STUDENT HANDBOOK

Applicable for students admitted into

M.Tech Programs from 2015-2016

K L University

u/s 3 of UGC Act, 1956

Koneru Lakshmaiah Education Foundation

INSIDE

CONTACT DETAILS

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Note: *While every effort has been made to ensure that this book is accurate and up to date, it may include typographical or other errors. Changes are periodically made to this publication and will be incorporated in new editions.*

ABOUT UNIVERSITY

VISION:

To be a globally renowned university.

MISSION :

To impart quality higher education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of students of all sections enabling them to be globally competitive and socially responsible citizens with intrinsic values.

OBJECTIVES :

Focus	**Objective**
Academics	1. To offer academic flexibility by means of Choice based credit systems and the like. 2. To identify and introduce new specializations and offer programs in emerging areas therein 3. To incorporate into the curriculum the Application orientation and use high standards of competence for academic delivery 4. To design and implement educational system adhering to outcome based International models. 5. To introduce and implement innovation in teaching and learning process to strengthen academic delivery 6. To offer academic programs at UG, PG, doctoral, Post-Doctoral which are industry focused, and incorporates Trans-discipline, inter-discipline aspects of the education system 7. To deliver higher education that includes technologies and meeting the global requirements
Research	8. To promote inter-disciplinary studies and create needful facilities that enhance inter-disciplinary research and innovation 9. To create an ambience that is conducive for undertaking sponsored research, internal funded research and offering consultancy services to wide spectrum of originations 10. To establish centers of excellence in frontier areas of research, and design innovation centers with industry collaboration 11. To create environment to innovate and incubate the products and services that addresses the societal requirements

	12. To integrate research into all academic programs 13. To maintain high standards in achieving research outcomes 14. To promote International conferences / Seminars / Workshops / in collaboration with professional bodies for creation of avenues for research exchange
Extramural and extension	15. To generate means and avenues for carrying out extramural research for Industry and Academia 16. To organize extension activities covering literacy promotion, health awareness and improve the living standards of community 17. To make the research outcomes useful and applicable for the societal needs
Infrastructure	18. To promote and maintain state of the art facilities for academic delivery, research and co & extra-curricular facilities and develop congenial and eco-friendly fully residential campus 19. To create and strengthen focused and modern infrastructure that address the national needs through generation of dedicated funds from Industry, Government and research organizations,
Equity / Access	20. To provide and promote the opportunities to higher education to socially deprived communities and remove disparities by promoting women, differently abled and socially deprived 21. To provide equal access to meritorious both in terms of admissions and financial support
ICT	22. To lay emphasis on effective usage of ICT, WEB –resources and train the faculty on the latest advancements thereof and develop effective e-content 23. To develop and maintain world class ICT infrastructure and lay emphasis on its effective usage, extend regular training to both faculty and students on its latest advancements there by ensure interactive academic delivery
Examinations and evaluations	24. To introduce reforms in the examination and evaluation system that brings out knowledge application skills and competencies of the students and ensure transparency

Ecology and Environment	25. To Build into curriculum, issues related to social awareness about ecology and environment towards achieving greener society
Linkages	26. To promote collaborations with international and national organizations for advancements of academics, research, Technology transfer and Intellectual property rights. 27. To Indigenize the global technological solutions and develop the products, and services that transforms the standard of living of rural India 28. Design new products and services that address commercially attractive needs and opportunities while leveraging the available resources in the form of un-employed and under-employed Individuals
Employability	29. To provide skills through curriculum and training that are essential in fostering entrepreneurial thoughts, employability prospects and at the same time provides necessary support for incubating the innovations and assisting them for prospective commercialization. 30. To provide necessary business infrastructure that allows attracting and sustaining the industry to commence their business establishments within the University Campus and aid in life long sustenance of employment. 31. To develop industrial cluster that helps the students to start their industry after incubating the products at the incubating centers which will create Jobs 32. To develop National depositories for meeting the goals of National skill development council 33. Train people to profile neighborhood and communities for the needs and commercial opportunities that will support financially sustainable new businesses
Governance	34. To institute measures for transparent administration that aid in improving efficiency, accountability and reliance 35. To comply with regulations of all the statutory bodies. 36. To install professional managers who are global visionaries, thought leaders, and thinkers into the management of the University so as to contribute to the ideals of the University system

Quality	37. To continuously upgrade the faculty in curriculum design, teaching pedagogy, usage of ICT and various processes pertaining to academics, research and University administration 38. To develop mechanism that attracts talented, qualified and experienced faculty from across the globe for pursuing their academic and research careers at the University. 39. To consider and implement norms, metrics, standards, procedures and benchmarks for assessing and improving the quality in every aspect of University system and achieve quality certifications by National and International bodies. 40. To establish Internal quality Assurance cell (IQAC) and install a quality systems that is integral part of all the University processes 41. To continuously upkeep overall quality of the University based on aspects of regular feedback from the stake holders 42. To improve the quality of faculty through faculty incentives, awards and recognitions
Value orientation	43. To mold the students to possess professional ethics, moral values and intrapersonal skills that shape them into effective leaders and who are having the thoughts of equality and unanimity towards all walks and sects of life. 44. To inculcate the self-consistency, self-reliance and self-learning qualities for shaping the students to lead their life on their own. 45. To sharpen the critical thinking and reasoning skills by making students tackle problems and ideas that are yet to be tackled through application of their intellectual discovery. 46. Developing the students towards human intellectual achievement and make them rich in cultural experience 47. Students to be encouraged and provided with necessary support enabling them to choose and pursue careers of their choice & interest that make them professionally satisfied.
National development	48. To expand the University in all its modes of delivery so as to contribute to the Nation’s increase in Gross Enrolment Ratio 49. To align the academic programs and courses to match the requirements of the National goals

	50. To develop technology that helps sustainable socio economic development

History

The President of KoneruLakshmaiah Education foundation, Er.KoneruSatyanarayana, along with Late Sri.KoneruLakshmaiah, founded the K L College of Engineering in the Academic year 1980-81. With the mighty vision and restless efforts of Er.KoneruSatyanarayana K L College of Engineering carved a niche for itself through excellence in engineering education, discipline and record numbers of placements and was the leading college in the state of AP. K L College of Engineering achieved NBA Accreditation for all its B.Tech. programs in 2004 and later re-accredited in 2007. K L College of Engineering was transformed into an autonomous engineering college in the year 2006. In 2008 this college received a record grade of 3.76 on a 4 points scale with "A" Grade from NAAC; and in February 2009, the college, through its founding society "KoneruLakshmaiah Education Foundation" was recognized as Deemed to be University by the MHRD-Govt. of India, Under Section 3 of UGC Act 1956. This Deemed to be University is named as "K L University".

Location

Vijayawada is located on the banks of river Krishna in the state of Andhra Pradesh and has been historically a cultural, political and educational center. It is also a part of Andhra Pradesh Capital Region. The city is well connected by National Highway and Rail with Chennai (440 km), Hyderabad (275 km), Vizag (385 km) and is a central junction for trains running from North to South India. Daily flights operate from Hyderabad and Bangalore.

K L University is situated in a spacious 100-acre campus on the banks of Buckingham Canal of river Krishna, eight kilometers from Vijayawada city. Built within a rural setting of lush green fields, the institute is a virtual paradise of pristine nature and idyllic beauty. The campus has been aptly named "Green Fields" and the splendid avenue of trees and gardens bear testimony to the importance of ecology and environment. The campus ambience is most befitting for scholastic pursuits. The University has been situated on a built up area of around 15, 00,000 S. Ft.

ACCREDITATIONS:

- Declared as Deemed to be University u/s 3 of UGC Act 1956.

- Accredited by National Assessment and Accreditation Council (NAAC) of UGC as 'A' Grade with 3.16 CGPA on 4 point scale.
- Approved by All India Council for Technical Education (AICTE), New Delhi.
- ISO 9001 - 2008 Certified Institution.

FACILITIES :

Central Library: E-Resources

The Central Library is the largest, and holds materials to serve the whole University community. It has materials relevant to the Engineering, Science & Humanities courses offered by the University.

The library system contains more than one lakh and fifty thousand books and periodicals on all subjects related to the teaching and research interests of the University staff and students. The library has over 15,000 electronic journal titles, academic databases and 5000 eBooks. Access is available on campus on student computers and remotely.

A new library building will be opened shortly on par with international standard with modern IT facilities.

Every department of the college maintains their library to cater the needs of students and faculty. All foreign and Indian journals are made available in the department library for the convenience of faculty and students.

The libraries render following library services.

- Circulation of library documentary.
- Inter-library loan services.
- Photo copying services.
- Reference service.
- CD-ROM search services.
- Inter Net services.
- OPAC
- WEB OPAC
- Audio visual
- Online lectures

The Data Center

A State-of-the-Art Data center with advanced servers provides highly interactive learning environment with full-fledged hardware and software training facilities.

Hardware:

The configuration of high end stream of servers that provides various services is

Super Computer

HPC Infrastructure (Super Computer):

- 5.3 TERA Flops (CPU + GPU)

- HP SL 230 4* SL230s Gen8, (2 * 2.6 GHz, 32GB RAM, 2x500GB HD, 10G IB HCA) providing -1.3TF
- HP SL 250 2* SL250s Gen8, (2 * 2.6 GHz, 32GB RAM, 2x500GB HD, 10G IB HCA + 2 NVIDIA K20 GPU providing -4TF. Master Node:
- HP DL 380P 1* DL380p Gen8 (2* 2.6Ghz, 64GB RAM, 2x2TB HD, 10G IB HCA).
- Compute Switch (48 Port Low latency switch)QLogic IB QDR 36 Port Switch.
- Intel® Composer XE for Linux.

The data centers consists of BYOD Servers& Backup Server, **Sun Servers, Dell and HP Blade Servers**, **Apple Server Xserve:**

SPECIAL LABORATORIES

The institute is equipped with various Industry Collaborated Labs

S. No	Discipline	Name of the Lab	Research Group Associated
1.	Computer Science and Engineering	CISCO	Computer Networks and security
2.	Computer Science and Engineering	IBM	Software Engineering
			Knowledge Engineering
3.	Computer Science and Engineering	Microsoft	Embedded Systems
			Software Engineering
			Knowledge Engineering
4.	Computer Science and Engineering	Adobe	Web technologies
			Image processing
5.	Computer Science and Engineering	Oracle	Knowledge Engineering
6.	Electronics Communication Engineering	NI Lab View	Communications Systems

Physical Education- Sports Facilities:

KL University encourages students to explore their latent talents by providing good games and sports facilities. The institute is equipped with the following.

- Athletic track
- Hockey Field
- Badminton Courts -4

- Tenni-koit Courts -2
- Cricket Field with Net practice - 3
- Volleyball Courts -4
- Tennis Courts - 2
- Handball Court
- Netball Courts - 2
- Throw ball courts - 2
- Beach Volleyball Court
- Football Field
- Basketball Courts – 2
- Kabaddi Courts – 2
- Table Tennis - 6
- Chess
- Caroms
- Kho Kho Court
- Soft Ball
- Archery

The University had State-of- the - Art Indoor stadium of 30000 sq.ft with:

- 4 wooden Shuttle Courts/ Basketball Court
- Yoga and Meditation Center
- Dramatics
- 8 Table Tennis Tables
- Hobby Center
- Gymnasium for Girls
- Gymnasium for Boys
- Multipurpose room with Chess, Carroms etc.
- Power lifting/Weight Lifting

Accommodation- Hostels

- KL University has separate hostels for boys and girls with well furnished rooms and modern amenities. The overall atmosphere is very conducive for the students to concentrate on studies.
- A state- of – the- art kitchen and spacious dining area has been provided for both the hostels.
- Generators have been provided as power back up.
- Emphasis has been laid on hygiene and cleanliness for healthy living. A customized menu caters to the student needs and it keeps changing according to their tastes.
- Teaching staff will have to address academic and personal problems of the students.
- Round-the-clock security, communication, dispensary facilities are also available.

The Girls Hostel

The girl's hostel is within the campus with a capacity of 1192 in 500 rooms. Different rooms accommodating 2 per room, 3 per room with attached toilets as well as A.C. rooms are available. Suite rooms with modern furniture and separate study room are also available.

The Boys Hostel

It is a short walk from the university with a capacity of 2040 in 780 rooms. Different rooms accommodating 2 per room, 3 per room with attached toilets as well as A.C. rooms are available.

➢ *Facilities in the Hostels*

Protected drinking water, state of the art kitchen, dining hall, newspapers, telephones, toilets and bathrooms are well maintained. Every student in the hostel is provided with a cot, study table, chair and a rack. Fan and light are also provided in each room.

- Gas & Steam based hygienic food preparation
- Palatable regional, national and international cuisines
- Cleanliness and Safety
- STD/ISD Facilities
- Medical Kits and First Aid Boxes
- Soft drinks, snacks, Fruits etc.
- Laundry
- Stationary shop

➢ **Hostel Rules & Regulations**

- Students are hereby informed that while staying in the hostel, it is essential to be responsible in maintaining dignity by upholding discipline. They must be obedient to the hostel warden/floor in – charges.
- Valuable items like jewelry etc., should not be kept with students while staying in the hostel. It is student's own responsibility to safeguard her/his Laptops, Money by locking suitcases and bags. If any loss is found, management will not take any responsibility.
- Student has to intimate to the hostel authorities before you giving police complaint against losses.
- Students are not allowed to indulge in smoking, consumption of Alcohol, Narcotic drugs etc., and defaulters will be strictly viewed upon.
- Students are directed that after locking their rooms they have to hand over the keys to security and can collect them on returning back to the hostel.
- Students must switch off Fans, Lights, Geysers, A/C's etc., before leaving their rooms.
- Visitors are not allowed inside the hostel at any time, however they are allowed into the visitor's hall with the prior permission of the warden. Only family members listed by the parents are allowed to contact the student. Visiting hours are up to 7.30 pm only and after 7.30 pm visitors are required to leave premises.
- Hostel students are not allowed to come into the hostel after 3.00 pm in case morning shift students and 6.00pm for day shift students. Those students who are utilizing

computer lab, library etc., after the times specified have to submit the permission slip to the security while entering into the hostel.

- During public holiday outings, those who seek permission to leave the hostel will have to obtain a written permission from warden. Permission will be given only to those students who get permission from parents to leave the hostel during holidays/outings. Moving out of campus without permission are strictly prohibited.
- Strict study hours from 7.30 to10.30 pm shall be maintained in the hostel. The hostellers must be in their allotted rooms during study hours.
- The general complaints of any kind should be noted in the complaint register, which is available at the hostel office. Registered complaints only will be entertained.
- Any health problem should be brought to the notice of Warden/Floor In – charge for necessary treatment.

Transportation:

- The institution runs 70 buses covering all the important points in Vijayawada City, Mangalagiri, Guntur & Tenali towns with a total seating capacity of 4000 students in two shifts.
- Transport is available 24 hrs in case of any emergency in the institute / hostels.
- Transportation is available for conducting industrial tours and visits etc.
- Regular transport facility available up to 10 PM.

Health Centre

A full-fledged health center with all the facilities is established to cater to the needs of the students, staff, Faculty and to the general public in the adopted villages. It consists of three doctors (Homoeopathy, Ayurvedic& Allopathy).

Cafeteria

- KL University has a spacious canteen with latest equipment and hygienic environment which provides quality food and prompts service and caters to needs of all the students and the staff.
- A central cafeteria of 1500 Sq.m. is available in the campus. Mini cafes and fast-food centers are available in various blocks.

- The canteen is open from 6:30 a.m. to 8:30 p.m. There is a wide variety of North-Indian and South-Indian cuisine and the students enjoy the pleasure of eating during the breaks. Cool aqua water for drinking is available.

Placements:

K L University has meticulously planned to make all its outgoing students employed. The University had installed the infrastructure, employed well experienced faculty, designed and delivered programs that help enhancing the communication and soft skills which are required for making the students employable. An excellent system is in place that considers all the issues that make a student employable. The University has been successful for the last 7 years, in employing all the students who have registered and eligible for placement through its offices located across the country. About 50 trained personnel work extensively to make the students ready for recruitment by the Industry.

Counselling & Career Guidance

A special Counseling Cell consisting of professional student counselors, psychologists, senior professors counsels/helps the students in preparing themselves to cope with studies, perform well in the tests & various competitions. This Cell provides its services to the students in getting the solutions for their personal problems and also provides career guidance with the help of Industrial Relations and Placements (IRP) department.

A group of 20 students are allotted to a senior faculty member who counsels them regularly and acts as their mentor.

Social Service Wing

KL University has a social service wing which is used to channelizing the social service activities of the faculty, the staff and the students. It has adopted 5 nearby villages and conducts activities like medical camps, literacy camps and educates the villagers regarding hygiene and health care on a regular basis.

NSS Wing of Institute

Regularly organizes Blood donation camps, Blood grouping camps, Fund collection and distribution to poor children and old age homes, distribution of old clothes and free medicines to slum dwellers, tree plantations, AIDS awareness program, teaching basic computer skills to a target group of 500 people in villages.

Hobby Clubs

Wholly and solely managed by the students, the clubs have in the past contributed much to the cultural life of the campus and to the cultural evolution of the students, A number of student bodies and clubs operate in the campus like music society, dance club, drama society, literary and debating club, English press club, drawing club, painting club, mime club, computer club etc. Students manage entire activities and budget of the organization for the entire semester in advance. Around 4000 students are the active members of the Hobby Clubs.

Life Skills and Inner Engineering

KL University feels that it is its responsibility to mould the students as good human beings contributing to the country and to the society by producing responsible citizens. Along with the regular programs every student admitted into KLU undergoes a one week special life skills /orientation program. Through this program, KLU is producing the students with the clarity of thoughts and charity at hearts. Strict regularity, implicit obedience, courtesy in speech and conduct, cleanliness in dress and person is expected of each KLU student. Life skills and inner engineering teach a student his/her obligations towards GOD, himself /herself his/her country and fellow human beings. Every student is encouraged to practise his/her own religious faith and be tolerant and respectful towards other religions.

Technical Festival

KLU organizes various programs for the all round development of the students. The technical festival and project exhibition is being organized in the odd semester (October) every year to elicit the innovative ideas and technical skills of the students.

Cultural Festival

The cultural festival in the even semester (February) of every year is the best platform for the students for exhibiting their talents and creativity. Through these festivals KLU is imparting organizational skills, leadership skills, competitive spirit, and team behavior skills to our students. Along with the knowledge, KLU festivals are providing recreation to the student community.

INNOVATION, INCUBATION AND ENTREPRENEURSHIP CENTER

KLU being a pioneering institute supporting Academics and Research in Engineering, Science and Technology is endowed with all the infrastructure and highly experienced faculty, has an Innovation, Incubation and Entrepreneurship Centre (IIE) that comprises of:

- Innovation centre which aims to inculcate a spirit of innovation.
- Incubation centre which aims to incubate the innovations through prototype product development.
- Entrepreneurship Development Centre (EDC) which aims at fostering entrepreneurial skills among the students.

UNIVERSITY ADMINISTRATION

KoneruSatyanarayana,

President

Sri KoneruSatyanarayana, BE, FIE, FIETE, MIEEE graduated in Electronics and Communication Engineering in the year 1977. Along with Sri KoneruLakshmaiah, he is the co-founder of the Institute which was established in the year 1980. He is an educationist of eminence and also an industrialist of great repute. He runs a number of industries in and around Vijayawada.

Dr. M Ramamoorty

Chancellor

Dr. Ramamoorty assumed charge as Chancellor, K L University with effect from 30th March 2015 after successful career as a Professor in IIT Kanpur and also as first Director General of CPRI.

Dr. Ramamoorty obtained his B.E. (Honors) from Andhra University in 1957 and M.E. from IISc Bangalore in 1959. He obtained his MASc and PhD from Toronto University in 1965 and 1967 respectively.

He was a Commonwealth Fellow at U of T from 1964 to 1967. He then joined IIT Kanpur as a faculty member in the Electrical Engineering Department and became a professor in 1972. He had established the first graduate program in Power Electronics in India in 1968 at IIT Kanpur.

He had supervised 12 doctoral projects and was associated with many sponsored research activities with industries like BHEL and Hindustan Steel Limited during his tenure at IIT Kanpur.

Dr.L.S.S Reddy

Vice Chancellor

Dr. L.S.S. Reddy is an eminent Professor in Computer Science and Engineering Department holding Ph.D in Computer Science Engineering from BITS Pilani. Dr. Reddy is an outstanding administrator, a prolific researcher and a forward looking educationist. Dr. Reddy has over 30 years of experience in Teaching, Research and Administration at prestigious institutes like BITS Pilani, CBIT etc.

Dr.L.S.S.Reddy had joined KoneruLakshmaiah College of Engineering in December 1995 and proved his administrative excellence as a Head of Department of Computer Science and Engineering. Dr. Reddy was instrumental and a driving force as Principal (2002-2009) in promoting KLCE as one of leading Institutions in India.

Dr.A.V.S.Prasad

Pro-Vice Chancellor

Dr.A.V.S.Prasad, M.E (Hydraulics & Irrigation Engineering) and Ph.D (Environmental Sciences and Technology) from JNTU, Hyderabad is a Professor in Civil Engineering. He has a rich experience of 27 Years in academics and 20 years in administration at various caders ranging from Head of the Department, Dean, Principal and Director.

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MASTER PLAN OF KL UNIVERSITY

ACADEMIC REGULATIONS

This document supplements the University's rules and regulations to provide assistance to all M.Tech students. It is the responsibility of the student to comply with it, under all circumstances.

1.0 TERMINOLOGY

Academic Council: The Academic Council is the highest academic body of the University and is responsible for the maintenance of standards of instruction, education and examination within the University. Academic Council is an authority as per UGC regulations and it has the right to take decisions on all academic matters including academic research.

Academic Year: It is the period necessary to complete an actual course of study within a year. It comprises of two consecutive semesters i.e., Even and Odd semester.

Course: A course is a subject offered by the University for learning in a particular semester.

Program: Program is a set of courses offered by the Department. A student can opt and complete the stipulated minimum credits to qualify for the award of a degree in that Program.

Term Paper: A 'term paper' is a research paper written by students engulfing their course based knowledge, accounting for a grade. Term paper is a written original research work discussing a topic in detail. It is a credit based course.

Dissertation: Dissertation is a course that a student has to undergo during his/her second year which involves the student to undertake a research or design, which is carefully planned to achieve a particular aim. It is a credit based course.

Practice School : It is a part of the total program and takes one/two full semester/s in a professional location, where the students and the faculty get involved in finding solutions to live industrial problems. A student can choose thesis/practice school during his/her 3rd and/or 4th semester of his/her course to meet the final requirements for a degree.

BOS (Board of Studies) : Board of studies is an authority as defined in UGC regulations, constituted by Vice Chancellor for each of the department separately. They are responsible for curriculum design and update in respect of all the programs offered by a department.

Backlog Course: A course is considered to be a backlog course if the student has obtained a failure grade (F).

Re-appearing:A student can reappear only in the semester end examination for the Theory component of a course, subject to the regulations contained herein.

Re- Registering: A student desiring to repeat a course is permitted to do so, subject to the regulations contained herein.

Credit :A credit is a unit that gives weight to the value, level or time requirements of an academic course. The number of 'Contact Hours' in a week of a particular course determines its credit value. One credit is equivalent to one lecture hour per week or two hours per week of tutorials/ self-learning/ practical/ field work during a semester.

Credit point : It is the product of grade point and number of credits for a course.

Grade Point : It is a numerical weight allotted to each letter grade on a 10 - point scale.

Grade : It is an index of the performance of the students in a said course. Grades are denoted by letters.

Course Handout : Course Handout is a document which gives complete plan of the course. It contains the details of the course viz. Course title, Course code, Credit structure, Course objectives, Course rationale, Course Outcomes and the relevant syllabus, textbook(s) and reference books, Course delivery plan and session plan, evaluation method, chamber consultation hour, course notices and other course related aspects. In essence, course handout is an agreement between students (learners) and the instructor.

Cumulative Grade Point Average (CGPA) : It is a measure of cumulative performance of a student over all the completed semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

Credit Transfer : The procedure of granting credit(s) to a student for course(s) undertaken at another institution.

Curriculum: Curriculum incorporates the planned interaction of students with instructional content, materials, resources, and processes for evaluating the attainment of Program Educational Objectives.

Detention in a course: Student who does not obtain minimum prescribed marks in continuous in-semester evaluation and /or minimum prescribed attendance in a course shall be detained in that particular course.

Evaluation : Evaluation is the process of judging the academic work done by the student in her/his courses. It is done through a combination of continuous in-semester assessment and semester end examinations.

Semester End Examinations : It is an examination conducted at the end of a course of study.

Make-up Test : An additional test scheduled on a date other than the originally scheduled date.

Compulsory course : Courses required to be undertaken for the award of the degree as per the program.

Elective Course: A course that can be chosen from a set of courses.

Degree: A student who fulfills all the Program requirements is eligible to receive a degree.

Overloading : Registering for more number of credits than normally prescribed by the Program in a semester.
Program Educational Objectives : The broad career, professional, personal goals that every student will achieve through a strategic and sequential action plan.

Student Outcomes: The essential skill sets that need to be acquired by every student during her/his program of study. These skill sets are in the areas of employability, entrepreneurial, social and behavioral.

Course Outcomes : The essential skills that need to be acquired by every student through a course.

Registration:It is a process of enrolling into a set of courses in a semester/ term of the Program.

Semester : It is a period of study consisting of 15 to 18 weeks of academic work equivalent to 90 actual teaching days. The odd Semester starts normally in July and even semester in December.

Substitution of Elective course: Replacing an elective course with another elective course as opted by the student.

Dropping from the Semester: A student who doesn't want to register for the semester should do so in writing in a prescribed format before commencement of the semester.

Department : An academic entity that conducts relevant curricular and co-curricular activities, involving both teaching and non-teaching staff and other resources.

2.0 DETAILS OF M.TECH PROGRAMS ON OFFER

K L University confers M. Tech degree to candidates who are admitted in the Program and fulfills the following requirements for the award of the degree.

a) Must successfully earn minimum of 80-85 credits, as stipulated in the program structure.
b) Must successfully complete four (4) Professional Elective Courses from the program
c) Must successfully complete the Seminar and term paper.
d) Must successfully complete Dissertation and/or practice school.
e) Must have published a minimum of one publication (along with Supervisor) in Scopus/SCI indexed Journals.
f) Must have successfully obtained a minimum CGPA of 5.5 at the end of the program.
g) Must have finished all the above-mentioned requirements in less than twice the period mentioned in the Academic structure of the program, which includes debarred period if any, from the University.

2.1 M.Tech. Programs offered:

The students are admitted into the following 2 year full time M. Tech Programs

1. Master of Technology in Biotechnology (BT)
2. Master of Technology in Structural Engineering (SE)
3. Master of Technology in Geo-Spatial Technology (GS)
4. Master of Technology in Construction Technology and Management (CT)
5. Master of Technology in Cloud Computing (CC)
6. Master of Technology in Computer Science & Engineering (CS)
7. Master of Technology in Computer Networks and Security (NS)
8. Master of Technology in Cyber Security & Digital Forensics (CSDF)
9. Master of Technology in Computational Intelligence (CI)
10. Master of Technology in Communication and Radar Systems (CRS)
11. Master of Technology in Signal Processing (SP)
12. Master of Technology in Very Large Scale Integration (VLSI)
13. Master of Technology in RF and Microwave Engineering (RFMW)
14. Master of Technology in Space Technology and Atmospheric Science (STAS)
15. Master of Technology in Wireless Communication and Sensor Networks (WCSN)
16. Master of Technology in Embedded Systems (ES)
17. Master of Technology in Power Electronics and Drives (PED)
18. Master of Technology in Power Systems (PS)
19. Master of Technology in Renewable Energy (RE)
20. Master of Technology in Thermal Engineering (TE)
21. Master of Technology in Mechatronics (MECH)

3.0 ELIGIBILITY CRITERIA FOR REGISTERING INTO M.Tech. PROGRAMS

Candidates should have passed B.E. / B.Tech. / MCA / M.Sc. from recognized universities / institutions in respective discipline with minimum of 55% marks or equivalent CGPA. Further more the candidates should have secured a qualifying rank in the PG entrance Examination i.e., KLU PGET / GATE / AP PGCET / any other equivalent examination.

For foreign students who wish to study at the University, please refer to the "Foreign Student Admission Procedures" stated separately and comply with the study requirements of the Ministry of HRD, Govt. of India.

4.0 PG PROGRAM CURRICULUM DESIGN

For an academic program the curriculum is the basic framework that will stipulate the credits, category, course code, course title, course delivery (Lectures / Tutorials / Lab / Project), in the choice based credit system.

4.1 Program Structure

a) Each Academic Year is divided into two semesters, each of, approximately, 18 weeks duration:

- Odd Semester (July – December)
- Even Semester (January – May).

b) All courses are categorized into three streams even, odd and dual semester courses.
c) Even semester courses are offered only during even semester i.e., January-May, Odd semester courses are offered only during odd semester i.e., July-December and dual semester courses are offered during both even & odd semesters.
d) A Program is a set of courses offered by the University that a student can opt and complete certain stipulated credits to qualify for the award of a degree.
e) A student can opt for dissertation either by means of research at the University (or) through Internship at a Industry; this is however allowed during 3rd (or) 4th semesters only.

4.2 Course Structure

a) Every course has a Lecture-Tutorial-Practice(L-T-P) component attached to it.
b) Based upon the LTP structure the credits are allotted to a course using the following criteria.
    i. Every lecture hour is equivalent to one credit.
    ii. Every Tutorial/Practice hour is equivalent to half credit.
    iii. If the calculated value of credit is a fraction, it is rounded to the lower number.

5.0 EVALUATION OF M.Tech. PROGRAMS

A student's academic progress is examined through one or more of the following methods as decided by the Course Coordinator and duly approved by the Dean Academic.

- Assignments
- Sessional Tests
- Semester End Examinations
- Term-paper
- Dissertation
- Laboratory Reviews
- Seminars
- Group Discussions
- Participation in Active Learning
- Case Study Reports
- Capstone Design Projects
- Simulations

a) The Sessional tests and the Semester-End Examinations will be conducted by the University Examination Cell as per the Academic Calendar.
b) Appearing in the Semester End Examinations is mandatory for all eligible students in each course of the program.
c) Students will be permitted to appear in the examinations only in those courses for which they have registered.
d) Students may have to take more than one examination in a day either during regular/supplementary examination.

5.1 In-Semester Evaluation

a) The process of evaluation should be continuous throughout the semester and involves components as decided by the course coordinator.

b) The distribution of weightage for various evaluation components will be decided and notified by the course coordinator through the course handout after approval by the Dean Academic.

c) In order to maintain transparency in evaluation, answer scripts will be shown to the students for verification, within one week of conduct of exam. If there is any discrepancy in evaluation, the student can request the course coordinator to re-evaluate.

d) No correction is permitted once the course coordinator submits the marks/grades to the Controller of Examination.

5.2 Detention policy

a) In any course, a student has to maintain a minimum of 75% attendance and must secure a minimum of 40% marks in continuous In-Semester Examinations to be eligible for appearing to the Semester End Examination, student will be detained in such courses were fulfillment of these two conditions is not achieved.

b) However the following are the special cases where the lack of attendance can be condoned:

   i. Up to a maximum of 10% on medical grounds, in such cases the student must submit the medical certificate from any recognized medical practitioner, immediately after the absence period.

   ii. Up to a maximum of 10% if the student represents the University / State / Country in any Extra / Co curricular activities in all such cases student must submit proofs to the HOD immediately after participation in such events.

   iii. The maximum extent to which a student can be condoned is 10%, and any student with less than 65% is deemed to be detained.

5.3 Semester End Examination

- The minimum weightage for Semester End Examination is 50% of the aggregate marks.
- The duration of such examination is 3 hours.
- The pattern of the examination will be decided and notified by the Course Coordinator through the Course handout, after approval from the Dean Academic.
- As double evaluation of answer scripts is followed, there is no re-evaluation for the P. G. programs in case of semester end examinations.

Re-appearing with Registration:

A student can repeat a course by re-registering under the following two conditions:

i) In case the student fails to fulfill the minimum academic requirements for the award of the degree
ii) When s/he is detained in a course.

*Repeating a course implies that the student will re-register for the course.

Re-appearing without Registration:

A student can reappear and clear the course in which s/he is failed by taking supplementary examinations. In such a case the continuous in semester evaluation components obtained earlier are carried forward.

5.4 Reports/Grades

5.4.1. Grading Process

a) At the end of all evaluation components based on the performance of the student, each student is awarded grades based on ***absolute grading system***. The list of absolute grades and its connotation are given below:

GRADE	GRADE POINTS	**RANGE**	
O (Outstanding)	10	85	100
A+(Excellent)	9	80	<85
A(Very Good)	8	65	<80
B+(Good)	7	60	<65
B(Above Average)	6	50	<60
C(Average)	5	45	<50
P (Pass)	4	40	<45
F(Fail)	0	<40	-
Ab (Absent)	0	-	-

b) The SGPA is the ratio of sum of the product of the number of credit s with the grade points scored by a student in all the courses and the sum of the number of credits of all the courses undergone by a student, in a semester.
i.e SGPA (S_i) = $\sum(C_i \times G_i) / \sum C_i$
where 'C_i' is the number of credits of the i^{th} course and 'G_i' is the grade point scored by the student in the i^{th} course.
c) The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a program,
i.e. CGPA = $\sum(C_i \times S_i) / \sum C_i$
where 'S_i' is the SGPA of the i^{th} semester and 'C_i' is the total number of credits in that semester.
d) The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
e) CGPA can be converted to percentage of marks : 10 X CGPA - 7.5
f) A student who obtains 'F' grade has to reappear for all the components of Semester End examination.

g) At the end of each semester, the University issues grade sheet indicating the SGPA and CGPA of the student. However, grade sheet will not be issued to the student if he/she has any outstanding dues.

6.0 REGISTRATION PROCESS

For every course, the student has to undertake the registration process prior to commencement of the course-work, based on the following conditions;

a) Registration into a course will be permitted only for such courses, which are offered by the program in that particular semester.
b) The University has the right to refuse registration process if a student does not turn up on the day of registration.
c) Registration shall not be permitted after the fifth working day from the scheduled date of commencement of classes.
d) The University reserves the right to withdraw any elective course offered within one week of the commencement of the semester if sufficient numbers of students have not registered or for any other reasons. In such cases, the students are permitted to register for any other elective course of their choice provided they have fulfilled the eligibility conditions.
e) The University reserves the right to cancel the registration of a student from a course or a semester or debar from the degree on disciplinary grounds.

7.0 ACADEMIC COUNSELING BOARD (ACB)

Academic Counseling Board is constituted by the Dean Academic, for each program separately. This board shall comprise of the Chairman, Board of Studies, of the relevant program, two (2) Professors and two (2) Associate Professors.
A student will be put under Academic Counseling Board in the following circumstances:

(i) Has CGPA of less than 6.00.
(ii) Has 'F' grade in multiple courses.

The students under Academic Counseling Board may not be allowed to register for all regular courses in the semester, based on the recommendation of Academic Counseling Board and decision of Dean, Academic.

8.0 BACKLOG COURSES

A course is considered to be a backlog if the student has obtained 'F' grade in the course; the student has to re-appear for all components of semester end examinations in that course. However, student must successfully complete such a course in a maximum of four (4) consecutive attempts, failing which s/he must re-register for that course or a substitute course. The decision for substitute course shall be obtained from the Dean Academic, based on the recommendations of the Board of Studies.

9.0 RUSTICATION

A student may be rusticated from the University on disciplinary grounds, based on the recommendations of committees constituted for such purposes as needed by the Vice Chancellor.

10.0 AWARD OF DEGREES

A student having cleared all the courses and met all the requirements for the award of degree with

1) CGPA between 5.5 to 6.75 will be awarded second class
2) CGPA $\geq$ 6.75 will be awarded first class
3) CGPA $\geq$ 7.5 will be awarded first class with distinction provided the student has cleared all the courses in first attempt, and must have fulfilled all the program requirements in two (2) years duration.

11.0 AWARD OF MEDALS

University awards Gold and silver medals to the top two (2) students based on CGPA. However,

1. The grade obtained through betterment, will not be considered for this award.
2. S/he must have obtained first class with distinction for the award of Gold or silver medal.

Any of the above rules can be altered at the discretion of the Vice Chancellor in special situations.

M. TECH - BIOTECHNOLOGY

First Year (First Semester):

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 BT 5101	Mathematics and Biostatistics	3	2	0	4
2	15 BT 5102	Biochemical Engineering	3	0	2	4
3	15 BT 5103	Molecular Biology and r-DNA Technology	3	0	2	4
4	15 BT 5104	Applied Bioinformatics	3	0	2	4
5		Elective 1	3	0	0	3
6		Elective 2	3	0	0	3
7	15 IE 5148	Seminar/Term Paper	0	0	4	2
		Total Credits	24			

First Year (Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 BT 5205	Plant and Animal Biotechnology	3	0	2	4
2	15 BT 5206	Immuno technology	3	0	2	4
3	15 BT 5207	Bioreactor modeling and Simulation	3	2	0	4
4	15 BT 5208	Downstream Processing	3	0	2	4
5		Elective 3	3	0	0	3
6		Elective 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total Credits	24			

Second Year (First & Second Semester) :

S.No	Corse Code	Course Title	Periods			Credits
			L	T	P	
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 BT 51A1	Protein Engineering	3	0	0	3
2	15 BT 51A2	Enzyme Technology	3	0	0	3
3	15 BT 51A3	Medical Biotechnology	3	0	0	3
4	15 BT 51A4	Stem cell technology	3	0	0	3
5	15 BT 51A5	Molecular Modeling and Drug Design	3	0	0	3
Elective-2						
6	15 BT 51B1	Food Technology	3	0	0	3
7	15 BT 51B2	Transport phenomenon in bioprocess	3	0	0	3
8	15 BT 51B3	Bio mining	3	0	0	3
9	15 BT 51B4	Bioprocess validation and cGMP	3	0	0	3
Elective-3						
10	15 BT 52C1	Perl programming and Bioperl	3	0	0	3
11	15 BT 52C2	Bioprocess Technology	3	0	0	3
12	15 BT 52C3	Environmental Biotechnology	3	0	0	3
13	15 BT 52C4	Nano Technology	3	0	0	3
14	15 BT 52C5	IPR and Patent Laws	3	0	0	3
Elective-4						
15	15 BT 52D1	Regulatory affairs & Clinical trials	3	0	0	3
16	15 BT 52D2	Bioprocess economics and plant design	3	0	0	3
17	15 BT 52D3	Genomics and Proteomics	3	0	0	3
18	15 BT 52D4	Bio catalysis and enzyme	3	0	0	3

MATHEMATICS & BIOSTATISTICS

Course Code: 15BT5101 **L-T-P:** 3-2-0
Prerequisites: Nil **Credits:4**

Syllabus:

Numerical Methods Solutions of algebraic & transcendental equations - Bisection Method, New-Raphson Method, Solution of linear simultaneous equations, Simpson's rule, Trapezoidal rule.
Linear-Differential equation:1st order differential equations, solutions of 1st order, variable separable, homogeneous equation linear and enact equations. Linear differential equations of higher order with constant co efficient. Rules for finding complementary function and particular integral.
Presentation of data & Measures of central tendency-Frequency distribution, graphical presentation of data by histogram, frequency curve and cumulative frequency curves. Mean, medium, mode, and their simple properties (without derivation), range, mean deviation, standard deviation and coefficient of variation.
Correlation, Regression and Tests of significance -Simple correlation and regression coefficients and their relations. Limits of correlationcoefficient, effect of change of origin and scale on correlation coefficient, Linear regression and equations of line of regression, association and independence of attributes. Paired and unpaired t-test for correlation and regression coefficient. T- test for comparison of variances of two populations. Chi-square test-independence of attributes, goodness of fit, and homogeneity of sample.
Experimental designs- Principles of experimental design, completely randomized design, randomized block design and Latin square design. Analysis of variance (ANOVA) and its use in the analysis of RBD. F-test.

Recommended Textbooks:
1. Norman T.J. Bailey, Statistical methods in biology (3rd edition), Cambridge University Press (1995).
2. Bernard Rosner, Fundamentals of Biostatistics, 5th edition, Thomson Brooks/ Cole, 2000.
3. Higher engineering mathematics by B.S Grawel

References Books:
1. S.C.Gupta and V.K. Kapoor – Fundamentals of Mathematical Statistics, 9th Extensively revised edition, Sultan Chand & Sons, 1999.
2. Advanced Engineering Mathematics, Michael D.Greenberg, Pearson Education.
3. Advanced Engineering Mathematics by Ervin Kreyszic.
4. Higher engineering mathematics by Bird john

BIOCHEMICAL ENGINEERING

Course Code: 15BT5102 **L-T-P:** 3-0-2
Prerequisites: Nil **Credits:**4

Syllabus:

Introduction to Biochemical reactions : Types of reactions (Simple stepwise and Parallel) and their applications in fermentations, reaction rates, kinetics of homogenous reactions, molecularity and order of reaction and temperature dependency of reaction rate.

Design and Operation of Bioreactors : Mass transfer aspect, Bioreactor types and design, Continuous stirred tank bioreactors, fed batch bioreactors, airlift bioreactors, Fluidised bed bioreactor, Bioreactors for plant and animal cell, scale up of bioreactor using constant p/v and constant KLa

Mass Transfer in Bioprocess Operation : Mass transfer by diffusion, Theories of Diffusional mass transfer film theory, Penetration theory, Surface renewal theory Mass transfer by convection, Gas-liquid mass transfer, correlation for mass transfer coefficient, measurement of KLa, O2 transfer, methodology in fermenters, specific oxygen uptake rate, critical oxygen concentration, maximum cell concentration.

Heterogeneous reactor systems : Classification of reaction systems, (homogenous, heterogeneous), mass transfer consideration in heterogeneous systems, Intra particle diffusion and reaction rates, Effectiveness factor and Thiele modules, observed Thiele modules, criterion for mass transfers limitations.

Non-ideal flow in bioreactors: Reasons for non-ideality, RTD studies (F-Curve, C-Curve for ideal and non-ideal CSTR and plug flow reactors), mean and variance of residence time, conversion using tracer information, modeling of non-ideal flow behavior by dispersion model.

Recommended textbooks:
1. Introduction to Biochemical Engineering by D.G.Rao
2. Biochemical Engineering fundamentals by Bailey and Oliss

Reference Books:
1. Bioprocess Engineering Principles by Pauline and Doran

<u>MOLECULAR BIOLOGY & R-DNA TECHNOLOGY</u>

Course Code: 15BT5103 **L-T-P:** 3-0-2
Prerequisites: Nil **Credits:** 4

Syllabus:

Scope: Recombinant DNA technology is fundamental to molecular biotechnology that is comprised of different scientific disciplines i.e. molecular biology, microbiology, biochemistry, immunology etc. The subject generates a wide range of consumer products (i.e. crops, drugs, vaccines, diagnostics, and livestock). Recombinant DNA technology uses prokaryotic and eukaryotic organisms and is the manipulation of DNA to generate clones, examine gene regulation, and express proteins. The course includes current technical procedures for recombinant DNA technology and its applications.
DNA Structure & Replication : Structure of DNA:-Watson & Crick's model, Types of DNA, Denaturation and renaturation Kinetics, Replication of DNA- Semi conservative, bi-directional replication. DNA damage and repair: Types of DNA damages- deamination, alkylation, pyrimidine dimmers; Repair mechanisms-Excision, mismatch and SOS repair, Recombination: Homologous and non homologous; **rec** gene and its role in DNA repair.
Transcription And Translation : Structure of Promoters-RNA Polymerases of Prokaryotic and Eukaryotic Organism; Transcription- Initiation, Elongation and Termination; Prokaryotic & Eukaryotic transcription; Post Transcriptional Processing of Eukaryotic RNA. Translation in prokaryotic and Eukaryotes: initiation of translation, elongation of polypeptide chain, termination of translation. Post-translational modifications.
Regulation of Gene Expression : Regulation of Gene expression in bacteria- Operon concept, ***lac, trp, ara*** operons. Control of gene expression by sigma factor and post transcriptional control. Absolute control by antisense RNA's; enhancers, upstream controlling elements, structural Motifs of transcription factors: helix turn, zinc finger motifs, leucine zippers and homeotic genes.
Enzymes And Vectors In Cloning : Restriction Enzymes; DNA ligase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern, Colony hybridization & FISH, Plasmids; Phagemids; Cosmids; Shuttle vectors, Artificial chromosome vectors (YACs; BACs); Expression vectors: Baculovirus and pichia vectors system; Plant based vectors: Ti and Ri vectors, Construction of cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Yeast two hybrid system; Phage display.
PCR, Sequencing & RNA Technologies : Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR; PCR Applications Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; Introduction to siRNA; siRNA technology; Micro RNA; Principle and application of gene silencing; Gene knockouts and Gene Therapy; knockout mice; Disease model; Transgenics; Differential gene expression and protein array.

Text Books:
1. Fundamentals of Molecular Biology by Avinash & Kakoli Upadhyay; Himalaya
Reference books:

1. Current protocols in Molecular biology; Wiley Publishers.

APPLIED BIOINFORMATICS

Course Code: 15BT5104 **L-T-P:** 3-0-2
Prerequisites: Nil **Credits:**4

Syllabus:

Scope: The Course aims to prepare the students for understanding biological data at molecular level from both informational and biological perspective and impart conceptual, computational and practical skills to acquire, analyze, process or use the data to address significant problems in the field of Bioinformatics, of both pure and applied nature.

Comparative Genomics
Genetic mapping, Physical mapping, SNPs, ESTs, GSS, Gene prediction methods, Gene prediction tools, Gene annotation, Molecular Predictions with DNA sequence, Human Genome Project.

Protein Structure Prediction and Evaluation methods
Structure of Protein – PDB, MMDB; Ramachandran Plots; Structure visualization – Rasmol; Methods of Structure prediction – Homology modeling - SPDBV, Threading, Ab-initio method; Structure Evaluation – DSSP, ProCheck, Verify 3D; Structure comparison.

Protein Identification And Interactions
Proteomics approaches for protein analysis; Protein identification Programs – Mascot, GFS; Comparative Proteomics methods; Protein interactions; Protein Interaction dbs – GRID, MINT; Network Mapping; Biological Pathway dbs – EcoCyc, KEGG; Pathway prediction; Metabolic pathway reconstruction.

Gene Expression Analysis
Introduction; Serial Analysis of Gene Expression; Microarray, Types of Microarrays, Microarray Fabrication, Microarray hybridization and detection, Microarray Image Processing and analysis, Expression ratios, Transformations of the Expression ratio, Data Normalization.

System Biology
Foundations of System Biology- Objectives of System Biology-Strategies relating to In Silico Modeling of biological processes- Metabolic Networks- Signal Transduction pathways, Gene Expression patterns – Applications of System Biology Markup Language (SBML), E-cell, V-cell simulations and Applications

Recommended Textbooks:
1. G. Gibson and SV Muse, A Primer of Genome Science, Second Edition - Sinauer Associates, Inc.
2. CW Sensen, Essentials of genomics and Bioinformatics, Wiley-VCH publication.

Reference textbooks:

1. Speed T. (ed.) Statistical analysis of gene expression microarray data (CRC, 2003)

PLANT AND ANIMAL BIOTECHNOLOGY

Course Code: 15BT5205 **L-T-P:** 3-0-2
Prerequisites: Nil **Credits:** 4

Syllabus:

Introduction & Overview
Introduction & Historical Overview of Plant Tissue Culture, Totipotency, Growth & Cytodifferentiation of Cultured Plant Tissues Nutritional Media- Obligatory & Optional Constituents, Growth Regulators. Concept of sterilization and aseptic technique, Incubation Systems: Light & Dark, Static & Agitated, And Problems in Plant Tissue Culture: Contamination, Phenolics, Recalcitrance and Seasonal variation.

Micro Propagation and Secondary Metabolites
Homozygous Plant Production through Anther Culture. Callus & Suspension Culture Systems and Organogenesis: Direct & Indirect- Basic aspects, Somatic Embryogenesis, Somaclonal & Gametoclonal Variation. Plant Secondary Metabolites: Commercial Production using appropriate media supplements (Elicitors, Growth Factors, Stress Factors, Precursors, Anti-metabolites and Defense Proteins.

Gene Transfer Techniques and Applications
Gene transfer methods (Direct and Indirect), current status and limitations. Agro bacterium mediated genetic transformation and application in crop improvement. Herbicide, stress and disease resistant plants and callus/cell line selection for resistance. Applications of Plant Tissue culture.

Animal cell culture
Basic requirements for animal cell culture; Cell culture media and reagents; Animal cell, tissue and organ cultures; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Somatic cell cloning and hybridization. Transfection and transformation of cells; Commercial scale production of animal cells; Stem cells and their application; Application of animal cell culture, for in vitro testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal vaccines and pharmaceutical proteins.

Animal Reproductive Biotechnology
Culture of embryos; Micromanipulation of animal embryos; Cryopreservation of embryos; Embryo transfer; Embryo-splitting; Embryo sexing; Transgenic animal technology and its different applications; Animal viral vectors; Animal cloning- basic concepts; Cloning from embryonic cells and adult cells; Ethical, social and moral issues related to cloning. Introduction

to animal genomics; Different methods for the characterization of animal genomes, SNP, STR, QTLS, RFLP, RAPD, Genetic basis for disease resistance; Biocrimes and Bioterrorism.

Recommended textbooks:

1. Experiments in Plant Tissue Culture (Dodds, J.H. and Roberts, L.W.) 1985.
2. Ed. John R.W. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, OUP, 2000.
3. Ed. Martin, Clynes Animal Cell Culture Techniques, Springer, 1998.
4. Plant Tissue Culture methods and application in agriculture (Thorpe, T.A.) 1981;

Reference books:

1. An Introduction to Plant Tissue Culture.MK Razdan.2nd Ed.2003. Oxford and IBH.
2. Plant Biotechnology by C.Chawla.2004.Oxford and IBH.
3. Animal Cell Biotechnology. Portner, 2nd Edition, Humana Press, 2007.
4. Plant Biotechnology and its applications in Plant tissue culture by Ashwani Kumar and Shikha Roy.

<u>IMMUNO TECHNOLOGY</u>

Course Code: 15 BT 5206 **L-T-P:** 3-0-2

Prerequisites: Nil **Credits:**4

Syllabus:

Immune system overview, innate and acquired immune system. Components of immune system.Phagocytosis; Inflammation, opsonization. Primary and secondary lymphoid organs. Complement. B cell, T cell ontogeny. Characteristics of antigen, T cell dependent and independent antigens and Super antigens. Types and applications of Hapten and Adjuvant.

Immune response

Generation of immune response - Primary and Secondary immune responses. Structure, functions of antibody and BCR.. Generation of Antibody diversity. TCR structure, δγTCR. MHC I and II gene, polymorphism. T helper, T cytotoxic cells. MHC peptide interaction. Antigen presentation, secondary signaling.

Immunological disorders

Immunological disorders; Hypersensitivity and autoimmune diseases. Immune response to viral and bacterial lymphatic infection. Kinetics of immune response. Techniques in humoral and cellular immunology.

Immunotechnology

Animal models and transgenic animals and their use in immunology. Experimental immunology. Hybridoma technology. Chimeric antibodies, phage display, antibody engineering; Large scale manufacture of antibodies. Manufacturing of immunodiagnostics.

Disease diagnosis and Vaccines

Concept of vaccination & Vaccine development. Strategies for development of vaccines against dreadful diseases – malaria, tuberculosis, HIV. Diagnostic tools and Kit development technology.

Recommended textbooks:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.

Reference books:

1. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
2. Paul.W.E, Fundamental of Immunology, 4th edition, Lippencott Raven.

BIOREACTOR MODELING AND SIMULATION

Course Code: 15 BT 5207 **L-T-P:** 3-0-2
Prerequisites: Nil **Credits:** 4

Syllabus:

Fundamentals of Modeling
Different approaches towards modeling, (Empirical and Modeling approach), applications and advantages of modeling and simulations, general flow diagrams for model building, simulation tools (Berkeley-Madonna, Mat Lab- Simu Link)

Enzymes and growth kinetic models
Michaelis-Menten equation, graphical determination of Km and Vmax, Double Michaelis Menten kinetic model, inhibition models (Competitive, Non-Competitive, Uncompetitive, Deactivation Kinetics models) Monad growth kinetics model, equation for inhibition of growth, Product inhibition, , Teisser equation for growth, Contoin equation, Moses equation for growth models.

Modeling of batch cultures
Unstructured growth models, structural kinetic model, metabolic models for batch cultures.

Product formation Kinetics
Product formation kinetic models, unstructured models, chemically structured models, genetically structured models.

Case studies of simulations
Programme for simulation of Batch fermentation, continuous fermentation, steady state and fed batch fermentation.

Recommended textbooks:

1. Biological reaction Engineering- J.J.Dunn, E.Heinzle, J.Ingham, J.E.Presnosil
2. Biochemical Engineering fundamentals- James.E.Bailey and David.F.Ollis, TMH Edition
3. Franks.R.G.E (1973), Modeling and simulation in chemical Engineering, Wiley, NY

Reference Books

1. Modeling and simulation in Biochemical Engineering. Adv, Biochemical Engineering, 3, 127-165
2. Hanm, B, Ruth. B (1997) Modeling dynamic biological systems, Springer-Verlag, NY.

DOWN STREAM PROCESSING

Course Code: 15 BT 5208 **L-T-P:** 3-0-2
Prerequisites: Nil **Credits:**4

Syllabus:

Down Stream Processing In Biotechnology
Overview of bioseparations, Characterization of Biomolecules, characterization of Bioprocess, characterization of fermentation broth: Morphology of cells, structure of the cell wall, product concentrations, Biomass density, Rheological Behavior of fermentation broth.

Primary Separation and Recovery Processes : **Recovery of intracellular products:** Cell disruption methods-physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear) – chemical methods (alkali, detergents)- enzymatic methods. **Removal of suspended solids**: Foam separation, filtration. Filtration equipment, centrifugation, tubular bowl centrifuge, disk. Bowl centrifuge, basket centrifuge, scale up of centrifuges.

Product Enrichment Operations : Membrane based separations – Classification & characteristics of membrane separation, merits of the process. Micro filtration, ultra filtration, Reverse osmosis, dialysis & electro dialysis. Selection of membrane, operational requirements of membrane. Retention coefficient, concentration factor, permeate yield & solid yield in membrane separation processes. Membrane modules: Plate & Frame, hollow fiber, spiral wound, shell & tube, cross flow micro filtration. **Aqueous two-phase extraction process:** Applications of aqueous two-phase extraction, reversed micelles extraction principle, micellar structures, critical micelle concentration. Protein solubilization, limitation of reversed micelles. Precipitations of proteins with salts and organic solvents, kinetics of protein aggregation.

Product Purification : Chromatographic Separations: Classification of chromatographic techniques, column chromatography, elusion frontal displacement techniques, partition coefficient, retention time and volume, capacity factor, column efficiency, design and scale up of chromatography. Principles & practices of Gel Filtration, Ion Exchange and Affinity chromatography.

Alternative Separation Methods and Product Polishing
Super critical extraction: principles of SCE, Flow scheme of a simple SCE system. **Formulation strategies**: Importance of formulation, formulation of beakers yeast, Enzymes, formulation of

pharmaceutical products. **Polishing**: Crystallization, Principles of crystallization and equipment. Principles of drying and lyophilization, Freeze dryer.

Recommended Textbooks

1. Butterworth and Heinmann. Product recovery in bioprocess Technology-Biotol series,
2. B.Siva Sankar. Bioseperations

References Books:

1. Harvey Blanch. Biochemical Engineering
2. Christie J.Geankoplis., Transport processes and Unit operations

ELECTIVES

<u>PROTEIN ENGINEERING</u>

Course Code: 15 BT 51A1 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Protein Engineering
Methods of protein isolation, purification, detection, quantitation and characterization. Study of protein structure and organization. Solid phase peptide synthesis, use of peptides in biology, examples of engineered proteins, protein design with examples.

Structure & Functional Relationship Of Proteins
Structural characteristics of DNA binding proteins, prokaryotic and Eukaryotic transcription factors, DNA polymerases, Bacteriorhodopsin, epidermal growth factors, insulin and PDGF receptors and their interaction effectors, protein phosphorylation, Immunoglobulins, nucleotide binding proteins, serine proteases, Ribonuclease, Lysozyme.

Protein Folding
Chaperons in protein folding, types of chaperons. Non-covalent forces in protein folding, Structural Dynamics of proteins, Protein folding models, Denaturation of proteins, Protein degradation and turn over; ATP dependent proteolysis, intracellular digestion of proteins in Lysosomes.

Protein Targeting
Introduction, Methods in targeting, translocation and transport. Signal sequences, Signal Recognition Particle, Protein export in bacteria, Protein modification and targeting. Protein targeting in Bacterial system. Protein targeting in Endoplasmic Reticulum, Mitochondria and Chloroplast.

Protein Techniques
Solution properties of proteins, Protein fragmentation, Peptide sequence determination, Protein hydration, Conformational stability of proteins, Recombinant protein, Fusion proteins, Modification of proteins, Protein labeling, Peptide mapping.

Recommended Textbooks:

1. L. Stryer by Biochemistry, 5th edition Freeman – Toppan publications.
2. TM Devlin, Textbook of Biochemistry with clinical correlations, 6th edition with human molecular genetics. John Wiley and Sons, Inc.

Reference textbooks:

1. Moody P C E and A J Wilkinson. Protein Engineering. IRL Press.
2. Creighton T E, Proteins. Freeman W H. Second edition 1993.

ENZYME TECHNOLOGY

Course Code: 15 BT 51A2 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Introduction to enzyme technology
Source of enzymes; Production, isolation and purification of enzymes; Characterization in terms of pH,temperature, ionic strength, substrate and product tolerance, effects of metal ions etc.; Various production methods for commercial enzymes; Large scale production of enzymes. Production of recombinant proteins (Insulin, Interleukin, Interferon); Important commercial enzymes; Amylases; Proteases; Lipases; Cellulases.

Enzyme Kinetics
Michaelis-Menten equation, alterations and significance. General mechanisms of enzyme regulation, Types of inhibition; Irreversible inhibition (proteases), Reversible (glutamine synthase & phosphorylase), competitive inhibition, Non & Un-competitive, mixed inhibition, and substrate & product.inhibition; Allosteric enzymes, qualitative description of concerted & sequential models for allosteric enzymes. Allo-steric regulation of enzymes; Deactivation kinetics. Feed back inhibition and feed forward stimulation. Half site reactivity, Flipflop mechanism, positive and negative co-operativity with special reference to aspartate transcarbamoylase. Protein-ligand binding measurement, analysis of binding isotherms, Hill and Scatchard plots.

Enzyme Engineering
Enzymes as biological catalysts; Active site, Functional group, Enzyme substrate complex, Cofactors; Acidbase catalysis, covalent catalysis, proximity, orientation effect. Strain & distortion theory. Chemical modification of active site groups. Random and rational approach of protein engineering; Directed evolution and its applications in the field of biocatalysis; Various approaches of creating variant enzyme molecules; Site directed mutagenesis of enzymes. Mechanism of action of chymotrypsin, lysozyme, carboxypeptidase and alcohol dehydrogenase.

Enzyme immobilization and applications
Introduction to enzyme immobilization; various immobilization methods; physical and chemical techniques for enzyme immobilization – adsorption; Matrix entrapment, encapsulation; Cross-linking; Covalent binding; Medical and analytical applications of immobilized enzymes; Design of enzyme electrode & their application in clinical diagnostics. Role of enzymes in recombinant DNA technology; Enzymes for diagnostic and analytical purposes. Use of enzymes in analysis-types of sensing-gadgetry and methods. Case studies on application – chiral conversion, esterification.

Mass transfer effects in immobilized systems
Analysis of Film and Pore Diffusion Effects on kinetics of Immobilized Enzyme Reactions; Calculations of diffusional resistances and Thiele's modulus; Multi step immobilized enzyme systems; Solutions of numerical problems; Application and future of immobilized enzyme

technology. Concentration gradients and Reaction rates in solid catalysts; Internal mass transfer and reaction; Steady state Shell Mass balance; Formulation of dimensionless groups and calculation of Effectiveness factors

Recommended Textbooks;

1. Nelson and Cox, Principles of Biochemistry, 4th Edition, W. H. Freeman, 2004.
2. J. Rehm and G. Reed, Enzyme Technology, Vol. 7a, VCH-Verlag.
3. Trevor Palmer: ENZYMES – Biochemistry, Biotechnology, Clinical chemistry. Horwood Publishing Ltd. Affiliated East – West Press Pvt. Ltd. New Delhi.

Reference Text Books:

1. Biotol Series (This series has many volumes pertaining to different subjects including white, red, blue and green biotechnology).

MEDICAL BIOTECHNOLOGY

Course Code: 15 BT 51A3 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Introduction to medical technology
Introduction and applications of medical Biotechnology. Artificial organs – methods and production principles. Artificial pancreas, Liver and Heart. Therapeutic proteins: Production of interferons, cytokinins, insulin etc.

Medical diagnosis
Immunodiagnostic techniques: monoclonal antibodies production as diagnostic reagents; Diagnosis by ELISA and Western blot. DNA sequencing and diagnosis. PCR and Array based techniques in diagnosis; Present methods for diagnosis of Specific diseases like Tuberculosis, Malaria and AIDS; ethics in Molecular Diagnosis

Gene transfer technology
Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy, Retro and adeno virus mediated gene transfer. Liposome and nanoparticles mediated gene delivery Cellular therapy.

Stem cell technology
Stem cells; definition, properties and potency of stem cells; Sources; embryonic and adult stem cells; Concept of tissue engineering; Role of scaffolds; Role of growth factors; Role of adult and embryonic stem cells. Clinical applications; Ethical issues.

Hybridoma technology
Hybridoma techniques and monoclonal antibody production. Production, purification,

characterization and applications of monoclonal antibodies. Antibody engineering – chimeric antibody, diabody.

Recommended text books (Latest Edition);

1. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002
2. Pratibha Nallari, V. Venugopal Rao; Medical Biotechnology, oxford University press, 2010.

Reference text books:

1. James W. Goding , Monoclonal antibodies; Principles and Practice , 3rd Edition , Academic Press 1996.
2. George Patrinos and Wilhelm Ansorage, Molecular Diagnostics, 1st Edition , Academic Press, 2005.

STEM CELL TECHNOLOGY

Course Code: 15 BT 51A4 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Introduction

What are stem cells, types, origin and nature of stem cells? Characteristic features, pluripotent stem cells and its types, Molecular basis of pluripotency. Cell surface markers of stem cells. Embryonic stem cells, factors requirements for maintain stem cells. Differences between human and mouse stem cells. Development of epithelial stem cell concept. Stem cell niches.

Stem cell characterization

Cell cycle regulation in stem cell. Mechanism of stem cell renewal, Changes of phenotypic characters, Characterization of human embryonic stem cells, Isolation and maintenance of Stem cell. Genetic manipulation of Embryonic Stem cell, homologous recombination of stem cells. Surface antigenic markers, lineage marking, Genomic reprogramming. Microarray analysis of stem cells & differentiation. Zebra fish and Stem cell research.

Tissue engineering

Neural stem cells and applications in neurodegenerative diseases, Treatment of heart diseases, diabetes, burns & skin ulcers, muscular dystrophy, regeneration of epidermis, orthopedic applications. Embryonic applications in tissue engineering. Novel sources of multipotent stem cells. Adult stem cells, Stem cell gene therapy.

Biopharming

What is biopharming? Applications of stem cell technology in animal biotechnology. Production of artificial organs using stem cell technology. Artificial pancreas, kidney, heart, liver etc.

Regulations and Ethics

Ethics of human cell research-immortal cells and moral selves, Ethical considerations, stem cell based therapies. FDA products and preclinical regulatory considerations. Patent advocacy, Science policies, ethics in stem cell research, primordial germ cells and germ cell development epigenetics and reprogramming in stem cell biology, norms in clean room.

Books recommended:

1. Rober Lanza, Essentials of Stem cell biology, Elsevier academic press, 2009
2. Joseph D. Bronzino Tissue engineering and artificial organs, Biomedical engineering hand book. volume -2, 3rd edition, CRC press, Taylor & Francis publications, 2006

Reference book:

1. Daniel R. Marshak, Stem Cell Biology, *Johns Hopkins University and Cambrex Corp.;* Richard L. Gardner, *University of Oxford;* David Gottlieb, *Washington University, St. Louis*, 2001.

MOLECULAR MODELING AND DRUG DESIGN

Course Code: 15 BT 51A5 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Empirical Force Fields and Molecular Mechanisms
Models, Approximations and Reality, Force Field concepts and Mathematical Expressions, Molecular Mechanical and Quantum Mechanical Force Fields, Parameterization, Generation of Potential energy surfaces. Bond Stretching, Angle bending, Torsional I terms, Out of plane, Bonding Motions, Electrostatic interactions, Vander Walls interactions, Effective pair potentials, Hydrogen Bonding, Simulation of liquid water.

Computer Simulation Methods
Time averages, Ensemble averages, Free energy methods, Thermo dynamic Perturbation Methods, Thermodynamic Integration Methods. Calculation of thermodynamics properties. Phase space; Practical aspects of computer simulation; Boundaries monitoring Equilibrium; Long range process; Analyzing results of simulation and estimation errors.

Molecular Dynamics Simulation Methods
Molecular Dynamics using simple modules; Molecular Dynamics with continuous potentials; Running Molecular Dynamics Simulation; Constant Dynamics; Time dependent properties; Molecular Dynamics at constant temperature and pressure.

Monte Carlo Simulation Methods
Metropolis methods; Monte Carlo simulation of molecules; Monte Carlo simulation of Polymers; Calculating Chemical potentials; Monte Carlo simulation and molecular dynamics.

Molecular Modeling In Drug Discovery
Molecular modeling in drug discovery-Deriving and using 3D Pharma cores, Molecular docking Structure Based methods to identify lead components-Denovo ligand design. QSARs and

QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors

Recommended textbooks:
1. Molecular Modeling Principles and Applications- AR Leach, Longman, 1996.
2. Molecular Dynamics Simulation-Elementary Methods- John Wiley and Sons, 1997.

Reference textbooks:
1. Current Protocols in Protein Science, Wiley Publishers, 2005; Deuflhard P., et al. Computational molecular dynamics - Challenges, methods, ideas.(Springer,1999)

FOOD TECHNOLOGY

Course Code: 15 BT 51B1 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Food associated Microbes
History of microorganisms in food, historical developments. Biotechnology in relation to the food industry, nutritive value of food, types of microorganism's associated with food, its sources, types and behavior in foods. Role and significance of microorganisms in food. Intrinsic and extrinsic parameters of foods that affect microbial growth.

Food processing
Bioprocessing of meat, fisheries, vegetables, diary product, enzymes and chemicals used in food processing, biochemical engineering for flavour and food productions. Emerging processing and preservation technologies for milk and dairy products.

Food preservation
Food preservation using irradiation, Characteristics of Radiations of interest in food preservation. Principles underlying the destruction of Microorganisms by irradiation, processing of foods for irradiation. Application of radiation, Radappertization, Radicidation, and Radurization of foods. Legal status of food irradiation. Effect of irradiation of food constituents.

Storage of foods
Stability of food preservation with low temperatures, high temperatures, drying. Indicator and food borne pathogens. Food borne illness, quality control, HFCS (High Fructose Corn Syrup) and mycoproteins. Air sampling, metabolically injured organisms, enumeration and detection of foodborne organisms.

Food microbiology
Utilization of microorganisms in food industries, genetic manipulations. Thermophiles and Radiation-resistant microorganisms, characteristics and growth of thermophilic microorganisms, Nature of Radiation resistance in microorganisms. Rheology of food production.

Recommended textbooks:

1. Lidsay, Willis Biotechnology, Challenges for the flavour and food industries, Elsevier Applied Science. 1988.
2. Food Science and Food Biotechnology by F.F.G. Lopez & G.V. B. Canovas (2003), CRC Press, Florida, USA.

Reference Books:

1. George J.B. Basic Food Microbilogy, CBS Publishers & Distributors, 1987.
2. Roger, A., Gordan B., and John T. Food Biotechnology, 1989.

TRANSPORT PHENOMENON IN BIOPROCESS

Course Code: 15 BT 51B2 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Introduction to transport phenomena
Three levels of transport process, conservation laws, Basic laws governing momentum, heat and mass transport, pressure and temperature dependence on viscosity, thermal conductivity and mass diffusivity, Molecular theories of viscosity, thermal conductivity and mass diffusivity under different condition, Introduction to convective transport process

Shell balances for momentum, mass and energy
Flow of a falling film, flow through a circular tube, flow through annulus, heat conduction with electrical, nuclear and chemical heat, heat conduction in a fin, diffusion through a stagnant gas film, diffusion with homogeneous and heterogeneous chemical reaction, diffusion and reaction in a porous catalyst, Forced convective momentum, heat and mass transport process

Transport process under turbulent conditions
Equations of change for isothermal and non-isothermal conditions, unsteady state momentum, heat and mass transport process, Velocity distribution in turbulent flow, time smoothed equation of change, turbulent flow in ducts, unsteady state heat conduction, temperature distribution for turbulent flow in tubes, jets and at large Prandtl number, concentration distribution in turbulent flow

Interphase transport process
Definition of friction factors, friction factors for flow in tubes and pressure drop calculations, heat transfer coefficients, heat transfer coefficient for free and forced convection, analytical calculations of heat transfer, mass transfer coefficient, mass transfer coefficient in single and two phase system, mass transfer with chemical reactions

Macroscopic balances and other mechanisms of transport
Macroscopic balances for steady and unsteady state balances in momentum, heat and mass transport. Heat transfer by radiation, radiation between nonblack bodies at different

temperatures, mass transport during centrifugation of proteins, diffusion of salts in aqueous solution, mass transport across permeable membranes, mass transport in porous media

Recommended Textbook:

1. R. B. Bird. W.E. Stewart and E.N. Lightfoor, Transport Phenomenoa Wiley II edition, India.

Reference books:

1. D.G.Rao, Introduction to Biochemical Engineering, Tata Mc Hill (2005).
2. Paul M. Doran, Bioprocess Engineering Principles Academic press (1995).
3. J E Bailey and D F Ollis, "Biochemical Engineering fundamentals "2nd edition Mc Graw-Hill (1986).
4. S Aiba, A E Humphrey and N Millis, "Biochemical Engineering" Prentice- Hall (1978).
5. Michaeln L shuler and F Kargi,Bio process Engineering : Basic concepts" 2nd ed., Prentice Hall of India (2003).

<u>BIOMINING</u>

Course Code: 15 BT 51B3 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Introduction to Data mining
Introduction to Data mining- methods- selection & sampling- Preprocessing and cleaning- Transformation & reduction- Data mining methods- Evaluation- visualization

Text mining
Overview on text mining- Natural Language Processing -Text summarization –tools- Applications of Data Mining

Introduction to Genetic Algorithms
Introduction to Genetic Algorithm, Genetic Operators and Parameters, Genetic Algorithmsin Problem Solving, Theoretical Foundations of Genetic Algorithms, Implementation issues

Neural Network
Neural Model and Network Architectures, Perceptron Learning, Supervised HebbianLearning, Backpropagation, Associative Learning, Competitive Networks, Hopfield-Network, Computing with Neural Nets and Applications of Neural Network

Introduction to Fuzzy Sets
Introduction to Fuzzy Sets, Operations on Fuzzy sets, Fuzzy Relations, Fuzzy Measures,Applications of Fuzzy Set Theory to different branches of Science and Engineering

Recommended textbooks:
1. Mitchell, M., 1998, an Introduction to Genetic Algorithms, Prentice-Hall.

2. Lau C., (Ed), 1992, Neural Networks, IEEE Press.

Reference textbooks:

1. Freeman, J. and Skapura, D., 1991 Neural Networks: Algorithms, Applications and Programming Techniques, Addison-Wesley.
2. Klir, G.J. and Folger, T.A., 1988, Fuzzy Sets, Uncertainty, and Information, PHI.

BIOPROCESS VALIDATION & Cgmp

Course Code: 15 BT 51B4 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Bioprocess Validations
Validations – Methods of validation. Prerequisites, process design & testing process characterization, Process optimization, Validation options, Prospective process validation, retrospective validations, Concurrent validations, Revalidation, Organizing Revalidation studies, Analytical method validations, Cleaning validation, Prevalidation verification, Documentation, Control of cleaning materials & ancillary tools, Frequency of cleaning, Development of validation protocol.

Quality Assurance
Quality Assurance, Quality control, Quality management, Responsibilities of quality management in laboratories, Development of quality records, Deviations of quality product process, Good laboratory practices, Responsibilities in GLP, Computational processes in GLP.

Standard Operating Procedures
Standard operating procedures, SOP of immunological industries, SOP of tissue culture, Deviations of SOP, Revision occurrence in SOP, Authorized control of SOP, Guidelines and regulation of FDA and ICH for GLP.

Good Manufacturing Practices
Quality control of a product, Good manufacturing practices, cGMP, GMP of industries, Sanitation & Hygiene, Control of finished products, Maintenance of materials in laboratories, Zero contamination, Documentation of GMP, Compliance of GMP.

Clinical Practices Of GMP
Clinical practices in laboratories, Clinical practices in vaccine production, Clean room, Class A, B (USFDA), Bacterial counts in clean room, Waste disposal in laboratories, Health & hygiene of persons involved in clinical laboratories. ICH guidelines for clinical laboratories.

Recommended Textbooks:
1. P. P. Sharma,How to Practice GMP's
2. ICH Guidelines – USFDA Hand book

Reference textbook:
1. J. Seiler,Good Laboratory Practices

PERL PROGRAMMING AND BIOPERL

Course Code: 15 BT 52C1 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

An Introduction to Perl & Variables and Data Types
The Perl Interpreter - Perl Variables-Scalar Values-Variable Definition-Special Variables

Arrays and Hashes
Arrays-Array Manipulation -Push and Pop, Shift and Unshift –Splice-Other Useful Array Functions- List and Scalar Context -Hashes -Maintaining a Hash

Control Structures & String Manipulation
Comparisons Choices- If - Boolean Operators- Else-Loops-For Loops -Foreach Loops 52. Indeterminate Loops -While -Repeat Until -Loop Exits -Last - Next and Continue -Array-Based Character Manipulation-Regular Expressions–Match-Substitute - Translate

Input and Output
Program Parameters -File I/O -Filehandles- Working with Files -Built-in File Handles -File Safety - The Input Operator–Binary- Interprocess Communications–Processes- Process Pipes-Creating Processes - Monitoring Processes

Bioperl
Sequences -SeqFeature –Annotation-Sequence - Example Bioperl Programs

Recommended text books:
1. Beginning Perl for Bioinformatics, James Tisdall, O'Reilly Publishers
2. Jamison D., Perl Programming for Biologists, Wiley publishers

Reference text books:
1. Introduction to computers, Peter Norton, Tata Mc Graw Hill publishers

BIOPROCESS TECHNOLOGY

Course Code: 15 BT 52C2 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Introduction
Isolation and screening of industrially important microbes. Strain improvement – mutation and recombination. Substrates for industrial fermentation.

Fermentation technology

Concepts of basic modes of fermentation - Batch, Fed batch and Continuous fermentation. Bioreactor designs, Media formulation. Air and media sterilization, Aeration & agitation in bioprocess.

Bioprocess control and monitoring

Bioprocess control and monitoring variables such as temperature, pH, agitation, pressure, online measurement, on / off control, PID control, computers in bioprocess control system.

Downstream processing

Downstream processing–Filtration, Centrifugation, cell disruption, chromatography, Liquid–liquid extraction, membrane process, drying crystallization, broth processing. Effluent treatment–disposal, treatment process, by-products. Fermentation economics, Bioprocess for the production of amino acids, organic acids, nucleotides, nucleosides and related compounds,

Bioproducts

Bioprocess for the production of enzymes, vitamins, antibiotics and SCP. Immobilization of enzymes and microbial cells.

Recommended Textbooks:

1. Industrial Microbiology & Biotechnology by Arnold L. demain & Julian E. Davis. (2004) ASM Press.
2. Fermentation Microbiology & Biotechnology by Emt.el-Mansi & CFA. Bryce (2004). Taylor & Francis Ltd.

REFERENCE BOOKS:

3. Principles of fermentation technology by P.F. Stanbury, A. Whitaker & S.J. Hall(1997). Oxford.
4. The Bacterial Vol. Ill by Gungalus, I.C. and stainer. RY. (Eds.) Academic press. New York.
5. Bacterial physiology and metabolism by Sala Teh JR - Academic press, New York..
6. Chemical Engineering by J.M. Coulson and J.F. Richardson (1984) Pergamon Press.

ENVIRONMENTAL BIOTECHNOLOGY

Course Code: 15 BT 52C3 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Environmental Pollution

Types, Environmental pollution (water, soil, air), Noise & Thermal pollution, sources, and control. Reduction of environmental impact of industrial effluents, chemical herbicides and fertilizers. Biotechnology for hazardous waste management, persistent organic pollutants, Xenobiotics, biological detoxification of pH. Removal of oil spills. Environmental monitoring. Bioremediation – solid & liquid waste treatment.

Water Pollution
Water Quality modeling for streams. Water pollution and its control, wastewater treatment – Biological processes for Industrial and domestic effluents treatments, Aerobic and non-aerobic Biological treatment. Role of Biotechnology in water purification systems. (Primary, secondary and tertiary treatments)

Air Pollution
Source of air, water and solid wastes. Micrometeorology and dispersion of pollutants in Environment. Centrifugal collectors, Electrostatics, precipitator, bag filters and wet scrubbers. Design and efficiencies. Combustion generated pollution mine drainages, vehicle emission control. Case studies – Bio techniques for Air pollution control.

Microbe-Metal Interaction
Heavy metal pollution and impact on environment Bioleaching Microbial systems for heavy metal accumulation, Biosorption, molecular mechanism of heavy metal tolerance, role of microbes insynthesis of nanoparticles.

Environment & Energy
Renewable sources of energy – Biogas, waste material, energy crops, cellulose. Bio-fuels & Biodiesel using microorganisms. Global Environmental problems. Ozone depletion, UV-B, Green house effect. National policy on environment.

Recommended textbooks:
1. T. Srinivas, Environmental Biotechnology, New-Age Publications, New Delhi (2008)
2. Bru E. Rittmann and Perry L.Mc Carty, Environmental Biotechnology: Principles and Applications, Mc Graw Hill Company (2001).

Reference textbooks:
1. Howard S. Peavy, Donal R. Rowe and George Tchobanoglous, Environmental Engineering, Mc Graw Hill Company (1985).

NANO TECHNOLOGY

Course Code: 15 BT 52C4 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Introduction to nanotechnology: Definition of nanoscale with reference to physics and bio-systems. Crystal Structure, Unit Cells, Bravais Lattices, Crystallographic Directions, Crystallographic Planes, Miller Indices, Bragg's Law, Single Crystal and Powder X-ray Diffraction. **Types of Material -**Different types of materials: Metals, Semiconductors, Composite materials, Ceramics, Alloys, Polymers and Bio Polymer composites. **Imperfections**

in solids -Imperfections of crystal structure: point defects, Grain boundaries, phase boundaries, Screw & Edge Dislocations.

Nano materials and synthesis: Nano material Synthesis: Top-Down Approach. Physical methods - Inert gas condensation, aerosol method, Arc discharge, RF-plasma technique, laser ablation, Spray Pyrolysis, Ball Milling. Bottom-up approach - Chemical Methods - Metal nanocrystals by reduction, Solvothermal synthesis, Photochemical synthesis, Electrochemical synthesis, Sonochemical routes, Solvated metal atom dispersion, Sol- gel technique.

Characterization of Nano materials by Spectroscopic techniques : Introduction to microscope, optical microscope, Optical absorption spectrometer, UV-Vis-NIR spectrometer, x-ray Diffraction, Scanning electron microscopy, scanning probe microscopy, scanning tunneling microscope and transmission electron microscopy.

Mechanical & Optical properties: Mechanical properties of nano materials, structural properties of nano materials, melting of nano materials, electrical conductivity, optical properties of nano structured metals and semiconductors.

CNT's : Introduction to carbon nano tubes, types of carbon nanotubes, synthesis, growth mechanism, Nanolithography, lithography using photons, lithography using paticle beams, scnaning probe lithography, soft lithography. Nano sensors, Carbon nano tube applications

Recommended text books:

1. Carl.C.Koch, "Nanostructured materials, processing, properties and applications, NFL publications,2007.
2. Hari Singh Nalwa – Handbook of nanostructured materials and nanotechnology: Synthesis and processing, ASP,2004.
3. Stephen Elliott & S. R. Elliott The Physics and Chemistry of Solids, John Wiley & Sons, 1998.

Recommended Reference:

1. Charles Kittel, Introduction to Solid State Physics, John Wiley & Sons, 2004
2. Van Vlack, Elements materials science, Addison-Wesley, 1964
3. Zhong Lin Wang, *"Characterization of Nanophase Materials"*, Wiley-VCH, 2001
4. T.J.Chung, P.M. Anderson, M.K.Wu and S.Hsieh, "Nanomechanics of materials and structures, Springer, 2006.
5. Jackie Ying. Ed "*Nanostructured Materials",* Academic Press, 2001. A small edited volume with some good articles on some specialized topics such as adsorption in nanoporous materials
6. R. Haynes, "Optical Microscopy of Materials, International Textbook Company, Glascow, 1984.
7. John J. Bozzola and Lonnie D. Russel, "Electron Microscopy", Jones and Bartlett Publishers Inc., USA, 1999.
8. YIP-WAH-CHUNG, "Practical Guide to Surface Science & Spectroscopy", Academic Press, 2001.

9. Christopher Hammond, “The Basics of Crystallography, II edition, Oxford Univ. Press, (2001).
10. D. P. Woodruff and T. A. Delchar, “Modern Techniques of Surface Science”, Cambridge Solid State Science Series, 1994.

INTELLECTUAL PROPERTY RIGHTS AND PATENT LAWS

Course Code: 15 BT 52C5 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Intellectual Property Rights
Patents and intellectual property rights (IPR): Definition, History of intellectual property; Types of intellectual property rights, copy rights, trade marks, geographical indication, Industrial design rights, patents. Sources of patent information, patent application procedures.

Principles, Scope and Functions of GATT&WTO
GATT- Historical perspective, objectives and fundamental principles, impact on developing countries. WTO-Objectives, scope, functions, structure, status, membership and withdrawal, dispute settlement, impact on globalization, India-tasks and challenges.

Regulatory Affairs
Indian contest-requirements and guidelines of GMP, understanding of Drugs and cosmetic act 1940 and rules 1945 with reference schedule M,U & Y. Related quality systems-objectives and guidelines of USFDA,WHO & ICH; Introduction to ISO series.

Documentation and Protocols
Documentation: Types related to pharmaceuticals industry, protocols, harmonizing formulation development for global fillings, NDA, ANDA, CTD, Dealing with post approval changes-SUPAC, handling and maintenance including electronic documentation.

Case Studies on Patents: Case Studies on patents (Basumati rice, turmeric, Neem, etc.)

Recommended Textbooks:
1. S. H. Willing, Good manufacturing practices for Pharmaceuticals

Reference textbooks:
1. P. Das & Gokul Das, Protection of Industrial property Rights.

REGULATORY AFFAIRS AND CLINICAL TRIALS

Course Code: 15 BT 52D1 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Basics and Features of Clinical Trails
What is clinical trial - Need, Types and phases of clinical trials, Benefits and Risks in clinical trials: Team involved in a clinical trial: Features and essential components of clinical trials: Good clinical trial practices:

Patent Requirement and Clinical Trail Statistic
Stages in patent recruitment: Recruitment evidence. Challenges in patent recruitment, Research methodology, Primary and secondary outcomes: Subgroup analysis, Checklists

Design of Experiments and Role of It In Clinical Trails
Design configuration, Multicenter trails, Types of comparison: Group sequential designs, Sample size, Data capture and processing: Role of IT in clinical trials: Clinical trial team

Clinical Trail Regulatory Affairs
The history of clinical testing and its regulation, Clinical trial regulation, Good clinical trail guidance-The Indian scenario, Essential standards for performing clinical trials, Good clinical practice, Institutional ethics committee, General ethical principles, Specific ethical principles, The guidelines for drug trails, Phase wise guidelines for clinical trials, Guidelines for vaccine trails, Essential documents.

Clinical Trail Business Environment
Basic components of clinical trials budgets, Clinical trial Industry, Economic challenges faced by Pharmaceutical companies, India as a place for conducting clinical trials. Indian/USA/EU ethics approval system.

Recommended Textbooks:
1. Good Clinical practices,Central Drugs Standard Control organization,Govt.of India
2. Drugs and cosmetics Act 1940.

Reference Books:
1. International Clinical Trail, Volume 1 & 2 Dominique P.brunier and Nahler, Interpham press, Denver, Colorado.
2. Code of Federal Regulation by USFDA-Download.

BIOPROCESS ECONOMICS AND PLANT DESIGN

Course Code: 15 BT 52D2 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Economic evaluation

Capital cost of a project. Interest calculations, nominal and effective interest rates. Basic concepts in tax and depreciation. Measures of economic performance, rate of return, payout time. Cash flow diagrams; Cost accounting-balance sheet and profit loss account. Break even and minimum cost analysis.

Bioprocess Economics
Introduction, elements of total production cost, outline of the total capital investment, equipment sizing, capital cost estimates large-scale equipment and utilities. Manufacturing cost estimates-Operating costs-Raw materials, utilities, fixed costs and overhead costs, case studies of antibiotics, recombinant products, single cell protein.

Introduction to process design
Schematic representation of unit operations, design information and flow diagrams, material and energy balances, formulation of the design problem, the Hierarchy of chemical process design and integration, optimization, Health and safety Hazards, Environment protection, plant location and lay out.

Basic considerations in equipment design
General design procedure, equipment classification, materials of construction-Mechanical propertiesstrength, elasticity, ductility, resilience, toughness, hardness, creep, fatigue. Metals-ferrous metals, types of iron & steels, Nonferrous metals and Non-metals. Corrosion: Forms of corrosion and their presentation. Choice of materials. Design conventions.

Basic Design Problems
Design examples on continuous fermentation, aeration and agitation. Design calculation of filter for air sterilization. Design of batch and continuous sterilizers. Design calculations for immobilized enzyme kinetics. Practical considerations in designing of Bioreactor/Fermentor construction. Introduction to different types of valves, pumps, steam traps, spargers and impellers used in fermentation industries. Design exercise on trickle flow fermenter. Problems associated with design equations.

Recommended Text Books:
1. Peters & Timmerhaus, Plant design and Economics for Chemical Engineers –
2. M V Joshi & V V Mahajani, Process equipment design
3. Robin smith, Chemical process design and integration

Reference books:
1. Harvey W Blanch, Biochemical Engineering
2. S.K. Hazra and choudary, Material Science & Processes

GENOMICS AND PROTEOMICS

Course Code: 15 BT 52D3 **L-T-P:** 3-0-0
Prerequisites: Nil **Credits:**3

Syllabus:

Organization of genome and its mapping
Organization and structure of genomes, Genome Mapping - Construction of genomic libraries, mapping strategies and techniques. Human Genome Project, Genomes of other organisms. Principles of gene expression; Global analysis of gene expression.

Structural and Functional genomics
Comparative genomics: protein evolution from exon shuffling, Protein structural genomics, Gene function by sequence comparison. Functional Genomics, Pharmacogenomics, Genomics in relation to molecular Diagnosis, Role of genomics in Drug discovery and development.

Microarrays and gene therapy
Whole genome analysis of mRNA and protein expression, micro array analysis, types of microarrays and applications. Gene Therapy: New Targets for drug discovery. Knockout mice, Role of animal models in identification of genes for disorders.

Proteomics
Principles of separation of Bio-molecules, Anfinsen's experiments, diagonal electrophoresis, 2D-Gel Electrophoresis, MALDI-TOF, Protein-protein interaction networks – Topology, Network motifs, Protein Expression profiling, Protein Biochips, Applications of Proteomics and Protein arrays.

Yeast two hybrid systems
Yeast two hybrid, Co-Precipitation, Phage Display, Phylogenetic Profile, Domain fusion, Gene Neighborhood, Gene Cluster, Mirror Tree, Analysis of genome wide Protein-Protein Interactions in yeast, Genome wide yeast two hybrid analysis of other organisms, Protein fragment complementation assays.

Recommended Text Books:
1. S.Sahai, Genomics and Proteomics, "Functional an Computational Aspects", Pienum Publications, 1999.
2. Moody P C E and A J Wilkinson. Protein Engineering. IRL Press.

Reference Books:
1. Molecular Biology by Watson *et al*
2. Creighton T E, Proteins. Freeman W H. Second edition 1993.
3. Lela Buchingham and Maribeth L Flawsm , Molecular Diagnostics; Fundamentals, Methods and Clinical Application , 1st Edition F.A. Davis Company Philadelphia USA, 2007.

BIOCATALYSIS AND ENZYME MECHANISMS

Course Code: 15 BT 52D4 **L-T-P:** 3-0-0

Prerequisites: Nil **Credits:**3

Syllabus:

Biocatalysis - Current Status, Advantages & disadvantages, Comparison with other Catalysts, Biocatalysts as a technology, Green Chemistry.

Characterization of a Biocatalyst: Enzyme Kinetics, Basis of Enzyme Action, Theories of Enzyme Catalysis, Efficiency, Stability, Selectivity of Enzymes, Screening of New Enzyme Activity

Biocatalytic Asymmetric Synthesis: Basic of stereochemistry; Enantiomerically pure amino acids, Hydroxy esters with carbonyl reductase, Alcohols with ADH, Penicillin G, Ephedrine, Chiral drugs, Anticholesterol drugs, Anti-infectives, Anti-AIDS drugs, Cardiovascular drugs, Applications of Lipases and Esterases in the Pharma industry, Steroids UNIT-IV

Biocatalysis In Non-Conventional Media: Enzymes in organic solvents, Advantages of Biocatalysis in organic media, Role of water in Enzyme reactions in Organic solvents, Substrate as solvent, Ionic liquids and Supercritical Solvents for enzymatic reactions .

Industrial Enzymes: Enzymes in the food industry, Cell-wall degrading enzymes, Lipases, Proteases, Amylases, Xylanases, Enzymes in brewing, Fat splitting, Enzymes in the paper and pulp industry, Enzymes in the textile industry, Enzymes for preservation, The future of enzyme applications

Text books:

1. Biocatalysis: Fundamentals & Applications by Andreas Sebastian Bommarius , Bettina R. Riebel, VCH. 2. Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin.

Reference books:

1. Enzymes by palmer, 2. Enzymes in Industry by Wolfgang Aehle, Wiley-VCH.

M-TECH - STRUCTURAL ENGINEERING

First Year [First Semester]						
S No	**Code**	**Course Title**	**L**	**T**	**P**	**Cr**
1	15 CE 5101	Applied Mathematics	3	2	0	4
2	15 CE 5102	Theory of Elasticity	3	2	0	4
3	15 CE 5103	Structural Dynamics	3	0	2	4
4	15 CE 5104	Advanced Prestressed Concrete	3	0	2	4
5		Elective – I				
6		Elective – II	3	0	0	3
7	15 CE 5148	Seminar	0	0	4	2
		Total Credits:				24

First Year [Second Semester]						
S No	**Code**	**Course Title**	**L**	**T**	**P**	**Cr**
1	15 CE 5205	Finite Element Analysis	3	0	2	4
2	15 CE 5206	Bridge Engineering	3	2	0	4
3	15 CE 5207	Earthquake Resistant Design of Structures	3	0	2	4
4	15 CE 5208	Theory of Plates and Shells	3	2	0	4
5		Elective – III				
6		Elective – IV				
7	15 IE 5250	Term Paper	0	0	4	2
		Total Credits:				24

Second Year						
S No	**Code**	**Course Title**	**L**	**T**	**P**	**Cr**
1	15 IE 6050	DISSERTATION	0	0	72	36
		Total Credits:				36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 CE 51A1	Repair and Rehabilitation of structures	3	0	0	3
2	15 CE 51A2	Design of Offshore structures	3	0	0	3
Elective-2						
1	15 CE 51B1	Geotechnical Earthquake Engineering	3	0	0	3
2	15 CE 51B2	Stability of Structures	3	0	0	3
Elective-3						
1	15 CE 52C1	Industrial Structures	3	0	0	3
2	15 CE 52C2	Design of Tall Structures	3	0	0	3
3	15 CE 52C3	Optimization of Structures3	3	0	0	3
Elective-4						
1	15 CE 52D1	Advanced Design of structures	3	0	0	3
2	15 CE 52D2	Fracture Mechanics	3	0	0	3
3	15 CE 52D3	Green Buildings	3	0	0	3

APPLIED MATHEMATICS

Course Code :15 CE 5101 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

One Dimensional Wave and Heat Equations
Laplace transform methods for one-dimensional wave equation – Displacements in a long string – longitudinal vibration of an elastic bar – Fourier transform methods for one-dimensional heat conduction problems in infinite and semi-infinite rods.

Elliptic Equation
Laplace equation – Properties of harmonic functions – Solution of Laplace's equation by means of Fourier transforms in a half plane, in an infinite strip and in a semi-infinite strip – Solution of Poisson equation by Fourier transform method.

Calculus of Variations
Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries –Direct methods – Ritz and Kantorovich methods.

Eigen Value Problems
Methods of solutions: Faddeev – Leverrier Method, Power Method with deflation – Approximate Methods: Rayleigh – Ritz Method

Numerical Integration
Gaussian Quadrature – One and Two Dimensions – Gauss Hermite Quadrature – Monte Carlo Method – Multiple Integration by using mapping function

TEXT BOOKS:

1. Introduction to Partial Differential Equations by K. Sankara Rao, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
2. Numerical Methods in Science and Engineering A Practical Approach by S. Rajasekaran, A. H. Wheeler and Company Private Limited, 1986.
3. Calculus of Variations with Applications by A.S. Gupta, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
4. Integral Transforms for Engineers by L.C. Andrews and B. K. Shivamoggi, Prentice Hall of India Pvt. Ltd., New Delhi, 2003.

THEORY OF ELASTICITY

Course Code :15 CE 5102 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Two-dimensional problems in rectangular coordinates
Plane stress ; Plane strain; Differential equations of equilibrium; Boundary conditions; Compatibility equations; Stress function; Governing differential equation; Solution by Polynomials; End effects – Saint-Venant's Principle; Determination of displacements; Bending of a cantilever loaded at the end; Bending of a beam by uniform load

Two-dimensional problems in polar coordinates
General equations in polar coordinates; Stress distribution symmetrical about an axis; Effect of circular holes on stress distribution in plates; Concentrated force at a point of a straight boundary; Concentrated force acting on a beam; Stresses in a circular disc, general solutions of the two dimensional problem in polar coordinates, applications of the general solutions in polar coordinates.

Strain energy methods
Total strain energy; Principle of virtual work; Griffith's theory of rupture; Castigliano's theorem; Principle of least work (Stationary potential energy), applications of the principle of least workrectangular plates, shear lag

Analysis of stress and strain in three dimensions
Stress at a point – components of stress; Principal stresses; Stress ellipsoid and stress director surface; Determination of principal stresses; Stress invariants; Determination of maximum shear stresses; Octahedral shear stress; strain at a point – Components of strain; differential equations of equilibrium, the principle of superposition

Torsion
Torsion of straight bars – Saint Venant's theory; Elliptic cross section; Membrane analogy; Torsion of a bar of narrow rectangular cross-section; Torsion of rolled profile sections; Torsion of thin tubes

Text Books:
1. Theory of Elasticity by Timoshenko, S. and Goodier J.N., McGraw Hill Book Co., Newyork, 1988.

Reference Books
1. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 1988.
2. Hearn , E.J. "Mechanics of Materials", Vol.2, Pergamon Press, Oxford, 1985
3. Irving H.Shames and James, M.Pitarresi, "Introduction to Solid Mechanics", Prentice Hall of India Pvt. Ltd., Newl Delhi -2002.

STRUCTURAL DYNAMICS

Course Code :15 CE 5103 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Equation of Motions, Problem Statement, Solution Methods of Single Degree of Freedom Systems (SDOF) *:* Basic concepts of structural dynamics; single degree of freedom system, force displacement relationship, damping force, equation of motion, mass-spring-damper system, methods of solution of differential equation.
Free Vibration (SDOF): Undamped free vibration, viscously damped free vibration, energy in free vibration.
Response to Harmonic and Periodic Excitations (SDOF) : Harmonic vibration of undamped systems, Harmonic vibration with viscous damping, response to vibration generator, natural frequency and damping from harmonic test, force transmission and vibration isolation, vibration measuring instruments, energy dissipated in viscous damping. Response to periodic force.
Response to Arbitrary, Step And Pulse Excitations (SDOF) : Response to unit impuse, response to arbitrary force, step force, ramp force, response to pulse excitations, solution methods, effects of viscous damping.
Numerical Evaluation of Dynamic Response (SDOF) : Time stepping methods, methods based on interpolation of excitation, central difference method, newmark's method, stability and computational error, analysis of nonlinear response by newmark's method.Earthquake Response to Linear Systems (SDOF)
Earthquake excitation, equation of motion, response quantities, response history, response spectrum concept, deformation, pseudo-velocity and pseudo acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics, elastic design spectrum, comparison and distinction between design and response spectra.
Generalised Single Degree of Freedom Systems : Generalised SDOF systems, rigid body assemblages, systems with distributed mass and elasticity, lumped mass system-shear building, natural vibration frequency by Rayleigh's method.
Multi -degree of freedom systems (MDOF) : Equation of motions: simple system-two storey shear building, general approach for linear systems, static condensation, symmetric plan systems: ground motion. Multiple support excitation, methods of solving the equation of motions.
Free Vibration (MDOF) : Natural frequencies and modes: systems without damping, modal and spectral matrices, orthogonality of modes, normalization of modes. Solution of undamped free vibration systems, solution methods for eigenvalue problem.

Text Books:

1. Dynamics of structures by Anil K Chopra; Prentice-Hall of India Limited, New Delhi.3rd edition 2006.
2. Dynamics of Structures by R.W. Clough and P.E. Penzien, McGraw-Hill. 1st edition 1975

Reference Books:

1. Structural Dynamics for Structural Engineers by G. C. Hart & K. Wang; John Wiley & Sons. 1st edition 1991
2. Structural Dynamics by Mario Paz, CBS Publishers.1st edition 1991.

ADVANCED PRESTRESSED CONCRETE

Course Code :15 CE 5104 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction, Prestressing Systems and Material Properties
Basic concepts of pre-stressing; Historical development; Advantages and Types of Pre-stressing, Pre-tensioning Systems and Devices, Post-tensioning Systems and Devices, Need for High strength steel and High strength concrete; **Losses Of Prestress:** Nature of losses of pre-stress; Loss due to elastic deformation of concrete, shrinkage of concrete, creep of concrete, relaxation of stress in steel, friction and anchorage slip; Total losses allowed for in design.
Analysis of Prestressed Member
Analysis of Members under Axial Load: Analysis at Transfer, Analysis at Service , Analysis for Ultimate Strength, Analysis of Member under Flexure:, Analysis at Transfer and at Service, Cracking Moment, Kern Point, Pressure Line, Analysis for Ultimate Strength, design loads and strength, Calculation of Crack Width, Variation of Stress in Steel, Analysis of a Rectangular Section, Analysis of a Flanged Section.
Deflections of Prestressed Concrete Members:
Importance of control of deflections; Factors influencing deflections; Short term deflections of uncracked members. Long term deflection of cracked member; **Transmission Of Pre-Stress:** Transmission of Pre-stressing force by bond; Transmission length; Bond stresses; Transverse tensile stresses; End zone reinforcement; Flexural bond stresses in pre –tensioned and post –tensioned grouted beams, stress distribution in end block, Anchorage zone reinforcements; **Shear And Torsion Resistance Of Prestressed Concrete Member:** Shear and Principal stresses; Ultimate shear resistance of pre-stressed concrete members; Design of shear reinforcement, pre-stressed concrete members in torsion, Design of reinforcements for torsion, shear and bending.
Design of Pre-Stressed Members : Design of sections for flexure, Design of Sections for Axial Tension, Design of Sections for compression and bending, design of pre-stressed section for shear and torsion, design of pre-stressed member for bond. Dimensioning of flexural member, design for pre-tensioning member, design of post-tensioning members.
Composite Construction of Prestressed Concrete : Composite structural member, types of composite construction, analysis of stresses, differential shrinkages, deflection of composite member, flexural strength of composite sections, shear strength of composite section; **Design of Continuous Prestressed Concrete Member:** Advantages of continuous members, ultimate load analysis of continuous pre-stressed member, design of continuous pre-stressed concrete beams.
Text Books: (supplemented with IS: 1343)

1. Prestressed Concrete by N. Krishna Raju; Tata Mc Graw - Hill Publishing Company Limited, New Delhi.3rd edition, 1995.
2. Design of Prestressed Concrete Structures by T.Y. Lin & Ned H. Burns; John Wiley & Sons, 3rd edition, 1981.

Reference Books

1. Prestressed concrete by N. Rajagopalan; Narosa Publishing House.2nd edition, 2005.
2. Design of Prestressed Concrete by A. Nilson; John Willey & Sons.2nd edition, 1987.

REPAIR AND REHABILITATION OF STRUCTURES

Course Code :15 CE 51A1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction
Deterioration of structures with aging; Need for rehabilitation
Distress in concrete /steel structures
Types of damages; Sources or causes for damages; effects of damages; Case studies

Damage assessment and evaluation models
Damage testing methods; Non-destructive testing methods

Rehabilitation methods
Grouting; Detailing; Imbalance of structural stability; Case studies

Methods of Repair
Shortcreting; Grouting; Epoxy-cement mortar injection; Crack ceiling

Seismic Retrofitting of reinforced concrete buildings
Introduction; Considerations in retrofitting of structures; Source of weakness in RC frame building – Structural damage due to discontinuous load path; Structural damage due to lack of deformation; Quality of workmanship and materials; Classification of retrofitting techniques; Retrofitting strategies for RC buildings – Structural level (global) retrofit methods; Member level (local) retrofit methods; Comparative analysis of methods of retrofitting

Text Books:

1. Diagnosis and treatment of structures in distress by R.N.Raikar, Published by R&D Centre of Structural Designers & Consultants Pvt.Ltd., Mumbai, 1994.
2. Handbook on Repair and Rehabilitation of RCC buildings, Published by CPWD, Delhi, 2002.
3. Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikhande, Prentice-Hall of India, 2006.

<u>DESIGN OF OFFSHORE STRUCTURES</u>

Course Code :15 CE 51A2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

WAVE THEORIES
Wave generation process, small and finite amplitude wave theories.

FORCES OF OFFSHORE STRUCTURES
Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation.

OFFSHORE SOIL AND STRUCTURE MODELLING
Different types of offshore structures, foundation modeling, structural modeling.

ANALYSIS OF OFFSHORE STRUCTURES
Static method of analysis, foundation analysis and dynamics of offshore structures.

DESIGN OF OFFSHORE STRUCTURES
Design of platforms, helipads, Jacket tower and mooring cables and pipe lines.

Text Books:

Dawson.T.H., "Offshore Structural Engineering", Prentice Hall Inc Englewood Cliffs, N.J. 1983

Reference Books:

1. Chakrabarti, S.K. "Hydrodynamics of Offshore Structures", Computational Mechanics Publications, 1987.
2. Brebia, C.A and Walker, S., "Dynamic Analysis of Offshore Structures", New Butterworths, U.K. 1979.
3. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex, 2000.
4. Reddy, D.V. and Arockiasamy, M., "Offshore Structures", Vol.1 and Vol.2, Krieger Publishing Company, Florida, 1991.

GEOTECHNICAL EARTHQUAKE ENGINEERING

Course Code :15 CE 51B1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Seismology and Earthquakes
Introduction, Seismic Hazards, seismic waves, internal structure of earth, Continental drift and plate tectonics, faults, elastics rebound theory, geometric notations, location of earthquakes, size of earthquakes.

Strong Ground Motion
Strong ground motion measurement, ground motion parameters, estimation of ground motion parameters.
Seismic Hazard Analysis: Identification and Evaluation of Earthquake Sources, deterministic seismic hazard analysis, probabilistic seismic hazard analysis.

Wave propagation
Waves in unbounded media, waves in a semi – infinite body, waves in a layered media, attenuation of stress waves.
Dynamic soil properties: Measurement of dynamic soil properties using field and laboratory tests (overview), stress strain behavior of cyclically loaded soils, strength of cyclically loaded soils.

Ground Response Analysis
One – Dimensional Ground response Analysis – Linear and Non-Linear Approaches.
Local Site Effects: Effect of local site conditions on ground motion, design parameters, development of design parameters.

Liquefaction
Flow liquefaction, cyclic mobility, evaluation of liquefaction hazards, liquefaction susceptibility, initiation of liquefaction, effects of liquefaction.
Soil Improvement for Remediation of Seismic Hazards: Densification techniques, Reinforcement Techniques, Grouting and Mixing techniques, Drainage techniques.

TEXT BOOK:
Geotechnical Earthquake Engineering by Steven L. Kramer, prentice Hall, 1st edition, 1996.

REFERENCE BOOK:
Geotechnical Earthquake Engineering Handbook by Robert W. Day, McGraw-Hill.2nd edition, 2010.

STABILITY OF STRUCTURES

Course Code :15 CE 51B2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

BUCKLING OF COLUMNS
Introduction; Methods of finding critical loads; Critical loads for straight columns with different end conditions and loading; Inelastic buckling of axially loaded columns; Energy methods; Prismatic and non-prismatic columns under discrete and distributed loading; General Principles of elastic 0stability of framed structures.
Buckling of thin walled members of open cross section
Torsion of thin-walled bars; warping; Non-uniform torsion; Torsional buckling under axial loading; Combined bending and torsion buckling.
Lateral Buckling of Beams
Beams under pure bending; Cantilever and simply supported beams of rectangular and I-sections; Beams under transverse loading; Energy methods; Solution of simple problems.
Buckling of Rectangular Plates
Plates simply supported on all edges and subjected to constant compression in one or two directions; Plates simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides.
Buckling of Shells
Introduction to buckling of axially compressed cylindrical shells.

