; Customizing and Animating Presentation using Slide Show features.

Prerequisite Course: None

Reference Books:

1. "Fundamentals of Computers", Raja Raman.V, 4th edition, Prentice Hall of India Publishers, New Delhi.
2. Laboratory Manual material prepared by Department of BBA, PESU

UM18BB158
ACCOUNTS PRACTICAL- 2 (0-0-2-0-1)

Course Objective:

- To understand the advanced concepts of Financial Accounting using the accounting software- Tally.
- To equip the students with a strong application knowledge of the accounting software and help them develop a managerial perspective towards the same.

Course Outcomes:

At the end of the course, the student should be able to:

- Create inventory masters in Tally
- Prepare purchase procedure and sales procedure for a company in Tally
- Prepare payroll accounting in Tally
- Calculate ratios using Tally

Course Contents:

1. **Creation of Inventory Masters:** Stock Groups, Stock Categories, Units of Measurement, Price Lists, Item Master, Optional Features of Tally for Inventory Accounting – F11, Configuration options of Tally for inventory – F12, Inventory Transactions.
2. **Purchase Procedure in a Company :** Purchase Order, Receipt of Goods, Purchase invoice, Purchase Returns, Credit Note,
3. **Sales Procedure in a Company:** Sales Order, Dispatch of Goods, Sales invoice Sales Returns, Debit Note, Using Optional Vouchers for Purchase Enquiry, Quotations, Inventory Reports, Reports pertaining to inventory.

4. **Budgets and Controls :** Budget Masters and Configurations-Budget Reporting and Analysis
5. **Payroll Accounting :** Understanding Payroll- Pay Heads and Categories- Employee Details & Salary Details- Pay sheet & Pay Slips
6. **Analysis of Financial Statement :** Ratio analysis

Reference Books:

1. Laboratory Manual prepared by Department of BBA, PESU

UM18BB159
GERMAN LANGUAGE LEVEL – 2 (0-0-0-0-0)

Course objectives:

- Students will build on their vocabulary, grammar, listening, and communicative skills by acquiring more sophisticated forms and applications to be able to express their ideas and desires easily at a basic beginner's level.

Course Outcomes:

At the end of the course students are be able to

- Acquires communicative skills of listening, speaking, reading and writing as the just above basic level
- Communicate in German Language to survive as well as feel comfortable with German Speaking People.

Course Contents:

1. **Essen und Trinken -** (Food and Drink) How to ask the way, How to order food and drink,
2. **Einkaufen und Bestellen** - (Shopping & ordering). How to talk about going for shopping, How to ask and give prices, How to order food and drinks in a restaurant, How to say what you like eating and drinking,
3. **Freizeit** - (Leisure ...) How to say what people are doing, How to talk about leisure pursuits, How to state likes and dislikes,
4. **dieUhrzeit.**(the time.......). How to tell the time, How to talk about daily routines,
5. **Was machenwirheute?** - (What are we doing today?) How to describe/say, what's there to do in a given town, How to make appointments, How to say what you would like to do and what you have to do. How to say, why you can't do things on the date suggested

Prerequisite Course: None

Reference Books:

1. Manual material prepared by Department of BBA, PESU

UM18BB160
COMMUNICATIVE KANNADA – 2 (0-0-0-0-0)

Course Objective:

- To get basic knowledge in Kannada language, to speak in Kannada language & get communication skills.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the communication process in Kannada

Course Contents:

1. Personal Pronouns
2. Basic numerals
3. Relative nouns
4. Possessive forms of nouns
5. Ordinal numerals

Reference Books:

1. ಪ್ರೌಢಶಾಲಾ ಕನ್ನಡ ವ್ಯಾಕರಣ ಮತ್ತು ವಾಕ್ಯರಚನೆ – ಸಿ.ಎಸ್. ಬನಶಂಕರಯ್ಯ
2. ಕನ್ನಡ ಕಲಿ, ಸಂ.ಲಂಗದೇವರು ಹಳೆಮನೆ – ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ

UM18BB161
KANNADA KALI – 2 (0-0-0-0-0)

Course Objective:

- To impart skills in reading, listening, comprehending complex texts and communication

Course Outcomes:

At the end of the course, the student should be able to

- Get an insight of different media related communication and Kannada software
- Carry on one to one and group communication in Kannada effectively.

Course Contents:

1. Enquiring about Room – Predicative forms, Locative case
2. Vegetable Market – Dative case
3. About Medical College – Plural Markers
4. In a Cloth Shop – Colour adjectives, detective verbs
5. Plan to go for a picnic – Imperative, Permissions and hortative

Reference Books:

1. ಕನ್ನಡ ಕಲಿ, ಸಂ.ಲಂಗದೇವರು ಹಳೆಮನೆ – ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ
2. ಸಂವಹನ ಕೌಶಲ್ಯ – ಸಂ.ಡಾ.ಗಂಗಾಧರ – ಬೆಂಗಳೂರು ವಿಸ್ವವಿದ್ಯಾಲಯ

UM18BB162
KANNADA MANASU – 2 (0-0-0-0-0)

Course Objective:

- To enlighten the students with Kannada literature & impart skills in reading listening comprehending complex text and communication

Course Outcomes:

At the end of the course, the student should be able to

- Read and visualize text of an expository/ descriptive/ narrative nature; to identify salient points, deduce meanings of words, and recognize text organization.

Course Contents:

1. ನಮ್ಮ ಎಮ್ಮೆಗೆ ಮಾತು ತಿಳಿಯುವುದೇ? : ಗೊರೂರು ರಾಮಸ್ವಾಮಿ ಅಯ್ಯಂಗಾರ್
2. ಆನೆಹಳ್ಳದಲ್ಲಿ ಹುಡುಗಿಯರು : ಬಿ.ಜಿ.ಎಲ್ ಸ್ವಾಮಿ
3. ಬೆಡ್ ನಂಬರ್ ಏಳು : ತ್ರಿವೇಣಿ
4. ರೊಟ್ಟಿ ಮತ್ತು ಕೋವಿ : ಸು ರಂ ಎಕ್ಕುಂಡಿ
5. ವಿವಿಧ ಮಾಧ್ಯಮಗಳ ಪರಿಚಯ – ಪತ್ರಿಕೆ, ದೂರದರ್ಶನ, ರೆಡಿಯೋ, ಚಲನಚಿತ್ರ, ದೂರವಾಣಿ, ಅಂತರ್ಜಾಲ.

Reference Books:

1. ಕನ್ನಡ ಕಲಿ, ಸಂ.ಲಂಗದೇವರು ಹಳೆಮನೆ – ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ
2. ಸಂವಹನ ಕೌಶಲ್ಯ – ಸಂ.ಡಾ.ಗಂಗಾಧರ – ಬೆಂಗಳೂರು ವಿಸ್ವವಿದ್ಯಾಲಯ

UM17BB201
INTERNATIONAL BUSINESS (3-0-0-0-3)

Course objectives:

- The objective of the course is to enable the student grasp the sense of business happening in the International Arena, familiarize with the terminologies connected to global business & understand the various methods, tools and techniques in Global Business.

Course outcome:

At the end of the course, the student should be able to

- Identify & understand the business ramifications of globalization.
- Compare the relationships between international business and the political, economic, legal and social environment.

- Analyse current business environment and future opportunities and risks for international business activities.
- Develop suitable strategies to face global competition.

Course contents:

1. **Introduction**: Meaning-definition-Historical evolution-nature and need of international business-Difference between domestic, multinational, global, international , and transactional companies Why go international?-International stages and Orientations-drivers and restrainers of globalization-International business decisions
2. **International Business Environment**: Economic Environment-social/Cultural environment-Political environment-Technological environment
3. **Entry into International Business**: Exporting, Licensing, Franchising, Contract manufacturing, Turnkey projects, Foreign Direct Investments (FDI), Mergers and Acquisition, Joint Ventures and strategic alliances,
4. **Global Trade Environment**: Trade theories-trade strategies-Types of tariff and non-tariff barriers-Trade Blocs-WTO-GATT-NAFTA-SAARC-European Union-TRIPS-TRIMS-Free Trade Agreement-Boon/ bane?
5. **Organizations of International Business**: Logistics and supply chain management-international investment and finance-international organization and HRM- International business strategies

Prerequisite Course: None

Reference Books:

1. "International Business: Environment and Operations", Daniels, Johan D, Radebaugh, Lee H. Sullivan, Pearson Education, 2012.
2. "International Business Texts and Cases", Francis Cherunilam, PHI Publishers, 2010.
3. "International Business", Ashwathappa, Tata McGraw Hill, 2003.
4. "International Business", P. Subba Rao, HPH, 2009.

UM17BB202
ENTREPRENEURSHIP DEVELOPMENT (4-0-0-0-4)

Course Objectives:

- The objective of the course is to familiarize with the students with the entrepreneurship concepts, develop entrepreneurial talents and generate innovative business ideas in emerging industrial scenario.

Course Outcomes:

At the end of the course, the student should be able to

- Acquire the basic processes involved in starting or managing new ventures
- Understand methods to develop business plans for entrepreneurial ventures
- Apply the entrepreneurship knowledge to a new or existing company
- Identify the financial assistance available to MSME

Course Contents:

1. **Entrepreneurship:** Entrepreneurship: Introduction, Meaning, Definition, Differences between Entrepreneurship, Entrepreneur & Enterprise, Functions of Entrepreneur, Role of Entrepreneur for Economic Development, Factors influencing Entrepreneurship, Challenges of an Entrepreneur, Differences between Manager and Entrepreneur, Types of Entrepreneur. Entrepreneurs, problems and promotion Competency requirement for entrepreneurs - Awareness of self-competency and its development.
2. **Small and Medium Scale Enterprises:** Small and Medium Scale Enterprises: Definition, Meaning, Product Range, Capital Investment, Ownership Patterns, Problems faced by SME & the steps taken to solve the problems. Sickness in SME: Meaning, Definition, Causes of Industrial Sickness, Preventive, Remedial measures, Rehabilitation for Sick Industries.
3. **Preparing the Business Plan:** Business Plan: Meaning, Importance, preparation. Business Plan format: Financial aspects, Marketing aspects, People Resource, Technical aspects & Social aspects. Common pitfalls in preparation of Business Plan.
4. **Starting a Business:** Business Opportunity: Scanning the environment for opportunities, Evaluation of alternatives and selection based on personal competencies. Steps involved in promoting start-up, Steps involved in starting a Business Venture: Location, Clearances and permits required, Formalities, Licensing and Registration procedures. Assessment of the market for proposed project. Importance of financial, technical and social feasibility of the project.
5. **Project Assistance:** Project Assistance: Institutional support for Small and Medium Scale Enterprises – Central & State Government Policy regarding Small and Medium Scale Enterprises in India, Financial assistance through SFC's, SIDBI, Commercial Banks, Agile investors, Venture Capitalist & IFCI. Non-financial Assistance: DIC, SISI, AWAKE & KVIC. Financial incentives for SME , Assistance for obtaining Raw Material, Machinery, Technical Assistance, Land and Building. Industrial Estates: Role and Types.

Prerequisite Course: None

Reference Books:

1. "Essentials of Business Environment", K Ashwathappa, Himalaya Publishing House, 2011.
2. "International Business", Czinkota, Michael.R. The Dryden Press, Fortworth. 1999.
3. "Business, Financial Times", Bennet, Roger, Pitman Publishing, London, 2000
4. "Business: Environment and Operations", Danoes, John D. and Radebaugh, Lee H., 8th Edition, Addison Wesley, Readings, 1998.
5. "Business Environment", Francis Cherunilam, Text *& Cases*, Himalaya Publishing House, 2010.
6. "Business: A Managerial Perspective", Griffin, Ricky W. and Pustay Michael W, Addison Wesley, Readings, 1999.
7. "The Dynamics of Entrepreneurship Development and Management", Vasant Desai, Himalaya Publishing House, 2001.

UM17BB203
COST ACCOUNTING (4-0-0-0-4)

Course Objectives:

This course aims to provide students with basic concepts of cost accounting and introduces business management approach to the use of accounting information. The course is intended as an introduction for individuals who make business decisions and evaluate the performance of business units using data obtained from the accounting system

Course Outcomes:

The student will be able to

- Understand cost accounting knowledge, such as terminology, fundamental principles, classifications, generalizations & methods.
- Develop the acumen to understand various cost behaviour.
- Prepare cost sheets for various industries.

Course Contents:

1. **Introduction:** Cost Accounting – Definition – Meaning and Scope – Concept and Classification – Costing an aid to Management - Types and Methods of Cost – Elements of Cost-Preparation of Cost Sheet and Tender.

2. **Material Cost Control:** Material Control: Levels of material Control – Need for Material Control –Economic Order Quantity – ABC analysis – Perpetual inventory – Purchase and stores Control: Purchasing of Materials – Procedure and documentation involved in purchasing – Requisition for stores – Stores Control – Methods of valuing material issue-. FIFO, LIFO, Simple average and weighted average.
3. **Labour Cost Control:** System of wage payment – Time Rate, Piece rate, Taylor, Merrick, Piece Rate System, Incentive Schemes, Halsey – Rowan - Idle time – Control over idle time. Labour turnover.
4. **Overheads:** Classification – Allocation, Apportionment & Absorption of Overheads - Methods of Absorption of Factory Overheads.
5. **Job /Order, Batch, Contract and Process Costing:** Introduction, Job/order costing, Definition, Features, Job Sheet, Batch Costing, Definition, Batch Size, Contract Costing, Definition, Types of contract, Calculation of Profit, Process Costing, Definition, Characteristics, Application of Process costing , computation of abnormal gain and abnormal loss(excluding inter-process profit and equivalent production). Operating Costing - Contract costing- basic problems.

Prerequisite Course: None

Reference Books

1. "Cost and Management Accounting", M.N. Arora, Himalaya Publishing House, New Delhi, 2013.
2. "Cost and Management Accounting", S.P. Jain and K.L. Naran, 13th Edition, Kalyani Publishers, 2012.
3. "Cost Accounting", M.Y. Khan, P.K. Jain, 2nd Edition, McGraw Hill Education (India) Private Limited. 2014.
4. "Management Accounting Text - Problems And Cases,", M.Y Khan & P K Jain 5th Edition, 3rd Reprint, McGraw Hill Publication. 2011.
5. "Management Accounting", S.K. Gupta, Kalyani Publishers, New Delhi. 2011.
6. "Management Accounting", Pandey I.M., Vikas Publishing House, New Delhi. 2012.

UM17BB204
MANAGEMENT OF HUMAN CAPITAL (3-0-0-0-3)

Course Objectives:

The objective of the course is to provide the students' knowledge about nature and practice in Human Capital Management and their influence on Decision making skills.

Course Outcomes:

At the end of the course, the student should be able to

- Comprehend the fundamental principles, concepts, and practices in Human Capital Management.
- Analyse and synthesize the role of human resources management as it supports the success of the organization including the effective development of human capital as an element for organizational change.

Course Content:

1. **Human Capital Management:** Introduction, Role of HC Manager, Functions & challenges of HC Manager, Functions of HCM. **People Planning**- Introduction, Objectives, Importance, Short term and long term planning. Job Analysis & Evaluation.
2. **Recruitment, Selection & Training:** Recruitment- Sources of recruitment, procedure, e- recruitment, Social Media recruitment.

   Selection- Process of Selection, Basis of selection, Tests and Interviews, Process of Interview and its types.

   Training- Meaning, Importance, Training Need Analysis, Types of Training, Training Design & Kirkpatrick's, Training Evaluation Model.
3. **Development & Performance Appraisal:** Development-Objectives, Importance, Essential ingredients of Executive/ Management development Programme, Techniques of Development, Self-Development & ROI.

   Performance Appraisal: Need, objectives, Concept of Performance management, methods of Performance Appraisal, Systems of Performance appraisal, Feedback system and 720-degree appraisal. (Based on pre and post round of feedback)
4. **Career Management:** Career Planning, Career Development-Executive/Manager, Career Counselling, Promotion, Demotion & Transfer.

   Employee engagement: Importance, contributors, Parameters

   Grievance Redressal & Grievance Handling: Grievance Procedure, Discharge, Dismissal, Retrenchment, Lay-offs, Lockout. Employee Engagement: - Importance, Contributors, Parameters.
5. **Work Place Ethics and Recent Trends in HCM:** Work Place Ethics, Gender Equity, Internal compliance committee, Competency Mapping, Knowledge Management, Talent Management, Employer Branding, Right sizing.

Prerequisite Course: None

Reference Books:

1. "Fundamentals of HRM", Remond Noe, John R. Hollen Beck, Barry Gerhart, Patrick M., Tata McGraw Hill, 2012.
2. "Human Resource Management", Mirza and Saiyadin, 8th Edition, Tata Mac Graw Hill, 2013.
3. "Effective Human Resource Training and Development Strategy", Rathan Reddy Himalaya Publishing House, 2012.
3. "Human Resource Management - Principles and Practice," P. G. Acquinas, Vikas Publishing, 2012.
4. "Human Capital Management: Achieving Added Value Through People," Angela Baron, Michael Armstrong, British Library Cataloguing in Publication Data, 2007.
5. "Essentials of Human Resource Management and Industrial Relations", Subba Rao and Ganesh, Text, Cases, Himalaya Publishing House, 2010.

UM17BB205
FINANCIAL MANAGEMENT (3-0-0-0-3)

Course Objectives:

- This course enables students to understand the basic concepts of Financial Management and emphasizes the financial aspects of managerial decisions.

Course Outcome:

At the end of the course, the student should be able to

- Understand the basics of Financial Management.
- Inculcate the attitude of analytic thinking.
- Illustrate real time financial management elements like EPS, operating profit, cost of capital and investment decision.

Course Contents:

1. **Introduction to Corporate Finance:** Corporate Finance: Introduction, Meaning, Corporate Finance, Finance Function Role of Finance Manager. Goals of Financial Management-Profit maximization Vs Wealth Maximization. Sources of fund: Long term and short term sources of fund.
2. **Time Value of Money:** Time Preference for Money, Future Value, Present Value, Annuities, Multi period compounding, Risk-return

relationship. **Investment decision:** Capital Budgeting: Meaning & Definition- Techniques: Payback Period, Accounting Rate of Return, Net Present Value, Internal Rate of Return, Profitability Index.(Simple Problems)

3. **Cost of Capital:** Cost of Capital: Meaning, Computation of Cost of capital, cost of equity, preference, risk cost of equity, Debt, Retained earnings, calculation of weighted average cost of capital.
4. **Capital Structure & Leverages:** Meaning, Factors influencing Capital structure, Capital structure theories- EBIT-EPS Analysis Leverages: concept, Types of Leverages- computation of leverages. (Simple problems)
5. **Dividend Decision:** Introduction, Meaning, Definition, Determinants of Dividend Policy, Types of Dividends, Dividend Theories- Walters Model, Gordon's Model, Legal and Procedural aspects of payment of Dividend. **Management of working capital:** Introduction, Concept, Types, components of working capital. Significance of Adequate Working Capital, Evils of Excess or Inadequate Working Capital, Determinants of Working Capital. Working capital -Estimation -Techniques, Latest trend in W.C. finance

Prerequisite Course: None

Reference Books:

1. "Financial Management", I M Pandey, Vikas Publishing House Pvt. Ltd, 2009.
2. "Financial Management", Prasanna Chandra, Tata McGraw-Hill Education, 2011.
3. "Financial Management" Khan and Jain, Tata McGraw-Hill Education, 2012.
4. "Financial Management," S N Maheshwari, Sultan and Chand Publications, 2014.
5. "Financial Management", Sharma and Sashi Gupta, Kalyani Publications, 2011.

UM17BB206
BUSINESS REGULATIONS (4-0-0-0-4)

Course Objectives:

- The objective of the course is to introduce the students towards various regulations affecting business and familiarize with business regulations.

Course Outcome:

At the end of the course, the student should be able to

- Appreciate the relevance of business law to individuals and businesses and the role of law in an economic, political and social context
- Identify the fundamental legal principles behind contractual agreements
- Examine how businesses can be held liable in tort for the actions of their employees
- Explain the legal and fiscal structure of different forms business organizations and their responsibilities as an employer acquire problem solving techniques and to be able to present coherent, concise legal argument
- Understand the basic theoretical concepts of direct taxes

Course Contents:

1. **Introduction:** Nature of law, meaning and definition of business laws, scope and sources of business law, fundamental rights and directive principle of state policies' principles having legislation, an overview of business laws in India.
2. **Contract Laws:** Definition – types of contracts – essentials of valid contracts – offer, acceptance, consideration, capacity of parties, free consent, legality of object and consideration, various modes of discharge of a contract, performance of contracts, remedies for breach of contract. Intellectual Property Laws: Meaning and scope of intellectual properties – Patent Act of 1970 and its amendments as per WTO agreement, back ground, objects, definition, Inventions, patentee, true and first inventor, procedure for grant of process and product. Patents, WTO rules as to patents, rights to patentee – infringement – remedies. The copy rights act, meaning – its uses and rights.
3. **Competition Laws:** Concept of Competition, Development of Competition Law, Overview Of MRTP Act 2002, Anticompetitive Agreements, Abuse of Dominant Position, Combination, Regulation of Combinations, Competition Commission of India; Appearance Before Commission, Compliance of Competition Law
4. **Consumer Laws:** Consumer Protection Act 1986: Back Ground – Definitions – Consumer, Consumer Dispute, Complaint, Deficiency, Service, Consumer Protection Council, Consumer Redress Agencies, District Forum, State Commission and National Commission.
5. **Laws to Prevent Money Laundering:** Money Laundering Act, Prevention of Money Laundering- Genesis and Definitions, Various Transactions. Obligations of Banks and Financial Institutions, RBI Guidelines on know your client.

Prerequisite Course: None

Reference Books:

1. "A Manual of Mercantile Law", Shukla, M.C, Sultan Chand and Sons, New Delhi, 2010.
2. "Business Law", Kuchhal, M.C, Vikas Publishing House, New Delhi, 6th Edition, 2010.
3. "Business Law: Text & Exercise ", Miller, R.L.R. & Hollowell, W.E., 6th Edition, 2010.
4. "Business Law for Management", Bulchandani, K.R., Himalaya Publishing House, 6th Edition, 2009.
5. "Business Law" Kapoor, N.D., Sultan Chand & Sons, 29th Edition, New Delhi, 2007.
6. "Direct Taxes", Girish Ahuja and Ravi Gupta, Wolters Kluwer, Recent Edition, 2010.

UM17BB207
HUMAN CAPITAL PRACTICAL (0-0-2-0-1)

Course Objectives:

- To achieve efficiency and effectiveness by mean of management of Human Capital. Management of Human Capital serves other functional areas, so as to help them to attain efficiency in their operations and attainment of goals to attain efficiency.

Course Outcomes:

At the end of the course, the student should be able to

- Understanding of how to utilize management of Human Capital to enhance Organizational Performance.
- Management of Human Capital as a mode of improvement in efficiency and effectiveness of Organizational operations.

Course Contents:

1. Change Agent - Strategic Partner - Employee Interviews- Employee Champion
2. Recruitment and Selection Process - Employee Training Programme - Employee Performance Appraisal - Career Counselling - Talent Identification - Employee Engagement - Employer Branding - Grievance Procedure - SWOT analysis

Prerequisite Course: None

Reference Books:

1. "Fundamentals of HRM", Remond Noe, John R. Hollen Beck, Barry Gerhart, Patrick M, Tata Mac Graw Hill, 2012.

2. "Human Resource Management", Mirza and Saiyadin, Tata McGraw -Hill Publisher, 8th Edition, 2013.
3. "Effective Human Resource Training and Development Strategy" Rathan Reddy, Himalaya Publishing House, 2012.
4. "Human Resource Management - Principles and Practice", P. G. Acquinas, Vikas Publishing, 2012.

UM17BB208
FINANCIAL MANAGEMENT PRACTICAL (0-0-2-0-1)

Course Objectives:

- To obtain the ability to use tools of analysis such as Time value of money, cost of capital, capital budgeting, capital structure, leverages, dividend decisions and working capital management

Course Outcomes:

At the end of the course, the student should be able to

- Calculate the compound value and present value of cash flows, financial leverage, operating leverage, combined leverage, payback, NPV, IRR, ARR, profitability index and value of the firm
- Compute cost of specific source of finance and weighted average cost of capital.
- Determine EPS, EBIT. Optimum Pay-out of dividend, and Market price of the share at different dividend pay-out
- Estimate Working Capital requirements of the firm

Course Contents:

1. Problems in time value of Money
2. Computation of cost of capital
3. Appraising of capital budgeting proposals
4. Case studies in capital structure
5. Financial analysis through leverages
6. Dividend theory of relevance and irrelevance
7. Estimation of working capital requirement

Prerequisite Course: None

Reference Books:

1. "Financial Management", I M Pandey, Vikas Publishing House Pvt. Ltd., 2009.
2. "Financial Management", Prasanna Chandra, Tata McGraw-Hill Education, 2011.
3. "Financial Management," Khan and Jain, Tata McGraw-Hill Education, 2011.

UM17BB209
GERMAN LANGUAGE LEVEL - 3 (0-0-0-0-0)

Course Objectives:

- Continuing to build upon the previously learned skills, students will acquire additional vocabulary and grammatical forms
- To enable them to engage in complex conversations and to write proficiently. Students will also be introduced to contemporary life and culture in German-speaking countries.

Course Outcomes:

At the end of the course, the student should be able to

- Learn basic conversation based on daily routine activities.
- Express their ideas with a full command of adjectives, adverbs and prepositional phrases.
- Understand the three major tenses, present, past, and future with some combinations of imperfect, conditional and subjunctive, as well as the passive voice.

Course Contents:

1. **EineFahrkartenach Heidelberg, bitte** (a ticket to Heidelberg, please)-How to buy a ticket and read timetables, How to say how to travel to work or university, How to ask how you can get somewhere, Language points/Grammar: dative after preposition, Audio, Vocabulary- Expression.
2. **Was hast du am Wochenende gemacht** (What did you do at the weekend?) How to say what happened at the weekend, How to talk about recent events, How to describe purchases, Language points/Grammar: perfect tense adjectival ending, Audio, Vocabulary- Expression.
3. **Wirsind ins Grunegefahren**(We went into the countryside) How to talk about recent events (continued), How to talk about more distant past, Language points/Grammar: more on the perfect tense, Audio, Vocabulary- Expression.
4. **Wohnen in Deutschland** (living in Germany, How to talk about different kinds of housing, How to name the various rooms in a house or a flat, How to make comparisons, Language points/Grammar: more on the dative, the comparative, Audio, Vocabulary- Expression.
5. **Welches Hotel nehmenwir?** (Which hotel shall we take?), How to book a hotel room, How to compare different hotel, How to describe the location of buildings, Language points/ Grammar: the superlative, more prepositions (+acc/dat), Audio, Vocabulary- Expression.

Prerequisite Course: None

Reference Book:

1. Study material prepared by Department of BBA, PESU

UM17BB210
COMMUNICATIVE KANNADA – 3 (0-0-0-0-0)

Course Objective:

- To get basic knowledge in Kannada language, to speak in Kannada language & get communication skills.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the communication process in Kannada

Course Contents:

1. Possessive forms of Nouns
2. Dubitive questions
3. Relative Nouns
4. Dative Case
5. Verbs

Reference Books:

1. ಪ್ರೌಢಶಾಲಾ ಕನ್ನಡ ವ್ಯಾಕರಣ ಮತ್ತು ವಾಕ್ಯರಚನೆ – ಸಿ.ಎಸ್. ಬನಶಂಕರಯ್ಯ
2. ಕನ್ನಡ ಕಲಿ, ಸಂ.ಲಂಗದೇವರು ಹಳೆಮನೆ – ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ

UM17BB211
KANNADA KALI – 3 (0-0-0-0-0)

Course Objectives:

- To impart skills in reading, listening, comprehending complex texts and communication

Course Outcomes:

At the end of the course, the student should be able to

- Get an insight of different media related communication and Kannada software
- Carry on one to one and group communication in Kannada effectively.

Course Contents:

1. Enquiring about one's family – Verb, Corresponding negotion
2. Plan to go for a movie – Comparative, Past tense
3. Conversation between Doctor and Patient – Potential forms, accusative case
4. Enquiring about friend's family – Past Tense
5. Conversation between friends – Past Tense – Negation Verbal noun

Reference Books:

1. ಕನ್ನಡ ಕಲಿ, ಸಂ.ಲಂಗದೇವರು ಹಳೆಮನೆ – ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ
2. ಸಂವಹನ ಕೌಶಲ್ಯ – ಸಂ.ಡಾ.ಗಂಗಾಧರ – ಬೆಂಗಳೂರು ವಿಸ್ವವಿದ್ಯಾಲಯ

UM17BB212
KANNADA MANASU – 3 (0-0-0-0-0)

Course Objectives:

- To enlighten the students with Kannada literature & impart skills in reading listening comprehending complex text and communication

Course Outcomes:

At the end of the course, the student should be able to

- Read and visualize text of an expository/ descriptive/ narrative nature; to identify salient points, deduce meanings of words, and recognize text organization.

Course Contents:

- ಗುಬ್ಬಚ್ಚಿಯ ಗೂಡು : ಪಿ ಲಂಕೇಶ್
- ಚೇಂಕ್ರ ಮೇಸ್ತ್ರಿ ಮತ್ತು ಅರಿಸ್ಟಾಟಲ್ : ಕೆ ಪಿ ಪೂರ್ಣಚಂದ್ರ ತೇಜಸ್ವಿ
- ಗಾಂಧಿ: ಬೆಸಗರಹಳ್ಳಿ ರಾಮಣ್ಣ
- ಬೆಲ್ಚಿಯ ಹಾಡು: ಸಿದ್ದಲಿಂಗಯ್ಯ
- ಸಂವಹನ ಮತ್ತು ವ್ಯಾವಹಾರಿಕ ಕನ್ನಡ, ಜಾಹಿರಾತು, ಕನ್ನಡ ಸಾಫ್ಟ್‌ವೇರ್

Reference Books:

1. ಕನ್ನಡ ಮನಸು : ಪ್ರಕಾಶಕರು: ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ
2. ಸಂವಹನ ಕೌಶಲ್ಯ – ಸಂ.ಡಾ.ಗಂಗಾಧರ – ಬೆಂಗಳೂರು ವಿಸ್ವವಿದ್ಯಾಲಯ

UM17BB251
TAXATION - 1 (4-0-0-0-4)

Course Objectives:

- This course assists in understanding the basic concepts of income tax.
- The course provides understanding of computation of income and tax liability of individuals under different heads.
- This course provides understanding the implications of different deduction and of tax liability income tax.

Course Outcome:

At the end of the course, the student should be able to

- Explain the basic concepts of income tax.
- Exhibit skills in computation of taxable income under different heads of income.
- Exhibit skills in computation of tax liability of individuals and implications of set off and carry forward

Course Contents:

1. **Income Tax Act:** Definition – Income – Agricultural Income – Assessee – Previous year – Assessment year – Residential Status – Scope of Total Income – Capital and Revenue – Receipts and Expenditure – Exempted Incomes.
2. **Computation** of Income from Salaries and Income from House Property. (Simple problems).
3. **Computation of Profits and Gains of Business or Profession**: Calculation of Capital Gain. (Simple problems)
4. **Computation of Income from Other Sources**: Set-off and carry Forward of Losses - Deduction from Gross Total Income.
5. **Assessment of Individuals-Income Tax Authorities**: Procedure for Assessment – Tax Deducted at Source (TDS) – Residents and to Non – Residents – Tax collected at Source.

Prerequisite Course: None

Reference Books:

1. "Income Tax Law & Practice", Gaur & Narang, DP Kalyani Publishers, New Delhi, 2017.
2. "Income Tax Law & Practice", H.C.Mehorotra, Prentice Hall Pvt Ltd, New Delhi, 2017.
3. "Tax Laws", Dingar Pagare, S.Chand & Sons Publisher, New Delhi, 2015.
4. "Income Tax", Bhagavathi Prasad, Wishwa Prakashan, New Delhi, 2015.
5. "Direct Taxes", Vinod K. Singhania, Taxmann's Publications, New Delhi, 2015.

UM17BB252
DIGITAL MARKETING (3-0-0-0-3)

Course Objectives:

- This course builds understanding of digital marketing & how to develop innovative strategies in display advertising, social media marketing, mobile & internet marketing, search engine optimization & marketing & website design to produce a higher response to your online marketing efforts. It also equips the students with the tools needed for creating & implementing for digital marketing campaigns as an entrepreneur or as a professional.

Course Outcomes:

At the end of the course, the student should be able to

- Understand fundamentals of Digital Marketing
- Understand online marketing efforts
- Recognize digital marketing tools

Course Contents:

1. **Introduction to Digital Marketing:** Marketing, Digital Marketing, Understanding marketing Process, Benefits of Digital Marketing, Digital Marketing platforms and strategies, defining marketing goals, latest Digital Marketing trends.
2. **Search Engine Optimisation**: Working principle of Search Engine, components of Search Engine, Google Algorithms, Google result page, online resources, Key word search, Business analysis and categorisation, SEO ranking signals.
3. **PPC Advertising**: Introduction to Paid Marketing, Google Account setup, Interface Tour and Billing Settings, Account Structure, Campaigns settings, AdGroup setup, Keyword Match Types, Keyword Research Tools, Understanding Ad Auction, Quality Score, Factors to improve Quality Score, Types of CPC's, Bidding strategies , Ad Formats, Ad Guidelines, Ad Extensions
4. **Google Analytics**: Introduction , Importance of Analytics for Business, Popular Analytics Software's, Key Performance Metrics [KPI] in Analytics - Visits and Users - Time on Page / Site - Bounce Rate - Exit Rate - Conversion Rate Engagement , Installing Analytics code in site, Analytics account structure.
5. **Mobile Marketing & Video Marketing**: Growth, benefits, mobile marketing goals, creating a mobile website, app creation strategy, best practice in video ads.
6. **Social Media Marketing**: SMM vs SMO, benefits of SMM, social media statistics, social media strategy, impact of social media on SEO, Facebook marketing, Facebook advertising.

Prerequisite Course: None

Reference Books:

1. “Understanding Digital Marketing”, Marketing Strategies for Engaging the Digital Generation”, Damian Ryan, Tata Mac Graw Hill. 2010.
2. “Digital Marketing: Strategy, Implementation & Practice”, Dave Chaffey & Fiona Ellis-Chadwick, Everest Publishers, 2015.

UM17BB253
PROJECT MANAGEMENT (3-0-0-0-3)

Course Objective:

- The objective of the course is to enable the students to understand the concept of Project Management, its feasibility to develop and implement project Management Decisions.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the basic concept of project feasibility and management
- Analyse and make decisions in project scenario.
- Evaluate the project feasibility condition, internal and external factors influencing project implementation and its costs and revenues.

Course Contents:

1. **Introduction to Project Management:** Understanding Project, features, types of project, Project family tree, Project Life cycle, Project Manager, Defining Project Managers, Project Manager Roles, Project Manager as a planning agent, Project Driven Vs Non Project Driven organization, Marketing in the Project Driven Organization, Position of the Project Manager, Programs and Projects, Product Vs Project Management.
2. **Project Planning:** Identifying strategic project variables, Project planning, Statement of work, Project specifications, Milestone schedule, Work breakdown structure, Project planning cycle, Management Control.
3. **Feasibility of the project:** Technical feasibility, marketing feasibility, socio economic feasibility, Managerial feasibility and financial feasibility.
4. **Project Evaluation and Review techniques:** Objectives of Network Analysis, Estimating activity time, Estimating total program time, PERT/CPM planning, Crash time, Differences between CPM and PERT
5. **Project Management Functions:** Controlling, Directing, Project authority, Risk management - Sensitivity Analysis - Simulation Analysis - Decision Tree Analysis, Team building, Leadership, communications, Project review meetings, Reverse Financial Engineering.

Prerequisite Course: None

Reference Books:

1. “Operations Research: Problems & Solutions” , J.K .Sharma, Macmillan India Limited, 2014.
2. “Managing Projects”, Harvard Business Review, Harvard Business Publishing, March 2014.
3. “Fundamentals of Corporate Finance”, Ross Westerfield Jordan, Tata-McGraw Hill Publisher, 2012.
4. “Corporate Finance Theory and Practice”, Ashwath Damodaran, Wiley India Pvt Ltd., 2007.

UM17BB254
SUPPLY CHAIN MANAGEMENT (3-0-0-0-3)

Course Objectives:

- This course will equip students with knowledge of supply chain management and the specific knowledge, skills and attitudes to immediately contribute to organizational objectives at the appropriate entry level.

Course Outcomes:

At the end of the course, the student should be able to

- Explain supply chain management, contrast it from operations management and propose the main performance drivers of supply chain performance.
- Relate the strategic role and impact of IT technologies on supply chain integration.
- Express the major slacks in supply chains and formulate the approaches to manage them.
- Analyze the inventory management methodologies and apply the existing models to propose the optimal order sizes

Course Contents:

1. **Introduction to SCM**: Development of SCM Concepts and Definitions – Key Decision Areas – Strategic Supply Chain Management and Key Components, External Drivers of Change. Dimensions of Logistics – The Macro Perspective and Macro Dimension – Logistic System Analysis, Role of SCM - Make in India.
2. **Information Technology in the Supply Chain:** IT Framework - E Commerce and Supply Chain Management. Organizational Issues and Supply Chain. ERP and Supply Chain Management, Bull -Whip Effect.
3. **Sourcing Strategy**: The Role of Sourcing in a Supply Chain - In-House or Outsource - Supplier Scoring and Assessment - Supplier Selection-Auctions and Negotiations - Contracts and Supply Chain Performance - The Procurement Process - Sourcing Planning and Analysis - The Role of IT in Sourcing - Making Sourcing Decisions in Practice
4. **Distribution Strategy:** The Role of Distribution in the Supply Chain - Factors Influencing Distribution Network Design - Design Options for a Distribution Network - e-Business and the Distribution Network - Distribution Networks in Practice - The Role of IT in Network Design - Evaluating Network Design Decisions Using Decision Trees
5. **Inventory Strategy:** Demand Forecasting – Inventory Planning – Planning of Stocking Facilities – Warehouse Location Allocation. Warehouse Design and Operations – Inventory Norms.

Prerequisite Course: None

Reference Books:

1. “Essentials of Supply Chain Management”, R.P. Mohanty & S.G. Deshmukh Jaico Publishing House, 2010.
2. “Supply Chain Management- Strategy, Planning & Operations”, 4th Edition, Sunil Chopra & Peter Meindi, Pearson Education, New Delhi, 2010.
3. “Designing & Managing The Supply Chain”, David Simchi-Levi, Philip Kamiusky, Edith Simchi-Levi , TATA Mc-Graw Hill Publication, 2012.

UM17BB255
DIGITAL MARKETING LAB (0-0-2-0-1)

Course Objectives:

- This course builds understanding of digital marketing & how to develop innovative strategies in display advertising, social media marketing, mobile & internet marketing, search engine optimization & marketing & website design to produce a higher response to your online marketing efforts. It also equips the students with the tools needed for creating & implementing for digital marketing campaigns as an entrepreneur or as a professional.

Course Outcomes:

At the end of the course, the student should be able to

- Understand fundamentals of Digital Marketing
- Understand online marketing efforts
- Recognize digital marketing tools

Course Contents:

1. **Introduction to Digital Marketing:** Marketing, benefits of Digital Marketing, Digital Marketing platforms and strategies, defining marketing goals, latest Digital Marketing trends.
2. **Search Engine Optimisation**: Working principle of Search Engine, components of Search Engine, Google Algorithms, Google result page, online resources, Key word search, Business analysis and categorisation, SEO ranking signals.
3. **PPC Advertising**: Introduction, Google account setting, Interface tour and billing settings, campaign settings, Adgroups setup, Ad format.
4. **Mobile Marketing & Video Marketing**: Growth, benefits, mobile marketing goals, creating a mobile website, app creation strategy, best practice in video ads.
5. **Social Media Marketing**: SMM vs SMO, benefits of SMM, social media statistics, social media strategy, impact of social media on SEO, Facebook marketing, Facebook advertising.

Prerequisite Course: None

Reference Books:

1. "Understanding Digital Marketing", Marketing Strategies for Engaging the Digital Generation", Damian Ryan, Tata Mac Graw Hill. 2009

UM17BB256
PROJECT MANAGEMENT PRACTICAL (0-0-2-0-1)

Course Objectives:

- The course offers a practical approach to managing projects, focusing on organizing, planning, and controlling the efforts of the project. Students participate in structured workshops where simulated project plans are designed, implemented and evaluated.

Course Outcomes:

At the end of the course, the student should be able to

- Understand & apply Practical applications of project management to formulate strategies in constructing & implementation.
- Critical-thinking and analytical decision-making capabilities to investigate complex business problems to propose project-based solutions.

Course Contents:

1. **Introduction to Projectlibre and Project Management**: Overview of Projectlibre, Introduction to project management terminology, Tasks, resources and costs, Installing project libre, navigation.
2. **Create a Project:** Defining activities and sub activities.
3. **Activities**: Defining activity durations and Predecessors relationships.
4. **Understanding WBS**: critical activities, non-critical activities, progression of project.
5. **Resource Usage**: Defining types of Resources and allocation of the resources to activities.
6. **Baselines**: Working with Baselines, interpretation of baselines.
7. **Reporting:** Reports generation.
8. **Exercises :** Rock band Show organizing, Software development, Construction, Manufacturing Plant, Exams Conduction, Conference organization

Prerequisite Course: None

Reference Books:

1. "Operations Research: Problems & Solutions," JK Sharma, Macmillan India Limited, 2010.
2. "Managing Projects", Harvard Business Review, Harvard Business Publishing, 2014.

UM17BB257
GERMAN LANGUAGE LEVEL – 4 (0-0-0-0-0)

Course Objectives:

- Continuing to build upon the previously learned skills, students will acquire additional vocabulary and grammatical forms
- To enable them to engage in complex conversations and to write proficiently. Students will also be introduced to contemporary life and culture in German-speaking countries

Course Outcomes:

At the end of the course the students are able to

- Complete reading, writing, speaking, and listening assignments with ever increasing proficiency and accuracy.
- Increase grammatical accuracy on written assignments.
- Increase grammatical accuracy in conversational German.
- Use and understand a wide range of vocabulary items from the skill areas covered in class.

Course Contents:

1. **ist Mode wichtig?** (Is fashion important?). How to describe items of personal appearance, How to say what clothes you like wearing,
2. **und was kann man ihnenschenken?** (and what can we give them?). How to read invitations to various events - How to say what is given to whom, How to ask for help and advice,
3. **Gesundheit** (health………). How to discuss health, - How to name parts of the body,
4. **Wohnen in Deutschland** (living in Germany). How to talk about different kinds of housing, How to name the various rooms in a house or a flat, How to make comparisons,
5. **Telefonieren und die Geschaftswelt** (Telephoning and the business world). How to make and answer phone calls, How to say what belongs to whom,

Prerequisite Course: None

Reference Book:

- Study material prepared by Department of BBA PESU

UM17BB273
COMMUNICATIVE KANNADA – 4 (0-0-0-0-0)

Course Objective:

- To get basic knowledge in Kannada language, to speak in Kannada language & get communication skills.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the communication process in Kannada

Course Contents:

1. Colour adjectives
2. Reflective Verbs

3. Plural Markers
4. Past & Future Tense
5. Present & Perfect Tense

Reference Books:

- ಪ್ರೌಢಶಾಲಾ ಕನ್ನಡ ವ್ಯಾಕರಣ ಮತ್ತು ವಾಕ್ಯರಚನೆ – ಸಿ.ಎಸ್. ಬನಶಂಕರಯ್ಯ
- ಕನ್ನಡ ಕಲಿ, ಸಂ.ಲಂಗದೇವರು ಹಳೆಮನೆ – ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ

UM17BB274
KANNADA KALI – 4(0-0-0-0-0)

Course Objective:

- To impart skills in reading, listening, comprehending complex texts and communication

Course Outcomes:

At the end of the course, the student should be able to

- Get an insight of different media related communication in Kannada software
- Carry on one to one and group communication in Kannada effectively.

Course Contents:

1. Routine activities of a student – Group Discussion
2. About children's education – Discussion about present day problems
4. Halebeedu – Beluru – History of Karnataka
5. Discussion about examination – Discussion about student related problems
6. Karnataka History & Culture – Knowledge about Karnataka

Reference Books:

1. ಕನ್ನಡ ಕಲಿ, ಸಂ.ಲಂಗದೇವರು ಹಳೆಮನೆ – ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ
2. ಸಂವಹನ ಕೌಶಲ್ಯ – ಸಂ.ಡಾ.ಗಂಗಾಧರ – ಬೆಂಗಳೂರು ವಿಸ್ವವಿದ್ಯಾಲಯ

UM17BB275
KANNADA MANASU – 4 (0-0-0-0-0)

Course Objective:

- To enlighten the students with Kannada literature & impart skills in reading listening comprehending complex text and communication

Course Outcomes:

At the end of the course, the student should be able to

- Read and visualize text of an expository/ descriptive/ narrative nature; to identify salient points, deduce meanings of words, and recognize text organization.

Course Contents:

1. ಎಲ್ಲ ಹುಡುಗಿಯರ ಕನಸು : ಸವಿತಾ ನಾಗಭೂಷಣ್
2. ನೀರು: ಬಸವರಾಜ ಕುಕ್ಕರಹಳ್ಳಿ
3. ಕರ್ನಾಟಕ ಸಂಸ್ಕೃತಿಯ ಒಂದು ಚಿತ್ರ : ರಹಮತ್ ತರೀಕೆರೆ
4. ವೃತ್ತಿ ಶಿಕ್ಷಣದಲ್ಲಿ ಕನ್ನಡ ಮಾಧ್ಯಮ: ಎಸ್. ಸುಂದರ್
5. ಕೊಣವೇಗೌಡ (ಕಾವ್ಯ): ಜಾನಪದ

Reference Books:

1. ಕನ್ನಡ ಕಲಿ, ಸಂ.ಲಂಗದೇವರು ಹಳೆಮನೆ – ಕನ್ನಡ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಹಂಪಿ
2. ಸಂವಹನ ಕೌಶಲ್ಯ – ಸಂ.ಡಾ.ಗಂಗಾಧರ – ಬೆಂಗಳೂರು ವಿಸ್ವವಿದ್ಯಾಲಯ

UM17BB258
SALES MANAGEMENT (4-0-0-0-4)

Course Objectives:

- To examine managerial issues surrounding sales force management. These include motivation and training issues, sales force recruitment issues, and evaluation and analysis of the sales force
- To familiarize students with the activities involved in managing a sales force.

Course Outcomes:

At the end of the course, the student should be able to

- Demonstrate an understanding of the role that a sales force plays in marketing strategies,
- Describe the selling process,
- Understand the factors that affect sales force success,
- Identify and explain the processes involved in recruiting, selecting, training, motivating, compensating, and retaining sales people.

Course Contents:

1. **Introduction to Sales Management**: Nature, Scope and Importance of Sales Management, Evolution of Sales Management, Role and Skills of Sales Managers, Sales Objectives, Sales Strategies, Emerging Trends in Sales Management, Difference between Marketing strategies and Sales Strategies.
2. **Personal Selling:** Personal Selling Process, Theories of Selling, SPIN Model, Types of Selling, Transactional and Relationship Selling, Sales Forecasting Methods.
3. **Sales Organization and Relationship:** Purpose of sales organization - Types of sales organization structures - Sales department external relations - Distributive network relations, Sales leadership
4. **Sales Force Management**: Sales Force Recruitment and Selection Process, Design, Execution and Evaluation of Sales Force Training, Motivation and Compensation of Sales Personnel, Design and Management of Sales Territories and Quotas.
5. **Evaluation of Sales Personnel**: Sales Budgets, Sales Audits, Legal and Ethical Issues in Sales Management, Role of Information Technology in Sales Management

Prerequisite Course: None

Reference Books:

1. "Sales Management, Principles, Process and Practice", Donaldson Bill Palgrave Macmillan, 2007.
2. "Selling and Sales Management", 7th Edition, Jobber, David and Lancaster, Geoffery, Pearson Education, New Delhi, 2006.
3. "Sales Management-Analysis and Decision Making Ingram", LaForge, Avila.Schwepker Jr, Williams, Thomson South – Western, 2007.

UM17BB259
CONSUMER BEHAVIOUR (4-0-0-0-4)

Course Objectives:

- The course deals with the behavioural aspects of Marketing Management stakeholder's. It explains how the consumers behave under circumstances and how the cultural, social, personal and psychological factors influence their behaviour.

Course Outcomes:

At the end of the course, the student should be able to

- Define the concepts in consumer psychology.
- Explaining psychological process of consumers & how they behave accordingly.
- Analyse the influence of demographic factors in individual buying behaviour.
- Apply the basic models of consumer behaviour in real marketing environment.

Course Contents:

1. **Introduction to Consumer Behaviour:** Meaning, Types of consumers, Interdisciplinary nature of Consumer Behaviour,

Scope and Application, current trends. Concept of consumerism, consumerism in India, reasons for growth of consumerism, Types of buying, major features of consumer protection act 1986.

2. **Consumer Decision Making Process:** Problem recognition, Pre purchase search, purchasing process, Post purchase behaviour, Concept of Consumer Satisfaction, sources of consumer dissatisfaction, dealing with consumer complaint, working towards enhancing consumer satisfaction, (Models of Consumer Behaviour.)
3. **Individual and External Determinants of Consumer Behaviour:** Traditional and contemporary Behavioural Theories– Expectation confirmation theory and Three stage model of Buyer Behaviour (John – Howard and Jagdish Sheth, Nicosia Model) Family Influences: FLC stages, Family decision making, Dynamics of husband wife decision making, Role of child in decision making, Household decision making. Group Influence: Reference group, Types of reference group, Nature of reference groups and its influence on consumers.
4. **Influence of Social Class, Culture and Subculture on Consumer Behaviour:** Measurement of Social class, Life style profiles, VALS, AIOS, and Social class mobility. Expert talk on influence of Culture and Subculture on Consumer Behaviour- religious, regional, racial, age and gender.
5. **Diffusion of Innovation:** Innovation: Diffusion process, Channels of communication, Social system and time, Stages adoption process, Information sources

Prerequisite Course: None

Reference Books:

1. "Consumer Behaviour", Jay D. Lindquist & M. Joseph Sirgy, Biztantra Publication, 2009.
2. "Consumer Behaviour", Leon, S., & Leslie, K., 10th Edition, Prentice Hall, 2009.
3. "Consumer Behaviour and Marketing Action", Assael Henry, 6th Edition, Asian Books (P) Ltd., 2009.
4. "Consumer Behaviour in Indian Perspective", Nair. R. Suja, 1st Edition Reprint, Himalaya Publishing House, 2002.

UM17BB260
BRAND MANAGEMENT (4-0-0-0-4)

Course Objectives:

- To develop students' understanding of the importance of brand equity as well as how to build, measure, and manage brand equity. It will cover topics in the utilities of branding, steps/ process of building brands, methods of measuring brand equity, ways to leverage brand equity, strategies in managing brand portfolios, and management of brands over time, geographic boundaries, and market segments.

Course Outcomes:

At the end of the course, the student should be able to

- Understand key principles of branding
- Explain branding concepts and ideas in their own words
- Understand and conduct the measurement of brand equity and brand performance
- Practically develop a brand, including positioning and communication

Course Content:

1. **Brand Management:** Meaning of Brand – Brand Development: Extension, Rejuvenation, Re launch- Product Vs Brands, Goods and services, Retailer and distributors, People and organization, Brand challenges and opportunities
2. **Brand Positioning & Brand Building**: Brand knowledge, Brand portfolios and market segmentation – Steps of brand building, Identifying and establishing brand positioning, Defining and establishing brand values. Global Brands.
3. **Managing Brand Equity:** The brand equity concept, Identity and image.

   Establishing a brand equity management system, measuring sources of brand equity and consumer mind-set, Co-branding, celebrity endorsement.
4. **Designing & Sustaining Branding Strategies:** Brand hierarchy, Branding strategy, Brand extension and Brand transfer – Managing brand over time. Technology Branding. Retail Brands.
5. **Special Branding Categories:** Service brands, Private labels, Industrial brands, Luxury brands, Heritage brands, Internet brands, TOM (Top of mind recall) Branding in developing countries. Managing Premium brands.

Prerequisite Course: None

Reference Books:

1. "Brand Relevance: Making Competitors Irrelevant", Aaker, D.A., Jossey-Bass, 2011.
2. "Managing Brand Equity". Aaker, D.A. New York: Free Press, 1991.
3. "Building Strong Brands", Aaker, D.A, .New York: Free Press. 1996.
4. "Brand Leadership". Aaker, D.A. & Joachimsthaler. E, New York: Free Press, 2000.
5. "Strategic Brand Management", Kapferer, Jean- Noel, Dover, NH Kogan Page. 1997
6. "The Brand who Cried Wolf", Deming, S, Wiley Publishers. 2007
7. "Positioning: The Battle of Minds", Ries, A.I., & Trout, J, 2010.

UM17BB261:
FINANCIAL MARKETS & INSTITUTIONS (4-0-0-0-4)

Course Objectives:

- This course enables students to understand prevailing financial system and various financial services offered for public.

Course Outcomes:

At the end of the course, the student should be able to

- Define the structure of financial system & its components.
- Identify the financial intermediaries & their functioning with capital market in India.
- List the financial sector reforms in India
- Illustrate Non-Banking financial institution, Mutual fund and Credit Rating Agencies.

Course Contents:

1. **Financial System:** The Structure of Indian Financial System – components of financial system-Functions of the Financial System – Financial System and Economic Development. **Primary Market and Secondary Market:** Mechanism of Buying and selling of shares on a stock exchange. Recognized Stock Exchanges in India (brief discussion of NSE & BSE). Depositaries, National Securities Depository Ltd. (NSDL) Central Securities Depository Ltd.(CSDL), Financial Instruments- shares ,debentures, gilt edged securities, capital market instruments and money market instruments.
2. **Trading on a Stock Market:** Equity Trading - Various types of Orders, Stop-loss, Delivery Vs Day trade, Margin Funding and calculation of Margin amount. Complete Settlement cycle procedure. Patterns of Trading -Speculations – Types of Speculations – functions of Brokers – Brokerage – Settlement Procedure. Understanding of Index- economic significance of index movements-Index construction issues, models on

Calculation of Index. Insiders, Regulations relating to Disclosures by insiders and Investment advisors.

3. **Banks as Financial Intermediaries:** Banks as Financial Intermediaries – Commercial Banks- growth and development of banking system in India- Role and functions of commercial banks in India- Cooperative banks-Role of co-operative banks in India. RBI – Role and functions of RBI in regulation and development of money market. Development banks, Merchant Banks-meaning, functions of merchant banks
4. **Non-Banking Financial Intermediaries:** NBFCs-Investment & Finance Companies - Merchant Banks - Hire Purchase Finance. Lease Finance, Housing Finance, Venture Capital Funds, Angel Investors and Factoring.
5. **Credit Rating & Mutual Funds:** Credit rating-Meaning - credit rating process, Role and functions of credit rating agencies-ICRA, CRISIL, CARE. Concept of Mutual Funds - Growth of Mutual Funds in India. Mutual Fund Schemes – Role of UTI-Money Market Mutual Funds – Private Sector Mutual Funds – Evaluation of the performance of Mutual Funds. **Recent Trends In Financial Services:** Reforms in Financial Sector in India- Micro finance – Meaning – objectives, SHG. Personalized Banking – ATM – Tele-banking, E-banking and Mobile banking-Payments Bank -IRDA –Insurance-Bancassurance.

Prerequisite Course: None

Reference Books:

1. "Financial Markets & Services", E Gardon & K Natarajan, Himalaya Publications, 2013.
2. "The Indian Financial System Markets, Institutions and Services", Pathak, B.V, Pearson Education India, 2011.

UM17BB262
INVESTMENT & PORTFOLIO MANAGEMENT (4-0-0-0-4)

Course Objectives:

- The objective of this course is to provide an exposure to its students on the various Concepts of investment and portfolio management and to facilitate an in-depth of various techniques.

Course Outcomes:

At the end of the course, the student should be able to

- Explain the concepts of fundamental & technical analysis, Risk, Returns, SWOT analysis, and portfolio management.
- Exhibit skills in estimating, evaluating and interpreting using techniques of fundamental analysis, Risk and Return assessment, Portfolio evaluation models-Sharpe Index- Jensen's Measure, Treynor's Measure.
- Identify, estimate, evaluate, and interpret investment and portfolio decisions in practice.

Course Contents:

1. **Introduction to Investment: Meaning** of Investment – Features of Investment-Investment Vs Speculation-Features of good Investment-Objectives of Investment-Investment Process-Investment Alternatives– Classification of Investment Securities.
2. **Risk & Return analysis:** Risk & Types of Risks-Systematic and Non-systematic Risks, Returns – Measurement of Risk. Concept of Return- Measuring Returns over multiple period- Expected Returns of Security and Portfolio, Volatility, Statistical Application of Correlation. Diversification, Benefits of Diversification, Hedging Risk.
3. **Fundamental & Technical Analysis:** E-I-C approach –Economic Analysis-Variables and Techniques for Economic Analysis. Economic Forecasting- Industry Analysis-Industry Life Cycle-SWOT Analysis for the industry- Company Analysis-variables of company analysis. Technical Analysis-Concept, Theories- Dow Theory, Eliot wave Theory. Charts –types, trends and trend reversal pattern. Indicators-Moving Average-ROC, RSI, and Market Indicators. (Simple problems in Fundamental Analysis only)
4. **Alternative Investments & Strategies:** Alternative Investments, Valuation of Real Estate Using DCF Model, Investments in Precious Metals, Private Equity, Graham's Quantitative Navigator, Buffett's Investment Strategy, Zurich Axioms, Contrarian Investment Strategy of Dreman (simple problems)
5. **Portfolio Management:** Introduction – Active and Passive Portfolio -Markowitz Model – Sharpe Single Index Model - Capital Market Line –Capital Asset Pricing Model – Security Market Line – Beta Factor – Alpha and Beta Coefficient – Jensen's Measure, Treynor's Measure. (Simple problems)

Prerequisite Course: None

Reference Books:

1. "Security Analysis and Portfolio Management", A.P. Dash: I.K. International, 2005.
2. "Investment Analysis and Portfolio Management", Prasanna Chandra, McGraw-Hill, 2008.
3. "Security Analysis and Portfolio Management", Fischer and Jordan, Prentice Hall, 2008.
4. "Standard and Poor's Guide to Long term Investing", Joseph R. Tigue, TATA McGraw-Hill, 2010.

UM17BB263
STRATEGIC FINANCIAL MANAGEMENT (4-0-0-0-4)

Course Objectives:

- The objective of this course is to acquaint students with the advanced concepts of financial management and the application of the same in developing financial strategies for business organizations.

Course Outcomes:

At the end of the course, the student should be able to

- Explain the concepts of strategic financial planning, corporate restructuring, Asset based financing-leasing, Hire purchase, Venture capital financing and different hybrid financing strategies.
- Exhibit skills in estimating, evaluating and interpreting major strategic investment proposals, and corporate restructuring decisions including M&A and asset based financing.
- Identify, estimate, and evaluate different corporate strategic financing decisions including various hybrid financing strategies in business practices

Course Contents:

1. **Strategic Financial Management:** Meaning and importance of Strategic Financial Management, Scope and Constituents of Strategic Financial Management. Financial Planning & Strategy: Strategic Decisions - Characteristics of Financial Planning - Estimating between Strategic Planning & Financial Planning - Meaning of Financial Requirements, Financial Linkage. Challenges in Strategic Financial Management – Knowledge Intensive Industries – E-Commerce – Issues in business/ product/ IP valuations.
2. **Risk Analysis in Capital Budgeting**: Sources & Nature of Risk - Statistical techniques for Risk Analysis – Probability defined – Standard Deviation – Co efficient of Variation– Conventional

Techniques of Risk Analysis Payback Method - Risk Adjusted Discount Rate – Certainty Equivalent Sensitivity analysis – Decision Tree analysis (simple problems). Corporate Valuations – Introduction, Need, Case studies & Issues; Approaches to Valuation – Comparable Companies Approach, DCF, Adjusted Book Value etc.; Valuation of IP

3. **Corporate Restructuring**: Meaning and forms of corporate Restructuring – Spin off, Split off, Split up, Leveraged Buyout, Divestiture and other forms of Corporate Restructuring. Mergers & Acquisitions-Meaning, Types of Business Combination - M & A trends in India. -Motives, Value creation of M&A- Valuation under M&A- DCF method - Financing of Merger and Settlement – Exchange Ratio, Stock Vs. Cash Payments -Defensive Tactics of Takeovers and disinvestment of PSU's-Regulations of M&A in India. (Simple problems)
4. **Asset Based Financing**: Leasing – Meaning, Importance, Types, Tax & Accounting considerations. Evaluation of Lease from the point of Lesser & Lessee. Lease vs. Buy Decision – Sale & Leaseback; Hire-Purchase (HP) – Meaning – Features – Difference between HP & Credit sale Differences between Leasing & HP Differences between Leasing &Instalment system - Project Financing – Characteristics - & Financing arrangements for Infrastructure Projects
5. **Venture Capital Financing**: Concept, Characteristics, Growth, Differences between VC financing - Stages of VC Financing Schemes. Functioning of venture capital funding agencies in India. **Financing Strategy**: Hybrid securities- Convertible & Non-Convertible Debentures. Deep Discount Bonds, Secured Premium Notes, Convertible Preference shares - Option Financing, Warrants, Convertibles & Exchangeable. Alternative source of financing and role of Valuation-Boot-strapping- Angel funding, ECB and Challenges in raising capital during expansion and Restructuring.

Prerequisite Course: None

Reference Books:

1. "Financial Management", Chandra, Prasanna, Tata McGraw Hill Publishing Limited, 2007.
2. "Financial Management", Sudhindra Bhat, Excel Books, 2010.
3. "Financial Management and Police", R.M.Srivastava, HPH, 2007.
4. "Strategic Financial Management", Jakhotiya, G.P., Vikas Publishing House Private Limited, 2008.
5. "Strategic Financial Management – Achieving Sustainable Competitive Advantage", Vedpuriswar, A.V, Vision Books, 2010.
6. "Corporate Governance", Swamy Parthsastri, Biztantra, 2010.
7. "Exploring Strategic Financial Management", Grundy & Scholes, Prentice Hall, 2009.

UM17BB264
INNOVATIONS IN HR PRACTICE (4-0-0-0-4)

Course Objectives:

This course will enable students to develop an understanding of innovations in HR in organisations, analyse new frameworks for managing the HR innovation process and to identify the strategic challenges involved in managing innovation.

Course Outcome:

At the end of the course, the student should be able to

- Understand concept of innovations in HR
- Analyse new framework in HR structures
- Evaluate contemporary models of HR practices
- Formulate new HR strategies.

Course Contents:

1. **Innovation**: Fundamentals, Innovation Taxonomy, Models of Innovation, Sources and Transfer of Innovation, Strategizing, Implementation, Different aspects of Innovation, Creativity and Innovation, Basic Innovation Principles, Radical vs Routine Innovation.
2. **Innovation as a Core Business Process**: Evolving models of the process-Managing Innovation-Measuring innovation success.
3. **Human Resource Management Innovation**: Human Resource Management Practices and Innovation, technology invention in HRM.
4. **Digital HR SMAC:** Social media recruitment, mobile recruitment gamigication, MOOCS, E-learning, Challenges and issues in HR and Digital Leadership.
5. **Managing Creation: Creativity Techniques-** Brainstorming, lateral thinking, Forced relationship, Morphological Analysis, Attribute listing, Strategies for Innovation.

Prerequisite Course: None

Reference Books:

1. "Innovation Management: Strategies, Concepts and Tools for Growth and Profit", Shlomo Maital, Response, 2010.
2. "Innovation Management: Strategies, Implementation, and Profits", Allan Afuah, Oxford University Press, 2009.
3. "Innovation and Entrepreneurship", Peter F Drucker, Pearson Publisher, 2010.
4. "Managing Innovation: Integrating Technological, Market and Organizational Change", Joe Tidd and John Bessant, Wiley, 2014.
5. "Innovation Management Framework", Marco Cigaina, Pearson Publisher 2015.
6. "Growth Through Innovation: Managing the Technology-Driven Enterprise (Management for Professionals)", Roman Boutellier and MareikeHeinzen, Prentice hall of India, 2010.

UM17BB265
STRATEGIC HCM (4-0-0-0-4)

Course Objectives:

- The objective of the course is to explore the relationship between the management of people and pursuit of an organizations strategic goals and objectives and also to understand transforming role of HR functions from being a support function to strategic function.

Course Outcomes:

At the end of the course, the student should be able to

- Comprehend basic concepts of strategic Human Capital Management
- Express the investment perspectives of HR
- Explain performance management and appraisal
- Describe and apply all the aspects of managing strategic organization.
- Discuss various aspects of employment compensation.

Course Contents:

1. **Introduction to Strategic HRM:** Strategic Role of HRM, Planning and Implementing Strategic HR policies, HR Strategies to increase firm performance.
2. **Investment Perspectives of HR:** Investment Consideration, Investments in Training and Development, Investment Practices for Improved Retention, Investments Job Secure Work Courses, Non-traditional Investment Approaches.
3. **Competitiveness and HRM**: Three models of HR system – commitment model, collaborative model, talent model. Aligning

HR with Corporate Strategy, Competencies of HR Professional in a SHRM Scenario, Corporate Ethics, Values and SHRM, Evaluating the Effectiveness of SHRM.

4. **Managing Strategic Organization:** Managing Strategic Organizational Renewal- Managing Change and OD, Instituting TQM Programmes, Creating Team based Organizations, HR and BPR, Flexible Work Arrangement.
5. **Establishing Strategic Plans:** Establishing Strategic Pay Plans, Determining Periods, Establishing Periods, Pricing Managerial and Professional Jobs, Compensation Trends, Objectives of International Compensation, Approaches to International Compensation, Issues related to Double Taxation. Compensation Survey Analysis and Trends

Prerequisite Course: None

Reference Books:

1. "Strategic Human Resource Management", Charles R. Greer, Pearson Education, 2003.
2. "Managing Human Resources", Luis R. Gomez-Mejia, David B. Balkin, Robert L. Cardy, PHI, 2001.
3. "International Human Resource Management", Peter J. Dowling, Denice E. Welch, Randall S. Schuler, Thomson South-Western, 2002.

UM17BB266
ORGANIZATIONAL CHANGE AND DEVELOPMENT (4-0-0-0-4)

Course Objectives:

- The objective is to enable the students to understand need for Organizational Change and Development and the OD interventions

Course Outcomes:

At the end of the course, the student should be able to

- Understand organizational change and its impact.
- Apply various individual, team, comprehensive and structural interventions

Course Contents:

1. **Organizational Change and Development:** Definition, Types of changes, Change and human response. Introducing change effectively - factors influencing change- Resistance to change - Overcoming resistance to change - Models of Change- Lewin three stage model - Koter's eight stage model.
2. **Organizational Development:** Assumptions and values. OD Interventions: Inter-group interventions, personal, interpersonal and group processes interventions: A descriptive inventory of OD interventions
3. **Developing Excellence in Individuals and Teams:** Process Intervention Skills - Types of Process Interventions, Johari window, Employee Empowerment and Interpersonal Interventions: Laboratory Learning - Transactional analysis. Developing High Performance in Teams - Team Development Interventions: Team approach - The team development process - Self Managed Work Teams
4. **Comprehensive and Structural OD Interventions:** Comprehensive interventions - Survey feedback, Strategic management activities, Grid Organizational Development- Trans organizational Development. Structural interventions- Self Managed teams- Work Redesign- Job enrichment and MBO- Quality Circles- Conditions for optimal success of OD
5. **Power, Politics, research and Organizational Development:** Power- Sources of Power, Organizational Politics, Framework for analysing power and politics, Role of power and politics in the practice of OD. Assessing the effects of OD – issues and problems, positive developments in research of OD-Research on OD- Future Trends of OD- The failure of OD. **Developing Success in Organizations -** Learning Organizations: Survey Research and Feedback - Learning Organizations - Organization Transformation and Strategic Change: Strategy and Transformation. OD-Emerging Issues and Values.

Prerequisite Course: None

Reference Books:

1. "Organizational Development". French, W.L, & Bell, C.H. Jr., London, Prentice Hall, 1980.
2. "Organizational Change and Development", Kavita Singh, Excel Books India, 2006.
3. "An Experiential Approach to Organization Development", Harvey, D.R., & Brown, R. D., 5th Edition, Pearson Prentice Hall, New Delhi, 2012.
4. "Organizational Design and Change", Jones, R, G.Canada, Pearson Education Prentice Hall, 5th Edition, 2006.
5. "Organization Theory & Design", Daft, R.L, Cengage Learning Southwestern, 8th Edition, 2004.
6. "Organization Development and Change", Cummings, T.G., & Worley, C.G. Cengage Learning, Southwestern, 9th Edition, 2008.

UM17BB267
FOREIGN TRADE POLICY (4-0-0-0-4)

Course Objectives:

- The course objective is to acquaint the students with recent trends in Foreign Trade & policy related issues in trade in the global context

Course Outcomes:

At the end of the course, the student should be able to:

- Define & explain various concepts of foreign trade in global context
- Classify policies & procedures meant for export & import activities
- Analyze importance of exchange rate in trade policy
- Demonstrate the functions of various export promotion initiatives like EOU, SEZ & EPZ.