Mathematical treatment of stability problems
Discrete/Discontinuous systems; Eigen value problem; Converting continuous systems to discrete systems using the finite element method – Buckling of a column with sudden change in cross-section

Text Books:
Theory of elastic stability by Timoshenko & Gere, McGraw Hill, 1961.

Reference Books:
1.Background to buckling by Allen and Bulson, McGraw-Hill, 1980.
2.Elastic stability of structural elements by N.G.R.Iyengar, Macmillan India Ltd., 2007.

FINITE ELEMENT ANALYSIS

Course Code :15 CE 5205 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Basic Principles
Equilibrium equations; Strain-displacement relations; linear constitutive relations;Principle virtual work; Principle of stationary potential energy
Element Properties
Different types of elements; Displacement models; Relation between nodal degrees of freedom and generalized coordinates; Convergence requirements; Compatibility requirement; Geometric invariance; Natural coordinate systems; Shape functions; Element strains and stresses; Element stiffness matrix; Element nodal load vector. Isoparametric elements – Definition, Two-dimensional isoparametric elements – Jacobian transformation, Numerical integration
Direct Stiffness method and Solution Technique
Assemblage of elements–Obtaining Global stiffness matrix and Global load vector; Governing equilibrium equation for static problems; Storage of Global stiffness matrix in banded and skyline form; Incorporation of boundary conditions; Solution to resulting simultaneous equations by Gauss elimination method
Plane-stress and Plane-strain analysis
Solving plane stress and plane-strain problems using constant strain triangle and four nodded isoparametric element
Analysis of plate bending
Basic theory of plate bending; Shear deformation plates; Plate bending analysis using four noded isoparametric elements

Text Books:
1. Introduction to Finite Elements in Engineering by R.T. Chandrupatla and A.D. Belegundu, Prentice Hall of India, 1997.

Reference Books:
1. Finite Element Analysis by Abel and Desai, New Age Publishers, 2007.
2. Finite Element Analysis: Theory and Programming by C. S. Krishnamoorthy, Tata McGraw-Hill, 1995
3. Finite Element Procedures in Engineering Analysis by K. J. Bathe, Prentice Hall Inc., 1996.
4. The Finite Element Method by O.C. Zienkiewicz, and R.L.Taylor, McGraw – Hill, 1987.

BRIDGE ENGINEERING

Course Code :15 CE 5206 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

I.R.C. Specifications For Road Bridges
Different types of bridges; I.R.C. specifications for road bridges; **Design Of R.C Slab Culvert:** Loads considered for design, Design of R.C. slab culvert.

Design of T – Beam Bridge
Pigeaud's method for computation of slab moments; courbon's method for computation of moments in girders; Design of simply supported T-beam Bridge.

Design of Sub Structure For Bridges
Pier and abutment caps; Materials for piers and abutments' Design of pier; Design of abutment; Backfill behind abutment; approach slab.

Design of Bearings For Bridges
Importance of bearings; bearings for slab bridge; bearings for girder bridges; Expansion bearings; Fixed bearings; Design of elastomeric pad bearing; **Foundations For Bridges:** Scour at abutments and piers; Grip length; Types of foundations; Design of well foundation.

Cable Supported Bridge
Different types of cable supported bridge, difference between suspension bridge and cable stayed bridge. Different components and factors considered for design of a) suspension bridge, b) cable stayed bridge.

Text Books:

1. Essentials of Bridge Engineering by Johnson Victor; Oxford & IBH publishing Co. Pvt. Ltd.2007
2. Cable supported bridges, concepts and design by N J Gimsing. John Willey and Sons, 2nd edition

Reference Books:

1. Design of Bridge Structures by T. R Jagadeesh, M.A Jayaram, Prentice Hall of India Pvt. Ltd. 2nd edition.

EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

Course Code :15 CE 5206 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Seismic-resistant building architecture
Introduction; Lateral load resisting systems- moment resisting frame, Building with shear wall or bearing wall system, building with dual system; Building configuration – Problems and solutions; Building characteristics – Mode shape and fundamental period, building frequency and ground period, damping, ductility, seismic weight, hyperstaticity/redundancy, non-structural elements, foundation soil/ liquefaction. Foundations; Quality of construction and materials – quality of concrete, construction joints, general detailing requirements

Design forces for buildings
Introduction; Equivalent static method; Mode superposition technique; Dynamic inelastic-time history analysis; Advantages and disadvantages of these methods; Determination of lateral forces as per IS 1893(Part 1) – Equivalent static method, Model analysis using response spectrum

Ductility considerations in earthquake resistant design of RCC buildings
Introduction; Impact of ductility; Requirements for ductility; Assessment of ductility– Member/element ductility, Structural ductility; Factor affecting ductility; Ductility factors; Ductility considerations as per IS13920

Earthquake resistant design of a long two-storey, two-bay RCC building
Determination of lateral forces on an intermediate plane frame using Equivalent static method and Model analysis using response spectrum; Analysis of the intermediate frame for various load combinations as per IS1893(Part 1); Identification of design forces and moments in the members; Design and detailing of typical flexural member ,typical column, footing and detailing of a exterior joint as per IS13920.

Base isolation of structures
Introduction; Considerations for seismic isolation; Basic elements of seismic isolation; seismic-isolation design principle; Feasibility of seismic isolation; Seismic-isolation configurations

Text Books:

1. Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikhande, Prentice-Hall of India, 2006.
2. Seismic design of reinforced concrete and masonry buildings by T. Paulay and M.J.N. Priestley, John Wiley & Sons, 1991.
3. The seismic design handbook, Edited by F. Naeim, Kluwer Academic publishers, 2001.

THEORY OF PLATES AND SHELLS

Course Code :15 CE 5208 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: Assumptions in the theory of thin plates – Pure bending of Plates – Relations between bending moments and curvature - Particular cases of pure bending of rectangular plates, Cylindrical bending - immovable simply supported edges – Synclastic bending and Anticlastic bending – Strain energy in pure bending of plates in Cartesian and polar co-ordinates – Limitations.

Laterally Loaded Circular Plates:- Differential equation of equilibrium – Uniformly loaded circular plates with simply supported and fixed boundary conditions – Annular plate with uniform moment and shear force along the boundaries.

Laterally Loaded Rectangular Plates: - Differential equation of plates – Boundary conditions – Navier solution for simply supported plates subjected to uniformly distributed load and point load – Levy's method of solution for plates having two opposite edges simply supported with various symmetrical boundary conditions along the other two edges loaded with u. d. l. – Simply supported plates with moments distributed along the edges - Approximate Methods.

Effect of transverse shear deformation - plates of variable thickness – Anisotropic plates-thick plates- orthotropic plates and grids - Large Deflection theory.

Deformation of Shells without Bending:- Definitions and notation, shells in the form of a surface of revolution, displacements, unsymmetrical loading, spherical shell supported at isolated points, membrane theory of cylindrical shells, the use of stress function in calculating membrane forces of shells.

General Theory of Cylindrical Shells:- A circular cylindrical shell loaded symmetrically with respect to its axis, symmetrical deformation, pressure vessels, cylindrical tanks, thermal stresses, in extensional deformation, general case of deformation, cylindrical shells with supported edges, approximate investigation of the bending of cylindrical shells, the use of a strain and stress function, stress analysis of cylindrical roof shells.

Text Books:

1. S.P Timoshenko and S.W Krieger, Theory of Plates and Shells, McGraw Hill, 1989.

Reference Books:

1. R. Szilard, Theory and Analysis of Plates – Classical Numerical Methods', Prentice Hall inc, 1974.
2. P.L Gould, Analysis of Shells and Plates, Springer-Verlag, New York, 1988.

INDUSTRIAL STRUCTURES

Course Code :15 CE 52C1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

PLANNING AND FUNCTIONAL REQUIREMENTS
Classification of Industries and Industrial structures - planning for Layout Requirements regarding Lighting, Ventilation and Fire Safety – Protection against noise and vibration - Guidelines of Factories Act.

INDUSTRIAL BUILDINGS
Roofs for Industrial Buildings - Steel and RCC - Gantry Girders - Design of Corbels and Nibs – Machine foundations.

POWER PLANT STRUCTURES
Types of power plants – Design of Turbo generator foundation – containment structures.

POWER TRANSMISSION STRUCTURES
Transmission Line Towers - Substation Structures - Tower Foundations - Testing Towers.

AUXILLIARY STRUCTURES
Chimneys and Cooling Towers – Bunkers and Silos – Pipe supporting structures.

Text Books:

1. Manohar S.N, “Tall Chimneys - Design and Construction”, Tata McGraw Hill, 1985
2. Santha kumar A.R. and Murthy S.S., “Transmission Line Structures”, Tata McGraw Hill, 1992.
3. Srinivasulu P and Vaidyanathan.C, “Handbook of Machine Foundations”, Tata McGraw Hill, 1976.
4. Jurgen Axel Adam, Katharria Hausmann, Frank Juttner, Klauss Daniel, “Industrial Buildings: A Design Manual”, Birkhauser Publishers, 2004.
5. Proceedings of Advanced course on “Industrial Structures”, Structural Engineering Research Centre, Chennai, 1982.

DESIGN OF TALL STRUCTURES

Course Code :15 CE 52C2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction : Why Tall Buildings, Factors affecting growth, Height and structural form
The Tall Building Structure: Design process, Philosophy, scope and content; **Design Criteria:** Design philosophy, Loading, Sequential loading, Strength and Stability, Stiffness and drift limitations, Human Comfort criteria, Creep, Shrinkage and temperature effects, Fire, Foundation settlement and soil structure interaction.
Loading On Tall Structures : Gravity loading:-Methods of live load reduction, Impact gravity loading, Construction loading, Wind loading:-Simple static loading, Dynamic loading, Earthquake loading:-Equivalent lateral force procedure, Model analysis procedure, Combination of loading:-Working stress design, Limit Sate design; **Structural Form:** Structural form:-Braced frame structures, Rigid Frame structures, In filled-Frame structures, Flat plate- Flat slab structures, Shear wall structures, Wall frame structures, Framed tube structures, Suspended structures, Floor systems :-(Reinforced concrete):-One-way slabs on beams or walls, One-way pan joints and Beams, One-way slab on beams and girders, Two-way Flat plate, Twoway flat slab, Waffle flat slabs, Two-way slab and beam, Floor systems :- (Steel framing):-Oneway beam system, Two-way beam system, Three way beam system, Composite Steel-Concrete floor system
Modeling For Analysis : Approaches to analysis:-Preliminary analyses, Intermediate and final analysis, Assumptions:- Materials, Participating components, Floor slabs, Negligible stiffnesses, Negligible deformations, Cracking, High-Rise Behavior, Modeling for Approximate analyses:- Approximate Representation Bents, Approximate modeling of slabs, Modeling for continuum analyses, Modeling for Accurate analyses:-Plane frames, Plane shear walls, Three dimensional frame and wall structures, P-Delta effects, The assembled model; **Braced Frames:** Types of bracings, Behavior of bracings, Behavior of bracing bents, Methods of analysis:-member force analysis, Drift analysis, Worked example for calculating drift by approximate methods, use large scale bracing.
Rigid-Frame Structures : Rigid frame behavior, Approximate determination of member forces caused by Gravity loading:- Girder forces-Code recommended values, two cycle moment distribution, and Column forces, Approximate Analysis of member forces caused by horizontal loading:-Allocation of loading between bents, member force analysis by portal frame method, Approximate method by cantilever method, Approximate analysis of rigid frames with setbacks, Approximate analysis for drift:- Components of drift, correction of excessive drift, Effective shear rigidity (GA), Flat plate structures:-Analogues rigid frame, Worked examples, Computer analysis of rigid frames, Reduction of rigid frames for analysis:-Lumped girder frame, single-bay substite frame; **Shear Wall Structures:** Behavior of shear wall structures, Analysis of proportionate wall systems:- Proportionate Non twisting structures, Proportionate twisting structures, Non Proportionate structures:-No proportionate Non twisting structures, Non proportionate twisting structures, Behavior of nonproportionate structures, Effects of discontinuities at base, Stress analysis of shear wall:- Membrane finite element analysis, Analogous frame analysis
Tubular Structures

Structural behavior of tabular structures:-Framed- tube structures, Bundled Tube structures, Braced-Tube structures, General three dimensional structural analysis, Simplified Analytical models for symmetrical Tubular structures:-Reduction of three dimensional frame tube to an equivalent plane frame, Bundled-Tube structures, Diagonally braced frame tube structures;
Dynamic Analysis: Dynamic Response to Wind Loading:-Sensivity of structures wind forces, Dynamic structural response due to wind forces, Along wind response, Cross wind response, worked examples, Dynamic response to Earthquake motions:-Response of Tall buildings to ground accelerations, response spectrum analysis, Empirical relations for fundamental natural frequency, Structural damping ratios, Comfort criteria: Human response to building motions:-Human perception of building motion, Perception thresholds, Use of comfort criteria in design

Text Books:

1. Tall Building Structures Analysis and Design by Bryan Stafford Smith & Alex Coull; A Wiley-Interscience Publications, Newyork,1991

Reference Books:

1. Tall Building Structures on Elastic Subgrade and Research of Semi-Analytical. Method [D] by Gong Yaoqing. Beijing: Tsinghua University, 2006
2. ETABS, Three Dimensional Analysis of Building Systems. Computers and Structures inc., Berkeley, California, 1989.

OPTIMIZATION OF STRUCTURES

Course Code :15 CE 52C3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Basics of engineering analysis and design, Need for optimal design, formulation of optimal design problems, basic difficulties associated with solution of optimal problems,
Classical optimization methods, necessary and sufficient optimality criteria for unconstrained and constrained problems, Kuhn-Tucker conditions, Global optimality and convex analysis,
Linear optimal problems, Simplex method, Introduction to Karmarkar's algorithm.
Numerical methods for nonlinear unconstrained and constrained problems, sensitivity analysis, Linear post optimal analysis, sensitivity analysis of discrete and distributed systems.
Introduction to variational methods of sensitivity analysis, shape sensitivity,
Introduction to integer programming, dynamic programming, stochastic programming and geometric programming,
Introduction to genetic algorithm and simulated annealing.

Text Books

1. S.S. Rao, Optimization, Theory and Applications, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1991.
2. Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and examples, Prentice Hall India Pvt. Ltd, 1998.

Reference Books:

1. J.S. Arora, Introduction to Optimum Design, McGraw-Hill Book Company, New York, 1989.
2. A.J. Morris (Editor), Foundations of Structural Optimization - A Unified Approach; John Wiley and Sons, Chichester, 1982.
3. R.T. Hafta and Z. Gurdal, Elements of Structural Optimization, 3rd Ed., Kluwer academic publishers, 1996.

ADVANCED DESIGN OF STRUCTURES

Course Code :15 CE 52D1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Analysis and design of portal frames, Design example for hinged and fixed frame.

Reinforced concrete deep beams:
Introduction to Deep Beams Parameters influencing design; IS code provisions; design of simply supported and continuous beam

Elevated water tanks: Introduction, Analysis & Design of INTZ Tanks including staging and continuous deep beams.

Earthquake resistant design: Concept of Earthquake resistant design, provisions of seismic code IS 1893 (Part-I), Response spectrum, Design spectrum, Design of buildings, Reinforcement detailing, Provisions of IS 13920

Introduction to plastic analysis: stress strain relationship of Mild steel, Elastic design versus Ultimate load design, Plastic bending of beams, Shape factor, Load factor, Plastic analysis, Procedure for plastic analysis, Design consideration

Text Book:

Advanced Reinforced Concrete Design, by N.Krishna Raju, CBS publishers, 2009.

Reference Books:

1. Advanced Reinforced Concrete Design by Varghese,Pentice Hall India, 1st edition 2004.
2. Advanced Reinforced Concrete Design (vol-II) by S. S. Bhavikatti, New age international, 2nd edition, 2009.
3. Design of steel structures by L.S Negi Tata Mc Graw Hill publishing company Limited, 2nd edition, 1997
4. Earthquake Resistant Design of structures by Pankaj Agarwal and Manish Shrikande PHI Learning Private Limited. 2006.

FRACTURE MECHANICS

Course Code :15 CE 52D2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction:- Significance of fracture mechanics, Griffith energy balance approach, Irwin's modification to the Griffith theory, Stress intensity approach, Crack tip plasticity, Fracture toughness, sub-critical crack growth, Influence of material behaviour, I, II & III modes, Mixed mode problems.
Linear Elastic Fracture Mechanics (LEFM):- Elastic stress field approach, Mode I elastic stress field equations, Expressions for stresses and strains in the crack tip region, Finite specimen width, Superposition of stress intensity factors (SIF), SIF solutions for well known problems such as centre cracked plate, single edge notched plate and embedded elliptical cracks.
Crack Tip Plasticity:- Irwin plastic zone size, Dugdale approach, Shape of plastic zone, State of stress in the crack tip region, Influence of stress state on fracture behaviour. Energy Balance approach:- Griffith energy balance approach, Relations for practical use, Determination of SIF from compliance, Slow stable crack growth and R-curve concept,
Description of crack resistance. LEFM Testing:- Plane strain and plane stress fracture toughness testing, Determination of R-curves, Effects of yield strength and specimen thickness on fracture toughness, Practical use of fracture toughness and R-curve data.
Elastic Plastic Fracture Mechanics (EPFM):- Development of EPFM, J-integral, Crack opening displacement (COD) approach, COD design curve, Relation between J and COD, Tearing modulus concept, Standard JIc test and COD test.
Fatigue Crack Growth:- Description of fatigue crack growth using stress intensity factor, Effects of stress ratio and crack tip plasticity – crack closure, Prediction of fatigue crack growth under constant amplitude and variable amplitude loading, Fatigue crack growth from notches – the short crack problem.
Practical Problems:- Through cracks emanating from holes, Corner cracks at holes, Cracks approaching holes, fracture toughness of weldments, Service failure analysis, applications in pressure vessels, pipelines and stiffened sheet structures.

Text Book:
1. Ewalds, H.L. & Wanhill, R.J.H., Fracture Mechanics – Edward Arnold Edition

Reference Books:

1. Broek, D. Elementary Engineering Fracture Mechanics, Sijthoff & Noordhoff Int. Pub., 1988.
2. Broek, D. The Practical Use of Fracture Mechanics, Kluwer Academic Pub., 1990.
3. Hellan, D. Introduction to Fracture Mechanics, McGraw Hill Book Company, 1985.
4. Kumar, P. Elements of Fracture Mechanics, Wheeler Publishing, 1998.
5. Simha, K.R.Y. Fracture Mechanics for Modern Engineering Design, University Press,1996.

GREEN BUILDINGS

Course Code :15 CE 52D3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:
Introduction
What is Green Building, Why to go for Green Building, Benefits of Green Buildings, Green Building Materials and Equipment in India, What are key Requisites for Constructing a Green Building, Important Sustainable features for Green Building,
Green Building Concepts and Practices
Indian Green Building Council, Green Building Moment in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation;
Green Building Opportunities And Benefits: Opportunities of Green Building, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy Saving Approach in Buildings, LEED India Rating System and Energy Efficiency,
Green Building Design
Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximise System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources. Ecofriendly captive power generation for factory, Building requirement,
Air Conditioning
Introduction,CII Godrej Green business centre,Design philosophy,Design interventions,Energy modeling, HVAC System design,Chiller selection,pump selection,Selection of cooling towers,Selection of air handing units,Precooling of fresh air,Interior lighting system,Key feature of the building. Eco-friendly captive power generation for factory,Building requirement.
Material Conservation
Handling of non process waste, waste reduction during construction,materials with recycled content,local materials,material reuse,certified wood ,Rapidly renewable building materials and furniture;
Indoor Environment Quality And Occupational Health: Air conditioning, Indore air quality, Sick building syndrome, Tobacco smoke control, Minimum fresh air requirements avoid use of asbestos in the building, improved fresh air ventilation, Measure of IAQ, Reasons for poor IAQ, Measures to achieve Acceptable IAQ levels,

Text Books:
1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.
2. Green Building Hand Book by Tomwoolley and Samkimings, 2009.

Reference Books:
1. Complete Guide to Green Buildings by Trish riley
2. Standard for the design for High Performance Green Buildings by Kent Peterson, 2009

M. TECH - GEOSPATIAL TECHNOLOGY

First Year (First Semester):

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 CE 5109	Fundamentals of Geospatial Technology	3	0	2	4
2	15 CE 5110	Geographical Information System	3	0	2	4
3	15 CE 5111	Advanced computer Programming and Statistics	3	2	0	4
4	15 CE 5112	Photogrammetry	3	2	0	4
5		Elective 1	3	0	0	3
6		Elective 2	3	0	0	3
7	15 IE 5148	Seminar	0	0	4	2
		Total Credits	24			

First Year (Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	**T**	**P**	
1	15 CE 5213	Digital Image Processing	3	0	2	4
2	15 CE 5214	GIS Data Analysis & Modelling	3	0	2	4
3	15 CE 5215	Geodesy and GPS	3	2	0	4
4	15 CE 5216	Geospatial Applications	3	2	0	4
5		Elective 3	3	0	0	3
6		Elective 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total Credits	24			

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	**T**	**P**	
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 CE 51E1	Principles of Earth & Environment Sciences	3	0	0	3
2	15 CE 51E2	Geoinformatics for Water Resource Management	3	0	0	3
3	15 CE 51E3	Data base Management system(DBMS)	3	0	0	3
4	15 CE 51E4	Topographical Surveying	3	0	0	3
Elective-2						
1	15 CE 51F1	Advanced Surveying and cartography	3	0	0	3
2	15 CE 51F2	Environmental Geoinformatics	3	0	0	3
3	15 CE 51F3	Structural Analysis using Geomatics	3	0	0	3
4	15 CE 51F4	Geospatial Technology for Transport Engineering	3	0	0	3
Elective-3						
1	15 CE52G1	Statistics and Adjustment Computations	3	0	0	3
2	15 CE52G2	Cadastral survey' and information system	3	0	0	3
3	15 CE52G3	Engineering Survey Methodology and Instrumentation	3	0	0	3
4	15 CE52G4	Geospatial Technology for Natural Resources &Disaster Management	3	0	0	3
Elective-4						
1	15 CE 52H1	Coordinate systems and Map Projections	3	0	0	3
2	15 CE 52H2	Principles of Geomatics	3	0	0	3
3	15 CE 52H3	Geospatial Technology for Rural Development	3	0	0	3
4	15 CE 52H4	Urban Water Management using Geomatics	3	0	0	3

FUNDAMENTALS OF GEOSPATIAL TECHNOLOGY

Course Code :15 CE 5109 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

INTRODUCTION : Definition, History of Remote Sensing. Basic components of Remote sensing, Electromagnetic Remote sensing process, Passive and active remote sensing. Electromagnetic Spectrum, Energy source and its characteristics, Nature of EMR, Blackbody radiation priciples, radiation quantities and terminology
PHYSICS OF REMOTE SENSING : .EMR Interaction With Earth Surface Materials -Spectral signature concepts – Spectral reflectance & emittance – Typical spectral reflective characteristics of water – vegetation, soil, minerals/rock, man-made structuresAtmospheric properties, solar radiant energy characteristics with atmosphere Atmospheric Scattering, Particulate scattering & absorption, Rayleigh's & Mie's theories. Sunlight & skylight & its spectral composition, Atmospheric Windows.
REMOTE SENSING PLATFORMS AND SENSORS : Introduction; Satellite system parameters; instrumental and viewing parameters, sensor parameters: Spatial, Spectral and Radiometric resolutions, Imaging sensor systems: Multi spectral imaging sensor systems, Thermal sensing systems, microwave image systems. Earth resources satellites: Landsat, SPOT, IRS, AEM and other recent satellites. Meteorological satellites: NOAA, GOES, NIMBUS, Meteosat series, Oceansat, IKONOS satellites.
Visual Image Interpretation: Introduction; Types of pictorial data products; Image interpretation strategy, Levels of interpretation keys; Process of image interpretation; Basic elements of image interpretation. Overview on visual image interpretation equipment.Key elements of visual image interpretation, Topography, Drainage Pattern and Texture, Erosion, Image tone, Vegetation and land use; Concept of converging evidence. Temporal aspects of image interpretation.
Image Analysis: Visual image analysis for land use / land cover mapping, geological and soil mapping, Agriculture applications for forestry applications, water resources applications, Urban and regional planning, Environmental assessment. Principles of land form identification and evaluation : Sedimentary, Igneous and Metamorphic rock terrain.

Text books:

1. Lillesand, T.M. and Kiefer R.W. Remote Sensing and Image Interpretation, John Wiley and Sons, Inc, New York, 1987.
2. Remote Sensing by JAMES B. CAMPBELL Published by Taylor & Francis Ltd.
3. M.Anji Reddy , Text book of Remote sensing and GIS by, BSP Publications, Hyderabad, 2001.

GEOGRAPHICAL INFORMATION SYSTEM

Course Code :15 CE 5110 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

INTRODUCTON : Introduction, Definitions of GIS and related terminology, The Evaluation of GIS, Components of GIS, Geospatial data, Spatial data infrastructure,Introduction, Map as a model, Spatial elements and terminology, Classification of maps, Map scale, Spatial referencing system, Computers in map production, Trends in computer construction, General software's in map production.
FUNDAMENTALS OF GIS : A brief history of GIS, GIS architecture, Components of a GIS, GIS workflow, Theoretical models of GIS: Functional elements, Fundamental operations, Theoretical framework, GIS categories, Levels of measurement.Introduction; Stages of GIS data modeling; Graphic representation of Spatial Data, Raster data representation, Vector data representation, Spatial data models; Raster GIS models: Types of raster GIS models, Compact raster data models; Vector GIS models, Spaghetti model, Topological model, Shape file, Compact vector data models; Comparison of Raster and Vector Models.
GIS DATA MANAGEMENT : Introduction, Database management systems: Functions of DBMS, Components of DBMS; GIS data file management: Simple list, Ordered sequential files, Indexed files, Building GIS worlds; Database models: Hierarchical database models, Network systems, Relational database models, Standard query language (SQL), Storage of GIS data, The hybrid data model, The integrated data model; Object based data models: Entity-Relationship-Attribute model, Organizational strategy of DBMS in GIS.
DATA INPUT, DATA EDITING AND DATA QUALITY : Introduction, The data stream, Data input methods: Keyboard entry, Manual digitizing, Scanning and automatic digitizing; GPS for GIS data captureData editing, Detecting and correcting errors, Data reduction and generalization, Edge matching and Rubbersheeting
DATA QUALITY : Components of data quality. Accuracy, Precision and resolution, Consistency, Completeness, Sources of error in GIS; Modeling errors, Point data error models, Line and area data error models, Models for dot and pixel counting; Error evaluation by graphical methods. GIS APPLICATIONS:Remote sensing and GIS Linkage, GIS software, Topography as an environmental factor, locational factor, topographic elements, topographic structures and topographic connections. Case studies

Books:

1. Manual of Geospatial Science and Technology Edited By John. D. Bossler, Taylor And Francis, London
2. Text book of Remote sensing and GIS by M. Anji Reddy, BSP Publications, Hyderabad.
3. Geographical Information Sysytems by Demmeers

ADVANCED COMPUTER PROGRAMMING AND STASTICS

Course Code :15 CE 5111 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Computer basics :Problem solving using computers- flowcharts-algorithms-CPU-Input and output units-.computer memory- Basic concepts of Object oriented Languages, Basic structure of C++ programming- tokes-keywords-data types: basic data types-derived data types-user defined data types- constants-variables-arrays-one, two and multi dimensional arrays-structure-union-enumerated data types.
Arithmetic operators- relational operators-increment and decrement operators-bit wise operators-arithmetic expression-precedence of operators-Evaluation of expression- type compatibility-expression and implicit conversion-manipulators-control structures: decision making and branching-decision making and looping-Function declaration and definition- argument passing-return values. Class and objects-member functions- array of objects-object as a argument-function overloading- friend function-operator overloading-this pointer-static data member-static member function
Constructors: default constructor-parameterized-copy constructor-dynamic constructor-destructors-Inheritance-single inheritance-multiple inheritance-multilevel inheritance-pointers virtual functions and polymorphismIntroduction to statistics :population-sample –primary data and secondary data - graphical and diagrammatic representation of data- Measure of central tendency-Mean, median and mode-measure of dispersion-range-standard deviation -raw and central moments-skewness and kurtosis(definition only)-Concept of probability –classical and relative frequency definition of probability-addition and multiplication laws of probability(without proofs) and examples.
Concept of Random variables: Probability mass function-probability density function-probability distribution function(definitions only)- Binomial ,Poisson and Normal distribution(definitions and statements of properties and examples).Principles of least square-fitting of straight line-parsons coefficient of correlation and concept of linear regression.

Concept of testing of hypothesis critical region-two type errors-level of significance of large sample tests for single mean and difference of means. single proposition and difference proportion- chi square test for goodness of fit and chi square test of means and f-test for equality of variances-arithmetic, Geometric and harmonic mean.

Text book :

1) Fundamentals of Computers by V Raja Raman

2) Object Oriented Programming with C++ by E. Balagurusawmy

3) Statistical methods S.P.Gupta. S Chand Pubplications

PHOTOGRAMMETRY

Course Code :15 CE 5112 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

INTRODUCTION : Definition of photogrammetry, History of photogrammetry, Types of photographs, Organisation of Aerial photography, Geometry of vertical photograph, Scale of vertical aerial photograph, Displacement of image position due to height, Displacement of image position due to tilt. Introduction, Types of aerial cameras, Classification single lens frame camera, Components of frame aerial camera, Fudicial marks, Principle point, Camera mounts, Camera controls, Automatic data recording, Camera calibration, Elements of interior orientation.
STEREO PHOTOGRAMMETRY : Depth perception, Monoscopic depth perception, stereoscopic depth perception, Experiment for stereoscopic viewing, Stereoscopic viewing of overlapping aerial photographs, Stereoscope, pocket stereoscope, Mirror stereoscope, Procedure for use of stereoscopes, Steps for viewing stereo pair of aerial photographs, Y parallax, Vertical exaggeration in stereo viewing.Definition of parallax, stereoscopic parallax, Methods of parallax measurement (monoscopic), Principle of floating mark, Stereoscopic methods of parallax measurement, parallax equations, Elevation by parallax differences, Approximate equation for elevation, Measurement of parallax differences, Parallax corrections, Parallax correction graph, Computation of flight height and air base, Error evaluation.
FLIGHT PLANNING : Need for flight planning, Items for flight planning, Purpose of photography, Photo scale, Flying height, End lap and side lap, Base-height (B-H) ratio, Neat model, Flight map, Flight planning template.
CONTROL FOR AERIAL PHOTOGRAPHY : Definition, Classification (Horizontal,Vertical), Nature and characteristics of control points, Location and numbering, Bridging of strip, Bridging of blocks, Ground control provision, Post-pointing and pre-pointing.
ORIENTATION PROCEDURES FOR STEREOPLOTTING INSTRUMENTS :Introduction, Basic concept, Interior orientation, Relative orientation, Absolute orientation.
AERIAL TRIANGULATION : Introduction, Purpose of aerial triangulation, Principle of Aerial Triangulation, Classification of Aerial triangulation based on methods, Preparation for aerial triangulation, Independent Model Triangulation (IMT), Aerial Triangulation (Analytical method), Blocks of photos, Bundles adjustment.

Text Books:

1. Paul,R.Wolf Elements of Phogrammetry,McGrew-Hill,International BookCompany,Japan, 1993.
2. Geoinformatics for Environmental Management by M. Anji Reddy, BS Publications
3. Remote sensing and image interpretation by Lillesand and Kiefer, John wiley and sons.
4. Elements of Photogrammetry by K.K.Rampal.

PRINCIPLES OF EARTH & ENVIRONMENT SCIENCES

Course Code :15 CE 51E1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Fundamentals of Earth Sciences: Introduction, Origin of the Earth; Age of the Earth; Internal constitution of the Earth; surface-features of the globe; Concepts of petrology - Igneous, sedimentary and metamorphic rocks.**Groundwater Hydrology:** Geologic formations as aquifers, Types of aquifers, Ground water basins, ground water quality aspects, concepts of basin management, Floods –Estimation and control, Reservoir, Surface investigation of ground water.
Fundamentals of Geomorphology: Definition of Geomorphology, geomorphological agents, weathering, Soil process, fluvial, eolian, coastal and other land forms, Stream deposition. **Hydro Chemistry :** Physical , Chemical and Microbial nature of Water. Water Pollution- Surface and Ground water pollution- Point and Non-point sources.
Ecosystems: Structure and function, Abiotic and Biotic components. Biochemical aspects of toxic chemicals in the environment-Air, Water: Pesticides in water. **Scope of ecology in environmental management:** Physical, chemical and environmental factors and their relation to organisms. Climatic factors: Interaction of ecological factors - light – temperature. Precipitation-Humidity-Wind.

Edaphic Factors (Soil Science): Composition of soil-formation of soil-Factors affecting soil formation-soil profile- Soil classification – Soil Complex – components and properties-soil erosion – soil conservation.

Structure and Function of Ecosystem: Energy flow - Food chains - producers-herbivores – carnivores – decomposers – food webs – Ecological pyramids. Major Ecosystems: Pond, Marine, Grassland, Forest, Desert and Cropland ecosystems – Productivity of different ecosystems.

Text Books:

1. A textbook of Geology, P.K. Mukerjee, 12th Edition, 1995.
2. Textbook of Engineering and general geology by Parbin Singh 7th Edition 2004
3. Ground water hydrology, Danid Keithtodd, 2nd Edition, 1995.
4. Hydrology, HM Raghunath, 1986.
5. Principles of Geomorphology, William D Thonbury, 2nd Edition 2002.
6. Ecology & Environment, P.D.Sharma, Ashish Publications, 1994.
7. Introduction to Ecology, Paul Colinvaux, 1973. Wiley International Edition.
8. Fundamentals of Ecology, E.P. Odum, 1971. W.B. Saunders & Co.

GEOINFORMATICS FOR WATER RESOURCES MANAGEMENT

Course Code :15 CE 51E2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Fundamentals: Internal Constitution of the Earth. Basic Concepts of Geologic Structures Governing Occurrence and Movement of Ground Water, Ground Water in Igneous, Metamorphic and Sedimentary Rocks, Hydrogeological Methods of Exploration**Watershed Management:** Objectives of Planning Watershed Projects, Guidelines for Project Preparation, Watershed Delineation, Codification, Resources Surveys, Hydrological, Soil, Vegetative and Land Use Surveys, Socio-Economic Surveys, Water and Soil Conservation Works, People's Participation and Constraints, Participatory Rural Appraisal in Watershed Programme, Community Mobilization & Participatory Management, Peoples Institutions, Capacity Building.
Rain Water-Harvesting Methods: Methods of Rainwater Harvesting from Roof Tops, Purification Techniques for Direct use, Harvesting of Surface Runoff, Climatic Changes, Its Effects on Water Resourc
Wetlands:Introduction, Definition, Classification, Delineation, Identification Methods, Importance Of Wetlands, Human Impacts, Wetland Protection, Mitigation. Wetland Management: Designed Ecosystem, Water and Treated Wastewater Recycling and Reuse, Soil Filters, Constructed Wetlands.es & Water Supplies.
Introduction, concept of watershed, need for watershed management, concept of sustainable development ,Hydrology of small watersheds ,Principles of soil erosion, causes of soil erosion, types of soil erosion, estimation of soil erosion from small watersheds Control of soil erosion, methods of soil conservation – structural and non-structural measures.
Principles of water harvesting, methods of rainwater harvesting, design of rainwater harvesting structures ,Artificial recharge of groundwater in small watersheds, methods of artificial recharge ,Reclamation of saline soils ,Micro farming, biomass management on the farm

TEXT BOOKS:
1.Hydrogeology by Davis and Dewiest
2.Soil and Water Conservation Engineering by Schwarb, Fengmin, John Wiley, 2002.
3.Applied Hydrology by Ven Te Chow, Maidenment & Mays, Mc Graw Hill, 1987.
4.Water Resources Engineering by L.W.Mays, Wiley, 2004.

REFERENCE BOOKS:
1. Watershed Management for Indian conditions by E.M. Tademan, Omega Scientific Publishers, 2002.
2. Watershed Hydrology by Peter.S.Black, Prentice Hall, 1991.
3. Manual on Water Supply and Treatment, 3rd Edition- Revised & Updated, May, 1999 Published by CPHEEO, Ministry of Urban Development, GOI, New Delhi.
4. Analysis of flow in water distribution Networks by P.R. Bhave, Technomic Publishing Co., USA, 1991.
5. Geiger, W.F., Marsalek, J. Zudima and Rawls, G. J. (1987 "Manual on Drainage in Urban Areas", 2 Volumes, UNESCO, Paris.

6. Storm water Management by Wanelista and Edelin, Wiley publications, 1993.

DATA BASE MANAGEMENT SYSTEMS

Course Code :15 CE 51E3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

INTRODUCTION : Databases and Application development, Components, Advantages of the DBMS, System approach, Leading commercial databases, Brief history of DBMS, Application development
DATABASE DESIGN : Designing Databases, Class diagrams, Data types (Domains), Events, Large projects, Application design. DATA NORMALIZATION:Tables, Classes and Keys, Sample database, Normal Forms, Data Rules and Integrity, Converting a class diagram to normalized Tables, View Integration, Data Dictionary
DATA QUERIES : Three Tasks of a Query Language, Query basics, Computations, Subtotals and GROUP BY, Multiple tables ADVANCED QUERIES AND SUBQUERIES:NOT IN, OUTER JOINTS, SQL SELECT, SQL Data Definition Commands, SQL Data Manipulation Commands, Quality: Testing Queries
FORMS, REPORTS AND APPLICATIONS : Effective Design of Reports and Forms, Form Layout, Creating Forms, Direct manipulation of Graphicalobjects,Reports,ApplicationFeatures**DATABASEINTEGRITYANDTRANSACTIONS:**Procedural languages, Data triggers, Transactions, Multiple users and concurrent Access ACID Transactions, Key generation, Database cursors.
DATA BASE ADMINISTRATION : Introduction, Data administrator, Data Base administrator, Data Base Structure, Meta data, Backup and recovery, Security

BOOKS:

1. Data Base Management Systems by Gerald V.Post, Tata Mcgraw-hill edition
2. Data Base Management Systems by Ramakrishnan and Gehrke Tata Mcgraw-hill.
3. DataBase Systems Concepts by Silberschatz , Tata Mcgraw-hill edition.

TOPOGRAPHICAL SURVEYING

Course Code :15 CE 51E4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Fundamentals of Surveying: Historical development of surveying, principles of surveying, types of surveying, classification of surveys & maps, Plan Vs Map, Accuracy Vs Precision, sources and kinds of error; Principle, use and adjustment of surveying instruments – Chain, Compass, Plane table, Level & Tacheometer; **Chains**- types, errors in chaining, chain triangulation, basic problems in chain surveying; **Compass**- types, designation of bearings, **Plane table**- instruments used for plane table survey, working with plane table, methods of plane tabling; **Leveling** – definition, leveling instruments, methods of leveling;
Tacheometric surveying – principle, methods to determine horizontal distance, uses of tachymetric surveying; azimuth, bearing, relationship between bearings & azimuths.
Advanced Surveying: Electronic Distance Measurement (EDM) – principle, instrument characteristics, accessories, operation, EDM without reflecting prisms; **Total Station –** types, instrument description, field techniques, motorized total stations; field procedures for total stations in topographic surveys.
Topographical Surveying: Definition, uses of topographical maps, relief, methods of representing relief, contour and contour interval, characteristics of a contour, procedure in topographic surveying, Methods of locating contours, Interpolation of contours, DAM Surveys
Project Planning: Definition & Terms, Systems of Co-ordinates, constitution of a survey party, duties of an Officer-in-charge, Duties of camp Officers; planning, execution and completion of a topographical survey, Quality Vs Quantity; Case studies.

TEXT BOOKS:

1. Text Book of Plane Surveying By David Clark Part I and Part II
2. Text Book of Surveying By Punmia Part I and Part II

REFERENCES:

1. Surveying and Leveling – Agor
2. Principles of Cartography – K.S.Singh
3. Estimation & Costing – N.D.Chakraborti

ADVANCED SURVEYING AND CARTOGRAPHY

Course Code :15 CE 51F1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Topographical Surveying: Introduction to topographical mapping, scale of topographical maps, Indian topographical series and their numbering system, topographical survey methods. Precise level and Precise levelling
Electronic Surveying: Basic principles, classifications, applications, comparison with conventional surveying. electromagnetic wave theory - electromagnetic distance measuring system - principle of working and EDM instruments, application of Lasers in distance measurement .
Geodesy and Astronomy: Introduction to Geodesy, Earth and its size and shape, coordinate systems, earth and its motions-annual, spin, precession, nutation, polar motion. Earth and its gravity field – anamoly, gravity potential, geoid and deflection to vertical. Celestial sphere, meridians and vertical circles, astronomical coordinate systems, astronomical triangle, determination of azimuth
Cartography: Definition, scope and content the spheroid, map scale, co-ordinate system, methods of mapping, relief maps, thematic maps, map projections, classification, principles of construction of common projections, cylindrical, conical, azimutal, and globular projections, properties and uses and choice of projections, plane co-ordinates, UTM system, projection used in Survey of India topographical sheets, map reproduction.
Global Positioning System: Components of GPS – space segment, control segment and user segment, reference systems, satellite orbits, GPS observations. Applications of GPS: Surveying and mapping, remote sensing, GIS.

Textbooks :

1.Gopi, “Advanced surveying: Total station, GIS and Remote Sensing”, Pearson Education India, 2007.

2. Hoffman.B, H.Lichtenegga and J.Collins, "Global Positioning System - Theory and Practice", Springer - Verlag Publishers, 2001.

3. Borden D. Dent, Jeffrey Troguson, Thomas W. Hodler, “Cartography: Thematic map Design”, McGraw-Hill Higher Education, 2008.

4. Wolfgang Torge, “Geodesy”, Berlin: de Gruyter, 2001.

ENVIRONMENTAL GEOINFORMATICS

Course Code :15 CE 51F2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Forest Resources Management
Geomatics in forestry, forest cover mapping and change detection, forest inventory and stock mapping, dynamics of forest ecosystem and forest canopy, forest damage assessment, parameters of forest inventory, development of working plan, forest management information system (FMIS), forest fire forecasting and risk area mapping, biodiversity characterization, wildlife habitat mapping.
Watershed Management
Introduction and concepts of watershed, role of remote sensing and GIS database for watershed management, objectives of watershed management, Watershed characteristics, research approach, thematic mapping for a model watershed, watershed management for sustainable development.
Water Quality Mapping and Modeling
Geoinformatics for water resources development and management, ground water exploration and targeting using RS and GIS, water quality management case studies – groundwater and surface water quality mapping and salt water intrusion modeling.
Solid Waste Management
Introduction, types and classification of solid waste, impacts of solid waste, physical and chemical characteristics of solid waste, factors affecting solid waste generation rates, collection and transportation systems, solid waste sampling techniques, types, merits and demerits of solid waste disposal methods, hierarchy of solid waste management, disposal site identification.
Natural Disaster Management
Introduction, types of landslides, common features of landslides, causes of landslides and related phenomena, landslide analysis, remote sensing for landslide mapping, hazard mapping of landslides. **Urban Planning and Management**:Introduction, geoinformatics in urban planning, issues in urban planning, urban growth management, urban sprawl assessment, urban land use and infrastructure, urban transport network identification and mapping, urban city guide map change detection and updation, pipeline alignment studies, Land evaluation and suitability studies, Land use/Land cover mapping and planning.

Textbooks:

1. Geoinformatics for Environmental Management by Anji Reddy, M.
2. Introduction to Environmental Remote Sensing by Barrett, E.C.
3. Remote Sensing and Tropical Land Management by Eden, M.J., Parry I.T.
4. Remote Sensing and Image Interpretation by Lillesand and Kiefer.
5. Remote Sensing in Hydrology by Engman
6. Advances in Environmental Remote Sensing by F. Mark Danson.
7. Remote Sensing in Geology by Siegal.
8. Remote Sensing in Soil Science by Mulders M.A.

9. Principles odd GIS for Land Resources Assessment by Burrough P.A.

STRUCTURAL ANALYSIS USING GEOMATICS

Course Code :15 CE 51F3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Remote sensing: Electromagnetic spectrum, electromagnetic radiation-atmospheric interaction, interaction with matter, resolutions, platforms, IRS, LANDSAT, etc. Geographical information system: Components and structure, databases and structures, data types, data models, spatial data analysis techniques.
Structural Analysis: Attitude of beds, Structural mapping- lineaments, folds, faults, joints and unconformities, Structural analysis using aerial and satellite data.
Lithology: Igneous, sedimentary and metamorphic rocks, Lithological mapping using aerial photos and satellite imagery.Elements of interpretation - Digital analysis for litho logical discrimination.
Geomorphology: Geomorphological mapping using aerial photos and satellite imagery, Landforms like denudational, structural - fluvial, marine, aeolian, glacial and volcanic landforms. Flood and drought studies – flood frequency analysis, flood plane zoning, estimation of flood for different frequencies, flood forecasting, drought assessment and monitoring.
Exploration Techniques: Mineral Resources, Groundwater, Engineering Geology, Hydrogeomorphological mapping, Landslide studies.

Text books:

1. Ravi P. Gupta - Remote Sensing Geology - Springer Verlag Publications, 2005.

2. Floyd F. Sabins: Remote sensing: Principles and Interpretation, W.H. Freeman and Company, 2007.

3. Verstappean H.T, Remote Sensing in Geomorphology,Elsevier Scientific Publications,1977.

4. Druary, S.A - Image Interpretation in Geology - Allen and Unwin Ltd,2004.

5. Lintz J and Simonett David.S, - Remote Sensing of Environment - Addission Wesley Reading,1976.

GEOSPATIAL TECHNOLOGY FOR TRANSPORT ENGINEERING

Course Code :15 CE 51F4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

GIS – T Data Models: Data Domains and Data Modelling in GIS – T; Data Modelling Techniques; Data Modeling and Design Issues; Graph Theory and Network Analysis; Network representation of a Transportation System; Linear referencing methods and systems; Transportation Data Models for ITS and related Applications.
Transportation Data Sources And Integration: Basic Mapping Concepts; Transportation Data Capture and Data Products; Transportation Data Integration; Spatial Data Quality; Spatial and Network aggregation.
Shortest Paths And Routing: Fundamental Network Properties; Fundamental Properties of Algorithms; Shortest Path Algorithms; Routing Vehicles with in Networks.
Network Flows And Facility Location: Flow through Uncongested Networks; Flow through Congested Network; Facility location within Networks; Spatial Aggregation in Network Routing and location problems.
GIS based Spatial Ananlysis and Modeling: GIS and spatial Analysis; Urban sprawl; GIS Analytical functions; Coupling Transportation Analysis and Modelling with GIS; Customising GIS; Supporting Advanced Transportation Analysis in GIS.
Transportation Planning:: Transportation Analysis Zone Design; Travel demand Analysis; Landuse – Transportation Modelling; Route Planning; Decision supportIntelligent Transportation Systems: ITS Applications; ITS Architectures and Geographic Information; Integrating GIS and ITS. Transportation, Environment and Hazards: Mapping sensitive Environmental features; GIS and Transportation related Air Quality; Accidents and Safety Analysis; Transportation of hazardous Materials.

Text books:

1. Miller HJ and Shaw SL, Geographic Information Systems for Transportation: Principles and Applications, Oxford University Press,2001.

2. Implementation of GIS in State DOTs, NCHRP Report No:180.

3. Simlowitz HJ. GIS Support Transportation System Planning. International GIS Sources Book.

4. Scholton HJ and Stillwell JCH, Geographical Information Systems for Urban and Regional Planning, Kluwer Acedemic Publishers,2010.

5. Hill JC, GIS in Transportation, Transportation Research Part C & 2000.

DIGITAL IMAGE PROCESSING

Course Code :15 CE 5213 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

DIGITAL COMPUTERS AND IMAGE PROCESSING : Introduction: Information Systems – Encoding and decoding, modulation Satellite data – acquisition, storage and retrieval – generation of data products digital data formats. Computer basics: Hardware and Software, Networks, Image Display Subsystem, Color Display System, Hard copy System , Data Format for Digital Satellite Imagery, Image file Format and Data Compression
PRE PROCESSING OF REMOTE SENSING DATA : Introduction, Cosmetic Operations- Missing Scan Lines, De –stripping Methods, Geometric Corrections and Registration. Coordinate Transformations, Atmospheric Correction Methods, Illuminations and View Angle Effects, Sensor Calibration and Terrain Effects and radiometric correction methods
IMAGE ENHANCEMENT TECHNIQUES : Introduction, Human Visual Systems, Contrast Enhancement- Linear Contrast Stretch, Histogram Equalization, Guassian Stretch, Pseudo Color Enhancement- Density Slicing, Pseudo Color Transform.IMAGE TRANSFORMS:Introduction, Arithmetic Operations- Image Addition, Subtraction, Multiplication and Division. Empirically Based Image Transforms- Perpendicular Vegetation Index, Tasselled Cap Transformations, NDVI. Principal Component Analysis
IMAGE FILTERING TECHNIQUES : Introduction, Low Pass Filters- Moving Average Filters, Median Filters, Adaptive Filters, High Pass Filters- Image Subtraction Method, Derivative Based Method, Frequency Domain Filters, Filtering for Edge Enhancement
IMAGE CLASSIFICATION : Introduction**,** Geometrical Basis of Classification, Unsupervised classification, Supervised Classification Training Samples, Statistical Parameters and Classifiers IMAGECLASSIFICATION ACCURACY ASSESSMENT:Image classification accuracy assessment, Performance analysis, Various Band Data for Land use, Land Cover Classification System with Case Studies. Image Classification and GIS, Integration and Linkage. Software: ERDAS, Geomatica, ENVI and e-Cognition
Image Processing Lab
Geo-coding of Images/Toposheets,Geo-referencing of Images,Subset & Mosaic of images/Toposheets,Data fusion (Data merging),Image Enhancement, Point operators, Spatial domain operators,Edge detection,Supervised classification of data,Unsupervised classification of dataGIS – Creating of layered thematic information and GIS Analysis,TIN – 3D viewingBasic understanding of the TNT MIPS, ERDAS, GEOMEDIA, ENVI Software packages.

Textbooks:

1. John, R. Jensen, Introductory Digital Image Processing – Prentice Hall, New Jersey, 1986.
2. Robert, A. Schowengergt. Techniques for image processing and classification in Remote Sensing, 1983.
3. Hord, R.M. Digital Image Processing, Academic Press Pub. 1982.
4. Paul. M. Mather- Computer Processing of RS Images, Wiley

GIS DATA ANALYSIS & MODELLING

Course Code :15 CE 5214 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Fundamentals of GIS: Map – scale, projection and symbolism. GIS - Introduction, definition and terminology, categories, components, fundamental operations, functional elements. Data structures, data models, GIS data, acquisition, input, storage, output generation. Data preprocessing, database management, integrated analysis of spatial and attribute data.
GIS Spatial Analysis: Introduction, Defining spatial objects - point, line and area objects based on their attributes, higher level point, line and area objects. **Measurement:** Measuring length of linear objects, measuring polygons, measuring shape, measuring distance. Classification – Principles, Neighborhood functions, Polygonal neighborhoods, Buffers.
Statistical Surfaces: Surface mapping, sampling the statistical surface, Digital Elevation Model (DEM). Interpolation- linear and non-linear, uses and problems. Terrain reclassification – steepness of slope, aspect, shape or form. Discrete surfaces - dot distribution maps, choropleth maps.
Spatial Arrangement: Spatial Arrangement - Point patterns, Theissen Polygons, Area patterns, Linear patterns, Directionality of Linear and Areal objects, Connectivity of Linear objects, Routing and allocation.
Overlay Analysis: Cartographic overlay, point-in-polygon and line-in-polygon operations, Polygon overlay, Automating point-in-polygon and line-in-polygon procedures in Raster, Automating Polygon overlay in Raster, Automating vector overlay, types of overlay.
Data Modelling: The state of GIS for Environmental Problem Solving, A Perspective on the State of Environmental Simulation Modeling, GIS and Environmental Modeling, The Role of Software Venders in Integrating GIS and Environmental Modeling, Cartographic Modeling, Scope of GIS and relationship to environmental modeling, data models and data quality.
Integrated Modelling using GIS: Hydrological Modeling - water quality modeling, watershed management and modeling, saltwater intrusion models. Land-surface-subsurface Process Modeling - pipeline alignment studies, solid and hazardous waste disposal site selection, zoning atlas for industrial siting, environmental information system development. Ecosystem modeling, risk and hazard modelling.
GIS data analysis and Modelling Lab:
Spatial data analysis using ArcView,Map Composition and Out put Generation using Arc View GIS software ,Alignment survey by handheld GPS,Processing of GPS survey data with GIS software,
Plot by Total Station Survey in field,Data conversion from AutoCAD into ArcGIS.,Open source GIS.,Integration of Spatial and Non Spatial Data ,Datum and Projection,Layout Preparation in Arc View

Text Books:

1. Fundamentals of GIS by MICHAEL N DEMERS. Published By john Wiley & Sons Inc.

2. Environmental Modelling with GIS, Michael F. Goodchild, Bradley O. Parks, Louis T. Steyaert

GEODESY AND GPS

Course Code :15 CE 5215 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

INTRODUCTION
Definition of Geodesy, Classification of Geodesy, Geometric Geodesy, - Physical Geodesy, Physical surface of earth, The Geoid, The Ellipsoid.ELLIPSOID OF REVOLUTION**:**Mathematical properties, The Ellipse, Basic properties of ellipse, Flattening, Eccentricity, Relationship between eccentricity and flattening, Principal parameters of ellipsoid, Parameters of commonly used ellipsoid, Use of ellipsoid as regional datum. Co ordinate system of rotational ellipsoid- Ellipsoid geographic co-ordinates, Spatial ellipsoidal coordinate system.
COMPUTATION OR THE ELLIPSOID
Need for mathematical surface, Reduction of baseline to mathematical surface, Reduction of baseline to reference ellipsoid, Effect or height of a point observed on the azimuth of a line, Convergence of meridians, Forward and backward Azimuths, Plane curves and geodesic line, Calculation of coordinates.
GRAVITY
Expressions for gravity and potential, Geoid undulations and deflections of vertical, Measurement of gravity on earth, Reduction of gravity values. **SATELLITE GEODESY:** Introduction, Artificial satellite, Satellite orbit, Celestial coordinate system, Geodetic position from known orbit, Coordinate transformation in equatorial plane, Range observation from three satellite positions.
MAP PROJECTION
Geometry of map projections, Evolution of map projection, Development of projection surfaces, Characteristics of map projections, Equidistant projections with one standard parallel, Equidistant projections with two standard parallel, Equal area projections with straight meridians, Projections with all parallels standard, Conformal projections with straight meridians.
GLOBAL POSITIONING SYSTEM (GPS)
Introduction, Background, The space segment, The control segment, The user segment, The performance of GPS, Factors influencing GPS accuracy, GPS positioning. GPS signal characteristics, signal structure, signal coverage, signal propagation, Differencing of GPS data, single differenced data. **GPS MATHEMATICAL MODEL AND GPS APPLICATION**:GPS mathematical model, Pseudo range mathematical model, Preparation for data processing, Baseline data computation coordinate change and satellite positions GPS receivers, Fundamentals of GPS application for various results. Making sense of GPS Techniques, GPS project planning, Possible applications like high resolution contour data.

Books:
1. Manual of Geospatial Science & Technology edited by John D. Bossler (Taylor & Francis)

2. Essentials of GPS by NK Agarwal, Spatial Network Pvt Ltd,Hyderabad.

GEOSPATIAL APPLICATIONS

Course Code :15 CE 5216 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

UNIT-I: Interpretation: Fundamentals of interpretation, Land use/Land cover mapping, Geological and soil mapping, agriculture, water resources, Rangeland and Wildlife Ecology applications, Interpretation for terrain evaluation – Soil characteristics, Land use suitability.**Plant Sciences:** Introduction, Manual interpretation, Structure of the Leaf, Spectral Behavior of the Living Leaf, vegetation Indices, Applications of Vegetation Indices, Phenology, Advanced very High Resolution Radiometer (AVHRR), Separating Soil Reflectance from Vegetation Reflectance, Tasseled Cap Transformation.
UNIT-II: Earth Sciences: Introduction, Photogeology, Lineaments, Geobotany, Direct Multispectral Observation of Rocks and Minerals, Mineral targeting, Photoclinometry, Band Ratios, Soil and Landscape Mapping, Integrated Terrain Units.
UNIT-III: Hydrospheric Sciences: Introduction, Spectral Characteristics of Water Bodies, spectral Changes as Water Depth increases, Location and Extent of Water Bodies, Roughness of the water Surface, Bathymetry, Chromaticity diagram, Drainage basin Hydrology, Evapotranspiration, manual interpretation irrigation and command area development, ground water mapping, watershed delineation.
UNIT-IV: Land Use and Land Cover: Introduction, Significance of Land Use and Land Cover Information, Applications of Remote Sensing, Land Use classification, mapping land use change, broad – scale land cover studies.
UNIT-V: Global Remote Sensing: Introduction, Biogeochemical Cycles, Advanced Very High Resolution Radiometer (AVHRR), Earth Observing System, EOS Instruments, EOS Bus, EOS Data and Information system, Long –Term Environment Research Sites, Global Land Information System, Global Data Base.

Test book:

1. Introduction to Remote Sensing by JAMES B.CAMPBELL. Published by Taylor & Francis Ltd.
2. Remote Sensing and Image Interpretation by THOMASLILLESAND AND RALPH W KEIFER published by John Wiley & Sons

STATISTICS AND ADJUSTMENT COMPUTATIONS

Course Code :15 CE 52G1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Introduction, Direct and Indirect Measurement, Measurement Error Sources, Definitions, Precision versus Accuracy, Redundant Measurements in Surveying and Their Adjustment, Advantages of Least squares Adjustments**Measurements and Their Analysis:** Introduction, Sample Versus Population, Range and Median, Graphical Representation of Data.

Numerical Methods of Describing Data: Measures of Central Tendency, Additional Definitions, Alternative Formula for Determining Variance, Numerical Examples, Derivation of the Sample Variance (Bissell's Correction), STATS AND SYS-STAT Program **Random Error Theory:** Introduction, Theory of Probability, Properties of the Normal Distribution Function, Probability of the Standard Error, Uses of Percent Errors

Confidence Intervals And Statistical Testing: Introduction, Distributions used in Sampling Theory, Confidence Interval for the Mean: t Statistic, Testing the Validity of the Confidence Interval, Selecting a Sample Size, Confidence Interval for a Population Variance , Confidence Interval for the Ratio of Two Population Variances. **Hypothesis Testing:** Test of Hypothesis for the Population Mean, Test of Hypothesis for the Population Variance: σ^2 , Test of Hypothesis for the Ratio of Two Population Variances.

Error Propagation In Traverse Surveys: Introduction, Derivation of Estimated Error in Latitude and Departure, Derivation of Estimated Standard Errors in Course Azimuth, Computing and Analyzing Polygon Traverse Misclosure Errors, Computing and Analyzing Link Traverse Misclosure Errors

Error Propagation In Elevation Determination: Introduction, Systematic Errors in Differential Leveling, Random Errors In Differential Leveling, Error Propagation in Trigonometric Leveling

Text books:

1. Adjustment Computations (Statistics and Least Squares in Surveying and GIS) - Paul R.Wolf & Charles D. Ghilani

CADASTRAL SYRVEY AND INFORMATION SYSTEM

Course Code :15 CE 52G2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Definitions,Technical and legal requirements,status of cadastral surveys in India,Land registration system,Records of rights,Resettlement operations,Relocation of parcels,Village and Distract boundaries.
Cadastral survey specifications,Application of Photogrammetry to Cadastral surveys,Drawing and reproduction of cadastral maps,Consolidation of Land holdings.
Projections and coordinate systems for cadastral surveys,Grids,Rectangular and Curvillinear grid,Indian grid,Cassini,Lambert conformal Conic,Policonic,Transverse Mercator and UTM projections,Conversion of coordinates from one projection to another,Linear affined and conformal transformation of coordinates.
Land registration systems in India,Computerization of Land records,Cadastral survey practices in developing and developed countries.
Concepts of LIS, Applications of Digital mapping,and Digitial photogrammetry to LIS and Cadastral survey mapping.

Text books:

1) Text Book of Plane Surveying—Devid Clark (Part I&II)
2) Text Book of Surveying---- Punmia (Part I&II)

ENGINEERING SURVEY METHODOLOGY AND INSTRUMENTATION

Course Code :15 CE 52G3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Fundamentals of engineering drawing, Interpretation of isometric and section drawings. Plotting of cross sections.
Accuracy and Precision of instruments. Specifications and procedures for medium and large scale surveys for engineering, irrigation, hydel, command area development, urban development, pipe line, power and transmission lines, town planning etc. Standards of Accuracy.
Techniques of depth sounding and ranging. Bathymetric contours. Tides and tide gauges.
Setting out of circular, transition, and vertical curves. Transferring alignment of railways, roads, pipe lines, conveyor belts, canals etc. from plan to ground.
Computation of areas and volumes. Planimeter and pantograph. Volume determination from Digital Elevation Models.Setting out of tunnels and shafts. Survey in underground and open-cast mines. Transfer of points and azimuth through vertical shafts (Correlation). Gyro-theodolite and photo- theodolite; uses in mines.
Electronic theodolites and levels, Precise leveling, Deformation measurements, Precise targeting. Subsidence surveys, crustal movements. Electronic Total Stations, GPS Receivers and their applications to Engineering Surveys.

Text books:

1. Text Book of Plane Surveying David Clark Part I & II
2. Text Book of Surveying Punmia Part I and Part II

GEOSPATIAL TECHNOLOGY FOR NATURAL RESOURCES & DISASTER MANAGEMENT

Course Code :15 CE 52G4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Land Resources: Land evaluation and suitability studies by Remote sensing and GIS. Techniques of land use / land cover map preparation. Land use / land cover mapping and planning. **Municipal GIS:** Geomatics in Solid and Hazardous waste disposal site selection, Environmental Information System Development for municipalities: Case studies

Geosciences: Role of Remote sensing and GIS in geological studies and case studies. **Water Resources:** Ground water exploration and targeting. Watershed characteristics, watershed management and Integrated approach for sustainable planning. Water quality modeling.

AGRICULTURE
Soil and altitude, Soil and aspect, Soil and slopes, Soil landscapes, Soil erosion modeling.Crop type classification, area estimates, and spectral response of different crops. Crop diseases and Assessment, Crop and Water management and monitoring. Advances in Crop monitoring. **FORESTRY:**Survey and mapping of forest cover, Forest change detection, Forest damage assessment and Forests monitoring, Land evaluation for forestry.

Ecosystem Modeling: Spectral response of vegetation and mapping, Ecosystem Analysis, Environmental impact analysis and monitoring, Ecosystem modeling, Wetland mapping. Spatial Models of Ecological Systems and Process.

Disaster Management: Introduction and Overview- Natural and man made hazards – land slides- volcanoes- floods and famines- earth quakes- forest fires Human Induced disasters-industrial disasters- dams- constructional and others.

Text books:

1. Environmental Modelling with GIS, Michael F. Goodchild, Bradley O. Parks, Louis T. Steyaert
2. Manual of Geospatial Science and Technology Edited By John. D. Bossler, Taylor And Francis, London
3. Lillesand, T.M. and Kiefer R.W. Remote Sensing and Image Interpretation, John Wiley and Sons, Inc, New York, 1987.
4. Geographical Information Systems by David Martin
5. RS in Geology by Siegal
6. RS in Forest Resources by John. A. Howard, Chapman and Hall.

COORDINATE SYSTEMS AND MAP PROJECTIONS

Course Code :15 CE 52H1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Coordinate Systems: Terrestrial coordinate system- Geocentric systems and Topo-centric systems, Introduction to celestial coordinate systems, Terrestrial geocentric systems, Conventional International Origin, Polar motion, Reference coordinate systems, Geodetic coordinate systems- Indian Geodetic System and WGS 84, Rectangular and curvilinear coordinate systems in two and three dimensions.
Map Projections: Basic problem and purpose of map projections, Classification of Map Projections, Curves/ Lines of special properties- Geodesic, Great circle, Rhumb line or Loxodrome, Distortions, Guassian fundamental quantities, Conformal mapping, Review of complex variables and differential geometry, Condition of conformality, Isometric latitude, Cauchy-Reimann equations, Scale factor, Meridian convergence, Geometry of projected curves.
Polyconic projection, Mercator's projection, Transverse Mercator and Universal Transverse Mercator projections, Lambert Conformal Conic projection, Polar Stereographic projection, Universal Polar Stereographic projection, Cassini Projection.
Transformation of coordinates from geodetic to various projections- Direct and Inverse problems, Transformation of coordinates from one projection to another, Grids- Lambert grid for India,
Design of grids and layouts for various zones/states, Comparative merits of various projections, Choice of projections, Linear and non-linear conformal and affine transformations.

Text books:

1. Text Book of Plane Surveying David Clark Part I & II
2.Text Book of Surveying Purmia Part I and Part II

Reference books:

1. Map Projections used by the U. S. Geological Survey, by John P. Snyder, U. S. Government Printing office Washington, 1982.
2. Coordinate systems in Geodesy, by E. J. Krakiwsky and D. E. Wells, The Department of Surveying Engineering, The University of New Brunswick, Frederiction N. B. 1971.
3. Conformal Map Projections in Geodesy, by E. J. Krakiwsky, Department of Survey Engineering, University of New Brunswick, Frederiction N. B. 1973.
4. Map projections for Geodesists, Cartographers, and Geographers, by Peter
5. Richardus,Ph..D.and Ron K. Adler, D.Sc.,North-Holland Publishing Company-Amsterdam, Oxford.

PRINCIPLES OF GEOMATICS

Course Code :15 CE 52H2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Geomatics basics, data types, data acquisition sources and techniques
Geodesy and Cartography:
Modern surveying instruments, projection systems, heights and geoids-local and global, datums, map classification-Topographic, thematic, map reading
Global positioning systems: GPS signal, segments, GPS errors, technical characteristics, measurement techniques, other positioning systems
Remote sensing: Electromagnetic spectrum, electromagnetic radiation-atmospheric interaction, interaction with matter, resolutions, platforms, IRS, LANDSAT, etc.
Geographical information system: Components and structure, databases and structures, data types, data models, spatial data analysis techniques, applications

Text books:

1. Gopi, "Advanced surveying: Total station, GIS and Remote Sensing", Pearson Education India, 2007

2. Hoffman. B, H.Lichtenegga and J.Collins, "Global Positioning System - Theory and Practice", Springer - Verlag Publishers, 2001

3. Lillesand T.M and Kiefer R.W., Remote Sensing and Image Interpretation, John Wiley and Sons, 2008.

4. Kang Tsung Chang., Introduction to Geographic Information Systems, Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2008.

GEOSPATIAL TECHNOLOGY FOR RURAL DEVELOPMENT

Course Code :15 CE 52H3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Concepts of Rural Area and Rural Development; Causes of Rural Backwardness, Need for Rural Development, Levels of Living of Rural People Poverty indicators.
Organizational Aspects of Agriculture, Alternative Occupations in Rural Areas, Assessment of Rural Energy Supply and Demand, Planning for Rural Development,
Definition and Characteristics of Village Communities – Concept and Importance of Rural Industrialization. Engineering aspects of rural infrastructure development - Education - Housing – Health - Drinking Water Supply Road Network, PURA model, Study of poverty alleviation programmes implementation.
Governance of Rural Information and Communication Technology: Opportunities and Challenges; GIS and Governance in Development in India: Trends and Strategy for Implementation; ICT Infrastructure for Rural Development: Issues and Priority for Application.
Geospatial techniques for mapping of rural resources. Spatial technologies in rural planning management administration and development.

Text books:

1. Jain S.C. Indigenous Resources for Rural Development, Concept Publishers, 2005.

2. N.I.R.D. Facets of Rural Development,

3.Technologies for Rural Development; http://en.wikibooks.org/wiki/ Technologies for_Rural_Development, 2010.

4. Harekrishna Misra (ed.), Governance of Rural Information and Communication Technologies, Opportunities and Challenges, Academic Foundation, 2009.

URBAN WATER MANAGEMENTUSING GEOMATICS

Course Code : 15 CE 52H4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

General introduction to urbanisation and its effect on water cycle – urban hydrological cycle – trends in urbanisation – Effect of urbanisation on hydrology.
Urban Hydrological cycle – time of concentration – importance of short duration of rainfall and runoff data – methods of estimation of time of concentration for design of urban drainage systems.
Master drainage plans – issues to be concentrated upon – typical content of an urban drainage master plan – interrelation between water resources investigation and urban planning processes – planning objectives – comprehensive planning – use of models in planning.
Basic approaches to urban drainage – runoff quantity and quality – wastewater and stormwater reuse – major and minor systems.
Elements of drainage systems – open channel – underground drains – appurtenances – pumping – source control. Stormwater Analysis Calculation of runoff and peak – Design of stormwater network systems.
Best Management Practices – Detention and retention facilities – Swales-constructed wetlands.
Operation and maintenance of urban drainage system – interaction between stormwater management and solid waste management, Various model available for stormwater management.
Legal aspects

Text books:

1. Geiger W. F., J Marsalek, W. J. Rawls and F. C. Zuidema, "Manual on Drainage in Urbanised area" – 2 volumes, UNESCO, 1987.
2. Hall M J , Urban Hydrology, Elsevier Applied Science Publisher,1984.
3. Stahre P and Urbonas B , "Stormwater Detention for Drainage", Water Quality and CSO Management, Prentice Hall, 1990.
4. Wanielista M P and Eaglin ,"Hydrology – Quantity and Quality Analysis", Wiley and Sons, 1997.
5. Marsalek et al "Urban water cycle processes and interactions", Publication No. 78, UNESCO, Paris(http://www.bvsde.paho.org/bvsacd/cd63/149460E.pdf), 1997.
6. Maksimovic C and J A Tejadxa-Guibert "Frontiers in Urban Water Management – Deadlock or Hope", IWA Publishing,2001.
7. http://www.water.ca.gov/urbanwatermanagement/
8. http://www.adb.org/publications/good-practices-urban-water-management

M. TECH - CONSTRUCTION TECHNOLOGY AND MANAGEMENT

First Year (First Semester):

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 CE 5117	Construction Technology	3	0	2	4
2	15 CE 5118	Construction Materials	3	2	0	4
3	15 CE 5119	Construction Planning Scheduling and Control	3	0	2	4
4	15 CE 5120	Statistical Methods for Management	3	2	0	4
5		Elective 1	3	0	0	3
6		Elective 2	3	0	0	3
7	15 IE 5148	Seminar	0	0	4	2
		Total Credits	24			

First Year (Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	**T**	**P**	
1	15 CE 5221	Mechanized Construction and Machinery	3	0	2	4
2	15 CE 5222	Project Formulation Appraisal	3	2	0	4
3	15 CE 5223	Construction Laws and Regulations	3	2	0	4
4	15 CE 5224	Quality Management and Safety Management Systems in Construction	3	0	2	4
5		Elective 3	3	0	0	3
6		Elective 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total Credits	24			

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	**T**	**P**	
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 CE 51I1	High Performance Buildings	3	0	0	3
2	15 CE 51I2	Precast Concrete Structure	3	0	0	3
3	15 CE 51I3	Special Concrete	3	0	0	3
4	15 CE 51I4	Structural Health Monitoring	3	0	0	3
Elective-2						
1	15 CE 51J1	Construction Personnel Management	3	0	0	3
2	15 CE 51J2	Building Services, Maintenance Management	3	0	0	3
3	15 CE 51J3	Infrastructure Valuation	3	0	0	3
4	15 CE 51J4	Construction Economics & Finance	3	0	0	3
Elective-3						
1	15 CE 52K1	Environmental Impact Assessment on built Environment	3	0	0	3
2	15 CE 52K2	Deep Excavations and ground water control methods	3	0	0	3
3	15 CE 52K3	Mass Transport Systems	3	0	0	3
4	15 CE 52K4	Form Work for Construction Structures	3	0	0	3
Elective-4						
1	15 CE 52L1	Emerging construction Technologies	3	0	0	3
2	15 CE 52L2	Building Envelopes	3	0	0	3
3	15 CE 52L3	Construction and fire safety	3	0	0	3
4	15 CE 52L4	Resource Management and Control In Construction	3	0	0	3

CONSTRUCTION TECHNOLOGY

Course Code : 15CE5117 **L-T-P : 3-0-2**
Prerequisites: - Nil - **Credits: 4**
Syllabus

Materials - Modular co-ordination, standardization and tolerances-system for prefabrication. Pre-cast concrete manufacturing techniques, Moulds –construction design, maintenance and repair.
Pre-casting techniques - Planning, analysis and design considerations - Handling techniques - Transportation Storage and erection of structures.
Joints -Curing techniques including accelerated curing such as steam curing, hot air blowing etc., -Test on precast elements - skeletal and large panel constructions - Industrial structures.
Pre-cast and pre-fabricating technology for low cost and mass housing schemes. Small pre-cast products like door frames, shutters, Ferro-cement in housing - Water tank service core unit.
Quality control - Repairs and economical aspects on prefabrication.

Lab:
Students have to visit minimum of 10 construction Sites and shall submit the reports on various construction practices which include foundation Practice, Farm Work, Rod bending, Concreting, Slab Work, Highway construction.

TEXT BOOKS

1. Levitt. M., Precast concrete - Materials, Manufacture Properties and Usage, Applied Science Publs. 1982,
2. Konex.T., Handbook of Pre-cast Construction, Vol.1.2&3.

REFERENCES:

1. Richardson,J.G., Pre-cast concrete Production, Cement and Concrete Association, London, 1973.
2. MadhavaRao.A-G., Modern Trends in Housing in Developing Countries, Oxford & UBH Publishing co., 1985. -
3. Lewicki.B., Building with Large Pre-fabrications, Elsevier Publishers.
4. Large Panel Prefabricated Constructions, Proc. of Advance Course conducted by SERC, Madras.
5. Bruggeling.A.S.G.,&Huyghe.G.F., Prefabrication with Concrete, A.s.A., Balkema Publishers, Netherland, 1991.

CONSTRUCTION MATERIALS

Course Code : 15CE5118 **L-T-P : 3-2-0**
Prerequisites: - Nil - **Credits: 4**

Syllabus

STONES – BRICKS – CONCRETE BLOCKS
Stone as building material – Criteria for selection – Tests on stones – Deterioration and Preservation of stone work – Bricks – Classification – Manufacture of clay bricks – Tests on bricks – Compressive Strength - Water Absorption – Efflorescence –Bricks for special use – Refractory bricks – Cement and Concrete hollow blocks – Light weight concrete blocks – Code Practices

LIME – CEMENT – AGGREGATES - MORTAR
Lime – Preparation of lime mortar – Cement. Ingredients – Manufacturing process – Types and Grades – Properties of cement and Cement mortar – Hydration - Compressive strength – Tensile strength – Soundness and consistency – Setting time – Aggregates – Natural stone aggregates – Industrial byproducts – Crushing strength – Impact strength – Flakiness – Abrasion Resistance – Grading – Sand – Bulking – Code Practices

CONCRETE
Concrete – Ingredients – Manufacture – Batching plants – RMC – Properties of fresh concrete – Slump – Flow and compaction – Principles of hardened concrete – Compressive, Tensile and shear strength – Modulus of rupture – Tests – Mix specification – Mix proportioning – IS method – High Strength Concrete and HPC – Other types of Concrete – Code Practices

TIMBER AND OTHER MATERIALS
Timber – Market forms – Industrial timber- Plywood - Veneer – Thermocole – Panels of laminates – Steel – Aluminum and Other Metallic Materials - Composition – uses – Market forms – Mechanical treatment – Paints – Varnishes – Distempers – Code Practices

MODERN MATERIALS
Glass – Ceramics – Sealants for joints – Fibre glass reinforced plastic – Clay products – Refractories – Composite materials – Types – Applications of laminar composites – Fibre textiles – Geosynthetics for Civil Engineering applications.

TEXT BOOKS:

1. R. K. Rajput, Engineering Materials, S. Chand & Company Ltd., 2000.
2. 2.M. S. Shetty, Concrete Technology (Theory and Practice), S. Chand & Company Ltd,2003.

CONSTRUCTION PLANNING SCHEDULING AND CONTROL

Course Code : 15CE5119 **L-T-P : 3-0-2**
Prerequisites: - Nil - **Credits: 4**

Syllabus

UNDERSTANDING PROJECT MANAGEMENT : Project manager, organization structures, organizing and staffing the project office and team

MANAGEMENT FUNCTIONS:Directing, controlling, project authority, interpersonal influences, barriers, team building, communication, time management, conflicts

CONSTRUCTION PLANNING : Project planning, milestone schedules, WBS , Network techniques, CPM, PERT and Prima Vera, Resources leveling and smoothing.

COST CONTROL : Understanding control, operating cycles, cost account codes, Job cost report, Projected Cost Estimates, status reporting, variance and earned value

PROJECT MANAGEMENT INFORMATION SYSTEM : MIS reporting, Daily, Weekly and monthly reporting, Actual vs. Planned cost reports, Planning & Cost control document. Quality and safety.

TEXT BOOKS

1. Chitkara, K.K. Construction Project Management: Planning, Scheduling and Control, Tata McGraw-Hill Publishing Company, New Delhi, 1998.

REFERENCES

1. Harold Kerzner Project Management CBS Publisers& Distributors 2nd Edition.
2. Frank Harris & Ronald McCaffer Modern Construction Management Blackwell science 4th Edition.
3. Roy Pilcher Principles of Construction Management McGraw Hill London.
4. Calin M. Popescu, ChotchaiCharoenngam, Project Planning, Scheduling and Control in Construction: An Encyclopedia of terms and Applications, Wiley, New York, 1995.
5. Chris Hendrickson and Tung Au, Project Management for Construction –Fundamental Concepts for Owners, Engineers, Architects and Builders, Prentice Hall, Pittsburgh, 2000.
6. Willis, E. M., Scheduling Construction Projects, John Wiley & Sons, 1986.
7. Halpin, D. W., Financial and Cost Concepts for Construction Management, John Wiley & Sons, New York, 1985

STATISTICAL METHODS FOR MANAGEMENT

Course Code : 15CE5120 **L-T-P : 3-2-0**
Prerequisites: - Nil - **Credits: 4**

Syllabus

ONE DIMENSIONAL RANDOM VARIABLE
Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

ESTIMATION THEORY
Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines.

TESTING OF HYPOTHESES
Sampling distributions - Type I and Type II errors - Tests based on Normal, t, χ^2 and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

DESIGN OF EXPERIMENTS
Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design.

QUEUEING MODELS
Poisson Process – Markovian queues – Single and Multi Server Models – Little's formula Machine Interference Model – Steady State analysis – Self Service queue.

TEXT BOOKS :

1. D. Gross, C. M. Harris, Fundamentals of Queuing Theory, Third Edition, John Wiley and Sons, 2002.
2. Vohra, N.D. "Quantitative Techniques in Management", Tata McGraw – Hill Company Limited, 2007.

REFERENCES:

1. D. C. Montgomery, G. C. Runger, Applied Statistics and Probability for Engineers, Third Edition, John Wiley and Sons, 2007.
2. Walpole, R.E., Myer, R.H., Myer, S.L. and Ye, K., Probability and Statistics for Engineers and Scientists, 7th edition, Pearson Education, Delhi, 2

MECHANIZED CONSTRUCTION AND MACHINERY

Course Code : 15CE5221 **L-T-P : 3-0-2**
Prerequisites: - Nil - **Credits: 4**

Syllabus

STANDARD TYPES OF EQUIPMENT
Special equipment, cost of owning and operating equipment, depreciation costs, investment and operating costs, economic life, sources of construction equipment, factors affecting selection of construction equipment, balancing of equipment. Study of equipment with reference to available types and their types and their capacities, factors affecting their performance

EARTHMOVING EQUIPMENT -I
Tractors and attachments, dozers and rippers, scrapers , shovels, draglines, trenching machines, clamshell, hoes, trucks and wagons, dumpers, rollers and compactors Drilling and blasting equipments,

EARTHMOVING EQUIPMENT -II
Bits, jackhammers, drifters, drills, blasting material, firing charge, safety fuse, electric blasting caps, drilling patterns, transporting and handling of explosives. Pile driving equipmentsTypes, pile driving hammers, single acting and double acting, differential acting hammers, hydraulic and diesel hammers, vibratory drivers

PUMPING EQUIPMENTS
Reciprocating, diaphragm & centrifugal pumps, well point system Stone crushing equipment:- jaw, gyratory and cone crushers, hammer mills, roll crushers, rod and ball crushers, aggregate screens and screening plants,

PUMPING EQUIPMENTS
Portable plants Concrete manufacture, transport, placing and compacting equipment, mixers, central batching and mixing plants, pavers, transit mixers, concrete pumps shotcrete Air Compressor Equipments for moving materials, builder's hoists, forklifts , cranes, belt-conveyors, cableways, ropeways.

Text Books

1. Construction planning, Equipments and methods. R.L.Peurify, TMH, 1996

Reference

1. "Construction Equipment and its Planning and Applications", Mahesh Varma, Metropolitan Book Co.(P) Ltd., New Delhi. India.

2. Construction Machinery and Equipment in India". (A compilation of articles Published in Civil Engineering and Construction Review) Published by Civil Engineering and Construction ReviewNew Delhi, 1991

PROJECT FORMULATION AND APPRAISAL

Course Code : 15CE5222 **L-T-P : 3-2-0**
Prerequisites: - Nil - **Credits: 4**

Syllabus

PROJECT FORMULATION
Project – Concepts – Capital investments - Generation and Screening of Project Ideas - Project identification – Preliminary Analysis, Market, Technical, Financial, Economic and Ecological - Pre-Feasibility Report and its Clearance, Project Estimates and Techno-Economic Feasibility Report, Detailed Project Report – Different Project Clearances required

PROJECT COSTING
Project Cash Flows – Time Value of Money – Cost of Capital

PROJECT APPRAISAL
NPV – BCR – IRR – ARR – Urgency – Pay Back Period – Assessment of Various Methods – Indian Practice of Investment Appraisal – International Practice of Appraisal – Analysis of Risk – Different Methods – Selection of a Project and Risk Analysis in Practice

PROJECT FINANCING
Project Financing – Means of Finance – Financial Institutions – Special Schemes – Key Financial Indicators – Ratios

PRIVATE SECTOR PARTICIPATION
Private sector participation in Infrastructure Development Projects - BOT, BOLT, BOOT - Technology Transfer and Foreign Collaboration - Scope of Technology Transfer

REFERENCES:

1. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation Review,Tata McGraw Hill Publishing Company Ltd., New Delhi. 2006.
2. Joy P.K., Total Project Management - The Indian Context, New Delhi, Macmillan India Ltd., 1992.
3. United Nations Industrial Development Organisation (UNIDO) Manual for the Preparation of Industrial Feasibility Studies, (IDBI Reproduction) Bombay, 1987
4. Barcus, S.W. and Wilkinson.J.W., Hand Book of Management Consulting Services,. McGraw Hill, New York, 1986.

CONSTRUCTION LAWS AND REGULATIONS

Course Code : 15CE5223 **L-T-P : 3-2-0**
Prerequisites: - Nil - **Credits: 4**

Syllabus

CONSTRUCTION CONTRACTS
Indian Contracts Act – Elements of Contracts – Types of Contracts – Features – Suitability – Design of Contract Documents – International Contract Document – Standard Contract Document– Law of Torts.

TENDERS
Prequalification – Bidding – Accepting – Evaluation of Tender from Technical, Contractual and Commercial Points of View – Contract Formation and Interpretation – Potential Contractual Problems – World Bank Procedures and Guidelines – Andhra Pradesh Transparency in Tenders Act.

ARBITRATION
Comparison of Actions and Laws – Agreements – Subject Matter – Violations – Appointment of Arbitrators – Conditions of Arbitration – Powers and Duties of Arbitrator – Rules of Evidence – Enforcement of Award – Costs.

LEGAL REQUIREMENTS
Insurance and Bonding – Laws Governing Sale, Purchase and Use of Urban and Rural Land – Land Revenue Codes – Tax Laws – Income Tax, Sales Tax, Excise and Custom Duties and theirInfluence on Construction Costs – Legal Requirements for Planning – Property Law – Agency Law– Local Government Laws for Approval – Statutory Regulations.

LABOUR REGULATIONS
Social Security – Welfare Legislation – Laws relating to Wages, Bonus and Industrial Disputes, Labour Administration – Insurance and Safety Regulations – Workmen's Compensation Act – Indian Factory Act – Andhra Pradesh Factory Act – Child Labour Act - Other Labour Laws.

Textbooks
1. Gajaria G.T., Laws Relating to Building and Engineering Contracts in India,
2. Jimmie Hinze, Construction Contracts, McGraw Hill, 2001.

References:
1. Joseph T. Bockrath, Contracts and the Legal Environment for Engineers and Architects, McGraw Hill, 2000.

2. Kwaku, A., Tenah, P.E. Jose M.Guevara, P.E., Fundamentals of ConstructionManagement and Organisation, Printice Hall, 1985.M.M.Tripathi Private Ltd., Bombay, 1982. Patil. B.S, Civil Engineering Contracts and Estimates, Universities Press (India) PrivateLimited, 2006.

QUALITY MANAGEMENT AND SAFETY MANAGEMENT SYSTEMS IN CONSTRUCTION

Course Code : 15CE5224 **L-T-P : 3-0-2**
Prerequisites: - Nil - **Credits: 4**

Syllabus

QUALITY MANAGEMENT : Introduction – Definitions and objectives – Factors influencing construction quality –Responsibilities and authority – Quality plan – Quality Management Guidelines – Quality circles.
QUALITY SYSTEMS : Introduction - Quality system standard – ISO 9000 family of standards – Requirements – Preparing Quality System Documents – Quality related training – Implementing a Quality system – Third party Certification.
QUALITY PLANNING : Quality Policy, Objectives and methods in Construction industry - Consumers satisfaction, Ergonomics - Time of Completion - Statistical tolerance – Taguchi's concept of quality – Codes and Standards – Documents – Contract and construction programming – Inspection procedures -Processes and products – Total QA / QC programme and cost implication.
QUALITY ASSURANCE AND QULAITY IMPROVEMENT TECHNIQUES : Objectives – Regularity agent, owner, design, contract and construction oriented objectives, methods – Techniques and needs of QA/QC – Different aspects of quality – Appraisals, Factors influencing construction quality – Critical, major failure aspects and failure mode analysis, –Stability methods and tools, optimum design – Reliability testing, Reliability coefficient and reliability prediction - Life cycle costing – Value engineering and value analysis. Quality Improvement Tools and Techniques.
SAFETY MANAGEMENT SYSTEMS : Fundamental of safety management, construction safety, safety in scaffolding and working platform, welding and handling, excavation work, concreting and cementing work. Building construction, TAC and NBC rules, High rise building. Evolution of modern safety concept- Safety policy - Safety Organization. Safety survey, safety inspection, safety sampling, Safety Audit. Concept of an accident, Reportable and non reportable accidents, unsafe act and condition principles of accident prevention, Overall accident investigation process. Risk management

REFERENCES:

1. Hutchins.G, ISO 9000 : A Comprehensive Guide to Registration, Audit Guidelines and Successful Certification, Viva Books Pvt. Ltd., 1994.
2. James, J.O' Brian, Construction Inspection Handbook – Total Quality Management, Van Nostrand, 1997
3. John L. Ashford, The Management of Quality in Construction, E &F.N.Spon, 1989.

4. Juran Frank, J.M. and Gryna, F.M. Quality Planning and Analysis, McGraw Hill, 2001
5. Kwaku.A., Tena, Jose, M. Guevara, Fundamentals of Construction Management and Organisation, Reston Publishing Co., Inc., 1985.
6.Steven McCabe, Quality Improvement Techniques in Construction, Addison Wesley Longm

HIGH PERFORMANCE BUILDINGS

Course Code : 15CE51I1 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

INTRODUCTION
What is High Performance Building, Why to go for High Performance Building, Benefits of High Performance Buildings, High Performance Building Materials and Equipment in India, What are key Requisites for Constructing a High Performance Building, Important Sustainable features for High Performance Building,

HIGH PERFORMANCE BUILDING CONCEPTS AND PRACTICES
Indian Green Building Council, Green Building Moment in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation;

HIGH PERFORMANCE BUILDING OPPORTUNITIES AND BENEFITS
Opportunities of High Performance Building, High Performance Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy Saving Approach in Buildings, LEED India Rating System and Energy Efficiency,

HIGH PERFORMANCE BUILDING DESIGN AND AIR CONDITIONING
Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximise System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources. Ecofriendly captive power generation for factory, Building requirement, Introduction to air conditioning, CII Godrej Green business centre, Design philosophy, Design interventions, Energy modeling, HVAC System design, Chiller selection, pump selection, Selection of cooling towers, Selection of air handing units, Precooling of fresh air, Interior lighting system, Key feature of the building. Eco-friendly captive power generation for factory, Building requirement.

MATERIAL CONSERVATION AND INDOOR ENVIRONMENT QUALITY AND OCCUPATIONAL HEALTH
Handling of non process waste, waste reduction during construction, materials with recycled content, local materials, material reuse, certified wood, Rapidly renewable building materials and furniture, Air conditioning, Indore air quality, Sick building syndrome, Tobacco smoke control, Minimum fresh air requirements avoid use of asbestos in the building, improved fresh air ventilation, Measure of IAQ, Reasons for poor IAQ, Measures to achieve Acceptable IAQ levels,

Text Books:
1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.
2. Green Building Hand Book by Tomwoolley and Samkimings,2009.

Reference Books:

1. Complete Guide to Green Buildings by Trish riley
2. Standard for the design for High Performance Green Buildings by Kent Peterson, 2009

PRECAST CONCRETE STRUCTURES

Course Code : 15CE51I2 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

INTRODUCTION
Need for prefabrication – Principles – Materials – Modular coordination – Standarization – Systems – Production – Transportation – Erection.
PREFABRICATED COMPONENTS
Behaviour of structural components – Large panel constructions – Construction of roof and floor slabs – Wall panels – Columns – Shear walls
DESIGN PRINCIPLES
Disuniting of structures- Design of cross section based on efficiency of material used – Problems in design because of joint flexibility – Allowance for joint deformation.
JOINT IN STRUCTURAL MEMBERS
Joints for different structural connections – Dimensions and detailing – Design of expansion joints
DESIGN FOR ABNORMAL LOADS
Progressive collapse – Code provisions – Equivalent design loads for considering abnormal effects such as earthquakes, cyclones, etc., - Importance of avoidance of progressive collapse.

References:

1. CBRI, Building materials and components, India, 1990
2. Gerostiza C.Z., Hendrikson C. and Rehat D.R., Knowledge based process planning for construction and manufacturing, Academic Press Inc., 1994
3. Koncz T., Manual of precast concrete construction, Vols. I, II and III, Bauverlag, GMBH, 1971.
4. Structural design manual, Precast concrete connection details, Socie

SPECIAL CONCRETE

Course Code : 15CE51I3 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

CONCRETE INGREDIENTS

Composition of OPC – Manufacture – Modified Portland Cements – Hydration Process of Portland Cements – Structure of Hydrated Cement Pastes Mineral Admixtures – Slags – Pozzolanas and Fillers – Chemical Admixtures –Solutes – Retarders – Air Entraining Agents – Water Proofing Compounds –Plasticizers and Super Plasticizers Aggregates – Properties and testing of fine and course aggregates – combining of aggregates – Substitute material for aggregates – recent advancements.

SPECIAL CONCRETES

Fibre Reinforced Concrete – Self Compacting Concrete – Polymer Concrete – High performance concrete – Sulphur concrete – pervious Concrete.

CONCRETE MIX DESIGN

Mix Proportioning – Mixes incorporating Fly ash, Silica fume, GGBS – Mixes for High Performance Concrete – High strength concrete – variations in concrete strength.

MECHANICAL PROPERTIES OF CONCRETE

Interfacial Transition Zone – Fracture Strength – Compressive strength – Tensile strength - Impact strength - Bond strength.

DURABILITY OF CONCRETE

Factors affecting durability – Chemical Attack – Permeability – chloride penetration –water absorption – creep – Shrinkage.

REFERENCES:

1. Santhakumar.A.R., Concrete Technology, Oxford University press, New Delhi. 2007.
2. Gambhir.M.L., Concrete Technology – Tata McGraw Hill Book Co. Ltd.,Delhi, 2004.
3. Neville, A.M., Properties of Concrete, Longman, 1995.
4. MethaP.K.andMontreio P.J.M., Concrete Structure Properties and Materials, Prentice Hall, 1998.
5. Gupta.B.L. and Amit Gupta, Concrete Technology, Standard Publishers Distributer, New Delhi, 2004.

STRUCTURAL HEALTH MONITORING

Course Code : 15CE51I4 **L-T-P : 3-0-0**

Prerequisites: - Nil - **Credits: 3**

Syllabus

Static Field Testing: Types of static tests - Simulation and loading methods - Static response measurement
Dynamic Field Testing: Stress history data, types of dynamic field test - Dynamic response methods
Periodic and Continuous Monitoring; Hardware for Remote data acquisition systems; Remote Structural Health Monitoring: Networking of sensors –
Data comparison technique; Case Studies.
Structural Cracks and Reasons for various cracks, observation of structure on visual eye and also from non destructive tests.

Textbooks

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, John Wiley and Sons, 2006.
2. Douglas E Adams, Health Monitoring of Structural Materials and Components-Methods with Applications, John Wiley and Sons, 2007.
3. J.P. Ou, H.Li and Z.D. Duan, Structural Health Monitoring and Intelligent Infrastructure, Vol-1, Taylor andFrancis Group, London, U.K, 2006.
4. Victor Giurglutiu, Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc, 2007

CONSTRUCTION PERSONNEL MANAGEMENT

Course Code : 15CE51J1 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

MANPOWER PLANNING
Manpower Planning process , Organizing, Staffing, directing, and controlling – Estimation, manpower requirement – Factors influencing supply and demand of human resources – Role of HR manager – Personnel Principles.
ORGANISATION
Requirement of Organisation – Organisation structure – Organisation Hierarchical charts – Staffing Plan - Development and Operation of human resources - Managerial Staffing – Recruitment – Selection strategies – Placement and Training.
HUMAN RELATIONS AND ORGANISATIONAL BEHAVIOUR
Basic individual psychology – Approaches to job design and job redesign – Self managing work teams – Intergroup – Conflict in organizations – Leadership-Engineer as Manager – all aspects of decision making – Significance of human relation and organizational – Individual in organization – Motivation – personality and creativity – Group dynamics, Team working – Communication and negotiation skills.
WELFARE MEASURES

Compensation – Safety and health – GPF – EPF – Group Insurance – Housing - Pension – Laws related to welfare measures.

MANAGEMENT AND DEVELOPMENT METHODS

Wages and Salary, Employee benefits, Employee appraisal and assessment – Employee services – Safety and Health Management – Special Human resource problems – Productivity in human resources – Innovative approach to designing and managing organization – Managing New Technologies – Total Quality Management – Concept of quality of work life – Levels of change in the organizational Development – Requirements of organizational Development – System design and methods for automation and management of operations – Developing policies, practices and establishing process pattern – Competency up gradation and their assessment – New methods of training and development – Performance Management.

TEXT BOOKS

1. Carleton Counter II and Jill Justice Coutler, The Complete Standard Handbook of Construction Personnel Management, Prentice-Hall, Inc., 1989.

REFERENCES:

1. Charles D Pringle, Justin GooderiLongenecter, Management, CE Merril Publishing Co. 1981.
2. Dwivedi R.S, Human Relations and OrganisationalBehaviour, Macmillian India Ltd.,2005.
3. Josy.J. Familaro, Handbook of Human Resources Administration, McGraw-Hill International Edition, 1987.
4. Memoria,C.B., Personnel Management, Himalaya Publishing Co., 1997.

BUILDING SERVICES, MAINTENANCE MANAGEMENT

Course Code : 15CE51J2 **L-T-P : 3-0-0**

Prerequisites: - Nil - **Credits: 3**

Syllabus

WATER SUPPLY AND ELECTRIC SERVICES

Water requirements for different types of buildings, simple method of removal of impurities, water saving practices and their potential Service connection from mains, sump and storage tank, types and sizes of pipes, special installation in multistoried buildings. Material, types of fixtures and fitting for a contemporary bathroom– taps – quarter turn, half turn, ceramic, foam flow etc, hot water mixer, hand shower Rainwater harvesting to include roof top harvesting, type of spouts, sizes of rainwater pipes and typical detail of a water harvesting pit

Electrical systems – Basic of electricity – single/Three phase supply – protective devices in electrical installation – Earthing for safety – Types of earthing – ISI Specifications. Electrical installations in buildings – Types of wires, Wiring systems and their choice – planning electrical wiring for building – Main and distribution boards –Principles of illumination

DRAINAGE AND SOLID WASTE DISPOSAL

Principles of drainage, surface drainage, shape and sizes of drains and sewers, storm water over flow chambers, methods of laying and construction of sewers Traps – shapes, sizes, types, materials and function, Inspection chambers - sizes and construction, Ventilation of House drainage: Anti siphonage pipe, system of plumbing - single stack , one pipe system, one pipe partially ventilating system and two pipe system, grey water recycling and dual plumbing Types of fixtures and materials: sinks, shower tray, shower temple, bath tub, Jacuzzi, water closets, flushing cisterns, urinals, sinks , wash basins, bidet, etc. Design of Septic tank, Oxidation pond, Dispersion trench and soak pits. Arrangements of fixtures in a bathroom Treatment system- Root zone treatment system, Decentralized Wastewater Treatment Systems (DEWATS), Soil Bio technology, packaged Bio-Reactor System

Approaches for solid waste management, Solid wastes collection and removal from buildings. On-site processing and disposal methods, guidelines for municipal solid waste management, e-waste management. Disposal of Wastes: Sanitary land filling, Composting, Vermi-compost, Incineration, Pyrolysis

FIRE FIGHTING SERVICES, PLUMBING AND FIRE FIGHTING LAYOUT OF SIMPLE BUILDING

Classification of buildings based on occupancy , causes of fire and spread of fire, Fire fighting, protection and fire resistance, Fire fighting equipment and different methods of fighting fire. Combustibility of materials, Structural elements and fire resistance, Fire escape routes and elements – planning and design. Wet risers, dry risers, sprinklers, heat detector, smoke detectors, fire dampers, fire doors, etc.

Application of above studies in current design problems and preparing design layout and details - Plumbing layout of residential and public buildings, Fire fighting layout, Reflected ceiling plan of smoke detectors / sprinklers, etc.

ILLUMINATION AND LIGHTING DESIGN

Visual tasks – Factors affecting visual tasks – Modern theory of light and colour – synthesis of light – Additive and substractive synthesis of colour – Luminous flux – Candle – solid angle illumination – utilization factor –Depreciation factor –MSCP – MHCP –Laws of illumination. Classification of lighting –Artificial light sources – Spectral energy distribution – Luminous efficiency – Colour temperature – Colour rendering. Design of modern lighting – Lighting for stores, offices, schools, hospitals and house lighting. Elementary idea of special features required and minimum level of illumination required for physically handicapped and elderly in building types.

ELECTRICAL LAYOUT OF SIMPLE BUILDINGS, HEAT VENTILATION AND AIR CONDITIONING (HVAC)

Electrical layout of a simple residential, school and commercial building

Behaviour of heat propagation, thermal insulating materials and their co-efficient of thermal conductivity. General methods of thermal insulation: Thermal insulation of roofs, exposed walls.Ventilation: Definition and necessity, system of ventilation. Principles of air conditioning Air cooling, Different systems of ducting and distribution, Essentials of air-conditioning system.

REFERENCE BOOKS

1. Charangith shah, Water supply and sanitary engineering, Galgotia publishers. Kamala & DL Kanth Rao, Environmental Engineering, Tata McGraw – Hill publishing company Limited.

2. E.R.Ambrose, Heat pumps and Electric Heating, John and Wiley and Sons Inc, New York, 1968.
3. Handbook for Building Engineers in Metric systems, NBC,New Delhi, 1968.
4. Philips Lighting in Architectural Design, McGraw Hill, New York, 1964.
5. R.G.Hopkinson and J.D.Kay, the Lighting of Buildings, Faber, and Faber, London, 1969.
6. S.C.Rangwala, Water supply and sanitary engineering, Charotar publishing house.

INFRASTRUCTURE VALUATION

Course Code : 15CE51J3 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

Concepts: Introduction, History of value engineering, Value Function, Cost, Worth, Case Study Discussions.

General Techniques in infrastructure Valuation: General Techniques- Brainstorming Technique, The Gordon Technique, Feasibility Ranking, The Morphological Analysis Technique, ABC Analysis, Probabilistic Approach, Make or Buy Technique, Case Study Discussions.

Special Techniques in infrastructure valuation:Special Techniques, function, cost, worth Analysis, Function Analysis System Technique, Technically oriented Fast and Customer, Oriented Fast, Weighted Evaluation Method, Equal Importance Method, Descending Order of Importance Method.

Numeric Analysis, Forced Distribution technique, Quantitative Mehod, Predetermined minimum method, Evaluation Matrix, Break even analysis, Life Cycle Cost (LCC), Case Study Discussions.

Applications of infrastructure valuation: Team Dynamics, Team Structure and team Building, Definition of the creative and Structured Phases of value engineering, The Workshop approach to achieving value, target setting,time management, case study discussions.

References:

1. Anil Kumar Mukhopadhyaya, Value Engineering Concepts, Techniques and Applications, Response Books, 2013.
2. Anil Kumar Mukhopadhyaya, Value Engineering Mastermind from Concept to Value Engineering Certification, Response Books, 2009.
3. Lawrence D. Miles, Techniques of Value Analysis and Engineering, McGraw-Hill Book Company, 2009.
4. M.R.S. Murthy, Cost Analysis for Management Decisions, Tata McGraw-Hill Publishing Company Ltd., 1988.

CONSTRUCTION ECONOMICS & FINANCE

Course Code : 15CE51J4 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

Construction accounting, Income statement. Depreciation and amortization. Engineering economics,
Time value of money, discounted cash flow, NPV, ROR, PI, Bases of comparison, Incremental rate of return
Benefit-cost analysis, Replacement analysis, Break even analysis. Risks and uncertainties and management decision in capital budgeting. Taxation and inflation. Work pricing, cost elements of contract, bidding and award, revision due to unforeseen causes, escalation.
Turnkey activities, Project appraisal and project yield. Working capital management, financial plan and multiple source of finance.
International finance, Budgeting and budgetary control, Performance budgeting. appraisal through financial statements, Practical problems and case studies.

Reference

1. Simon A. Burtonshaw-Gunn, "Risk and Financial Management in Construction", Gower Publishing, Ltd.,2009
2. Warneer Z, Hirsch, Urban Economics, Macmillan, New York, 1993
3. Eugene F. Brigham, Michael C. Ehrhardt, "Financial Management Theory and Practice", Cengage hLearning, 2010

ENVIRONMENTAL IMPACT ASSESSMENT ON BUILT ENVIRONMENT

Course Code : 15CE51K1 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring
Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements. Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions,

Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts,

Global Environmental Issues, EIA Methodologies: Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods- Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods,

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.

Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts,

References:

1. Canter, L.W., Environmental Impact Assessment, McGraw Hill Pub. Co., 1997.
2. David P. Lawrence, Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley & Sons, 2003.
3. Hosetti, B. B., Kumar Eds, A., Environmental Impact Assessment and Management, Daya Publishing House, 1998.
4. UNESCO, Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development, UNESCO/UNEP, Paris, 1987.
5. Anjaneyulu.Y., and Manickam. V., Environmental Imapact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
6. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.

DEEP EXCAVATIONS AND GROUND WATER CONTROL METHODS

Course Code : 15CE51K2 **L-T-P : 3-0-0**

Prerequisites: - Nil - **Credits: 3**

Syllabus

Deep Excavation

Deep excavations - Standards & codes of practice / Types & uses, Construction methodologies & detailing, Analysis methods & ground movements, Design of retaining structure, Design of temporary works, Tutorial, Monitoring systems, Maintenance / Operation / Coursework discussion

Roads & Tunnels

Roads & Tunnels - Standards & codes of practice / Road geometry & drainage, Pavement design & Geotechnics / Monitoring / Maintenance of Roads, Embankments & Cuttings - Standards & codes of practice / Types & uses / Construction methodologies & detailing, Embankments & Cuttings - Analysis methods & ground movements / Monitoring systems / Maintenance , Standards & codes of practice / Types & uses, Construction methodologies & detailing, Analysis methods & ground movements, Design of lining, Design of temporary works, Tunnels – Tutorial, Monitoring systems, Tunnels - Maintenance / Operation / Coursework discussion

Dewatering

Dewatering of shallow and deep open excavations. Effect of ground water movement. Methods of groundwater control. Shallow and deep well points. Horizontal drainage, vacuum dewatering by electro-osmosis, single and multiple well system, group of wells. Draw down factors, vertical sand drains, pressure relief beneath excavation, well point pumps, headers discharge lines control of surface water. Installation and operation of well point system.

Grouting Methods

Cement grouting, colgrout, colcrete process, prepacked concrete, intrusion grout. Alluvial grouting, various types of clay grouting. Chemical grouting – grouts for injection of fine sands. Resingrouting.Polymerisation technique. Field procedure, applications and limitations.

Piling & Coffer dams and Caisson

Behaviour of single pile and a group piles during driving, under loads-ultimate loads on driven and cast in Situ piles. Construction details of precast piles, prestressed piles, and steel piles, friction piles.

Driven and bored piles, large diameter piles, negative and positive skin friction, multiple under reamed piles, raker piles, sand piles, Anchor piles, load on piles – Static. Vibrating loads, cyclic loading, safe bearing load, methods of pile driving by vibration above and under water through different strata, micro piles.

Cofferdams – types, design and construction of single, double wall. Cofferdam. Sheet pile cofferdams, concrete wall movable cofferdam, land cofferdams, soldier construction method. Cofferdam wall by ICOS method, caissons, details, design and construction.

References:

1. Construction Planning, Equipment and methods – Peurifoy-Tata McGraw Hill Publication
2. Construction Equipment Planning and Applications – Dr. Mahesh Verma
3. Brochures Published by various agencies associated with construction.
4. Journals such as CE & CR. Construction world, International Construction Document Reports of actual major works executed.

MASS TRANSPORT SYSTEM

Course Code : 15CE51K3 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

FORM WORK FOR CONSTRUCTION STRUCTURES

Course Code : 15CE51K4 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

PLANNING, SITE EQUIPMENT & PLANT FOR FORM WORK
Introduction - Forms for foundations, columns, beams walls etc., General objectives of formwork building - Planning for safety - Development of a Basic System - Key Areas of cost reduction - Planning examples. Overall Planning - Detailed planning - Standard units - Corner units - Pass units - Calculation of labour constants - Formwork hours - Labour Requirement - Overall programme - Detailed programme - Costing - Planning crane arrangements - Site layout plan - Transporting plant - Formwork beams - Scaffold frames - Framed panel formwork - Formwork accessories.
MATERIALS ACCESSORIES PROPRIETARY PRODUCTS & PRESSURES
Lumber - Types - Finish - Sheathing boards working stresses - Repetitive member stress - Plywood - Types and grades - Jointing Boarding - Textured surfaces and strength - Reconstituted wood - Steel - Aluminum - Hardware and fasteners - Nails in Plywood - Allowable withdrawal load and lateral load. Pressures on formwork - Examples - Vertical loads for design of slab forms -Uplift on shores - Laterals loads on slabs and walls.
DESIGN OF FORMS AND SHORES : Basic simplification - Beam formulae - Allowable stresses - Deflection, Bending - Lateral stability -Shear, Bearing - Design of Wall forms - Slab forms - Beam forms - Column forms - Examples in each. Simple wood stresses - Slenderness ratio - Allowable load vs length behaviour of wood shores - Form lining Design Tables for Wall formwork - Slab Formwork - Column Formwork - Slab props - Stacking Towers - Free standing and restrained - Rosett Shoring - Shoring Tower - Heavy Duty props.
BUILDING AND ERECTING THE FORM WORK : Carpentry Shop and job mill - Forms for Footings - Wall footings - Column footings - Sloped footing forms - Strap footing - Stepped footing - Slab form systems - Sky deck and Multiflex - Customized slab table - Standard Table module forms - Swivel head and uniportal head - Assembly sequence - Cycling with lifting fork - Moving with table trolley and table prop. Various causes of failures - ACI - Design deficiencies - Permitted and gradual irregularities.
FORMS FOR DOMES AND TUNNELS, SLIP FORMS AND SCAFFOLDS : Hemispherical, Parabolic, Translational shells - Typical barrel vaults Folded plate roof details - Forms for Thin Shell roof slabs design considerations - Building the forms - Placing concrete - Form removed -Strength requirements -Tunnel forming components - Curb forms invert forms - Arch forms - Concrete placement methods - Cut and cover construction - Bulk head method - Pressures on tunnels - Continuous Advancing Slope method - Form construction - Shafts. Slip Forms - Principles -Types - advantages - Functions of various components - Planning -Desirable characteristics of concrete - Common problems faced - Safety in slip forms special structures

built with slip form Technique - Types of scaffolds - Putlog and independent scaffold -Single pole scaffolds - Truss suspended - Gantry and system scaffolds.

REFERENCES:

1. Austin, C.K., Formwork for Concrete, Cleaver -Hume Press Ltd., London, 1996.
2. Hurd, M.K., Formwork for Concrete, Special Publication No.4, American Concrete Institute, Detroit, 1996
3. Michael P. Hurst, Construction Press, London and New York, 2003.
4. Robert L. Peurifoy and Garold D. Oberlender, Formwork For Concrete Structures, McGraw -Hill , 1996.

<u>EMERGING CONSTRUCTION TECHNOLOGIES</u>

Course Code : 15CE51L1 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

GFRC Facade Panels System, Prefabricated Building, Vertical ICF Wall, Mechanical Concrete, Filterpave systems, FRP Rebar, FRP Deck: Rehabilitation of a Steel Truss Bridge, Concrete Lumber, Bone-shaped Short Fiber Composite, Slurry Infiltrated Mat Concrete, Alternative Material Dowel Bars for Rigid Pavement Joints, Snap Joint Technology for Composite Structures, Superpave System,
Modular FRP Composite Bridge Deck, Composite Column Reinforcement, Rapid In situ Load Testing, Carbon Fiber Reinforced Polymer (CFRP), Polymer Concrete Pipes, Use of Composite Piping Offshore, Recycled Plastic Composite Railroad Ties. High Performance Steel (HPS), Embedded Galvanic Anodes, DIS Seismic Isolator, Hydraulic Vibratory Pile Driver, Soft Trencher, Deep Mixing Method for Ground Improvement, Mortar less Concrete Block System, Post-tensioned Steel Structure
Attachment of Steel Decking using Mechanical Fasteners and Powder Actuated or Pneumatic Tools, Seismic Isolation Bearings, Bridge Lock-up Device System, Adjustable Steelwork Connectors, Precast Hybrid Moment Resistant Frames, Precast Concrete Beam to Column System (BSF)
Low Temperature Concrete Admixture, Use of Recycled Tire Rubber in Concrete, Steel Free Concrete Bridge Deck, Rapid Repair Products, Concrete Restoration & Protection System, Precast Inverted T Beam, Conductive Concrete, Smart Concrete.
Rapid Drying Concrete, Rapid-1 Hardening Accelerator Concrete Admixture, Reactive Powder Concrete, Mellose non-dispersible Underwater Concrete, Segment Precast Floating Draw Span, Self-Placing Concrete, Shrinkage Reducing Admixture for Concrete, Corrosion Inhibitors for Reinforced Concrete, High Performance Concrete(HPC).

TEXT BOOKS

1. Levitt. M., Precast concrete - Materials, Manufacture Properties and Usage, Applied Science Publs. 1982,
2. Konex.T., Handbook of Pre-cast Construction, Vol.1.2&3.

REFERENCES:

1. Richardson,J.G., Pre-cast concrete Production, Cement and Concrete Association, London, 1973.
2. MadhavaRao.A-G., Modern Trends in Housing in Developing Countries, Oxford & UBH Publishing co., 1985. -
3. Lewicki.B., Building with Large Pre-fabrications, Elsevier Publishers.
4. Large Panel Prefabricated Constructions, Proc. of Advance Course conducted by SERC, Madras.
5. Bruggeling.A.S.G.,&Huyghe.G.F., Prefabrication with Concrete, A.s.A., Balkema Publishers, Netherland, 1991.\

BUILDING ENVELOPES

Course Code : 15CE51L2 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

BUILDING ENVELOPE SYSTEM
Building Envelope System-Performance Objectives-Physical Components-Sources of Moisture Intrusion-Results of Failure.
FOUNDATION CONSTRUCTION
Thermal and Moisture Protection-Groundwater Gutters-Crawl spaces-Damp proofing and Waterproofing- Girders
WALL CONSTRUCTION & ROOF CONSTRUCTION
Wall Framing-Vapour Diffusion Problems-Recommendations-House Wrap and Underlayment-Window and Door Openings-Flashing and Caulking-Siding
Skylights-Moisture Penetration-Roof Valleys-Shingles and Shakes-Roof Sheathing-Repairs Flashing

WINDOW AND DOOR INSTALLATION & VENTILATION SYSTEM INSTALLATION AND REQUIREMENTS
Windows, Doors and Skylights-Proper Flashing-Door and Window Installation Code-Attic Ventilation-Heating, Ventilation and Air Conditioning

BUILDING ENVELOPE BEST PRACTICES
Moisture Retarding Construction, Capillary Breaks, House Wrap Installation, Window and Door Installation, Siding Installation, Roofing Best Practices

TextBooks

1. H. Hens, 2012, Building Physics: Heat, Air and Moisture, Fundamentals and Engineering Methods with Examples and Exercises, Second Edition

2. ASHRAE, HANDBOOK - Vol. 1-4 ed. ASHRAE 2009-2012.

CONSTRUCTION AND FIRE SAFETY

Course Code : 15CE51L3 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

Classification of fire, Portable fire extinguishers, Pumps and primers, Foam and foam making equipments, Hose and hose fittings, Water relay systems, Breathing apparatus, Small gears.
Fire protective clothing, Ladders, Ropes and lines, bends & hitches, Fire prevention, Special appliances, Fire fighting codes and standards, Electrical fire hazards, Structures under fire.
Site planning and housekeeping, Types of Scaffolds, Scaffold Erection & dismantling, Scaffold Inspection.
Safety in scaffolding – an overview, Investigation of scaffold accident, Provisions on scaffold under the building other construction workers central rules, 1998, Safety in excavations, trenching and shoring
Road work and pilling operation, Ladders, Use of safety nets and fall protection systems, Concrete and concert foams and shoring, Importance of civil work in construction industry, Material handling, Important safety requirements and inspections

Text Books:

RESOURCE MANAGEMENT AND CONTROL IN CONSTRUCTION

Course Code : 15CE51L4 **L-T-P : 3-0-0**
Prerequisites: - Nil - **Credits: 3**

Syllabus

Resource Planning
Resource Planning, Procurement, Identification, Personnel, Planning for material, Labour, time schedule and cost control, Types of resources, manpower, Equipment, Material, Money, Time.
Labour Management
Systems approach, Characteristics of resources, Utilization, measurement of actual resources required, Tools for measurement of resources, Labour, Classes of Labour, Cost of Labour, Labour schedule, optimum use Labour.
Materials and Equipment
Material: Time of purchase, quantity of material, sources, Transportation, Delivery and Distribution. Equipment: Planning and selecting by optimistic choice with respect to cost, Time, Source and handling.
Time Management , Resource Allocation and Leveling
Personnel time, Management and planning, managing time on the project, forecasting the future, Critical path measuring the changes and their effects – Cash flow and cost control.
Time-cost trade off, Computer application – Resource leveling, resource list, resource allocation, Resource loading, Cumulative cost – Value Management.
Textbooks:

1. Andrew,D., Szilagg, Hand Book of Engineering Management, 1982.
2. Harvey, A., Levine, Project Management using Micro Computers, Obsorne -McGraw Hill C.A.Publishing Co., Inc. 1988.Industry, Granda Publishing Ltd., 1980.

Reference:

1. James.A.,Adrain, Quantitative Methods in Construction Management, American Elsevier Publishing Co., Inc., 1973.
2. Oxley Rand Poslcit, Management Techniques applied to the Construction Industry, Granda Publishing Ltd., 1980.

M.TECH - COMPUTER SCIENCE & ENGINEERING

First Year (First Semester):

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Contact Hours	Credits
1	15 CS 5101	Mathematical Foundations of Computer Science	3	2	0		4
2	15 CS 5102	Computer Organization & Architecture	3	2	0		4
3	15 CS 5103	Data Structures & Algorithms	3	0	2		4
4	15 CS5104	Distributed Database Management System	3	0	2		4
5		Elective – 1	3	0	0		3
6		Elective - 2	3	0	0		3
7	15 IE 5149	Seminar	0	0	4		2
		Total	**18**	**4**	**8**		**24**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Contact Hours	Credits
1	15 CS 5205	Operating System Design	3	2	0		4
2	15 CS 5206	Computer Networks & Security	3	2	0		4
3	15 CS 5207	Object Oriented Analysis and Design	3	0	2		4
4	15 CS 5208	Enterprise Programming	3	0	2		4
5		Elective – 3	3	0	0		3
6		Elective - 4	3	0	0		3
7	15 IE 5250	Term Paper	0	0	4		2
		Total	**18**	**4**	**8**		**24**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods L	Periods T	Periods P	Credits
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 CS 51A1	Soft Computing	3	0	0	3
2	15 CS 51A2	Machine Learning and pattern Classification	3	0	0	3
3	15 CS 51A3	Data Mining	3	0	0	3
4	15 CS 51A4	Natural Language Processing	3	0	0	3
Elective-2						
1	15 CS 51B1	Requirements Engineering	3	0	0	3
2	15 CS 51B2	Principles of Programming Languages	3	0	0	3
3	15 CS 51B3	Compiler Design	3	0	0	3
4	15 CS 51B4	Software Testing & Quality Assurance	3	0	0	3
Elective-3						
1	15 CS 52C1	Cryptography & Network Security	3	0	0	3
2	15 CS 52C2	Mobile computing	3	0	0	3
3	15 CS 52C3	High Performance Computing	3	0	0	3
4	15 CS 52C4	Network management Systems	3	0	0	3
Elective-4						
1	15 CS 52D1	Service Oriented Architecture	3	0	0	3
2	15 CS 52D2	Visual Programming	3	0	0	3
3	15 CS 52D3	Digital Image Processing	3	0	0	3
4	15 CS 52D4	Big Data Analytics	3	0	0	3

MATHEMATICAL FOUNDATIONS FOR COMPUTER SCIENCE

Course Code :15 CS 5101 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Logic, Proofs, sets functions and relations, Algorithm and Integers, Induction and Recursion, Counting, Graph theory, Trees, Boolean Algebras, Automata, Grammars and Languages**.**

Textbooks:

1. Joe L.Mott, Abrabam Kandel & Theodore P.Bakev, 'Discrete Mathematics for Computer Scientists & Mathematics' PHI.
2. John.E.Hopcroft, R.Motwani, & Jeffery.D Ullman, "Introduction to Automata Theory, Languages and Computations", Second Edition, Pearson Education, 2003

References:

1. Kenneth H Rosen, "Discrete Mathematics and its Applications", Tata McGraw Hill Publishing Company Limited, New Delhi, Sixth Edition, 2007.
2. Tremblay J P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill Publishing Company Limited, New Delhi, 2007.
3. John E Hopcroft & Jeffery D Ullman' 'Introduction to Automata Theory & Languages And Computation', Narosa Publishing House
4. KLP Mishra & N.Chandrasekharan, 'Theory of Computation', PHI.
5. Discrete and Combinational Mathematics- An Applied Introduction-5th Edition – Ralph. P.Grimaldi. Pearson Education.

COMPUTER ORGANIZATION & ARCHITECTURE

Course Code :15 CS 5102 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Computer abstractions and technology: Assemblers, Linkers, and the SPIM Simulator: The Basics of Logic Design: Instructions: Language of the Computer: Arithmetic for Computers: A Survey of RISC Architectures desktop and server RISCs: Assessing and Understanding Performance: Mapping Control to Hardware. Large and Fast: Exploiting Memory Hierarchy,Parallel Processors from Client to Cloud 500

Text Book:

1. Computer Organization and Design, Third Edition, by David Patterson and John Hennessy Morgan Kaufmann Publishers, 2013

References:

1. Computer Organization and Architecture, Design for Performance 7th Edition – 2009, Stallings, Pearson Education
2. Computer organization 5th Edition Hamacher, Vranessis Zaky -2002 Mc-Graw Hill International.
3. Computer Architecture and Organization 3rd Edition John P.Hayes
4. Fundamentals of Digital Logic & Micro Computer Design , 5TH Edition, M.Rafiquzzaman John Wiley
5. Digital Design Fourth Edition, M.Morris Mano, Pearson Education/PHI.

DATA STRUCTURES & ALGORITHMS

Course Code :15 CS 5103 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: Algorithms, Algorithms as a technology, Insertion Sort, Analyzing algorithms, Designing algorithms, asymptotic notations, standard notations, common functions, **Recurrences:** substitution method, master method. **Sorting and order statistics: Quick sort:** Description, Performance, Worst Case Analysis, Heap sort, sorting in linear time. **Elementary Data Structures:** – Linked lists, Stacks, Queues, **Hash Tables**: Direct address tables, Hash tables, Hash functions, Open addressing, B**inary search trees**: Quering, Insertion, Deletion, Red-Black Trees. **Advanced Data Structures:** B – Trees, Binomial Heaps **Data Structures for Disjoint Sets:** Operations, Linked-list representation, Disjoint-set forests. **Advanced Design and Analysis Techniques: Greedy Algorithms:** An activity-selection Problem, Elements of greedy strategy, Huffman codes. **Dynamic Programming:** Matrix Chain multiplication, Optimal Binary Search Trees, **Amortized Analysis:** Aggregate analysis, The Accounting Method, The Potential Method.**Graph Algorithms: Elementary graph algorithms:** Representation of graphs, BFS, DFS, Topological Sort, Strongly connected components, **Minimum Spanning Trees**: The algorithms of Kruskal and Prim's. **Single-Source Shortest Paths**: The Bellman-Ford algorithm, Single source shortest paths in DAG's, Dijkstra's algorithm, **All-Pair Shortest paths**: Shortest paths and Matrix multiplication, Floyd-Warshall algorithm. **Maximum Flow:** Flow networks, The Ford-Fulkerson method, Maximum Bipartite matching. **String Matching:** The naïve string matching algorithm, Rabin-Karp algorithm, Knuth-Morris-Pratt algorithm. **NP-Completeness:** NP-Completeness and the classes P an NP, P, NP, and NP-Complete problems

Text Books:

1. Introduction to Algorithms, second edition, T.H.Cormen, C.E.Leiserson, R.L.Rivest, and C.Stein, PHI Pvt.Ltd./ Pearson Education

Reference Books:

1. Algorithm Design: Foundations,Analysis and Internet examples, M.T.Goodrich and R.Tomassia,John wiley and sons.
2. Fundamentals of Computer Algorithms,Ellis Horowitz,Satraj Sahni and S.Rajasekharam,Galgotia publications pvt. Ltd.
3. Introduction to Design and Analysis of Algorithms A strategic approach, R.C.T.Lee, S.S.Tseng, R.C.Chang and T.Tsai, Mc Graw Hill.
4. Data structures and Algorithm Analysis in C++, Allen Weiss, Second edition, Pearson education.
5. Design and Analysis of algorithms, Aho, Ullman and Hopcroft, Pearson education.

DISTRIBUTED DATABASE MANAGEMENT SYSTEM

Course Code :15 CS 5104 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Database Fundamentals: DBMS Characteristics & Advantages, Database Environment, Database Users, Database Architecture, Data Independence, Languages, Tools and Interface in DBMS, DBMS types, **Data Modeling:** ER Model, Notation used in ER Diagram, Constraint, Types, Relationships in ER Model and other considerations in designing ER diagram. Enhanced ER data Model, EER Diagram, Specialization and Generalization, Lattice, Union, Disjoint Properties, Constraints and relationships, Other issues in designing EER diagrams ,Relational Model, Relational Algebra, Operators in relational algebra, Algorithms for ER to relational mapping. Distributed databases features – distributed database management systems – Review of databases and computer networks. Levels of distribution transparency – reference architecture – types of data fragmentation – distributed transparency for read only applications and update applications – distributed database access primitives and integrity constraints. Distributed database design – a frame work for distributed database design – the design of database fragmentation – the allocation of fragments. Translational global queries to fragment queries – equivalence transformation for queries – transforming global queries into fragment queries – distributed grouping and aggregate function evaluation – parametric queries. Query optimization – problems in query optimization – objectives in query process optimization – similar representation of queries – model for query optimization – join query – general queries. Distributed transactions and concurrency control. Frame work for transaction management – properties and goals of transaction – atomicity of distributed transactions – recovery procedures – concurrency control for distributed transactions. Foundations of distributed concurrency control – distributed deadlocks – concurrency control based on time stamps.

TextBooks:

1. Elmasri and Navathe, 'Fundamentals of Database Systems', 2008, 4th edition, Pearson Education. '
2. Seri and Pelagatti, "Distributed databases principles and systems" ,McGraw Hill, 12th Edition.

Reference Books:

1. Raghuramakrishnan – "Database management system", 3/e, McGraw Hill.
2. Valduriez, Sridhar, Principles of Distributed Database Systems, 2/e, OZSU, , Pearson, 2001
3. Korth, Silberschatz, Sudershan Database System Concepts, 5/e, , TMH
4. P O' Neil, E O'Neil Data Base Principles, Programming, and Performance, 2/e, , Elsevier

SOFT COMPUTING

Course Code :15 CS 51A1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Intelligent systems and soft computing: Intelligence systems, Knowledge-based systems, knowledge representation and processing, soft computing. **Fundamentals of Fuzzy Logic Systems:** Fuzzy sets, Fuzzy logic operations, generalized operations, Fuzziness and fuzzy resolution, relations, composition and interface, considerations of fuzzy decision- making. **Fuzzy logic control: B**asics of fuzzy control, Fuzzy control architecture, Properties of fuzzy control, robustness and stability. **Fundamentals of artificial neural networks:** Learning and acquisition of knowledge, features of artificial neural networks, fundamentals of connectionist modeling. **Major classes of neural networks**: The multi-layer perceptrons, radial basis function networks, Kohonen's self-organizing network, The Hopfield network, industrial and commercial application of ANN. **Dynamic neural networks and their applications to control and chaos prediction:T**raining algorithms, fields of applications of RNN, dynamic neural networks for identification and control, neural network–based control approaches, dynamic neural networks for chaos time series, Artifical neural networks for chaos predictions. **Neuro Fuzzy Systems**: Architecture of Neuro fuzzy systems, construction of Neuro fuzzy systems. **Evolutionary computing:** Over view of Evolutionary computing, Genetic algorithms and optimization, the schema theorem: the fundamental algorithm of Genetic algorithms, operations, integration of Genetic algorithms with neural networks, integration of Genetic algorithms with fuzzy logic. Known issues in Genetic algorithms, population-based incremental learning, ES applications, Swarm Intelligence, Artificial Immune systems, simulated annealing, Rule Mining with Soft Computing.

Text Books:

1.Fakhreddine O. Karry, Clarence De Silva, ―Soft Computing and Intelligent systems
Design Theory, Tools and Applications‖ , Pearson, 2009

2. Introduction to Evolutionary Algorithms by Xinjie Yu · Mitsuo Gen, Springer

References:

1. Data Mining Multimedia, Soft Computing, and Bioinformatics by Sushmita Mitra, Tinku acharya, Wiley edition
2. S N Sivanandam, S N Deepa, ―Principles of Soft Computing‖ , Wiley India,2008
3. Laurene Fausett, ―Fundamentals of Neural Networks‖ , Pearson, 2004.
4. Timothy J Ross ―Fuzzy Logic with Engineering Applications‖ , 3rd Edition, Wiley, 2010.
5. Bart Kosko, ―Neural Networks and Fuzzy Systems‖ , PHI, 2004
6. Soft Computing: Methodologies and Applications (Advances in Intelligent and Soft Computing) by Frank Hoffmann, Mario Koeppen, Frank Klawonn and Rajkumar

MACHINE LEARNING AND PATTERN CLASSIFICATION

Course Code :15 CS 51A2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Supervised Learning, Bayesian Decision Theory, Parametric Methods, Multivariate Methods, Dimensionality Reduction. Clustering, Nonparametric Methods, Decision Trees, Linear Discrimination, Local Models, Kernel Machines. Bayesian Estimation, Hidden Markov Models, Bayesian Decision Theory. Pattern Classifications: Maximum-Likelihood and Bayesian Parameter Estimation,Nonparametric Techniques, Linear Discriminant Functions, Multilayer Neural Networks. Stochastic Methods, Nonmetric Methods, Algorithm-Independent Machine Learning,Unsupervised Learning and Clustering.

Text Books

1. Ethem Alpaydin, ―Introduction to Machine Learning‖ , The MIT Press, 2010
2. Stephen Marsland, ―Machine Learning an Algorithmic Perspective‖ , CRC Press, 2009.

References:

1. Richard O. Duda, Peter E. Hart, David G. Stork, ―Pattern Classification‖ , Wiley, 2012
2. Horst Bunke, Abraham Kandel, Mark Last, ―Applied Pattern Recognition―, Springer, 2008.
3. Russel and Norvig, 'Artificial Intelligence', Pearson Education, PHI, 2003
4. M. Narasimha Murty and V. Susheela Devi, Pattern Recognition.
5. NPTEL Web Course, 2011 (http://nptel.iitm.ac.in/courses.php?disciplineId=106).

DATA MINING

Course Code :15 CS 51A3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: What is Data Mining?, Motivating Challenges, The Origins of Data Mining, Data Mining Tasks, Scope and Organization of the Book . **Data:** Types of Data, Data Quality, Data Preprocessing, Measures of Similarity and Dissimilarity. **Exploring Data: t**he Iris Data Set Summary Statistics, Visualization, OLAP and Multidimensional Data Analysis. **Classification: Basic Concepts, Decision Trees, and Model Evaluation:** Preliminaries, General Approach to Solving a Classification Problem, Decision Tree Induction, Model Over fitting, Evaluating the Performance of a Classifier, Methods for Comparing Classifiers. **Classification: Alternative Techniques**: Rule-Based Classifier, Nearest-Neighbor Classifiers, Bayesian Classifiers, Artificial Neural Network (ANN), Support Vector Machine (SVM), Ensemble Methods, Class Imbalance Problem, Multi class Problem. **Association Analysis: Basic Concepts and Algorithms:** Problem Definition, Frequent Item set Generation, Rule Generation, Compact Representation of Frequent Item sets, Alternative Methods for Generating Frequent Item sets, FP-Growth Algorithm, Evaluation of Association Patterns, Effect of Skewed Support Distribution. **Association Analysis: Advanced Concepts:** Handling Categorical Attributes, Handling Continuous Attributes, Handling a Concept Hierarchy, Sequential Patterns, and Sub graph Patterns, Infrequent Patterns. **Cluster Analysis: Basic Concepts and Algorithms:** Overview, K-means, Agglomerative, Hierarchical Clustering, DBSCAN, Cluster Evaluation. **Anomaly Detection:** Preliminaries, Statistical Approaches, Proximity-Based Outlier Detection, Density-Based Outlier Detection, Clustering-Based Techniques. **Cluster Analysis: Additional Issues and Algorithms:** Characteristics of Data, Clusters, and Clustering Algorithms, Prototype-Based Clustering, Density-Based Clustering, Graph-Based Clustering, Scalable Clustering Algorithms, Which Clustering Algorithm.

Text Book:

1. Introduction to Data Mining, BY Pang-Ning Tan / Michael Steinbach / Vipin Kumar, Pearson Education

References:

1. J. Han, M Kamber, “Data Mining: Concepts and Techniques”, second edition, Elsevier, New Delhi, 2006.
2. Dunham M, "Data Mining: Introductory and Advanced Topics”, Prentice Hall, New Delhi, 2002.
3. Hand.D, Mannila H, Smyth.P, “Principles of Data Mining”, MIT press, USA,2001.

NATURAL LANGUAGE PROCESSING

Course Code :15 CS 51A4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Mathematical Foundations, Linguistic Essentials, Corpus-Based Work. **Words:** Collocations, Statistical Inference: n-gram Models over Sparse Data, Word Sense Disambiguation, Lexical Acquisition. **Grammar:** Markov Models, Part-of-Speech Tagging, Probabilistic Context Free Grammars, probabilistic parsing. **Applications and Techniques:** Statistical Alignment and Machine Translation, Clustering, Topics in Information Retrieval, Text Categorization. A Comprehensive Mathematical Framework for the Development of Semantic Technologies, Formal Methods and Algorithms for the Design of Semantics-Oriented Linguistic Processors. **Structural Discovery in Natural Language Processing:** Graph Models, Small words of Natural Language, Graph Clustering, Unsupervised Language Separation. Unsupervised Part-of-Speech Tagging, Word sense Induction and Disambiguation, Graph Based Natural Language Processing.

Text Books:

1. Christopher D Manning, Hinrich Schutze, ―Foundations of Statistical Natural Language Processing‖ , MIT Press, 2003.
2. Semantics-Oriented Natural Language Processing by Vladimir A. Fomichov, Springer publications

References:

1. Structure Discovery in Natural Language by Chris Biemann, Springer publications
2. Graph-based Natural Language Processing and Information Retrieval by Rada Mihalcea, Dragomir Radev, Cambridge Publications
3. Lucja M Iwanska, Stuart C Shapiro, ―Natural Language Processing And Knowledge Representation: Language For Knowledge And Knowledge For Language‖ , AAAI Press, 2000.
4. Anne Kao, Stephen R Poteet, ―Natural Language Processing and Text Mining‖ , Springer, 2010.
5. Daniel Jurafsky, James H Martin, ―Speech and Language Procesing‖ , Pearson, 2000
5. James Allen, ―Natural Language Understanding‖ , 2nd Edition, Pearson, 2008.

REQUIREMENTS ENGINEERING

Course Code :15 CS 51B1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

View of Domain- Engineering, Stack Holders, Facets, Process Engineering Model. Requirement Engineering, Requirement Facets, the Requirements Engineering Models, Modeling and Models, Jacksons Description Principles, Domain- Attributes, Acquisition, Domain Analysis And Concepts Formation, Validation And Verification. Requirement -Stockholders, Acquisition, Analysis And Concept Formation, Verification And Validation, Satisfiability And Feasibility, Hardware/Software Co -Design, Software Architecture Design. Quality Assurance in Requirements Management, Planning for Requirements Management, Requirements Change Management, Requirements Tracing, Tracking and Reporting, Measurement and Metrics. Roles and Responsibilities in REM, Requirements Management through SDLC, Tools and Techniques for Requirements Engineering and Management and Pitfalls and Best Practices.

Text Books:

1. Dines Bjorner, Software Engineering Vol-3, Do mains, Requirements, Software Design, Springer, 2005.
2. Murali Chemuturi , "Requirements Engineering and Management for Software Development Projects ",Springer, 2013.

References:

1. The Requirements engineering handbook by Ralph R Young, Artech House, 2004.
2. Dines Bjorner, Software Engineering Vol-2, Do mains, Requirements, Software Design, Springer, 2004.
3. Pohl, Klaus, "Requirements Engineering: Fundamentals, Principles, and Techniques", Springer, 2010.

PRINCIPLES OF PROGRAMMING LANGUAGES

Course Code :15 CS 51B2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Describing Syntax and Semantics: Introduction, The General Problem of Describing Syntax, Formal Methods of Describing Syntax, Attribute Grammars, Describing the Meaning of Programs. **Lexical and Syntax Analysis:** Introduction, Lexical Analysis, The Parsing Problem, Recursive – Descent Parsing, Bottom – Up Parsing. **Names, Binding, Type Checking, and Scopes:** Introduction, Names, Variables, The Concept of Binding, Type Checking, Strong Typing, Type Compatibility, Scope, Scope & Lifetime, Referencing Environments, named Constants. **Data Types:** Introduction, Primitive Data Types, Character String Types, User – Defined Ordinal Types, array Types, associate Arrays, Record Types, Union Types, pointer & Reference Types. **Expressions and Assignment Statements:** Introduction, Arithmetic Expressions, Overloaded Operators, Type Conversions, Relational & Boolean Expressions, Short – Circuit Evaluation, Assignment Statements, Mixed – mode Assignment. **Statement-Level Control Structure:** Introduction, Selection Statements, iterative Statements, Unconditional Branching, Guarded Commands. **Subprograms:** Introduction, Fundamentals of Subprograms, Design Issues for Subprograms, Local Referencing Environments, Parameter – Passing Methods, Parameters That Are Subprogram Names, Overloaded Subprograms, Generic Subprograms, Design Issues for Functions, user-Defined Overloaded Operators, Co routines. **Implementing Subprograms: Abstract Data Types And Encapsulation Constructs:** The Concept of Abstraction, Introduction to Data Abstraction, Design Issues for Abstract Data Types, Language Examples, Parameterized Abstract Data Types, Encapsulation constructs, Naming Encapsulations. **Support for Object-Oriented Programming:** Introduction, Object-Oriented Programming, Design Issues for Object-Oriented Languages, Support for Object-Oriented Programming in Smalltalk, Support for Object-Oriented Programming in c++, Support for Object-Oriented Programming in Java, for Object-Oriented Programming in C#, for Object-Oriented Programming in Ada 95, The Object Model of JavaScript, Implementation of Object-Oriented Constructs. **Functional Programming Languages:**. **Logic Programming Languages:** Introduction, A Brief Introduction to Predicate Calculus, Predicate Calculus & Proving Theorems, An Overview of Logic Programming, The Origins of Prolog, the Basic Elements of Prolog, The Deficiencies of Prolog, applications of Logic Programming.

Textbooks:

1. 'Concept of Programming Languages', Robert W, Sebesta, Seventh Edition Pearson.

References:

1. Programming languages - Glezzi, 3/E, john wiley
2. Programming Languages Design and Implementation- Pratt and Zelkowitz, `4th edition, PHI/Person education.
3. Programming in PROLOG – clocksin, springer.

COMPILER DESIGN

Course Code :15 CS 51B3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Overview of Compilation, Scanners, Parsers. Context-Sensitive Analysis, Intermediate Representations. The Procedure Abstraction, Code shape. Introduction to Optimization, Data-Flow Analysis, Scalar Optimization. Instruction Selection, Instruction Scheduling , Register Allocation.

Text Book:

1. Keith Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann Publishers, 2004.

References:

1. Advanced Compiler Design Implementation by Steven S. Muchnick, Morgan Kaufmann, 1997.
2. Alfred Aho, Monica S. Lam, Ravi Sethi, Jeffrey D Ullman, “Compilers Principles, Techniques and Tools”, 2nd edition, Pearson Education, 2012.
3. Allen I. Holub “Compiler Design in C”, Prentice Hall of India, 2003.
4. N. Fischer and R. J. LeBlanc, “Crafting a compiler with C”, Benjamin Cummings, 2003.
5. C.D Brown, J Levine, T Mason, “LEX and YACC”, O’Reilly Media, 1992.
6. Henk Alblas and Albert Nymeyer, “Practice and Principles of Complier Building with C”, PHI, 2001.
7. Parag Himanshu Dave, Himanshu Bhalchandra Dave, “Compilers: Principles and Practice”, 1st Edition, Pearson.

SOFTWARE TESTING AND QUALITY ASSURANCE

Course Code :15 CS 51B4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Basic Concepts and Preliminaries, Theory of Program Testing, Unit Testing, Control Flow Testing, Data Flow Testing, Domain Testing. System Integration Testing, System Test Categories, Functional Testing, Test Generation from Fsm Models. System Test Design, System Test Planning and Automation, System Test Execution, Acceptance Testing, Test Team Organization. Organizing for Quality Management, Commercial and Governmental Standards for Use in Software Quality Assurance, Personnel Requirements to Make Software Quality Assurance Work, Training for Quality Management, The Pareto Principle Applied to Software Quality Assurance, Inspection as an Up-Front Quality Technique, Software Audit Methods. Software Safety and Its Relation to Software Quality Assurance, CMMI PPQA Relationship to SQA, SQA for Small Projects, Development Quality Assurance, Quality Management in IT, Costs of Software Quality.

Textbook:

1. Kshirasagar Naik, Priyadarshi Tripathy Software Testing and Quality Assurance Theory and Practice John Wiley & Sons, Inc., Publication
2. G. Gordon Schulmeyer Handbook of Software Quality Assurance Fourth Edition 2008 Artech House.

References:

1. Ilene Burnstein Practical Software Testing Springer 2003
2. William E. Lewis Software Testing and Continuous Quality Improvement Second Edition AUERBACH PUBLICATIONS
3. Jeff Tian Software Quality Engineering Testing, Quality Assurance, and Quantifiable Improvement JOHN WILEY.

OPERATING SYSTEM DESIGN

Course Code :15 CS 5205 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction, The Operating System Interface , Implementing Processes ,Interposes Communication, Processes, Memory ,Virtual Memory , Virtual Memory ,IO Devices , IO Systems ,File Systems , File System Organization , Resource Management, Design Techniques for Two level implementation, Interface design, Models of communication, Static versus dynamic tradeoffs, Caching, Hinting, Indirection

Text Book:

1. Charles Crowley, "Operating Systems: A Design-Oriented Approach", TMH,1998 edition.

References:

1. Silberschatz & Galvin, "Operating System Concepts", 8thedition, John Wiley & Sons Inc,
2. William Stallings, "Operating Systems – Internals and Design Principles", 5/e, Pearson.
3. Andrew S. Tanenbaum, "Modern Operating Systems",2nd Edition, Pearson Edu., 2004.
4. Gary Nutt, "Operating Systems", Third Edition, Pearson Education, 2004.
5. Harvey M. Deital, "Operating Systems", Third Edition, Pearson Education, 2004.

COMPUTER NETWORKS AND SECURITY

Course Code :15 CS 5206 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Computer Networks and the Internet , Application Layer,. Transport Layer, The Network Layer. The Link Layer: Links, Access Networks, and LANs, Congestion Control and Resource Allocation. Introduction to Network Security**:** Attacks, services, Security. A model of Inter network Security, Principles of Symmetric and public key cryptography, Steganography, One time PADS., E-Mail Security: PGP, SMIME, Intruders, Intrusion Prevention and Detection: Introduction, Prevention versus Detection, Types of Intrusion Detection systems, DoS Attack Prevention/Detection, Malware Defense.

Textbooks:

1. Kurose, J. and Ross, K. ,2012. Computer Networking: A Top-Down Approach (6th edition). Addison-Wesley.

Reference Books:

1. Peterson, L.L. and Davie, B.S. 2012. Computer Networks -- A Systems Approach. (5th edition), Morgan Kaufmann, Elsevier.
2. Comer, D.E. (2004). Computer Networks and Internets with Internet Applications. (4th edition). Prentice Hall.
3. Comer, D.E. 1995. Internetworking with TCP/IP vol. I. (3rd edition). Prentice Hall. ,5th edition, 2006.
4. anenbaum, Computer Networks, 4th Edition, (Pearson Education / PHI).

OBJECT ORIENTED ANALYSIS AND DESIGN

Course Code :15 CS 5207 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: software engineering and failures, software engineering concepts, software engineering development activities, manging software development, ARENA case study. **Project organization and communication**: introduction, an overview of projects, project organization concepts, project communication concepts, organizational activities. **Requirements Elicitation**:introduction,overview , concepts,activities, managing requirements Elicitation, ARENA case study. **analysis:** introduction,overview, concepts, activities, managing analysis, ARENA case study. **System design: decomposing the system-**introduction, overview, concepts, activities, managing system design, ARENA case study. **Object design: reusing pattern solutions**- introduction, overview, reuse concepts, reuse activities, managing reuse, ARENA case study. **Object design: specifying interfaces**- introduction, overview, concepts, activities, managing object design, ARENA case study,**Introducing to UML, Unified Process, Requirements** : The Requiements overflow, use case moeling, **advanced use case modeling Analysis**: The analysis workflow, Objects and classes, finding analysis classes, Relationships, inheritance and polymorphism, Analysis packages, use case realization, Activity diagrams.**Design:** The design workflow, design classes, refining analysis relationships, interfaces and components, use case realization - design, state machines. **Implementation**: The implementation workflow, deployment, **mapping models to code:** introduction, overview, concepts, activities, managing implmentation, ARENA case study. **Testing**: introduction, overview, concepts, activities, managing testing. **Rationale managements**: introduction, overview, concepts, activities, managing rationale, **configuration management**: introduction, overview, concepts,activities, managing configuration management.

Text Books

1. Bernd Bruegge Allen H.Dutoit "Object Oriented Software Engineering using UML,patterns and Java", Third Edition,Pearson Education
2. Jim Arlow,Ila Neustadt,"UML 2 and the Unified Process- Practical Object Oriented Analysis and Design",Pearson Education,Second Edition.

Reference Books

1. G. Booch, Object Oriented Analysis and Design with Applications 2/e Pearson
2. C. Larman, Applying UML and patterns, Pearson
3. R. Fairly, Software Engineering, Mc Graw Hill Publishing Co.
4. G. Booch, J.Rumbaugh, J. Jacobson, The Unified Modeling Language –User Guide Addison – Wesley
5. C.Ghezzi,M. Jazayeri and D. Mandrioli, Fundaments of Software Engineering prentice Hall of India, Ltd.
6. R.S Pressman, Software Engineering: A Practitioner's Approach, 5/e, Mc Graw Hill International Edition

ENTERPRISE PROGRAMMING

Course Code :15 CS 5208 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to XHTML, Cascading Style Sheets (CSS), JavaScript: Introduction to Scripting, Control Statements Part 1, Control Statements Part 2, Functions, Arrays, Objects. Dynamic HTML: Object Model and Collections, Dynamic HTML: Event Model, XML, RSS, Web Servers (IIS and Apache). Java EE Essentials, J2EE Multi-Tier Architecture, Advanced JSP topics, Java Server Faces, Working with Databases, Advanced topics in JDBC. EJB Fundamentals and Session Beans, EJB Entity Beans, Message Driven Beans, EJB Relationships, EJB QL, and JDBC. Design Patterns and EJB. J2EE Design patterns and Frameworks: Pattern Catalog-Handle-Forward pattern, Translator pattern, Distributor pattern, Broadcaster pattern, Zero sum pattern, Status Flag Pattern, Sequencer pattern, Behavior Separation pattern, Consolidator pattern, Simplicity pattern, Stealth Pattern. Web Services and JAX-WS. Java Mail API, Java Interface Definition Language and CORBA, Java Remote Method Invocation, Java Messaging Service, Java Naming and Directory Interface API.

Textbooks:

1. Beginning Java EE 5 From Novice to Professional by Kevin Mukhar, James L. Weaver, Jim Crume, Chris Zelenak, publisher: Apress, 2005 Edition.
2. J2EE: The complete reference by James Keogh, publisher: McGraw-hill Osborne Media; 1 editon.

References:

1. An Introduction to Network Programming with Java by Jan Graba, Publisher: Springer, 2nd edition, 2006.
2. Beginning Java EE 6 platform with GlassFish 3 From Novice to Professional by Antonio Goncalves, 2009, Apress Publisher.

CRYPTOGRAPHY AND NETWORK SECURITY

Course Code :15 CS 52C1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Basic Cryptographic Techniques: Encryption — Symmetric Techniques: Substitution Ciphers, Transposition Ciphers, Classical Ciphers: Usefulness and Security, The Data Encryption Standard (DES), The Advanced Encryption Standard (AES), Confidentiality Modes of Operation, Key Channel Establishment for Symmetric Cryptosystems. **Encryption — Asymmetric Techniques:** Insecurity of "Textbook Encryption Algorithms", The Diffie-Hellman Key Exchange Protocol, The Diffie-Hellman Problem and the Discrete Logarithm Problem**,** The RSA Cryptosystem (Textbook Version)**,** Cryptanalysis Against Public-key Cryptosystems**,** The RSA Problem**,** The Integer Factorization Problem**,** Insecurity of the Textbook RSA Encryption**,** The Rabin Cryptosystem (Textbook Version)**,** Insecurity of the Textbook Rabin Encryption**,** The ElGamal Cryptosystem (Textbook Version)**,** Insecurity of the Textbook ElGamal Encryption**,** Need for Stronger Security Notions for Public-key Cryptosystems, Combination of Asymmetric and Symmetric Cryptography, Key Channel Establishment for Public-key Cryptosystems. **Authentication Protocols — Principles:**. **Hash and Message Digests:** MD5, SHA1, HMAC. **Authentication Framework for Public-Key Cryptography:**Directory-Based Authentication, Non-Directory Based Public-key Authentication Framework. **Formal Approaches to Security Establishment- Formal and Strong Security Definitions for Public-Key Cryptosystems:** Introduction, A Formal Treatment for Security, Semantic Security — the Debut of Provable Security, Inadequacy of Semantic Security, Beyond Semantic Security. **Provably Secure and Efficient Public-Key Cryptosystems:** Introduction, The Optimal Asymmetric Encryption Padding, The Cramer-Shoup Public-key Cryptosystem, An Overview of Provably Secure Hybrid Cryptosystems. **Formal Methods for Authentication Protocols Analysis,Zero-Knowledge Protocols:** Basic Definitions**,** Zero-knowledge Properties Proof or Argument, Protocols with Two-sided-error, Round Efficiency, Non-interactive Zero-knowledge. **Network Security Standards:**

Text Books:

1. Modern Cryptography Theory and Practice, Wenbo Mao, Pearson Education 2008
2. Network Security: Private Communication in a Public World, Charlie Kaufman, Radia Perlman Mike Speciner, Prentice Hall 2/E.(**Hash and Message Digests, Unit V**)

References:

1. Cryptography and Network Security, William Stallings, 4/E Publisher: Prentice Hall
2. Information Security Principles & Practice, Mark Stamp, WILEY INDIA 2006.
3. Cryptography & Network Security by Behrouz A. Forouzan, TMH 2007.
4. Network Security: The complete reference, Robert Bragg, Mark Rhodes, TMH
5. Computer Security Basics by Rick Lehtinen, Deborah Russell & G.T.Gangemi Sr., SPD O'REILLY 2006.
6. Network Security Essentials (Applications and Standards) by William Stallings, Pearson

Education.

MOBILE COMPUTING

Course Code :15 CS 52C2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

An Overview of Wireless Systems, Teletraffic Engineering, Radio Propagation and Propagation Path-Loss Models. An Overview of Digital Communication and Transmission, Fundamentals of Cellular Communications. Multiple Access Techniques, Architecture of a Wireless Wide-Area Network (WWAN), Speech Coding and Channel Coding. Modulation Schemes, Antennas, Diversity, and Link Analysis, Spread Spectrum (SS) and CDMA Systems. Mobility Management in Wireless Networks, Security in Wireless Systems, Security in Wireless Systems.

Textbooks:

1. Vijay K. Garg WIRELESS COMMUNICATIONS AND NETWORKING Morgan Kaufmann Publishers 2007

References:

1. Anurag Kumar, D. Manjunath and Joy Kuri WIRELESS NETWORKING Morgan Kaufmann Publishers

HIGH PERFORMANCE COMPUTING

Course Code :15 CS 52C3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Migrating into a Cloud, Enriching the 'Integration as a Service' Paradigm for the cloud era, Enterprise cloud computing paradigm, Infrastructure as a Service (Iaas): Virtual Machines provisioning and migration services, management of virtual machines for cloud infrastructures, Enhancing Cloud Computing Environments Using a Cluster as a Service, Secure distributed data storage. PaaS & IaaS, Integration of Private and Public Clouds, Cometcloud, Workflow Engine, Scientific applications for Cloud Environments, The Map Reduce Programming Model and Implementations. Monitoring and Management: An Architecture for federated cloud computing, SLA management in cloud computing, performance prediction for HPC on Clouds, Applications in the AWS Cloud, Online game hosting on cloud resources, Content delivery networks, Organizational readiness and change management, Data Security and Legal Issues, Achieving Production Readiness for Cloud Services. Technologies and Applications, Key Enabling Technologies for Virtual Private Clouds, Role of Networks and Grid Computing Technologies, Data-Intensive Technologies, Storage and Fault Tolerance Strategies, Adaptive Agent Based Approach, Cloudweaver, Enterprise Knowledge Clouds, Integration of High-Performance Computing into Cloud Computing Services, Vertical Load Distribution for Cloud Computing, HPC on Competitive Cloud Resources, Scientific Data Management.

Text Books:

1. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski,"Cloud Computing Principles and Paradigms", Wiley (2011).
2. Furht B., Escalante A, "Handbook of cloud computing", Springer (2010).

References:

1. Syed A. Ahson, Mohammad Ilyas, "Cloud Computing and Software Services Theory and Techniques", CRC Press, 2010.
2. Jack J Dongarra, Kavi Hawng, Geoffrey C Fox, ―Distributed and Cloud Computing", Elsevier, 2012.
3. Sitaram, Manjunath, "Moving to the Cloud", Elsevier, 2011.
4. Nick Antonopoulos, Lee Gillam, "Cloud Computing Principles Systems And Applications", Springer, 2012.
5. Tom White, "Hadoop: The Definitive Guide", O'Reilly.

NETWORK MANAGEMENT SYSTEMS

Course Code :15 CS 52C4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Data communications and Network Management Overview : Analogy of Telephone Network Management, Communications protocols and Standards, Case Histories of Networking and Management, Challenges of Information Technology Managers, Network Management: Goals, Organization, and Functions, Network and System Management, Network Management System Platform, Current Status and future of Network Management.
SNMPV1 Network Management : Organization and Information and Information Models. Managed network : Case Histories and Examples, The History of SNMP Management, The SNMP Model, The Organization Model, System Overview, The Information Model.
SNMPv1 Network Management : Communication and Functional Models. The SNMP Communication Model, Functional model.
SNMP Management: SNMPv2 : Major Changes in SNMPv2, SNMPv2 System Architecture, SNMPv2 Structure of Management Information, The SNMPv2 Management Information Base, SNMPv2 Protocol, Compatibility With SNMPv1.
SNMP Management : RMON : What is Remote Monitoring? , RMON SMI and MIB, RMON1, RMON2, ATM Remote Monitoring, A Case Study of Internet Traffic Using RMON
Telecommunications Management Network : Why TMN? , Operations Systems, TMN Conceptual Model, TMN Standards, TMN Architecture, TMN Management Service Architecture, An Integrated View of TMN, mplementation Issues.
Network Management Tools and Systems:Network Management Tools, Network Statistics Measurement Systems, History of Enterprise Management, Network Management systems, Commercial Network management Systems, System Management, Enterprise Management Solutions.
Web-Based Management: NMS with Web Interface and Web-Based Management, Web Interface to SNMP Management, Embedded Web-Based Management, Desktop management Interface, Web-Based Enterprise Management, WBEM: Windows Management Instrumentation, Java management Extensions, Management of a Storage Area Network: , Future Directions.

TEXT BOOK : 1. Network Management, Principles and Practice, Mani Subrahmanian, Pearson Education.

REFERENCES: 1. Network management, Morris, Pearson Education. 2. Principles of Network System Administration, Mark Burges, Wiley Dreamtech. 3. Distributed Network Management, Paul, John Wiley.

SERVICE ORIENTED ARCHITECTURE

Course Code :15 CS 52D1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Computing with Services-Basic Standards for Web Services, Programming Web Services, Enterprise Architectures, Principles of Service-Oriented Computing, Description- Modeling and Representation, Resource Description Framework, Web Ontology Language, Ontology Management, Engagement- Execution Models, Transaction Concepts, Coordination Frameworks for Web Services, Process Specifications, Formal Specification and Enactment. Collaboration-Agents, Multiagent Systems, Organizations, Communication, Solutions- Semantic Service Solutions, Social Service Selection, Economic Service Selection, Engineering- Building SOC Applications, Service Management, Security, Directions- Challenge and Extensions. On The Impact of AOSE In Service-Oriented Computing, Testing Object-Oriented Software. SOA — Architecture Fundamentals, Designing Service Interfaces, Designing Service Implementations, Composing Services , Using Services to Build Enterprise Solutions. Enterprise Service Bus: JDO, Data Services, Service Data Objects, Service Component Architecture, Message-Oriented Middleware, Enterprise Service Bus, Business Process Enterprise Language (BPEL). **Service Inventory Design Patterns**: Foundational Inventory Patterns, Logical Inventory Layer Patterns, Inventory Centralization Patterns, Inventory Implementation Patterns, Inventory Governance Patterns, **And Service Design Patterns**

Text Books:

1. Munindar P. Singh, Michael N. Huhns, “Service-Oriented Computing: Semantics, Processes, Agents”, John Wieley, 2005.
2. Andrea De Lucia, Filomena Ferrucci, Genny Tortora, Maurizio Tucc, “Emerging Methods, Technologies and Process Management in Software Engineering”, Wiley, 2008.

References:

1. Nathan Griffiths, Kuo-Ming Chao, “Agent-Based Service-Oriented Computing”, Springer, 2010.
2. Michael Rosen, Boris Lublinsky, Kevin T. Smith, Marc J. Balcer, “Applied SOA: Service-Oriented Architecture and Design Strategies”, Wiley, 2010.
3. Binildas A. Christudas, Malhar Barai, “Service Oriented Architecture with Java”, Packt publishing, 2008.
4. Thomas Erl, “SOA Design Patterns”, Pearson , 2009.
5. Douglas K. Barry, “Web Services, Service-Oriented Architectures, and Cloud Computing”, Elsevier, 2003.
6. James Bean, “SOA and Web Services Interface Design: Principles, Techniques, and Standards”, Elsevier, 2010.

VISUAL PROGRAMMING

Course Code :15 CS 52D2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

The Internet and Visual C#, Dive Into Visual C# 2010 Express. Introduction to C# Applications, Introduction to Classes, Objects, Methods and strings, Control Statements. Methods: A Deeper Look, Arrays, Introduction to LINQ and the List Collection, Classes and Objects: A Deeper Look. Object-Oriented Programming: Inheritance, OOP: Polymorphism, Interfaces and Operator Overloading, Exception Handling: A Deeper Look. graphical User Interfaces with Windows Forms, Strings and Characters, Files and Streams, Databases and LINQ, Web App Development with ASP.NET.

Textbook:

1. Visual C# 2012 How to Program by Paul Deitel, Harvey Deitel, Prentice Hall; 5 edition.

References:

1. Starting Out With Visual Basic 2008 Update, 4th Edition, By Tony Gaddis, Kip R. Irvine, Published by Addison-Wesley Copyright © 2010.
2. Starting Out With Visual Basic 2010, 5th Edition, By Tony Gaddis, Kip R. Irvine, Published by Addison-Wesley, Copyright © 2011.

DIGITAL IMAGE PROCESSING

Course Code :15 CS 52D3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

FUNDAMENTALS: Digital image Representation, Fundamental steps in Image processing, Elements of Digital Image processing systems. Elements of Visual perception, Sampling and Quantization, Basic relationships between pixels. Imaging geometry, basic transformations, perspective transformation. **IMAGE TRANSFORMATION:** Image transforms, Fourier transform, Discrete Fourier transform, properties of 2D Fourier transform, FFT, Walsh Transform, Hadamard Transform, Discrete Cosine Transform, Haar, Slant, Hotelling Transforms, KL transform – Wavelet Transform. **IMAGE ENHANCEMENT AND RESTORATION TECHNIQUES:** Image Enhancement**,** Spatial Domain and Frequency domain enhancement methods – Histogram processing, Color image processing, Image restoration, Degradation model, Diagonalisation of restoration, Inverse filtering, Wiener Filter, Constrained Least squares restoration, Interactive Restoration, Restoration in the spatial Domain, Geometric transformation. **IMAGE COMPRESSION TECHNIQUES:** Image Compression, Redundancy, fidelity Criteria, Image compression models, Elements of Information Theory – Lossless and Lossy image compression, Fractal and wavelet image compression, Image compression standards, Data Compression, Huffman coding, Arithmetic coding, Dictionary Based Techniques, Static Dictionary, Adaptive Dictionary, Predictive coding, Differential coding, Transform coding, Subband coding. **IMAGE ANALYSIS:** Image segmentation, Detection of Discontinuities, Edge linking and boundary detection, Thresholding, Region-oriented segmentation, use of motion in segmentation, Image representation and description, representation schemes, Boundary descriptors, regional descriptors, Morphology

Textbook:

Rafael C. Gonzalez, Richard E Woods, “Digital Image Processing”, third edition, Pearson Education, New Delhi, 2007.

References:

1. Pratt, “Digital Image Processing”, John Wiley & sons, New York, 2004.
2. Anil K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall, New Delhi, 1988.

BIG DATA ANALYTICS

Course Code :15 CS 52D4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Big Data, Complexity of Big Data, Big Data Processing Architectures, Big Data Technologies, Big Data Business Value, Data Warehouse, Re-Engineering the Data Warehouse, Workload Management in the Data Warehouse, New Technology Approaches. Integration of Big Data and Data Warehouse, Data Driven Architecture, Information Management and Lifecycle, Big Data Analytics, Visualization and Data Scientist, Implementing The "Big Data" Data. Choices in Setting up R for Business Analytics, R Interfaces, Manipulating Data, Exploring Data, Building Regression Models, Clustering and Data Segmentation, Forecasting and Time Series Models. Writing Hadoop Map Reduce Programs, Integrating R and Hadoop, Using Hadoop Streaming with R, Learning Data Analytics with R and Hadoop, Understanding Big Data Analysis with Machine Learning. Big Data, Web Data, A Cross-Section of Big Data Sources and the Value They Hold, Taming Big Data, The Evolution of Analytic Scalability, The Evolution of Analytic Processes, The Evolution of Analytic, Processes The Evolution of Analytic Tools and Methods. Legacy Data, Hypothesis Testing, Prediction, Software, Complexity, Business problems suited to big data analytics, High Performance Appliances for Big Data Management, Using Graph analytics, The New Information Management Paradigm, Big Data's Implication for Businesses, Big Data Implications for Information Management, Splunk's Basic Operations on Big Data.

Textbooks:

1. Data Warehousing in the Age of Big Data by Krish Krishnan, Morgan Kaufmann.
2. A.Ohri, “R for Business Analytics”, Springer, 2012.

References:

1. Big Data Analytics with R and Hadoop by Vignesh Prajapati
2. Principles of Big Data Preparing, Sharing, and Analyzing Complex Information, 1st Edition, by J Berman, published by Morgan Kaufmann
3. “Big Data Analytics - From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph” By David Loshin, Morgan Kaufmann
4. Big Data Imperatives: Enterprise 'big Data' Warehouse, 'BI' Implementations and Analytics by Soumendra Mohanty, Apress
5. Big Data Analytics Using Splunk By Peter Zadrozny , Raghu Kodali, Apress 2013
6. Franks, Bill, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, Wiley, 1st Edition, 2012.
7. Big Data Application Architecture Q&A: a Problem - Solution Approach Nitin Sawant, Himanshu Shah
8. Big Data Now: Current Perspectives from O'Reilly Radar By O'Reilly Radar Team

M.TECH - COMPUTER NETWORKS & SECURITY

First Year (First Semester):

S. No.	Course Code	Course Title	Periods L	T	P	Credits
1	15 CS 5109	Data Networks	**3**	**2**	**0**	4
2	15 CS 5110	Network Programming	**3**	**0**	**2**	4
3	15 CS 5111	Applied Cryptography	**3**	**0**	**2**	4
4	15 CS 5112	Secure Coding	**3**	**2**	**0**	4
5		Elective – 1	3	0	0	3
6		Elective - 2	3	0	0	3
7	15 IE 5149	Seminar	0	0	4	2
		Total	**18**	**4**	**8**	**24**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods L	T	P	Credits
1	15 CS 5213	Performance Analysis of Computer Networks	**3**	**2**	**0**	4
2	15 CS 5214	Wireless Networks & Mobile Computing	**3**	**0**	**2**	4
3	15 CS 5215	Network and Cyber Security	**3**	**0**	**2**	4
4	15 CS 5216	Wireless Network Security	**3**	**2**	**0**	4
5		Elective – 3	3	0	0	3
6		Elective - 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
Total			**18**	**4**	**8**	**24**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods L	T	P	Credits
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods L	T	P	Credits
Elective-1						
1	15 CS 51E1	Network Routing	3	0	0	3
2	15 CS 51E2	Network Optimization	3	0	0	3
3	15 CS 51E3	Simulation of Computer Network	3	0	0	3
4	15 CS 51E4	Programming Mobile Devices	3	0	0	3
Elective-2						
1	15 CS 51F1	Storage Area Networks	3	0	0	3
2	15 CS 51F2	Adhoc Networks	3	0	0	3
3	15 CS 51F3	Cognitive Radio Networks	3	0	0	3
4	15 CS 51F4	Sensor Networks	3	0	0	3
Elective-3						
1	15 CS 52G1	Secure Protocols Design	3	0	0	3
2	15 CS 52G2	Distributed System Security	3	0	0	3
3	15 CS 52G3	Elliptic Curve Cryptography	3	0	0	3
4	15 CS 52G4	Cyber forensics	3	0	0	3
Elective-4						
1	15 CS 52H1	Information Systems Control and Audit	3	0	0	3
2	15 CS 52H2	Intrusion Detection And Prevention System	3	0	0	3

3	15 CS 52H3	Cryptanalysis	3	0	0	3
4	15 CS 52H4	Cyber Security	3	0	0	3

DATA NETWORKS

Course Code :15 CS 5109 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction Concepts: Goals and Applications of Networks, Network structure and architecture, The OSI reference model, services, Network Topology Design ,Back Bone Design, Local Access Network Design, Physical Layer Transmission Media, Switching methods, ISDN, Terminal Handling. Medium Access sub layer: Medium Access sub layer - Channel Allocations, LAN protocols, Overview of IEEE standards, Elementary Data Link Protocols, Sliding Window protocols, Error Handling. Network Layer: Network Layer - Point - to Pont Networks, routing, Congestion control Internetworking -TCP / IP, IP packet, IP address, IPv4, IPv6, Comparison of IPv4 and IPv6 Headers. Transport Layer: Transport Layer - Design issues, connection management, session Layer- Design issues, remote procedure call. Presentation Layer-Design issues, Application Layer: File Transfer, Access and Management, Electronic mail, Virtual Terminals, Other application. Example Networks - Internet and Public Networks.

Text Book

1. Kurose, J and Ross, K Computer Networking: A Top-Down Approach Addison-Wesley- 6th edition-2012
2. Behrouz A. Forouzan , "Data Communication and Networking", TMH, 5th Edition 2012

References

1. Andrew S. Tanenbaum, David J.Wetheral “Computer Networks” Pearson, 5th –Edition-2011
2. W Stallings “Data and Computer Communication” Macmillan Press- 12th –Edition
3. Peterson, LL and Davie, BS (2012) Computer Networks -- A Systems Approach 5th edition, Morgan Kaufmann, Elsevier
4. Comer, DE Computer Networks and Internets with Internet Applications ,4th edition,

Prentice Hall (Most recent edition is 5th edition, 2009
5. Comer, DE ,Internetworking with TCP/IP vol I ,3rd edition, Prentice Hall Most recent edition is 5th edition, 2006
6. Tanenbaum, Computer Networks, 4th Edition,PHI

NETWORK PROGRAMMING

Course Code :15 CS 5110 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Posix IPC, System V IPC, Pipes and FIFOs, Posix Message Queues, System V Message Queues, Posix Semaphores, System V Semaphores, Shared Memory Introduction, Posix Shared Memory, System V Shared Memory, Doors, Sockets Introduction, Elementary TCP Sockets, TCP Client/Server Example, I/O Multiplexing**,** The select and poll Functions Socket Options, Elementary UDP Sockets, Name and Address Conversions, and Functions, Sun RPC, XDR, UNIX Domain Protocols, Routing Sockets, Threads Raw Sockets

Text Books

1. UNIX Network Programming, Volume 1: The Sockets Networking API, W. Richard Stevens, Bill Fenner, Andrew M. Rudoff, Prentice Hall 3/E, 2008
2. UNIX Network Programming, Volume 2: Interprocess Communications, W. Richard Stevens, Prentice Hall 2/E.2007

Reference Books:

1. TCP/IP Illustrated, Volume 2: The Implementation, Gary R. Wright, W. Richard Stevens, Addison Wesley, 2005
2. Internetworking with TCP/IP Volume : III Client and Server Programming and Applications BSD Socket Versions, Douglas E Comer, David L Stevens, Second edition PHI, 2007
3. Advanced Programming in the UNIX® Environment, Richard Stevens, Stephen A. Rago, Addison Wesley Professional/ Pearson, Second Edition, 2009
4. UNIX Systems Programming: Communication, Concurrency, and Threads, Kay A. Robbins, Steven Robbins, Prentice Hall PTR, 2009.

APPLIED CRYPTOGRAPHY

Course Code :15 CS 5111 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Classical Cryptography-The Shift Cipher, The Substitution Cipher, Cryptanalysis Of The Substitution Cipher, Cryptanalysis Of The Vigenere Cipher, Shannon's Theory. **Symmetric Techniques:** Block Cipher and the Advanced Encryption Standard-Substitution –Permutation Networks, Linear Cryptanalysis, Differential Cryptanalysis, The Data Encryption Standard, The Advanced Encryption Standard, Modes Of Operation Definition – Substitution Ciphers – Transposition Ciphers - Stream And Block Ciphers. **Asymmetric Techniques:** Introduction To Public –Key Cryptography, Number Theory, Principles Of Public Key Cryptosystems, The RSA Cryptosystem,Key Management – Diffie Hellman Key Exchange – The Elgamal Cryptosystem, Finit Fields, Elliptic Curves Over The Reals, Signature Scheme –Digital Signature Algorithm. **Key Management:** Key Distribution- Diffie-Hellman Key, Predistribution, Unconditionally Secure Key Predistribution, Key Agreement Scheme-Diffie-Hellman Key Agreement, Public Key Infrastructure-PKI, Certificates, Trust Models. **Message Authentication:** Authentication Requirements – Authentication Functions – Message Authentication Codes (MAC) – Hash Functions – Security Of Hash Functions And Macs. **Hash and Digital Signatures:** MD5 Message Digest Algorithm – Secure Hash Algorithm (SHA) –RIPMED160 - HMAC - Digital Signatures - Authentication Protocols - Digital Signature Standard (DSS).

Text Books

1. Bruce Schneier, "Applied Cryptography", John Wiley & Sons, New York, 2004.
2. Douglas R. Stinson ,"Cryptography Theory and Practice ", Third Edition, Chapman & Hall/CRC,2006

References:

1. Menges A. J , Oorschot P, Vanstone S.A,"Handbollk of Appliled Cryptography" CRC Press,1997.
2. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, New Delhi, 2006.
3. Bernard Menezes, "Network Security and Cryptography", Cengage Learning, New Delhi, 2010.
4. Ingemar J.Cox, Matthew L.Miller, Jeffrey A.Bloom, Jessica Fridrich, Ton Kalker, "Digital Watermarking and Steganography", Morgan Kaufmann Publishers, New York, 2008.
5. William Stallings, "Cryptography and Network Security, Prentice Hall, New Delhi, 2006.
6. Jonathan Katz, Yehuda Lindell, "Introduction to Modern Cryptography", Chapman & Hall/CRC, New York, 2007.

SECURE CODING

Course Code :15 CS 5112 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction : Risk Analysis , Security Concepts , C and C++ , Platforms. **Software Security Assessment :** White box vs. black box testing ,Design Review, Operational Review, Code Review Strategies. **Strings:** Common String Manipulation Errors, String Vulnerabilities, Process Memory Organization, Stack Smashing, Code Injection, Arc Injection, Mitigation Strategies. **Pointer Subterfuge :** Data Locations , Function Pointers, Data Pointers, Modifying the Instruction Pointer, Global Offset Table, The .dtors Section, Virtual Pointers, atexit(), on-exit(), longjmp(), Exception Handling, Mitigation Strategies. **Dynamic Memory Management :** Common Dynamic Memory ,Management Errors, Doug Lea's Memory Allocator, RtlHeap , Mitigation Strategies. **Integer Security:** Integers ,Integer Conversions ,Integer Error Conditions ,Integer Operations ,Vulnerabilities ,Nonexceptional Integer Logic Errors ,Mitigation Strategies. **Formatted Output:** Variadic Functions, Formatted Output Functions, Exploiting, Formatted Output Functions , Stack Randomization, Mitigation Strategies. **File I/O**: Concurrency, Time of Check, Time of Use, Files as Locks and File Locking, File System Exploits, Mitigation Strategies. **Procactive Security Development Process:** Installing a Security Culture, The Defender's Dilemma and the Attacker's Advantage, Role of Education, Integrating Security into the Development Process, Security Principles. **Language Independent Security Issues:** Appropriate Access Control, Running with Least Privilege, Cryptogpraphic Foibles, Protecting Data, Input checking and canonicalization, Database input.

Text Book

1. Robert C. Seacord: Secure Coding in C and C++. SEI Series (CERT Book), Addison- Wesley, 2006.

References:

1. Mark Dowd, John McDonald, and Justing Schuh: Teh Art of Software Security Assessment: Identifying and Preventing Software Vulnerabilities, Addison Wesley, 2007
2. Michael Howard and David LeBlanc: Writing Secure Code, Microsoft Press, 2003
3. Tom Gallagher, Bryan Jeffries, Lawrence Landauer: Hunting Security Bugs, Microsoft Press, 2006.

NETWORK ROUTING

Course Code :15 CS 51E1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Network Routing: Basics and Foundations: Networking and Network Routing: An Introduction,: Routing Algorithms: Shortest Path and Widest Path, Network Flow Modelling. **Routing in IP Networks:** OSPF and Integrated IS-IS, IP Traffic Engineering, BGP. **Routing in the PSTN**: Hierarchical and Dynamic Call Routing in the Telephone Network, Traffic Engineering in the Voice Telephone Network. **Router Architectures:** Router Architectures, IP Address Lookup Algorithms, Quality of Service Routing, MPLS and GMPLS. **Toward Next Generation Routing:** Routing and Traffic Engineering with MPLS, Packet Queuing and Scheduling, Traffic Conditioning, Transport Network Routing, Optical Network Routing and Multilayer Routing.

Text Book

1. D. Medhi and K. Ramasamy: Network Routing: Algorithms, Protocols, and Architectures, Morgan and Kaufmann Publ., 2008.

References:

1. G. Varghese: Network Algorithmics, Elsevier 2005
2. Network Routing Basics: Understanding IP Routing in Cisco Systems, James Macfarlane, Wiley; 1 edition , 2006
3. Computer Networking: A Top-Down Approach (6th Edition), James F. Kurose, Keith W. Ross, Pearson; 6th edition , 2012
4. Computer Networks and Internets (6th Edition), Douglas E. Comer, Addison-Wesley; 6 edition ,2014
5. Internetworking with TCP/IP Vol.1: Principles, Protocols, and Architecture, Douglas E. Comer , Prentice Hall; 4th edition , 2000.

NETWORK OPTIMIZATION

Course Code :15 CS 51E2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction - Example Opportunistic Scheduling Problem , General Stochastic Optimization Problems , Lyapunov Drift and Lyapunov Optimization, On General Markov Decision Problems On Network Delay, Introduction to Queues, Rate Stability, Stronger Forms of Stability, Randomized Scheduling for Rate Stability , Dynamic Scheduling Example: Scheduling for Stability, Stability and Average Power Minimization, Generalizations, Optimizing Time Averages, Lyapunov Drift and Lyapunov Optimization, General System Model, Optimality via ω-only Policies, Virtual Queues, The Min Drift-Plus-Penalty Algorithm, Optimizing Functions of Time -Solving the Transformed Problem, A Flow-Based Network Model, Multi-Hop Queueing Networks, General Optimization of Convex Functions of Time Averages, Non-Convex Stochastic Optimization, Worst Case Delay , Alternative Fairness Metrics , Approximate Scheduling, Time-Invariant Interference Networks, Multiplicative Factor Approximations Optimization of Renewal Systems- The Renewal System Model ,Drift-Plus-Penalty for Renewal Systems , Minimizing the Drift-Plus-Penalty Ratio , Task Processing Example ,Utility Optimization for Renewal ,Systems , Dynamic Programming Examples

Text Book

JeanWalrand, “Stochastic Network Optimization with Application to Communication and Queueing Systems”Morgan & Claypool 2010

Reference

1. My T Thai, Panos M Pardalos “ Handbook of Optimization in Complex Networks Theory and Applications” Springer
2. Carlos AS Oliveira _ Panos M Pardalos “Mathematical Aspects of Network Routing Optimization” Springer
3. R. Srikant, Lei Ying Communication Networks An Optimization, Control and Stochastic Networks Perspective” Cambridge -2014

SIMULATION OF COMPUTER NETWORK

Course Code :15 CS 51E3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction *:*Discrete-event Simulation, The Principle of Discrete-event Simulation, The Event-scheduling Time-advance Algorithm , Starting and Stopping of Simulations,Types of Simulation Runs , Modeling for Computer Simulation , Good Performance Models and Good Simulation. Tools and Methods for Network Simulation: The *ns–3* Network Simulator Introduction, Modeling the Network Elements in *ns–3,* Simulating a Computer Network in *ns–3* *,*Smart Pointers in *ns–3,* Representing Packets in *ns–3* ,Object Aggregation in *ns–3,*Events in *ns–3* ,Compiling and Running the Simulation, Animating the Simulation, OMNeT++*:* Introduction, the Component Model, Programming, Result Collection and Analysis. Modeling the Network Layer and Routing Protocols-Introduction, Routing, Internet Mobility Modeling Transport Layer Protocols - Introduction Existing Simulation Models Using Real Implementations in Simulators, Transport Layer Traces ,Analytical Performance Modeling Fluid Models and Integration with Packet-level Simulation Modeling Application Traffic -Introduction, Modeling HTTP, Modeling FTP Traffic, Modeling Voice Traffic, Modeling Video, Modeling Security Aspects of Networks-Introduction, Role of Modeling and Simulation in Security Research , Security Models, Evaluation Metrics.

Text Books:

1. Klaus Wehrle Mesut Güne¸s, James Gross “Modeling and Tools for Network Simulation” Springer-2010

References:

1. Hussein Al-Bahadili “ Simulation in Computer Network Design and Modeling: Use and Analysis” IGI Global Snippet, 2012
2. Adarshpal S. Sethi , Vasil Y. Hnatyshin “ The Practical OPNET User Guide for Computer Network Simulation Hardcover” ,CRC Press- 2010
3. Mohsen Guizani, Ammar Rayes, Bilal Khan, Ala Al-Fuqaha “Network Modeling and Simulation: A Practical Perspective” ,Wiley-2010
4. R. Jain, "The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling," Wiley- Interscience, New York, NY, April 1991

PROGRAMMING MOBILE DEVICES

Course Code :15 CS 51E4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Memory Management - Design Patterns for Limited Memory, Memory Management in Mobile Java, Memory Management in example OS. Applications - Workflow for Application Development, Techniques for Composing Applications, Application Models in Mobile Java, Case study: Symbian OS Application Infrastructure. Dynamic Linking - Implementation Techniques, Implementing Plugins, Managing Memory Consumption Related to Dynamically Linked Libraries, Rules of Thumb for Using Dynamically Loaded Libraries, Mobile Java and Dynamic Linking. Concurrency - Infrastructure for Concurrent Programming, MIDP Java and Concurrency, Case study: Symbian OS and Concurrency. Resource Management - Resource-Related Concerns in Mobile Devices, MIDP Java. Networking - MIDP Java and Web Services, Bluetooth Facilities with an example OS. Security - Secure Coding and Design, Infrastructure for Enabling Secured Execution, Security Features in MIDP Java, Case study: Symbian OS Security Features

Text Book

Tommi Mikkonen.“Programming Mobile Devices: An Introduction for Practitioners” Wiley,First Edition-2007

References:

1. Craig Heath “Symbian OS Platform Security: Software Development Using the Symbian OS Security Architecture”-Wiley -2010
2. Frank H. P. Fitzek, Frank Reichert “Mobile Phone Programming: and its Application to Wireless Networking” Springer; 2007 edition ,June 26, 2007
3. Zigurd Mednieks, Laird Dornin, G. Blake Meike, Masumi Nakamura “Programming Android Java Programming for the New Generation of Mobile Devices” O'Reilly Media-2011

STORAGE AREA NETWORKS

Course Code :15 CS 51F1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Storage Technology Review data creation and the amount of data being created and understand the value of data to a business, challenges in data storage and data management, Solutions available for data storage, Core elements of a data center infrastructure, role of each element in supporting business activities, Storage Systems Architecture Hardware and software components of the host environment, Key protocols and concepts used by each component, Physical and logical components of a connectivity environment, Access characteristics, and performance Implications, Concept of RAID and its components , Different RAID levels and their suitability for different application environments, High-level architecture and working of an intelligent storage system, Introduction to Networked Storage Evolution of networked storage, Architecture, components, and topologies of FC -SAN, NAS, and IP-SAN, Benefits of the different networked storage options, Information Availability & Monitoring & Managing Datacenter, Impact of downtime, Differentiate between business continuity (BC) and disaster recovery (DR) ,RTO and RPO, Identify single points of failure in a storage infrastructure and list solutions to mitigate these failures ,Architecture of backup/recovery and the different backup/recovery topologies , replication technologies and their role in ensuring information availability and business continuity, Remote replication technologies, Industry standards for data center monitoring and management, Key metrics to monitor for different components in a storage infrastructure, Key management tasks in a data center, Securing Storage and Storage Virtualization Information security, Critical security attributes for information systems, Storage security domains, List and analyzes the common threats in each domain, Virtualization technologies

Textbook:

1. EMC Corporation, Information Storage and Management, Wiley,2010.

References:

1. Robert Spalding, “Storage Networks: The Complete Reference“, Tata McGraw Hill, Osborne, 2003.
2. Marc Farley, “Building Storage Networks”, Tata McGraw Hill ,Osborne, 2001.
3. Meeta Gupta, Storage Area Network Fundamentals, Pearson Education Limited,
4. Richard Barker (Author), Paul Massiglia “Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs” John Wiley & Sons, 2001
5. Meeta Gupta “Storage Area Network Fundamentals” Cisco Press, 2002

ADHOC NETWORKS

Course Code :15 CS 51F2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Applications, History of Wireless Communication, Simplified Reference Model, Introduction to adhoc networks – definition, characteristics features, Application. Characteristics of Wireless channel, Adhoc Mobility Models: - Indoor and outdoor models. Medium Access Protocols :MAC protocols: design issues, doals and classification. Contention based protocols – with reservation, scheduling algorithms, protocols using direction antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15. HIPERLAN. Network Protocols: Routing protocols: Introduction, Design issues, goals and Classification of Proactive vs. reactive routing, uncast routing algorithms such as Destination Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP), Ad Hoc on-Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR), Temporally Ordered Routing Algorithm (TORA), Signal Stability Routing (SSR), Location-Aided Routing (LAR), Power-Aware Routing (PAR), Zone Routing Protocol (ZRP)., Multicast routing hierarchical routing, QoS aware routing. End-End Delivery and Security: Transports layer- Issues in designing- transport layer classification, adhoc transport protocols. Security issues in adhoc network: issues and challenges, network security attacks, secure routing protocols. Multicast Routing in Adhoc Networks: Introduction, Issues in Designing A Multicast Routing Protocol, Operation of Multicast Routing Protocols, An Architecture Reference Model for Multicast Routing Protocols, Classifications of Multicast Routing Protocols, Tree–based Multicast Routing Protocols- Bandwidth Efficient Multicast Routing Protocol, Zone Based – Core Extraction Routing Protocol, Ad Hoc on-Demand Vector Routing Protocol, Mesh-Based Multicast Routing Protocols, On-Demand Multicast Dynamic Core Based Multicast Routing Protocol, Energy-Efficient Reliable Broadcast And Multicasting Protocols, Wireless Ad Hoc Real-Time Multicasting, Application, Dependent Multicast Routing.

Text Book

Ad Hoc Mobile Wireless Networks Protocols and Systems, C. K. Toh, Prentice Hall, PTR, 2001.

References:

1. Ad Hoc Wireless Networks Architectures and Protocols, C.Siva Ram Murthy and B.S. Manoj, Prentice Hall, 2004
2. Stojmenovic and cacute, handbook of wireless networks and mobils computing, wiley, 2002, ISBN 0471419028.
3. Edgar H. Callaway, wireless sensor networks: architecture and protocols, Auerbach publications.
4. Fang Zhao, leonidas J. Guibas, wireless sensor networks: an information processing approach.
5. Ad Hoc Networking, Charles E.Perkins, Addison Wesley, 2000

COGNITIVE RADIO NETWORKS

Course Code :15 CS 51F3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Wireless Communications, Software Defined Radio, Wireless Networks, Cooperative Communications and Networks, Cognitive Radio Communications, Cognitive Radio Networks, Spectrum Sensing, Medium Access Control, Network Layer Design, Trusted Cognitive Radio Networks, Spectrum Management of Cognitive Radio Networks. Capacity Analysis of Cognitive Radio Networks, Power Control for Cognitive Radio Ad Hoc Networks, Medium Access Control in Cognitive Radio Networks. Cross-Layer Optimization in Cognitive Radio Networks, Security in Cognitive Radio Networks. Distributed Coordination in Cognitive Radio Networks, Cognitive Radio for Pervasive Healthcare, Cognitive Radio Networks: An Assessment Framework.

Text Book

Kwang-Cheng Chen and Ramjee Prasad, *Cognitive Radio Networks,* 2009, John Wiley & Sons Ltd. ISBN: 978-0-470-69689-7.

References:

1. Yan Zhang, Jun Zheng, Hsiao-Hwa Chen, Cognitive Radio Networks, Architectures, Protocols, and Standards, CRC Press, 2010 by Taylor and Francis Group, LLC.
2. Cognitive networks Towards Self-Aware Networks, Qusay H. Mahmoud, Copyright-2007 John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester.
3. Cognitive Radio technology- Bruce A Fette IST Edition, 2006 Elsevier Inc

SENSOR NETWORKS

Course Code :15 CS 51F4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Overview of Wireless Sensor Networks: Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks. Architectures : Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts. Networking Sensors: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols-Energy-Efficient Routing, Geographic Routing. Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control. Sensor Network Platforms And Tools: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

Text Book

Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

References:

1. Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" John Wiley, 2005.
2. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks-Technology, Protocols, And Applications”, John Wiley, 2007.
3. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.
4. F. Jurdak “wireless ad hoc and sense networks” Springer publications.

PERFORMANCE ANALYSIS OF COMPUTER NETWORKS

Course Code :15 CS 5213 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction, Design for Performance, Characterization of Data Traffic, Simulation, Commonly Used Distributions, Random Number Generators, Queuing Theory (M/M/1/∞): Introduction, Derivation of Equilibrium State Probabilities, Simple Performance Figures, Response Time and Its Distribution, Waiting Time Distribution, Analysis of Busy Times and Forward Data Link Performance and Optimization. State Dependent Markovian Queues-1: Introduction, Stochastic Processes, Markov Process, Continuous Parameter Markov Chains, Markov Chains for State Dependent Queues, Intuitive Approach for Time Averages. State Dependent Markovian Queues-2
:Statistical Analysis of Markov Chains Sample Functions, Little"s Result – FIFO Case and Non-FIFO Case, Application Systems, Medium Access in Local Area Networks. Discrete Time Queues-1: Introduction, Timing and Synchronization, State Transitions and Their Probabilities, Discrete Parameter Markov Chains, Classification of States, Analysis of Equilibrium Markov Chains. Discrete Time Queues-2: Performance Evaluation of Discrete Time Queues, Applications of Discrete Time Queues. Continuous Time Queuing Networks: Introduction, Model and Notation for Open Networks, Global Balance Equations, Traffic Equations, The Product Form Solution, Validity of Product Form Solution, Development of Product Form Solution for Closed Networks, Convolution Algorithm, Performance Figures from the G(N,M) Matrix, Mean Value Analysis.

Textbooks:

1. Performance Analysis of Queuing and Computer Networks, G R Dattatreya, CRC Press, 2008
2. The Art of Computer Systems Performance Analysis: Techniques for Experimental design, Measurement, Simulation, and Modeling Raj Jain, Wiley- Interscience, 1991.

References:

1. Quantitative System Performance, E.D. Lazowska, J. Zahorjan, G.S. Graham and K.C. Sevcik, Prentice-Hall, 1984.;PDF Available from :Www.Cs.Washington.Edu /Homes/Lazowska/Qsp
2. Probability and Statistics with Reliability, Queueing and Computer Science Applications K.S. Trivedi, Prentice-Hall, 1982.
3. Queueuing Systems, Vol. 1: Theory, L. Kleinrock, Wiley 1975.
4. Queueuing Systems, Vol. 2: Applications, L. Kleinrock Wiley 1976.
5. Measurement and Tuning of Computer Systems, D. Ferrari, G. Serazzi and A. Zeign, Prentice-Hall, 1983.

WIRELESS NETWORKS & MOBILE COMPUTING

Course Code :15 CS 5214 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Wireless Networks: Wireless Network, Wireless Network Architecture, Wireless Switching Technology, Wireless Communication problem, Wireless Network Reference Model, Wireless Networking Issues & Standards. **Mobile Computing**: Mobile communication, Mobile Computing Architecture, Mobile Devices, Mobile System Networks, Mobility Management. WIRELESS LAN: Infrared Vs radio transmission, Infrastructure and Ad-hoc Network, IEEE 802.11: System Architecture, Protocol Architecture, 802.11b, 802.11a, Newer Developments, HIPERLAN 1, HIPERLAN 2, Bluetooth : User Scenarios, Architecture. **Global System For Mobile Communications** (GSM): Mobile Services, System Architecture, Protocols, Localization & Calling, Handover, Security. GPRS: GPRS System Architecture, **Mobile Network Layer:** Mobile IP: Goals, Assumptions, Entities and Terminology, IP Packet Delivery, Agent Discovery, Registration, Tunneling and Encapsulation, Optimizations, Dynamic Host Configuration Protocol (DHCP). **Mobile Transport Layer**: Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission /time-out freezing, Selective retransmission, Transaction oriented TCP, TCP over 2.5G/3G Wireless Networks.

Textbooks:

1. Jochen Schiller, “Mobile Communications”, Pearson Education, Second Edition, 2008.
2. Dr. Sunilkumar, et al “Wireless and Mobile Networks: Concepts and Protocols”, Wiley India,2011

References:

1. Raj Kamal, “Mobile Computing”, OXFORD UNIVERSITY PRESS Asoke K Talukder, et al, “Mobile Computing”, Tata McGraw Hill, 2008.
2. Matthew S.Gast, “802.11 Wireless Networks”, SPD O’REILLY.
3. Ivan Stojmenovic, “Handbook of Wireless Networks and Mobile Computing”, Wiley, 2007.
4. Handbook of Security of Networks, Yang Xiao, Frank H Li, Hui Chen, World Scientific, 2011.
5. Kumkum Garg, “Mobile Computing”, Pearson

NETWORK AND CYBER SECURITY

Course Code :15 CS 5215 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Understanding Computer Network Security: Securing the Computer Network Forms of Protection, Security Standards. **Security Threats to Computer Networks:** Sources of Security Threats, Security Threat Motives, Security Threat Management, Security Threat Correlation, Security Threat Awareness. **Computer Network Vulnerabilities:** Sources of Vulnerabilities, Vulnerability Assessment. **Cyber Crimes and Hackers:** Cyber Crimes, Hackers, Dealing with the Rising Tide of Cyber Crimes. **Hostile Scripts:** Introduction to the Common Gateway Interface (CGI), CGI Scripts in a Three-Way Handshake, Server–CGI Interface, CGI Script Security Issues, Web Script Security Issues, Dealing with the Script Security Problems, Scripting Languages. **Security Assessment, Analysis, and Assurance:** System Security Policy, Building a Security Policy, Security Requirements Specification, Threat Identication, Threat Analysis, Vulnerability Identification and Assessment, Security Certification, Security Monitoring and Auditing, Products and Services. **Disaster Management:** Disaster Prevention, Disaster Response, Disaster Recovery, Make your Business Disaster Ready, Resources for Disaster Planning and Recovery. **Access Control and Authorization:** Access Rights, Access Control Systems, Authorization, Types of Authorization Systems, Authorization Principles, Authorization Granularity, Web Access and Authorization. **Authentication:** Multiple Factors and Effectiveness of Authentication, Authentication Elements, Types of Authentication, Authentication Methods, Developing an Authentication Policy. **Firewalls:** Types of Firewalls, Configuration and Implementation of a Firewall, The Demilitarized Zone (DMZ), Improving Security Through the Firewall, Firewall Forensics, Firewall Services and Limitations. **System Intrusion Detection and Prevention:** Intrusion Detection, Intrusion Detection Systems (IDSs), Types of Intrusion Detection Systems, The Changing Nature of IDS Tools, Other Types of Intrusion Detection Systems, Response to System Intrusion, Challenges to Intrusion Detection Systems, Implementing an Intrusion Detection System, Intrusion Prevention Systems (IPSs), Intrusion Detection Tools. **Computer and Network Forensics:** Computer Forensics, Network Forensics, Forensics Tools. **Virus and Content Filtering:** Scanning, Filtering, and Blocking, Virus Filtering, Content Filtering, Spam. **Computer Network Security Protocols:** Application Level Security, Security in the Transport Layer, Security in the Network Layer, Security in the Link Layer and over LANS. **Security in Wireless Networks and Devices:** Cellular Wireless Communication Network Infrastructure, Wireless LAN (WLAN) or Wireless Fidelity (Wi-Fi), Standards for Wireless Networks, Security in Wireless Networks. **Security in Sensor Networks:** The Growth of Sensor Networks, Design Factors in Sensor Networks, Security in Sensor Networks, Security Mechanisms and Best Practices for Sensor, Trends in Sensor Network

Security Research. **Security Beyond Computer Networks: Information Assurance:** Collective Security Initiatives and Best Practices. **Network Perimeter Security:** General Framework, Packet Filters, circuit Gateways, Application Gateways, Trusted Systems and Bastion Hosts, Firewall Configurations, Network Address Translations, Setting Up Firewalls. **The Art of Anti Malicious Software:** Viruses, Worms, Virus Defence, Trojan Horses, Hoaxes, Peer-to-Peer Security, Web Security, Distributed Denial of Service Attacks. **The Art of Intrusion Detection:** Basic Ideas of Intrusion Detection, Network-Based Detections and Host-Based Detections, Signature Detections, Statistical Analysis, Behavioural Data Forensics, Honeypots.

Textbooks:

1. Computer Network Security- Theory and Practice by Jie Wang, 2009 edition, Higher Education Press, Beijing and Springer-Verlag.
2. A Guide to Computer Network Security by Joseph Migga Kizza, 2009 Edition, Springer-Verlag London Limited.

References:

1. Network Security Essentials- Applications and Standards by William Stallings, 4^{th} edition.
2. Modern Cryptography: Theory and Practice by Wenbo Mao Hewlett-Packard Company, 1^{st} edition, Prentice Hall PTR.
3. Network Security: Private Communication in a Public World by Charlie Kaufman, Radia Perlman, Mike Speciner, 2^{nd} edition.
4. Cryptography and Network Security: Principles and Practice by William Stallings, 6^{th} edition.

WIRELESS NETWORK SECURITY

Course Code :15 CS 5216 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

The Security of Existing Wireless Networks: Vulnerabilities of Wireless Networks, Security Requirements, How Existing Wireless Networks are Secured. Upcoming Wireless Networks and New Challenges: Introduction, Upcoming Wireless Networks, Trends and Security Challenges in Wireless Networks. Trust Assumptions and Adversary Models: About Trust, Trust in the Era of Ubiquitous Computing, Adversary. Naming and Addressing: The Future of Naming and Addressing in The Internet, Attacks Against Naming and Addressing, Protection Techniques. Establishment of Security Associations: Key Establishment in Sensor Networks, Exploiting Physical Contact, Exploiting Mobility. Securing Neighbor Discovery: The Wormhole Attack, Wormhole Detection Mechanisms, Secure Routing in Multi-Hop Wireless Networks: Routing Protocols for Mobile Ad Hoc Networks, Attacks on Ad Hoc Network Routing Protocols. Secure Routing in Multi-Hop Wireless Networks: Securing Ad Hoc Network Routing Protocols, Provable Security for Ad Hoc Network Routing Protocols, Secure Routing in Sensor Networks. Privacy Protection: Important Privacy Related Notions and Metrics, Privacy in RFID Systems, Location Privacy in Vehicular Networks, Privacy Preserving Routing in Ad Hoc Networks Selfish Behavior at the MAC Layer of CSMA/CA: Operating Principles of IEEE 802.11, Detecting Selfish Behavior in Hotspots, Selfish Behavior in Pure Ad Hoc Networks. Selfishness in Packet Forwarding: Game Theoretic Model of Packet Forwarding, Meta-Model, Analytical Results, Simulation Results. Wireless Operators in a Shared Spectrum: Multi-Domain Sensor Networks, Border Games in Cellular Operators. Secure Protocols for Behavior Enforcement: System Model, Cooperation-Optimal Protocol, Protocol for the Routing Stage, Protocol for Packet Forwarding, Discussion.

Textbook:

Security and Cooperation in Wireless Networks: Thwarting Malicious and Selfish Behavior in the Age of Ubiquitous Computing, Levente Buttyan and Jean-Pierre Hubaux, Cambridge University Press,2007.

References:

1. Cryptography and Network Security: Principles and Practices, Fourth Edition, William Stallings, Prentice-Hall India.
2. Wireless Security: Models, Threats and Solutions, Randall K. Nichols, Panos C. Lekkas, TMH.
3. Xiao**,** Yang, Shen, Xuemin (Sherman), Du, Ding-Zhu “Wireless Network Security” Springer 2007
4. Vacca**,** John R. “Guide to Wireless Network Security” Springer 2006
5. Shafiullah Khan, Jaime Lloret Mauri” Security for Multihop Wireless Networks CRC Press2014

SECURE PROTOCOLS DESIGN

Course Code :15 CS 52G1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: The security of existing wireless networks, Vulnerabilities of wireless networks, Security requirements, challenges -Upcoming wireless networks, Trends and security challenges in wireless networks Thwarting malicious behavior : Naming and addressing, Attacks against naming and addressing, Protection techniques , Establishment of security associations, Key establishment in sensor networks, Exploiting physical contact, Exploiting mobility, Exploiting the properties of vicinity and of the radio link, Revocation. Securing neighbor discovery: the wormhole attack, Wormhole detection mechanisms, Secure routing in multi-hop wireless networks, Routing protocols for mobile ad hoc networks, Attacks on ad hoc network routing protocols, Securing ad hoc network routing protocols, Provable security for ad hoc network routing protocols, Secure routing in sensor networks, Thwarting selfish behavior- Selfish behavior at the MAC layer of CSMA/CA, Operating principles of IEEE 802.11, Detecting selfish behavior in hotspots, Selfish behavior in pure ad hoc networks Selfishness in packet forwarding, Privacy protection- Important privacy related notions and metrics, Location privacy in vehicular networks, Privacy preserving routing in ad hoc networks, Secure protocols for behavior enforcement, System model, Cooperation-optimal Protocol, Protocol for the routing stage ,Protocol for packet forwarding.

Text Book

1. Levente Buttyán and Jean-Pierre Hubaux, *Security and Cooperation in Wireless Networks*, 2008.

References

1. Frank Adelstein, Sandeep K.S. Gupta, Golden G. Richard III, and Loren Schwiebert, *Fundamentals of Mobile and Pervasive Computing*, 2005.
2. Noureddine Boudriga, *Security of Mobile Communications*, 2010.
3. James Kempf, *Wireless Internet Security: Architectures and Protocols*, 2008.
4. Patrick Traynor, Patrick McDaniel, and Thomas La Porta, *Security for Telecommunications Networks*, 2008.

DISTRIBUTED SYSTEM SECURITY

Course Code :15 CS 52G2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Distributed Systems, Distributed Systems Security, Secure Development Life Cycle Processes – An Overview, A Typical Security Engineering Process, Important Security Engineering Guidelines and Resources. Common Security Issues and Technologies, Security Issues, Common Security Techniques. Host level Threats and Vulnerabilities, Malware, Eaves dropping, Job faults, Resource starvation, Overflow, Privilege escalation, Injection attacks. Infrastructure Level Threats & Vulnerabilities, Introduction, Network Level Threats and Vulnerabilities, Grid Computing Threats and Vulnerabilities, Storage Threats and Vulnerabilities, Application Level Vulnerabilities and Attacks, Introduction, Application Layer Vulnerabilities. Service Level Issues, Threats and Vulnerabilities-Introduction, SOA and Role of Standards, Service Level Security Requirements, Service Level Threats and Vulnerabilities, Service Level Attacks, Services Threat Profile, Chapter 8: Host level Solutions, Sandboxing, Virtualization, Resource Management, Proof carrying code, Memory firewall, Anti malware, Infrastructure Level Solutions-Introduction, Network Level Solutions, Grid Level Solutions, Storage Level Solutions.

Text Books:

1. Abhijit Belapurkar, Anirban Chakrabarti, Harigopal Ponnapalli, Niranjan Varadarajan, Srinivas Padmanabhuni, Srikanth Sundarrajan Distributed Systems Security: Issues, Processes and Solutions Wiley-2009.

References:

1. G. Coulouris, J. Dollimore, and T. Kindberg "Distributed Systems: Concepts and Design" 4th Edition,
2. Distributed Systems **,**2nd Edition, Sape Mullender
3. Distributed Systems: Principles and Paradigms, Andrew S. Tanenbaum, Maarten van Steen

ELLIPTIC CURVE CRYPTOGRAPHY

Course Code :15 CS 52G3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

INTRODUCTION, THE BASIC THEORY: Weierstrass Equations, The Group Law, Projective Space and The Point at Infinity, Proof of Associativity, Other Equations for Elliptic Curves, Other Co-ordinate Systems, The j-Invariant, Elliptic Curves in Characteristic 2, Endomorphisms, Singular Curves, Elliptic Curves mod n. **TORSION POINTS:** Torsion Points, Division Polynomials, the Weil Pairing, the Tate-Lichtenbaum Pairing. **ELLIPTIC CURVES OVER FINITE FIELDS:** Examples, The Frobenius Endomorphism, Dertermining the Group Order, A Family of Curves, Schoof's Algorithm, Supersingular Curves. **THE DISCRETE LOGARITHM PROBLEM:** The Index Calculus, General Attacks on Discrete Logs, Attacks With Pairings, Anomalous Curves, Other Attacks. **ELLIPTIC CURVE CRYPTOGRAPHY:** The Basic Setup, Diffie-Hellman Key Exchange, Massey-Omura Encryption, ElGamal Public Key Encryption, ElGamal Digital Signatures, The Digital Signature Algorithm, ECIES, A Public Key Scheme based on factoring, A Cryptosystem Based on the Weil Pairing. **OTHER APPLICATIONS:** Factoring using Elliptic Curves, Primality Testing. **DIVISORS:** Definitions And Examples, The Weil Pairing, The Tate-Lichtenbaum Pairing, Computation Of The Pairings, Genus One Curves and Elliptic Curves, Equivalance Of The Defintitions Of The Pairings, Nondegeneracy Of The Tate-Lichtenbaum Pairing, **HYPERELLIPTIC CURVES:** Basic Definitions, Divisors, Cantor's Algorithm, The Discrete Logarithm Problem.

Textbook:

1. Elliptic Curves Number Theory and Cryptography Second Edition by Lawrence C. Washington Publisher: Chapman & Hall/CRC Taylor & Francis Group 2008

References:

1. Applied Cryptography Seconf Edition Bruce Schneier Wiley India Edition
2. Cryptography and network Security, Fourth edition, William Stallings, PHI

CYBER FORENSICS

Course Code :15 CS 52G4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Computer Forensics Fundamentals, Computer Forensics Services, Benefits of Professional Forensics Methodology, Types of Computer Forensics Technology, Computer Forensics Evidence and Capture: Data Recovery Defined -Data Back-up and Recovery, Types of Evidence Controlling Contamination, Legal Aspects of Collecting and Preserving Computer Forensic Evidence Computer Image Verification and Authentication, Computer Forensics analysis and validation, Network Forensics, Processing Crime and Incident Scenes, Current Computer Forensic tools, validating and testing forensics software E-Mail Investigations: Exploring the role of e-mail in investigation, exploring the roles of the client and server in email, investigating e-mail crimes and violations, understanding e-mail servers, using specialized e-mail forensic tools Cell phone and mobile device forensics: Understanding mobile device forensics, understanding acquisition procedures for cell phones arid mobile devices. Working with Windows and DOS Systems: understanding file systems, exploring Microsoft File Structures. Examinig NTH disks. Understanding whole disk encryption, windows registry. NI icrosoft startup tasks. MS-DOS startup tasks, virtual machines.

Textbooks:

Computer Forensics, Computer Crime Invistigation by Jhon R. Vacca, Firewall Media, New Delhi.

References:

1. Computer Forensics and Investigations by Nelson. Phillips Enfinger.Steuart, CENGAGE Learning
2. Albert Marcella Jr., Doug Menendez “Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes”, Second Edition, Auerbach Publications-2007
3. Albert J. Marcella Jr., Frederic Guillossou Cyber Forensics: From Data to Digital Evidence; Wiley; First Edition-2012
4. Warren G. Kruse II & Jay G. Heiser “Computer Forensics: Incident Response Essentials” Addison Wesley, published 2001

INFORMATION SYSTEMS CONTROL AND AUDIT

Course Code :15 CS 52H1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: IT Today and Tomorrow, Information Integrity, Reliability, and Validity, Control and Audit, Future of Electronic Payment Systems, Legal Issues Impacting IT, Privacy on the Information Superhighway, Privacy Legislation, Privacy, and Audit. **The Legal Environment and Its Impact on Information Technology :** IT Crime Issues, Protection against Computer Fraud, Computer Fraud and Abuse Act, Computer Abuse Amendments Act, Remedies and Effectiveness, Legislation Providing for Civil and Criminal Penalties, Privacy on the Information Superhighway, National Strategy for Securing Cyberspace Methods That Provide for Protection of Information, Web Copyright Law. **Audit and Review: Their Role in Information Technology-**Importance of Audit Independence, Past and Current Accounting and Auditing Pronouncements, AICPA Pronouncements. **Audit Process in an Information Technology Environment :** Audit Universe, Risk Assessment, Audit Plan, Developing an Audit Schedule, Audit Process, **Auditing IT Using Computer-Assisted Audit Tools and Techniques:** Auditor Productivity Tools, Using Computer-Assisted Audit Tools in the Audit Process, Flowcharting Techniques, Flowcharting as an Analysis Tool, Appropriateness of Flowcharting Techniques, Computer-Assisted Audit Tools and Techniques for Operational Reviews, Web Analysis Tools, Web Analysis Software as an Audit Tool, Computer Forensics. **Managing IT Audit:** IT Auditor Career Development and Planning, Establishing a Career Development Plan, Evaluating IT Audit Quality, Terms of Assessment, IT Audit and Auditor Assessment Form, Criteria for Assessing the Audit, Criteria for Assessing the Auditor, Applying the Concept, Evaluation of IT Audit Performance

Textbooks:

1. Sandra Senft, Frederick Gallegos, Aleksandra Davis " Information Technology Control and Audit, Fourth Edition " Auerbach Publications in 2012

Reference

1. Xenia Ley Parker, Lynford Graham "Information Technology Audits "CCH-2008 01-Jun-2008
2. Ron Weber " Information Systems Control & Audit " Pearson Education -1999
3. Richard E. Cascarino "Auditor's Guide to Information Systems Auditing", Wiley February 2007
4. Hossein Bidgoli "Handbook of Information Security, Threats, Vulnerabilities, Prevention, Detection, and Management" John Wiley & Sons, 2006
5. Hossein Bidgoli "Encyclopedia of information systems" , Volume 1, Academic Press, 2003 - Computers

INTRUSION DETECTION AND PREVENTION SYSTEM

Course Code :15 CS 52H2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

INTRODUCTION: Understanding Intrusion Detection – Intrusion detection and prevention basics – IDS and IPS analysis schemes, Attacks, Detection approaches –Misuse detection – anamoly detection – specification based detection – hybrid detection. **THEORETICAL FOUNDATIONS OF DETECTION:** Taxonomy of anomaly detection system – fuzzy logic – Bayes theory – Artificial Neural networks – Support vector machine – Evolutionary computation – Association rules – Clustering. **ARCHITECTURE AND IMPLEMENTATION:** Centralized – Distributed – Cooperative Intrusion Detection - Tiered architecture. **JUSTIFYING INTRUSION DETECTION:** Intrusion detection in security – Threat Briefing – Quantifying risk – Return on Investment (ROI). **APPLICATIONS AND TOOLS:** Tool Selection and Acquisition Process - Bro Intrusion Detection – Prelude Intrusion Detection - Cisco Security IDS - Snorts Intrusion Detection – NFR security. **LEGAL ISSUES AND ORGANIZATIONS STANDARDS:** Law Enforcement / Criminal Prosecutions – Standard of Due Care – Evidentiary Issues, Organizations and Standardizations.

Text Book :

1. Ali A. Ghorbani, Wei Lu, "Network Intrusion Detection and Prevention: Concepts and Techniques", Springer, 2010.

References:

1. Carl Enrolf, Eugene Schultz, Jim Mellander, "Intrusion detection and Prevention", McGraw Hill, 2004
2. Paul E. Proctor, "The Practical Intrusion Detection Handbook ",Prentice Hall , 2001.
3. Ankit Fadia and Mnu Zacharia, "Intrusiion Alert", Vikas Publishing house Pvt., Ltd, 2007.
4 .Earl Carter, Jonathan Hogue, "Intrusion Prevention Fundamentals", Pearson Education, 2006.

CRYPTANALYSIS

Course Code :15 CS 52H3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

CLASSIC CIPHERS: Introduction, Good Guys And Bad Guys, Terminology, Selected Classic Crypto Topics. **WORLD WAR II CIPHERS:** Introduction, Enigma, Purple, Sigaba. **STREAM CIPHERS:** Introduction, Shift Registers, ORYX, RC4, PKZIP. **BLOCK CIPHERS:** Introduction, Block Cipher Modes, Feistel Cipher, Hellmans Time-Memory Trade-off, CMEA, Akelarre, FEAL**. HASH FUNCTIONS:** Introduction, Birthdays and Hashing, MD4, MD5. **PUBLIC KEY SYSTEMS:** Introduction, Merkle-Hellman Knapsack, Diffie-Hellman Key Exchange, Arithmetica Key Exchange, RSA, Rabin Cipher, NTRU Cipher, ElGamal Signature Scheme**. PUBLIC KEY ATTCAKS:** Introduction, Factoring Algorithms, Discrete Log Algorithms, RSA Implementation Attacks.

Textbook:

Appllied Cryptanalysis Breaking Ciphers in the Real World by Mark Stamp, Richard M. Low John

References:

1. Applied Cryptography Seconf Edition Bruce Schneier Wiley India Edition
2. Cryptography and network Security, Fourth edition, William Stallings, PHI/Pearson

CYBER SECURITY

Course Code :15 CS 52H4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Background, The Field of Cyber Security, The DHS EBK Initiative, Applying the EBK. EBK ROLES AND REQUIRED CAPABILITIES, The Executive role, The Functional role, The Corollary role. AREAS OF INFORMATION SECURITY, Data Security, Digital Forensics, Enterprise Continuity, Incident Management. IT Security Training and Awareness, IT Systems Operations and Maintenance, Network and Telecommunications Security, Personnel Security, Physical and Environmental Security. Procurement, Regulatory and Standards Compliance, Security Risk Management, Strategic Security Management, System and Application Security.