Course Contents:

1. **International Trade**: need and importance of international trade-recent trends in international trade-leading players in the international trade-major items traded in global context, Export Marketing Organizations- Steps in Export Procedure- Role of Clearing and Forwarding Agents- Registration Formalities- IEC-RCMC-Export Licensing-Selection of Export Product – Identification of Markets – Methods of Exporting – Letter of Credit-Customs & Central excise Procedures related to exports and Imports.
2. **Balance of Trade and Balance of Payment**: concept-nature of BOP-structure of BOP-calculation of BOP and BOT-economic transaction-causes of disequilibrium-measures of correction.
3. **Export Promotion Schemes & Incentives**: Creation of enclaves for export production & promotion- Exim bank-functions and role - a) Inland container depots, b) Export oriented units, c) Export houses and d) Trading houses

   Market development assistance; market Access initiatives. Type of export documents-Export Inspection council-Aligned Documentation System – Commercial Invoice – Shipping Bill

– Certificate of Origin – Consular Invoice –Bill of Lading – GR Form – ISO 9000 – Procedure for obtaining ISO 9000 – BIS 14000 Certification.

4. **Foreign Exchange** rates: meaning and determination-fixed, flexible and floating exchange rate: meaning and their advantages and disadvantages- fluctuations in exchange rate- reason for causes and methods to control fluctuation
5. **Institutional Set up for Export Promotion in India**, commodity boards & service institutions. Need for strategic Re – orientation of export promotion. State Government involvement in promoting exports – institutional infrastructure – export promotion initiatives – EPZ & SEZ – obstacles to state govts. In export promotion. Role of dept of commerce & foreign trade. Functions of the Director General of Foreign Trade.

Prerequisite Course: None

Reference Books:

1. "International Trade: Free, Fair and Open", Love, P. and R. Lattimore, OECD Publishing, Paris, 2015.
2. "International Trade and Export Management", Francis Cherunilam, Himalaya Publications, 2014.

UM17BB268
GLBOAL BUSINESS ENVIRONMENT (4-0-0-0-4)

Course Objectives:

- To understand the influence of various environmental factors on international business operations.

Course Outcomes:

At the end of the course, the student should be able to

- Define the concepts and challenges of international management and describe the global competitive landscape.
- Analyze critical and strategic thinking, primarily through deciphering complex international business environments.
- Explain the current business technology acquisition.

Course Contents:

1. **Business Environment:** An Introduction-Introduction, Concept of Business, Levels of the Business Environment, Understanding the Environment- Environmental Context of International Business- Framework for analyzing international business environment – Domestic, foreign and global environments and their impact on international business decisions.
2. **Economic Environment:** Introduction, Economic Environment of Business, the Global Economic Environment, Economic Policies, Business and Economic Policies- Capitalist Economy, Socialist Economy, Mixed Economy-changing trade in world business environment.
3. **Socio Cultural Environment:** Introduction, Business and Society, Business and Culture, Indian Business Culture compared with global business culture- cultural orientation in international environment.
4. **Political Environment:** Introduction, Political Environment and the Economic system, Types of Political Systems, Indian Constitution and Business, Changing Profile of Indian Economy , Business Risks Posed by the Indian Political System.
5. **Technological Environment:** International Technology Transfers – importance and types, Foreign Technology Acquisition- Impact of technological change, Technology Assessment and Environmental Impact Analysis- Environmental impact analysis process- Guidelines on the scope of EIA; Issues in preparation of EIA report; Elements of the environmental problem.

Prerequisite Course: None

Reference Books:

1. "International Business, Financial Times", Bennet, Roger, Pitman Publishing, London, 2013.
2. "International Business: Environment and Operations", Danoes, John D. and Radebaugh, Lee H., 8th Edition, Addison Wesley, Readings, 2008.
3. "International Business: A Managerial Perspective", Griffin, Ricky W. and Pustay, Michael W, Addison Wesley, Readings, 1999.
4. "International Business", Hill, Charles W. L., McGraw Hill, New York, 2014.

UM17BB269
GLOBAL MARKETING (4-0-0-0-4)

Course Objectives:

- The objective of the course is to analyse and understand the historical definition of "global marketing" and its objective, challenges in addition to today's main emerging markets and differences with our domestic market.

Course Outcomes:

At the end of the course, the student should be able to:

- Define the concepts in international marketing & distinguish between domestic & international market
- Explain the various procedures to be followed in product & pricing decisions
- Analyse the different distribution& promotion strategy to be adopted for international standards
- Demonstrate the marketing research process & take an effort to be updated with global marketing practices.

Course Contents:

1. **Introduction to Global Marketing:**Meaning of International Marketing, Nature and scope of International marketing, Stages of international marketing, Evolutionary Process of Global marketing-Reasons for entering international marketing-EPRG Concept, Digital revolution in global marketing
2. **International Product Decisions**: Product-Product Mix- Packaging & Labelling-Identifying foreign market product- scanning for exports- Developing products for international market-New product launch for international markets-international product strategy
3. **International Pricing Decisions:** Overseas Market research pricing, Exporters cost and pricing objectives, Methods, approaches and steps in pricing-Dumping-transfer pricing Information requirements for pricing- Factors influencing pricing decisions-INCOTERMS- Terms of payment in international transactions
4. **International Promotions and Distribution:** Marketing Environment and Promotion strategy, International marketing communication mix, Export promotions, Trade fairs and exhibitions, Problems in International Marketing- International channels system, Direct and Indirect exports, Distribution strategies
5. **International Marketing Research:** Nature and scope of international marketing research-International marketing research process-Problems in International Marketing Research

Prerequisite Course: None

Reference Books:

1. "International Marketing Management", B.S.Rathore & J.S.Rathore, Pearson Education Limited, 2014.
2. "International Marketing Management", B.L.Varshney and B. Bhattachary, Macmilan Publisher, 2010.

UM17BB270
ESSENTIALS OF FAMILY BUSINESS MANAGEMENT
(4-0-0-0-4)

Course Objectives:

- The objectives of this course is to provide depth knowledge about the need and various aspects of professionalization starting from what is considered as a professionally run business.

Course Outcomes:

At the end of the course, the student should be able to:

- Discuss what one needs to do to professionalize and
- Understand various challenges and hurdles that one needs to overcome in that journey and ow to travel that path successfully.

Course Contents:

- **Introduction**: Family Business, types, History, Responsibility and rights of shareholders of a family business, succession in family business Family Business Management Formula, Structural Management of the Family Business, Family Complexity, Business Complexity, Effects of Complexity on the Family Business Structure
- **Family Business Models:** Captain Model, Emperor Model, Family Team Model, Professional Family Model, Corporation Model, Family Investment Group (FIG) Model, Comparative Analysis of the Models, Mind-set and Structure.
- **Aspects of Professionalization**: Decentralization of Activities, Empowerment of Employees, Methodological Decision Making, Setting of Systems and Processes.
- **Challenges of Professionalization:** Unincorporated Enterprises, Lack of Succession Planning and Plans, Unawareness of Government Policies on Entrepreneurship Policies and Entrepreneurship Development in the Country, High Operational Costs, Financial Constraints.
- **Managing Growth and Transformation**: Applying Survival Skills as a Son or Daughter in the Family Business, Indian and International Cases of Professional Family Business, Contemporary Issues

Prerequisite Course: None

Reference Books:

1. "Family Business Models-Practical Solutions for the Family Business", Alberto Gimeno, Gemma Baulenas, Joan Coma-Cross, 7th Edition, Palgrave Macmillan, 2014.
2. "Challenges in Managing a Family Business Washington: US Small Business", Bowman – Upton, N. 2016.
3. "Generation to Generation: Life Cycles of the Family Business", Kelin E. Gersick, John A. Davis, Marion McCollom Hampton, Ivan Lansberg, (Latest Edition), Harvard Business Review Press, 2016.

UM17BB271
MANAGING INNOVATIONS (4-0-0-0-4)

Course Objectives:

- The objectives of this course provide knowledge about how to manage ideas in a technological based organization.

Course Outcomes:

At the end of the course, the student should be able to:

- Understand the dynamics of technological innovation
- Familiar with how to formulate technology strategies
- Know how to implement technology strategies.

Course Contents:

1. **Introduction:** Technology for Survival and Growth, Innovate or Abdicate, Change or Perish.
2. **Science and Technology**: Scientific Discovery, Technology, Differences between Science and Technology, Types of Technologies, Technology Portfolio, Technology Life Cycle, Globalization of Technology.
3. **Management of Technology**: Strategic Management of Technology, Strategic Technology Management System, Technology Forecasting, Technology Generation.
4. **Asset Protection and Timing of Innovation and Technology**: Methods to Protect Technological Knowledge, Patents, Secrets, Etc., Models and Strategies of Market Timing for Innovations.
5. **Technology Maturity, Obsolesce and Discontinuities**: Technology Maturity, Technology Obsolescence, Technological Discontinuities. Introduction to New Product Development (Internal Technology Transfer) and Open Innovation New Product Development (NDP)

Prerequisite Course: None

Reference Books:

1. "Management of Technology and Innovation", Vijay Kumar Khurana, Ane Books Pvt. Ltd. 2015.
2. "Strategic management of technological Innovation", Schilling, M, McGrawHill, 2010.
3. "Strategic Management of Technology and Innovation", Robert Burgelman, McGraw-Hill/Irwin, 2014.
4. "Management of Technology: The Key to Competitiveness and Wealth Creation", Khalil, Tarek, Boston, MA: McGraw Hill Irwin, 2013.

UM17BB272
SOCIAL ENTREPRENEURSHIP MANAGEMENT
(4-0-0-0-4)

Course Objectives:

- The objectives of this course to provide exposure towards the field of social entrepreneurship and many of the opportunities, challenges, and issues faced by social entrepreneurs.

Course Outcomes:

At the end of the course, the student should be able to:

- To understand and appreciate the role of (and need for) social entrepreneurship in building a sustainable society.
- To acquire the knowledge, skills, tools and techniques needed to become an entrepreneur in the social sector.
- To understand how to develop sustainable "business" model for building a social enterprise that can make a difference.

Course Contents:

1. **Social Entrepreneurship**: Definition and meaning of Social Entrepreneurship, Pioneers in Social Entrepreneurship, Social Entrepreneur roles and responsibilities, Social and Business Entrepreneurship concept.
2. **Social Entrepreneurs' DNA:** Social Enterprise Cases, Global v/s Local
3. **Managing a Social Venture**: The Challenge of Managing Business Professional's V/S Social Activists, Managing Operations, Accounting in A Non Profit Context, Marketing Social Entrepreneurship, Hybrids, Partnerships and Alliances.
4. **Measuring Social Impact:** Delivering the Promises.
5. **Understanding Risk:** The Social Entrepreneur, and Risk Management, Envisioning an Innovative Society, Social Entrepreneurship Changing Minds, Governments Role.

Prerequisite Course: None

Reference Books:

1. "How to Change the World", David Bornstein, Oxford University Press, New York, 2011.
2. "Social Entrepreneurship: What Everyone Needs to Know", David Bornstein, Oxford University Press, New York, 2015.
3. "Everyday Legends: The Ordinary People Changing Our World, the Stories of 20 Great UK Social Entrepreneurs", Justine C. Law and James J. Baderman, WW Publishing, 2015.
4. "The World That Changes The World: How Philanthropy, Innovation, And Entrepreneurship Are Transforming The Social Ecosystem", Willie Cheng, John Wiley & Sons, 2012.

UM16BB301
RESEARCH METHODS (3-1-0-0-4)

Course Objectives:

- The objective of this course is to develop the skills of investigating a business problem & interpreting the results of their investigation in the form of systematic reports for the purpose of management decision making.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the basic concepts of business research methods.
- Exhibit the skills of identifying business problems, collect and process data for managerial decisions.
- Apply the concepts of research design & methodology for solving business problems.

Course Contents:

1. **Introduction:** Meaning: Definitions - Objectives - Motivations - Importance of Research - Types of Research – Social & Business Research-Research Approaches - Research Methods Vs Research Methodology - Steps in Research.
2. **Defining the Research Problem:** Meaning: Need - Selecting the Research Problem - Process of Selection - Criteria for selecting - Defining problem - Techniques involved in defining the Problem-Sources of Problem Identification. Literature Review - Techniques - Importance of Literature review.
3. **Research Design:** Meaning - Need - Features - Important Concepts relating to Research Design - Types of Research Design Formulation of Hypothesis - Sources of Hypothesis - Characteristics of Hypothesis - Role of Hypothesis - Hypothesis Testing. **Sampling:** Meaning - Need - Census & Sample Survey Sampling Designs-Probability Sampling (Simple Random - Systematic - Stratified - Cluster Area Multistage - Sequential Sampling Methods) - Non Probability Sampling.
4. **Data Collection and Processing:** Collection of Primary data - Collection of Data through Questionnaire & Schedules - Secondary data – Qualitative techniques of Data Collection - Interview, Observation- Attitude Measurement Techniques-Motivational Research Techniques - Tabulation of Data- Analysis of Data- Drawing Testing of Hypothesis, ANOVA, Chi-square (Only concepts) - Multidimensional Scaling, Parametric & Non-Parametric tests.
5. **Analysis and Interpretation of Data and Research Reporting:** Meaning of Interpretation - Technique of Interpretation - Significance of Report Writing - Steps - Layout of the Research Report - Types of Reports - Precautions while Writing Research Reports.

Prerequisite Course: None

Reference Books:

1. "Marketing Research: An Applied Orientation", Malhotra, Naresh K, Pearson Education, New Delhi, 3rd Edition, 1999.
2. "Research Methods and Methodologies", James Arthur, Michael Waring, Robert Coe, Larry V Hedges, Sage Publication, 2012.
3. "Business Research Methods", Zikmund, William G, "Cengage Learning, New Delhi, 7th Edition, 2003.
4. "Research Methodology: Methods & Techniques", Kothari R., 2nd Revised Edition, New Age International, New Delhi, 2004.

UM16BB302
BUSINESS INFORMATION SYSTEM (3-1-0-0-4)

Course Objectives:

- To introduce the students to the managerial issues relating to information systems, its role in organization, support for decision making & how information technology can be leveraged to provide business value.

Course Outcomes:

At the end of the course, the student should be able to

- Understand basic information system concepts as applied to business operations & management.
- Evaluate, select & use computer-based information system from a management perspective.
- Apply the concepts of Information systems to gain competitive advantages in business organizations.

Course Contents:

1. **Introduction to Information System: Introduction to Information System:** The Real World of Information Systems - The Fundamental Roles of IS in Business - Trends in Information Systems - The Role of e-Business in Business - Components of Information Systems - Information System Resources - Information System Activities. Meaning and Definition of System, Information and Information System - Business Information System — Features of Information System — Uses of Business Information Systems, Users of Information Systems - Components of Business Information Systems.
2. **Types of Information Systems:** Management Support Systems (MSS), Management Information Systems, Transaction Processing Systems(TPS), Decision Support Systems (DSS), Group Decision Support System (GDSS), Office Automation System, Process Control Systems, Executive Information Systems, Levels of Management and Information Systems.
3. **Business Applications of IS:** e-Business Systems - Cross-Functional Enterprise Applications - Enterprise Collaboration Systems - Marketing Systems - Manufacturing Systems - Human Resource Systems - Accounting Systems - Financial Management Systems - Enterprise Resource Planning - Supply Chain Management system
4. **Information Subsystems and Organization:** Subsystems and Function Based Systems – HRM, CRM, Sales Force, financial systems, Business Value of Systems in Business; Enterprise Resource Planning (ERP); Supply Chain Management Software, Artificial Intelligence(AI), Knowledge Management System(KMS).
5. **Functional Based Systems**: systems used in Marketing, Finance and Human Resource functional departments. Significance of E-Business systems for organizations in the present context.

Prerequisite Course: None

Reference Books

1. "Management Information System", James. A, O'Brien, George M Behl, Ramesh, 9th Edition, Tata McGraw- Hill, New Delhi, 2009.
2. "Management Information Systems: Managing The Digital Firm", Laudon, Kenneth C Laudon, Jane P, 8th Edition, Pearson Education, New Delhi, 2004.
3. "Fundamentals of Information Systems", Stair, Ralph M. Reynolds, George W., 3rd Edition, Course Technology, Australia, 2006.

UM16BB303
ADVANCE SPREAD SHEET PRACTICAL (0-0-2-0-1)

Course Objectives:

- The objective the course is to enables students to customize excel spread sheet to produce valid and clear reporting of data integrated with macros for faster ways of working.

Course Outcomes:

At the end of the course, the student should be able to

- Perform complex calculations more efficiently, using various spreadsheets functions.
- Organizing &analysing large volume of data.
- Create MIS report.
- Designing & using templates
- Consolidating & managing data from multiple workbooks

Course Contents:

1. **Introduction to Spread Sheets**: Understanding files, ribbon & short cut: Create a workbook, Enter Data in a work sheet, format a worksheet, Format numbers in a worksheet, create a table, Filter data by using an Auto Filter, Sort data by using an AutoFilter. Essential worksheet operations: Using Help (F1), Key Board Shortcuts. Working with Cells & Ranges: Formatting cells, Name Manager. Visualizing Data using Conditional Formatting.
2. **Working with Dates, Time & Text**. Creating formulas that Manipulate Text – Upper, Proper, Lower, Text to column
3. **Creating Advanced Formulas** - count, countif, sum, sumif, subtotal, Use a function in a formula. V Lookup, H Lookup, Match & Index. Creating advance formulas for financial applications: Introduction to formulas e.g. PV, PMT, NPER, RATE, Creating Balance Sheet, Investment Calculations, Depreciation calculations. Creating charts and Graphics: Chart your data, Creating Spark line Graphics, Using insert Tab Utilizes
4. **Performing Spread Sheet What-if Analysis**: Create a macro, Activate and use an add-in 2 Using Pivot tables for data analysis: Create data base for Pivot, analyzing Data with Pivot Tables, Producing Report with a pivot table
5. **Analysing Data with the Analysis Tool Pak**: ANOVAs, Correlation, Covariance, Descriptive Statistics, Histogram, Random Number Generation, Rank & Percentile, Regression, t-test, Z Test

Prerequisite Course: None

Reference Books:

1. "Excel 2010 for Dummies", Greg Harvey, Excel Books, New Delhi, 2010.
2. "EXCEL 2010 Bible", John Walkenbach, John Wiley & Sons, Pearson Education, New Delhi, 2010.

UM16BB304
VISUAL COMMUNICATION PRACTICAL (0-0-2-0-1)

Course Objectives:

- In this course, Students will follow the formation of an advertising campaign from the preparation of the creative brief to the development of a creative strategy and end up with a folio of creative ideas that work across a variety of media, for a range of target audiences.

Course Outcomes:

At the end of the course, the student should be able to

- Produce attractive and professional solutions to advertising communication briefs using creative art direction and/or copywriting skills.
- Demonstrate working knowledge of Visual Art, especially Graphics to help them understand their role in Advertising

Course Contents:

- **Art & Design** : Concept and Role of Graphics in Communication/ Advertising "Components of Graphics and their Function – Typography and Visuals"
- **Layout and Various Stages of Layout**: Design Appreciation based on Design Principle " Colour Theory and its logical use in Design " Design Applications –Advertising, Direct Printed Pieces, Poster, Magazine and Digital Outdoor,
- **Developing an Advertising Campaign for a Product or Service**
- **Designing for Digital Canvas**: Introduction to User Interface – Theories and Best Practices "Understanding Popular Digital Devices

Prerequisite Course: None

Reference Books:

1. "Visual Elements of Arts and Design", Longman porter, Pearson Education, New Delhi, 2010.
2. "Media Presentation of Visual Arts", Frederic, University of Luton press, 2009.
3. Laboratory Manual prepared by Department of BBA, PESU.

UM16BB305
GERMAN LANGUAGE – LEVEL 4 (0-0-0-0-0)

Course Objectives:

- To enable the students to acquire additional vocabulary and grammatical forms; to engage in complex conversations to write proficiently.

Course Outcomes:

- Students completing the course should be able to
- Increase language vocabulary and be able to apply the words in speech and writing
- Articulate once taught in grammatically correct German language.

Course Contents:

1. **ist Mode wichtig? -** (Is fashion important?) How to describe items of personal appearance, How to say what clothes you like wearing,
2. **und was kann man ihnenschenken?** (and what can we give them?) -How to read invitations to various events, How to say what is given to whom, How to ask for help and advice
3. **Gesundheit -** (health………) How to discuss health, How to name parts of the body,
4. **Wohnen in Deutschland -** (living in Germany) How to talk about different kinds of housing, -How to name the various rooms in a house or a flat, -How to make comparisons
5. **Telefonieren und die Geschaftswelt -** (Telephoning and the business world) How to make and answer phone calls, How to say what belongs to whom,

Prerequisite Course: None

Reference Book:

1. Study Material prepared by Department of BBA, PESU.

UM16BB306
ADVERTISING & MEDIA MANAGEMENT (2-1-0-0-3)

Course Objectives:

- The interdisciplinary nature of the concentration of advertising and media management provides the students understanding of the latest developments in media, technology and the subsequent effects of these developments on business and society

Course Outcomes:

At the end of the course, the student should be able to

- Gain expanded knowledge in relation to newly developing advertising forms & media.
- Understand ethical media management strategies.
- Develop strong analytical skills to review various advertising campaigns.
- Analyse emerging trends in advertising in global environment.
- Apply the concepts of effective media management while organizing events.

Course Contents:

1. **Introduction:** Advertising- Meaning, Features, Setting Advertising Objectives based on 5M's of Advertising, Types of Advertising, Social, Economic and Legal implications of advertising, Role of Advertising in Marketing, AIDAS Model, Drawbacks of Advertising, Deceptive Advertising. Major Institutions of Advertising Management - Objective - Functions of ACI.
2. **Advertising Planning & Decision Making:** Advertising Planning in Line with Marketing Strategies, DAGMAR Approach, Developing Advertising Campaign, Ad Appeals, Elements of Successful Advertising Plan, Role of Advertising Agencies. Advertising Budget - Types – Significance.

- **Creative Execution and Judgment:** Choosing an Effective Advertising Theme, Creative Approaches- Rational, Emotional; Using an Endorser; Distraction Effects. Creative Process- Idea Development, Copywriting, Illustration, Layouts, Positioning and Creative Interpretation
- **Media Strategy:** Media plan – Types and Choice Criteria, Media Mix, Reach and Frequency of Advertisements, TRP, Media Scheduling, Cost of Advertisements related to Sales – Media Strategy and Scheduling, Role of Media, Media Buying and Organization
- **Global Marketing & Advertising Practices: Globalization** of Markets; Global Consumer Segments; Global Advertising-Message, Strategies and Tactics, Integrated Marketing Communications- Process: **E-Advertising:** E- advertising: Evolution; Types of E-advertising, Impacts of E-advertising, Limitations of E-Advertising, Social Media Advertising

Prerequisite Course: None

Reference Books:

1. "Advertising Management- Concepts and Cases", Mohan Mahendra, Tata McGraw-Hill, 1995.
2. "Foundations of Advertising - Theory & Practice", Chunnawalla S.A & Sethia K C, Himalaya Publishing House, 5th Revised Edition, 2003.
3. "Advertising Management", Batra, R., Myers, J.G., & Aaker, D., Pearson Education Inc., 9th Edition, 2009.

UM16BB307
RETAIL MANAGEMENT (2-1-0-0-3)

Course Objectives:

- The objective of this course is to introduce the student to the world of retailing from a managerial viewpoint. Consequently, focusing on the study towards elements of retail mix, types of retailers, multichannel retailing, consumer buying behaviour& retailing marketing strategies.

Course Outcomes:

At the end of the course, the student should be able to

- Demonstrate an understanding of how retailers develop a retail mix to build a sustainable competitive advantage.
- Explain how retailers use marketing communications to build a brand image and customer loyalty.
- Understand the financial implication of strategic retail decisions.
- Demonstrate an understanding of decisions retailers make to satisfy customer needs in a rapidly changing & competitive environment.

Course Contents:

1. **Introduction to Retailing:** Reasons for Studying Retailing, Economic Significance & Opportunities in Retailing, Types of Retailers –Food Retailers, General Merchandise Retailer, Non-Store Retail Format, Service Retailing, Single Store Establishment, Corporate Retail Chain, Multi-Channel Retailing, Benefits Offered by Electronic Channel. Retailing in Emerging World, Multinational Brand and Retailing in Third World,Store Price benchmarking.
2. **Retail Market Strategy & Retail Locations:** Target Market Retail Format, Building a Sustainable Competitive Advantage for Growth Strategies, Steps in Strategic and Retail Planning and Operation Management. Evaluating Competition in Retailing. Retail Market Information System, Site Location – Factors Affecting the Demand for a Region & Attractiveness of a Site, Human Resource Management in Retailing- Promoters Planning.
5. **Retail Marketing Mix:** Introduction to Retailing Marketing Mix, Product- Decisions Related to Selection of Goods (Merchandise Management), and Decisions Related to Delivery of Service. Pricing- Influencing Factors, Approaches to Pricing-Price Sensitivity-Value Pricing-Markdown Pricing, Pricing Strategies – Cost Oriented, Demand Oriented, Competition Oriented & Use of Break Even Analysis, Price Adjustments to Stimulate Retail Sales. Place- Supply Channel -Retail Logistics-Computerized Replenishment System. Promotion- Setting Objectives-Communication Effects-Promotional Mix.
6. **Merchandise and Store Management:** Objectives for Merchandise Plan, Assortment Planning Process; Establishing and Maintaining Relationships with Vendors, Fill-rates management, Store Layout, Types & Features, Point of Purchase visibility, Store Design –Merchandise Presentation Techniques, Atmospherics, Customer Service GAPS Model for Improving Retail Service Quality.
7. **IT in Retailing:** Non Store Retailing, Impact of Information Technology in Retailing, Integrated Systems and Networking-EDI- Bar Coding- Electronic Article Surveillance- Electronic Shelf Labels- Customer Database Management System.. E-Tailing – Advantages and Disadvantages.

Prerequisite Course: None

Reference Books:

1. "Retail Marketing Management", Gilbert, D., Pearson Education, 2nd Edition 2008.
2. "Retail Management Text & Cases", Pradhan, S., McGraw Hill Co., 2nd Edition, 2007.
3. "Retail Management", Nair", S., Himalaya Publishing House, 4th Edition, 2011.
4. "Start & Run a Retail Business", Dion, J., & Topping, T., Jaico Publishers, 2007.

UM16BB308
SUPPLY CHAIN MANAGEMENT (2-1-0-0-3)

Course Objectives:

- This course will equip students with knowledge of supply chain management and the specific knowledge, skills and attitudes to immediately contribute to organizational objectives at the appropriate entry level.

Course Outcomes:

At the end of the course, the student should be able to

- Explain supply chain management, contrast it from operations management and propose the main performance drivers of supply chain performance.
- Relate the strategic role and impact of IT technologies on supply chain integration.
- Express the major slacks in supply chains and formulate the approaches to manage them.
- Analyze the inventory management methodologies and apply the existing models to propose the optimal order sizes

Course Contents:

1. **Introduction to SCM**: Development of SCM Concepts and Definitions – Key Decision Areas – Strategic Supply Chain Management and Key Components, External Drivers of Change. Dimensions of Logistics – The Macro Perspective and Macro Dimension – Logistic System Analysis, Role of SCM - Make in India.
2. **Information Technology in the Supply Chain:** IT Framework - **E** Commerce and Supply Chain Management. Organizational Issues and Supply Chain. ERP and Supply Chain Management, Bull -Whip Effect.
3. **Sourcing Strategy**: The Role of Sourcing in a Supply Chain - In-House or Outsource - Supplier Scoring and Assessment - Supplier Selection-Auctions and Negotiations - Contracts and Supply Chain Performance - The Procurement Process - Sourcing Planning and Analysis - The Role of IT in Sourcing - Making Sourcing Decisions in Practice
4. **Distribution Strategy:** The Role of Distribution in the Supply Chain - Factors Influencing Distribution Network Design - Design Options for a Distribution Network - e-Business and the Distribution Network - Distribution Networks in Practice - The Role of IT in Network Design - Evaluating Network Design Decisions Using Decision Trees
5. **Inventory Strategy:** Demand Forecasting – Inventory Planning – Planning of Stocking Facilities – Warehouse Location Allocation. Warehouse Design and Operations – Inventory Norms.

Prerequisite Course: None

Reference Books:

1. "Essentials of Supply Chain Management", R.P. Mohanty & S.G. Deshmukh Jaico Publishing House, 2010.
2. "Supply Chain Management- Strategy, Planning & Operations", 4th Edition, Sunil Chopra & Peter Meindi, Pearson Education, New Delhi, 2010.
3. "Designing & Managing The Supply Chain", David Simchi-Levi, Philip Kamiusky, Edith Simchi-Levi , TATA Mc-Graw Hill Publication, 2012.

UM16BB309

INTERNATIONAL LOGISTICS MANAGEMENT (3-1-0-0-4)

Course Objective:

- To understand about concepts of logistics principles
- To expose students to the language of Logistics functions including transportation, inventory, material handling and IT used in logistics.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the basic concepts of logistics and transportation
- Analyse and apply information flow in a logistics management
- Explain about various procedures and processes involved in inventory and warehousing

1. **Concepts of Logistics**: Definition-Evolution –concepts- Nature and Importance – components of logistics management- Competitive Advantages of Logistics- functions of Logistics management- principles Logistics Network- Integrated Logistics system.
2. **Containerization and Chartering**: Containerization: Genesis, Concept, Classification, Benefits and Constraints; Inland Container Depot (ICD)-Roles and Functions, CFS, Export Clearance at ICD; CONCOR; ICDs under CONCOR; Chartering: Kinds of Charter, Charter Party, and Arbitration.
3. **Basics of Transportation**: Transportation Functionality and Principles; Multimodal Transport: Modal Characteristics; Modal Comparisons; Legal Classifications; International Air Transport; Air Cargo Tariff Structure; Freight: Definition, Rate; Freight Structure and Practice
4. **Logistical Information System (LIS**): Operations – Information Functionality, Principles of Logistic Information, Information Architecture, Planning / Coordination, Logistic Information System Flow; Application of Technology In Logistics: Electronic Data Interchange, PC, Artificial Intelligence / Expert Systems-RFID-Applications of New Information Technologies
5. **Inventory Management and Warehousing:** Inventory Management: Introduction, Characteristics, Functionality, Components, Planning; Warehousing: Evolution, Importance and Benefits, Operating Principles, Alternatives; Material Handling: Managing Warehouse Resources, Material Handling; Automated Material Handling: Order Selection Systems, ASRS Systems, Information Directed Systems, Special Handling

Prerequisite Course: None

Reference Books:

1. "Logistic Management and World Sea Borne Trade", Multiah Krishnaveni, Himalaya Publication, 2014.
2. "Logistic and Supply Chain Management", Donald J. Bower Son, Prentice Hall of India, 2012.
3. "Logistics and Supply Chain Management", D.K. Agarwal, MacMillan India Ltd., 2013.

UM16BB310

GLOBAL BUSINESS ENVIRONMENT (3-1-0-0-4)

Course Objectives:

- To understand the influence of various environmental factors on international business operations.

Course Outcomes:

At the end of the course, the student should be able to

- Define the concepts and challenges of international management and describe the global competitive landscape.
- Analyze critical and strategic thinking, primarily through deciphering complex international business environments.
- Explain the current business technology acquisition.

Course Contents:

1. **Business Environment:** An Introduction-Introduction, Concept of Business, Levels of the Business Environment, Understanding the Environment- Environmental Context of International Business- Framework for analyzing international business environment – Domestic, foreign and global environments and their impact on international business decisions.
2. **Economic Environment:** Introduction, Economic Environment of Business, the Global Economic Environment, Economic Policies, Business and Economic Policies- Capitalist Economy, Socialist Economy, Mixed Economy-changing trade in world business environment.

3. **Socio Cultural Environment:** Introduction, Business and Society, Business and Culture, Indian Business Culture compared with global business culture- cultural orientation in international environment.
4. **Political Environment:** Introduction, Political Environment and the Economic system, Types of Political Systems, Indian Constitution and Business, Changing Profile of Indian Economy , Business Risks Posed by the Indian Political System.
5. **Technological Environment:** International Technology Transfers – importance and types, Foreign Technology Acquisition- Impact of technological change, Technology Assessment and Environmental Impact Analysis- Environmental impact analysis process- Guidelines on the scope of EIA; Issues in preparation of EIA report; Elements of the environmental problem.

Prerequisite Course: None

Reference Books:

1. "International Business, Financial Times", Bennet, Roger, Pitman Publishing, London, 2013.
2. "International Business: Environment and Operations", Danoes, John D. and Radebaugh, Lee H., 8th Edition, Addison Wesley, Readings, 2008.
3. "International Business: A Managerial Perspective", Griffin, Ricky W. and Pustay, Michael W, Addison Wesley, Readings, 1999.
4. "International Business", Hill, Charles W. L., McGraw Hill, New York, 2014.

UM16BB311
GLOBAL HUMAN CAPITAL MANAGEMENT (3-1-0-0-4)

Course Objectives:

- The objective of the course is to create awareness of the concept and issues of Global Human Capital Management and suggest appropriate solution in contemporary international business environment to manage their Human Resource at home and abroad.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the basic Concept and Acquaint himself with concepts, principles and practices in Global Human Capital Management.
- Analyse the impact of internationalization on the role of HR departments in MNE and SME.

Course Contents:

1. **International HRM**: **Introduction** - Distinction between Domestic and International HRM – HRM activities: An International Perspective – Internationalization and HRM –Major Economies & their HRM practices- Japan, United States, United Kingdom, Middle East, China and others.
2. **The Functional Aspects of IHRM:** Recruitment, Selection and Staffing in International Context- International Managers – Recruitment, Selection and Staffing in International context, International Staffing: other issues, Repatriation. **Training and Development in International Context:** Backdrop of International Training – Current scenario in terms of Training and Development activity of expatriates – Training & Development of International Staff – Types of Expatriate Training – HCN Training – Career Development – Repatriate Training.
3. **Compensation Management in International Context:** Forms of Compensation and Factors that influence Compensation Policy – Objectives and Key components of International Compensation – Approaches to Compensation Management in the International Context – Compensation Practices across the Countries – Social Security systems across the Countries – Global Compensation: Emerging Issues. **Performance Management**: Introduction – Performance Management Cycle – Performance Appraisal – Performance Management for Expatriates – Performance Appraisal in International Context – Expatriate Performance Management Model, Issues and Challenges in International Performance Management – Country specific Performance Management Practices. **Industrial Relations in International Context**: International IR- issues and concerns, Regional integration and IR - NAFTA, ASEAN, EU, Country Specific IR Practice.
4. **Role of Culture in International HRM:** Organizational Culture & IHRM, Effects of Cultural Differences on Organizational Work Behaviour, Implication of Cultural Impact on International Management, Organizational Processes in International HRM, Work Behaviour varies across Cultures, Strategy for Managing across Cultures. **Organizational Process in IHRM:** Intercultural Communication, Motivation across Cultures, Global Leadership, Decision Making in Global Context.
5. **Special Issues in IHRM. The Role of the Global HR Manage**r- Competency Clusters required by the Global Leaders, International Team Working, Types of Diversity in Teams. **Women Expatriates**- Reasons for Less Number of Female Expatriates, Work Place related factors faced by Women Expatriates, Role of HR Manager in improving the Situation, **International Joint Ventures**- Reasons for International Joint Ventures(IJVs), Failure & Success of IJVs, The role of Cultures on IJVs, HRM factors in IJVs, Methods of Overcoming **Cultural & other Problems in IJVs.**Hiring Inpatriate and Expatriate Managers: Choices and Dilemmas for MNCs – Major Issues for Success/ Failure of Expatriate Managers, Comparing Inpatriate and Expatriate Managers- Issues & Dimensions, HR & other related issues facilitating the Inpatriation Process, Proactive Inpatriation Program.

Prerequisite Course: None

Reference Books:

1. "International Human Resources Management", Peter J. Dowling, Tata Mc Graw Hills, New Delhi. 3rd Edition, 2009.
2. "International HRM", Chris Rees, Tony Edwards, Pearson Education, New Delhi, 2nd Edition, 2010.
3. "International Human Resources Management", Monir H Tayeb, Oxford University Press, 2004.
4. "International HRM", Nilanjan Sengupta & Mousumi S Bhattacharya, Excel Books, New Delhi, 2nd Edition, 2007.
5. "International HRM – Text and Cases", Aswathappa K. & Dash Sadhna. Tata McGraw Hills. New Delhi, 2nd Edition, 2008.

UM16BB312
BUSINESS TAXATION (3-1-0-0-4)

Course Objectives:

- The objective is to equip students with an understanding of concepts and provisions of Central sales tax, Customs act, Central excise, Value Added tax laws, and Service tax law and to enable the students to understand income assessment of Companies under Income tax act.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the concepts of GST, Customs Act and assessment of companies
- Exhibit understanding in and be able to estimate tax liability under various tax laws viz GST, Customs, and assessment of companies.
- Identify, estimate, evaluate, and interpret implications of corporate tax liabilities in business

Course Contents:

1. **GST**: Meaning, legal framework, GST model, Constitutional implications, nations that have implemented GST, GST roadmap in India
2. **CGST, IGST and SGST**: Meaning, applicability, basis, rates, registration of dealers, threshold limit, GST for MSME, Cases and problems
3. **Custom Duty**: Introduction and nature, Types of Custom duty, Prohibition of Import and Export, valuation rules, Computation of assessable value and calculation of custom Duty.
4. **Income from business and profession**: Introduction – Computation of Depreciation – Allowable Expenditures – Disallowed Expenditures
5. **Assessment of companies**: Computation of Taxable Income of Companies – Minimum Alternative Tax (MAT) – Carry Forward and Set Off Provisions – Computation of Tax Liability (Simple Problems) –Taxation of Foreign Companies; Assessment and Appeal Provisions

Prerequisite Course: None

Reference Books:

1. "Indirect Taxes", Mehrotra, Sahitya Bhawan Publications, 2014.
2. "A Systematic Approach to Direct and Indirect Taxes", Girish Ahuja and Ravi Gupta, Bharath Publications, 2010.
3. "Indirect Taxation", Balachandran, Sultan Chand & Co., New Delhi, 2008.

UM16BB313
FINANCIAL DERIVATIVES & COMMODITIES (4-0-0-0-4)

Course Objectives:

- To understand the concepts of Equity valuation & trading, Derivative instruments,
- Formulate trading strategies, hedging strategies,
- Ability to plot and Interpret Technical Price charts for Short term and long term trading strategies and be able to handle a stock market dealers desk.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the basic Concept of Stock and Derivates market.
- Analyze Stocks, returns, understand stock market pulse, reading price quotes and making Bid/offer price.
- Continuously keep a track of the stock market, developments in market sentiments, and opinions of various research analysts, regular portfolio analysis and management.

Course Contents:

1. **An Overview of Capital and Commodity Markets**: Primary Market, Secondary Market (Stock Market), Depositaries, Private placements of shares / Buy back of shares, Issue mechanism. Meaning of commodity and Commodity markets, difference between stock market and commodity market.
2. **Introduction to Derivatives -** Derivatives –meaning, types of contracts, History of financial derivatives markets- economic functions of derivatives market- participants of derivatives market. Forwards & Futures, difference between forward Vs future contracts
3. **Options Market:** Options – types of options- Call and Put Options, Calculations of Premium and Option Pricing. Various Option strategies (Long call, short call, long put, short put, covered call, Bull call Spread, Bear Call spread, Bear Put Spread, Straddle, Strangle) with Calculations . Uses of Derivatives in Hedging- Arbitrage.
4. **Commodity Market:** Evolution, Commodity derivatives, Commodity exchanges-Regional & National and International, Functions objectives and types, Role. Types of transactions in Commodity market – Spot, Future and Forward options markets.
5. **Trading in Commodity:** Patterns of Trading & Settlement, Price discover, Efficiency of Commodity Markets - Size of Commodity Markets in India - Benefits of Commodity Markets

Prerequisite Course: None

Reference Books:

1. "Investments", Bodie, Kane, Marcus, Mcgraw-Hill International, 2013.
2. "Investment Analysis and Portfolio Management", Prasanna Chandra, Mcgraw-Hill, 2012.
3. "Management of Financial Institutions" Srivastava RM :, HPH.2011
4. "Financial Markets and Institutions", Saunders, 3rd Edition, Tata McGraw Hill, 2010.
5. "Equity – The Next Investment Destination" Pallavi Modi, 2011.

UM16BB314
BANK MANAGEMENT (4-0-0-0-4)

Course Objectives:

- To enable the students to understand the structure of banking system in India, various banking operations
- To enable them to contribute to the strategic operational policies and practices of commercial bank.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the structure of banking system in India
- Understand the concepts of liquidity and credit management in banks
- Under the different regulations that Banks need to abide by when operating in India
- Understand the concepts ALM and NPA management in banks.

Course Contents:

1. **Commercial Banking IN India:** Introduction– Origin & Development- Evolution and growth of banking system in India – Present Structure – Scheduled and non-scheduled banks, NABARD, EXIM Bank and SIDBI- Recommendations of Narasimham Committee –Challenges before Indian commercial banks – Opportunities for Indian commercial banks – Strengths and weaknesses of Indian commercial banks – Banking sector reforms.
2. **Liquidity and Credit Management**: Liquidity – Purpose – Sources – Measurement – Liquidity / profitability Problem – Theories of liquidity management – Priorities in the employment of bank funds – Problem of resource allocation in Indian commercial banks. Credit Management - Cardinal principles of sound bank lending – Formulating loan policy – Factors influencing loan policy – Contents of loan policy –Evaluating credit applicant – Loan supervision.
3. **Investment Management:** Nature and significance of investment management in commercial banks – Fundamental principles of security investment by commercial bank – Management of security investment – Reviewing investment portfolio – Organization of investment function.
4. **Capital Adequacy in Banks:** Functions of capital funds in commercial banks – Capital adequacy – Basle norms on capital adequacy – Capital adequacy norms in Indian commercial banks – Present position of capital adequacy in Indian commercial banks, Stress Testing in Banks

5. **Asset Liability Management and Non-Performing Assets**: Concept of ALM – Objectives – Functions – Process – Measurement and Management of Risks, Concept of NPAs, NPAs in Indian commercial banks, Causes, Management of NPA's in Indian Banks Prudential norms

Prerequisite Course: None

Reference Books:

1. "Management of Indian Financial Institutions", Srivastava, Divya Nigam, Himalaya Publishing House, 2011
2. "Indian Financial System", M. Y. Khan, Tata McGraw Hill, 2010.
3. "Indian Financial System", Bharati Pathak, Pearson Education publishers, 2016
4. "Money and Banking", Dudley Luckett, MacGraw Hill. 2015
5. "Managing Indian Banks- Challenges Ahead", Vasant Joshi and Vinay Joshi, Response Books, 2010.

UM16BB315
MANAGEMENT OF EMPLOYEE RELATIONS (3-1-0-0-4)

Course Objectives:

- To acquaint the students the concept of Industrial Relation labour, problems in industrial organizations and the laws relating to them.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the basic Concept of Industry and influences of various factors on Functioning and system.
- Demonstrate analytic thinking and decision making.
- Analyse Employee behaviour, internal and external factors influencing Organizational decisions.

Course Contents:

1. **Introduction to Industrial Relation:** Definition, Concept, Importance, Nature and Scope of Industrial Relation, Approaches to Industrial Relation, the Labour Movement, Characteristics of Indian Labour
2. **Indian Trade Union Movement:** Definition, Nature of Trade Union, Functions, Objectives, Importance of Trade Union Movement, Reasons for Employee Joining Trade Union, Problem of Trade union and Remedies, Trade Union Act of 1926, Trends in Trade Union Movement in India, International Labour Organisation & Indian labour legislation.
3. **Collective Bargaining:** Definition, Concept. Essential Pre requisites for Collective Bargaining. Levels of Collective Bargaining-Plant Level, Industry Level and National Level. Principles of Collective Bargaining, The collective Bargaining in India, Advantages and disadvantages of collective bargaining.
4. **Industrial Disputes:** Meaning, Causes of Industrial Conflict, Types of Industrial Conflicts-Strike, Lockout, Machinery for resolving Industrial Dispute under the Industrial Dispute act of 1947, Arbitration, Adjudication, Conciliation Prevention of Industrial conflict, Approaches to Settlement of Conflicts
5. **Collaboration and Workers Participation in Management:** Bases of Collaboration, Interventions for Collaboration, Meaning, Objectives, Concepts of Workers Participation in Management, Growth and Development of Workers Participation in Management, Types of Workers Participation in Management

Prerequisite Course: None

Reference Books:

1. "Industrial Relations", Amandeep Kaur and Punam Aggarwal, Kalyani Publication, 2013.
2. "The Law of Industrial Disputes - A Guide to Settlement of Industrial Disputes", Malhotra, O.P., Arya, Vikas Publishing House Private Limited, 2005.
3. "Gherao and Industrial Relations", Aggarwal, Arjun P. and Larki, H.Trade Unionism in the New Society, 2009.
4. "Personnel Management", Monnappa & Saiyaddin, Tata McGraw Hill, 2000.
5. "Industrial Relations", C.S. Venkata Ratnam, Oxford University Press, 2011.
6. "Industrial Relations", Dwivedi, Galgotia Publications, 2000.

UM16BB316
LABOUR LAWS (3-1-0-0-4)

Course Objectives:

- In this course, the students are to be acquainted with the Industrial relations framework and also to gain a broad understanding of the practical problems inherent in their implementation of labour statute.

Course Outcomes:

At the end of the course, the student should be able to

- Elucidate the scope and objective of various laws relating to human capital
- Suggest various labour legislations relating to organizational requirements and issues.

Course Contents:

1. **Factories Act** : Factories Act, 1948 (6) - Equal Remuneration Act, 1976 (2)
2. **Bonus Act** : Payment of Bonus Act, 1965 (5) - Payment of Gratuity Act, 1972 (4)
3. **Employees Insurance and Provident Fund**: Employees' State Insurance Act, 1948 (4) - Employees Provident Funds and Miscellaneous Provisions Act, 1952 (6)
4. **Industrial Employment**: The Industrial Employment (Standing Orders) Act, 1946 (5) - Worker compensation Act.
5. **Labour Act**: The ID Act, 1947 (5) - Contract Labour (Regulation and Abolition) Act, 1970 (4)

Prerequisite Course: None

Reference Books:

1. "Industrial Relation", D. R. N. Sinha, Indu Balasinha & Semma Priyadarshini Shekar, Trade unions and Labour Legislation, 2004.
2. "Industrial Laws", P.K. Padhi, PHI, 2006.
3. "Elements of Mercantile Law", Kapoor N. D, Sultan Chand, Vikas Publisher Private, 2009.

UM16BB317
STRATEGIC HCM (3-1-0-0-4)

Course Objectives:

- The objective of the course is to explore the relationship between the management of people and pursuit of an organizations strategic goals and objectives and also to understand transforming role of HR functions from being a support function to strategic function.

Course Outcomes:

At the end of the course, the student should be able to

- Comprehend basic concepts of strategic Human Capital Management
- Express the investment perspectives of HR
- Explain performance management and appraisal
- Describe and apply all the aspects of managing strategic organization.
- Discuss various aspects of employment compensation.

Course Contents:

1. **Introduction to Strategic HRM:** Strategic Role of HRM, Planning and Implementing Strategic HR policies, HR Strategies to increase firm performance.
2. **Investment Perspectives of HR:** Investment Consideration, Investments in Training and Development, Investment Practices for Improved Retention, Investments Job Secure Work Courses, Non-traditional Investment Approaches.
3. **Competitiveness and HRM**: Three models of HR system – commitment model, collaborative model, talent model. Aligning HR with Corporate Strategy, Competencies of HR Professional in a SHRM Scenario, Corporate Ethics, Values and SHRM, Evaluating the Effectiveness of SHRM.
4. **Managing Strategic Organization:** Managing Strategic Organizational Renewal- Managing Change and OD, Instituting TQM Programmes, Creating Team based Organizations, HR and BPR, Flexible Work Arrangement.
5. **Establishing Strategic Plans:** Establishing Strategic Pay Plans, Determining Periods, Establishing Periods, Pricing Managerial and Professional Jobs, Compensation Trends, Objectives of International Compensation, Approaches to International Compensation, Issues related to Double Taxation. Compensation Survey Analysis and Trends

Prerequisite Course: None

Reference Books:

1. "Strategic Human Resource Management", Charles R. Greer, Pearson Education, 2003.
2. "Managing Human Resources", Luis R. Gomez-Mejia, David B. Balkin, Robert L. Cardy, PHI, 2001.
3. "International Human Resource Management", Peter J. Dowling, Denice E. Welch, Randall S. Schuler, Thomson South-Western, 2002.

UM16BB351
E - COMMERCE (2-0-0-0-2)

Course Objectives:

- This course focuses on concepts and skills for the strategic use of e-commerce and related information technology from three perspectives: business to consumers, business-to-business, and intra-organizational. Examination of e-commerce in altering the structure of entire industries, and how it affects business processes including electronic transactions, supply chains, decision making and organizational performance.

Course Outcomes:

At the end of the course, the student should be able to

- Understand the foundations and importance of E-commerce
- Demonstrate an understanding of retailing in E-commerce
- Analyse the impact of E-commerce on business models and strategy

Course contents:

1. **Introduction to E-Commerce**: E-Business Framework: Definition of E-Business, Origin of E-Business, History of the Internet, E-Business Opportunities for Businesses, Working of E-Business, E-Business Vs the Traditional Business Mechanism, Advantages of E-Business, Disadvantages of E-Business, Main Goals of E-Business
2. **E-commerce Business Models and Concepts**: Evolution of Internet Business Models, Business Models in Practice, Business Model: The Six Components
3. **E-commerce Marketing Concepts:** Challenges of Traditional Marketing, Retailing in E-Business Space, Internet Marketing, Advertisement and Display on the Internet, E-Business for Service Industry
4. **Mobile Commerce: Overview of M-Commerce**: Wireless Application Protocol (WAP), Generations of Mobile Wireless Technology, Components of Mobile Commerce, Networking Standards for Mobiles
5. **E-Payment Systems:** B2B Electronic Payments, Third-Party Payment Processing, Electronic Payment Gateway–Security Standard for Electronic Payment System

Prerequisite Course: None

Reference Books:

1. "E-Commerce", Kenneth C. Laudon, Business, Technology, Society, 4th Edition, Pearson Publishers, 2013.
2. "E-Commerce: An Indian perspective", S. J. Joseph, PHI Publishers, New Delhi, 2014.

UM16BB352
SOCIETY AND VALUE SYSTEM (2-0-0-0-2)

Course Objectives:

- To provide basic knowledge about Society and Changing Value system
- To make the students understand their roles and responsibilities in the society
- To sensitize the students with the significance of social inclusion and values in career progression.

Course Outcomes:

At the end of the course, the student should be able to

- Comprehend the structure of society and Indian Society in particular and where they belong;
- Apply their personal intuition in different social situations;
- Analyse the value system required in career
- Develop ideal and relevant behavioural traits for their future.

Course contents:

1. **Basic Concepts of Society:** Community; Institution; Association; Groups; Sub-groups; Social Structure; Status and Role; Position; Aggregate…
2. **Indian Society:**, Family systems, Inequality of Caste and Gender, Religion, Ethnic, Regional, Minorities, Backward Class and Dalits,Mortality,Fertility,Age-Sex ratio, Urban Migration, Inter Generation Conflict
3. **Values and Social Fabric:** General Values in management, Indian Patriarchal Culture Modern Society value Role of religious institutions, Gen-Z value thoughts, Philosophy of Yoga and its modern relevance.
4. **Societal Issues:** Developmental and Disorganization Development Induced Displacement**,** Community degradation**,** Crisis of Values**,** Crimes and Delinquencies**,** White Collar Crimes and Criminals, Drug Addiction, Suicide, Terrorism, Cyber Crime, Corruption in Public Sphere, Human Rights and Violation
5. **Societal Developmental and Value Reorientation for Future**: Impact of Media , uclear Families - Work-Life Balance and Compatibility- Urban and rural value division- Understanding Society backward for future course of progression

Prerequisite Course: None

Reference Books:

1. "A Foundation Course in Human Values and Professional Ethics", M. Govindarajan, Natarajan, Seenthilkumar, Kindle Edition, Paperback, 2010.
2. "Indian Society and Culture", Vinita, Rawat Publications, India, 2013.

BACHELOR OF BUSINESS ADMINISTRATION (HOSPITALITY AND EVENT MANAGEMENT)

Program Educational Objectives:

- Train and prepare the students to be a professionally strong graduates of Hospitality and Event industry
- Prepare the graduates to be employable in Hospitality & Event establishments
- Prepare students to acquire necessary entrepreneurial skills
- To prepare students secure benefitting placements in Hospitality and Event Industry
- Prepare students to be conversant in hands on of various Hospitality operational departments and Events managing

PROGRAM OUTCOMES:

- **Scholarship of Knowledge:** To acquire knowledge in the field of Hospitality and Event management.
- **Critical Thinking:** Analyze complex problems in the field of hospitality and event industry.
- **Problem Solving:** Identify, formulate and critically study problem.
- **Collaborative and Multidisciplinary Work:** Enhance shills and continuously acquire knowledge in hospitality and event domains for excellence.
- **Communication:** Effective and confident in communication with society and with industry professionals.
- **Lifelong Learning:** Engage in lifelong learning for professional advancement and effective work environment.
- **Ethical Practices and Social Responsibility:** Become a complete professional with high integrity and ethics, with excellent professional conduct with empathy towards the environmental and contribute to the community for sustainability development of society.

UM18BH101: HINDI (2- 0-0-0-2)

Course Objective:

To impart the basic knowledge of Hindi Language in terms of verbal & written communication skills in daily work situations.

Course Outcome:

By the end of the course, the student is capable of

- Communicating verbally in daily routine
- Delivering a simple welcome address, introducing a guest and a vote of thanks
- Writing a personal and a business letter
- Reading and summarizing a news item in a Kannada daily

Course Contents:

1. 'कफन' – प्रेमचन्द : दलित ग्रामीण जीवन को चित्रित करनेवाली कथा
2. 'धर्तीकास्वर्ग' – विष्णु प्रभाकर :लेखक को कश्मीर की यात्रा पर हुए अनुभवों का चित्र
3. "समय पर मिलनेवाले' – हरिशंकर परसाई :हास्य व्यंग्य जीवनचित्रण
4. (i) कुरुक्षेत्र (1–9 पदमात्र) रामधारीसिंह दिनकर महाभारत के युद्ध के बाद पितामह भीष्म से दुखी युधिष्ठिर को दिये जानेवाले उपदेशों का वर्णन
   (ii) आँसू (1–9 पदमात्र) – जयशंकर प्रसाद : कवि के जीवन का दु:खपूर्ण चित्रण– प्रकृति के साथ तुलना
5. व्याकरण – सन्धि – परिभाषा और व भेद

Prerequisite Course: None

Reference Books:

1. "Hindi Literature in Modern Days", .Srinivas Sharma, Oxford India Perennials, 8th Edition 1995.
2. "Indian Poetry", Suresh Agarwal, Pristine Femininity, 7th Edition 2008.
3. Study Material prepared by the Department of BBA-HEM, PES University.

UM18BH102: ENGLISH (2- 0-0-0-2)

Course Objective:

The main objectives of this course are:

- To equip students with the skills of effective communication in English language.
- To enable students to read and comprehend complex English texts
- To help them write logical, coherent, creative and persuasive prose in English language.

Course Outcome:

By the end of the semester, the student is capable of

- Identifying salient points deduce meanings of words; recognize text organization prose in English language.
- Pronouncing, pause and lay emphasis correctly, describe, explain, narrate, and be an active participant in Group Discussions effectively in English language.
- Expansion of ideas while at the same time be able to express and argue a point of view, condense ideas and write in Formal and Informal styles in English language.

Course Content:

1. **Communication:** Meaning, Importance, Objective & Principles, Process of Communication / Types, Channels & Modes of Communication / Impediments & Strategies for effective Communication / Cross Cultural Dimensions of Inter Personal Communication / Social Etiquettes
2. **Poetry:** Road Not Taken - Robert Frost; Prose: The Story of the Inexperienced Ghost - HG Wells; Play: His Return – Perceval Wilde
3. **Poetry:** Because I could not stop for Death – Emily Dickinson Profile: Vaman Srinivas Kudva – One of the Founding Directors of Syndicate Bank; Prose: In Sahyadri Hills, a Lesson in Humility – Sudha Narayana Murthy
4. **Speech:** Hillary Rodham Clinton's address at the U.N. 4th World Conference on Women Plenary Session - delivered on 5 September 1995, Beijing, China; Writing and delivering speeches; Expansions – Proverbs / Idioms
5. **Instruments of Business Communication:** Business Letters/ Inquiries/ Circulars/Quotations/ Sales Letters/ Memos/ Minutes of Meeting/ Notices/ Job Application Letters (CV, Covering Letter, Letters of Reference, Etc.)/ E–Mail Etiquette
6. **Meetings:** Importance/ Opening & Closing Meetings/ Meeting Etiquettes/ Participating & Conducting Group Discussions/ Brainstorming & its benefits/ E –meetings / Telephone Etiquette

Pre-requisite courses : None

Reference Books:

1. "Communication", Rayudu C S, Himalaya Publishing House, New Delhi, 10th Edition, 2012.
2. "Effective Communication", Adair, J Pan, Mcmillan, 2003.
3. "Organization Behavior", Fred Luthans, McGraw-Hill, 2005.
4. "Excellence in Business Communication", Thill J V and Bovee G L McGrawhill New York, 1993.
5. "Business Communication from Process to Product", Bowman, J P and Brachaw P, Dryden Press, Chicago, 1987.

6. “Business Communication”, Meenakshi Raman & Prakash Singh, Oxford Publisher, 2012.
7. “Business Communication”, Kaul, Prentice Hall, New Delhi, 2010.

UM18BH103
FRENCH (2- 0-0-0-2)

Course Objective:

- The objective of this course is to impart a working knowledge of French language

Course Outcome:

By the end of the course, the student is capable of:

- Formulating the basic structures, written & oral using alphabets, numbers, verbs, articles, prepositions, adjectives etc.
- Understanding and speaking the beginner level formal conversation like Greeting the clients, understanding their needs etc.
- Comprehending French terms related to hospitality staff
- Understanding the real-life communication situations related to hotel industry and responding back to the problems
- Reading and describing the ingredients, names of vegetables etc.
- Comprehending wine labels and reading them

Course Content:

1. **Conversational Terms:** Conversation starters & Conversational phrases; Restaurant Conversations ; Conversations between friends ; Phone Conversations & Etiquette ; How to say “Thank you”!; How to say “Sorry”!; Common Greetings & Good Bye ; Self introduction, **French Numbers & Letters:** Alphabets and its pronunciation; Numbers 1 to 100; Ordinal Numbers, **Time, days, months, seasons:** Times of the Day in French; French days of the Week; Talking about time in French; French months of the year & Their abbreviations; French seasons, Usage of Grammar in the context (Nouns, Pronouns, Article, Verbs, Verb Conjugations & Sentence Construction)
2. **Describing People:** French Emotions; Describe People & Appearance; French Family; French Personality Description; Parts of the Body; Face & Head; French Honorifics, French Clothes: Men’s clothing; Women’s clothing; Children clothing; Colors
3. **French Food & Restaurant:** Types of Restaurant; Food & Drink; Restaurant vocabulary usage in French; Meal time customs & Etiquette; Fruits & Vegetables; Describing the food; Words for meat; Seafood; Names of few animals; Practical - cooking
4. **French House & Home:** House & Room; Garden; Living room; Furniture; Bedroom; Bathroom; kitchen & kitchen Items; Household chores; Laundry & Storage Room; Appliances; Practical Session for House Keeping
5. **French Expressions & Special Greetings:** French Pleasantries; Phrases for tourists; Speak about Halloween; Christmas, New Year, Birthday Greetings; Congratulations & Best wishes; French Holidays & Celebration of Wedding; Easter Festivals; Party & how to write an invitation for the Party, **French General Expressions:** French Hobbies & Activities; French Travel; French Health & Wellness; French Measurement & Units; Shape words in French; Professions

Reference Books:

1. Workbook in French Language, PES University

UM18BH104
GERMAN (2- 0-0-0-2)

Course Objective:

- The objective of this course is to impart a working knowledge of German language

Course Outcome:

By the end of the course, the student is capable of:

- Formulating the basic structures, written & oral using alphabets, numbers, verbs, articles, prepositions, adjectives etc.
- Understanding and speaking the beginner level formal conversation like Greeting the clients, understanding their needs etc.
- Comprehending German terms related to hospitality staff
- Understanding the real-life communication situations related to hotel industry and responding back to the problems
- Reading and describing the ingredients, names of vegetables etc.
- Comprehending wine labels and reading them

Course content:

1. **Conversational terms:** Conversation starters & Conversational phrases; Restaurant Conversations ; CONVERSATIONS between friends; Phone Conversations & Etiquette ; How to say “Thank you”!; How to say “Sorry”!; Common Greetings & Good Bye ; Self introduction, **German numbers & letters:** Alphabets and its pronunciation; Numbers 1 to 100; Ordinal Numbers, **Time, days, months, seasons:** Times of the Day in German; German days of the Week; Talking about time in German; German months of the year & Their abbreviations; German seasons, Usage of Grammar in the context (Nouns, Pronouns, Article, Verbs, Verb Conjugations & Sentence Construction)
2. **Describing People:** German Emotions; Describe People & Appearance; German Family; German Personality Description; Parts of the Body; Face & Head; German Honorifics, German Clothes: Men’s clothing; Women’s clothing; Children clothing; Colors
3. **German Food & Restaurant:** Types of Restaurant; Food & Drink; Restaurant vocabulary usage in German; Meal time customs & Etiquette; Fruits & Vegetables; Describing the food; Words for meat; Seafood; Names of few animals; Practical - cooking
4. **German House & Home:** House & Room; Garden; Living room; Furniture; Bedroom; Bathroom; kitchen & kitchen Items; Household chores; Laundry & Storage Room; Appliances; Practical Session for House Keeping
5. **German Expressions & Special Greetings:** German Pleasantries; Phrases for tourists; Oktoberfest; Christmas, New Year, Birthday Greetings; Congratulations & Best wishes; German Holidays & Celebration of Wedding; Halloween, Easter Festivals; Party & how to write an invitation for the Party; **German General Expressions:** German Hobbies & Activities; German Travel; German Health & Wellness; German Measurement & Units; Shape words in German; Professions

Reference Books:

1. Workbook in German Language, PES University

UM18BH105:
FUNDAMENTALS OF CULINARY ARTS (2 -1-0- 0- 3)

Course Objective:

- To introduce the students to operations of the kitchen in a five-star hotel & the fundamentals of cooking

Course Outcome:

By the end of the course, the student will be capable of:

- Understanding the organization, & layout of the kitchen of a five-star hotel.
- Identifying the equipment used in the kitchen & their uses.
- Compiling a balanced menu.
- Classifying soups, sauces & methods of cooking
- Understanding commodities
- Adopting Food photography and Video capturing

Course content:

1. **Introduction to Cookery: History of Cuisines,** basic practices adopted in cooking, application of various sources of heats
2. **Hierarchy of Kitchen Department:** Duties and responsibilities, coordination with other departments, Classical kitchen brigade
3. **Layout of Kitchen Department**: Layout of general kitchen department, Formats used in purchase and receiving, Equipment& fuels used in the kitchen.
   Basic commodities used in Indian kitchen **(Self-study)**
4. **Basic Principles of Vegetables Cookery**, classification of fruits and their uses in cooking. **Rice cereals and Pulses (self-study)**
5. **Basic Indian Gravies, Curries and Masalas:** Gravies & curries, preparation, usage & storage, regional gravies**,** Methods of cooking
6. **Stocks, Soups & Salads:** Classification, uses, preparation, soups, classification, preparation, Types of soups & sauces, Meats, fish, shellfish

Pre-requisite courses : None

Reference Books:

1. "Food Production Operations", Parvinder S. Bali, Oxford University Press, New Delhi, 2009.
2. "Practical Cookery", 10th 11th 12th Editions, Victor Ceserani & Ronald Kinton, ELBS, UK, 2008.
3. "Theory of Catering", 10th 11th 12th Editions, Victor Ceserani & Ronald Kinton, ELBS, UK, 2007.
4. Theory of Cookery", 5th, 6th Editions, Krishna Arora, Frank Bros & Co., New Delhi, 2008
5. "Modern Cookery – Volume I & II", 5th Edition, Thangam E Philip, Orient Blackswan, Telengana, 2004.
6. "Food and Beverage Service", 10th 11th 12th Editions, Dennis Lillicrap, ELBS, UK, 2006.

UM18BH106: FUNDAMENTALS OF FOOD & BEVERAGE SERVICE (3- 0-0-0-3)

Course Objective:

- The objective of this course is to provide an overview of the principles of food and beverage concepts, various equipment used menu development and food service operations in various segments of the hospitality and tourism industries.

Course Outcome:

By the end of the course, the student is capable of:

1. Understanding the principle & Objectives of menu planning
2. Framing balanced menus and 12 course French classical menu
3. Understanding the organization & hierarchy of service department
4. Maintaining hygiene and personal grooming
5. Basics of Non-Alcoholic Beverages

Course content:

1. **Introduction to Food & Beverage Service Operations:** Different types of catering operations, F&B service areas, Organizational hierarchy, Room service organization
2. **Meals and Menu Planning:** Types of meals, Origin of menu, Types of menu, Food and accompaniments
3. **Types of Service:** Table service Self service, Assisted service, Special service, Restaurant service cycle, Types of room service, , Types of breakfast
4. **Banquet Operations**: Types of functions, Banquet organization structure, Seating Arrangements.
5. **Non-Alcoholic Beverages**: Definition of Non-Alcoholic Beverages. Different types of Non-Alcoholic Beverages with relevant examples.

Prerequisite courses : None

Reference books:

1. F& B Service-–7th Edition, Lillicrap & cousins, Hodder& Stoughton, London; 2008
2. "Food and Beverage Service: A Training Manual; 3rd Edition, Sudhir Andrews Publisher TMH, New Delhi;1995
3. "Food and Beverage Service", 2nd Edition, Vijay Dhawan; Frank Bros. & Co., New Delhi; 2000

UM18BH107: FUNDAMENTALS OF FRONT OFFICE OPERATIONS (3- 0-0-0-3)

Course Objective:

- The objective of this course is to provide an overview of the Hotel Industry and Front Office Department

Course Outcome:

By the end of the course, the student is capable of:

- Explaining how the Travel & Tourism industry has influenced the evolution of Hospitality industry
- Classifying Hotels in terms of their size, location, facilities and ownership
- Planning the layout of different types of rooms & tariff fixation methods
- Suggesting the organization of the Front Office, including the vision & mission statements, work shifts and job descriptions and job specifications
- Understanding the various functions performed at the Bell Desk, reservations and front desk

Course content:

1. **Introduction to the Hospitality Industry:** Evolution & growth of Hotels in the world & in India; Personalities in Hotel Industry: India & International; Portfolios of major hotel chains around the world; Classification of Hotels; Alternative Accommodation; Technology based room aggregators – Airbnb, Oyo rooms
2. **Hotel Organization:** Vision & Mission; Major Departments of a Hotel; Sections & Layout of Front Office; Multi-functional front desk; Organization of Front Office Staff: Work Shifts, Job Description, Job Specification, Duties & Responsibilities; Types of guest Rooms; Status, Rates, Tariff fixation; Guest profiling
3. **Front Office Layout & Operations:** Layout of Lobby, Different lobby layouts and their functionality; Bell Desk Organization, Concierge; Services performed at Bell Desk; Forms & Formats used in Bell Desk; Guest cycle; Supporting departments and allied departments role in the guest cycle (Housekeeping, Engineering & Maintenance, Sales departments)
4. **Reservations:** Types of reservations, sources and modes; Guaranteed & non-guaranteed reservations; Group reservations: Group Block, displacement, wash factor; E-commerce in hotel reservations: hotel website, CRS, GDS, single image inventory, dynamic package pricing; Guest segmentation; Online travel agents, distribution channels, commissions; OTAs and the reducing hotel revenue – Literature review (Self-study)
5. **Front Desk Functions:** Registration**;** Check-in procedures (Guest with reservation, Walk-ins, VIP, Group); Selling techniques in Front Office; E - check-in, mobile check-in; Information directory, reader board, Safe custody & control of room keys, Handling guest complaints, safe deposit locker; Emergency situations: Fire safety, accidents & first aid, Terrorist activities, bomb threat, Robbery & theft, guests in drunken state, log book

Pre-requisite courses : None

Reference Books:

1. "Hotel Front Office Operations And Management", Jatashankar R Tewary, Oxford University Press, New Delhi, 2012
2. "Hotel Front Office Management", Bardi, J. A., John Wiley & Sons, USA, 2011.
3. "Managing Front Office Operations", Kasavana, M. L., & Brooks, R. M. American Hotel & Lodging Educational Institute, USA, 8th Edition, 2013.

UM18BH108: FUNDAMENTALS OF ACCOMODATION OPERATIONS (3- 0-0-0-3)

Course Objective:

- To develop skill and competency in House Keeping Operations

Course Outcome:

By the end of the course, the student is capable of:

- Drawing an Organization chart of a typical Housekeeping department
- Prescribing an audit protocol for the procedures involved in room cleaning & public area cleaning (Guest areas & back of the house areas)
- Preparing the job description and job specifications of the House Keeping personnel
- Using cleaning agents and equipment operated in hotels.