Text Book:

1. Dan Shoemaker, Wm. Arthur Conklin Cybersecurity: The Essential Body Of Knowledge Cengage Learning.

Reference

1. P.W.Singer, Allan Friedman "Cybersecurity and Cyberwar" Published Oxford University Press-2014
2. Richard A. Clarke, Robert Knake Cyberwar: The Next Threat to National Security & What to Do About It" Ecco 2010
3. James Graham, Ryan Olson, Rick Howard" Cyber Security Essentials" Auerbach Publications; First Edition -December 15, 2010

M.TECH - CLOUD COMPUTING

First Year (First Semester):

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Credits
1	15 CS 5117	Enterprise Devices & Networks	3	1	0	4
2	15 CS 5118	Enterprise Storage Systems	3	1	0	4
3	15 CS 5119	Cloud Computing	3	0	2	4
4	15 CS 5120	Web Application Development	3	0	2	4
5		Elective – 1	3	0	0	3
6		Elective - 2	3	0	0	3
7	15 IE 5149	Seminar	0	0	4	2
		Total	**18**	**4**	**8**	**24**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Credits
1	15 CS 5221	Parallel Algorithms	3	0	2	4
2	15 CS 5222	Cloud Security	3	1	0	4
3	15 CS 5223	Mobile Cloud	3	0	2	4
4	15 CS 5224	Data Centre Virtualization	3	1	0	4
5		Elective – 3	3	0	0	3
6		Elective - 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total	**18**	**4**	**8**	**24**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods L	Periods T	Periods P	Credits
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 CS 51I1	Data Analysis	3	0	0	3
2	15 CS 51A3	Data Mining	3	0	0	3
3	15 CS 51I2	Distributed Systems	3	0	0	3
4	15 CS 51I3	Big Data Analytics	3	0	0	3
Elective-2						
1	15 CS 51J1	Service Oriented Architecture	3	0	0	3
2	15 CS 51J2	Application Development Frameworks	3	0	0	3
3	15 CS 51J3	Web Semantics	3	0	0	3
4	15 CS 51J4	Network Security	3	0	0	3
Elective-3						
1	15 CS 52K1	Natural Language Processing	3	0	0	3
2	15 CS 52K2	Cloud Application Architectures	3	0	0	3
3	15 CS 52K3	Cloud Strategy Planning and Management	3	0	0	3
4	15 CS 52K4	Scripting for System Administrators	3	0	0	3
Elective-4						
1	15 CS 52L1	Object Oriented Software Engineering	3	0	0	3
2	15 CS 52L2	Map Reduce Design Patterns	3	0	0	3
3	15 CS 52L3	Open Source Cloud Computing and Testing	3	0	0	3
4	15 CS 52L4	Advances in Computing	3	0	0	3

ENTERPRISE DEVICES & NETWORKS

Course Code :15 CS 5117 **L-T-P : 3-1-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Devices for Every Kind of User, Desktop PCs Inside and Out, Storage Devices, Peripheral Devices, Networking, Windows Operating System, Open-Source Operating Systems, Meet Macintosh, Notebooks and Net books, Mobile Devices, Thin Clients and Virtualization, Taking it to the Cloud, Business Continuity, Ongoing Maintenance, Troubleshooting, Focus on Design, Network Fundamentals, Hardware Fundamentals, Network Infrastructure, Switches, TCP/IP, Routing, Wireless Networking, Network Design, Network Deployment, Network Administration and Management, Network Operations, Network Security, Troubleshooting, Optimization, Availability and Reliability, PCM+

Text Books:

1. Jean Maurice Merel, HP ASE Network Infrastructure Official Certification HP0-Y32 Exam Guide (HP ExpertONE) Hardcover, HP Press, 2013
2. HP Prescribed Courseware

References:

1. Computer networks, Andrew Tanenbaum, 3/e, PHI.
2. Computer Networks – a system approach – Larry L. Peterson, Bruce S. Davie, 2/e, Harcourt Asia PTE LTD.
3. Data Communication and Networking, 4/e, Forouzan, TMH
4. An engineering approach to computer networking, Kesav, PEA
5. Data and Computer Communications, 8/e, Stallings, PHI
6. Computer communication and networking technologies, Gallo, Hancock, Cengage
7. Understanding data communications, 7/e, Held, PEA
8. Communication Networks, 2/e, Leon-Garcia, TMH

ENTERPRISE STORAGE SYSTEMS

Course Code :15 CS 5118 **L-T-P : 3-1-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Why Businesses Need Servers, What is a Data Center?, Inside a Server, Installing a Rack Server, Solution Stacks, Installing and Configuring Windows Small Business Server, Installing and Configuring Linux, HP System Management, Configuring Networking, Storage Technologies, Configuring Storage, Business Continuity Planning, Configuration Management, Troubleshooting, Optimization, Understanding Blade System Architecture, Requirements Gathering and Design.

Text Books:

1. Richard Barker, Paul Massiglia, "*Storage area network essentials*", Wiley New York, 2002.
2. HP Prescribed Courseware

References:

1. EMC, "*Information Storage and Management*" Wiley; 2 edition

2. Ulf Troppens, Rainer Erkens, Wolfgang Mueller-Friedt, Rainer Wolafka, Nils Haustein, "*Storage Networks Explained*" Wiley; 2 edition, 2009.

3. W.Curtis Preston, "*Using SANs and NAS*", O'Reilly & Associates Sebastopol, Calif., 2002.

4. Himanshu Dwivedi, "*Securing storage*", Addison-Wesley Upper Saddle River, NJ, 2006

CLOUD COMPUTING

Course Code :15 CS 5119 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

From Silos to Converged Infrastructure Introduction, Blade System Implementation, Blade System Interconnects and Storage, Server Virtualization, VMware ESXi and vSphere Client, Virtual Machines, Monitoring, Troubleshooting and Optimizing Virtual Machines, Virtual and Remote Clients, Bursting to the Cloud, File Sharing Solutions, Messaging and Communication Solutions, Group Productivity and Collaboration Solutions, Designing and Implementing an Application Hosting Solution, Designing and Implementing and Online Presence, Social Media: Joining the Conversation, Designing and Implementing a Disaster Recovery Solution, Optimizing and Troubleshooting an End-to-End Solution, Exploring HP Converged Cloud.

Text Books:

1. HP Prescribed Courseware
2. Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi Mastering Cloud Computing: Foundations and Applications Programming, Morgan Kaufmann, 2013.

References:

1. Michael Miller, Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, August 2008.
2. Haley Beard, Cloud Computing Best Practices for Managing and Measuring Processes for On demand Computing, Applications and Data Centers in the Cloud with SLAs, Emereo Pty Limited, July 2008.
3. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010
4. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile, 2011
5. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012

WEB APPLICATION DEVELOPMENT

Course Code :15 CS 5120 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Internet technology and Internet standards, Advanced Dynamic web client side programming, Java network programming, Dynamic web server side programming, Advanced server side programming, Web application frameworks

Text Book

1. Paul J. Deitel, Harvey Deitel, Abbey Deitel, *Internet and World Wide Web How to Program*, Edition 5, 2011.

References:

1. Chris Bates, Web Programming – Building Intranet applications, Wiley Publications, 3rd Edition, 2009.
2. Jeffrey C. Jackson, *Web Technologies A computer Science Perspective*, Pearson, 2011
3. Eilliote, Rusty Harold, *Java Network Programming*, 3/e, O'Reilly Media, Inc.
4. Java server programming java JavaEE5 Black Book, Kogent Solutions Inc, Dreamtech Press
5. AJAX black book, new edition, Kogent Solutions Inc, Dreamtech Press

DATA ANALYSIS

Course Code :15 CS 51I1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Meaning of Multivariate Analysis, Measurements Scales, Factor Analysis, Cluster Analysis, Basics of forecasting, Box-Jenkins Methodology for ARIMA models.

Text Books:

1. Joseph F.Hair, William C.Black, Barry J.Babin, Rolph E.Anderson and Ronald L.Tatham (2006). Multivariate Data Analysis, 6th Edition, Pearson Education, Inc., (Chapters 1, 3 and 8).
2. Spyros Makridakis, Steven C.Wheelwright and Rob J. Hyndman (2005). Forecasting methods and Applications, Third Edition, John Wiley & Sons Inc., New York (Chapters 1, 4 and 7).

References

1. Bendat, J. S. and A. G. Piersol, 1986: Random Data: Analysis and Measurement Procedures. John Wiley & Sons, 566 pp.
2. Daley, R., 1991: Atmospheric Data Analysis. Cambridge University Press, 457 pp.
3. Emery, W. J. and R. E. Thomson, 2001: Data Analysis Methods in Physical Oceanography, 2nd edition. Elsevier, 638 pp.
4. Lawson, C. L. and R. J. Hanson, 1974: Solving Least Squares Problems. Prentice-Hall, 340 pp. (reprinted 1997)
5. Menke, W., 1989: Geophysical Data Analysis: Discrete Inverse Theory. Academic Press, 289 pp.
6. Noble, B., and J. W. Daniel, 1988: Applied Linear Algebra, 3rd edition. Prentice-Hall, 521 pp

DATA MINING

Course Code :15 CS 51A3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Data, Exploring Data, Classification: Basic Concepts, Decision Trees, and Model Evaluation, Classification: Alternative Techniques, Association Analysis: Basic Concepts and Algorithms, Association Analysis: Advanced Concepts, Cluster Analysis: Basic Concepts and Algorithms, Anomaly Detection, Cluster Analysis: Additional Issues and Algorithms.

Text Book:

Data Mining, Concepts and Techniques, 2/e, Jiawei Han , Micheline Kamber , Elsevier,2006.

References:

1. Introduction to Data Mining, BY Pang-Ning Tan / Michael Steinbach / Vipin Kumar, Pearson Education
2. J. Han, M Kamber, "Data Mining: Concepts and Techniques", second edition, Elsevier, New Delhi, 2006.
3. Dunham M, "Data Mining: Introductory and Advanced Topics", Prentice Hall, New Delhi, 2002.
4. Hand.D, Mannila H, Smyth.P, "Principles of Data Mining", MIT press, USA,2001.

DISTRIBUTED SYSTEMS

Course Code :15 CS 51I2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Characterization of DS, System Models, Interprocess Communication, Indirect Communication, Operating System Support, Dist. Objects and Components, Distributed File Systems, Time and Global States, Coordination and Agreement, Transactions and Concurrency Control, Distributed Transactions

Text Book

1. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, “Distributed Systems: Concepts and Design”, 5th Addison-Wesley Publishing Company , ISBN:0132143011 9780132143011

Reference Books

1. Kenneth Birman Reliable Distributed Systems: Technologies, Web Services, and Applications Springer; 2005 edition
2. Paulo Vera-Ssimo, Luís Rodrigues Distributed Systems for System Architects Springer; 2001 edition
3. Ajay D. Kshemkalyani , Mukesh Singhal Distributed Computing: Principles, Algorithms, and Systems Cambridge University Press; Reissue edition (3 March 2011)
4. Zoltan Juhasz, Peter Kacsuk, Dieter Kranzlmuller, ”Distributed and Parallel Systems: Cluster and Grid Computing”, Springer; 2004 edition (October 28, 2004)
5. Andrew S. Tanenbaum, “Distributed Operating Systems”, Prentice Hall, 1995

BIG DATA ANALYTICS

Course Code :15 CS 51I3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Big Data Processing Architectures, Big Data Technologies, Data Driven Architecture, Information Management and Lifecycle, Big Data Analytics, Visualization and Data Scientist, Implementing The "Big Data" Data. Writing Hadoop Map Reduce Programs, Integrating R and Hadoop, Learning Data Analytics with R and Hadoop, Understanding Big Data Analysis with Machine Learning, The Evolution of Analytic Scalability, The Evolution of Analytic Processes, Hypothesis Testing, Prediction, Software, Complexity, Using Graph analytics, The New Information Management Paradigm, Big Data's Implication for Businesses, Big Data Implications for Information Management, Splunk's Basic Operations on Big Data.

Text Books:

1. Data Warehousing in the Age of Big Data by Krish Krishnan, Morgan Kaufmann.
2. A.Ohri, "R for Business Analytics", Springer, 2012.

References:

1. Big Data Analytics with R and Hadoop by Vignesh Prajapati
2. Principles of Big Data Preparing, Sharing, and Analyzing Complex Information, 1st Edition, by J Berman, published by Morgan Kaufmann
3. "Big Data Analytics - From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph" By David Loshin, Morgan Kaufmann
4. Franks, Bill, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", Wiley, 1st Edition, 2012.
5. Big Data Application Architecture Q&A: a Problem - Solution Approach Nitin Sawant, Himanshu Shah
6. Big Data Now: Current Perspectives from O'Reilly Radar By O'Reilly Radar Team

SERVICE ORIENTED ARCHITECTURE

Course Code :15 CS 51J1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Computing with Services, Framework, Web Ontology Language, Ontology Management, Engagement- Execution Models, Transaction Concepts, Process Specifications, Formal Specification and Enactment. Collaboration, Solutions, Engineering- SOA — Architecture Fundamentals, Designing Service Interfaces, Designing Service Implementations, Composing Services, Using Services to Build Enterprise Solutions. Enterprise Service Bus: Service Inventory Design Patterns, Service Advertisement and Discovery, Dependability in Service-Oriented Computing, Consensus Issues for Service Advertisement and Selection, Trust and Reputation, QoS-Aware Service Selection, Future Directions

Text Books:

1. Munindar P. Singh, Michael N. Huhns, "Service-Oriented Computing: Semantics, Processes, Agents", John Wieley, 2005.
2. Andrea De Lucia, Filomena Ferrucci, Genny Tortora, Maurizio Tucc, "Emerging Methods, Technologies and Process Management in Software Engineering", Wiley, 2008.

References:

1. Nathan Griffiths, Kuo-Ming Chao, "Agent-Based Service-Oriented Computing", Springer, 2010.
2. Michael Rosen, Boris Lublinsky, Kevin T. Smith, Marc J. Balcer, "Applied SOA: Service-Oriented Architecture and Design Strategies", Wiley, 2010.
3. Thomas Erl, "SOA Design Patterns", Pearson , 2009.
4. Douglas K. Barry, "Web Services, Service-Oriented Architectures, and Cloud Computing", Elsevier, 2003.
5. James Bean, "SOA and Web Services Interface Design: Principles, Techniques, and Standards", Elsevier, 2010

APPLICATION DEVELOPMENT FRAMEWORKS

Course Code :15 CS 51J2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Spring Framework, Effective Middle-Tier Architecture, Implementing Enterprise Information Connectivity, Integration with Enterprise Services, Enterprise Integration.

Text Book:

Rod Johnson... [et al.] 2005, Professional Java development with the Spring Framework, Wiley Pub. Indianapolis, IN

References:

1. Mark Fisher 2011, Spring Integration in Action, 1st Ed., Manning Publications
2. Craig Walls, Ryan Breidenbach, Spring in Action
3. Paul Fisher, Solomon Duskis, Spring Persistence with Hibernate

WEB SEMANTICS

Course Code :15 CS 51J3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

The Future of the Internet.- Concepts.- Ontology in Computer Science.- Knowledge Representation in Description Logic.- RDF and RDF Schema.- OWL.- Rule Languages.- Semantic Web Services.- Technologies.- Methods for Ontology Development.- Ontology Sources.- Semantic Web Software Tools.- Applications.- Software Agents.- Semantic Desktop.- Ontology Applications in Art.- Geospatial Semantic Web.

Text Book:

1. Breitman, Karin, Casanova, Marco Antonio, Truszkowski, Walt, "Semantic Web: Concepts, Technologies and Applications" NASA Monographs in Systems and Software Engineering 2007, XIV, 327 p.

References

1. Vipul Kashyap, Christoph Bussler, Matthew Moran, "The Semantic Web: Semantics for Data and Services on the Web (Data-Centric Systems and Applications)", Springer; 2008 edition (August 15, 2008)
2. Grigoris Antoniou, Paul Groth, Frank van Harmelen and Rinke Hoekstra, "A Semantic Web Primer, third edition", MIT Press, 2012
3. Toby Segaran Colin Evans Jamie Taylor, "Programming the Semantic Web" O'Reilly Media, Inc. Publisher, July 9, 2009
4. Dean Allemang James Hendler "Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL, Edition 2" Elsevier Publisher, 2011
5. Pascal Hitzler Markus Krotzsch Sebastian Rudolph, "Foundations of Semantic Web Technologies", CRC Press, March 23, 2011

NETWORK SECURITY

Course Code :15 CS 51J4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Internet Security & Encryption, Firewalls, Sniffers and Packet Crafting, Wireless Security, Intrusion Detection & Prevention.

Text Book

1. Eric Cole, Ronald L. Krutz, James Conley 2005, Network Security Bible, Wiley.

References:

1. John R. Vacca 2006, Guide to Wireless Network Security, Springer
2. Johnny Long, Chris Hurley, SensePost, Mark Wolfgang, Mike Petruzzi 2005, Penetration Tester's Open Source Toolkit, Syngress
3. Barrie Dempster, James Eaton-Lee 2006, Configuring IPCop Firewalls: Closing Borders with Open Source, Packet Publishing
4. Lucian Gheorghe 2006, Designing and Implementing Linux Firewalls and QoS using netfilter, iproute2, NAT, and L7-filter, Packt Publishing

PARALLEL ALGORITHMS

Course Code :15 CS 5221 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Principles of Parallel Algorithm Design: Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models. **Dense Matrix Algorithms:**, Matrix-Matrix Multiplication, Solving a System of Linear Equations. **Sorting algorithms**: Issues in Sorting on Parallel Computers Sorting Networks, Quicksort, Bucket and Sample Sort, Other Sorting Algorithms. **Graph Algorithms:** Definitions and Representation, Minimum Spanning Tree: Prim's Algorithm, Single-Source Shortest Paths: Dijkstra's Algorithm, All-Pairs Shortest Paths, Transitive Closure, Connected Components, Algorithms for Sparse Graphs. **Search Algorithms for Discrete Optimization Problems**: Definitions and Examples, Sequential Search Algorithms, Search Overhead Factor, Parallel Depth-First Search, Parallel Best-First Search, Speedup Anomalies in Parallel Search Algorithms. **Parallel hardware and parallel software:** modifications of the von Neumann model, parallel hardware, and parallel software parallel program design, writing and running parallel programs. **Distributed memory programming with MPI**-getting started, the trapezoidal rule in MPI, dealing with I/O, collective communication, MPI derived data types, performance evaluation of MPI programs, A parallel sorting algorithm . **Shared memory programming with Pthreads**: processes, threads and pthreads , hello, world, matrix vector multiplication, critical sections, busy waiting, mutexes, producer consumer synchronization and semaphores , barriers and condition variables, read write locks, caches, cache coherence and false sharing, thread safety. **Shared memory programming with openMP**: The trapezoidal rule, scope of variables, the reduction clause, the parallel for directive, more about loops in openMP: sorting, scheduling loops, producers and consumers, caches, cache coherence and false sharing, thread safety.

Text Books:

1. Peter S. Pacheco, An Introduction to Parallel Programming, 1st Edition, Elsevier, 2011.
2. Ananth Grama, Anshul Guptha, Vipin Kumar, Introduction to Parallel Computing, 2nd Edition. Addison Wesley, 2003.

References:

1. Parallel Programming in C with MPI and OpenMP, Michael Jay Quinn, McGraw-Hill Higher Education, 2004
2. Parallel computing theory and practice, MICHAEL J.QUINN, 2nd Edition, McGraw-Hill, 2008
3. Thomas Ruber, Parallel Programming for Multicore and Cluster Systems, 1st Edition, Springer, 2010.

4. Henri Casanova, Arnaud Legrand, and Yves Robert, Parallel Algorithms, 1st Edition, CRC Press, 2010.
5. Algorithms for Parallel processing, Michael T Heath, Abhiram Ranade, Schreiber, Springer. 1996,
6. Handbook of Parallel Computing Models, algorithms and applications, Samgithevar Rajasekharan, John Reif, Taylor and Franics group. 2008
7. Parallel Processing and Parallel Algorithms: Theory and Computation, Seyed H. Roosta, Springer, 2000

CLOUD SECURITY

Course Code :15 CS 5222 **L-T-P : 3-1-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Security Concepts: Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, defence in depth, least privilege, importance of security in the cloud, Importance in PaaS, IaaS and SaaS; **Cryptographic Systems**: Symmetric cryptography, stream ciphers, block ciphers, modes of operation, public-key cryptography, hashing, digital signatures, public-key infrastructures, key management, X.509 certificates, OpenSSL. **Multi-tenancy Issues:** Isolation of users/VMs from each other. **Virtualization System Security Issues**: e.g. ESX and ESXi Security, ESX file system security, storage considerations, backup and recovery; **Virtualization System Vulnerabilities**: Management console vulnerabilities, management server vulnerabilities, administrative VM vulnerabilities, guest VM vulnerabilities, hypervisor vulnerabilities, hypervisor escape vulnerabilities, configuration issues, malware (botnets etc). **Virtualization System-Specific Attacks:** Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyperjacking. **Technologies for Virtualization-Based Security Enhancement:** IBM security virtual server protection, virtualization-based sandboxing; **Storage Security**: HIDPS, log management, Data Loss Prevention. Location of the Perimeter, **Legal and Compliance Issues:** Responsibility, ownership of data, right to penetration test. Local laws, examination of modern Security Standards (eg PCIDSS), Standards to deal with cloud services and virtualization, compliance for the cloud provider vs. compliance for the customer.

Text Book:

Tim Mather, SubraKumaraswamy, ShahedLatif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, O'ReillyMedia Inc, 2009

References:

1. Ronald L. Krutz, Russell Dean Vines, Cloud Security,2010.
2. John Rittinghouse, James Ransome, Cloud Computing,2009.
1. J.R. ("Vic") Winkler, Securing the Cloud,2011.

MOBILE CLOUD

Course Code :15 CS 5223 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: Mobile Clouds Introduction and Background, Sharing Device Resources in Mobile Clouds; **Enabling Technologies For Mobile Clouds:** Wireless Communication Technologies, Network Coding for Mobile Clouds, Mobile Cloud Formation and Maintenance; **Social Aspects Of Mobile Clouds:** Social Mobile Clouds; **Green Aspects Of Mobile Clouds:** Green Mobile Clouds: Making Mobile Devices More Energy Efficient; **Application Of Mobile Clouds:** Mobile Clouds Applications; **Some Insights on the Future Developments of Mobile Clouds**

Text Book:

Frank H. P. Fitzek, Marcos D. Katz, Mobile Clouds: Exploiting Distributed Resources in Wireless, Mobile and Social Networks, Wiley Publications, ISBN: 978-0-470-97389-9, Jan 2014.

References:

1. Paul J. Deitel, Harvey M. Deitel, Abbey Deitel, and Michael Morgano, Android for Programmers: An App-Driven Approach, Prentice Hall, November 3, 2011.

DATA CENTRE VIRTUALIZATION

Course Code :15 CS 5223 **L-T-P : 3-1-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Data Center Challenges: reducing data centre footprint through server, desktop, network Virtualization and cloud computing, environmental impact and power requirements by driving server consolidation; **Evolution of Data Centres:** The evolution of computing infrastructures and architectures from stand alone servers to rack optimized blade servers and unified computing systems (UCS). **Enterprise-level Virtualization:** Provision, monitoring and management of a virtual datacenter and multiple enterprise-level virtual servers and virtual machines through software management interfaces; **Networking and Storage in Enterprise Virtualized Environments**: Connectivity to storage area and IP networks from within virtualized environments using industry standard protocols. **Virtual Machines & Access Control:** Virtual machine deployment, modification, management. monitoring and migration methodologies. **Resource Monitoring**: Physical and virtual machine memory, CPU management and abstraction techniques using a hypervisor. **Virtual Machine Data Protection**: Backup and recovery of virtual machines using data recovery techniques; **Scalability**: Scalability features within Enterprise virtualized environments using advanced management applications that enable clustering, distributed network switches for clustering, network and storage expansion; High Availability **:** Virtualization high availability and redundancy techniques.

Text Book:

1. Mickey Iqbal 2010, IT Virtualization Best Practices: A Lean, Green Virtualized Data Center Approach, MC Press

References:

2. Mike Laverick, VMware vSphere 4 Implementation,2010

3. Jason W. McCarty, Scott Lowe, Matthew K. Johnson, VMware vSphere 4 Administration Instant Reference,2009.

4. Brian Perry, Chris Huss, Jeantet Fields, VCP VMware Certified Professional on vSphere 4 Study Guide,2010

5. Brian Perry, Chris Huss, Jeantet Fields, VCP VMware Certified Professional on vSphere 4 Study Guide,2010.

6. Jason Kappel, Anthony Velte, Toby Velte, Microsoft Virtualization with Hyper-V: Manage Your Datacenter with Hyper-V, Virtual PC, Virtual Server, and Application Virtualization,2009.

NATURAL LANGUAGE PROCESSING

Course Code :15 CS 52K1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Regular Expressions and Finite State Automata – Morphology and Finite State Transducers – Computational Phonology and Text to speech - N-grams: Counting words in Corpora –Simple N- grams – Smoothing – Entropy – HMMS. **Speech Recognition**: Speech Recognition Architecture – Overview of HMM – Advanced Methods for decoding – Training a speech Recognizer – Human Speech Recognition – Part of Speech Tagging – Rule Based, Stochastic Part-of-Speech Tagging – Transformation Based Tagging. **Context Free Grammars for English**: Context Free Rules and Trees, Sentence Level Constructions, Coordination, Agreement, Grammars and Human Processing, Parsing with Context Free Grammars, Top down

Parser – Problems with Basic Top Down Parser – Finite State Parsing Methods – Representing Meaning: Computational Desiderata for Representations – Meaning Structure of Language – First Order Predicate Calculus - Semantic Analysis: Syntax driven Semantic Analysis – Attached for a Fragment of English- Integrating Semantic Analysis into the Early Parser, Robust Semantic Analysis - Dialogue and Machine. **Translation:** Dialogue Acts – Automatic, Plan inferential, Cue based Interpretation of Dialogue Acts – Dialogue Structure and coherences – Dialogue Managers - Language Similarities and Differences – The Transfer Metaphor – The Interlingua Idea- Direct Translation – Using Statistical Techniques – Usability and System Development

Text Books:

D. Jurafsky and J. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition. Pearson Education, 2004.

References:

1. C. Manning and H. Schutze, Foundations of Statistical Natural Language Processing. Massachusetts Institute of Technology, 2003
2. James Allen, Natural Language Understanding. The Benajmins/Cummings Publishing Company Inc. 1994

CLOUD APPLICATION ARCHITECTURES

Course Code :15 CS 52K2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Cloud Computing : The Cloud, Cloud Application Architectures, The Value of Cloud Computing, Cloud Infrastructure Models, An Overview of Amazon Web Services, **Amazon Cloud Computing:** Amazon S3,Amazon EC2, **Before The Move Into The Cloud:** Know Your Software Licenses , The Shift to a Cloud Cost Model, Service Levels for Cloud Applications, Security, Disaster Recovery, **Ready For The Cloud:** Web Application Design, Machine Image Design, Privacy Design, Database Management **Security:** Data Security, Network Security, Host Security, Compromise Response, **Disaster Recovery:** Disaster Recovery Planning, Disasters in the Cloud, Disaster Management, **Scaling A Cloud Infrastructure:** Capacity Planning, Cloud Scale

Text Book:

George Reese, Cloud Application Architectures, O’Rielly Media Inc, 2009

References:

1. GautamShroff, Enterprise Cloud Computing Technology Architecture Applications,2010.

2. Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing, A Practical Approach,2009.

3. Dimitris N. Chorafas, Cloud Computing Strategies,2009.

CLOUD STRATEGY PLANNING & MANAGEMENT

Course Code :15 CS 52K3	**L-T-P : 3-0-0**
Pre-requisite: NIL	**Credits: 3**

Syllabus:

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; **Developing Business Strategy:** Investigate business strategy models to gain competitive advantage for organizations, SWOT/PEST, Economies of scale, Porter's 3 Strategies and 5 Competitive Forces, D'Aveni's hypercompetition models. **Strategic IT Leadership in the Organization:** Emphasize the 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. **Planning a Cloud Computing Based 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 are essential in delivering a successful strategic IT Plan. **SOA and Business Agility:** Shared services delivered by a Service Oriented Architecture (SOA) in a Private or Public Cloud. Services, Databases and Applications on demand. The effect on Enterprise Architecture and its traditional frameworks such as Zachman and The Open Group Architecture Framework (TOGAF). **Benefit Realization and IT Governance:** 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. 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.

Text Book:

1. Andy Mulholland, Jon Pyke, Peter Finger, Enterprise Cloud Computing - A Strategy Guide for Business and Technology Leaders, Meghan Kiffer,2010.

References:

1. Arnold J Cummins, Easiest Ever Guide to Strategic IT Planning
2. David S. Linthicum, Cloud Computing and SOA Convergence in Your Enterprise, Addison Wesley,2009.
3. Charles Babcock, Management Strategies for the Cloud Revolution, 1st

Ed., McGraw/Hill,2010.

4. Mark I. Williams, A Quick Start Guide to Cloud Computing: Moving Your Business into the Cloud,2010.

SCRIPTING FOR SYSTEM ADMINISTRATORS

Course Code :15 CS 52K4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Power shell: Shell and Powershell Scripting: Shell syntax, sed, awk, grep, diff, join, etc.

Cmdlets: Unix and Windows CLI. cmdlets, wmic. **Trouble shooting:** Managing processes, services, events and network connections; Troubleshooting. **Applications Of Scripting:**

Scripting in a high-level Language: Language syntax, Applications of scripting e.g. querying SNMP devices, running external processes, managing user accounts, monitoring file systems & processes, **Using Ldap And Ad :** Working with LDAP and AD.

Text Book:

1. Hal Rottenberg, "Managing VMware Infrastructure with Windows PowerShell TFM", Sapien Press, 2009.

References:

1. Justin Seitz, "Gray Hat Python", NO STARCH PRESS, 2009.
2. RytisSileika, "Pro Python System Administration" A press; 1 edition, 2010.
3. Noah Gift and Jeremy Jones, "Python for Unix and Linux system administration", O'Reilly Farnham, 2008.
4. Marty Alchin, "Pro Python" A press, 2010.
5. Mark Lutz, "Learning Python" O'Reilly Media; 5 edition, 2013.
6. Mark Summerfield, "Programming in Python 3: A Complete Introduction to the Python Language" Addison-Wesley Professional; 2 edition, 2009.
7. David N. Blank-Edelman, "Automating system administration with Perl", O'Reilly Media Sebastopol, CA, 2009.

OBJECT ORIENTED SOFTWARE ENGINEERING

Course Code :15 CS 52L1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Software Engineering Paradigms - Software Development process models - Project & Process -Project management – Process & Project metrics – Object Oriented concepts & Principles. **Planning & Scheduling:** Software prototyping - Software project planning – Scope – Resources - Software Estimation -Empirical Estimation Models-Planning-Risk Management - Software Project Scheduling – Object oriented Estimation & Scheduling. **Analysis & Design:** Analysis Modeling - Data Modeling - Functional Modeling & Information Flow- Behavioral Modeling-Structured Analysis - Object Oriented Analysis - Domain Analysis-Object oriented Analysis process - Object Relationship Model – Object Behaviour Model; Design Concepts & Principles - Design Process - Design Concepts - Modular Design –Design Effective Modularity - Introduction to Software Architecture – Data Design – Transform Mapping – Transaction Mapping – OOD - Design System design process- Object design process -Design Patterns. **Implementation & Testing:** Top-Down , Bottom-Up , object oriented product Implemention & Integration. Software Testing methods-White Box, Basis Path-Control Structure –Black Box-Unit Testing- Integration testing-Validation & System testing. Testing OOA & OOD models-Object oriented testing strategies.

Maintenance: Maintenance process-System documentation-program evolution dynamics-Maintenance costs-Maintainability measurement – Case Studies

Text Book

1. Roger S. Pressman, “Software Engineering A Practitioner’s Approach”, Fifth Edition,Tata McGraw Hill,2001.

References:

1. Grady Booch,James Rumbaugh,Ivar Jacobson –“the Unified Modeling Language User Guide” – Addison Wesley,1999. (Unit III)

2. Ian Sommerville, “Software Engineering”, V Edition Addison- Wesley 1996

3. Pankaj Jalote “An Integrated Approach to Software Engineering” Narosa Publishing House 1991

4. Carlo Ghezzi Mehdi Jazayer, Dino Mandrioli “Fudamentals of Software Engineering” Prentice Hall of India 2002.

MAP REDUCE DESIGN PATTERNS

Course Code :15 CS 52L2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Design Patterns and MapReduce: Design Patterns, MapReduce History ,MapReduce and Hadoop,Refresher, Hadoop Example: Word Count ,Pig and Hive. **Summarization Patterns:** Numerical Summarizations, Pattern Description,Numerical Summarization, Examples, Inverted Index Summarizations, Pattern Description, Inverted Index Example, Counting with Counters, Pattern Description, Counting with Counters Example. **Filtering Patterns:** Filtering,Pattern Description, Filtering Examples, Bloom Filtering, Pattern Description, Bloom Filtering Examples, Top Ten, Pattern Description, Top Ten Examples, Distinct , Pattern Description , Distinct Examples. **Data Organization Patterns.:** Structured to Hierarchical, Pattern Description , Structured to Hierarchical Examples, Partitioning, Pattern Description, Partitioning Examples, Binning, Pattern Description, Binning Examples , Total Order Sorting , Pattern Description , Total Order Sorting Examples, Shuffling, Pattern Description, Shuffle Examples, **Join Patterns:** A Refresher on Joins, Reduce Side Join , Pattern Description, Reduce Side Join Example, Reduce Side Join with Bloom Filter, Replicated Join , Pattern Description, Replicated Join Examples , Composite Join ,Pattern Description , Composite Join Examples ,Cartesian Product , Pattern Description, Cartesian Product Examples, **Metapatterns** Job Chaining, With the Driver, Job Chaining Examples, With Shell Scripting, With JobControl, Chain Folding, The ChainMapper and ChainReducer Approach, Chain Folding Example , Job Merging, Job Merging Examples, **Input and Output Patterns:** Customizing Input and Output in Hadoop, InputFormat, RecordReader, OutputFormat, RecordWriter , Generating Data, Pattern Description, Generating Data Examples, External Source Output, Pattern Description, External Source Output Example, External Source Input , Pattern Description, External Source Input Example , Partition Pruning , Pattern Description, Partition Pruning Examples , **Final Thoughts and the Future of Design Patterns:** Trends in the Nature of Data, Images, Audio, and Video, Streaming Data, The Effects of YARN, Patterns as a Library or Component.

Text Book:

1. Donald Miner and Adam Shook, *MapReduce Design Patterns,* O'reilly Media Inc, 2013

References:

1. Thomas Erl, Cloud Computing Design Patterns, Pearson Education, 2014
2. Christoph Fehling, Frank Leymann, Ralph Retter, Walter Schupeck, Peter Arbitter, Cloud Computing Patterns: Fundamentals to Design, Build, and Manage Cloud Applications, Springer, 2014
3. Bill Wilder, Cloud Architecture Patterns, Oreilly, 2012
4. Srinanth Perera, Thilina Gunarathne, Hadoop MapReduce Cook Book, PACKT publishning, 2013

OPEN SOURCE CLOUD COMPUTING AND TESTING

Course Code :15 CS 52L3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

OpenStack Cloud Computing: Keystone OpenStack Identity Service, Starting OpenStack Image Service, Starting OpenStack Compute, Installing OpenStack Object Storage, Using OpenStack Object Storage, Administering OpenStack Object Storage, Starting OpenStack Block Storage, OpenStack Networking, Using OpenStack Dashboard. High Avaliability Open Stack. Monitoring OpenStack services, **OpenNebula Cloud Computing:** OpenNebula,and its underlying technologies. basic networking and OpenNebula frontend, hypervisors supported by OpenNebula: KVM, Xen, and VMWare ESXi, OpenNebula resource management process. OpenNebula management tasks and monitoring using Sunstone, the OpenNebula cloud operations center Health and Monitoring, Ganglia, Hybrid Cloud Computing: Extending OpenNebula, Public Cloud Computing and High Availability with OpenNebula. **Software Testing in the Cloud** - **SMART-T:** Migrating Testing to the Cloud, **HadoopUnit:** Test Execution in the Cloud

Text Book:

1. Kevin Jackson, Cody Bunch *OpenStack Cloud computing Cookbook, Second Edition, Packt Publishing, 2013*
2. Scott Tilley, Tauhida Parveen Software Testing in the Cloud Migration and Execution, Springer, 2012
3. Giovanni Toraldo, OpenNebula 3 Cloud Computing, Packt Publishing, 2012

References:

1. Tom Fifield etal, OpenStack Operations Guide, O’Rielly Publishers, 2014
2. John Rhoton, OpenStack Cloud Computing: Architecture Guide, Recursive Press, 2014

ADVANCES IN COMPUTING

Course Code :15 CS 52L4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Grid Computing, **Autonomic Computing**, **Cluster Computing 1**: Cluster setup & its Administration, Performance Models & Simulations; Networking, Protocols & I/O, Lightweight Messaging systems, Active Messages. **Cluster Computing 2**: Distributed shared memory, parallel I/O Clusters, Jib and Resource management system, scheduling parallel jobs on clusters.

Cluster Computing 3: Load sharing and Fault tolerance manager, parallel programming scheduling techniques, Dynamic load balancing. Example Cluster System – Beowlf, COMPaS and NanOS. **Pervasive Computing, Quantum Computing.**

Text Book

1. Raj Kumar Buyya, High performance cluster computing, PEA,1999.

References:

1. J. Joseph & C. Fellenstein, Grid Computing, PEA,1999.
2. J.Burkhardt et .al, Pervasive computing, PEA, 2002.
3. Vishal Sahni, Quantum computing, TMH, 2006.
4. Marivesar, Approaching quantum computing, PEA.
5. Neilsen & Chung L, Quantum computing and Quantum Information, Cambridge University Press,2000.
6. A networking approach to Grid Computing , Minoli, Wiley, 2005.

M.TECH - COMPUTATIONAL INTELLIGENCE

First Year (First Semester):

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 CS 5125	Probability & Distributions	**3**	1	0	4
2	15 CS 5126	Applied Statistics	**3**	1	0	4
3	15 CS 5127	Data Base Management Systems	**3**	0	2	4
4	15 CS 5128	Object Oriented Programming in JAVA	**3**	0	2	4
5		Elective – 1	3	0	0	3
6		Elective - 2	3	0	0	3
7	15 IE 5149	Seminar	0	0	4	2
		Total	**18**	**4**	**8**	**24**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 CS 5229	Machine Learning	**4**	0	0	4
2	15 CS 5230	Expert Systems	**4**	0	0	4
3	15 CS 5231	Big Data Analytics & Business Intelligence	**3**	0	2	4
4	15 CS 5232	Data ware Housing & Data Mining	**3**	0	2	4
5		Elective – 3	3	0	0	3
6		Elective - 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total	**18**	**4**	**8**	**24**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 CS 51A1	Soft Computing	3	0	0	3
2	15 CS 51M1	Cloud Computing and Distributed Technologies	3	0	0	3
3	15 CS 51M2	Semantic Web Architecture	3	0	0	3
4	15 CS 51M3	Formal Languages and Automata Theory	3	0	0	3
5	15 CS 51M4	Human Computer Interaction	3	0	0	3
Elective-2						
1	15 CS 51N1	Artificial Intelligence	3	0	0	3
2	15 CS 51N2	Algorithms and Complexity	3	0	0	3
3	15 CS 51N3	Pattern Recognition	3	0	0	3
4	15 CS 51N4	Web Services	3	0	0	3
5	15 CS 51F1	Storage Area Networks	3	0	0	3
Elective-3						
1	15 CS 52O1	Natural Language Processing	3	0	0	3
2	15 CS 52O2	Simulation and Modeling	3	0	0	3
3	15 CS 52O3	Computer Vision	3	0	0	3
4	15 CS 52O4	Pervasive Computing	3	0	0	3
5	15 CS 52O5	Software Engineering & Project Management	3	0	0	3
Elective-4						
1	15 CS 52P1	Information Retrieval and Extraction	3	0	0	3
2	15 CS 52P2	Multi agent Systems	3	0	0	3
3	15 CS 52P3	Algorithms in Computational Biology	3	0	0	3
4	15 CS 52P4	Enterprise Computing Methodologies	3	0	0	3
5	15 CS 52P5	Bio-Informatics	3	0	0	3

PROBABILITY & DISTRIBUTIONS

Course Code :15 CS 5125 **L-T-P : 3-1-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Concept of probability: Historical introduction and citation of examples for application of probability. Definition of probability - classical, relative frequency and subjective approaches, their drawbacks, practical exercises on relative frequency approach. Sample space and events; calculus of events, examples of sample space. Concept of random experiment with examples. Axiomatic development of probability- discrete and general probability space, properties of probability. Conditional probability, Bayes' theorem, independence of events, pairwise and mutual independence.
Concept of random variables and probability distribution: Definition of random variable, cumulative distribution function. Discrete random variables and their Probability mass function (p.m.f). and Distribution function (d.f). with some general examples. Continuous random variables and their probability density function (p.d.f}. and distribution function (d.f). with some general examples
Discrete random variable and its distribution: Bernoulli trials, binomial, Poisson, geometric, negative binomial, hyper geometric distributions, their properties, relationship and simple approximations (Hyper geometric to binomial and binomial to Poisson). Numerical examples and statistical tables for individual and cumulative probabilities. Discrete random vector and bivariate cases marginal and conditional density functions, independence of discrete random variables. Distribution of the sum of two or more discrete independent random variables. Probability generating function (p.g.f.), properties and exercise.
Continuous random variable and its distribution: Uniform, normal, gamma, beta, exponential, weibull, Cauchy, lognormal distribution, Relationship between gamma and Poisson, beta and binomial. Cumulative probabilities. Bivariate distribution - marginal and conditional density, bivariate normal, independence of continuous random variables. Distribution of sum, product and ratio of two independent random variables. Some derived distributions such a χ^2, t, F. Order statistics and distribution of range.
Expected values and moments: Mathematical expectation and its properties; Moments, their properties and interpretation; moments through p.g.f.; variance of sum of independent random variables, conditional expectation, conditional variance. Correlation coefficient and its properties.

Text Books:

1. Ronald E.Walpole, Sharon L.Myers, Keying ye, Probability & Statistic for Engineers & scientist- 8th Edition, Pearson
2. Walpole.E.Ronald, Myers.H.raymond, Myers.l.Sharon,Ye Keying, Probability & Statistics for Engineers & Scientist– 8th Edition, Pearson

References:

1. S.M. Ross, A first course in Probability.

2. Erwin Kreyszig , Introductory Mathematical Statistics principles and methods, John Wiley Publisher
3. Paul G Hoel, Introduction to mathematical Statistics, John Wiley Publisher
4. Norman L Johnson, Distributions in Statistics continuous and uni-variate distributions, John Wiley Publisher
5. Richard A Johnson, Probability and Statistics for Engineers. Pearson Publishers
6. Irwin miler, John E Freund's mathematical Statistics, Pearson Publishers
7. V K Rohatgi, Introduction to probability and mathematical statistics, Wiley Publishers

APPLIED STATISTICS

Course Code :15 CS 5126 **L-T-P : 3-1-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: Principles of Statistical Inference. Formulation of the problems with examples.

Estimation: Point estimation. Estimator and estimate criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Illustrations. Methods of estimation of Parameters of standard distributions. Interval estimation by examples- Confidence internals of the parameters of the standard distributions, one-sided confidence interval.

Testing of Hypothesis: Formulation of the problem and concepts for evaluation of tests, Illustrations. Statistics Sampling distribution of statistic and its standard error. Small sample tests associated with standard univariate probability distributions and corresponding sampling distributions (without derivations) Large sample tests in one and two-sample problems of standard probability distributions, Statement of central limit theorem, Determination of sample size. Small sample tests connected with Bivariate Normal population, Simple linear regression and correlation and corresponding confidence intervals. Transformation of statistics to stabilize the residual plots. Assessment of the model. Fitting of non-linear regression using transformation. Analysis of categorical data. Pearsonian chi-square and its applications.

Linear Statistical Models: Definition of linear model, interactions with illustrations. One way and two way analysis of variance.

Non-parametric Inference: Comparison with parametric inference, Use of order statistics. Confidence interval for fractile. Sign test, Wilcoxon signed rank test, Mann-Whitney test, Run test, Kolmogorov-Smirnov test. Spearman's and Kendall's test. Tolerance region.

Text Books:

1. MILLER AND Freund's, Probability and Statistics for Engineers, Richard A Johnson, PHI New Delhi, 11th Edition.

References:
1. Ronald E.Walpole, Sharon L.Myers, Keying ye, Probability & Statistic for Engineers & scientist- 8^{th} Edition, Pearson
2. S.C.Gupta and V.K.Kapur, Applied Statistics, S.Chand & sons.

DATABASE MANAGEMENT SYSTEMS

Course Code :15 CS 5127 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Data base System Applications, data base System VS file System - View of Data - Data Abstraction - Instances and Schemas - data Models - the ER Model - Relational Model - Other Models - Database Languages - DDL - DML - database Access for applications Programs - data base Users and Administrator - Transaction Management - data base System Structure - Storage Manager - the Query Processor - History of Data base Systems.Data base design and ER diagrams - Beyond ER Design Entities, Attributes and Entity sets - Relationships and Relationship sets - Additional features of ER Model - Concept Design with the ER Model - Conceptual Design for Large enterprises.
Introduction to the Relational Model - Integrity Constraint Over relations - Enforcing Integrity constraints - Querying relational data - Logical data base Design - Introduction to Views - Destroying /altering Tables and Views.
Relational Algebra and Calculus
Relational Algebra - Selection and projection set operations - renaming - Joins - Division - Examples of Algebra overviews - Relational calculus - Tuple relational Calculus - Domain relational calculus - Expressive Power of Algebra and calculus.
Form of Basic SQL Query - Examples of Basic SQL Queries - Introduction to Nested Queries - Correlated Nested Queries Set - Comparison Operators - Aggregative Operators - NULL values - Comparison using Null values - Logical connectivity's - AND, OR and NOTR - Impact on SQL Constructs - Outer Joins - Disallowing NULL values - Complex Integrity Constraints in SQL Triggers and Active Data bases.
Schema refinement - Problems Caused by redundancy - Decompositions - Problem related to decomposition - reasoning about FDS - FIRST, SECOND, THIRD Normal forms - BCNF - Lossless join Decomposition - Dependency preserving Decomposition - Schema refinement in Data base Design - Multi valued Dependencies - forth Normal Form.
ACID Properties - Transactions and Schedules - Concurrent Execution of transaction - Lock Based Concurrency Control - Performance Locking - Transaction Support in SQL - Introduction to Crash recovery.
Serializability, and recoverability - Introduction to Lock Management - Lock Conversions - Dealing with Dead Locks - Specialized Locking Techniques - Concurrency without Locking. Crash recovery : Introduction to ARIES - the Log - Other Recovery related Structures - the

Write-Ahead Log Protocol - Check pointing - re3covering from a System Crash - Media recovery - Other approaches and Interaction with Concurrency control.
Data on External Storage - File Organization and Indexing - Cluster Indexes, Primary and Secondary Indexes - Index data Structures - Hash Based Indexing - Tree base Indexing - Comparison of File Organizations - Indexes and Performance Tuning.
The Memory Hierarchy - Redundant Arrays of Independent - Disks - Disk Space Management - Buffer Manager - Files of records - Page Formats - record formats.
Tree Structured Indexing: Intuitions for tree Indexes - Indexed Sequential Access Methods (ISAM) - B+ Trees: A Dynamic Index Structure.

Hash Based Indexing: Static Hashing - Extendable hashing - Linear Hashing - Exendble vs. Liner hashing.

TEXT BOOKS

1. Data base Management Systems, Raghurama Krishnan, Johannes Gehrke, TATA McGrawHill 3rd Edition
2. Data base System Concepts, Silberschatz, Korth, McGraw hill, IV edition.
3. Data base Management System, Elmasri Navate Pearson Education

REFERENCES

1. Introduction to Database Systems, C.J.Date Pearson Education
2. Data base Systems design, Implementation, and Management, Rob & Coronel 5th Edition.Thomson
3. Data base Management System Mathew Leon, Leon Vikas.
4. Data base Systems, Connoley Pearson Education.

OBJECT ORIENTED PROGRAMMING IN JAVA

Course Code :15 CS 5128 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Basics of Object Oriented Programming (OOP): Need for OO paradigm , A way of viewing world- Agents, responsibility, messages, methods, classes and instances, class hierarchies(Inheritance), method binding, overriding and exceptions, summary of oop concepts, coping with complexity , abstraction mechanisms
Java Basics: Data types, variables, scope and life time of variables, arrays, operators, expressions, control statements, type conversion and costing, simple java program, classes and objects- concepts of classes, objects, constructors methods, access control, this keyword, garbage collection, overloading methods and constructors, parameter passing, recursion, string handling.
Inheritance: Hierarchial abstractions, Base class object, subclass, subtype, substitutability, forms of inheritance- specialization, specification, construction, extension, limitation, sombination, benifits of inheritance costs of inheritance. Member access rules, super uses, using final with inheritance, polymorphism, abstract classes.

Packages and Interfaces: Defining, Creating and Accessing a package, Understanding CLASSPATH, Importing packages, differences between classes and interfaces, defining an interface, Implementing interface, applying interfaces variables in interface and extending interfaces.

Exception handling and Multithreading: Concepts of exception handling, benefits of exception handling, Termination or presumptive models, exception hierarchy, usage of try, catch, throws and finally, built in exceptions, creating own exception sub classes. Differences between multi threading and multitasking, thread life cycle, creating threads, synchronizing threads, daemon threads, thread groups.

Event Handling: Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes, inner classes. The AWT class hierarchy , user interface components-labels, button, canvas, scrollbars, text components, check box, check box groups, choices, list panes- scrollpane, dialogs, menubar, graphics, layout manager- layout manager types- boarder, grid, flow, card and grid bag.

Applets: Concepts of Applets, differences between applets and applications, lifecycle of an applet, types of applets, creating applets, passing parameters to applets. **Swings:** Introduction, limitations of AWT, MVC architecture, components, containers, exploring swing- JApplet, JFrame and JComponent, Icons and Labels, text fields, buttons-The JButton class, Check boxes, Radio Buttons, Combo boxes, Tabbed panes, Scroll panes, Trees and Tables.

.

TEXTBOOKS:

1.Java-The complete reference,7/e, Herbert schildt, TMH.

REFERENCES:

1.JAVA:How to program, 8/e, Dietal , Dietal,PHI.
2.Introduction of programming with JAVA,S.Dean,TMH.
3.Introduction to Java programming, 6/e, Y.Daniel Liang, Pearson.
4.Core Java 2, Vol 1(Vol 2) Fundamentals(Advanced), 7/e, Cay.S.Horstmann,Gary Cornell, Pearson.
5.Big Java2,3/e, Cay.S. Horstmann,Wiley.
6.Object Oriented Programming through Java, P.Radha Krishna, University Press.
7.JAVA&Object Orientation an Introduction, 2/e, John Hunt, Springer.
8. Introduction to JAVA Programming, 7/e, Y.Daniel Liang, Pearson.
9. JAVA Programming and Object –Oriented Application Development, Johnson, Cengage Learning.
10.First Encounter with JAVA, S.P.Bhuta, SPD
11.JAVA for Professionals , B.M.Harwani, SPD.
12.Program with JAVA, Mahesh Bhave, Palekan, Pearson.
13.Programming with JAVA, 3/e, E.Balaguruswamy, TMH.

SOFT COMPUTING

Course Code :15 CS 51A1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Intelligent Systems and Soft Computing: Intelligence systems, Knowledge-based systems, knowledge representation and processing, soft computing.
Fundamentals of Fuzzy Logic Systems: Fuzzy sets, Fuzzy logic operations, generalized operations, Fuzziness and fuzzy resolution, fuzzy relations, composition and interface, considerations of fuzzy decision-making. **Fuzzy Logic Control:** Basic of Fuzzy control, Fuzzy control architecture, Properties of Fuzzy control, robustness and stability.
Fundamentals of Artificial neural networks: Learning and acquisition of knowledge, features of artificial neural networks, fundamentals of connectionist modeling, .**Major classes of neural networks:** The multi-layer perceptions, radial basis function networks, Kohonen's self-organizing networks, The Hopfield network, industrial and commercial Application of ANN.
Dynamic neural networks and their applications to control and chaos prediction: Training algorithms, fields of applications of RNN, dynamic neural networks for identification and control, neural network-based control approaches, dynamic neural networks for chaos time series prediction, artificial neural networks for chaos predictions.
Neuro Fuzzy Systems: Architecture of neuro fuzzy systems, construction of neuro fuzzy systems,
Evolutionary computing: Over view of Evolutionary computing, Genetic Algorithms and Optimization, the schema theorem: the fundamental algorithm of Genetic algorithms,
Genetic algorithms- operations, integration of Genetic algorithms with neural networks, integration of Genetic algorithms with fuzzy logic, known issues in Genetic algorithms, population-based incremental learning, Evolutionary Strategies, ES applications

Text Books:

1. Fakhreddine O. Karry, Clarence De Silva, " Soft Computing and Intelligent systems Design Theory, tools and Application", Pearson, 2009

Reference Books:

1. Laurene Fausett, "Fundamentals of Neural Networks", Person, 2004.
2. Timothy J Ross " Fuzzy Logic with Engineering Applications", 3rd Edition, Wiley 2010.
3. Bart Kosko, " Neural Networks and Fuzzy Systems", PHI, 2004
4. S N Sivanandam, S N Deepa, " Principles of Soft Computing", Wiley India ,2008

CLOUD COMPUTING AND DISTRIBUTED TECHNOLOGIES

Course Code :15 CS 51M1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

- Enabling Technologies and System Models for Cloud Computing
- Introduction to Cloud Computing including benefits, challenges, and risks
- Cloud Computing Models including Infrastructure/Platform/Software – as-a-service
- Public cloud, private cloud and hybrid clouds
- Cloud OS
- Cloud Architectures including Federated Clouds
- Scalability, Performance, QoS
- Data centers for Cloud Computing
- Principles of Virtualization platforms
- Security and Privacy issues in the Cloud
- VMWare ESX Memory Management
- Capacity Planning and Disaster Recovery in Cloud Computing

TEXT BOOK:

1. Distributed and Cloud Computing, 1st edition, Morgan Kaufmann, 2011.

REFERENCES:

1. echnical papers from major journals and major conferences on computing, networking, cloud computing

SEMANTIC WEB ARCHITECTURE

Course Code :15 CS 51M2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Objective: To introduce the advanced concepts in emerging trends in Web architecture.

Introduction to semantic web technology : Traditional web to semantic web – meta data search engines .

Resource Description Framework –elements -rules of RDF – tools- RDFS core elements- Taxonomy and ontology concepts .
Web ontology language: OWL: define classes- set operators –enumerations- defining properties – Validating OWL ontology.

Semantic web services and applications :
Web services – web services standards – web services to semantic web services- UDDIConcept of OWL-S – building blocks of OWL-S- mapping OWL-S to UDDI- WSDL-S overview

Real world examples and applications : Swoogle- architecture and usage of meta data;FOAF – vocabulary – creating documents – overview of semantic markup – semantic web search engines.

References

1. Liyang Yu .Introduction to the Semantic Web and Semantic web services. Chapman & Hall/CRC, Taylor & Francis group, 2007.
2. Johan Hjelm. Creating the Semantic Web with RDF. Wiley, 2001
3. Grigoris Antoniou and Frank van Harmelen. A Semantic Web Primer. MIT Press

FORMAL LANGUAGES AND AUTOMATA THEORY

Course Code :15 CS 51M3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Fundamentals : Strings, Alphabet, Language, Operations, Finite state machine, definitions, finite automaton model, acceptance of strings, and languages, deterministic finite automaton and non deterministic finite automaton, transition diagrams and Language recognizers.
Finite Automata : NFA with Î transitions - Significance, acceptance of languages. Conversions and Equivalence : Equivalence between NFA with and without Î transitions, NFA to DFA conversion, minimisation of FSM, equivalence between two FSM's, Finite Automata with output- Moore and Melay machines.
Regular Languages : egular sets, regular expressions, identity rules, Constructing finite Automata for a given regular expressions, Conversion of Finite Automata to Regular expressions. Pumping lemma of regular sets, closure properties of regular sets (proofs not required).
Grammar Formalism : Regular grammars-right linear and left linear grammars, equivalence between regular linear grammar and FA, inter conversion, Context free grammar, derivation trees, sentential forms. Right most and leftmost derivation of strings.
Context Free Grammars : Ambiguity in context free grammars. Minimisation of Context Free Grammars. Chomsky normal form, Greiback normal form, Pumping Lemma for Context Free Languages. Enumeration of properties of CFL (proofs omitted).
Push Down Automata : Push down automata, definition, model, acceptance of CFL, Acceptance by final state and acceptance by empty state and its equivalence. Equivalence of CFL and PDA, interconversion. (Proofs not required). Introduction to DCFL and DPDA.

Turing Machine : Turing Machine, definition, model, design of TM, Computable functions, recursively enumerable languages. Church's hypothesis, counter machine, types of Turing machines (proofs not required).
Computability Theory : Chomsky hierarchy of languages, linear bounded automata and context sensitive language, LR(0) grammar, decidability of, problems, Universal Turing Machine, undecidability of posts. Correspondence problem, Turing reducibility, Definition of P and NP problems, NP complete and NP hard problems.

TEXT BOOKS:
1. "Introduction to Automata Theory Languages and Computation". Hopcroft H.E. and Ullman J. D. Pearson Education
2. Introduction to Theory of Computation –Sipser 2nd edition Thomson
REFERENCE BOOKS:
1. Introduction to Computer Theory, Daniel I.A. Cohen, John Wiley.
2. Introduction to languages and the Theory of Computation ,John C Martin, TMH
3. "Elements of Theory of Computation", Lewis H.P. & Papadimition C.H. Pearson /PHI.
4 Theory of Computer Science – Automata languages and computation -Mishra and Chandrashekaran, 2nd edition, PHI

HUMAN COMPUTER INTERACTION

Course Code :15 CS 51M4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction : Importance of user Interface – definition, importance of good design. Benefits of good design. A brief history of Screen design.

The graphical user interface – popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface.

Design process – Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, understanding business junctions.

Screen Designing : Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design.

Windows – New and Navigation schemes selection of window, selection of devices based and screen based controls.

Components – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors.

Software tools – Specification methods, interface – Building Tools.

Interaction Devices – Keyboard and function keys – pointing devices – speech recognition digitization and generation – image and video displays – drivers.

TEXTBOOKS :

1. The essential guide to user interface design, Wilbert O Galitz, Wiley DreamaTech.
2. Designing the user interface. 3rd Edition Ben Shneidermann , Pearson Education Asia.

REFERENCES :

1. Human – Computer Interaction. ALAN DIX, JANET FINCAY, GRE GORYD, ABOWD, RUSSELL BEALG, PEARSON.
2. Interaction Design PRECE, ROGERS, SHARPS. Wiley Dreamtech,
3. User Interface Design, Soren Lauesen , Pearson Education.

ARTIFICIAL INTELLIGENCE

Course Code :15 CS 51N1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to AI, Problems, Problem Spaces and Search: Defining the Problem as a State space Search, Production Systems, Problem Characteristics, Production system characteristics, Issues in the Design of Search Programs.

Heuristic Search Techniques: Generate-and-test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis.

Knowledge Representation Using Predicate Logic: Representing Simple Facts in logic, Representing Instance and Isa Relationships, Computable Functions and Predicates, Resolution.

Representing Knowledge Using Rules: Procedural versus Declarative Knowledge, Logic Programming, Forward versus Backward Reasoning, Matching, Control Knowledge.

Weak slot-and-filler structures: Semantic Nets, Frames,

Strong slot-and-filler structures: Conceptual dependency, Scripts.

Connectionist models: Hopfield Networks**,** perceptron, Back Propagation Networks, Applications of Neural networks.

PROLOG Language: Facts, Objects and predicates, Variables, Rules, Input and Output, Arithmetic Operations, Cut, Fail, Recursion, String operations, Dynamic databases.

Text Books:

1. Elaine Rich & Kevin Knight, 'Artificial Intelligence', 3rd Edition, (Tata McGraw Hill Edition) Reprint 2008
2. Carl Townsend, 'Introduction to TURBO PROLOG', BPB Publications. 2011

Reference Books:

1. Patrick Henry Winston, 'Artificial Intelligence', Pearson Education, 2003
2. Russel and Norvig, 'Artificial Intelligence', Pearson Education, PHI, 2003

ALGORITHMS AND COMPLEXITY

Course Code :15 CS 51N2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Objective: To introduce the advanced concepts of data structures and algorithms with an insight into the complexity-related aspects of computing.

Module I: Analysis: RAM model – Notations, Recurrence analysis - Master's theorem and its proof - Amortized analysis - Advanced Data Structures: B-Trees, Binomial Heaps, Fibonacci Heaps, Disjoint Sets, Union by Rank and Path Compression

Module II: Graph Algorithms and complexity: Matroid Theory, All-Pairs Shortest Paths, Maximum Flow and Bipartite Matching.

Module III: Randomized Algorithms : Finger Printing, Pattern Matching, Graph Problems, Algebraic Methods, Probabilistic Primality Testing, De-Randomization

Module IV: Complexity classes:NP-Hard and NP-complete Problems-Cook's theorem NP completeness reductions. Approximation algorithms – Polynomial Time and Fully Polynomial time Approximation Schemes. Probabilistic Complexity Classes, Probabilistic Proof Theory and Certificates.

References

1. Dexter Kozen, *The Design and Analysis of Algorithms*, Springer, 1992.
2. T. H. Cormen, C. E. Leiserson, R. L. Rivest, *Introduction to Algorithms*, Prentice Hall India, 1990.
3. S. Basse, *Computer Algorithms: Introduction to Design and Analysis*, Addison Wesley, 1998.

4. U. Manber, *Introduction to Algorithms: A creative approach*, Addison Wesley, 1989.
5. V. Aho, J. E. Hopcraft, J. D. Ullman, *The design and Analysis of Computer Algorithms*, Addison Wesley, 1974.
6. R. Motwani andP. Raghavan, *Randomized Algorithms*, Cambrdige University Press, 1995.
7. C. H. Papadimitriou, *Computational Complexity*, Addison Wesley, 1994
8. S.S. Skeina. The Algorithm Design Manual.Springer Verlag. 1998

PATTERN RECOGNITION

Course Code :15 CS 51N3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Objective: To introduce the theoretical and practical aspects of pattern recognition.

Module I

Introduction - introduction to statistical - syntactic and descriptive approaches - features and feature extraction - learning - Bayes Decision theory - introduction - continuous case - 2-category classification - minimum error rate classification - classifiers – Discriminant functions - and decision surfaces - error probabilities and integrals - normal density - Discriminant functions for normal density

Module II

Parameter estimation and supervised learning - maximum likelihood estimation - the Bayes classifier - learning the mean of a normal density - general Bayesian learning -nonparametric technique - density estimation - Parzen windows - k-nearest neighbor estimation - estimation of posterior probabilities - nearest-neighbor rule – k nearest neighbour rule

Module III

Linear discriminant functions - linear Discriminant functions and decision surfaces - generalised linear discriminant functions - 2-category linearly separable case - non-separable behaviour - linear programming procedures - clustering - data description and clustering - similarity measures - criterion functions for clustering.

Module IV

Syntactic approach to PR - introduction to pattern grammars and languages – higher dimensional grammars - tree, graph, web, plex, and shape grammars - stochastic grammars - attribute grammars - parsing techniques - grammatical inference

References

1. Duda & Hart P.E, Pattern Classification And Scene Analysis, John Wiley
2. Gonzalez R.C. & Thomson M.G., Syntactic Pattern Recognition - An Introduction, Addison Wesley.
3. Fu K.S., Syntactic Pattern Recognition And Applications, Prentice Hall, Eaglewood cliffs
4. Rajjan Shinghal, Pattern Recognition: Techniques and Applications, Oxford University Press, 2008.

5. Christopher M. Bishop: Pattern Recognition and Machine Learning (Information Science and Statistics). Springer Pub.
6. Ethem Alpaydın, Introduction to Machine Learning (Adaptive Computation and Machine Learning), MIT Press, 2004.
7. Mitchell. T, Machine Learning, McGraw Hill, 1997
8. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.9. David J. C. MacKay: Information Theory, Inference & Learning Algorithms.

WEB SERVICES

Course Code :15 CS 51N4 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Evolution and Emergence of Web Services -Evolution of distributed computing, Core distributed computing technologies –client/server, CORBA, JAVA RMI, Micro Soft DCOM, MOM, Challenges in
Distributed Computing, role of J2EE and XML in distributed computing,
emergence of Web Services and Service Oriented Architecture (SOA).
Introduction to Web Services The definition of web services, basic operational model of web services, tools and technologies enabling web services, benefits and challenges of using web services
Web Services Architecture
Web services Architecture and its characteristics, core
building blocks of web services, standards and technologies available for implementing web services, web services communication, basic steps of implement
ing web services, developing web services
enabled applications.
Core fundamentals of SOAP, SOAP Message Structure, SOAP encoding, SOAP message exchange models, SOAP communication and messaging, SOAP security
-Developing Web Services using SOAP
Building SOAP Web Services, developing SOAP Web Services using Java,
limitations of SOAP.
Describing Web Services, WSDL , WSDL in the world of Web Services, Web Services life cycle,
anatomy of WSDL definition document, WSDL bindings, WSDL Tools, limitations of WSDL
Discovering Web Services – Service discovery, role of service discovery in a SOA, service discovery mechanisms, UDDI –UDDI Registries, uses of UDDI Registry, Programming with UDDI,
UDDI data structures, support for categorization
in UDDI Registries, Publishing API, Publishing information to a UDDI Registry, searching information in a UDDI Registry, deleting information in a UDDI Registry, limitations of UDDI.

Web Services Interoperability Means of ensuring Interoperability, Overview of .NET and J2EE. Web Services Security XML security frame work, XML encryption, XML digital signature, XKMS structure, guidelines for signing XML documents.

TEXT BOOKS:
1.Developing Java Web Services, R. Nagappan, R. Skoczylas, R.P. Sriganesh, Wiley India, rp 2008.
2. Developing Enterprise Web Services, S. Chatterjee, J. Webber, Pearson Education, 2008.
3. XML, Web Services, and the Data Revolution, F.P.Coyle, Pearson Education.

REFERENCE BOOKS:
1.Building Web Services with Java, 2 ndEdition, S. Graham and others, Pearson Edn., 2008.
2Java Web Services, D.A. Chappell & T. Jewell, O'Reilly,SPD.
3 McGovern, et al., "Java Web Services Architecture", Morgan Kaufmann Publishers,2005.
4. J2EE Web Services, Richard Monson Haefel, Pearson Education.
5. Web Services, G. Alonso, F. Casati and others, Springer, 2005.

STORAGE AREA NETWORKS

Course Code :15 CS 51F1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Storage Technology,Review data creation and the amount of data being created and understand the value of data to a business, challenges in data storage and data management, Solutions available for data storage, Core elements of a data center infrastructure, role of each element in supporting business activities
Storage Systems Architecture Hardware and software components of the host environment, Key protocols and concepts used by each component ,Physical and logical components of a connectivity environment ,Major physical components of a disk drive and their function, logical constructs of a physical disk, access characteristics, and performance Implications, Concept of RAID and its components , Different RAID, levels and their suitability for different application environments: RAID 0, RAID 1, RAID 3, RAID 4,RAID 5, RAID 0+1, RAID 1+0, RAID 6 , Compare and contrast integrated and modular storage systems ,High -
and working of an intelligent storage system
Introduction to Networked Storage, Evolution of networked storage, Architecture, components, and topologies of FC SAN, NAS, and IPSAN, Benefits of the different networked storage options, understand the need for long term archiving solutions and describe how CAS fulfills the need, understand the appropriateness of the different networked storage options for different application environments
Information Availability & Monitoring & Managing Datacenter List reasons for planned/unplanned outages and the impact of downtime, Impact of downtime, Differentiate between business continuity (BC) and disaster recovery (DR) ,RTO and RPO, Identify single points of failure in a storage infrastructure and list solutions to mitigate these failures

,Architecture of backup/recovery and the different backup/recovery topologies , replication technologies and their role in ensuring information availability and business continuity, Remote replication technologies and their role in providing disaster recovery and business continuity capabilities, Identify key areas to monitor in a data center, Industry standards for data cen ter monitoring and management, Key metrics to monitor for different components in a storage infrastructure, Key management tasks in a data center
Securing Storage and Storage Virtualization, Information security, Critical security attributes for information systems, Storage security domains, List and analyzes the common threats in each domain, Virtualization technologies, blocklevel and filelevel virtualization technologies and processes
Case Studies The technologies described in the course, are reinforced with EMC examples of actual solutions. Realistic case studies enable the participant to design the most appropriate solution for given sets of criteria

TEXT BOOK:
1.EMC Corporation, Information Storage and Management, Wiley.

REFERENCE BOOKS:
1.Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill, Osborne, 2003.
2.Marc Farley, "Building Storage Networks", Tata McGraw Hill ,Osborne, 2001.
3.Meeta Gupta, Storage Area Network Fundamentals, Pearson Education Limited, 2002.

MACHINE LEARNING

Course Code :15 CS 5229 **L-T-P : 4-0-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Supervised Learning: Learning a Class from Examples, Vapnik Chervonenkis (VC) Dimension, Probably Approximately Correct (PAC) Learning, Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of a Supervised Machine Learning Algorithm.
Bayesian Decision Theory: Classification, Losses and Risks, Discriminant functions, Utility Theory, Association Rules.
Parametric methods: Maximum Likelihood Estimation, Evaluating an Estimator: Bias and Variance, The Bayes' Estimator, Parametric Classification, Regression, Tuning Model, Complexity: Bias/Variance Dilemma, Model Selection procedures.
Nonparametric Methods: Nonparametric Density Estimation, Generalization to Multivariate data, nonparametric classification, Condensed Nearest neighbor, Nonparametric Regression: smoothing models, choosing the smoothing parameter.

Multivariate Methods: Multivariate Data, parameter Estimation, Estimation of Missing values, Multivariate Normal Distribution, Multivariate Classification, Tuning Complexity, Discrete Features Multivariate Regression

Linear Discrimination: Generalizing the linear model, Geometry of the Linear Discriminant, Pairwise Separation, Gradient Descent, Logistic Discrimination, and Discrimination by Regression.

Local Models: Competitive Learning, Radial Basis Functions, Incorporating Rule-based, knowledge, Normalized basis functions, Competitive basis functions, learning vector, Quantization, Mixture of experts, Hierarchical Mixture of Experts.

Kernel Machines: Optimal separating Hyper plane, The Non-separable Case: Soft Margin Hyper, plane, v-SVM, Kernel Trick, Vectorial Kernels, Defining Kernels, Multiple Kernel Learning, Multiclass Kernel Machines, Kernel Machines for Regression, One-class Kernel Machines, Kernel , dimensionality Reduction 0

Bayesian Estimation: Estimating the parameter of a Distribution, Bayesian Estimation of the parameters of a function , Gaussian Processes,

Hidden Markov Models: Discrete Markov Processes, Hidden Markov Models, Three Basic problems of HMMs, Evaluation problem, Finding the state sequence, Learning model parameters, continuous observations, The hmm with Input , Model Selection in HMM.

Text Books :

1. Ethem Alpaydin, “ Introduction to Machine learning”, The MIT Press, 2010

Reference Book:

1. Stephen Marsland, “ Machine Learning an Algorithmic Perspective” , CRC Press, 2009

EXPERT SYSTEMS

Course Code :15 CS 5230 **L-T-P : 4-0-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to Expert Systems: Definitions, Advantages, concepts, characteristics, Technologies, applications, domains, languages, shells, tools, elements production systems, procedural paradigms, non-procedural paradigms, inductive learning

Knowledge representation: Meaning, production, semantics, object-attribute-value triples, Presentation of semantics in PROLOG Schemata, logics, sets, limitations of predictive logic.

Methods of Inference: Trees, lattices, graphs, state and problem spaces, AND-OR trees, deductive logic, Syllogisms, inference rules, logic systems, Resolution Systems, Deduction, shallow and Casual reasoning, other inference methods, Meta-knowledge, Hidden Markov Models

Reasoning under Uncertainty: Uncertainty, Types of errors, errors and induction, Classical Probability, Experimental and subjective probabilities, compound probabilities, Hypothetical reasoning, Backward Induction, Temporal reasoning, Markov chains, Sufficiency and necessity, Uncertainty in inference chains, Evidence combinations, Inference nets, propagation of probabilities.

Inexact reasoning: Uncertainty and rules, certainty factors, Dumpster-Shafer theory, approximate reasoning, state of uncertainty, fuzzy logics and applications

Designing of expert systems: Problem selection, Development stages, Errors in development stages, Software Engineering of expert systems., Life cycle models for development of expert systems.

Modular design: execution control and rule efficiency: DEF-templates, Salience, phases, control facts, Misuse of salience, def-module constructs, Importing and exporting facts, Modules and execution control, RETE pattern matching algorithm, Pattern network, join network, pattern order, ordering patterns, Multi-field variables, TEST CE, Pattern matching constraints, Comparison of general rules, specific rules, simple rules and complex rules,
Expert systems design examples: A monitoring problems, Certainty factors, decision trees, backward chaining

Text Book

1. **Expert systems**, Joseph Giarratano, Gary D Riley, 4/e, Cengage Learning Publishers, 2011

Reference Book

2. **Introduction to Expert systems**, 3/e, Peter Jackson, Person education, 2005

BIG DATA ANALYTICS AND BUSINESS INTELLIGENCE

Course Code :15 CS 5231 | **L-T-P : 3-0-2**
Pre-requisite: NIL | **Credits: 4**
Syllabus:

Introduction to Big Data Analytics: Big data overview, State of the practice in analytic role of data scientists, Big data Analytics in industry verticals, **End to end data analytics life cycle**: Key roles for successful Analytic project, Main phases of life cycle, Developing Core deliverables for stake holders .**Basic Analytic Methods**: Introduction to " R" analyzing and exploring data with "R", Statistics for Model Building and Evaluation. **Advanced analytics and**

statistical modeling for Big Data: Native Bayesian Classifier means clustering, Association rules, Decision trees, Linear and logistic regression, Time series Analysis, Text Analytics **Technology and tools**: Mapreduce/Hadoop,In-Database Analytics,MADlib and advanced SQL Tools.

Introduction to Business Intelligence:, Changing Business Environments and Computerized Decision Support , A Framework for Business Intelligence (Bl), Intelligence Creation and Use and Bl Governance, Transaction Processing versus Analytic Processing, Successful Bl Implementation Major Tools and Techniques of Business Intelligence

Business Performance Management: Overview of Business Performance Management (BPM) ,BPM and Bl Compared , Strategic Planning ,The Strategy Gap Operational Planning Financial Planning and Budgeting, Monitoring the process, Diagnostic Control Systems Pitfalls of Variance Analysis , Act and Adjust for Needs , Performance Measurement KPIs and Operational Metrics Problems with Existing Performance Measurement Systems , Effective Performance Measurement , BPM Methodologies ,Balanced Scorecard (BSC), Six Sigma, BPM Technologies and Applications, BPM Architecture Commercial BPM Suites , BPM Market versus the Bl Platform Market, Performance Dashboards and Scorecards ,Dashboards versus Scorecards , Dashboard Design, What to Look for in a Dashboard, Data Visualization

Business Intelligence Implementation: Integration and Emerging Trends Collaboration and Productivity:

Implementing Bl: An Overview, Bl Implementations Factors Managerial Issues Related to Bl Implementation, Integration Implementation ,Types of Integration , Levels of Bl ,Connecting Bl Systems to Databases and Other Enterprise Systems Integrating Bl Applications and Back-End Systems , Middleware , On-Demand Bl The Limitations of Traditional Bl , Issues of Legality, Privacy, and Ethics , Legal Issues, Privacy, Ethics in Decision Making and Support , Emerging Topics in Bl,

Text Book

1. Efraim Turban, Ramesh Sharda, Dursun Deleii, David King Business Intelligence, A MANAGERIAL APPROACH, , Prentice Hall, 2nd edition
2. Noreen Burlingame, The little book on Big Data, **New Street Publisher (eBook)**

Reference Books:

1. Elizabeth Vitt, Michael Luckevich and Stacia Misner, Business Intelligence: Making Better Decisions Faster, Micro soft press
2. Cindi Howson, B001IGJMQS B00G0NFJIO Successful Business Intelligence: Unlock the Value of BI & Big Data, Second Edition, McGraw-Hill Osborne Media; 2 edition, 2013
3. http://www.prlog.org/11800911-just -published-the-little-book-of-big-data-2012-edition.html
4. Norman Matloff, The Art of R programming : A Tour of Statistical Software Design,ISBN-13:978-1-59327-384-2:ISBN-10: 1-59327-384-3
5. http://www.johndcook.com/R_language_for_programmers.html
6. http://bigdatauniversity.com/
7. http://home.ubalt.edu/ntsbarsh/stat-data/topics.htm#rintroduction

DATAWARE HOUSING & DATA MINING

Course Code :15 CS 5232 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

DATA WAREHOUSING : Data warehousing Components –Building a Data warehouse –- Mapping the Data Warehouse to a Multiprocessor Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata.
BUSINESS ANALYSIS : Reporting and Query tools and Applications – Tool Categories – The Need for Applications – Cognos Impromptu – Online Analytical Processing (OLAP) – Need – Multidimensional Data Model – OLAP Guidelines – Multidimensional versus Multirelational OLAP – Categories of Tools – OLAP Tools and the Internet.
DATA MINING : Introduction – Data – Types of Data – Data Mining Functionalities – Interestingness of Patterns – Classification of Data Mining Systems – Data Mining Task Primitives – Integration of a Data Mining System with a Data Warehouse – Issues –Data Preprocessing.
ASSOCIATION RULE MINING AND CLASSIFICATION : Mining Frequent Patterns, Associations and Correlations – Mining Methods – Mining Various Kinds of Association Rules – Correlation Analysis – Constraint Based Association Mining – Classification and Prediction - Basic Concepts - Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by Backpropagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods - Prediction
CLUSTERING AND APPLICATIONS AND TRENDS IN DATA MINING Cluster Analysis - Types of Data – Categorization of Major Clustering Methods - K- means – Partitioning Methods – Hierarchical Methods - Density-Based Methods –Grid Based Methods – Model-Based Clustering Methods – Clustering High Dimensional Data - Constraint – Based Cluster Analysis – Outlier Analysis – Data Mining Applications.

TEXT BOOKS:
1.Alex Berson and Stephen J. Smith, “ Data Warehousing, Data Mining & OLAP”, Tata McGraw – Hill Edition, Tenth Reprint 2007.
2.Jiawei Han and Micheline Kamber, “Data Mining Concepts and Techniques”, Second Edition, Elsevier, 2007.
REFERENCES:
1.Pang-Ning Tan, Michael Steinbach and Vipin Kumar, “ Introduction To Data Mining”, Person Education, 2007.

2.K.P. Soman, Shyam Diwakar and V. Ajay “, Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006.
3.G. K. Gupta, “ Introduction to Data Mining with Case Studies”, Easter Economy Edition, Prentice Hall of India, 2006.
4.Daniel T.Larose, “Data Mining Methods and Models”, Wile-Interscience, 2006.

NATURAL LANGUAGE PROCESSING

Course Code :15 CS 52O1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction – Models -and Algorithms - The Turing Test -Regular Expressions
Basic Regular Expression Patterns -Finite State Automata -Regular Languages and FSAs – Morphology -Inflectional Morphology - Derivational Morphology -Finite-
State Morphological Parsing -Combining an FST Lexicon and Rules -Porter Stemmer
N-grams Models of Syntax - Counting Words - Unsmoothed N-grams – Smoothing- Backoff - DeletedInterpolation – Entropy - English Word Classes - Tagsets for English -
Part of Speech Tagging -Rule-Based Part of Speech Tagging -
Stochastic Part of Speech Tagging - Transformation-Based Tagging -
Context Free Grammars for English Syntax- Context-Free Rules and Trees - Sentence-
Level Constructions–Agreement – Sub Categorization – Parsing – Top-down – Earley Parsing - Feature Structures - ProbabilisticContext-Free Grammars
Representing Meaning - Meaning Structure of Language - First Order Predicate Calculus
- Representing Linguistically Relevant Concepts -Syntax-Driven Semantic Analysis -
Semantic Attachments -Syntax-Driven Analyzer - Robust Analysis -
Lexemes and Their Senses - Internal Structure - Word SenseDisambiguation -
Information Retrieval
Discourse -Reference Resolution - Text Coherence -Discourse Structure -
Dialog and Conversational Agents - Dialog Acts – Interpretation – Coherence - Conversational Agents - Language Generation – Architecture -Surface Realizations -
Discourse Planning – Machine Translation -Transfer Metaphor –Interlingua –
Statistical Approaches.

TEXT BOOKS:
1. **D. Jurafsky and J. Martin “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”,**
2. **C. Manning and H. Schutze, “Foundations of Statistical Natural Language Processing”**

REFERENCE:

1. **James Allen. "Natural Language Understanding", Addison Wesley, 1994.**

SIMULATION AND MODELING

Course Code :15 CS 52O2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

System Models: Concepts, Continuos and Discrete Systems, Systems Modeling, Types of Models, Subsystems, Corporate Model and System Study
System Simulation: Techniques, comparison of Simulation and Analytical methods, types of Simulation, Distributed Logmodels, cobweb models
Continuos System Simulation: Numerical Solution of Differential Equations, Analog Computers, Hybrid Computers, Continuos System Simulation Languages, CSMT, System Dynamic Growth Models, Logistic Curves
Probability Concepts in Simulation: Monte-Carlo techniques, Stochastic variables, Probability functions, Random Number Generation Algorithms
Queing Theory: Arrival Pattern Distributions, Servicing Times, Queing disciplines, Measure of Queues, Mathematical Solutions to Queuing problems. Discrete Systems Simulation: Events, Generation of Arrival Pattern, Simulation Programming Tasks, Analysis of Simulation Output.
GPSS & SIMSCRIPT: General Description of GPSS and SIMSCRIPT, Programming in GPSS. Simulation Programming Techniques: Data Structures, Implementation of Activities, Events and Queues, Event Scanning, Simulation Algorithms in GPSS and SIMSCRIPT.

Textbooks:
1. Geoffrey Gordon: System Simulation, PHI, 2nd Edition

Reference:
1. V.P.Singh, System Modeling and Simulation, New Age International Publishers, 1st Edition.

COMPUTER VISION

Course Code :15 CS 52O3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Cameras: Sensing, **Sources, Shadows, and Shading**: Qualitative Radiometry, Sources and their effects, Local shading models, Application: photometric stereo, Inter-reflections: global shading models **Color**: The physics of color, Human color Perception, Representing color, A Model for image color, Surface color from image color **Linear Filters**: Linear filters and convolution, Shift Invariant linear systems, Spatial Frequency and Fourier Transforms, Sampling and Aliasing, Filters as Templates, Technique: Scale and Image Pyramids, **Edge Detection**: Noise, Estimating Derivatives, Detecting Edges **Texture**: Representing Texture, Analysis Using Oriented Pyramids, Application: Synthesizing Textures for Rendering, Shape from Texture **The Geometry of Multiple Views**: Two Views, Three Views **Stereopsis**: Reconstruction, Human Stereopsis, Binocular Fusion, Using More Cameras **Segmentation by Clustering**: Human Vision: Grouping and Gestalt, Applications: shot boundary detection and background subtraction, Image segmentation by clustering pixels, Segmentation by Graph-Theoretic Clustering **Segmentation by Fitting a Model**: The Hough Transform, Fitting Lines, Fitting Curves, Robustness, Example: Using RANSAC to fit Fundamental matrices **Segmentation and Fitting Using Probabilistic Methods**: Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in practice, Model selection: best Fit, **Model-Based Vision**: Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypotheses Using Invariants, Verification, Application: Registrations in Medical Imaging Systems, Curved Surfaces and Alignment **Finding Templates Using Classifiers:** Classifiers, Building Classifiers from Class Histograms, Feature selection, Neural Networks, The Support Vector Machine **Recognition by Relations between Templates**: Finding objects by voting on relations between templates, Relational Reasoning Using Probabilistic Models and Search, Using Classifiers to Prune Search, Technique: Hidden Markov Models, Applications: Hidden Markov Models and Sign Language Understanding **Geometric Templates from Spatial Relations**: Simple Relations between object and image, Primitives, Templates, and Geometric Inference, Object Recognition.

Text Book:

1.Forsyth David A and Ponce J, “Computer Vision – A Modern Approach”, Pearson Publication 2003.

Reference Book:

1.Computer Vision: Algorithms and Applications, R. Szeliski, Springer Verlag, 2011

PERVASIVE COMPUTING

Course Code :15 CS 52O4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Pervasive Computing Application Pervasive Computing devices and Interfaces, Device technology trends, Connecting issues and protocols

Pervasive Computing and web based Applications, XML and its role in Pervasive Computing, -Wireless Application Protocol (WAP) Architecture and Security–Wireless Mark-Up language (WML)– Introduction

Voice Enabling Pervasive Computing -Voice Standards,Speech Applications in Pervasive Computing and security PDA in Pervasive Computing–Introduction-PDA software Components, Standards, emerging trends
PDA Device characteristics-PDA Based Access Architecture
User Interface Issues in Pervasive Computing, Architecture-Smart Card-based Authentication Mechanisms Wearable computing Architecture

TEXT BOOKS:
1.Jochen Burkhardt, Horst Henn, Stefan Hepper, Thomas Schaec & Klaus Rindtorff. ---Pervasive Computing Technology and Architecture of Mobile Internet Applications, Addision Wesley,Reading, 2002.
2. Uwe Ha nsman, Lothat Merk, Martin S Nicklous & Thomas Stober: Principlesof Mobile Computing, Second Edition, Springer -Verlag, New Delhi, 2003.

REFERENCE BOOKS:
1.Rahul Banerjee: Internetworking Technologies: An Engineering Perspective, Prentice – Hall of India, New Delhi, 2003. (ISBN 81 203-2185-5)
2.Rahul Banerjee: Lecture Notes in Pervasive Computing, Outline Notes, BITS -Pilani, 2003.

SOFTWARE ENGINEERING AND PROJECT MANAGEMENT

Course Code :15 CS 52O5 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Software Engineering Fundamentals: Definition of software product, software engineerin
g paradigms, Software engineering, knowledge engineering, and End user development approach, software engineering life cycle, process modules
(Waterfall model, Spiral model)
System Analysis : An abstraction, Partitioning and projection, systemspecification, software requirement specification (SRS) standards, formal specification methods, specification tools, flow based, data based and object oriented analysis (data flow diagram, data dictionary).
System Design: Problem partitioning, abstraction, top down &bottomup strategies, modularity structure charts, idealized and constraint design (Warnier -Orr, E-R modeling),
object oriented design (Booch approach), cohesion and coupling, design matrices, design documentation standard.
Role of CASE tools: relevance of CASE tools, high-end low end CASE tools, automated support for data dictionaries, DFDs,ERDs.
Coding and Programming: choice of programming languages, mixed language pro
gramming and cell semantics, structured programming, information hiding, documentation, re-engineering legacy systems, coding standard.
Software quality and testing: software quality assurance, types of software testing (White box and Black box testing, unit testing integration testing, verification and validation of software), debugging and softwa~e reliability analysis, software quality and matrices, software maturity model and extensions.
Software Cost and Time Estimation:
functions points, issues in software cost estimation: Introduction to the Rayleigh curve, algorithmic cost models (CO COMO, PutnamSlim, Watson, and felix), other approaches to software cost and size estimation (software complexity, delphi, costing by analogy).
Software Project Management:
planning software, project, work breakdown structures, integrating software design and project planning, software project teams, projecting monitoring control.

References

1.Software Engineering, Rogers G. Pressman, MH

2.Fundamentals of Software Engineering,2ndEd. ,Ghezzi,PHI
3. Software Engineering, Pankaj Jalote, PHI
4.Classical and Object Oriented Software Engineering, Schach, TMH
5.Software Engineering: Principles & Practice,Van Vliet,SPD/JOHN WILEY
6.Software Engineering, K.K.Aggarwal & Yogesh Singh , New Age International
7. Software Engineering, Leon, VIKAS
8.Software Testing Fundamentals: Methods& Metrices,Marmie Hutcheson, And Wiley Dreamtech
9.Managing for Total Quality,Logothetis,PHI
10.TQM,J.Kiron,EPH

INFORMATION RETRIEVAL AND EXTRACTION

Course Code :15 CS 52P1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Objective: To introduce the basics of modeling and design off Information Retrieval systems and methods of information extraction.
Introduction: Information versus Data Retrieval, IR: Past, present, and future. Basic concepts: The retrieval process, logical view of documents. Modeling: A Taxonomy of IR models, ad-hoc retrieval and filtering. Classic IR models: Set theoretic, algebraic,probabilistic IR models, models for browsing. Retrieval evaluation: Performance evaluation of IR: Recall and Precision, other measures
Reference Collections such as TREC, CACM, and ISI data sets. Query Languages: Keyword based queries, single word queries, context queries, Boolean Queries, Query protocols, query operations.
Text and Multimedia Languages and properties, Metadata, Text formats, Markup languages, Multimedia data formats, Text Operations. Indexing and searching:
Information Extraction: Basic Assumptions-Various Tasks-Chunking- Developing and Evaluating Chunkers-Entity Recognition-Topic Spotting-Slot Filling-Layered Finite State Methods-Query Expansion-Question Answering Systems
Word Sense Disambiguation and Information Retrieval: Selectional Restriction Based Approaches-Limitations of Selectional Restrictions-Robust Word Sense Disambiguation Machine Learning Approaches, Dictionary-Based Approaches
Applications to Information Retrieval:Term Weighting,Term Selection and Creation-Homonymy, Polysemy and Synonymy -Improving User Queries-Other Information Retrieval Tasks

References

1.R. Baeza-Yates and B. R. Neto: Modern Information Retrieval:, Pearson Education, 2004.
2.C.J. van Rijsbergen: Information Retrieval, Butterworths, 1979.
3.C.D. Manning and H. Schutze: Foundations of Statistical natural Language Processing

(Chapters 13, 14, and 15 only), The MIT Press, Cambridge, London. 2001.
4.Information Retrieval: Algorithms and Heuristics (The Information Retrieval Series:2nd Edition): David A. Grossman and Ophir Frieder
5. W. Bruce Croft and John Lafferty (editors): Language Modeling for Information Retrieval, *Kluwer Academic Publishers, 2003*,The Kluwer International Series on Information Retrieval, Volume 13.
6.Introduction to Information Retrieval:Christopher D. Manning, Raghavan, and Schutze

MULTIAGENT SYSTEMS

Course Code :15 CS 52P2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Intelligent Agents: Environments, Intelligent Agents, Agents and Objects, Agents and Expert Systems, Agents as Intentional Systems, Abstract Architectures for Intelligent Agents. **Deductive Reasoning Agents:** Agents as Theorem Provers, Agent-Oriented Programming, Concurrent MetateM. **Practical Reasoning Agents:** Practical Reasoning Equals Deliberation Plus Means-Ends Reasoning, Means-Ends Reasoning, Implementing a Practical Reasoning Agent, The Procedural Reasoning System. **Reactive and Hybrid Agents:** Reactive Agents, Hybrid Agents. **Understanding each other:** Ontology fundamentals, Ontology Languages, RDF, Constructing an Ontology, Software Tools for Ontologies **Communication:** Speech Acts, Agent Communication Languages. **Working Together:** Cooperative Distributed Problem Solving, Task Sharing and Result Sharing, Result Sharing, Combining Task and Result Sharing, Handling Inconsistency, Coordination, Multiagent Planning and Synchronization **Methodologies:** Appropriate Agent-Based Solution, Agent-Oriented Analysis and Design Techniques, Pitfalls of Agent Development, Mobile Agents**. Applications :** Agents for Distributed Sensing, Agents for Information Retrieval and Management, Agents for Electronic Commerce, Agents for Human-Computer Interfaces, Agents for Virtual Environments, Agents for Social Simulation

Text Book:

1.Michael Wooldridge, “An Introduction to MultiAgent Systems”, 2/e, John-Wiley & sons, 2009.

Reference Books:

1.Adelinde M. Uhrmacher, Danny Weyns, Multi-Agent Systems: Simulation and Applications, CRC Press, 2009.

2.Shoham, Kevin Leyton-Brown, “MultiAgent Systems - Algorithmic, Game-Theoretic, and Logical Foundations”, Cambridge University Press, 2009

ALGORITHMS IN COMPUTATIONAL BIOLOGY

Course Code :15 CS 52P3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Algorithms in Computing; Analyzing algorithms-Asymptotic otation, Standard notations, Big ‘O’ notations; Algorithm design techniques- Exhaustive Search, Branch-and-Bound Algorithms, Greedy Algorithms, Dynamic Programming, Divide-and-Conquer Algorithms, Machine Learning, Randomized Algorithms; Time and space complexity of algorithms, common Sort and Search algorithms.
Exhaustive Search - Restriction Mapping, Finding Motifs; Greedy Algorithms
- Genome Rearrangements, Sorting by Reversals, Finding Motifs; Dynamic Programming Algorithms - Edit Distance and Alignments, Global and local Sequence Alignment, Scoring Alignments, Alignment with Gap Penalties, Gene Prediction, Multiple Alignment; Divide-and-Conquer Algorithms - Divide-and-Conquer Approach to Sorting, Space-Efficient Sequence Alignment,
Block Alignment; Combinatorial Pattern Matching - Hash Tables, Repeat Finding, Exact Pattern Matching; Expectation and Maximation (EM) with forward and backward algorithms, discriminative learning; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications in bioinformatics Hidden Markov Models:Markov processes and Markov Models, Hidden Markov Models, Parameter estimation for HMMs, Optimal model construction, Applications of HMMs Artificial Neural Networks: Historic evolution – Perceptron, NN Architecture, supervised and unsupervised learning, Back Propagation Algorithm, Training and Testing, Self-organizing Feature Map and

Radial Basis Function Network; Overview of Support Vector Machines, Bayesian network Clustering and Trees: Hierarchical Clustering, k-Means Clustering, Evolutionary Trees, Distance-Based Tree Reconstruction, Reconstructing Trees from Additive Matrices, Character-Based Tree Reconstruction, Small and large Parsimony Problem.

Text Books:
1.Fundamentals of Computer Algorithms by Horowitz, S. Sahini, and Rajasekharan. Galgotia Publications.1984
2.An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press.2004

Reference Books:
1.Bioinformatics: the machine learning approach by Pierre Baldi, Søren Brunak. MIT Press.2001
2. Probabilistic Methods for Bioinformatics: With an Introduction to Bayesian Networks by Richard E. Neapolitan. Morgan Kaufmann Publishers. 2009
3. Hand book for Hidden Markov model for Bioinformatics by Martin Gollery. CPC Press. 2008.
4. Neural Networks: A Systematic Introduction by Raul Rojas. Springer. 1996

ENTERPRISE COMPUTING METHODOLOGIES

Course Code :15 CS 52P4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

1. Introduction to Contemporary Information Systems
i. Enterprise Resource Planning (ERP) ii. Customer Relationship Management (CRM) iii. Supply Chain Management (SCM)
iv. Application Service Provider (ASP)
2. Review of Information Systems in an Organization
i. Functional Areas of Business
ii. Business Processes
3. The Development of Enterprise Resource Planning Systems
i. Manufacturing Roots of ERP
ii. ERP Software: SAP
4. Marketing Information Systems
5. Production and Materials Management Information Systems
6. Accounting and Finance
7. Human Resources: PeopleSoft
8. ERP and the World Wide Web i. Business Solutions
ii. E-Commerce
9. Advanced Computer Business Modeling Techniques.
i. Spreadsheet Modeling
ii. Database Modeling

Reference:

[1] Concepts in Enterprise Resource Planning by Brady, Monk and Wagner, Course Technology, A division of Thomson Learning, 2001
[2] Advanced Cases in MIS by Brady, & Monk, Course Technology, A division of Thomson Learning, 2000 MCS-205C Multimedia Technology

BIO-INFORMATICS

Course Code :15 CS 52P5 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Molecular Biology: DNA, RNA and protein concept, gene expression,gene regulatory network.
Introduction to Bio-informatics: Definition, Classification – Data Storage and Main tenance, data analysis.
Data Storage and Maintenance: Different Databases for Gene sequence and protein sequence data, different databases for Geneexpression data.
Data Analysis: Genomics: Structural Genomics– Gene sequence analysis, different sequence alignment algorithm for predicting open reading frame from DNA sequence, Id entification of transcription factors.

`Functional Genomics
– Introduction to Gene expression data, CDNA and a ffimatrix technique for generating Gene expression data, Gene expression data clustering techniques – Aglomerative, Diana, K-Mins, K-midoid, Graph partitioned based clustering algorithms, FUZZY clustering algorithms, Gene regulatory network discovering techniques – Baysean Net, Neural Net base techniques

Proteomics:
Protein sequence data analysis data analysis, finding secondary and tertiary structures from protein sequence data, prediction of protein functionality from protein sequence.

Reference:

[1] Bio-informatics Computing, Bryan Bergeron MCS-301C

M.TECH - CYBER SECURITY & DIGITAL FORENSICS

First Year (First Semester):

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 CS 5133	Introduction to Cyber Security & ICS	3	0	2	4
2	15 CS 5134	Digital Forensics	3	0	2	4
3	15 CS 5135	Advance Network Security & Investigations	3	0	2	4
4	15 CS 5136	Software Security	3	0	2	4
5		Elective – 1	3	0	0	3
6		Elective - 2	3	0	0	3
7	15 IE 5149	Seminar	0	0	4	2
		Total	**18**	**4**	**8**	**24**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 CS 5237	Cryptography for Cyber Defense	3	0	2	4
2	15 CS 5238	Malware Analysis & Reverse Engineering	3	0	2	4
3	15 CS 5239	Cyber Incident Response & Resilience	3	0	2	4
4	15 CS 5240	Cyber Law, Governance & Compliance	3	0	2	4
5		Elective – 3	3	0	0	3
6		Elective - 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total	**18**	**4**	**8**	**24**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 CS 51Q1	Mobile Device Threats & Investigation	3	0	0	3
2	15 CS 51Q2	Fundamentals of E-Discovery	3	0	0	3
Elective-2						
1	15 CS 51R1	Introduction to Big Data Analytics	3	0	0	3
2	15 CS 51R2	Social Media Forensics	3	0	0	3
3	15 CS 51R3	Critical Information Infrastructure Security	3	0	0	3
Elective-3						
1	15 CS 52S1		3	0	0	3
2	15 CS 52S2		3	0	0	3
3	15 CS 52S3		3	0	0	3
Elective-4						
1	15 CS 52T1		3	0	0	3
2	15 CS 52T2		3	0	0	3
3	15 CS 52T3		3	0	0	3

INTRODUCTION TO CYBER SECURITY & ICS

Course Code :15 CS 5133 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to Cyber Crime: Types of Cyber Crimes, Threat vectors, Cyberspace and Criminal profiling, Cyber security, Computer as a target, Introduction to Incident Response, Introduction to Digital Forensics, Recent threats to cyber domain, Internet, Destruction of Data, Privacy, Cyber Laws and Ethics.**Cyber Security Threats** Unauthorized Access, Computer Intrusions, White collar Crimes, Viruses and Malicious Code, Internet Hacking and Cracking, Virus Attacks, Pornography, Software Piracy, Intellectual Property, Mail Bombs, Exploitation, Stalking and Obscenity in Internet, Digital laws and legislation, Law Enforcement Roles and Responses. **Malware Fundamentals** Types of malware, Malware analysis techniques, How malware can affect the system security, Malware analysis lab setup, Financial malwares, Code review, Behavioral analysis, online malware analysis. **BCP, DR planning & Audit** Introduction to Risk Analysis, Risk Assessment, Risk Mitigation, Need for BCP, Overview of BCP Life Cycle, Identifying and Selecting Business Continuity Strategies, DR Strategies, Plans fo Business Resumption, BCM Program Management and System Audit.

Books:

1) Cyber Security & Cyber War – P.W.Singer and Allan Friedman
2) Principles of Cybercrime By Jonathan Clough

DIGITAL FORENSICS

Course Code :15 CS 5134 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Digital Forensics and Investigations: Locard's Principal as applicable to Digital Forensics, Digital Forensics & its terminology, Classification of Digital Forensics, Digital Forensics basic Practices, Computing Devices, Storage Media, Potential Digital Evidence, Artifacts, Search & seizure, Forensic acquisition of digital devices, Digital evidence handling, Chain of Custody, Legal Report Writing **Computing Device Forensics**
Hardware & software, Data Storage system, Hard Disk Geometry & Fundamentals, Disk Forensics, Types of OS, Data Recovery Tools, Open Source tools for investigation, Peripherals forensics, Tools and Techniques, *nix Forensics, Command line tools, Rootkits, RAM Forensics **Mobile Phone Forensics** Recent developments in mobile technology, Cell Phone Theory, Smart devices, Smart Operating Systems, Android, iOS, RIM OS, Windows, Mobile Phone Forensics, Logical v/s Physical extraction, Mobile phone forensics tools, SIM Forensics, Call Data Records, Smartphones **Artifact analysis & Anti Forensics** Operating Systems related Artifact analysis, Internet Artifacts, OS Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Log analysis, Windows Logs, UNIX Logs, Application Logs, Network Log Analysis, File System Analysis, Anti-Forensics of Windows & Linux, Tool Development, Tool Strategy, Smart phone Anti-forensics, Log Manipulation, Application Manipulation, Time Date based Anti-forensics concepts

Books:

1) Digital Forensics and Cyber Crime: by Pavel Gladyshev, Andrew Marrington, Ibrahim Baggili
2) The Basics of Digital Forensics: The Primer for Getting Started in Digital ... By John Sammons

ADVANCE NETWORK SECURITY & INVESTIGATIONS

Course Code :15 CS 5135 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to Network Systems: Networking concepts, How network works, LAN, MAN, WAN, Network Topology, Protocols & Technologies governing Internet, OSI Model, TCP/IP, IP Calculation, List of well-known ports & services, Internet Relay Chat, Point to Point, Packet Switching, Network services and applications: DNS, FTP, BGP, HTTP, SMTP, P2P Network **Network Connectivity** Network transport architectures, TCP, UDP, ICMP, ARP, NETBIOS, Network Devices, Modem, DSL/ADSL, Router, Switch, Hub, Repeater, Ethernet, Wi-Fi, Windows Networking, Workgroups and Domains, NETBIOS, RPC, pstools, Unix Networking, SSH, Routing and forwarding, intra-domain and inter-domain routing algorithms, Link layers and local area networks**Network Protocols & Email Forensics** Network Basics & Concepts, Types of Network, How network works, Protocols & Technologies, TCP/IP, IP Calculation, DNS, BGP, FTP, HTTP, List of well-known ports & services, Internet Relay Chat, Point to Point, Packet Switching, Packet Capture, Sniffing, Instant Messaging and IRC, Network Forensics, Email Forensics, Email header analysis, tracing & tracking of emails, Cloud Forensics **Network Attacks** Network Threat Vectors, MITM, OWAPS, ARP Spoofing, IP & MAC Spoofing, DNS Attacks, SYN Flooding attacks, UDP ping-pong and fraggle attacks, TCP port scanning and reflection attacks, DoS, DDOS. **Network Penetration Testing** Threat assessment, Penetration testing tools, Penetration testing, Vulnerability Analysis, Threat matrices, Firewall and IDS/IPS, Wireless networks, Wireless Fidelity (Wi-Fi), Wireless network security protocols, Nmap, Network fingerprinting, BackTrack, Metasploit **Network Investigation** Network Artifact analysis, Sqlite database file analysis for various browsers, Introduction to Social engineering, Port Scanning, Peer to Peer Networking, Torrent Forensics, LAN Security assessment, HTTPS, Secure socket layer, Network Surveillance, Intelligence Gathering

Books:

1) Introduction to Network Security: Theory and Practice By Jie Wang, Zachary A. Kissel
2) The Practice of Network Security Monitoring: Understanding Incident ... By Richard Bejtlich
3) **Penetration Testing: A Hands-On Introduction to Hacking** By Georgia Weidman

SOFTWARE SECURITY

Course Code :15 CS 5136 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Web Security: Evolution of Web applications, Web application security, Core Defense Mechanisms, Web Application Management, Web Architecture, Web Hacking, Internet Filtration, Pornographic evidence, Link Redirection Attacks, Web Messenger, Unblocking applications, OWASP, Code Injecting.**Web Hacking** Review of attack methods and tools, Penetration testing methodology, Port scanning, denial of service, attack on authentication system, and input validation attacks, Web application attacks, SQL injection, Cross-Site Scripting, Directory traversal**Protocol based Attacks**

TCP Syn Flooding, Frame busting, Web Anonymity, Cookie Reusing, SSL/TLS Attacks, Forceful browsing, Session Stealing, DNS Changer, APT **Secure coding**: Programming Fundamentals, Introduction to JAVA, .NET and PHP, Secure coding for SQL Injection, XSS, XSRF and Response splitting, Buffer overruns and format string problems.**Web Investigation** Web Hacking Investigations, Web site Crime Scene, web Logs, Investigation of hacking incident, database logs, web server intrusion investigations, code bugs.

Book:

1) Security Controls Evaluation, Testing, and Assessment Handbook - Leighton Johnson
2) Securing Systems: Applied Security Architecture and Threat Models - By Brook S. E. Schoenfield

MOBILE DEVICE THREATS & INVESTIGATION

Course Code :15 CS 51Q1	**L-T-P : 3-0-0**
Pre-requisite: NIL	**Credits: 3**

Syllabus:

The evolution of mobile device and applications, common Mobile Application Functions, Mobile Application Security, Key problem factors, OWASP Mobile security practices. Mobile Hacking & Investigation, Android Process Dump, YAFFS, iOS Hacking, Tools for mobile device Anti forensics, Mobile device Security, Securing smart OS, Smart Phone Packet capturing, Firesheep, Mobile Device Management

Books

1) The Mobile Application Hacker's Handbook - Dominic Chell, Tyrone Erasmus
2) Mobile Forensic Reference Materials: A Methodology and Reification by U.s. Department of Commerce

FUNDAMENTALS OF E-DISCOVERY

Course Code :15 CS 51Q2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Basics of E-Discovery: History and development of e-discovery, Overview of technology at issue in e-discovery matters, including distinction between data and metadata, General framework of e-Discovery, Legal aspects of e-Discovery, E-discovery industry, Electronic Discovery Reference Model Project, Developing "data maps" for enterprises, Technology tools for archiving and retrieving Electronically Stored Information.**E-Discovery Data Collection:** Data Preservation & Data Collection, Technology and data preservation - issues and means of preservation, Identifying the scope of data collection efforts - sources of data, Technical means of collecting ESI, including the use of forensic and non-forensic means and tools, Preservation of metadata and data during the collection process, International issues and privacy laws.**Tools & ESI:** Discovery Tools and E-Discovery Issues, Inspection of data collections, including inspection of computers and forensic imaging, Backup tape preservation and processing, Technological impediments to collection and data processing, The role of sampling in ESI production disputes, ESI Processing & Search, Reducing the volume of ESI through de-duplications, system file filtering, or other culling methodologies.**E-Discovery investigation:** Technical anatomy of e-mail messages and e-mail systems, Enterprise class e-mail vs. private e-mail systems such as G-Mail, Web 2.0 Technologies, HotMail, Yahoo!, etc. Collecting, processing, reviewing and producing e-mail messages, E-discovery of instant messaging, Discovery of online information assets like Facebook, web sites, wikis and other web 2.0 technologies, Investigatory opportunities using computer forensics (recovering deleted files, retrieving internet activity, file fragment analysis, etc.)

Books:

1. e-Discovery For Dummies by Linda Volonino, Ian Redpath, 2009.
2. Arkfeld on Electronic Discovery and Evidence, 3rd Ed. By Michael R. Arkfeld, Law Partner Publishing.
3. http://ediscoveryservicesinindia.blogspot.in/
4. Techno Security's Guide to E-Discovery and Digital Forensics: A Comprehensive Handbook by Jake Wiles, Syngress 1st edition, 2007.

INTRODUCTION TO BIG DATA ANALYTICS

Course Code :15 CS 51R1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Big Data and Database Evolution in Big Data: Introduction to Big Data, Relational Databases and SQL, Introduction to Hadoop, Pig, Hive, Casadenra, Mahout, Introduction to R, NoSQL databases and MongoDB, Comparison between SQL and NoSQL DBs, HDFS, Polyglot Persistence **Data Analytics:** What is data analytics?, Basics for Data Analytics, Data Analytics Lifecycle and methodology, Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, Communicating results, Deployment, Data exploration & preprocessing, Measures and evaluation, Using R for Initial Analysis of the Data,**Methods and Tools for Data Analytics:** Methods and Tools for Data Analytics (Structured Data), Methods and Tools for Data Analytics (Unstructured Data), Text mining, Web mining

Books:

1. Data-Intensive Text Processing with MapReduce, Jimmy Lin and Chris Dyer, Morgan & Claypool Publishers, 2010.
2. Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, Addison-Wesley April 2005.
3. Hadoop Beginner's Guide, Garry Turkington, PACKT Publication, ISBN : 9789351101109
4. Mining of Massive Datasets, AnandRajaraman and Jeff Ullman, Cambridge Press.
5. Data Mining: Concepts and Techniques, Jiawei Han and MichelineKamber, The Morgan Kaufmann Series in Data Management Systems, Jim Gray, Series Editor Morgan Kaufmann Publishers, August 2000. ISBN 1-55860-489-8.
6. Hadoop in Action, Chuck Lam, December, 2010, ISBN: 978193518219

SOCIAL MEDIA FORENSICS

Course Code :15 CS 51R2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Social Networking: Fundamentals of Social Networking, Social Networking viral, why social networking is popular, Psychology & Sociology for Online Media, Concepts of Geospatial Information System, How Facebook works? **Social Media & Legal Implication:**Graph Theory and Social Networks, Markets and Strategic Interactions in Networks, Information Networks and the World Wide Web, Network Dynamics: Population and Structural Models, Legal aspects of Privacy in India, Institutions and Aggregate Behavior, Social Media and its impact on Business, Politics, Law and Revolutions, Legal Responsibilities for Social Networking, **Information Gathering from Resources:** Intelligence gathering, People searching, OSINT, Deep Web, Defamatory content analysis, Multimedia forensics over Social Networking, Emerging Trends in Social Networks

Social Networking exploitation and hacking: Introduction: hacking on Twitter data Microformats: semantic markup and common sense collide, Twitter: friends, followers, and setwise operations, Twitter: the tweet, LinkedIn: clustering your professional network for fun (and profit?), Google buzz: TF-IDF, cosine similarity, and collocations, Facebook: the hackers outlook

Books:

1. Open Source Intelligence Techniques: Resources for Searching and Analyzing Online Information, by Michael Bazzell, CreateSpace Independent Publishing Platform; 2 Edition, 2013.
2. Social Media Investigation for Law Enforcement, Joshua L. Brunty, Katherine Helenek, Larry S. Miller, Forensic Studies for Criminal Justice, Anderson; 1 edition, 2012.
3. http://inteltechniques.com/links.html

CRITICAL INFORMATION INFRASTRUCTURE SECURITY

Course Code :15 CS 51R3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Basics of SCADA: Define different types of SCADA control systems and various components, Describe control system protocols, Understand why controlling systems are at risk, Define IT security terminology, SCADA Security Policies **SCADA cyber security:** Introduction to SCADA cyber security, Define different security documents and techniques for writing policy statements, Understanding SCADA security policies, SCADA Physical and Logical Security, Understanding differences between physical and logical security, Define perimeter controls and terms, Define various security zones, Understand communication cyber threats, Understand firewall, architectures

SCADA Remote Access: Define different types of remote access, Explain security goals of remote access, Comparison of different security architectures and understanding remote access techniques, Lab of Implementing and Writing Security Policies, Identifying security policy mistakes, Writing security policies, Lab of Firewall and DMZ Architecture and Rules, Implement DMZ, Create firewall architecture, Create firewall rules, Lab of SCADA Protocols simulation **Security Standards and Protocols:** Define SCADA systems security documents and standards, Explanation of field protocols and their migration to IP, Explain security in field protocols, Lab for SCADA Monitoring Systems; Understanding SCADA protocols control field devices, Simulation of attacks and extracting monitored logs, Lab of SCADA Attacks, Setting up packet injection attack in VM environment, Capturing the attack using Wireshark, Lab of Creation of Custom Short Signature for SCADA Protocol

Books:

1. An Architecture for SCADA Network Forensics, Tim Kilpatrick M.S., Jesus Gonzalez Ph.D., Rodrigo Chandia Ph.D., Mauricio Papa, SujeetShenoi, Springer 2006.
2. Handbook of SCADA/Control Systems Security, Robert Radvanovsky, Jacob Brodsky, CRC Press, 2013.

CRYPTOGRAPHY FOR CYBER DEFENSE

Course Code :15 CS 5237 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to Cryptography, Encryption & Decryption, Cipher text, Review of number theory and algebra, Security definitions and secure padding schemes, computational complexity, probability and information theory, primarily testing. Cryptography and cryptanalysis, Best practices and standardized cryptographic algorithms, Key generation and management, symmetric key encryption, DES, Triple DES, AES, RC4, OpenSSL, HTTPS, modes of operation. Public key encryption, RSA cryptosystem, Diffie-Hellman, elliptic curve cryptography, Rabin, ElGamal, Goldwasser-Micali, Blum-Goldwasser cryptosystems, Security engineering principles, Smart cards and RFID Message authentication, Digital signatures and time stamping, Digital Certification, Security handshake pitfalls, Strong password protocols. Side-channel attacks and countermeasures, Applications of cryptographic algorithms, Bank cards and terminals, Electronic passports, RFID systems in public transportation and automobiles, Smart cards and mobile phone security, Financial cryptography, payment systems, crypto currencies, bitcoin

Books:

1) Applied Cryptography for Cyber Security and Defense: Information Encryption and Cyphering: by Hamid R. Nemati and Li Yang

MALWARE ANALYSIS & REVERSE ENGINEERING

Course Code :15 CS 5238 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to MalwareL: Malware Analysis Fundamentals & Approaches, Types of malware and their features, Malware distribution techniques, Web threats, Intrusion signatures, Honeypot technology, Project work. Malware taxonomy and characteristics, Understanding Malware Threats, Malware indicators, Malware examination **Introduction to RE:** Sandboxing Executable and Gathering Information from Runtime Analysis, The Portable Executable (PE32) File Format, Introduction to the IDA Pro Disassembler, Identifying Executable Metadata, Executable Packers and Compression, and Obfuscation Techniques, Memory Dumping, Kernel Rootkit, Kernel hook (function pointer) protection, File carving, Metadata Analysis

Malware Analysis: Static Analysis, Code Review, Dynamic Analysis, Behavioral analysis of malicious executable, Sandbox Technologies, Reverse-engineering malware, Defeat anti-reverse engineering technique, automated analysis, intercepting network connections, Network flow analysis, Malicious Code Analysis, Network analysis, Anti-disassembling techniques, Identifying assembly logic structures with a disassembler.**Malware Handling:** Malicious Documents and Memory Forensics - Reverse engineering of malicious executable using memory forensic techniques, Analyze malicious Microsoft Office (Word, Excel, PowerPoint) and Adobe PDF documents, Analyzing memory to assess malware characteristics and reconstruct infection artifacts. Using memory forensics to analyze rootkit infections, Legal & Ethical Issues - Reinforce understanding and the application of discipline specific legal and ethical issues, Reverse Engineering Malware (REM) Methodology

Books:

1. Cameron H. Malin (Author), Eoghan Casey (Author), James M. Aquilina (Author), Linux Malware Incident Response: A Practitioner's Guide to Forensic Collection and Examination of Volatile Data: An Excerpt from Malware Forensic Field Guide for Linux Systems.
2. Malware Analyst's Cookbook: Tools and Techniques for Fighting Malicious Code, First Edition: Michael Ligh, Steven Adair, Blake Hartstein, and Matthew Richard. ISBN-10: 0470613033, ISBN-13: 978-0470613030. Wiley Publications
3. Malware: Fighting Malicious Code: Ed Skoudis and Lenny Zeltser. ISBN-10: 0131014056, ISBN-13: 978-0131014053. Prentice Hall Publications
   Practical Malware Analysis

CYBER INCIDENT RESPONSE & RESILIENCE

Course Code :15 CS 5239 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to Incident Response: Cyber Incident Statistics, Computer Security Incident, Information as Business Asset, Data Classification, Information Warfare, Key Concepts of Information Security, Vulnerability, Threat, and Attack, Types of Computer Security Incidents, Examples of Computer Security Incidents, Verizon Data Breach Investigations Report – 2008, Incidents That Required the Execution of Disaster Recovery Plans, Signs of an Incident, Incident Categories, Incident Categories: Low Level, Incident Categories: Middle Level, Incident Categories: High Level**. Incident Response and Handling Process:** Step 1: Identification, Step 2: Incident Recording, Step 3: Initial Response, Step 4: Communicating the Incident, Step 5: Containment, Step 6: Formulating a Response Strategy, Step 7: Incident Classification, Step 8: Incident Investigation, Step 9: Data Collection, Step 10: Forensic Analysis, Step 11: Evidence Protection, Step 12: Notify External Agencies, Step 13: Eradication, Step 14: Systems Recovery, Step 15: Incident Documentation, Step 16: Incident Damage and Cost Assessment, Step 17: Review and Update the Response Policies**Incident Response Team Development:**Security Awareness and Training Checklist, Incident Management, Purpose of Incident Management, Incident Management Process, Incident Management Team, Incident Response Team, Incident Response Team Members, Incident Response Team Members Roles and Responsibilities, Developing Skills in, Incident Response Personnel, Incident Response Team Structure, Incident Response Team Dependencies, Incident Response Team Services

Books/Reference:

1. CERT IN Guidelines.
2. Incident Response & Computer Forensics, Third Edition Paperback, Jason T. Luttgens, Matthew Pepe, Kevin Mandia
3. Computer Security Incident Handling Guide, NIST, http://csrc.nist.gov/publications/nistpubs/800-61rev2/SP800-61rev2.pdf

CYBER LAW, GOVERNANCE & COMPLIANCE

Course Code :15 CS 5240 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Computer ethics, Privacy & Legislation: Computer ethics, moral and legal issues, descriptive and normative claims, Professional Ethics, code of ethics and professional conduct. Privacy, Computers and privacy issue, legislative background and better privacy protection. **Intellectual property issues in cyberspace:** Introduction to intellectual property, WIPO, Copyright, Trade Secrets, Trademarks, Patents, Design, protection of intellectual property, Protection options – Encryption, copyright on web-content, copyright on software. Ethical Decision Making: Types of ethical choices, Making defensible decisions. **Cyber Forensics legal aspects:** Cyber forensics, cyber crime examples, forensics casework, investigative incident response actions, computer forensics tools, Threats in cyberspaces. **Compliances & Standards:** IT Service Management Concept, IT Audit standards, ISO/IEC 27000 Series, COBIT, HIPPA, SOX, System audit, Information security audit, ISMS, SoA (Statement of Applicability), BCP (Business Continuity Plan), DR (Disaster Recovery), RA (Risk Analysis/Assessment).

Books:

1. Deborah G Johnson, “Computer Ethics”
2. Earnest A. Kallman, J.P Grillo, “Ethical Decision making and IT: An Introduction with Cases”
3. Cyber Law - The Indian Perspective by Pawan Duggal
4. Michael E. Whitman, Herbert J. Mattord, “Principles of Information Security”, Cengage Learning Pub., 2012.

M.TECH - COMMUNICATION & RADAR SYSTEMS

First Year (First Semester):

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 EC 5101	Modern Digital communication	3	1	2	5
2	15 EC 5102	Microwave Antennas	3	1	2	5
3	15 EC 5103	EMI / EMC Techniques	3	1	0	4
4	15 EC 5104	Radar Engineering	3	1	0	4
5		Elective – 1	3	0	0	3
6		Elective - 2	3	0	0	3
7	15 IE 5149	Seminar	0	0	4	2
		Total	**18**	**4**	**8**	**26**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 EC 5205	Microwave and Millimetric wave Circuits	3	1	2	5
2	15 EC 5206	Antenna Measurements	3	1	2	5
3	15 EC 5207	Wireless Cellular Communication	3	1	0	4
4	15 EC 5208	Modern Radar Systems	3	1	0	4
5		Elective – 3	3	0	0	3
6		Elective - 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total	**18**	**4**	**8**	**26**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 EC 51A1	Fundamentals of Electronic Warfare	3	0	0	3
2	15 EC 51A2	Microwave Semi Conductor Devices	3	0	0	3
3	15 EC 51A3	Smart Antennas	3	0	0	3
Elective-2						
1	15 EC 51B1	Phased Array Systems	3	0	0	3
2	15 EC 51B2	GPS & Global Navigation Satellite System	3	0	0	3
3	15 EC 51B3	Optical Communications	3	0	0	3
Elective-3						
1	15 EC 52C1	Estimation & Detection Theory	3	0	0	3
2	15 EC 52C2	Radar Signal Processing	3	0	0	3
3	15 EC 52C3	High Performance Communication Networking	3	0	0	3
Elective-4						
1	15 EC 52D1	RF & Microwave System Design	3	0	0	3
2	15 EC 52D2	VLSI Design	3	0	0	3
3	15 EC 52D3	Remote Sensing & Sensors	3	0	0	3

MODERN DIGITAL COMMUNICATION

Course Code :15 EC 5101 **L-T-P : 3-1-2**

Pre-requisite: NIL **Credits: 5**

Syllabus:

Modern Digital Modulation Techniques:
Introduction, Information Capacity, Bits, Bit Rate, Baud rate & M-ary Encoding, ASK, FSK, PSK QAM Bandwidth Efficiency Carrier Recovery, Clock Recovery, DPSK, Trellis Code Modulation, Probability of Error & Bit Error Rate, Error Performance.
Baseband Data Transmission: Introduction – Baseband Binary PAM Systems – Baseband Pulse Shaping, Optimum Transmitting and Receiving Filters – Duobinary Baseband PAM System – Use of Controlled ISI in Duobinary Signaling Schemes, Transmitting and Receiving Filters for Optimum Performance **– M-ary Signaling Schemes** – Analysis and Design of M-ary Signaling Schemes, Binary Versus M-ary Signaling Schemes - Shaping of the Transmitted Signal Spectrum – Effect of Pre coding on the Spectrum, Pulse Shaping by Digital Methods - Equalization - Transversal Equalizer, Automatic Equalizers
Block and Convolutional Channel Codes: Linear Block Codes - The Generator Matrix and Parity Check Matrix, Cyclic Codes, Bounds on Minimum Distance of Linear Block Codes, Non Binary Block Codes – Convolutional Codes – Transfer Function of a Convolutional Code, Optimum Decoding of Convolutional Code –Distance Properties of Binary Convolutional Codes
Spread Spectrum Signals for Digital Communication: Model of Spread Spectrum Digital Communication System – Direct Sequence Spread Spectrum Signals – Error Rate Performance of the Decoder, Some Applications of DS Spread Spectrum Signals, Generation of PN Sequences – Frequency Hopped Spread Spectrum Signals – Performance of FH Spread Spectrum Signals in an AWGN Channel, CDMA System Based on FH Spread Spectrum
Signals Emerging Digital Communication Technologies.: The North American Hierarchy, Digital Services, Broad band Digital Communication: SONET, Digital Switching Technologies, Broadband Services for Entertainment and Home office Applications, Video Compression, High Definition Television(HDTV)

TEXT BOOKS

1. Advanced Electronic Communications Systems, by Wayne Tomasi, 6 Edition Pearson Education.
2. K Sam Shanmugam, Digital and Analog Communication Systems, John Wiley and sons (Asia) Pvt Ltd.

REFERENCES

1. Simon Haykin, Digital communications, John Wiley and sons, 1998
2. Wayne Tomasi, Advanced electronic communication systems, 4th Edition Pearson Education Asia, 1998
3. B.P.Lathi Modern digital and analog communication systems, 3rd Edition, Oxford University press

MICROWAVE ANTENNAS

Course Code :15 EC 5102 **L-T-P : 3-1-2**

Pre-requisite: NIL **Credits: 5**

Syllabus:

Introduction to Antenna Theory: Antenna Radiation concept, Types of Antennas, Antenna parameters, Friis Transmission equation.

Aperture Antenna: Introduction, Pyramidal Horns- Design Procedure, Conical and Corrugated Horns, Aperture Corrugated Horns, Reflected Antennas- Parameters, Analysis of front-fed parabolic reflector, Feed methods and feed types, Cassegrain Reflector Horns.

Microstrip Radiators: Introduction, Rectangular Microstrip Antenna analysis and Design, Circular Microstrip Antenna Analysis and Design.

Pencil-Beam and Fanned-Beam Antennas: Pencil-beam Requirements and Techniques, Geometrical Parameters, The Surface-current and Aperture-field distributions, The Radiation Field of the Reflector, The Antenna Gain, Primary Pattern Designs for maximizing gain, Impedance Characteristics, The Vertex-plate matching Technique, Rotation of Polarization Technique, Structural Design Problems. Simple Fanned-Beam Antennas: Applications of Fanned Beams and methods of Production, Symmetrically Cut Paraboloids, Feed Offset and Contour Cutting of Reflectors, The Parabolic Cylinder and Line Source, Parallel-plate Systems, Pillbox Design Problems.

Shaped-Beam Antennas:
Shaped-beam Applications and Requirements, Effect of a Directional Target Response Survey of Beam-shaping Techniques, Design of Extended Feeds, Cylindrical Reflector Antennas, Reflector Design on the Basis of Ray Theory, Radiation Pattern Analysis, Double Curvature Reflector Antennas, Variable Beam Shape.

Text Books:

1. Constantine A. Balanis – "Antenna Theory-Analysis and Design", 3rd Edition, John Wiley, 2005.
2. Samuel Silver, "Microwave Antenna - Theory and design", IEE Press, 1984.

Reference Books:

1. Ramesh Garg, Prakash Bhatia, "Microstrip Antenna Design - Hand Book" Architect House Inc. 2001.
2. Bahl IJ, and Bhartia N, "Microstrip Antennas", Artech House, 1982.
3. James.J R. Hall, P S. Wood.C., "Micro strip Antenna-Theory and Design", PeterPeregrinu, 1981.

EMI / EMC TECHNIQUES

Course Code :15 EC 5103 **L-T-P : 3-1-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction, Natural and Nuclear sources of EMI / EMC: Electromagnetic environment, History, Concepts, Practical experiences and concerns, frequency spectrum conservations. An overview of EMI / EMC, Natural and Nuclear sources of EMI.

EMI from apparatus, circuits and open area test sites: Electromagnetic emissions, noise from relays and switches, non-linearities in circuits, passive inter-modulation, cross talk in transmission lines, transients in power supply lines, electromagnetic interference (EMI). Open area test sites and measurements.

Radiated and conducted interference measurements and ESD: Anechoic chamber, TEM cell, GH TEM Cell, characterization of conduction currents / voltages, conducted EM noise on power lines, conducted EMI from equipment, Immunity to conducted EMI detectors and measurements. ESD, Electrical fast transients / bursts, electrical surges.

Grounding, shielding, bonding and EMI filters: Principles and types of grounding, shielding and bonding, characterization of filters, power lines filter design.

Cables, connectors, components and EMC standards: EMI suppression cables, EMC connectors, EMC gaskets, Isolation Transformers, optoisolators, National / International EMC standards.

Text Books:

1. Dr. V.P. Kodali, "Engineering Electromagnetic Compatibility", IEEE Publication, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.
2. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi, Modules1 – 9.

Reference Books :

1. C.R. Pal, "Introduction to Electromagnetic Compatibility", A John Wiley & Sons, Inc. Publication, 1992.
2. Terence Rybak, Mark Steffka, "Automotive Electromagnetic Compatibility (EMC)", Kluwer Academic Publisher, London.

RADAR ENGINEERING

Course Code :15 EC 5104 **L-T-P : 3-1-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

The Radar and its Ground Environment: Primary and Secondary Radar, Coordinate systems and range, Main monostatic radar components, Basic quantities, maximum range, Secondary radar, Bistatic radar, Performance.

Transmitters: Transmitter power, Power output stage, Spectrum and side bands, Pulse compression, Harmonics from the Transmitter.

Factors outside the Radar, propagation, scattering and clutter: Amplitude and phase of the echo, Effects of the atmosphere, Scattering without fading, overview of scattering models, second-time-around effect, scenario to simulate a typical radar environment.

Receiver: Dynamic range, the control of gain, and sensitivity time control, radio frequency section, Intermediate frequency amplifier and filter, limiters, receiver characteristics.

Determination of position: Fire control radars, sector scan radars, fast scanning radars, surveillance radars, accuracy.

Text Books

1. Hamish Meikle, “Modern Radar Systems”, Second Edition, Artech House Radar Library.

FUNDAMENTALS OF ELECTRONIC WARFARE

Course Code :15 EC 51A1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Targets of Electronic Warfare Operations: A General Description of Targets of Electronic Warfare Operations, Mathematical Models of Electronic Systems as Targets of Electronic Warfare, Mathematical Models of Automated Systems for the Control of AAD Forces as Targets of EW, Mathematical Models of Automated Systems for the Control of AAD Weapons as Targets of Electronic Warfare

Mathematical Models of Signals, Systems and Techniques for Electronic Jamming: A General Description of the Basic Elements of Electronic Jamming, Mathematical Models of Jamming Signals, Mathematical Models of Systems and Techniques for Jamming.

Electronic Warfare Effectiveness Criteria: General Characteristics of the Criteria, Information Indicators of the Effectiveness of Jamming Signals, Systems and Techniques of Electronic Attack, Energy Effectiveness Criteria of Jamming Signals and Techniques of Electronic Jamming, Operational and Tactical Indicators of EW Effectiveness

Active Jamming of Radar -The Jamming Equation: Fundamental Concepts, The Jamming Equation for Monostatic Radar Using Active Jamming, Reduction of the Jamming Equation to Canonical Form -Methods of Determining Information Damage, Specifics of the Jamming Equation Using Active Jamming against Various Types of Radar, Particulars of Jamming Radar Using Screening Jamming with Limited Information Quality Indicators -Use of the Jamming Equation for Analysis of the Electronic Environment

Targets and Decoys: Types of False Radar
Targets, Decoys and Disposable EW Devices, Parameters Simulated by False Radar Targets and Radar Decoys, Thermal Decoys, The Use of Towed and Launched Decoys, Selecting Decoy Launch Time

TEXT BOOK
Sergei A. Vakin,Lev N. Shustov, Robert H. Dunwell, "Fundamentals of Electronic Warfare, Artech House

MICROWAVE SEMICONDUCTOR DEVICES

Course Code :15 EC 51A2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Transient and ac behavior of p-n junctions, effect of doping profile on the capacitance of p-n junctions, noise in p-n junctions, high-frequency equivalent circuit, varactor diode; Schottky effect, Schottky barrier diode; Heterojunctions.

Tunnel and Avalanche Transit Time diodes: Tunneling process in p-n junction and MIS tunnel diodes, V-I characteristics and device performance, backward diode. Impact ionization, IMPATT diode, small-signal analysis of IMPATT diodes.

Gunn diode: Two-valley model of compound semiconductors, vd-E characteristics, Gunn effect, modes of operation, power frequency limit.

PIN Diodes: Construction and operation of microwave PIN diodes, equivalent circuit, PIN diode switches and modulators.

Microwave Transistor: High frequency limitations of BJT, microwave bipolar transistors, Operating characteristics of MISFETs and MESFETs, short-channel effects, high electron mobility transistor.

Text books:

1. Liao, S.Y., “Microwave Devices and Circuits”, 4th Ed., Pearson Education 2002.
2. Rebeiz, M.G., “R.F. MEMS: Theory, Design and Technology”, 2nd Ed.,Wiley-Interscience 2003.

Reference Books:

1. Sze, S.M., and Ng, K.K., “Physics of Semiconductor Devices”, 3rd Ed.,Wiley-Interscience 2006.
2. Glover, I.A., Pennoek, S.R. and Shepherd P.R., “Microwave Devices, Circuits and Sub-Systems”, 4th Ed., John Wiley & Sons 2005.
3. Golio, M., “RF and Microwave Semiconductor Devices Handbook”, CRC Press 2002.

SMART ANTENNAS

Course Code :15 EC 51A3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Smart Antennas: Introduction, Need for Smart Antennas, Overview, Smart Antenna Configurations, Switched-Beam Antennas, Adaptive Antenna Approach, Space Division Multiple Access (SDMA), Architecture of a Smart Antenna System, Receiver, Transmitter, Benefits and Drawbacks, Basic Principles, Mutual Coupling Effects.

DOA Estimation Fundamentals: Introduction, Array Response Vector, Received Signal Model, Subspace-Based Data Model, Signal Auto-covariance, Conventional DOA Estimation Methods, Conventional Beam forming Method, Capon's Minimum Variance Method, Subspace Approach to DOA Estimation, MUSIC Algorithm, ESPRIT Algorithm, Uniqueness of DOA Estimates .

Beam Forming Fundamentals: Classical Beam former, Statistically Optimum Beam forming Weight Vectors, Maximum SNR Beam former, Multiple Side-lobe Canceller and Maximum, SINR Beam former, Minimum Mean Square Error (MMSE), Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV), Adaptive Algorithms for Beam forming

Integration and Simulation of Smart Antennas: Overview, Antenna Design, Mutual Coupling, Adaptive Signal Processing Algorithms, DOA, Adaptive Beam forming, Beam forming and Diversity Combining for Rayleigh-Fading, Channel, Trellis-Coded Modulation (TCM) for Adaptive Arrays, Smart Antenna Systems for Mobile Ad Hoc Networks (MANETs), Protocol, Simulations, Discussion.

Space–Time Processing: Introduction, Discrete Space–Time Channel and Signal Models, Space–Time Beam forming, Inter-symbol and Co-Channel Suppression, Space–Time Processing for DS-CDMA, Capacity and Data Rates in MIMO Systems, Discussion.

Text Books:

1. Constantine A. Balanis & Panayiotis I. Ioannides, "Introduction to Smart Antennas", Morgan & Claypool Publishers' series-2007
2. Joseph C. Liberti Jr., Theodore S Rappaport - "Smart Antennas for Wireless Communications IS-95 and Third Generation CDMA Applications", PTR – PH publishers, 1st Edition, 1989.

Reference Books:

1. T.S Rappaport - "Smart Antennas Adaptive Arrays Algorithms and Wireless Position Location", IEEE press 1998, PTR – PH publishers 1999.
2. Lal Chand Godara, "Smart Antennas", CRC Press, LLC-2004.

PHASED ARRAY SYSTEMS

Course Code :15 EC 51B1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Conventional Scanning Techniques: Mechanical versus electronic scanning, Techniques of Electronic scanning, Frequency, Phase and time delay scanning principle, Hybrid scanning techniques.

Array Theory: Linear and Planner arrays, various grid configuration, Concept of cell and grid, Calculation of minimum number of elements, Radiation pattern, Grating lobe formation, Rectangular and triangular grid design of arrays.

Feed Networks for phased Arrays: Corporate Feed, Lens and Reflect feed Techniques, Optimum f/d ratio basic building block for corporate feed network, Series, Parallel feed networks, Comparison of various feeding techniques, Antenna Array Architecture, Brick/ Tile Type construction.

Frequency Scanned Array Design: Snake feed, Frequency-phase scanning, Phase scanning, Digital phase shifter PIN diode and Ferrite phase shifters for phased arrays, Beam pointing errors due to digitalization, Beam pointing accuracy.

Search Patterns: Calculation of search frame time, airborne phased array design, Electronic scanning radar parameter calculation, Application of phased arrays, Phased Array Radar Systems, Active Phased Array, TR/ATR Modules.

Text Books:

1. Olliner, A.A, and G.H. Knittel, "Phased Array Antennas", Artech House, 1972.
2. Kahrilas. PJ, "Electronic Scanning Radar Systems Design Handbook", Artech House, 1976.

Reference Books:

1. Skolnik. MI, "Radar Handbook", Mcgraw Hillso, NY,McGrow Hills-2007.

2. Galati,G-(editor), "Advanced Radar Technique and Systems", Peter Peregrims Ltd, London,1993.

GPS & GLOBAL NAVIGATION SATELLITE SYSTEM

Course Code :15 EC 51B2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

GPS Signals: GPS and UTC Time, Signal structure, C/A and P-code, ECEF and ECI coordinate systems and WGS 84 datum, Important components of receiver and specifications.

GPS error Models: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Antenna phase center variation, multipath, estimation of Total Electron Content(TEC) using Dual Frequency measurement, Various DOP's, UERE.

GPS data processing and position fixing: RINEX navigation and observation formats, Code and Carrier phase observables, Linear combinations and derived observables, Ambiguity resolutions, Cycle slips, Position estimation.

GNSS fundamentals: Trilateration, Hyperbolic navigation, Transit, GNSS principle of operation, Architecture, Operating frequencies, orbits, Keplerian elements.

Other satellite Navigation Systems: Galileo, GLONASS, IRNSS, Space, control and ground segments and Signal characteristics.

Text Books:

1. Global Navigation Satellite Systems – G. S. Rao, McGraw-Hill publications, New Delhi, 2010.
2. GPS Theory and Practice - B.Hofmann Wollenhof, H.Lichtenegger, and J.Collins, Springer Wien, New York, 2000.

Reference Books:

1. Introduction to GPS - Ahmed El -Rabbany, Artech House, Boston, 2002.
2. Global Positioning System Signals, Measurements, and Performance - Pratap Misra and Per Enge, Ganga-Jamuna Press, Massachusetts, 2001.

OPTICAL COMMUNICATIONS

Course Code :15 EC 51B3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Signal propagation in Optical Fibers: Geometrical Optics approach and Wave Theory approach, Loss and Bandwidth, Chromatic Dispersion, Non Linear effects- Stimulated Brillouin and Stimulated Raman Scattering, Propagation in a Non-Linear Medium, Self Phase Modulation and Cross Phase Modulation, Four Wave Mixing, Principle of Solutions.
Fiber Optic Components for Communication & Networking: Couplers, Isolators and Circulators, Multiplexers, Bragg Gratings, Fabry-Perot Filters, Mach Zender Interferometers, Arrayed Waveguide Grating, Tunable Filters, High Channel Count Multiplexer Architectures, Optical Amplifiers, Direct and External Modulation Transmitters, Pump Sources for Amplifiers, Optical Switches and Wavelength Converters.
Modulation and Demodulation: Signal formats for Modulation, Subcarrier Modulation and Multiplexing, Optical Modulations – Duobinary, Single Side Band and Multilevel Schemes, Ideal and Practical receivers for Demodulation, Bit Error Rates, Timing Recovery and Equalization, Reed-Solomon Codes for Error Detection and Correction.
Transmission System Engineering: System Model, Power Penalty in Transmitter and Receiver, Optical Amplifiers, Crosstalk and Reduction of Crosstalk, Cascaded Filters, Dispersion Limitations and Compensation Techniques.
Fiber Non-Linearities and System Design Considerations: Limitation in High Speed and WDM Systems due to Non-linearities in Fibers, Wavelength Stabilization against Temperature Variations, Overall System Design considerations – Fiber Dispersion, Modulation, Non-Linear Effects, Wavelengths, All Optical Networks.

Text Books:

1. Rajiv Ramaswami and Kumar N. Sivarajan, “Optical Networks: A Practical Perspective”, 2nd Ed., 2004, Elsevier Morgan Kaufmann Publishers, Elsevier.
2. Gerd Keiser, “Optical Fiber Communications”, 3rd Ed., 2000, McGraw Hill.

Reference Books:

1. John.M.Senior, “Optical Fiber Communications: Principles and Practice” 2nd Ed., PE, 2000.
2. Harold Kolimbris, “Fiber Optics Communication”, 2nd Ed., PEI, 2004.
3. Uyless Black, “Optical Networks: Third Generation Transport Systems”, 2nd Ed., PEI, 2009.
4. Govind Agarwal, “Optical Fiber Communications”, 2nd Ed., TMH, 2004.
5. S.C.Gupta, “Optical Fiber Communications and Its Applications”, PHI, 2004.

MICROWAVE AND MILLIMETRIC WAVE CIRCUITS

Course Code :15 EC 5205 **L-T-P : 3-1-2**

Pre-requisite: NIL **Credits: 5**

Syllabus:

Analysis of Microwave Circuits: Introduction, Microwave Components – E-plane Tee, H-plane Tee, Magic Tee, Directional Coupler, Isolator, Circulator & their Scattering.

Transformers & Resonators: Parameters, Impedance Transformers – Quarter wave Transformers, Microwave Resonators – Rectangular and Cylindrical Resonators.

Filters And Periodic Structures: Design of Narrow Band Low Pass, Band Pass and High Pass Filters, Maximally flat and Chebyshev Designs, Introduction to Periodic Structures, Floquet's Theorem, Circuit Theory Analysis of Infinite and Terminated Structures.

Obstacles In Wave Guides: Introduction, Posts in Waveguides, Diaphragms in Waveguides, Waveguide Junctions, Waveguide Feeds, Excitation of Apertures.

Millimeter Wave Circuits: Wave Propagation in microstriplines, Discontinues in Microstrips, Parallel Coupled lines, Power Dividers and Directional Couplers, Microwave and Millimeter Wave Integrated Circuits

TEXT BOOKS

1. Roger F. Harrington, "Time-Harmonic Electromagnetic Fields", Mc graw-hill
2. Robert E Collin, "Foundation for Microwave Engineering", Mc Graw-Hill.

REFERENCE BOOKS

1. Cam Nguyun, "Analysis Methods for RF, Microwave, and Millimeter-Wave Planar Transmission Line Structures", John Wiley & Sons, Inc. 2000.
2. Hoffman R. K., "Handbook of Microwave Integrated Circuits", Artech House Publishers, 1987.

ANTENNA MEASUREMENTS

Course Code :15 EC 5206 **L-T-P : 3-1-2**

Pre-requisite: NIL **Credits: 5**

Syllabus:

Antenna Pattern Measurements: Basic Considerations, Pattern Formats, Fresnel Region Measurements, Modeling Techniques,**Antenna Range Design and Evaluation**: Introduction, Electromagnetic Design Consideration, Antenna Range Evaluation.

Antenna Testing: Introduction, Types of of Ranges: Elevated Ranges, Ground Ranges, Near Field Ranges, Radar Cross Section Ranges.

Far Field Range Design: Introduction, Designing the Range, Source Design, Receiving Site Design, Ground Ranges.

Far Field Antenna Tests: Introduction, Pattern Testing, Gain and Directivity, Polarization. **Far Field Pattern Errors**: Introduction, Error Estimates, Error Correction, Antenna Errors.

Compact Ranges: Introduction, Room Design, Feed Design, Reflector Design. **Near Filed Testing**: Introduction, Planar Near Field Ranges, Errors, Cylindrical and Spherical Scanning

TEXT BOOKS

1.Evans, Gray E," Antenna measurements techniques", Artech House, Inc
2.J S Hollis, T J Lyon, L Clayton," Microwave Antenna Measurements" , Scientific Atlants, Inc

WIRELESS CELLULAR COMMUNICATION

Course Code :15 EC 5207 **L-T-P : 3-1-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to Cellular Mobile Systems: Cellular Mobile Telephone Systems, A Basic Cellular System, Operation of Cellular Systems. **Elements of Cellular Mobile Radio System Design:** General Description of the problem, Concept of Frequency reuse channels, Co-Channel Interference Reduction Factor, Handoff Mechanism, Cell Splitting.

Speech Coding for Wireless Systems Applications: Introduction to Digital Signal Processing (DSP) Techniques in Wireless Telephone and Broadcast Systems, Speech Coding Techniques for Audio and Voice – Pulse Code Modulation, DPCM, Delta Modulation, Vocoder and Linear Predictive Coding, Performance Comparison of Speech Processing Techniques.

Radio Propagation and Cellular Engineering Concepts: Fundamental Radio Propagation and System Concepts, Propagation Characteristics, Models of Multipath-faded radio signals – Un modulated Carrier, Envelope and Phase faded, Level Crossing rate and fade Duration, Delay Spread Measurements.

Digital Modulation-Demodulation (Modem) Principles and Architectures: Coherent Modem – Baseband Modem Equivalence, Coherent and Differentially Coherent Binary Phase Shift Keying Systems, Synchronization – Carrier Recovery and Symbol Timing Recovery, Differential Encoding and Decoding Requirement, Quadrature Phase shift Keying – Coincident and offset Types, Pi/4 DQPSK Modems – Architecture.

Interference In Wireless Digital Communication: Carrier-to-Interference and Carrier-to-Noise Limited Systems, Cochannel Interference, Adjacent Channel Interference. Externally caused Cochannel Interference, Definitions and performance of Spectral and Power Efficiency, Relationship of the Bit-Energy to Noise-Density Ratio and the Carrier-to-Noise Ratio, Power Efficiency and Bit-Error-Rate performance in an Additive White Gaussian Noise Environment, Concepts of Diversity Branch and Signal paths; Combining and Switching Methods.

TEXT BOOKS

1. Dr Kamilo Feher Wireless Digital Communications, Prentice Hall of India, New Delhi – 1999
2. William Cy Lee, Mobile Cellular Telecommunications, 2nd Edition, MC Graw Hill.

MODERN RADAR SYSTEMS

Course Code :15 EC 5208 **L-T-P : 3-1-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Overview: Advanced Techniques in Modern Radar: Introduction, Radar Modes, Radar and System Topologies.

Advanced Pulse Compression Waveform Modulations and Techniques: Introduction, Stretch Processing, Stepped Chirp Waveforms, Nonlinear Frequency Modulated Waveforms, Stepped Frequency Waveforms, Quadriphase Signals, Mismatched Filters.

MIMO Radar: Introduction, An Overview of MIMO Radar, The MIMO Virtual Array, MIMO Radar Signal Processing, Waveforms for MIMO Radar, Applications of MIMO Radar.

Radar Applications of Sparse Reconstruction and Compressed Sensing: Introduction, CSTheory, SR Algorithms, Sample Radar Applications.

Adaptive Digital Beamforming: Introduction, Digital Beamforming Fundamentals, Adaptive Jammer Cancellation, Adaptive Beamformer Architectures, Wideband Cancellation.

TEXT BOOKS

1. William L.Melvin, James A. Scheer, “Principles of Modern Radar”, volume II: Advanced Techniques, SciTech Publishing.

ESTIMATION AND DETECTION THEORY

Course Code :15 EC 52C1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Detection Theory: Maximum likelihood decision criterion; Neymann-Pearson criterion; Probability of error criterion; Bayes risk criterion; Minimax criterion; Robust detection; Receiver operating characteristics.
Detection Theory: Vector observations; The general Gaussian problem; Waveform observation in additive Gaussian noise; The integrating optimum receiver; Matched filter receiver.
Maximum Likelihood Estimation; Bayes cost method Bayes estimation criterion – Mean square error criterion; Uniform cost function; absolute value cost function; Linear minimum variance - Least squares method;

Estimation in the presence of gaussian noise -Linear observation; Non-linear estimation. Properties of estimators**:** Bias, Efficiency, Cramer Rao bound Assymptotic properties; Sensitivity and error analysis
Prediction: Kalman filter. Sufficient statistics and statistical estimation of parameters: Concept of sufficient statistics; Exponential families of distributions; Exponential families and Maximum likelihood estimation; Uniformly minimum variance unbiased estimation.

TEXT BOOKS

1.Steven M. Kay, Statistical Signal Processing: Vol. 1: Estimation Theory, Vol. 2: Detection Theory, Prentice Hall Inc., 1998.
2.Harry L. Van Trees, Detection, Estimation and Modulation Theory, Part 1, John Wiley & Sons

REFERENCES

1.James L. Melsa and David L. Cohn, Decision and Estimation Theory, McGraw Hill, 1978.
2.Dimitri Kazakos, P. Papantoni Kazakos, Detection and Estimation, Computer Science Press,
3.Jerry M. Mendel, Lessons in Estimation Theory for Signal Processing,
Communication and Control, Prentice Hall Inc.
4. Sophocles J. Orfanidis, Optimum Signal Processing 2nd edn., McGraw Hill.
5.Monson H. Hayes, Statistical Digital Signal Processing and Modelling, John Wiley & Sons
6. Scott C. Statistical Signal Processing , June 14, 2004.

RADAR SIGNAL PROCESSING

Course Code :15 EC 52C2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Angle-of-Arrival Estimation in the Presence of Multipath: The Low-Angle Tracking Radar Problem, Spectrum Estimation Background, Thomson’s Multi-Taper Method, Comparison of Some Popular Spectrum Estimation Procedures, Multi-taper Spectrum Estimation, *F*-Test for the Line Components

Time–Frequency Analysis of Sea Clutter: An Overview of Non-stationary Behavior and Time–Frequency Analysis, Theoretical Background on Non-stationary, High-Resolution Multi-taper Spectrograms

Dynamics of Sea Clutter: Statistical Nature of Sea Clutter: Classical Approach, Is There a Radar Clutter Attractor, Hybrid AM/FM Model of Sea Clutter, Modeling Sea Clutter as a Non-stationary Complex Autoregressive Process

Sea-Clutter Non-stationary: The Influence of Long Waves: Radar and Data Description, Statistical Data Analyses, Modulation of Long Waves: Hybrid AM/FM Model, Non-stationary AR Model

Two New Strategies for Target Detection in Sea Clutter: Bayesian Direct Filtering Procedure, Operational Details, Experimental Results on the Bayesian Direct Filter, Correlation Anomally Detection Strategy - Overview

TEXT BOOKS

1. I. Haykin, Simon S, ”Rader Adaptive signal processing”, John Wiley & Sons
2. Mark A Richards, “Fundamentals of Radar signal processing”, M C Graw Hill

HIGH PERFORMANCE COMMUNICATION NETWORKS

Course Code :15 EC 52C3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Principles of Networks networking principles: Network services, High performance networks, Network elements, network mechanisms, layered architecture

Packet Switched Networks Principles: OSI & TCP/IP models, transmission media, routing algorithms, Congestion control algorithms, Internetworking, Ethernet(IEEE 802.3), Tokenring (IEEE 802.5),Tokenbus (IEEE802.4), FDDI.

Network security: (cryptography, symmetric key algorithms, private key algorithms, digital signatures, authtication protocols)

The Internet And TCP/IP Networks & Circuit Switched Networks: Overview of Internet protocols, Internet control protocols, Elements of transport Protocols, TCP & UDP , Performance of TCP/IP networks, SONET, DWDM, Solitons

Optical Networks: Fiber principles (elements of optical fiber communication, acceptanceangle, Numerical aperture, modes, fiber types), optical links(point to point links,attenuation,optical budgeting, dispersion),splices ,connectors optical Lans,non Semiconductors, opticalamplifiers,Erbium doped Fiber mplifiers, couplers/splitters, optical switches ATM networks Main features of ATM, Addressing , signaling, routing, ATM header structure

TEXT BOOKS

1. Jean Walrand and Pravin variya , " High performance Communication networks", 2nd edition, Harcourt and Morgan Kauffman, London 2000
2. Andrew S. Tanenbaum, "Computer networks", PHI Private limited, new Delhi

REFERENCES

1. Gerd Keiser, MC Graw Hill International edition, optical fiber communication , third edition
2. John M Senior, PHI limited, optical fiber communication , third edition
3. Leon Gracia, Widjaja, " Communication Networks", Tata Mc Graw –Hill, New Delhi, 2000.
4. Behroz a. Forouzan, "Data communication and networking ", Tata MC Graw –Hill, New Delhi
5. Sumit Kasera, Pankaj Sethi, " ATM Networks", Tata Mc Graw- Hill, New Delhi , 2000

RF & MICROWAVE SYSTEM DESIGN

Course Code :15 EC 52D1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Importance of RF and Microwave Concepts and Applications- and Units- Frequency Spectrum, RF and Microwave Circuit Design, Dimensions - RF Behavior of Passive Components: High Frequency Resistors, High Frequency Capacitors, High Frequency Inductors, General Introduction, Types of Transmission Lines-Equivalent Circuit representation.
The Smith Chart: Introduction, Derivation of Smith Chart, Description of two types of smith chart, Z-Y Smith chart, Distributed Circuit Applications, Lumped Element Circuit Applications. SINGLE AND MULTIPORT NETWORKS: Basic Definitions, Interconnecting Networks.
Scattering Parameters: Scattering Parameters: Definition, Meaning, Chain Scattering Matrix, Conversion Between S- and Z-parameters, Signal Flow Chart Modelling.
Stability and Gain Considerations – RF Design RF Source, Transducer Power Gain, Additional Power Relations-Stability Considerations: Stability Circles, Unconditional Stability, and Stabilization Methods-Unilateral and Bilateral Design for Constant Gain- Noise Figure Circles- Constant VSWR Circles.
Rf Filters, Amplifiers And Oscillators Design Generalization-Basic Resonator and Filter Configurations: Low Pass, High Pass, Band Pass and Band Stop type Filters-Filter Implementation using Unit Element and Kuroda's Identities Transformations. Introduction, Types and Characteristics of Amplifiers, Small Signal Amplifiers, Design of different types of amplifiers (NBA, HGA, MGA, LNA, MNA, BBA), Design of Large Signal Amplifiers Oscillator vs Amplifier Design, Design procedure of Transistor Oscillators.

TEXT BOOKS
1.Mathew M. Radmanesh, “Radio Frequency & Microwave Electronics”, Pearson Education Asia, Second Edition,
2.Reinhold Ludwig and Powel Bretchko,” RF Circuit Design – Theory and Applications”, Pearson Education Asia, First Edition.
REFERENCES
1.Joseph . J. Carr, “Secrets of RF Circuit Design”, McGraw Hill Publishers, Third Edition.
2.Ulrich L. Rohde and David P. New Kirk, “RF / Microwave Circuit Design”, John Wiley & Sons USA, 2000.
3.Roland E. Best, “Phase - Locked Loops: Design, simulation and applications”, McGraw Hill Publishers 5^{TH}
4.Devendra K.Misra ,”Radio Frequency and Microwave Communication Circuits – Analysis and Design “John Wiley & Sons, Inc.
7. Ian Hickman, " RF HandBook ", Butter Worth Heinemann Ltd., Oxford, 1993.
8. Ulrich L.Rohde, T.T.N.Bucher, " Communication Recievers ", McGraw-Hill, New York, 1998.

VLSI DESIGN

Course Code :15 EC 52D2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Design Methodology: Structured design techniques; Programmable logic; Gate array and sea of gates design; cell based design; full custom design; Design flow; Design Economics.

Data path Subsystems: Adders; One/zero Detectors; Comparators; Counters; Shifters; Multipliers; Power and Speed Trade-off.

Memory and Array Subsystems: SRAM, DRAM, ROM, Serial access memories; CAM, PLAs; Array yield, reliability; Power dissipation in Memories.

Special-purpose Subsystems: Packaging; power distribution; I/O pads; **Interconnect:** Interconnect parameters; Electrical wire models, capacitive parasitics; Resistive parasitics; Inductive parasitic; Crosstalk; Advanced Interconnect Techniques.

Timing Issues: Timing classification; Synchronous design; Self-timed circuit design; **Clock Synthesis and Synchronization:** Synchronizers; Arbiters; Clock Synthesis; PLLs; Clock generation; Clock distribution; Synchronous Vs Asynchronous Design.

TEXT BOOKS

1.Neil H. E. Weste, David. Harris and Ayan Banerjee,, "CMOS VLSI Design" - Pearson Education, Third
Edition, 2004.
2.Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits" Pearson Education,
Second Edition.

REFERENCES:

1.Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits" TMH, Third Edition, 2003
2. Wayne Wolf, "Modern VLSI Design ", 2nd Edition, Prentice Hall,1998.

SIMULATION BOOKS

1. Etienne Sicard, Sonia Delmas Bendhia, "Basics of CMOS Cell Design", TMH, EEE, 2005.

REMOTE SENSING AND SENSORS

Course Code :15 EC 52D3 L-T-P : 3-0-0
Pre-requisite: NIL **Credits: 3**

Syllabus:

Basics of Remote Sensing : Principles of Remote sensing, History of Remote sensing, Remote sensing in India, Electromagnetic Radiation and Electromagnetic Spectrum, EMR quantities: Nomenclature and Units Thermal Emission of Radiation, Radiation Principles (Plank's Law, Stephen Boltezman law), Interaction of EMR with the Earth Surface (Wien's displacement law, Kirchoffs Law) Spectral signature, Reflectance characteristics of Earths cover types, Remote sensing systems.

Platforms and sensors : Platforms, Remote sensing sensors, resolutions Across track and along the track scanning, Optical sensors, Thermal scanners, Microwave sensing radar satellite missions, Landsat series, SPOT series, IRS satellite series, IKNOS

Microwave Remote Sensing: Airborne and Space borne radar systems basic instrumentation. System parameters - Wave length, Polarization, Resolutions, Radar geometry. Target parameters - Back scattering, Point target, Volume scattering, Penetration, Reflection, Bragg resonance, Cross swath variation. Speckie radiometric calibration. Radar - Grametry - Introduction, Mosaicing Stereoscope. Application : Geology, Forestry, Land use, Soils etc. Future trends and Research

Thermal Imaging system : Thermal Imaging System: Introduction - IR region of theElectromagnetic spectrum, Atmospheric transmission, Kinetic and radiant temperature, Thermal properties of materials, Emissivity, Radiant temperature. Thermal conductivity. Thermal capacity, thermal inertia, Apparent thermal inertia, Thermal diffusivity. IR - radiometers, Airborne and Satellite TTR scanner system, Characteristics of IR images ,i) Scanner distortion, ii) image irregularities, iii) Film density and recorded iv)Temperature ranges. Effects of weather on images i) Clouds, ii) Surface winds, iii) Penetration of smoke plumes. Interpretation of thermal imagery. Advantages of Thermal imagery

Meteorological satellites: Meteorological satellite characteristics and their orbits, TIROS, NIMBUS, NOAA, TIROS N, SEASAT, GOES, METEOSAT, INSAT. Measurement of Earth and Atmospheric energy and Radiation budget parameters from satellites

Text books:

1. P.H. Swain and S.M. Davis, “Remote Sensing: The quantitative approach”, McGraw Hill.
2. W Travelt, “Imaging Radar for Resource Survey: Remote Sensing Applications”, Chapman & Hall.

Reference Books:

1. Floyd, F. Sabins, Jr: “Remote Sensing Principles and Interpretation”, Freeman and Co. San Franscisco, 1978
2. C.P.L.O., Longman, “Applied Remote Sensing”, Scientific and Technical Publishers.
3. E.C. Barrett & L.F Curtis, “Introduction to Environmental Remote Sensing”, Chapman and Hall, London
4. George Joseph, “Fundamentals of remote sensing”, Universities Press.

M.TECH - SIGNAL PROCESSING

First Year (First Semester):

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 EC 5109	Wavelets, Filter Banks and Applications	3	1	2	5
2	15 EC 5110	Mathematics for Signal Processing	3	1	0	4
3	15 EC 5111	Speech Signal Processing	3	1	0	4
4	15 EC 5112	Adaptive Signal Processing	3	1	2	5
5		Elective – 1	3	0	0	3
6		Elective - 2	3	0	0	3
7	15 IE 5149	Seminar	0	0	4	2
		Total	**18**	**4**	**8**	**26**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 EC 5213	Image Processing	3	1	2	5
2	15 EC 5214	Pattern Classification and Clustering	3	1	0	4
3	15 EC 5215	Detection and Estimation Of Signals	3	1	0	4
4	15 EC 5216	Statistical Signal Processing	3	1	0	4
5		Elective – 3	3	0	0	3
6		Elective - 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total	**18**	**4**	**8**	**25**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 EC 51E1	Audio Signal Processing	3	0	0	3
2	15 EC 51E2	Array Signal Processing	3	0	0	3
3	15 EC 51E3	Multi-rate Signal Processing	3	0	0	3
Elective-2						
1	15 EC 51F1	Wireless Communication Signal Processing	3	0	0	3
2	15 EC 51F2	Intelligent Systems and Control	3	0	0	3
3	15 EC 51F3	Bio-Medical Signal Processing	3	0	0	3
Elective-3						
1	15 EC 52G1	VLSI for Signal Processing	3	0	0	3
2	15 EC 52G2	DSP Processors and Architecture	3	0	0	3
3	15 EC 52G3	Multimedia Signal Processing	3	0	0	3
Elective-4						
1	15 EC 52H1	Linear and Non Linear Optimization	3	0	0	3
2	15 EC 52H2	Bioinformatics	3	0	0	3
3	15 EC 52H3	Digital Video Processing	3	0	0	3

WAVELETS, FILTER BANKS AND APPLICATIONS

Course Code :15 EC 5109 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:
Integral wavelet transform, wavelet frames, orthogonal bases of Wavelets, Wavelet transform: Signal representation using basis function, ideal band pass wavelet, L2 -spaces, Basic properties of wavelet transform, Time frequency representation, Design of wavelet function.
Multi-rate Signal Processing: Filtering, Decimation, Poly-phase, Perfect Reconstruction and Aliasing Removal. Matrix Analysis: Toeplitz Matrices and Fast Algorithms.
Wavelet Transform: Pyramid and Cascade Algorithms, Haar wavelet basis, Daubechies Wavelets, Orthogonal and Biorthogonal Wavelets, Smoothness, Approximation, Boundary Filters and Wavelets, Time-Frequency and Time-Scale Analysis, Second-Generation Wavelets.
Spectral Factorization, Cosine-Modulated Filter Banks, Lattice Structure, Ladder Structure (Lifting.)
Going from piecewise linear to piecewise polynomial. The class of spline wavelets - a case for infinite impulse response (IIR) filter banks. Variants of the wavelet transform and its implementation structures, The wave packet transform, The lattice structure, The lifting scheme.
Audio and Image Compression, Quantization Effects, Digital Communication and Multicarrier Modulation, Trans multiplexers, Text-Image Compression: Lossy and Lossless, Medical Imaging and Scientific Visualization, Edge Detection and Feature Extraction, Seismic Signal Analysis, Geometric Modelling, Matrix Preconditioning, Multi scale Methods for Partial Differential Equations and Integral Equations.

Simulation Software
MATLAB® Wavelet Toolbox, Software for Filter Design, Signal Analysis, Image Compression, PDEs, Wavelet Transforms on Complex Geometrical Shapes.

Text Books:

1. Strang, and Nguyen. Wavelets and Filter Banks. Wellesley-Cambridge Press, 1997.
2. L. Debnath.. Wavelet Transforms and Their Applications, Birkhauser Pub.
3. E. Mallat.. A Wavelet Tour of Signal Processing, Elsevier, Indian Ed.
4. Yves Meyer.. Wavelets and Operators, Cambridge Univ. Press.
5. G. Kaiser.. A Friendly guide to Wavelets, Birkhauser.

REFERENCES

1. Howard L. Resnikoff, Raymond O. Wells, Wavelet Analysis: The Scalable Structure of Information, Springer, 1998.
2. Raghuveer M. Rao, Ajit S. Bopardikar, Inroduction to Wavelet Transforms.
3. K. P. Soman, K. I. Ramachandran, Insight Into Wavelets - From Theory to Practice.
4. Michael W. Frazier, An Introduction to Wavelets Through Linear Algebra, Springer.
5. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education.

MATHEMATICS FOR SIGNAL PROCESSING

Course Code :15 EC 5110 — **L-T-P : 3-1-0**
Pre-requisite: NIL — **Credits: 4**

Syllabus:

Mathematical Models and Vector Space Concepts: Metric Spaces, Vector Spaces, Norms and Normed Vector Spaces, Inner Products, Induced Norms, The Cauchy- Schwarz Inequality, Orthogonality of Vectors, Linear Transformations and The projection theorem.

Least Square and Minimum Mean Square Filtering and Estimation: Approximation problem in Hilbert space, Orthogonality principle, Error Minimization via Gradients, Matrix representation of least square problems, Minimum error in Hilbert-space approximations, Least squares filtering, Minimum mean square estimation, MMSE filtering, Comparison of least squares and minimum mean squares.

Linear Operators and Matrix Inverses: Linear operators, Operative norms, Adjoint operators and transposes, Geometry of linear equations, four fundamental sub spaces of a linear operator, Pseudo inverses, Inverse of a block matrix. The LU Factorization and QR Factorization.

Eigen values and Eigen vectors: Eigen values and linear systems, Linear dependence of eigenvectors, Diagonalization of a matrix, Geometry of invariant subspaces, Karhunen- Loeve Transform, The concept of PCA.

Singular Value Decomposition: Theory of SVD, Matrix structure from the SVD, Computation of SVD. Applications of the SVD: System Identification, Total least square problems.

Simulation Software

MATLAB® Signal Processing Toolbox, Least squares, Minimum Mean Squares applications, Filtering, Matrix Operations, Eigen Vector Applications, PCA and SVD.

TEXT BOOKS

1. Todd K. Moon, Wynn C. Stirling, ‘Mathematical Methods and Algorithms for signal processing’, Pearson education.
2. Statistical Signal Processing of Complex-Valued Data, Peter J. Schreier and Louis L. Scharf, Cambridge University Press

REFERENCE TEXT BOOKS

1. Mathematical Modelling: Models, Analysis and Applications, Banerjee, CRC Press, 2014.

SPEECH SIGNAL PROCESSING

Course Code :15 EC 5111 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

The Speech Production mechanism: Physiological and Mathematical Model, Relating the physiological and mathematical model, Categorization of Speech Sounds based on the source-system and the articulatory model.
Basic Speech Signal Processing Concepts: Discrete time speech signals, relevant properties of the fast Fourier transform and Z-transform for speech recognition, convolution, linear and non linear filter banks. Spectral estimation of speech using the Discrete Fourier transform. Pole-zero modeling of speech and linear prediction (LP) analysis of speech. Homomorphic speech signal de convolution, real and complex cepstrum, application of cepstral analysis to speech signals.
The Speech Recognition Front End: Feature extraction for speech recognition, Static and dynamic features for speech recognition, robustness issues, discrimination in the feature space, feature selection. Mel frequency cepstral co-efficients (MFCC), Linear prediction cepstral coefficients (LPCC), Perceptual LPCC.
Distance measures for comparing speech patterns: Log spectral distance, cepstral distances, weighted cepstral distances, distances for linear and warped scales. Dynamic Time Warping for Isolated Word Recognition.
Statistical models for speech recognition: Vector quantization models and applications in speaker recognition, Gaussian mixture modeling for speaker and speech recognition, Discrete and Continuous Hidden Markov modeling for isolated word and continuous speech recognition.

Simulation Software: MATLAB® Speech processing Toolbox, Using the HTK toolkit for building a simple speech recognition system.

1. **The HTK toolkit for speech recognition** **http://htk.eng.cam.ac.uk/.**
2. **The Sphinx toolkit for speech recognition**
   http://cmusphinx.sourceforge.net/html/cmusphinx.php.

Text Books:

1. Discrete-Time Speech Signal Processing: Principles and Practice, Thomas F. Qatari, Cloth, 816 pp. ISBN: 013242942X Published: OCT 29, 2001.
2. Fundamentals of Speech Recognition, L. Rabiner and B. Juang, Prentice-Hall Signal Processing Series, Pages: 507, Year of Publication: 1993, ISBN:0-13-015157-2.
3. Speech and Audio Signal Processing: Processing and perception of speech and music B. Gold and N. Morgan, Wiley 2000, ISBN: 0-471-35154-7.

ADAPTIVE SIGNAL PROCESSING

Course Code :15 EC 5112 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

Introduction to Adaptive Filters: Adaptive filter structures, issues and examples, Applications of adaptive filters, Channel equalization, active noise control, Echo cancellation, beamforming. Discrete time random processes, Power spectral density – properties, Autocorrelation and covariance structures of discrete time random processes, Eigen-analysis of autocorrelation matrices.

Wiener filter, search methods and the LMS algorithm: Wiener FIR filter, Steepest descent search and the LMS algorithm, Extension of optimal filtering to complex valued input, The Complex LMS algorithm.

Convergence and Stability Analyses: Convergence analysis of the LMS algorithm, Learning curve and mean square error behavior, Weight error correlation matrix, Dynamics of the steady state mean square error (mse), Mis-adjustment and stability of excess mse.

Variants of the LMS Algorithm: The sign-LMS and the normalized LMS algorithm, Block LMS, Review of circular convolution, Overlap and save method, circular correlation, FFT based implementation of the block LMS Algorithm.

Vector space framework for optimal filtering: Axioms of a vector space, examples, subspace, Linear independence, basis, dimension, direct sum of subspaces, Linear transformation, examples, Range space and null space, rank and nullity of a linear operator, Inner product space, orthogonality, Gram-Schmidt orthogonalization.

Simulation Software

MATLAB® Signal Processing Toolbox.

Text Books:

1. "Adaptive Filter Theory" by S. Haykin, Prentice Hall, Englewood Cliffs, NJ, 1991 (end Ed.).
2. "Adaptive Filters â€“ Theory and Applications", by B. Farhang-Boroujeny, John Wiley and Sons, 1999.

AUDIO SIGNAL PROCESSING

Course Code :15 EC 51E1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction To Audio Systems: Introduction, Studio Technology, Digital Transmission System, Storage Media, Audio Components at Home, Signal Quantization, Dither, AD/DA Conversion, jitter, spectral analysis.

Audio Processing Systems: Digital Audio Interfaces, Single-processor System, Scalable Audio System.

Equalizers: Recursive Audio Filters, Non-recursive Audio Filters, Multi-complementary Filter Bank.

Room Simulation: Room Acoustics, Model-based Room Impulse Responses, Measurement of Room Impulse Responses, Simulation of Room Impulse Responses, Early Reflections, Subsequent Reverberation.

Audio Coding: Lossless Audio Coding, Lossy Audio Coding, Psychoacoustics, ISO-MPEG-1 Audio Coding, MPEG-2.

TEXT BOOKS

1. Digital Audio Signal Processing, 2nd Edition, Udo Zolzer, ISBN: 978-0-470-99785-7, A John Wiley & Sons, Ltd, Publication.
2. Audio Signal Processing For Nextgeneration Multimedia Communication Systems, Yiteng (Arden) Huang, Jacob Benesty, Kluwer Academic Publishers 2004.

REFERENCE BOOKS

1. Applications Of Digital Signal Processing To Audio And Acoustics, Mark Kahrs And Karlheinz Brandenburg, Kluwer Academic Publishers 2002.

2. Audio Signal Processing And Coding, Andreas Spanias, Ted Painter And Venkatraman Atti, Wiley-Interscience, A John Wiley & Sons, Inc., Publication, 2007.

ARRAY SIGNAL PROCESSING

Course Code :15 EC 51E2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Spatial Signals, Signals in space and time. Spatial frequency, Direction vs. frequency. Wave fields. Far field and Near field signals.

Sensor Arrays, Spatial sampling, Nyquist criterion. Sensor arrays. Uniform linear arrays, planar and random arrays. Array transfer (steering) vector. Array steering vector for ULA. Broadband arrays.

Spatial Frequency, Aliasing in spatial frequency domain. Spatial Frequency Transform, Spatial spectrum. Spatial Domain Filtering. Beam Forming. Spatially white signal.

Direction Of Arrival Estimation, Non parametric methods - Beam forming and Capon methods. Resolution of Beam forming method.

Subspace methods - MUSIC, Minimum Norm and ESPRIT techniques. Spatial Smoothing.

TEXT BOOKS
1. Dan E. Dugeon and Don H. Johnson.," Array Signal Processing: Concepts and Techniques.Prentice Hall.
2. Petre Stoica and Randolph L. Moses. "Spectral Analysis of Signals. Prentice Hall.

MULTI-RATE SIGNAL PROCESSING

Course Code :15 EC 51E3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Fundamentals of Multirate Theory: The sampling theorem - sampling at sub-Nyquist rate - Basic Formulations and schemes - Basic Multirate operations- Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank- Identities- Polyphase representation.

Maximally decimated filter banks: Polyphase. representation - Errors in the QMF bank- Perfect Reconstruction (PR) QMF Bank - Design of an alias free QMF Bank

M-channel perfect reconstruction filter banks: Uniform band and non uniform filter bank - tree structured filter bank- Errors created by filter bank system- Polyphase representation- perfect reconstruction systems

Perfect reconstruction (PR) filter banks:Para-unitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Two channel FIR paraunitary QMF Bank- Linear phase PR Filter banks- Necessary conditions for Linear phase property- Quantization Effects: -Types of quantization effects in filter
banks. - coefficient sensitivity effects, dynamic range and scaling.

Cosine Modulated filter banks: Cosine Modulated pseudo QMF Bank- Alas cancellation- phase - Phase
distortion- Closed form expression- Polyphase structure- PR Systems.

TEXT BOOKS
1. P.P. Vaidyanathan. "Multirate systems and filter banks." Prentice Hall. PTR.
2. N.J. Fliege. "Multirate digital signal processing ." John Wiley.
3. Sanjit K. Mitra. " Digital Signal Processing: A computer based approach."

REFERENCES
1. R.E. Crochiere. L. R. "Multirate Digital Signal Processing", Prentice Hall. Inc.
2. J.G. Proakis. D.G. Manolakis. "Digital Signal Processing: Principles. Algorithms and Applications", 3rd Edn. Prentice Hall India

WIRELESS COMMUNICATION SIGNAL PROCESSING

Course Code :15 EC 51F1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Cellular Mobile Systems: Cellular Mobile Telephone Systems, A Basic Cellular System, Operation of Cellular Systems. **Elements of Cellular Mobile Radio System Design:** General Description of the problem, Concept of Frequency reuse channels, Co-Channel Interference Reduction Factor, Handoff Mechanism, Cell Splitting.

Speech Coding for Wireless Systems Applications: Introduction to Digital Signal Processing (DSP) Techniques in Wireless Telephone and Broadcast Systems, Speech Coding Techniques for Audio and Voice – Pulse Code Modulation, DPCM, Delta Modulation, Vocoder and Linear Predictive Coding, Performance Comparison of Speech Processing Techniques. **Radio**

Propagation and Cellular
Engineering Concepts: Fundamental Radio Propagation and System Concepts, Propagation Characteristics, Models of Multipath-faded radio signals – Un modulated Carrier, Envelope and Phase faded, Level Crossing rate and fade Duration, Delay Spread Measurements.

Digital Modulation-Demodulation (Modem) Principles and Architectures: Coherent Modem – Baseband Modem Equivalence, Coherent and Differentially Coherent Binary Phase Shift Keying Systems, Synchronization – Carrier Recovery and Symbol Timing Recovery, Differential Encoding and Decoding Requirement, Quadrature Phase shift Keying – Coincident and offset - Types, Pi/4 DQPSK Modems – Architecture.

Interference In Wireless Digital
Communication: Carrier-to-Interference and Carrier-to-Noise Limited Systems, Cochannel Interference, Adjacent Channel Interference. Externally caused Cochannel Interference, Definitions and performance of Spectral and Power Efficiency, Relationship of the Bit-Energy to Noise-Density Ratio and the Carrier-to-Noise Ratio, Power Efficiency and Bit-Error-Rate performance in an Additive White Gaussian Noise Environment, Concepts of Diversity Branch and Signal paths; Combining and Switching Methods.

TEXT BOOKS

1. Dr. Kamilo Feher Wireless Digital Communications, Prentice Hall of India, New Delhi – 1999
2. William Cy Lee, Mobile Cellular Telecommunications, 2 Edition, MC Graw Hill.

INTELLIGENT SYSTEMS AND CONTROL

Course Code :15 EC 51F2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Biological foundations to intelligent systems I: Artificial neural networks, Back-propagation networks, Radial basis function networks, and recurrent networks.

Biological foundations to intelligent systems II: Fuzzy logic, knowledge representation and inference mechanism, genetic algorithm, and fuzzy neural networks.

Fuzzy and expert control (standard, Takagi-Sugeno, mathematical characterizations, design example), Parametric optimization of fuzzy logic controller using genetic algorithm. System identification using neural and fuzzy neural networks.

Stability analysis: Lyapunov stability theory and Passivity Theory. Adaptive control using neural and fuzzy neural networks, Direct and Indirect adaptive control, and Self-tuning Pill Controllers.

Genetic Programming: Genetic Algorithm, Multi objective optimization using Genetic Algorithm.

Software Simulations: Applications to pH reactor control, flight control, robot manipulator dynamic control, under actuated systems such as inverted pendulum and inertia wheel pendulum control and visual motor coordination. Simulation models of all fuzzy membership functions. Simulation models of single neurons, Simulation models of ANN algorithms, Speed control of a permanent magnet direct current (PMDC) motor, A tracking controller for moving objects, A door position control system, Additional examples from industry and other sources.

Text Books:

1. Intelligent Systems and Control: Principles and Applications Paperback – 12 Nov 2009,by Laxmidhar Behera, Indrani Kar.
2. Rao, Vallinu B.,and Rao, Hayagriva . Neural networks and fuzzy Logic, second edition, BPB Publication
3. Freeman A. James, Skapura M. David- neural networks algorithms, applications and programming Techniques, Pearson Education.
4. Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence," by J.S.R. Jang, C.T. Sun, and E. Mizutani, Prentice Hall, 1996

BIOMEDICAL SIGNAL PROCESSING

Course Code :15 EC 51F3	**L-T-P : 3-0-0**
Pre-requisite: NIL	**Credits: 3**

Syllabus:

Introduction To Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG etc., Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio potentials - Review of linear systems - Fourier Transform and Time Frequency Analysis (Wavelet) of biomedical signals- Processing of Random &Stochastic signals – spectral estimation – Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments.

Concurrent, Coupled and Correlated Processes - Illustration with case studies – Adaptive and optimal filtering - Modeling of Biomedical signals - Detection of biomedical signals in noise - removal of artifacts of one signal embedded in another -Maternal-Fetal ECG - Muscle-contraction interference. Event detection – case studies with ECG & EEG - Independent component Analysis - Cocktail party problem applied to EEG signals -Classification of biomedical signals.

Cardio Vascular Applications : Basic ECG - Electrical Activity of the heart- ECG data acquisition – ECG parameters & their estimation - Use of multi-scale analysis for ECG parameters estimation - Noise & Artifacts- ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection -Arrhythmia analysis

Data Compression: Lossless & Lossy- Heart Rate Variability – Time Domain measures - Heart Rhythm representation - Spectral analysis of heart rate variability - interaction with other physiological signals.

Neurological Applications: The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models – Non-linear modeling of EEG - artifacts in EEG & their characteristics and processing – Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis – correlation analysis of EEG channels - coherence analysis of EEG channels.

TEXT BOOKS

1. D.C.Reddy ,"Biomedical Signal Processing: Principles and techniques" ,Tata McGraw Hill, New Delhi, 2005
2. Willis J Tompkins , Biomedical Signal Processing -, ED, Prentice – Hall, 1993

REFERENCES BOOKS

1. R. Rangayan, "Biomedical Signal Analysis", Wiley 2002.
2. Bruce, "Biomedical Signal Processing & Signal Modeling," Wiley, 2001
3. Sörnmo, "Bioelectrical Signal Processing in Cardiac & Neurological Applications", Elsevier
4. Semmlow, "Bio-signal and Biomedical Image Processing", Marcel Dekker
5. Enderle, "Introduction to Biomedical Engineering," 2/e, Elsevier, 2005

IMAGE PROCESSING

Course Code :15 EC 5213 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

Introduction : Digital Image definitions ,Types of Operations ,Types of neighborhoods, Video parameters 2D convolution ,Properties of 2D convolution ,2D Fourier Transforms, Properties of 2D Fourier Transforms , Importance of phase and magnitude , Circularly Symmetric Signals, Examples of 2D Signals and transforms, Statistical Description of Images, Perception, Brightness Sensitivity, Wavelength Sensitivity , Stimulus Sensitivity, Spatial Frequency Sensitivity, Psychophysics of Color vision, Perceived color, Color metrics, CIE chromaticity coordinates, Spatial effects in color vision, Optical illusions. MATLAB Implementations.
Image Sampling: Two dimensional Sampling theory, Extensions of sampling theory, Non rectangular Grid sampling, Hexagonal sampling, Optimal sampling. **Image Quantization:** The optimum Mean Square Lloyd-Max quantizer, Optimum mean square uniform quantizer for non uniform densities, Analytic Models for practical quantizes, Visual quantization, Vector Quantization. MATLAB Implementations.
Image Transforms: Two dimensional orthogonal and unitary transforms, Separable unitary transforms, Basis images: Dimensionality of Image Transforms, Discrete linear orthogonal, DFT,

WHT, KLT, DCT and SVD, Quantization of Transform coefficients, Transform Coding of Color images.

Image Enhancement: Contrast and dynamic Range Modification, Histogram-based operations, Smoothing operations, Edge Detection-derivative based operation, Image Interpolation and Motion Estimation, Pseudo coloring.

Image Restoration: Degradation Estimation, Reduction of Additive Noise, Reduction of Image Blurring, Simultaneous reduction of noise and blurring, Reduction of Signal dependent noise, Temporal filtering for Image Restoration, Extrapolation of Band limited Signals.

Simulation Software: MATLAB® Image processing Toolbox, Simulink for Image Analysis, PDEs, and Applications to Image Analysis.

Text Books:

1. Digital Image Processing (3rd Edition) Hardcover – August 31, 2007 by Rafael C. Gonzalez ,Richard E. Woods .
2. Algorithms for Image Processing and Computer Vision Paperback – December 21, 2010 by J. R. Parker.
3. Digital Image Processing Using MATLAB Hardcover – December 26, 2003, by Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins.

PATTERN CLASSIFICATION AND CLUSTERING

Course Code :15 EC 5214	**L-T-P : 3-1-0**
Pre-requisite: NIL	**Credits: 4**

Syllabus:

Introduction, Data Sets for Pattern Recognition, Different Paradigms for Pattern Recognition, Data Structures for Pattern Representation, Representation of Clusters, Proximity Measures.

Features: Size of Patterns, Abstractions of the Data Set, Feature Extraction, Feature Selection, Evaluation of Classifiers, Evaluation of Clustering.

Nearest Neighbour Based Classifiers: Nearest Neighbour Algorithm, Variants of the NN Algorithm, Use of the Nearest Neighbour Algorithm for Transaction Databases, Minimal Distance Classifier (MDC).

Bayes Classifier: Bayes Theorem, Minimum Error Rate Classifier, Estimation of Probabilities Comparison with the NNC, Naive Bayes Classifier.

Hidden Markov Models: Markov Models for Classification, Hidden Markov Models, HMM Parameters, Learning HMMs, Classification Using HMMs, Classification of Test Patterns.

TEXT BOOKS

1. Pattern Recognition, An Algorithmic Approach, M. Narasimha Murty · V. Susheela Devi, 2011, Universities Press (India) Pvt. Ltd, Co-Published by SPRINGER.
2. Handbook of Pattern Recognition and Computer Vision, Third Edition by C. H. Chen, Patrick S. P. Wang, World Scientific Publishing Co. Pvt. Ltd.,2005.

REFERENCES
1. Neural Networks for Pattern Recognition by Bishop, Oxford University Press, 2005.
2. R. O. Duda,P.E. Hart and D. G.Stork,Pattern Classification, Wiley, 2000,

DETECTION AND ESTIMATION OF SIGNALS

Course Code :15 EC 5215 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to Discrete-time signals: Fourier Transform of a discrete time signal, Amplitude and phase spectrum, Frequency content and sampling rates, Transfer function, Frequency response.
Random - Discrete-time signals: Review of probability, Random data, Generation of Pseudo-random noise, Filtered signals, Autocorrelation and power spectral density, Sampling band-Limited random.
Detection of Signals in Noise:- Minimum probability of Error Criterion, Neyman-Person criterion for Radar detection of constant and variable amplitude signals, Matched filters, Optimum formulation, Detection of Random signals, Simple problems thereon with multi sample cases.
Estimation of Signals in Noise: Linear mean squared estimation, Non linear estimates, MAP and ML estimates, Maximum likelihood estimate of parameters of linear system, Simple problems thereon.
Recursive linear mean squared Estimation: Estimation of a signal parameter, Estimation of time varying signals, Kalman filtering, Filtering signals in noise, Treatment restricted to two variable case only, Simple problems.

TEXT BOOKS

1. Signal processing: Discrete Spectral analysis, Detection and Estimation, Mischa Schwartz and Leonard Shaw, Mc-Graw Hill Book Company, 1975.
2. Signal Detection and Estimation, 2nd edition, Mourad Barkat, Artech House Inc, Norwood, MA 02062, 2005,
3. Fundamentals of Statistical Signal Processing: Estimation Theory, Steven M. Kay, Prentice Hall New Jersey, 1993,

REFERENCE TEXT BOOK

1. "Probability, Random Variables and Random Signal Principles", ***Peyton Z.Peebles*** Jr, 4th Edition, Tata Mc Graw Hill.
2. Jerry M. Mendel, Lessons in Estimation Theory for Signal Processing, Communication and Control, Prentice Hall Inc., 1995.
3. Shanmugam and Breipohl, 'Detection of signals in noise and estimation', John Wiley & Sons, New York, 1985.
4. Srinath, Rajasekaran & Viswanathan, Introduction to statistical Signal processing with Applications, Prentice Hall of India, New Delhi, 110 001,1989.

5. Steven M. Kay, Intuitive Probability and Random Processes using Matlab, Springer, 2006.

SIMULATION TEXT BOOKS

1. Statistical Digital Signal Processing and Modeling by Monson Hayes, John Wiley & Sons, Inc., 2.Statistical Signal Processing Modelling and ESTIMATION BY Chonavel, T., Springer 2001

STATISTICAL SIGNAL PROCESSING

Course Code :15 EC 5216 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Review of random variables: Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Schwarz Inequality Orthogonality principle in estimation, Central Limit theorem, Random processes, wide-sense stationary processes, autocorrelation and auto covariance functions, Spectral representation of random signals, Wiener Khinchin theorem Properties of power spectral density, Gaussian Process and White noise process, Linear System with random input, Spectral factorization theorem and its importance, innovation process and whitening filter, .Random signal modeling: MA(q), AR(p) , ARMA(p,q) models.
Parameter Estimation Theory: Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Cramer Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties ; Bayesian estimation : Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation.
Estimation of signal in presence of white Gaussian Noise: Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter, Non causal I I R Wiener filter, Wiener filter, Non causal I I R Wiener filter, Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters.
Spectral analysis: Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Parametric method, AR(p) spectral estimation and detection of Harmonic signals, Burg, ESPRIT, MUSIC algorithm.
Kalman filtering: State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter.

Simulation Software: MATLAB® SSP Toolbox, Software for Filter Design, Signal Analysis, PDEs, and Applications to Signal Analysis.

TEXT BOOKS

1. M. Hays: Statistical Digital Signal Processing and Modelling, John Willey and Sons, 1996.
2. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan: Statistical Signal Processing with Applications, PHI, 1996.

VLSI FOR SIGNAL PROCESSING

Course Code :15 EC 52G1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:
Introduction To DSP Systems: Introduction; representation of DSP algorithms: Block Diagram, signal flow graph, data flow graph, dependence graph.

Iteration Bound: Data flow graph representations, loop bound and iteration bound, longest path matrix algorithm, iteration bound of Multirate data flow graphs.

Pipelining and Parallel Processing: Pipelining and parallel processing of FIR digital filters, pipeline interleaving in digital filters: signal and multichannel interleaving.

Retiming, Unfolding and Folding: retiming techniques; algorithm for unfolding, Folding transformation, systolic architecture design, systolic array design methodogy.

Fast Convolution, Filters and Transforms: Cook-toom algorithm, modified cooktoom algorithm, winogard algorithm, iterated convolution Algorithm strength reduction in filters and transforms.

TEXT BOOK

1. Keshab k. Parhi," VLSI Digital Signal Processing Systems: Design and Implementation", Wiley, inter science.

REFERENCE BOOKS

1. S.Y.kung, H.J.White house, T. Kailath," VLSI and Modern Signal Processing", Prentice hall,

DSP PROCESSORS AND ARCHITECTURES

Course Code :15 EC 52G2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Digital Signal Processing: Review of a digital signal-processing system, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear Time Invariant Systems, Digital filters IIR and FIR, Decimation and interpolation.
Computational Accuracy in DSP Implementations: Number formats for signals and coefficients in DSP systems, Dynamic range and precision, Sources of error in DSP implementations, ADC and DAC conversion errors, DSP computational errors, Compensating filter.
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, Features for external interfacing.
Execution Control and Pipelining: Hardware looping, Interrupts, Stacks, Relative Branch support, Pipelining and Performance, Pipeline Depth, Interlocking, Branching effects, Interrupt effects, Pipeline Programming models.
Programmable Digital Signal Processors: Commercial DSP Devices, Data Addressing modes of TMS320C54XX, DSPs, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and programming, On-Chip Peripherals, Interrupts of TMS320C54XX processors, Pipeline operation of TMS320C54XX Processors.
Implementations of Basic DSP Algorithms: The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, 2-D Signal Processing, An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation, An 8-Point FFT
implementation on the TMS320C54XX, Computation of the signal spectrum.
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.

TEXT BOOKS

1. Digital Signal Processing – Avtar Singh and S. Srinivasan, Thomson Publications, 2004.
2. DSP Processor Fundamentals, Architectures & Features - Lapsley et al. S. Chand & Co, 2000.

REFERENCE BOOKS

1. Digital Signal Processors, Architecture, Programming and Applications – B. Venkata Ramani and M. Bhaskar, TMH, 2004.
2. Digital Signal Processing –Principles, Algorithms Applications by J.G. Proakis & D.G.Manolokis, PHI, 2005.

MULTIMEDIA SIGNAL PROCESSING

Course Code :15 EC 52G3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Multimedia: Elements of Image Compression System, Video Coding : Fixed-length and Variable-length Codes, Lossless and Lossy Compression, Lossy Compression

Technique, Lossy Compression Technique : Discrete Cosine Transforms, Bit Allocation Strategies for DCT Coefficients - 1
Bit Allocation Strategies for DCT Coefficients – 2, Limitations of the DCT.

Motion Estimation : Matching Criteria, Motion Estimation : Generalised Matching, Generalised Deformation Model in Motion Estimation
Multimedia Standards: Still Image Compression Standards : JPEG, JPEG-2000, Video Compression Standards : An Overview, Video Compression Standards : H.261, Video Compressing Standards : H.261 & H.263 Standards, MPEG-1 Standards : Specifications, MPEG-1 Standards : Continuity & Synchronization.

Synchronization of Media: Continuity Aspects of MPEG-1 Multimedia Streams, Multimedia Synchronization, MPEG-2 Standards, The MPEG-2 Scalable Profiles,
MPEG- 4 Standards : Introduction, MPEG- 4 Standards : Audio Visual Objects, MPEG- 4 Multifunctional Coding Capabilities, MPEG- 1 Audio Standards, MPEG- 1 Audio Coder, MPEG - Audio - Layer-1 Encoding, MPEG - Audio - Layer-2 Encoding, MPEG - Audio : Bit Allocation and Psychoacoustic Model, MPEG - Audio : Masking Effects and Layer-3 Encoding

Multimedia Content Representation and Retrieval: Video Content Representation, Content-based Video : Motion Representation, Content-based Video : Low to High-level Representation, Content Retrieval Schemes

Text Books:

1. Multimedia Signal Processing: Theory and Applications in Speech, Music and Communications Hardcover – 5 Oct 2007, by Saeed V. Vaseghi.

2. Brad Perry et.al. "Content-Based Access To Multimedia Information From Technology Trends to State of the Art," Kluwer Academic Publishers 1999.

3. Multimedia Signals and Systems (The Springer International Series in Engineering and Computer Science)31 December 2002 by Mrinal Kr. Mandal.

LINEAR & NONLINEAR OPTIMIZATION

Course Code :15 EC 52H1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Mathematical Background: Sequences and Subsequences- Mapping and functions- Continuous functions- Infimum and Supremum of functions- Minima and maxima of functions- Differentiable functions. Vectors and vector spaces- Matrices- Linear transformation- Quadratic forms- Definite quadratic forms- Gradient and Hessian- Linear equations- Solution of a set of linear equations-Basic solution and degeneracy. Convex sets and Convex cones- Introduction and preliminary definition- Convex sets and properties- Convex Hulls- Extreme point- Separation and support of convex sets- Convex Polytopes and Polyhedra-Convex cones- Convex and concave functions- Basic properties- Differentiable convex functions- Generalization of convex functions. **Linear Programming:** Introduction Optimization model, formulation and applications-Classical optimization techniques: Single and multi variable problems-Types of constraints. Linear optimization algorithms: The simplex method -Basic solution and extreme point Degeneracy-The primal simplex method -Dual linear programs - Primal, dual, and duality theory - The dual simplex method -The primal-dual algorithm-Duality applications. **Post optimization problems:** Sensitivity analysis and parametric programming- **Nonlinear Programming**: Minimization and maximization of convex functions- Local & Global optimum- Convergence-Speed of convergence. **Unconstrained optimization:** One dimensional minimization - Elimination methods: Fibonacci & Golden section search - Gradient methods - Steepest descent method. **Constrained optimization:** Constrained optimization with equality and inequality constraints. Kelley's convex cutting plane algorithm - Gradient projection method - Penalty Function methods. Constrained optimization: Lagrangian method - Sufficiency conditions - Kuhn-Tucker optimality conditions- Rate of convergence - Engineering applications Quadratic programming problems-Convex programming problems.

TEXT BOOKS

1. David G Luenberger, .Linear and Non Linear Programming., 2nd Ed, Addison-Wesley.
2. S.S.Rao, .Engineering Optimization.; Theory and Practice; Revised 3rd Edition, New Age International Publishers, New Delhi

REFERENCES

1. S.M. Sinha, Mathematical programming: Theory and Methods, Elsevier, 2006.
2. Hillier and Lieberman ***Introduction to Operations Research***, McGraw-Hill, 8th edition, 2005.
3. Saul I Gass, Linear programming, McGraw-Hill, 5th edition, 2005.
4. Bazarra M.S., Sherali H.D. & Shetty C.M., Nonlinear Programming Theory and Algorithms, John Wiley, New York, 1979.
5. Kalyanmoy Deb, Optimization for Engineering: Design-Algorithms and Examples, Prentice Hall (India), 1998

BIOINFORMATICS

Course Code :15 EC 52H2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Algorithms and Complexity:
Biological Algorithms versus Computer Algorithms, Correct versus Incorrect Algorithms, Recursive Algorithms, Algorithm Design Techniques, Structure of DNA, Analysis of DNA.

Exhaustive Search
Restriction Mapping, Impractical Restriction Mapping Algorithms, A Practical Restriction Mapping Algorithm, Regulatory Motifs in DNA Sequences, The Motif Finding Problem.

Greedy Algorithms
Genome Rearrangements, Sorting by Reversals, Approximation Algorithms, Breakpoints: A Different Face of Greed, A Greedy Approach to Motif Finding.

Dynamic Programming Algorithms

The Power of DNA Sequence Comparison, The Change Problem Revisited, The Manhattan Tourist Problem, Edit Distance and Alignments, Longest Common Subsequence’s.

Graph Algorithms

Graphs, Graphs and Genetics, DNA Sequencing, Shortest Superstring Problem, DNA Arrays as an Alternative Sequencing Technique, Sequencing by Hybridization, Spectrum Graphs, Protein Identification via Database Search, Spectral Convolution.

Text Books:

1. An introduction to bioinformatics algorithms by Jones N.C., Pevzner P.A.
2. Introduction to Protein Structure Prediction: Methods and Algorithms (Wiley Series in Bioinformatics) by Huzefa Rangwala, George Karypis.

References:

1. Parallel Computing for Bioinformatics and Computational Biology: Models, Enabling Technologies, and Case Studies by Albert Y. Zomaya.
2. Introduction to Mathematical Methods in Bioinformatics by Alexander Isaev.

DIGITAL VIDEO SIGNAL PROCESSING

Course Code :15 EC 52H3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Basics of Video, Analog and digital Video, time varying Image formation models.

Spatio Temporal Sampling: Sampling for analog and digital video, 2D Rectangular sampling, 2D periodic sampling, Reconstruction from samples.

2D Motion Estimation: Optical flow methods, The occlusion problem, aperture problem, OF Equation, Second order differential methods, Block motion model, Horn schunck OF, Lukas kande OF. Application of OF to Motion segmentation.

Video Filtering: Motion compensated filtering, Fourier transform methods, filtering among motion trajectories, Noise Filtering, intraframe filtering, Restoration.

Video Compression: 3D transform coding, 3D subband coding, Motion compensated coding, Model based Coding.

Text Books:

1. Digital Video Processing by A. Murat Tekalp, Prentice Hall.
2. "Handbook on Image and Video Processing", A.I.Bovik, Academic Press.

Reference Books:

1. "Multimedia Communication Technology", J.R.Ohm, Springer Publication.
2. "Video Coding for Mobile Communications" David Bull et al, Academic Press.

M.TECH - SPACE TECHNOLOGY & ATMOSPHERIC SCIENCE

First Year (First Semester):

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 EC 5117	Microwave and Satellite Communications	3	1	0	4
2	15 EC 5118	Foundations of Atmospheric Science & Space Technology	3	1	0	4
3	15 EC 5119	Global Navigation Satellite System	3	1	2	5
4	15 EC 5120	Physics and Dynamics of Lower Atmosphere	3	1	2	5
5		Elective – 1	3	0	0	3
6		Elective - 2	3	0	0	3
7	15 IE 5149	Seminar	0	0	4	2
		Total	**18**	**4**	**8**	**26**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 EC 5221	Satellite Meteorology	3	1	2	5
2	15 EC 5222	Atmospheric & Space Instrumentation	3	1	0	4
3	15 EC 5223	Advanced Satellite Navigation Systems	3	1	0	4
4	15 EC 5224	Weather and Climate Applications	3	1	0	4
5		Elective – 3	3	0	0	3
6		Elective - 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total	**18**	**4**	**8**	**25**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 EC 51I1	Atmospheric and Weather Radars	3	0	0	3
2	15 EC 51I2	Modern Digital Communications	3	0	0	3
Elective-2						
1	15 EC 51J1	GIS Analysis & Modeling	3	0	0	3
2	15 EC 51J2	Global Weather and Climate	3	0	0	3
Elective-3						
1	15 EC 52K1	Aeronomy	3	0	0	3
2	15 EC 52K2	Detection and Estimation Theory	3	0	0	3
Elective-4						
1	15 EC 52L1	Weather Hazards & Risk Assessment	3	0	0	3
2	15 EC 52L2	Climate Change	3	0	0	3

MICROWAVE AND SATELLITE COMMUNICATIONS

Course Code :15 EC 5117 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: Basic Concepts of Satellite Communications, Frequency Allocations for Satellite Services, Applications.

Orbital Mechanics: Orbital Mechanics, Look Angle determination, Orbital perturbations.

Satellite Subsystems: Attitude and Orbit Control System, Telemetry, Tracking, Command and Monitoring, Power Systems, Communication Subsystems, Satellite Antennas**.**

Satellite Link Design: Basic Transmission Theory, System Noise Temperature and G/T Ratio, Design of Down Links, Up Link Design, Design Of Satellite Links For Specified C/N, System Design Examples.

Propagation Effects & their impact on Satellite – Earth Links: Introduction, Atmospheric absorption, Cloud attenuation, Tropospheric Scintillations, Ionospheric Scintillations, Rain attenuation, Rain and Ice crystal Depolarization, Propagation impairment countermeasures.

TEXT BOOKS:

1. Satellite Communications - Timothy Pratt, Charles Bostian and Jeremy Allnutt, WSE, Wiley Publications, 2nd Edition, 2003.
2. Satellite Communications Engineering – L.Pritchard, Robert A Nelson and Henri G.Suyderhoud, 2nd Edition, Pearson Publications

REFERENCE BOOKS:

1. Satellite Communications: Design Principles - M. Richharia, BS Publications, 2nd Edition.
2. Fundamentals of Satellite Communications - K. N. Raja Rao, PHI, 2004
3. Satellite Communication - D.C Agarwal, Khanna Publications, 5th Ed.
4. Satellite Communications - Dennis Roddy, McGraw Hill, 4th Edition, 2009.
5. Satellite Communications - Robert M Gagliardi,, DTS Publishers Ltd.
6. Communication Systems - Simon Haykin, 4th Edition, John Wiley & Sons

FOUNDATIONS OF ATMOSPHERIC SCIENCE & SPACE TECHNOLOGY

Course Code :15 EC 5118 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:
Structure of atmosphere – Atmospheric composition, vertical thermal structure, environmental lapse rate; standard atmosphere; hydrostatic equation; Geopotential.
Thermodynamics - Thermodynamics of dry air and moist air: Equation of state for water vapour; Moisture variables, vertical stability of the atmosphere: Dry and moist adiabatic lapse rates; stability of layers.
Radiation - Solar and terrestrial Radiation: Characteristics, absorption and transmission of radiation through the atmosphere; Radiative cooling or heating of the atmosphere; Mean heat balance of the earth - atmosphere system; Atmospheric greenhouse effect.
Climate: Weather and climate concepts; World climate system: climate of the hemispheres. Global distribution of radaition, temperature, pressure, winds, precipitation; Atmospheric circulation patterns during winter and summer seasons. Jet streams. Monsoons – Asia, Australia, E. Africa and North America. Koppen and Thornthwaite climate classifications.
Electrodyanamics and radio wave propagation- Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Ground wave propagation, terrain and earth curvature effects. Tropospheric propagation; fading, diffraction and scattering; Ionospheric Propagation-refractive index, critical frequencies.
Remote Sensing: Electromagnetic (EM) energy and radiation; electromagnetic spectrum, wavelength; absorption, reflection and scattering of radiation in atmosphere, albedo, laws of radiation; active and passive remote sensing, radiation terminology; interaction between EM radiation and matter in the optical/ thermal and microwave region; spectral signatures; Spectral, spatial, temporal and radiometric resolutions. Kepler’s laws of universal planetary motion, Geostationary, Sun-synchronous and special purpose orbits; visible, IR and microwave imagery, vertical sounding; Limb sounding.
Signal processing - DT Sequences and DT Systems - Analysis of LTI Systems, *Z- Transforms* and its applications; DFT and FFT Design and Realization of Digital IIR and FIR Filters:
Communications - Analog communication systems: amplitude and angle modulation and demodulation systems, Noise performance in communication systems.

TEXT BOOKS:

1. Compendium of Meteorology (WMO Pub.) - Physical Meteorology, 1973, Vol.1, No.2
2. General Climatology: by howard Critchfield. 2nd ed. Prentice-Hall, 1966
3. Fundamentals of Remote Sensing – George Joseph
4. John G Proakis, Dimtris G Manolakis, Digital Signal Processing: Principles, Algonithms and Applications, Pearson Education.
5. R. Collin, Antennas and Radio wave Propagation, McGraw Hill, 1985. ISBN 0070118086.
6. Advanced Electronic Communications Systems, by Wayne Tomasi, 6 Edition Pearson Education.

REFERENCE BOOKS:

1. Meteorology Today - C. Donald Ahrens, Brooks Cole Pub., 2004.
2. Dynamical and Physical Meteorology - G.J.Haltiner and F.L.Martin
3. Physical Meteorology - H.G.Houghton.

4. World Climatic Systems - by John G. Lockwood, Hodder Arnold, 1985.

GLOBAL NAVIGATION SATELLITE SYSTEM

Course Code :15 EC 5119 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

GNSS fundamentals: Trilateration, Hyperbolic navigation, Transit, GNSS principle of operation, Architecture, Operating frequencies, orbits, Keplerian elements.

GPS Signals: GPS and UTC Time, Signal structure, C/A and P-code, ECEF and ECI coordinate systems and WGS 84 datum, Important components of receiver and specifications.

GPS error Models: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Antenna phase center variation, multipath, estimation of Total Electron Content (TEC) using Dual Frequency measurement, Various DOP's, UERE.

GPS data processing and position fixing: RINEX navigation and observation formats, Code and Carrier phase observables, Linear combinations and derived observables, Ambiguity resolutions, Cycle slips, Position estimation.

Other satellite Navigation Systems: Galileo, GLONASS, IRNSS, Space, control and ground segments and Signal characteristics.

TEXT BOOKS:

1. Global Navigation Satellite Systems – G. S. Rao, McGraw-Hill publications, New Delhi, 2010.
2. GPS Theory and Practice - B.Hofmann Wollenhof, H.Lichtenegger, and J.Collins, Springer Wien, New York, 2000.

REFERENCE BOOKS:

1. Introduction to GPS - Ahmed El -Rabbany, Artech House, Boston, 2002.
2. Global Positioning System Signals, Measurements, and Performance - Pratap Misra and Per Enge, Ganga-Jamuna Press, Massachusetts, 2001.

PHYSICS AND DYNAMICS OF LOWER ATMOSPHERE

Course Code :15 EC 5120 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

Atmospheric Stability - Conditional, latent and potential instability, Stability of layers, Cloud formation, Precipitation mechanisms; Bergeron and Fendeisen process; Collision and coalescence processes.

Atmospheric motion - Inertial and Non-inertial frames- Fundamental Forces-Pressure Gradient forces, Gravitational force. Frictional force. Apparent forces - Centrifugal Force, Coriolis force. Equations of motion. Hydrostatic approximation. Balanced motion: Geostrophic Wind, Gradient Wind, Thermal wind.

Continuity equation – Horizantal divergence, Vertical motion; Circulation and Vorticity. Land and Sea breeze. Vorticity equation, barotropy and baroclinicity.

Atmospheric boundary layer (ABL) - Reynolds stresses, Laminar and Turbulent flow; Vertical subdivisions of ABL and their characteristics; Drag coefficient. Bulk aerodynamic formulae. Vertical profile of wind speed; Richardson's Number and Monin-Obukhov length.

Atmospheric Modelling - Dynamical equations for weather prediction; *Numerical methods:* Finite difference methods- forward, centered and Implicit schemes; CFL Criterion. *Numerical Models*: Quasi-Geostrophic Models: Linear and Non-linear Balance Models, Primitive Equation (PE) Models, Problem of initialization for PE models. Two Level PE Model in Momentum form; Staggered Grid Systems- Arakawa C grid, 3D General circulation models.

TEXT BOOKS:

1. Dynamical and Physical Meteorology - G.J.Haltiner and F.L.Martin
2. Compendium of Meteorology (WMO Pub.) - Physical Meteorology, 1973, Vol.1, No.2
3. Numerical Prediction and Dynamic Meteorology, G.J.Haltiner and R.T.Williams.
4. An Introduction to Dynamic Meteorology - J.R.Holton

REFERENCE BOOKS:

1. Physical Meteorology - H.G.Houghton
2. Atmospheric Thermodynamics - J.V.Iribarne and W.L.Godson
3. A first course in atmospheric radiation - G.W. Petty, Sundog Publishing
4. Meteorology Today - C. Donald Ahrens, Brooks Cole Pub., 2004.

ATMOSPHERIC AND WEATHER RADARS

Course Code :15 EC 51I1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Principles of Radar: Doppler radar (Transmitting and receiving aspects) scattering cross section radar equation, Doppler Shift attenuation Practical considerations. Basic system antenna arrays, TR Duplexer and transmitting systems, receiving systems coding and decoding coherent integration.

Radar signal processing: Spectral analysis of Radar signals discrete Fourier transform, power spectrum of random sequences spectral moment's extraction of structure constant velocity fields and turbulence parameters. Range ambiguities velocity ambiguities echo coherency direction of weakly scattering weather targets

Wind profilers and MST Radars: studies on clear Air turbulence (CAT) using ST / MST radar Systems Observations of structure (Cn2 and Stratified Layers) winds, waves and Turbulence parameters

TEXT BOOKS:

1. Doppler Radar & Weather Observations, R. J. Doviak, D. S. Zrnic, 2nd Edition, Dover Publications.
2. Electromagnetic waves & Radiation Systems – Edward C Jordan and Keith G.Balmain,PHI,Second Edition,India

REFERENCE BOOKS:

1. Elements of Electromagnetics - Matthew N. O. Sadiku, Oxford University Press.

ATMOSPHERIC AND WEATHER RADARS

Course Code :15 EC 51I2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Modern Digital Modulation Techniques: Introduction, Information Capacity, Bits, Bit Rate, Baud rate & M-ary Encoding, ASK, FSK, PSK, QAM, Bandwidth Efficiency, Carrier Recovery, Clock Recovery, DPSK, Trellis Code Modulation, Probability of Error & Bit Error Rate, Error Performance.

Spread Spectrum Signals for Digital Communication: Model of Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum Signals, Error Rate Performance of the Decoder, Applications of DS Spread Spectrum Signals.

Frequency Hopped Spread Spectrum signals: Generation of PN Sequences, Frequency Hopped Spread Spectrum Signals, Performance of FH Spread Spectrum Signals in an AWGN Channel, CDMA System Based on FH Spread Spectrum Signals.

TEXT BOOKS:

1. Principles of communication systems-Herbert Taub, Donald L. Schilling, McGraw-Hill, 1986
2. Advanced Electronic Communications Systems - Wayne Tomasi, 6 Edition Pearson Education.
3. Digital and Analog Communication Systems - K Sam Shanmugam, John Wiley and sons (Asia) Pvt Ltd.

REFERENCE BOOKS:

1. Digital communications - Simon Haykin, John Wiley and sons, 1998
2. Advanced electronic communication systems - Wayne Tomasi, 4th Edition Pearson Education Asia, 1998
3. Modern digital and analog communication systems - B.P.Lathi, 3rd Edition, Oxford

University press.
4. Digital Communications: Microwave Applications-Kamilo Feher, SciTech Publishing,1997

ATMOSPHERIC AND WEATHER RADARS

Course Code :15 EC 51J1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Fundamentals of GIS: Map – scale, projection and symbolism. GIS - Introduction, definition and terminology, categories, components, fundamental operations, functional elements. Data structures, data models, GIS data acquisition, input, storage, output generation. Data preprocessing, database management, integrated analysis of spatial and attribute data.
GIS Spatial Analysis: Introduction, Defining spatial objects - point, line and area objects based on their attributes, higher level point, line and area objects.
Measurement: Measuring length of linear objects, measuring polygons, measuring shape, measuring distance. Classification – Principles, Neighborhood functions, Polygonal neighborhoods, Buffers.
Statistical Surfaces: Surface mapping, sampling the statistical surface, Digital Elevation Model (DEM). Interpolation - linear and non-linear, uses and problems. Terrain reclassification – steepness of slope, aspect, shape or form. Discrete surfaces - dot distribution maps, choropleth maps.
Spatial Arrangement: Spatial Arrangement - Point patterns, Theissen Polygons, Area patterns, Linear patterns, Directionality of Linear and Areal objects, Connectivity of Linear objects, Routing and allocation.
Overlay Analysis: Cartographic overlay, point-in-polygon and line-in-polygon operations, Polygon overlay, Automating point-in-polygon and line-in-polygon procedures in Raster, Automating Polygon overlay in Raster, Automating vector overlay, types of overlay.
Data Modelling: The state of GIS for Environmental Problem Solving, A Perspective on the State of Environmental Simulation Modeling, GIS and Environmental Modeling, The Role of Software Venders in Integrating GIS and Environmental Modeling, Cartographic Modeling, Scope of GIS and relationship to environmental modeling, data models and data quality.

TEXT BOOKS:

1. Fundamentals of GIS by MICHAEL N DEMERS. Published By john Wiley & Sons Inc.
2. Environmental Modelling with GIS, Michael F. Goodchild, Bradley O. Parks, Louis T. Steyaert.

ATMOSPHERIC AND WEATHER RADARS

Course Code :15 EC 51J2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Global atmospheric circulation - Atmospheric circulation patterns. Zonally averaged meridional and zonal circulations, zonally asymmetric components of the general circulation - standing eddies and Walker circulations.