Course Content:

1. **The role of housekeeping in hospitality operations,** Importance, Responsibilities, Organizational structure
2. **Room division organization,** Sections and layout of housekeeping department, Coordination with other departments **(Self Study)**
3. **Managing housekeeping personnel**
4. **Hotel guest room cleaning,** Types of keys, preparing to clean: assembling supplies and room assignments, deep cleaning, Turn down service
5. **Public area cleaning:** Entrances, Front Desk, Elevators, Staircase, Guest Corridors, Leisure Areas, Public Guestrooms, Banquet Halls, Dining Area**.**

Pre-requisite courses : None

Reference Books:

1. "Hotel Housekeeping", Singh, M. Tata Mcgraw-Hill, New Delhi, 2012
2. "Hotel Housekeeping: Operations & Management", G. Raghubalan & Smritee Raghubalan, Oxford University Press, New Delhi, 2012.
3. "Theory & Practices of Professional Housekeeping", Sunita Srinivasan, Anmol Publication Pvt. Ltd., Bangalore, 2009.

UM18BH109: FUNDAMENTALS OF EVENT OPERATIONS

Course outcome

- To provide the skills and knowledge required to develop underpinning skills to ideate and develop an event concept.

Course Outcome:

At the end of the course, the student is capable of

- Understanding various elements and theories of events.
- Distinguishing between the different types of events and their specific requirements
- Utilizing the basic knowledge and skills needed to plan the event.
- Developing appropriate attitude to deal with untoward problems

Course content:

1. **The Concept of Event Management:** A Definition of Event Management and Brief History of how Event Management became a professional domain
2. **Introduction to Event Management:** Theories and Models in Event Management –Business perspective - Growth opportunities
3. **Principles of Event Management:** Event Team, Code of ethics, Principles of event Management, concept & designing. Analysis of concept, Logistics of concept.
4. **Types of events:** Introduction to different kind of events, Concerts, sports, weddings, corporate and exhibitions
5. **Personal Development & Communication Skills:** Personal grooming, expression, bearing, body language. Written communications, Verbal communications and computer skills.

Pre-requisite courses : None

Reference Books:

1. "The Business of Events Management, Complementary Literature", Bowdin, G., Pearson Education, Harlow 2014.
2. "Events Management", Beech, J., Chadwick, S., Elsevier 2011.
3. "The Business of Sport Management", Van der Wagen, L., Carlos, B., Prentice Hall 2013.
4. "Event Management for Tourism, Cultural, Business and Sporting Events", Yeoman, I. Pearson 2005.

UM18BH110: FUNDAMENTALS OF CULINARY ARTS - PRACTICAL (0-0-4-0-2)

Course Objective:

- To provide an overview of the different methods of cooking and demonstrate the same using local ingredients and available equipments

Course Outcome:

By the end of the course, the student is capable of:

- Defining basic culinary operations.
- Analyzing the recipe, practice the same and bringing out the prescribed standard
- Working out the menu, indenting, costing & controlling, promoting sales.
- Following the standard recipes as a habit or converting any recipes into the format of standard recipe and carry over for the practice
- Being energetic, knowing the customer needs, and adopting patience, working for long hours

Course Content:

Identification of Kitchen equipment, Project to be made

1. Demonstration and practice of different cuts of vegetables
2. Practice of cuts of various vegetables
3. Explain sources of heat, Demonstration of cooking methods
4. Boiling, steaming, poaching, (Egg, Fish) blanching, sautéing frying – (shallow & deep) ,
5. Demo and cuts of Chicken & Fish.
6. Mid semester assessment
7. Stuffing & Trussing, Roast chicken with stuffing and barbeque sauce
8. Eggs
9. Cooking of rice and pasta,
10. Soups, Stocks and Sauces – Demo

11. Making of bread rolls,
12. Salads, Garnishes and plate presentations, Tossed salad with dressings
13. Assessment

Pre-requisite courses : None

Reference Books:

1. "Food Production Operations", Parvinder S. Bali, Oxford University Press, New Delhi, 2009.
2. "Practical Cookery", Victor Ceserani & Ronald Kinton, ELBS, UK, 10th 11th 12th Editions, 2008.

UM18BH111: FUNDAMENTALS OF FOOD & BEVERAGE SERVICE – PRACTICAL (0-0-4-0-2)

Course Objective:

The objective of this course is to provide an overview of the food and beverage concepts, various equipment used menu development and food service operations in various segments of the hospitality and tourism industries.

Course Outcome:

By the end of the course, the student is capable of:

1. Maintaining hygiene and personal grooming
2. Laying a table, setting a cover & service of a meal
3. Mis-en-place and mis-en-scene
4. Setting a cover
5. Basic service skills

Practical content:

1. Identify Cutlery and crockery
2. Identify Glassware
3. Laying and relaying of table cloth, Napkin folds
4. Setting up a table for 3 course menus
5. Pre-Plated Service
6. Mid-sem assessment
7. Silver Service
8. Room Service Tray-Set-up
9. Breakfast Tray and Table set-up
10. Formal Service Sequence
11. Innovative service and table set-up
12. Revision
13. Assessment

Pre-requisite courses : None

Reference Books:

1. "F & B Service", Lillicrap & Cousins, 7th Edition Publisher, Hodder & Stoughton, London, 2008.

UM18BH112: FUNDAMENTALS OF FRONT OFFICE OPERATIONS PRACTICAL (0-0-2-0-1)

Course Objective:

To inculcate and use customer relation skills relevant to front office operations

Course Outcome:

By the end of the course, the student is capable of:

1. Receiving & handling guests
2. Selling rooms & facilities using various selling tactics
3. Making a reservation, checking-in and checking-out a guest
4. Analyzing safety procedures followed in hotels

Course Content:

Front Office:

1. How to greet a Guest
2. Guest Delight Bank
3. Rooming Procedure
4. How to take guest messages
5. Reservation Module- Telephone etiquette
6. Mid semester assessment
7. Check in of VVIP, Repeat Guest, First time guest
8. PPT- Itinerary
9. Create a brochure for a hotel
10. Role Play Check-in of guest
11. Role Play check-out of guest
12. Emergency situation Handling
13. Final Assessment

Pre-requisite courses : None

Reference Books:

1. "Hotel Front Office Operations and Management", Jatashankar R Tewary, Oxford University Press, New Delhi, 2012

UM18BH113: FUNDAMENTALS OF ACCOMMODATION OPERATIONS PRACTICAL (0-0-2-0-1)

Course Objective:

to develop skill and competency in House Keeping Operations

Course Outcome:

By the end of the course, the student is capable of:

1. Using the cleaning agents and equipment operated in hotels.
2. Basic stitching, hemming & brassoing
3. Setting up a room according to a theme

Course Content:

Housekeeping:

1. Identifying Manual, Mechanical Equipment,
2. Identifying Cleaning Chemicals
3. Identifying different types of Linen
4. Visit to laundry Facility
5. Guest Room Amenities (Report)
6. Certification Eco Lab Launder Care
7. Mid Semester Assessment
8. Public Area Cleaning
9. Bed Making
10. Brassoing
11. Hemming, Button & Hook Stitching
12. Standard Guestroom Setup
13. Final Assessment

Pre-requisite courses : None

Reference Books:

1. "Hotel Housekeeping", Singh, M., Tata McGraw-Hill, New Delhi, 2012.
2. "Hotel Housekeeping: Operations & Management", G. Raghubalan & Smritee Raghubalan, Oxford University Press, 2012

UM18BH114: FUNDAMENTALS OF EVENT OPERATIONS PRACTICAL (0-0-2-0-1)

Course Objective:

To be able to use PowerPoint, excel and coral draw for an effective Event Management promotion and poster

Course Outcome:

By the end of the course, the student will be capable of

1. Creating an effective PPT presentation
2. Working with MS Excel & spreadsheets
3. Creating designs and posters using COREL

Course Content:

1. Understand PowerPoint
2. Use of PowerPoint tools, Effective PPT layouts
3. Presentation
4. Basics of Excel
5. Summation, commands, spreadsheet
6. Use of Excel in Data
7. Mid semester assessment
8. Basics of Corel
9. Use of coral in posters
10. Design a simple template
11. Thematic poster
12. Assessment

Pre-requisite courses : None

Reference Books:

1. Fundamentals of Event Operations Laboratory Manual, PES University

UM18BH151: HOSPITALITY ACCOUNTING (2-1-0-0-3)

Course Objective:

- To introduce basic accounting principles & concepts relevant to the hospitality industry

Course Outcome:

By the end of the course student will be capable of:

- Making journal entries, posting & balancing of ledger accounts
- Preparing bank reconciliation statements & cash books
- Preparing a trading & P & L accounts

Course Content:

1. **Introduction to Accounting:** Meaning, definition, objectives and importance of accounting and hotel accounting. Book keeping and accounting, Single entry system and double entry system of book-keeping.
2. **Accounting Principles:** Accounting concepts and conventions, Capital, revenue and deferred revenue expenditures and incomes, Classification of accounts, Rules of debit and credit.
3. **Journal and Ledger**: Book of Prime entry – meaning – objectives – advantages of journal – journalizing – journal entry – recording problems on journal entry - Book of secondary entry - meaning – features – distinction between journal and ledger-posting- steps involved in posting of entries from journal to ledger – balancing of accounts.
4. **Cash Book:** Simple cash book, two column cash book, three column cash book and imprest system of petty cash book, importance and reasons for preparing bank reconciliation statement.
5. **Final Accounts:** Trial balance, Importance, purpose and advantages, Final accounts of small hotels and restaurants, trading account, profit and Loss account and balance sheet

Pre-requisite courses : None

Reference Books:

1. "Fundamentals of Accounting", S P Jain and K L Narang, Kalyani Publishers, 2016.
2. "Double Entry Book-keeping", T.S. Grewal, S Chand & Sons, New Delhi, 2016.
3. Hospitality Accounting: A Financial and Managerial Accounting Reference, Steven M. Bragg, Accounting Tools, 2015.

UM18BH152: PATISSERIE AND CONFECTIONERY (3- 0-0-0-3)

Course Objective:

- The objective of this course is to provide an overview of Bakery and confectionery

Course Outcome:

By the end of the course, the student is capable of:

- Suggesting basic commodities used in bakery
- Describing various procedures applied for different baked products
- Understanding the role & function of each ingredient in a bakery recipe
- Distinguishing between different baked products
- Applying a recipe & creating basic bakery products

Course Content:

1. **Basic Commodities Used in Bakery and Pastry:** Flour, structure of wheat grain, raising agents, Fats and oil Other commercial products and miscellaneous ingredients used in bakery (Self-study)
2. **Bread Fabrication** & **Cake Making:** Baking, ingredients used, basic fault, equipment used. International breads and other yeast dough products
3. **Basic Sponges and Cakes:** Introduction, pastry techniques and principles, ingredients used in sponge making specialty cakes and cake products.
4. **Pastes, Creams, Fillings and Sauces Making of marzipans and fondants, Laminated pastries**: Puff pastry, methods of making puff pastry, inverted puff pastry
5. **Menu Planning:** Functions of menu, types, used as control tool, menu balancing, wine food pairing, basic principles of vegetable cooking.

Pre-requisite courses : None

Reference Books:

1. "Food Production Operations", Parvinder S. Bali, Oxford University, 2009.
2. "Practical Cookery", Victor Ceserani & Ronald Kinton – 10th 11th 12th Editions, ELBS, UK, 2008.
3. "Theory of Catering", Victor Ceserani & Ronald Kinton, 10th 11th 12th Editions, ELBS, UK, 2007.
4. "Theory of Cookery", Krishna Arora, Frank Bros & Co., 5th, 6th Editions, 2008.
5. "Modern Cookery – Volume 1 & 2", Thangam E Philip, Orient Longman, 5th Edition, 2006.

UM18BH153: BREW BASICS AND WINE STUDIES (3- 0-0-0-3)

Course Objective:

The objective of this course is to provide an overview of Room service concepts and about Fermented Beverages and its service

Course Outcome:

By the end of the course, the student is capable of:

- Classifying beverages
- Describing the manufacture of wines
- Describing wine regions of the world & famous wine brands
- Suggesting proper wines for different food items
- Selling and up selling of the fermented beverages
- Narrating manufacturing process of beer & other fermented beverages.

Course Content:

1. **Introduction and classification to Beverages:** Types of Alcohol, Origin, History, Calculation of alcoholic percentage, Classification of beverages: Types of beverages, Non alcoholic beverages, alcoholic beverage
2. **Introduction to wines:** Vine, Classifications of wines, Manufacturing process of table wines and sparkling wines, champagne
3. **Food and Wine harmony-** Planning Food menus with wines, Trends, Disruptions, Costing
4. **Beer & Micro brewing-** Manufacturing process, Types of beer, Consumption patterns, Trends
5. **Other fermented alcoholic beverages:** Cider, sake & toddy,

Pre-requisite courses : None

Reference Books:

1. "The Beverage Manager's Guide to Wines, Beers & Spirits", 4th Edition, John Peter Laloganes/ Albert W.A. Schmidt, 2017.
2. "F & B Service", Lillicrap & Cousins, Hodder & Stoughton, 2008.
3. "Restaurant Service Basics", Sondra J. Dahmer and Kurt W. Kahl, John Wiley & Sons, 2008.
4. "Food & Beverage Service – A Training Manual" 3rd Edition, Sudhir Andrews, Oxford University Press, 2013.

UM18BH154: ACCOMMODATION OPERATIONS (3- 0-0-0-3)

Course Objective:

To develop advanced skill and competency in House Keeping Operations

Course Outcome:

By the end of the course, the student is capable of:

- Planning & Analyzing different laundry operations
- Suggesting appropriate inventory management techniques in housekeeping department
- Describing the safety protocol for hotel in emergency situations
- Detailing the planning & organizing of housekeeping department
- Suggest the alternative approaches to conservation of resources in hotels including adopting Green philosophies

Course Content:

1. **Hotel laundry operations:** Planning of On-Premise Laundry, The Linen Cycle within OPL, Machine & Equipment used in OPL, Valet Service, Outsourced laundry services-Pros& Cons **(Self study)**.
2. **Managing inventories & lost and found process:** Par levels, Linens, Uniforms, Guest Loan Items, Guest Supplies; Bed-Types, Pillow-Types, Lost& Found Register, Managing consumable, renewable and capital inventory.
3. **Safety and security,** Hotel Security Staff and systems, Security and Control of Room Keys, OSHA Regulations, OSHA's Hazardous Communication Standard. Fire Safety, Types of fire Extinguishers, Accidents-Slip, Trips & fall; First Aid, Safety committee and role of safety committee in a hotel, POSH at workplace.
4. **Environmental and energy management:** Sustainability and Green Philosophies, Housekeeping role in a green property, Water conservation, Energy Efficiency, Waste Management, Benefits of energy management systems in Hospitality Industry-Literature review.
5. **Planning and organizing the housekeeping department:** Planning the work of housekeeping department, Area Inventory lists, Frequency Schedules, Performance Standards, Productivity Standards, and Inventory Levels. Other Management functions and Executive Housekeeper. Coordinating and staffing, Directing and controlling, Evaluating.

Pre-requisite courses : None

Reference Books:

1. "Hotel Housekeeping", Singh, M., Tata McGraw-Hill, New Delhi, 2012.
2. "Hotel Housekeeping: Operations & Management", G. Raghubalan & Smritee Raghubalan; Oxford University Press, 2012.
3. "Professional Housekeeping", Sunita Srinivasan, Anmol Publication, 2009.

UM18BH155: EVENT MANAGEMENT (3- 0-0-0-3)

Course Objective:

- The objective of this course is to train the students in planning, organizing need-based events.

Course Outcome:

At the end of the course, the student is capable of

- Identifying the scope for event sales in a given market
- Understanding various elements of events.
- Coordinating with service providers and organize the logistics as required for the event
- Utilizing the basic knowledge and skills needed to plan the event.
- Developing appropriate attitude to deal with untoward problems

Course Content:

1. **Event Operations basics:** Understanding how event production works. Understand different branches of operations.
2. **Event Check List:** Understand the event and create a checklist and event flow. Planning and structuring the event.
3. **Organizing the event**: Purpose, Concept, theme, Fabrication, light & sound, handling vendors
4. **Marketing and Branding**: Types of Marketing and branding – competitions/contests - promotions - website and email marketing, social media marketing etc.
5. **Values & Ethics of Event Industry:** Code of ethics, professional association

Pre-requisite courses : None

Reference Books:

1. "The Business of Events Management, Complementary Literature", Bowdin, G., Pearson Education, Harlow 2014.
2. "Events Management", Beech, J., Chadwick, S., Elsevier 2011.
3. "The Business of Sport Management", Van der Wagen, L., Carlos, B., Prentice Hall 2013.
4. "Event Management for Tourism, Cultural, Business and Sporting Events", Yeoman, I. Pearson 2005.

UM18BH156: MANAGEMENT OF SERVICES (3- 0-0-0-3)

Course Objective:

- Study "breakthrough" services to understand the operations of successful service firms that can be benchmarks for future management practice.
- Widen an awareness of the opportunities that information technology can have for enhancing service firm's competitiveness.
- Comprehend the dimensions of service growth and expansion both domestically and internationally.

Course outcome:

At the end of the course, the student will be capable of

- Studying "breakthrough" services to understand the operations of successful service firms that can be benchmarks for future management practice.
- Appraising the opportunities that information technology can have for enhancing service firm's competitiveness.
- Appreciating the organizational significance of managing the service encounter to achieve internal and external customer satisfaction. .

Course Content:

1. **The Role of Services in an Economy:** Service Definitions-Economic Evolution-Nature of Service Sector- New Experience Economy-Sources of Service Sector Growth-Services Classifying Services for Strategic Insights. The service triangle.
2. **Service Strategy and Development:** The Strategic Service Vision- Understanding the Competitive Environment of Services-Competitive Service Strategies-Winning Customers in the Market Place- New Service Development- Service Design Elements-Service Blueprinting-Strategic Position to Process Structure-Customer Value Equation
3. **Managing service employees and service customers**: Managing the firm's physical evidence. Meaning of Hospitality, Marketing Mix of Hospitality Industry
4. **Technology in Services**: Technology in Service Encounter- The Emergence of Self-Service- Automation in Services- Internet Services-Economics of Scalability-Technological Innovation in Services.
5. **Planning & Managing Service Delivery-Service Quality**: Defining Service Quality-Measuring Service Quality- Quality Service by Design-

Reference Books:

1. "Service Modeling, Principles and Applications", Raisanen, V., John Wiley & Sons, 2010.
2. "Managing Services", Nankervis, A. Cambridge Press, 2009.
3. "Principles of Service Marketing and Management", Lovelock, C. and Wright, L., Prentice Hall, 2011.
4. "Service Management: Operations, Strategy, and Information Technology", Fitzsimmons, James A., and Fitzsimmons M. J., 5th Edition, Irwin/McGraw-Hill. 2006

UM18BH157: PATISSERIE AND CONFECTIONERY PRACTICAL (0-0-4-0-2)

Course Objective:

- The objective of this course is to provide hands on training in practical baking & confectionery skills & continental cuisine.

Course Outcome:

By the end of the course, the student is capable of:

- Carrying out basic culinary operations of bakery
- Working out the menu, indenting, costing & controlling for bakery products and continental menus. Following the standard recipes as a habit or converting any recipes into the format of standard recipe and carried over for the practice for bakery goods & continental recipes.
- Preparing basic bakery products & five course continental menu from a standard recipe.
- Being energetic, knowing the customer needs, and adopting patience, working for long hours
- Demonstrating basic sugar art.

Course Content:

1. Yeast dough products
2. Tarts and Tartlets
3. Basic Sponge & Icings
4. Cookies
5. Confectionary
6. Petit Fours & Marzipan
7. Mid semester assessment & Plate presentation evaluation
8. Continental menu 1
9. Continental menu 2
10. Continental menu 3
11. Continental menu 4
12. Continental menu 5
13. Final assessment

Pre-requisite courses : None

Reference Books:

1. "Food production Operations", Parvinder S. Bali, Oxford University, 2009.
2. "Practical Cookery", Victor Ceserani & Ronald Kinton, 10th 11th 12th Editions, ELBS, UK, 2008.

UM18BH158: BREW BASICS AND WINE STUDIES (0, 0, 4, 0, 2)

Course Objective:

The objective of this course is to provide hands on training in Room service concepts and about Fermented Beverages and its service

Course Outcome:

By the end of the course, the student is capable of:

1. Service of wines
2. Suggesting proper
3. Wines for different food items
4. Reading Labels

Course Content:

1. Setting up a cover for White Wines
2. Cover for Red wines
3. Service of White wines

4. Service of Red Wines
5. Service of Fortified and Aromatized Wine white wine and red wine
6. Industry Visit
7. Mid-Sem Assessment
8. Reading wine labels
9. Menu Planning with wines – 3-5 Courses (Continental, Indian, etc.)
10. Service of Beer
11. Beer and Food Menu pairing
12. Revision
13. END SEMESTER ASSESSMENT

Pre-requisite courses : None

Reference Books:

1. "The Beverage Manager's Guide to Wines, Beers & Spirits", 4th Edition, John Peter Laloganes/ Albert W.A. Schmidt, 2017
2. "F & B Service", Lillicrap & Cousins – Hodder & Stoughton, 2008.
3. "Restaurant Service Basics", Sondra J. Dahmer and Kurt W. Kahl, John Wiley & Sons, 2008.
4. "Food & Beverage Service – A Training Manual", Sudhir Andrews, 3rd Edition, Oxford University Press, 2013.

UM18BH159: FRONT OFFICE OPERATIONS PRACTICAL (0-0-2-0-1)

Course Objective:

- Expose & familiarize the students to automation in front office & its applications

Course Outcome:

By the end of the course student will be capable of:

- Identifying icons on PMS
- Making a reservation, cancellation / modification on PMS
- Registering a guest & allotting rooms on PMS
- Posting charges & printing a bill
- Performing POS functions on PMS

Course Content:

Front office software (IDS):

1. Identification of Icons - Identification of IDS Icons on system and their uses
2. Reservation - How to make a Reservation on system
3. Modification, Cancellation and Reinstating of Reservation
4. Registration - How to register a guest on system by assigning the inspected room, entering messages for reserved guests prior to check-in and showing check in on system
5. Filling all the Guest details in the system for a reserved guest, walk in guest
6. Mid semester assessment
7. Posting in guest folio from front office, modifying the posting
8. Give paid outs, posting room rate and printing bill.
9. How to transfer the F & B bill to guest folio
10. Point Of Sale - How to make a KOT on system, Modification of the KOT, Table transfer and Post the Restaurant and Bar bill on the system.
11. Give discounts, spilt quantity, spilt bill, print bill & settlement.
12. Settlement and Check out Procedure - How to Settle the bill by cash / credit card, How to show checkout on system
13. Final assessment

Pre-requisite courses : None

Reference Books:

1. "Managing Front Office Operations", Kasavana, M. L., & Brooks, R. M., Pearson Education, 2013.
2. "Managing Technology in Hospitality Industry", Kasavana, M.L., Pearson Education, 2013.

UM18BH160: ACCOMMODATION OPERATIONS PRACTICAL (0-0-2-0-1)

Course Objective:

- To expose the student to appropriate skills & develop competency in housekeeping operations

Course Outcome:

By the end of the course, the student is capable of:

- Demonstrating, room cleaning & public area cleaning procedures
- Setting up amenities in a room & maid's trolley.
- Applying linen control procedures in Housekeeping Operations
- Making different types of beds

Course Content:

Housekeeping:

1. Set up Of Maids Trolley
2. Public Area cleaning
3. Inventory Checklist
4. Snagging list
5. Bed Making
6. Mid semester assessment
7. Ironing
8. Towel Art - Basic
9. Towel Art - Advanced
10. Guest Room Cleaning
11. Flower Arrangement
12. Flower Arrangement
13. Final Assessment

Prerequisite courses: None

Reference Book:

1. "Hotel Housekeeping", Singh, M., Tata McGraw-Hill, New Delhi, 2012.
2. "Hotel Housekeeping: Operations & Management", G. Raghubalan & Smritee Raghubalan, Oxford University Press, 2012.

UM18BH161: EVENT OPERATIONS PRACTICAL (0-0-2-0-1)

Course Objective:

- To be able to conceptualize and plan an event based on a theme

Course Outcome:

At the end of the course, the student will be capable of:

- Generating leads for sponsorship
- Planning an event based on a theme
- Identifying the various elements imperative in organizing an event
- Comprehending he use of social media in promotion of an event

Course Content:

1. Write a sponsorship Letter
2. Plan an Event
3. Create a theme
4. Identify a Venue
5. Logistics
6. Mid semester assessment
7. Risk Identification
8. Plan a guest list
9. Identify the equipment
10. Create a Media Page
11. Link to Instagram and twitter handle
12. Final assessment

Pre-requisite courses : None

Reference Book:

1. "The Business of Events Management, Complementary Literature", Bowdin, G., Pearson Education, Harlow 2014.
2. "Events Management", Beech, J., Chadwick, S., Elsevier 2011.
3. "The Business of Sport Management", Van der Wagen, L., Carlos, B., Prentice Hall 2013.
4. "Event Management for Tourism, Cultural, Business and Sporting Events", Yeoman, I. Pearson 2005.

UM17BH201:
INDUSTRY EXPOSURE TRAINING – HOSPITALITY INDUSTRY (0-0-0-54-12)

Course Objective:

- The objective of industrial training is to provide to students the feel of the actual working environment and to gain practical knowledge and skills, which in turn will motivate, develop and build their confidence. Industrial training is also expected to provide the students the basis to identify their key operational area of interest.

Course Outcome:

By the end of the course, the student is capable of:

- Preparing an Organigram of a five-star hotel
- Summarizing the functions of all departments of the hotel
- Analyzing operations of 4 core departments of the hotel
- Identifying operational / procedural problems in the various departments & suggesting solutions for them

Schedule:

Beginning of the second year (III Semester), students have to undergo Industrial Exposure Training in a leading Hotel identified by the university for a period of 12 weeks. After completion of Industrial Exposure Training the students must submit the IET Certificate and Training Report.

Attendance

Students must compulsorily have 100% attendance in internship. In genuine cases 10% relaxation is allowed if internship coordinator is informed in advance in writing or by official email and permission has been granted by university for leave.

Project report & presentation

The students must make a report on the IET and a 10 slide PPT presentation on training hotel to the University on completion of the internship.

Pre-requisite courses : None

Reference Book :

1. Hotel Internship Log Book, PES University.

UM17BH251:
FOOD CULTURE & SUSTAINABILITY (3- 0-0-0-3)

Course Objective:

- To introduce students to the concepts of food culture, food sustainability and familiarize them to various cuisines Indian and western.

Course Outcome:

By the end of the course, the student is capable of:

- Analyzing the impact of historical background & geographical location on regional Indian Cuisines & know about the variation in cuisines due to seasonal availability of ingredients
- Understanding the basic concept of specialty Indian cooking methods & analyze the different techniques applied
- Explore how food and culture are interlinked with the region and country.
- Gain an understanding of sustainable food practices.
- Assess sustainable practices and issues to preserve cuisines.

Course Content:

1. **Introduction, Meanings of Food, Culture and Sustainable:** What are food- Food and various cultures- role of culture- Meaning of Sustainable cuisine- Food as a healer
2. **Social Conditions of Food, Eating Habits and Native food History:** Gender Foods, affordability and eating habits - learning old food - Hunger and food (local and National) **Sustainable and Sustainability issues in Food:** Industrialization of food - Food as a commercial tool - lost cuisines - forgotten recipes - mixed culture for cuisine dilution - Detriments of Globalization; **Regional Cuisines of India & Current Trends in Indian Cuisine:** Hyderabadi, Awadh, Bengal, Goa, Kashmir, Kerala, Maharashtra, Parsi, Punjab, Rajasthan, Tamilnadu (Self-study)
3. **Best Practices and trends- Food and Identity:** Food and Power, Understanding Science of food - consumption patterns - Health and tradition - modernist approach to native food
4. **Traditional home – style cooking:** Concept of Ghar ka Khana; **Concept of Health Food**: types of nutrients, balanced diet and nutritional analysis
5. **International Cuisines**: Western cuisines, European cuisines, Pan Asian cuisines (Self-study) **Advanced Pastry and Confectionery:** Chocolate, hot & cold desserts, Ice creams & frozen desserts, Sauces & coulis

Pre-requisite courses : None

Reference Books:

1. "Quantity food Production Operations & Indian Cuisine", Parvinder Singh Bali**,** Oxford Publications, 2014.
2. "International Cuisine and Food Production Management",Parvinder S. Bali, Oxford Higher Education, 2013.
3. "Theory of Catering", Victor Ceserani & Ronald Kinton, ELBS, 10th 11th 12th Editions, 2007.
4. "Theory of Cookery", Krishna Arora, Frank Bros & Co., 5th, 6th Editions, 2006.
5. "Modern Cookery – Volume I & II", 5th Edition, Thangam E Philip, Orient Longman, 2004.

UM17BH252: DISTILLED BEVERAGES (3, 0, 0, 0, 3)

Course Objective:

- Familiarize the students to advanced service operations.

Course Outcome:

By the end of the course, the student is capable of:

- Classifying tobacco products based on types, brands, manufacture, country of origin
- Describing the distillation process of alcoholic beverages.
- Identification of liqueurs
- Detailing responsible bar service procedures
- Classifying cocktails & their preparation methods

Course content:

1. **Introduction** to KSBCL, Different types of Licenses, Excise rules-regulations
2. **Distilled Alcoholic Beverages**: This Unit will initiate the students in understanding the world of distillates and spirits Industry. Students will have knowledge of types of distillation and the products evolved from these distillation styles
3. **Introduction to Beverages and Bar Operations: T**his Unit will initiate the students to the world of alcoholic beverages. Students will have knowledge of alcohol, types of alcohol, ill effects of alcohol and social responsibility towards the trade; The Unit will also cover the business of Bars and Lounges; the students to understand the operation of Bar and management of the beverage business. Students will have knowledge of types of bars, styles, layouts and various aspect of the trade with regards to working, timings, layouts, spaces and work-flow.
4. **The world of clear/white spirits:**
   a. **Unaged spirits** of the world, production, Uniqueness of each product, manufacture, brands and service. Spirits to be covered - White Rum, Aguardente de cana, cacaçha, Vodka, Gin, Alcool Blanc. Tequila
   b. **Aged spirits:** The Unit will impart knowledge of aged spirits of the world of the world, production, Uniqueness of each product, manufacture, brands and service. The spirits to be covered would be- Whisky/Whiskey (Scotch, Irish, American, Canadian, Japanese and Indian), Brandy (Cognac, Armagnac and other brandies of the world), Rum,
5. **Cocktails- Art of Mixology:** Students will have knowledge of the art of Mixology, types of cocktails, Classical and contemporary and pricing.

Pre-requisite courses : None

Reference Books:

1. "F & B Service", Hodder & Stoughton, Lillicrap & Cousins, 7th Edition, London, 2008.
2. "The Beverage Manager's Guide to Wines, Beers & Spirits", John Peter Laloganes, Albert W.A. Schmidt, Pearson Education Limited, 4th Edition, 2017.
3. "F & B Service", Hodder & Stoughton, Lillicrap & Cousins, London, 2008.
4. "Restaurant Service Basics", Sondra J. Dahmer and Kurt W. Kahl, John Wiley & Sons, 2008.
5. "Food & Beverage Service – A Training Manual", Sudhir Andrews, Oxford University Press, 3rd Edition, 2013.

UM17BH253: FRONT OFFICE MANAGEMENT (3- 0-0-0-3)

Course Objective:

The objective of this course is to provide an understanding of the accounting operations in a hotel Front Office and an introduction to automation in Hospitality industry

Course Outcome:

By the end of the course, the student is capable of:

- Describing the Accounting procedures in Front Office
- Sequencing the Front Office audit process
- Understanding basics of human behavior and self-management
- Understanding the Different Hospitality Technology Systems used in Hotels and their operation

Course Content:

1. **Check-out & Settlement:** The check-out and settlement process; Departure procedures; Methods of settlement; Check-out options; Unpaid account balances, account collection
2. **Front Office Accounting & Audit:** Accounts; folios; vouchers; points of sale; ledgers, Tracking transactions, Internal control, Settlement of accounts; Functions of the Front office audit; the front office audit process; system update; centralized front office audits
3. **Front Office Planning & Operations:** Management functions, forecasting room availability, Evaluating front office operations
4. **Transactional Analysis in Front Office:** Conflicts and conflict management, Johari window, Transactional analysis: Ego states, Life Positions, Rules of Communication, Karpman's triangle
5. **Hospitality Technology Systems:** Property management system, rooms management module, guest accounting module

Pre-requisite courses : None

Reference Books:

1. "Managing Front Office Operations", Kasavana, M. L., & Brooks, R. M., Pearson Education, 2013.
2. "Managing Technology in Hospitality Industry" Kasavana, M.L., Pearson Education, 2013.
3. "Hotel Front Office Management", Bardi, J. A., John Wiley & Sons, 2011.

UM17BH254: ACCOMMODATION AESTHETICS (2-1-0-0-3)

Course Objective:

- To develop advanced skills related to the design & planning of housekeeping operations

Course Outcome:

By the end of the semester student will be capable of:

- Stating the functions of a supervisor.
- Interpreting the elements of design & color wheel
- Detailing types of furnishing
- Prescribing redecoration & refurbishment process in a given situation
- Analyzing the operating budget of a housekeeping department
- Describing the pre – opening procedures in a hotel

Course Content:

1. **Interior decoration**: Introduction & Definition, Design & Elements of Design, Principles of Design, Hotel design vs hotel

maintenance, Color and lighting- Psychological impact of Colour, Colour Wheel, Colour Scheme & types of colour Scheme

2. **Standard Practices in Housekeeping:** Area inventory list, cleaning schedule, Supervisor's check list, snagging list, duty roster
3. **Wall and floor covering,** Introduction Definition, importance, types, selection, trends, cleaning procedures
4. **Furniture & Soft furnishing:** Importance, types, selection, trends and cleaning procedures, Window**,** Window treatments, Fabric used for Curtains**,** Loose Covers, Cushions and Bolsters
5. **Modern Room Aesthetics**: New Trends, New Design. Space Management, Spacing, Amenities, Maintenance

Pre-requisite courses : None

Reference Books:

1. "Hotel Housekeeping", Singh, M., Tata Mcgraw-Hill,New Delhi, 2012.
2. "Hotel Housekeeping: Operations & Management", G. Raghubalan & Smritee Raghubalan; Oxford University Press, New Delhi, 2008.
3. "Theory & Practices of Professional Housekeeping", Sunita Srinivasan, Anmol Publication Pvt. Ltd., Bangalore, 2004.

UM17BH255: EVENT MANAGEMENT (3- 0-0-0-3)

Course Objective:

- To provide an understanding of the management functions involved in conducting an event

Course Outcome:

- By the end of the course student will be capable of:
- Describing the procedures in planning an event
- Understanding the role & importance of marketing, advertising & public relations in event management
- Describing the steps in conduction of the event
- Planning safety measures & procedures for an event

Course Content:

1. **Event Process and Event control:** Identify Event Objectives, structure a procedure, Different strategies, Timelines for execution, Event deliverables and Specific techniques and tools of the event planning process, manage and monitor the success of the event, Customer Engagement post Event, Event Outcome Statements
2. **Event Expenses planning and accounting:** Budget, breakeven point, cash flow analysis, Profit & loss statement, balance sheet, payments, financial control system.
3. **Business of Events:** Effective Event Planning- Curate Event ideas, Logistics and support systems, Event communication channels- Time management and task management, Optimize Event's success
4. **Event Mapping:** Clarity - SWOT analysis - estimating attendance - media coverage - advertising - budget - special considerations - Evaluating success.
5. **Evaluation and Feedback:** Budget - cost of event - return on investment - media coverage - attendance – feedback, Leadership Skills, Event Exposure, Newer Approaches to Event Management

Pre-requisite courses : None

Reference Books:

1. "The Business of Events Management", Bowdin, G., Pearson Education, Harlow, 2014.
2. "Events Management", Beech, J., Chadwick, S., Elsevier, 2011.
3. "The Business of Sport Management", Van der Wagen, L., Carlos, B., Prentice Hall, 2013.
4. "Event Management for Tourism, Cultural, Business and Sporting Events", Yeoman, I. et al., Pearson 2005.
5. "Festival & Events Management", Butterworth, Heinemann, 2006.

UM17BH256: RESEARCH METHODOLOGY (4-0-0-0-4)

Course Objective:

- Familiarize the students with the steps involved in conducting a research & writing a report

Course Outcome:

By the end of the course the student will be capable of:

- Understanding the relevance of research
- Developing a research plan
- Describing different sampling designs
- Detailing the methods of data collection & processing
- Writing a research report

Course Content:

1. **Research**: scientific method, meaning and definition, scope and purpose of doing research, social science research, type and area of research, research, process, problem of conduction research
2. **Research method:** Identifying research area and problem designing the objectives, rational for conducting study, Research method, sample planning
3. **Sampling:** What's sampling, advantages and limitation, sample unit, types of sampling, sampling selection, Process, sampling size
4. **Data collection:** Introduction to data collection method, observation – type, advantage & limitation, interview type, design of questionnaire, introduction to other research methods
5. **Data analysis:** Planning, organizing and supervising fieldwork, Data Analysis, Classification, Tabulation, Analysis and Interpretation, Introduce Basic statistical tool/method, Type of table, Graphical Representation, Report Writing

Pre-requisite courses : None

Reference Books:

1. "Hospitality & Travel marketing"; Alastair M. Morrison; Delmar Publishers Inc.; 2010.
2. "Marketing Research"; Harper W. Boyd Richard D. Irwin, INC. 1977.
3. "How to complete your research project successfully"; Judith Bell; 5th Edition; Open University Press; 2005.

UM17BH257: EVENT MANAGEMENT PRACTICAL (0-0-2-0-1)

Course Objective:

- To be able to plan, strategize, and execute an Event Profitably.

Course Outcome:

- Successfully execute an event
- Develop leadership quality
- Develop Event Entrepreneurial acumen.

The event to be related to Hospitality.

To be executed in Campus

1. Plan and Name the Event

2. Schedule the timeline
3. Assign and Delegate Responsibility
4. Identifying local vendors & negotiating price
5. Create a media Page (FB, Instagram, Twitter, etc)
6. Sponsorship Pitch
7. Posters and fliers
8. Ticketing
9. Budget approval
10. Invites and guest list
11. Actual Event
12. Feedback
13. Assessment

Pre-requisite courses : None

Reference Books:

1. "The Business of Events Management, Complementary Literature", Bowdin, G., Pearson Education, Harlow 2014.
2. "Events Management", Beech, J., Chadwick, S., Elsevier 2011.
3. "The Business of Sport Management", Van der Wagen, L., Carlos, B., Prentice Hall 2013.
4. "Event Management for Tourism, Cultural, Business and Sporting Events", Yeoman, I. Pearson 2005.

UM17BH258: CULINARY OPERATIONS PRACTICAL (0-0-4-0-2)

Course Objective:

- To familiarize students with volume cooking and Indian Cuisine.

Course Outcome

By the end of the course, the student is capable of:

- Planning & indenting for 5 course Indian regional menus for large volumes.
- Following standard recipes & preparing dishes of 5 course regional Indian menus.
- Following standard recipes & preparing south Indian breakfast dishes & comfort foods

Course Content:

1. Bengali
2. Goan
3. Kashmiri
4. Kerala
5. Parsi
6. Tandoor
7. Mid semester assessment & plate presentation evaluation
8. Andhra
9. Karnataka
10. Punjabi
11. Rajasthani
12. Slow food
13. Final assessment

Pre-requisite courses : None

Reference Books:

1. "Quantity Food Production Operations & Indian Cuisine", Parvinder Singh Bali, Oxford Publications, 2014.
2. "Theory of Cookery", Krishna Arora, Frank Bros & Co., 5th, 6th Editions, 2006.
3. "Modern Cookery – Volume I& II", Thangam E Philip, Orient Longman, 5th Edition, 2004.

UM17BH259: DISTILLED BEVERAGES PRACTICAL (0-0-4-0-2)

Course Objective

- Familiarize the students to advanced service operations

Course Outcome

By the end of the course student will be capable of:

- Organizing Mise en place in a bar
- Demonstrating service of alcoholic beverages
- Preparing & Demonstrating service of Cocktails

Practical content:

1. Setting up a bar
2. Identify Bar Equipment
3. Identify and read labels
4. Service of Aged Spirits
5. Service of White Spirits
6. Mid-Sem Assessment
7. Cocktails –Aged Spirits
8. Cocktails-Aged Spirits
9. Cocktails-White Spirits
10. Cocktails- White Spirits
11. Service of Aperitifs and of Liqueurs
12. Compile Beverage Menu
13. Final Assessment

Pre-requisite courses : None

Reference books

1. "The Beverage Manager's guide to Wines, Beers & Spirits", 4th Edition, John Peter Laloganes / Albert W.A. Schmidt, 2017
2. "F & B Service", Lillicrap& Cousins – Hodder & Stoughton, 2008
3. "Restaurant Service Basics", Sondra J. Dahmer and Kurt W. Kahl, John Wiley & Sons, 2008

UM17BH260: FRONT OFFICE MANAGEMENT PRACTICAL (0-0-4-0-2)

Course Objective:

- To equip students with advanced communication & interpersonal skills necessary for effective Front Office operations

Course Outcome:

At the end of the course, the student will be able to:

- Communicate effectively & professionally on various topics
- Develop basic managerial skills
- Understand different ways of handling problem situations
- Apply sales techniques

Course Content:

1. Presentation skills – SWOT, USP
2. Letter writing – Welcome letter, Apology letter, promotional letter, memo
3. Service Recovery – Online & in person
4. Public speaking skills
5. Communication activities – JAM, Flip, Group discussion
6. Mid semester assessment
7. Sales techniques – Team activity
8. Upselling skills
9. Critical incidents in Front Office – Role play

10. Leadership skills – Team activity
11. Transactional Analysis – Role play
12. Conflict handling – Group activity
13. Final Assessment

Prerequisite Course: None

Recommended Books:

1. "Front Office Procedures Social skills & Yield Management", Peter Abbott & Sue Lewry, Routledge, 2011.
2. "Cases in Hospitality Management", Timothy R.Hinkin, John Wiley & Sons Inc., 1995
3. "Case Studies in Front Office Management", Todd Comen, AH & LA (EI), 2003.

UM17BH261: ACCOMMODATION AESTHETICS PRACTICAL (0-0-4-0-2)

Course Objective:

- To equip students with advanced skills in housekeeping operations

Course Outcome:

By the end of the semester student will be capable of:

- Making different styles of flower arrangements
- Demonstrating supervisory skills required for housekeeping department
- Preparing budgets & calculating par stock

Course Content:

- Preparation and use of Snagging List
- Preparation of Duty roster
- Preparation of budgets
- Presentation of budget & staffing
- Calculation of Par-stock
- Case studies
- Mid semester assessment
- Stain Removal
- Flower Arrangement - Demonstration
- Flower arrangement – Practice
- Innovative flower arrangement
- Making a Terrarium
- Final assessment

Pre-requisite courses : None

Reference Book:

1. "Theory & Practices of Professional Housekeeping", Sunita Srinivasan, Anmol Publication Pvt. Ltd, Bangalore, 2004.

UM17BH262: EVENT INTERNSHIP (0-0-0-54-8)

Course Objective:

To Provide training and experiential learning opportunities for the development of skills in assessment, outreach, and supervision in the field of event management

Course Outcome:

By the end of the course, the student is capable of:

- Understanding the organization structure of an Event Management company
- Summarizing the functions of all departments of the Event Management company
- Analyzing the various events conducted by the company and identifying positive and negative aspects
- Identifying operational / procedural problems in the various departments & suggesting solutions for them

Schedule:

During the summer term of 4th semester, students must undergo Industrial Exposure Training in a leading Event Management company identified by the university for a period of 7 weeks. After completion of Industrial Exposure Training the students must submit the IET Certificate and Training Report.

Attendance

Students must compulsorily have 100% attendance in internship. In genuine cases 10% relaxation is allowed if internship coordinator is informed in advance in writing or by official email and permission has been granted by university for leave.

Project report & presentation

The students must make a report on the IET and a 10 slide PPT presentation on training company to the University on completion of the internship.

Pre-requisite courses : None

UM16BH301: CULINARY OPERATIONS – II (3- 0-0-0-3)

Course Objective:

- To facilitate the development of advanced culinary skills in students

Course Outcome:

By the end of the course student will be capable of:

- Preparing the layout & function of a cold kitchen
- Classifying traditional appetizers & garnishes
- Describing the features of western & oriental cuisine
- Analyzing the nutritional value of a menu
- Incorporation of wine in foods
- Adopting Food photography and Video capturing

Course Content:

1. **Cold Kitchen**: Larder, Charcuterie
2. **Appetizers & Garnishes**: classification, popular traditional appetizers, sandwiches, Herbs and wines in cooking
3. **International Cuisines**: Western cuisines, European cuisines, Pan Asian cuisines (Self study)
4. **Advanced Pastry and Confectionery:** Chocolate, hot & cold desserts, Ice creams & frozen desserts, Sauces & coulis
5. **Concept of Health Food**: types of nutrients, balanced diet and nutritional analysis

Prerequisite Course: UM16BH251: Culinary Operations - I

Reference Books:

1. "International Cuisine and Food Production Management", Parvinder S. Bali, Oxford Higher Education, 2013.
2. "Practical Cookery", 10th 11th 12th Editions, Victor Ceserani & Ronald Kinton, ELBS, UK, 2009.
3. "Theory of Catering", 10th 11th 12th Editions, Victor Ceserani & Ronald Kinton, ELBS, UK, 2008.

UM16BH302: FOOD AND BEVERAGE MANAGEMENT (4- 0-0-0-4)

Course Objective:

To provide advanced managerial skills in F & B Service

Course Outcome:

By the end of the course student will be capable of:

- Detailing the F & B control operation
- Planning & Designing a service & production area
- Applying menu management techniques to analyze a menu
- Applying management principles in handling human resource in F & B operation

Course Content:

1. **Introduction to Food and Beverage Management:** Structure, scope and future of the catering industry
2. **Food and Beverage Control Operation:** Types of Controls, Checklists, forms, formats, hierarchy, purchasing, stores, requisition
3. **Planning and Design of Service Area & Planning and Design of Production area:** Space, spacing, feasibility, demographic trends, market
4. **Managing F & B Operations:** Forecasting, Menu analysis, Marketing & merchandising techniques
5. **F & B Human Resource Development:** Recruitment types, orientation, specialization, Various F&B Segments, Training, work-life balance

Prerequisite Course: UM16BH252 - Advanced Food & Beverage Operations

Reference Books:

1. "Textbook of Food & Beverage Management", Sudhir Andrews, Tata McGraw Hill, 2008.
2. "F & B Service", Lillicrap & Cousins Hodder & Stoughton London, 7th Edition, 2008.
3. "The Beverage Manager's guide to Wines, Beers & Spirits", Albert W.A. Schmidt, John Peter Laloganes, 4th Edition, 2017.
4. "F & B Service", Lillicrap & Cousins – Hodder & Stoughton, 2008.
5. "Restaurant Service Basics", Sondra J. Dahmer and Kurt W. Kahl, John Wiley & Sons, 2008.
6. "Food & Beverage Service – A Training Manual", Sudhir Andrews, Oxford University Press, 3rd Edition 2013.

UM16BH303: FRONT OFFICE MANAGEMENT (2-1-0-0-3)

Course Objective:

To introduce the student to advanced managerial skills required for the efficient functioning of a Hotel Front Office

Course Outcome:

By the end of the course, the student is capable of:

- Describing the management process in terms of the functions managers perform to achieve organizational objectives
- Calculating operating ratios of a Hotel from a given data
- Explaining the concept of Revenue Management and the various strategies used by Revenue managers
- Understanding organizational behavior & conflict management
- Relating the importance of Marketing and Sales to Front Office functions

Course Content:

1. **Planning & Evaluating Front Office Operations:** Management functions, Forecasting room availability, Evaluating front office operations; Data analytics – Relevance of Big data in Hospitality Industry
2. **Revenue Management:** The concept of revenue management, Elements of revenue management, Benefits of revenue management, Revenue management strategies; STR – Analyzing a hotel revenue report; Rep Up
3. **Some OB Concepts Applicable to Front Office:** Team building, Conflicts and conflict management, Johari window, Transactional analysis: Ego states, Life Positions, Rules of Communication, Karpman's triangle
4. **Hospitality Marketing:** Relationship marketing, Marketing plan, Steps of a marketing plan; Subconscious marketing; Digital marketing & the role of social media in branding
5. **Internal Marketing & Sales:** The role of employees in internal sales, Internal merchandising; Empowering employees to increase sales – Literature review (Self study)

Prerequisite course: UM16BH253: Hotel Front Office Operations

Reference Books:

1. "Managing Front Office Operations", Kasavana, M. L., & Brooks, R. M., Pearson Education, 2013.
2. "Managing Technology in Hospitality Industry", Kasavana, M.L., Pearson Education, 2013.
3. "Hospitality Sales & Marketing", James R. Abbey. AHLEI, USA, 5th Edition, 2008.

UM16BH304: EVENT MANAGEMENT (3- 0-0-0-3)

Course Objective:

- To provide managerial skills relevant to managing an event

Course Outcome:

1. Knowing the legal formalities in conducting an event

Course Content:

1. **Event Planning and Strategy:** Sustainable Event Management Events, the Law and Risk Management
2. **Event Execution and Project Management:** Events and New Media Technologies, The Event Life Cycle, Event Stakeholders
3. **The Role of Sports:** Cultural and Business Venues, Impact, Evaluation of Events
4. **Event Management and the Hospitality Industry:** Creating and Designing Live Events, Events in Public Spaces
5. **Events as a Sponsorship Investment:** Trends in Event Management, Franchising and Equity Generation in Event Management

Prerequisite course: UM16BH255 - Event Operations

Reference Books:

1. "Successful Event Management A Practical Handbook", 2nd Edition, Anton Shone & Bryn Parry, Cengage Learning EMEA, 2004.
2. "Event Marketing and Management", Sanjaya Singh Gaur, Sanjay V. Saggere, Vikas Publishing, Noida, 2003.
3. "Media & Communication Marketing Management", C. S. Rayudu, Himalaya Publishing House, Bangalore, 2011.
4. "Best Practices in Modern Event Management", Goldblatt, John Wiley & Sons, USA, 2nd Edition, 2000.

UM16BH305

ELECTIVE: MANAGEMENT OF SERVICES (3- 0-0-0-3)

Course Objective:

- The objective of this course is to provide an overview of related services industries where the concept of Hospitality Management can be applied

Course Outcome:

By the end of the course, the student will be capable of:

- Listing the various co related industries where hospitality services are applicable
- Understanding the application of Hospitality Management in various industries

Course content:

1. **Retail Management:** Retail Operations, Systems & Inventory, Retail Supply Chain Management
2. **Facilities Management:** Housekeeping, Engineering, Procurement & Finance
3. **Wellness Management:** SPA Management, Curative / Preventive Alternate therapy
4. **MICE:** Concept of MICE, Definition of conference & the components of the conference facilities.
5. **Alternative Lodging Industry Management**: Types, Marketing, Staffing, Franchisee/ Group/ Ownership (Self Study)

Pre-requisite courses : None

Reference Books:

1. "Retail management", S.C. Bhatia, Jain Publications, New Delhi, 2008.
2. "Total Facility Management", Brian Atkin, Adrian Brooks; Wiley-Blackwell, 4th Edition, 2014.

UM16BH306:

ELECTIVE: INTERNATIONAL HOSPITALITY MANAGEMENT (3- 0-0-0-3)

Course Objective:

To create awareness about the issues related to globalization of hospitality operations

Course Outcome:

By the end of the course student will be capable of:

- Summarizing the factors that have contributed to globalization & cite comprehensive advantages of transnational hotels
- Describing issues surrounding the financial structuring for hotel development
- Defining the term culture & summarizing the importance to hoteliers of understanding cultures different from their own.

Course Content:

1. **Overview and Historical Perspective:** Globalization, tourism and the lodging sector**,** the emergence of international hotels, Political aspects of the international travel, tourism and lodging industry
2. **International Hotel Investment, Development and Agreements:** Financing international, operating in a multinational environment, Developing an international hotel project
3. **Human Resources and Cultural Diversity:** Understanding cultural diversity, International human resource management
4. **International Hotel Operations:** Special consideration in managing international hotel operations, International hotel classifications and standards, International hotel sales & marketing
5. **Global Competition and the Future:** Long-term tourism growth trends (Self study)

Pre-requisite courses : None

Reference Book:

"International Hotels Development and Management", **Gee, Chuck Kim;, Singh, A. J, American Hotel & Lodging Educational Institute,** 2ND Edition , **2012.**

UM16BH307:

CULINARY OPERATIONS - II PRACTICAL (0-0-4-0- 2)

Course Objective:

To facilitate the development of advanced culinary skills in students

Course Outcome:

By the end of the course student will be capable of:

- Preparing 5 course menus pertaining to western & oriental cuisines from a standard recipe
- Analyzing a menu & determining the cuisine
- Advanced presentation & garnishing of dishes
- Applying advanced cooking methods specific to particular cuisines

Course Content:

1. Chinese menu 1
2. Chinese menu 2
3. Mexican menu 1
4. Mexican menu 2
5. Italian menu 1
6. Italian menu 2
7. Spanish menu 1
8. Spanish menu 2
9. Thai menu 1
10. Thai menu 2
11. Japanese menu
12. Lebanese menu

Pre-requisite courses : None

Reference Books:

1. "International Cuisine and Food Production Management", Parvinder S. Bali, Oxford Higher Education, 2013.
2. "Practical Cookery", Victor Ceserani & Ronald Kinton, ELBS, UK, 10th 11th 12th Editions, 2009.

UM16BH308:

FOOD AND BEVERAGE MANAGEMENT - PRACTICAL (0-0-4-0- 2)

Course Objective:

To provide hands on training in advanced managerial skills in F & B Service

Course Outcome:

By end of the course student will be capable of:

- Demonstrating, preparation & Service of classic & innovative cocktails

- Demonstrating Carte service
- Demonstrating service of special foods
- Preparing a banquet function prospectus

Course Content:

1. Pairing food with wines from new regions of the world
2. Preparation of Classic & Innovative Cocktails
3. French service/carte service
4. Preparation & Service of starters
5. Special Food Service
6. Preparing function prospectus

Pre-requisite courses : None

Reference Books:

1. "Restaurant Service Basics", Sondra J. Dahmer and Kurt W. Kahl, John Wiley & Sons, 2008.
2. "Food & Beverage Service – A Training Manual", Sudhir Andrews, Oxford University Press, 3rd Edition, 2013.

UM16BH309: ROOMS DIVISION MANAGEMENT PRACTICAL (0-0-4-0- 2)

Course Objective:

Expose & familiarize the students to automation in front office & its applications

Course Outcome:

By the end of the course student will be capable of:

1. Identifying icons on PMS
2. Making a reservation, cancellation / modification on PMS
3. Registering a guest & allotting rooms on PMS
4. Posting charges & printing a bill
5. Performing POS functions on PMS

Course Content:

Front office software (IDS):

1. Identification of Icons - Identification of IDS Icons on system and their uses
2. Reservation - How to make a Reservation on system
3. Modification, Cancellation and Reinstating of Reservation - How to modify / Cancel and reinstate the Reservation in the software.
4. Registration - How to Register a guest on system by assigning the inspected room, entering messages for reserved guests prior to check-in and showing check in on system, Filling all the Guest details on the system for a reserved guest.
5. Registration - How to Register a guest on system by assigning the inspected room and showing check in on system, Filling all the Guest details on the system for a Walk-in guest.
6. Posting in guest folio from front office, modifying the posting, Give paid outs, posting room rate and printing bill. How to transfer the F &B bill to guest folio
7. Point Of Sale - How to make a KOT on system, Modification of the KOT, Table transfer and Post the Restaurant and Bar bill on the system. Give discounts, spilt quantity, spilt bill, print bill and settlement.
8. Settlement and Check out Procedure - How to Settle the bill by cash / credit card, How to show checkout on system

Housekeeping:

1. Hotel design – To prepare checklist of facilities for classification/ reclassification of hotels
2. Checklist for supervision
3. Housekeeping control desk forms & formats
4. Uniform designing
5. Free style Flower Arrangements
6. Inventory Operations
7. Mini bar operation
8. Setting up of floor pantry
9. Designing of a suite room

Pre-requisite courses : None

Reference Books:

1. "Managing Front Office Operations", Kasavana, M. L., & Brooks, R. M., Pearson Education, 2013.
2. "Managing Technology in Hospitality Industry", Kasavana, M.L., Pearson Education, 2013.
3. "Theory & Practices of Professional Housekeeping", Sunita Srinivasan, Anmol Publication Pvt. Ltd., Bangalore, 2004.

UM16BH351: ENTREPRENEURSHIP DEVELOPMENT (3- 0-0-0-3)

Course Objective:

The objective of this course is to introduce the concept of Entrepreneurship to students and to inspire the creation of a new generation of entrepreneurs

Course Outcome:

By the end of the course, the student will be capable of:

1. Understanding the concept, importance and relevance of entrepreneurship
2. Describing the different types of entrepreneurs
3. Describing the procedure involved in starting a small business
4. Preparing a Business Plan

Course Content:

1. **Entrepreneurship:**entrepreneurship and enterprise, importance and relevance of the entrepreneur, factors influencing entrepreneurship
2. **Small scale industries:**Definitions, characteristics of SSI, advantages of SSI, Ownership patterns
3. **Starting a small industry:**Business opportunity, scanning the environment for opportunities, evaluation of alternatives and selection, Steps involved in starting a business venture
4. **Preparing the business plan:**Meaning, importance, preparation of the business plan
5. **Institutional assistance:**financial assistance through SFSCs**(Self study)**,Non financial assistance, Financial incentives and tax concessions, Industrial estates – roles & types

Pre-requisite courses : None

Reference Books:

1. "Entrepreneurship Development Program", Vasant Desai, Appanaiah, Reddy, Gopala Krishna; Himalaya Publishing House, 2009.
2. "Entrepreneurial Development", K. Venkataramana, Seven Hills Book Publication, 2008.
3. "Entrepreneurship Development", C. S. V. Murthy, Himalaya Publishing House, 2010.

UM16BH352:
HOSPITALITY MARKETING (3- 0-0-0-3)

Course Objective:

Understanding the relevance of marketing in hospitality industry

Course Outcome:

By the end of the course student will be capable of:

1. Differentiating between selling & marketing
2. Applying segmentation strategy to a Hospitality segment
3. Differentiating services marketing from the rest
4. Interpreting consumer behavior
5. Describing the marketing environment

Course content:

1. **Introduction to marketing:** marketing vs. Selling, different aspects of marketing, marketing management
2. **Introduction to hospitality service marketing and marketing mix:** Meaning and definition of service, growth of service sector, goods & services, development stages of services marketing, 7p's
3. **Market segmentation:** differentiation, segmentation strategy, hospitality market segment, tourism markets
4. **Consumer behavior in hotel industry:** concept, factors influencing consumer buying behavior, hospitality organizational customer
5. **Marketing environment:** types of marketing environment, Research, Indian Hotel Industry **(Self Study)**

Pre-requisite courses : None

Reference Books:

1. "Sales & Marketing: A Textbook For The Hospitality Industry", Sudhir Andrews, McGraw Hill Education (India) Private Limited, 2007.
2. "Hotel Management Sales and Marketing Service", M.C. Metti, Anmol Publications Pvt. Ltd., 2010.
3. "Marketing of Hospitality and Tourism Services", Prasanna Kumar, Tata McGraw-Hill Education Pvt. Ltd., 2010.

UM16BH353:
HOSPITALITY FINANCIAL MANAGEMENT (2-0-0-0-2)

Course Objective:

- To create an awareness of financial management practices in the hospitality industry.

Course Outcome:

By the end of the course student will be capable of:

1. Understanding the concept of financial management in hospitality industry
2. Understanding the factors affecting the hotel industry
3. Detailing collection policy & procedures
4. Preparing a typical budget

Course content:

1. **Financial Management in the Hospitality Sector:** increasing shareholder value, shareholder versus management, shareholder versus creditors, shareholders & social responsibility, how do hotel companies achieve the objective, organization of finance in the hotel industry
2. **Factors affecting the Hotel Industry:** Culture, legislation, tourism scenario, structure of business organization, financial environment, tax environment.
3. **Time value of money:**Timeline, simple interest, compound interest, finding growth rate, present value of ingle amount, compounding more than one year, continuous compounding, amortizing a loan
4. **Inventory and Receivables:** Objectives, cost associated with inventory, order quantity, assumptions, when to order, maintaining the par level of inventory, safety stock, inventory control, credit management and control, cost benefits associated with receivables, credit standards- terms, cash discount, default risk, front office and accounts receivables
5. **Collection Policy and Procedure:** Short term, finance, for hotel and restaurants, Accruals, trade credit, loans from commercial banks for working capital, Sources of long term finance, capital, kind of shares, debentures, franchising types, benefits, advantages and disadvantages, leasing, types, mechanics

Pre-requisite courses : None

Reference Book:

1. "Hotel Finance", Anand Iyengar, Oxford Higher Education, 2009

UM16BH354:
HUMAN RESOURCE MANAGEMENT (3- 0-0-0-3)

Course Objective:

Familiarize the students with human resource management practices in hospitality industry

Course Outcome:

By the end of the course the student will be capable of:

- Understanding human resource planning concepts
- Comprehending methods of recruitment, selection, induction and placement
- Understanding training and development needs and effectiveness
- Comprehending performance monitoring and appraisal

Course Content:

1. **Human Resource Planning:** Introduction, Objectives, Concepts, Qualitative Dimensions of Human Resource Planning, Job evaluation, Job analysis and job description(Self study)
2. **Recruitment, Selection, Induction, Placement:** Introduction, Recruitment, Selection, process methods, Selection Test, Limitations, Interviews, Limitations, Physical Examination, Importance
3. **Training & Development:** Need, Benefits and Development, Methods Determining training Needs, Training Policy and Effective Training program, Training Methods, Evaluation of Training and Development, Retraining
4. **Motivation, Productivity & Counseling:** Issues in Managing people, Maslow's Need Theory, Social Needs and Productivity, Hygiene Factors and Motivators
5. **Performance Monitoring AND Reward Policies:** Performance Appraisal, Methods of Appraisal, **Rewards policies** - Need for a transfer policy, Types of Transfer, Promotion and Promotion Policy

Pre-requisite Courses : None

Reference Books:

1. "Personnel & Human Resource Management: Text & Cases", SubbhaRao. P.,Himalaya Publishing House, Bangalore, 2003.
2. "Human Resource Management: Texts & Cases", Ashwathappa K, McGraw Hill Education (India) Pvt. Ltd., 7th Edition, 2013.

UM16BH355: SPECIALIZATION INTERNSHIP (0-0-0-26-3)

Course Objective:

- To equip PESU (BBA-HEM) graduates with at least one specialized skill which will give them an edge over other Hospitality graduates during placement / entrepreneurship.
- To facilitate student learning in real time work environment in order to enable them to gain specialized knowledge / expertise or develop specific skills in the chosen area of specialization

Course Outcome:

By the end of the course, the student will be capable of:

- Understanding the operations of the specialization department in a commercial establishment
- Comprehending the functions and responsibilities of the department manager
- Developing specialized skills and expertise in the chosen field

Internship process: 6 weeks of specialization internship

Prerequisite courses : None

UM16BH311: MANAGING A COFFEE SHOP KITCHEN (0-2-4-0-3)

Course Objective:

- To provide each student an opportunity to manage an operational facilityin their area of specialization on their own

Course Outcome:

By the end of the course the student will be capable of:

- Managing an independent food outlet
- Understanding managerial functions and responsibilities
- Preparing and handling financial transactions
- Developing entrepreneurship acumen

Course Content:

Prerequisite Courses : None

UM16BH312: MANAGING A FOOD SERVICE OUTLET (0-2-4-0-3)

Course Objective:

- To provide each student an opportunity to manage an operational facilityin their area of specialization on their own

Course Outcome:

By the end of the course the student will be capable of:

- Managing a food truck
- Understanding managerial functions and responsibilities
- Preparing and handling financial transactions
- Developing entrepreneurship acumen

Course Content:

Prerequisite Courses : None

UM16BH313: MANAGING A TRAINING HOTEL (0-2-4-0-3)

Course Objective:

- To provide each student an opportunity to manage an operational facility in their area of specialization on their own

Course Outcome:

By the end of the course the student will be capable of:

- Managing an independent accommodation outlet
- Understanding managerial functions and responsibilities
- Preparing and handling financial transactions
- Developing entrepreneurship acumen

Course Content:

Prerequisite Courses : None

UM16BH314: MANAGING A TRAINING HOTEL'S ROOMS(0, 2, 4, 0, 3)

Course Objective:

- To provide each student an opportunity to manage an operational facilityin their area of specialization on their own

Course Outcome:

By the end of the course the student will be capable of:

- Managing an independent accommodation outlet
- Understanding managerial functions and responsibilities
- Preparing and handling financial transactions
- Developing entrepreneurship acumen

Course Content:

Prerequisite Courses : None

UM16BH321: ADVANCED CULINARY OPERATIONS PRACTICAL (0- 0-8-0-4)

Course Objective:

To equip with specialized skills in culinary operations

Course Outcome:

By the end of the course student will be capable of:

1. Preparing innovative dishes in a specific culinary area or cuisine
2. Planning, budgeting, costing, pricing & selling dishes on a specified menu
3. Independently managing the operations of a small food production facility

Course Content:

1. The specialization students have to compile 8 five course menus based on their chosen cuisine
2. Students should prepare the indent for the menu
3. Each student has to make a menu card for the day and take the order and prepare during the practical hours and serve the dishes.
4. Students should prepare a project report on the chosen cuisine (minimum 30 pages and maximum of 50 pages) consisting of ingredients use, standard recipes, variations, costing, innovations, pictures/photos, regional influence… etc.

Pre-requisite courses : None

Reference Book:

1. "Practical Cookery", Victor Ceserani & Ronald Kinton, ELBS, UK, 10^{th} 11^{th} 12^{th} Editions, 2009.

UM16BH322: MANAGING FOOD & BEVERAGE SERVICE PRACTICAL (0-0-8-0-4)

Course Objective:

To equip with specialized skills in Food & Beverage Service operations

Course Outcome:

By the end of the semester student will be capable of:

1. Planning, preparing & pricing a menu
2. Demonstrating different service skills
3. Conducting theme based service for a full course meal
4. Independently managing the operations of a small food service facility

Course Content:

1. Planning of a menu
2. Finding APC, Cover turnover
3. Planning of beverage list
4. Control Sheet
5. Planning & designing floor plans of service outlets
6. Preparation of Duty Rosters
7. Performing stock taking and maintaining inventory
8. Case studies and guest handling
9. Projects
10. Management & Operational Aspects of an existing F&B outlet
11. How to plan a new F&B outlet
12. Role Play : Toast Master, F&B outlet Managers

Pre-requisite courses : None

Reference Books:

1. "Restaurant Service Basics", Sondra J. Dahmer and Kurt W. Kahl, John Wiley & Sons, 2008.
2. "Food & Beverage Service – A Training Manual", Sudhir Andrews, Oxford University Press, 3rd Edition, 2013.

UM16BH323: HOTEL FRONT OFFICE MANAGEMENT PRACTICAL (0-0-8-0-4)

Course Objective:

To equip the students with specialized skills in front office management

Course Outcome:

By the end of the course student will be capable of:

1. Planning & designing the facilities of a hotel
2. Marketing a hotel property using relevant sales & marketing techniques
3. Analyzing the market share of various hotels in Bangalore
4. Independently managing the front office operations of a small accommodation facility

Course Content:

1. Select three 5 star hotels from a competitive set in Bangalore and do a SWOT analysis and Market share analysis for each hotel
2. Conceptualize a 5 star property in competition with the competitive set chosen in assignment 1, plan target market, design the facilities and prepare a detailed marketing plan for this hotel
3. Make a 15 slide PowerPoint presentation on any one major international hotel chain
4. Research paper on a Front Office topic
5. Present a paper at a seminar and publish a research paper in a recognized publication (on Assignment 4 topic)
6. Case studies & situation handling
7. Drafting letters: Welcome letter, Promotion letter, Service Recovery letter, Invitation letter

Pre-requisite courses : None

Reference book

1. "Managing Front Office Operations", Kasavana, M. L., & Brooks, R. M., Pearson Education, 2013.
2. "Hospitality Sales & Marketing", James R. Abbey, AHLEI, USA, 5th Edition, 2008.

UM16BH324: ACCOMODATION OPERATIONS & MANAGEMENT PRACTICAL (0-0-8-0-4)

Course Objective:

To equip the students with specialized skills in Accommodation Management

Course Outcome:

By the end of the course student will be capable of:

1. Making elaborate innovative flower arrangements
2. Analyzing & planning linen inventory & par stock
3. Identifying problem areas in housekeeping operations and rectifying them.
4. Independently managing the housekeeping operations of a small facility

Course Content:

1. Elaborate Flower arrangement Eye for detail
2. Physical linen inventory and Par stock
3. Making room
4. Budgeting
5. Case study/ Situation Handling
6. Project Report on hotel guest security minimum 5 hotels

Pre-requisite courses : None

Reference Book:

1. "Theory & Practices of Professional Housekeeping", Sunita Srinivasan, Anmol Publication Pvt. Ltd. Bangalore, 2004.