Monsoon systems - Land and sea breezes, Asian monsoons –onset, withdrawal, active and break monsoon situations. Monsoon rainfall distribution; monsoon rain bearing systems - monsoon depressions, Mid-tropospheric cyclones and Offshore vortices.

Mesoscale weather systems - CAPE and CINE, Thunderstorm, Dust storm, Hail storm, mesoscale convective system, fog, tropical cyclones, extra-tropical frontal systems.

Global and regional Circulation systems: Jet streams- Tropical Easterly jet, Subtropical Westerly jet, Somali jet over India. Easterly waves, Rossby waves and Kelvin waves.

Atmospheric –Ocean phenomena: North Atlantic Oscillation, North Pacific Oscillation, El-Nino, La Nina, Southern Oscillation, Walker circulation, Hadley circulation, Tropical Biennial Oscillation, Indian Ocean Dipole.

TEXT BOOKS:

1. Physical climatology - William D. Sellers.
2. Essentials of Meteorology – C. Donald Ahrens
3. Global Physical Climatology - Dennis L. Hartmann

REFERENCE BOOKS:

1. Dynamical and physical Meteorology - George J.Haltiner and Frank L. Martin.
2. Monsoons - P.K.Das
3. Tropical Meteorology - G.C.Asnani
4. World Climate Systems, J.G.Lockwood

SATELLITE METEOROLOGY

Course Code :15 EC 5221 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

Remote sensing for meteorology - Overview of remote sensing systems for meteorology; earth stations for remote sensing and meteorological satellites; space based measurement systems for meteorology; Active and passive remote sensing; imagery and sounding.
Radiation measurements and estimation– Mean Global Energy Balance; The First Satellite Experiment to Measure the Net Radiation; The Radiation Budget.
Radiative Transfer Equation (RTE) - Derivation of RTE; Temperature Profile Inversion; RTE in Cloudy Conditions;
Meteorological satellite systems – Series of Indian Remote Sensing Satellite, INSAT, Meteosat, NOAA, TRMM and SSMI; QuikSCAT, Oceansat2, Terra, Aqua, Megha-Tropiques satellite products.
Satellite meteorological data and products - Satellite image interpretation and enhancement techniques, cloud type identification.
Land surface temperatures from satellites; Infrared and microwave observations of sea surface temperatures (SST); Global SST retrieval algorithms from NOAA-AVHRR data.
Vegetation spectral response and vegetation indices; Normalized Difference Vegetation Index; Normalized Difference Water Index; Normalized Difference Snow Index; Normalized Difference moisture Index.
Satellite based ocean and atmospheric parameters - Satellite based rainfall estimations; cloud motion vectors; outgoing longwave radiation (OLR) and cloud top.
Active and passive sensors for ocean surface winds; soil moisture using microwave radiometer; atmospheric temperature profile retrieval; limb sounding retrieval of trace gases; GPS-RO (Global Positioning System- radio Occultation) techniques to retrieve temperature and humidity profiles.
Total Water Vapour Estimation. Determination of total Ozone and Geopotential Height. Microwave Estimation of Tropical Cyclone Intensity. Satellite measurement of Atmospheric Stability. Detection of forest fire and area estimation; Aerosol optical thickness; ISCCP; CLAVR; CO2 slicing.

TEXT BOOKS:

1. Fundamentals of Remote Sensing – George Joseph
2. Satellite Meteorology: An introduction - S.Q. Kidder and T.H. Vonder Haar
3. Lecture Notes for Post Graduate Course on Satellite Meteorology and Global Climate, Vols.1, 2 and 3. ISRO Publications.
4. Applications with Meteorological Satellites - W. Paul Menzel, Technical document, WMO/TD No. 1078.

REFERENCE BOOKS:

1. The use of satellite data in rainfall monitoring- E.C. Barrett and W. N. Martin
2. Remote sensing of atmosphere - J.T. Houghton, F.W. Taylor and C.D. Rodgers.
3. Satellite Meteorology - R.R. Kelkar, B.S.Publications.

ATMOSPHERIC & SPACE INSTRUMENTATION

Course Code :15 EC 5222 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Observational Techniques of atmospheric parameters – Measurement of temperature:

Electrical Resistance thermometers, Semiconductor thermometers, Bimetallic thermometers, Thermocouples.

Measurement of Atmospheric Pressure – Mercury, Aneroid & Piezo – resistive barometers.
Measurement of Humidity- Psychrometer, Hygrometer
Measurement of Surface wind - Wind vane, Cup anemometer, Hotwire Anemometer, Sonic Anemometer.

Radiosonde & Rawin measurement sensors
Measurement of Precipitation – Recording & Non-recording precipitation gauges.
Measurement of Radiation - Pyrheliometer, Pyranometer, Net Radiometer, Pyrgeometer
Radar principles and technology - propagation, scattering and attenuation of microwaves in the lower atmosphere, weather radar signal processing and display, Weather Radar: Signal Processing and display, Phenomena observed, operational weather Radar.

Radar Measurements -,Observation and estimation of precipitating systems, radar equation for precipitation targets. Doppler radar – Velocity measurements, Radar wind profiler – MST Radar, Lidar & Sodar, Observation of Tropical Cyclones, use of weather Radar in Aviation, observation of clear air turbulence.

Satellite Sensors - Advance very high resolution radiometer, very high resolution radiometer, visible and infrared spin scan Radiometer, Atmospheric sounder – VAS, special sensor microwave imager – SSM/I, High resolution infrared Radiation sounder – HIRS, microwave sounding unit-MSU, Scatterometer, Synthetic Aperture Radar, Altimeter, Ocean Colour Monitor-OCM.

TEXT BOOKS:

1. Radar Meteorology - Henry Sauvageot, Artech House, 1992.
2. Satellite Meteorology – An Introduction, Stanely Q Kidder, Thomas H VanderHaus, Academic Press Inc.
3. Guide to Meteorological Instruments and Methods of Observation. WMO-No. 8, World Meteorological Organization, 2008.

REFERENCE BOOKS:

1. Radar Meteorology – S. Raghavan, Kluwer Academic Publishers, 2003
2. Weather Radar: Principles and Advanced Applications - Peter Meischner, Springer - Verlag, 2004

ADVANCED SATELLITE NAVIGATION SYSTEMS

Course Code :15 EC 5223 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Differential GPS systems: Introduction to Differential GPS systems, LADGPS, WADGPS, Relative advantages of SBAS and GBAS, Wide area augmentation system (WAAS) architecture, GAGAN, EGNOS and MSAS, Local Area Augmentation system (LAAS).
Inertial Navigation Systems: Introduction to Inertial Navigation, Inertial sensors, Navigation Co ordinates, System implementations, System-level error Models.
GPS/INS Integration: GPS receiver performance issues, inertial sensor performance issues, Kalman filter, GPS-INS integration methods.
GPS receivers: Signal Conditioning, Signal acquisition and carrier and code tracking.

TEXT BOOKS:

1. Understanding GPS Principles and Applications - E.Kaplan Artech House, 1996, ISBN 0890067937.
2. Global Positioning Systems, Inertial Navigation, and Integration - Mohinder S. Grewal, California State University at Fullerton, A John Wiley & Sons, Inc. Publication.

REFERENCE BOOKS:

1. Introduction to GPS - Ahmed El -Rabbany, Artech House, Boston, 2002.
2. Global Navigation Satellite Systems – G. S. Rao, McGraw-Hill publications, New Delhi, 2010.
3. GPS Theory and Practice - B.Hofmann Wollenhof, H.Lichtenegger, and J .Collins, Springer Wien, New York, 2000.

WEATHER AND CLIMATE APPLICATIONS

Course Code :15 EC 5224 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:
Weather and climate data - Sources for local, regional and global meteorological data; data from national and international sources; spatial and temporal resolution of data; Observational and model generated data.
Applications to hydrology – Rainfall: interception and infiltration, surface runoff and sub-surface run-flow. Rainfall-Runoff models, Flood forecasting. Drought categories and assessment techniques. Effects of urbanization on climate and stream flow. Urban hydrology modeling and risk assessment.
Applications to air quality - Sources and classification of atmospheric pollutants, Factors affecting atmospheric pollution. Atmospheric pollution at local, urban, regional, continental and global scales. Air quality standards and legislation.

Transport and dispersion of atmospheric pollutants: estimation of pollutants. Application of weather data for air quality assessment using models. Effects of atmospheric pollution on human health, animals, vegetation, materials and property. Air quality risk assessment.

Applications to agriculture - Relationship between weather and agriculture; climatic requirements of common agricultural crops, Plant phenology; effect of weather factors on the growth and development of plants; Weather factors conducive to infection; crop protection from adverse meteorological phenomena-droughts, heavy rains, storms, cold waves and frost, heat waves, strong winds.

Crop-weather calendars; statistical analysis of crop and weather data; Agro-meteorological forecasting: basic principles, phenological forecasting, crop-yield forecasting, weather forecast and warning for agriculture. Principles of weather prediction for crops with special reference to India.

TEXT BOOKS:

1. Hydrometeorology - C.J.Wiesner
2. Guide to Agricultural Meteorological Practices: WMO No.134, 1981.
3. Agroclimatic/Agrometeorological Techniques, S.Jeevananda Reddy, Jeevan Charitable Trust, ICRISAT Colony, Secunderabad, 1993

REFERENCE BOOKS:

1. Physico, Chemical aspects of Air pollution - Henry.C Perkins.
2. Hand book of Applied meteorology – David D. Houghton (John Wiley & Sons, 1985)
3. Atmosphere, Weather and Climate - Barry and Chorley (Routledge Publ., 2009)

AERONOMY

Course Code :15 EC 52K1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Neutral Atmosphere: Structures and Composition: Nomenclature- Thermal structure of the atmosphere. Hydrostatic equation of the atmosphere structure. Scale height and geopotential height and geopotential height. Exosphere.

Chemical concepts in Atmosphere: Thermodynamic considerations- Enthalpy. Elements chemical kinetics- Reaction rate constants and chemical life time of spieces. Unimolecular, biomolecular and termoecular reactions. Effect of dynamics on chemical species.

Ionoized atmosphere: Photochemical processes in the ionosphere? Introduction to ionosphere- discovery. Continuity equation and photochemical equilibrium. Theory of photo-ionization and Chapman production function. Chemical recombination and electron density. Solar radiation and production of ionospheric layers.

Loss process in D, E and F regions: different types of recombination processes. Chemistry of D,E and F regions. D region balance equations. D region chemistry –formation of water cluster ions. Electron attachment and negative ions, Linear and square law loss formulae and splitting of F layer. Vertical transport, ambipolar diffusion.

Morphology: Spatial and temporal structure of the ionosphere- Diurnal, seasonal and solar cycle variations of D, E and F regions and F region anomalies. Space weather disturbances, Sudden Ionospheric Disturbances (SIDs), magnetic storm effects.

TEXT BOOKS:

1. Introduction to Ionospheric Physics - H. Rishbeth and O.K Garriott
2. Upper Atmosphere and Solar Terrestrial Relations - J.K. Hargreaves

REFERENCE BOOKS:

1. An Introduction to the Ionosphere and Magnetosphere. John Ashworth Ratcliffe,1972.

DETECTION AND ESTIMATION THEORY

Course Code :15 EC 52K2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Random - Discrete-time signals: Review of probability, Random data, Generation of Pseudo-random noise, Filtered signals, Autocorrelation and power spectral density, Sampling band- Limited random.

Detection of signals in noise:- Minimum probability of Error Criterion, Neyman-Person criterion for Radar detection of constant and variable amplitude signals, Matched filters, Optimum formulation, Detection of Random signals.

Estimation of signals in noise: Linear mean squared estimation, Non linear estimates, MAP and ML estimates, Maximum likelihood estimate of parameters of linear system, Simple problems thereon.

Recursive linear mean squared Estimation: Estimation of a signal parameter, Estimation of time-varying signals, Kalman filtering, Filtering signals in noise,

Case studies related to estimation and detection processes.

TEXT BOOKS:

1. Signal processing: Discrete Spectral analysis, Detection and Estimation - Mischa Schwartz and Leonard Shaw, Mc-Graw Hill Book Company, 1975.
2. Signal Detection and Estimation - Mourad Barkat, Artech House Inc, , 2nd edition, Norwood, MA 02062, 2005,
3. Fundamentals of Statistical Signal Processing: Estimation Theory - Steven M. Kay, Prentice Hall New Jersey, 1993

REFERENCE BOOKS:

1. Probability, Random Variables and Random Signal Principles - Peyton Z.Peebles Jr, 4th Edition, Tata Mc Graw Hill.
2. Lessons in Estimation Theory for Signal Processing, Communication and Control - Jerry M. Mendel, Prentice Hall Inc., 1995.
3. Detection of signals in Noise and Estimation - Shanmugam and Breipohl, John Wiley & Sons, New York, 1985.
4. Intuitive Probability and Random Processes using Matlab - Steven M. Kay, Springer, 2006.

SIMULATION TEXT BOOKS**:**

1. Statistical Digital Signal Processing and Modeling - Monson Hayes, John Wiley & Sons.
2. Statistical Signal Processing Modell

WEATHER HAZARDS & RISK ASSESSMENT

Course Code :15 EC 52L1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Weather hazards: Types of weather hazards, vulnerability to weather elements, tropical cyclones, severe local storms, heavy precipitation, flash floods, fog, heat and cold waves, tornadoes.

GIS based Modelling -Hydrological Modeling - water quality modeling, watershed management and modeling, saltwater intrusion models. Land-surface-subsurface Process Modeling - pipeline alignment studies, solid and hazardous waste disposal site selection, zoning atlas for industrial silting, environmental information system development. Ecosystem modeling, risk and hazard modelling.

Disaster Impact and Damage Analysis: The use of satellite imagery for disaster relief and recovery; Impact analysis and preliminary damage assessment.

Pre-Disaster Risk Assessment: Hazard Assessment; Elements at risk and vulnerability assessment; Types and methods of risk assessment, risk evaluation, cost-benefit analysis.

Risk Information for Risk Reduction Planning: Risk evaluation, Visualization of risk information; Risk information and spatial planning.

TEXT BOOKS:

1. Weather Risk Management: A guide for Corporations, Hedge Funds and Investors - Tang, K., Ed., Risk Books, 2010.
2. The transfer of weather risk faced with the challenges of the future - Finas, B., SCOR, 2012.
3. Climate Risk and the Weather Market: Financial Risk Management with Weather - Hedges, Robert S. Dischel Ed., Risk Books, 2002.
4. Weather Derivatives: Modeling and Pricing Weather-Related Risk - Antonis Alexandridis K. and Achilleas D. Zapranis , Springer, 2012.

REFERENCE BOOKS:

1. Climate risk assessment and management in agriculture - Ramasamy Selvaraju; http://www.fao.org/docrep/017/i3084e/i3084e06.pdf
2. Severe and hazardous weather: An introduction to high impact meteorology - Rauber Robert M, Walsh John E, Charlevoix Donna J, Kendall Hunt Publishing, 2013.
3. Meteorology Today - C. Donald Ahrens, Brooks Cole Pub., 2004.

CLIMATE CHANGE

Course Code :15 EC 52L2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

The Climate system – energy balance of the earth-atmosphere. History of climate change – glacial cycle, inter-glacial and insterstadial events, year to decadal variations, natural variability.

Global warming – Anthropogenic climate change. Greenhouse gases (GHG) and global warming – GHGs trend, global temperature trend, global distribution of emissions, Sources of CO_2 in the Land, Ocean and atmosphere.

Future Emissions and Energy Resources, Current and Future sources of Methane, Biological sources of Nitrous oxide, societal resilience. Mitigation strategies: Reducing Carbon Emissions, Energy use and Emission trading,

Climate trends: Teleconnections of the world climate system, consequences of global warming; Ozone hole; Volcanic eruptions and aerosols, Nuclear winter; Climate in relation to sunspot and cosmic activity.

IPCC Assessment of climate change: Detection and Attribution of Climate Change: from Global to Regional scales. Short term climate change: Projections and Predictability. Long-term climate change: Projections, commitments and irreversibility. Climate phenomena and their relevance for future regional climate change.

The measurement of climate change. Climate change and extreme weather events. Climate change impacts on ecosystems, agriculture.

TEXT BOOKS:

1. Earth's Climate: Past and Future - Ruddiman, William F.2001.
2. Climate Change 2001 - Houghton, J.T., 2001, (ed). The Scientific Basis. 881pp.
3. Climate Change: A Multidisciplinary Approach - William James Burroughs
4. Current trends in Global Environment - A.L. Bhatia (2005).

REFERENCE BOOKS:

1. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC 2013 report. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
2. Causes of Climate - J.G.Lockwood

M.TECH - RF AND MICROWAVE ENGINEERING

First Year (First Semester):

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 EC 5125	Advanced Electromagnetic Engineering	3	1	2	5
2	15 EC 5102	Microwave Antennas	3	1	2	5
3	15 EC 5103	EMI / EMC Techniques	**3**	**1**	**0**	4
4	15 EC 5104	Microwave Semiconductor Devices and Applications	3	1	0	4
5		Elective – 1	3	0	0	3
6		Elective - 2	3	0	0	3
7	15 IE 5149	Seminar	0	0	4	2
		Total	**18**	**4**	**8**	**26**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 EC 5206	Antenna Measurements	**3**	**1**	**2**	5
2	15 EC 5226	RFIC and MMIC	3	1	0	4
3	15 EC 5205	Microwave and Millimetric Wave Circuits	3	1	2	5
4	15 EC 5227	RF MEMS	**3**	**1**	**0**	4
5		Elective – 3	3	0	0	3
6		Elective - 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total	**18**	**4**	**8**	**26**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 EC 51A3	Smart Antennas	3	0	0	3
2	15 EC 51M1	Software Defined Radio	3	0	0	3
3	15 EC 51F3	Biomedical Signal Processing	3	0	0	3
Elective-2						
1	15 EC 51B1	Phased Array Systems	3	0	0	3
2	15 EC 51B2	GPS & Global Navigation Satellite System	3	0	0	3
3	15 EC 51B3	Optical Communications	3	0	0	3
Elective-3						
1	15 EC 52O1	CMOS RF Circuit Design	3	0	0	3
2	15 EC 52C2	Radar Signal Processing	3	0	0	3
3	15 EC 52O2	Computational Techniques in Electromagnetics	3	0	0	3
Elective-4						
1	15 EC 52D1	RF and Microwave System Design	3	0	0	3
2	15 EC 52D2	VLSI System Design	3	0	0	3
3	15 EC 52P1	Advanced Digital Signal Processing	3	0	0	3

ADVANCED ELECTROMAGNETIC ENGINEERING

Course Code :15 EC 5125 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

Review of Vector Analysis, Coordinate Systems.
Wave equations, propagation and properties: Introduction, Time-varying electromagnetic fields, Time-harmonic electromagnetic fields, Solution to the wave equation, TEM modes, TEM in lossy media, Polarization, Normal incidence-lossless media, Oblique incidence-lossless media, Lossy media, Reflection and transmission of multiple interfaces, Polarization characteristics on reflection.
Auxiliary vector potentials, electromagnetic theorems and principles: Introduction, Vector potentials A and F, Construction of solutions, Solution of inhomogeneous vector potential wave equation, Far-field radiation, Radiation and scattering equations, Duality theorem, Uniqueness theorem, Image theory, Reciprocity theorem, Reaction theorem, Volume equivalence theorem, Huygen's principle, Induction theorem.
Rectangular cross-section waveguides and cavities: Introduction, Rectangular waveguide, Rectangular resonant cavities, Hybrid modes, Partially filled waveguide, Transverse resonance method, Dielectric waveguide, Stripline and microstrip lines, Ridged waveguide.
Circular cross-section waveguides and cavities: Introduction, Circular waveguides, Circular cavity, Radial waveguides, Dielectric waveguides and resonators.
Spherical transmission lines and cavities: Introduction, Construction of solutions, Bi-conical transmission line, Spherical cavity.

Text Books:

1. Balanis, C.A., "Advanced Engineering Electromagnetics", John Wiley & sons, 1989.
2. Kraus, J.D. and Fleisch, D.A., "Electromagnetics with Applications", McGraw-Hill, 1999.

Reference Books:

1. Jordan, E.C. and Balmain, K.G., "Electromagnetic Waves and Radiating Systems", 2nd Ed., Prentice-Hall of India, 1993.
2. R. F. Harrington, "Time Harmonic Electromagnetic Fields", Wiley Interscience, IEEE Press, 2001.
3. R. E. Collin, "Field Theory of Guided Waves", 2nd Ed, Wiley Interscience, IEEE Press, 1991.

MICROWAVE ANTENNAS

Course Code :15 EC 5102 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

Introduction to Antenna Theory: Antenna Radiation concept, Types of Antennas, Antenna parameters, Friis Transmission equation.
Aperture Antenna: Introduction, Pyramidal Horns- Design Procedure, Conical and Corrugated Horns, Aperture Corrugated Horns, Reflected Antennas- Parameters, Analysis of front-fed parabolic reflector, Feed methods and feed types, Cassegrain Reflector Horns.
Microstrip Radiators: Introduction, Rectangular Microstrip Antenna analysis and Design, Circular Microstrip Antenna Analysis and Design.
Pencil-Beam and Fanned-Beam Antennas: Pencil-beam Requirements and Techniques, Geometrical Parameters, The Surface-current and Aperture-field distributions, The Radiation Field of the Reflector, The Antenna Gain, Primary Pattern Designs for maximizing gain, Impedance Characteristics, The Vertex-plate matching Technique, Rotation of Polarization Technique, Structural Design Problems. Simple Fanned-Beam Antennas: Applications of Fanned Beams and methods of Production, Symmetrically Cut Paraboloids, Feed Offset and Contour Cutting of Reflectors, The Parabolic Cylinder and Line Source, Parallel-plate Systems, Pillbox Design Problems.
Shaped-Beam Antennas:
Shaped-beam Applications and Requirements, Effect of a Directional Target Response Survey of Beam-shaping Techniques, Design of Extended Feeds, Cylindrical Reflector Antennas, Reflector Design on the Basis of Ray Theory, Radiation Pattern Analysis, Double Curvature Reflector Antennas, Variable Beam Shape.

Text Books:

1. Constantine A. Balanis – “Antenna Theory-Analysis and Design”, 3rd Edition, John Wiley, 2005.
2. Samuel Silver, “Microwave Antenna - Theory and design”, IEE Press, 1984.

Reference Books:

1. Ramesh Garg, Prakash Bhatia, “Microstrip Antenna Design - Hand Book” Architect House Inc. 2001.
2. Bahl IJ, and Bhartia N, “Microstrip Antennas”, Artech House, 1982.
3. James.J R. Hall, P S. Wood.C., “Micro strip Antenna-Theory and Design”, PeterPeregrinu,1981.

EMI / EMC TECHNIQUES

Course Code :15 EC 5103 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction, Natural and Nuclear sources of EMI / EMC: Electromagnetic environment, History, Concepts, Practical experiences and concerns, frequency spectrum conservations. An overview of EMI / EMC, Natural and Nuclear sources of EMI.
EMI from apparatus, circuits and open area test sites: Electromagnetic emissions, noise from relays and switches, non-linearities in circuits, passive inter-modulation, cross talk in transmission lines, transients in power supply lines, electromagnetic interference (EMI). Open area test sites and measurements.
Radiated and conducted interference measurements and ESD: Anechoic chamber, TEM cell, GH TEM Cell, characterization of conduction currents / voltages, conducted EM noise on power lines, conducted EMI from equipment, Immunity to conducted EMI detectors and measurements. ESD, Electrical fast transients / bursts, electrical surges.
Grounding, shielding, bonding and EMI filters: Principles and types of grounding, shielding and bonding, characterization of filters, power lines filter design.
Cables, connectors, components and EMC standards: EMI suppression cables, EMC connectors, EMC gaskets, Isolation Transformers, optoisolators, National / International EMC standards.

Text Books:

1. Dr. V.P. Kodali, "Engineering Electromagnetic Compatibility", IEEE Publication, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.
2. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi, Modules1 – 9.

Reference Books :

1. C.R. Pal, "Introduction to Electromagnetic Compatibility", A John Wiley & Sons, Inc. Publication, 1992.
2. Terence Rybak, Mark Steffka, "Automotive Electromagnetic Compatibility (EMC)", Kluwer Academic Publisher, London.

MICROWAVE SEMICONDUCTOR DEVICES AND APPLICATIONS

Course Code :15 EC 5104 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: Transient and ac behavior of p-n junctions, effect of doping profile on the capacitance of p-n junctions, noise in p-n junctions, high-frequency equivalent circuit, varactor diode and its applications; Schottky effect, Schottky barrier diode and its applications; Heterojunctions.
Tunnel and Avalanche Transit Time diodes: Tunneling process in p-n junction and MIS tunnel diodes, V-I characteristics and device performance, backward diode. Impact ionization, IMPATT diode, small-signal analysis of IMPATT diodes.
Gunn diode: Two-valley model of compound semiconductors, vd-E characteristics, Gunn effect, modes of operation, small-signal analysis of Gunn diode, power frequency limit.
PIN Diodes: Construction and operation of microwave PIN diodes, equivalent circuit, PIN diode switches, limiters and modulators.
Microwave Transistor: High frequency limitations of BJT, microwave bipolar transistors, hetero-junction bipolar transistors; Operating characteristics of MISFETs and MESFETs, short-channel effects, high electron mobility transistor and its applications .

Text books:

1. Liao, S.Y., "Microwave Devices and Circuits", 4th Ed., Pearson Education 2002.
2. Rebeiz, M.G., "R.F. MEMS: Theory, Design and Technology", 2nd Ed.,Wiley-Interscience 2003.

Reference Books:

1. Sze, S.M., and Ng, K.K., "Physics of Semiconductor Devices", 3rd Ed.,Wiley-Interscience 2006.
2. Glover, I.A., Pennoek, S.R. and Shepherd P.R., "Microwave Devices, Circuits and Sub-Systems", 4th Ed., John Wiley & Sons 2005.
3. Golio, M., "RF and Microwave Semiconductor Devices Handbook", CRC Press 2002.

SMART ANTENNAS

Course Code :15 EC 51A3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:
Smart Antennas: Introduction, Need for Smart Antennas, Overview, Smart Antenna Configurations, Switched-Beam Antennas, Adaptive Antenna Approach, Space Division Multiple Access (SDMA), Architecture of a Smart Antenna System, Recei ver, Transmitter, Benefits and Drawbacks, Basic Principles, Mutual Coupling Effects.
DOA Estimation Fundamentals: Introduction, Array Response Vector, Received Signal Model, Subspace-Based Data Model, Signal Auto-covariance, Conventional DOA Estimation Methods, Conventional Beam forming Method, Capon's Minimum Variance Method, Subspace Approach to DOA Estimation, MUSIC Algorithm, ESPRIT Algorithm, Uniqueness of DOA Estimates .
Beam Forming Fundamentals: Classical Beam former, Statistically Optimum Beam forming Weight Vectors, Maximum SNR Beam former, Multiple Side-lobe Canceller and Maximum,

SINR Beam former, Minimum Mean Square Error (MMSE), Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV), Adaptive Algorithms for Beam forming

Integration and Simulation of Smart Antennas: Overview, Antenna Design, Mutual Coupling, Adaptive Signal Processing Algorithms, DOA, Adaptive Beam forming, Beam forming and Diversity Combining for Rayleigh-Fading, Channel, Trellis-Coded Modulation (TCM) for Adaptive Arrays, Smart Antenna Systems for Mobile Ad Hoc Networks (MANETs), Protocol, Simulations, Discussion.

Space–Time Processing: Introduction, Discrete Space–Time Channel and Signal Models, Space–Time Beam forming, Inter-symbol and Co-Channel Suppression, Space–Time Processing for DS-CDMA, Capacity and Data Rates in MIMO Systems, Discussion.

Text Books:

1. Constantine A. Balanis & Panayiotis I. Ioannides, "Introduction to Smart Antennas", Morgan & Claypool Publishers' series-2007
2. Joseph C. Liberti Jr., Theodore S Rappaport - "Smart Antennas for Wireless Communications IS-95 and Third Generation CDMA Applications", PTR – PH publishers, 1st Edition, 1989.

Reference Books:

1. T.S Rappaport - "Smart Antennas Adaptive Arrays Algorithms and Wireless Position Location", IEEE press 1998, PTR – PH publishers 1999.
2. Lal Chand Godara, "Smart Antennas", CRC Press, LLC-2004.

SOFTWARE DEFINED RADIO

Course Code :15 EC 51M1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: The Need for Software Radios, What is Software Radio, Characteristics and benefits of software radio- Design Principles of Software Radio, RF Implementation issues- The Purpose of RF Front – End, Dynamic Range- The Principal Challenge of Receiver Design – RF Receiver Front- End Topologies- Enhanced Flexibility of the RF Chain with Software Radios- Importance of the Components to Overall Performance- Transmitter Architectures and Their Issues- Noise and Distortion in the RF Chain, ADC and DAC Distortion.

Multi Rate Signal Processing: Introduction- Sample Rate Conversion Principles- Poly-phase Filters- Digital Filter Banks- Timing Recovery in Digital Receivers Using Multi-rate Digital Filters.

Digital Generation of Signals: Introduction- Comparison of Direct Digital Synthesis with Analog Signal Synthesis- Approaches to Direct Digital Synthesis- Analysis of Spurious Signals- Spurious Components due to Periodic jitter- Band Pass Signal Generation- Performance of Direct Digital Synthesis Systems- Hybrid DDS-PLL Systems- Applications of direct Digital Synthesis- Generation of Random Sequences- ROM Compression Techniques.

Analog to Digital and Digital to Analog Conversion: Parameters of ideal data converters- Parameters of Practical data converters- Analog to Digital and Digital to Analog Conversion- Techniques to improve data converter performance- Common ADC and DAC architectures.
Digital Hardware Choices: Introduction- Key Hardware Elements- DSP Processors- Field Programmable Gate Arrays- Trade-Offs in Using DSPs, FPGAs, and ASICs- Power Management Issues- Using a Combination of DSPs, FPGAs, and ASICs.
Case Studies in Software Radio Design: Introduction and Historical Perspective, SPEAK easy- JTRS, Wireless Information Transfer System, SDR-3000 Digital Transceiver Subsystem, Spectrum Ware, CHARIOT.

Text Books:

1. Jeffrey H. Reed, “Software Radio: A Modern Approach to Radio Engineering”, PEA Publication, 2002.
2. Walter Tuttle Bee, “Software Defined Radio: Enabling Technologies”, Wiley Publications, 2002.

Reference Books:

1. Paul Burns, “Software Defined Radio for 3G”, Artech House, 2002.
2. Markus Dillinger, Kambiz Madani, Nancy Alonistioti, “Software Defined Radio: Architectures”, Systems and Functions - 2003, Wiley.
3. Joseph Mitola, “Software Radio Architecture: Object Oriented Approaches to wireless System Enginering”, John Wiley & Sons, 2000.
4. B. Razavi, “R.F Microelectronics”, PHI, 1998.
5. S. K. Mithra, “DSP – A Computer Based Approach”, McGraw-Hill, 1998.

BIOMEDICAL SIGNAL PROCESSING

Course Code :15 EC 51F3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:
Introduction To Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG etc - Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio potentials - Review of linear systems - Fourier Transform and Time Frequency Analysis (Wavelet) of biomedical signals- Processing of Random & Stochastic signals – spectral estimation – Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments.
Concurrent, Coupled And Correlated Processes - illustration with case studies – Adaptive and optimal filtering - Modeling of Biomedical signals - Detection of biomedical signals in noise -removal of artifacts of one signal embedded in another -Maternal-Fetal ECG - Muscle-contraction interference. Event detection - case studies with ECG & EEG - Independent component Analysis - Cocktail party problem applied to EEG signals - Classification of biomedical signals.
Cardio Vascular Applications : Basic ECG - Electrical Activity of the heart- ECG data acquisition – ECG parameters & their estimation - Use of multiscale analysis for ECG parameters estimation - Noise & Artifacts- ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection - Arrhythmia analysis

Data Compression: Lossless & Lossy- Heart Rate Variability – Time Domain measures - Heart Rhythm representation - Spectral analysis of heart rate variability - interaction with other physiological signals.

Neurological Applications: The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models – Non linear modeling of EEG - artifacts in EEG & their characteristics and processing – Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis – correlation analysis of EEG channels - coherence analysis of EEG channels.

Text Books:

1. D.C.Reddy, "Biomedical Signal Processing: Principles and techniques", Tata McGraw Hill, New Delhi, 2005.
2. Willis J Tompkins , "Biomedical Signal Processing", ED, Prentice – Hall, 1993.

References Books:

1. R. Rangayan, "Biomedical Signal Analysis", Wiley 2002.
2. Bruce, "Biomedical Signal Processing & Signal Modeling," Wiley, 2001
3. Sörnmo, "Bioelectrical Signal Processing in Cardiac & Neurological Applications", Elsevier
4. Semmlow, "Bio-signal and Biomedical Image Processing", Marcel Dekker
5. Enderle, "Introduction to Biomedical Engineering," 2/e, Elsevier, 2005

GPS & GLOBAL NAVIGATION SATELLITE SYSTEM

Course Code :15 EC 51B1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

GNSS fundamentals: Trilateration, Hyperbolic navigation, Transit, GNSS principle of operation, Architecture, Operating frequencies, orbits, Keplerian elements.

GPS Signals: GPS and UTC Time, Signal structure, C/A and P-code, ECEF and ECI coordinate systems and WGS 84 datum, Important components of receiver and specifications.

GPS error Models: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Antenna phase center variation, multipath, estimation of Total Electron Content(TEC) using Dual Frequency measurement, Various DOP's, UERE.

GPS data processing and position fixing: RINEX navigation and observation formats, Code and Carrier phase observables, Linear combinations and derived observables, Ambiguity resolutions, Cycle slips, Position estimation.

Other satellite Navigation Systems: Galileo, GLONASS, IRNSS, Space, control and ground segments and Signal characteristics.

Text Books:

1. Global Navigation Satellite Systems – G. S. Rao, McGraw-Hill publications, New Delhi, 2010.

2. GPS Theory and Practice - B.Hofmann Wollenhof, H.Lichtenegger, and J.Collins, Springer Wien, New York, 2000.

Reference Books:

1. Introduction to GPS - Ahmed El -Rabbany, Artech House, Boston, 2002.
2. Global Positioning System Signals, Measurements, and Performance - Pratap Misra and Per Enge, Ganga-Jamuna Press, Massachusetts, 2001.

PHASED ARRAY SYSTEMS

Course Code :15 EC 51B2	**L-T-P : 3-0-0**
Pre-requisite: NIL	**Credits: 3**

Syllabus:

Conventional Scanning Techniques: Mechanical versus electronic scanning, Techniques of Electronic scanning, Frequency, Phase and time delay scanning principle, Hybrid scanning techniques.

Array Theory: Linear and Planner arrays, various grid configuration, Concept of cell and grid, Calculation of minimum number of elements, Radiation pattern, Grating lobe formation, Rectangular and triangular grid design of arrays.

Feed Networks for phased Arrays: Corporate Feed, Lens and Reflect feed Techniques, Optimum f/d ratio basic building block for corporate feed network, Series, Parallel feed networks, Comparison of various feeding techniques, Antenna Array Architecture, Brick/ Tile Type construction.

Frequency Scanned Array Design: Snake feed, Frequency-phase scanning, Phase scanning, Digital phase shifter PIN diode and Ferrite phase shifters for phased arrays, Beam pointing errors due to digitalization, Beam pointing accuracy.

Search Patterns: Calculation of search frame time, airborne phased array design, Electronic scanning radar parameter calculation, Application of phased arrays, Phased Array Radar Systems, Active Phased Array, TR/ATR Modules.

Text Books:

1. Olliner, A.A, and G.H. Knittel, “Phased Array Antennas”, Artech House, 1972.
2. Kahrilas. PJ, “Electronic Scanning Radar Systems Design Handbook”, Artech House, 1976.

Reference Books:

1. Skolnik. MI, “Radar Handbook”, Mcgraw Hillso, NY,McGrow Hills-2007.

2. Galati,G-(editor), “Advanced Radar Technique and Systems”, Peter Peregrims Ltd, London, 1993.

OPTICAL COMMUNICATIONS

Course Code :15 EC 51B3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:
Signal propagation in Optical Fibers: Geometrical Optics approach and Wave Theory approach, Loss and Bandwidth, Chromatic Dispersion, Non Linear effects- Stimulated Brillouin and Stimulated Raman Scattering, Propagation in a Non-Linear Medium, Self Phase Modulation and Cross Phase Modulation, Four Wave Mixing, Principle of Solitons.
Fiber Optic Components for Communication & Networking: Couplers, Isolators and Circulators, Multiplexers, Bragg Gratings, Fabry-Perot Filters, Mach Zender Interferometers, Arrayed Waveguide Grating, Tunable Filters, High Channel Count Multiplexer Architectures, Optical Amplifiers, Direct and External Modulation Transmitters, Pump Sources for Amplifiers, Optical Switches and Wavelength Converters.
Modulation and Demodulation: Signal formats for Modulation, Subcarrier Modulation and Multiplexing, Optical Modulations – Duobinary, Single Side Band and Multilevel Schemes, Ideal and Practical receivers for Demodulation, Bit Error Rates, Timing Recovery and Equalization, Reed-Solomon Codes for Error Detection and Correction.
Transmission System Engineering: System Model, Power Penalty in Transmitter and Receiver, Optical Amplifiers, Crosstalk and Reduction of Crosstalk, Cascaded Filters, Dispersion Limitations and Compensation Techniques.
Fiber Non-Linearities and System Design Considerations: Limitation in High Speed and WDM Systems due to Non-linearities in Fibers, Wavelength Stabilization against Temperature Variations, Overall System Design considerations – Fiber Dispersion, Modulation, Non-Linear Effects, Wavelengths, All Optical Networks.

Text Books:
1. Rajiv Ramaswami and Kumar N. Sivarajan, “Optical Networks: A Practical Perspective”, 2nd Ed., 2004, Elsevier Morgan Kaufmann Publishers, Elsevier.
2. Gerd Keiser, “Optical Fiber Communications”, 3rd Ed., 2000, McGraw Hill.

Reference Books:
1. John.M.Senior, “Optical Fiber Communications: Principles and Practice” 2nd Ed., PE, 2000.
2. Harold Kolimbris, “Fiber Optics Communication”, 2nd Ed., PEI, 2004.
3. Uyless Black, “Optical Networks: Third Generation Transport Systems”, 2nd Ed., PEI, 2009.
4. Govind Agarwal, “Optical Fiber Communications”, 2nd Ed., TMH, 2004.
5. S.C.Gupta, “Optical Fiber Communications and Its Applications”, PHI, 2004.

ANTENNA MEASUREMENTS

Course Code :15 EC 5206 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

Antenna Pattern Measurements: Basic Considerations, Pattern Formats, Fresnel Region Measurements, Modeling Techniques,**Antenna Range Design and Evaluation**: Introduction, Electromagnetic Design Consideration, Antenna Range Evaluation.

Antenna Testing: Introduction, Types of of Ranges: Elevated Ranges, Ground Ranges, Near Field Ranges, Radar Cross Section Ranges.

Far Field Range Design: Introduction, Designing the Range, Source Design, Receiving Site Design, Ground Ranges.

Far Field Antenna Tests: Introduction, Pattern Testing, Gain and Directivity, Polarization. **Far Field Pattern Errors**: Introduction, Error Estimates, Error Correction, Antenna Errors.

Compact Ranges: Introduction, Room Design, Feed Design, Reflector Design. **Near Filed Testing**: Introduction, Planar Near Field Ranges, Errors, Cylindrical and Spherical Scanning

TEXT BOOKS

1.Evans, Gray E," Antenna measurements techniques", Artech House, Inc
2.J S Hollis, T J Lyon, L Clayton," Microwave Antenna Measurements" , Scientific Atlants, Inc

RFIC AND MMIC

Course Code :15 EC 5226 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: Introduction to microstrip circuits design. Advantages and tradeoffs: cost, performance, reliability, size. Applications: Satellite communications, wireless LANs, microwave links, cellular networks. Choosing among device technologies: GaAs FET/pHEMT, GaAs HBT, GaN HEMT. MMIC Design cycle : process selection, device characterization, circuit topology decision, design, taping-out, testing.
Passive MMIC Elements: Lumped element modeling : resistors, capacitors, inductors, via-holes. Transmission line modeling : microstrip, coplanar. Combiners and dividers : Wilkinson, Lange. Baluns, coupled lines, transformers, couplers. Design example: 50-to-5 ohm matching network.

Active Devices: De-embedding, Characterization, modeling. GaAs MESFET, HEMT, HBT, and GaN HEMT Emerging technologies : Si CMOS, SiGe BiCMOS. Device parameters : ft, fmax, gm, RON, COFF, parasitics. Equivalent circuit—physical basis. Intrinsic equivalent circuit. Illustrative example: equivalent circuit extraction. Thermal resistance and lifetime estimation. Design example: choosing FET gate-pitch and bias for 10+ years lifetime.

Buffer Amplifiers: Biasing network selection. Single stage design: lumped vs. distributed matching. Design example: 30 GHz power amplifier. Multi-stage design. Feedback amplifiers. Design example: 5 GHz, 1/2 – Watt power amplifier.

Layout steps: Microstrip layout rules. Coplanar layout rules. Process control and monitoring. Design rules and component values limitations. Reverse engineering. Yield and sensitivity analysis.

Testing and Packaging: Rapid testing: on-wafer, dc-screening. Package design. Package parasitics: cavity effects, stabilization. Thermal management: epoxy, eutectic.

Text Books:

1. I.D Robertson,C .Lucyszyn, "RFIC and MMIC Design and Technology", The Institution of Engineering and Technology, 2001. Microwave Transistor Amplifiers.
2. G. Gonzalez, "Microwave Transistor Amplifiers: Analysis and Design", 2nd edition .

Reference Books:

1. Gupta K. C. & Amarjit Singh, "Microwave Integrated Circuits", John Wiley & Sons, 1975.
2. Hoffman R. K., "Handbook of Microwave Integrated Circuits", Artech House Publishers, 1987.
3. Leo G. Maloratsky, "Passive RF & Microwave Integrated Circuits", Elsevier, 2004.
4. Joseph J. Carr, "RF Components and Circuits", Newnes, 2002

MICROWAVE AND MILLIMETRIC WAVE CIRCUITS

Course Code :15 EC 5205 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

Analysis of Microwave Circuits: Introduction, Microwave Components – E-plane Tee, H-plane Tee, Magic Tee, Directional Coupler, Isolator, Circulator & their Scattering.

Transformers & Resonators: Parameters, Impedance Transformers – Quarter wave Transformers, Microwave Resonators – Rectangular and Cylindrical Resonators.

Filters And Periodic Structures: Design of Narrow Band Low Pass, Band Pass and High Pass Filters, Maximally flat and Chebyshev Designs, Introduction to Periodic Structures, Floquet's Theorem, Circuit Theory Analysis of Infinite and Terminated Structures.

Obstacles In Wave Guides: Introduction, Posts in Waveguides, Diaphragms in Waveguides, Waveguide Junctions, Waveguide Feeds, Excitation of Apertures.

Millimeter Wave Circuits: Wave Propagation in microstriplines, Discontinues in Microstrips, Parallel Coupled lines, Power Dividers and Directional Couplers, Microwave and Millimeter Wave Integrated Circuits

TEXT BOOKS

1. Roger F. Harrington, “Time-Harmonic Electromagnetic Fields”, Mc graw-hill
2. Robert E Collin, “Foundation for Microwave Engineering”, Mc Graw-Hill.

REFERENCE BOOKS

1. Cam Nguyun, “Analysis Methods for RF, Microwave, and Millimeter-Wave Planar Transmission Line Structures”, John Wiley & Sons, Inc. 2000.
2. Hoffman R. K., “Handbook of Microwave Integrated Circuits”, Artech House Publishers, 1987.

RF MEMS

Course Code :15 EC 5227 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: RF MEMS for microwave applications, MEMS technology and fabrication, mechanical modelling of MEMS devices, MEMS materials and fabrication techniques.
MEMS Switches: Introduction to MEMS switches; Capacitive shunt and series switches: Physical description, circuit model and electromagnetic modelling; Techniques of MEMS switch fabrication and packaging; Design of MEMS switches.
RF Filters and Phase Shifters: Modeling of mechanical filters, micromachined filters, surface acoustic wave filters, micromachined filters for millimeter wave frequencies; Various types of MEMS phase shifters; Ferroelectric phase shifters.
Transmission Lines and Antennas: Micromachined transmission lines, losses in transmission lines, coplanar transmission lines, micromachined waveguide components; Micromachined antennas: Micromachining techniques to improve antenna performance, reconfigurable antennas.
Integration and Packaging: Role of MEMS packages, types of MEMS packages, module packaging, packaging materials and reliability issues.

Text books:

1. Varadan, V.K., Vinoy, K.J. and Jose, K.J., “RF MEMS and their Applications”, John Wiley & Sons. 2002.
2. Rebeiz, G.M., “MEMS: Theory Design and Technology”, John Wiley & Sons. 1999.

Reference books:

1. De Los Santos, H.J, “RF MEMS Circuit Design for Wireless Communications”, Artech House. 1999
2. Trimmer, W., “Micromechanics & MEMS”, IEEE Press. 1996
3. Madou, M., “Fundamentals of Microfabrication”, CRC Press. 1997
4. Sze, S.M., “Semiconductor Sensors”, John Wiley & Sons. 1994

CMOS RF CIRCUIT DESIGN

Course Code :15 EC 52O1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to RF Design and Wireless Technology: Design and Applications, Complexity and Choice of Technology. Basic concepts in RF design: Nonlinearly and Time Variance, Inter symbol interference, random processes and noise. Sensitivity and dynamic range, conversion of gains and distortion.
RF Modulation: Analog and digital modulation of RF circuits, Comparison of various techniques for power efficiency, Coherent and non-coherent detection, Mobile RF communication and basics of Multiple Access techniques. Receiver and Transmitter architectures, Direct conversion and two-step transmitters.
RF Testing: RF testing for heterodyne, Homodyne, Image reject, Direct IF and sub sampled receivers.
BJT and MOSFET behavior at RF Frequencies: BJT and MOSFET behavior at RF frequencies, modeling of the transistors and SPICE model, Noise performance and limitations of devices, integrated parasitic elements at high frequencies and their monolithic implementation.
RF Circuits Design: Overview of RF Filter design, Active RF components & modeling, Matching and Biasing Networks. Basic blocks in RF systems and their VLSI implementation, Low noise Amplifier design in various technologies, Design of Mixers at GHz frequency range, Various mixers- working and implementation. Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Radio frequency Synthesizers- PLLS, Various RF synthesizer architectures and frequency dividers, Design issues in integrated RF filters.

Text Books:

1. B. Razavi, “RF Microelectronics” PHI 1998.
2. R. Jacob Baker, H.W. Li, D.E. Boyce “CMOS Circuit Design, layout and Simulation”, PHI

Reference Books:

1. Thomas H. Lee “Design of CMOS RF Integrated Circuits” Cambridge University press 1998.
2. Y.P. Tsividis, “Mixed Analog and Digital Devices and Technology”, TMH 1996. Hoffman R. K., “Handbook of Microwave Integrated Circuits”, Artech House Publishers, 1987.

RADAR SIGNAL PROCESSING

Course Code :15 EC 52C2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Angle-of-Arrival Estimation in the Presence of Multipath: The Low-Angle Tracking Radar Problem, Spectrum Estimation Background, Thomson's Multi-Taper Method, Comparison of Some Popular Spectrum Estimation Procedures, Multi-taper Spectrum Estimation, *F*-Test for the Line Components

Time–Frequency Analysis of Sea Clutter: An Overview of Non-stationary Behavior and Time–Frequency Analysis, Theoretical Background on Non-stationary, High-Resolution Multi-taper Spectrograms

Dynamics of Sea Clutter: Statistical Nature of Sea Clutter: Classical Approach, Is There a Radar Clutter Attractor, Hybrid AM/FM Model of Sea Clutter, Modeling Sea Clutter as a Non-stationary Complex Autoregressive Process

Sea-Clutter Non-stationary: The Influence of Long Waves: Radar and Data Description, Statistical Data Analyses, Modulation of Long Waves: Hybrid AM/FM Model, Non-stationary AR Model

Two New Strategies for Target Detection in Sea Clutter: Bayesian Direct Filtering Procedure, Operational Details, Experimental Results on the Bayesian Direct Filter, Correlation Anomally Detection Strategy - Overview

TEXT BOOKS

1. I. Haykin, Simon S, ”Rader Adaptive signal processing”, John Wiley & Sons
2. Mark A Richards, “Fundamentals of Radar signal processing”, M C Graw Hill

COMPUTATIONAL TECHNIQUES IN ELECTROMAGNETICS

Course Code :15 EC 52O2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Fundamental Concepts: Review of Maxwell's equations and boundary conditions, integral equations versus differential equations, radiation and edge conditions, modal representation of fields in bounded and unbounded media.

Green's Functions: Green's function technique for the solution of partial differential equations, classification of Green's functions, various methods for the determination of Green's functions including Fourier transform technique and Ohm-Rayleigh technique, dyadic Green's functions, determination of Green's functions for free space, transmission lines, waveguides, and microstrips.
Integral Equations: Formulation of typical problems in terms of integral equations: wire antennas, scattering, apertures in conducting screens and waveguides, discontinuities in waveguides and microstriplines; Solution of Integral equations: General Method of Moments (MoM) for the solution of integro-differential equations, choice of expansion and weighting functions, application of MoM to typical electromagnetic problems.
Finite Element Method: Typical finite elements, Solution of two dimensional Laplace and Poisson's equations, solution of scalar Helmholtz equation.
Finite-difference Time-domain Method: Finite differences, finite difference representation of Maxwell's equations and wave equation, numerical dispersion, Yee's finite difference algorithm, stability conditions, programming aspects, absorbing boundary conditions.

Text Books:

1. Collin, R.E., "Field Theory of Guided Waves", 2nd Ed., Wiley-IEEE Press, 1991.
2. David B. Davidson, "Computational Electromagnetics for RF and Microwave Engineering", Cambridge University Press, UK.

Reference Books:

1. Peterson, A.F, Ray, S.L. and Mittra, R., "Computational Methods for Electromagnetics", Wiley-IEEE Press. 1998.
2. Harrington, R.F., "Field Computation by Moment Methods", Wiley- IEEE Press. 1993
3. Sadiku, M.N.O., "Numerical Techniques in Electromagnetics", 2nd Ed., CRC Press. 2001
4. Stutzman, W.L. and Thiele, H.A., "Antenna Theory and Design", 2nd Ed., John Wiley & Sons. 1998
5. Volakis, J.L., Chatterjee, A. and Kempel, L.C., "Finite Method for Electromagnetics", Wiley-IEEE Press. 1998
6. Taflov, A. and Hagness, S.C., "Computational Electrodynamics", 3rd Ed., Artech House.

RF & MICROWAVE SYSTEM DESIGN

Course Code :15 EC 52D1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:
Introduction: Importance of RF and Microwave Concepts and Applications- and Units-Frequency Spectrum, RF and Microwave Circuit Design, Dimensions - RF Behavior of Passive Components: High Frequency Resistors, High Frequency Capacitors, High Frequency Inductors, General Introduction, Types of Transmission Lines-Equivalent Circuit representation.
The Smith Chart: Introduction, Derivation of Smith Chart, Description of two types of smith chart, Z-Y Smith chart, Distributed Circuit Applications, Lumped Element Circuit Applications. SINGLE AND MULTIPORT NETWORKS: Basic Definitions, Interconnecting Networks.
Scattering Parameters: Scattering Parameters: Definition, Meaning, Chain Scattering Matrix, Conversion Between S- and Z-parameters, Signal Flow Chart Modelling.
Stability and Gain Considerations – RF Design RF Source, Transducer Power Gain, Additional Power Relations-Stability Considerations: Stability Circles, Unconditional Stability, and Stabilization Methods-Unilateral and Bilateral Design for Constant Gain- Noise Figure Circles- Constant VSWR Circles.
Rf Filters, Amplifiers And Oscillators Design Generalization-Basic Resonator and Filter Configurations: Low Pass, High Pass, Band Pass and Band Stop type Filters-Filter Implementation using Unit Element and Kuroda's Identities Transformations. Introduction, Types and Characteristics of Amplifiers, Small Signal Amplifiers, Design of different types of amplifiers (NBA, HGA, MGA, LNA, MNA, BBA), Design of Large Signal Amplifiers Oscillator vs Amplifier Design, Design procedure of Transistor Oscillators.

TEXT BOOKS

1.Mathew M. Radmanesh, “Radio Frequency & Microwave Electronics”, Pearson Education Asia, Second Edition,
2.Reinhold Ludwig and Powel Bretchko,” RF Circuit Design – Theory and Applications”, Pearson Education Asia, First Edition.

REFERENCES

1.Joseph . J. Carr, “Secrets of RF Circuit Design”, McGraw Hill Publishers, Third Edition.
2.Ulrich L. Rohde and David P. New Kirk, “RF / Microwave Circuit Design”, John Wiley & Sons USA, 2000. (3) Roland E. Best, “Phase - Locked Loops: Design, simulation and applications”, McGraw Hill Publishers 5THEdition. (4) .Devendra K.Misra ,”Radio Frequency and Microwave Communication Circuits – Analysis and Design “John Wiley & Sons, Inc.
5. Ian Hickman, " RF HandBook ", Butter Worth Heinemann Ltd., Oxford, 1993.
6. Ulrich L.Rohde, T.T.N.Bucher, " Communication Recievers ", McGraw-Hill, New York, 1998.

VLSI SYSTEM DESIGN

Course Code :15 EC 52D2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Design Methodology: Structured design techniques; Programmable logic; Gate array and sea of gates design; cell based design; full custom design; Design flow; Design Economics.
Data path Subsystems: Adders; One/zero Detectors; Comparators; Counters; Shifters; Multipliers; Power and Speed Trade-off.
Memory and Array Subsystems: SRAM, DRAM, ROM, Serial access memories; CAM, PLAs; Array yield, reliability; Power dissipation in Memories.
Special-purpose Subsystems: Packaging; power distribution; I/O pads; **Interconnect:** Interconnect parameters; Electrical wire models, capacitive parasitics; Resistive parasitics; Inductive parasitic; Crosstalk; Advanced Interconnect Techniques.
Timing Issues: Timing classification; Synchronous design; Self-timed circuit design; **Clock Synthesis and Synchronization:** Synchronizers; Arbiters; Clock Synthesis; PLLs; Clock generation; Clock distribution; Synchronous Vs Asynchronous Design.

TEXT BOOKS
1.Neil H. E. Weste, David. Harris and Ayan Banerjee,, “CMOS VLSI Design” - Pearson Education, Third Edition, 2004.
2.Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, “Digital Integrated Circuits” Pearson Education, Second Edition.

REFERENCES:
1.Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits” TMH, Third Edition, 2003
2. Wayne Wolf, “Modern VLSI Design ", 2nd Edition, Prentice Hall,1998.

SIMULATION BOOKS
1. Etienne Sicard, Sonia Delmas Bendhia, “Basics of CMOS Cell Design”, TMH, EEE, 2005.

ADVANCED DIGITAL SIGNAL PROCESSING

Course Code :15 EC 52P1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:
Review of DFT, FFT, IIR Filters and FIR Filters.
Multi Rate Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design & Implementation for sampling rate conversion.

Applications of Multi Rate Signal Processing: Design of Phase Shifters, Interfacing of Digital Systems with Different Sampling Rates, Implementation of Narrow Band Low Pass Filters, Implementation of Digital Filter Banks, Sub-band Coding of Speech Signals, Quadrature Mirror Filters, Trans-multiplexers, Over Sampling A/D and D/A Conversion.
Non-Parametric Methods of Power Spectral Estimation: Estimation of spectra from finite duration observation of signals, Non-parametric Methods: Bartlett, Welch & Blackman-Tukey methods, Comparison of all Non-Parametric methods
Implementation of Digital Filters: Introduction to filter structures (IIR & FIR), Frequency sampling structures of FIR, Lattice structures, Forward prediction error, Backward prediction error, Reflection coefficients for lattice realization, Implementation of lattice structures for IIR filters, Advantages of lattice structures.
Parametric Methods of Power Spectrum Estimation: Autocorrelation & Its Properties, Relation between auto correlation & model parameters, AR Models - Yule-Walker & Burg Methods, MA & ARMA models for power spectrum estimation, Finite word length effect in IIR digital Filters – Finite word-length effects in FFT algorithms.

Text Books:

1. J.G.Proakis & D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms & Applications”, 4th Ed., PHI.
2. Alan V Oppenheim & Ronald W Schaffer, “Discrete Time signal processing” PHI.
3. Emmanuel C. Ifeacher, Barrie. W. Jervis, “DSP – A Practical Approach”, 2 ed., PE.

Reference Books:

1. S. M .Kay, “Modern spectral Estimation: Theory & Application”, PHI, 1988.
2. P.P.Vaidyanathan, “Multi Rate Systems and Filter Banks”, Pearson Education.
3. S.Salivahanan, A.Vallavaraj, C.Gnanapriya, “Digital Signal Processing”, 2000,TMH
4. Jr. Marple, Digital Spectral Analysis

M.TECH – VLSI

First Year (First Semester):

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 EC 5128	MOS Circuit Design	3	1	2	5
2	15 EC 5129	Algorithm for VLSI Design Automation	3	1	0	4
3	15 EC 5130	HDL & PLD Architectures	3	1	2	5
4	15 EC 5131	IC Fabrication Technology	3	1	0	4
5		Elective – 1	3	0	0	3
6		Elective - 2	3	0	0	3
7	15 IE 5149	Seminar	0	0	4	2
		Total	**18**	**4**	**8**	**24**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods			Credits
			L	T	P	
1	15 EC 5232	Advanced Analog IC Design	3	1	2	5
2	15 EC 5233	Low Power VLSI Circuits	3	0	2	4
3	15 EC 5234	VLSI System Design	3	1	0	4
4	15 EC 5235	Testing of VLSI Circuits	3	1	0	4
5		Elective – 3	3	0	0	3
6		Elective - 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total	**18**	**4**	**8**	**24**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 EC 51Q1	Embedded System Design	3	0	0	3
2	15 EC 51Q2	VLSI Signal Processing	3	0	0	3
3	15 EC 51Q3	CMOS Mixed Signal Circuits	3	0	0	3
4	15 EC 51Q4	Nano Electronics	3	0	0	3
5	15 EC 51Q5	CAD Tools for VLSI	3	0	0	3
Elective-2						
1	15 EC 51R1	Image and Video Processing	3	0	0	3
2	15 EC 51R2	Bi-CMOS Technology & Applications	3	0	0	3
3	15 EC 51R3	Semiconductor Device Modeling	3	0	0	3
4	15 EC 51R4	Memory Design and Testing	3	0	0	3
5	15 EC 51R5	Reconfigurable Computing	3	0	0	3
Elective-3						
1	15 EC 52S1	System on Chip Design	3	0	0	3
2	15 EC 52S2	Process and Device Characterization Measurements	3	0	0	3
3	15 EC 52S3	Advanced VLSI Design	3	0	0	3
4	15 EC 52S4	MEMS System Design	3	0	0	3
5	15 EC 52S5	VLSI for Wireless Communication	3	0	0	3
Elective-4						
1	15 EC 52T1	Optimization Techniques and Applications in VLSI Design	3	0	0	3
2	15 EC 52O1	CMOS RF Circuit Design	3	0	0	3
3	15 EC 52T2	Advanced Digital IC Design	3	0	0	3
4	15 EC 52T3	Nano Sensors and its applications	3	0	0	3
5	15 EC 52T4	ASIC Design Flow	3	0	0	3

MOS CIRCUIT DESIGN

Course Code :15 EC 5128 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

Introduction: Classification of CMOS digital circuits and Circuit design, Overview of VLSI design methodologies, VLSI design flow, Design hierarchy and concepts, VLSI design styles, Design quality, Packing technology, CAD technology, Fabrication process flow, CMOS n-well process, layout design rules. **MOS Transistor and Circuit Modeling:** MOS structure, MOS system under external bias, structure and operation of MOS transistor, MOSFET current-voltage characteristics, MOSFET scaling and small-geometry effects, MOSFET capacitances, Modeling of MOS transistor using SPICE. **MOS Inverter static characteristics and Interconnect Effects:** Introduction, Resistive-Load Inverter, Inverter with n-type MOSFET load, CMOS Inverter, Delay-Time Definitions, Calculation of Delay Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters. **Combinational and Sequential MOS logic Circuits:** Introduction, MOS logic circuits with depletion nMOS loads, CMOS logic Circuits, Complex logic circuits, CMOS transmission gates (Pass gates), Behavior of bistable elements, SR latch circuit, clocked latch and flip-flop circuits, CMOS D-latch and Edge-triggered flip-flop. **Dynamic logic Circuits:** Basic principles of pass transistor circuits, voltage bootstrapping, synchronous dynamic circuit techniques, Dynamic CMOS circuit techniques, High-performance dynamic CMOS circuits.

TEXT BOOKS

1. Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits” TMH 2003
2. Neil H. E. Weste and David. Harris Ayan Banerjee,, “CMOS VLSI Design” - Pearson Education, 1999.

REFERENCES

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, “Digital Integrated Circuits” Pearson Education, 2003
2. Uyemura, “Introduction to VLSI Circuits and Systems” Wiley-India, 2006.
3. Wayne Wolf, “Modern VLSI Design ", 2nd Edition, Prentice Hall,1998.
4. Kamran Ehraghian, Dauglas A. Pucknell and Sholeh Eshraghiam, “Essentials of VLSI Circuits and Systems” – PHI, EEE, 2005 Edition.

SIMULATION BOOKS

1. Etienne Sicard, Sonia Delmas Bendhia, “Basics of CMOS Cell Design”, TMH, EEE, 2005.

ALGORITHMS FOR VLSI DESIGN AUTOMATION

Course Code :15 EC 5129 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to Design Methodologies: Design Automation tools, Algorithmic Graph Theory, Computational Complexity, Tractable and Intractable Problems
Layout: Compaction, Placement, Floor planning and Routing Problems, Concepts and Algorithms **Modeling:** Gate Level Modeling and Simulation, Switch level modeling and simulation, Basic issues and Terminology, Binary – Decision diagram, Two – Level Logic Synthesis. **Hardware Models:** Internal representation of the input algorithm, Allocation, Assignment and Scheduling, Some Scheduling Algorithms, Some aspects of Assignment problem, High – level Transformations. **FPGA technologies:** Physical Design cycle for FPGA's partitioning and routing for segmented and staggered models. MCM technologies, MCM physical design cycle, Partitioning, Placement – Chip array based and full custom approaches, Routing –Maze routing, Multiple stage routing, Topologic routing, Integrated Pin – Distribution and routing, routing and programmable MCM's.

TEXT BOOKS
1. S.H.Gerez, "Algorithms for VLSI Design Automation", John Wiley 1999.
2. Naveed Sherwani, "Algorithms for VLSI Physical Design Automation" 3rd edition, Springer International Edition.

REFERENCES
1. Hill & Peterson, "Computer Aided Logical Design with Emphasis on VLSI" Wiley,1993
2. Wayne Wolf, "Modern VLSI Design: Systems on silicon" Pearson Education Asia, 2nd Edition.

HDL & PLD ARCHITECTURES

Course Code :15 EC 5130 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

Introduction to Verilog HDL: Basic concepts, Design modeling, Tasks and functions, Timing and delays, user-defined primitives, PLI, Simulation and Synthesis Tools.**Synthesis of Combinational & Sequential Logic:** Decoders and encoders, Multiplexers and Demultiplexers, Priority encoder, Priority decoder, Comparators, Adders, synthesis of three-state devices and bus interfaces. **,** Latches & Flip-flops, counters, registers, explicit state machines, implicit state machines. **Programmable Logic Devices:** Full Custom Design, Semicustom Design, Programmable Logic Devices, Read Only Memory (ROM), Programmable Read Only Memory (PROM), and Programmable Logic Array (PLA), and Programmable Array Logic (PAL).

Complex Programmable Logic Devices : Basic Architecture, XC9500 CPLD, GAL, Altera series – Max 5000, Max 7000 Series , ALTERA FLEX Logic – 10000 Series CPLDs. AMD's – CPLD (Mach 1 to 5).**Field Programmable Gate Arrays:** Introduction, Basic Architecture, Design flow, Xilinx XC3000 & XC4000 Architectures, Actel Architectures, ALTERA's FLEX 8000, and ALTERA's FLEX 10000 FPGAs.

TEXT BOOKS

1.Michael D.Celetti "Advanced Digital Design with the Verilog HDL" Prentice Hall.

2.S.Trimberger, Edr., Field Programmable Gate Array Technology, Kluwer Academic Publications.

REFERENCE BOOKS

1. Verilog Digital System Design RT Level synthesis TestBench and verification by Zainalabedin Navabi, 2008 Mc Graw Hill Publishers

2.Stephen Brown Zvonko Vranesic "Fundamentals of Digital Logic with VHDL Design" McGraw-Hill.

SIMULATION BOOKS

1. Verilog HDL A Guide To Digital Design And Synthesis, Edition: 2 by Samir Palnitkar.

IC FABRICATION TECHNOLOGY

Course Code :15 EC 5131	**L-T-P : 3-1-0**
Pre-requisite: NIL	**Credits: 4**

Syllabus:

Introduction to IC Technology: Basic fabrication steps and their Importance. **Environment of IC Technology:** Concepts of Clean room and safety requirements, Concepts of Wafer cleaning processes and wet chemical etching techniques. **Impurity Incorporation:** Solid State diffusion modeling and technology; Ion Implantation modeling, technology and damage annealing, characterization of Impurity profiles **Oxidation:** Kinetics of Silicon dioxide growth both for thick, thin and ultra thin films, Oxidation technologies in VLSI and ULSI, Characterization of oxide films, High k and low k dielectrics for ULSI. **Lithography:** Photolithography, E-beam lithography and newer lithography techniques for VLSI/ULSI, Mask generation. **Chemical Vapour Deposition Techniques:** CVD techniques for deposition of polysilicon, silicon dioxide, silicon nitride and metal films; **Epitaxial growth of silicon:** modeling and technology. **Metal Film Deposition:** Evaporation and sputtering techniques, Failure mechanisms in metal interconnects Multi-level metallization schemes. **Plasma and Rapid Thermal Processing:** PECVD, Plasma etching and RIE techniques; RTP techniques for annealing, growth and deposition of various films for use in ULSI.

TEXT BOOKS

1. S.M.Sze(2^{nd} Edition)"VLSI Technology", McGraw Hill Companies Inc.

2. C.Y. Chang and S.M.Sze (Ed), **"**ULSI Technology**"**, McGraw Hill Companies Inc.

REFERENCES TEXT BOOKS
1.Stephena, Campbell, **"**The Science and Engineering of Microelectronic Fabrication**"**, Second Edition, Oxford University Press.
2.James D.Plummer, Michael D.Deal, "Silicon VLSI Technology" Pearson Education

EMBEDDED SYSTEM DESIGN

Course Code :15 EC 51Q1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Embedded systems: Embedded systems, processor embedded into a system, embedded hardware units and devices in a system, embedded software in a system, examples of embedded systems, embedded SOC and use of VLSI circuit design technology, Complex systems design and processors, Design process in embedded system, formalization of system design, design process and design examples, classification of embedded systems, skills required for an embedded system designer. **PIC Microcontrollers**: PIC 16 Series family overview, An architecture overview of the 16F84A, Status register, 16F84A memory, Some issues of timing, Power-up and Reset, PIC 16F84A parallel ports, 16F84A clock oscillator, 16F84A operating conditions, 16F84A interrupt structure. **Larger systems and the PIC 16F873A:** The main idea – the PIC 16F87XA, The 16F873A block diagram and CPU, 16F873A memory and memory maps, 16F873A interrupts, 16F873A oscillator, reset and power supply, 16F873A parallel ports. **RTOS:** Basic design using RTOS, Micro/OS-II and V_x works, windows CE, OSEK, real-time Linux functions, **case study:** digital camera hardware and software architecture, embedded systems in automobile, embedded system for a smart card, mobile phone software for key inputs.

TEXTBOOKS
1. Embedded Systems Architecture Programming and Design by Raj Kamal, II edition, Tata MC Graw-Hill.
2. Designing Embedded Systems with PIC Microcontrollers: principles and applications by Tim Wilmshurst, Elsevier.

REFERENCES
1. Embedded Systems Design by Steve Heath, II edition, Newnes publications
2. Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers by Tammy Noergaard, Elsevier.

SIMULATION BOOKS
1. An embedded software primer by David E. Simon, Pearson Education, 1995.

VLSI SIGNAL PROCESSING

Course Code :15 EC 51Q2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction To DSP Systems: Introduction; representation of DSP algorithms: Block Diagram, signal flow graph, data flow graph, dependence graph. **Iteration Bound**: Data flow graph representations, loop bound and iteration bound, longest path matrix algorithm, iteration bound of Multirate data flow graphs. **Pipelining and Parallel Processing:** Pipelining and parallel processing of FIR digital filters, pipeline interleaving in digital filters: signal and multichannel interleaving. **Retiming, Unfolding and Folding**: retiming techniques; algorithm for unfolding, Folding transformation, systolic architecture design, systolic array design methodogy. **Fast Convolution, Filters and Transforms**: Cook-toom algorithm, modified cook-toom algorithm, winogard algorithm, iterated convolution Algorithm strength reduction in filters and transforms.

TEXT BOOK
1.Keshab k. Parhi," VLSI Digital Signal Processing Systems: Design and Implementation", Wiley, inter science.

REFERENCE BOOKS
1.S.Y.kung, H.J.White house, T. Kailath," VLSI and Modern Signal Processing", Prentice hall,

CMOS MIXED SIGNAL CIRCUITS

Course Code :15 EC 51Q3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Data Converter Modeling and SNR: Sampling and Aliasing: A modeling Approach, SPICE models for DACs and ADCs, Quantization noise, Viewing the quantization noise spectrum using simulations, quantization noise voltage spectral density, Data converter SNR: an overview, Improving SNR using averaging, Decimating filters for ADC, Interpolating filters for DACs, Using feedback to improve SNR. **Submicron CMOS Circuit Design:** Submicron CMOS overview and models, Digital circuit design, Analog circuit design. **Implementing Data Converters:** R-2R topologies for DACs, Op-Amps in data converters, Implementing ADCs. **Noise-Shaping Data Converters:** Noise-shaping fundamentals, Second-order noise-shaping, noise-shaping topologies. **Integrator-Based CMOS Filters:** Integrator building blocks, filtering topologies, Filters using Noise-shaping.

TEXT BOOKS
1 R. Jacob Baker, "CMOS: Mixed-Signal Circuit Design", Wiley-Student Edition, IEEE Press,

REFERENCE BOOKS

1. Behzad Razavi, "Principles of Data Conversion System Design, "John Wiley & Sons.
2.P. Allen and D. Holberg, "CMOS Analog Circuit design," Oxford Press.
3. E. Bogatin, "Signal and Power –Simplified," 2nd edition, Prentice Hall.

NANO ELECTRONICS

Course Code :15 EC 51Q4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Recent past, the present and its challenges, Future, Overview of basic Nano electronics. **Nano electronics & Nanocomputer architectures:** Introduction to Nanocomputers, Nanocomputer Architecture, Quantum DOT cellular Automata (QCA), QCA circuits, Single electron circuits, molecular circuits, Logic switches – Interface engineering – Properties (Self-organization, Size-dependent) – Limitations. **Nanoelectronic Architectures:** Nanofabrication – Nanopatterning of Metallic/Semiconducting nanostructures (e-beam/X-ray, Optical lithography, STM/AFM- SEM & Soft-lithography) – Nano phase materials – Self-assembled Inorganic/Organic layers. **Spintronics:** Introduction, Overview, History & Background, Generation of Spin Polarization Theories of spin Injection, spin relaxation and spin dephasing, Spintronic devices and applications, spin filters, spin diodes, spin transistors. **Memory Devices And Sensors:** Memory devices and sensors – Nano ferroelectrics – Ferroelectric random access memory –Fe-RAM circuit design –ferroelectric thin film properties and integration – calorimetric -sensors – electrochemical cells – surface and bulk acoustic devices – gas sensitive FETs – resistive semiconductor gas sensors –electronic noses – identification of hazardous solvents and gases – semiconductor sensor array

TEXT BOOKS

1.Nanoelectronics & Nanosystems: From Transistor to Molecular & Quantum Devices: Karl Goser,
JanDienstuhl and others.
2. Nano Electronics and Information Technology: Rainer Waser

REFERENCES

1. Concepts in Spintronics – Sadamichi Maekawa
2. Spin Electronics – David Awschalom

CAD TOOLS FOR VLSI

Course Code :15 EC 51Q5 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to VLSI design methodologies and supporting CAD environment. **Schematic editors:** Parsing: Reading files, describing data formats, Graphics & Plotting Layout. Layout Editor: Turning plotter into an editor. Layout language: Parameterized cells, PLA generators, Introduction to Silicon compiler, Data path. Compiler, Placement & routing, Floor planning. Layout Analysis: Design rules, Object based DRC, Edge based layout operations. Module generators. **Simulation:** Types of simulation, Behavioral simulator, logic simulator, functional simulator & Circuit simulator. Simulation Algorithms: Compiled code and Event-driven. **Optimization Algorithms:** Greedy methods, simulated annealing, genetic algorithm and neural models. **Testing ICs:** Fault simulation, Aids for test generation and testing. Computational complexity issues: Big Oh and big omega terms. **Recent topics in CAD-VLSI:** Array compilers, hardware software co-design, high-level synthesis tools and VHDL modeling.

TEXT BOOKS

1. Stephen Trimberger," Introduction to CAD for VLSI", Kluwer Academic publisher, 2002
2. Naveed Shervani, "Algorithms for VLSI physical design Automation", Kluwer Academic Publisher,
   Second edition.

REFERENCE BOOKS

1.Gaynor E. Taylor, G. Russell, "Algorithmic and Knowledge Based CAD for VLSI", Peter peregrinus ltd.
   London.
2. Gerez, "Algorithms VLSI Design Automation", John Wiley & Sons.

IMAGE AND VIDEO PROCESSING

Course Code :15 EC 51R1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Fundamentals of Image processing and Image Transforms: Basic steps of Image processing system sampling and quantization of an Image – Basic relationship between pixels Image Transforms: 2 – D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms **Image Processing Techniques:** Image Enhancement: Spatial Domain methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering Image Segmentation: Segmentation concepts, point, line and Edge detection, Thresholding, region based segmentation **Image Compression** Image compression fundamentals – coding Redundancy, spatial and temporal redundancy. Compression models : Lossy and Lossless, Huffmann coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, transform coding, predictive coding , wavelet coding, JPEG standards **Basic Steps of Video Processing:** Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals, filtering operations **2-D Motion Estimation:** Optical flow, general methodologies, pixel based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding.

TEXT BOOKS

1. Gonzaleze and Woods ,"Digital Image Processing ", 3rd edition , Pearson
2. Yao wang, Joem Ostarmann and Ya – quin Zhang, "Video processing and communication ",1st edition ,
PHI

REFERENCE TEXT BOOK

1. M. Tekalp ,"Digital video Processing", Prentice Hall International

SIMULATION TEXT BOOKS

1. Relf, Christopher G.,"Image acquisition and processing with LabVIEW", CRC press
2. Aner ozdemi R, "Inverse Synthetic Aperture Radar Imaging with MATLAB Algorithms", John Wiley &
Sons
3. Chris Solomon, Toby Breckon ,"Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab", John Wiley & Sons,

BiCMOS TECHNOLOGY & APPLICATIONS

Course Code :15 EC 51R2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Device Modeling: Modeling of the MOS Transistor, Modeling of the Bipolar Transistor. **Device Design Considerations:** Design Considerations for MOSFET's, Design Considerations for Bipolar Transistors, BiCMOS Device Synthesis. **BiCMOS Device Scaling:** MOS Device Scaling, Bipolar Device Scaling. **BiCMOS Process Technology:** BiCMOS Isolation Consideration, CMOS Well & Bipolar Collector tradeoffs, CMOS & BiCMOS Processes considerations, Interconnect Processes for submicron BiCMOS, Submicrometer BiCMOS Process for 5V Digital Applications, Analog BiCMOS Process Technology, Process Reliability. **Digital Design:** Delay Analysis, Gate Design, Performance Comparisons. **Analog Design:** BiCMOS Operational Amplifiers, BiCMOS Analog Subsystems**. BiCMOS Digital Circuit Applications**: Adders, Multiplier, Random Access Memory, Programmable Logic Arrays, BiCMOS Logic Cells, BiCMOS Gate Arrays.

TEXT BOOKS:
1. A L ALVAREZ, BICMOS Technology & Applications, Kluwer Academic Publishers.
2. Sherif H.K. Embabi, Abdellatif Bellaouar & Mohamed 1. Elmasry "Digital BiCMOS Integrated Circuit Design" Springer Science+ BusÎness Media, LLC.

REFERENCE
1. Kiat-Seng yeo, Samir S. Rofail, Wang-Ling Goh, CMOS/BiCMOS ULSI, Pearson Education.
2. James C. Daly, Denis P. Galipeau, Analog BiCMOS Design: Practices & Pitfalls, CRC Press
3. Klaas-Jan de Langen, Johan Huijsing, Compact Low-Voltage and High-Speed CMOS, BiCMOS and Bipolar Operational Amplifiers, Springer Science

SEMICONDUCTOR DEVICE MODELING

Course Code :15 EC 51R3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Basic Device Physics : Electrons and holes in silicon, p-n junction, MOS capacitor, Highfield effects. **MOSFET Devices** : Long-channel MOSFETs, Short-channel MOSFETs. CMOS Device Design : MOSFET Scaling, Threshold voltage, MOSFET channel length. **CMOS Performance Factors** : Basic CMOS circuit elements, Parasitic elements, Sensitivity of CMOS delay to device parameters, Performance factors of advanced CMOS devices. **Bipolar Devices** : n-p-n Transistors, Ideal current-voltage characteristics, Characteristics of a typical n-p-n transistor, Bipolar device models for circuit and time-dependent analyses, Breakdown voltages. **Bipolar Device Design** : Design of the emitter design, Design of the base region, Design of the collector design, Modern bipolar transistor structures.

TEXT BOOKS
1. Yuan Taur, Tak.H.Ning, Fundamentals of Modern VLSI Devices, Cambridge University Press,

REFERENCE BOOKS
1. Donald Neamen, Semiconductors Physics and Devices, Tata Mc Graw Hill, 2003
2. Tyagi, Introduction to Semiconductor Materials and Devices, Wiley Publications, 2002.
3. Semiconductor Devices, Basic Principles Jasprit Singh, Wiley Publications, 2001
4. S.M. Sze (Ed), Physics of Semiconductor Devices, 2nd Edition, Wiley Publications, 1998
5. Analysis and Design of Analog Integrated Circuits 4/e, Paul R. Gray, Paul J. Hurst, Robert G Meyer, 2001, Wiley Publications
6. Physics of Semiconductor Devices 3/e S. M. Sze, Wiley Publications, 2007.

MEMORY DESIGN AND TESTING

Course Code :15 EC 51R4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**
Syllabus:

Random Access Memory Technologies-Static Random Access Memories (SRAMs): SRAM Cell Structures-MOS SRAM Architecture-MOS SRAM Cell and Peripheral Circuit Operation-Bipolar, SRAM Technologies-Silicon On Insulator (SOl) Technology-Advanced SRAM Architectures and Technologies- Application Specific SRAMs. Dynamic Random Access Memories (DRAMs): DRAM Technology Development-CMOS DRAMs-DRAMs Cell Theory and Advanced Cell Structures- BiCMOS DRAMs-Soft Error Failures in DRAMs-Advanced DRAM Designs and Architecture-Application Specific DRAMs. **Non-Volatile Memories-**Masked Read-Only Memories (ROMs)-High Density ROMs-Programmable Read-Only Memories (PROMs)- Bipolar PROMs-CMOS PROMs-Erasable (UV) - Programmable Road-Only Memories (EPROMs)-Floating- Gate EPROM Cell-One-Time Programmable (OTP) Eproms-Electrically Erasable PROMs (EEPROMs)- EEPROM Technology And Architecture-Nonvolatile SRAM-Flash Memories (EPROMs or EEPROM)-Advanced Flash Memory Architecture. **Memory Fault Modeling, Testing, And Memory Design For Testability And Fault Tolerance-**RAM Fault Modeling, Electrical Testing, Pseudo Random Testing-Megabit DRAM Testing-Nonvolatile Memory Modeling and Testing-IDDQ Fault Modeling and Testing-Application Specific Memory Testing. **Semiconductor Memory Reliability And Radiation Effects-**General Reliability Issues-RAM Failure Modes and Mechanism-Nonvolatile Memory Reliability-Reliability Modeling and Failure Rate Prediction-Design for Reliability-Reliability Test Structures-Reliability Screening and Qualification. Radiation Effects-Single Event Phenomenon (SEP)-Radiation Hardening Techniques-Radiation Hardening Process and Design Issues-Radiation Hardened Memory Characteristics-Radiation Hardness Assurance and Testing - Radiation Dosimeter-Water Level Radiation Testing and Test Structures. **Advanced Memory Technologies And High-Density Memory Packaging Technologies-**Ferroelectric Random Access Memories (FRAMs)-Gallium Arsenide (GaAs) FRAMs-Analog Memories-Magneto resistive Random Access Memories (MRAMs)-Experimental Memory Devices. Memory Hybrids and MCMs (2D)-Memory Stacks and MCMs (3D)-Memory MCM Testing and Reliability Issues-Memory Cards-High Density Memory Packaging Future Directions.

TEXT BOOKS

1.Ashok K.Sharma, " Semiconductor Memories Technology, Testing and Reliability ", Prentice-Hall of India Private Limited, New Delhi, 1997.

REFERENCE BOOKS

1. Luecke Mize Care, “Semiconductor Memory design & application”, Mc-Graw Hill.
2.Belty Prince, “ Semiconductor Memory Design Handbook”.
3.Memory Technology design and testing 1999 IEEE International Workshop on: IEEE Computer Society Sponsor (S).

RECONFIGURABLE COMPUTING

Course Code :15 EC 51R5 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction Goals and motivations - History, state of the art, future trends - Basic concepts and related fields of study - Performance, power, and other metrics - Algorithm analysis and speedup projections - RC Architectures - Device characteristics - Fine-grained architectures - Coarse-grained architectures . **Fpga Design** FPGA Physical Design Tools -Technology mapping - Placement & routing - Register transfer (RT)/Logic Synthesis - Controller/Data path synthesis - Logic minimization .**Parallel Processing** RC Application Design - Parallelism - Systolic arrays - Pipelining - Optimizations - Bottlenecks - High-level Design - High-level synthesis - High-level languages - Design tools. **Architectures** Hybrid architectures- Communication - HW/SW partitioning - Soft-core microprocessors- System architectures -System design strategies - System services - Small-scale architectures - HPC architectures - HPEC architectures - System synthesis - Architectural design space explorations. **Case Study** Case Studies- Signal and image processing - Bioinformatics - Security - Special Topics - Partial Reconfiguration - Numerical Analysis -Performance Analysis/Prediction - Fault Tolerance

TEXT BOOK
1. Paul S. Graham and Maya Gokhale "Reconfigurable Computing Accelerating Computation with Field-Programmable Gate Arrays" springer .

ADVANCED ANALOG IC DESIGN

Course Code :15 EC 5232 **L-T-P : 3-1-2**
Pre-requisite: NIL **Credits: 5**

Syllabus:

Small Signal & large signal Models of MOS & BJT transistor. Analog MOS Process **Passive & Active Current Mirrors:** Basic current mirrors, Cascode current mirror, Active loads, voltage and current references; **Frequency response of integrated circuits:** Single Stage (CS,CG,CD) amplifiers, Cascade Stage; frequency response(miller effect) of CG, CS, CD, Operation of Basic Differential Pair, differential pair with MOS loads, Frequency response of Cascade & Differential Pair; **Operational Amplifiers with single ended outputs:** Applications of operational amplifiers, basic two stage MOS operational amplifiers, Deviations from ideality in real operational amplifiers, Basic two-stage MOS operational amplifier, MOS Folded – cascode operational amplifiers, **Feedback**: Ideal feedback equation, gain sensitivity, feedback configurations, practical configuration and effect of loading **Nonlinear Analog circuits & other applications:** Precision rectification ,phased locked loops, Sampling Switches, switched capacitor integrator, oscillators, ADC, DAC.

TEXT BOOKS

1. Gray & Meyer, Analysis & Design of Analog Integrated Circuits, 4th edition, Wiley, 2001.
2. Behzad Razavi, "Design Of Analog CMOS Integrated Circuits", Tata Mcgraw Hill,2005.

REFERENCE

1. Jacob Baker,"CMOS Mixed Signal Circuit Design", John Wiley.
2. Gray, Wooley, Brodersen, " Analog MOS Integrated Circuits ", IEEE Press, 1989.
3. Kenneth R. Laker, Willy M.C. Sansen, William M.C.Sansen, "Design of Analog Integrated Circuits and Systems ", McGraw Hill.

LOW POWER VLSI CIRCUITS

Course Code :15 EC 5233 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches. **Device & Technology Impact on Low Power:** Dynamic dissipation in CMOS, Transistor sizing& gate oxide thickness, Impact of technology Scaling, Technology & Device innovation. **Simulation Power analysis**: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation. **Probabilistic power analysis**: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy. **Low Power Circuit's**: Transistor and gate sizing, network restructuring and Reorganization. Special Flip Flops & Latches design, high capacitance nodes, low power digital cells library. **Logic level:** Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic. **Low power Architecture & Systems:** Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components. **Low power Clock Distribution:** Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network. **Special Techniques**: Power Reduction in Clock networks, CMOS Floating Node, Low Power Bus Delay balancing, and Low Power Techniques for SRAM.

TEXT BOOKS

1. Gary K. Yeap, "Practical Low Power Digital VLSI Design", KAP, 2002
2. Rabaey, Pedram, "Low Power Design Methodologies" Kluwer Academic

REFERENCES

1. Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley, 2000
2. Yeo, "CMOS/BiCMOS ULSI Low Voltage Low Power" Pearson Education

VLSI SYSTEM DESIGN

Course Code :15 EC 5234 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Design Methodology: Structured design techniques; Programmable logic; Gate array and sea of gates design; cell based design; full custom design; Design flow; Design Economics. **Data path Subsystems:** Adders; One/zero Detectors; Comparators; Counters; Shifters; Multipliers; Power and Speed Trade-off. **Memory and Array Subsystems:** SRAM, DRAM, ROM, Serial access memories; CAM, PLAs; Array yield, reliability; Power dissipation in Memories. **Special-purpose Subsystems:** Packaging; power distribution; I/O pads; **Interconnect:** Interconnect parameters; Electrical wire models, capacitive parasitics; Resistive parasitics; Inductive parasitic; Crosstalk; Advanced Interconnect Techniques. **Timing Issues:** Timing classification; Synchronous design; Self-timed circuit design; **Clock Synthesis and Synchronization:** Synchronizers; Arbiters; Clock Synthesis; PLLs; Clock generation; Clock distribution; Synchronous Vs Asynchronous Design.

TEXT BOOKS

1. Neil H. E. Weste, David. Harris and Ayan Banerjee,, “CMOS VLSI Design” - Pearson Education, Third Edition, 2004.
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, “Digital Integrated Circuits” Pearson Education, Second Edition.

REFERENCES:

1. Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits” TMH, Third Edition, 2003
2 Wayne Wolf, “Modern VLSI Design ", 2nd Edition, Prentice Hall,1998.

SIMULATION BOOKS

1. Etienne Sicard, Sonia Delmas Bendhia, “Basics of CMOS Cell Design”, TMH, EEE, 2005.

TESTING OF VLSI CIRCUITS

Course Code :15 EC 5235 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Basics of Testing And Fault Modeling Introduction to Testing - Faults in digital circuits - Modeling of faults - Logical Fault Models - Fault detection - Fault location - Fault dominance - Logic Simulation - Types of simulation - Delay models - Gate level Event-driven simulation. **Test Generation For Combinational and Sequential Circuits** Test generation for combinational logic circuits - Testable combinational logic circuit design - Test generation for sequential circuits - design of testable sequential circuits. **Design For Testability** Design for Testability - Ad-hoc design - Generic scan based design - Classical scan based design – System level DFT approaches. **Self Test and Test Algorithms** Built-In Self Test - Test pattern generation for BIST - Circular BIST - BIST Architectures - Testable Memory Design - Test algorithms - Test generation for Embedded RAMs. **Fault Diagnosis Logic** Level Diagnosis - Diagnosis by UUT reduction - Fault Diagnosis for Combinational Circuits - Self-checking design - System Level Diagnosis.

TEXT BOOKS

1.M. Abramovici, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design", Jaico
Publishing House.

2.M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal
VLSI Circuits", Kluwer Academic Publishers.

REFERENCE BOOKS

1.P.K. Lala, "Digital Circuit Testing and Testability", Academic Press, 2002.

2.A.L. Crouch, "Design Test for Digital IC's and Embedded Core Systems", Prentice Hall International.

SYSTEM ON CHIP DESIGN

Course Code :15 EC 52S1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

System Level Design: System level design-Tools & methodologies for system level design, System level space & modeling languages, SOC block based design & IP assembly, Performance evaluation methods for multiprocessor SOC design, **Power Management And Synthesizing** System level power management, Processor modeling & design tools, Embedded software modeling & design Using performance metrics to select microprocessor for IC design, Parallelizing High-Level Synthesize ,A code transformational approach to High Level Synthesize.
Micro-Architecture Design And Power Optimization Micro-architecture design, Cycle accurate system – level modeling, Performance evaluation, Micro architectural power estimation optimization, Design planning. **Software Design Verification** logical verification, Design & Verification languages, Digital simulation, using transactional, level models in an SOC design, Assertion based verification. **Hardware Design Verification** Hardware acceleration & emulation, Formal property verification, TEST, DFT, ATPG,Analog
& mixed signal test

TEXT BOOK

1. Louis Scheffer Luciano Lavagno and Grant Martin, "EDA for IC System verification and Testing", CRC, 2006.

REFERENCES

1.Wayone Wolf," Modern VLSI Design: SOC Design"
2.Prakash Rashnikar, Peter Paterson, Lenna Singh" System-On-A-Chip Verification methodlogy & Techniques", Kluwer Academic Publishers.
3.Alberto Sangiovanni Vincentelli," Surviving the SOC Revolution: A Guide to Platformbased Design", Kluwer Academic Publishers

PROCESS AND DEVICE CHARACTERIZATION & MEASUREMENTS

Course Code :15 EC 52S2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction And Preliminary Concepts: Macro-Meso, Micro and Nanostructure of Materials, Fundamentals of crystallography and Crystal structures Optical Microscopy: Geometry of

Optics, Resolution, and Construction of a Microscope, Image Contrast, and Phase Contrast. **Electron Microscopy**: SEM: Electron Optics - Interaction of Electrons and Matter - Elastic and Inelastic Scattering, Backscattered Electrons, Secondary Electrons, Scanning Electron Microscopy – Image Formation, EPMA, Magnification, and Depth of Field, Distortion, Detectors, Contrast, and Resolution. TEM: Electron diffraction, different electron Diffraction techniques. **Semiconductor Material Impurity Characterization**: Spectroscopic Ellipsometry (SE), X-ray Reflectivity (XRR), X-ray Fluorescence (XRF), X-ray Diffraction (XRD), Secondary Ion Mass Spectrometry (SIMS), Auger Electron Spectrometry (AES), Rutherford Backscattering Spectrometry (RBS), EDAX, FTIR. **Electrical Characterization**: Four-probe technique, Hall Effect, sheet resistance C-V measurements, DLTS, Carrier lifetime, impurity profiling, I-V measurements . **Process And Spice Model Parameter Extraction**

TEXT /REFERENCES

1) W.R. Reunyan, "Semiconductor Measurements and Instrumentation", Mc-Graw Hill
2) Micro structural Characterization of Materials - David Brandon and Wayne Kaplan, John Wiley and
Sons, New York, NY.
3) Schroder, "Semiconductor Material and Device Characterization"
4) Philips F. Kare and Greydon B. Lauabee, "Characterization of semiconductor Materials", Mc-Graw Hill.
5) K.V. Ravi, "Imperfections and Impurities in Semiconductor Silicon", John Wiley and Sons.

ADVANCED VLSI DESIGN

Course Code :15 EC 52S3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Review of MOS Circuits: MOS and CMOS static plots, switches, comparison between CMOS and BI - CMOS. **MESFETS**: MESFET and MODFET operations, quantitative description of MESFETS. **MIS Structures and MOSFETS**: MIS systems in equilibrium, under bias, small signal operation of MESFETS and MOSFETS. **Short Channel Effects and Challenges to CMOS**: Short channel effects, scaling theory, processing challenges to further CMOS miniaturization **Beyond CMOS**: Evolutionary advances beyond CMOS, carbon Nano tubes, conventional vs. tactile computing, computing, molecular and biological computing Mole electronics-molecular Diode and diode- diode logic ,Defect tolerant computing. **Super Buffers, Bi-CMOS and Steering Logic**: Introduction, RC delay lines, super buffers- An NMOS super buffer, tri state super buffer and pad drivers, CMOS super buffers, Dynamic ratio less inverters, large capacitive loads, pass logic, designing of transistor logic, General functional blocks - NMOS and CMOS functional blocks. **Special Circuit Layouts and Technology Mapping**: Introduction, Talley circuits, NAND-NAND, NORNOR, and AOI Logic, NMOS, CMOS Multiplexers, Barrel shifter, Wire routing and module lay out. **System Design**: CMOS design methods, structured design methods, Strategies encompassing hierarchy, regularity, modularity

& locality, CMOS Chip design Options, programmable logic, Programmable inter connect, programmable structure, Gate arrays standard cell approach, Full custom Design.

TEXT BOOKS

1. Kevin F Brennan **“**Introduction to Semi Conductor Device**”**, Cambridge publications
2. Eugene D Fabricius **“**Introduction to VLSI Design**”**, McGraw-Hill publications

REFERENCE BOOKS

1. D.A Pucknell **“**Basic VLSI Design**”**, PHI Publication
2. Wayne Wolf, **“**Modern VLSI Design**”** Pearson Education, Second Edition

MEMS SYSTEM DESIGN

Course Code :15 EC 52S4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

MEMS and Microsystems, Microsystems and microelectronics, Microsystems and miniaturization, Working principle of micro system - Micro sensors, Micro actuators, MEMS with Micro actuators. **Materials For MEMS** - Substrate and wafer, silicon as a substrate material, silicon compound, silicon Piezo-resistors, Gallium Arsenide, quartz, Piezoelectric crystals, polymers and packaging Materials. **Fabrication Process** - Photolithography, Ion implantation, Oxidation, Chemical vapor deposition (CVD), Physical vapor deposition, Deposition by Epitaxy, Etching. **Manufacturing Process** - Bulk Micromachining, Surface Micromachining, LIGA Process. Micro system Design - Design consideration, process design, Mechanical design, Mechanical design using MEMS. **Mechanical packaging of Microsystems**, Microsystems packaging, interfacing in Microsystems packaging, packaging technology, selection of packaging materials, signal mapping and transduction. **Case study on strain sensors**, Temperature sensors, Pressure sensors, Humidity sensors, Accelerometers, Gyroscopes , RF MEMS Switch, phase shifter, and smart sensors. Case study of MEMS pressure sensor Packaging.

TEXTBOOKS

1.Tai Ran Hsu,” MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi, 2002.
2.Julian W Gardner, "Microsensors MEMS and smart devices", John Wiley and sons Ltd,2001.
3.Chang Liu, "Foundation of MEMS", Pearson International Edition,2006.

REFERENCES

1.Stephen Santuria,” Microsystems Design”, Kluwer publishers, 2000.
2.Nadim Maluf,” An introduction to Micro electro mechanical system design”, Artech House,
3.Mohamed Gad-el-Hak, editor,” The MEMS Handbook”, CRC press Baco Raton,2000.
4.Gabriel M Rebeiz, "RF MEMS - Theory Design and Technology", John Wiley and Sons, 2003.

VLSI FOR WIRELESS COMMUNICATION

Course Code :15 EC 52S5 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Communication Concepts: Wireless Channel Description, Path Loss, Multipath Fading, Channel Model and Envelope Fading, Frequency Selective and Fast Fading **Receiver Architectures**: Receiver Front End:, Filter Design, Rest of Receiver Front End, Derivation of NF, IIP3 of Receiver Front End, **Low Noise Amplifier**: Wideband LNA Design, Narrow Band LNA:, Impedance Matching, Core Amplifier **Active Mixer**: Balancing, Qualitative Description of the Gilbert Mixer, Distortion, Low Frequency Case: Analysis of Gilbert Mixer, Distortion, High-Frequency Case, Noise **Passive Mixer**: Switching Mixer, Distortion in Unbalanced Switching Mixer, Conversion Gain in Unbalanced Switching Mixer, Noise in Unbalanced Switching Mixer, practical Unbalanced Switching Mixer, Sampling Mixer, Conversion Gain in Single-Ended Sampling Mixer **Analog-to-Digital Converters**: Demodulators, A/D converters Used in a Receiver, Low-Pass Sigma-Delta Modulators, Implementation of Low-Pass Sigma-Delta Modulators, Bandpass Sigma-Delta Modulators, Implementation of Bandpass Sigma-Delta Modulators

TEXT BOOK

1. Bosco Leung, "VLSI for Wireless Communication, Second Edition, Springer

REFERENCES

1. Emad N Farag, M.I Elmasry, “Mixed Signal VLSI Wireless Design Circuits and Systems”, KluwerPublication.
2. David Tsee, Pramod Viswanath,” Fundamentals of Wireless Communication”, Cambridge Univ Press.

OPTIMIZATION TECHNIQUES AND APPLICATIONS IN VLSI DESIGN

Course Code :15 EC 52T1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Statistical Modeling: Modeling sources of variations, Monte Carlo techniques, Process variation modeling- Pelgroms model, principal component based modeling, Quad tree based modeling, Performance modeling-Response surface methodology, delay modeling, interconnect delay models Statistical Performance, Power And Yield Analysis Statistical timing analysis, parameter space techniques, Bayesian networks Leakage models, High level statistical analysis, Gate level statistical analysis, dynamic power, leakage power, temperature and power supply variations, High level yield estimation and gate level yield estimation Convex Optimization Convex sets, convex functions, geometric programming, trade-off and sensitivity analysis, Generalized geometric programming, geometric programming applied to digital circuit gate sizing, Floor planning, wire sizing, Approximation and fitting- Monomial fitting, Max-monomial fitting, Polynomial fitting. Genetic Algorithm Introduction, GA Technology-Steady State Algorithm-Fitness Scaling-Inversion GA for VLSI Design, Layout and Test automation- partitioning-automatic placement, routing technology, Mapping for FPGA- Automatic test generation-Partitioning algorithm Taxonomy-Multiday Partitioning Hybrid genetic-encoding-local improvement-WDFR-Comparison of Cas-Standard cell placement-GASP algorithm-unified algorithm. Ga Routing Procedures And Power Estimation Global routing-FPGA technology mapping-circuit generation-test generation in a GA frame work-test generation procedures. Power estimation-application of GA-Standard cell placement-GA for ATG-problem encoding-fitness function-GA vs Conventional algorithm.

REFERENCES

1.Ashish Srivastava, Dennis Sylvester, David Blaauw "Statistical Analysis and Optimization for VLSI:Timing and Power" , Springer, 2005.

2.Pinaki Mazumder, E.Mrudnick, "Genetic Algorithm for VLSI Design,Layout and test Automation",
Prentice Hall,1998.

3.Stephen Boyd, Lieven Vandenberghe "Convex Optimization", Cambridge University Press,

CMOS RF CIRCUIT DESIGN

Course Code :15 EC 52O1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to RF Design and Wireless Technology: Design and Applications, Complexity and Choice of Technology. Basic concepts in RF design: Nonlinearly and Time Variance, Inter symbol interference, random processes and noise. Sensitivity and dynamic range, conversion of gains and distortion **RF Modulation:** Analog and digital modulation of RF circuits, Comparison of various techniques for power efficiency, Coherent and non-coherent detection, Mobile RF communication and basics of Multiple Access techniques. Receiver and Transmitter architectures, Direct conversion and two-step transmitters **RF Testing:** RF testing for heterodyne, Homodyne, Image reject, Direct IF and sub sampled receivers. **BJT and MOSFET behavior at RF Frequencies:** BJT and MOSFET behavior at RF frequencies, modeling of the transistors and SPICE model, Noise performance and limitations of devices, integrated parasitic elements at high frequencies and their monolithic implementation **RF Circuits Design:** Overview of RF Filter design, Active RF components & modeling, Matching and Biasing Networks. Basic blocks in RF systems and their VLSI implementation, Low noise Amplifier design in various technologies, Design of Mixers at GHz frequency range, Various mixers-working and implementation. Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Radio frequency Synthesizers- PLLS, Various RF synthesizer architectures and frequency dividers, Design issues in integrated RF filters.

TEXT BOOKS

1. B. Razavi, “RF Microelectronics” PHI 1998
2. R. Jacob Baker, H.W. Li, D.E. Boyce “CMOS Circuit Design, layout and Simulation”, PHI

REFERENCE BOOKS

1. Thomas H. Lee “Design of CMOS RF Integrated Circuits” Cambridge University press 1998.
2. Y.P. Tsividis, “Mixed Analog and Digital Devices and Technology”, TMH 1996

ADVANCED DIGITAL IC DESIGN

Course Code :15 EC 52T2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Implementation Strategies for Digital ICs: Introduction, From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design Methodology, Standard Cell, Compiled Cells, Macrocells, Megacells and Intellectual Property, Semi-Custom Design Flow, Array-Based Implementation Approaches, Pre-diffused (or Mask-Programmable) Arrays, Prewired Arrays, Perspective—The Implementation Platform of the Future. **Coping with Interconnect:** Introduction, Capacitive Parasitics, Capacitance and Reliability—Cross Talk, Capacitance and Performance in CMOS, Resistive Parasitics, Resistance and Reliability—Ohmic Voltage Drop, Electromigration, Resistance and Performance—RC Delay. **Timing Issues in Digital Circuits:** Introduction, Timing Classification of Digital Systems,Synchronous Interconnect, Mesochronous interconnect, Plesiochronous Interconnect, Asynchronous Interconnect, Synchronous Design — An In-depth Perspective, Synchronous Timing Basics, Sources of Skew and Jitter, Clock-Distribution Techniques, Synchronizers and Arbiters, Synchronizers— Concept and Implementation, Arbiters, Clock Synthesis and Synchronization Using a Phase-Locked Loop, Basic Concept, Building Blocks of a PLL. **Designing Arithmetic Building Blocks: I**ntroduction, The Adder, The Binary Adder: Definitions, The Full Datapaths in Digital Processor Architectures, Adder: Circuit Design Considerations, The Binary Adder: Logic Design Considerations, The Multiplier, The Multiplier: Definitions, Partial- Product Generation, Partial Product Accumulation, Final Addition, Multiplier Summary, The Shifter, Barrel Shifter, Logarithmic Shifter. **Designing Memory and Array Structures:** Introduction, Memory Classification, Memory Architectures and Building Blocks, The Memory Core, Read-Only Memories, Nonvolatile Read-Write Memories, Read-Write Memories (RAM), Contents-Addressable or Associative Memory (CAM), Memory Peripheral Circuitry, The Address Decoders, Sense Amplifiers, Voltage References, Drivers/Buffers, Timing and Control.

TEXTBOOKS

1.Kamran Ehraghian, Dauglas A. Pucknell and Sholeh Eshraghiam, “Essentials of VLSI Circuits and Systems” – PHI, EEE, 2005 Edition.

2.Neil H. E. Weste and David. Harris Ayan Banerjee,, “CMOS VLSI Design” - Pearson Education.

REFERENCES

1. Sung-Mo Kang, Yusuf Leblebici,"CMOS Digital Integrated Circuits" TMH 2003
2. Jan M. Rabaey, "Digital Integrated Circuits" Pearson Education, 2003
3. Wayne Wolf, "Modern VLSI Design ", 2nd Edition, Prentice Hall,1998.

SIMULATION BOOKS

1. Etienne Sicard, Sonia Delmas Bendhia, "Basics of CMOS Cell Design", TMH, EEE, 2005.

NANO SENSORS AND ITS APPLICATIONS

Course Code :15 EC 52T3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Sensor Characteristics And Physical Effects: Active and Passive sensors – Static characteristic - Accuracy, offset and linearity – Dynamic characteristics - First and second order sensors – Physical effects involved in signal transduction- Photoelectric effect – Photo dielectric effect – Photoluminescence effect – Electroluminescence effect – Hal effect – Thermoelectric effect – Peizoresistive effect – Piezoelectric effect – Pyroelectric effect –Magneto-mechanical effect (magnetostriction) – Magneto resistive effect. **Nano Based Inorganic Sensors:** Density of states (DOS) – DOS of 3D, 2D, 1D and 0D materials – one dimensional gas sensors:- gas sensing with nanostructured thin films – absorption on surfaces – metal oxide modifications by additives – surface modifications – nano optical sensors – nano mechanical sensors – plasmon resonance sensors with nano particles – AMR, Giant and colossal magneto resistors – magnetic tunneling junctions. **Organic / Biosensors:** Structure of Protein – role of protein in nanotechnology – using protein in nanodevices – antibodies in sensing – antibody in nano particle conjugates – enzymes in sensing – enzyme nanoparticle hybrid sensors – Motor proteins in sensing – transmembrane sensors – Nanosensors based on Nucleotides and DNA – Structure of DNA – DNA decoders and microarrays – DNA protein conjugate based sensors – Bioelectronic sensors – DNA sequencing with nanopores – sensors based on molecules with dendritic architectures – biomagnetic sensors. **Nano Sensors:**Temperature Sensors, Smoke Sensors, Sensors for aerospace and defense: Accelerometer, Pressure Sensor, Night Vision System, Nano tweezers, nano-cutting tools, Integration of sensor with actuators and electronic circuitry Biosensors. **Applications:** Cantilever array sensors - Cantilever sensors for diagnosis of diabetes mellitus - Cantilever sensors for cancer diagnosis - Nanotube based sensors - Nanotube based sensors for DNA detection - Nanotube based sensors for capnography - Nanowire based sensors - Nanowire based electrical detection of single viruses - Nanowire based electrical detection of biomolecules. **Detectors and Applications:** Bio receptors –Bio detectors - Nano array based detector - Nano Particle based detector - Ultra-sensitive detection of pathogenic biomarkers - Ultra-sensitive detection of single bacteria.

REFERENCES:

1. Kourosh Kalantar – Zadeh, Benjamin Fry, "Nanotechnology- Enabled Sensors", Springer,
2. H.Rosemary Taylor, "Data acquisition for sensor systems", Chapman & Hall, 1997.
3. Jerome Schultz, Milan Mrksich, Sangeeta N. Bhatia, David J. Brady, Antonio J. Ricco, David
4 R. Walt, Charles L. Wilkins, "Biosensing: International Research and Development", Springer,

5. Ramon Pallas-Areny, John G. Webster, “Sensors and signal conditioning” John Wiley & Sons, 2001.
6. Vijay.K.Varadan, Linfeng Chen, Sivathanupillai, “Nanotechnology Engineering in Nano and Biomedicine”, John Wiley & Sons, 2010.

ASIC DESIGN FLOW

Course Code :15 EC 52T4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Types of ASICs – Design flow – Economics of ASICs – ASIC cell libraries – CMOS logic cell data path logic cells – I/O cells – cell compilers. **ASIC Library design**: Transistors as resistors – parasitic capacitance – logical effort programmable ASIC design software: Design system – logic synthesis – half gate ASIC. **Low level design entry:** Schematic entry – low level design languages – PLA tools – EDIF – An overview of VHDL and verilog. Logic synthesis in verilog and & VHDL simulation. **CMOS System case studies: Dynamic warp processor:** Introduction, the problem, the algorithm, a functional overview, detailed functional specification, structural floor plan, physical design, fabrication. **pixels-planes graphic engine:** introduction, raster scan graphic fundamental, pixels-planes system overview, chip electrical design, chip organization and layout, clock distribution. **Hierarchical layout and design of single chip 32 bit CPU:** Introduction ,design methodology, technology updatability and layout verification. **Floor planning & placement:** Floor Planning Goals and Objectives**,** Measurement of Delay in floor planning, Floor planning tools ,I/O and Power planning, Clock planning ,Placement Algorithms**. Routing**: Global routing, Detailed routing ,Special routing.

TEXT BOOKS

1. Application specific Integrated Circuits”, J.S. Smith, Addison Wesley.
2. Principles of CMOS VLSI Design : A System Perspective, N. Westle & K. Eshraghian ,Addison – Wesley Pub.Co.1985.

REFERENCES

1. Basic VLSI Design :Systems and Circuits, Douglas A. Pucknell & Kamran Eshraghian, Prentice Hall of India Private Ltd. , New Delhi , 1989.
2. Introduction to VLSI System,C. Mead & L. Canway, Addison Wesley Pub
3. Introduction to NMOS & VLSI System Design, A. Mukharjee, Prentice Hall,
4. The Design & Analysis of VLSI Circuits, L. A. Glassey & D. W. Dobbepahl, Addison Wesley Pub Co. 1985.
5. Digital Integrated Circuits: A Design Perspective, Jan A. Rabey, Prentice Hall of India Pvt Ltd

M.TECH - EMBEDDED SYSTEMS

First Year (First Semester):

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Credits
1	15 EM 5101	Microcontrollers for Embedded System Design.	3	0	2	4
2	15 EM 5102	Real Time Concepts for Embedded Systems	3	2	0	4
3	15 EM 5103	VLSI Technology & Design	3	0	2	4
4	15 EM 5104	Wireless Communications & Networks	3	2	0	4
5		Elective – 1	3	0	0	3
6		Elective - 2	3	0	0	3
7	15 IE 5149	Seminar	0	0	4	2
Total			18	4	8	24

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Credits
1	15 EM 5205	RSIC processor Architecture and Programming	3	0	2	4
2	15 EM 5206	Digital Signal Processors and Architectures	3	2	0	4
3	15 EM 5207	Advanced Embedded Systems Design	3	2	0	4
4	15 EM 5208	Linux System Concepts	3	0	2	4
5		Elective – 3	3	0	0	3
6		Elective - 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
Total			18	4	8	24

Second Year (First & Second Semester) :

S.No	**Course code**	**Course Title**	**Periods L**	**Periods T**	**Periods P**	**Credits**
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 EM 51A1	CPLD & FPGA Architectures and Applications	3	0	0	3
2	15 EM 51A2	Robotics	3	0	0	3
3	15 EM 51A3	System Modeling and Simulation	3	0	0	3
Elective-2						
1	15 EM 51B1	Embedded Real Time Operating Systems	3	0	0	3
2	15 EM 51B2	Object Oriented Analysis and Design	3	0	0	3
3	15 EC 51R1	Image and Video Processing	3	0	0	3
Elective-3						
1	15 EM 52C1	Networking of Embedded Systems	3	0	0	3
2	15 EM 52C2	Ad-hoc & Wireless Sensor Networks	3	0	0	3
3	15 EM 52C3	Cryptography and Network Security	3	0	0	3
Elective-4						
1	15 EM 52D1	Embedded Linux and Basics of Device drivers	3	0	0	3
2	15 EM 52D2	SOC Design and Verification	3	0	0	3
3	15 EM 52D3	Advanced Computer Networks	3	0	0	3

MICRO CONTROLLERS FOR EMBEDDED SYSTEM DESIGN

Course Code :15 EM 5101 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to Embedded Systems
Overview of Embedded Systems, Processor Embedded into a system, Embedded Hardware Units and Devices in system, Embedded Software, Complex System Design, Design Process in Embedded System, Formalization of System Design, Classification of Embedded Systems.
Microcontrollers and Processor Architecture & Interfacing
8051 Architecture. Real world interfacing, Introduction to advanced architectures, processor & memory organization, Instruction-level parallelism, and performance metrics.
PIC Microcontroller Hardware
Introduction, Architectural overview, Memory organization, interrupts and reset, I/O ports, Timers
Device Drivers & Interrupt service Mechanism
Programmed-I/O Busy-wait approach without ISM,ISR concept, Interrupt sources, Interrupt service mechanism, Multiple Interrupts, context and the periods for context switching, Interrupt latency and deadline, Classification of processors ISM from context-saving angle, Direct Memory Access, Device driver programming
Devices &Communication Buses for Devices Network
IO Types and examples, Serial communication Devices, Parallel Device ports, Networked Embedded systems, Serial Bus communication protocols

Text Books:
1. Embedded Systems - Architecture Programming and Design – Raj Kamal, 2nd ed., 2008, TMH.
2. Embedded C Programming and the Microchip PIC-Richard Barnett, O" Cull, Cox, 2009, Cengage Learning.

Reference Books:
1. Embedded Microcomputer Systems, Real Time Interfacing – Jonathan W. Valvano – Brookes Cole, 1999, Thomas Learning

REAL TIME CONCEPTS FOR EMBEDDED SYSTEMS

Course Code :15 EM 5102 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: Examples of Embedded Systems, Definition of Embedded Systems, Architecture of Embedded Systems, Real- Time Embedded Systems, Design Issues and Current Trends for Embedded Systems

Hard versus soft Real- Time Systems: Jobs and Processes, Release Times, Deadlines and Timing Constraints, Hard and Soft Timing Constraints, Hard Real Time Systems, Soft Real Time Systems

A Reference Model of Real – Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency, Functional Parameters- preemptivity of jobs, criticality of jobs, Resource Parameters of Jobs and Parameters of Resources, Scheduling Hierarchy- Scheduler and Schedules, Feasibility, Optimality and Performance Measures.

Classification of Real Time Scheduling Approaches: Clock- Driven Approach, Weighted Round- Robin Approach, Priority- Driven Approach, Dynamic versus Static Systems, Effective Release Times and Deadlines, optimality of the EDF and LST algorithms, Non optimality of the EDF and LST algorithms, Challenges in validating timing constraints in priority –driven systems Off-line versus On-line Scheduling

Clock-Driven Scheduling : Notations and Assumptions, Static, Timer -Driven Scheduler, General Structure of Cyclic Schedules, Cyclic Executives, Improving the Average Response Time of Aperiodic Jobs, Scheduling Sporadic Jobs-Acceptance test ,EDF Scheduling of accepted jobs and implementation, Pros and Cons of Clock Driven Scheduling,

Priority-Driven Scheduling of Periodic Tasks: Static Assumption, Fixed Priority v/s Dynamic Priority Algorithms, schedulability test for the EDF algorithm, a schedulability test for fixed priority tasks with short response times-time demand analysis, schedulability test for fixed priority tasks with arbitrary response times: busy intervals, general schedulability test, sufficient schedulability conditions for RM & DM algorithms: schedulable utilization of the RM algorithm for tasks with Di=pi, schedulable utilization of fixed priority tasks with arbitrary relative deadlines

Scheduling Aperiodic and Sporadic Jobs in Priority-Driven Systems: Assumptions and Approaches, Deferrable Servers- Operations of Deferrable Servers, Constant utilization server Scheduling of sporadic jobs-a simple acceptance test in deadline driven systems, a simple acceptance test in fixed- priority driven systems

Resources and Resource Access control: Assumptions on Resources and Their Usage, Effects of Resource Contention and Resource Access Control, Non-preemptive Critical Sections, Basic

Priority Inheritance Protocol, Basic Priority Ceiling Protocol- Definition, computation of blocking time, controlling accesses to Multiple Unit Resources

Real-Time Operating Systems: Overview- Threads and Tasks, The Kernel, Time Services and Scheduling Mechanisms- Time Services, Scheduling Mechanisms, Other Basic Operating System Functions- Communication and Synchronization, Event Notification and Software Interrupt, Memory Management, I/O and Networking

TEXT BOOKS:

1. Real Time Systems – By Jane W.S.Liu -Low Price Edition , Pearson Education Asia
2. Real-Time Concepts for Embedded Systems - Qing Li with Caroline Yao published by CMP Books.

VLSI TECHNOLOGY & DESIGN

Course Code :15 EM 5103 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Review of Microelectronics and Introduction to MOS Technologies: MOS, CMOS, BiCMOS Technology.

Basic Electrical Properties of MOS, CMOS &BiCMOS Circuits: Ids-Vds relationships, Threshold Voltage Vt, Gm, Gds and ωo, Pass Transistor, MOS, CMOS & Bi CMOS Inverters, Zpu/Zpd, MOS Transistor circuit model, Latch-up in CMOS circuits.

Layout Design and Tools: Transistor structures, Wires and Bias, Scalable Design rules, Layout Design and Tools.

Logic Gates & Layouts: Static Complementary Gates, Switch Logic, Alternative Gate circuits, Low power gates, Resistive and Inductive interconnect delays.

Combinational Circuit Design: Delay Estimation, Logical Effort and Transistor Sizing , Power Dissipation, Circuit Families, Circuit Pitfalls, Low-power Logic Design, Comparison of Circuit Families, Silicon-on-Insulator Circuit Design

Sequential Circuit Design: Introduction, Sequencing Static Circuits, Circuit Design of Latches and Flip-flops: Conventional CMOS Latches and Flip-Flops, Pulsed Latches, Resettable Latches and Flip-Flops, Enabled Latches and Flip-flops. Static Sequencing Element Methodology: Choice of Elements, Low-power Sequential Design. Synchronizers: A simple synchronizer, arbiter.

Floor Planning and System Design: Floor planning methods, Global interconnect, Floor Plan design, off-chip connections, Register Transfer Design, Pipelining

Text Books:

1. Essentials of VLSI Circuits and Systems, K. Eshraghian. D, A.Pucknell, 2005, PHI.
2. Modern VLSI Design - Wayne Wolf, fourth edition, Pearson Education.

3. CMOS VLSI Design A Circuits and systems perspective Third Edition Neil H.E.Weste

References:

1. Introduction to VLSI systems – A Logic, Circuit and System Perspective- Ming Bo, Liu, CRC Press, 1st Edition 2011.
2. Principals of CMOS VLSI Design – N.H.E Weste, K.Eshraghian, 2nd ed., Adisson Wesley.

WIRELESS COMMUNICATIONS & NETWORKS

Course Code :15 EM 5104 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction to Mobile and Wireless Landscape: Definition of Mobile and Wireless, Components of Wireless Environment, Challenges, Applications, Overview of Wireless Networks, Categories of Wireless Networks, open Research topics.
Wireless LAN: Infra redVs radio transmission, Infrastructure and Ad-hoc Network,
IEEE 802.11: System architecture, Protocol architecture. **Bluetooth:** User scenarios, Architecture.

Global System for Mobile Communications (GSM): Introduction, Mobile services, System architecture, Radio interface, Localization and calling, Handover, Security.
(Wireless) Medium Access Control: Motivation for a specialized MAC (Hidden and exposed terminals, Near and far terminals), SDMA, FDMA, TDMA, CDMA.

Mobile Network Layer:
Mobile IP: Goals, assumptions, entities and terminology, IP packet delivery, agent advertisement and discovery, registration, tunneling and encapsulation, optimizations, Dynamic Host Configuration Protocol (DHCP).
Mobile Ad hoc Networks (MANETs): Overview, Properties of a MANET, spectrum of MANET applications, routing and various routing algorithms.

Mobile Transport Layer: Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission /time-out freezing, Selective retransmission, Transaction oriented TCP.

Broadcast Systems: Overview, Cyclical repetition of data, Digital audio broadcasting: Multimedia object transfer protocol, Digital video broadcasting: DVB data broadcasting, DVB for high-speed internet access, Convergence of broadcasting and mobile communications.

Text Book:

1. Jochen Schiller, “Mobile Communications”, Pearson Education, Second Edition, 2009.

REFERENCE BOOKS:

1. MartynMallick, “Mobile and Wireless Design Essentials”, Wiley, 2008.
2. Asoke K Talukder, et al, “Mobile Computing”, Tata McGraw Hill, 2008.
3. Mobile Computing, Raj Kamal,Oxford University Press.
4. William Stallings, “ Wireless Communications & Networks”, Person, Second
5. Edition, 2007.
6. JimGeier, “Wireless Networks first-step”, Pearson, 2005.

CPLD AND FPGA ARCHITECTURES AND APPLICATIONS

Course Code :15 EM 51A1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Programmable Logic Devices:
Introduction, Simple Programmable Logic Devices – Read Only Memories, Programmable Logic Arrays, Programmable Array Logic, Programmable Logic Devices/Generic Array Logic; Complex Programmable Logic Devices – Architecture of Xilinx Cool Runner XCR3064XL CPLD Implementation of a Parallel Adder with Accumulation.
Field Programmable Gate Arrays:
Organization of FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, and Programmable I/O blocks in FPGAs, Dedicated specialized Components of FPGAs, and Applications of FPGAs.
SRAM Programmable FPGAs:
Introduction, Programming Technology, Device Architecture, The Xilinx XC2000, XC3000 And XC4000 Architectures.
Anti-Fuse Programmed FPGAs:
Introduction, Programming Technology, Device Architecture, The Actel ACT1, ACT2 and ACT3 Architectures.
Design Applications:
General Design Issues, Counter Examples, A Fast Video Controller, A position Tracker for a Robot Manipulator, A Fast DMA Controller, Designing Counters with ACT devices, Designing Adders and Accumulators with the ACT Architecture.

TEXTBOOKS:

1.Field Programmable Gate Array Technology by Stephen M. Trimberger, Springer International Edition.
2.Digital Systems Design by Charles H. Roth Jr, Lizy Kurian John, Cengage Learning.

REFERENCE BOOKS:

1. Field Programmable Gate Arrays by John V. Oldfield, Richard C. Dorf, Wiley India.
2. Digital Design Using Field Programmable Gate Arrays by Pak K. Chan/Samiha Mourad,

Pearson Low Price Edition.
3. Digital Systems Design with FPGAs and CPLDs by Ian Grout, Elsevier, Newnes.
4. FPGA based System Design by Wayne Wolf, Prentice Hall Modern Semiconductor Design Series.

ROBOTICS

Course Code :15 EM 51A2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction & Basic Definitions: Introduction, Control Programs for Robots, Industry Applications of Robots, Pick and Place, Gantry and Armtype Robots in typical set-ups like Automobile Industry
Coordinate Systems: Cartesian, Cylindrical, Polar, and Revolute systems: Robot Positioning: Robot Arms; Axes, their ranges, offset and In-line Wrist: Roll, Pitch and Yaw, their meaning in Robotics

Mechanical Aspects: Kinematics, Inverse Kinematics, Motion planning and Mobile Mechanisms

Sensors and Applications: Range and Use of Sensors, Micro switches, Resistance Transducers, Piezo-electric, Infrared and Lasers. Applications of Sensors : Reed Switches, Ultrasonic, Barcode Readers and RFID

Robot Systems: Hydraulic and Electrical Systems including pumps, valves, solenoids, cylinders, stepper motors, Encoders andAC Motors

Programming of Robots: Programming of Robots such as Lego Robots, Programming environment, Example Applications, Safetyconsiderations

Text Books:
1. Introduction to Robotics – P.J.Mckerrow, ISBN : 0201182408
2. Introduction to Robotics – S.Nikv, 2001, Prentice Hall,
3. Mechatronics and Robotics: Design & Applications – A.Mutanbara, 1999,CRC Press.

References:
1. Robotics – K.S.Fu, R.C.Gonzalez and C.S.G.Lee, 2008, TMH.

SYSTEM MODELING AND SIMULATION

Course Code :15 EM 51A3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Basic Simulation Modeling, Systems, Models and Simulation, Nature of Systems, event Driven Models, Simulation of Single Server Queuing System, event Driven Models, Characterizing Systems, Simulation Diagrams.
Stochastic generators: Uniformly Distributed Random Numbers, Statistical Properties of U[0,1] generators, Generation of Non-Uniform and Arbitrary Random Variates, Random processes, Characterizing and Generating Random
Processes, White Noise. Modeling Time Driven Systems: Modeling Input Signals, Discrete and Distributed Delays, System Integration, Linear Systems.
Exogenous Signals and Events: Disturbance Signals, State Machines, Petri Nets and their Analysis, System Encapsulation.
Markov Process: Probabilistic Models, Discrete Time Markov Processes, Random Walks, Poisson Processes, Exponential Distribution, Simulating a Poisson Process, Continuous Time Markov Process Event Driven Models: Simulation Diagrams, Queuing Theory, M/M/I Queues, Simulating Queuing Systems, Finite Capacity Queues, Multiple Servers, M/M/C Queues.
System Optimization: System Identification, Searches, Alpha / Beta trackers, Multidimensional Optimization, Modeling and Simulation Methodology.
Simulation Software and Building Simulation Models:
Comparison of Simulation Packages with Programming Languages, Classification of Simulation Software, Desirable software features, General Purpose Simulation Packages-Arena, Extend; Guide lines for determining the level of Model detail, Techniques for increasing Model Viability and credibility.

TEXT BOOKS:
1. System Modeling and Simulation: An Introduction – Frank L. Severance, 2001,John Wiley&Sons.
2. Simulation Modeling and Analysis - Averill M.Law, W.David Kelton, , 3 ed., 2003, TMH.

REFERENCES:
Systems Simulation-Geoffery Gordan, PHI.

EMBEDDED REAL TIME OPERATING SYSTEMS

Course Code :15 EM 51B1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Introduction to UNIX/LINUX, Overview of Commands, File I/O (open, create, close, lseek, read, write), Process Control (fork, vfork, exit, wait, waitpid, exec).

Real Time Operating Systems: Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, asks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, **Operations and Use**

Objects, Services and I/O

Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem

Exceptions, Interrupts and Timers: Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.

RT Linux, MicroC/OS-II, Vx Works, Embedded Linux, Tiny OS, and Basic Concepts of Android OS.

TEXT BOOKS:

1. Real Time Concepts for Embedded Systems – Qing Li, Elsevier, 2011

REFERENCE BOOKS:

1. Embedded Systems- Architecture, Programming and Design by Rajkamal, 2007, TMH.
2. Advanced UNIX Programming, Richard Stevens
3. Embedded Linux: Hardware, Software and Interfacing – Dr. Craig Hollabaugh

OBJECT ORIENTED ANALYSIS & DESIGN

Course Code :15 EM 51B2	**L-T-P : 3-0-0**
Pre-requisite: NIL	**Credits: 3**

Syllabus:

Methodology, Modeling: Object-oriented Methodologies; Rumbaugh et al.'s Object Modeling Technique; The Booch Methodology; The Jacobson et al. Methodologies; Patterns; Frameworks; The Unified Approach.

Unified Modeling Language: Introduction; Static and Dynamic Models; Modeling ; Introduction to the Unified Modeling Language; UML Diagrams; UML Class Diagram; Use-Case Diagram; UML Dynamic Modeling; Model Management: Packages and Model Organization; UML Extensibility; UML Meta-Model.

Object-Oriented Analysis: Use-Case Driven: Object-Oriented Analysis Process: Identifying use cases: Introduction; Why Analysis is a Difficult Activity; Business Object Analysis: Understanding the Business Layer; Use-Case Driven Object-Oriented Analysis: The Unified Approach; Business Process Modeling; Use-Case Model; Developing Effective Documentation; Case-Study: Analyzing the Via Net Bank ATM-The Use-Case Driven Process. **Classification:**

Introduction; classifications Theory; Approaches for Identifying Classes; Noun Phrase Approach; Common Class Patterns Approach; Use-Case Driven Approach: Identifying Classes and Their Behaviors through Sequence/Collaboration Modeling; Classes, Responsibilities, and Collaborators.
Identifying Object Relationships, Attributes, And Methods: Introduction; Associations; Super-Sub Class Relationships; A-Part-of Relationships-Aggregation; Case Study: Relationship Analysis for the Via Net Bank ATM System; Class Responsibility: Identifying Attributes and Methods; Class Responsibility: Defining Attributes by Analyzing Use Cases and Other UML Diagrams; Defining Attributes for Via Net Bank Objects; Object Responsibility: Methods and Messages; Defining Methods for Via Net Bank Objects. **The Object-Oriented Design Process And Design Axioms:** Introduction; The Object-Oriented Design Process; Object-Oriented Design Axioms; Corollaries.
Designing Classes: Introduction; The Object-Oriented Design Philosophy; UML Object Constraint Language; Designing Classes: The Process; Class Visibility: Designing Well-Defined Public, Private, and Protected Protocols; Designing Classes: Refining Attributes; Refining Attributes for the Via Net Bank Objects; Designing Methods and Protocols; Designing Methods for the Via Net Bank Objects; Packages and Managing Classes. **View Layer:** Designing Interface Objects: Introduction; User Interface Design as a Creative Process; Designing View Layer Classes;
Macro-Level Process: Identifying View Classes by Analyzing Use Cases; Micro-Level Process.

Text Books:

(1) Object Oriented Systems Development by Ali Bahrami Tata McGraw Hill International Editions, Computer Science Series.

Reference Books:

(1) Unified Modeling Language Reference Manual, James Rumbaugh, Jacobson, Booch, PHI.
(2) The Unified Software Development Process, Ivar Jacobson, Grady Booch, James Rumbaugh, Pearson Education.

IMAGE AND VIDEO PROCESSING

Course Code :15 EC 51R1	**L-T-P : 3-0-0**
Pre-requisite: NIL	**Credits: 3**

Syllabus:

Fundamentals of Image processing and Image Transforms: Basic steps of Image processing system sampling and quantization of an Image – Basic relationship between pixels Image Transforms: 2 – D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms **Image Processing Techniques:** Image Enhancement: Spatial Domain methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering Image Segmentation: Segmentation concepts, point, line and Edge detection, Thresholding, region based segmentation **Image Compression** Image compression fundamentals – coding Redundancy, spatial and temporal redundancy. Compression models : Lossy and Lossless, Huffmann coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, transform coding, predictive coding , wavelet coding, JPEG standards **Basic Steps of Video Processing:** Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals, filtering operations **2-D Motion Estimation:** Optical flow, general methodologies, pixel based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding.

TEXT BOOKS
1. Gonzaleze and Woods ,"Digital Image Processing ", 3rd edition , Pearson
2. Yao wang, Joem Ostarmann and Ya – quin Zhang, "Video processing and communication ",1st edition , PHI

REFERENCE TEXT BOOK
1. M. Tekalp ,"Digital video Processing", Prentice Hall International

SIMULATION TEXT BOOKS
1. Relf, Christopher G.,"Image acquisition and processing with LabVIEW", CRC press
2. Aner ozdemi R, "Inverse Synthetic Aperture Radar Imaging with MATLAB Algorithms", John Wiley & Sons
3. Chris Solomon, Toby Breckon ,"Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab", John Wiley & Sons,

RISC PROCESSOR ARCHITECTURE AND PROGRAMMING

Course Code :15 EM 5205 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

MSP430 – 16-bit Microcontroller family: CPU architecture, Instruction set, Interrupt mechanism, Clock system, Memory subsystem, bus –architecture, the assembly language and 'C' programming for MSP-430 microcontrollers.

Low Power embedded systems: On-chip peripherals, Examples of applications.

On-chip peripherals: digital input, output, Liquid crystal display, Watchdog timer, Op-Amp, Timer, Basic Timer, Real Time Clock (RTC),

Mixed signal systems: Comparator, Analog-to-digital conversion- general issues, Successive approximation, Sigma delta, signal conditioning using operational amplifiers and Digital-to-analog conversion.

Low power features of MSP430: Clock system, low-power modes, Clock request feature, Low-power programming and interrupts.
Communication peripherals: Serial peripheral interface, Inter-integrated circuit bus, Asynchronous serial communication
Applications of MSP430: Thermometer using I2C–Low Power RF circuits; Pulse Width Modulation (PWM) in Power Supplies.
32 bit microcontroller: ARM Cortex M0 technical overview, Architecture, ARM Cortex M0 operation modes, Registers & Special Registers, Stack Pointer, Link Register, Program Counter, combined Program Status Register
Instruction set: moving data, memory access, arithmetic & logic operations, shift & rotate, Instruction usage examples.
Memory System: memory map, program memory, boot loading, data memory, Little endian and Big endian support, memory attributes
xceptions and interrupts: Exception types, exception priority definition, vector table, Interrupt control & system control, overview of NVIC and Control block features, Interrupt Enable and Clear Enable, Interrupt pending status. 11
Introduction to ARM Cortex M3 & M4: Technical overview, Comparison of features of Cortex M0, M3 & M4.

Text Books:

1. John H. Davies, “MSP430 Microcontroller Basics”, Newnes (Elsevier Science), 2nd Edition, 2008.
2. Joseph Yiu “The Definitive Guide to the ARM Cortex-M0”, Newnes, (Elsevier), 2011.
3. MSP430 Teaching CD-ROM, Texas Instruments, 2008.
4. Sample Programs for MSP430 downloadable from msp430.com
5. David Patterson and John L. Hennessey, “Computer Organization and Design”, (ARM Edition), 3rd Revised Edition, Morgan Kauffman Publishers, 2007.

DIGITAL SIGNAL PROCESSORS AND ARCHITECTURES

Course Code :15 EM 5206 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction To Digital Signal Processing: Introduction, A Digital signal-processing system, The sampling process, Discrete time sequences. DiscreteFourier Transform (DFT) and Fast Fourier Transform (FFT), linear time-invariant systems, Digital filters, Decimation and interpolation
Computational Accuracy in DSP Implementations: Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of errorin DSP

implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.

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, Features for External interfacing.

Programmable Digital Signal Processors: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and Programming, On-Chip Peripherals, Interrupts of TMS320C54XX processors, Pipeline Operation of TMS320C54XX Processors.

Analog Devices Family of DSP Devices: Analog Devices Family of DSP Devices- ALU and MAC block diagram, Shifter Instruction, Base Architecture of ADSP2100, ADSP-2181 high performance Processor.

Introduction to Blackfin Processor – The Blackfin Processor, Introduction to Micro Signal Architecture, Overview of Hardware Processing Units and Register files, Address Arithmetic Unit, Control Unit, Bus Architecture and Memory, Basic Peripherals.

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).

Text Books

1. Digital Signal Processing – Avtar Singh and S. Srinivasan, Thomson Publications, 2004.
2. A Practical Approach to Digital Signal Processing – K Padmanabhan, R. Vijayarajeswaran, Ananthi.S, New Age International, 2006/2009.
3. Embedded Signal Processing with the Micro Signal Architecture Publisher: Woon-Seng Gan, Sen M. Kuo, Wiley-IEEE Press, 2007.

References

1. Digital Signal Processors, Architecture, Programming and Applications – B. Venkataramani and M. Bhaskar, 2002, TMH.
2. Digital Signal Processing – Jonatham Stein, 2005, John Wiley.
3. DSP Processor Fundamentals, Architecture & Features- Lapsley et al. 2000, S. Chand & Co.
4. Digital Signal Processing Applications Using the ADSP-2100 Family by The Applications Enguneering Staff of Analog Devices, DSP Division, Edited by Amy Mar, PHI.
5. The Scientist and Engineering’s Guide to Digital Signal Processing by Steven W. Smith, Ph.D., California Technical Publishing, ISBN 0-9660176-3-3, 1997.
6. Embedded Media Processing by David J. Katz and Rick Gentile of Analog Devices, Newnes, ISBN 0750679123, 2005.

ADVANCED EMBEDDED SYSTEMS DESIGN

Course Code :15 EM 5207 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Co- Design Issues
Co- Design Models, Architectures, Languages, A Generic Co-design Methodology.
Co- Synthesis Algorithms:
Hardware software synthesis algorithms: hardware – software partitioning distributed system co-synthesis.
Prototyping and Emulation:
Prototyping and emulation techniques, prototyping and emulation environments, future developments in emulation and prototyping
Target Architectures:
Architecture Specialization techniques, System Communication infrastructure, Target Architecture and Application System classes, Architecture for control dominated systems (8051-Architectures for High performance control), Architecture for Data dominated systems (ADSP21060, TMS320C60), Mixed Systems.
Compilation Techniques and Tools for Embedded Processor Architectures:
Modern embedded architectures, embedded software development needs, compilation technologies practical consideration in a compiler development environment.
Design Specification and Verification:
Design, co-design, the co-design computational model, concurrency coordinating concurrent computations, interfacing components, design verification, implementation verification, verification tools, interface verification
Languages for System – Level Specification and Design-I
System – level specification, design representation for system level synthesis, system level specification languages.
Languages for System – Level Specification and Design-II
Heterogeneous specifications and multi-language co-simulation the cosyma system and lycos system

Text Books:
1. Hardware / software co- design Principles and Practice – Jorgen Staunstrup, Wayne Wolf – 2009, Springer.
2. Hardware / software co- design Principles and Practice, 2002, kluwer academic publishers

LINUX SYSTEM CONCEPTS

Course Code :15 EM 5208 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

GNU Development tools: Compilation tools and its functionalities, Debugging applications, Using Make, Creating Libraries.

Operating Systems Concepts: Structure of Linux Operating System, Process Management, Memory Management, File System Management, I/O Management, Networking Subsystem.

Introduction Linux Kernel: Linux installation, partitioning, Compilation of open sources, Configuration & Compilation of kernel sources, Kernel modules, Implementing System Calls.

Linux Kernel Concepts: The proc file system, Unified Device Model and systems, Memory Management and Allocation, User and Kernel Space communication, Interrupt Handling. Kernel Debugging.

Linux Device drivers:, Skeleton of device drivers, Character Driver, Block Drivers, Building driver into the kernel
Networking in Linux: Sockets, a sample example

Text Books:

1. Programming Embedded Systems, 2nd Edition With C and GNU Development Tools by Michael Barr, Anthony Massa.
2. Michael Beck (1998), " Linux Kernel Internals", Addison Wealey
3. Doug Abbott. (2003), "Linux for Embedded and Real time Applications", Newnes publishers.

Reference Books:

1. Understanding the Linux Kernel, Third Edition Daniel P. Bovet , Marco Cesati, 3rd edition, Orally Publications
2. Linux Device Drivers, 3rd edition, Linux Device Drivers, 3rd Edition Jonathan Corbet, Alessandro Rubini , Greg Kroah-Hartman, Orally Publications
3. Advanced Programming in UNIX Environment– Richard Stevens, Addison-Wesley, 1992.
4. Linux Kernel Development, Robert Love, 2nd Edition, 2006, Pearson Education.

NETWORKING OF EMBEDDED SYSTEMS

Course Code :15 EM 52C1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

EMBEDDED COMMUNICATION PROTOCOLS: Embedded Networking: Introduction – Serial/Parallel Communication – Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming -ISA/PCI Bus protocols – Firewire.

USB Bus: Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types –Enumeration –Descriptors –PIC 18 Microcontroller USB Interface

CAN Bus: Introduction - Frames –Bit stuffing –Types of errors –Nominal Bit Timing – PIC microcontroller CAN Interface –A simple application with CAN.

EMBEDDED ETHERNET: Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.

WIRELESS EMBEDDED NETWORKING: Wireless sensor networks – Introduction – Applications – Network Topology – Localization –Time Synchronization - Energy efficient MAC protocols –SMAC – Energy efficient and robust routing – Data Centric routing

TEXT BOOKS

1. Frank Vahid, Givargis ‘Embedded Systems Design: A Unified Hardware/Software Introduction’, Wiley Publications
2. Jan Axelson, ‘Parallel Port Complete’, Penram publications
3. Dogan Ibrahim, ‘Advanced PIC microcontroller projects in C’, Elsevier 2008
4. Jan Axelson ‘Embedded Ethernet and Internet Complete’, Penram publications
5. Bhaskar Krishnamachari, ‘Networking wireless sensors’, Cambridge press 2005

AD-HOC & WIRELESS SENSOR NETWORKS

Course Code :15 EM 52C2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Ad Hoc Networks: Characteristics of MANETs, Applications of MANETs and challenges of MANETs - **Routing in MANETs:** Criteria for classification, Taxonomy of MANET routing algorithms, Topology based routing algorithms, Position based routing algorithms, Other routing algorithms.

Data Transmission: Broadcast storm problem, Broadcasting, Multicasting and Geocasting - **TCP over Ad Hoc:** TCP protocol overview, TCP and MANETs, Solutions for TCP over Ad hoc

Basics of Wireless Sensors and Applications: Applications, Classification of sensor networks, Architecture of sensor network, Physical layer, MAC layer, Link layer.

Data Retrieval in Sensor Networks: Routing layer, Transport layer, High-level application layer support, Adapting to the inherent dynamic nature of WSNs, Sensor Networks and mobile robots - **Security:** Security in Ad Hoc networks, Key management, Secure routing, Cooperation in MANETs, Intrusion Detection systems.

Sensor Network Platforms and Tools: Sensor Network Hardware, Berkeley motes, Sensor Network Programming Challenges, Node-Level Software Platforms - **Operating System:** TinyOS - **Imperative Language:** nesC, Dataflow style language: TinyGALS, Node-Level Simulators, ns-2 and its sensor network extension, TOSSIM

TEXT BOOKS:

1. Ad Hoc and Sensor Networks – Theory and Applications, *Carlos Corderio Dharma P.Aggarwal,* World Scientific Publications, March 2006, ISBN – 981-256-681-3
2. Wireless Sensor Networks: An Information Processing Approach, Feng Zhao, Leonidas Guibas, Elsevier Science, ISBN – 978-1-55860-914-3 (Morgan Kauffman)

CRYPTOGRAPHY & NETWORK SECURITY

Course Code :15 EM 52C3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: Attacks, Services and Mechanisms, Security attacks, Security services, A Model for Internetworksecurity. Classical Techniques: Conventional Encryption model, Steganography, Classical EncryptionTechniques.
Modern Techniques: Simplified DES, Block Cipher Principles, Data Encryption standard, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and Modes of operations.
Algorithms: Triple DES, International Data Encryption algorithm, Blowfish, RC5, CAST-128, RC2, Characteristics of Advanced Symmetric block cifers.

Conventional Encryption: Placement of Encryption function, Traffic confidentiality, Key distribution, Random Number Generation.
Public Key Cryptography: Principles, RSA Algorithm, Key Management, Diffie-Hellman Key exchange, Elliptic Curve Cryptography.
Number theory: Prime and Relatively prime numbers, Modular arithmetic, Fermat's and Euler's theorems, Testing for primality, Euclid's Algorithm, the Chinese remainder theorem, Discrete logarithms.
Message authentication and Hash functions: Authentication requirements and functions, Message Authentication, Hash functions, Security of Hash Functions and MACs
Hash and Mac Algorithms: MD File, Message digest Algorithm, Secure Hash Algorithm, RIPEMD-160, and HMAC. **Digital signatures and Authentication protocols**: Digital signatures, Authentication Protocols, Digital signature standards. **Authentication Applications**: Kerberos, X.509 directory Authentication service. Electronic Mail Security: Pretty Good Privacy, S/MIME.
IP Security: Overview, Architecture, Authentication, Encapsulating Security Payload, Combining security Associations, Key Management
Web Security
Web Security requirements, Secure sockets layer and Transport layer security, Secure Electronic Transaction. **Intruders, Viruses and Worms:**Intruders, Viruses and Related threats. **Fire Walls** Fire wall Design Principles, Trusted systems.

Text Book:
1. Cryptography and Network Security: Principles and Practice - William Stallings, 2000, PE.

References:
1. Principles of Network and Systems Administration, Mark Burgess,JohnWiel

EMBEDDED LINUX AND BASICS OF DEVICE DRIVERS

Course Code :15 EM 52D1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction: History of Embedded Linux, Embedded Linux versus Desktop Linux, Embedded Linux Distributions, Architecture of Embedded Linux, Linux Kernel Architecture, Linux Start-Up Sequence, GNU Cross-p\Platform Tool chain.

Board Support Package: Inserting BSP in Kernel Build Procedure, Boot Loader Interface, Memory Map, Interrupt Management, PCI Subsystem, Timers, UART, and Power Management.
Embedded Storage: Flash Map, MTD—Memory Technology Device, MTD Architecture, Flash-Mapping Drivers, MTD Block and Character devices, Embedded File systems, Optimizing Storage Space.

Embedded Drivers: Linux Serial Driver, Ethernet Driver, I2C subsystem on Linux, USB Gadgets, Watchdog Timer, and Kernel Modules.

Porting Applications: Architectural Comparison, Application Porting Road Map, Programming with Pthreads, Operating System Porting Layer (OSPL), Kernel API Driver.

Real-Time Linux: Linux and Real-Time, Real-Time Programming in Linux, Hard Real-Time Linux.

Text Books:

1. Embedded Linux System Design and Development, P.Raghavan, Amol Lad, SriramNeelakandan, 2006, Auerbach Publications

Reference Books:

1.Embedded Linux – Hardware, Software and Interfacing

SOC DESIGN AND VERIFICATION

Course Code :15 EM 52D2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Motivation for SoC Design - Review of Moore's law and CMOS scaling, benefits of system-on-chip integration in terms of cost, power, and performance, Comparison of System-on-Board, System-on-Chip, and System-in-Package, Typical goals in SoC design – cost reduction, power reduction, design effort reduction, performance maximization.
System on chip design process: A canonical SoC Design, SoC Design flow waterfall vs. spiral, top down vs. Bottom up. Specification requirement, Types of Specification, System Design process, System level design issues, Soft IP Vs Hard IP, hardware-software co-design, Design for timing closure, Logic design issues Verification strategy, On chip buses and interfaces.
VLSI System Testing & Verification: Introduction, A walk through the Test Process, Reliability, Logic Verification Principles, Silicon Debug Principles, Manufacturing Test Principles, Design for Testability, Boundary Scan
Embedded Memories – cache memories, flash memories, embedded DRAM, cache memories, Cache coherence, MESI protocol and Directory-based coherence.
Interconnect Architectures for SoC – Bus architecture and its limitations, Network on Chip (NOC) topologies, Mesh-based NoC, Routing in an NoC, Packet switching and wormhole routing.
MP SoCs: What, Why, How MP SoCs. Techniques for designing MP SoCs, Performance and flexibility for MP SoCs design

Case study: A Low Power Open Multimedia Application Platform for 3G Wireless 21

Test Books:

1. Sudeep Pasricha and Nikil Dutt, “On-Chip Communication Architectures: System on Chip Interconnect”, Morgan Kaufmann Publishers, 2008.
2. Rao R. Tummala, Madhavan Swaminathan, “Introduction to system on package sop-Miniaturization of the Entire System”, McGraw-Hill-2008.
3. James K. Peckol, “Embedded Systems: A Contemporary Design Tool”, Wiley Student Edition, 2008.
4. Michael Keating, Pierre Bricaud, “Reuse Methodology manual for System on chip designs”, Kluwer Academic Publishers, 2nd edition, 2008.

References:

1. Ahmed Amine Jeraya, Wayne Wolf, “Multiprocessor System On Chip”, Morgan Kauffmann, 2005.
2. Sung- Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits”, Tata Mcgraw-hill, 3rd Edition, 1996.
3. Neil H.E. Weste, David Harris, “CMOS VLSI Design: A Circuits and System Perspectives” Addison Wesley - Pearson Education, 3rd Edition, 2004.
4. Henry Chang, Larry Cooke, Merrill Hunt, Grant Martin, Andrew McNelly, Lee Todd, “Surviving the SoC Revolution: A guide to platform-based design”, Springer, 2000.

ADVANCED COMPUTER NETWORKS

Course Code :15 EM 52D3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Congestion and Quality of Service (QoS): Data traffic, Congestion, Congestion Control, Open loop and Closed Loop Congestion Control in TCP andFrame Relay, Quality of Service, Flow Characterization, Flow Classes, Need For QoS, Resource Allocation,Best Effort Service Features, Techniques to Improve QoS.

Queue Management: Passive, Active (RED), and Fair (BRED, Choke) Queue Management Schemes, Scheduling, Traffic Shaping, Resource Reservation and Admission Control Scheduling, Integrated and Differential Services.

Wireless Local Area Networks: Introduction, Wireless LAN Topologies, Wireless LAN Requirements, the Physical Layer, the Medium Access Control (MAC) Layer, Latest Developments.

Wireless Personal Area Networks (WPANs): Introduction to PAN Technology and Applications, Commercial Alternatives- Bluetooth, Home RF.

Wireless Wide Area Networks and MANS: The Cellular Concept, Cellular Architecture, The First-Generation Cellular Systems, The Second- Generation Cellular Systems, The Third-Generation Cellular Systems, Wireless in Local Loop, Wireless ATM, IEEE 802.16 Standard.

Cellular Systems and Infrastructure- Based Wireless Networks: Cellular Systems Fundamentals, Channel Reuse, SIR and User Capacity, Interference Reduction Techniques, Dynamic Resource Allocation, Fundamental Rate Limits.
Virtual Private Network (VPN): Types of VPN, VPN General Architecture, Disadvantages, VPN Security Issues, VPN Standards.
ATM Protocol Reference Model: Introduction, Transmission Convergence (TC) Sub-layer, Physical Medium Dependent (PMD) Sub-layer, Physical Layer Standards for ATM.**ATM Layer:** ATM Cell Header Structure at UNI, ATM Cell Header Structure at NNI, ATM Layer Functions.
ATM Adaptation Layer: Service Classes and ATM Adaptation Layer, ATM Adaptation Layer 1 (AAL1), ATM Adaptation Layer 2 (AAL2), ATM Adaptation Layer 3/4 (AAL3/4), ATM Adaptation Layer 5 (AAL5).
ATM Traffic and Service Parameterization: ATM Traffic Parameters, ATM Service Parameters, Factors Affecting QoS Parameters, ATM Service Categories, QoS and QoS Classes.
Interconnection Networks: Introduction, Banyan Networks- Properties, Crossbar Switch, Three Stage Class Networks, Rearrangeable Networks, Folding Algorithm, Benes Networks, Looping Algorithm, Bit- Allocation Algorithm.
SONET/SDH: SONET/SDH Architecture, SONET Layers, SONET Frames, STS Multiplexing, SONET Networks.

Text Books:

1. Wireless Communications - Andrea Goldsmith, 2005, Cambridge University Press.
2. Ad Hoc Wireless Networks: Architectures and Protocols - C. Siva Ram Murthy and B.S.Manoj,2004, PHI.
3. Data Communication and Networking - B. A.Forouzan, 2nd updating, 2004,TMH

References:

1. Introduction to Broadband Communication Systems- Sadiku, Mathew N.O., Akujuobi, Cajetan.M, PHI
2. Wireless Networks- P. Nicopolitidis, A. S. Pomportsis, G. I. Papadimitriou, M. S. Obaidat, 2003, JohnWiley& Sons
3. High Performance TCP / IP Networking – Mahaboob Hassan, Jain Raj, PHI.
4. Telecommunication System Engineering – Roger L. Freeman, 4/ed., Wiley-Interscience, JohnWiley & Sons, 2004.

M.TECH - WIRELESS COMMUNICATION & SENSOR NETWORKS

First Year (First Semester):

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Credits
1	15 EM 5109	Computational Methods and Error Analysis	**3**	**2**	**0**	4
2	15 EM 5110	Wireless Communication	**3**	**0**	**2**	4
3	15 EM 5111	Sensors and Sensing Principles	**3**	**2**	**0**	4
4	15 EM 5112	Data Acquisition and Hardware Networks	**3**	**0**	**2**	4
5		Elective – 1	3	0	0	3
6		Elective - 2	3	0	0	3
7	15 IE 5149	Seminar	0	0	4	2
		Total	**18**	**4**	**8**	**24**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Credits
1	15 EM 5213	Micro Electro Mechanical Systems(MEMS)	**3**	**2**	**0**	4
2	15 EM 5214	Communications Protocols and Standards	**3**	**0**	**2**	4
3	15 EM 5215	Wireless Sensor Networks	**3**	**0**	**2**	4
4	15 EM 5216	Design and Analysis of Algorithms	**3**	**2**	**0**	4
5		Elective – 3	3	0	0	3
6		Elective - 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		Total	**18**	**4**	**8**	**24**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods L	Periods T	Periods P	Credits
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods	Credits

			L	T	P	
Elective-1						
1	15 EM 51E1	Ad hoc and Vehicular Networks	3	0	0	3
2	15 EM 51E2	Cryptography Wireless Security	3	0	0	3
3	15 EM 51E3	Advanced Data Communications	3	0	0	3
4	15 EM 51E4	Methods of Probability and Stochastic Process	3	0	0	3
Elective-2						
1	15 EM 51F1	Database Design and Management	3	0	0	3
2	15 EM 51F2	Remote Sensing	3	0	0	3
3	15 EM 51F3	RF System Design for Wireless Communications	3	0	0	3
4	15 EM 51F4	Optical Networks	3	0	0	3
Elective-3						
1	15 EM 52G1	Advanced Digital Communications	3	0	0	3
2	15 EM 52G2	Smart Grid Communications and Networking	3	0	0	3
3	15 EM 52G3	Advanced Wireless Networks	3	0	0	3
4	15 EM 52G4	CDMA and OFDM for Wireless Communications	3	0	0	3
Elective-4						
1	15 EM 52H1	Advanced Techniques for Wireless Reception	3	0	0	3
2	15 EM 52H2	Fuzzy logic and Neural Networks	3	0	0	3
3	15 EM 52H3	Reliability Engineering Applications	3	0	0	3
4	15 EM 52H4	Advanced Microcontroller and its Applications	3	0	0	3

COMPUTATIONAL METHODS AND ERROR ANALYSIS

Course Code :15 EM 5109 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Error Analysis: Errors in Numerical calculations, Solution of algebraic and transcendental equations: Bisection Method, Iteration method, Newton-Raphson method, Secant method, Muller method.

Interpolation: Newton's forward and Newton's backward interpolation formulas, Cubic spline interpolation; Lagrange's interpolation and Newton's divided difference interpolation for unequal intervals.

Curve fitting: Fitting of straight line, parabola, power curve, exponential curve using method of least squares and method of weighted least squares; Method of least squares for continuous functions; Grams-Schmidth process.

Numerical differentiation and Numerical Integration: Errors in numerical differentiation, Newton's forward and backward formulas; cubic spline method, maxima and minima of tabulated functions.

Numerical integration: Simpson's formulae, Weddle's rule, Boole's rule, cubic splines, Romberg integration.

Matrices and Linear system of equations: Formation of system of linear equations, Gauss elimination methods, Gauss-Jacobi iterative method, Gauss-Seidal iterative method, Power method to find eigen values.

Numerical solution of Ordinary differential equations: Euler's method, modified Euler's method, 4^{th} order Runge-Kutta method, and Runge-kutta method for simultaneous first order ordinary differential equations.

Finite difference method: Solution of BVP by finite differences, Classification of Partial differential equations, solution of PDE by finite differences: Laplace and Poisson equation by Gauss-Seidal method.

Text Books:

1. Introductory Methods to Numerical Analysis by S.S. Sastry, 4^{th} edn., PHI.
2. Numerical Methods for Scientific and Engineering computations by M.K. Jain, S.R.K. Iyengar, and R.K. Jain, 4^{th} edn., New Age publishers.

Reference Books:

1. Higher Engineering Mathematics by B.S. Grewal, 40^{rd} edn, Khanna publishers.
2. Advanced Engineering Mathematics by Erwin Kreyszig, 8^{th} edn, Wiley publishers. dory

WIRELESS COMMUNICATION

Course Code :15 EM 5110 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Cellular Concepts – System Design Fundamentals Cellular concept-channel reuse- handoff strategies-dynamic resource allocation-interference and system capacity-improving capacity and coverage of cellular systems. Second and third generation network standards: GSM standardization-architecture and function partitioning-GSM radio aspects-security aspects-protocol model-call flow sequences-evolution to 2.5G mobile radio networks. IS-95 service and radio aspects, key features of IS-95 CDMA systemsECWDMA-UMTS physical layer-UMTS network architecture-CDMA 2000 physical layer.

Radio Wave Propagation Free space propagation model- basic propagation mechanisms –reflection- ground reflection model diffraction-scattering-practical link budget design-outdoor and indoor propagation models.
Capacity of Wireless Channels Capacity of Flat Fading Channel- Channel Distribution Information known – Channel Side Information at Receiver – Channel Side Information at Transmitter and Receiver – Capacity with Receiver diversity – Capacity comparisons – Capacity of Frequency Selective Fading channels.
Diversity Realization of Independent Fading Paths – Receiver Diversity – Selection Combining – Threshold Combining – Maximal-Ratio Combining – Equal - Gain Combining – Transmitter Diversity – Channel known at Transmitter – Channel unknown at Transmitter – The Alamouti Scheme-basic concepts of RAKE receivers.
Multiple Access Techniques Frequency division multiple access-time division multiple access-spread spectrum multiples access space division multiple access- packet radio. MIMO and multicarrier modulation: Narrowband MIMO model-parallel decomposition of MIMO channel-MIMO channel capacity-MIMO diversity gain.

Text Books:

Andrea Goldsmith, "Wireless Communications," Cambridge University Press, 2005 2. T.S. Rappaport, "Wireless Communications," Pearson Education, 2003

Reference Books:

1. Raj Pandya, "Mobile and Personal Communication Systems and Services," Prentice Hall of India, 2002
2. William C.Y. Lee, "Wireless and Cellular Telecommunications," Third edition, Mc. Graw Hill, 2006.

SENSORS AND SENSING PRINCIPLES

Course Code :15 EM 5111 — **L-T-P : 3-2-0**
Pre-requisite: NIL — **Credits: 4**

Syllabus:

Sensor Fundamentals:
Basic sensor technology -sensor characteristics –static and dynamic –Principles of sensing- capacitance- magnetic and electromagnetic induction –resistance – piezoelectric effect –Pyroelectric effect -Hall effect- See beck and Pettier effect-heat transfer-light.

Physical sensors:
Position, Displacement and Level sensors, Velocity and Acceleration sensors, Force, Strain, Tactile and pressure sensors.

Chemical sensors:
Classification of chemical sensing Mechanism, Potentiometric sensors, Conduct metric Sensors, Amperometric Sensors, Enhanced Catalytic gas Sensors.

Optical Sensors:
Optical Radiation- Electromagnetic Spectrum, Snell's Law and Total internal reflection, Diffraction principles, Optical Detectors and Sources-Photo diodes and transistors, Photo-darling ton pairs, Photoconductive sensors, CCD sensors, Fiber optic sensors. Solid state light sources- LED , Diode lasers, Semiconductor laser optical cavity resonator.

Bio sensors
Origin and Transmission of bioelectrical Signals, The Electromyogram (EMG) & the Electrocardiogram (ECG) The Electroencephalogram (EEG) & Blood pressure measurement, Catalytic biosensors, mono-enzyme electrodes, bi-enzyme electrodes. cell based biosensors, biochips and biosensor arrays, problems and limitations.

Text books:

1. Biosensor Principles and Applications, Edited by Loïc J.Blum, Pierre R. Coulet Agarwal, Govind P, "fiber Optic Communication Systems", 2nd edition, Wiley, NewYork,1997
2. Principles of Biochemistry Albert L.Lehninger, David Lee Nelson,Michael M. 2005, Fourth Edition.
3. Sensors and Transducers D. Patranabis Prentice-Hall of India Pvt.Ltd August 15, 2004
4. Jacob Fraden, " Hand Book of Modern Sensors: physics, Designs and Applications", 3rd ed.,Springer, 2003.

DATA ACQUISITION AND HARDWARE NETWORKS

Course Code :15 EM 5112 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Power Supplies & Filters
Amplifiers-Instrumentation amplifiers-isolation-chopper and low drift amplifier -Lock- in amplifiers electrometer and trans-impedance amplifiers-modulation-filters-Constant voltage and constant current regulators, DC-DC converter, SMPS. D/A converters,
Comparator,PLL.

Sensor Signal Conditioning Circuits
Signal conditioning for resistive sensors, Reactive variation sensors and Self generating sensors-Error budget analysis.

Basic Signal Conversion and Communication
RS232 interface standard, S485 interface standard. Distributed and stand alone data loggers, IEEE488 standard. methods of frequency-to-code conversion-standard, indirect and combined counting method, two wire transmission-four wire, six wire sensing.

Data Acquisition Methods for Multi Channel Sensor Systems
Data acquisition method with time-division channeling, data acquisition with space- division channeling, and main errors of multi channel data-acquisition systems, data transmission and error protection.

Serial Communication &Networks
Serial data communication –transmission modes,SPI,I^2C, CAN. Examples of Implementation on a 8051 based microcontroller.
Interfacing: memory interfacing, linear variable Differential Transformer (LVDT), speed measurement (RPM meter), Digital Thermometer

Text books:
1. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 3rd edition, Springer, 2003.
2. Jon.S. Wilson, “Sensor Technology Hand Book”, Elsevier Inc., 2005.

Reference Books
1. Pallas Areny. R, Webster. J. G, “Sensors and Signal conditioning”, 2nd ed. John Wiley and Sons, 2001.
2 Taylor H Rosemary, “Data Acquisition for Sensor Systems”, Kluwer Academic Publishers Group, 1997
3.Microcontrollers (Theory & Applications) –A.V. Deshmuk, WTMH 2005
4.Embedded Systems Architecture, programming and Design 2nded.Rajkaml McGraw –Hill.

ADHOC AND VEHICULAR NETWORKS

Course Code :15 EM 51E1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to Ad Hoc Networks: Characteristics of MANETs, Applications of MANETs and challenges of MANETs - **Routing in MANETs:** Criteria for classification, Taxonomy of MANET routing algorithms, Topology based routing algorithms, Position based routing algorithms, Other routing algorithms.

Data Transmission: Broadcast storm problem, Broadcasting, Multicasting and Geocasting - **TCP over Ad Hoc:** TCP protocol overview, TCP and MANETs, Solutions for TCP over Ad hoc.Basics **of Wireless Sensors and Applications:** Applications, Classification of sensor networks, Architecture of sensor network, Physical layer, MAC layer, Link layer.

Data Retrieval in Sensor Networks: Routing layer, Transport layer, High-level application layer support, Adapting to the inherent dynamic nature of WSNs, Sensor Networks and mobile robots - **Security:** Security in Ad Hoc networks, Key management, Secure routing, Cooperation in MANETs, Intrusion Detection systems.

Introduction to GPS, Principles used in GPS, GPS Components, Signal structure and frame formats,Dilution of Precision, Position calculations, Data formats, DGPS, Applications.

IVC Routing: Broadcast; TRADE, DDT, Unicast: Position Based GPS, LAR, VANETS: **Introduction,** VANET Specifications, DSRC, IEEE802.11p/WAVE,
Inter Vehicular Communication, Current trends in GPS applications, Location Services; Security in IVC

TEXT BOOKS:

1.Ad Hoc and Sensor Networks – Theory and Applications, *Carlos Corderio Dharma P.Aggarwal,* World Scientific Publications, March 2006, ISBN – 981-256-681-3
2.Wireless Sensor Networks: An Information Processing Approach, Feng Zhao, Leonidas Guibas, Elsevier Science, ISBN – 978-1-55860-914-3 (Morgan Kauffman)

REFERENCES:

1. Jean-Marie zogg-Ublox, *GPS Basics: Introduction to GPS systems*
2. Sivaram Murthy and Manoj, *Adhoc networks by,Pearson,* 2006,
3. Latest Published articles related to IVC

CRYPTOGRAPHY WIRELESS SECURITY

Course Code :15 EM 51E2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction and Symmetric Key Encryption
Attacks-Services-Mechanisms-OSI Security architecture-Model for Network Security- Symmetric Cipher Model-Substitution and Transposition Techniques- Simplified DES- DES Block Cipher Principles-The Strength of DES-Differential and Linear Cryptanalysis-Block Cipher Design Principles- Block Cipher Modes of Operation- -AES cipher-Triple DES.

Number Theory and Public Key Encryption
Prime Numbers-Fermat's and Euler's Theorems-Testing of Primality-The Chinese Remainder Theorem-Discrete Logarithms-Principles of Public Key Cryptosystems-The RSA Algorithm-Key Management-Diffie-Hellman Key Exchange-Elliptic Curve Arithmetic- Elliptic Curve Cryptography.

Message Authentication and Hash Functions
Authentication Requirements- Authentication functions-message Authentication Codes- Hash Functions- Security of Hash Functions and MACs-MD5 Message Digest Algorithm-Digital Signatures- Authentication Protocols-Digital Signature Standard.

Network Security Practice
Authentication Application-Kerberos-Electronic Mail Security-Pretty Good Privacy- S/MIME-IP Security Overview-IP Security Architecture-Authentication Header Encapsulation Security Payload- Web Security Considerations-Secure Sockets Layer and Transport Layer Security-Secure Electronic Transaction.

System Security
Intruders- Intrusion Detection-Password Management-Viruses and Related Threats- Viruses Counter Measures-Firewall Design Principles-Types of Firewalls-Firewalls Configurations-Trusted Systems

Text book:
1. William Stallings, "Cryptography and Network Security-Principles and practice", 3rd Edition Prentice Hall, 2003.

Reference Books:
1. Michael E.Whitman and Herbert J.Mattord, "Principles of Information security," 1st Edition, 2003.
2. Bruce Schneier,"Applied Cryptography," 2nd Edition, Toha Wiley and Sons, 1996.

ADVANCED DATA COMMUNICATIONS

Course Code :15 EM 51E3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Digital Modulation Schemes: BPSK, QPSK, 8PSK, 16PSK, 8QAM, 16QAM, DPSK – Methods, Band Width Efficiency, Carrier Recovery, Clock Recovery.
Basic Concepts of Data Communications, Interfaces and Modems: Data Communication Networks, Protocols and Standards, UART, USB, I2C, I2S, Line Configuration, Topology,
Transmission Modes, Digital Data Transmission, DTE-DCE interface, Categories of Networks – TCP/IP Protocol suite and Comparison with OSI model.
Error Correction: Types of Errors, Vertical Redundancy Check (VRC), LRC, CRC, Checksum, Error Correction using Hamming code
Data Link Control: Line Discipline, Flow Control, Error Control
Data Link Protocols: Asynchronous Protocols, Synchronous Protocols, Character Oriented Protocols, Bit-Oriented Protocol, Link Access Procedures.
Multiplexing: Frequency Division Multiplexing (FDM), Time Division Multiplexing (TDM), Multiplexing Application, DSL.
Local Area Networks: Ethernet, Other Ether Networks, Token Bus, Token Ring, FDDI.
Metropolitan Area Networks: IEEE 802.6, SMDS
Switching: Circuit Switching, Packet Switching, Message Switching.
Networking and Interfacing Devices: Repeaters, Bridges, Routers, Gateway, Other Devices.
Multiple Access Techniques: Random Access, Aloha- Carrier Sense Multiple Access (CSMA)- Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA), Controlled Access- Reservation- Polling- Token Passing, Channelization, Frequency- Division Multiple Access (FDMA), Time – Division Multiple Access (TDMA), Code - Division Multiple Access (CDMA), OFDM and OFDMA.

TEXT BOOKS:
1. Data Communication and Computer Networking - B. A.Forouzan, 2nd Ed., 2003, TMH.
2. Advanced Electronic Communication Systems - W. Tomasi, 5th Ed., 2008, PEI.

REFERENCE BOOKS:
1. Data Communications and Computer Networks - Prakash C. Gupta, 2006, PHI.
2. Data and Computer Communications - William Stallings, 8th Ed., 2007, PHI.
3. Data Communication and Tele Processing Systems -T. Housely, 2nd Ed, 2008, BSP.
4. Data communications and computer networks –Brijendera Singh, 2 nd Ed, 2005,PHI

METHODS OF PROBABILITY AND STOCHASTIC PROCESS

Course Code :15 EM 51E4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Random Variables and their Probability Distributions
Random variables, Probability distribution function, Probability density function, Conditional probability, Statistical Independence, Bayes formula. Moments of random variables: Expected value and moments, Mean and variance of random variable, Coefficients of variation, Skewness and kurtosis, Moments, Covariance and Correlation coefficient, Mean and variance of sum and Product of two random variables. Conditional mean and variance, Application of conditional mean and variance.

Discrete Random Variables and their Distributions
Moment Generation Function, Characteristics Function, Cumulants, Probability generating function, Binomial Distribution, Negative Binomial Distribution, Hyper geometric distribution, Multinomial,

Continuous Random Variables and their Distributions
Normal, Log - Normal, Multivariate Normal, Gamma, Exponential, Chi-square, Weibull, Rayleigh distributions. Relationship between continuous distributions.

Transformation of Random Variables
Transformation of Single, Several Random Variables, Function of Random Variables, Sum, Differences, Product and Ratio of Two Random Variables, Transformation through characteristic Functions.

Stochastic Processes
Introduction- Classification of stochastic process, Stationary process (SSS and WSS) Stationary process, Ergodic Process, Independent increment Process, Markov Process, Counting Process, Narrow- Band Process, Normal Process, Wiener-Levy Process, Poisson, Bernoulli, Shot noise Process, Autocorrelation Function.

Text Book:
1. Michel K. Ochi , “Applied Probability and Stochastic Processes,” John Wiley & Sons, ISSN – 0271- 6356, 2008.

Reference Books:
1. Paboulis, A, “Probability, Random variables and Stochastic Processes,” Mc Graw Hill. New York 1984.
2 Kishor S. Trivedi, “Probability and Statistics with Reliability, Queuing and Computer Science Application,” John Wiley, 2002.

PROFESSIONAL ELECTIVES
Group-B

DATABASE DESIGN AND MANAGEMENT

Course Code :15 EM 51F1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Basic concepts: Database and Need for DBMS, Characteristics of DBMS, Database Users, 3-tier architecture of DBMS (its advantages over 2-tier), Data Models, Views of data-schemas and instances, Data Independence.

Database Design using ER model: Entities, Relationships, Representation of entities, attributes, relationship attributes, relationshipSet, Generalization, aggregation, Relational algebra, Structure of relational Database and different types of keys, Codd's rules, , ER to Relational model

Relational Model: Relational model concept, Relational model constraints, Data definition in SQL, Views and Queries in SQL Specifying constraints and Indexes in SQL., Functional dependencies, Normalization, Normal forms based on primary keys (1 NF, 2 NF, 3 NF, BCNF, 4 NF, 5 NF), Loss less joins and dependency preserving Decomposition

Transaction And Concurrency control: Concept of transaction, ACID properties, Serializibility, States of transaction, Concurrency control, Locking techniques, Time stamp based protocols, Granularity of data items, Deadlock

Storage and File Structure: Overview of physical storage media, Tertiary storage, Storage access, File organization, Organization of records in files, RAID, Database security issues, Failure classifications, Recovery & atomicity, Log base recovery, Recovery with concurrent transactions

Text books:
1. Database system concept Korth
2. Introduction to database systems C.J.Date

Reference books:
1. Database Management Systems Bipin Desai
2. Database Management systems Ramakrishnan & Gehrke

REMOTE SENSING

Course Code :15 EM 51F2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

EMR AND ITS INTERACTION WITH ATMOSPHERE & EARTH MATERIAL: Definition of remote sensing and its components – Electromagnetic spectrum – wavelength regions important to remote sensing – Wave theory, Particle theory, Stefan-Boltzman and Wein's Displacement Law – Atmospheric scattering, absorption – Atmospheric windows – spectral signature concepts – typical spectral reflective characteristics of water, vegetation and soil.

PLATFORMSANDSENSORS Types of platforms – orbit types, Sun-synchronous and Geosynchronous – Passive and Activesensors – resolution concept – Pay load description of important Earth Resources and Meteorological satellites – Airborne and spaceborne TIR and microwave sensors.

IMAGEINTERPRETATIONANDANALYSIS Types of Data Products – types of image interpretation – basic elements of image interpretation- visual interpretation keys – Digital Image Processing – Pre-processing – imageenhancement techniques – multispectral image classification – Supervised and unsupervised.

GEOGRAPHICINFORMATIONSYSTEM Introduction – Maps – Definitions – Map projections – types of map projections – map analysis –GIS definition – basic components of GIS – standard GIS softwares – Data type – Spatial andnon-spatial (attribute) data – measurement scales – Data Base Management Systems (DBMS).

DATAENTRY,STORAGEANDANALYSIS Data models – vector and raster data – data compression – data input by digitization andscanning – attribute data analysis – integrated data analysis – Modeling in GIS Highway alignment studies – Land Information System.

TEXTBOOKS

1. Lillesand, T.M., Kiefer, R.W. and J.W.Chipman. (2004). Remote Sensing and Image Interpretation. V Edn. John Willey and Sons (Asia) Pvt. Ltd., New Delhi. Pp:763. 2. Anji Reddy, M. (2001). Textbook of Remote Sensing and Geographical Information System. Second edn. BS Publications, Hyderabad.

REFERENCES

1. Lo. C.P.and A.K.W.Yeung (2002). Concepts and Techniques of Geographic Information Systems. Prentice-Hall of India Pvt. Ltd., New Delhi. Pp:492.

2. Peter A.Burrough, Rachael A.McDonnell (2000). Principles of GIS. Oxford University Press. 3. Ian Heywood (2000). An Introduction to GIS. Pearson Education Asia.

RF SYSTEM DESIGN FOR WIRELESS COMMUNICATIONS

Course Code :15 EM 51F3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Fundamentals of System Design
Linear Systems and Transformations:- Linear System, Fourier Series and Transformation, Frequency Response of LTI Systems, Band-Pass to Low-Pass Equivalent Mapping and Hilbert Transform –
Nonlinear System Representation and Analysis Approaches:- Representation of Memoryless Nonlinear Systems, Multiple Input Effects in Nonlinear System, Memoryless Band-Pass Nonlinearities and Their Low-Pass Equivalents.
Radio Architectures and Design Considerations
Super heterodyne Architecture: - Configuration of Superheterodyne Radio, Frequency Planning, Design Consideration of Superheterodyne Transceiver.
Direct Conversion (Zero IF) Architecture:- Configuration of Direct-Conversion Radio.
Low IF Architecture: - Configuration of Low IF Radio, Approaches to Achieve High Image Rejection, Some Design Considerations.
Receiver System Analysis and Design
Introduction - **Sensitivity and Noise Figure of Receiver**: -Sensitivity Calculation, Cascaded Noise Figure. **Adjacent/Alternate Channel Selectivity and Blocking Characteristics**: – Desired Signal Level and Allowed Degradation, Formula of AdjacedAlternate Channel Selectivity and Blocking Characteristics, Two-Tone Blocking and AM Suppression Characteristics. **Receiver Dynamic Range and AGC System**: -Dynamic Range of a Receiver. **System Design and Performance Evaluation**:- Receiver System Design Basics, Basic Requirements of Key Devices in Receiver System.
Transmitter System Analysis and Design
Introduction - Transmission Power and Spectrum - **Adjacent and Alternate Channel Power**: - Low-Pass Equivalent Behavioral Model Approach, Multitone Techniques.
Noise
Noise and Random Process: - Noise Power and Spectral Representation, Noise and Random Process Through Linear Systems, Narrow-Band Noise Representation, Noise Figure and Noise Temperature. **Noise Emission Calculation**: - Formulas for Noise-Emission Calculation, Some Important Notes in Noise-Emission Calculation, Noise Expressed in Voltage, Examples of Noise-Emission Calculations

Text Books:
1. Gu, Qizheng, "RF System Design of Transceivers for Wireless Communications," 1st ed. Corr. 2nd printing, 2005, XIV, 479 p. 125 illus., Hardcover, Springer, ISBN: 978-0-387-24161

Reference Books:
1. D.K.Misra, "Radio Frequency and Microwave Communication Circuits, Analysis and Design", John wiley & Sons., inc, 2004, kundli.
2. Pozar,D.M, "Microwave Engineering," Adison Wesley, 3rd Edition, 1990.

OPTICAL NETWORKS

Course Code :15 EM 51F4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction
Introduction to WDM optical networks-WDM networks architectures- issues in wavelength routed networks. Wavelength routing algorithms: Introduction- Classification of RWA algorithms-RWA algorithms- fairness and admission control- distributed control protocols.

Wavelength Convertible Networks
Need for wavelength conversion-wavelength convertible node architectures-converter placement and allocation problems. Wavelength rerouting algorithms: Benefits of wavelength rerouting-issues in wavelength rerouting-light path migration-rerouting schemes-rerouting in networks with sparse wavelength conversion- rerouting in multi fiber networks.

Virtual Topology Design
Introduction- virtual topology design problems- virtual topology design sub problems-virtual topology design heuristics-need for virtual topology design reconfiguration. Optical multicasting: Introduction to multicast routing-multicasting node architectures- multicast tree generation-source based tree generation-Steiner tree based generation.

Control and Management
Network management functions, management frame work and protocols, configuration management and adaptation management. Network survivability: failures and recovery- protection in SONET- benefits of optical layer protection-restoration schemes in WDM networks-multiplexing schemes-Traffic grooming in WDM.

Optical Burst Switching
OBS node architecture-burst switching protocols-wavelength channel scheduling. Optical packet switching and access networks: Introduction-optical packet switching node architecture- contention resolution protocols. Enhanced HFC-FTTC –PON architectures.

Text Books:

1. C. Siva Ram Murthy and Mohan Gurusamy, “WDM Optical Networks: Concepts, Design and Algorithms”, Prentice Hall of India, 2002.
2. Rajiv Ramaswami and Kumar N. Sivarajan, “ Optical Networks: A Practical Perspective, Second edition, Morgan Kaufmann Publishers, 2002.

Reference Book:

1. B.Mukherjee, “Optical Communication Networks”, Mc Graw Hills, New York, 1997.

MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)

Course Code :15 EM 5213 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Overview of MEMS and Micro Systems: Introduction, miniaturization, Reliability, Advantages of MEMS, working principles of chemical sensors, optical, pressure and thermal sensors, micro actuation: actuation using thermal forces, actuation using piezo electric crystals, actuation using electrostatic forces; micro accelerometers, micro fluidics, MEMS switches, phase shifters, varactors, tunable oscillators

Basics of MEMS technology: Molecular theory of matter and intermolecular forces, doping of semi conductors, the diffusion process, scaling laws in miniaturization, Engineering mechanics: static bending of thin plates, mechanical vibrations, thermo mechanics, fluid flow in nano scale.

Micro system Design: Introduction, design considerations, process design, mechanical design, micro system packaging, essential packaging technologies, 3D packaging, assembly, selection of materials, Finite Element Analysis (FEA).

Fabrication methods: Lithography:Introduction,wafers, masks, spinning resist and soft baking, exposure and post exposure treatment, resolution, mathematical expression of resist profiles, image reversal, interface effects, radiation and resist profiles, ion implantation, diffusion, oxidation, RIE , Chemical Vapour Deposition (CVD), Physical Vapour Deposition (PVD), deposition by epitaxy, comparison of bulk and surface micromachining, comparison of wet and dry etching, LIGA process. System level packaging, single and multichip packaging.

Case Study: MEMS capacitive switch, MEMS capacitive accelerometer, MEMS pressure sensor, quartz rate gyroscope, cantilever based micro cantilevers for mass measurement.

Text Books:

1. Microsystem Design by *Stephen D.Senturia,* Springer International Edition,2010
2. RF MEMS Theory, Design and Technology by *Gabriel M.Rebeiz,* Wiley India Pvt Ltd.
3. MEMS and Microsystems: Design and Manufacture by *Tai-Ran Hsu,* Tata McGraw Hill,2002
4. The MEMS Handbook, *Mohamed Gad-el-Hak,* CRC Press, 2002.
5. Foundations of MEMS by *Chang Liu,* Second Edition, Pearson Publication

COMMUNICATIONS PROTOCOLS AND STANDARDS

Course Code :15 EM 5214 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Networks in process automation
Networks in process automation: Information flow requirements, Hierarchical communication model, Data Communication basics, OSI reference model, Industry Network, Network Topologies.

Communication Protocols:
Communication Protocols: Communication Basics, Basics, Network Classification, Device Networks, Control Networks, Enterprise Networking, Network selection. Proprietary and open networks: Network Architectures, Building blocks

Wired Communication:
Wired: Wired Communication: Industry open protocols (RS-232C, RS- 422, RS-485), CAN bus, I2C, SPI, Ethernet,USB ,OFC, Modbus, Modbus Plus, Data Highway Plus, Advantages and Limitations of Open networks.

Fieldbus Trends
Fieldbus: Fieldbus Trends, Hardware selection, Fieldbus design, Installation, Documentation, Fieldbus advantages and limitations, Automotive Most bus, Hot standby router protocol(HSRP) and Hot 255 modem, Dial up modem, Physical media -Cabling types and noise level conditions, leased line modems.

WPAN
Wireless: WPAN, Wi-Fi, Bluetooth, Zig-Bee, Z-wave, GPRS, GSM. Infrared communication: Routers, Hubs, Bridges, Ethernet switches, Different type of converters - Serial to Ethernet, Ethernet to OFC, Serial to OFC, RS232 to RS485
Outcomes: After completion of these course students should able to, Build sensor networks and Communicate through various media

Text Books:
1. TCIP/IP protocol suite , Behrouz A. Forouzen, III Edition
2. Data communications, computer networks, open systems, Prakash C. Guptha, V Edition

WIRELESS SENSOR NETWORKS

Course Code :15 EM 5215 **L-T-P : 3-0-2**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Cellular and Ad Hoc Wireless Networks-Applicationa of Ad Hoc Wireless Networks,Issues in Ad Hoc Wireless Networks: Medium Acces Scheme-Routing-Multicasting Transport Layer Protocols-Pricing Scheme-Quality of Service Provisioning-Self Organization-Security-Addressing and Service Discovery-Energy management Scalability-Deployment Considerations, Ad Hoc Wireless Internet.

Comparison with Adhoc wireless networks-Challenges for WSNs – Difference between sensor networks and Traditional sensor networks ,Types of Applications, Enabling Technologies for Wireless Sensor Networks –Single Node Architectures , Hardware Components , Energy Consumption of Sensor Nodes, Issues in Designing a Multicast Routing Protocol.

Data Dissemination-Flooding and Gossiping-Data gathering Sensor Network Scenarios –Optimization Goals and Figures of Merit – Design Principles for WSNs Gateway Concepts – Need for gateway – WSN to Internet Communication –Internet to WSN Communication –WSN Tunneling

MAC Protocols for Sensor Networks -Location Discovery-Quality of Sensor Networks Evolving Standards-Other Issues- Low duty cycle and wake up concepts- The IEEE802.15.4 MAC Protocols- Energy Efficiency -Geographic Routing Mobile nodes

Gossiping and Agent based Unicast Forwarding-Energy Efficient Unicast-Broadcastand Multicast-Geographic Routing-Mobile nodes-Security-Application SpecificSupport - Target detection and tracking-Contour/ edge detection-Field Sampling.

Text Books:

1. Holger Karl and Andreas Wiilig, “Protocols and Architectures for Wireless Sensor Networks” John Wiley & Sons Limited 2008.

2. I.F .Akyildiz and Weillian, “A Survey on Sensor Networks”,IEEE Communication Magazine, August 2007.

Reference Books:

1. Wilson , “Sensor Technology hand book,” Elsevier publications 2005.

2. Anna Hac “Wireless Sensor Networks Design,” John Wiley& Sons Limited Publications 2003.

3. C.Siva Ram Murthy and B.S.Manoj “Ad Hoc Wireless Networks,” Pearson Edition 2005

DESIGN & ANALYSIS OF ALGORITHMS

Course Code :15 EM 5216 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: Algorithm, Pseudo code for expressing algorithms, performance Analysis- Space complexity, Time complexity, Asymptotic Notation-Big oh notation. Omega notation, Theta notation and little oh notation.
Divide and conquer: General method, applications-Binary search, Quick sort, Merge sort, Strassen's Matrix Multiplication.
Greedy method: General method, applications-Job sequencing with dead lines, 0/1 knapsack problem, Minimum cost spanning trees, Single source shortest path problem.
Dynamic Programming: General method, applications-Matrix chain multiplication, Optimal binary search trees, 0/1 knapsack problem, All pairs shortest path problem, Traveling sales person problem, Reliability design.
Search Trees- Balanced search trees-AVL trees, representation, Operations-insertion, deletion and searching, B-Trees-B-Tree of order m, Operations- insertion, deletion and searching.
Backtracking General method -Applications-n-queen problem, sum of subsets problem, graph coloring, Hamiltonian cycles.
and Branch and Bound: General method, **Applications** - Traveling sales person problem, 0/1 knapsack problem-LC Branch and Bound solution, FIFO Branch and Bound solution.
NP-Hard and NP-Complete problems: Basic concepts, non-deterministic algorithms, NP – Hard and NP-Complete classes

Text Books:
1. Computer Algorithms/C++, E.Horowitz, S.Sahani and S.Rajasekharan, Galgotia Publishers pvt. Limited.
2. Data Structures and Algorithm Analysis in C++, 2nd Edition, Mark Allen Weiss, Pearson Education.

Reference Books:
1. Design and Analysis of algorithms, Aho, Ullman and Hopcroft, Pearson Education.
2. Introduction to the Design and Analysis of Algorithms, A.Levitin, Pearson Education.
3. Data structures, Algorithms and Applications in C++, S.Sahni, University press (India) pvt ltd, 2nd edition, Orient Longman pvt.ltd.
4 Object Oriented Programming Using C++, 2nd Edition, I.Pohl, Pearson Education.

PROFESSIONAL ELECTIVES
Group-C

ADVANCED DIGITAL COMMUNICATIONS

Course Code :15 EM 52G1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction
Elements of a digital communication system – Communication channels and their characteristics– Mathematical model for channels. Representation of digitally modulated signals Performance of memory less modulation methods – signaling schemes with memory – CPFSK CPM.
Optimum Receivers for AWGN Channels
Waveform and vector channel models. Detection of signals in Gaussian noise. Optimum detection and error probability for band limited signaling and power limited signaling – Non coherent detection – Comparison of digital signaling methods – Lattices and constellations based on lattices – Detection of signaling schemes with memory – Optimum receiver for CPM – Performance analysis for wire line and radio communication systems. Introduction to partially coherent, double differentially coherent communication systems.
Channel Coding
Introduction to linear block codes, Convolution coding –Tree, Trellis and State diagrams – Systematic, Non-recursive and recursive convolution codes – The inverse of a convolution Encoder and Catastrophic codes – Decoding of convolution codes - Maximum likelihood decoding, Viterbi algorithm and other decoding algorithms – Distance properties – Punctured convolution codes, Dual-k codes, Concatenated codes – MAP and BCJR algorithms – Turbo coding and Iterative decoding – Factor graphs and sum-product algorithms – LDPC codes – Trellis coded modulation - Performance comparison.
Pulse Shaping and Equalization
Pulse shaping: Characterization of Band limited channels – ISI – Nyquist criterion – Controlled ISI – Channels with ISI and AWGN – Pulse shaping for optimum transmissions and reception. Equalization: MLSE – Linear equalization – Decision feedback equalization – ML detectors – Iterative equalization – Turbo equalization. Adaptive linear equalizer – Adaptive decision feedback equalization – Blind equalization.
Synchronization
Signal parameter Estimation-Carrier phase Estimation–Symbol timing Estimation – Joint estimation of carrier phase and symbol timing – Performance characteristics of ML Estimators.

Text Books:

1. John G. Proakis and Masoud Salehi, “Digital Communications”, Fifth edition, Mc Graw Hill International edition, 2008.
2. Ian A. Glover and Peter M. Grant, “Digital communications”, Second edition, Pearson education, 2008.
3. Andrea Goldsmith, “Wireless Communications,” Cambridge University Press, 2005

Reference Books:

1. Marvin K. Simon, Sami M. Hinedi and William C. Lindsey, “Digital Communication Techniques : Signal Design and Detection” PHI publishers, 2009.
2. Bernard Sklar, “Digital Communications: Fundamentals and Applications”, Second edition, Pearson Education

SMART GRID COMMUNICATIONS AND NETWORKING

Course Code :15 EM 52G2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Communication networks in smart grid: an architectural view: Introduction , Smart grid conceptual model , Smart grid communication infrastructures, Interoperability issues, Role of communication infrastructures in smart grid.**New models for networked control in smart grid:** Introduction, Information in today's power system management operations,Enhanced smart grid measuring functionalities,Demand-side management and demand response: the key to distribute cheap and green electrons

Communications and access technologies for smart grid: Introduction, Communications media, Power-line communication standards, Wireless standards, Networking solutions
Machine-to-machine communications in smart grid: Introduction, M2M communications technologies, M2M applications, M2M architectural standards bodies, M2M application in smart grid

Networking technologies for wide-area measurement applications: Introduction 205, Components of a wide-area measurement system, Communication networks forWAMS, WAMS applications, WAMS modelling and network simulations

Wireless networks for smart grid applications: Introduction,Smart grid application requirements, Network topologies, Deployment factors, Performance metrics and tradeoffs

Wireless sensor networks for smart grid: research challenges and potential applications : Introduction, WSN-based smart grid applications**. Sensor techniques and network protocols for smart grid:** Introduction**,** Sensors and sensing principles, Communication protocols for smart grid**. Potential methods for sensor and actuator networks for smart grid:** Introduction, Energy and information flow in smart grid, SANET in smart grid, Proposed mechanisms, Home energy–management system – case study of SANET in SG

Cyber-attack impact analysis of smart grid: Introduction, Background, Cyber-attack impact analysis framework, Case study.

Text Books

Smart Grid Communications and Networking By Ekram Hossain, Zhu Han and H. Vincent Poor , Cambridge University Press 2015

Ref. books
1) Communication and Networking in Smart Grids (Novel by Yang Xiao)Originally published: January 1, 2012. CRC Press.

2) Smart Grid Applications, Communications And Security ,_ Wiley Publications

ADVANCED WIRELESS NETWORKS

Course Code :15 EM 52G3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction
Evolution of Wireless Networks - Wireless Local Area Networks - Public Wide-Area Wireless networks. Introduction to 1G/2G/3G/4G Terminology. Evolution of Public Mobile Services – First Wave of Mobile Data Services: Text-Based Instant Messaging. Second Wave of Mobile Data Services: Low-Speed Mobile Internet Services. Current Wave of Mobile Data Services: High-Speed and Multimedia Mobile Internet Services. IP-Based Wireless Networks - 3GPP, 3GPP2.

Wireless IP Network Architectures
3GPP Packet Data Networks - Network Architecture-3GPP2 Packet Data - MWIF All-IP Mobile Networks - Network Architectures - Access to MWIF Networks - Session Management.

IP Multimedia Subsystems and Application-Level Signaling
Signaling in IP Networks -Session Initiation Protocol (SIP) -Session Description Protocol (SDP) 3GPP IP Multimedia Subsystem (IMS) - IMS Architecture 3.2.2 Mobile Station Addressing for Accessing the IMS - Reference Interfaces -Service Architecture - Registration with the IMS - Deregistration with the IMS -End-to-End Signaling Flows for Session Control 3GPP2 IP Multimedia Subsystem (IMS)

Mobility Management
Basic Issues in Mobility Management - Mobility Management in IP Networks - Mobility Management in 3GPP Packet Networks -Mobility Management in 3GPP2 Packet Data Networks –Mobility Management in MWIF Networks - Comparison of Mobility Management in IP, 3GPP, and 3GPP2 Networks .

Quality of Service
Internet QoS - QoS Challenges in Wireless IP Networks - QoS in 3GPP - QoS in 3GPP2 - 3GPP2 QoS Architecture -3GPP2 QoS Management -3GPP2 QoS Classes -QoS Attributes (QoS Profile) Management of End-to-End IP QoS.

Text Books:

1. Jyh-Cheng Chen and Tao Zhang, “IP-Based Next-Generation Wireless Network Systems, Architectures, and Protocols,” John Wiley & Sons, Inc. Publication, 2006.
2. Crosspoint Boulevard , “Wireless and Mobile All-IP Networks,” Wiley Publication, 2005.

Reference Books

1. Minoru Etoh, “Next Generation Mobile Systems3G and Beyond,” Wiley Publications, 2005.
2. Savo Glisic , “Advanced Wireless Communications 4G Technologies,” Wiley Publications, 2004.http://www.ebookee.com/Advanced-Wireless-Communications-4G- Technologies-

CDMA AND OFDM FOR WIRELESS COMMUNICATIONS

Course Code :15 EM 52G4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Principles of Code Division Multiple Access
Spread spectrum technique – Direct sequence and frequency hopping spread spectrum communication system – PN codes and Walsh codes – Rake receiver – Capacity – Effects of loading, sectorization and voice activity – Power control – Hand off – Link structure – Forward link – Pilot, synchronization, paging and traffic channels – Reverse Link – access and traffic channel.

Call Processing and Traffic
Call processing states – Initialization, idle, access and traffic states – Forward link and Reverse link analysis - Calculation of Ec/I0 and Eb/N0 – Traffic intensity – Grade of Service – Erlang- B and C models.

OFDM Basics
OFDM principles – system model – Generation of sub carrier using IFFT, guard time and cyclic extensions – windowing - Choice of OFDM parameters - OFDM signal processing.

Coding, Modulation and Channel Estimation
FEC coding – Interleaving – QAM – Coded modulation – Synchronization – Synchronization using cyclic extension and special training symbols – Coherent detection – One and two dimensional channel estimation – Special training symbols – Decision directed channel estimation – Differential detection in the time and frequency domain.

OFDMA and MC-CDMA
Frequency hopping in OFDMA - OFDMA system description – Channel coding, modulation, time and frequency synchronization, Combination of OFDM and CDMA - MC-CDMA, MT- CDMA and MC-DS CDMA systems - Difference between OFDMA and MC-CDMA

Text books:
1. Samuel C Yang, “CDMA RF System Engineering”, Artech House, 1998.
2. Richard Van Nee and Ramjee Prasad, “OFDM for wireless Multimedia Communication”, Artech House, 2000.

Reference Books:
1. Lajas Hanzo, “OFDM and MC-CDMA for Broadband Multiuser Communications,” 2003
2. Khaled Fazal and Stephen Kaiser, “Multicarrier and Spread Spectrum Systems,” 2008

PROFESSIONAL ELECTIVES
Group-D

ADVANCED TECHNIQUES FOR WIRELESS RECEPTION

Course Code :15 EM 52H1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Blind Multiuser Detection
Wireless signaling environment, Basic receiver signal processing for wireless reception- matched filter/raked receiver, equalization and MUD. Linear receiver for synchronous CDMA- decorrelating and MMSE detectors. Blind MUD, direct and subspace methods.

Group Blind MUD
Linear group blind MUD for synchronous CDMA, Non-linear group blind multiuser detectors for CDMA-slowest descent search. Group blind multiuser detection in multipath channels- Linear group blind detectors.

Space-Time MUD
Adaptive array processing in TDMA systems-Linear MMSE combining, sub-space based training algorithm and extension to dispersive channels. Optimal space time MUD. Linear space time MUD- Linear MUD via iterative interference cancellation, single user space-time detection and combined single user/multiuser linear detection.

NBI Suppression
Linear predictive techniques-linear predictive methods. Non-linear predictive techniques-ACM filter, Adaptive non-linear predictor, Non-linear interpolating filters and HMM based methods. Code aided techniques-NBI suppression via Linear MMSE detector.

Signal Processing for Wireless Reception
Bayesian signal processing- Bayesian framework, batch processing Versus adaptive processing, Monte-Carlo methods. Signal processing for fading channels. Coherent detection in fading channels based on EM algorithm. Decision feedback differential detection in fading channels-Decision feedback differential detection in flat channels, Decision feedback space-time differential decoding.

Textbook:

1. X.Wang and H.V.Poor," Wireless Communication Systems," Pearson,2004
2. Iti Saha Misra,"Wireless Communications and Networks,"Tata McGraw Hill,2009.
3. Doughas R.Stinson, "Cryptography-Theory and Practice," CRC Press,1995

FUZZY LOGIC AND NEURAL NETWORKS

Course Code :15 EM 52H2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

INTRODUCTION TO FUZZY LOGIC PRINCIPLES
Basic concepts of fuzzy set theory – operations of fuzzy sets – properties of fuzzy sets – Crisp relations – Fuzzy relational equations – operations on fuzzy relations – fuzzy systems – propositional logic – Inference – Predicate Logic – Inference in predicate logic – fuzzy logic principles – fuzzy quantifiers – fuzzy inference – fuzzy rule based systems – fuzzification and defuzzification – types.

ADVANCED FUZZY LOGIC APPLICATIONS
Fuzzy logic controllers – principles – review of control systems theory – various industrial applications of FLC adaptive fuzzy systems – fuzzy decision making – Multiobjective decision making – fuzzy classification – means clustering – fuzzy pattern recognition – image processing applications – systactic recognition – fuzzy optimization – various

INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS
Fundamentals of neural networks – model of an artificial neuron – neural network architectures – Learning methods – Taxonomy of Neural network architectures – Standard back propagation algorithms – selection of various parameters – variations Applications of back propagation algorithms.

OTHER ANN ARCHITECTURES
Associative memory – exponential BAM – Associative memory for real coded pattern pairs – Applications adaptive reasonance theory – introduction – ART 1 – ART2 – Applications – neural networks based on competition – kohenen self organizing maps – learning vector quantization – counter propagation networks – industrial applications.

RECENT ADVANCES
Fundamentals of genetic algorithms – genetic modeling – hybrid systems – integration of fuzzy logic, neural networks and genetic algorithms – non traditional optimization techniques like ant colony optimization – Particle swarm optimization and artificial immune systems – applications in design and manufacturing.

TEXT BOOKS:

1. S.Rajasekaran.G.A.Vijayalakshmi Pai “Neural Networks, fuzzy logic and genetic algorithms”, prentice hall of India private limited, 2003
2. Timothy J.Ross, “Fuzzy logic with engineering applications”, McGraw Hill, 1995
3. Zurada J.M. “Introduction to artificial neural systems”, Jaico publishing house, 1994

REFERENCES:

1. Klir.G, Yuan B.B. “Fuzzy sets and fuzzy logic prentice Hall of India private limited, 1997.
2. Laurance Fausett, “Fundamentals of neural networks”, Prentice hall, 1992
3. Gen, M. and R. Cheng “Genetic algorithm and engineering design”, john wiley 1997

RELIABILITY ENGINEERING APPLICATIONS

Course Code :15 EM 52H3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Concept of reliability: What is Reliability, System Reliability Parameters, Component Reliability, Reliability Function, and Failure Rate Failures: Causes of failures, types of failures, Modes of failure, Bath tub curve, Effect of preventive maintenance. Mathematics of reliability: Variation, Probability concept, Rules of probability, Continuous variation, Continuous distribution functions, Variation in engineering, Discrete variation, Statistical confidence, Statistical hypothesis testing, Non-parametric inferential methods, Goodness of fit Series of events, Computer software for statistics, Practical conclusions, Probability plotting

Electronic System Reliability: Reliability of electronic Components, Component Types & Failure Mechanisms, Summary Of Device Failure Modes, Circuit & System Aspects, Electronic System reliability prediction, Reliability in electronic system design, Parameter variation and tolerance Design for production test and maintenance.

Design for higher redundancy: Computer aided engineering, Environment, Design analysis methods Quality function deployment, Reliability prediction, Load strength analysis, Failure mode effect and criticality analysis, Fault tree analysis, Hazard and operability study, Parts material and process review System reliability models: Series, Parallel, Series-parallel, parallel-series, non- series-parallel configurations, Expressions for the reliability of the basic configurations, Reliability evaluation of Non-series-parallel configurations, Decomposition methods, Deduction of the minimal cut sets from the minimal path sets.

Quality: Managing production quality, Quality audit, Quality management approach.

Maintainability: Maintenance time distribution, Preventive maintenance strategy, Maintenance schedule, Technology aspect, Calibration, Maintainability prediction, Design for maintainability Basic Safety Technology Principles for Processing Systems :Basic Requirements, Risk Definition and Analysis, Risk and Consequences of a Malfunction, Risk Assessment, Risk Graphs, Requirement Classes, Risk Acceptability, Standard Institutes and the role of Standards and Norms, Developing Safety Critical Computer Systems: General Concepts.

Reliability Management: Corporate policy for reliability, integrated reliability programs, Standards for quality reliability and safety, contracting for reliability achievement, managing lower level supply, Customer management of reliability, Organization for reliability, reliability and cost, economics: Cost, Economics.

Text Books:
1. Practical Reliability Engineering -Patrick D. T. O' Connor., IV Edition
2. Electronic Safety Systems - Josef Borcsok

ADVANCED MICROCONTROLLER AND ITS APPLICATIONS

Course Code :15 EM 52H4 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**

Syllabus:

Overview of Microcomputer systems, Addresses, General Operation of a computer, Microprocessors in Digital System design. Purpose of micro controller. Difference between microprocessor and microcontroller. Advantages and Disadvantages. Block diagram of a microcontroller – operation, Microcontroller functioning. Microprocessors architectures **Architecture,** RISC and CISC processors.Memory **organization,** ports, interrupts.

Internal architecture: Introduction to ARM7TDMI processor – Pin Description, Pinfunctionality, internal architecture, Instruction Set and Instruction Cycle timings, ARM 32- bit and THUMB (16-bit) operating modes, Switching between ARM and THUMB instructions. Types of memory – Code memory, External Memory, Internal memory, Register Set.

PIC16F877 Instructions Set, addressing modes, Assembly language Programs. **PIC16F877 PERIPHERALS:** Timers, CCP modules, ADC modules, configuration word and programming.

SERIAL COMMUNICATION MODULES: UART, I2C, PSP, EEPROM, Reset, Oscillator modes, configuration word and programming.
INTERFACING: Interfacing of keys, Display - LEDs, 7-segment LED (multiplexed display) & LCDs, (Programs in assembly and C). DAC and ADC, generation of PWM with PIC microcontroller. (Programs in assembly and C)

APPLICATIONS OF MICROCONTROLLERS. EX: RPM meter, event counter, temperature, controller. (Programs in assembly and C). Development Tools: Simulators, debuggers, cross compilers, in-circuit Emulators for the microcontrollers.

TEXT BOOKS:
1. J.B.PEATMAN Design with PIC microcontrollers-, PHI 1998.
2. Barrnett Cox & Cull, Embedded C programming and the microchip PIC- Thomson Publications 2004.

REFERENCE BOOKS:
1. Ajay .V. Deshmukh Micro Controller theory and Application, TATA McGraw –Hill, 2008, 1st Edition

M.TECH - POWER ELECTRONICS AND DRIVES

First Year (First Semester):

S. No.	Course Code	Course Title	Periods L	T	P	Contact Hours	Credits
1	15 EE 5101	Design of Power Converters	3	0	2	6	4
2	15 EE 5102	Power Electronic Control of Drives	3	0	2	6	4
3	15 EE 5103	Optimization Techniques	3	2	0	4	4
4	15 EE 5104	Modern Control theory	3	2	0	4	4
5		Elective – 1	3	0	0	3	3
6		Elective - 2	3	0	0	3	3
7	15 IE 5149	Seminar	0	0	4	4	2
		T	**18**	**4**	**8**	**30**	**24**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods L	T	P	Contact Hours	Credits
1	15 EE 5205	Advanced Power Converters	3	2	0	4	4
2	15 EE 5206	Micro controllers and Embedded Systems	3	0	2	6	4
3	15 EE 5207	Modeling and Simulation of Power Electronic Systems	3	0	2	6	4
4	15 EE 5208	Industrial Applications of Electronics	3	2	0	4	4
5		Elective – 3	3	0	0	3	3
6		Elective - 4	3	0	0	3	3
7	15 IE 5250	Term Paper	0	0	4	4	2
Total			**18**	**4**	**8**	**30**	**24**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods L	T	P	Credits
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 EE 51A1	Instrumentation & Control	3	0	0	3
2	15 EE 51A2	Special Machines	3	0	0	3
3	15 EE 51A3	Electric and Hybrid Vehicles	3	0	0	3
Elective-2						
1	15 EE 51B1	Digital Signal Processor	3	0	0	3
2	15 EE 51B2	Non Conventional Energy Resources	3	0	0	3
3	15 EE 51B3	AI Techniques in Power Electronics & Drives	3	0	0	3
Elective-3						
1	15 EE 52C1	FACTS	3	0	0	3
2	15 EE 52C2	Power Quality	3	0	0	3
3	15 EE 52C3	Embedded Control of Electric Drives	3	0	0	3
Elective-4						
1	15 EE 52D1	Smart Grids	3	0	0	3
2	15 EE 52D2	State Estimation & Adaptive Control	3	0	0	3
3	15 EE 52D3	Advance PWM Techniques	3	0	0	3

DESIGN OF POWER CONVERTERS

Course Code : 15 EE 5101 **L-T-P : 3-0-2**

Credits : 4

Syllabus:

DESIGN OF SNUBBER CIRCUITS: Design of snubber circuits for diode, transistor and thyristor- snubbers for bridge circuit configuration- GTO snubber circuit design considerations- Problems. **DESIGN OF GATE AND BASE DRIVE CIRCUITS**: Preliminary design considerations- DC-coupled drive cuircuits- electrically isolated drive circuits- cascaded connected drive circuits- thyristor drive circuits- power device protection in drive circuits- Problems. **DESIGN ASPECTS OF HEAT SINKS:** control of semiconductor device temperature- Heat transfer by conduction, convection and radiation- Heat sink design-Problems. **DESIGN OF MAGNETIC COMPONETS:** Analysis of a specific inductor design- Inductor design procedure- Analysis of a specific transformer design- transformer design procedure- comparison of transformer and inductor sizes- Problems. **DESIGN OF DC-DC CONVERTERS**- Design considerations of DC-DC converters- Current Mode Control- Controller Design- Problems.

Text Books:

1. Ned Mohan, T.M. Undeland and William P. Robbins "Power Electronics: Converters, Applications and Design", 3rd Edition, John Wiley & Sons, (2009).
2. M.H. Rashid "Power Electronics-circuits, Devices and Applications", 3rd Edition, PHI, (2005).
3. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, (2003).

Reference Books:

1. Jai P.Agrawal, "Power Electronics Systems", Second Edition, Pearson Education, (2002).
2. P.T. Krein, Elements of Power Electronics, Oxford University Press, (1998).

POWER ELECTRONIC CONTROL OF DRIVES

Course Code : 15 EE 5102 **L-T-P : 3-0-2**

Credits : 4

Syllabus:

Control of induction motor, Review of steady-state operation of Induction motor, Equivalent circuit analysis, torque-speed characteristics. VSI Fed Induction motor drives &CSI Fed Induction motor drives. Control of induction by Slip power recovery schemes. **Vector control of Induction Motor**: Principles of vector control, Direct vector control, derivation of indirect vector control, implementation – block diagram; estimation of flux, flux weakening operation. **Control of Synchronous motor drives**: Synchronous motor and its characteristics- Control strategies-Constant torque angle control- power factor control, constant flux control, flux weakening operation, Load commutated inverter fed synchronous motor drive. PMSM and BLDC control of Drives, control of Variable Reluctance Motor Drive .**Speed control of dc Motors**-Different types of speed control techniques by using single phase& three phase ac systems .Closed loop control of phase controlled DC motor Drives. Open loop Transfer function of DC Motor drive- Closed loop Transfer function of DC Motor drive –Phase-Locked loop control.**Closed loop control of chopper fed DC motor Drives**, Speed controlled drive system – current control loop – pulse width modulated current controller – hysteresis current controller – modeling of current controller – design of current controller .

Text Books:

1. B. K. Bose , "Modern Power Electronics and AC Drives",Pearson Publications (2005).
2. R.Krishanan,"Electric Motor Drives", Indian Edition,Prentice Hall, (2008).

Reference Books:

1. Shepherd, Hulley, Liang , "Power Electronics and Motor Control",II Edition, Cambridge University Press ,(2004).
2. M. H. Rashid , "Power Electronic Circuits, Devices and Applications, 3 rd edition,PHI, (2003).
3. GK Dubey, "Fundamentals of Electrical Drives" , 2 nd edition ,Narosa Publishers, (20020.

OPTIMIZATION TECHNIQUES

Course Code : 15 EE 5103 **L-T-P : 3-2-0**

Credits : 4

Syllabus:

Linear Programming: Standard form of Linear programming problem; Simplex method two phase simplex method; Duality in Linear programming, Decomposition Principle .Some simple numerical problems**. Non-Linear Programming:** Fibonacci method, Univariate method, Pattern directions, Golden section method, Powell's method, Newton's method, Quasi Newton method.Some simple numerical problems. **Transportation Problem:** Definition of transportation problem, transportation algorithm, North-West corner method, Vogel approximation method, Least cost method, Unbalanced & Transportation Problems. Hungarian method for assignment. Unbalanced Assignment, problems. **Project planning through Networks:** Arrow diagram representation; Rules for constructing an arrow diagram. PERT and CPM, critical path calculations, Earliest start and latest completion times; Determination of floats. Some simple numerical problems. **Dynamic Programming:** Multistage decision processes; Types of multistage decision problems, concept of sub-optimization and the principle of sub-optimality computational procedure in dynamic programming. Some simple numerical problems.

Text Books:

1.S.S. Rao ,"Engineering optimization theory and practice",New Age International Publications. A Wiley Interscience publication,(1996).

2.Hamdy A. Taha , "Operations Research, An introduction", PHI learning private Ltd. New Delhi,(2010).

Reference Books:

1.S.D. Sharma, "Operations Research", Kedarnath & Ramnath Publishers, Delhi.

2.Hiller and Liberman , "Introduction to operations research", McGrawHill Eduction Pvt Ltd, (2010).

MODERN CONTROL THEORY

(Common to Both PED & PS)

Course Code : 15 EE 5104 **L-T-P : 3-2-0**

Credits : 4

Syllabus:

System representation: Introduction to state and state variable – system representation in state variable form – transformations – phase variable form – canonical forms – physical systems – plant models – representation using state function - language linearization. **Time response:** state transition matrix - properties and methods of valuation – time response of linear systems – state diagrams – resolvent matrix – resolvent algorithm. **Controllability and Observability:** definition and concepts – criteria for controllability and observability – state variable feedback – pole placement – luenberger observer design. S**tability:** introduction – definitions of stability – stability in the sense of liapunov – stability of linear systems – transient response – behaviour of estimation – stability of non linear systems – generation of liapunov functions.**Optimal control:**formulation of the optimal control problem – method of calculus of variations – use of hamiltonian method – pontryagin's minimum principle - optimal control problem – hamilton – jacobi approach – continuous time linear state regulator matrix riccati equation – methods of solution – state variable feedback design.

Text Books:

1. M. Gopal, “Modern Control Systems Theory”, Wiley Eastern Limited, New Delhi,(1996).
2. K.Ogata , “Discrete Time Control Systems”,Pearson Education (2005).
3. M.Gopal, “Digital Control systems and State Variables methods”,(2006)

Reference Books:

1. M. Gopal , “Modern Control System Theory”, New Age International (2005).
2. Ogata. K , “Modern Control Engineering”,Prentice Hall (2006).
3. Kirck , “Optimal control”.

<u>ADVANCED POWER CONVERTERS</u>

Course Code : 15 EE 5205 **L-T-P : 3-2-0**
Credits : 4

Syllabus:

PWM INVERTERS (SINGLE-PHASE)-Principle of operation – performance parameters – single phase bridge inverter – evaluation of output voltage and current with resistive, inductive and Capacitive loads – Voltage control of single phase inverters – single PWM – Multiple PWM – sinusoidal PWM – modified PWM – phase displacement Control – Advanced modulation techniques for improved performance – Trapezoidal , staircase, stepped, harmonic injection and delta modulations – Advantage – application – numerical problems. **PWM INVERTERS (THREE-PHASE)-**Three phase inverters – analysis of 180 degree condition for output voltage And current with resistive, inductive loads – analysis of 120 degree Conduction – voltage control of three phase inverters – sinusoidal PWM – Third Harmonic PWM – 60 degree PWM – space vector modulation – Comparison of PWM techniques – harmonic reductions – Current Source Inverter – variable DC link inverter – buck and boost inverter – inverter circuit design – advantage applications – numerical problems. **RESONANT CONVERTERS-**Resonant converters – Zero current switching resonant converters – L type ZCS resonant converter – M type ZCS resonant converter – zero voltage Switching resonant converters – comparison between ZCS and ZVS resonant Converters – Two quadrant ZVS resonant converters – resonant de-link Inverters – evaluation of L and C for a zero current switching inverter – Numerical problems.