UM16BH325: MANAGING EVENTS PRACTICAL (0-0-8-0-4)

Course Objective:

To equip the students with specialized skills in Managing Events

Course Outcome:

By the end of the course student will be capable of:

1. Preparing an event proposal
2. Designing promotion material for an event
3. Understanding the marketing & distribution process of an event
4. Organizing a small event

Course Content:

1. Preparation of Event Proposal & Blue Print
2. Sales Skills – Role Play (With Clients & Sponsors)
3. Digital Marketing for Event Management
4. Designing Promotion Materials – Printed, Video & PowerPoint Presentation
5. Ticketing

Pre-requisite courses : None

Reference Books:

1. "Successful Event Management A Practical Handbook", Anton Shone & Bryn Parry, Cengage Learning EMEA, 2nd Edition, 2004,

MASTER OF BUSINESS ADMINISTRATION

MBA PROGRAM

Program Educational Objectives:

1. To deploy contemporary pedagogy to impart knowledge of the Management theory and its applications.
2. To equip students to survive and flourish in the Digital Economy.
3. Supported financially by the University, expose the students to extended corporate stintsto make them comprehensively industry ready.
4. Facilitate students to specialize in high-growth areas to achieve higher trajectory of career path.
5. To blend the curriculum with a wide choice of topical courses and residential programs at world-class institutions.
6. To integrate cutting-edge labs and tools into the program enabling students to experience truly state-of-the-art learning experience.

Program Outcomes

1. Students learn the best practices and core-value creation in successful global companies
2. Students comprehend the building blocks of the digital-ecosystem and carve out a path to pursue a fruitful career.
3. Imbibing real-world dynamics, key to succeed in the management profession, is one of the important learnings of the program.
4. In a world that rewards specialists, students add depth in specific high-growth domains to have a fulfilling career.
5. The holistic experience of the blended program broadens students' cognitive canvas.
6. Students graduate armed with skill-base that is valued by the corporate world.

UM18MB501: ACCOUNTING FOR MANAGERS (2-1-2-2-4)

Course Objectives:

- To familiarize students with the fundamental concepts of Accounting.
- To enable students to understand the applicability of Accounting Standards and IFRS.
- To enable preparation of company final accounts with appropriate schedules.
- To develop skills to analyze and interpret financial statements.

Course Outcomes:

At the end of the course students can:

- Acquire basic concepts of accounting and skill of maintaining appropriate books of accounts.
- Exhibit competency in preparation of final accounts of the companies with appropriate schedules.
- Exhibit skills in analysis and interpretation of financial statements.

Course Contents:

1. **Introduction to Accounting and IFRS:** Need for accounting, Accounting Concepts and Conventions, GAAP, Accounting Standards and Accounting Equations Overview of Indian Accounting Standards and International Financial Reporting Standards and its relevance, comparison of Indian Accounting Standards and IFRS
2. **Book – Keeping:** Types of Accounts, Accounting rules, preparation of Journal and Ledger Accounts and trail balance, Subsidiary Books (Problems on two and three column cash books only), Rectification of errors and types of errors.
3. **Financial Statements:** Preparation of Final Accounts of Company (Horizontal & Vertical Form).
4. **Depreciation Accounting:** Meaning, Depreciation methods– Straight Line Method(SLM), Written Down Value Method (WDV), Annuity Method, Sinking Fund and Revaluation Method (problems with adjustments on SLM & WDV only.
5. **Financial Statement Analysis:** Meaning and tools of Analysis and Interpretation. Comparative Statements, Common Size Statements, Trend analysis, Ratio Analysis, DuPont analysis, Preparation of Cash flow statement as per AS3 (Indirect Method).

Practical Component using Tally Package

Pre-requisites: None

Reference Books:

1. "Corporate Accounting", S N Maheshwari and S K Maheshwari, 5th Revised and Enlarged Editions, Vikas Publishing House Pvt. Ltd., New Delhi, 2009.
2. "Fundamentals of Corporate Accounting", Ashok Sehgal, 3rd Edition, Taxman, New Delhi, 2012.
3. "Financial Accounting", S.P. Jain & K.L. Narang, Kalyani Publishers, New Delhi, 2011.
4. "Financial Accounting", P.C. Tulsian, Pearson Education India, 2002
5. "Accounting Text and Cases", Anthony, Robert N. Hawkins, David F. Merchant, Kenneth A., 12th Edition, Tata McGraw Hill, New Delhi, 2007.
6. Laboratory manual prepared by Department of MBA, PES University.

UM18MB502: QUANTITATIVE METHODS – I (2-1-2-2-4)

Course Objective:

- The course aims at equipping students with an understanding of the basic statistical concepts, statistical tools & techniques and their applications in managerial decision making.

Course Outcomes:

At the end of this course students can:

- Apply the knowledge of statistical concepts in their decision-making roles.
- Understand the significance of statistical tools and their applicability in various practical situations.
- Exhibit the right skills of data interpretations and develop the statistical models to work on real-time data.

Course Contents:

1. **Introduction to Descriptive Statistics:** Data, Types of Data, Frequency Distribution, Measures of Central Tendency: Mean, median, mode and other partition values. Measures of Dispersion: Standard Deviation, Variance, Coefficient of Variation, Skewness, Kurtosis, Outliers, Box and Whisker plot
2. **Probability: Theory of Probability:** Terminology, Rules of probability, Statistical Probability, Conditional Probability, Bayes' Theorem

Probability Distribution: Distribution of a discrete and continuous variable, Binomial, Poisson and Normal distribution.

3. **Correlation and Regression Analysis:** Correlation Analysis: Types of Correlation, Karl Pearson correlation, Spearman's Rank correlation, Linear Regression Analysis.
4. **Forecasting and Decision Analysis:** Components of a Time Series, Moving averages and exponential smoothing, trend projection, seasonality and trend.

   Decision analysis: Problem formulation, decision making with probabilities, decision analysis with sample information.
5. **Introduction to Linear Programming and Project Scheduling:** Problem formulation (minimization and maximization), Graphical solution procedure, PERT and CPM.

Practical Components

- **Spreadsheet:** Data coding and decoding, charts and diagrams, data sorting and filtering, formatting of data, data validation, writing formulae, applications of functions and formulae, linking of sheets and files, pivot tables and pivot charts, practical applications of spreadsheet.

List of Experiments

- Descriptive Statistics with Excel Functions, Data Visualizations Practical with MS Excel.
- MS-Excel Functions - SUM, MAX, MIN, COUNT, IF, SUMIF, COUNTIF, AND, OR, LEFT, RIGHT, CONCATENATE, ROUND, VLOOKUP, HLOOKUP.
- Pivot Tables and Pivot Charts, Correlation and Regression Analysis using Formula and Functions.
- Probability Distributions, LPP, CPM/PERT.

Pre-requisites: None

Reference Books:

1. "Statistics for Business and Economics", Anderson David R, Sweeney Dennis J, Williams Thomas A, Cengage Publications, 12th Edition, 2015.
2. "Quantitative Methods for Business", Anderson David R, Sweeney Dennis J, Williams Thomas A, Cengage Publications, 12th Edition, 2013.
3. "Complete Business Statistics", Amir D Aczel, Jayavel Sounderpandian, P Saravanan, Tata McGraw Hill Publications, 6th Edition, 2006.
4. Laboratory manual prepared by Department of MBA, PES University.

UM18MB503: MANAGING ORGANIZATION (2-1-0-2-3)

Course Objectives:

- To explore fundamental knowledge of individual, group and organizational dynamics.
- To understand the research perspectives on organizational structure and processes.
- To understand the fundamental principles and major functions played by management.

Course Outcomes:

At the end of the course students can:

- Remember the fundamental concepts and principles, functions of management, individual, group and organizational behavior.
- Exhibit fair understanding of the concepts of management and influence of individual in group.
- Apply the skills of functions of management and individual dynamics in group in real time application.
- Analyze eco system associated with organizational dynamics.
- Evaluate the cases of management and organizational dynamics.

Course Contents:

1. **Introduction to Management:** Levels of management and skills of manager. Contributions of management gurus, F W Taylor, Henry Fayol and Elton Mayo. Role approach: Mintzberg roles. Contingency and systems approaches.
2. **Functions of Management:** Planning - process, types of plans and levels. Organizing-definition, basic elements and characteristics. Directing – leading, organizational communication; controlling-types, process and techniques; coordination-process.
3. **Introduction to Organizations:** Evolution of organization theory and design.

   Organization Structures – Definition, types of structures-functional, divisional, geographical, hybrid, matrix, horizontal, virtual, modular and contemporary organization structures.
4. **Foundations of individual behavior:** Values-types-instrumental & terminal value, Attitudes-components, formation process and functions, personality-types & traits theories, Emotions-dimensions, Perception-process, determinants, attribution theory, errors in perception. Motivational theories- content and process.
5. **Foundations of group behavior:** Stages of group formation, Work groups and Teams-types, group properties, Conflict-types, process, resolution strategies. Negotiation- strategies, types of third party negotiations, Power- bases of power, power tactics and Politics- consequences, impression management.

Pre-requisites: None

Reference Books:

1. "Organizational Behavior", Stephen P Robbins, Timothy A. Judge, Niharika Vohra, Pearson Education, New Delhi, 14th Edition, 2009.
2. "Organization Theory and Design", Richard L Daft, South-Western Cengage Learning Publications, Australia, 8th Edition, 1994.
3. "Managing Human Resources", Snell, Scott A., Bohlander, George W., Cengage Learning Publications, 16th Edition, 2012.

UM18MB504: MANAGERIAL ECONOMICS (2-1-0-2-3)

Course Objective:

- The objective of this course is to emphasize on application of economic principles and tools in demand and supply analysis, forecasting, cost and production analysis, pricing and output decisions under different market structure, pricing practices and contemporary theories of firm.

Course Outcomes:

At the end of the course students can:

- Understand basic concepts and theories in managerial economics.
- Apply quantitative techniques in managerial decision problems.
- Exhibit appropriate skill in managerial decision making under given resource constraints and objectives of the firm.

Course Contents:

1. **Introduction:** Economics: Definition and, Scope, Types of Economic Analysis, Kinds of Economic Decisions, Managerial Economics, Economic Principles relevant to managerial

decisions, Relationship of Managerial Economics with decision sciences.

Demand and Supply Analysis: Demand, Law of Demand, Supply, Law of Supply, Market Equilibrium.

2. **Elasticity of Demand:** Price Elasticity of Demand, Revenue and Price Elasticity of Demand, Income Elasticity of Demand, Cross Elasticity of Demand, Promotional Elasticity of Demand, Importance of Elasticity of Demand.

   Demand Forecasting: Meaning, Techniques, Subjective methods, Quantitative methods, Limitations.

3. **Production Analysis:** Types of Inputs, Production function, production function with one variable input, Product Function with 2 variable inputs, Elasticity of substitution, Iso-cost lines.

   Cost Concepts: Types of cost, Cost curves, Cost – Output Relationship in the short run and in the long run, LAC curve., Cost-volume profit relationships and breakeven analysis, Economies of scale, Economics of Scope, Cost and learning curves.

4. **Market Structure:** Perfect Competition, Features, determination of price under perfect competition. Monopoly: Features, Pricing under monopoly. Price Discrimination, Monopolistic Competition: Features, Pricing Under monopolistic competition, Product differentiation. Oligopoly: Features, Kinked demand Curve, Cartels, Price leadership, Prisoners Dilemma.

5. **Macro-Economic Aspects of Managerial Economics:** Circular flow of economic activities, Macroeconomic variables, consumption function, investment function, IS-LM analysis.

   National Income: Concepts, Measurement, Uses and Difficulties, Money Supply and Inflation: Demand and supply of money, Inflation, causes, Inflation and decision making, Measuring inflation, Inflation and Employment, Control of Inflation

   Business Cycle Features, Phases, Concepts of Multiplier and Accelerator, Causes, Effects and, controlling business cycles.

Pre-requisites: None

Reference Books:

1. "Microeconomics", Samuelson and Nordhaus, McGraw-Hill, 19th Edition, 2013.
2. "Managerial Economics in a Globalized Economy", Dominique Salvatore, McGraw-Hill, Singapore, 2nd Edition, 2006.
3. "Managerial Economics", D N Dwivedi, Vikas Publishing House, Noida, 7th Edition, 2008.
4. "Economics for Managers", Xavier V K, Magi's Publications 1st Edition, Bangalore, 2014.

UM18MB505: MARKETING MANAGEMENT (2-1-0-2-3)

Course Objectives:

- Students will understand the function of marketing in a competitive, dynamic business.
- Students will comprehend the key elements in developing a marketing strategy and planning a marketing program by covering topics such as customer segmentation, positioning, branding, consumer research, pricing, marketing communications, new product development and channel strategy.

Course Outcomes:

At the end of the course students can:

- Explain the role and functions of marketing in a range of organizations.
- Exhibit the Skills of applying the introduced conceptual frame works, theory and techniques to various marketing contexts.
- Describe and analyze the marketing behavior of firms and consumers.

Course Contents:

1. **Introduction & Understanding the Customer:** Defining Marketing for the 21st century, Developing Marketing Strategies and Plans, Gathering Information and scanning the environment, Conducting Marketing Research, Creating Customer Value, Satisfaction and Loyalty.
2. **Connecting with Customer, Building Strong Brands & Shaping the Market offerings:** Analyzing Consumer Markets & Business Markets, Identifying Market Segments and Targets Competitive forces, competitive strategies, dealing with competition, Creating Brand Equity definition, building, managing, and devising strategies.
3. **Brand Positioning:** Crafting the Brand Positioning developing and communicating positioning strategies and PLC strategies.

   Product Marketing: Product characteristics and classification and product and brand relationships, packaging and labeling.

4. **Services Marketing:** Nature of services, managing service quality and brands, designing and Managing Services, Developing Pricing Strategies and Program.
5. **Delivering and Communicating Value:** Designing and managing Integrated Marketing Channels, Managing Retailing, wholesaling and logistics.

   Integrated Marketing Communication: Designing and Managing IMC, Managing Mass Communication & Personal Communication, Introducing New Market Offerings.

Pre-requisites: None

Reference Books:

1. "Marketing Management - A South Asian Perspective", Kotler, Philip, Keller, Kevin Lane, Koshy, Abraham, Pearson Education, New Delhi, 14th Edition, 2012.
2. "Marketing Management", Ramaswamy V. S., Namakumar S, Macmillan Publishers, New Delhi, 5th Edition, 2013.

UM18MB506: LEADERSHIP (2-1-0-2-3)

Course Objectives:

- To explore fundamental knowledge of management leadership evolution.
- To understand the research perspectives on individual leadership traits.
- To understand the various roles played by corporate leaders.
- To understand the Business and corporate communication dynamics.

Course Outcomes:

At the end of the course students can:

- Remember the fundamental concepts of leadership theories, models, characteristics and communication.
- Exhibit fair understanding of the concepts of corporate leadership theories, models, characteristics and communication.
- Apply the skills of corporate leadership theories, models, characteristics and communication in real time application.
- Analyze eco - system associated with corporate leadership dynamics and corporate communication.

- Evaluate the cases of famous corporate leadership practices and corporate communication.

Course Contents:

1. **Introduction to Leadership:** Importance- Leader and leadership definition – The new reality for present organization. Comparing management with leadership. Evolution of Leadership: context, framework and implications.
2. **Research Perspectives on Individual Leadership:** Traits, Behavior and Relationships - Trait approach and Behavior approach. Contingency approaches - Fiedler's contingency model, Hersey and Blanchard's theory, Path goal theory and Blake and Mouton managerial grid.
3. **Leader as Visionary:** Social and cultural influence on Leadership vision, mission & Strategy formulation.

   Leader as Change and Transformation Agent: Leading change – coaching and mentoring. Transactional, transformational, level five leaders and servant leadership.

   Leader as Social Architect: Shaping culture and values. Value based leadership.
4. **Business Communication:** Introduction, Types of communication- Horizontal, vertical and Diagonal, Formal communication- Internal stakeholders--Circulars, Notices, Memo, External stakeholders- official letters and Informal communication- Rumors, Gossip and Grapevine. Application of digital Technology in communication - Audio and Video conferencing.
5. **Strategic Corporate Communication:** Meetings- Types-Executive meets and Board meets, procedure for conducting executive meeting, board meeting. Minutes of meeting and Executive summary preparation. Brain storming, group discussion and corporate presentation techniques.

Pre-requisites: None

Reference Books:

1. "Leadership-Theory and Practice", Richard L Daft, Dryden Press Publications, USA, 1999.
2. "Effective Leadership", Robert Lussier, Achua, South-Western Cengage learning Publications, 4th Edition, 2010.
3. "Business Communication: Connecting In A Digital World", Raymond V. Lesikar, Marie E. Flatley, Kathryn Rentz, Paula Lentz and Neerja Pande, The McGraw Hill , 13th Edition, ISBN: 9789351342960, 2015.

UM18MB507: MATHEMATICS FOR MANAGEMENT (0-1-0-2-1)

Course Objectives:

- To help students understand the basic algebraic concepts.
- To provide an insight on concepts of calculus that aids in business decision making.
- To enable students comprehend fundamental concepts of descriptive statistics and Probability.
- To introduce students with fundamental concepts of Finance.

Course Outcomes:

At the end of the course students can understand:

- Acquire basic comprehension in algebraic concepts and relate the proposition to the concepts of Managerial Economics.
- Exhibit the proficiency in describing data using concepts of Central tendency, skewness, outliers and variability. Also, the students can showcase prowess in data visualization using Bar graphs and Histograms.
- Exhibit their potential in applying concepts of Regression on different business/social scenarios.
- Understand fundamental concepts of Finance and their application in Business environment.

Course Contents:

1. **Algebra:** Variables, Functions of One and More than One Variable, Linear Equations: One Variable, The Cartesian Plane, Straight Lines, Finding Solutions: Two Equations, Linear Inequalities: One Variable, Linear Inequalities: Two Variables, Polynomials and Quadratic Functions, Powers and Exponents, Power Function, Cobb-Douglas Function, Order of Operations, Entering Formulas and Graphing Functions in Excel, Inverse Functions, Ratios and Percentages, Elasticity of Demand, Logarithms, Index Numbers.
2. **Calculus:** Motivation for Differential Calculus, Determining the Slope of a Function, Slope and Tangent Lines, Rules for Computing Derivatives, Second Derivatives, Convex, and Concave Functions, Maximizing and Minimizing Functions, Inflection Points.
3. **Statistics:** Summation Notation, Using Bar Graphs and Histograms to Summarize Data, Measures of Central Tendency, skewness and Measures of Central Tendency, Measures of Variability, The Rule of Thumb and Outliers, Covariance and Correlation.
4. **Probability:** Experiments, Sample Spaces, and Events, Calculations Involving Sample Spaces, Mutually Exclusive Events, Complementary Events, Conditional Probability, Independent Events, Random Variables, Continuous Random Variables, The Normal Random Variable.
5. **Finance:** Net Present Value (NPV), Internal Rate of Return (IRR), Payback Criteria, Future Value, Annuities, Perpetuities, Growing Perpetuity, Compound Interest, Basic Bond Math, CAGR: Compound Annual Growth Rate, Option Pricing.

Pre-requisites: None

Reference Material:

Harvard Online Material- www.hbsp.harvard.edu

UM18MB508: FINANCIAL ACCOUNTING (0-1-0-2-1)

Course Objective:

- To enable students to understand the fundamental concepts of Financial Accounting and Cost analysis.

Course Outcomes:

At the end of the course students can:

- Prepare the company financial statements
- Exhibit skills in cash flow statement preparation and inventory statement.

Course Contents:

1. **Terms and Concepts:** Overview of Financial Reports, Balance Sheet, Income Statement, Statement of Cash Flows, Introduction to Concepts, Entity, Money Measurement, Going Concern, Consistency, Materiality, Quality Attributes: Relevance and Reliability, Accrual Accounting: Accrual vs. Cash-Basis, GAAP, IFRS, Principles vs. Rules.

   The Balance Sheet: Assets, Liabilities, Owner's Equity, the Accounting Equation, Concepts: Dual Aspect, **Historical Cost, Ratios:** Current Ratio and Total Debt to Equity Ratio.

   Income Statement Link to Balance Sheet, Retained Earnings and Dividends. Concepts: Realization, Matching, and Conservatism, Recording Transactions: Cash and Credit Sales, Expenses, Salaries, Utilities, Rent, Depreciation, Amortization, Operating

Expenses, Debt Service, ratios: Gross Margin Percentage and Return on Sales Percentage.

2. **Accounting Records:** Double-Entry Accounting, Journal Entries: Debits and Credits, Ledger: T-Accounts, Adjusting and Closing Entries, Preparing the Balance Sheet and Income Statement.

   The Statement of Cash Flows: Direct Method, Indirect Method, Net Income, Operating Cash Flows, Recap of the Indirect Method, Relation to the Balance Sheet, Interpretation, Analysis of Indirect Statement.

3. **Revenue & Receivables:** Unredeemed Gift Certificate, Deferred Revenue, Redeeming Certificates, Bad Debts, Refunds, Prompt Payment Discounts, Adjusting Allowances: Month's End, Bad Debt Ratio, Days Receivable Ratio.

   Inventories and Cost of Sales: Bought Merchandise Flow, Merchandise and COGS, Jam Production, Costs, Product Costs, Inventory Accounts, Raw Materials, Work-in-Process, Finished Goods, Tracking Inventory, Cost of Goods Sold, Price Change, Inventory Valuation, Flow Assumptions, Cost vs. Physical Flows, FIFO, LIFO, Inventory Write-Down, Inventory Ratios: Turnover and Days Inventory.

   Depreciation and Non-Current Assets: Acquisition Cost, Asset Usage, Depreciation, Accumulated Depreciation, Straight-Line and Accelerated Methods, IFRS Allowed Alternative, Improvements and Repairs, Asset Sales, Intangibles, Capitalizing, Accounting and Amortization, Ratio: Turnover by Industry.

4. **Liabilities and Financing Costs:** Executory Contracts, Zero Coupon Debt, Future Value, Present Value, Semi-Annual Compounding, Loan Value, Leases: Capital Lease and Operating Lease, Contingent Liabilities, Debt Ratings.

5. **Investments & Investment Income:** Investment Motivations, Control, Marketable Securities: Intent, Hold-to-Maturity, Trading, and Available-for-Sale, Business Acquisitions: Purchase Price, Net Assets Fair Value, Goodwill, Recording Acquisition, and Income Effects.

   Deferred Taxes and Tax Expense: Management Challenges, Tax vs. Financial Reporting, Tax Expense vs. Taxes Due, Deferred Tax Accruals, Deferred Tax Liabilities, Deferred Tax Assets, Current and Deferred Tax Expense.

   Owner's Equity: Management Challenges, Common Stock, Preferred, Stock Repurchases, Dividends, Stock Splits, Stock Options, Comprehensive Income, Equity Ratios: ROE Drivers.

Pre-requisites: None

Reference Material:

Harvard Online Material-www.hbsp.harvard.edu

UM18MB509: SPREADSHEET MODELING (0-1-0-2-1)

Course Objective:

- This course will make students exhibit the skills of analytical thinking and application of functions and models to solve business problems using spreadsheet.

Course Outcomes:

At the end of the course students can:

- Understand the features and capabilities of excel spreadsheet
- Apply the functions and formulae of excel spreadsheet to solve decision making problems
- Develop and apply the spreadsheet models for solving business problems
- Present the data in most appropriate visual forms.

Course Contents:

1. **The Excel Environment:** Opening a Workbook, The Excel 2013 Ribbon, The Quick Access Toolbar, Worksheets, Moving Around a Worksheet and Workbook, printing a Worksheet, Saving a Workbook File.

   Working with Data: Basic Techniques: Cells and Ranges, Selecting Ranges, Selecting All Cells in a Dataset Using Shortcut Keys, Selecting All Cells on a Worksheet, Selecting Noncontiguous Ranges, Selecting Cells and Named Ranges, Selecting Otherwise Difficult to- Select Cells with Go-To Special, Filling Series, Copying and Moving Cell Entries, The Undo Command.

   Increasing Spreadsheet Readability: Working with Rows and Columns, Making Better Use of Screen Space, Basic Cell Formatting, Basic Number Formats, Conditional Formatting, Formatting and Other Options with Paste Special, Setting Up a Worksheet for Printing.

2. **Excel Formulas:** Copying Formulas, The AutoComplete Formula Option, Entering Formulas by Pointing, Other Ways to Copy Formulas, Absolute Addressing, Using the F4 Key, Hierarchy of Mathematical Operations, Summation Icon, Editing or Correcting Formulas, Showing the Actual Formula in a Cell, Do-It-Yourself Exercise.

   Useful Excel Functions: IF Statements, Text Functions, Flash Fill, Basic Date and Time Functions, Range Names, Lookup Functions, Other Lookup and Reference Functions, Error Trapping, Rounding Functions, The Sum product Function, Modeling Uncertainty in Excel, Excel Financial Functions, Count, CountA, and Countblank Functions, Excel Statistical Functions, Conditional Counts, Conditional Sums, Removing Duplicates, Sorting in Excel, Filtering Data, Subtotals, Pivot Tables, Pivot Charts, Conditional Formatting: The Formula Option.

3. **Charts:** Creating Charts, Resizing and Moving Charts, Basic Formatting of Charts, Formatting Axes and Data Series, Customizing Charts.

   Importing Data into Excel: from a Text or Word File, Using Web Queries to Import Data from the Web, Exercises.

   The Art of Spreadsheet Modeling: Model Building Blocks, Model Terminology, The Spreadsheet Model Building Process, Rules to Guide Intelligent Modeling, building a Model, Set Up the Spreadsheet Model, Data Tables, Two-Way Data Tables, Goal Seek, Auditing, Flexibility, Comments and Text Boxes, Error Trapping, Using F9 and Evaluate Formula Feature, Scenarios, Spinners, Model Limitations.

   Using Excel Solver: Solving Optimization Problems, developing a Solver Model, Configuring Solver to Solve the Problem.

4. **Three Dimensional Formulas and The Table Feature:** Three-Dimensional Formulas, Using the Excel Table Feature.

5. **Monte Carlo Simulation:** Uncertainty and the Monte Carlo Simulation, Random Variables: The Key to the Monte Carlo Simulation, Using @RISK to Simulate a New Product Introduction.

Pre-requisites: None

Reference Material: Harvard Online Material-www.hbsp.harvard.edu

UM18MB551: STRATEGIC MANAGEMENT (2-1-2-2-4)

Course Objectives:

- To develop the ability to understand strategy, analyze the competitive environment, understand firm positioning and value creation.
- To explore the theory and frameworks underlying the foundations of a successful business strategy.

Course Outcomes:

At the end of the course students can:

- Understand the strategic context within which organizations do business.
- Apply strategic tools to analyze an organization in the context of its external and internal environment.
- Recommend strategic value creation and positioning of a firm given the environment within which it operates.
- Provide insights into and reflect upon strategies of Indian companies.

Course Contents:

1. **Introduction to Strategic Management:** Concept of Strategy, Managing the strategy making process for competitive advantage including Vision and Mission, strategic Fit and strategic intent, External Analysis: Identification of opportunities and threats, Porter's five forces model, Strategic groups, Industry life cycle analysis, Industry life cycle analysis, Limitations of models.
2. **Internal Analysis:** Distinctive competencies, Competitive advantage and Profitability, SWOT analysis, Value Chain.

   Building Competitive Advantage through Functional Level Strategy: Achieving superior Efficiency, Quality, Innovation and Customer Responsiveness.
3. **Building Competitive Advantage Through Business Level Strategy:** Choosing a generic business level strategy, the BCG matrix and GE 9 cell matrix, Competitive positioning and Business level strategy.
4. **Corporate level strategy:** Horizontal integration, Vertical Integration, Cooperative relationships, Strategic outsourcing, Strategic Alliances, Diversification.
5. **Corporate Performance, Governance, and Business Ethics:** Causes of poor performance, improving performance, stakeholders and corporate performance, ethics and strategy.

   Implementing Strategy: Implementing strategy through organization structure, control and culture; strategic control systems, restructuring and reengineering.

Practical Component based on Harvard strategy simulation games and Case Studies

List of Simulations:

1. Benihana
2. Universal Rental Car
3. Back Bay Battery
4. Root Beer
5. Data Analytics

Pre-requisites: None

Reference Books:

1. **"Crafting and Executing Strategy:** The Quest for Competitive Advantage, Concepts and Cases", Arthur A. Thompson Jr., AJ Strickland III, John E Gamble, Tata McGraw Hill, New Delhi, 18th Edition, 2013.
2. **"Strategic Management:** An Integrated Approach", Hill, Charles W L. Jones, Gareth R., Cengage Learning, New Delhi, 6th Edition, 2008.
3. Harvard Online Simulation Materials-www.hbsp.harvard.edu

UM18MB552: CORPORATE FINANCE (2-1-2-2-4)

Course Objectives:

- To familiarize students with basic concepts of financial management & time value of money.
- To evaluate projects using capital budgeting techniques.
- To estimate working capital requirements.

Course Outcomes:

At the end of the course students can:

- Explain the concepts of wealth maximization, time value of money, cost of capital.
- Exhibit skills in evaluating and analyzing future value & present value of major investment proposals.
- Calculate working capital requirements of a firm.
- Evaluate and make corporate financial decisions in practice.

Course Contents:

1. **Financial Management:** Introduction, Objectives of Financial Management – Profit Maximization, Wealth Maximization, Finance functions and its organization, Role of finance manager. Time value of money: Future Value of single cash flow and annuity, Present Value of single cash flow, Annuity and perpetuity, intra year compounding and discounting, doubling period, effective interest rate and loan amortization.
2. **Capital Structure: Planning:** Requisites of optimum capital structure, EBIT-EPS analysis, Point of indifference, Leverages- Types- Computation of different leverages.
3. **Cost of Capital:** Basic concepts, specific costs, composite cost (WACC) and marginal cost, CAPM, Dividend Policy, Types and factors affecting Dividend policy.
4. **Capital Budgeting Decisions:** Estimation of cash flows, Incremental cash flows, Methods of Selecting Capital Projects for new and replacement projects DCF and Non DCF techniques, Capital Rationing, Impact of Risk on Capital Budgeting.
5. **Working Capital Management:** Concepts of Working Capital**,** Factors affecting working capital requirements, operating cycle & cash cycle, Estimation of working capital requirements, sources of financing working capital, determination of current assets.

Pre-requisites: None

Reference Books:

1. "Financial Management: Text, Problems and Cases", Khan, M Y. Jain, P K, Tata McGraw Hill, New Delhi, 7th Edition, 2004.
2. "Financial Management", I M Pandey, Vikas Publishing House Pvt. Ltd., New Delhi, 11th Edition, 2011.
3. "Corporate Finance", Ross, Stephen A. Westerfield, Randolph W. Jaffe, Jeffrey, Tata McGraw Hill, New Delhi, 10th Edition, 2008.

UM18MB553: INTERNATIONAL BUSINESS (2-1-0-2-3)

Course Objectives:

- Make students understand the basic concepts related to globalization, PEST variables, government intervention, regional trade agreements and competitiveness at global level.
- Providing students with ability to understand how changes in global environment have dramatically altered the competitive field confronting many businesses.

- This course also will review the different strategies that are available to exploit the opportunities and counter the threats from globalization.

Course Outcomes:

At the end of the course students can:

- Understand how the process of globalization is creating opportunities and challenges for business managers.
- Explain the implications of national differences in political, legal, cultural and economic system for management practices.
- Able to analyze the impact of competitive and global financial environment on business decision making processes worldwide.
- Able to create and evaluate global strategy and structure of a firm.

Course Contents:

1. **Globalization** and International business, Strategy of International business.
2. **Cultural Environments** facing business, Political and legal environments facing business, Economic Environment facing Business.
3. **International trade** and Factor Mobility theory, Government influence on Trade, Cross-National Cooperation and agreements.
4. **Global foreign exchange** markets, Determination of exchange rates.

   Country evaluation and selection, Export and import strategies, direct investment and collaborative strategies.
5. **Organization of International Business**, Marketing Globally, Global manufacturing and supply chain management, International Accounting issues, Multinational finance function, Human resources management.

Pre-requisites: None

Reference Books:

1. **"International Business:** Competing in the Global Market Place", Hill, Charles W L. Jain, Arun K, Tata McGraw-Hill, New Delhi, 10th Edition, 2014.
2. **"International Business:** Environment and Operations", Daniels, John D. Radebaugh, Lee H. Sullivan, Daniel P, Pearson Education, New Delhi, 12th Edition, 2010.

UM18MB554:
DIGITAL TRANSFORMATION (2-1-0-2-3)

Course Objectives:

- Understand the impact of Information Technology (IT) in digital transformation.
- Identify technologies that are significant for readiness of an organization in digital era.
- Evaluate the significance of data for the organization in digital era.
- Analyze the economic value of digitalization for organizations and the economy.
- Appreciate digitalization in bringing organizational, societal disruptions to create value for customers.

Course Outcomes:

At the end of the course students can:

- Appreciate the scope and magnitude, digital transformation can bring to organizations and economy.
- Develop preparedness from technological perspective which will enable students to understand the significance of digitalization and critical Information Technology (IT) infrastructure that organizations require to compete and sustain itself in the present business environment.
- Inculcate Managerial perspective to enable them to analyze various digital technologies and leverage them for better decision making leading to value for organizations tomorrow.

Course Contents:

1. **The Digital ecosystem**: Definition of Digital Economy-Meaning-advantages-impact of digital economy on business-two-sided markets, Digital ecosystem definition-Market space as a digital ecosystem-competition in digital ecosystem. Technology eras and evolution, Introduction to Digital Change-Meaning-definition-Importance of digital transformation-Significance of digital strategy for organizations and its stakeholders-Digitally fit organization.
2. **IT Infrastructure for Digital Readiness**: The Digital firm, Digitalization meaning, New IT infrastructure for Digital firm – implementation - ERP systems, E-Business and E Commerce, Building blocks of digital firm - ERP, SCM, CRM, KMS, BI, SFA. The Digital transformation - Five domains of digital transformation, Internet induced Digital Innovation - Defining Digital Innovation and key characteristics-Layered architecture of digital technology, Digital Readiness, Integrated Infrastructure for Digital Innovation - Introduction to SMAC (Social, Mobile, Analytics and Cloud)-four types of digital organization – digital leadership-technological change.
3. **Data, the New Oil**: Data as a value creator-Sharing Economy-Big Data-Growth and value creation- transformative potential of big data in five domains - Personal data. The world of SMAC-Decoding SMAC-four pillars of SMAC- How SMAC is transforming enterprises -Social media and its influence. Impact of data in different business sectors, Optimization of Business Models-Four types for digital era. Organizational roadmap for digitally enabled business.
4. **Disruptive Digital World**: The impact of Internet, Disruptive business models – developing platforms for business - Disruptive Innovations in organizations. The Sharing Economy. Technologies of the future.
5. **Towards Digital India**: Digital democracy-digital ecosystem in India. E-Governance -Inclusive India through e-identity (Aadhar). Electronic access Government schemes (PMJDY - E- Government services) case of state government of Karnataka.

Pre-requisites: None

Reference Books / Articles:

1. "Information Rules: A Strategic Guide to the Network Economy", Shapiro, C., & Varian, H. R.Harvard Business Press, United States, 1998.
2. "Two-sided markets: an Overview", Rochet, J. C., & Tirole, J, IDEI working paper, Paris, and MIT Vol. 258, 2004.

UM18MB555:
RESEARCH METHODS (2-1-0-2-3)

Course Objectives:

- The paper aims to develop a research orientation among students.
- The objective of this course is to develop the skills of investigating a business problem and interpreting the results in the form of systematic reports for management decision making.

Course Outcomes:

At the end of the course students can:

- Describe the basic concepts of Research Methods.
- Demonstrate the skills of identifying business problems, collect and process data for managerial decisions.
- Apply the concepts of research design and methodology for solving business problems in practice.

Course Contents:

1. **Role of Business Research:** Scope of Business Research, Business research defined, Basic research and applied research, when is business research needed, Language of research, Research process- Stages in research process. **Research Design: An overview:** Research design: Definition, classification, Exploratory, Descriptive and causal research (methods), potential sources of error.
2. **Sampling, Measurement and scaling:** Sample or census, Sampling design process, Classification of sampling techniques- Probability and non-probability, Scale characteristics and Level of Measurement, Primary scales of Measurement, Itemized Rating scale – Likert and Semantic Differential Scale.
3. **Questionnaire Design and Data collection:** Questionnaire definition, objectives and Design process – What should be asked, Phrasing Questions, The Art of Asking Questions, what is the best Sequence, what is the best layout and Methods of data collection.
4. **Data Preparation and Hypothesis Testing:** Data editing, data coding, data transcribing, data cleaning, selecting a data analysis strategy, Logic of hypothesis testing, Tests of significance- Parametric &Non-parametric test using SPSS.
5. **Report Writing:** Report Writing-Introduction and significance and types of report, layout of report, Mechanics of writing a research report.

Pre-requisites: None

Reference Books:

1. **"Marketing Research:** An Applied Orientation", Malhotra, Naresh K, Pearson Education. 7th Edition, 2009.
2. "Business Research Methods", Zikmund, William G, Cengage Learning, New Delhi, 8th Edition, 2012.
3. "Business Research Methods", Cooper and Schindler, TMH, 11th Edition, 2012.
4. **"Research Methodology:** Methods and Techniques", Kothari, C R., New Age International, New Delhi, 3rd Edition, 2004.

UM18MB556:
STRATEGIC HUMAN RESOURCE MANAGEMENT (2-1-0-2-3)

Course Objectives:

- To expose students to the dynamics of need analysis, design, development and evaluation of strategic HR Functions
- To use technology platforms used in Strategic HR functions

Course Outcomes:

At the end of the course students can:

- Remember the concepts and characteristics of Strategic HR Functions.
- Exhibit fair Understanding of the concepts of strategic HR practices.
- Apply the skills of strategic HR practices in real time application.
- Analyze Eco system associated with strategic HR functional dynamics.
- Evaluate the cases of strategic HR functional dynamics in real time application.

Course Contents:

1. **Introduction to SHRM**: An Investment Perspective of Human Resource Management- valuation of assets and Investment oriented organization. Trends affecting Human Resource Management-Work force demographic changes and diversity. Influence of technology on human resource management. Major functions of HRM.

   HBS Case: Best buy co Inc: An Innovator's journey
2. **HRM and Strategy**: Strategic Planning- the evolving / Strategic role of Human Resource Management. Barriers to Strategic HR. Strategic reorganization of HR function.

   HBS case: Siemens' medical solutions: strategic turnaround
3. **Human Resource Planning**: Objectives, types of planning- aggregate planning, succession planning. Tools and Techniques- HRIS

   HBS case: Developing professionals: The BCG way
4. **Design and Redesign of Work Systems**: Design of work systems- determinants of job design, job rotation, job outsourcing, understanding change and managing change. Redesign of work systems.

   HBS case: Midwest office products
5. **Strategic Human Auditing**: Monetary and Nonmonetary value. Factors influencing the nonmonetary accounting practices. Cost center and Profit center analysis. Cost control techniques- Employee separation, outsourcing and voluntary retirement options.

   HBS case: Bradley Marquez: reduction in force.

Pre-requisites: None

Reference Book:

1. "Strategic Human Resource Management", Jeffrey A, Mello, Thompson Learning, New Delhi, India, 4th Edition, 2002.

UM18MB557:
FINANCE (0-1-0-2-1)

Course Objectives:

- Enable students to understand the fundamental concepts of Financial Management.

Course Outcomes:

At the end of the course students can:

- Analyze and interpret financial data for management decision making.
- Exhibit skills in financial forecasting.

Course Contents:

1. **Introduction** Financial Statements, Golden State Canning

   Ratio Analysis Definition, Growth, Profitability, Efficiency, Liquidity, Leverage, Risk, Common-Size Financial Statements, Interpretation, List of Common Ratios, Qualifications.

   Cash Cycle and Growth Cash Cycle, Sources and Uses, Growth.
2. **Financial Forecasting** Basic Ingredients, The Process, Bias, Error, and Uncertainty, Pro forma

   Rearranging Financial Statements Real vs. Financial, Cash vs. Non-Cash, Simplification.
3. **Capital Structure** Formulation of the Problem, Debt, Equity, Financial Leverage and Risk, Irrelevance, Relaxing M&M Condition—Taxes, Cost of Financial Distress, Tax Shields and CFD—The Static Tradeoff Model, Alternative Models, Payout Policy.
4. **Time Value of Money and Project Valuation** Introduction, Compounding and Discounting, Valuing Golden State's Jarring Line Project, Investment Decision Criteria, Perpetuities.
5. **Risk & Return** Roadmap, Expected Cash Flow, Risk-Adjusted Discount Rates, Value Maximization & Opportunity Cost, Roadmap, CAPM, Roadmap, Project Discount Rates, Roadmap, The Weighted Average Cost of Capital.

   Valuing a Business Basic Approaches, DCF Ingredients, Putting It Together, Sensitivity Analysis, Conclusion.

Pre-requisites: None

Reference Material:

Harvard Online Material-www.hbsp.harvard.edu

UM18MB558:
QUANTITATIVE METHODS – II (0-1-0-2-1)

Course Objectives:

- To help students understand the fundamental concepts of Data and its analysis.
- To provide an insight on formulation and testing of Hypothesis.
- To enable students to understand different statistical tools and their applications.
- To equip students to take business decisions driven by decision analysis tools.

Course Outcomes:

At the end of the course students can:

- Acquire basic concepts of Data, describing and summarizing of data, relationships between variables.
- Exhibit the competency in formulating hypothesis and to analyze it based on P-values.
- Exhibit their ability in applying concepts of Regression on different business/social scenarios.
- To inculcate managerial way of taking decisions by using decisional tools like Sensitivity analysis, Risk analysis.

Course Contents:

1. **Basics: Data Description** Introducing Data, Describing and Summarizing Data, Variability, Applying Data Analysis, Relationships Between Variables.
2. **Sampling & Estimation** Introduction to Sampling, Generating Random Samples, The Population Mean, The Normal Distribution, Confidence Intervals, Proportions.

   Hypothesis Testing Introduction to Hypothesis Testing, Single Population Means, Single Population Proportions, P-Values, Comparing Two Populations.
3. **Regression Basics** Introduction to Regression, Calculating the Regression Line, Deeper into Regression.
4. **Multiple Regression** Introduction to Multiple Regression, Adapting Basic Concepts, New Concepts in Multiple Regression.
5. **Decision Analysis I** Introduction to Decision Analysis, Decision Trees, Comparing the Outcomes, Sensitivity Analysis.

   Decision Analysis II Conditional Probabilities, the Value of Information, Risk Analysis.

Pre-requisites: None

Reference Material:

Harvard Online Material-www.hbsp.harvard.edu

UM18MB559:
MANAGEMENT COMMUNICATION (0-1-0-2-1)

Course Objective:

- To familiarize the learners with the mechanics of communication planning, writing and presenting.

Course Outcomes:

Upon successful completion of this course, you will be able to:

- Understand the mechanics of oral and written communication in real-time.
- Apply the knowledge and skills required in effective communication.

Course Contents:

1. **Planning Communication** Included in the complete course and each section. Introduction, What Are Good Models? Case Study: Planning Communication, analyzing a Communication Situation, Organizing a Message, Templates and Checklists.
2. **Writing in Business** Introduction, The Writing Process, What Is Good Business Writing? Four Qualities of Business Writing, Using Visual Clues, Writing Style, Case Study: Writing in Business, Informative Writing, Persuasive Writing, Writing Action Plans, Short-Form Writing, Long-Form Writing, Templates and Checklists.
3. **Presenting in Business** Introduction, Obstacles to Persuasive Presentations, analyzing a Communication Situation, Case Study: Presenting in Business.
4. **The Message:** Organizing the Content, The Message: Preparing the Plan, The Message: Enriching the Presentation, The Message: Preparing Slides and Other Media.
5. **The Delivery:** Communicating the Message, Templates and Checklists.

Pre-requisites: None

Reference Material:

Harvard Online Material-www.hbsp.harvard.edu

UM17MB570:
RESIDENTIAL PROGRAM - IIT (2-2-0-4-4)

Course Objectives:

- To help students understand the basics in Analytics and Digital Marketing.
- To enable students to be able to relate and analyze the analytics and digital marketing concepts to the practices in the industry.
- To provide a hands-on practice to the students in the basics of Analytics and Digital Marketing.

Course Outcomes:

At the end of the course students can:

- Understand the basic concepts, techniques and approaches required in Analytics and Digital Marketing.
- Apply the concepts through different cases and real time scenarios.
- Get a Certificate from IIT Madras.

Course Contents:

1. **Business Analytics:** Introduction to Big Data, Decision making using analytics, Tools for data mining, Case studies, AI, Machine learning, Deep learning, Decision support systems, decision making under increasing uncertainty.
2. **Digital Marketing & e-Commerce:** Digital Marketing, Online customer acquisition, Impact of social media on online shopping, Digital advertising, Media planning, Mobile adaptation, E-Commerce and digital payment gateways.
3. **Application of Digital Marketing (Startups/New Economy Companies):** Introduction to Digital Economy, selling strategies using internet, Leveraging the Internet for Commerce, Pricing Strategy, Marketing using Social Media, Social Media Marketing using FB, Twitter, Acquiring Customers via Social Media, Using Social Media for customer support, why is customer support important? Business Models for online business.
4. Business Plan
5. Idea Pitch session

Pre-requisites: None

References:

1. Study material prepared by IIT-Madras

UM17MB570: RESIDENTIAL PROGRAM - NISM (2-2-0-4-4)

Course Objectives:

- To understand the process involved in capital market, trading, clearing, settlement and risk management.
- To understand the process of derivatives market at macro level.

Course Outcomes:

At the end of the course students can:

- Acquire knowledge about financial markets at macro level.
- Acquire knowledge in the process of derivatives market at macro level.

Course Contents:

1. **Introduction:** To financial markets-capital markets Vs primary Markets-overview of the financial sector.
2. Equity research analysis, Fundamental analysis, Economic analysis, Industry analysis, company analysis, Technical Analysis and Different investment styles.
3. **Mutual Fund and Fixed Income Securities:** Introduction-types and methods, performance analysis of mutual funds.
4. **Derivatives:** Introduction to derivatives, Futures and Options, Types and trading strategy in the derivatives market.
5. **Lab Sessions:** Equity cash market, Derivatives market and client level risk management.

Pre-requisites: None

Reference Books:

1. "Capital Market (Dealers) Module, Workbook from NSE.
2. "NISM Certification on Securities Operations and Risk Management" Workbook from NISM
3. "Indian Financial System", Vasant Desai, Himalaya Publishing House, New Delhi, 1999.
4. "Indian Financial System", M.Y. Khan, McGraw Hill Education; 10th Edition, 2017.
5. "Financial Institutions & Markets", L M Bhole, Tata McGraw Hill Education Private Limited, 2009.

UM17MB570: RESIDENTIAL PROGRAM - IUP (2-2-0-4-4)

Course Objectives:

- IUP has partnered with PES to organize short-term summer certificate programs for students from India.
- The students will attend nearly a dozen workshops in business areas such as investment planning, project management, supply chain management, customer relationship management, e-commerce, small business planning, database management, etc.
- The workshops will be taught by industry experts and faculty with doctoral degrees and extensive industry experience. In addition, the students will visit companies in industries such as manufacturing, retail/wholesale, financial and health care sectors.
- Students will also have the fun of visiting world-famous sites in Niagara Falls, New York, Washington D C Pittsburgh.
- Students will participate in special events on July4, the American Independence Day.

Course Outcomes:

Besides exposure to a multicultural environment, the students can look forward to:

- Interactive classes, accessible instructors, and a diverse student body
- Building connections with peers from around the world
- Attending speaking events, academics round- tables, and trips
- Students who successfully complete all requirements will receive Non-credit Certificate in Management and Leadership from IUP and Optional 6 credits from their University.

Course Contents:

1. Stay at IUP campus in superior housing facilities.
2. Eberly College of Business & IT will conduct seminars/workshops on management & leadership skills.
3. Workshops will be conducted by the industry experts and management faculty with extensive industry experience.
4. Students will visit companies in sectors such as manufacturing, retail} wholesale, financial, and healthcare sectors.
5. Students will experience the fun of visiting world-famous sites in Niagara Falls, Washington D.C. and Pittsburgh.
6. Students will participate in special events during July 4th, the American Independence Day.
7. Students will have opportunities to explore prospects for higher studies and business ventures in the U.S.

Pre-requisites: None

Reference Book:

1. Study material prepared by Indiana University of Pennsylvania (IUP).

UM17MB571: SUPPLY CHAIN MANAGEMENT (2-2-0-4-4)

Course Objectives:

- To help students understand the importance of supply chain, distribution and networking concepts for any company.
- To provide an insight about E commerce and supply chain in practice.

Course Outcomes:

At the end of the course students can:

- Understand the fundamental role of supply chain.
- Apply the skill acquired to manage supply chain of an organization.
- Evaluate current trends, growth opportunities, global patterns and niche markets within the area of supply chain management.

Course Contents:

1. **Introduction to Supply Chain Management:** Supply chain – objectives – importance – decision phases– process view – competitive and supply chain strategies – achieving strategic fit – supply chain drivers – Framework – facilities – inventory – transportation – information – sourcing – pricing.
2. **Designing the Supply Chain Network:** Designing the distribution network – role of distribution factors influencing distribution design options – online sales and distribution network, Indian FMCG and distribution channel network design in the supply chain – role of network – factors affecting the network design decisions, Designing and Planning Transportation Networks,

Role of transportation – modes and their performance – transportation infrastructure and policies design options and their tradeoffs – Tailored transportation.

3. **Sourcing and Pricing:** Sourcing – In-house or Outsource – 3rd and 4th PLs – Supplier scoring and assessment, selection – design collaboration – procurement process – sourcing planning and analysis Pricing and revenue management for multiple customers, perishable products, seasonal demand, bulk and spot contracts.
4. **Information Technology in the Supply Chain**: IT Framework – customer relationship management – internal supply chain management – supplier relationship management –transaction management Future of IT.
5. **Coordination in a Supply Chain:** Lack of supply chain coordination and the Bullwhip effect – obstacle to coordination managerial levers – building partnerships and trust – continuous replenishment and vendor managed inventories collaborative planning, forecasting and replenishment.

Pre-requisites: None

Reference Books:

1. "Supply Chain Management – Strategy, Planning and Operation", Sunil Chopra and Peter Meindl, Pearson Education, New Delhi, 4th Edition, 2010.
2. "Exploring Supply Chain Theory and Practice", Kachru, Upendra, Excel books, New Delhi, 1st Edition, 2009.

UM17MB572: FINANCIAL ECONOMETRICS (2-2-0-4-4)

Course Objectives:

- Enable students to understand the fundamental concepts of econometrics.
- To analyze, interpret & forecast financial data using econometric techniques.

Course Outcomes:

At the end of the course students can:

- Exhibit skills in evaluating and analyzing financial data.
- Explain, test and evaluate ARIMA models.
- Apply models of financial return volatility.

Course Contents:

1. **Introduction** to Econometrics, types of econometrics different data types-cross section, time series and panel data. Statistical concepts- Normal distribution, chi square, t and F distribution. Testing of Hypothesis.
2. **Properties of Financial Data:** Introduction, identify and analyze the prices, Returns, Simple returns, log returns, excess returns, dividends, spreads, Financial Distribution, transactions -summary statistics univariates, Bivariate-Percentile and computing Value at Risk, Efficient Market Hypothesis and Return Predictability, Efficient Market Hypothesis and Variance ratio test.
3. **Two Variable Regression Model**: The method of Ordinary Least Squares, Linear regression model, Assumptions of method of least squares, goodness of fit-R^2 and adjusted R^2, Violations of Classical Assumptions: Consequences, Detections and Remedies - Multicollinearity, heteroscedasticity, serial correlation.
4. **Time Series Econometrics**: Key concepts -Stochastic processes, Stationarity processes, non-stationarity processes unit root stochastic process, Tests of stationarity -Autocorrelation function, The Augmented Dickey Fuller test, co-integration, Testing for co-integration-Engle-Granger (EG) OR Augmented Engle-Granger (AEG) Test.
5. **Time Series Econometrics: Forecasting** – Approaches to economic forecasting, AR, MA and ARIMA Modeling of time series data, The Box-Jenkins Methodology, Identification and Estimation of ARIMA Model, Diagnostic Checking, Forecasting, Vector Autoregressive (VAR), Measuring the Volatility in Financial Time series: The ARCH and GARCH Models.

Pre-requisites: None

Reference Books:

1. **"Basic Econometrics:** Damodar N. Gujarati, Dawan C. Porter, Sangeetha Gunasekar, Mcgraw Hill Education Publications, 5th Edition, 2017.
2. **"The Basics of Financial Econometrics:** Tools, Concepts, and Asset", Bala G. Arshanapalli, Frank J. Fabozzi, Sergio M. Focardi, and Svetlozar Rachev, John Wiley & Sons, Inc. 1st Edition, 2014.
3. **"Introductory Econometrics for Finance",** Chris Brooks, Cambridge University Press; 3rd Edition, 2014.
4. **"Financial Econometrics:** From Basics to Advanced Modeling Techniques", Svetlozar Rache, Wiley, 1st Edition, 2006.

UM17MB573: DESIGN THINKING (2-2-0-4-4)

Course Objectives:

- To equip students with tools and practices that drive towards human centered outcomes.
- Identify a project with a dedicated team to apply design thinking to create a product, service or experience.

Course Outcomes:

At the end of the course students can:

- Define and preserve powerful user-centered outcomes and measure success based on the value created.
- Work in multidisciplinary teams and playback to communicate intent and improve on outcomes through iterations.
- Develop a strong bias towards action and ensure sponsor users validate work.

Course Contents:

1. **Discover:** Identify an opportunity, scope your project, create your brief, make your plans and do your research. We will create an environment map, which will help you understand the context in which you create. Discovery is a very important part of design thinking, for it prepares the ground for gaining customer insights and understanding the customer's perspective. Most products and services are created from the delivery point of view. We then must work very hard to attract customers and ensure repeat use or word of mouth referrals. Design thinking tools ensure that you create such a good value proposition that it saves you a huge amount of money and possible failure in the launch stage. Create and work with your customer personas.
2. **Design:** Identify insights, establish criteria, brainstorm ideas, develop concepts. Whether you want to create something from scratch or you are part of an exciting organization, the design part of design thinking allows you to invent and improve value propositions. We will use a variety of design thinking tools to explore multiple alternatives, before picking and refining a direction. You understand and get comfortable with the non-linear and iterative nature of value creation.
3. **Prototype:** Create napkin pitches, surface key assumptions, make prototypes, get feedback from stakeholders, run learning launches. The practice of building quick, inexpensive and rough models or prototypes to learn about the desirability, feasibility and viability of alternative value propositions and opportunities is invaluable. It of course saves you time and energy, but even

more important it bullet proofs your idea. Failure and mistakes, you discover at the proto-type stage saves you from the more expensive failure in the real world.

4. **Design the on-ramp:** How will the users learn about your offering, try it out and become regular users? Think through all the channels of communication, presence, attraction, trial, purchase, post purchase service, user communities and make your decisions. Make sure your channels and methods suit your customer personas.
5. **Deliver:** Test for value, execution, scale and defensibility; live in-market experiment of project. This final unit will help you design, prioritize and run tests to ensure that your ideas land successfully in the real world. Rank all your hypotheses in order of how critical it is for your idea to survive and thrive. Use experiments to test for customer interest and relevance, priorities and preferences and willingness to pay.

Pre-requisites: None

Reference Book:

1. "Complete Design Thinking Guide for Successful Professionals": Daniel Ling, Create Space Publishing , 2015.

UM17MB574: PRODUCT MANAGEMENT (2-2-0-4-4)

Course Objectives:

- This course will provide students an overview of the Product Management function in the corporate.
- A student will study the importance and the process of managing a product, marketing planning process and the background analyses necessary for constructing a successful marketing plan, how to set sound product objectives and develop a product strategy because of market analysis.

Course Outcomes:

At the end of the course students can:

- Understand the fundamentals of product management i.e. understanding marketing planning process, defining the competitive set, category attractiveness, competitor and customer analysis, developing the product strategy and new products.
- Apply the fundamentals of product management to different marketing scenarios.

Course Contents:

1. **Marketing Planning Process:** Introduction to Product Management: Product management, changes affecting product management, changes in marketing organization, Marketing Planning: the planning process, the components of marketing plan, Defining the competitive set: Levels of market competition, methods for determining competitors, competitor selection, enterprise competition.
2. **Market Analysis:** Category Attractiveness Analysis: aggregate market factors, category factors, environmental analysis, Competitor Analysis: sources of information, creating a product features matrix, assessing competitors' current objectives and strategies, differential advantage analysis, Customer Analysis: things to know about customer, segmentation.
3. **Product Strategy:** Developing the Product Strategy: elements, objectives, selection of strategic alternatives, positioning, product strategy over the PLC, New Products: Product Modifications, line extensions, Idea for new products, testing, extensions.
4. **Product Related Marketing Mix Decisions:** Pricing Decisions: role of pricing, measuring perceived value and price, psychological aspects, competition and pricing, objectives, factors, tactics, Advertising Decisions: target audience, objectives, budget, evaluation, media selection, Promotions: Objectives, budgeting, customer promotions, trade promotions, evaluation, Channel Management: Channel Selection, Management and Monitoring.
5. **Marketing Metric:** Customer relationship Management: economics of loyalty, framework, creating and analyzing the database, selection, targeting, customer relationship issues. Financial Analysis for Product Management: Sales and Profitability Analysis. Marketing Metrics: a framework for marketing metrics, web metrics.

Pre-requisites: None

Reference Book:

1. "Product Management", Lehmann D. R. and Russell Winer. S, McGraw-Hill Education, 4th Edition, 2005.

UM17MB575: ADVERTISING AND MARKETING COMMUNICATIONS (2-2-0-4-4)

Course Objectives:

- This course will provide students an overview of the Advertising and communication function in the corporate.
- A student will examine the role of advertising and promotion and its role in modern marketing.
- A student will also do the promotion program situation analysis and understanding the communication process.
- A student will also examine the various promotional mix elements that form the basis of integrated marketing communications program.
- The course ends by measuring the effectiveness of various elements of the IMC programs.

Course Outcomes:

At the end of the course students can understand:

- The fundamentals of Integrated Marketing Communications (IMC)
- The IMC program situation analysis
- The communication process
- The objectives and budgeting of IMC programs
- The developing of IMC programs

Course Contents:

1. **Introduction:** Introduction to IMC, the role of IMC in the marketing process, Organizing for Advertising and Promotion.
2. **Analyzing the Communication Process:** The Communication Process, Source, Message and Channel Factors, Objectives and Budgeting for IMC programs.
3. **Developing the IMC Program:** Creative Strategy – Planning and Development, Creative Strategy – Implementation and Evaluation, Media Planning and Strategy, Evaluation of Media: Television and Radio.
4. **Developing the IMC Program:** Evaluation of Print Media, Support Media, the Direct Marketing, the Internet and Interactive Media.
5. **Developing, Monitoring, Evaluation and Control of IMC Programs:** Sales Promotion, Public Relations, Publicity and corporate advertising, measuring the Effectiveness of the Promotional Program.

Pre-requisites: None

Reference Book:

1. "Advertising and Promotion: An IMC Perspective", George Belch, Michael Belch, McGraw Hill Education Publications, 9th Edition, 2014.

UM17MB576:
DIGITAL TRANSFORMATION (2-2-0-4-4)

Course Objectives:

- Understand the impact of Information Technology (IT) in digital transformation.
- Identify technologies that are significant for readiness of an organization in digital era.
- Evaluate the significance of data for the organization in digital era.
- Analyze the economic value of digitalization for organizations and the economy.
- Appreciate digitalization in bringing organizational, societal disruptions to create value for customers.

Course Outcomes:

At the end of the course students can:

- Appreciate the scope and magnitude, digital transformation can bring to organizations and economy.
- Develop preparedness from technological perspective which will enable students to understand the significance of digitalization and critical Information Technology (IT) infrastructure that organizations require to compete and sustain itself in the present business environment.
- Inculcate Managerial perspective to enable them to analyze various digital technologies and leverage them for better decision making leading to value for organizations tomorrow.

Course Contents:

1. **The Digital Ecosystem**: Definition of Digital Economy-Meaning-advantages-impact of digital economy on business-two-sided markets, Digital ecosystem definition-Market space as a digital ecosystem-competition in digital ecosystem. Technology eras and evolution, Introduction to Digital Change-Meaning-definition-Importance of digital transformation-Significance of digital strategy for organizations and its stakeholders-Digitally fit organization.
2. **IT Infrastructure for Digital Readiness**: The Digital firm, Digitalization meaning, New IT infrastructure for Digital firm – implementation - ERP systems, E-Business and E Commerce, Building blocks of digital firm - ERP, SCM, CRM, KMS, BI, SFA. The Digital transformation - Five domains of digital transformation, Internet induced Digital Innovation - Defining Digital Innovation and key characteristics-Layered architecture of digital technology, Digital Readiness, Integrated Infrastructure for Digital Innovation - Introduction to SMAC (Social, Mobile, Analytics and Cloud)-four types of digital organization – digital leadership-technological change.
3. **Data: the New Oil of Business**: Data as a value creator- Sharing economy- Big data- Growth and value creation- transformative potential of big data in five domains - Personal data. The world of SMAC-Decoding SMAC-four pillars of SMAC- How SMAC is transforming enterprises -Social media and its influence. Impact of data in different business sectors, Optimization of Business Models-Four types for digital era. Organizational roadmap for digitally enabled business.
4. **Disruptive Digital World**: The impact of Internet, Disruptive business models – developing platforms for business - Disruptive Innovations in organizations. The Sharing Economy. Technologies of the future.
5. **Towards Digital India**: Digital democracy- digital ecosystem in India. E-Governance -Inclusive India through e-identity (Aadhar). Electronic access Government schemes (PMJDY - E- Government services) case of state government of Karnataka.

Pre-requisites: None

Reference Books / Articles:

1. “Information Rules: A Strategic Guide to the Network Economy”, Shapiro, C., & Varian H. R., Harvard Business Press, United States, 1998.
2. “Two-sided markets: An Overview”, Rochet, J. C., & Tirole, J, IDEI working paper, Paris, and MIT Vol. 258, 2004.

UM17MB577:
PERSONAL GROWTH AND INTERPERSONAL EFFECTIVENESS (2-2-0-4-4)

Course Objectives:

- To understand the concepts of self-awareness, self-esteem and roles taken by individuals.
- To appreciate sense of personal worth through effective habits and spiritual involvement.
- To understand Interpersonal growth and effectiveness.

Course Outcomes:

The Students will be able to:

- Understand the components of personal growth.
- Gain insights about interpersonal growth and trust.
- Manage conflicts and create rapport.
- Appreciate the individual differences and respect others.

Course Contents:

1. **Personal:** Self-awareness and self-esteem, Role- Life roles, social roles, organizational roles, role clarity and role boundaries, Role efficacy, Role stress, Defense mechanisms and developing a self-improvement plan, NLP Test, Emotional Intelligence.
2. **Personal Growth:** Ego states, types of transactions and time structuring. Life position, scripts and Games, Strokes.
3. **Personal Effectiveness-I:** Understanding our Thinking Process, managing our Internal Dialogue, Perceptual Positions for Assertiveness, Managing Conflicts, Creating Rapport, Powerful Persuasion Strategies.
4. **Personal Effectiveness- II:** Seven habits of highly effective people. Effective Life and Time Management, Spiritual Foundations of Personal Effectiveness.
5. **Interpersonal Trust:** Discovering facets of interpersonal trust through Johari Window (Openness, confidentiality, blind spot and unknown part of personality); Self-disclosure, seeking feedback, self-reflection and practicing new behaviors. Interpersonal needs, motivation and behavior-FIRO-B and Johari Window, Defense Mechanism in groups, T-Group/sensitivity training, encounter groups and appreciative enquiry

Pre-requisites: None

Reference Books:

1. “Organizational Behavior: Human Behavior at work”, John W. Newstrom and Keith Davis, Tata McGraw Hill, 11th Edition, 2003.
2. “Human Relations in Organizations” Robert N. Lussier, Tata Mc-Graw Hill Education publications, 6th Edition, 2005.
3. “Development of Management Skills” David Whetten, Dr. Kim Cameron, Prentice Hall publications, 8th Edition, 2010.
4. “Understanding OB”, Udai Pareek, Oxford University Press Publications, 3rd Edition, 2007.
5. “Theories of Personality”, Calvin S Hall, Wiley India Pvt. Ltd, 4th Edition, 2007.
6. “Seven Habits of Highly Effective People”, Stephen R Covey, Simon & Schuster publications, Indian edition, 2013.
7. “Training in Interpersonal Skills”, Stephen Robbins, Pearson Education, 6th Edition, 2012.

UM17MB578: FINANCIAL PRODUCTS AND SERVICES (2-2-0-4-4)

Course Objectives:

- To introduce the concepts and provide an in depth understanding of the financial products and services.
- To comprehend the technological up gradation and application in banking.
- To provide an understanding of asset liability management in banks.

Course Outcomes:

At the end of the course students can:

- Understand the functioning of different financial services.
- Practically manage and analyze the assets and liabilities of banks.
- Identify the issues in securitization.

Course Contents:

1. **Concept of Retail Banking:** Distinction between Retail and Corporate/Wholesale Banking; Retail Products Overview: Customer requirements, products development process, Approval process for retail loans, credit scoring.
2. **Important Retail Asset Products:** Home loans, Auto/vehicle loans, Personal loans, Educational loans -Study of these products in terms of Eligibility, Purpose, Amounts, Margin, Security, Disbursement, Moratorium, Prepayment issues, Repayments/ Collection; Credit/Debit Cards-Eligibility, Purpose, Amounts, Margin, Security, Process of using the cards, Billing Cycle, Credit Points; Other products/Remittances/Funds Transfer Selling process in retail products; Customer Relationship Management-Role and impact of customer relationship management, stages in CRM process; Technology for retail banking.
3. **Trends in Retailing:** New products like insurance, Demat services, online/phone banking, property services, investment advisory/ wealth management, Reverse Mortgage-Growth of e-banking, Cross selling opportunities. Mutual Funds – Concept and Objectives, Functions and Portfolio Classification, Organization and Management, Guidelines for Mutual Funds, Working of Public and Private Mutual Funds in India – Demat Services-need and Operations-role of NSDL and CSDL.
4. **Recovery of Retail Loans:** Rescheduling, recovery process-SARA-FAESI, Act, DRT Act, use of Lok Adalat forum, Recovery Agents-RBI guidelines, Debt Securitization – Concept and Application.
5. **Asset Liability Management in Banks:** Components of Liabilities and Components of Assets, Significance of Asset Liability management, Purpose and objectives. ALM as co-ordinate Balance Sheet management. Securitization of debt: Meaning, Features, Special Purpose Vehicle, Types of Securities able assets, Benefits of Securitization, Issues in Securitization.

Pre-requisites: None

Reference Books:

1. "Fundamentals of Retail Banking", Agarwal, O.P., Himalaya Publishing House, Mumbai, 1st Edition, 2012.
2. "Bank Marketing",S M Jha, ISBN-10: 818488654, Himalaya Publishing House, Mumbai, 2011.

UM17MB590: STRATEGIC MANAGEMENT (2-1-2-2-4)

Course Objectives:

- To develop the ability to understand strategy, analyze the competitive environment, understand firm positioning and value creation.
- To explore the theory & frameworks underlying the foundations of a successful business strategy.

Course Outcomes:

At the end of the course students can:

- Understand the strategic context within which organizations do business.
- Apply strategic tools to analyze an organization in the context of its external and internal environment.
- Recommend strategic value creation and positioning of a firm given the environment within which it operates.
- Provide insights into and reflect upon strategies of Indian companies.

Course Contents:

1. **Introduction to Strategic Management:** Concept of Strategy, Managing the strategy making process for competitive advantage including Vision and Mission, strategic Fit and strategic intent, External Analysis: Identification of opportunities and threats, Porter's five forces model, Strategic groups, Industry life cycle analysis, Industry life cycle analysis, Limitations of models.
2. **Internal Analysis:** Distinctive competencies, Competitive advantage and Profitability, SWOT analysis, Value Chain.

   Building Competitive Advantage through Functional Level Strategy: Achieving superior Efficiency, Quality, Innovation and Customer Responsiveness.
3. **Building Competitive Advantage Through Business Level Strategy:** Choosing a generic business level strategy, the BCG matrix and GE 9 cell matrix, Competitive positioning and Business level strategy.
4. **Corporate Level Strategy:** Horizontal integration, Vertical Integration, Cooperative relationships, Strategic outsourcing, Strategic Alliances, Diversification.
5. **Corporate Performance, Governance, and Business Ethics:** Causes of poor performance, improving performance, stakeholders and corporate performance, ethics and strategy.

   Implementing Strategy: Implementing strategy through organization structure, control and culture; strategic control systems, restructuring and reengineering.

Practical Component based on Harvard strategy simulation games and Case Studies

List of Simulations

1. Benihana
2. Universal Rental Car
3. Back Bay Battery
4. Root Beer
5. Data Analytics

Pre-requisites: None

Reference Books:

1. "Crafting and Executing Strategy: The Quest for Competitive Advantage, Concepts and Cases", Arthur A. Thompson Jr., AJ Strickland III, John E Gamble, Tata McGraw Hill, New Delhi, 18th Edition, 2013.
2. "Strategic Management: An Integrated Approach", Hill, Charles W L. Jones, Gareth R., Cengage Learning, New Delhi, 6th Edition, 2008.
3. Harvard Online Simulation Materials- www.hbsp.harvard.edu

UM17MB591: SALES AND DISTRIBUTION MANAGEMENT (2-2-0-4-4)

Course Objectives:

- To help students understand the Sales & Distribution functions as an integral part of marketing functions in a business firm.

- To help students acquire and polish their selling skills through practical training sessions.
- Enable students to apply the theories, and concepts to practical situations.

Course Outcomes:

At the end of the course students can:

- Apply the concepts, attitudes, techniques and approaches required for effective decision making in the areas of Sales and Distribution.
- Demonstrate skills acquired, for designing, evaluating and selecting sales and distribution strategies in practical settings.
- Create, evaluate and select Sales and Distribution strategies in real time situations.

Course Contents:

1. **Introduction to Sales Force Management:** The Field of Sales Force Management, Strategic Sales Force Management, The Personal Selling Process, Sales Force Organization, Profiling and Recruiting Salespeople, Selecting and Hiring Salespeople.
2. **Sales Force Training and Compensation:** Developing, Delivering and Reinforcing a Sales Training Program, motivating a Sales Force, Sales Force Compensation, Sales Force Quotas and Expenses, Leaders hip of a Sales Force, Forecasting Sales and Developing Budgets.
3. **Sales Territories:** Analysis of Sales Volume, Marketing Cost and Probability Analysis, Evaluating a Salesperson's Performance, Ethical and Legal Responsibilities of Sales Managers.
4. **Marketing Channels:** Channel Integration, Channel Management.
5. **Evaluating Channel Performance:** Managing Channel Conflicts, Wholesaling, Retailing.

Pre-requisites: None

Reference Book:

1. "Management of a Sales Force", Spiro, Stanton, and Rich; McGraw-Hill Irwin Publisher, 12th Edition, 2007.

UM17MB592:
INTERNATIONAL TAXATION – 1 (2-2-0-4-4)

Course Objectives:

- Obtain an accounting overview for Tax Professionals.
- Understanding of US Income taxation laws.
- Partnership Taxation.
- US Taxation of Foreign Corporation.
- Individual Taxation.

Course Outcomes:

At the end of the course students can:

- Recognize the structure of the US Government.
- Understand key differences among types of US Tax Payers.
- Describe various tax jurisdictions in the US.
- Identify various types of taxation in US.

Course Contents:

1. **Comparison of US GAAP vs India GAAP:** Structure of the US Government, types of US Tax Payers, tax jurisdictions in the US, types of taxation in US, sources of US tax law, Code and Regulations, stages of tax life cycle.
2. **Partnership Basics:** Partnerships and types of Partnerships, Partners and types of Partners, box regulation, Subchapter K provisions, Partnership tax return filing and timing.

   Partnership Formation, cash and property contributions on a partnership balance sheet, partner's outside basis, tax consequences of partnership organization and syndication fees.
3. **Partnership Taxable Income:** Guaranteed payments to partners, items on Schedule K, Form 1065, book and taxable income on Schedule M-1 Form 1065 & Schedule M-3, Partners distributive share of income, gain, loss, deduction or credit, Concept of substantial economic effect, outside basis for Schedule K-1 information, Simulation - Comprehensive case study.
4. **Introduction to US Individual Taxation:** Basic concepts of US tax and Overview of form 1040, Filing Requirement, Filing Status, Dependents and exemptions, Income Types, Compensation, Basics of Income Sourcing & W-2, Stock Options, Interest, Dividend Income, Capital Gains and Sale of Main Home, Business Income (Schedule C and self-employment tax).
5. **Income and Loss from Rental Property:** Passive Activity Loss limitations, State and Local tax refunds, Other Income, Health Savings Account deduction, moving expenses, IRA deduction, Student loan and Interest, Tuition and Fees and other deductions, Itemized Deductions, Credits, Computation of Taxes, Alternate Minimum Tax, Additional Medicare Tax and Net Investment Income Tax, Filing due date, Extensions, Penalty and Interest. Tax rates and calculation of Taxes.

Pre-requisites: None

Reference Book: EA Review by Irvin.N.Gleim, James. R. Hasselback, Gleim publications, 2017.

UM17MB593:
INTERNATIONAL TAXATION– 2 (2-2-0-4-4)

Course Objectives:

- Obtain an accounting overview for Corporate Tax Professionals.
- Understanding of US Income taxation laws.
- Corporate Taxation.
- Technology for Taxation.

Course Outcomes:

At the end of the course students can:

- Recognize the Corporate Tax structure of the US Government.
- Understand key differences among types of US Corporate Tax Payers.
- Describe various Corporate Tax jurisdictions in the US.
- Identify various types of Corporate Tax in US.

Course Contents:

1. **Taxes Imposed by Different Jurisdictions**: Legal characteristics of business entities, federal income tax treatment of business entities, common non-business entities, Taxable Income Overview, Corporate book income and taxable Income, Schedule M-1 and M-3 disclosure requirements, Gross Income, common exclusion from Gross Income, general rules for timing of income recognition, effect of income related book - tax differences on Schedule M-3.
2. **Deductible and Non Deductible Expenses:** Broad categories of deductible expenses, examples of non-deductible expenses, general rules for timing of deductions, effect of expense -related book - tax differences on Schedule M-3, Asset basis and cost recovery, Initial tax basis of business property, deductible repairs and Capitalized improvements, Allowable cost recovery deductions, cost recovery book to tax differences on Schedule M-3.
3. **Sale of Assets, Gain or Loss:** Realized on business property dispositions, Sec. 1231 netting rules, capital loss limitations, Corporate Taxable Income, Tax treatment of Charitable Contributions, net operating losses, and dividends received deductions, corporate taxable income, Corporate Tax Liability,

Corporate Tax Liability, applicability and calculation of Corporate Alternative Minimum Tax, Simulation - Comprehensive case study.

4. **SQL Overview and RDBMS Concepts**: History of SQL and Why we need SQL, SQL Constraints, Data Integrity, Database Normalization, Single - Table Queries, SQL Data types, Joins and Sub queries, Table Expression and Set Operators, SQL Commands, SQL Programmable Objects, Overview on Stored Procedure, User Defined Function (UDFs) and Indexes, Basics of Error Handling.
5. **Power BI, Connecting to Data:** Introduction to data source concepts, Concepts and Options when Connecting to Data, Analysis, Geographic Map, Formatting, Building Interactive Dashboards, SharePoint, SharePoint Overview, SharePoint Architecture, SharePoint life cycle, Basics of SharePoint Site , sub site and site collection, List , Libraries, site columns, Content type, Managed Metadata, Out of the Box features, Security and Site permissions, "Features" in SharePoint, InfoPath forms, SharePoint Designer Workflows.

Pre-requisites: None

Reference Book:

EA Review by Irvin.N.Gleim, ,James.R.Hasselback, part 2 Businesses Gleim publications, 2017.

UM17MB601:
DATA MANAGEMENT (2-1-0-2-3)

Course Objective:

- The main purpose of the course is to develop and gain an understanding of the principles, concepts, functions and uses of data warehouses, data modeling and Machine Learning techniques which is used in organizations to take Strategic Decisions.

Course Outcomes:

At the end of the course students can:

- To study the physical and logical database designs, database modeling& retrieving data from relational data bases.
- Design a data warehouse for efficient decision support by providing adaptive and flexible source of information.
- Learn the general concepts of Machine Learning along with basic methodologies and applications in Business.

Course Contents:

1. **Data Base Management System:** Purpose of Database System-Database System Terminologies - Database characteristics - Data models – Types of Data models – Components of DBMS – Logical Data Base Design-Relational Data Base - Codd's Rule – Entity Relationship model.

   DBMS Lab: Implementation of ER model –SQL Statements -Restricting and sorting data Displaying data from multiple tables-Aggregating data using group function –Manipulating data -Creating and managing tables.
2. **Data Warehousing:** Introduction to Data warehouse - Difference between operational Database systems and Data warehouses - Data warehouse Characteristics - Data warehouse Architecture and its Components – Extraction – Transformation – Loading - Data Modeling - Schema Design – Star and Snow Flake Schema - Fact Table-Dimension Table-OLAP Cubes.

   ETL Lab Using Talend: Working with Databases -Introduction to Transformations using ETL.
3. **Introduction to Machine Learning:** Introduction to Machine Learning–Definition of learning systems--Knowledge Representation- Data Types -Training data- Interestingness of Patterns- Goals and applications of machine learning- perspective & issues in machine learning.
4. **Introduction to Machine Learning Algorithms:** Linear Regression-Supervised Classification-Decision Trees-k-Nearest Neighbors -Naïve Bayes-Support Vector Machine.

   Machine Learning Lab Using R: Demonstration of pre-processing on dataset –Linear Regression-Supervised Classification-Decision Tree-K Nearest Neighbor-Naïve Bayes- Support Vector Machine.
5. **Clustering and Trends in Machine Learning:** Cluster Analysis - Types of Data- Categorization of Major Clustering Methods K-means––Outlier Analysis –Applications-Time series Analysis-Association Rule Mining.

   Machine Learning Lab Using R: K-Means Clustering-Outlier Analysis –Time Series Analysis-Association Rule Mining.

Pre-requisites: None

Reference Books:

1. "Elements of Machine Learning", P. Langley, Morgan Kaufmann Publishers, 1st Edition, 1995.
2. "Learning From Data", Yaser Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien Lin, amlbook.com, 2012.
3. "Data Warehousing Fundamentals", Paulraj Ponnaiah Wiley, Student Edition, 2001.
4. "Data Mining – Concepts and Techniques",Jiawei Han & Micheline Kamber, Morgan Kaufmann Publishers, Elsevier, 2nd Edition, 2006.

UM17MB602:
INTRODUCTION TO STATISTICS WITH R (2-1-0-2-3)

Course Objectives:

- The purpose of this course is to introduce students to the statistical tools for data analysis.
- The course provides training in exploratory data analysis techniques with hands-on experience on R.

Course Outcomes:

At the end of the course students can:

- Use R to read and write data files, perform basic data manipulations (eg, creating new variables, merging data sets).
- Write and use R script files, use R packages, write and use R functions, perform basic programming in R, perform descriptive statistics including graphics, perform basic inferential statistical analyses including hypothesis testing, regression analysis etc.
- The course will help students to feel empowered and inspired to learn more R on their own/within a community of R users.

Course Contents:

1. **Introduction:** Scope of Statistics – Language of Statistics – Descriptive and Inferential Statistics – Sources of Data – Survey Data: Primary and Secondary, Internet – Types of Data: Quantitative and Qualitative Data, Time Series Data, Cross-section Data, Pooled Data, Panel/Longitudinal Data -- Types of measurement: Nominal, ordinal, ratio, and interval – Accuracy of Data: Sampling and Non-Sampling Errors – Data Dissemination.

   R lab: Getting and Installing R-Studio, R Language: Expressions, Assignment Statements – R Syntax: Numeric Vectors, Character Vectors, Expression – R Objects, Matrices, Time Series, Dates and Times.
2. **Data Manipulation:** Reading and Writing Data: Comma and Tab-Delimited Input Files, Fixed-Width Input Files – Databases: SQL, ODBC, MySQL – Basics of Subscripting – Numeric Subscripts – Character Subscripts – Subscripting Matrices and Arrays –

Subscripting Data Frames – Character Manipulation – Displaying and Concatenating Character Strings -- Working with Parts of Character Values – Breaking Apart Character Values -- Data Aggregation – Reshaping Data.

Lab: Data matrices disseminated in the form of Excel, Libre Spreadsheet, CSV, SQL, ODBC etc.

3. **Descriptive Analysis:** Data Summary – Mathematical Averages, Measures of Location, Measures of Dispersion, Measures of Skewness and Kurtosis – Bivariate Data Analysis – Correlation Analysis: Karl Pearson's Correlation Coefficient, Spearman's Rank Correlation – Graphs and Plots – Univariate Data Plotting, Box-Plots.

   Lab: Manifestation of the concepts using Mathematical Averages, Univariate and Bivariate Data Visualization.

4. **Hypothesis Testing:** Small Sample Test: Single Mean, Difference of Mean, Paired t-test, p-value and power of test – Large Sample Tests: Difference of Mean, Difference of Variance, t-test, Chi-square and F Distribution – Goodness of Fit.

   Lab: Demonstration of above Mentioned Concepts with suitable Database and examples.

5. **Regression:** Classical Normal Linear Regression Model (CNLRM), Regression Diagnostics, an Outlier Test, Influential Observations, Residual Plots, Assessing Normality, the Gauss-Markov Theorem– Hypothesis Testing for the Multiple Linear Regression Model – Goodness of Fit and Multiple Regression – Detection of Multicollinearity, Theil's Multicollinearity Effect, Detection of Heteroscedasticity: Park Test, Glejser Test, Goldfield-Quandt Test, White's General Test – Remedial Measures for Heteroscedasticity

   Lab: Estimation of intercept, slope coefficient of Two-variable and Multiple Regression Analysis – Interpretation of β coefficients, R^2, Adjusted R^2, and degree of freedom – Demonstrations of Regression Diagnostics to address the violation of CLRM assumptions – Remedial Measures for Heteroscedasticity, Multicollinearity etc.

Pre-requisites: None

Reference Books:

1. "R in A Nutshell", Adler, Joseph, O'Reilly Media, Inc., United States of America, 2010.
2. "Data Analysis and Graphics Using R", Main Donald, John, and Braun, John, Example-based Approach, Cambridge University Press, 2004.

UM17MB603:
PREDICTIVE ANALYTICS (2-1-0-2-3)

Course Objectives:

- To provide a working knowledge of handling data and Business Analytics' tools that can be used for decision-making.
- To provide real insights on the functions of business analytics in a competitive and dynamic business environment.

Course Outcomes:

At the end of this course, the students can:

- Understand the fundamental concepts of Predictive Analytics.
- Apply the predictive analytical tools in business situations.
- Develop predictive analytics questions, identify and select most appropriate predictive analytics methods and tools.

Course Contents:

1. **Introduction to Predictive Analytics and Multivariate Model:** Introduction to Analytics, Analytics in Decision making, Application of predictive analytics.

   ANOVA: Two-way ANOVA with and without interactions, **Simple Linear Regression (SLR):** Introduction to Regression, Model Development, Model Validation and Demo, **Multiple – Regression:** Introduction to Multiple Linear Regression, Estimation of Regression, Parameters, Model Diagnostics, Multi-collinearity, Model Deployment, Demo.

2. **Categorical Data Analysis:** Describing Categorical Data, Discrete choice model, Understanding the Concepts of Logistic Regression, MLE Estimate of parameter, Logistic Model Interpretation, Logistic Model Diagnostics, Model Fit and Demo.
3. **Classification and Prediction (Pattern Discovery):** Discriminant Analysis, Market Segmentation – Cluster Analysis, Multi-Dimensional-scaling.
4. **Decision Tree and Unstructured Data:** Introduction to Decision Trees, Types of decision tree method: Chi-Square Automatic Interaction, Detectors (CHAID), Classification and Regression Tree (CART), Analysis of Unstructured data - Demo
5. **Time Series and Forecasting:** Introduction to Time Series Data and Time Series Analysis based Forecasting, Exponential smoothing, and Forecasting Accuracy, Auto-regressive and Moving average model. Auto-correlated and Heteroscedastic Errors, Demo.

   Application of Predictive Analytics: Customer Analytics, Customer Churning, Cross selling in marketing, Threat & Fraud analytics, Employee retention, product or economy-level prediction.

Pre-requisites: None

Reference Books:

1. "Business Analytics - Data Analysis & Decision Making", S. Christian Albright and Wayne L. Winston, Cengage Publication, 5th Edition, 2012.
2. "Fundamentals of Business Analytics, Seema Acharya R N Prasad, Wiley publication, 2nd Edition, 2016.

UM17MB604:
SOCIAL MEDIA ANALYTICS (2-1-0-2-3)

Course Objectives:

- To provide an overview of issues that arises in social media.
- To study the methods and software tools needed for their analysis.

Course Outcomes:

At the end of this course, the students can:

- Learn to develop an understanding of the prevalent types of social media in use.
- Develop an understanding of social networks, the metrics used and analyze networks using NodeXL.
- Learn to use R to perform sentiment analysis and obtain insights from data.
- Gain an insight into the emerging domain of mobile social media analytics.
- Receive an introduction of the use of prescriptive analytics to help social media users.

Course Contents:

1. **Introduction to Social Media:** Course Introduction – What is Social Media – Strong and Weak Ties – Privacy – Long Tail – electronic word-of-mouth (eWOM).

   Lab: Social Media Data Analysis using Excel.

2. **Social Network Analysis:** Introduction to Networks – Types of Networks – Network Analysis Metrics – Application of Clustering to Social Media – Information Diffusion in Social Media – Influence and Homophily – Small World Phenomenon

   Lab: Social Network Analysis using NodeXL.

3. **Text Analytics in Social Media:** Text Analytics – Types of Social Media Text – Sentiment Analysis – Topic Analysis – Naïve Algorithm – Naïve Bayes Algorithm

   Lab: Sentiment Analysis using R.
4. **Mobile Social Media Analytics:** Geospatial Social Data Mining – Viral Marketing – Social Advertising – Social Tagging – Folksonomies – Social Media Integration – Google Analytics – Study User Behavior – Privacy.
5. **Prescriptive Analytics in Social Media:** Recommender Systems – Types of Recommender Systems - Collaborative Filtering – User-User Approach – Item-Item Approach – Content Based Filtering – Recommendation using Social Contexts – Evaluating Recommendations.

   Lab: Recommender System.

Pre-requisites: None

Reference Books:

1. "Networks, Crowds, and Markets", David Easley and Jon Kleinberg, Cambridge University Press, 2010.
2. "Analyzing Social Media Networks with Node XL", Ben Shneiderman, Derek Hansen, and Marc A. Smith, Morgan Kaufmann-Elsevier, Burlington, Massachusetts, USA, 2011.
3. "Mastering Social Media Mining with R", Sharan Kumar Ravindran, Vikram Garg, 1st Edition, Packet Publishing, 2015.
4. "Social Media Mining: An Introduction", Huan Liu, Mohammad Ali Abbasi, Reza Zafarani, Cambridge University Press, 2014.
5. "The Facebook Effect", David Kirkpatrick, Simon & Schuster, New York, United States, 2011.
6. "Seven Layers of Social Media Analytics: Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data", Gohar F. Khan, Create Space Publishing, 2015.

UM17MB605: DATA VISUALIZATION (2-1-0-2-3)

Course Objective:

- To understand the need for visualization and communicate practical implications of quantitative analyses by creating dash boards charts and reports to visually present the data.

Course Outcomes:

At the end of the course students can:

- Streamline the data and highlight their implications efficiently using visualizations in Tableau.
- Harness the human brain's innate perceptual and cognitive tendencies to convey conclusions directly and clearly.
- Design and persuasively present business "data stories" that use these visualizations.

Course Contents:

1. **Introduction to Tableau Basics:** Overview - Environment Setup - Get Started – Navigation- Design Flow - File Types - Data Types-Show Me - Data Terminology–Data Sources - Custom Data View - Extracting Data - Fields Operations - Editing Metadata - Data Joining - Data Blending - Add Worksheets - Rename Worksheet - Save & Delete Worksheet– Reorder - Paged Workbook.
2. **Tableau Calculations & Sort Filters:** Operators – Functions-Numeric Calculations- String Calculations - Date Calculations - Table Calculations -Basic Sorting - Basic Filters- Quick Filters - Context Filters - Condition Filters - Top Filters - Filter Operations.
3. **Tableau Charts& Dashboards**: Bar Chart - Line Chart- Pie Chart – Crosstab - Scatter Plot - Bubble Chart – Bullet Graph- Box Plot - Tree Map - Bump Chart - Gantt Chart- Histogram- Motion Charts-Waterfall Charts - Dashboard – Formatting – Forecasting- Trend Lines.
4. **COGNOS Insight:** Importing order data from a spreadsheet file - Reviewing sales data in an existing workspace - Filtering data to view details about specific products and customers.
5. **Calculations in COGNOS:** Calculating a salary increase with a dimension calculation - Identifying high and low revenue with color - Calculating revenue by modifying the model - Analyzing revenue - Modeling and analyzing discounts.

Pre-requisites: None

Reference Books:

1. Tableau user manual -https://www.tableau.com/support/help
2. IBM-COGNOS Handbook-https://www.redbooks.ibm.com/redbooks/pdfs/sg247912.pdf

UM17MB606: CAPITAL MARKET OPERATIONS (2-1-0-2-3)

Course Objectives:

- To understand the process involved in capital market, trading, clearing, settlement and risk management.
- To understand the process of derivatives market at macro level.
- To understand the basics of the legal framework relating to the financial markets.

Course Outcomes:

At the end of the course students can:

1. Acquire knowledge in the process of trading, clearing and settlement in capital markets.
2. Acquire knowledge in the process of derivatives market at macro level.
3. Acquire fair knowledge of the legal framework relating to the financial markets.

Course Contents:

1. **Primary Market:** Market Design -SEBI Issue of Capital and Disclosure Requirements (ICDR) Regulations 2009 - Merchant Banking Credit Rating- Demat Issues - Private Placement- Virtual Debt Portal - ADRs/GDRs. Secondary Market- Listing of securities - Delisting of Securities. Dematerialization- Trading -Trading Mechanism -Order Management.
2. **Trade Management:** Auction -Internet Broking Wireless Application Protocol -Trading, Clearing and Settlement, Clearing and Settlement Mechanism Rolling Settlement - Risk Management -Capital Adequacy Requirements -Margins On-Line Exposure Monitoring, Off-line Monitoring. Index-based Market-wide Circuit Breakers/ Price Bands for Securities Settlement Guarantee Mechanism Investor Protection Fund Market Index. Understanding the index number Understanding S&P CNX NIFTY. Role and functions of India Index Services & Products Ltd. (IISL)
3. **Government Securities Market:** Introduction to Indian Debt Markets -Market Subgroups -Instruments - Participants -Primary Market -Issuance Process-Government securities -Issuance Process–Treasury Bills -Participants .Secondary Market -Trading of Government Securities on Stock Exchanges to Repo and Reverse Repo Negotiated Dealing System - Wholesale Debt Market of NSE Clearing and Settlement ,Retail Debt Market ,Interest Rate Derivatives Zero Coupon Yield Curve - Fixed Income Money Market and Derivatives Association of India (**FIMMDA**) -NSE Mumbai Inter-Bank Offer Rate (**MIBOR**) and Mumbai Inter-Bank Bid Rate (**MIBID**) , NSE-VAR System, Bond Index.

4. **Derivatives Market:** Products, participants and functions, Types of derivatives -derivatives market in India -membership of NSE. Futures and Options -Forward Contract, Futures, Options, Pricing of Derivatives. Introduction to Clearing mechanism Settlement mechanism, Risk management- Margining System, SPAN approach of computing initial margins- Mechanics of SPAN Cross Margining.
5. **Regulatory Framework:** Securities Contracts (Regulation) Act, 1956 Securities Contracts (Regulation) Rules, 1957, Securities And Exchange Board Of India Act, 1992, SEBI (Stock Brokers & Sub-Brokers) Regulations, 1992, SEBI (Prohibition Of Insider Trading) Regulations, 1992,SEBI(Prohibition Of Fraudulent And Unfair Trade Practices Relating To Securities Markets) Regulations, 2003 The Depositories Act, 1996, Government Securities Act 2006 , Money Laundering Act, 2002.

Pre-requisites:

UM17MB503 – Accounting for Manager and UM17MB555 – Corporate Finance

Reference Books:

1. "Capital Market (Dealers) Module: Workbook from NSE.
2. "NISM Certification on Securities Operations and Risk Management" Workbook from NISM.
3. "Indian Financial System", Vasant Desai, Himalaya Publishing House, 1999.
4. "Indian Financial System", M.Y. Khan, McGraw Hill Education; 10th Edition, 2017.
5. "Financial Institutions & Markets", L M Bhole, Tata McGraw Hill Education Private Limited, 2009.

UM17MB607:
FUNDAMENTALS OF TECHNICAL ANALYSIS(2-1-0-2-3)

Course Objectives:

- To understand fundamentals concepts of Investment.
- To understand the process of economic, Industry and company analysis through various measurement metrics.
- To understand the process and tools of Technical analysis.

Course Outcomes:

At the end of the course students can:

- Acquire basic concepts on Investment and the process of investment.
- Exhibit the competency in process of economic and Industry analysis through various metrics.
- Exhibit their ability in using the different tools of Technical analysis.

Course Contents:

1. **Concept of Investment:** Investment, speculation-Investment Process-Various Investment Alternatives-Application of Investment Alternatives- Type of investors- Aim & Approaches of security analysis- Investment Alternatives. Concept of Return of Investment and Return on Investment-Calculation of Simple, Annualized and Compounded Returns-Risks in Investments-Concepts of Market Risk (Beta)-Sensitivity Analysis to Assumptions-Concept of Margin of Safety-Comparison of Equity Returns with Bond Returns-Basic Behavioral Biases Influencing Investments-Some Pearls of Wisdom from Investment Gurus across the World.
2. **Economic Analysis:** Basic Principles of Microeconomics-Basic Principles of Macroeconomics- Introduction to Various Macroeconomic Variables-Sources of Information for Economic Analysis- Industry Analysis-Michael Porter's Five Force Model for Industry Analysis-Political, Economic, Socio-cultural, Technological, Legal and Environmental (PESTLE) Analysis -Boston Consulting Group (BCG) Analysis-Analysis: Key-Regulatory environment/framework-Sources of information for industry analysis.
3. **Company Analysis:** Qualitative & Quantitative Dimensions Understand business and business models-competitive advantages/points of differentiation over the competitors-SWO analysis-quality of management (Including Independent Directors) and governance-pricing power and sustainability organization structure-critical business drivers-risks in the business-compliance orientation of the company-documentation on guidance v/s actual-analysis. History vs. future of business-basics of P&L account, balance sheet, cash flows-contingent liabilities-taxation affecting to companies-peer comparison-history of equity expansion-dividend and earnings history.
4. **Corporate Actions:** history of corporate actions-ownership and insiders' sales and purchase of stocks in the history of corporate actions-ownership and insiders' sales and purchase of stocks in the past. Differences between price and value-need of valuations are required-sources of value in a business – earnings and assets-DCF -absolute valuations vs. price-value sense-earnings based valuation matrices-assets based valuation matrices-relative valuations - trading and transaction multiples-sum-of-the-parts (SOTP) valuation-other valuation parameters in new age economy and businesses-objectivity of valuations-some important considerations in the context of business valuation.
5. **Technical Analysis:** Dow theory Elliott wave theory, Odd-lot theory, efficient market hypothesis -major indicators & oscillator – Types of charts-RSI-MACD–Multiple indicators for trading signals and trading strategies.

Pre-requisites:

UM17MB503 – Accounting for Manager and UM17MB555 – Corporate Finance

Reference Books:

1. "Work book for NISM-Series-XV: Research Analyst Certification Examination", 2015.
2. "Equity Valuation for Analysts and Investors", James Kelleher, McGraw-Hill Education, 1st Edition, 2010.
3. "Modern Portfolio Theory and Investment Analysis", Edwin J. Elton and Martin J. Grubor, Wiley, 8th Edition, 2010.
4. "Security Analysis and Portfolio Management", Ronald J. Jordan, Donald E. Fischer, Pearson, UK, 6th Edition, 1995.
5. "Security Analysis and Portfolio Management", V.A. Avadhani, Himalaya Publishing House, Mumbai, 2010.

UM17MB608:
MUTUAL FUNDS AND FIXED INCOME SECURITIES (2-1-0-2-3)

Course Objectives:

- To understand basic concepts of mutual funds and different methods of investments in mutual funds.
- To understand basic concepts Gold ETFs, Debt and Liquid Funds
- To understand the different models of constructing portfolios.
- To understand the different methods of analyzing the performance portfolios.

Course Outcomes:

At the end of the course students can:

- Acquire basic knowledge on different concepts of mutual funds and different methods of investments in mutual funds.

- Acquire basic knowledge on different concepts of Gold ETFs, Debt and Liquid Funds.
- Exhibit their ability in evaluating different models of constructing portfolios.
- Exhibit their ability indifferent methods of analyzing the performance portfolios.

Course Contents:

1. **Mutual Funds Introduction:** Introduction, mutual fund structure in India, custodian, AMC, NFO, role of registrar and transfer agents, investor rights and obligations. Mutual fund products and features – equity funds open ended & close ended, index fund, diversified large cap funds, midcap funds, and sectoral funds. Equity schemes, ELSS, entry and exit load, expense ratio, portfolio turnover, AUM affect portfolio turnover.
2. **Methods for Investment in Mutual Funds:** Objectives of AMFI, advantages of mutual funds, systematic investment plan (SIP), systematic transfer plan (STP), systematic withdrawal plan (SWP), choosing between dividend payout, dividend reinvestment and growth options. Capital gains taxation, indexation benefit, FMPS, without indexation, with indexation.
3. **Gold ETFs, Debt and Liquid Funds:** Introduction to exchange traded funds (ETF), salient features, working, NFO, market making by APS, creation units, portfolio deposit and cash component. Debt funds - salient features, interest rate and credit risk, pricing of debt instrument, debt mutual fund schemes. Liquid funds - salient features, floating rate scheme, portfolio churning.
4. **Recommending Model Portfolios and Financial Plans:** risk profiling-need for risk profiling- factors that influence the investor's risk profile- risk profiling tools- asset allocation- role of asset allocation- asset allocation types. Offer document- offer document – NFO, scheme information document (SID), contents - statement of additional information (SAI)-contents- update of SAI- role of offer documents- key information memorandum-role of KIM- contents of KIM- format of scheme information document (SID)- risk factors- scheme specific risk factors.
5. **Return, Risk & Performance of Funds:** Measures of risk-benchmarks and performance-quantitative measures of fund manager performance-drivers of risk in a scheme-measures of risk-benchmarks and performance-Quantitative measures of fund manager performance.

Pre-requisites:

UM17MB503 – Accounting for Manager and UM17MB555 – Corporate Finance

Reference Books:

1. "Indian Mutual Funds Handbook: A Guide for Industry Professionals and Intelligent Investors", Sundar Sankaran, Vision Books, New Delhi, 4th Edition, 2016.
2. "Financial Markets: A Beginners Module", Workbook from NSE (https://www.nseindia.com/invest/resources/download/Basics_of_finmkts.pdf)
3. The Commonsense Guide to Mutual Funds, Mary Rowland, Bloomberg Press, New York City 1st Edition, 1998.

UM17MB609: WEALTH MANAGEMENT (2-1-0-2-3)

Course Objectives:

- To understand the investment and financial issues arising from personal wealth management activities.
- To understand about the financial planning industry and the regulatory framework.
- To understand the comprehensive financial plan including the identification of asset allocation, securities trading, managing funds.
- To understand the different tax implications in wealth management decisions.

Course Outcomes:

At the end of the course students can:

- Acquire basic knowledge on investment and financial issues arising from personal wealth management activities.
- Exhibit the competency in financial plan including the identification of asset allocation, securities trading, managing funds.
- Exhibit their ability in evaluating wealth management decisions with different tax implications.

Course Contents:

1. **Financial Planning:** Introduction to financial planning, role of financial planner, financial planning process, client data collection, client data analysis, wealth cycle, systematic approach to investing – systematic investment plan(SIP), systematic withdrawal plan(SWP), systematic transfer plan (STP), financial plan – Goal-based financial plan, comprehensive financial plan, financial planning in India.
2. **Wealth Management & Economy:** Financial planning to wealth management, economic cycles and indicators – lag indicators, co-incident indicators, lead indicators, interest rate views, currency exchange rate, Deficits – Revenue deficit and fiscal deficit, current account deficit. Investment Evaluation Framework- Risk-return framework, risk-standard deviation, beta, risk adjusted returns- Sharpe ratio, Treynor ratio, Alpha.
3. **Investment and Risk Management:** Equity – role of equity, active and passive exposures, returns from passive exposure to S&P CNX nifty, sector exposure and diversification, fundamental valuation approaches, investment and speculation, leveraging. Debt – role of debt, deposits and debt securities, yields and interest rate risk, interest rate and debt investments, credit exposure and debt investments, concentration risk, passive investments in debt.
4. **Risk Profiling & Asset Allocation:** Risk profiling, why asset allocation, strategic asset allocation, tactical asset allocation, fixed asset allocation, flexible asset allocation, asset allocation returns in equity and debt- fixed asset allocation with annual re-balancing, flexible asset allocation, and allocation to speculation.
5. **Elements of Taxation:** Previous year and assessment year, gross total income, income tax slabs, advance tax, tax deducted at source(TDS), exempted income, deductions from income – sec 80C, 80CCC, 80D, 80E, 80GG, long term and short-term capital gain/loss, speculation profit /loss, capital gains tax exemption under sec 54EC, 54F, setting off & carry forward.

Pre-requisites:

UM17MB503 – Accounting for Manager and UM17MB555 – Corporate Finance

Reference Books:

1. "Wealth Management", Dun & Bradstreet, Tata McGraw Hills Publications, New Delhi, 2009.
2. "Wealth Engine: Indian Financial Planning and Wealth Management Handbook", Sankaran S, Paperback, Vision Books, New Delhi, 2012.
3. "Private Wealth Management: The Complete Reference for the Personal Financial Planner", G. Victor Hallman and Jerry Rosenbloom, McGraw-Hill Professional, 8th Edition, 2009.

UM17MB610:
ADVANCED CORPORATE FINANCE (2-1-0-2-3)

Course Objectives:

- This course provides the central ideas and theories of modern finance and develops familiarity with the analytical technique helpful in financial decision making.
- To understand the central ideas and theories of modern finance.
- To provide familiarity with the analytical technique used in the financial decision making.
- To analyze the short term as well as long term finance using financing models.

Course Outcomes:

At the end of the course students can:

- Explain the concepts of working capital sources, cash forecasting, Credit policies of business venture, Inventory techniques models, Agency problem and others.
- Exhibit skills in estimating, evaluating and interpreting the Working capital leverage, optimum size of cash, receivables and inventory etc.
- Identify, estimate, evaluate the Maximum permissible bank finance, credit risks, EPS and determine the good financial planning.

Course Contents:

1. **Working Capital Policy and Financing:** Current assets financing policy, (No problems on estimation of Working Capital) Trade credit, Bank credit and mode of securities, Scoring and rating model, Commercial papers, RBI guide lines on Certificate of deposits, Factoring, Working Capital Leverages.
2. **Cash and Liquidity Management:** Objectives of cash Management, Factors determining cash needs, Motives for holding cash, Forecasting Cash flows-Cash Budgeting, Long Term cash forecasting, monitoring collections and receivables, Optimum cash balances- Investment of Surplus Funds, Strategies for managing surplus funds. Cash Management conversion Models- Baumol Model, Miller-Orr Model.
3. **Credit Management:** Credit policy variables; Credit standards, Credit period, Cash discount, collection effort. Credit evaluation; Traditional credit analysis, Numerical credit scoring. Credit granting decision, Control of Account receivables; Days sales outstanding, ageing schedule, Collection matrix, Credit management in India.
4. **Inventory Management:** Objectives, Costs and Benefits of holding Inventory, Inventory Control Techniques; ABC system, Economic Order Quantity, Just in Time, Determination of inventory control levels; Ordering, Reordering, Danger level, Inventory Management in India.
5. **Theories of Capital Structure and Dividend Policy:** NI approach, NOI approach, Modigliani Miller approach, Arbitrage process in capital structure. Relevance and Irrelevance dividend decision. Walter's & Gordon's Model, Modigliani & Miller approach. Dividend policies stable dividend, stable payout and growth. **Corporate Financial Modeling:** Agency Problem and consideration. Effect of inflation on: Asset Value, Firm Value, returns. Economic Value Added [EVA] concepts, components of EVA, Market Value Added [MVA]

Pre-requisites:

UM17MB503 – Accounting for Manager and UM17MB555 – Corporate Finance

Reference Books:

1. "Financial Management Theory and Practice", Prasanna Chandra, TMH Education private Ltd., New Delhi, 8th Edition, 2011.
2. "Financial Management", Pandey I M, Vikas Publishing House Pvt. Ltd., New Delhi, 10th Edition, 2011.
3. "Financial Management: Text, Problems and Cases", Khan M Y, Jain P K, Tata McGraw Hill, New Delhi, 4th Edition, 2004.

UM17MB611:
INVESTMENT MANAGEMENT (2-1-0-2-3)

Course Objectives:

- This course provides a platform to explore the nature, concepts, theories and working of financial markets.
- This course aims in understanding the modern valuation techniques, pricing of fixed income securities and equities.
- This course helps in constructing and managing of portfolios.

Course Outcomes:

At the end of the course students can:

- Explain fundamental concepts of Investment theory and Management.
- Exhibit the skill of identifying, analyzing, evaluating and suggesting the portfolio mix in practice.
- Identify, analyze, evaluate and suggest portfolio mix in practice.

Course Contents:

1. **Introduction to Investment:** Investment- investment and Speculation, Investment Vs gambling. Investment Process-Asset classes and financial instruments, how securities are traded, Mutual funds and other investment companies, Fixed income securities.
2. **Fundamental and Technical Analysis:** Macroeconomic and Industry Analysis, Equity Valuation Models, Technical Analysis - Types of charts- Behavioral Finance.
3. **Bond Returns:** Bond prices and Yields, the term structure of interest rates, Managing Bond Portfolios, Portfolio Theory and Practice, Risk and Return, Risk aversion and Capital Allocation to risky Assets, Optimal risky Portfolios, Index Models.
4. **Capital Market Hypothesis**: Equilibrium in capital markets, CAPM, arbitrage theory and multifactor models of risk and return, efficient market hypothesis, empirical evidence of security returns.
5. **Portfolio Evaluation and Revision:** Applied portfolio management, Portfolio performance evaluation, International diversification, Hedge funds, the theory of active portfolio management, investment policy.

Pre-requisites:

UM17MB503 – Accounting for Managers and UM17MB555 – Corporate Finance

Reference Books:

1. "Investments", Bodie, Zvi. Kane, Alex. Marcus, Alan Jetal, Tata McGraw Hill, New Delhi, 10th Edition, 2005.
2. "Investments", Sharpe, William F. Alexander, Gordon J. Bailey, Jeffery V, Prentice Hall India, New Delhi, 6th Edition, 2009.
3. "Security Analysis and Portfolio Management", Donald E Fischer & Ronald J Jordan, Pearson Education, Delhi, 6th Edition, 1995.

UM17MB612:
CORPORATE TAXATION (2-1-0-2-3)

Course Objectives:

- The course provides understanding of the basic concepts of income tax.
- This course assists in the computation of tax liability and tax planning of corporate.

Course Outcomes:

At the end of the course students can:

- Explain the concepts of Assessment year, previous year, Residential status of an individual and Company, exemptions and deductions under corporate taxes both direct and indirect taxes.
- Exhibit skills in assessing, evaluating the taxable income and tax liability of company.
- Develop experience in identifying tax issues and applying the income tax law to arrive at reasoned solutions to problems.

Course Contents:

1. **Basic Concepts:** Assessment Year, Previous Year, Person Assessee Income, Charges on income, Gross Total Income, Taxable Income, Capital and Revenue Receipts, Receipt and Accrual of Income, Connotation of Income Deemed to Accrue or arise in India. Tax Planning, Tax Evasion and Tax Management. (Problems on residential Status and Tax incidence of an Individual assesses).
2. **Income Under the Head Profit and Gains:** Business or Professions and its Computation Basis- Method of Accounting-Scheme of Business Deductions/ Allowance- Deemed Profits maintenance of books, Depreciation. (Problems on computation of Income from Business/ Profession of Individual Assessee and Depreciation) Computation of Taxable, Income: Computation of Taxable Income of a company with Special reference to MAT. Tax planning with reference to specific managerial decisions.
3. **Income Under Capital Gains:** Basis of Charge, Transfer of Capital Asset, Inclusion & Exclusion from Capital Asset, Capital Gain, Computation of Capital Gain (theory & problems), Deductions from Capital Gains. Income from Other Sources. Permissible Deductions U/S 80C to 80U. Setoff and Carry forward of losses and Clubbing of Incomes.
4. **Overview of GST Introduction:** Challenges of Previous Tax Structure- GST International Scenario- Models of GST- GST in India- History of GST- GST Council- Framework of GST- Introduction to CGST Act, 2017- Important Definitions- Levy of GST- Liability under GST- Supply- Characteristic of Supply- Schedule I under CGST- Schedule II under CGST- Activities which are neither supply of goods nor supply of services. Composite and Mixed Supply, Composition Levy- Condition & Restrictions u/s 10(2) – Exemptions from GST. Place of supply, Time of Supply, Value of Supply.
5. **Input Tax Credit**: Registration, Tax Invoice, Credit and Debit Notes, Accounts and Records, Payment of Tax, Payment of Tax, Interest and Other Amounts, Tax Deduction at Source and Collection of Tax at Source- Returns, Refunds- Job Work- Electronic Commerce, Assessment and Audit.

Pre-requisites:

UM17MB503 – Accounting for Managers and UM17MB555 – Corporate Finance

Reference Books:

1. "Taxmann's Direct Taxes: Law and Practice", Singhania, Vinod K. Singhania, Kapil, Vinod Singhania and Kapil Singhania, Taxmann Publications, New Delhi, 51st Edition, 2013.
2. "Indirect Taxes - Law and Practice", V S Datey, Taxmann Publications, 39th Edition, 2017.
3. "Student Guide To Income Tax: Including Service Tax/Vat Problems and Solutions", Singhania, Vinod K. Singhania, Monica, Taxman Publications, New Delhi, 8th Edition, 2013.
4. "Direct Taxes", Mehrotra H C, Goyal S P, Sahitya Bhavan Publications, 20th Edition, 1999.
5. Online Study Material of ICAI, Indirect Taxes – GST, https://www.icai.org/post.html?post_id=13752

UM17MB613: CORPORATE VALUATION (2-1-0-2-3)

Course Objectives:

- This course aims to provide understanding of the concepts in mergers and acquisitions.
- To facilitate pre-and post-merger analysis.

Course Outcomes:

At the end of the course students can:

- Understand and identify the issues in mergers.
- Evaluate and analyze the pros and cons of a proposed merger deal.

Course Contents:

1. **Corporate Valuation:** Meaning and approaches to Corporate Valuation – Adjusted Book Value Approach, Stock and Debt Approach, Comparable Companies Approach, Discounted Cash Flow Approach – Concept of Free Cash Flow to the Firm, Two and Three Stage Valuation Models. Valuation of Physical Assets, Valuation of Intangible Assets – Brand Equity and Human Resources.
2. **Value Metrics:** Shareholder Value Creation – Traditional and Modern Approaches – Value Drivers. Approaches to Value Based Management – Marakon Approach, Alcar Approach, Mc Kinsey Approach, EVA Approach, BCG HOLT Approach. Metrics for Measurement of Performance – EPS, ROI, EBIT, EBITDA, RONA, ROCE, TSR, TBR, MVA, CVA, CFROI – Concept of Economic Depreciation. Executive Compensation and Value Creation.
3. **Corporate Restructuring:** Meaning and forms of corporate Restructuring – Spin off, split off, split up, Leveraged Buyout, Divestiture and other forms of corporate Restructuring.
4. **Mergers & Acquisitions:** Mergers and acquisitions – Definition, Types, Motives for Merger or Acquisition, Steps involved in Merger, Mechanics of Merger – Legal, Accounting and Tax, Valuation for Mergers and Acquisitions, Financing of Merger and settlement – Exchange Ratio, Stock Vs. Cash Payments, Takeovers, Defensive Tactics of Takeovers and disinvestment of PSU's.
5. **Valuation of Intangibles:** Intellectual Property - Intangibles – Brand Valuation Financial Innovations and Financial Engineering – Overview, Scope, Tools of Financial Engineering, Financial Engineering versus Financial Analysis.

Pre-requisites:

UM17MB503 – Accounting for Managers and UM17MB555 – Corporate Finance

Reference Books:

1. "Mergers, Acquisitions and Corporate Restructuring", Krishnamurti, Chandrashekar. Vishwanath, S R, Response Books, New Delhi, 2008.
2. "Corporate Finance - Theory and Practice", Aswath Damodaran, John Wiley & Sons, New Delhi, 2nd Edition, 2004.
3. "Creating Value from Mergers and Acquisitions - The Challenges", Sudi Sudarsanam, Pearson Education, New Delhi 2nd Edition, 2003.

UM17MB614: FINANCIAL DERIVATIVES (2-1-0-2-3)

Course Objectives:

- This course provides an understanding of the emerging issues in Enterprise risk management.
- This course provides a comprehensive knowledge to the students about the functioning of to understand financial derivatives markets.
- To analyze credit risk management strategies.

Course Outcomes:

At the end of the course students can:

- Explain conceptual and practical framework of the functioning of Derivatives Market.
- Demonstrate skills in using Option trading strategies, Black Scholes Model, Binomial Model, Arbitrage and hedging.
- Exhibit capability in identifying, evaluating and interpreting risk Management Strategies.

Course Contents:

1. **Overview of Risk:** Types of risk, Risk Management Process. Introduction to Derivatives Markets, Origin of Derivatives, Traders in a Derivatives Market, Exchanges, Contract Size, Multiplier, Lot Size and tick Size, Clearing house. Margins – types of margins, Preparations of margins statement.
2. **Forwards and Futures Contract:** Risk Management using Forwards and Futures Contracts. Differences between forwards and futures contract, Specification of futures Pricing of futures contract, Hedging using futures Commodity futures – Basis and Basis risk, Optimal Hedge Ratio. Index Futures – Futures Contract on Indices and Individual Stock. Application of Index futures – Hedging through Index futures. Interest rate futures. Commodity Markets.
3. **Options Contract:** Introduction to Options, Types of options, Terminology of Options, Option pricing, Factors affecting option pricing – Call and Put Options on Dividend and Non-Dividend Paying Stocks, One Step Binomial Model, Black and Scholes Analysis, Call and Put pricing using BSM, Options Greeks.
4. **Option Trading Strategies:** Spreads –Bull Spread Bear Spread and Butterfly Spread. Combinations Straddle Long and Short, Strangle Long and Short, Straps and Strips.
5. **Credit Derivatives:** Introduction to Credit Derivatives, Assessing Credit Risk, Credit risk Bond prices and the Probability of default, Historical Default Experience, reducing exposure to Credit risk, Credit Default Swaps, Total Return Swaps, Credit Spread Options, Collateralized Debt Obligations- Value at Risk (VAR) Measure, Historical Simulation, Model Building Approach, Monte Carlo Simulation, Stress Testing and Back Testing.

Pre-requisites: None

Reference Books:

1. "Options, Futures, and Other Derivatives", John C Hull, Prentice Hall, New Delhi, 8th Edition, 2003.
2. "Financial Derivatives", S.S.S.Kumar, PHI, New Delhi, 12th Edition, 2007.
3. "Futures and Options", Vohra, B.R.Bagri, Tata McGraw Hill, New Delhi, 2nd Edition, 2003.

UM17MB615:
INTERNATIONAL FINANCIAL MANAGEMENT (2-1-0-2-3)

Course Objectives:

- The course focuses on financial management in an international context.
- This course provides an overview of the macroeconomic environment, a review of parity relationships, exchange rate systems and financial markets and instruments.
- The course aims at understanding foreign exchange exposure management.

Course Outcomes:

At the end of the course students can:

- Understand the impact of exchange rates on balance of payments.
- Use country balance of payment to assess a country's external position.
- Identify legal issues that impact financial and other risks affecting business.

Course Contents:

1. **Global Financial Environment:** Current Multinational Challenges and the Global Economy, Corporate Ownership, Goals, and Governance, International Monetary System. The Balance of Payments, The Continuing Global Financial Crisis. The Global Cost and Availability of Capital, Raising Equity and Debt Globally, Multinational Tax Management.
2. **Foreign Exchange Theory and Markets:** The Foreign Exchange Market, International Parity Conditions, foreign Currency Derivatives and Swaps.
3. **Foreign Exchange Exposure:** Foreign Exchange Rate Determination and Forecasting, Transaction Exposure, Translation Exposure, Operating Exposure.
4. **Foreign Investment Decisions:** International Portfolio Theory and Diversification, Foreign Direct Investment and Political Risk, Multinational Capital Budgeting and Cross Border Acquisitions.
5. **Managing Multinational Operations:** Working Capital Management, International Trade Finance.

Pre-requisites:

UM17MB503 – Accounting for Managers and UM17MB555 – Corporate Finance.

Reference Books:

1. "Multinational Business Finance", Eiteman, David K. Stonehill, Arthur I. Moffett, Michael H, Dorling Kundersley, Noida, 13th Edition, 2014.
2. "International Financial Management", Madhu Vij, Excel Books, New Delhi, 3rd Edition, 2010.
3. "International Financial Management - Text and Cases", V K Bhalla, Anmol Publications, New Delhi, 4th Edition, 2004.

UM17MB616:
DEVELOPING AN ENTREPRENEURIAL MINDSET (2-1-0-2-3)

Course Objectives:

- To provide a practical view of human aspects of innovation and entrepreneurship those are universal with a focus on technology-driven startup/entrepreneurship.
- Develop an appreciation for various dimensions of 'soft side' of entrepreneurship, such as entrepreneurial mindset, skills, team formation and dynamics, leading a startup and finally managing the 'predictable unpredictability.
- Enable the student to understand the 'mind of the entrepreneur' and apply it in innovation efforts in a large enterprise or in a startup.

Course Outcomes:

At the end of the course, the student will exhibit the following:

- Ability to distinguish between innovation and entrepreneurship, identify and describe different forms of entrepreneurship (including startup vs. enterprise) and understand the interplay of innovation and technology.
- Understand the key qualities, skills of an entrepreneur, factors leading to formation of entrepreneurial team and entrepreneurial capital.
- Mechanics of kick starting the entrepreneurial process by setting Vision, Mission, Value proposition.

- Know how a new organization can access and use knowledge to build its new venture.
- Understand and Identify different levels of uncertainty, sources of uncertainty and managing risks.

Course Contents:

1. **Innovation and Entrepreneurship:** Distinction between Imagination, Creativity, Invention, Innovation and Entrepreneurship; Different forms of Entrepreneurship, Innovation and Technology, Forces driving technology innovation and entrepreneurship, Entrepreneurship vs. Intrapreneurship, Entrepreneur's Challenge.
2. **Decoding an Entrepreneur:** Key attributes of an Entrepreneur, Skills of entrepreneurship, Factors to determine whether to act as entrepreneur, Entrepreneurial Capital.
3. **Embarking on the Venture Journey:** Opportunity identification, Vision, Mission Statement, Value Proposition, Core competencies.
4. **Building and Leading the Venture:** New Venture Team, Organizational Design, Leadership, Management, Emotional Intelligence, Organizational Culture, Attracting and Retaining Talent, Leadership and characteristics of Successful CEO.
5. **Managing Learning, Knowledge and Risk/Uncertainty:** Managing knowledge assets, Learning organizations, Levels of uncertainty, Sources of uncertainty, Managing Risk and monitoring the entrepreneurial journey.

Pre-requisites: None

Reference Book:

1. "Technology Ventures from Idea to Enterprise", Thomas Byers, Richard Dorf, Andrew Nelson, McGraw Hill, 4th Edition, 2014.

UM17MB617: BUILDING STARTUPS (2-1-0-2-3)

Course Objectives:

- Discuss and understand the STARTUP eco-system in the world with more focus on Indian Startup ecosystem.
- Explore the focus areas for startups in India. Look at the investment ecosystem in India. Understand the policies that help startups in India.
- Understand the mindset required for venturing into a startup. Discuss about the risk-taking ability, financial capability and awareness of possible failure in the startup.
- Introduce the process for building startups in India.

Course Outcomes:

At the end of the course, the student will exhibit the following:

- Understand the need for startups and study the ecosystem of Startups in India.
- Understand various steps of building a startup.
- Understand the mindset, risk taking abilities and the challenges before venturing into a startup.
- Understand the business processes in a start-up and be comfortable to work in start-up.

Course Contents:

1. Introduction to Building Startups: Discuss and understand the STARTUP eco-system in the world with more focus on Indian Startup ecosystem. Explore the focus areas for startups in India. Look at the investment ecosystem in India. Understand the policies that help startups in India. Discuss about the mindset required for startups, risk taking ability and understand the mindset required for venturing into a startup.
2. **Identifying User Needs and Gathering Information:** Problem definition, gathering information, assessment of information gathered, case studies on analyzing customer requirements
3. Introduction to Product Design Process: Provide understanding of the product development process from ideation to product realization and product support. Discuss Cost / Time tradeoffs. Discuss pricing based on the target customers. Discuss build vs. buy for product components, cost vs. feature richness, right engineering vs. over engineering.

   Designing a Product: product drawings, prototypes, Design for Manufacturing, Design for Assembly, human aspects.

   Review case studies of products and productized services
4. **Designing a Sales & Marketing Strategy for the Startup:** Modes of sales & marketing – direct vs. through dealers, Regions of focus – India vs. global and develop strategy for selling the products of the company.

   Business Planning and Financing the Startup: Identify a suitable business planning process for the startup, create business plan and review, create financing models suitable for the business – own financing, micro-financing through friends & relatives, SME venture investments and venture capital investments.
5. **Building a Startup Team:** Identify suitable team to build a successful startup. Understand the need for multiple talents required for a successful startup – Technical, Sales & Marketing, Finance and Strategy. Building teams with a shared vision and conviction. Importance of building ethical value-based culture in the startups.

Prerequisites: None

Reference Books:

1. "Start a Successful Business (Inc.): Expert Advice to Take Your Startup from Idea to Empire", Colleen Debaise, AMACOM Special Edition, 2018.
2. "Design Thinking", Harvard Business Review, Brown, Tim, Harvard Business Review, 2008.

UM17MB618: INTELLECTUAL CAPITAL AND INNOVATION (2-1-0-2-3)

Course Objectives:

- Students are sensitized to realize the importance of Intellectual Capital (Intangibles) in value creation.
- This course shall acquaint the student with an action oriented and holistic perspective on how to increase value creation in companies and organization by leveraging intellectual capital.
- A blue-print to build a creative organization that fosters innovation is explained.
- The value created by innovation is detailed out.

Course Outcomes:

At the end of the course the student will exhibit the following:

- Understand the meaning, importance and different types of intellectual capital.
- Understand the process of putting IC resources to value-creating use.
- Appreciate the importance of a creative organization that fosters innovation.
- Understand the importance of innovation in creating value to the society.

Course Contents:

1. **Introduction to Intellectual Capital:** What is Intellectual capital? Why is it important? Key Characteristics of IC, value creation by intangibles, IC and corporate capitalization, what is driving the IC? The shape of Intellectual Capital, types of Intellectual Capital, characteristics of IC resources. Why are companies becoming IC-centric? The economics of intangibles, Human Capital, Relational

capital, and Organizational capital. Identifying IC resources of an organization. India's Intellectual Capital.

2. **Putting IC Resources to Value-Creating Use:** Deployment of IC resources-IC deployment decisions emanate from the Vision of the company. The Resource Distinction Tree (RDT). IC transformations, Transformation matrix, Intellectual Capital Navigator. Creating the ICN, drawing the ICN, Optimizing the IC resource deployment, Analyzing the ICN, Effector Plots, Effectors ratios, evaluating effectors Plots, Optimizing the effectors Plots. Key steps in IC strategy.
3. **Creative Thinking**: Role of creativity and innovation in the organizations. Dynamics that underlie creative thinking, becoming creatively fit as an individual, creative insight: Why do good ideas come to us when they do? - Idea evaluation: What to do with generated ideas, creativity in teams-creating an environment that keeps creative people creating.
4. **Leading for Creativity and Innovation:** Innovation – What's involved, innovation management, types of innovations, Radical Vs Incremental innovations, adoption cycle, characteristics of adopters, Innovation culture-encouraging innovation at workplace, ways to create innovation culture, building innovative organizations, sustaining creativity and innovation.
5. **Innovation as Value Creator**: Facets of Innovation. Innovation as a creator of Intellectual Capital. Innovation trends. How does innovation create value? Innovation at Silicon Valley. Building innovation capacities in Firms. Economic impact of innovation. Innovation and economic growth. Innovation in Firms. Monetizing innovation. The importance of protecting innovation. Societal benefits of innovation.

Prerequisites: None

Reference Books:

1. "Managing Intellectual Capital in Practice", Roos Goran, Pike Stephen, Fernstrom Lisa, Routledge, 2005, ISBN: 9780750679404
2. "Global Innovation & Economic Value", Kumar Vijay & Sundarraj R P, Springer, 2018, ISBN: 978-81-322-3758-7
3. "Creativity, Inc: Building an Inventive Organization",Mauzy Jeff & HarrimanRichard, Harvard Business School Press, ISBN: 1-57851-207-7, 2003

UM17MB619: TALENT ACQUISITION (2-1-0-2-3)

Course Objectives:

- The dynamics of need analysis, design, development and evaluation of talent acquisition cycle.
- Use of technology platforms in talent acquisition process.
- Talent selection practices applied in corporate environment.

Course Outcomes:

At the end of the course students can:

- Remember the concepts and characteristics of talent acquisition process.
- Exhibit fair Understanding of the concepts of corporate talent acquisition practices.
- Apply the skills of corporate talent acquisition practices in real time application.
- Analyze eco system associated with corporate talent Acquisition dynamics.
- Evaluate the cases of famous corporate talent acquisition practices.

Course Contents:

1. **Introduction to Talent Acquisition**: Importance, HR planning, Job Analysis- meaning, definition and purpose, job description and job specification. Techniques, task analysis inventory, position analysis questionnaire, subject expert, workshops, critical incident technique, Fleishmann job analysis survey, functional job analysis, job element method, repertory grid.
2. **Hiring Process**: Nature of hiring-: regular, temporary, part time, apprentice, contractual, and outsourcing. Determinants of hiring decisions: need, cost and job analysis. Application Forms: bio-data / resume / curriculum vitae and weighted application blanks.
3. **Recruitment:** Internal sourcing: meaning, definition, sources and cost-benefit analysis External sourcing: meaning, definition, sources and cost-benefit analysis. Job advertisement: draft and content.
4. **Selection Process**: selection decisions and stages of selection. Behavioral approach to short listing. Selection Techniques.
5. **Contemporary Talent Acquisition Practices**: IT sector, ITES, other services and FMCG.

Pre-requisites: None

Reference Books:

1. "Human Resource Selection", Robert D. Gate Wood and Hubert S. I, South Western Cengage Learning, Mason, Ohio, 2001.
2. "Staffing Organization", Herbert G. Heinemann III, Timothy A. Judge, Mc Graw Hill International, 5th Edition, 2005.

UM17MB620: TALENT DEVELOPMENT AND RETENTION (2-1-0-2-3)

Course Objectives:

- The dynamics of need analysis, design, development and evaluation of talent development cycle.
- E-learning and use of technology platforms used in talent development process.
- Talent retention and engagement practices applied in corporate environment.

Course Outcomes:

At the end of the course students can:

- Remember the concepts and characteristics of talent development and retention process.
- Exhibit fair Understanding of the concepts of corporate talent development and retention practices.
- Apply the skills of corporate talent development and retention practices in real time application.
- Analyze Eco system associated with corporate talent development and retention dynamics.
- Evaluate the cases of famous corporate talent development and retention practices.

Course Contents:

1. **Development Needs Analysis:** Introduction, importance, stakeholders, and methods, process- organizational, personal and task analysis and needs assessment in practice. Contemporary corporate development need analysis practices.
2. **Designing Talent Development Programs:** Effective developmental program design, principles of transfer, traditional training methods- on-the-job training (OJT), off the job training and modern training methods in practice.
3. **Evaluation of Talent Development Programs:** Introduction, reasons for evaluating training, overview of the evaluation process, outcomes used in the evaluation of training programs, relevance, reliability, discrimination, practicality, validity, types

of evaluation designs, considerations in choosing an evaluation design.

4. **E-Learning and Use of Technology in Training**: Introduction, technology's influence on training and learning, technology and learning environment, computer-based training.

   Online Learning: Internet, web-based training, E-Learning, and learning portals, developing effective on-line learning, blended learning and simulations.

   Mobile Technology and Training Methods: iPods, PDAs and Intelligent tutoring systems, electronic performance support systems, technologies for training administration.

5. **Talent Retention and Engagement***:* Importance, attrition analysis, retention methods, best practices for talent retention and engagement.

Pre-requisites: None

Reference Books:

1. "Employee Training and Development", Noe, Raymond A, McGraw Hill Higher Education, 5th Edition, 2010.
2. "Effective Training Systems Strategies and Practices", P. Nick Blanchard, James W Thacker, Pearson Education, India, 5th Edition, 2011.

UM17MB621: COMPENSATION AND REWARD MANAGEMENT (2-1-0-2-3)

Course Objectives:

The theoretical and practical developments in compensation and reward system.

- Discuss the strategic importance of compensation and reward function from organizational perspectives.
- Understand the relationship between compensation and rewards objectives and business strategy.
- Discuss the role of compensation and reward system in attracting, motivating, and retaining a high-quality workforce.

Course Outcomes:

At the end of the course students can:

- Remember the fundamental concepts of compensation and reward management.
- Exhibit understanding of the fundamental concepts of compensation and reward management.
- Apply the skills of managing the compensation and reward methods in practice.
- Analyze eco-system associated with corporate compensation and reward management practices.
- Evaluate the cases of corporate compensation and reward management practices.

Course Contents:

1. **Introduction to Compensation**: Definition of compensation, basic concepts of compensation, types of compensation management - The pay model, strategic pay policies, strategic perspectives of pay, strategic pay decisions, best practices vs. best fit options
2. **Internal Alignment**: Definition of internal alignment, internal pay structures, strategic choices in internal alignment design, internal structure. External Alignment: Definition of external alignment, structures, strategic choices external alignment design.
3. **Individual Alignment**: Fundamental concepts, definition, methods and major decisions in Job evaluation– pay structure-various methods of calculation of compensation. Performance based compensation system. Executive Compensation: Fundamentals, components and design from contemporary perspective.
4. **Performance Management:** Introduction, performance benchmark setting, measuring performance, traditional and modern contemporary methods, techniques and linking performance with reward system.
5. **Introduction to Reward Management**: Definition, concept, scope and importance of reward. Rewarding desired behaviors-model of reward system, types of rewards, monetary and non-monetary. Designing reward system.

Pre-requisites: None

Reference Book:

1. "Compensation", Milkovich, Newman, Irwin, McGraw-Hill, 6th Edition, 2011.

UM17MB622: DIGITAL MARKETING (2-1-0-2-3)

Course Objectives:

- In today's digital world companies are increasingly allocating resources to digital marketing such as advertising in online platforms, search engine optimization, social media marketing to target customers holistically.
- Technology has also empowered consumers to have a significant voice in the success or failure of brands through social media plat form such as social networking, product reviews/ recommendations and blogs.
- Hence it is important for marketers to understand the implications of these technologies, associated strategies and underlying theories for effective decision-making in digital platforms.
- The course deals with most of the digital marketing content impacting the consumer.

Course Outcomes:

At the end of the course students can:

- Understand the basics of the digital marketing.
- Understand how digital marketing is used to increase sales and business growth.
- Become familiar with the elements of the digital marketing plan.
- Analyze the use of different forms of digital marketing in the development of an online presence.

Course Contents:

1. **Introduction:** Introduction to Digital Marketing: Origin, traditional vs digital marketing, digital advertising market, skills required, digital marketing plan, Display Advertising: Concept, types, buying models, display plan, targeting, analytical tools, YouTube advertising.
2. **Search Engine Advertising& Social Media Marketing:** Understanding Ad Placement, understanding Ad ranks, creating the first ad campaign, enhance your ad campaign, performance reports, Social Media Marketing: Introduction, how to build a successful strategy, Facebook Marketing: Facebook for business, Anatomy of an ad Campaign, Adverts, Facebook Insights, Other Marketing Tools.
3. **Social Media Marketing:** LinkedIn Marketing: Why is it important to have LinkedIn presence, LinkedIn Strategy, Sales Lead Generation using LinkedIn, Content Strategy, LinkedIn Analytics, Targeting, Ad Campaign. Twitter Marketing: Getting Started with Twitter, Content Strategy, Twitter usage, twitter ads, twitter analytics. Instagram and Snapchat:

Instagram: Objectives, content strategy style guidelines, videos, sponsored ads, leads

Snapchat: What is snapchat, how does it work.

4. **Mobile Marketing& SEO:** Mobile usage, advertising, marketing tool kit, mobile marketing features, addressing the diversity through mobile, campaign development process. Search Engine Optimization: Concept, SEO Phases, On Page Optimization, Of Page Optimization, Social media reach, maintenance.
5. **Web Analytics:** Data Collection, Key metric, making web analytics actionable, multi-channel attribution, types of tracking codes, mobile analytics, universal analytics, competitive intelligence.

Pre-requisites:

UM17MB554 – Marketing Management

Reference Book:

1. "Digital Marketing", Seema Gupta McGraw Hill Education, Chennai, 1st Edition, 2018.

UM17MB623: BRAND MANAGEMENT (2-1-0-2-3)

Course Objectives:

- To increase understanding of the key issues in crafting, evaluating and managing brand strategies.
- To provide and be able to work with the appropriate theories, models and other tools to ensure better branding decisions, and to make these concepts relevant for any type of organization.
- To grant students hands on training on running a brand audit.
- Develop hands-on abilities on brand building and marketing.

Course Outcomes:

At the end of the course students can:

- Create and evaluate brand elements.
- Create a consumer-based Brand Equity.
- Create an integrated marketing communication to build BE.
- Choose and create necessary secondary associations to Build BE
- Generate branding strategies.
- Evaluate external opportunities.

Course Contents:

1. **Introduction:** Brands and Brand Management: Definition, why do brand matter, can anything be branded, Branding Challenges and Opportunities, Strategic Brand Management Process.
2. **Identifying and Establishing Brand Positioning and Values:** Customer-Based Brand Equity: CBBE, Sources of Brand Equity, building a Strong Brand, Brand Building Implications**,** Brand Positioning: Identifying and establishing brand positioning, Positioning Guidelines, Defining and Establishing Brand Values.
3. **Planning and Implementing Brand Marketing Programs:** Choosing Brand Elements to Build Brand Equity, Designing Marketing Programs to Build Brand Equity, IMC to build brand equity, Leveraging Secondary Brand knowledge to build brand equity.
4. **Measuring and Interpreting Brand Performance:** Developing a Brand Equity Measurement and Management System: The Brand Value chain, designing brand tracking studies, establishing a brand equity management system**,** Measuring Sources of Brand Equity: Qualitative and Quantitative Research, measuring outcomes of brand equity: Capturing Market Performance.
5. **Growing and Sustaining Brand Equity:** Designing and Implementing Branding Strategies, Introducing and Naming New Products and Brand Extensions, Managing Brands over Time**,** Managing Brands over Geographic Boundaries and Market Segments.

Pre-requisites:

UM17MB554 – Marketing Management

Reference Books:

1. "Strategic Brand Management", Keller, Kevin Lane, Upper Saddle, 4th Edition, 2013.
2. "Managing Brand Equity", Aaker, David, Simon and Schuster, New York, United States, 2009.

UM17MB624: RETAIL MARKETING (2-1-0-2-3)

Course Objectives:

- To help students understand the retail world.
- To enable students to be able to relate and analyze the retail concepts to the practices in the industry.
- To equip and train students to apply their analysis of concepts to real time scenarios.

Course Outcomes:

At the end of the course students can:

- Understand the concepts, techniques and approaches required for effective decision making in Retail Management.
- Apply skills critical for design, analyze and evaluate retail strategies learned during the course to real time situations.
- Analyze the theoretical concepts in a dynamic retail environment.

Course Contents:

1. **Introduction to Retail:** Introduction: Definition, Structure of retailing and distribution, opportunities, retail management decision process, Types of Retailers, Multi-Channel Retailing & Customer Buying behavior.
2. **Retailing Strategy:** Retail Market Strategy, Financial strategy: Objectives and Goals, Strategic Profit Model, Analysis of financial strength, Retail locations: types, unplanned retail locations, shopping centers, other location opportunities, Retail Site Locations: evaluation, trade area characteristics, estimating potential sales.
3. **Retailing Strategy:** Human Resource Management: Objectives, Issues, Designing the org structure, managing diversity, Information Systems and Supply Chain Management, Customer Relationship Management.
4. **Merchandise Management:** Managing the merchandise planning process: Overview, forecasting sales, forecasting fashion merchandise category, developing an assortment plan, setting inventory, establishing control systems, allocating merchandise to stores, analyzing merchandise management performance, Buying Merchandise: Brand alternatives, developing and sourcing a private label, negotiating with vendors, strategic relationships, Retail Pricing, Retail Communication Mix: Using communication programs to develop brand images, methods of communicating with customer, planning the retail communication program.
5. **Store Management:** Managing the Store: Store management responsibilities, recruiting and selecting, training programs, motivating and managing store employees, evaluating store employees, Store Layout, design and Visual Merchandising: Objectives, store design elements, space management, visual merchandising, , creating an appealing store atmosphere, web site design and Customer Service.

Pre-requisites:

UM17MB554 – Marketing Management

Reference Books:

1. "Retail Management" Levy & Weitz, Tata McGraw Hill, New Delhi, 8th Edition, 2013.
2. "Retail Management A Strategic Approach", Berman, Barry Evans, Joel R, Pearson Education, New Delhi, 11th Edition, 2004.

UM17MB625: SERVICES MARKETING (2-1-0-2-3)

Course Objectives:

- To help students understand the fundamentals of services marketing along with emphasis on practical from the corporate world.
- Enable students to apply the fundamentals of the course in the dynamic business world.

Course Outcomes:

At the end of the course students can:

- Illustrate the basic concepts of services marketing.
- Create a service mix for service organizations.
- Apply the skills required in identifying and closing the service gaps existing in a service organization.

Course Contents:

1. **Foundations for Services Marketing:** Introduction to services: Concepts, need and contribution, Service Characteristics, Search, Experience & Credence Qualities, Services Marketing Mix, GAPs Model of Service Quality, The Customer Gap, The Provider Gaps: Provider Gap 1, Provider Gap 2, Provider Gap 3, Provider Gap 4, Closing the Gaps.
2. **Focus on the Customer:** Customer Expectations of Service: Service Expectations, Factors that Influence Customer Expectations of Service, Issues involving Customers Service Expectations. Customer Perceptions of Service, Customer Perceptions, Customer Satisfaction, Service Quality, Service Encounters.
3. **Understanding Customer Requirements:** Listening to Customer through Research, Using customer research to understand customer expectations, elements in an effective service research program, analyzing and interpreting customer research findings, upward communication. Building Customer Relationships: Relationship Marketing, Customer Profitability Segments, Relationship Development Strategies, Service Innovation and Design, Types, Stages, Service Blueprinting, Customer Defined Service Standards, Factors Necessary for appropriate service standards, Types of Customer Defined standards.
4. **Aligning Service Design and Standards:** Service Innovation and Design: Challenges, important considerations for service innovation, types of service innovation, stages in service innovation and development, service blueprinting. Customer Defined Service Standards: Factors necessary for appropriate service standards, types of customer defined service standards, development of customer defined service standards. Physical Evidence and the Service Scape: Definition, Types of Physical Evidence, Strategic Roles, Guidelines for Physical evidence strategy, Employees Role in Service Delivery, Service Culture, The critical role of service employees, Boundary Spanning Roles, Strategies for Delivering Service Quality through people.
5. **Delivering, Performing and Managing Services:** Employees role in service delivery: Service Culture, the critical role of service employees, boundary spanning roles, strategies for delivering service quality through people. Customers role in service delivery: Importance of customers in service co-creation and delivery, customers sole, self-service technologies, strategies for enhancing customer participation. Integrated Service Marketing Communication.

Pre-requisites: UM17MB554 – Marketing Management

Reference Book:

1. "Services Marketing: Integrating Customer Focus Across the Firm", Zeithaml, Valarie A Bitner, Mary Jo, Tata McGraw Hill, New Delhi, 7th Edition, 2018.

UM17MB626: MARKETING STRATEGY (2-1-0-2-3)

Course Objectives:

- This course will provide students an overview of the Marketing Strategy function in the corporate.
- A student will study Market-Oriented perspectives underlying successful corporate, business and marketing strategies, corporate strategy decision and their marketing implications, business strategies and their marketing implications, understanding market opportunities, measuring market opportunities: forecasting and market knowledge, targeting attractive market segments, differentiation and positioning, marketing strategies for new markets, growth markets, mature and declining markets.

Course Outcomes:

At the end of the course students can:

- Understand the fundamentals of marketing strategy i.e. understanding the marketing implications of corporate and business strategy, understanding market opportunities, targeting attractive market segments and formulating marketing strategies for the new, growth and mature markets.
- Apply the fundamentals of marketing strategy to different marketing scenarios.
- Analyze different marketing situations and prepare a marketing plan.

Course Contents:

1. **Introduction to Strategy:** Market-Oriented Perspectives underlie corporate, business and marketing strategies, Corporate Strategy Decisions and their Marketing Implications, Business Strategies and their marketing Implications: Strategic Decisions at the Business Unit Level, how do businesses compete, How do competitive strategies differ from one-another, the fit between business strategy and environment, How different business strategies influence marketing decisions? Understanding Market Opportunities, Market & Industry, Assessing Market and Industry attractiveness, Macro trend analysis, understanding markets at the micro level, the team domains.
2. **Opportunity Analysis:** Understanding Market Opportunities: Market and Industries, assessing market and industry attractiveness, Macro trend Analysis, Understanding markets at Macro level, team Domains, Measuring Market opportunities: Tools for forecasting, rate of diffusion of innovations, market knowledge systems and research, Targeting attractive Market Segments, Making sense of Segmentation and Target Marketing, Segments defined, Process to choose attractive segments, Different targeting strategies.
3. **Opportunity Analysis:** Targeting Attractive Market Segments: Rationale, Definition, Choosing Attractive market segments, Different targeting strategies, Differentiation and Positioning: Differentiation, Physical positioning, Perceptual Positioning, The Positioning Process.
4. **Formulating Marketing Strategies:** Marketing Strategies for New Market entries, Strategies for Growth Markets.
5. **Formulating Marketing Strategies:** Strategies for Mature and Declining Markets, Marketing Strategies for the New Economy.

Pre-requisites:
UM17MB554 – Marketing Management

Reference Books:
1. "Marketing Strategy - A Decision Focused Approach", Orville Walker, John Mullins, Jr. Boyd, Tata McGraw Hill Publication, 7th Edition, 2014.
2. "Strategic Marketing", David W Cravens, McGraw-Hill, 7th Edition, 2009.

UM17MB627:
SELLING TODAY (2-1-0-2-3)

Course Objectives:
- The objective of the course is to give an exposure to the students in the Relationship Selling function across different industry.
- This course will provide a student with a common template which can be used in any kind of relationship selling function in different sectors.
- A Student will understand the concept of personal selling and relationship strategy, developing customer and product-based selling strategy and finally learning to present, close and service the sale.

Course Outcomes:
At the end of the course students can:
- Understand the Personal Selling and Relationship strategy.
- Develop a Selling Strategy for a product/service.
- Develop a customer strategy.
- Develop a presentation Strategy.
- Understand negotiating, closing and servicing the sale.

Course Contents:
1. **Developing a Personal Selling Philosophy & Relationship Strategy:** Relationship Selling Opportunities in the Information economy, Evolution of Selling Models That Complement the Marketing Concept, Creating Value with a Relationship Strategy.
2. **Developing a Selling Strategy for the Product/Service:** Creating Product Solutions, Product Selling Strategies that add value
3. **Developing a Customer Strategy:** The Buying Process and Buyer Behavior : Developing a Customer Strategy, Consumer Versus Business Buyers, Achieving Alignment with the Customer's Buying Process, Understanding the Buying Process of the Transactional, Consultative, and Strategic Alliance Buyer, Understanding Buyer Behavior, Developing and Qualifying a Prospect Base: Prospecting—An Introduction, Prospecting Requires Planning, Sources of Prospects, Qualifying the Prospect, Collecting and Organizing Prospect Information, Managing the Prospect Base.
4. **Developing a Presentation Strategy:** Approaching the Customer with Adaptive Selling, Determining Customer Needs with a Consultative Questioning Strategy, Creating Value with the Consultative Presentation.
5. **Negotiating, Closing and Servicing the Sale:** Negotiating Buyer Concerns, Adapting the Close and Confirming the Partnership, Servicing the sale and building the Partnership.

Pre-requisites:
UM17MB554 – Marketing Management

Reference Book:
1. "Selling Today: Partnering to Create Value" Gerald L. Manning, Michael Ahearne, Barry L. Reece, Pearson Publications, NJ, USA, 12th Edition, 2011.

UM17MB651:
INTERNSHIP (0-0-16-0-8)

Course Objective:
- To provide a platform for the students to imbibe practices of a company

Course Outcomes:
At the end of the course students can:
- Feel comfortable about working in an organizational setup
- Understand the nuances of being a good team-player
- Realize the importance of being goal-focused
- Appreciate the importance of meeting deadlines
- Recognize the value of organizational processes

Course Contents:
1. Introduction to corporate Internship: Orientation about the company and about the functional areas
2. Managerial Structure and Style
3. Organizational Skills and Synergy
4. Study of systems and processes
5. Organizational Shared Value
6. Individual Report preparation and presentation

Pre-requisites: None

UM17MB652:
PROJECT WORK (0-0-16-0-8)

Course Objective:
- To provide a platform for applying the research Methodology in practice and develop Research Plan to implement in Research Based Project work.

Course Outcomes:
At the end of the course students can:
- Exhibit fundamentals concepts of Research Design and process
- Exhibit skills in developing research Design.
- Exhibit ability to develop and Implement research Plan

Course Contents:
1. **Submission of Synopsys to the Internal Guide:** Identification of Research Topic in specific Domains, Developing Keywords, Literature Survey and Identification of Research Gaps, Formulation of Objectives, Formulation of Hypotheses, Research Design
2. **Submission of Draft**: Questionnaire for final approval to internal Guide: Data Collection tool design
3. Data Collection from field
4. **Data presentation, Data Analysis:** Summary of findings, conclusions and recommendations.
5. Report Writing and evaluation

Pre-requisites: None

Note:
1. Every student must identify a Research Problem from current business scenario with the support of Internal and or External guide allotted by the department.
2. Student must follow the schedule for his/her Research Plan.

MASTER IN APPLIED ECONOMICS

Program Educational Objectives:

1. The course will provide a sound theoretical understanding and empirical grounding in fundamental of economics.
2. The course will prepare the students with an analytical understanding in the evolution of the national and global economy and provide hands-on experience.
3. The course develops skill in economic reasoning, and in constructing and estimating economic models through the use of econometrics and other quantitative techniques.
4. The course will culminate with the final submission of a thesis by the students in a practical area of their interest under the supervision of an expert.

Program Outcomes:

1. Students learn the techniques to apply economic reasoning to individual and firm behavior, and their role in the aggregate economy.
2. Students learn to use economic models to analyse the impact of price, income, and investment rate on consumption, savings, and investment.
3. Students expertise themselves in deterministic, forecasting, and classification models using large cross section and time series data.
4. The course trains the students to use appropriately the relevant concepts, research process, and the basic mechanics of research.
5. The course prepares students as professional economists for government, non-government, and corporate sectors.

UM17AE601:
FRONTIERS OF INTERNATIONAL ECONOMICS (3-0-0-0-3)

Course Learning Objectives:

- To understand concepts, broad principles and theories, which tend to govern the flow of trade in goods, services and capital — both short–term and long-term — at the global level.
- To learn the interrelationship of economic factors at a country level and the world trade scenario.
- To explore the role of world economic institutions (GATT, WTO, UNCTAD) and their operations in International trade.

Course Outcomes:

- Good acquaintance with the concepts, tools, issues and models in International Economics.
- Learn the policy challenges in International Trade and history of changes during last few decades.
- Understand the tenets of World Trade organisations and role of different country groups.

Course Contents:

1. **Theories of International Trade**: **Classical & Neo–Classical Trade Theories:**– Absolute and Comparative – The Theorems of Heckscher-Ohlin – The Leontief Paradox and Factor Price Equalization – Dynamic Version of Trade Theories – New International Economy of Scale – Linder's Hypothesis – Intra Industry Trade. **Trade and Technology:** Alternatives to the Standard Trade Theories Including the Product Cycle and Technology Gap Models – International Technology Transfer and Foreign Trade–Effect of Trade on Welfare–Trade and New Economic Geography –Krugman &Venables.
2. **Trade and Growth: Export Led or Outward Looking Industrialization**: Import Substituting or Inward-looking Industrialization – Growth and Terms of Trade –Foreign Exchange Constraint on Growth – Savings Gap Versus Foreign Exchange Gap Controversy –Theories of Protection – Rybczynski Theorem – Immiserising Growth. **The Elasticity Approach**: Marshall-Lerner Condition – Purchasing Power Parity (PPP) – Fischer Effect – Monetary Approach – Overshooting – Monetary Policy and Fiscal Policy.
3. **Trade Policy and International Market Structures: Under Perfect Competition:** Tariffs and Welfare for Small and Large Countries –Tariffs Versus Quantitative Restrictions – The Concept of the Optimum Tariff –Empirical Modelling of Trade Policy – Domestic Factor – Distortions and the Effects of Trade Policy – Multilateral Trade Agreements and Political Economy.

   Under Imperfect Competition: Monopolistic Competition Models of Trade – Love-For-Variety Preferences – Gains from Trade – Tariff Versus Quota Under Monopoly – Alternative to Standard Theories Including the Product Cycle. **Strategic Trade Policy**: Cournot and Bertrand Competition – Voluntary Import Expansion and Export Restrictions.
4. **Tariff and Non-Tariff Barriers: The Rationale of Tariffs, Quotas and Subsidies**: Distortions in Commodity and Factor Markets – The Optimum Tariff Rate – Infant Industry Argument – Tariffs and Factor Income Distribution – Tariff and Terms of Trade and Domestic Prices – The Theorems of Stolper-Samuelson Theorem – Quota and VER – Optimal Tariff – Free Trade Versus Protection. **Effect of Tariffs and Non-Tariff Barriers:** Dumping – Subsidies – Technical Administration and Other Regulations – Tariffs as Instrument to Market Imperfection and Strategic Device-Tariff Vs Quotas – Non-Tariff Barriers – Theory of Dumping – Anti-Dumping Measures – Policy Interventions in Terms of Tariffs (Metzler Paradox) – Offer Curves – Determination of International Equilibrium Price – Concepts of Terms of Trade
5. **Economic Integration and Global Trade Scenario: Multilateral Trade Negotiation**: GATT And Its Objectives – The GATT Rounds – WTO & The Indian Position–UNCTAD and Evolution of World Trading Arrangements – Fair Trade – IPR and Trade in Agriculture and issues. **The Theory of Customs Unions and Welfare Effects**: Trade Creation Versus Trade Diversion – Theory of Customs Union – **Formation of Regional Trade Blocs** – Regional Trade Blocs and Barriers to Free Flows of Trade – Multilateralism Vs Regionalism.

References:

1. "Lectures on International Trade", Bhagwati, Jagdish, Arvind Panagariya and T.N. Srinivasan, MIT Press, 2nd Edition, 1998.
2. "International Economics", Carbaugh, R. J., 11th Edition, Thomson South Western, New Delhi, 2008.
3. " International Economics: Trade Theory and Policy", Dennis, Appleyard and Alfred Field Jr., McGraw–Hill UK, ISBN10: 0071181016, 2001.
4. "Elements of International Economics", Gandolfo, Giancarlo, Springer, 2004.
5. "International Economics: Theory and Policy", Krugman, Paul, and Obstfeld, Maurice, Addison Wesley, 2008.
6. "International Economics", Salvatore, D, Wiley India, 8th Edition, New Delhi, 2007.
7. "International Economics", Soderston, B. and Reed G., McMillan Press Ltd., London, 3rd Edition, 1999.
8. "Advanced International Trade Theory and Evidence", Feenstra, R., Princeton University Press, 2009.

UM17AE602:
INTERNSHIP (0-0-8-0-4)

Course Objective:

- To provide a platform for the students to analyze and understand real-world economic issues by utilizing concepts learned in classes.

Course Outcomes:

- Learn to use economic tools and theories to analyze tradeoffs and make decisions based on scarcity and opportunity costs in an organization or public policy setting.
- Learn how an organization allocates its resources internally and within the market.
- Learn to interpret the affect of government policy on the market.
- Learn to study the economics of a business startup by conducting in-depth research on organizations and through communications with organizational representatives.
- Gain insights about crucial economic indicators (GDP, unemployment, retail numbers, etc.).
- Learn to make sure that there is an appropriate balance of work being requested and accomplished.

Course Content:

1. Introduction to Corporate/Academic and Research Institute Internship: Orientation about the organization and functional areas.
2. Structure of the organization and way of functioning.
3. Organizational Skills and Synergy.
4. Study of Systems and Processes.
5. Individual Report Preparation and Presentation.

UM17AE603:
REVIEW OF DISSERTATION (0-0-0-20-5)

Course Objective:

- The dissertation presents a major piece of guided independent research on a topic agreed between the student and their supervisor. It typically involves a literature review and an appropriate form of critical analysis of sources of primary and /or secondary data; it may involve field and/or laboratory work. The dissertation must show evidence of wide reading and understanding of critical analysis and/or appropriate use of advanced research techniques in the field of applied economics.

Course Outcomes:

At the end of the course students can:

- Plan, and engage in, an independent and sustained critical investigation and evaluation of a chosen research topic relevant to applied economics.
- Systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions.
- Appropriately apply qualitative and/or quantitative evaluation processes to relevant data.
- Understand and apply ethical standards of conduct in the collection and evaluation of data and other resources.
- Communicate research concepts and contexts clearly and effectively both in presenting the research work and in writing the dissertation.

Course Contents:

1. Identification of research topic in specific domain in consultation with internal and external mentor.
2. Literature survey and identification of research gaps.
3. Formulation of research objectives.
4. Formulation of Hypothesis.
5. Relevant data sources.
6. Research plan.
7. Submission of research proposal to the internal guide at the end of the semester and presenting the proposed research plan.

Pre-requisites: None

Note: Every student must identify a research problem from current economic scenario with the support of internal and or external guide allotted by the department.

UM17AE651:
PUBLIC ECONOMICS (3-0-0-0-3)

Course Objectives:

- To learn about the role of State & Public sector in the economic development. Understand the government interventions and its influence on growth and development.
- To enable students to acquire knowledge about the role of state in the applications of economic theory and non-market decision–making process.
- The focus on understanding the key issues relating to the government spending, taxing and financing activities and the outcomes.

Course Outcomes:

- Good acquaintance with the concepts, tools, issues and models in Public Economics.
- Learn the policy challenges that the governments face, the potential solutions and the difficulties involved.
- Understand the tenets of generation of State Revenue, Taxes, Expenditure and Budget analysis.

Course Contents:

1. **Theoretical Base of Public Economics: Public Good:** Understanding the Properties of Public Good / Bad –Pareto Optimality: Pure Exchange Economy and Economy with Production, Consumption and Distribution – Social Welfare Maximization – Theory of Second Best – Market Failure and Rationale for Government Intervention – Public goods and Externalities – Merit Goods – Private and Public – Samuelson's Theory – Externality – Problem of Free Riders – Lindahl Solution – Coasian Theory.
2. **Public Finance– Theory and Practice: Taxation and Tax Reforms:** Direct and Indirect Taxes – Canons of Taxation – Benefits and Ability to Pay – Efficiency and Equity – Dead Weight Loss – Taxation and Monopoly – Measurement of Income and Expenditure – Tax Incidence: Partial (Income Tax – Input Tax – Commodity Tax etc.) – Taxation and Labour Supply – Taxation and Savings – Risk-Taking and Wealth – – Theory of Optimal Taxation –– Tax Evasion and Avoidance – Designing of Modern Tax System – Laffer Curve Analysis.

   Public Expenditure and the Macro-Economy: Determining Optimal Size of Government – Wagner's Law – Wiseman-Peacock Hypothesis – Financing of Public Expenditure: Debt Versus Tax Financing – Fiscal Federalism: Central and Sub-National Expenditures –– Impact of Government Expenditure on Output and Employment – Designing Optimal Government Expenditure Policy: Issues of Size and Composition.
3. **Fiscal Policy Issues:** Budget Deficit and Public Debt – Keynesian – Neo-Classical – Ricardian Equivalence – Debt Dynamics – Interdependence of Fiscal and Monetary Policies – Theory of

Inter-Governmental Transfers – Theory of Fiscal Federalism – Issues of Equity and Efficiency – Designing Equalization Transfers – Types of Grants – Matching – Non-matching – Conditional and Unconditional – Finance Commissions – Pattern of Transfers – Equity and Efficiency Aspects.

4. **Indian Public Economics:** Indian Tax System – Emergence and Development – Constitutional Assignment of Taxing and Expenditure Responsibilities to Various Levels of Government – Selective Taxes and Tax Reforms – Raja Chellaiah Committee – Parthasarathy Shome Committee –GST and Implications – History of Indian Tax Reforms – Gains and Issues.
5. **Fiscal Responsibility and Budget Management(FRBM) Act and Public Expenditure Management in India**: Introduction to Budgets of Centre and State Governments – Plan and Non-Plan Expenditure – Capital and Revenue Heads – Subsidies in India – Debate on Subsidies – Social Security and Pension Reforms – Deficit and Public Debt: Concepts of Deficits – Fiscal Deficit – Primary Deficit – Revenue Deficit – Public Enterprises and the Budget – Public Debt Dynamics in India – An Evaluation of FRBM Act – Intergovernmental Transfers in India: Vertical and Horizontal Imbalances.

Reference Books:

1. "Handbook of Public Economics", Aurebach, A. and Feldstein M., Vol. 3, North Holland, 2002.
2. "Towards Sustainable Growth: Essays in Fiscal and Financial Sector Reforms in India", Chelliah, R.J., Oxford University Press, 1996.
3. "Public Finance & Public Choice",Cullis John and Jones Philip, 3rdEdition, Oxford Publications, 2010
4. "Intermediate Public Economics", Hindriks, J. and G.D. Myles, MIT Press, 2006.
5. "Public Finance in Theory and Practice", Musgrave, Richard A, Musgrave, Peggy B, Tata Mc Graw Hill Company, New Delhi. 2004

UM17AE652:
DEFENCE OF DISSERTATION (0-0-0-20-5)

Course Objective:

- The dissertation presents a major piece of guided independent research on a topic agreed between the student and their supervisor. It typically involves a literature review and an appropriate form of critical analysis of sources of primary and / or secondary data; it may involve field and/or laboratory work. The dissertation must show evidence of wide reading and understanding of critical analysis and/or appropriate use of advanced research techniques in the field of applied economics.

Course Outcomes:

At the end of the course students can:

- Plan, and engage in, an independent and sustained critical investigation and evaluation of a chosen research topic relevant to applied economics.
- Systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions.
- Appropriately apply qualitative and/or quantitative evaluation processes to relevant data.
- Understand and apply ethical standards of conduct in the collection and evaluation of data and other resources.
- Communicate research concepts and contexts clearly and effectively both in presenting the research work and in writing the dissertation.

Course Contents:

1. Data collection
2. Data analysis and presentation
3. Summary of findings
4. Writing of the dissertation chapters.
5. Pre-submission seminar of the dissertation.
6. Final submission of dissertation
7. Defence of dissertation

Pre-requisites: None

Note: Student must follow the research plan and submit completed dissertation on time.

UM17MB603:
PREDICTIVE ANALYTICS (2-1-0-2-3)

Course Objectives:

- To provide a working knowledge of handling data and Business Analytics' tools that can be used for decision-making.
- To provide real insights on the functions of business analytics in a competitive and dynamic business environment.

Course Outcomes:

At the end of this course, the students can:

- Understand the fundamental concepts of Predictive Analytics
- Apply the predictive analytical tools in business situations
- Develop predictive analytics questions, identify and select most appropriate predictive analytics methods and tools

Course Contents:

1. **Introduction to Predictive Analytics and Multivariate Model:** Introduction to Analytics, Analytics in Decision making, Application of predictive analytics

   ANOVA: Two-way ANOVA with and without interactions, **Simple Linear Regression (SLR):** Introduction to Regression, Model Development, Model Validation and Demo, **Multiple – Regression:** Introduction to Multiple Linear Regression, Estimation of Regression, Parameters, Model Diagnostics, Multi-collinearity, Model Deployment, Demo
2. **Categorical Data Analysis:** Describing Categorical Data, Discrete choice model, Understanding the Concepts of Logistic Regression, MLE Estimate of parameter, Logistic Model Interpretation, Logistic Model Diagnostics, Model Fit and Demo,
3. **Classification and Prediction (Pattern Discovery):** Discriminant Analysis, Market Segmentation – Cluster Analysis, Multi-Dimensional-scaling
4. **Decision Tree and Unstructured Data:** Introduction to Decision Trees, Types of decision tree method: Chi-Square Automatic Interaction, Detectors (CHAID), Classification and Regression Tree (CART), Analysis of Unstructured data - Demo
5. **Time series and Forecasting:** Introduction to Time Series Data and Time Series Analysis based Forecasting, Exponential smoothing, Forecasting Accuracy, Auto regressive and Moving average model. Auto-correlated and Heteroscedastic Errors, Demo

   Application of Predictive Analytics: Customer Analytics, Customer Churning, Cross selling in marketing, Threat andFraud analytics, Employee retention, product or economy-level prediction,

Pre-requisites: None

Reference Books:

1. "Business Analytics - Data Analysis & Decision Making", S. Christian Albright and Wayne L. Winston, Cengage Publication, 5th Edition, 2012.
2. "Fundamentals of Business Analytics, Seema Acharya R N Prasad, Wiley Publication, 2nd Edition, 2016.

FACULTY OF LAW

SCHEME OF INSTRUCTION

Programs of Study: BBA, LLB

Sl. No.	Course Type
1.	Preliminary (PC)
2.	Foundation (FC)
3.	Core (CC)
4.	Elective (EC)
5.	Project / Self learning / Seminar / Internship (PW)
6.	Non credit (NC) (All non credit courses are mandatory)

STRUCTURE OF CURRICULUM

FACULTY OF LAW

BBA, LLB

I SEMESTER (2018 – 23 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1.	UL18BL101	Law and Language	4	0	0	0	4	CC
2.	UL18BL102	Legal Methods and Legal Systems	4	0	0	0	4	CC
3.	UL18BL103	Law of Contract - I	4	0	0	0	4	CC
4.	UL18BL104	Principles and Practices of Management	4	0	0	0	4	CC
5.	UL18BL105	Managerial Economics	4	0	0	0	4	CC
6.	UL18BL106	Principles and Practices of Financial Accounting	4	0	0	0	4	CC
		TOTAL	**24**	**0**	**0**	**0**	**24**	

II SEMESTER (2018 – 23 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1.	UL18BL151	Law and Literature	4	0	0	0	4	CC
2.	UL18BL152	Law of Contract - II	4	0	0	0	4	CC
3.	UL18BL153	Law of Torts	4	0	0	0	4	CC
4.	UL18BL154	Fundamentals of Marketing Management	4	0	0	0	4	CC
5.	UL18BL155	Managerial Psychology	4	0	0	0	4	CC
6.	UL18BL156	Cost and Management Accounting	4	0	0	0	4	CC
		TOTAL	**24**	**0**	**0**	**0**	**24**	

Internship (2018 – 23 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1.	UL18BL180	Internship	0	0	0	8	2	PW

III SEMESTER (2017 – 2022 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1.	UL17BL201	Business Statistics	4	0	0	0	4	CC
2.	UL17BL202	Human Resource Management	4	0	0	0	4	CC
3.	UL17BL203	Business Environment	4	0	0	0	4	CC
4.	UL17BL204	Constitutional Law – I	4	0	0	0	4	CC
5.	UL17BL205	Family Law- I	4	0	0	0	4	CC
6.	UL17BL206	Consumer Protection Law	4	0	0	0	4	CC
		TOTAL	**24**	**0**	**0**	**0**	**24**	

IV SEMESTER (2017 – 2022 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1.	UL17BL251	Strategic Management	4	0	0	0	4	CC
2.	UL17BL252	Corporate Accounting	4	0	0	0	4	CC
3.	UL17BL253	Business Communication	4	0	0	0	4	CC
4.	UL17BL254	Constitutional Law – II	4	0	0	0	4	CC
5.	UL17BL255	Family Law- II	4	0	0	0	4	CC
6.	UL17BL256	Jurisprudence	4	0	0	0	4	CC
		TOTAL	**24**	**0**	**0**	**0**	**24**	

Internship (2017 – 2022 BATCH)

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1.	UL17BL280	Internship	0	0	0	8	2	PW

FACULTY OF LAW

Program Educational Objectives:

1. Train and prepare the students into highly skilled legal professionals to adorn the Bar, Bench and Corporate sectors which are indispensable for a healthy society.
2. To make students socially relevant individuals in order to nurture the justice delivery system for the poor and needy.
3. To inculcate the concept of interpretation of laws by emphasizing the ethos of the jurisprudence and legal system.
4. To inculcate in students a research bent of mind order to contribute for a sustainable development of democracy.
5. To inculcate in students the usage of various legal data bases by accessing the library resources and the online search engines.
6. To prepare the students to secure befitting placements at a global level.

Program Outcomes:

1. **Knowledge:** Acquiring in depth knowledge in the field of Law and Management by application of laws in the real time situation.
2. **Interpretation skills:** Acquisition of interpretation skills by analysis of the complexities involved in various aspects of law and management.
3. **Oratory skills:** To be an orator extraordinaire with an impeccable hold on the subject and language.
4. **Research skills:** Critical analysis of various literature, judgments and observations made by the Judiciary
5. **Societal value:** Contribution to the society in a positive manner and be a socially relevant individual by adaptation of the values in the Society.
6. **Justice-oriented:** To be a legal professional, for upholding 'Dharma' which is the backbone of the Society.
7. **Ethics:** To become a legal professional adhering to professional ethics.
8. **Reflective Learning:** Critical evaluation the outcomes of one's actions and application of self-corrective measures to improve the performance.
9. **Team-building:** Enhancement the skills of an individual by taking another person into confidence, by working with him/her.
10. **Constitutional ethos:** To uphold the Constitution of India by being a professional who is accountable to the Society.

UL18BL101
LAW AND LANGUAGE (4-0-0-0-4)

Course Objective:

- To understand the use of English language with the help of various legal words, maxims, comprehensions and select portions of writings of jurists.
- To demonstrate proficiency in the critical written skills of communication.

Course Outcome:

- To enable the students to hone the necessary skills required for legal drafting, writing and interpreting
- Understand the nuances of English language with relation to legal/business usage and towards better preparation for placements.
- Understand importance of listening vis-a-vis other aspects of communication.

Course Content:

1. **The Development of Modern English-** Sources of Legal English; Difficulties of English Language; Basic standards of legal writing: Dates; Numbers; Citations- Terminology and Linguistic Peculiarities- Abbreviations.
2. **Advanced Grammar:** Semantics; Morphology; Phonetics ; Forensic linguistics; Easily Confused Words; Phrasal Verbs Used In Legal English; Foreign Terms used in Law; Legal Terminology. Idioms- Communication Skills for Advocacy ; Etiquettes and Manners for law professionals; Telephone Etiquettes.
3. **Legal Maxims:**
   - Actus non facit reum nini mens sit rea.
   - Actio Personalis moritur cum persona.
   - Actus dei nemini facti injuriam
   - Audi alteram partem.
   - Communis error facit jus.
   - Cessante ratione legis cessat ipsa lex.
   - Delegatus non potest delegare.
   - Damnum sine injuria; injuria sine damnum.
   - Ex nudo pacto non oritur actio
   - Ex turpi causa non oritur actio
   - Generalia specialibus non derogant
   - In pari delicto poitur et condition defendantis.
   - Ignorantia facti excusat; ignorantia juris non excusat
   - Omnia prae sumuntar contra spoiatorem
   - Respondeat superior
   - Res ipsa loquitur
   - Salus populi suprema lex.
   - Ut res magis valeat quam pereat.
   - Ubi jus ibi remedium
   - Volenti non fit injuria.
4. **Legal Comprehension:** Language and the law by Glanville Williams published in LQR(Law Quarterly Review) (1945) 61; 71-86, 179-185, 293-303 and 384-406; (1946) 62 LQR 3872406; 2. Frank E Cooper, Writing in legal practice, 1-66, 183-202 and 206-301; 3. Lord Denning, Command of Language and the interpretations of the statutes, 5-19 in the Discipline of Law.
5. **Legal Words:** Accused, Accomplice, Arrest, Amendment, Adjournment, Award, Arbitration, Agreement, Approver, Bail, Bench, Bond, Breach of Contract, Consent, Contract, Contempt, Counterclaim, Court, Counsel, Compromise, Coercion, Claim, Damages, Decree, Defamation, Defendant, Defence, Document, Distress, Divorce, Evidence, Estoppel, Equity, Execution, Fraud, Hearsay, Homicide, Injunction, Insolvency, Instrument, Issue, Judgement, Jurisprudence, Jury, Justice, Juvenile, Kidnap, Lawyer, Liability, Litigation, Oath, Objection, Partnership, Partition, Perjury, Petition, Plaintiff, Plaint, Pleadings, Privity, Pre emption, Proviso, Prosecutor, Procedure, Presumption, Punishment, Right, Remedy, Remand, Redemption, Respondent, Regulation, Rule, Sentence, Settlement, Statute, Summon, Summons, Surety, Title, Transfer, Trespass, Trial, Vicarious, Verdict, Void, Voidable, Warrant, Witness, Will.

Prerequisite Courses: None

Reference Books:

1. "Law and Language", R. P. Bhatnagar, R. Bhargava, (Editor) Madhav Menon, MacMillan, 1985.
2. "Living English Structure", W.S. Allen, Pearson Education; 5 edition, 2009.

3. "Modern English: A Book of Grammar, Usage and Composition", N. Krishaswamy, Laxmi Publications, 2009.
4. "A Spectrum of Rhetoric", Darothy M. Guinn Daniel Marder, National Council of Teachers of English, 1974.
5. "Strengthen your Writing" , V.R.Narayanswamy, Orient Longman, 1979.
6. "Contemporary English Grammar", David Green, Laxmi Publications, 2015.
7. "Law and Language", R.P. Bhatnagar, Publisher, Trinity Press Pvt. Ltd., 2012.
8. "Legal Language and Legal Writing", K.L. Bhatia, Universal Law Publishing, 2010.
9. "Outlines of Legal Language in India", Anirudh Prasad, Central Law Publications, 8th Edition, 2016.

UL18BL102
LEGAL METHODS and LEGAL SYSTEMS (4-0-0-0-4)

Course Objective:

- This course is planned to impart to the students both the philosophical underpinnings of law as well as the practical research tools to understand the technical issues involved in the legal matters.
- Enable first year students to identify, analyze and research issues in any area of law.
- Introduce students to systematic study of law so that they can learn the skills of finding, using and interpreting law.

Course Outcome:

- Students after studying this course will get a bird's eye view of the meaning and nature of law and legal systems.
- to understand the issues involved in interpretation of statutes and the research tools to unravel the formulae of understanding the reasoning process of the judges.
- To enable students to pick up the basics required for legal research.

Course Content:

1. **Meaning and Nature of Law:** Law and Society: Multifarious Dimensions- The important theories of Law- Natural Law, Imperative Law, Legal realism and Law as a system of rules; Hart-fuller debate;
2. **Classification and Functions of Law**: Civil and Criminal Law; Public and Private Law; Municipal and International Law; Substantive and Procedural law- Major legal systems of the world- Common Law Legal System, Equity, Civil Law Legal System, Religious legal systems- Important concepts connected to legal systems: Separation of powers, Rule of law, Constitutionalism, State and forms of government; Civil and Criminal administration of justice.
3. **Sources of Law:** Meaning- Custom as a Source of Law; Precedent as a Source of Law; Legislation as a Source of Law- Inter-relationship of the sources, relative significance with the help of leading case laws.
4. **Legal History:** Charter Act of 1753; Judicial Plans of Warren Hastings-1772, 1774; Regulation Act, 1773; Charter Acts 1853, 1858,1861; Government of India Acts- 1909, 1935; Case Laws - Raja Nand Kumar's case, Patna Case, Cossijurah Case.
5. **Legal Research Skills**: Meaning and Importance of Legal Research and writing; Research design and its components; Basic concepts of interpretation; *Ratio Decidendi* and *Obiter Dicta*- Legal Reasoning- Inductive and Deductive Reasoning; Judicial decision making; Forms of Citation- Blue Book, 19th Edition and other forms of citation.

Prerequisite Courses: None

Reference Books:

1. "Indian Legal System", Joseph Minattur, Indian Law Institute, 2015.
2. "Legal Theory", Friedmann, Universal Law Publishing, 2011.
3. "Learning the Law" , Glanville Williams, Universal Law publishing Co., 2013.
4. "Idea of Law", Dennis Llyod, Penguin Books, 1991.
5. "Research Methodology", Indian Law Institute, Delhi.

UL18BL103
LAW OF CONTRACT – I (4-0-0-0-4)

Course Objective:

- This course outlines the fundamental tenets of the contractual law and the case law built around the same.
- To learn and understand the fundamental principles of law of contracts.

Course Outcome:

- The Course aims at helping the students to understand the basic principles of contract law
- To enable students to appreciate the Legal framework surrounding valid contracts as interpreted by the judiciary.

Course Content:

1. **Introduction:** Nature and functions of a contract; Justification for and the limits of contract law; Freedom of contract and its exceptions**;** Modern trends in contract law. Elements of a valid contract- Offer – kinds of offer, distinction between invitation to treat, revocation and termination- Acceptance – modes of acceptance, communication of acceptance, revocation- Intention to create legal relations- Consideration – definition and kinds of consideration, exceptions to the requirement of consideration.- Free consent – doctrine of *consensus ad idem.*
2. **Competency to Contract:** Minor's agreement – status, agreement for the benefit and to the detriment of a minor, fraud by minor and estoppels, restitution as a remedy- Unsoundness of mind – meaning and exceptions- Insolvency- Elements vitiating free consent- Coercion – definition, essential elements, duress and coercion distinguished- Undue Influence – definition, essential elements, parties between whom it can exist, who is to prove- Misrepresentation – definition, essential elements, fraud distinguished.

   Fraud – definition, essential elements, when silence amounting to fraud.
3. **Void Agreements**: Mistake – definition, mistake of fact and law and their consequential effects upon the validity of the agreement- Legality of objects – lawful objects and considerations, immoral agreements, agreements opposed to public policy- Agreements expressly declared to be void – agreements in restraint of: marriage, trade and legal proceedings; Uncertain agreements- Wagering agreements
4. **Special Categories of Contracts**: Contingent contracts – nature, when contingent contract becomes void- Quasi contracts – meaning and nature, theory of unjust enrichment, situations where law implies contractual relationship- Government as a contracting party – formation, and constitutional requirements as provided under Art. 299 of the Constitution of India- Standard form contracts – nature and advantages, principles of protection against the possibility of exploitation, judicial approach to such contracts

5. **Discharge of Liability Under a Contract**: By performance- conditions of valid tender of performance, reciprocal promises- By death, Inheritance, part performance- By breach - time as essence of contract, anticipatory breach and actual breach, constructive breach- By frustration of contract - Impossibility of performance, specific grounds of frustration, *force majeure*- By period of limitation- By agreement- rescission and alteration - their effect- remission and waiver of performance - extension of time- accord and satisfaction- Remedies for Breach of contract- Meaning, kinds of breach, remedies for breach- Damages – meaning, measure of damages, remoteness of damage- Specific Performance of contract – which contracts may be specifically enforced, which may not, persons against whom it can be enforced- Injunction. Emerging trends – MOU, LOU, Online contracts.

Prerequisite Courses: None

Reference Books:

1. "Contract & Specific Relief", Avtar Singh, Eastern Book Company, 2013.
2. "Anson's Law of Contract", Beatson, Burrows and Cartwright (Eds), 29th Edition, Oxford University Press, 2010.
3. "Law of Contract and Specific Relief", Moitra's 6th Edition, Universal Law Publishing Co., 2012.
4. "The Indian Contract and Specific Relief Acts Volume I & II", Pollock & Mulla, Nilima Bhadbhade (Ed), 14th Edition, Lexis Nexis Butterworths Wadhwa Nagpur, 2012.
5. "Introduction to the Law of Contract", Stephen A. Smith, 6th Edition, Oxford University Press, 2007.
6. "The Indian Contract Act, 1872", H.K. Saharay (Ed.), Eastern Law House, 11th Edition, 2013.

UL18BL104
PRINCIPLES AND PRACTICES OF MANAGEMENT (4-0-0-0-4)

Course Objectives:

- The objective is to provide an understanding of basic concepts, principles of management.
- The aim is to inculcate the ability to apply multifunctional approach to Organizational objectives.

Course Outcomes:

- At the end of the course the student will be able to plan and control the management process of a business setup.
- The student will be equipped to understand and make required decision in existing business setup and output organizational skills needed to operate in a business.
- The student will be able enough to deal with recruitment process, and be output the learnt leadership and communication skills and train other employee on the same.

Course Content:

1. **Management:** Definition, nature, importance, evolution of management thought, contribution made by Taylor, Fayol, and Hawthorne experiments Maslow; Is managing a science or art? Functions of manager, ethics in managing and social responsibility of managers.
2. **Planning & Control:** Why Management process starts with planning, steps in planning, types of planning, barriers to effective planning, operational plan, strategic planning, Mckinsey's 7's Approach, SWOT analysis, Controlling- concept, Planning- control relationship, process of control, human response to control, dimensions of control, MBO.
3. **Decision Making & Organizing:** Nature, process of decision making, decision making under Certainty and Uncertainty, decision-tree, group-aided decision, brain-storming. Organizing – concept, nature and process of organizing, authority and responsibility, delegation and empowerment, centralization and decentralization, concept of departmentation.
4. **Staffing & Motivation:** Concept, Manpower planning, Job design, recruitment & selection, training and development, performance appraisal, motivation, motivators and satisfaction, motivating towards organizing objectives, morale building.
5. **Leadership & Communication**: Defining leadership and its role, should managers lead, leadership style, leadership development, Leadership behavior. Communication- Process, Bridging gap-using tools of communication, electronic media in Communication.

Prerequisite Courses: None

Reference Books:

1. "Principles of Management", Koontz , Tata McGrew Hill, 1st Edition 2008.
2. "Principles & Practices of Management", L.M. Prasad, Sultan Chand & Sons, New Delhi, 2013.
3. "Management Principles and Practices", Parag Diwan, Excel Books, New Delhi, 2002.
4. "Management", Stoner, Freeman, Gilbert. Jr., Prentice Hall of India, 1995.

UL18BL105
MANAGERIAL ECONOMICS (4-0-0-0-4)

Course Objectives:

- To provide under graduate students of economics with an introduction to the basic frameworks of Microeconomics and Macroeconomics.
- To develop deeper insights into economic environment, which functions through markets, firms, industries, management and government.
- To enable students to understand economy-wide phenomenon such as growth, unemployment and inflation and infer their implications for business decisions.

Course Outcomes:

- Describe the nature of economics in dealing with the issue of scarcity. Perform supply and demand analysis to analyse the impact of economic events on markets.
- Analyse the behaviour of consumers in terms of the demand for products, evaluate the factors affecting firm behaviour, such as production and costs.
- Analyse the conduct and performance of firms under different market structures

Course Content:

1. **Introduction:** Managerial Economics – Meaning, Definitions and scope. Importance of studying economics for business manager; Normative Vs Positive Analysis; Microeconomics Vs macroeconomics; Fundamental Problems of an Economy, Alternative Economic Systems; Goals of macroeconomic policies
2. **Demand Analysis**: Meaning of demand, determinants of demand, Law of Demand, Deriving demand curve; Elasticity of Demand- Price elasticity. Income Elasticity and cross Elasticity. Demand forecasting.
3. **Supply Analysis**; Meaning of supply, determinants of supply, Law of Supply, Deriving supply curve; Elasticity of Supply;

Market Equilibrium, Price Control: floor pricing and price ceiling.- Production Analysis: Meaning of production, Factors of Production, Production function with One Variable Input and Two Variable Inputs, Isoquants and Iso-costs, Producers Equilibrium, Returns to Scale- Analysis of Market Structure: Meaning and definition of Market, Types of Market; Perfect and imperfect competition; Features of perfect competition, monopoly, oligopoly and monopolistic competition – Price and output determination in each market environment in both Short Run and Long Run- Cost and Revenue Analysis- Meaning; Concepts, Short-Run and Long-Run Cost Functions, Learning curve, Economies of Scale and Scope Various concepts of revenue and profit determination. Areas and tools of cost control.

4. **National Income**: Concepts – Domestic v/s National, Gross v/s Net, Factor cost v/s Market price; Real v/s nominal GDP; personal income, per capita income, disposable income; Price indices and GDP deflator; Measuring National Income; Limitations of measurement; Usefulness of national income analysis.- Banking System: Evolution of banking system; Commercial Banks – Functions; Credit creation by commercial banks; Limitations of credit creation; Central Bank – Functions; Role of Central Bank in economic development.
5. **Monetary and Fiscal Policy**: Monetary policy-Objectives and tools; Components of money supply; Fiscal policy – Objectives; Tools – Taxation, public expenditure, public debt and budget; Different concepts of budget deficit.- Business Cycles: Definition; Theories of business cycle; Different phases of business cycles; Features of business cycles; Indicators of business cycles; Business under business cycles- Inflation and Unemployment: Meaning and types of inflation; Causes of inflation; Effects of inflation; Measures to control inflation.

   Unemployment: Meaning and types; Effects of unemployment; Measures to control unemployment.

Prerequisite Courses: None

Reference Books:

1. "Economics for Business", John Sloman & Mark Sutcliffe, Pearson Education, 2009.
2. " Microeconomics", R.Pindyck, D Rubinfeld and P Mehta, 7th Edition, Pearson Education, 2009.
3. "Managerial Economics", Dominick Salvatore & Ravikesh Srivastava, Oxford Higher Education, 2012.
4. "Macroeconomics", R. Dornbusch & S. Fisher, Tata Mc. Graw Hill, 2012.

UL18BL106
PRINCIPLES & PRACTICES OF FINANCIAL ACCOUNTING (4-0-0-0-4)

Course Objectives:

- To understand the basic concepts and nuances of financial accounting and relate them to real life documents and business events.
- The course enables students to understand and prepare final accounts (Financial Statements) .

Course Outcomes:

Upon completion of the Course the students should be able to:

- Understand and practice the preparation of accounting records including trial balance
- Understand comprehend GAAP and Indian Accounting Standards and their relevance in financial accounting and reporting
- To prepare balance sheet and profit and loss account and cash flow statement
- Trace out as to how a company could window dress its financial reports
- Carry out financial analysis of a company and bring out financial strengths and weaknesses.

Course Content:

1. **Introduction to Accounting**: Meaning of Accounting, Objectives of Accounting, the Users of Financial Accounting Information and their Needs, Accounting as an Information System, Qualitative Characteristics of Accounting, Functions, GAAP, Accounting Concepts and Conventions, Systems of Accounting, Basis of Accounting, Branches of Accounting, Differences between Financial Accounting, Cost Accounting and Management Accounting, Indian Accounting Standards.
2. **Accounting Process**: Preparation of Journal, Ledger, Trial Balances and Subsidiary Books (Cash Book only)- Final Accounts of Sole Proprietorship Concerns- Preparation of Trading Account, Profit and Loss Account and Balance Sheet of Sole Proprietors.
3. **Company Final Accounts**: Preparation of Profit and Loss Account and Balance Sheet- Significant Accounting Policies, Annexure and Notes to Final Accounts- Cash Flow Statement - Cash Flow Statement: Meaning and Objective, Preparation (as per Revised Standard issued by ICAI)
4. **Depreciation Accounting**: Concept and Causes of Depreciation, Need for Depreciation, Methods of Depreciation, Accounting treatment under different methods- Inventory Valuation- Methods of Pricing Material Issues -FIFO – LIFO – Weighted Average -Price Method and Simple Average Price Method.
5. **Financial Statement Analysis**: Introduction to Financial Statement Analysis, Ratio Analysis, Common Size and Comparative Statements.

Prerequisite Courses: None

Reference Books:

1. "Financial Accounting", Gupta R.L. and Radha Swami M, Sultan Chand and Sons., New Delhi, 2016.
2. "Financial Accounting", Monga J.R., Ahuja Girish and Sehgal Ashok, Mayur Paper Back, Noida, 2011.
3. "Advanced Accounts", Shukla M.C., Grewal T.S. and Gupta S.C., S. Chand and Company, New Delhi, 2014.
4. "Financial Accounting", Goel, D.K., Arya Publications, New Delhi, 1997.

UL18BL151
LAW AND LITREATURE (4-0-0-0-4)

Course Objectives:

- This course intends to integrate law and literature as both deals with society. It will sensitize students about social issues and provide them with an opportunity to think about law.
- It will also enable the students to examine law from a humanistic perspective, after analyzing real situations in life.

Course Outcome:

- The study of this course sensitizes the students about contemporary issues
- To enable students to analyze contemporary issues from a human rights perspective.
- To help students in appreciating their writing skills and employing the best use of literature in their profession as such.

Course Content:

1. **Jurisprudential Theories:** Antigone by Sophocles. This epic symbolises the conflicting Jurisprudential theories and celebrates the natural law.
2. **Trial And Tribulations:** The trial by Kafka. This work analyses the legal and political perspectives with reference to the classical liberalism.
3. **The Penal Policy:** Paradise Lost by John Milton. This epic poem examines the aspect of Penology and Retribution.
4. **The Lawyers and Legal System**: The law and lawyers by M K Gandhi. This seminal work explores the different avenues of the lawyers and their professional lives.
5. **Law Reforms:** Merchant of Venice by William Shakespeare. This play highlights the nitty- gritty of the Legal System of the subtle yet grave loop holes of a legal system.

Prerequisite Courses: None

Reference Books:

1. "Literature and the Law", Thomas Morawetz, Aspen Publishers, 2007.
2. " Antigone ", Sophocles, Prestwick House Inc; 2005 edition.
3. "The Trial", Franz Kafka, CreateSpace Independent Publishing Platform, 2016
4. "Paradise Lost", John Milton, Penguin Publishing Group, 2003
5. "The Law And The Lawyers", M.K.Gandhi, Navjivan Trust; New Revised edition 2011.
6. "The Merchant of Venice (Text with Parphrase)", Xavier Pinto, Beeta Publications; Second Edition 2014 edition

UL18BL152
LAW OF CONTRACT - II (4-0-0-0-4)

Course Objectives:

- This course is devised to amplify on the general principles of contract. While the Indian contract act deals with the basic principles of contract, this course delves into the specific contracts such as indemnity and guarantee, Bailment and pledge, agency, sale of goods and Negotiable instruments.
- This course is focused on the application of principles of contract to specific contract situations.

Course Outcomes:

- At the end of the course, the students are enabled to understand the contours of specific contracts and application of general principles to deal with them.
- To be familiar with some of the specific contracts enshrined in the Indian Contract Act, 1872.

Course Content:

1. **Contracts of Indemnity and Guarantee**: Contract of Indemnity – Nature and definition; Rights of indemnity holder; Commencement of liability; Contract of Guarantee – Nature and definition; Essential features of guarantee; Extent of surety's liability, discharge of surety; Rights of the surety.
2. **Contracts of Bailment and Pledge:** Bailment – Nature and definition; Essential features; Rights and duties of Bailor and Bailee; Pledge – Nature and definition; Rights of pawnor and Pawnee
3. **Contract of Agency:** Agency – Definition and kinds of agency; Essentials of agency; Modes of creation of agency; Duties and rights of agents; Authority of agent – express, implied, and ostensible authority, Liabilities- liability of principal & agent; Termination of agency- Partnership Contracts; Partnership – nature and definition; Test of partnership, registration of partnership; Minor as a partner; Dissolution of partnership and dissolution of partnership firm.
4. **Contracts for Sale of Goods:** The Sale of Goods Act 1930 – purpose of the Act; Sale, Agreement to sell; Difference between sale and agreement to sell; Caveat Emptor, Caveat Venditor, Nemo dat quod non habet; Condition and warranties; Passing of property, rules relating to passing off property; Rights of the unpaid seller.
5. **Negotiable Instruments:** Negotiable Instruments – Definition, Nature and Types. Characteristics, Rights and Obligations of Parties; Rules of honour and dishonor on presentment; Endorsements, accommodation and notices; Criminal Liability for non-payment of cheque.

Prerequisite Courses: None

Reference Books:

1. "Contract & Specific Relief, Avtar Singh, 11th Edition, Eastern Book Company, 2013.
2. "Anson's Law of Contract, Beatson, Burrows and Cartwright (Eds), 29th Edition, Oxford University Press, 2010.
3. "Moitra's Law of Contract and Specific Relief, 6th Edition, Universal Law Publishing Co., 2012.
4. "Khergamvala on the Negotiable Instruments Act", BM Prasad & Manish Mohan (Eds), 21st Edition, Lexis Nexis Butterworths Wadhwa Nagpur, 2013.
5. "Negotiable Instruments", Avtar Singh, 4th Edition, Eastern Book Company, 2005.

UL18BL153
LAW OF TORTS (4-0-0-0-4)

Course Objective:

- The course is devised to understand the historical development and the legal changes that have evolved around law of torts.
- To familiarize the students with the basis of liability in tort and to distinguish it with the basis of contractual liability.

Course Outcome:

- The students, after studying this course, would be familiarised with this unique branch of civil wrongs and the various judicial actions and remedies available for the plaintiff.

Course Content:

1. **The Nature of a Tort & General Defences :** Definitions; Essentials of a tort viz., Act or Omission, Legal Damage, Injuria sine damno, Damnum sine injuria; Malice in Law and Malice in Fact; Volenti non fit injuria, contributory negligence, plaintiff the wrongdoer, vis major, inevitable accident, private defence, mistake, necessity, statutory authority, absolute and conditional authority.
2. **Capacity and Vicarious Liability (Including State):** Capacity; Act of State, corporations, minor, capacity to sue, independent and joint tortfeasors etc.; Vicarious liability; prinicipal and agent , master and servant; Vicarious liability of the State, position in England and in India. Acts of Police, military etc.; Sovereign liability and immunity.
3. **Remoteness Of Damage & Tresspass To The Person:** The problem of remoteness, the test of reasonable foresight, the test of directness. Assault, battery, use of force, false imprisonment, lawful and unlawful detention followed by remedies available.
4. **Defamation & Nuisance:** Libel and Slander, essentials of defamation, defences , reports of parliamentary , judicial or other public proceedings, absolute privilege and qualified privilege, defamation and freedom of press. Nuisance, kinds of nuisance, essentials, defences.

5. **Abuse Of Legal Procedure, Neglignce, Strict and Absolute Liability:** Malicious Prosecution, prosecution by the defendant, proceedings before a quasi judicial authority, maintenance and Champerty. Negligence, essentials of negligence, breach of duty, damage, medicial and professional negligence, contributory negligence. The Rule of Strict liability and absolute liability and its exceptions.

Prerequisite Courses: None

Reference Books:

1. "Law of Torts", Singh, Guru Prasanna. Ratanlal & Dhirajlal, 26h Edition. New Delhi: Wadhwa & Co, 2013.
2. "Text book on Torts", Jones, Michael A., Lawman, New Delhi,1995.
3. "Law of Torts", Lakshminath, A. and Sridhar M. Ramaswamy lyer, 10th Edition New Delhi: Lexisnexis, 2007.
4. Weir, Tony, Introduction to Tort Law, 2nd Edition, New York: Oxford University Press, 2006.
5. "A Law of Tort", Pillai, P. S., 9th Edition, Eastern Book-Co., Lucknow, 2004.
6. "Clerk & Lindsell on Torts", Dugdale, Anthony (Ed.), 19th Edition, London: Sweet & Maxwell, 2006.
7. Howarth, D. R., Hepple Howarth, and Mathews, Tort: Cases & Materials. London: Oxford University Press, 2005.
8. "Case Book on Tort", Weir, Tony, 10th Edition, Sweet & Maxwell, London, 2004.
9. "Law of Tort", Harpwood, Vivenne, Cavendish, London, 1994.
10. "Tort", Giliker, Paula, Sweet & Maxwell, London, 2008.
11. "Street on Torts", Brazier, Margaret. 9th Edition, Butterworth's, London, 1993.
12. "Torts", Epstien, Richard, Aspen Law & Business, New York, 1999.
13. "Tort: Cases & Materials", Samuel, Geoffrey, 2nd Edition, Sweet & Maxwell, London, 2007.
14. "Tort", Rogers, W. V. H. London: Sweet & Maxwell, 2002.

UL18BL154
FUNDAMENTALS OF MARKETING MANAGEMENT (4-0-0-0-4)

Course Objectives:

- To provide conceptual understanding and in-depth knowledge of Fundamentals of Marketing Management.

Course Outcomes:

At the end of the course the student is expected

- To understand the basic marketing concepts and fundamental marketing practices
- To expose the students to the varied real life issues of marketing and dilemmas faced in practice.
- To examine marketing mix variables while developing an effective marketing strategy
- To understand the behaviour of consumer as well as business markets
- To evaluate the framework of product/service PLC Strategies.

Course Content:

1. **Defining Marketing** for the 21^{st} Century; Importance of Marketing; Scope of Marketing; Core marketing concepts; Company orientation towards market place [Production concept, Product concept, selling concept, Marketing concept, Holistic Marketing concept]- Marketing right and wrong; Relationship marketing; Integrated marketing; Internal marketing, and Performance marketing; Marketing management tasks.
2. **Developing Marketing Strategies and Plans**; Marketing and Customer Value; Corporate and division strategic planning; Business unit strategic planning; Product planning; Nature and contents of a marketing plan; Gathering Information and Scanning the Environment; Components of modern marketing information system; Internal Records and Marketing Intelligence; Analyzing the macro environment; Demographic environment; Other major macro environments [Economic, Socio-cultural, Natural, Technological, Political-Legal Environment]
3. **Conducting Marketing Research and Forecasting Demand**; Forecasting and demand measurement; Marketing Research System; Marketing Research Process [Defining the problem, developing the research plan, marketing research design and present findings; Overcoming barriers to the use of Marketing Research- Creating Customer Value & Customer Relationship; Building Customer Value, Satisfaction and Loyalty; Maximizing Customer lifetime Value; Cultivating customer relationships
4. **Analyzing Consumer Markets**; Factors influencing consumer behaviour (Motivation, Perception, Learning, Emotions & Memory).; Buying Decision Process: The five stage model; Theories of consumer decision making; Organizational buying; Participants in Business buying process; Procurement process, Stages in buying process
5. **Identifying Market Segments and Targets**; Levels of market segmentation; Bases of segmentation; Bases for segmenting business market; Market Targeting; Competitive Dynamics-Competitive Strategies for Market Leaders; Other Competitive Strategies; Product Life-Cycle Marketing Strategies; Marketing in Economic Downtown.

Prerequisite Courses: None

Reference Books:

1. "Marketing Management", Arunkumar & Meenakshi, Vikas Publishing, 2000.
2. "Marketing Management", Kotler & Amstrong, Pearson Publications, 2012.
3. "Marketing Management", Rajan Saxena, Tata Mcgraw Hill Publications, 2010.
4. "Marketing Management", Ramaswamy and Namakumari, Mac Millan Business Books Publishers, 2012 .

UL18CBL155
MANAGERIAL PSYCHOLOGY (4-0-0-0-4)

Course Objectives:

- The course shall acquaint the student of Law with core principles of psychological science as exhibit in the management realm.
- It shall be a trajectory of learning that visits the course from the core principles of psychological domain to an understanding of how these dynamics find reflection in current and past managerial practices with special relevance to a future practitioner of law.

Course Outcomes:

- To be acquainted with the area of Managerial Psychology.
- To gain insight into where and how these principles are applied and reflected in the modern workplace.
- To understand the behavioural process of individuals and groups better.
- To develop skills in presenting and handling humans at the workplace more effectively.

Course Content:

1. **Introduction to Managerial Psychology:** Historical Antecedents and development of field ; Methods in Managerial Psychology. Contemporary Challenges and Scope of Discipline- Core Concepts: Individual Differences in People: Perception: Theories of Perception &Drawbacks ; Perceptual Errors; Personality: Theories - Psychoanalytical School, Behavioral Theories; Humanistic Theories; Contemporary Theories – Type vs Trait Theories. Big Five Model.
2. **Individual Processes: Learning:** Theories – Classical & Operant Conditioning; Cognitive & Social Learning Theories of Learning; Motivation: Definition; Theories: Process vs Content Oriented Theories of Motivation- Stress and behavior: The general adaptation Syndrome; Stress response, Basic Forms of Stress; Frustration and Anxiety; Sources of Stress; Consequences of Job Stress; Stress and Job Performance; Coping with Stress
3. **Psychological Process Foundations:** Attitudes : Definition and Attitude Formation; ABC Model of Attitudes; Attitude Change Models : Festinger' s Cognitive Dissonance; Stereotypes Formation- Emotions : Theories off Emotions. Schechter Singers two factor theory etc. Emotional Intelligence. Memory : Models and Theories: Eyewitness Testimony(Loftus) ; Forgetting : Motivated Forgetting- Group Processes : Groups : Definition ; Norms ; Conformity and Compliance; Intergroup Relations and Processes: Social Loafing ; Groupthink; Prejudice and Discrimination; Group Communication; Social Influence: Impression Management Tactics. Decision Making : Group vs Individual Decision Making Strategies.
4. **Organizational Level Dynamics:** Diversity at the Workplace; Leadership: Theories Classical Theories of Leadership & Contemporary Theories of Leadership; Conflicts: Sources of Conflicts; Types of Conflict; Resolving Workplace Conflicts: Negotiation and Conflict Management Styles-
5. **Applied Managerial Psychology:** Practices in Everyday Organizations: Management By Objectives MBO; Appraisal Systems -Traditional vs 360 Systems; Johari Window; Transactional Analysis; T groups; Sensitivity Training.

Prerequisite Courses: None

Reference Books:

1. "Managing Behavior in Organizations", Greenberg, Jerald. 4th Edition, Upper Saddle River, NJ: Prentice Hall, 2004.
2. "Influence: Science and Practice", Cialdini, Robert B. 4th Edition, Boston, Allyn and Bacon, 2000
3. "The One Minute Manager", Kenneth H. Blanchard, Spencer Johnson, Berkley Books, 1983.
4. "Readings in Managerial Psychology", Leavitt, Harold J., Louis R. Pondy, and David M. Boje (Ed.). 4th Edition, The University of Chicago Press, 1989.

UL18BL156
COST AND MANAGEMENT ACCOUNTING (4-0-0-0-4)

Course Objectives:

- The course aims at imbibing the knowledge to the students in order to make them industry ready for taking necessary decisions
- This course aims to provide students with basic concepts of cost and Management and introduces business management approach to the use of accounting information.
- The course is intended as an introduction for individuals who make business decisions and evaluate the performance of business units using data obtained from costing

Course Outcomes:

Up on competition of the course the students should be able to:

- Comprehend and understand relevant cost concepts, types and various costing systems
- Take appropriate pricing decisions pertaining to both manufacturing and service related sectors
- Prepare various budgets and analyze them and study their impact on organizational efficiency
- Take make or buy and product mix decisions
- At the end of the course, the student should be able to
- Understand cost and management accounting knowledge, such as terminology, fundamental principles, classifications, generalizations and methods.
- Develop the acumen to understand basic tools of financial statement analysis.

Course Content:

1. **Meaning and Introduction** to cost accounting and management accounting. Differences between cost accounting, management accounting and financial accounting-
2. **Cost concepts**, Elements of Cost, cost classification, costing for materials, Labour and overhead- Costing methods: Unit costing, process costing, contract costing, activity based costing system-
3. **Variable and Absorption Costing**: application of variable and absorption costing systems, advantages and disadvantages- Standard costing and Variance analysis: material variances, Labour variances and overhead variances-
4. **Budgeting and Budgetary Control**: sales budget, cash budget and fixed and flexible budgets-
5. **Responsibility Accounting**: Meaning and objectives. Types of responsibility centers

Prerequisite Courses: None

Reference Books:

1. "Cost and Management Accounting", S.P. Jain and K.L. Naran, 13th Edition, Kalyani Publishers, 2012.
2. "Cost Accounting", M.Y. Khan, P.K. Jain, 2nd Edition, McGraw Hill Education (India) Private Limited, 2014.
3. "Management Accounting", M.Y Khan & P K Jain, Text, Problems And Cases, 5th Edition, 3rd Reprint, McGraw Hill Publication, 2011
4. "Management Accounting", S.K. Gupta, Kalyani Publishers, New Delhi, 2011.
5. "Management Accounting", Pandey I.M., Vikas publishing House, New Delhi, 2012.

UL18BL180:
INTERNSHIP (0-0-0-8-4)

Course Objectives:

- To provide hands-on working experience to students
- To hone the profession/industry-centric skills of students
- To build the network amongst the students and stake-holders in the profession
- To enhance the employability of students

Course Outcomes:

- Students receive the necessary practical exposure after each internship cycle
- Students acquire the necessary skills needed for a litigating lawyer, law firm associates, in house counsels, etc.,

- They act as a bridge between the academia on one hand, and legal professionals, firms and other stake-holders, on the other hand.
- Regular and periodical internships increase the employability of the student and expand the horizon of professional paradigms.

UL17BL201
BUSINESS STATISTICS (4-0-0-0-4)

Course Objectives:

- The course provides a statistical foundation for the various quantitative techniques that are used in Managerial Decision Making.
- To develop quantitative aptitude among management students**.**

Course Outcomes:

At the end of the course, the student should be able to

- Appreciate the utility of central tendency, dispersion, correlation, regression time series and index number, probability distributions
- Understand concepts & procedures of Business Statistics.
- Apply Statistical concepts& procedures in Business.
- Develop analytical skills among students.

Course Contents:

1. **Background and Basic Concepts:** Introduction – Definition of Statistics – Functions – Scope – Limitations. Diagrammatic and graphic representation: Introduction – Significance – Difference between diagrams and graphs – Types of diagrams and graphs.
2. **Measures of Central Tendency and Dispersion:** Introduction – Types of averages – Arithmetic mean (Simple and weighted) – Median – Mode-Range – Quartile deviation – mean deviation – standard deviation – coefficient of variation – Measures of Skewness: Meaning of Skewness - & Symmetrical Skewed Distributions – Measures of Skewness - Absolute and Relative Measures of Skewness – Karl Pearson's Coefficient of Skewness and Bowley‟s Coefficient of Skewness
3. **Correlation and Regression Analysis:** Meaning – Types – probable error – Karl Pearson's coefficient of correlation – rank correlation (excluding vicariate and multiple correlation); Regression - Meaning - Definition – regression equations.
4. **Time Series and Index Numbers:** Meaning and components – Computation of trend values by moving average and least square method. Classification – Construction of index numbers – methods of constructing index numbers – simple aggregative method – weighted aggregative method – Fishers ideal method including time & factor reversibility tests – Consumer price index numbers.
5. **Introduction to Probability:** Probability distributions – Meaning, Discrete & Continuous probability functions – binomial, Poisson, normal distribution.

Prerequisites: None

Reference Books:

1. "Business Statistics", B G Sathyaprasad & Chikkodi. Himalaya Publishing House, 2011.
2. "Business Statistics: An Applied Orientation", P.K. Viswanathan, Pearson Education.2003.
3. "Fundamentals of Business Statistics", David Anderson, Thomas Arthur Williams, International Edition, 6th Revised Edition, South-Western College Publishing, 2011.
4. "Fundamentals of Statistics", S P Gupta & V K Kapoor, Sultan Chand Publisher, 2014.
5. "Business Statistics", Aggarwal S L, Kalyani Publisher, New Delhi, 2013.

UL17BL202
HUMAN RESOURCE MANAGEMENT (4-0-0-0-4)

Course Objectives:

- To help students to acquire the specific concepts, skills, techniques associated with the management of the human resources of the organization.
- To familiarize the students with the common HR practices, the problems within the field and will equip them with the knowledge and skills to deal more effectively with the employees of the organization

Course Outcomes:

- Describe the human resource management process.
- Understand the major functional areas within HRM.
- Understand the challenges faced in managing Human Resources.
- Identify some of the key skills required for current HRM practice.
- Explain how HR initiatives can add value to the bottom line of an organization.
- Demonstrate critical thinking when presented with HR issues.
- Be cognizant of the ethical issues related to Human Resource Management
- Assess how human resource management strategies can be aligned to organizational strategies

Course Content:

1. **I introduction to Human Resource Management:** Dimensions of HRM; Importance of HRM; Trends in HRM and Strategic HRM- Human Resource Planning- What is human resource planning?; Forecasting demand for labour; Internal & External supply of labour.- Case Analysis/ Class Presentation- Module 3 -Job Analysis; Process; Sources of information for JA- Module -4 -Job Description; Writing JD- Job Specification; Writing JS
2. **Recruitment:** Recruitment process; Internal v/s External recruitment; Recruitment diverse workforce; Challenges in effective Recruitment**;** Evaluating & benchmarking Recruitment-Case Analysis/ Class Presentation- Selection; Selection process; Selection; Tests; Interview; Significance of background verification, Impact of social media in selection; Work samples and simulations**;** Reliability & validity in selection tests.- Training & Development- Training v/s Development; Training need analysis; Designing training programs; Methods of training and developing employees; Evaluating effectiveness of programs.
3. **Performance Assessment & Management**: Performance management & Appraisal; Criteria for good assessment; Methods of appraising performance; Raters of employee performance; Feedback process; Enhancing performance measurement**;** Balanced scorecards- Case Analysis/ Class Presentation-compensation administration; Legal regulation in Indian compensation; Job evaluation methods – establishing internal equity- external equity- individual equity**;** Establishing the pay structure- Incentive Compensation; Linking pay to performance; Individual incentives; Group incentives**;** Making variable pay successful- Benefits Management; Types of benefits; Issues in indirect compensation; Role of benefits in reward systems-Employee Transactions; Career planning; Career management methods

4. **Separations**: Retirement; Voluntary & involuntary turnover; Employee-at-will; Termination; Managing dismissals; Retrenchment & lay off- Succession Planning- Indian scenario- Industrial Relations; Labour laws; Trade unions; Employer associations- Disputes; Handling grievances; Disciplinary measures; Settlement machinery- Collective Bargaining; Bargaining terms; Negotiation process- Safety & Health management; Safety and health issues @ workplace; Employee fitness & wellness programs; Workplace violence
5. **Social Media Applications in Human Resource Management**: HR Audit; Fundamentals of record keeping- HR Accounting; Approaches to HR accounting; Controlling costs of manpower; Human Resource Information System (HRIS)- Employee engagement; Engaging & nurturing a productive workforce- Case Analysis

Prerequisite Courses: None

Reference Books:

1. “Human Resource Management”, K Aswathappa,Tata MCGraw Hill, 2013.
2. “Human Resource Management in Practice”, Armstrong, Michael, Kogan Page Ltd., 2005.
3. "Human Resource Management”, Fisher, C.D; Schoenfeldt, L.F; Shaw, J.B, All India Publishers and Distributors, 1997.

UL17BL203: BUSINESS ENVIRONMENT (4-0-0-0-4)

Course Objectives:

- To understand the influence of various environmental factors on international business operations.

Course Outcome:

At the end of the course, the student should be able to

- Define the concepts and challenges of international management and describe the global competitive landscape.
- Analyze critical and strategic thinking, primarily through deciphering complex international business environments.
- Explain the current business technology acquisition.

Course contents:

1. **Business Environment:** An Introduction-Introduction, Concept of Business, Levels of the Business Environment, Understanding the Environment- Environmental Context of International Business- Framework for analyzing international business environment – Domestic, foreign and global environments and their impact on international business decisions.
2. **Economic Environment:** Introduction, Economic Environment of Business, the Global Economic Environment, Economic Policies, Business and Economic Policies- Capitalist Economy, Socialist Economy, Mixed Economy-changing trade in world business environment.
3. **Socio Cultural Environment:** Introduction, Business and Society, Business and Culture, Indian Business Culture compared with global business culture- cultural orientation in international environment.
4. **Political Environment:** Introduction, Political Environment and the Economic system, Types of Political Systems, Indian Constitution and Business, Changing Profile of Indian Economy , Business Risks Posed by the Indian Political System.
5. **Technological Environment:** International Technology Transfers – importance and types, Foreign Technology Acquisition- Impact of technology change, Environmental Impact Analysis-Environmental impact analysis process- Guidelines on the scope of EIA; Issues in preparation of EIA report; Elements of the environmental problem.

Prerequisite Courses: None

Reference Books:

1. “International Business, Financial Times”, Bennet, Roger, Pitman Publishing, London, 2013.
2. “International Business: Environment and Operations”, Danoes, John D. and Radebaugh, Lee H., 8th Edition, Addison Wesley, Readings, 2008.
3. “International Business: A Managerial Perspective”, Griffin, Ricky W. and Pustay, Michael W, Addison Wesley, Readings, 1999.
4. “International Business”, Hill, Charles W. L., McGraw Hill, New York, 2014.

UL17BL204 CONSTITUTIONAL LAW – I (4-0-0-0-4)

Course objective:

- This course is devised to impress upon the students the salient features of the constitution, the fundamental rights, the directive principles of state policy and the fundamental duties.
- To enrich the student’s knowledge and enable them to appreciate the relevance of this fundamental law.

Course Outcome:

- Better position to grasp the conceptual as well as the judicial conspectus of the constitutional law.
- Understanding the Jurisprudence developed around it over the last six and half decades.

Course Contents:

1. **Introduction:** Constitutional Law and Constitutionalism; Rule of Law; Historical Evolution; Salient Features of the Indian Constitution; Fundamental Law; Preamble; Part I the union and its territory(Articles 1-4); Part II Citizenship (Articles 5 -11).
2. **Fundamental Rights Part III (Articles 12-18):** Introduction; Concept, Origin and Development; Magna Carta; The English Bill of Rights of 1689; The American Bill of Rights of 1791; The French Declaration of Rights of Man; The Universal Declaration of Human Rights, 1948; Need for Fundamental Rights in India; Classification; State and Fundamental Rights (Article 12); Justifiability of Fundamental Rights (Article 13); Unconstitutionality of a Statute; Doctrine of Eclipse; Doctrine of Severability; Waiver of Fundamental Rights; Right to Equality (Articles 14-18); Equality Before Law and Equal Protection of Laws (Article 14); Rule of Law under Article 14; Reasonable Classification; Administrative Discretion and Article 14; Articles 15 and 16 and Reservation in India; Mandal Commission and Its Effect; Article 17 and abolition of untouchability; Article 18.
3. **Fundamental Rights Part III (Articles 19-24):** Right to Freedom (Article 19); Protection Against Conviction; Ex Post Facto Law; Double Jeopardy; Prohibition Against Self-Incrimination (Article 20); Protection of Life and Personal Liberty (Article 21); Right to Education (Article 21-A); Protection against arrest and detention in certain cases (Article 22); Right against exploitation (Articles 23 and 24).
4. **Fundamental Rights Part III (Article 25-30 and 31- A,B,C,D and article 32):** Right to freedom of religion and cultural and educational rights (Articles 25-30); Right to Property (Article 31 and Article 31- A, B, C and D; Right to Constitutional remedies (Article 32)

5. **Directive Principles Of State Policy And Fundamental Duties Part IV and Part IV A (Articles 36 - 51-A):** Object and Purpose; Directive Principles and Fundamental Rights Distinguished; Directive principles read into the fundamental rights (Articles 36-51); Fundamental Duties (Articles 51-A);

Prerequisite Courses: None

Reference Books:

1. "Constitution of India", Singh, M. P., and V. N. Shukla, 11th Edition, Eastern Book Co., Lucknow, 2010.
2. "Constitution of India. 2 Vols." De, D. J., 2nd Edition, Asia Law House, Hyderabad, 2005.
3. "Constitutional Law of India", Basu, D. D., 7th Edition, Wadhwa, Nagpur, 1998.
4. "Indian Constitutional Law", Jain, M. P., 6th Edition, Lexis Nexis Butterworths Wadhwa, Nagpur, 2010.
5. "Constitutional Law of India: A Critical Commentary 3 Vols.", Seervai, H. M., 4th Edition , Universal Law Publishers, New Delhi, 2006.
6. "Lok Sabha Secretariat. Constituent Assembly Debates 5 Vols.", Lok Sabha Secretariat, New Delhi, 2014.
7. "Shorter Constitution of India", Chandrachud, Y. V. Durga Das Basu, 13th Edition, Wadhwa and Co., Nagpur, 2005.
8. "Working a Democratic Constitution: A History of the Indian Experience", Austin, Granville, Oxford University Press, New Delhi, 1999.
9. "Casebook on Indian Constitution", Basu, D. D., 2nd Edition, Kolkata: Kamal Law House, 2007.
10. "American Constitution", Tribe, Lawrence. 3rd Edition, Foundation Press, New York, 2000.
11. "The Framing of India's Constitution 6 Vols.", Rao, Shiva. Universal Law Publishing, New Delhi, 2004.
12. "Constitution of India 2 Vols." Swarup, Jagdish, 2nd Edition, Modern Law Publications, New Delhi, 2013.

UL17BL205
FAMILY LAW – I (4-0-0-0-4)

Course Objective:

- This course is designed to enable the students to understand the nuances of ancient Hindu law and analyse the same in juxta position with e contemporary norms and judicial interpretations.

Course Outcomes:

- The students will be in a position, pursuant to the study of this course, to understand the basics governing the arena of Hindu law.
- Critique the modern developments with reference to the legislative and judicial changes.

Course Content:

1. **Introduction:** Nature and evolution of family system; persons governed by Hindu law; sources of law- Ancient sources - The Vedas, Dharmashastras, Dharmasutras, Srutis, Smritis and customs; Modern sources of law - Precedents, Legislation, Justice, Equity and Good Conscience; Schools of Hindu law- Mitakshara and Dayabhaga Schools; Differences between Mitakshara and Dayabhaga Schools and sub-schools of Mitakshara; Joint Hindu Family Property - The Hindu Joint Family and The Role of Karta; Joint Family Property, Coparcenary System, Devolution of Property as per Ancient Law.
2. **Marriage**: Law prior to the Hindu Marriage Act 1955 – Forms of marriage, Requirements of a valid marriage and marriage ceremonies**;** The Hindu Marriage Act 1955 – Applicability, conditions for a Hindu Marriage, Ceremonies, Restitution of Conjugal rights and judicial separation, Nullity of marriage and divorce and Jurisdiction and procedure.
3. **Law on Hindu Succession:** Prior to the Hindu succession Act 1956**;** The Hindu Succession Act 1956 - Introduction and Application; Intestate Succession; General rules of succession in the case of males, Order of succession among class I heir, class II heirs, Agnates and cognates; Property of a Hindu female to be her absolute property, general rules of succession in the case of Hindu females, Order of succession in the case of Hindu females; Special provisions respecting persons governed by Marumakkattayam and Aliyasantana laws, full blood, half blood and uterine blood, disqualification to inherit, escheat and testamentary succession.
4. **Law on Hindu Adoptions and Maintenance:** The Hindu Adoptions and Maintenance Act – 1956 - Application of the Act - Definitions, Pre-requisites for Valid Adoption, Capacity of a Male Hindu to take in adoption, Capacity of a Female Hindu to take in adoption, Persons capable of giving in adoptions, Persons who may be adopted, Conditions for valid adoptions; Effects of adoption, Right of adoptive parents to dispose of their properties, Valid adoption not to be cancelled; Maintenance of wife, widowed mother, widowed daughter-in-law, children and aged parents, dependents, Quantum of maintenance, debts to have priority.
5. **Law on Hindu Minority and Guardianship:** The Hindu Minority and Guardianship Act – 1956 **-** Guardian under the Act, Natural guardians of Hindu Minor, Powers of Natural Guardian, Testamentary guardians and their powers and welfare of minor to be of paramount consideration; Incapacity of minor to act as guardian of property, De facto guardian not to deal with minor's property- Family Courts- Structure of Family courts, procedure and jurisdiction.

Prerequisite Courses: None

Reference Books:

1. "Modern Hindu Law", Diwan, Paras & Peeyushi Diwan, Allahabad law agency; 22nd edition (2013).
2. "Law of Marriage & Divorce", Peeyushi Diwan, Shailendra Jain, Paras Diwa, 5th Edition, Universal Law Publishing Co., 2016.
3. "Law of Intestate and Testamentary Succession", Diwan, Paras 3rd Edition, Universal Law Publishing, New Delhi, 2006.
4. "Hindu Law", Mulla, 20th Edition, LexisNexis Buttorworths, New Delhi, 2007.
5. "Cases and Materials on Family Law", Kusum, Universal Law Publishing Co., New Delhi, 2007.
6. "Hindu Law", Mulla, LexisNexis, 2013

UL17BL206
CONSUMER PROTECTION LAW (4-0-0-0-4)

Course Objective:

- Understanding the solitary principle of jurisprudence that consumer is King.
- Consumer's satisfaction and its importance to any manufacturer or vendor.
- Understanding the globalisation and liberalisation, with respect to the Consumer movement in India.

- Understanding different dimensions of Consumer Movement and law in India and the attending legislative and Judicial crusade to realise the consumer rights.

Course Outcomes:

- Appreciation of the law relating to consumer protection in theory and examine the role of regulatory and judicial as well as quasi judicial authorities.
- Understanding various Judgments and policy decisions under Consumer Protection Act.

Course Content:

1. **Introduction:** Consumer movement at the International level- The global march towards consumer protection and awareness; International Instruments for safeguarding the Consumer Protection.
2. **The Constitutional Background:** The Constitutional provisions underscoring the Consumer's rights, The Apex Court on the protection of Consumers;
3. **Regulatory Framework:** Consumer Protection Act, 1986 – Objectives, Meaning of Consumer, Protection of rights of Consumer, Deficiency in goods and services, Liability in professional services, Public Utility Services, Consumer Councils- Consumer exploitation through unfair trade practices.
4. **Consumer Disputes Redressal Agencies:** District forum, State commission, National commission; Constitution, Powers, Jurisdiction, Limitation and Procedure of the Adjudicatory bodies; Enforcement of Consumer rights through PIL; Consumer awareness and education in India.
5. **The Working of Consumer Protection Law in Different Sectors:** Telephone, Railways, Airlines, Electricity, Insurance, Finance, Medical Services, etc.

Prerequisite Courses: None

Reference Books:

1. "Supreme Court on Consumer Protection Act", Justice S N Aggarwal, Universal Law Publishing Co., 2013.
2. "The Law of Consumer Protection", Wadhwa, Justice D. P. (Ed). New Delhi, Wadhwa and Company Nagpur, 2006.
3. "Consumer Protection Law in India: An Eco-legal Treatise on Consumer Justice", Nayak, Rajendra Kumar, N. M Tripathi Pvt Ltd., Bombay, 1991.
4. "Treatise on Consumer Protection Law (Law & Practice)", Sheth, Dilip K. Snow White, Mumbai, 2003.
5. "Consumer Protection (Law & Practice)", Agarwal, Dr V. K. Bharat, 6th Edition, B. L. H. Publishers and Distributors Pvt. Ltd., New Delhi, 2008.
6. "Law of Consumer Protection (Principles & Practice)" Singh, Avtar, 4th Edition, Eastern Book Co., Lucknow, 2005.
7. "Law of Consumer Protection in India", Majumdar, P. K., 5th Edition, Orient Publishing Company, New Delhi, 2003.

UL17BL251
STRATEGIC MANAGEMENT (4-0-0-0-4)

Course Objectives:

The objective of this course is

- to develop the ability to understand strategy, analyze the competitive environment, and understand firm positioning and value creation.
- To explore the theory and frameworks underlying the foundations of a successful business strategy.

Course Outcomes:

At the end of the course students are able to:

- Understand the strategic context within which organizations do business
- Apply strategic tools to analyze an organization in the context of its external and internal environment
- Provide insights into and reflect upon strategies of Indian companies

Course Content:

1. **Introduction to Strategic Management:** Concept of Strategy, Managing the strategy making process for competitive advantage including Vision and Mission, strategic Fit and strategic intent, External Analysis: Identification of opportunities and threats, Porter's five forces model, Strategic groups, Industry life cycle analysis, Industry life cycle analysis, Limitations of models
2. **Internal Analysis:** Distinctive competencies, Competitive advantage and Profitability, SWOT analysis, Value Chain. Building Competitive Advantage Through Functional Level Strategy: Achieving superior Efficiency, Quality, Innovation and Customer Responsiveness
3. **Building Competitive Advantage Through Business Level Strategy:** Choosing a generic business level strategy, the BCG matrix and GE 9 cell matrix, Competitive positioning and Business level strategy,
4. **Corporate Level Strategy:** Horizontal integration, Vertical Integration, Cooperative relationships, Strategic outsourcing, Strategic Alliances, Diversification
5. **Corporate Performance, Governance, and Business Ethics**: Causes of poor performance, improving performance, stakeholders and corporate performance, ethics and strategy Implementing Strategy: Implementing strategy through organization structure, control and culture; strategic control systems, restructuring and reengineering. Practical Component based on Strategy simulation games and Case Studies

Prerequisite Courses: None

Reference Books:

1. "Strategic Management: An Integrated Approach", Hill, Charles W L. Jones, Gareth R., 6th Edition, Cengage Learning, New Delhi, 2008.
2. "Crafting and Executing Strategy: The Quest For Competitive Advantage, Concepts and Cases", Arthur A. Thompson Jr., AJ Strickland III, John E Gamble, Tata McGraw Hill, New Delhi, 18th Edition, 2013.
3. "Transnational Management", Bartlett, C., Ghoshal, S, Beamish P, McGraw Hill, 5^{th} Edition, 2008.

UL17BL252
CORPORATE ACCOUNTING (4-0-0-0-4)

Course Objectives:

- to gain knowledge and insights into, the preparation of various accounts of joint stock companies, the valuation of goodwill and shares and the recent trends in accounting.

Course Outcome:

At the end of the course, the student should be able to

- Illustrate the methods in which the joint stock companies issue, redeem, convert and underwrite the shares and debentures.
- Prepare the final accounts of large concerns.
- Calculate an estimate of the value of goodwill and shares.
- Explain the recent trends in accounting.

Course Contents:

1. **Company Accounts – Issue of Equity Shares:** Application and allotment of shares, over and under subscription, refund of issue money; Pro-Rata allotment of shares, calls in advance and calls arrears, forfeiture and re-issue of shares, issue of bonus shares, employee stock options and sweat equity shares, issue of shares at premium.
2. **Company Accounts:** Issue and Redemption of Preference Shares and Debentures and Underwriting:
   (a) Preference shares types and issue; redemption of preference shares; conversion into Equity Shares;
   (b) Debentures - nature and difference from shares; issue, redemption and conversion into shares;
   (c) Underwriting of issue of securities.
3. **Final Accounts of Companies-I:** Final accounts of companies: Preparation of income statement and Balance sheet-Cost of goods sold-Operating expenses- Finance cost-Dividend and appropriation-share capital-Reserves and surplus-Secured loan-Fixed assets-Current assets and advances- Current liabilities and provisions- Fictitious Assets- depreciation and amortization
4. **Valuation of Goodwill and Valuation of Shares:** Meaning of goodwill, nature of goodwill, factors affecting goodwill, methods of calculating goodwill, computation of average profits and calculation of future maintainable profits after tax. Meaning, need for valuation, factors affecting valuation, methods of valuation, intrinsic value method, yield method, earning capacity method, fair value method.
5. **Recent Developments in Accounting & Accounting Standards:** Human Resource Accounting – Environmental Accounting – Social Responsibility Accounting. Accounting Standards - their role in company accounts. IFRS and US GAAP – brief overview, Differences between Indian standards, US GAAP and IFRS, INDAS.

Prerequisite Courses: None

Reference Books:

1. "Corporate Accounting", Maheshwari, S N Maheshwari, S K, Vikas Publishing House, 2016.
2. "Corporate Accounting", P.C Tulsan, Tata Mc Graw Hill, 2012.
3. "Advanced Accountancy", S. N. Maheshwari, Vol 2, Vikas Publishing House, 2011.
4. "Taxman's Accounting: CA Intermediate (IPCC)", D.G Sharma, 2nd Edition CA, 2014.

UL17BL253
BUSINESS COMMUNICATION (4-0-0-0-4)

Course Objectives:

- To understand the fundamental principles of effective business communication and their practical applications in the current business practices.

Course Outcomes:

At the end of the course, the student should be able to.

- Understand the communication process.
- Practically carry out business communication.
- Deliver public speeches and make presentation.
- Participate and conduct meetings effectively.

Course Contents:

1. **Elements of Communication:** Meaning – Importance – Objective and principles of communication, types of communication-communication process, impediments of effective communication, the cross cultural dimensions of Business communication, Business and social etiquettes.
2. **Interview Technique**: Importance of interview – art of conducting and giving interviews –types of interview, Resume drafting, onverbal communication, types of NVC, listening – types.
3. **Public Speaking:** Speech and presentation, Principles of effective speech and presentation – speech of introduction of a speaker – speech of vote of thanks – occasional speech –theme speech-
4. **Instruments of Business Communication**: Inquiries, Circulars, Quotations, Orders, Acknowledgments, Complaints, Claims and adjustments, banking correspondence, Sales letters, Memos, Covering letter, Interview letters, leave letter.
5. **Meetings:** Meaning, Importance, Minutes of Meeting-Meetings, Participating and conducting group discussions, Brain Storming and its benefits, use of technology, report writing.

Prerequisite Courses: None

Reference Books:

1. "Communication", Rayudu C S, Himalaya Publishing House, 10th Edition, New Delhi, 2012.
2. "Excellence in Business Communication", Thill J V and Bovee G L, Mc-Graw Hill, New York, 1993.
3. "Business Communication from Process to Product", Bowman, J P and Brachaw P P, Dryden Press, Chicago, 1987.
4. "Business Communication", Meenakshi Raman & Prakash Singh, Oxford Publisher, 2012.
5. "Business Communication", Kaul, Prentice Hall, New Delhi, 2010.
6. "Business Communication: The Real World and Your Career", Senguin, J, Allied Publishers, New Delhi, 2012.
7. "Basic Communication Skills for Technology", Rutherford J, Andre, Pearson Education, Noida, 2012.
8. "Essentials of Business Communication", Rajendra Paul, Korlahalli, J S, Sultan Chand & Sons, New Delhi, 2011.

UL17BL254
CONSTITUTIONAL LAW –II (4-0-0-0-4)

Course Objectives:

- Indian Polity and Administration are characterised by a quasi-federal structure and the three organs of the state closely knitted.
- The Centre-State relations have always been the focal point ever since the inception of the Constitution of India.
- Understanding emergency and amendment provisions, are elaborately dealt with in the Constitution and a huge corpus of law is developed around them.
- This course aims at the Study of the federal structure, the working of legislature, executive and judiciary, the Centre-State Relations and other important provisions on elections, emergency, amendment and others.

Course Outcomes:

- The students would be equipped with the working of the Constitutional institutions and functionaries.
- Analysing judicial role in safeguarding of the Constitution
- Analysing the Doctrine of pleasure with Centre and State relations.

Course Contents:

1. **Federalism, Executive and Legislature:** The Nature of Federalism and Indian Federation; President and Vice-President of India – Qualifications, Election, Powers and Functions; Governors of

States - Appointment, Powers and Functions; Parliament and State Legislatures – The Officers, Conduct of Business, Powers and Privileges of the members and the Committees, The Legislative procedure of Law making, Budget.

2. **Judiciary:** Establishment and Constitution, Court of Record, Jurisdiction, Original and Appellate Jurisdiction, Special Leave Petition, Precedents; High Courts – Establishment and constitution, Writ jurisdiction and Prerogative Writs – *Habeas Corpus, Mandamus,* Prohibition*, Certiorari, Quo Warranto*; Control over subordinate courts.
3. **Centre State relations:** Legislative Relations, Administrative Relations, Financial Relations, Finance Commission, Trade Relations.
4. **Contracts and Services under the Union and the States:** Government contracts, Recruitment and conditions of service, Doctrine of pleasure
5. **Elections, Emergency & Amendment:** Election commission of India – Composition, Powers and Functions, Role of Election Commission in the Superintendence of Elections, Anti-Defection Law, Representation of People's Act, 1951; Emergency provisions – National, State and Financial emergency, Amendment of the Constitution – power and procedure, the basic structure of the Constitution, IX th Schedule to the Constitution.

Prerequisite Courses: None

Reference Books:

1. "Constitution of India", Singh, M. P., and V. N. Shukla, 11th Edition, Eastern Book Co., Lucknow, 2010.
2. "Constitution of India 2 Vols.", De, D. J., 2nd Edition, Asia Law House, Hyderabad, 2005.
3. "Constitutional Law of India", Basu, D. D., 7th Edition, Wadhwa, Nagpur, 1998.
4. "Indian Constitutional Law", Jain, M. P., 6th Edition, Lexis Nexis Butterworths Wadhwa, Nagpur, 2010.
5. "Constitutional Law of India: A Critical Commentary. 3 Vols.", Seervai, H. M. 4th Edition, Universal Law Publishers, New Delhi, 2006.
6. "Lok Sabha Secretariat. Constituent Assembly Debates. 5 Vols.", Lok Sabha Secretariat, New Delhi, 2014.
7. "Shorter Constitution of India", Chandrachud, Y. V. Durga Das Basu, 13th Edition, Wadhwa and Co., Nagpur, 2005.
8. "Working a Democratic Constitution: A History of the Indian Experience", Austin, Granville, Oxford University Press, New Delhi, 1999.
9. "Casebook on Indian Constitution", Basu, D. D., 2nd Edition,. Kamal Law House, Kolkata, 2007.
10. "American Constitution", Tribe, Lawrence, 3rd Edition, Foundation Press, New York, 2000.
11. "The Framing of India's Constitution. 6 Vols.", Rao, Shiva, Universal Law Publishing, New Delhi, 2004.
12. "Constitution of India. 2 Vols.", Swarup, Jagdish, 2nd Edition, Modern Law Publications New Delhi,. 2013

UL17BL255
FAMILY LAW – II (4-0-0-0-4)

Course Objective:

- This course is designed to understand the theoretical as well as practical implications of one of the important personal laws namely Mohomedan Law.
- It deals with several aspects of the personal law relating to Muslims such as religion, marriage, property and others.
- The course offers a wide array of religious exposition and the judicial delineation of this important branch of law.
- It also focuses on the Constitutional perspective on the personal laws in general.

Course Outcome:

- The students studying this course would, apart from obtaining the necessary inputs into the law governing the Muslims.
- Develop the requisite incisive analytical skills and comparative outlook with reference to different personal laws in India.
- Understanding the implications of personal laws in the society

Course Contents:

1. **Introduction** – Mohamedans – Meaning and Nature, Conversion; Mahomedian sects and sub-sects; Sources of Interpretation of Mahomedan Law - The Koran, Hadis, IjmaaQiyas; Interpretation of the Koran; Precepts of The Prophet; Ancient Texts and General rules of interpretation of Hanafi Law; Muslim Personal Law (Shariat) Application Act, 1937.
2. **Marriage**, Maintenance of wives and Restitution of Conjugal Rights- Definition of Marriage; Capacity for Marriage; Essentials of Marriage; Kinds of Marriage; Iddat Period; Marriage between Sunni and Shia Muslims; Presumption of Marriage; Muta Marriage; Marriage of Minors; Repudiation under the Dissolution of Muslim Marriage Act, 1939- Divorce; Divorce by Husband; Judicial Divorce at the Suit of Wife; Effects of Divorce-Maintenance of Wives; Suits for Restitution of Conjugal Rights; Dower- Definition, Kinds of Dower, Suit for Dower and Limitation; Widow's Right to Retain Possession of Husband's estate in lieu of Dower
3. **Succession and Administration:** Administration of the Estate of a Deceased Mahomadan – General rules; Vesting of estate in Executor and Administrator; Devolution of Inheritance; Alienation; Extent of liability of Heirs for Debts; Distribution of Estate; Suits; Hanafi Law of Inheritance; Shia Law of Inheritance; Wills - Persons Capable of Making Wills; Limit of Testamentary Power; Death- bed Gifts and Marz-ul-maut, Conditions necessary for its validity, Death-bed acknowledgment of Debt, Gifts or Hiba; Persons capable of making gifts; Gift to unborn person, Extent of donor's power, Gift of Actionable Claim & incorporeal property, Gift of equity or redemption, Relinquishment by donor of ownership and dominion, Essentials of Gift, Contingent gift, Revocation of gift & Kinds of gift.
4. **Wakfs :** Definition; Subject of Wakf; Object of Wakf, Law relating to private wakfs before the Mussalamn Wakf Validating Act, 1913; Preemption- Meaning; Special Acts, Preemption among Hindus, Preemption by contract; Who may claim Preemption; Sale alone gives rise to Preemption; Legitimacy and Acknowledgment - Paternity and Maternity- Acknowledgement of paternity- Guardianship of person and property of Minor.
5. **Indian Succession Act:** Preliminary, Jurisdiction, Dissolution of Marriage, Nullity of Marriage, Judicial separation, Restitution of Conjugal Rights, Alimony, Settlements, Re-marriage; Domicile (Ss 4-19), Consanguinity (Ss 23-28); Intestate Succession (Ss 29-56); Testamentary Succession (Ss 57-191); Probate, Letters of Administration of assests of deceased, Succession of Certificate (Ss 370-390)- part 'c'- Indian Divorce Act- Special Marriage Act, 1954; The Muslim Women (Protection of rights on Divorce) Act, 1986.

Prerequisite Courses: None

Reference Books:

1. "Cases and Materials on Family Law", Kusum, Universal Law Publishing Co., New Delhi, 2007.

2. “Principles of Mohamedan Law”, Hidayatullah, M., and Arshad Hidayatullah. Mulla, 19th Edition, LexisNexis Butterworths, New Delhi, 2006.
3. “Marriage, Adoption and Guardianship and Canon Law on Marriage”, Chmpappilly, Sebastian, Southern Law Publishers, Cochin, 2003.
4. “Christian Law of Divorce”, Champappilly Sebastian, Southern Law Publishers, Cochin, 2007
5. “The Indian Succession Act”, Paruck, 9th Edition, LexisNexis Buttorworths, New Delhi, 1995.
6. “Principles of Mahomedan Law”, Mulla, LexisNexis, 2017
7. “Mohammedan Law”, Aqil Ahmad, Central Law Agency, 26th Edition, 2016
8. “Muslim Law in Modern India”, Paras Diwan, Allahabad Law Agency; 12th Edition, 2016.

UL17BL256
JURISPRUDENCE (4-0-0-0-4)

Course Objective:

- To understand the Philosophy of Law or The Knowledge of Law.
- It is a course that throws light on the various conceptual understandings of the discipline of law
- Directs the concerned to explore the application of the paradigms of law to the practical situations.
- This Course is devised to ascertain the philosophical moorings of the discipline of law and their application to the pragmatic facts situations to arrive at the required solution to the legal problems.

Course Outcome:

- Every student of Jurisprudence would be looking at a two-pronged advantage after studying it.
- Hands-on necessary epistemological background of law as a discipline.
- An in-depth idea of the various sources of law and the concepts developed as a result of the same.

Course Contents:

1. **Introduction:** The nature and value of jurisprudence
2. **The Nature of Law:** The Purpose of legal theory; Natural Law; Imperative Law; Legal realism; Law as a system of rules; International Law; the Authority of Law; The Function and purpose of Law; Law and fact; the territorial nature of law and Constitutional law.
3. **The Administration of Justice:** Necessity of administration of Justice; Civil and criminal justice; the purpose of criminal and civil Justice; Secondary functions of courts of law.
4. **The Sources of Law:** Legal and historical sources; the legal sources of English Law; Legislation; Precedent; Customs.
5. **Legal Concepts:** Legal rights; Ownership; Possession; Persons; Titles; Liability; The law of property; The law of obligations; The law of procedure.

Prerequisite Courses: None

Reference Books:

1. “Jurisprudence—The Philosophy and Method of Law”, Bodenheimer, Universal, New Delhi, 1996.
2. Friedmann, W., Legal Theory. New Delhi: Universal, 1999.
3. “Lloyd’s Introduction to Jurisprudence”, Freeman M. D. A. (Ed.), Sweet and Maxwell, 1994.
4. “Jurisprudence”, Paton G. W., ELBS, OUP, Oxford, 1972.
5. “The Concepts of Law”, Hart, H. L. A., ELBS, OUP, Oxford, 1970.
6. “Introduction to the Philosophy of Law”, Pound, Roscoe., Universal, New Delhi, 1996 (reprint).
7. “Jurisprudence”, Dias R. W. M., Adithya Books (First Indian re-print) New Delhi, 1994.
8. “Jurisprudence: A Study of Indian Legal Theory”, Dhyani S. N., New Delhi, Metropolitan, 1985.

UL17BL280:
INTERNSHIP (0-0-0-8-4)

Course Objectives:

- To provide hands-on working experience to students
- To hone the profession/industry-centric skills of students
- To build the network amongst the students and stake-holders in the profession
- To enhance the employability of students

Course Outcomes:

- Students receive the necessary practical exposure after each internship cycle
- Students acquire the necessary skills needed for a litigating lawyer, law firm associates, in house counsels, etc.,
- They act as a bridge between the academia on one hand, and legal professionals, firms and other stake-holders, on the other hand.
- Regular and periodical internships increase the employability of the student and expand the horizon of professional paradigms.

MINORS

MINOR

PES University is offering Minor in a chosen area. A student may register for a Minor in a program area outside his/her Major discipline. Students opting for Minors should register and successfully complete at least FOUR (minimum of 12 credits) courses as specified by the concerned Departmental Curriculum Committee.

University is currently offering Minor in the following:

Sl. No.	Course Code	Course Title	Credits
1.	**Computer Science and Engineering**		
	UE18CS160*	Data Structures	4
	UE18CS180	Data Base Management Systems	4
	UE18CS240*	Design and Analysis of Algorithms	4
	UE18CS280**	Introduction to Operating Systems	4
	UE18CS162	Data Structures Laboratory	1
	UE18CS242	Design and Analysis of Algorithms Laboratory	1
	UE18CS282	Introduction to Operating Systems Laboratory	1
2.	**Civil Engineering**		
	UE16CV140	Strength of Materials	4
	UE16CV180	Geoinformatics	4
	UE16CV240	Construction Materials & Technology	4
	UE16CV280	Estimation and Costing	4
3	**Electronics and Communication Engineering**		
	UE18EC140	Probability and Random Process (For all branches)	4
	UE18EC160	Real Time Embedded System (only for EEE)	4
	UE18EC180	Digital Signal Processing (For all branches except EEE)	4
	UE18EC240	Computer Network (only for EEE)	4
	UE18EC260	Embedded System (For all branches except EEE)	4
	UE18EC280	Communication Engineering (For all branches)	4
4.	**Electrical and Electronics Engineering**		
	UE18EE140	Generation, Transmission And Distribution Systems	4
	UE18EE180	Solar Photovoltaic Systems	4
	UE18EE240	Sensors and Actuators	4
	UE18EE280	Wind Electrical Systems	4
5.	**Mechanical Engineering**		
	UE18ME140	Material Science and Metallurgy	4
	UE18ME180	Engineering Thermodynamics	4
	UE18ME240	Mechanics of Solids	4
	UE18ME280	Mechanics of Fluids	4
6.	**Management**		
	UM18MB140	Managing Organizations	3
	UM18MB180	Marketing Management in The Digital Era	3
	UM18MB240	Supply Chain Management	3
	UM18MB280	Financial Management	3
* UE18/17/16CS151 ** Data Structures			

7.	**Design**		
	UA17BD140	Design Methods and Creativity	4
	UA17BD180	Ergonomics	4
	UA17BD240	Design, Innovation and Management	4
	UA17BD280	Design Project	4
8.	**Economics**		
	UM17AE140	Principles of Economics	4
	UM17AE180	Economics of Technology and Innovation	3
	UM17AE240	Econometric Analytics	4
	UM17AE280	Financial Economics	3
9.	**Law**		
	UL17BL140	Introduction to Law and Legal Systems	4
	UL17BL180	Company Law and Business Ethics	4
	UL17BL240	Intellectual Property Law	4
	UL17BL280	Law of Contracts	4

A student is certified to have completed the Minors in the chosen discipline after he / she completes the assessments prescribed for the course (In Semester Assessment – ISA and End Semester Assessment - ESA) and secures a letter grade as detailed below:

#	Letter Grade	Grade points	Remarks
1	S	10	Outstanding
2	A	9	Excellent
3	B	8	Very good
4	C	7	Good
5	D	6	Fair
6	E	5	Satisfactory

MINOR IN COMPUTER SCIENCE AND ENGINEERING

UE18CS160
DATA STRUCTURES (4-0-0-0-4)

Course Objectives:
The objective(s) of this course is to,

- Enable the learner with the concepts of recursion and linear data structures viz., Linked Lists, Stacks and Queues.
- Enable the learner with the concepts of non-linear data structures viz., Graphs, Trees, Heaps, Trie and Hashing.
- Hone the learner such that they obtain the ability to compare different implementations of data structures and recognize the advantages and disadvantages of different implementations.
- Inculcate in the learner, the aspects of choosing the appropriate data structure and algorithm design method for a specified application and with the usage of standard libraries.

Course Outcomes:
At the end of the course, the student will be able to:

- Implement fundamental data structures viz., Lists, Stacks, Queues, Linked Lists, Binary Trees from first principles.
- Demonstrate the use of appropriate data structures for a given problem.
- Design and implement solutions to basic practical problems using customized data structures.
- Develop quick and foolproof solutions to practical problems using abstract data types.

Course Content:
1. **Data Structures Overview**: Recursion, Pointers, Programming Practices. **Lists**: Definition, Create, Insert, Delete, Update, Traverse and Position-based Operations, Linked List and Array Implementations, Concatenate, Merge, and Reverse Lists, Doubly-Linked List Implementation and Operations, Circular Lists and Multi-List, Applications of Lists.
2. **Stacks**: Definition, Operations, Implementation using Linked-List and Arrays, Applications of Stacks – Postfix Conversion and Expression Evaluation, Parentheses Balancing. **Queues**: Definition, Operations, Implementation, Applications, Circular Queue, Dequeue.
3. **Graphs:** Definition, Complete Graphs, Regular Graphs, Paths, Connectivity, Euler and Hamilton Graphs, Representation of Graphs - Adjacency/ Cost Matrix, Adjacency Lists, and Traversal of Graphs. **Trees**: General Tree Representation, Traversals, Applications. **Binary Trees**: Definition, Properties, Implementation, Traversals, Applications.
4. **Binary Search Tree**: Definition, Implementation, Search, Insert, Delete operations. Building and Evaluating Binary Expression Tree. **Heap Tree**: Implementation, Insert, Delete, FindMin operations. Priority Queue using Arrays and Heap.
5. **Tries:** Definition, Implementation, Applications. **Hashing**: Hash Table, Hash Functions, Collision Handling by Open Addressing, Chaining.

Pre-requisite Courses: UE17CS151 – Problem Solving with C.

Reference Book(s):
1. "Data Structures and Program Design in C", Robert Kruse, C L Tondo, Bruce Leung and Shashi Mogalla, PHI, 2nd Edition, 2015.
2. "Data Structures Using C and C++", Tanenbaum, Langsam, Augenstein, Pearson, 2nd Edition, 2015.

UE18CS180
DATABASE MANAGEMENT SYSTEMS (3-2-0-0-4)

Coure Objectives:
The objective(s) of this course is to,

- Introduce fundamental concepts, terminology and application of databases.
- Teach design concepts and creation of relational databases.
- Teach basic and advanced SQL commands.
- Provide overview of database programming and procedural languages.
- Provide overview of transaction management, database recovery and security.

Course Outcomes:
At the end of the course, the student will be able to:

- Construct an Entity-Relationship (E-R) model from specifications and transform it to a relational model.
- Design databases and apply normalization constraints.
- Construct queries in SQL or Relational Algebra to perform CRUD (Create, Retrieve, Update and Delete) operations on database.
- Understand and apply the concepts of procedural languages.
- Apply the principles of database transaction management, database recovery and security.

Course Content:
1. **Introduction to Database and Conceptual Design using ERD:** Introduction to Databases**,** Conceptual Model**,** Conceptual Design using ERD, Entity, Weak Entity, Relationships, Attributes and Keys, Roles and Constraints, Relational Model, Constraints and Database Schemas, ER to Relational Mapping, Relational Algebra, Unary Operations - SELECT and PROJECT, Set Theory Operations, Binary Relational Operations - JOIN, DIVISION, Aggregate Functions and Grouping.
2. **SQL:** SQL Data Definition, Primary Data Types and Advanced Data Types like CLOB,BLOB, Specifying Constraints in SQL, Basic Retrieval Queries, Insert, Delete, Update and Schema Change Statements in SQL, Advanced SQL Queries, Specifying General Constraints as Assertions and Triggers, Views, Additional Features of SQL, Database Programming, PL/SQL.
3. **Database Design:** Informal Design Guidelines for Schemas, Functional Dependencies, Inference Rules, Closure, Equivalence, Minimal Cover, Normal Forms Based on Primary Keys (1st, 2nd and 3rd NF), General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form, Properties of Relational Decompositions, Overview of Higher Normal Forms.
4. **DBMS Architecture and Database Security:** Three-Schema Architecture, Data Abstraction and Data Independence, Database Languages and Interfaces, DBMS Modules, Database Security, Access Control.
5. **Transaction Management and Database Security:** ACID Properties, Transactions and Schedules, Serializability and Recoverability, Precedence Graphs, Concurrency, Lock-Based Protocols, 2PL, Strict 2PL Protocols, Timestamp-Based Protocols, Deadlocks-Detection and Prevention, Crash Recovery, Advanced Topics - NoSQL.

Pre-requisite Courses: None.

Reference Book(s):
1. "Fundamentals of Database Systems", Ramez Elamsri, Shamkant B Navathe, Pearson, 7th Edition, 2017.
2. "Database Management Systems", Johannes Gehrke and Raghu Ramakrishnan, McGraw-Hill, 3rd Edition, 2003.

3. "Database Systems: The Complete Book", Garcia-Molina, J D Ullman and Widom, 2nd Edition, Prentice-Hall, 2008.
4. Silberschatz, H Korth and S Sudarshan, Database System Concepts, 6th Edition, McGraw-Hill, 2010.

UE18CS240
DESIGN AND ANALYSIS OF ALGORITHMS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Learn to design and analyze algorithms with an emphasis on the resource utilization in terms of time and space.
- Learn various techniques in development of algorithms so that the effect of problem size and architecture design on the efficiency of the algorithm is appreciated.

Course Outcomes:

- At the end of the course, the student will be able to:
- Identify the design technique used in an algorithm.
- Design an algorithm for a problem in a known design technique.
- Prove the correctness of an algorithm.
- Analyze the resource utilization of an algorithm in terms of time and space.
- Understand the limits of algorithms and the ways to cope with the limitations.

Course Content:

1. **Introduction:** Algorithms, Fundamentals of Algorithmic Problem Solving, Important Problem Types. **Analysis of Algorithm Efficiency:** Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non - Recursive and Recursive Algorithms.
2. **Brute Force:** Sequential Search, Brute Force String Matching, Selection Sort, Bubble Sort, Depth-First Search and Breadth-First Search, Exhaustive Search. **Divide-and-Conquer:** Merge Sort, Quick Sort, Binary Search, Binary Tree Traversals, Multiplication of Large Integers, Strassen's Matrix Multiplication and Master Theorem.
3. **Decrease-and-Conquer:** Insertion Sort, Topological Sorting, Algorithms for Generating Combinatorial Objects, Decrease-by-a-Constant-Factor Algorithms. **Transform-and-Conquer:** Presorting, Heap Sort, AVL Trees, Red-Black Trees, 2-3 Trees and B Trees.
4. **Space and Time Tradeoffs:** Sorting by Counting, Input Enhancement in String Matching - Horspool's and Boyer-Moore Algorithms. **Dynamic Programming:** Computing a Binomial Coefficient, The Knapsack Problem and Memory Functions, Warshall's and Floyd's Algorithms.
5. **Greedy Technique:** Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees. **Limitations of Algorithm Power:** Lower-Bound Arguments, Decision Trees, P, NP, and NP-Complete Problems. **Coping with the Limitations of Algorithm Power:** Backtracking, Branch-and-Bound.

Pre-requisite Courses: UE17CS151 – Problem Solving with C.

Reference Book(s):

1. "Introduction to the Design and Analysis of Algorithms", Anany Levitin, 2nd Edition, Pearson Education, 2011 (Updated Version of the Book).
2. "Introduction to Algorithms", Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, 3rd Edition, Prentice-Hall India, 2009.
3. "Fundamentals of Computer Algorithms", Horowitz, Sahni, Rajasekaran, 2/e, Universities Press, 2007.
4. "Algorithm Design", Jon Kleinberg, Eva Tardos, Pearson Education, 2006.

UE18CS280
INTRODUCTION TO OPERATING SYSTEMS (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Provide an understanding on the various components of an Operating System.
- The course focuses on fundamental problems and optimal solutions for resource management in operating systems such as process, disk and memory management.
- The course will introduce design principles and tradeoffs in the design of Operating Systems.
- The course will also introduce the interface for interacting with a contemporary Operating system such as Linux.

Course Outcomes:

At the end of the course, the student will be able to:

- Gain extensive knowledge on principles and modules of Operating Systems.
- Understand the design of various algorithms for scheduling and their relative performance.
- Design pieces of operating systems such as process management, concurrent processes and threads, memory management and virtual memory.
- Use tools and interface of the operating system.
- Explore design tradeoffs in designing various components of an Operating System.

Course Content:

1. **Introduction and CPU:** What Operating Systems Do? **Introduction to Virtualization of Resources:** CPU/ Memory, Concurrency, Persistence. The Process Abstraction, Process States, Description, Control, API (fork()/ exec()). **Scheduling:** Workload Assumptions, Metrics, Types of Scheduling: FIFO, SJF, Response Time, Round Robin, Multi - Level Feedback Queue. **Case Study:** Linux/ Windows/ UNIX Scheduling Algorithms.
2. **Concurrency:** Introduction and Threads, Types of Threads, Multi - Core/ Multi - Threading, Shared Data, **Thread API:** Thread Creation, Completion, Locks, Condition Variables, Compilation. **Mutual Exclusion and Synchronization:** Software Approaches, Principles of Concurrency, Hardware Support, Semaphores, Message Passing, Readers Writers Problem, pthread Locks. **Deadlocks and Starvation:** Principles of Deadlock, Tools for Detection.
3. **Memory:** Requirements, Partitioning, Paging, Segmentation, Memory API – malloc/ free, Errors. **Virtual Memory**: Hardware and Control Structures, OS Support, Address Translation, Dynamic Relocation, Segmentation, Paging, TLBs, Context Switches, Replacement Policy - LRU, Design Alternatives – Inverted Page Tables, Bigger Pages, Swapping. **Case Study:** Linux/ UNIX Memory Management.
4. **Persistence: I/O Devices** – System Architecture, Canonical Devices/ Protocol – Organization of I/O, CPU Overheads and Interrupts, DMA, OS Design Issues - Device Interaction, Device Driver, Buffering. **Disk Drives:** Performance Parameters - Geometry, I/O Time Computation, Disk Scheduling Policies, Data Integrity and Protection – Checksum.
5. **File Systems:** File Organization and Access, Directories, Sharing, Security – Access Controls, Record Allocation, Secondary Storage Management. **Case Study:** UNIX/ Windows/ Linux File System. **FS Interface:** Creating/ Reading/ Writing, Random Access, fsync(), Renaming, Hard Links and Symbolic Links, Mounting File Systems. **Security:** Intruders and Malicious Software, Buffer Overflow, OS Hardening, Case Study: UNIX/ Windows.

Pre-requisite Courses: UE16CS202 – Data Structures.

Reference Book(s):

1. "Operating Systems - Internals and Design Principles", William Stallings, 9th Edition, Pearson, 2018.
2. "Operating Systems: Three Easy Pieces", Remzi Arpaci-Dusseau and Andrea Arpaci Dusseau, http://pages.cs.wisc.edu/~remzi/OSTEP/
3. "Advanced Programming in the Unix Environment", Richard Stevens and Stephen A Rago, Pearson, 3rd edition, 2017.
4. "Operating System Concepts", Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, 9th Edition, John Wiley and Sons, 2013.
5. "Operating Systems", Harvey Deitel, Paul Deitel, David Choffnes, 3rd Edition, Prentice Hall.
6. "Modern Operating Systems", Andrew S Tannenbaum, 3rd Edition, Pearson.

UE18CS162
DATA STRUCTURES LABORATORY (0-0-2-0-1)

Course Objectives:

The objective(s) of this course is to,

- Enable the learner with the concepts of recursion and linear data structures viz., Linked Lists, Stacks and Queues.
- Enable the learner with the concepts of non-linear data structures viz., Graphs, Trees, Heaps, Trie and Hashing.
- Hone the learner such that they obtain the ability to compare different implementations of data structures and recognize the advantages and disadvantages of the different implementations.
- Inculcate in the learner, the aspects of choosing the appropriate data structure and algorithm design method for a specified application and with usage of standard library.

Course Outcomes:

At the end of the course, the student will be able to:

- Implement fundamental data structures viz., Lists, Stacks, Queues, Linked Lists, Binary Trees from first principles.
- Demonstrate the use of appropriate data structures for a given problem.
- Design and implement solutions to basic practical problems using customized data structures.
- Develop quick and foolproof solutions to practical problems using abstract data types.

Course Content:

1. Write a program to perform the following operations using a Linked List:
   a) Insert an element at the beginning.
   b) Delete the specified element from the list.
   c) Display elements of the list.
2. Write a program to perform the following operations using Linked List:
   a) Insert an element at a specified position.
   b) Delete the element at the end of the list.
   c) Reverse the nodes in the list.
   d) Display elements of the list.
3. Write a program to perform the following operations using Doubly Linked List:
   a) Insert an element at the beginning.
   b) Delete the specified element from the list.
4. Write a program to perform the following operations using Doubly Linked List:
   a) Insert an element at a specified position.
   b) Delete the element at the end of the list.
5. Create an array or linked list implementation of Stack. Provide PUSH, PEEP (or TOP) and POP methods. Check for:
   a) Overflow b) Underflow
   exceptions during these operations.
6. Create an array or linked list implementation of Queue. Provide ENQUEUE, DEQUEUE and FRONT methods. Check for:
   a) Overflow
   b) Underflow
   exceptions during these operations.
7. Covert a given infix expression to postfix expression.
8. Write a program to perform matching of brackets – parentheses, square and flower brackets.
9. Implement a circular queue CQUEUE and implement ENQUEUE and DEQUEUE functions.
10. Write a C program to find the number of connected components in an undirected graph using DFS traversal.
11. Implement a Binary Search Tree and perform the following:
    a) Insert a node.
    b) Preorder Traversal.
    c) Postorder Traversal.
    d) Inorder Traversal.
12. Implement a Binary Search Tree and perform the following:
    a) Find the minimum element in the tree.
    b) Find the maximum element in the tree.
    c) Find the number of nodes in the tree.
    d) Find the number of internal nodes in the tree.
    e) Find the number of external nodes in the tree.
13. Implement a Priority Queue using heap with:
    a) Insert.
    b) Remove Min methods.
14. Construct a dictionary of key-value pair using Trie and search for a value matching a key.

Pre-requisite Courses: None.

Reference Book(s):

1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE18CS242
DESIGN AND ANALYSIS OF ALGORITHMS LABORATORY (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- To design and implement algorithms of Brute Force technique.
- To design and implement algorithms with Divide and Conquer technique.
- To design and implement algorithms with Decrease and Conquer and Transform and conquer techniques.
- To design and implement algorithms with Space and Time Tradeoffs.
- To design and implement optimization algorithms using Dynamic Programming and Greedy technique.

Course Outcomes:

At the end of the course, the student will be able to:

- Design and implement algorithms of Brute Force Technique.
- Design and implement algorithms with Divide and Conquer technique.
- Design and implement algorithms with Decrease and Conquer and Transform and Conquer techniques.
- Design and implement algorithms with Space and Time Tradeoffs.
- Design and implement optimization algorithms using Dynamic Programming and Greedy technique.

Course Content:

1. **Brute Force:** Implementation of Sequential Search Algorithm.
2. **Brute Force:** Implementation of Brute Force String Matching Algorithm.
3. **Brute Force:** Implementation of Selection Sort and Bubble Sort Algorithms.
4. **Brute Force:** Implementation of Depth - First Search and Breadth - First Search Algorithms.
5. **Brute Force:** Exhaustive Search Algorithm for solving the Traveling Salesman Problem.
6. **Divide-and-Conquer:** Implementation of Merge Sort and Binary Search Algorithms.
7. **Divide-and-Conquer:** Implementation of Quick Sort Algorithm.
8. **Decrease-and-Conquer:** Implementation of Insertion Sort Algorithm and Topological Sort.
9. **Transform-and-Conquer:** Implementation of AVL Trees.
10. a) **Transform-and-Conquer:** Implementation of Heap Sort Algorithm.
    b) **Space and Time Tradeoffs:** Implementation of Distribution Counting Sort Algorithm.
11. **Space and Time Tradeoffs:** Implementation of Horspool's Algorithm for String Matching.
12. **Dynamic Programming:** Implementation of Warshall's and Floyd's Algorithms.
13. **Greedy Technique:** Implementation of Dijkstra's Algorithm.

Pre-requisite Courses: None.

Reference Book(s):

1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

UE18CS282
INTRODUCTION TO OPERATING SYSTEMS LABORATORY (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Teach students the design aspects of operating system.
- Teach process management concepts and techniques.
- Teach memory management concepts.
- Enable students to learn the problems in inter-process communication and the possible solutions.
- Imbibe students with disk scheduling concepts and techniques.

Course Outcomes:

At the end of the course, the student will be able to:

- Write programs to implement the basic functionality of an operating system and its components.
- Write programs to implement the various scheduling algorithms and analyze their performance tradeoffs.
- Implement algorithmic solutions to process synchronization problems.
- Implement algorithmic solutions to handle deadlocks.
- Write programs to implement memory and device management.

Course Content:

Each lab will be of 3 weeks duration and will involve a component of design and a component of analysis.

1. **Objective - Process Management**: Build a shell & execute commands. Include piping and standard I/O redirection. Implement a command to list all the processes on the system & their threads.
   a. Objective:
      i. Demonstrate ability to work with process management system calls like fork(), exec(), pthreads().
      ii. Design and performance tradeoffs between using threads and processes.
      iii. Demonstrate ability to use inter process communication and decide when to use a mutex vs a semaphore.
2. **Objective - Memory Management:** Write a program to allocate memory that pushes another executing process out of memory into swap. Determine how many pages are accessed by the new process. Compute page fault rate.
   a. Objective:
      i. Understand the memory layout of a process/ thread. Map this to types of variables and scope in a program.
      ii. Analyze the paging system using tools to understand scenarios of swapping.
3. **Objective – File Systems and Device Management**: Build a user level file system on a layer of an abstract block device. Design the metadata layout of the file system.
   a. Analysis: Analyze the system fragmentation v/s performance when block size is modified.
4. **Putting It All Together:** Boot Minix and write a new system call into Minix. Modify the default scheduling algorithm for Minix.

Pre-requisite Courses: None.

Reference Book(s):

1. Laboratory Manual prepared by Department of Computer Science and Engineering, PES University.

MINOR IN CIVIL ENGINEERING

UE16CV140
STRENGTH OF MATERIALS (3-0-2-0-4)

Course Objectives:

- Study fundamental principles of mechanics of materials and its application to various structural elements. Understand concepts of stress, strain and deformations, determination of stresses and strains in structural material under axial, bending and thermal loads. Understand coordinate transformation of stress and strain, stress invariance, surface stresses and their importance.
- Study concepts of material properties like Young's modulus, shear modulus and Poisson ratio, yield stress, ultimate stress and allowable stress, factor of safety.
- Understand stress analysis concepts, demonstrate ability to perform analysis of beams subjected to a bending moment and shear forces, pressure vessels under internal fluid pressures, predict buckling strength of columns for various end conditions under compressive load conditions and analyze shafts subjected to torsion loading.

Course Outcomes:

- To apply the formal theory of solid mechanics to calculate forces, deflections, moments, stresses, and strains in a wide variety of structural members subjected to tension, compression, torsion, bending, both individually and in combination, including : axially loaded bars, components in pure shear, circular shafts in torsion, beams in bending, trusses.
- To understand the concepts of stress at a point, strain at a point, and the stress-strain relationships for linear, elastic, homogeneous, isotropic materials.
- To determine principal stresses and angles, maximum shearing stresses and angles, and the stresses acting on any arbitrary plane within a structural element.
- To draw Free Body Diagrams (FBD) for rigid bodies, beams, 2-D structures, frames and set up equilibrium equations (i.e. forces and couples) for them.
- To utilize basic properties of materials such as elastic moduli and Poisson's ratio to appropriately to solve problems related to isotropic elasticity.

Course Content:

1. **Concept of Stress:** Normal (tensile and compressive) and shear stress, uniform and non-uniform stress distributions, analysis and design concepts, numerical accuracy and sample problems. Components of stress under general loading conditions, yield strength and ultimate strength, ultimate and allowable stress, factor of safety, factors influencing the determination of factor of safety. **Behavior and analysis of axially loaded members:** Load vs. displacement diagram, normal and shearing stresses and strains, stress-strain diagram, true stress vs. true strain diagram, brittle and ductile materials, isotropic materials, Hooke's law: Young's modulus of elasticity, Poisson's ratio. Generalized Hooke's law, dilatation - bulk modulus, shearing strain, shear modulus, relation among E, υ and G, numerical problems. Deflections of axially loaded members. Effect of temperature loading: coefficient of thermal expansion, thermal and elastic strains, numerical problems.
2. **Concept of Bending Moment and Shear force:** Introduction to different types of transverse loads, supports and beams, bending moment and shearing force, sign conventions, shear force and bending moment diagrams (SFD & BMD), relationship among load, shear and bending moment, numerical problems.
3. **Behavior and Analysis of Beams subjected to Flexure and Shear:** Deformations in prismatic and symmetric members in pure bending, pure bending theory and assumptions, bending stresses and strains, elastic flexural formulae, elastic section modulus, radius of curvature of neutral surface, modulus of rupture, flexural rigidity and numerical problems covering bending of various types of beam sections. Shear stresses in beams, shear stress diagram for rectangular and I sections, numerical problems.
4. **Deflection of Beams:** Introduction, deformation of a beam under transverse loading, equation of the elastic curve, using singularity functions to determine the slope and deflection of a beam (Macaulay's Method), numerical problems. **Elastic Stability of Columns:** Introduction, stability of structures, Euler's Formula for pin-ended columns, extension of Euler's formula to columns with other end conditions. Numerical problems.
5. **Torsion of Circular Shafts:** Introduction, deformations in a circular shaft, angle of twist, shearing strain, shearing stresses in the elastic range, elastic torsion formulae, torsion testing, modulus of rigidity G, polar moment of inertia J, numerical problems. **Principal Stresses and Strains**: Introduction to plane stress problems, principal planes, Mohr's circle of stress, numerical problems.

   Lab Component: Tensile test and Compression test on Mild steel, Aluminum, Hardness test on Mild steel, Brass, Aluminum

Prerequisite Courses: UE17CV101- Engineering Mechanics

Reference Books:

1. "Mechanics of Materials (In SI Units)", Ferdinand P Beer, E Russell Johnston Jr., John T DeWolf, David F Mazurek, 6th Edition, Tata McGraw Hill Education (India) Edition 2013.
2. "Mechanics of Materials", James M Gere & Stephen P Timoshenko, 2nd Edition, CBS Publishers & Distributers Private Limited, India, Reprint 2004.
3. "Strength of Materials", S Ramamrutham, Dhanpat Rai Publications, Reprint 2005.
4. "Strength of Materials", I.B. Prasad, 8th Edition, Khanna Publishers, 1989.
5. "Strength of Materials – Elementary Theory and Problems - Part 1", Stephen P Timoshenko, 3rd Edition, CBS Publishers, Reprint 2002.
6. "Strength of Materials –Advanced Theory and Problems - Part 2", Stephen P Timoshenko, 3rd Edition, CBS Publishers, Reprint 2002.
7. "Solid Mechanics", S.M.A. Kazioni, 1st Revised Edition, Tata McGraw Hill, New Delhi, 1988.
8. "Introduction to Mechanics of Solids",E.P. Popov, Prentice Hill of India, New Delhi, 1973.
9. "Mechanics of Solids: An Introduction", S.H. Crandall, N.C. Dahl and T.V. Lardner,McGraw Hill International, Tokyo, 1994
10. "The Testing of Engineering Materials", Davis & Troxell McGraw-Hill Higher Education, 1982.

UE16CV180
GEOINFORMATICS (4-0-0-0-4)

Course Objectives:

- To understand different geometric objects – setting of curves, area & volume calculation.
- To know concepts of electro- magnetic waves, EDM, GPS, remote sensing, photography and usage of computers in surveying.
- To identify basic equipments like Tapes/Chains, Compass, Plane Table, Dumpy Level and Theodolite.

Course Outcomes:

- On successfully completing this course:
- Students are able to analyze and solve the problems relating to setting of curves.
- Students will be able to operated and collect the required data using total station
- Students will be able to analyze the mapping technique
- Students are able to apply appropriate surveying data capture technique.

Course Content:

1. **Basic Surveying Techniques:** Definition of surveying, classification of surveys, Basic principles of surveying, map numbering, introduction to instruments - tapes, chains, ranging rods, working principle of optical square, prism square, cross staff, conventional symbols, Meridians and bearings, principle, working and use of - prismatic compass, surveyor's compass, magnetic bearing, true bearings, whole circle bearing and reduced bearing, dip and declination, local attraction, Levelling: Principles, basic definitions and methods of leveling, parts and usage of digital level .Theodolite: temporary adjustments of a transit theodolite, measurement of horizontal angles – method of repetitions and reiterations, measurements of vertical angles, Contouring: Contours and their characteristics, use of contours, grade contours and uses. Areas & Volumes: General methods of determining areas and volumes, Plane Table Surveying: Plane table and accessories, advantages and limitations of plane table survey, methods of plotting – radiation, intersection, basic principle of Trigonometrical Leveling and Tacheometry - tacheometric equation for horizontal line of sight and inclined line of sight in fixed hair method, Beaman stadia arc.
2. **Simple Circular Curves and Compound Curves:** Introduction to curves - simple circular curves, compound and reverse curves, transition curves and vertical curves, parts of curve and usage. Simple circular curves- necessity, types, elements, designation of curves, setting out simple curves by linear methods, setting out curves by Rankine's deflection angle method, Obstacles to location of curves. Compound curves-Elements, Design of compound curves, setting out of compound curves (numerical problems)
3. **Curves, EDM and Total Station:** Reverse Curves - Elements, Reverse curve between two parallel straights (numerical problems on Equal radius and unequal radius), Transition curves-Requirements, Characteristics, Super elevation, Length of Transition curve and related numerical problems. **Electro Magnetic Distance Measurement &Total Station**: Electro Magnetic Distance Measurement: Introduction, electromagnetic

waves, modulation, types of EDM instruments - Geodimeter, Tellurometer and Wild Distomat, principle of their working. Total Station – Introduction to electronic theodolite, Salient features of total station, advantages of total station over conventional instruments, types of Total Station, application of total station.

4. **Global Positioning System (GPS):** Introduction, GPS principles, Satellite navigation System, GPS segments - Space segment, Control segment, User segment, GPS satellite signals, Receivers-features, structure, types, consideration in selection of receiver, DGPS- methods, Static and Kinematic DGPS, Application of GPS. **Geographical Information System (GIS):** Definition and components of GIS, four M's, database and data models, Introduction of Remote sensing and GIS, GIS packages and usage of GIS.
5. **Introduction to Remote Sensing:** Definition, Principles of energy interaction in atmosphere and earth surface features, Idealized remote sensing system and real remote sensing system, basic principles of remote sensing, platforms and sensors , imaging Sensor Systems and its applications in satellite systems, image interpretation techniques, visual interpretation, Digital image processing and applications of remote sensing. **Photogrammetry:** Basic concepts of terrestrial photogrammetry and aerial photogrammetry, photo theodolite, horizontal & vertical angles, horizontal position, type of photographs and geometry of aerial photographs and related problems.

Prerequisites Courses: None

Reference Books:

1. "Surveying Volume I", B. C. Punmia, Ashok K Jain, Arun K Jain, 15th Edition, Laxmi Publications, 2005.
2. Surveying Volume II", B. C. Punmia, Ashok K Jain, Arun K Jain, Laxmi Publications, 15th Edition, 2005.
3. "Surveying Volume III", B. C. Punmia, Ashok K Jain, Arun K Jain, 15th Edition, Laxmi Publications, 2005.
4. "Remote Sensing and GIS", M. Anji Reddy, BS Publications/BSP Books, 4th Edition, 2012.
5. Geomatics Engineering, Manoj K Arora and R C Badjatia, Nem Chand and Bros Publishers, 2011
6. "Surveying Theory and Practice", James M. Anderson, McGraw Hill Publication, 7th Edition, 1997.
7. "Fundamentals of Surveying", Milton O. Schimidt, Wong, Thomson, 2nd Edition, 1997.
8. "Fundamentals of Surveying", S.K. Roy, 2nd Edition, Prentice Hall of India, 2006
9. Surveying: volume 2, K.R. Arora, Standard Book House ,2010
10. Surveying: volume 1, K.R. Arora, 16th edition, Standard Book House ,2010
11. Concepts and Techniques of Geographic Information Systems Second Edition, Chor Pang Lo, Albert K. W. Yeung, Pearson, 2016

UE16CV240
CONSTRUCTION MATERIALS & TECHNOLOGY
(3-0-2-0-4)

Course Objectives:

- To learn about various materials used in construction
- To know about alternative materials used in industry.
- To learn about various types of foundation.
- To learn about the construction techniques used in industry.
- To know about sustainable construction.

Course Outcomes:

- Knowledge of various materials which are used in the construction field.
- Brief idea of the components of a building structure.

Course Content:

1. **Stones:** Varieties of building stones, qualities of good building stones, dressing of stones, selections and suitability of stones, uses of stones, decay and preservation of stones, quarrying of stones. **Bricks:** Qualities of brick earth, standard specifications for shape, size and properties, testing of bricks.**Alternative materials:** Solid and hollow blocks, stabilized mud blocks, aerated blocks, rammed earth, reinforced brick work.
2. **Cement:** Raw materials, manufacture, types, properties, use of puzzolonic materials such as fly ash, granulated blast furnace slag, rice husk ash as partial replacement, tests on cement. **Fine and Coarse Aggregates:** Properties and uses. M Sand, **Grading of aggregates, tests on aggregates Mortar, Concrete:** materials, preparation, properties and uses. **Reinforcing and Structural Steel:** Types, properties – yield strength, ultimate strength, proof stress, elongation, shapes and uses.
3. **Timber:** Classification of timber, fundamental engineering properties of good timber, defects in timber, seasoning of timber, solar timber seasoning kiln preservation of timber, ply wood and its uses. **Plastics:** Types, constituents of plastic, properties, uses of plastics in building industries. **Paints, Varnishes and Distempers:** Constituents of oil paint, chatacteristics of a good paint, types of paints, painting to wood, steel, iron and wall surfaces. Varnishes- Constituents of varnishes – types of varnishes, method of applying varnishes. Distemper and application to new and old surfaces. Surface preservatives – metallic coating by hot dipping.**Flooring:** Base preparation, Types of flooring, laying details.**Form work:** Economy in form work, material for form work details in RCC columns, beams and floors, slip forming. **Scaffolding, Shoring**
4. **Techniques of Sub Structures Foundations:** Need, concepts of foundation, shallow foundation, depth of excavation, Isolated and combined footings. Pile foundations, bearing, friction, under reamed types, pile caps. **Masonry: Brick Masonry:** Different types of bonds - English, Flemish.Stone masonry types, **Plastering, Pointing Doors, Windows and Ventilators:** Location of doors, size of doors and door frames, types of doors and windows, ventilators. **Roofs:** Different types of roofs and roof coverings, one way, two way slabs - typical sketches.
5. **Sustainable Construction:** Concept**,** Need, embodied energy and CO2 emissions in building materials, recurring and operational energy in buildings, total energy in building life cycle, zero energy and water neutral buildings, green buildings, rating systems – GRIHA (Green Rating for Integrated Habitat Assessment), LEED – India (Indian Green Building Council), points allocation and rating. Construction and Demolition (C & D) waste management – 4 R's Golden rule (Reduce, Reuse, Recycle, Recover) before final disposal. Safety, health and welfare facilities in construction sites.

Lab Component: Tests on Aggregates, Specific Gravity, Sieve Analysis, Bulking of sand.

Prerequisites Courses: None

Reference Books:

1. "Building Construction", B.C. Punmia, Laxmi Publications, New Delhi, 10th Edition, 2007.
2. "Engineering Materials", S.C Rangwala, Charotar Publishing House, Anand, 28th Edition, 1997.
3. "Building Construction", P.C. Varghese. Prentice Hall of India, New Delhi, 2007.
4. "Building Construction", Sushil Kumar, 16th Edition, Standard Publishers & Distributors, New Delhi, 2005.
5. "Building Construction" W B Mackay, Vol 4, Pearson Publications 2013.
6. "Construction Technology", Chudley 4th Edition, Pearson Publications. 2005.

7. "Alternative Building Materials and Technologies", K.S. Jagadish and B.V. Venkatarama Reddy, 1st Edition, New Age International (P) Ltd., 2009.
8. "Construction of Buildings", Barry, 7th Edition, Wiley-Blackwell Publications, April 2014
9. National Building Code, BIS, New Delhi, 2015
10. IGBC Manual, GRIHA Manual, 2010
11. IS CODES: 2185 part 1, 8041-1990, 12330-1988, 12600-1989

UE16CV280
ESTIMATION AND COSTING (4-0-0 -0-4)

Course Objectives:

- To estimate quantities and cost of a structure.
- To understand detailed specification of different components of buildings.
- Student will be able to determine the quantity of earthwork for road construction.
- To analyse the unit rate of different items in building construction.

Course Outcome:

On completion of this course the student should be able to

- Perform estimation, cost analysis and valuation for the given structure.

Course Content:

1. **Introduction**: Purpose of Estimating. **Different Types of Estimates**: Different types of estimates; detailed estimate; Schedule of rates: Substituted items; Recasting of estimate ; External services; Prime cost; Day work; Provisional sum; Taking off in Quantity Surveying; Bill of quantities; Sub-work; General abstract of cost; Complete set of estimate. **Approximate Estimate**: Importance of approximate estimate; Purpose of approximate estimate; Approximate methods of estimating buildings; Cost from materials and labour; Approximate cost for Water Supply, Sanitary and Electrification works; Method of preparation approximate estimate for road projects, Bridge, Culvert and Road works.
2. **Method of Building Estimate:** General items of work for building estimate; Principle Units for various items of works; Limits of measurement and degree of accuracy in Estimating; General items of works, Unit of measurement for different items of works and materials; Some simple estimates; Different Methods for estimating Building works. Principle of estimating a single roomed building; two roomed building; Estimate of an underground water tank; Calculation of brickwork for typical figures and finding floor areas.. **Estimate of Buildings**: Detailed estimate of a single roomed building; Detailed estimate of a two roomed building; Estimate from line plan; Detailed estimate for a two storied building with comparative cost for different portions.
3. **Water Supply and Sanitary Works**: Method of measurement of water supply and sanitary works based on IS 1200; Estimate of septic tanks; Detailed Estimate of a Manhole. **Bridges and Culverts**: Process of calculations to estimate quantities for Abutment, Wing walls and Return walls of splayed culverts. Estimates for Arch culvert, Slab culvert. **Pavement**: Pavement portion of a Road structure.
4. **Analysis of Rate**: Quantity of materials per unit rate of work; Estimating labour; Task or outturn work; Quantity of material required for different items of works; Rate of materials and labour; plinth Area Rate; Analysis for Manufacturing materials; Analysis for Earthwork Analysis for concrete works; Shuttering and staging; Damp-proof course with cement concrete; Analysis for Brickwork; Analysis for stone masonry; Analysis for roofing; Analysis for plastering. **Contracts:** Definition, essentials of contracts, Types of Engineering contract, their advantages and disadvantages. Definition of terms Tender, Tender form, Tender documents, Tender notice.
5. **Specification**: What is Specification; Necessity of Specification; Types of Specifications; Standard Specification; Special specification; Open specification; Advantages and disadvantages of open specification; General specification; Specifications for Bricks, Cement, Sand, Water, Lime Coarse aggregate and Reinforcement; Earthwork; Cement concrete; Reinforced cement concrete; First class brickwork; Half brick thick partition wall in cement mortar;; Stone masonry; Damp-proof course; Glazed Tiles in skirting and dado; Cement plaster; Wood work; Steel doors and windows; Cement plastering; Cement pointing; White-washing; Colour-washing; Lime punning; Distempering; Glazing; Painting; Varnishing; French polishing; Decorative Water-proof cement coating. **Valuation**: Qualifications and functions of a Valuer; The purposes of valuations; Gross income; Outgoings; Net income; Scrap value; Salvage value, Market value; Factors which affect the value of a property; Book value; Assessed value; Distressed value or Forced sale value; Replacement value; Potential value; Monopoly value; Sentimental value; Speculative value; Accommodation value; Sinking fund; Capitalized value; Essential characteristics of an ideal investment;

Prerequisite Course: None

Reference Books:

1. "Estimating, Costing, & Valuation in Civil Engineering", M. Chakraborti Published by author, Calcutta. 25th Edition 2014.
2. "Estimating and Costing in Civil Engineering", B.N. Dutta UBS Publishers and distributors, New Delhi. 26th Edition December 2008.
3. "Estimating Construction Costs", R.L. Peurifoy & G.D.Oberlender McGraw-Hill Publication. 5th Edition November 2001.
4. KPWD Schedule of rates for the current year.

MINOR IN ELECTRONICS AND COMMUNICATION ENGINEERING

UE18EC140
PROBABILITY THEORY AND RANDOM PROCESS (4-0-0-0-4)

Course Objectives:

- The objective of this course is to equip the students with the basic tools required to build and analyze probabilistic and random process models in both the discrete and continuous context.

Course Outcomes:

- After completion of the course, students will be able to apply and use the probabilistic and random process models to real-world situations, such as determining expected values, standard deviations, autocorrelations, cross-correlations, power spectrum and so on.

Course Content:

1. **Probability and Random Variables:** Probability: Review, independence and Bernoulli trails. Discrete Random Variable: Definition, Probability mass function, Cumulative distribution and different types of discrete random variable. Continuous random variable: Concept, distribution and density function and different types of continuous random variables.
2. **Moments and Multiple random variables:** Expectation, moments; transformation of random variables, conditional density and distribution function. Vector random variables, Joint distribution and its properties, Joint density and its properties, Conditional distribution and density, Statistical independence, Distribution and density of a sum of random

variables. Central limit theorem, Expected value of a function of random variables, Jointly Gaussian random variables, Law of large numbers.

3. **Random Process:** Concept, Stationarity and independence, Ergodicity, Correlation functions, Gaussian, Poisson and Bernoulli random processes.
4. **Power density spectrum of Random Process:** Power density spectrum and its properties, relationship between power spectrum and autocorrelation function, cross-power density spectrum and its properties.
5. **Linear Systems with Random Inputs:** Random signal response of linear systems, System evaluation using random noise, Spectral characteristics of system response, Spectral factorization, Noise bandwidth, Bandpass, Band-limited and narrow band processes.

Prerequisite Course : Nil

Reference Books:

1. "Probability, Random Variables and Random Signal Principles", Peyton Z. Peebles, Jr.,, 4th Edition, McGraw-Hill, 2001.
2. "A first Course in Probability", Pearson Education, 6th Edition Sheldon Ross, Publisher, Year.

UE18EC280
COMMUNICATION ENGINEERING (3-0-0-0-1)

Course Objectives:

- The main objective of the course is to understand and develop fundamentals associated with the analysis, design and Communication systems.

Course Outcomes:

On successful completion of this Course, the students would be able to;

- Be able to classify systems based on their properties: in particular. Determine Fourier transforms for continuous-timeand discrete-time signals (or impulse-response functions), and interpret and plot Fourier transform magnitude and phase functions.
- Analyze the performance of different analog communication systems.
- Apply the concepts of analog modulation & demodulation techniques in developing better circuits of these systems.
- Analyse the performance capabilities of current digital communication systems.
- Analyze the Band pass digital modulation and demodulation.

Course Content:

1. **Review of Signals and Systems:** Classification of signals, Continuous-time and discrete-time signals, Transformations of the independent variable, Exponential and sinusoidal signals. The Continuous-Time Fourier Transform .The Discrete-Time Fourier Transform .Fourier Series Representation of Periodic Signals.
2. **Analog Modulation:** Generation and detection of AM wave. Generation and Detection of DSBSC.of DSBSC waves: balanced modulator, Ring modulator. SSB,Frequency translation, Frequency division multiplexing. FM, Bandwidth of FM waves, constant average power, Generation of FM waves Demodulation of FM waves.
3. **Introduction to Digital Communication:** Basic signal processing operations in digital communication, Channels for digital communication. Sampling theorem, Reconstruction of a message from its samples, Signal distortion in sampling, Practical aspects of sampling and signal recovery, PAM, TDM.
4. **Coding Techniques :** Waveform Coding Techniques: PCM, Channel noise and error probability, quantization noise and SNR, robust quantization, DPCM, DM, ADM, Coding speech at low bit rates, applications.
5. **Digital Modulation :** Digital modulation techniques, ASK, PSK, FSK, DPSK, QPSK and MPSK generation. Coherent and noon coherent methods of detection.

Lab Experiments

1. Collector AM and Demodulation using envelope detector
2. Balanced modulation
3. Transistors mixers – up/down conversions
4. Frequency modulation using IC 8038
5. Pre-emphasis and de-emphasis
6. PAM (modulation and demodulation)
7. Study of Flat Top Sampling
8. ASK generation and detection.
9. FSK generation and detection.
10. QPSK generation and detection.

Prerequisite Course : Nil

Reference Books:

1. "Signals and Systems", A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, 2nd Edition, Pearson Education, 1997.
2. "Anlaog and Digital Communication", Simon Haykin, 4th edition John Wiley, 2003.

UE18EC180
DIGITAL SIGNAL PROCESSING (4-0-0-0-4)

Course Objective:

The study of the subject should enable the student to learn:

- Different types of signals, LTI systems and Z-transform
- Discrete fourier transform, its properties, FFT and its applications
- Design of digital FIR and IIR filters
- Realization of digital filters

Course Outcomes:

On successful completion of this Course, the students would be able to;

1. Explain basic concepts of signals and systems
2. Apply z-Transform and its properties
3. Develop algorithms to process discrete samples using Discrete Fourier transform (DFT) and Fast Fourier transform
4. Design digital filters, FIR and IIR filters
5. Draw realization structures for the given digital system function

Course Content:

1. **Introduction to signals and systems:** Signals, Systems and Processing, Classification of Signals**,** The Concept of Frequency in Continuous-Time and Discrete-Time Signals**,** Analog-to-Digital and Digital-to-Analog Conversion.
2. **Discrete –time signals and systems:** Discrete time signals, discrete time systems, analysis of discrete time LTI systems, discrete time systems described by difference equations.
3. **Z-Transform:** the direct z-transform, inverse z-transform and properties of z-transform
4. **Discrete Fourier Transform (DFT):** Introduction to Fourier Transform**, f**requency domain sampling and reconstruction of discrete signals, DFT as a linear transformation, its relationship with other transforms, properties of DFT.
5. **Fast Fourier Transform (FFT):** Direct computation of DFT, need for FFT, Radix-2 FFT algorithm for computation of DFT and IDFT: decimation-in-time and decimation-in-frequency algorithms.

6. **Design of FIR filters: I**ntroduction to FIR filters, design of FIR filters using window functions, Hilbert transformer and differentiator, FIR design using frequency sampling technique.
7. **Design of IIR filters from analog filters:** Design of analog Butterworth and Chebyshev filters, mapping of transfer function: backward method, bilinear transformation and impulse invariance transformation methods, verification for stability and linearity during mapping**.**
8. **Realization of Digital Filters: Realization of FIR filters:** direct, cascade, and lattice realizations. Realization of IIR filters: direct form I and form II, cascade and parallel realizations.

Prerequisite Course : Nil

Reference Books:

1. "Digital Signal Processing: Principles, Algorithms and Applications", Proakis and Manolakis,, 4th Edition, Pearson Education, New Delhi, 2007.
2. "Fundamentals of Digital Signal Processing", L. C. Ludeman, John Wiley and Sons, New York, 1986.
3. "Digital Signal Processing", S. K. Mitra, 2nd Edition, TMH, 2004
4. "Digital Signal Processing", Oppenheim and Schaffer, PHI, 2003.
5. "Analog and Digital Signal Processing", Ashok Ambardar, Thomas Learning, 1999.

UE18EC260
EMBEDDED SYSTEM DESIGN (4-0-0-0-4)

Course Objectives:

- Develop knowledge and understanding of fundamental embedded systems design paradigms, architectures, possibilities and challenges, both with respect to software and hardware and wide competence from different areas of technology.
- Theoretical knowledge in the areas of real time systems, sensor and measuring systems, and their interdisciplinary nature needed for integrated hardware/software development of embedded systems.
- Ability to analyze a system both as whole and in the included parts, to understand how these parts interact in the functionality and properties of the system.
- To educate students to meet current and future industrial challenges and emerging embedded systems engineering trends.

Course Outcomes:

Students completing the course should be able to

- Design and implement applications on ARM based controllers.
- Write applications in assembly and embedded C
- Develop systems with RTOS features like inter process communication, process synchronization techniques, process scheduling algorithms
- Interface peripherals with standard buses like I2C,SPI, UART,USB and SDIO
- Understand embedded system's hardware components and software tool chain.
- Design an embedded system, Debug and test it

Course Content:

1. **Embedded System components:** Introduction to embedded systems, Overview of Embedded system blocks Physical system -Processor and peripherals Embedded software: Tool chains, Boot loader, Device Drivers, Embedded OS
2. **ARM Processor Fundamentals:** Registers, Current program status register, Pipeline, Exceptions, Interrupts and vector table, core extensions, architecture revisions, ARM Processor families.
3. **Introduction to ARM9 Instruction Set:** Data Processing Instructions, Branch Instructions, Load- store Instructions, software Interrupt Instruction, Program status register Instructions, Loading constants ARM Extensions, conditional execution. Introduction to Thumb Instruction set. Programming examples
4. **Overview of Operating Systems & RTOS:** Introduction-OS Overview, process management-Process, Process control block, Process states (5 State model), Inter Process Communication using LINUX-Pipes, FIFO. Concurrency issues (Race condition, Deadlock, Starvation).Semaphore and Programming examples. Threads-Threads and programming example, Process Scheduling-Basic concepts, Scheduling Criteria, Scheduling Algorithms (FCFS, SJF, RR, Priority Scheduling) , Memory management-Protection, Relocation, Partition (Fixed, Dynamic), Paging, Segmentation. RTOS features. Priority inversion, Priority inheritance and Priority ceiling.
5. **Peripherals:** Overview of Device drivers, I2C, SPI, UART, USB, SDIO overview. Case Study of Embedded Systems with RTOS.

Prerequisite Course : Nil

Reference Books:

1. "ARM System Developer's Guide – Designing and Optimizing System Software", Andrew N Sloss,
2. Dominic Symesand Chris Wright, Morgan Kaufmann Publishers, 2004.
3. "ARM System Architecture", Stephen B. Furber, Addison Wesley, 1996.
4. "Operating Systems Internals and Design", William Stallings, Person Prentice Hall, 6th Edition, 2009.
5. "Operating System Concepts", Silberschatz, Galvin and Gagne, Wiley, 8th Edition, 2010.
6. "Introduction to Embedded System", Shibu K.V., Tata McGraw Hill, 2009

UE18EC240
COMPUTER NETWORKS (4-0-0-0-4)

Course Objectives:

- The objective of this course is to give the students an in-depth understanding and hands on experience of internet protocols and algorithms.
- This course aims to enable the students to design and analyze simple computer networks.
- The course begins with an introduction to the internet architecture and service models. A top down approach is followed to explain the complex operation of sending data from one host to another.
- The standard application protocols, transmission protocols, networking protocols and MAC layer protocols are covered.

Course Outcomes:

At the end of the course, the student should be able to

- Analyze the internet protocols related to the application layer, transport layer, network layer and link layer
- Design simple computer networks using GNS3 and analyze packet capture using Wireshark
- Implement routing algorithms, client and server socket programs
- Solve numerical problems and logical problems in the design of computer networks
- Apply networking concepts to simple projects in the computer networks

Course Content:

1. **Introduction:** Introduction to internet, ISPs and their hierarchy, Access networks and Physical media, Delays in transmission,

circuit and packet switching, core networks, Concept of protocol stack and TCP/IP model, National and international Internet regulatory authorities;

2. **Application Layer and Sockets:** Architectures and service models, HTTP, FTP, Mail access protocols (SMTP, POP3 and IMAP), DNS, Peer-to-peer applications (Torrent, DHT and Skype), Introduction to Sockets, Socket programming, Connectionless Transport (UDP sockets), Connection Oriented Transport (TCP sockets)
3. **Transport Layer and Network Layer:** UDP segment structure, TCP segment structure, Reliable data transfer under TCP, Congestion control, Flow control; Internal organisation of a Router, IPv4 Addressing format, CIDR, sub-netting and super-netting, IPv4 Datagram format, Network address translation (NAT), ICMP, IPv6 addressing and datagram format.
4. **Routing**: Dijkstra and Bellman-Ford routing algorithms, RIP, OSPF, BGP, Brief treatment of IS-IS, Brief overview of MPLS, Brief overview of SDN.
5. **Link Layer:** Role and importance of link layer, Error detection and error correction techniques, switching and addressing, Forwarding and filtering, Basic random access techniques, Ethernet: protocol and frame format, Point to Point Protocol (PPP), Virtual Local Area Networking (VLAN);

Prerequisite Course : Nil

Reference Books:

1. "Computer Networking: A Top Down Approach", James F Kurose and Keith W Ross, 6th Edition, Pearson Education, 2013.
2. "Computer Networks", Andrew S. Tanenbaum, 4th Edition, Prentice Hall, 2003.
3. "Telecommunication Networks, Protocols, Modeling and Analysis", Schwartz M, 2nd Edition., Addison-Wesley, 1987.
4. "Data and Computer Communications", William Stallings, 8th Edition, Prentice Hall, 2007.

UE18EC160
REAL TIME EMBEDDED SYSTEMS (4-0-0-0-4)

Course Objectives:

- The primary goal of this course is to meet the basics of real-time systems and enable the students with the knowledge and skills necessary to design and develop embedded applications by means of real-time operating systems.

Course Outcomes:

Students completing the course should be able to

- Use the multitasking techniques in real-time systems.
- Use real time scheduling policies in applications
- Design embedded applications using RTOS.
- Use RTOS software mechanisms
- Identify real time service and estimate the WCET and schedule it

Course Content:

1. **Introduction to Real-Time Embedded Systems:** Brief history of Real Time Systems, A brief history of Embedded Systems. **System Resources:** Resource Analysis, Real-Time Service Utility, Scheduling Classes, The Cyclic Executive, Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies, Real-Time OS, Thread Safe Reentrant Functions.
2. **Processing:** Preemptive Fixed-Priority Policy, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline –Monotonic Policy, Dynamic priority policies. **I/O Resources:** Worst-case Execution time, Intermediate I/O, Execution efficiency, I/O Architecture.
3. **Memory:** Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash file systems. **Multi-resource Services:** Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion
4. **Soft Real-Time Services:** Missed Deadlines, QoS, Alternatives to rate monotonic policy, Mixed hard and soft real-time services **Embedded System Components:** Firmware components, RTOS system software mechanisms, Software application components.
5. **High availability and Reliability Design:** Reliability and Availability, Similarities and differences, Reliability, Reliable Software, Available Software, Design trade offs, Hierarchical applications for Fail-safe design.

Prerequisite Course : Nil

Reference Books:

1. "Real-Time Embedded Systems and Components", Sam Siewert, Cengage Learning India Edition, 2007.
2. "Programming for Embedded Systems", Dreamtech Software Team, John Wiley, India Pvt. Ltd., 2008.
3. "Real Time Concepts for Embedded Systems", Qing Li and Croline Yao CMP Books, India Edition, 2011.

MINOR IN ELECTRICAL AND ELECTRONICS ENGINEERING

UE18EE140:
GENERATION, TRANSMISSION AND DISTRIBUTION SYSTEMS (3-0-0-4-4)

Course Objectives

At the end of the course the student will be able to:

- Understand the working of some of different types of power generation systems namely thermal, nuclear, and gas plants.
- Gain knowledge on the primary renewable energy resources namely hydro, solar and wind energy systems
- To learn the usage of passive elements in various Power Transmission Systems
- To understand the factors affecting Insulators and also in Under Ground cables.
- To calculate the various parameters in Distribution System.

Course Outcomes

Upon completion of the course the students would be able to:

- Explain different methods of electric power generation at power generation plants
- Explain the science of energy conversion from various schemes
- Describe the significance of various components of power generation plants
- Describe the importance of power generation from renewable sustainably
- Apply power system fundamentals to the design of a system that meet specific needs.
- Design a power system solution based on the problem requirements and realistic Constraints.
- Develop a major design experience in power a system that prepares them for engineering practice.

Course Content:

1. **Non Renewable Energy Sources:** Thermal Power Plants: Main parts & working, Fuels, Fuel Handling, Combustion and Combustion equipment, Ash disposal, & Dust Collection, Draught Systems, Types of Boilers and their characteristics, Feed Water, steam turbines, alternators, Layout and Control. Nuclear Power Plants: Nuclear Reactions, Nuclear Materials Feasibility of nuclear power station, main parts of reactor and their functions, coolant cycles, reactor control, nuclear reactor classification – Boiling water, Pressurized water, CANDU reactor,

Breeder Reactor. Gas Turbine Power Plants: Typical GT power plant: components of a gas turbine plants, Open and Close Cycle Gas Turbine Plants, Methods to improve thermal efficiency of a gas turbine plant, Fuels for gas turbine plants; Different arrangement of components; Plant layout, advantages of gas turbine plants over steam plants.

2. **Renewable Energy Sources:** Hydroelectric Energy: Factors for selection of site; Hydrology, classification of hydro electric plants, Types of Turbines, governing of turbines, Power station structure, Layout and Control. Solar Energy: Introduction, Solar Constant, Solar Radiation at the Earth's surface, Solar Radiation Measurements. Thermal electric conversion, Electric power conversion; The PV cell, Module and array, equivalent electrical circuit, open circuit and short circuit current, I-V and P-V curves, PV system components; Wind Energy: Introduction, Wind Speed and Power Relations, Wind speed measurements, Site and turbine selection. Wind Power System – System Components, Variable speed operation, Applications - Interconnected System, Safety Systems, and Environmental impact.
3. **Constants of Overhead Transmission Lines:** Inductance of a conductor due to internal flux, Inductance of a conductor due to external flux, Inductance of a single phase two wire line, Inductance of composite conductor lines- self and mutual GMDs , Inductance of three-phase lines (single circuit), Inductance of three phase lines with more than one circuit (double circuit). Potential difference between two points due to a charge, capacitance of two-wire line, potential difference between two conductors of a group of charged conductors, capacitance of three-phase lines (single circuit), charging current due to capacitance, capacitance of three phase line with more than one circuit (double circuit), skin effect and proximity effect.
4. **Performance of Transmission Lines:** Short Line- Regulation, General Network constants, ABCD constants for short line, Medium Lines- General Network constants for medium lines, Long Lines- Long line equation, Evaluation of ABCD constants Surge Impedance and surge loading of transmission lines, Ferranti Effect, Equivalent T and π networks of a long line, Power transmission in a short line.
5. **Overhead Line Insulators-** Introduction, Insulator Materials, Types, Potential distribution over a string of suspension insulators, Methods of Increasing the string efficiency. UNDERGROUND CABLES - Introduction, types of cables, Insulation in cables, Armouring and covering of cables, Insulation resistance of cables, stress in Insulation and capacitance, Sheathing in cables, Use of Inter-sheaths, Capacitance grading. POWER DISTRIBUTION SYSTEMS: DC SYSTEMS- Introduction, Radial and ring main systems, Different types of distributors, AC distribution - AC Distributor with concentrated loads.

Prerequisite Course: None

Reference Books:

1. "A Text Book on Power System Engineering", A Chakrabarti, M L Soni, and P V Gupta, Dhanpat Rai and Co., New Delhi, 2010.
2. "Wind and Solar Power Systems", Mukund R. Patel, CRC Press, 1999.
3. "Elements of Power System Analysis", W D Stevenson, Mc Graw Hill, 1975.
4. "Electric Power", S L Uppal, Khanna Publishers, 2007.
5. "Electric Power Systems", C L Wadhwa, New Age International, 2009.
6. "Electric Power Generation, Transmission and Distribution", S N Singh, PHI, 2010.
7. "Non-Conventional Sources of Energy", Rai, G. D, 4th Edition, Khanna Publishers, New Delhi, 2007.
8. "Fundamentals of Renewable Energy Systems", Mukherjee. D, and Chakrabarti. S, New Age International Publishers, 2005.
9. nptel.ac.in/video.php?subjectId=108102047
10. freevideolectures.com › Electrical Engineering › IIT Delhi

UE18EE180: SOLAR PHOTOVOLTAIC SYSTEMS (4-0-0-0-4)

Course Objectives:

- To explain basics of solar photovoltaic systems.
- To know in depth of its types and design of various PV-interconnected systems

Course Outcomes

- To explain basics of solar photovoltaic systems.
- To know in depth of its types and design of various PV-interconnected systems.

Course Content

1. **Photovoltaic Basics**: Structure and working of Solar Cells, Electrical properties and Behaviour of Solar Cells - Cell properties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays - Basics of Load Estimation.
2. **Stand Alone PV Systems**: Schematics, Components, Batteries, Charge Conditioners - Balance of system components for DC and/or AC Applications
3. **Grid Connected PV Systems**: Schematics, Components, Charge Conditioners, Interface Components - Balance of system Components - PV System in Buildings.
4. **Hybrid Systems**: Solar, Biomass, Wind, Diesel Hybrid systems - Comparison and selection criteria for a given application.
5. **Design of PV Systems**: Radiation and load data - Design of System Components for different PV Applications - Sizing and Reliability

Prerequisite Course: None

Reference Books:

1. **"**Solar Photovotaics: Fundamentals, Technologies and Applications**",** CS Solanki, PHI Learning Pvt. Ltd., 2011.
2. **"**Solar Cells Operating Principles, Technology, and System Applications**",** Martin A. Green, Prentice- Hall, 2008.
3. "The Physics of Solar Cells", Nelson, J. Imperial College Press, 2003.
4. "Solar Electricity", Thomas Markvart, John Wiley and Sons, 2001.
5. "Applied Photovoltaics", Stuart R. Wenham, Martin A. Green, Muriel E. Watt, Richard Corkish (Editors), Earthscan, 2008.
6. "The Solar Electricity Handbook", Michael Boxwell, Code Green Publishing, UK, 2009.
7. "Solar Power Your Home for Dummies", Rik DeGunther, Wiley Publishing Inc, 2008.
8. "Photovoltaics: Design and Installation Manual", Solar Energy International, New Society Publishers, 2004.

UE16EE240: SENSORS AND ACTUATORS (4-0-0-0-4)

Course Objectives::

- Understand static and dynamic characteristics of measurement systems.
- Study various types of sensors.
- Study different types of actuators and their usage.
- Study State-of-the-art digital and semiconductor sensors.

Course Outcomes:

Upon completion of the course the student will be able to

- explain fundamental physical and technical base of sensors and actuators
- describe basic laws and phenomena that define behaviour of sensors and actuators

- analyze various premises, approaches, procedures and results related to sensors and actuators
- create analytical design and development solutions for sensors and actuators

Course Content:

1. **Introduction to Measurement Systems**: General concepts and terminology, measurement systems, sensor classification, general input-output configuration, methods of correction, performance characteristics: static characteristics of measurement systems, accuracy, precision, sensitivity, other characteristics: linearity, resolution, systematic errors, random errors, dynamic characteristics of measurement systems: zero-order, first-order, and second-order measurement systems and response.
2. **Resistive and Reactive Sensors**: Resistive sensors: potentiometers, strain gages, resistive temperaturedetectors, magneto resistors, light-dependent resistors, Signalconditioning for resistive sensors: Wheatstone bridge, sensor bridge calibration and compensation, Instrumentation amplifiers, sources of interference and interference reduction, Reactance variation and electromagnetic sensors, capacitive sensors, differential, inductive sensors, linear variable differential transformers (LVDT), magneto elastic sensors, hall effect sensors, Signal conditioning for reactance-based sensors & application to the LVDT.
3. **Self-generating Sensors**: Self-generating sensors: thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors, Signal conditioning for self-generating sensors: chopper and low-drift amplifiers, offset and drifts amplifiers, electrometer amplifiers, charge amplifiers, noise in amplifiers.
4. **Actuators Drive Characteristics and Applications**: Relays, Solenoid drive, Stepper Motors, Voice-Coil actuators, Servo Motors, DC motors and motor control, 4-to-20 mA Drive, Hydraulic actuators, variable transformers: synchros, resolvers, Inductosyn, resolver-to-digital and digital-to-resolver converters.
5. **Digital Sensors and Semiconductor Device Sensors**: Digital sensors: position encoders, variable frequency sensors – quartz digital thermometer, vibrating wire strain gages, vibrating cylinder sensors, saw sensors, digital flow meters, Sensors based on semiconductor junctions: thermometers based on semiconductor junctions, magneto diodes and magneto transistors, photodiodes and phototransistors, sensors based on MOSFET transistors, CCD imaging sensors , ultrasonic sensors, fiber-optic sensors.

Prerequisite Course: None

Reference Books:

1. "Sensors and Actuators in Mechatronics Design and Applications" Andrzej M. Pawlak, CRC Press, 2006.
2. "Process Control Instrumentation Technology", D. Johnson, John Wiley and Sons, 1999.
3. "Sensors and Transducers", D.Patranabis, TMH 2003.
4. "Measurement System : Applications and Design", E.O. Doeblin, McGraw Hill publications, 2007.
5. "Introduction to Sensors for ranging and imaging", Graham Brooker, The Institution of Engineering and Technology, 2009.
6. "Instrument Transducers – An Introduction to Their Performance and Design", Herman K.P. Neubrat, Oxford University Press, 1963.
7. "Sensors and Transducers", Ian Sinclair, Elsevier, 3rd Edition, 2011.
8. "Sensor Technology Handbook", Jon Wilson, Elsevier, 2004.
9. "PC Interfacing and Data acquisition", Kevin James, Elsevier, 2011.
10. "Sensors and Signal Conditioning", Ramon Pallás Areny, John G. Webster, 2nd Edition, John Wiley and Sons, 2000.
11. "Sensors and Actuators: Control System Instrumentation", Clarence W. de Silva, CRC Press, 2007.

UE16EE280:
WIND ELECTRICAL SYSTEMS (4-0-0-0-4)

Course Objectives:

- To learn the design and control principles of Wind turbine
- To understand the concepts of fixed speed and variable speed, wind energy conversion systems
- To analyze the grid integration issues.

Course Outcomes

At the end of the course the students will be able to:

- Understand the schemes used for WECS
- Have a knowledge on fixed speed systems and variable speed systems
- Gain knowledge on Grid connected Systems

Course Content:

1. **Introduction**: Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient- Sabinin‟s theory-Aerodynamics of Wind turbine
2. **Wind Turbines**: HAWT-VAWT-Powerdeveloped-Thrust Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.
3. **Fixed Speed Systems**: Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model Generator model for Steady state and Transient stability analysis.
4. **Variable Speed Systems**: Need of variable speed systems-Power wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling - Variable speed variable frequency schemes.
5. **Grid Connected Systems**: Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

Prerequisite Courses: None

Reference Books

1. "Wind Electrical Sytems", S.N. Bhadra, D. Kastha, & S. Banerjee, Oxford University Press, 2010.
2. "Wind Energy Conversion Systems", L.L. Freris, Prentice Hall, 1990.
3. "Variable Speed Generators", Ion Boldea, Taylor & Francis group, 2006.
4. "The Generation of Electricity by Wind Power", E.W. Golding, Redwood Burn Ltd., Trowbridge, 1976.
5. "Wind Energy Technology", N. Jenkins, John Wiley & Sons, 1997.
6. "Grid Integration of WECS", S.Heir, Wiley and Sons, 1998.

MINOR IN MECHANICAL ENGINEERING

UE18ME140:
MATERIAL SCIENCE AND METALLURGY (4-0-0-2-4)

Course Objectives:

- To introduce the basic concepts of crystal structure, its different types and defects
- To enable the student to visualize lattice atomic diffusion

- To familiarize the students with mechanical behavior of metals, different types of mechanical testing and fracture behavior of metals
- To enable the students to understand solid and liquid phase reactions and phase diagrams, under equilibrium and non-equilibrium conditions
- To provide an overview of different types of heat treatment processes of ferrous, non-ferrous metals and learn about polymers, ceramics composites and nanomaterials

Course Outcomes:

At the end of the course, the student will be able to

- explain the importance of materials for various applications
- identify and analyze the various crystal structures and defects responsible for change in the material properties and explain the process of diffusion, its types and mechanisms
- identify different phases in iron-carbon diagram for steels and cast-iron and non equilibrium phases
- use the phase diagrams effectively to identify the phase-state of the material for a given temperature condition
- select the best heat treatment process based on application and identify the composition, properties and application of various ferrous, non-ferrous, polymer, ceramic, composite and nanomaterials

Course Content:

1. **Lattice, Unit cell, Basis and crystal structure:** Unit cell, Space lattice, Bravais Lattices, Miller indicesin cubic and hexagonal structures, Crystal Imperfections, Atomic Diffusion: Fick's laws of diffusion
2. **Mechanical Properties and Behavior:** deformations, Tensile test, Plastic deformation, Hardness of Materials, Strain rate effects and Impact testing, Fatigue and Creep
3. **Solid Solutions and Phase Equilibrium: S**olid solutions, Rules governing formation of solid solutions, Phase diagrams, Lever rule, Nonferrous Phase Diagrams, Al-Si, Al-Cu, Cu-Zn Phase diagrams
4. **Iron Carbon Equilibrium Diagram:** Phases in the Fe-C system, Invariant reactions, critical temperatures, Microstructures, The TTT diagram; **Heat Treatment of Steels:** Annealing, Normalizing, Hardening, Tempering, Martempering, Austempering, Surface hardening; **Hardenability of Steels:** Hardenability concept – Jominy End Quench test, effect of alloying elements
5. **Engineering Alloys (Ferrous& Non-Ferrous):** Properties and uses of Carbon steels, Steel designation as per AISI designation; Properties and uses of Cast Irons, Properties and uses of light alloys; Properties and uses of Copper and its alloys; **Ceramic and Polymeric Materials; Composites and Nanomaterials**

Prerequisite Course: None

Reference Books:

1. "The Science and Engineering of Materials ", Donald R Askeland and Pradeep, P. Phule, Cengage Learning, Sixth Edition, 2010.
2. "Materials Science and Engineering: An Introduction", William D. Callister, Jr., John Wiley & Sons, Eighth Edition, 2009.
3. "Characterization of Materials", Volumes 1 and 2, John Wiley & Sons, New Jersey, 2003
4. "Introduction to Nanotechnology" Charles P. Porte, Frank Owens, Wiley Publishing Company, 2007

UE18ME180: ENGINEERING THERMODYNAMICS (3-1-0-4-4)

Course Objectives:

- To introduce the fundamental concepts, terms and terminologies involved in thermodynamics.
- To enable students to understand and apply the laws of thermodynamics and the concepts of available energy and availability (exergy) to solve engineering problems.
- To train the students to use charts, tables and equations used in solving engineering problems related to thermodynamics.

Course Outcomes:

At the end of the course, the student will be able to

- apply fundamental thermodynamic concepts to classify systems as open, closed and isolated and apply the zeroth law of thermodynamics to solve problems
- apply the 1st and 2nd laws of thermodynamics and the concept of entropy to solve engineering problems involving closed and open systems by making proper assumptions
- analyze closed and open systems using the concepts of available energy and availability (exergy)
- apply thermodynamic concepts to describe the performance of individual components of a system (e.g. power plant, a jet engine etc) and relate that information to the overall performance of the entire system
- analyze different processes involving gases, gas mixtures and pure substances using charts, tables and equations

Course Content:

1. **Introduction**: concept of temperature; zeroth law of thermodynamics; Work and Heat Transfer.
2. **First Law of Thermodynamics:** first law for a closed system-isolated-open system- analysis of steady & unsteady flow systems
3. **Second Law of Thermodynamics:** limitations of first law; Kelvin-Planck and Clausius statements of second law; reversibility and causes of irreversibility; corollaries of second law
4. **Entropy and Availability:** Clausius inequality (Clausius theorem), Entropy generation in closed and open systems; Tds relations, Isentropic process; availability analysis for closed and open systems
5. **Properties of Gases, Gas Mixtures and Pure Substances:** Dalton's law and Gibb's law; state diagrams for a pure substance.

Prerequisite Course: None

Reference Books:

1. "Fundamentals of Thermodynamics", Claus Borgnakke and Richard E Sonntag, Wiley Student Edition, 2010
2. "Thermodynamics - An Engineering Approach", Yunus A Cengel & Michael Boles, 7th Edition, TMH publishing Co. Ltd., 2011
3. "Engineering Thermodynamics", P.K.Nag, TMH publishing Co. Ltd., 2008

UE18ME240: MECHANICS OF SOLIDS (4-0-0-0-4)

Course Objectives:

To enable the students to

- acquire fundamental understanding of the behavior of components used in machines
- develop skills to help them model and analyze the behavior of machine components subjected to various loading support conditions based on equilibrium principles
- understand the concepts of stress and strain in materials and to understand various terminologies associated such as tensile strength, factor of safety, yield stress and many more
- understand the concepts of shear force/bending moment deflection in beams
- understand the concepts of torsion and its application to design of shafts
- understand the concepts of column loading and its effect due to buckling

Course Outcomes:

At the end of the course, the student should be able to

- display a good understanding of the behavior of components used in machines
- demonstrate the required skill sets needed to model and analyze the behavior of machine components subjected to various loading support conditions based on equilibrium principles
- use the concepts of stress and strain in materials and apply the understanding of various terminologies associated such as tensile strength, factor of safety, yield stress and many more in solving simple numerical problems
- demonstrate a thorough understand of the concepts related shear force/bending moment deflection in beams, torsion and its application to design of shafts
- apply their understanding of buckling of beams demonstrate their ability to analyze buckling of simple beams subject to simple boundary and loading conditions understand the concepts of column loading and its effect due to buckling

Course Content:

1. **Axial Loading**: Stress and Strain, stress-strain diagram, Hooke's law, deformation statically indeterminate problems, Multiaxial loading; **Thermal Stresses**
2. **Columns:** Stability, Euler's Formula, Empirical formula; **Torsion:** Deformations in a Circular Shaft, Stresses in the Elastic Range, Design of Transmission Shafts; **Energy Methods:** Strain Energy, Energy for normal and shearing stresses
3. **Transformation of Stress and Strain:** Transformation of plane stress, Principal Stresses, Maximum Shearing Stress, Mohr's Circle for Plane Stress; **Pressure Vessels:** Stresses in Thin and Thick-Walled Pressure Vessels.
4. **Analysis and Design of Beams for Bending:** Shear and Bending-Moment Diagrams;

   Pure Bending: Deformation in a Symmetric Member in pure Bending, Stresses and Deformations in the Elastic Range
5. **Shearing Stress in Beams:** Determining shearing stress in a beam, shear stress distribution in beam cross sections; **Deflection of Beams:** Deformation of a Beam under Transverse Loading, Elastic Curve, Singularity Functions, Area moment method.

Prerequisite Course: UE16CV101: Engineering Mechanics

Reference Books:

1. "Mechanics of Materials (In SI Units)", Ferdinand P Beer, E Russell Johnston, Jr John T DeWolf, TATA McGraw-Hill, Special Indian Edition, 3rd Edition, 2009.
2. "Mechanics of Materials", James M. Gere, Barry J. Goodno, Cengage Learning, 8th Edition, 2012
3. "Strength of Materials", S Ramamrutham, Dhanpat Rai Publications, Reprint 2005.
4. "Strength of Materials", I.B. Prasad, Khanna Publishers, 8th Edition 1989.

UE18ME280: MECHANICS OF FLUIDS (3-1-0-4-4)

Course Objectives:

- To introduce the students to fundamental concepts, terms and terminologies involved in fluid mechanics
- To enable the students to understand and apply the various contributive laws and concepts to solve fluid engineering problems.
- To familiarise the students with measurement and visualisation of fluid flow types, kinematics, and its analysis
- To introduce the students to real world machinery incorporating fluid flow, its performance and the efficiency determining factors

Course Outcomes:

At the end of the course, the student will be able to

- explain the meaning and significance of fluid properties and solve related problems and analyze and solve problems on fluid pressure and related measurement devices
- analyze the various types of fluid motion and its stability based on the fundamental laws and forces affecting fluid flow
- visualize different types of fluid flow, and compare them based on kinematic flow descriptions and analyze how mass and momentum is conserved in various situations based on Bernoulli's & Newton's laws
- analyze flow through closed conduits and determine energy loss for turbulent and laminar flows
- apply the concepts of dimensional analysis and non-dimensionalisation and use Buckingham's Pi theorem to obtain expressions for various fluid flow situations; analyze the principles of flow over bodies; explain the working principles of hydraulic turbines and pumps

Course Content:

1. **Fluids Properties:** Introduction; Fluid Statics: Fluid pressure and its measurement; Hydrostatic Forces on Submerged Surfaces; Buoyancy and Stability.
2. **Fluid Kinematics:** Lagrangian and Eulerian Descriptions; Flow Visualization; Plots of fluid flow data; Types of Motion, Vorticity and Rotationality; Reynolds Transport Theorem.
3. **Mass, Bernoulli Equations and Momentum Analysis:** Conservation of Mass; Mechanical energy and Efficiency; The Bernoulli equation; Momentum Analysis, Newton's Laws and Conservation of Momentum;
4. **Flow In Pipes:** Laminar and Turbulent Flows: The Entrance Region; Piping Networks; Flow rate and Velocity Measurement
5. **Dimensional Analysis:** Method of Repeating Variables and Buckingham π Theorem; **Flow Over Bodies:** Lift and Drag; **Turbomachinery:** Working Principles of Hydraulic Turbines and Pumps; **Introduction to compressible flow**

Prerequisite Course: None

Reference Books:

1. "Fluid Mechanics – Fundamental and Applications", Yunus A.Cengel, John M.Cimbala, Tata McGraw-Hill Publishing Co. Ltd. 2006.
2. "Fluid Mechanics" (In SI units), Frank M White, McGraw-Hill Publication, Seventh Edition, 2011.

MINOR IN MANAGEMENT

UM18MB140: MANAGING ORGANIZATIONS (2-1-0-2-3)

Course Objectives:

- To explore fundamental knowledge of individual, group and organizational dynamics.
- To understand the research perspectives on organizational structure and processes.
- To understand the fundamental principles and major functions played by management.

Course Outcomes:

At the end of the course students can:

- Remember the fundamental concepts and principles, of functions of management, individual, group and organizational behavior.
- Exhibit fair Understanding of the concepts of management and influence of individuals in group.

- Apply the skills of functions of management and individual dynamics in group, in real time application.
- Analyze eco system associated with organizational dynamics.
- Evaluate the cases of management and organizational dynamics.

Course Contents:

1. **Introduction to Management:** Levels of management and skills of manager. Contributions of management gurus, F W Taylor, Henry Fayol and Elton Mayo. Role approach: Mintzberg roles. Contingency and systems approaches.
2. **Functions of Management:** Planning - process, types of plans and levels. Organizing-definition, basic elements and characteristics. Directing – leading, organizational communication; controlling- types, process and techniques; coordination-process.
3. **Introduction to Organizations:** Evolution of organization theory and design.

   Organization Structures – Definition, types of structures-functional, divisional, geographical, hybrid, matrix, horizontal, virtual, modular and contemporary organization structures.
4. **Foundations of individual behavior:** Values-types-instrumental & terminal value, Attitudes-components, formation process and functions, personality-types & traits theories, Emotions-dimensions, Perception-process, determinants, attribution theory, errors in perception. Motivational theories- content and process.
5. **Foundations of group behavior:** Stages of group formation, Work groups and Teams-types, group properties, Conflict-types, process, resolution strategies. Negotiation- strategies, types of third party negotiations, Power- bases of power, power tactics and Politics- consequences, impression management.

Pre-requisites: None

Reference Books:

1. "Organizational Behavior", Stephen P Robbins, Timothy A. Judge, Niharika Vohra, Pearson Education, New Delhi, 14th Edition, 2009.
2. "Organization Theory and Design", Daft, Richard L, Thomson Learning, Australia, 8th Edition, 1994.
3. "Managing Human Resources", Snell, Scott A., Bohlander, George W., Cengage Learning, 16th Edition, 2012.

UM18MB180:
MARKETING MANAGEMENT IN THE DIGITAL ERA (2-1-0-2-3)

Course Objectives:

- This course is designed to improve the student's understanding of the basic concepts of marketing management in digital era.
- Students will understand the function of marketing in a competitive, dynamic business and how technology is disrupting the way consumers choose products and the way business delivers value to customers.
- Students will comprehend the key elements in developing a marketing strategy and planning a marketing program by covering topics such as customer segmentation, positioning, branding, consumer research, pricing, marketing communications, new product development, and channel strategy with emphasis of technology.

Course Outcomes:

At the end of the course students can:

- Explain the role and functions of marketing in a range of organizations in digital era.
- Exhibit the Skills of applying the introduced conceptual frameworks, theory and techniques to various marketing contexts.
- Describe and analyze the marketing behavior of consumers.

Course Contents:

1. **Understanding marketing management through customer value:** Defining Marketing for the 21st century, Developing Marketing Strategies and Plans, scanning the marketing environment, conducting marketing research.
2. **Connecting with Customer by Shaping the Market Offerings:** Analyzing Consumer Markets & Business Markets, Identifying Market Segments **Brand Positioning:** branding concepts, Crafting the Brand Positioning- developing and communicating positioning strategies and PLC strategies
3. **Designing Value through Product & Services marketing**: Product characteristics and classification and product and brand relationships, **Services Marketing:** Nature of services, managing service quality and brands, Designing and Managing Services. **Pricing**: introduction to pricing concepts, Developing Pricing Strategies.
4. **Delivering value in digital era:** Designing and managing Integrated Marketing Channels, Managing Retailing, wholesaling and logistics, introduction to E Commerce.
5. **Communicating Value in digital era:** Designing and Managing Integrated Marketing Communication (IMC), Managing Mass Communication & Personal Communication, introduction to digital marketing, internet and mobile marketing, search engine advertising and search engine optimization, social media marketing.

Pre-requisites: None

Reference Books:

1. "Marketing Management – A South Asian Perspective", Philip Kotler, Kevin Lane Keller, Abraham Koshy, Mithileshwar Jha, Pearson Education, 14th Edition, 2013.
2. Digital Marketing, Seema Gupta, McGraw Hill Education, Chennai, 1ST Edition, 2018.

UM18MB240:
SUPPLY CHAIN MANAGEMENT (2-1-0-2-3)

Course Objectives:

- To help students understand the importance of supply chain, distribution and networking concepts for any company.
- To provide an insight about E commerce and supply chain in practice.

Course Outcomes:

At the end of the course students can:

- Understand the fundamental role of supply chain.
- Apply the skill acquired to manage supply chain of an organization.
- Evaluate current trends, growth opportunities, global patterns and niche markets within the area of supply chain management.

Course Contents:

1. **Introduction to Supply Chain Management:** Supply chain – objectives – importance – decision phases – competitive and supply chain strategies – supply chain drivers – Framework – facilities – inventory – transportation – information – sourcing – pricing.
2. **Designing the Supply Chain Network:** Designing the distribution network – role of distribution factors influencing distribution design options – online sales and distribution network, Indian FMCG and distribution channel network design in the supply chain – factors affecting the network design decisions, Designing Transportation Networks, Role of transportation – modes and their performance – transportation infrastructure.

3. **Sourcing and Pricing:** Sourcing – In-house or Outsource – 3rd and 4th PLs – selection – design collaboration – procurement process – Pricing and revenue management for multiple customers, perishable products, seasonal demand, bulk and spot contracts.
4. **Information Technology in the Supply Chain**: IT Framework – customer relationship management – internal supply chain management – supplier relationship management –transaction management Future of IT.
5. **Coordination in a Supply Chain:** Lack of supply chain coordination and the Bullwhip effect – obstacle to coordination managerial levers – continuous replenishment and vendor managed inventories collaborative planning, forecasting and replenishment.

Pre-requisites: None

Reference Books:

1. "Supply Chain Management – Strategy, Planning and Operation", Sunil Chopra and Peter Meindl, Pearson Education, New Delhi, 4th Edition, 2010.
2. "Exploring Supply Chain Theory and Practice", Kachru, Upendra, Excel books, New Delhi, 1st Edition, 2009.

UM14MB280: FINANCIAL MANAGEMENT (2-1-0-2-3)

Course Objective:

- This course enables students to understand the basic concepts of Financial Management and emphasizes the financial implications of managerial decisions.

Course Outcomes:

At the end of the course students can:

- Understand the basics of Financial Management.
- Inculcate the attitude of analytic thinking.
- Illustrate real time financial management elements like EPS, operating profit, cost of capital and investment decision.

Course Contents:

1. **Basic concepts of finance:** Assets-Fixed Assets, Current Assets, Liquid Assets, Liabilities-Long Term Liability, Current Liability, Income, Expenditure, Capital receipts, Revenue Receipts, Capital Expenditure, Revenue expenditure, Meaning of Depreciation, Overview of Financial statements.
2. **Introduction to Corporate Finance:** Corporate Finance: Introduction, Meaning, Corporate Finance, Finance Function Role of Finance Manager.

   Financial Management: Goals of Financial Management-Profit maximization Vs Wealth Maximization. Sources of fund: Long term and short term sources of fund.
3. **Time Value of Money & Investment Decision:** Simple Interest, Compound Interest, Time Preference for Money, Future Value, Present Value.

   Capital Budgeting: Meaning & Definition - Techniques: Payback Period, Accounting Rate of Return, Net Present Value, Internal Rate of Return, Profitability Index.(Simple Problems)
4. **Cost of Capital:** Cost of Capital: Meaning, Computation of Cost of capital, cost of equity, preference, Debt, Retained earnings, calculation of weighted average cost of capital. (Simple problems)
5. **Capital Structure & Leverages:** Capital Structure: Meaning, Factors influencing Capital structure, Optimum Capital structure EBIT-EPS Analysis

   Leverages: concept, Types of Leverages- computation of leverages. (simple problems)

   Management of Working Capital: Working Capital: Introduction, Concept, Types, components of working capital. Operating Life Cycle concept, Determinants of Working Capital. Estimation of Working capital requirements.

Pre-requisites: None

Reference Books:

1. "Financial Management: Principles and Practice", S N Maheshwari, Sultan Chand & Sons, 14th Edition, 2014.
2. "Financial Management MBA", Gupta Shashi K., Sharma RK, Gupta Neeti, Kalyani Publications, 1st Edition, 2017.
3. "Financial Management", I M Pandey, Vikas Publishing House Pvt Ltd, 11th Edition, 2015.
4. "Financial Management", Prasanna Chandra, Tata McGraw-Hill Education, 9th Edition, 2015.
5. "Financial Management", M Y Khan, P. K Jain, Tata McGraw-Hill Education, 7th Edition, 2014.

MINOR IN DESIGN

UA17BD140: DESIGN METHODS AND CREATIVITY (2-4-0-4)

Course Objectives:

To introduce students to

- Design methods to solve various design problems
- Design methods for design in various design contexts
- Patterns of reasoning in design
- Methods for Analysis and Synthesis and their preliminary application
- Methods for Simulation and evaluation, and their preliminary application

Course Outcomes:

At the end of the course the students will be able to

- Appreciate the importance of methods during design
- Choose methods particular to the design stage in question
- Apply methods individually or in groups in the design stage
- Apply techniques in Analysis and Synthesis
- Apply methods for Simulation and evaluation

Course Contents:

- Introduction to design method and design methodology
- Patterns of reasoning in design. Significance of methods for questioning the status quo and creativity. Methods for understanding user needs, validation and their application
- Introduction to methods for analysis and their preliminary application
- Introduction to methods for Synthesis and their preliminary application
- Introduction to methods for Simulation and evaluation, and their preliminary application

Pre-requisite Courses: None

References:

1. "Design Methods- Seeds of Human Futures", C.J. Jones, Wiley–Interscience, 1989
2. "Product Design: Fundamentals and Methods", NFM Roozenburg and J Eekels, 1995
3. "How Designer's Think: The Design Process Demystified", B. Lawson, Architectural Press, 1997
4. "Product Design and Development", U. T. Karl and S. D. Eppinger, 3rd Ed., Tata McGraw Hill, 2004

5. "Industrial Design in Engineering – a Marriage of Techniques", C.H. Flurscheim Ed., The Design Council, 1983
6. "Design of Everyday Things", D. Norman, , Currency Books, New York, 1990
7. "Usability Engineering", J. Nielsen, , Morgan Kaufmann, San Francisco, 1993

UA17BD180
ERGONOMICS (3-2-0-4)

Course Objectives:
To introduce students to

- Human capabilities and limitations
- Human limitations
- Aspects of safety and comfort for a product design
- Aspects of comfort for a product design
- Key concepts in Design for everyone

Course Outcomes:
At the end of the course the students will be able to

- Categorize human capabilities and identify their use during product design
- Categorize limitations and identify their use during product design
- Apply aspects of ergonomics during product design
- Evaluate usability of designed interventions from a human-centric view
- Apply design principles for displays

Course Content:
1. History and focus of ergonomics, Ergonomics and its areas of application in the work system, humanizing work, modern ergonomics
2. Human capabilities and limitations, Anthropometrical, Physiological, Psycho-social considerations in Ergonomics
3. Basic body mechanics, Postural stability and postural adaptation, Risk factors for musculoskeletal disorders in the workplace, behavioral aspects of posture
4. Designing for a population of users, Sources of human variability, Anthropometry and its uses in ergonomics, Principles of applied anthropometry for ergonomics in design
5. Design for everyone; Design for Seating and Standing work. Principles for the design of visual displays; Auditory displays, Design of controls; Combining displays and controls; Virtual environment.

Pre-requisite Courses: None

References:
1. "Introduction to Ergonomics", R.S Bridger, , McGraw-Hill Inc., 1995
2. "Human Factors in engineering and Design", M. S. Sanders and Ernest J. McCormick:,Sixth Edi.,McGraw-Hill International Editions, 1987
3. "Indian Anthropometric Dimensions for Ergonomic Design Practice", D. Chakrabarti, National Institute of Design, Ahmedabad, 1997
4. "Handbook of Human Factors and Ergonomics", G. Salvendy Ed., , John Wiley and Sons, 1997

UA17BD240:
DESIGN, INNOVATION AND MANAGEMENT (4-0-2-4)

Course Objectives:
To introduce students to

- Broader context of design in organizations and for innovation
- Broader context for innovation
- Design and intellectual property management
- Methods of management in design projects within small teams
- Role of design for driving customer experiences

Course Outcomes:
At the end of the course the students will be able to

- understand the critical role of design and the design process for innovation
- manage design projects within small teams
- search patent databases to estimate novelty
- Conduct patent searches
- Appreciate the role of design for customer driving experiences

Course Content:
- Significance of design as a process for change and a motivator
- Importance of the design process for creating novelty
- Aspects of forming and managing design projects and teams
- Conducting patent searches and making reports to propose/ establish novelty; understand IP rights and design registration procedures
- Role of design for driving experiences and corporate/ organizational innovation

Pre-requisite Courses: None

References:
1. "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Sep 2009, Tim Brown, HarperBusiness, Hardcover: ISBN-13: 978-0061766084
1. "Design Thinking: Integrating Innovation, Customer Experience, and Brand Value", Nov 10, 2009, Thomas Lockwood, Allworth Press; 1st edition, ISBN-13: 978-1581156683
2. "Product Innovation: Leading Change through Integrated Product Development", David L. Rainey, Cambridge University Press, 2011
3. "Design Management: Using Design to Build Brand Value and Corporate Innovation", Brigitte Borja De Mozota, Allworth Press, 2004

UA17BD280
DESIGN PROJECT (4-0-2-4)

Course Objectives:
To introduce students to:

- Approach to design projects
- Observation, and need analysis
- Prototyping Methods
- Basic User Testing
- Simulation methods

Course Outcomes:
At the end of the course the students will be able to

- Execute design projects
- Apply observation methods and need analysis to problems
- Develop successful prototypes
- Create various models for user testing
- Simulate for use

Course Content:
- Approach to Design Projects
- Observation Methods and Analysis Techniques
- Prototyping Methods and Techniques
- User Studies and testing
- Simulation methods and guidelines

Pre-requisite Courses: None

References:

1. "Product Design and Development", Ulrich, Karl T., Eppinger, Steven D., McGraw-Hill, 2004
2. "Creating Breakthrough Products: Innovation from Product Planning to Program Approval", Cagan, Jonathan; Vogel, Craig M., Financial Times Prentice Hall; 2002
3. "About Face 3: The Essentials of Interaction Design", 3rd Edition, Alan Cooper, Robert Reimann and David Cronin, Jenson Books Inc. ISBN-13: 978-0470084113
4. "Design Thinking for Visual Communication (Basics Design)" Paperback – April 23, 2015, Gavin Ambrose, Fairchild Books, 2 Edition, ISBN-13: 978-1472572714
5. "Launch: Using Design Thinking to Boost Creativity and Bring Out the Maker in Every Student", John Spencer, A J Juliani, May 19, 2016, Dave Burgess Consulting, Incorporated, Paperback: ISBN-13: 978-0996989541

MINOR IN ECONOMICS

UM17AE140: PRINCIPLES OF ECONOMICS (4-0-0-0-4)

Course Objectives:

- To equip the students with basic economics principles necessary to understand the working of our economic systems.

Course Outcomes:

- Expertise in basic economics used in the Masters Programme of Economics.

Course Contents:

1. **Exploring Economics:** Why Economics? – Scope and Methods of Economics – Central Ideas in Economics – The Questions of: What to Produce – How to Produce and Distribute Output – Science of Economics – Managerial Economics – Relationship of Managerial Economics with decision sciences
2. **Theory of Demand:** Demand and Supply – Comparative Statics: Changes in Demand and Supply – Price Elasticity of Demand – Total Revenue – Marginal Revenue – Price Elasticity – Factors Affecting Price Elasticity – Cross Price Elasticity – Income Elasticity of Demand – Other Elasticities – Elasticities for Nonlinear Demand Functions – Elasticity of Supply – Choice and Utility Theory – Law of Diminishing marginal utility – Consumer Equilibrium – Indifference curve Analysis – Consumer Surplus – Price effect, Substitution Effect and Income Effect – Demand Forecasting.
3. **Production analysis:** Types of Inputs – Production function – Elasticity of substitution – Iso-cost lines – *Cost Concepts*: Types of cost – Cost curves – LAC curve – Cost- volume profit relationships and breakeven analysis – Economies of scale – Economics of Scope, Cost and learning curves – Economies of Scope.
4. **Market structure:** The Nature of Industry – Perfect Competition – Monopoly – Monopolistic Competition – Oligopoly – Product pricing
5. **Principles of Macro-economics:** National Income – Banking System – Monetary policy – Fiscal policy – Business Cycles – Inflation – Unemployment and Unemployment

Reference Books:

1. "Macroeconomics", Dornbusch R. and Fisher S., Tata Mc. Graw Hill, 2012.
2. "Principles of Macroeconomics", Mankiw N Gregory, Cengage Learning, 2012.
3. "Microeconomics", Pindyck R., Rubinfeld D and Mehta P, 7th Edition, Pearson Education, 2009.
4. "Managerial Economics", Salvatore Dominick & Srivastava Ravikesh, Oxford Higher Education, 2012.
5. "Macro Economics", Samuelson Paul A. and Nordhaus William D., McGraw-Hill Education, 2013.
6. "Economics for Business", Sloman John and Sutcliffe Mark,Pearson Education, 2009.
7. "Managerial Economics: Concept and Applications", Thomas Christopher R, S Maurice Charles, 8th Edition, McGraw- Hill. 2004.

UM17AE180: ECONOMICS OF TECHNOLOGY AND INNOVATION (3-0-0-0-3)

Course Learning Objectives

- To understand economic principles governing application of technology and innovations.

Course Outcomes

- Appreciate the importance of Technology in Economics.

Course Contents

1. **Basic Concepts:** View of Technology in Economics – Technology in production process of selected industries – Effects of Technology on the Economy – Technology for markets & Markets for Technology – Examples.
2. **Measuring Technology**: Can Technology be measured – Ways of measuring Technology in Economics - Examples.
3. **Understanding Technological Change:** What is Technological Change – Impact of Technological Change within the industry, across the industry, and throughout the economy – Examples.
4. **Innovation and Technology Policy:** Nature and Importance of Innovation – Inventions and Innovations – Role of Research and Development – Radical and Disruptive Innovations and User led Innovations – Linear and Chain Linked Innovations – Examples. Market Failure and Need for Policy Intervention, R&D Incentives, IPR Regime, Problems of Appropriation and Patents.
5. **Indian Experience in Technology and Innovations:** Phases in Technological Changes and Indian Economic Policy – Policy towards Technology Imports and Dissemination – Changes in Innovations and Patents Policy – Allocation of Funds to Public and Private R & D.

Reference Books:

1. "Innovation, Intellectual Property, and Economic Growth", Greenhalgh, C. And Mark Rogers, Princeton University Press, 2010.
2. "The Economic Analysis of Technological Change", Stoneman, P., Oxford University Press, 1983.
3. "The Economics of Innovation", Swann, P.G M., Edward Elgar, 2009.

UM17AE240: ECONOMETRIC ANALYTICS (4-0-0-0-4)

Course Objectives:

- To acquaint students to problems associated with economics data and to familiarize them with techniques suitable to analyze such data.
- To familiarize students with theoretical underpinning of the relevant techniques.
- To combine theory with hands-on experience in analyzing data

Course Outcomes:

- Obtain an understanding of different types of datasets.
- Obtain an understanding of building and testing hypothesis.
- Build experience in estimating econometric models using econometric software.

Course Content:

1. **Ordinary Least Squares**
   a. **Review of Statistics:**Descriptive Statistics, Random Variables, Parameter Estimation, Tests of Hypothesis
   b. **Simple Regression Model:**Population and Sample Regression Functions, CLRM Assumptions, Deriving OLS Estimators, Functional Forms and Interpretation,Properties of OLS Estimators, Goodness of Fit, Gauss-Markov Theorem, Regression through Origin,CNLRM Assumptions and Implications, Interval Estimation and Hypothesis Testing.
   c. **Multiple Regression Model:**CLRM Assumptions Revisited, Deriving OLS Estimators,Properties of OLS Estimators, Measures of Goodness of Fit,More Functional Forms and Interpretation, Hypothesis Testing, Dummy Variables Regression Models
2. **Relaxing CLRM Assumptions:**
   a. **Multicollinearity:**Nature of Problem, Estimation in Presence of Multicollinearity, Theoretical and Practical Consequences, Detection and Remedial Measures
   b. **Heteroskedasticty:**Nature of Problem, OLS Estimation in Presence of Heteroskedasticity, Consequences,GLS and WLS, Detection and Remedial Measures
   c. **Autocorrelation:**Nature of Problem, OLS Estimation in Presence of Autocorrelation, Consequences, Detection and Remedial Measures
   d. **Model Specification and Diagnostics:** Specification Error and Tests for Specification Error, Measurement Error, Model Selection Criterion
3. **Topics in Time Series Econometrics:** Autoregressive and Distributed Lag Models, Unit Root Process and Tests, Causality and Cointegration, AR, MA, and ARIMA Processes, Box-Jenkins Methodology

Reference Books:

1. "Basic Econometrics", Gujarati, Damodar N., Fourth Edition, Tata McGraw-Hill, 2004.
2. "Econometric Methods with Applications in Business and Economics", Heij, Christiaan, Paul de Boer, Philip Hans Franses, TeunKloek, Herman K. van Dijk, Oxford University Press, 2004.
3. "Introductory Econometrics: An Introductory Approach", Wooldridge, Jeffrey M., 5th Edition, South-Western, Cengage Learning, 2013.

UM17AE280:
FINANCIAL ECONOMICS (3-0-0-0-3)

Course Objectives:

- To get acquainted with functions of different types of financial instruments used in the financial industry.
- Understand the characteristics of financial instruments, associated risks and returns.

Course Outcomes:

- Students will become skilled at following the financial markets and will be equipped to engage in debate on current issues affecting these markets.

Course Content:

1. **Financial Markets and Instruments:** Types of markets, Equity, Debt, Derivatives, Commodities, Types of investment avenues, Participants, Primary market, Secondary market, Regulators, Exchanges, Depositaries, Clearing Corporations
2. **Bond Markets:**Indian debt market, Bond prices, term structure, Theories of term structure, types of bonds
3. **Equity and derivatives markets:**IPO, IPO Process, Demat, Listing in secondary market, trading rules, transaction costs. Derivatives, Introduction, Types: Futures, Forwards, Options, Open Interest, Valuation, Implied interest rate and volatility.
4. **Forex Markets:** Introduction to forex, Basic arbitrage relationship in forex, Interest rate parity , purchase power parity, Forward rate.
5. **Returns and valuation:** CAPM, Modeling equilibrium returns, Valuation models, DCF, Relative, Free cash flows

Reference Books:

1. "Investment Analysis and Portfolio Management" , Prasanna chandra, McGraw Hill, 5th Edition, 2017.
2. "Quantitative Financial Economics," Keith Cuthbertson, Wiley Publication, 2nd Edition, 2004.
3. Securities Market Basic Module, NCFM, NSE.

MINOR IN LAW

UL18BL140:
INTRODUCTION TO LAW AND LEGAL SYSTEMS (4-0-0-0-4)

Course Objectives:

- Enable students to identify, analyze and research issues in any area of law.
- Introduce students to systematic study of law

Course Outcomes:

- Understand what is meant by the 'Legal Framework' of a Nation.
- An understanding of the Indian Legal system and its Common Law roots

Course Contents:

1. **Introduction to Law**: Meaning of Law, Relationship between Law and Society, Need for Laws in Society, Relationship between Law and Morality, Introduction to Legal System and Courts, Evolution of Justice, Equity and Social Justice.
2. **Constitution of India**: Making of constitution, Preamble-Basic Structure Theory, Fundamental rights, Fundamental Duties, Directive principles of State Policy, Centre State Relationships.
3. **Classification of law** : Civil and Criminal Law; Public and Private Law; Municipal and International Law; Substantive and Procedural law- Major legal systems of the world- Common Law Legal System, Equity, Civil Law Legal System, Religious legal systems.
4. **Source of Law**- Meaning and Definition of Law (Laws, Legislations, Rules, Orders, Notifications)- Custom as a Source of Law; Precedent as a Source of Law; Legislation as a Source of Law- Inter-relationship of the sources, Constitution of India as source of Laws- Other sources: Judge Made Law, Law Commission Reports.
5. **Court System in Modern India:** Hierarchy of Courts, Role of High Court and Supreme Court, Access to High Court and Supreme Court, Jurisdiction of Courts. Basic concepts of interpretation- Reading a judgement- Understanding *Ratio Decidendi* and *Obiter Dicta.*- Writs, Public Interest Litigation (PIL), Epistolary Jurisdiction, Role of NGOs, Role of Right to Information Act.

Reference Books:

1. "Indian Legal System", Joseph Minattur, Indian Law Institute, 2015.
2. "Jurisprudence and Legal Theory", V.D. Mahajan, Eastern Book Company, 2016.

UL17BL180:
COMPANY LAW AND BUSINESS ETHICS (4-0-0-0-4)

Course Objectives:

- To help the students to understand the basic concepts of formation and procedures of company as a form of business and also to give them a clear idea about the corporate sector, capital and securities markets

Course Outcomes:

- At the end of the course students should be able to clearly analyse the technical procedures of formation, registration and winding up of a company.

Course Contents:

1. **Introduction to Company Law-** Company or Corporate personality – Concept**;** Nature and Features of a Corporate Body**;** Lifting of Corporate Veil**;** Classification of company.
2. **Pre-incorporation, Incorporation and Commencement of Business-** Promoters - Promotion of company; Promoters: Position, Duties and Liabilities; Pre-incorporation contracts- Memorandum of Association; Certificate of Incorporation; Certificate of Commencement
3. **Corporate Management, Corporate abuses and their remedies-** Directors- Concept and Definition; Kinds of Directors; Powers and Duties of Directors; - Meetings; Meaning; Kinds of Meeting; **Remedies for Abuses**; Majority rule and Minority rights; Protection against Oppression and Mismanagement; Role of Central Government
4. **Corporate Breakdown**- Meaning of Winding up; Modes of Winding up; Winding up by the Tribunal; - Voluntary Winding up; i) By Members ii) By Creditors; Contributories; **Restructuring after breakdown**; Takeover, Mergers/Amalgamation; Acquisition; Takeover. Corporate Social Responsibility under Company Law: Need for CSR, Corporate Environment Responsibility (CER).
5. **Business Ethics**: Principles of Business Ethics, Corporate Governance, Workplace Ethics, Ethics in Marketing and Consumer Protection, ethics in Accounting and Finance.

Reference Books:

1. "Elements of Company Law", N.D. Kapoor, Sultan Chand and Sons, 2016.
2. "Company Law", Avtar Singh, Eastern Book Company; 16th Edition 2015.

UL17BL240:
INTELLECTUAL PROPERTY LAW (4-0-0-0-4)

Course Objectives:

- Emphasis will be both on the origin and development of IPR.
- It attempts to examine the extent and level of protection extended to IPRs under domestic legislations and international commitments.

Course Outcomes:

- To analyse the rationale behind protecting intellectual property. To examine major international instruments concerning the IPRs and their evolution

Course Content:

1. **Introduction to Intellectual Property Law:** Introduction; History of IPR Protection, Trade Secrets and Technology Transfer; Patents, Trademark, Copyrights, Industrial Designs Layout Design of Integrated Circuits; Information Technology and IPR Farmers and breeders rights,
2. **International Legal Regime:** The Berne Convention, Universal Copyright Convention, the Paris Union; TRIPS the World Intellectual Property Rights Organisation (WIPO) and the UNESCO.
3. **Copyrights, Patents, Trademarks: Copyright** - Historical evolution of the law relating to copyright; Copyright in literary, dramatic and musical works; Copyright in sound records, cinematograph films and Copyright in computer program, Infringement of copyright by films of literary and dramatic works, Importation and infringement; **Patents-** Concept of patent, Historical view of the patents law in India; Patentable- Biotechnology; Process of obtaining a patent: **Trademarks-** Definition, concept of trademarks and Registration- Remedies
4. **Geographical Indications and Plant Varieties-** Protection of Geographical Indications; Objectives, Justification, International Position; Position; Plant Varieties Protection-Objectives, Justification. International Position, Plant Varieties Protection in India.
5. **Contemporary Intellectual Property Issues, IPR Transaction & Litigation-** Rationale for Intellectual Property Protection of Microorganisms; Moral Issues in Patenting.

Reference Books:

1. "Intellectual Property Rights a Global Vision", S.K Verma and Raman Mittal, ILI, 2004.
2. "Intellectual Property Law", Gopalakrishnan N.S, Eastern Book Co, 2008.

UL17BL280:
LAW OF CONTRACTS (4-0-0-0-4)

Course Objectives:

- The chief object of the course is learning & understanding the fundamental principles of law of contract.

Course Outcomes:

- To impart knowledge on sources of contract law, its theoretical underpinnings, and the influences of common law and statutory law in its development.
- To build an understanding of the principles particularly of contract formation and validity, enforcement of promises and liability.

Course Content:

1. **Introduction:** Nature and functions of a contract; Freedom of contract Elements of a contract- Offer – kinds of offer, revocation and termination- Acceptance – modes of acceptance, revocation- Intention to create legal relations- Consideration - Free consent
2. **Competency to Contract:** Minor's agreement –fraud by minor and estoppels- Unsoundness of mind –exceptions- Insolvency- Coercion –Undue Influence –Misrepresentation. Fraud – definition, essential elements, when silence amounting to fraud.
3. **Void Agreements**: Mistake- Legality of objects –immoral agreements, agreements opposed to public policy- Agreements expressly declared to be void – agreements in restraint of: marriage, trade and legal proceedings; Uncertain agreements- Wagering agreements
4. **Special Categories of Contracts**: Contingent- Quasi contracts –Standard form contracts –principles of protection against the possibility of exploitation, judicial approach to such contracts
5. **Discharge of Liability under a Contract**: By performance- By death, Inheritance, part performance- By breach- anticipatory breach and actual breach, *force majeure*- **Remedies** for Damages - remoteness of damage- Specific Performance of contract- Negotiable Instruments Act, Contracts for Sale of Goods.

Reference Books:

1. "Contract & Specific Relief", Avtar Singh, Eastern Book Company, 2013.
2. "The Indian Contract and Specific Relief Acts Volume I & II", Pollock & Mulla, Nilima Bhadbhade (Ed.), 14th Edition, Lexis Nexis Butterworths Wadhwa Nagpur, 2012.