MULTILEVEL INVERTERS- Multilevel concept – Classification of multilevel inverters – Diode clamped multilevel inverter –Principle of operation – main features – improved diode Clamped inverter – principle of operation–Flying capacitors multilevel inverter –main features. Cascaded multilevel inverter – principle of operation – main features – Multilevel inverter applications –reactive power compensation – back to back intertie system – adjustable drives – Switching device currents – de link capacitor voltage balancing – features of Multilevel inverters

– comparisons of multilevel converters. **MATRIX CONVERTERS-** Introduction-Matrix converter circuit-Control strategies for PWM matrix converters in three-phase motor Application, DC-DC Converters & SVM Techniques

Text Books:

1.N.Mohan, T.M.Undeland, W.P Robbins, "Power Electronics, Converters, Applications & Design", Wiley India Pvt. Ltd.(2013).
2.William Shepherd and Li Zhang, "Power Converter Circuits",CRC press ,Taylor & Francis (2004).

Reference Books:

1. Ned Mohan, Tore M. Undeland and William P. Robbins , "Power Electronics", Second Edition ,John Wiley and Sons .
2. Gyugyi, L., B. R. Pelly, "Static Power Frequency Changers," Wiley, New York.
3. Muhammad. H. Rashid , "Power Electronics Handbook", Academic Press,(2001).
4. Ali Emadi, Alireza Khaligh, ,Zhong Nie, Young Joo Lee, " Integrated Power Electronic Converters and Digital Control", CRC press.

MICROCONTROLLERS & EMBEDDED SYSTEMS

Course Code : 15 EE 5206 **L-T-P : 3-0-2**
Credits : 4

Syllabus:

MICRO CONTROLLERS: Micro controller families - 8051 Micro controller-Architecture - Register organization -Addressing modes -Instruction set -Assembler directives, Introduction to 16-bit microcontroller. **EMBEDDED SYSTEMS:** Embedded System Classification – Components of an Embedded System Hardware - Overview of Processors in the System - Other hardware units - Software embedded into the system - Embedded System on a Chip (SOC) – Structural units in Processor. **DEVICE NETWORK AND EMBEDDED PROGRAMMING:** Device I/O types and Examples-Synchronous, ISO-synchronous and Asynchronous communication from Serial Devices – Timer and Counting devices - Programming in Assembly language (ALP) versus High Level Language - C program elements –embedded programming in C++ and JAVA. **REAL TIME OPERATING SYSTEMS:** Operating System services –Process management – Memory management – Device, File and I/O Subsystem management – IEEE Standard POSIX functions for Standardization of RTOS and inter-task communication functions OS Security Issues – Mobile OS. **HARDWARE SOFTWARE CO - DESIGN IN AN EMBEDDED SYSTEM**

Text Books:

1. Mazidi & Mc Kinley, " The 8051 Micro controller and Embedded Systems using Assembly and c", 2nd edition, published by Person Education,(2006).

2. Rajkamal, “Embedded Systems Architecture, Programming and Design”, TATA McGraw-Hill Publications,(2003).

Reference Books:

1. Dr.K.V.K.K.Prasad, “Embedded/Real-time Operating System”, Dreamtech Press, (2003).

MODELLING AND SIMULATION OF POWER ELECTRONIC SYSTEMS

Course Code : 15 EE 5207 **L-T-P : 3-0-2**
Credits : 4

Syllabus:

SIMMULATION OF AC-DC CONVETERS: Modeling of single phase and three phase uncontrolled and controlled (SCR) rectifiers- simulation of converter fed DC drives- computation of performance parameters: harmonics, power factor, angle of overlap. **SIMULATION OF DC-DC CONVERTERS:** Modeling of Chopper circuits- Simulation of thyristor choppers with voltage, current and load commutation schemes- Simulation of chopper fed dc motor- computation of performance parameters.**SIMULATION OF DC-AC CONVERTERS**: Modeling of single and three phase inverters circuits – Space vector representation- Pulse-width modulation methods for voltage control- Simulation of inverter fed induction motor drives.**SIMULATION OF AC-AC CONVERTERS:** Modelling of AC voltage controllers, and Cyclo-converters- Simulation of AC voltage controllers and Cyclo-converters feeding different loads- Computation of performance parameters.

Text Books:

1.Rashid, M., “Simulation of Power Electronic Circuits using PSPICE”, Prentice Hall Inc., (2006).

2.M. B. Patil, V. Ramnarayanan and V. T. Ranganathan., “Simulation of Power Electronic Converters”, 1st Edition, Narosa Publishers, (2010).

3.John Keown., “Microsim, Pspice and circuit analysis”, third edition, Prentice Hall Inc., (1998).

Reference Books:

1.Robert Ericson, ‘Fundamentals of Power Electronics’, Chapman & Hall, (1997).

2.ssa Batarseh, ‘Power Electronic Circuits’, John Wiley,(2004).

3.Simulink Reference Manual, Math works, USA.

INDUSTRIAL APPLICATIONS OF ELECTRONICS

Course Code : 15 EE 5208 **L-T-P : 3-2-0**
Credits : 4

Syllabus:

Industrial power controllers: Review of switching regulators and switch mode power supplies, uninterrupted power.supplies- off-line and on-line topologies-Analysis of UPS topologies, solid state circuit.Breakers, solid-state tap-changing of transformer. **Analog controllers:** Analog Controllers - Proportional controllers, Proportional – Integral controllers, PID controllers, derivative overrun, integral windup, cascaded control, Feed forward control, Digital control schemes, control algorithms, programmable logic controllers. **Signal conditioners-Instrumentation amplifiers:** Signal conditioners-Instrumentation amplifiers – voltage to current, current to voltage, voltage to frequency, frequency to voltage converters; Isolation circuits – cabling; magnetic and electro static shielding and grounding. **Opto-electronic devices and control:** Opto-Electronic devices and control , electronic circuits for photo-electric switches-output signals for photo-electric controls; Applications of opto-isolation, interrupter modules and photo sensors; Fibre-optics; Bar code equipment, application of barcode in industry. **Servo-systems and Stepper motors:** Introduction to servo systems and microcomputer based servo amplifiers-block diagram of servo systems and servo amplifiers-functional description cascade control circuits-velocity loop amplifier-current loop amplifier-PWM control circuits-input and output signal for the control circuits-programming and operation of microcomputer based servo controllers. Stepper motors – types, operation, control and applications; servo motors- types, operation, control and applications – servo motor controllers – servo amplifiers – linear motor applications-selection of servo motor.

Text Books:

1. James Maas, 'Industrial Electronics', Prentice Hall,(1995).
2. M.D. Singh and K. B. Khanchandani, 'Power Electronics', 2nd Edition ,Tata McGraw-Hill, , New Delhi,(2008).

Reference Books:

1. Michael Jacob, 'Industrial Control Electronics – Applications and Design', Prentice Hall,(1995).
2. Thomas E. Kissell, 'Industrial Electronics', Prentice Hall India,(2003).

INSTRUCTIONS

INSTRUMENTATION AND CONTROL

Course Code : 15 EE 51A1 **L-T-P : 3-0-0**

Credits : 3

Syllabus:

BASIC PRINCIPLES OF MEASUREMENT – generalized configuration and functional descriptions and Dynamic performance characteristics of measuring instruments– Classification and elimination of errors. Examples with block diagrams **MEASUREMENT OF DISPLACEMENT:** Theory and construction of various transducers to measure displacement – Calibration procedures, measurement of temperature -Classification – Ranges. **MEASUREMENT OF PRESSURE** : Units – classification – different principles used. Low pressure measurement – Thermal conductivity gauges **MEASUREMENT OF LEVEL :** Direct method – Indirect methods – capacitative, ultrasonic, magnetic, cryogenic fuel level indicators – flow measurement, Laser Doppler Anemometer (LDA).**MEASUREMENT OF SPEED :** Mechanical and Electrical tachometers – Measurement of Acceleration and Vibration Different simple instruments – Principles of Seismic instruments.

Text Books:

1. D.S Kumar “Mechanical Measurement Control” 3rd edition, Metropolitan Publishers, (2004).
2. T.BeckWith, R.Marangoni, J.Linehard, “Mechanical Measurements”,6th edition PHI/PE,(2009).

Reference Books:

1. Doeblin Earnest. O. Adaptation by Manik and Dhanesh, “Measurement systems: Application and design”, TMH,(2007).
2. Instrumentation and Control systems/ S.Bhaskar/ Anuradha Agencies, (2004).

SPECIAL MACHINES

Course Code : 15 EE 51A2 **L-T-P : 3-0-0**
Credits : 3

Syllabus:

Induction generators: self excitation requirements, steady state analysis, voltage regulation, different methods of voltage control. Doubly fed induction machines: control via static converter, power flow, voltage/frequency control (generation mode), application to grid connected wind and mini/micro hydel systems. **Brushless DC Machines**: construction operation, performance, control and applications. Micro Machines: principles of operation of various types. Sensors for control, e.g. Position sensor. **Linear Machines**: Linear Induction Machines and Linear Synchronous Machines. Construction, operation, performance, control and applications. PMDC and PM Synchronous Machine, control and applications. Recent developments in electrical machines. **Stepper Motors**: Various types, principle of operation, operating characteristics, applications. Servo Motors. Servo amplifier and control. Special types of permanent magnet motors for servo application. Switched Reluctance Motor: Construction, operating performance, control and applications. S**ynchronous And Special Machines :**Construction of synchronous machines-types - Induced emf - Voltage regulation; emf and mmf methods - Brushless alternators - Reluctance motor - Hysteresis motor – Axial flux machine, Flux Reversal Machine.

Text Books:

1. P.C Sen, 'Principles of Electrical Machines and Power Electronics', Second edition ,Wisley Edition, ,(1997).
2. Gopal K Dubey, 'Fundamentals of Electrical Drives', Second edition, Narosa Publications,(2008).

Reference Books:

1. Bimal K. Bose, 'Modern Power Electronics And AC Drives', First edition ,Low Price Edition,(2002).
2. R.K Rajput, 'Electrical Machines', Fifth Edition, Laxmi Publications Pvt Ltd,(2005).

ELECTRIC AND HYBRID VEHICLES

Course Code : 15 EE 51A3 **L-T-P : 3-0-0**
Credits : 3

Syllabus:

History, Journey and necessity of Electric and Hybrid Vehicle-Vehicle dynamics- Architectures of Hybrids-Motors, Power converters for Electric and Hybrid Vehicle-Power converters for

Electric and Hybrid Vehicle-Design of Electric and Hybrid Vehicle - Energy storage systems – Control systems for Electric and Hybrid Vehicle.

Text Books:

1. M. Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, (2005).
2. Husain and Iqbal, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, London,(2003) .

Reference Books:

1. A. E. Fuhs, "Hybrid Vehicles and the Future of Personal Transportation", CRC Press, (2009).
2. Jefferson, C.M., Barnard and R.H., "Hybrid Vehicle Propulsion", WIT Press, Boston, (2002).
3. Erjavec, Jack, Arias and Jeff Hybrid, "Electric and Fuel-Cell Vehicles", Thomson, Australia,(2007).

DIGITAL SIGNAL PROCESSOR

Course Code : 15 EE 51B1 **L-T-P : 3-0-0**

Credits : 3

Syllabus:

INTRODUCTION TO DIGITAL SIGNAL PROCESING: Introduction, A Digital Signal processing system, The sampling process, Discrete time sequences. Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear time-invariant systems, Analysis and Design tool for DSP Systems MATLAB, DSP using MATLAB.**NUMBERING SYSTEMS:** Floating, Integer and Fixed point Processors, IEEE-754 Floating-Point Format, Q-Format.**ARCHITECTURES FOR PROGRAMMABLE DSP DEVICES:** Architecture for two selected DSPs, Pipelining process of instructions, Read and write operations, Interrupts, Timers.**PROGRAMMING FOR SELECTED DSP**(TMS320F28335/F2812)**:** Code composer studio, implementation of small programs like Digital I/O, PID control, Digital Filters, Timer and interrupts, PWM signal generation, Analog to Digital Conversion

Text Books:

1. Sanjit K Mitra, "Digital Signal Processing", Tata MCgraw Hill Publications.
2. J G Proakis, D G Manolokis, "Digital Signal Processing Principles, Algorithms, Applications" PHI.
3. TMS320F28335 Manuals

Reference Books:

1. A V Oppenhiem, R W Schafer , “Discrete-Time Signal Processing”,Pearson Education.
2. Emmanuel C Ifeacher Barrie. W. Jervis, “DSP- A Practical Approach’,Pearson Education.
2. S. M .Kay , “Modern spectral Estimation techniques”,PHI,(1997).

NON CONVENTIONAL ENERGY RESOURCES

Course Code : 15 EE 51B2 **L-T-P : 3-0-0**

Credits : 3

Syllabus:

SOLAR RADIATION : Extraterrestrial solar radiation, Terrestrial solar radiation, solar thermal conversion, solar ponds, solar heating/cooling technique, solar distillation, photovoltaic energy conversion, solar cells – 4 models. **WIND ENERGY :**Planetary and local winds, vertical axis and horizontal axis wind mills, principles of wind power, maximum power, actual power, wind turbine operation, design parameters of wind turbine. **ENERGY FROM OCEANS :**Ocean temperature differences, principles of OTEC plant operations, wave energy, devices for energy extraction, tides, simple single pool tidal system, double pool tidal system. **BIO-ENERGY & GEOTHERMAL ENERGY :** Bio fuels, classification, direct combustion for heat and electricity generator, anaerobic digestion for biogas, biogas digester types, power generation. Origin and types of geothermal energy, geothermal energy extraction. **MICRO- HYDEL ELECTRIC SYSTEMS**: Power potential–scheme layout-generation efficiency and turbine part flow-different types of turbines for micro hydel electric systems.

Text Books*:*

1. Godfrey Boyle “Renewable Energy”, Oxford Publications, Second edition,(2004).
2. G. D. Rai, “Non-Conventional Energy Sources”, First edition, Khanna Publishers,(2004).

Reference Books*:*

1. Roger H.Charlier, Charles W. “Ocean Energy- Tide and Tidal Power”ISBN: Library of Congress Control Number: 2008929624_c Springer-Verlag Brerlin Heidelberg (2009).
2. John Twidell & Toney Weir: E&F.N. Spon, “Renewable Energy Sources”, 2nd edition ,Taylor & Francis New York.
3. John F.Walker & N.Jenkins, “Wind Energy Technology”, John Willey and Sons Chichester, U.K(1997).

AI TECHNIQUES IN POWER ELECTRONICS AND DRIVES

Course Code : 15 EE 51B3 **L-T-P : 3-0-0**
Credits : 3

Syllabus:
Elements of neural control: ANN architectures- training algorithms- neural network implementation, NN in induction motor drives, Other NN applications. Fuzzy Logic Fundamentals: Fuzzy sets-membership functions-linguistic variables- Fuzzy logic operators-Fuzzy control systems-Fuzzy logic in power and control applications. Fuzzy control of induction motor drives, Fuzzy DC motor control, Fuzzy control of reluctance motor. Hybrid Systems-Genetic Algorithms, Genetic Algorithms applications, Genetic Algorithms with Fuzzy controllers.

Text Books:
1. M.N. Cirstea, A. Dinu, J.G. Khor and M. McCormick, "Neural and Fuzzy Logic Control of Drives and Power System", Newnes,(2002).
2. T. J. Ross "Fuzzy Logic with Engineering Application", 3rd Edition, John Wiley and Sons, (2010).

Reference Books:
1. P. Vas, "Artificial-Intelligence-Based Electrical Machines and Drives: Application of Fuzzy, Neural, Fuzzy-Neural, and Genetic-Algorithm-Based Techniques", Oxford University Press, (1999).

FLEXIBLE AC TRANSMISSION SYSTEMS

Course Code : 15 EE 52C1 **L-T-P : 3-0-0**
Credits : 3

Syllabus:

FACTS CONCEPT AND GENERAL SYSTEM CONSIDERATIONS: Transmission interconnections, Power Flow in AC system, Dynamic stability Considerations and the importance of the controllable parameters, Introduction to Facts devices, Basic types of FACTS Controllers, benefits from FACTS controllers. **VOLTAGE SOURCE CONVERTERS AND CURRENT SOURCE CONVERTERS:** Basic concept of voltage source converters, Single phase, there phase full wave bridge converters operation, Transformer connections for 12 pulse, 24 and 48 pulse operation. Three level voltage source converter, Pulse width modulation converter, basic concept of current source converters, Comparison of current source converters with voltage source converters. **STATIC SHUNT COMPENSATION:** Objectives of shunt compensation, Methods of controllable VAR generation, variable impedance type static VAR generators (SVC): TCR, TSR, TSC, FC-TCR, TSC-TCR, switching converter type VAR generators: STATCOM, Comparison between SVC and STATCOM, STATCOM for transient and dynamic stability enhancement. **STATIC SERIES COMPENSATION :**Objectives of series compensation, variable impedance type static series controllers: GCSC, TSSC, TCSC, switching converter type controller: SSSC, Operation and Control External system Control for series Compensator SSR and its damping – Static Voltage and Phase angle Regulators - TCVR and TCPAR – Operation and Control. **UPFC AND IPFC:** The unified power flow Controller – Operation –Comparison with other FACTS devices – control of P and Q – dynamic performance – special Purpose FACTS controllers – Interline Power flow Controller – Operation and Control.

Text Books:

1. N.G Hingorani & L.Gyugyi " Understanding FACTS: Concepts and Technology of Flexible AC Transmission System" , IEEE Press,(2000).
2. K.R.Padiyar "FACTS Controller in power Transmission and Distribution" New Age Int Publisher,(2007).

Reference Books:

1. Ned Mohan et.al "Power Electronics"2 nd edition John wiley & Sons,(2002).
2. T.J.E Miller, "Reactive power control in electric Systems" John willey & sons,(1982).

POWER QUALITY

Course Code : 15 EE 52C2 **L-T-P : 3-0-0**

Credits : 3

Syllabus:

Introduction - Power or voltage quality, terms and definitions: short duration voltage variations, Interruptions – Voltage sag – Swell – Surges – Harmonics – Voltage fluctuations. Long duration voltage variations: Over voltage – Under voltage – Sustained interruptions, Transients: Impulse transients – Oscillatory transient, Power quality terms. **Long Interruptions** - Definition – Interruptions – Causes of long interruptions – Origin of interruptions – Limits for the interruptions frequency – Limits for the interruption duration. **Short Interruptions** - Definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions. **Voltage sag analysis** - Voltage sag magnitude – Monitoring - Theoretical calculations – Examples - Sag magnitude in non-radial systems, Voltage calculation in meshed systems, Voltage sag duration, Fault clearing time – Magnitude duration plots- Measurement of sag duration, Magnitude and Phase angle jumps for three phase unbalanced sags – Phase to phase fault – Single phase faults – Two phase to ground faults – High impedance fault – Meshed systems. **Mitigation of Interruptions and Voltage Sags**- Overview of mitigation methods – From fault to trip, Reducing the number of faults, Reducing the fault clearing time changing the power system, Installing mitigation equipment, Improving equipment immunity, Different events and mitigation methods. System equipment interface – Voltage source converter, series voltage controller with MATLAB, Shunt voltage controller with MATLAB, combined shunt and series controller with MATLAB simulation. Typical wiring and grounding problems.

Text Books:

1. Math H J Bollen, "Understanding Power Quality Problems: voltage sags and interruptions", Wiley-IEEE Press, (2000), Indian Reprint (2013).
2. Roger C Dugan, Surya Santoso, Mark F. Mc Granaghan, H. Wayne Beaty, "Electrical power systems quality", Second edition, (2002).

Reference Books:

1. Angelo Baggini, "Hand book of power quality", Wiley publications,(2008).
2. Arindam Ghosh, Gerard Ledwich, "Power Quality Enhancement using Custom Power Devices" Springer International Edition,(2009).
3. C. Sankaran, "Power Quality", CRC Press, Indian Reprint – (2011).
4. Ewald F. Fuchs, Mohammed A.S. Masoum, "Power Quality in Power Systems and Electrical Machines" 2008. First Indian Reprint – (2009).

EMBEDDED CONTROL OF ELECTRIC DRIVES

Course Code : 15 EE 52C3 **L-T-P : 3-0-0**

Credits : 3

Syllabus:

8051 Architecture Basic organization - 8051 CPU structure - Memory Organization – Addressing modes - Instruction set – Programming – Timing diagram – Memory expansion.
Peripherals and Versions of 8051 Parallel Ports – Timers and Counters – Interrupts – Serial Communication – Simple Programs ADC, DAC and Analog Comparator options in P87LPC769 – PWM and Watch dog timer options in P89C66x - Assemblers and Compilers – Generation of .LST and .HEX files for applications using Keil / RIDE IDE. **Architecture of DSPIC Architecture** – Timer- I/O ports-PWM module-ADC-Case study. **Peripherals Interfacing of DSPIC I/O Ports** – Timers / Counters – Capture / Compare / PWM modules – Master Synchronous Serial Port (MSSP) module – USART – A / D Converter module – Comparator module - .LST and .HEX files generation for applications using MpLab IDE. **Applications using 8051 and PIC16f87XA Real Time Clock** – DC motor speed control – Generation of gating signals for Converters and Inverters – Frequency measurement – Temperature control – Speed control of induction motors – Implementation of PID controller.

Text Books:

1. Muhammad Ali Mazidi, JaniceGillispie Mazidi, Rolin D. McKinlay, "The 051Microcontroller and Embedded Systems- Using Assembly and C", Prentice Hall of India, New Delhi, (2007).

2. Peatman, "Design with Pic Microcontrollers,Pearson", (2003).
3. David Calcutt, Fred Cowan, Hassan Parchizadeh, 8051 Microcontrollers - An Application
4. "Based Introduction", Elsevier,(2006).

Reference Books:

1. Muhammad Ali Mazidi, JaniceGillispie Mazidi, Rolin D. McKinlay, PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18, Prentice Hall of India, New Delhi,(2007).
2. Kenneth Ayala, "The 8051 Microcontroller (With CD)", 3rd Edition, Cengage Learning, (2007).
3. Subrata Ghoshal, "Embedded Systems & Robots: Projects Using The 8051 Microcontroller",1st Edition Cengage Learning, (20090.
4. PIC16F87XA Data Sheet – DS39582B, Microchip Technology Inc., (2003).

SMART GRIDS

Course Code : 15 EE 52D1 **L-T-P : 3-0-0**
Credits : 3

Syllabus:

Basics of Power Systems: Load and Generation, Power Flow Analysis, Economic Dispatch and Unit Commitment Problems. Integration of renewable to smart grid. **Introduction to Smart Grid**: Definition, Applications, Government and Industry, Standardization. **Renewable Generation**: Carbon Footprint, Renewable Resources: Wind and Solar, Microgrid Architecture, Tackling Intermittency, Stochastic Models and Forecasting, Distributed Storage and Reserves. **Smart Grid Communications:** Two-way Digital Communications Paradigm, Network Architectures, IP-based Systems, Power Line Communications, Advanced Metering Infrastructure. Measurements: Sensor Networks, Phasor Measurement Units, Communications Infrastructure, Fault Detection and Self-Healing Systems, Applications and Challenges. **Distribution system management**: Data sources and associated external systems, Modeling and analysis tools, applications. **Demand Response**: Definition, Applications, and State-of-the Art, Pricing and Energy Consumption, Scheduling, Controllable Load Models, Dynamics, and Challenges, Electric Vehicles and Vehicle-to-Grid Systems, Demand Side Ancillary Services.
Economics and Market Operations: Energy and Reserve Markets, Market Power, Generation Firms, Locational Marginal Prices, Financial Transmission Rights. **Security and Privacy**: Cyber Security Challenges in Smart Grid, Load Altering Attacks, False Data Injection Attacks, Defense Mechanisms, Privacy Challenges.

Text Books:

1. James Momoh, “Smart Grid Fundamentals of Design and Analysis”, Wiley IEEE Press, Ed (2012).
2. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Nick Jenkins, “Smart Grid Technology and Applications”, Wiley Press, Ed (2012).

Reference Books:

1. Aranya Chakraborthy, “Control and Optimization Methods for Electric Smart Grids”, Marija D llic Editor, Springer Publications.

STATE ESTIMATION & ADAPTIVE CONTROL

Course Code : 15 EE 52D2 **L-T-P : 3-0-0**
Credits : 3

Syllabus:

Elements of probability theory: definition of probability and random variable, probability functions, expected value, mean and covariance, independence and correlation, Gaussian distribution and its properties. **Stochastic processes and system models:** Elements of the theory of stochastic processes, mean value function and covariance kernel, independent and correlated stochastic processes, stationery and non sequence model, Gaussian white process. **Non parametric methods & parametric methods:** Nonparametric methods: Transient analysis-frequency analysis-Correlation analysis-Spectral analysis. Liner Regression: The Lease square estimate-best liner unbiased estimation under linear constraints-Prediction error methods: Description of Prediction error methods-Optimal Prediction –relationships between Prediction error methods and other identification methods theoretical analysis. **Adaptive control schemes** Introduction – users- Definitions-auto tuning-types of adaptive control-gain scheduling controller-model reference adaptive control schemes – self tuning controller. MRAC and STC: Approaches – The Gradient approach – Lyapunov functions – Passivity theory – pole placement method Minimum variance control – Predictive control. **Adaptive control and application:** Stability – Convergence – Robustness – Application of adaptive control, direct model reference adaptive control. Introduction: Basic approaches to adaptive control. Applications of adaptive control. Identification: Error formulations linear in the parameters. Direct adaptive control: Linear error equations with dynamics. Gradient and pseudo-gradient algorithms. Strictly positive real transfer functions. Kalman-Yacubovitch-Popov lemma. Passivity theory.

Text Books:

1. Dan Simon, “Optimal State Estimation”, Wiley Intersience, (2006).
2. S. Sastry and M. Bodson, “Adaptive Control: Stability, Convergence, and Robustness”, Prentice-Hall, (1989).

Reference Books:

1. K.J. Astrom and B. Wittenmark, “Adaptive Control”, 2^{nd} edition, Addison-Wesley, (1995).

2. I.D. Landau, R. Lozano, and M. M'Saad, "Adaptive Control", Springer Verlag, London, (1998).
3. Meditch, "Stochastic Optimal Linear Estimation and Control" Mc-Graw Hill Company, (1969).
4. K.S. Narendra and A.M. Annaswamy, "Stable Adaptive Systems", Prentice-Hall,(1989).
5. P.E. Wellstead & M.B. Zarrop, "Self-Tuning Systems: Control and Signal Processing", J. Wiley & Sons, Chichester, England,(1991).

ADVANCED PWM TECHNIQUES

Course Code : 15 EE 52D3 **L-T-P : 3-0-0**
Credits : 3

Syllabus:

Power electronic converters for DC-AC and AC-DC power conversion: Electronic switches, dc-dc buck and boost converters, H-bridge, multilevel converters – diode clamp, flying capacitor and cascaded-cell converters voltage source and current source converters; evolution of topologies for dc-ac power conversion from dc-dc converters. **Applications of voltage source converters:** Overview of applications of voltage source converter, motor drives, active front-end converters, reactive compensators, active power filters. **Purpose of pulse width modulation :**Review of Fourier series, fundamental and harmonic voltages; machine model for harmonic voltages; undesirable effects of harmonic voltages –line current distortion, increased losses, pulsating torque in motor drives control of fundamental voltage; mitigation of harmonics and their adverse effects. **Pulse width modulation (PWM) at low switching frequency:** Square wave operation of voltage source inverter, PWM with a few switching angles per quarter cycle, equal voltage contours, selective harmonic elimination, THD optimized PWM, off-line PWM. **Triangle-comparison based PWM:** Average pole voltages, sinusoidal modulation, third harmonic injection, continuous PWM, bus-clamping or discontinuous PWM. **Space vector based PWM:** Space vector concept and transformation, per-phase methods from a space vector perspective, space vector based modulation, conventional space vector PWM, bus-clamping PWM, advanced PWM, triangle comparison approach versus space vector approach to PWM.**PWM for multilevel inverter:** Extensions of sine-triangle PWM to multilevel inverters, voltage space vectors, space vector based PWM, analysis of line current ripple and torque ripple

Text Books:

1. P.C. Sen, "Modern Power Electronics", Third edition, Wheeler Publishing Co, New Delhi,(2008).
2. Ned Mohan, Undeland and Robbin, "Power Electronics: converters, Application and design", John Wiley and sons.Inc, Newyork, Reprint (2009).
3. Jai P.Agrawal, "Power Electronics Systems", Second Edition, Pearson Education,(2002).

Reference Books:

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Third Edition, Prentice Hall India, New Delhi, (2011).

2. Bimal K Bose, "Modern Power Electronics and AC Drives", Second Edition, Pearson Education, (2003).
3. Dubey. G.K., "Thyristorised power controllers", New age International, New Delhi, (2002).
4. Bhimbhra P.S., "Power Electronics", Khanna Publishers, New Delhi, (2005).

M.TECH - POWER SYSTEMS

First Year (First Semester):

S. No.	Course Code	Course Title	Periods L	T	P	Contact Hours	Credits
1	15 EE 5109	Power System Dynamics & stability	3	0	2	6	4
2	15 EE 5110	Advanced Power System Analysis	3	0	2	6	4
3	15 EE 5103	Optimization Techniques	3	2	0	4	4
4	15 EE 5104	Modern Control theory	3	2	0	4	4
5		Elective – 1	3	0	0	3	3
6		Elective - 2	3	0	0	3	3
7	15 IE 5149	Seminar	0	0	4	4	2
		T	**18**	**4**	**8**	**30**	**24**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods L	T	P	Contact Hours	Credits
1	15 EE 5211	Real Time Control of Power System	3	0	2	6	4
2	15 EE 5206	Micro Controllers & Embedded Systems	3	0	2	6	4
3	15 EE 5212	EHVAC & HVDC Transmission	3	2	0	4	4
4	15 EE 5213	Power Systems Digital Protection	3	2	0	4	4
5		Elective – 3	3	0	0	3	3
6		Elective - 4	3	0	0	3	3
7	15 IE 5250	Term Paper	0	0	4	4	2
Total			**18**	**4**	**8**	**30**	**24**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods L	T	P	Credits
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 EE 51E1	Reactive Power Compensation & Management	3	0	0	3
2	15 EE 51E2	Distribution System Planning & Automation	3	0	0	3
3	15 EE 51E3	Power System Reliability	3	0	0	3
Elective-2						
1	15 EE 51F1	Power System Restructuring, Deregulation & Power Markets	3	0	0	3
2	15 EE 51B2	Non Conventional Energy Resources	3	0	0	3
3	15 EE 51B1	Digital Signal Processor	3	0	0	3
Elective-3						
1	15 EE 52G1	Energy Conservation & Audit	3	0	0	3
2	15 EE 52C1	FACTS				
3	15 EE 52C2	Power Quality				
Elective-4						
1	15 EE 52H1	AI Techniques in Power Systems	3	0	0	3
2	15 EE 52D1	Smart Grids	3	0	0	3
3	15 EE 52D2	State Estimation & Adaptive Control	3	0	0	3

POWER SYSTEM DYNAMICS & STABILITY

Course Code : 15 EE 5109 **L-T-P : 3-0-2**

Credits : 4

Syllabus:

POWER SYSTEM STABILITY: Introduction, General basic concept of Power System Stability, swing equations, power angle equations, natural frequencies of oscillations, single machine infinite bus system- equal area criterion- classical model of a multi machines systems. **SMALL SIGNAL STABILITY:** Small signal stability of a single machine infinite bus system, Effects of excitation systems, Power system stabilizers **SYNCHRONOUS MACHINE MODELING:** Modeling of Synchronous Machine, Park's Transformation, Analysis of Steady State Performance, P. U. Quantities, Equivalent Circuit of Synchronous Machine, Vector diagrams in steady state and transient state, power angles curves of a salient pole machine **EXCITATION SYSTEMS:** Typical Excitations configurations and excitation (Automatic) Voltage regulators, Effect of excitation on (a) Power limits, (b) Transient stability, (c) Dynamic stability, **VOLTAGE STABILITY:** Basic Concepts Related to Voltage Stability – Voltage Collapse – Voltage Stability Analysis – Prevention of Voltage Collapse.

Text Books:

1. Prabha Kundur, "Power System Stability and Control",TATA McGRAW – HILL, (2006).
2. P. M. Anderson & A.A. Fouad , "Power System Control and Stability",2nd Edition, Wiley IEEE press,(2002).

Reference Books:

1. K.R.Padiyar, "Power System Dynamics Stability & Control",2nd Edition, B.S. Publication,(2002).
2. Kimbark, "Power System Stability",Vol- I, II & III – (1968), Dover Publication Inc, Newyork,(1968).

ADVANCED POWER SYSTEM ANALYSIS

Course Code : 15 EE 5110 **L-T-P : 3-0-2**

Credits : 4

Syllabus:

Network Modeling-Single phase and three phase modeling of alternators, transformers and transmission lines, Conditioning of Y Matrix- Incidence matrix method, Method of successive elimination, Triangular factorization. **Load flow analysis**- Newton Raphson method, Fast decoupled method, AC-DC load flow-Single and three phase methods-Sequential solution techniques and extension to multiple and multi-terminal DC systems. **Fault studies**-Analysis of balanced and unbalanced three phase faults-fault calculations-Short circuit faults-open circuit faults. **System optimization**- strategy for two generator systems-generalized strategies-effect of transmission losses-Sensitivity of the objective function-Formulation of optimal power flow-solution by Gradient method-Newton's method.

Text Books:

1. D. P. Kothari, I. J. Nagrath, "Modern Power System Analysis", Tata McGraw Hill-Education, New Delhi, (2003).
2. Arrillaga, J and Arnold, C. P., "Computer analysis and power systems" John Wiley and Sons, New York, (1997)

Reference Books:

1. Grainger, J. J. and Stevenson, W. D. "Power System Analysis", Tata McGraw Hill, New Delhi, (2003).
2. Hadi Saadat, "Power System Analysis", Tata McGraw Hill, New Delhi, (2002).
3. Pai, M. A., "Computer Techniques in Power System Analysis", Tata McGraw Hill, New Delhi, (2006).
4. P. Venkatesh,B V Manikandan,S Charles Raja and A Srinivasa Rao, "Electric Power System Analysis, Security & Deregulation", PHI, (2012).

REAL TIME CONTROL OF POWER SYSTEMS

Course Code : 15 EE 5211 **L-T-P : 3-0-2**

Credits : 4

Syllabus:

Unit Commitment Problem-Introductions to UCP, Economic Dispatch- characteristics of thermal, nuclear and hydro-generator units, **Economic dispatch problem**- The Lambda iteration method, first order gradient method, base point and participation factors**, Load frequency control**- single area control, block diagram representation, steady state analysis, dynamic response, AGC multi area system, static and dynamic response, Load frequency control of 2-area system, **Computer control of power systems**- Energy Control Centre, various levels, SCADA system, data acquisition and controls, EMS system, expert system applications for power system operation, **Security control**-Security analysis and monitoring, generator and line outages by linear sensitivity factors, **State estimation**- Power system state estimation, Weighted least square state estimation, state estimation of AC network, Treatment of bad data – network observability and pseudo measurements.

Text Books:

1. Allen J. Wood and Bruce F. Wollenberg "Power Generation, Operation & Control" 2nd edition, John Wiley and Sons, (1996).
2. I.J. Nagarath & D. P. Kothari , "Modern power system analysis" 3rd Edition, TMH, New Delhi, (20030.

Reference Books:

1. Elgard , “Electric Energy Systems Theory – An Introduction” TMH, (1983).
2. Abhijit Chakrabarti & Sunita Halder “ Power System Analysis operation and Control “ 1st edition, PHI, (2006).
3. Mahalanabis A.K., Kothari D.P. and Ahson S.I., “Computer aided power system analysis and control”, 4th Edition, TMH, 2011.
4. J.J.Grainger, W.D.Stevenson JR, “Power system analysis”, Tata McGraw Hill N.D. (2007).
5. A. Handschin and E. Petroiaenu,” Energy Management Systems, Operations and Control of Electric Energy Transmission Systems”, Springer-Verlag, Berlin, Heidelberg, (1991).

EHVAC & HVDC TRANSMISSION

Course Code : 15 EE 5212 **L-T-P : 3-2-0**

Credits : 4

Syllabus:

Introduction: Need of EHV transmission, Limitations, EHV transmission, Comparison of EHV-AC & HVDC transmission, Interconnected Network and Role of Interconnecting Transmission Lines. **EHV-AC Transmission:** Parameters of EHV line, over-voltages due to switching, Ferro resonance, line insulator and clearance, corona, long distance transmission with series & shunt compensations, principle of half wave transmission, flexible AC transmission. **HVDC Transmission:** Types of DC links, terminal equipments & their operations, HVDC system control, reactive power control, harmonics, multi terminal DC (MTDC) system, AC/DC system analysis, protection of terminal equipments. **Insulation Requirement of EHV-AC and HVDC:** Classification, Insulation design aspect, Difference between Insulation Coordination-EHV-AC and HVDC, Insulation Coordination, Surge arrester protection in HVDC and EHV-AC Substation, Clearance for HVDC and EHV-AC. **Towers for (EHV-AC and HVDC):** Types and configuration of self supporting and flexible towers, Foundation of towers, mechanical design of towers, Tower design based on switching surges and lightning strokes.

Text Books:

1. K. R. Padiyar, “HVDC Power Transmission System”, Wiley Eastern Limited, (1990).
2. S. Rao, “EHV-AC, HVDC Transmission and Distribution Engineering”, Khanna Publishers,(2001).

Reference Books:

1. Rakesh Das Begmudre, “Extra High Voltage AC Transmission Engineering”, Wiley Eastern Limited, New Delhi, (1987).
2. E.W.Kimbark, “EHV-AC and HVDC Transmission Engineering &Practice”, Khanna Publishers.

POWER SYSTEM DIGITAL PROTECTION

Course Code : 15 EE 5213 **L-T-P : 3-2-0**

Credits : 4

Syllabus:

General philosophy of protection – Characteristic functions of protective relays – basic relay elements and relay terminology – Classification of Relays – Construction and operation of Electro magnetic relays – A review of conventional protection schemes for Transmission lines and station apparatus, CT, PT, summation transformer, phase-sequence current segregating network. **Protection of Power System Equipment** - Generator, Transformer, Generator-Transformer Units, Transmission Systems, Bus-bars, Motors. **Pilot wire and Carrier Current Schemes**: Use of optical fibers for protection schemes. System grounding –ground faults and protection; Load shedding and frequency relaying; Out of step relaying; Re-closing and synchronizing. **Static Relays:** Advantages of static relays, working principles of static impedance, static reactance using phase comparator, static distance, static over current, static differential relay using amplitude comparator, use of sampling comparator. **Microprocessor based protection relays** – Working principles of μP based over current, impedance, reactance directional, reactance (distance) & mho relays – digital relaying algorithms, various transform techniques employed like discrete Fourier, Walsh-Hadamard, Haar, microprocessor implementation of digital distance relaying algorithms – protection of lines against lightning & traveling waves.

Text Books:

1. T.S. Madhava Rao, "Power System Protection: Static Relays With Microprocessor Applications", 2nd edition,Tata McGraw-Hill, (19920.
2. Badri Ram & DN Viswakarma, "Power System Protection & Switch Gear", Tata McGraw Hill Publishing Company Limited, New Delhi (1995)

Reference Books:

1. A.R. Van C. Washington, "Protective Relays Their Theory & Practice", Vol.I & II, John Wiley & Sons.
2. Singh L.P , "Digital Protection, Protective Relaying from Electromechanical to Microprocessor", John Wiley & Sons, (1994).
3. D. Robertson, "Power System Protection – Reference Manual", Oriel Press, London, (1982).
4. C.R. Mason, "The art and science of protective relaying", John Wiley & sons, Wiley Eastern Ltd.,(1979).
5. Sunil S.Rao ,"Switchgear & Protection" ,10th edition, Khanna Publishers, (2006).
6. J.L. Blackburn, "Protective Relaying: Principles and Applications", Marcel Dekker, New York, (19870.
7. Ravindar P. Singh, "Digital Power System Protection", PHI, NewDelhi, (2007).

REACTIVE POWER COMPENSATION AND MANAGEMENT

Course Code : 15 EE 51E1 **L-T-P : 3-0-0**
Credits : 3

Syllabus:

LOAD COMPENSATION: Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- example.: Steady – state reactive power compensation in transmission system: Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples. **TRANSIENT STATE REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEMS:** Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers –**:** Reactive power coordination: Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences. **DEMAND SIDE MANAGEMENT:** Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels**:** Distribution side Reactive power Management: System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks . **USER SIDE REACTIVE POWER MANAGEMENT:** KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations. **REACTIVE POWER MANAGEMENT IN ELECTRIC TRACTION SYSTEMS AND ARC FURNACES:** Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

Text Books:

1. T.J.E.Miller, "Reactive power control in Electric power systems", John Wiley and sons, (1982).
2. D. M. Tagare, "Reactive power Management", Tata McGraw Hill, (2004).

Reference Books:

1. Hong Chen, "Practices of reactive power management and compensation", PJM Interconnection, Norristown, PA;
2. T E Miller, "Reactive Power Control in Power Systems", John Wiley, (1982).

DISTRIBUTION SYSTEM PLANNING & AUTOMATION

Course Code : 15 EE 51E2 **L-T-P : 3-0-0**
Credits : 3

Syllabus:

Distribution system planning and load characteristics: Planning and forecasting techniques, present and future role of computer, load characteristics, load forecasting, regression analysis, correlation theory and time series analysis, load management. **Distribution transformers:** Types, Regulation and Efficiency, KW-KVA-Method of determining regulation. **Design of sub transmission lines and distribution substation:** Introduction, sub transmission systems, distribution substation, substation bus schemes, description and comparison of switching schemes, substation location and rating, application of network flow techniques in rural distribution networks to determine optimum location of substation**. Voltage Drop and Power Loss Calculations:** DC 2 wire system, DC 3 wire system, AC single phase distribution system, % VD calculations, power loss estimation in distributed systems. **Design considerations on primary systems:** Introduction, types of feeders, voltage levels, radial type feeders, feeders with uniformly distributed load and non-uniformly distributed loads. **Design considerations of secondary systems:** Introduction, secondary voltage levels, secondary banking existing systems improvement. **Capacitors in distribution systems and distribution system protection:** Effects of series and shunt capacitors, justification of capacitors, procedure to determine optimum capacitor size and location, basic definition and types of over current protection device, objective of distribution system protection, coordination of protective devices. **Distribution system automation:** Reforms in power sector, methods of improvement, reconfiguration, reinforcement, automation, communication systems, sensors, automation systems architecture, software and open architecture, SCADA requirement, GIS based mapping of distribution network, integrated substation, metering systems, revenue improvement, issuing multiyear tariff and availability based tariff.

Text Books:

1. Turan Gonen , "Electrical Power Distribution Engineering" ,McGraw Hill, (1986).

Reference Books:

1. A. S. Pabla, "Electrical Power Distribution" ,5th Ed., TMH, (2004).
2. V Kamaraju, "Electrical Power Distribution" TMH,(2009).

POWER SYSTEM RELIABILITY

Course Code : 15 EE 51E3 **L-T-P : 3-0-0**
Credits : 3

Syllabus:

Network Modelling and Reliability Analysis: Reliability concepts – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique - Bath tub curve - reliability measures MTTF, MTTR, MTBF. **Frequency & Duration Techniques:** Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one , two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering of merged states. **Generation System Reliability Analysis:** Reliability model of a generation system– recursive relation for unit addition and removal – load modeling - Merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE. **Transmission System Reliability Analysis:** Deterministic contingency analysis-Determination of reliability indices like LOLP and expected value of demand not served. **Distribution System Reliability Analysis:** Basic Concepts – Additional interruption indices - Evaluation of Basic and performance reliability indices of radial networks.

Text Books:

1. R. Billinton, R.N.Allan, "Reliability Evaluation of Power systems" second edition, Springer.
2. Charles E. Ebeling, "An Introduction to Reliability and Maintainability Engineering", TATA Mc Graw - Hill – Edition.

Reference Books:

1. R. Billinton, R.N.Allan, "Reliability Evaluation of Engineering System", Plenum Press, New York.
2. Eodrenyi, J., "Reliability modelling in Electric Power System", John Wiley, (1980)

POWER SYSTEM RESTRUCTURING, DEREGULATION & POWER MARKETS

Course Code : 15 EE 51F1 **L-T-P : 3-0-0**
Credits : 3

Syllabus:

Key Issues in Electric Utilities Introduction – Restructuring models – Independent System Operator (ISO) – Power Exchange - Market operations – Market Power – Standard cost – Transmission Pricing – Congestion Pricing – Management of Inter zonal/Intra zonal Congestion. Open Access Same-time Information System (OASIS) Structure of OASIS - Posting of Information – Transfer capability on OASIS. **Available Transfer Capability (ATC)** Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow. **Electricity Pricing** Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves – Short-time Price Forecasting. **Power System Operation in Competitive Environment** Introduction – Operational Planning Activities of ISO- The ISO in Pool Markets – The ISO in Bilateral Markets Operational Planning Activities of a GENCO. **Market Power :** Introduction - Different types of market Power – Mitigation of Market Power - Examples. **Transmission Congestion Management :**Introduction - Transmission Cost Allocation Methods : Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods.

Text Books:

1. Loi Lei Lai, "Power System Restructuring and Deregulation", John Wiley & Sons Ltd., England,

(2001).
2. Kankar Bhattacharya, "Operation of Restructured Power System", Math H.J. Boller and Jaap E.Daalder Kulwer Academic Publishers, (2001).

Reference Books:
1.Mohammad Shahidehpour and Muwaffaq alomoush, "Restructured Electrical Power Systems", Marcel Dekker, Inc., (2001).
2.P. Venkatesh,B V Manikandan,S Charles Raja and A Srinivasa Rao, "Electric Power System Analysis, Security & Deregulation", PHI, (2012).

ENERGY CONSERVATION & AUDIT

Course Code : 15 EE 52G1 **L-T-P : 3-0-0**
Credits : 3

Syllabus:

BASIC PRINCIPLES OF ENERGY AUDIT: Energy audit- definitions, concept, types of audit, energy index, cost index, pie-charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit. **ENERGY MANAGEMENT:** Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting - Energy manger, Qualities and functions, language, Questionnaire - check list for top management. Demand side management. **ENERGY EFFICIENT MOTORS:** Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics - variable speed, variable duty cycle systems, RMS hp- voltage van at ion-voltage unbalance- over motoring- motor energy audit. **POWER FACTOR IMPROVEMENT, LIGHTING AND ENERGY INSTRUMENTS:** Power factor - methods of improvement, location of capacitors, PF with non linear loads, effect of harmonics on PF , PF motor controllers - Good lighting system design and practice, lighting control, lighting energy audit - Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's. **ECONOMIC ASPECTS AND ANALYSIS:** Economics Analysis - Depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, life cycle costing analysis - Energy efficient measures- calculation of simple payback method, net present worth method - Power factor correction, lighting - Applications of life cycle costing analysis, return on investment.

Text Books:
1. W.C.Turner, "Energy management hand book", John wiley and sons Energy management and good lighting practice: fuel efficiency- book let 12-EEO
2. W.K. Murphy, G- Mckay Butier worth, "Energy management", Heine mann publications, (20070.

Reference Books:
1. Paulo Callaghan, "Energy management", 1st edition, Mc-graw Hill Book company, (1998)

2. Giovanni and Petrecca, "Industrial Energy Management: Principles and Applications", The Kluwer international series-207 (1999)
3. Howard E.Jordan, "Energy-Efficient Electric Motors and their applications", Plenum pub corp; 2nd ed. (1994)

AI TECHNIQUES IN POWER SYSTEMS

Course Code : 15 EE 52H1 **L-T-P : 3-0-0**

Credits : 3

Syllabus:

Artificial neural networks- introduction- neural network models- architectures – knowledge representation– learning process – learning tasks- ann paradigms- back propagation, rbf algorithms- hop field network. **Fuzzy logic**- introduction – fuzzy sets - membership function – fuzzy logic – fuzzy inference- defuzzification methods. **Genetic Algorithms** - introduction- encoding – fitness function-reproduction operators-genetic modeling –genetic operators-cross over and mutation- generational cycle-convergence of genetic algorithm. **Applications of AI Techniques**- load forecasting – load flow studies – economic load dispatch – load frequency control –reactive power control – speed control of dc and ac motors.

Text Books:

1. S.Rajasekaran and G.A.V.Pai , "Neural Networks, Fuzzy Logic & Genetic Algorithms", PHI, New Delhi, (2003).
2. S.N.Sivanandam & S.N.Deepa, "Principles of Soft Computing", 1st Indian Edition ,Wiley India (P) Ltd., (2008)

Reference Books:

1. D.E Goldberg," Genetic Algorithms", Addison – Wisley,(1999).
2. J.S.R. Jang, C.T. Sun, E. Mizutani "Neuro Fuzzy and Soft Computing", PHI/Pearson education, New Delhi, (2004).
3. Bast Kosko, "Neural networks & Fuzzy systems: dynamical system approach to machine intelligence", New Delhi, Prentice Hall of India (2003).

M.TECH - MECHATRONICS

First Year (First Semester):

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Contact Hours	Credits
1	15 ME 5101	Fundamentals of Mechatronics	3	2	0	4	4
2	15 ME 5102	Advanced Engineering Mathematics	3	2	0	4	4
3	15 ME 5103	Sensors and Actuators	3	2	0	4	4
4	15 ME 5104	Modeling and Simulation of Mechatronic Systems	3	0	2	4	4
5		Elective – 1	3	0	0	3	3
6		Elective - 2	3	0	0	3	3
7	15 IE 5149	Seminar	0	0	4	4	2
		Total	**18**	**4**	**8**	**30**	**24**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Contact Hours	Credits
1	15 EM 5205	Robotics: Advanced Concepts and Analysis	3	2	0	4	4
2	15 EM 5206	Control of Mechatronic Systems	3	2	0	4	4
3	15 EM 5207	Mechatronics Product Design	3	2	0	4	4
4	15 EM 5208	Precision Engineering	3	2	0	4	4
5		Elective – 3	3	0	0	3	3
6		Elective - 4	3	0	0	3	3
7	15 IE 5250	Term Paper	0	0	4	4	2
		Total	**18**	**4**	**8**	**30**	**24**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods L	Periods T	Periods P	Credits
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 ME 51A1	Signal Processing in Mechatronic Systems	3	0	0	3
2	15 ME 51A2	MEMS and NEMS	3	0	0	3
3	15 ME 51A3	Vehicle Dynamics and Multi-body Systems	3	0	0	3
Elective-2						
1	15 ME 51B1	Emerging Smart Materials for Mechatronics Applications	3	0	0	3
2	15 ME 51B2	Intelligent Visual Surveillance	3	0	0	3
3	15 ME 51B3	Microprocessors and Embedded Systems	3	0	0	3
Elective-3						
1	15 ME 52C1	Computational Fluid Dynamics	3	0	0	3
2	15 ME 52C2	Nonlinear Optimization	3	0	0	3
Elective-4						
1	15 ME 52D1	Industrial Automation	3	0	0	3
2	15 ME 52D2	Fuzzy Sets and Artificial Intelligence	3	0	0	3

FUNDAMENTALS OF MECHATRONICS

Course Code :15 ME 5101 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Module I: Introduction: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach.

Module II: Review of fundamentals of electronics. Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs.

Module III: Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems.

Module IV: Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits. Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems. Description

Module V: Description of PID controllers. CNC machines and part programming. Industrial Robotics.

Texts:

- HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
- G.W. Kurtz, J.K. Schueller, P.W. Claar . II, Machine design for mobile and industrial applications, SAE, 1994.
- T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall, 1996.
- R. Iserman, Mechatronic Systems: Fundamentals, Springer, 1st Edition, 2005
- Musa Jouaneh, Fundamentals of Mechatronics, 1st Edition, Cengage Learning, 2012.

ADVANCED ENGINEERING MATHEMATICS

Course Code :15 ME 5102 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Linear Algebra: Matrix algebra; basis, dimension and fundamental subspaces; solvability of Ax = b by direct Methods; orthogonality and QR transformation; eigenvalues and eigenvectors, similarity transformation, singular value decomposition, Fourier series, Fourier Transformation, FFT.
Vector Algebra & Calculus: Basic vector algebra; curves; grad, div, curl; line, surface and volume integral, Green's theorem, Stokes's theorem, Gauss-divergence theorem.
Differential Equations: ODE: homogeneous and non-homogeneous equations, Wronskian, Laplace transform, series solutions, Frobenius method, Sturm-Liouville problems, Bessel and Legendre equations, integral transformations; PDE: separation of variables and solution by Fourier Series and Transformations, PDE with variable coefficient.
Numerical Technique: Numerical integration and differentiation; Methods for solution of Initial Value Problems, finite difference methods for ODE and PDE; iterative methods: Jacobi, Gauss-Siedel, and successive over-relaxation.
Complex Number Theory: Analytic function; Cauchy's integral theorem; residue integral method, conformal mapping.
Statistical Methods: Descriptive statistics and data analysis, correlation and regression, probability distribution, analysis of variance, testing of hypothesis.

Text Books:

- H. Kreyszig, "Advanced Engineering Mathematics", Wiley, (2006).
- Gilbert Strang, "Linear Algebra and Its Applications", 4th edition, Thomson Brooks/Cole, India (2006).
- J. W. Brown and R. V. Churchill, "Complex Variables and Applications", McGraw-Hill Companies, Inc., New York (2004).
- J. W. Brown and R. V. Churchill, "Fourier Series and Boundary Value Problems", McGraw-Hill Companies, Inc., New York (2009).
- G. F. Simmons, "Differential Equations with Applications and Historical Notes", Tata McGraw-Hill Edition, India (2003).
- S. L. Ross, "Differential Equations" 3rd edition, John Wiley & Sons, Inc., India (2004).
- K. S. Rao, "Introduction to Partial Differential Equations", PHI Learning Pvt. Ltd (2005).
- R. Courant and F. John, "Introduction to Calculus and Analysis, Volume I and II", Springer-Verlag, New York, Inc. (1989).
- K. Atkinson and W. Han, "Elementary Numerical Analysis" 3rd edition, John Wiley & Sons, Inc., India (2004).
- R. A. Johnson and G. K. Bhattacharya, "Statistics, Principles and Methods", Wiley (2008).

SENSORS AND ACTUATORS

Course Code :15 ME 5103 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Brief overview of measurement systems, classification, characteristics and calibration of different sensors. Measurement of displacement, position, motion, force, torque, strain gauge, pressure flow, temperature sensor sensors, smart sensor. Optical encoder, tactile and proximity, ultrasonic transducers, opto-electrical sensor, gyroscope. Principles and structures of modern micro sensors, micro-fabrication technologies: bulk micromachining, surface micromachining, LIGA, assembly and packaging.

Pneumatic and hydraulic systems: actuators, definition, example, types, selection. Pneumatic actuator. Electro-pneumatic actuator. Hydraulic actuator, control valves, valve sizing valve selection. Electrical actuating systems: solid-state switches, solenoids, voice coil; electric motors; DC motors, AC motors, single phase motor; 3-phase motor; induction motor; synchronous motor; stepper motors. Piezoelectric actuator: characterization, operation, and fabrication; shape memory alloys.

Text Books

- John G. Webster, Editor-in-chief, "Measurement, Instrumentation, and Sensors Handbook", CRC Press (1999).
- Jacob Fraden, "Handbook of modern Sensors", AIP Press, Woodbury (1997).
- Nadim Maluf, "An Introduction to Microelectromechanical Systems Engineering", Artech House Publishers, Boston (2000).
- Marc Madou, "Fundamentals of Microfabrication", CRC Press, Boca Raton (1997).
- Gregory Kovacs, "Micromachined Transducers Sourcebook", McGraw-Hill, New York (1998).
- E. O. Deobelin and D. Manik, "Measurement Systems – Application and Design", Tata McGraw-Hill (2004).
- D. Patranabis, "Principles of Industrial Instrumentation", Tata McGraw-Hill, eleventh reprint (2004).
- B. G. Liptak, "Instrument Engineers' Handbook: Process Measurement and Analysis", CRC (2003).

MODELING AND SIMULATION OF MECHATRONIC SYSTEMS

Course Code :15 ME 5104 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Physical Modelling: Mechanical and electrical systems, physical laws, continuity equations, compatibility equations, system engineering concept, system modelling with structured analysis, modelling paradigms for mechatronic system, block diagrams, mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, thermal systems, fluid systems, mechanical rotational system, electrical-mechanical coupling.

Simulation Techniques: Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation by finite element method, transfer function and frequency response, non-parametric methods, transient, correlation, frequency, Fourier and spectra analysis, design of identification experiments, choice of model structure, scaling, numeric methods, validation, methods of lumped element simulation, modelling of sensors and actuators, hardware in the loop simulation (HIL), rapid controller prototyping, coupling of simulation tools, simulation of systems in software (MATLAB, LabVIEW) environment.

Modelling and Simulation of Practical Problems:

- Pure mechanical models
- Models for electromagnetic actuators including the electrical drivers
- Models for DC-engines with different closed loop controllers using operational amplifiers
- Models for transistor amplifiers
- Models for vehicle system

Text Books:

- L. Ljung, T. Glad, “Modeling of Dynamical Systems”, Prentice Hall Inc. (1994).
- D.C. Karnopp, D.L. Margolis and R.C. Rosenberg, “System Dynamics: A Unified Approach”, 2nd Edition, Wiley-Interscience (1990).
- G. Gordon, “System Simulation”, 2nd Edition, PHI Learning (2009).
- V. Giurgiutiu and S. E. Lyshevski, “Micromechatronics, Modeling, Analysis, and Design with MATLAB”, 2nd Edition, CRC Press (2009).

SIGNAL PROCESSING IN MECHATRONIC SYSTEMS

Course Code :15 ME 51A1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Discrete- Time Signals: Sequences; representation of signals on orthogonal basis; Sampling and Reconstruction of signals

Discrete systems: Z-Transform, Analysis of LSI systems, Frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform algorithm, Implementation of Discrete Time Systems.

Frequency selective filters: Ideal filter characteristics, lowpass, highpass, bandpass and bandstop filters, Paley-Wiener criterion, digital resonators, notch filters, comb filters, all-pass filters, inverse systems, minimum phase, maximum phase and mixed phase systems.

Design of FIR and IIR filters: Design of FIR filters using windows, frequency sampling, Design of IIR filters using impulse invariance, bilinear transformation and frequency transformations, Butterworth, Chebyshev Filters.

Introduction to multi-rate signal processing: Decimation, interpolation, polyphase decomposition; digital filter banks: Nyquist filters, two channel quadrature mirror filter bank and perfect reconstruction filter banks, subband coding.

Introduction to DSP Processors: Introduction to various Texas processors such as TMS320C6713, TMS320C6416, DM6437 Digital Video Development Platform with Camera, DevKit8000 OMAP3530 Evaluation Kit.

Applications: Application of DSP to Speech and Radar signal processing, A few case studies of DSP applications in multimedia using TI DSP kits.

Text books:

- S. K. Mitra, Digital Signal Processing: A computer-Based Approach, 3/e, TMcHl, 2006.
- A. V. Oppenheim and R. W. Shafer, Discrete-Time Signal Processing, Prentice Hall India, 2/e, 2004.
- J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 4/e, Pearson Education, 2007.

References:

- V.K. Ingle and J.G. Proakis, “Digital signal processing with MATLAB”, Cengage, 2008.
- T. Bose, Digital Signal and Image Processing, John Wiley and Sons, Inc., Singapore,04.
- L. R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, PH, 2005.
- A. Antoniou, Digital Filters: Analysis, Design and Applications, Tata McH, 2003.

MEMS AND NEMS

Course Code :15 ME 51A2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**
Syllabus:

Micro and nano mechanics – principles, methods and strain analysis, an introduction to microsensors and MEMS, Evolution of Microsensors & MEMS, Microsensors & MEMS applications, Microelectronic technologies for MEMS, Micromachining Technology – Surface and Bulk Micromachining, Micromachined Microsensors, Mechanical, Inertial, Biological, Chemical,Acoustic, Microsystems Technology, Integrated Smart Sensors and MEMS, Interface Electronics for MEMS, MEMS Simulators, MEMS for RF Applications, Bonding & Packaging of MEMS, Conclusions & Future Trends.
Nanoelectromechanical systems (NEMS) – a journey from MEMS to NEMS, MEMS vs. NEMS, MEMS based nanotechnology – fabrication, film formation and micromachining, NEMS physics – manifestation of charge discreteness, quantum electrodynamical (QED) forces, quantum entanglement and teleportation, quantum interference, quantum resonant tunneling and quantum transport, Wave phenomena in periodic and aperiodic media – electronic and photonic band gap crystals and their applications, NEMS architecture, Surface Plasmon effects and NEMS fabrication for nanophotonics and nanoelectronics, Surface Plasmon detection – NSOM/SNOM

TEXT BOOKS

- Electromechanical Sensors and Actuators, Ilene J. Busch-Vishniac, Springer, 2008.
- Introduction to Microelectronics Fabrication, Vol. V, G. W. Neudeck and R. F. Pierret (eds.), Addison – Wesley, 1988.
- Introduction to Microelectromechanical Microwave Systems, H. J. De Loss Santos, 2nd edition, Norwood, MA: Artech, 2004.
- Microsystems Design, S. D. Senturia, Kluwer – Academic Publishers, Boston MA, 2001.
- Principles and Applications of Nano-MEMS Physics, H. J. Delos Santos, Springer, 2008.
- Materials and Process Integration for MEMS Microsystems, Vol. 9, Francis E. H. Tay, Springer, 2002.

REFERENCE BOOKS

- Quantum Mechanical Tunneling and its Applications, D. K. Roy, World Scientific, Singapore, 1986
- Encyclopedia of Nanoscience and Technology, Vol. 5, H. S. Nalwa (ed.), American scientific Publishers, 2004
- Carbon Nanotubes and Related Structures, P. J. F. Harris, Cambridge University Press, UK, 1986.
- Carbon Nanoforms and Applications, M Sharon and M. Sharon, Mc Graw Hill, 2010
- VLSI Technology, S. M. Sze (eds.), Mc-Graw Hill, NY, 1983
- Quantum Phenomena, S. Datta, Addison – Wesley, 1989.

VEHICLE DYNAMICS AND MULTI-BODY SYSTEMS

Course Code :15 ME 51A3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**
Syllabus:

Introduction to vehicle dynamics: Vehicle coordinate systems; loads on axles of a parked car and an accelerating car. Acceleration performance: Power-limited acceleration, traction-limited acceleration.

Tire models: Tire construction and terminology; mechanics of force generation; rolling resistance; tractive effort and longitudinal slip; cornering properties of tire; slip angle; camber thrust; aligning moments.

Aerodynamic effects on a vehicle: Mechanics of airflow around the vehicle, pressure distribution, aerodynamic forces; pitching, rolling and yawing moments; crosswind sensitivity.

Braking performance: Basic equations for braking for a vehicle with constant deceleration and deceleration with wind-resistance; braking forces: rolling resistance, aerodynamic drag, driveline drag, grade, tire-road friction; brakes, anti-lock braking system, traction control, braking efficiency.

Steering systems and cornering: Geometry of steering linkage, steering geometry error; steering system models, neutral steer, under-steer, over-steer, steering ratio, effect of under-steer; steering system force and moments, low speed and high speed cornering; directional stability of the vehicle; influence of front-wheel drive.

Suspension and ride: Suspension types—solid axle suspensions, independent suspensions; suspension geometry; roll centre analysis; active suspension systems; excitation sources for vehicle rider; vehicle response properties, suspension stiffness and damping, suspension isolation, active control, suspension non-linearity, bounce and pitch motion.

Roll-over: Quasi-static roll-over of rigid vehicle and suspended vehicle; transient roll-over, yaw-roll model, tripping.

Multi-body systems: Review of Newtonian mechanics for rigid bodies and system of rigid bodies; coordinate transformation between two set of axes in relative motion between one another; Euler angles; angular velocity, angular acceleration, angular momentum etc. in terms of Euler angle parameters; Newton-Euler equations of motion; elementary Lagrangian mechanics: generalised coordinates and constraints; principle of virtual work; Hamilton's principle; Lagrange's equation, generalized forces. Lagrange's equation with constraints, Lagrange's multiplier.

Text Books

- T.D. Gillespie, “Fundamental of Vehicle Dynamics”, SAE Press (1995)
.
- J.Y. Wong, “Theory of Ground Vehicles”, 4th Edition, John Wiley & Sons (2008).
- Reza N. Jazar, “Vehicle Dynamics: Theory and Application”, 1st Edition, 3rd Printing, Springer (2008).
- R. Rajamani, “Vehicle Dynamics and Control”, Springer (2006).
- A.A. Shabanna, “Dynamics of Multibody Systems”, 3rd Edition, Cambridge University Press (2005).

Reference Books

- G. Genta, “Motor Vehicle Dynamics”, World Scientific Pub. Co. Inc. (1997).
- H.B. Pacejka, “Tyre and Vehicle Dynamics”, SAE International and Elsevier (2005).
- Dean Karnopp, “Vehicle Stability”, Marcel Dekker (2004).
- U. Kiencke and L. Nielsen, “Automotive Control System”, Springer-Verlag, Berlin.
- M. Abe and W. Manning, “Vehicle Handling Dynamics: Theory and Application”, 1st Edition, Elsevier (2009).
- L. Meirovitch, “Methods of Analytical Dynamics”, Courier Dover (1970).
- H. Baruh, “Analytical Dynamics”, WCB/McGraw-Hill (1999).

EMERGING SMART MATERIALS FOR MECHATRONICS APPLICATIONS

Course Code :15 ME 51B1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**
Syllabus:

Introduction: Smart materials and their application for sensing and actuation, Mechatronics aspects.

Piezoelectric materials: Piezoelectricity and piezoelectric materials, Constitutive equations of piezoelectric materials, Piezoelectric actuator types, Control of piezoelectric actuators, Applications of piezoelectric actuators for precise positioning and scanning.

Shape memory alloys (SMA): Properties of shape memory alloys, Shape memory effects, Pseudo-elasticity in SMA, Design of shape memory actuator, selection of materials, Smart actuation and control, Applications of SMA in precision equipments for automobiles, trains and medical devices.

Electro-active polymers (EAPs): Ionic polymer metal composites (IPMC), Conductive polymers, Carbon nanotubes, Dielectric elastomers, Design & control issues for EAP actuators, Applications of EAP for biomemetic, tactile display and medical devices.

Magnetostrictive materials: Basics of magnetic properties of materials, magnetostriction: constitutive equations, types of magnetostrictive materials, Design & control of magnetostrictive actuators, Applications of magnetostrictive materials for active vibration control. **Summary, conclusion and future outlook:** Comparative analysis of different smart materials based actuators, Conclusions, Future research trend and applications trends of smart materials and smart materials based actuator technology.

Text books:

- Jose L. Pons, Emerging Actuator Technologies, a Micromechatronics Approach, John Wiley & Sons Ltd, 2005. .
- Ralph Smith, Smart Material Systems: Model Development, SIAM, Society for Industrial and Applied Mathematics, 2005. .
- F. Carpi, D. De Rossi, R. Kornbluh, R. Pelrine, P. Sommer-Larsen, Dielectric Elastomers as Electromechanical Transducers, Elsevier, Hungry, 2008. .
- Y. B. Cohen, Electroactive Polymer (EAP) Actuators as Artificial Muscles Reality, Potential and Challenges, SPIE press, USA, 2004.

INTELLIGENT VISUAL SURVEILLANCE

Course Code :15 ME 51B2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**
Syllabus:

Basics of Image Processing: Introduction to Image Processing methods, Image Transforms, Wavelet Transform, JPEG Image Compression, Image Formats, Color Spaces- RGB, CMY, HSI.

Video Compression Standards: H. 261, H. 263, H.264, MPEG-1, MPEG-2, MPEG-4, MPEG-7, and MPEG-21, Video shot boundary detection, motion modeling and segmentation techniques.

Object Detection and Classification- Shape based object classification, motion based object classification, Silhouette-Based Method for Object Classification, Viola Jones object detection framework, Multiclass classifier boosting.

Multi-Object Tracking- Classification of multiple interacting objects from video, Region-based Tracking, Contour-based Tracking, Feature-based Tracking, Model-based Tracking, Hybrid Tracking, Particle filter based object tracking, Mean Shift based tracking, Tracking of multiple interacting objects.

Human Activity Recognition- Template based activity recognition, Sequential recognition approaches using state models (Hidden Markov Models), Human Recognition Using Gait, HMM Framework for Gait Recognition, Description based approaches, Human interactions, group activities, Applications and challenges.

Camera Network Calibration - Types of CCTV (closed circuit television) camera- PTZ (pan-tilt zoom) camera, IR (Infrared) camera, IP (Internet Protocal) camera, wireless security camera, Multiple view geometry, camera network calibration, PTZ camera calibration, camera placement, smart imagers and smart cameras.

Text Books

- Murat A. Tekalp, "Digital Video Processing", Prentice Hall, 1995.
- Y. Ma and G. Qian (Ed.), "Intelligent Video Surveillance: Systems and Technology", CRC Press, 2009.

MICROPROCESSORS AND IMBEDED SYSTEMS

Course Code :15 ME 51B3 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**
Syllabus:

Introduction to Embedded Systems and microcomputers: Introduction to Embedded Systems, Embedded System Applications, Block diagram of embedded systems, Trends in Embedded Industry, Basic Embedded system Models, Embedded System development cycle, Challenges for Embedded system Design, Evolution of computing systems and applications. Basic Computer architecture: Von-Neumann and Harvard Architecture. Basics on Computer organizations. Computing performance, Throughput and Latency, Basic high performance CPU architectures, Microcomputer applications to Embedded systems and Mechatronics.

Microprocessor: 8086 Microprocessor and its Internal Architecture, Pin Configuration and their functions, Mode of Operation, Introduction to I/O and Memory, Timing Diagrams, Introduction to Interrupts.

Microprocessor Programming: Introduction to assembly language, Instruction format, Assembly language programming format, Addressing mode, Instruction Sets, Programming 8086 microprocessor.

Microprocessor Interfacing: Introduction to interfacing, Memory Interfacing, Programmable Peripheral Interfacing, Programmable I/O, Programmable Interrupt Controller, Programmable Timers, Programmable DMA Controller, Programmable Key board Controller, Data acquisition Interfacing: ADC, DAC, Serial and parallel data Communication interfacing.

Microcontroller: Introduction to Microcontroller and its families, Criteria for Choosing Microcontroller. Microcontroller Architecture, Programming model, Addressing modes, Instruction sets, Assembly and C programming for Microcontroller, I/O programming using assembly and C language, Interrupt Controller, I/O interfacing, Timers, Real Time Clock, Serial and parallel Communication protocols, SPI Controllers. LCD Controller.

Microcontroller Interfacing: Introduction to Microcontroller Interfacing and applications: case studies: Display Devices, controllers and Drivers for DC, Servo and Stepper Motor.

Introduction to Advanced Embedded Processor and Software: ARM Processor, Unified Model Language (UML), Embedded OS, Real Time Operating System (RTOS), Embedded C.

Microprocessor and Embedded system Laboratories: Basic assembly language programming implementation on Microprocessor and Microcontroller. Interfacing Displays, Key boards and sensors with Microprocessors and Microcontrollers, Data Acquisition using Microprocessor and

Microcontroller, Implementation of Controlling schemes for DC, Servo, Stepper motor using assembly and C programming in microprocessors and Microcontrollers.

Books:

- Introduction to Embedded Systems: Shibu K V, McGRAW Hill Publications.
- Embedded Systems: Raj Kamal, TATA McGRAW Hill Publications.
- Computer System Architecture: M. Morris Mano.
- 8086 Microprocessors and Interfacings: D. Hall, TATA McGRAW Hill .
- The Intel Microprocessors: B. Brey, Prentice Hall Publications.
- PIC Microcontrollers and Embedded Systems: M. A. Mazidi, R.D. Mckinlay and D. Casey, Pearson Publications.
- Programming and Customizing the PIC Microcontroller: M. Predko, McGRAW Hill Publications.
- Embedded C Programming and Microchip PIC: R. Barnett, L. O'Cull and S. Cox

ROBOTICS : ADVANCED CONCEPTS AND ANALYSIS

Course Code :15 ME 5205 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**
Syllabus:

Introduction to robotics: brief history, types, classification and usage and the science and technology of robots.

Kinematics of robot: direct and inverse kinematics problems and workspace, inverse kinematics solution for the general 6R manipulator, redundant and over-constrained manipulators. **Velocity and static analysis of manipulators:** Linear and angular velocity, Jacobian of manipulators, singularity, static analysis.

Dynamics of manipulators: formulation of equations of motion, recursive dynamics, and generation of symbolic equations of motion by a computer simulations of robots using software and commercially available packages.

Planning and control: Trajectory planning, position control, force control, hybrid control Industrial and medical robotics: application in manufacturing processes, e.g. casting, welding, painting, machining, heat treatment and nuclear power stations, etc; medical robots: image guided surgical robots, radiotherapy, cancer treatment, etc;

Advanced topics in robotics: Modelling and control of flexible manipulators, wheeled mobile robots, bipeds, etc. Future of robotics.

Reference Books

- M. P. Groover, M. Weiss, R. N. Nagel and N. G. Odrey, "Industrial Robotics-Technology, Programming and Applications", McGraw-Hill Book and Company (1986).
- S. K. Saha, "Introduction to Robotics", Tata McGraw-Hill Publishing Company Ltd. (2008).
- S. B. Niku, "Introduction to Robotics–Analysis Systems, Applications", Pearson Education (2001).
- . A. Ghosal, Robotics: "Fundamental Concepts and Analysis", Oxford University Press (2008).
- Pires, "Industrial Robot Programming–Building Application for the Factories of the Future", Springer (2007).
- Peters, "Image Guided Interventions – Technology and Applications", Springer (2008).
- K. S. Fu, R. C. Gonzalez and C.S.G. Lee, "ROBOTICS: Control, Sensing, Vision and Intelligence", McGraw-Hill (1987).
- J. J. Craig, "Introduction to Robotics: Mechanics and Control", 2nd edition, Addison-Wesley (1989).

CONTROL OF MECHATRONIC SYSTEMS

Course Code :15 ME 5206 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**
Syllabus:

Time response design: Routh-Hurwitz test, relative stability, Root locus design, construction of root loci, phase lead and phase-lag design, lag-lead design.

Frequency response design: Bode, polar, Nyquist, Nichols plot, lag, lead, lag-lead compensator, time delay, process plant response curve. PID controller design.

Modern control: Concept of states, state space model, different form, controllability, observability; pole placement by state feedback, observer design, Lunenburg observer, reduced order observer, observer based control.

Optimal control design: Solution-time criterion, control-area criterion, performance indices; zero steady state step error systems; modern control performance index: quadratic performance index, Ricatti equation.

Digital control: Sampling process, sample and hold, analog to digital converter, use of z-transform for closed loop transient response, stability analysis using bilinear transform and Jury method, digital control design using state feedback.

Non-Linear Control System: Common physical non-linear system, phase plane method, system analysis by phase plane method, stability of non-linear system, stability analysis by describing function method, Liapunov's stability criterion, Popov's stability criterion.

Text Books:

- K. Ogata, "Modern Control Engineering", Prentice Hall India (2002).
- Gene F. Franklin, J. D. Powell, A E Naeini, "Feedback Control of Dynamic Systems", Pearson (2008).
- John Van De Vegte, "Feedback Control Systems", Prentice Hall (1993).
- Thomas Kailath, "Linear Systems", Prentice Hall (1980).
- Alok Sinha, "Linear Systems: Optimal and Robust Control", Taylor & Francis (2007).
- Brian D. O. Anderson and John B. Moore, "Optimal Control: Linear Quadratic Methods", Dover Publications (2007).
- K. Ogata, "Discrete-Time Control Systems", PHI Learning (2009).
- H.K. Khalil, "Nonlinear Systems", Prentice Hall (2001).

MECHATRONICS PRODUCT DESIGN

Course Code :15 ME 5207 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**
Syllabus:

Introduction: Integrated Design issues in Mechatronics, Mechatronics Design process, Mechatronics Key Elements, Applications in Mechatronics.

Modeling and simulation of physical systems: Electrical systems, Mechanical systems-translational&rotational systems, fluid systems.

Sensors and Transducers: Introduction, sensor for motion and position measurement, force, torque and tactile sensors, vibration – Acceleration sensors, sensor for flow measurement, temperature sensing devices, sensor applications.

Actuating Devices:DC Motors, Stepper motors, fluid power Actuation, fluid power design elements, piezoelectric Actuators.

System Control – Logic Methods: Number Systems in Mechatronics, Binary Logic, Karnaugh Map Minimization, Programmable Logic Controllers.

Signal Conditioning and Real Time Interfacing: Elements of a Data Acquisition and Control System, Transducers and Signal Conditioning, Devices for Data Conversion, Data Conversion Process.

Case Studies

TEXT BOOKS:

1. DevdasShetty, Richard A.Kolk, “Mechatronics System Design”, PWS Publishing Company, 1997.

2. Boltan, “Mechatronics-Electronic Control Systems in Mechanical and Electrical Engineering”, 2nd Edition, Addison Wesley Longman Ltd., 1999

REFERENCE BOOK:

1. D.A Bradley, D.Dawson, N.C Burd and A.J.Loader, “Mechatronics” CRC Press, 2010.

PRECISION ENGINEERING

Course Code :15 ME 5208 **L-T-P : 3-2-0**
Pre-requisite: NIL **Credits: 4**
Syllabus:

Concept of Accuracy and Accuracy of NC Systems:

Introduction-General concept of accuracy of machine tool-spindle rotation accuracy-Displacement accuracy-Influence of Geometric Accuracy of Machine Tools on Work piece Accuracy-Definition of Accuracy of NC system-Errors due to Numerical Interpolation-Errors due to displacement measurement system-Periodic errors-Errors due to velocity Lags-Transient Response.

Geometric Dimensioning and Tolerancing:
Tolerance Zone Conversions – Surfaces, Features, Features of Size, Datum Features – Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datums –Datum Feature of Representation – Form Controls, Orientation Controls – Logical Approach to Tolerancing.

Tolerances and Fits:
Sign convention-Tolerance zone-Fits-Basic Hole System of fits-Standards of Limits and Fits-Expected accuracy of a manufacturing process-Commonly used classification of types of fits-Tolerances and Fits for bearings-Methods of specifying Fits on splined shafts and holes-Selective assembly-Gauges for the control of distances between axes.

Surface Roughness and Micro finishing Processes:
Relation among the various indices of surface roughness-Ideal and Final Roughness in Machining-Influence of machining parameters on surface roughness-Ideal surface roughness in slab milling-Bearing area curves-Micro finishing processes in the machining of metals.

Methods of Improving accuracy and surface finish:
Concept of precision Machining-Finish Turning, Boring and Grinding-Precision Cylindrical Grinding-Internal Cylindrical Grinding-Errors in shape of surface grinding

Applications and Future Trends in Nano Technology:
Nano-grating system-Nanolithography, photolithography, electron beam lithography- Machining of soft metals, diamond turning, mirror grinding of ceramics-Devlopment of intelligent products-Nano processing of materials for super high density Ics-Nano-mechanical parts and micromachines.

TEXT BOOKS:

1. Precision Engineering in Manufacturing / murthy R. L., / New Age International(P)
2. limited,1996.
3. Geometric Dimensioning and Tolerancing / James D.Meadows / Marcel Dekker
4. Inc.1995.
5. Norio Taniguchi,- " Nano Technology ", Oxford university,Press,1996.

REFERENCE BOOKS:

1. Precision Engineering- V. C. Venkatesh, & Sudin Izman/ Tata McGraw-Hill

COMPUTATIONAL FLUID DYNAMICS

Course Code :15 ME 52C1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**
Syllabus:

Concept of Computational Fluid Dynamics: Different techniques of solving fluid dynamics problems, their merits and demerits, governing equations of fluid dynamics and boundary conditions, classification of partial differential equations and their physical behavior, Navier-Stokes equations for Newtonian fluid flow, computational fluid dynamics (CFD) techniques, different steps in CFD techniques, criteria and essentialities of good CFD techniques.

Finite Difference Method (FDM): Application of FDM to model problems, steady and unsteady problems, implicit and explicit approaches, errors and stability analysis, direct and iterative solvers. Finite Volume Method (FVM): FVM for diffusion, convection-diffusion problem, different discretization schemes, FVM for unsteady problems.
Prediction of Viscous Flows: Pressure Poisson and pressure correction methods for solving Navier-Stokes equation, SIMPLE family FVM for solving Navier-Stokes equation, modelling turbulence.
CFD for Complex Geometry: Structured and unstructured, uniform and non-uniform grids, different techniques of grid generations, curvilinear grid and transformed equations.
Lattice Boltzman and Molecular Dynamics: Boltzman equation, Lattice Boltzman equation, Lattice Boltzman methods for turbulence and multiphase flows, Molecular interaction, potential and force calculation, introduction to Molecular Dynamics algorithms.

Text Book/ Reference Books:

- J. D. Anderson, “Computational Fluid Dynamics”, McGraw-Hill Inc. (1995).
- S. V. Patankar, “Numerical Heat Transfer and Fluid Flow”, Hemisphere Pub. (1980).
- K. Muralidhar, and T. Sundarajan, “Computational Fluid Flow and Heat Transfer”, Narosa (2003).
- D. A. Anderson, J. C. Tannehill and R. H. Pletcher, “Computational Fluid Mechanics and Heat Transfer”, Hemisphere Pub. (1984).
- M. Peric and J. H. Ferziger, “Computational Methods for Fluid Dynamics”, Springer (2001).
- H. K. Versteeg and W. Malalaskera, “An Introduction to Computational Fluid Dynamics”, Dorling Kindersley (India) Pvt. Ltd. (2008).
- C. Hirsch, “Numerical Computation of Internal and External Flows”, Butterworth-Heinemann, (2007).
- J. M. Jaile, “Molecular Dynamics Simulation: Elementary Methods”, Willey Professional, 1997.
- A. A. Mohamad, “Lattice Boltzman Method: Fundamentals and Engineering Applications with Computer Codes”, Springer (2011).

NONLINEAR OPTIMIZATION

Course Code :15 ME 52C2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**
Syllabus:

Nonlinear programming: Convex sets and convex functions, their properties, convex programming problem, generalized convexity, Pseudo and Quasi convex functions, Invex functions and their properties, KKT conditions.

Goal Programming: Concept of Goal Programming, Model Formulation, Graphical solution method.

Separable programming. Geometric programming: Problems with positive coefficients up to one degree of difficulty, Generalized method for the positive and negative coefficients.

Search Techniques: Direct search and gradient methods, Unimodal functions, Fibonacci method, Golden Section method, Method of steepest descent, Newton-Raphson method, Conjugate gradient methods.

Dynamic Programming: Deterministic and Probabilistic Dynamic Programming, Discrete and continuous dynamic programming, simple illustrations.

Multiobjective Programming: Efficient solutions, Domination cones.

Text Books:

- Mokhtar S. Bazaaraa, Hanif D. Shirali and M.C.Shetty, Nonlinear Programming, Theory and Algorithms, John Wiley & Sons, New York (2004).

Reference Books:

- D. G. Luenberger, Linear and Nonlinear Programming, Second Edition, Addison Wesley (2003).
- R. E. Steuer, Multi Criteria Optimization, Theory, Computation and Application, John Wiley and Sons, New York (1986).

INDUSTRIAL AUTOMATION

Course Code :15 ME 52D1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**
Syllabus:

Automation: Introduction, automation principles and strategies, basic elements of advanced functions, levels modeling of manufacturing systems.

Material handling: Introduction, material handling systems, principles and design, material transport system: transfer mechanisms automated feed cut of components, performance analysis, uses of various types of handling systems including AGV and its various guiding technologies.

Storage system: Performance, location strategies, conventional storage methods and equipments, automated storage systems.

Automated manufacturing systems: Components, classification, overview, group technology and cellular manufacturing, parts classification and coding, product flow analysis, cellular manufacturing, application considerations in G.T.

FMS: Introduction, components, application, benefits, planning and implementation, transfer lines and fundamentals of automated production lines, application, analysis of transfer line without internal storage (numerical problems).

Inspection Technology: Introduction, contact and non-contact conventional measuring, gauging technique, CMM, surface measurement, machine vision, other optical inspection techniques, non-contact non-optical inspection technologies versus.

Manufacturing support system: Process planning and concurrent engineering- process planning, CAPP, CE and design for manufacturing, advanced manufacturing planning, production planning and control system, master production schedule, MRP.

Capacity planning, shop floor control, inventory control, MRP-II, J.I.T production systems. lean and agile manufacturing.

Text Books

- M.P. Groover, Automation, “Production Systems and Computer Integrated manufacturing”, 2nd Edition, Pearson Education (2004).

References Books

- Vajpayee, “Principles of CIM”, PHI, 1992.
- Viswanathan and Narahari, “Performance Modeling of Automated Manufacturing Systems”, PHI, 2000.
- R.S. Pressman, “Numerical Control and CAM, John Wiley , 1993.

FUZZY SETS AND ARTIFICIAL INTELLIGENCE

Course Code :15 ME 52D2 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**
Syllabus:

Basic Concepts of Fuzzy Sets, Fuzzy Logic, Zadeh's Extension Principle, Operations on Fuzzy Sets, Fuzzy Measures, Probability and Possibility Measures, Fuzzy Inference Methodologies, Fuzzy Relations, Applications of Fuzzy Sets in Management, Decision Making, Medicine and Computer Science.

Introduction to Artificial Intelligence, Production System and Artificial Intelligence, Problem Solving by Search, Predicate Calculus, Knowledge Representation, Semantics Nets, Frames, Conceptual Dependencies, Knowledge Bases and Expert Systems, Fuzzy Rule, Neuro Fuzzy Approaches, Case Studies in Various Domain.

Texts:

- S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 2nd Ed, Prentice Hall, 2003.
- H.J.Zimmermann, Fuzzy Set Theory and Its Applications, 2nd Ed., Kluwer Academic Publishers, 1996.
- D.Dubois and H. Prade, Fuzzy Sets and Systems: Theory and Applications, Academic Press, 1980.

References:

- E. Charniak and D. McDermott, Introduction to Artificial Intelligence, Addison-Wesley, 1985.
- E. Rich, Artificial Intelligence, McGraw-Hill, 1983.
- P. H. Winston, Artificial Intelligence, Addison Wesley, 1993.
- J.Yen and R.Langari, Fuzzy Logic Intelligence, Control, and Information, Pearson Education, 2005.
- T.J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1997.
- J.Kacprzyk, Multistage Fuzzy Control, Wiley, 1997.

M.TECH - THERMAL ENGINEERING

First Year (First Semester):

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Contact Hours	Credits
1	15 ME 5109	Numerical Methods in Thermal engineering	3	2	0	4	4
2	15 ME 5110	Advanced Thermodynamics	3	2	0	4	4
3	15 ME 5111	Design of Thermal Systems	3	2	0	4	4
4	15 ME 5112	Advanced Heat and Mass Transfer	3	2	0	4	4
5		Elective – 1	3	0	0	3	3
6		Elective - 2	3	0	0	3	3
7	15 IE 5149	Seminar	0	0	4	4	2
		Total	**18**	**4**	**8**	**30**	**24**

First Year (Second Semester) :

S. No.	Course Code	Course Title	Periods L	Periods T	Periods P	Contact Hours	Credits
1	15 ME 5213	Incompressible and Compressible Flows	3	2	0	4	4
2	15 ME 5214	Computational Fluid Dynamics	3	0	2	5	4
3	15 ME5215	Refrigeration and Cryogenics	3	2	0	4	4
4	15 ME 5216	Measurements in Thermal Engineering	3	2	0	4	4
5		Elective – 3	3	0	0	3	3
6		Elective - 4	3	0	0	3	3
7	15 IE 5250	Term Paper	0	0	4	4	2
		Total	**18**	**4**	**8**	**30**	**24**

Second Year (First & Second Semester) :

S.No	Course code	Course Title	Periods L	Periods T	Periods P	Credits
1	15 IE 6050	Dissertation	0	0	72	36

ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
Elective-1						
1	15 ME 51E1	Heat Exchanger Design	3	0	0	3
2	15 ME 51E2	Convection and Two-Phase Flow	3	0	0	3
3	15 ME 51E3	Compact Heat Exchangers	3	0	0	3
Elective-2						
1	15 ME 51F1	Engine Systems and Performance	3	0	0	3
2	15 ME 51F2	IC Engine Combustion and Pollution	3	0	0	3
3	15 ME 51F3	Alternative Fuels	3	0	0	3
Elective-3						
1	15 ME 52G1	Principles of Turbo-machinery	3	0	0	3
2	15 ME 52G2	Gas Turbine Engineering	3	0	0	3
3	15 ME 52G3	Turbo-Compressors	3	0	0	3
Elective-4						
1	15 ME 52H1	Energy Conservation, Management & Audit	3	0	0	3
2	15 ME 52H2	Renewable Energy Technology	3	0	0	3
3	15 ME 52H3	Solar Energy and Wind Energy	3	0	0	3

NUMERICAL METHODS IN THERMAL ENGINEERING

Course Code :15 ME 5109 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Mathematical Description of the Physical Phenomena: Governing equations—mass, momentum, energy, species, General form of the scalar transport equation, Elliptic, parabolic and hyperbolic equations, Behavior of the scalar transport equation with respect to these equation type; **Discretization Methods:** Methods for deriving discretization equations-finite difference, finite volume and finite element method, Method for solving discretization equations, Consistency, stability and convergence; **Diffusion Equation:** 1D-2D steady diffusion, Source terms, non-linearity, Boundary conditions, interface diffusion coefficient, Under-relaxation, Solution of linear equations (preliminary), Unsteady diffusion, Explicit, Implicit and Crank-Nicolson scheme, Two dimensional conduction, Accuracy, stability and convergence revisited; **Convection and Diffusion:** Steady one-dimensional convection and diffusion, Upwind, exponential, hybrid, power, QUICK scheme,Two-dimensional convection-diffusion, Accuracy of Upwind scheme; false diffusion and dispersion, Boundary conditions; **Flow Field Calculation:** Incompressibility issues and pressure-velocity coupling, Primitive variable versus other methods, Vorticity-stream function formulation, Staggered grid, SIMPLE family of algorithms; **Numerical Methods for Radiation:** Radiation exchange in enclosures composed of diffuse gray surfaces, Finite volume method for radiation, Coupled radiation-conduction for participating media

TEXT BOOKS:

1. Numerical heat transfer and fluid flow, S. V. Patankar, Hemisphere publishing company (1980)
2. Computational Fluid Mechanics and Heat Transfer, J. C. Anderson, D. A. Tanehil and R. H. Pletcher, Taylor & Francis publications, USA (1997)

REFERENCE BOOKS:

1. Advances in numerical heat transfer, (Eds.) W. J. Minkowycz, E. M. Sparrow, Taylor & Francis publications (1997)
2. Heat Transfer - Mathematical Modelling, Numerical Methods and Information Technology, (Ed.) A. Belmiloudi, InTech Publications (2011)
3. Numerical heat transfer by T. M. Shih, Hemisphere publications company (1984)
4. Numerical methods in thermal problems: Proceedings of seventh international conference held in Staford, USA, Volumes 1-2, (Eds.) K. Morgan (1991)
5. Computational Heat Transfer, Mathematical Modelling, A. A. Samarskii, P. N. Vabishchevich, John Wiley & Sons (1995)
6. Hand book of numerical heat transfer, W. J. Minkowycz, E. M. Sparrow, G. E. Schneider, R. H. Pletcher, Wiley publishers (2001)

ADVANCED THERMODYNAMICS

Course Code :15 ME 5110 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Review of first and second law of thermodynamics, Maxwell equations, Joule-Thompson experiment, irreversibility and availability, exergy analysis, phase transition, types of equilibrium and stability, multi-component and multi-phase systems, equations of state, chemical thermodynamics, combustion. Third law of thermodynamics, Kinetic theory of gases-introduction, basic assumption, molecular flux, equation of state for an ideal gas, collisions with a moving wall, principle of equi-partition of energy, classical theory of specific heat capacity. Transport phenomena-intermolecular forces, The Vander Waals equation of state, collision cross section, mean free path, Statistical thermodynamics- introduction, energy states and energy levels, macro and micro-scales, thermodynamic probability, Bose-Einstein, Fermi-Dirac, Maxwell-Boltzmann statistics, distribution function, partition energy, statistical interpretation of entropy, application of statistics to gases-mono-atomic ideal gas.

TEXT BOOKS:

1. Advanced Engineering Thermodynamics, A. Bejan, Wiley and sons, (2006)
2. Thermodynamics, J. P. Holman, McGraw-Hill Inc., (1998)

REFERENCE BOOKS:

1. Advanced Thermodynamics for Engineers, Kenneth Wark, McGraw-Hill
2. Thermodynamics, Kinetic theory, and Statistical thermodynamics, F. W. Sears, and G. L. Salinger, Narosa Publishing House (1998)
3. Fundamentals of Engineering thermodynamics, M. J. Moron, and H. N. Shapiro, John Wiley& Sons
4. Heat and thermodynamics, M. W. Zemansky, and R. H. Dittman, Mc_Graw Hill International (2007)

DESIGN OF THERMAL SYSTEMS

Course Code :15 ME 5111 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Modeling of Thermal Systems: types of models, mathematical modeling, curve fitting, linear algebraic systems, numerical model for a system, system simulation, methods for numerical simulation; Acceptable Design of a Thermal System: initial design, design strategies, design of systems from different application areas, additional considerations for large practical systems; Economic Considerations: calculation of interest, worth of money as a function of time, series of payments, raising capital, taxes, economic factor in design, application to thermal systems; Problem Formulation for Optimization: optimization methods, optimization of thermal systems, practical aspects in optimal design, Lagrange multipliers, optimization of constrained and unconstrained problems, applicability to thermal systems; search methods: single-variable problem, multivariable constrained optimization, examples of thermal systems; geometric, linear, and dynamic programming and other methods for optimization, knowledge-based design and additional considerations, professional ethics. Optimization, Objective function formulation, Constraint equations, Mathematical formulation, Calculus method, Dynamic programming, Geometric programming, linear programming methods, solution procedures. Equation fitting, Empirical equation, best fit method, method of least squares. Modeling of thermal equipments such as turbines, compressors, pumps, heat exchangers, evaporators and condensers

TEXT BOOKS:

1. W.F. Stoecker, Design of Thermal Systems - McGraw-Hill
2. Y. Jaluria, Design and Optimization of Thermal Systems –CRC Press

REFERENCE BOOKS:

1. Bejan, G. Tsatsaronis, M.J. Moran, Thermal Design and Optimization – Wiley.
2. R. F. Boehm, Developments in the Design of Thermal Systems – Cambridge University Press.
3. N.V. Suryanarayana, Design & Simulation of Thermal Systems – MGH.

ADVANCED HEAT AND MASS TRANSFER

Course Code :15 ME 5112 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction - review of heat transfer Fundamentals - transient conduction and extended surface Heat Transfer, Unsteady heat conduction. Lumped capacity model, awareness of one-dimensional unsteady results (charts; Biot and Fourier numbers), Brief review of Steady Laminar and Turbulent Heat Transfer in External and Internal Flows - Heat Transfer at High Speeds - Unsteady Laminar and Turbulent Forced Convection in Ducts and on Plates - Convection with body forces, Boundary layers and internal flows. Awareness of these configurations, some knowledge of internal flow energy balances, Convection correlations. Finding heat transfer coefficients from Reynolds numbers and Rayleigh numbers, Heat Exchangers. Typical configurations and epsilon-NTU analysis, phase-change heat transfer. General awareness of processes of condensation and boiling in a pure substance, some use of correlations, Quenching of metals, Leidenfrost problem, heat transfer of sprays, jets and films, Radiation basics - Radiation in Enclosures - Gas Radiation - Diffusion and Convective Mass Transfer - Combined Heat and Mass Transfer from Plates and in Pipes.

TEXT BOOKS:

1. Heat transfer, A. Bejan, John Wiley & Sons (1993)
2. Advanced Heat and Mass Transfer, A. Faghri, Y. Zhang, J. Howell, Global Digital Press (2010)

REFERENCE BOOKS:

1. A Heat Transfer Text Book, J. H. Lienhard iv, and J. H. Lienhard V, Phlogiston Press (2008)
2. Heat and Mass Transfer, H. D. Baehr, and K. Stephan, Springer-Verlag (1998)
3. Heat transfer, F. M. White, Addision-Wesley (1984)
4. Basic heat and mass transfer, K. C. Rolle, Prentice-Hall (2000)
5. Heat Transfer – A practical approach, Y. A. Cengel, Tata McGraw-Hill (2002)

HEAT EXCHANGER DESIGN

Course Code :15 ME 51E1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Heat Exchangers-Introduction, C1assfication, and Selection. Heat Exchanger Thermo-Hydraulic Fundamentals. Heat Exchanger Design. Compact Heat Exchangers. Shell and Tube Heat Exchanger Design. Regenerators. Plate Heat Exchangers and Spiral Plate Heat Exchangers. Heat-Transfer Augmentation. Fouling; Flow-Induced Vibration of Shell and Tube Heat Exchangers. Mechanical Design of Shell and Tube Heat Exchangers. Corrosion; Material Selection and Fabrication. Quality Control and Quality Assurance and Nondestructive Testing. Heat Exchanger Fabrication.

TEXT BOOKS

1. Heat Exchanges: Selection, Design and Construction, E. A. Saunders, Longman Scientific and Technical (1988)
2. Fundamentals of Heat Exchanger Design, Ramesh K. Shah, Dusan P. Sekulic, Wiley (2002)

REFERENCES

1. Heat Transfer, J. P. Holman, McGraw Hill, New York (1989)
2. Process Heat Transfer, CRC Press, G.F. Hewitt, G.L. Shires, T.R. Bott (1994)
3. Fluid Dynamics and Heat Transfer, J.G. Knudsen and D.L. Katz, McGraw Hill, New York (1958)
4. Heat Exchanger Design Handbook, K. Thulukkanam, CRC Press (2013)
5. Heat Exchangers: Selection, Rating and Thermal Design, S. Kakaç and H. Liu, CRC Press (2002)
6. Fluid Mechanics and Transfer Processes, Cambridge University Press, J. M. Kay, and R. M. Nedderman (1985)
7. Heat exchanger design handbook, Hemisphere publishing corp., (1981)

CONVECTION AND TWO-PHASE FLOW

Course Code :15 ME 51E2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Introduction to two-phase flow and heat transfer technology, Liquid-vapor phase change phenomena, Interfacial tension, Wetting phenomenon, Contact angles, Transport effects, Dynamic behavior of interfaces, Phase stability and nucleation, Two-phase flow fundamentals, Flow patterns and map representation, Development of homogeneous, separated flow and drift flux models, Flooding mechanisms, Boiling Fundamentals, Homogeneous and heterogeneous nucleation, Pool boiling and convective flow boiling, Heat transfer and CFH mechanisms, Enhancement techniques, Condensation fundamentals, External and internal condensation, Film condensation theory, Drop-wise condensation theory, Enhancement techniques, Application of two-phase flow and heat transfer, Electronics thermal management, Latent heat storage devices, Gravity assisted thermo-siphons/Vapor chambers, Theory and operation of Conventional heat pipes, Micro heat pipes, Pulsating heat pipes, Capillary pumped loops/ Loop heat pipes, Micro two-phase heat exchangers, Static and dynamic instabilities, micro-scale boiling and condensation, atomistic nucleation models.

TEXT BOOKS

1. Liquid Vapor Phase Change Phenomena, Van P. Carey, Taylor & Francis
2. Boundary layer theory, H. Schlichting, Springer (2002)

REFERENCES

1. Heat Transfer - Incropera and Dewitt, John Wiley and Sons
2. One Dimensional Two-Phase Flow, G. B. Wallis, McGraw Hill (1969)
3. Heat transfer, McGraw Hill book, C. Gebhart (1961)
4. Convective Boiling And Condensation by Collier John (Oxford Engineering Science)
5. Two-phase Flow and Heat Transfer - P. B. Whalley (Oxford Engineering Science)
6. Heat Transfer Characteristics in Boiling and Condensation by Karl Stephan (Springer)
7. Heat Pipe Technology and Applications by J. P. Peterson (John Wiley & Sons)

COMPACT HEAT EXCHANGERS

Course Code :15 ME 51E3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Classification of heat exchangers - compactness - heat transfer correlation for laminar and turbulent flow through channels, fins their geometries and efficiently. Applications and selection of compact heat exchangers. Basic heat exchangers theory related to compact heat exchangers - Definition of important HX parameters - ε NTU, F - LMTD, P-NTU, P-θ and combination charts. Coupling of heat exchangers, effect of longitudinal conduction in compact heat exchangers, effects of variable property and heat transfer coefficient, core pressure drop and velocity distribution in compact heat exchangers. Contraction and expansion pressure loss. Compact recuperators - Advantages and disadvantages of plates fin and tube fin heat exchangers - fin configuration, heat transfer and pressure drop data in finned heat exchangers, importance of laminar flow in finned recuperators and entry length effect. Plate and frame heat exchangers - Advantages of PHE, Plate geometry and flow configurations, effectiveness and pressure drop in PHE, Fouling in PHE. Thermal regenerations - working principle of periodic flow and rotary regenerators, transient temperature profile, Hausen's chart, optimization of thermal storage. Heat Pipe Heat Exchangers - Working principles, Wick types, various operating limits of heat pipes, pressure gradient and heat transfer requirements in heat pipe heat exchangers. Use of compact heat exchangers in multiphase applications.

TEXT BOOKS:

1. Heat Exchangers Selection, Rating and Thermal design, Sadik Kakac, Hongtan Liu,CRC Press (2002)
2. Heat Exchanger Design, P Arthur. Frass, John Wiley & Sons (1988)

REFERENCE BOOKS:

1. Heat Exchangers, Theory and Practice, Taborek.T, Hewitt.G.F and Afgan.N, McGraw-Hill Book Co. (1980)
2. Fundamentals of Heat Exchanger Design, Ramesh K. Shah, Dusan P. Sekulic, Wiley (2002)
3. Process Heat Transfer, Hewitt.G.F, Shires.G.L, Bott.T.R, CRC Press (1994)

ENGINE SYSTEMS AND PERFORMANCE

Course Code :15 ME 51F1 L-T-P : 3-0-0
Pre-requisite: NIL Credits: 3
Syllabus:

Working principle; Constructional details; Classification and application of different types of I.C. Engines; Wankel and other rotary engines; Operation of the Stirling engine; Mixture preparation systems for SI and CI engines; Combustion chambers; Ignition, lubrication and cooling systems; Speed governing systems; Intake and exhaust systems; Supercharging methods; Turbocharger matching; Aero-thermodynamics of compressors and turbines; Engine Testing and performance; Effects of engine design and operating parameters on performance and emissions

TEXT BOOKS

1. John B Heywood, Internal Combustion Engine Fundamentals, Tata McGraw-Hill (1988)
2. Elements of gas turbine technology, J. D. Mattingly, Tata McGrawHill (2005)

REFERENCE BOOKS:

1. Ganesan V, Internal Combustion Engines , Third Edition, Tata Mcgraw-Hill , 2007
2. Gas turbine theory, Cohen, Rogers, Saravanamutto, Pearson education (2001)
3. Patterson D.J. and Henein N.A, "Emissions from combustion engines and their control" Ann Arbor Science publishers Inc, USA, 1978
4. Gupta H.N, "Fundamentals of Internal Combustion Engines" ,Prentice Hall of India, 2006
5. Ultrich Adler ," Automotive Electric / Electronic Systems, Published by Robert Bosh**,** GmbH,1995

IC ENGINE COMBUSTION AND POLLUTION

Course Code :15 ME 51F2 L-T-P : 3-0-0
Pre-requisite: NIL Credits: 3

Syllabus:

Role of fuel in engine combustion, selection of fuels, Basic combustion processes for SI and CI engines - Factors affecting combustion in these engines - Combustion chambers - Instrumentation to study the combustion process in engines. Pollution formation in SI and CI engines - Factors affecting emissions - Control measures for evaporative emissions - Thermal reactors and catalytic converters - Engine modifications to reduce emissions - Instrumentation to measure pollutants - Emission standards and testing.

TEXT BOOKS:

1. Internal Combustion Engines Fundamentals- John B. Heywood, Pub.-McGraw Hill, New York
2. Engineering fundamental of the I.C.Engine – Willard W. Pulkrabek Pub. PHI, India

REFERENCE BOOKS:

1. Fundamentals of I.C. Engines - P.W. Gill, J.H. Smith & Ziurys- IBH & Oxford pub.
2. Internal Combustion Engines –V. Ganesan, Pub.-Tata McGraw-Hill.
3. Internal Combustion Engines & Air pollution- Obert E.F, Pub.-Hopper & Row Pub., New York

ALTERNATIVE FUELS

Course Code :15 ME 51F3 L-T-P : 3-0-0

Pre-requisite: NIL Credits: 3

Syllabus:

Fossil fuels and their limitations; Engine requirements; Potential alternative liquid and gaseous fuels; Methods of production; Properties, safety aspects, handling and distribution of various liquid alternative fuels like alcohols, vegetable oils, Di-methyl and Di-ethyl ether etc., their use in engines, performance and emission characteristics; Conversion of vegetable oils to their esters and effect on engine performance; Use of gaseous fuels like biogas, LPG, hydrogen, natural gas, producer gas etc. in SI/CI engines; Production, storage, distribution and safety aspects of gaseous fuels. Different approaches like dual fuel combustion and surface ignition to use alternative fuels in engines; Use of additives to improve the performance with alternative fuels; Hybrid power plants and fuel cell.

TEXT BOOKS:

1. Richard.L.Bechfold – Alternative Fuels Guide Book - SAE International Warrendale - 1997.
2. Handbook of Alternative Fuel Technologies, Sungyu Lee, CRC Press

REFERENCE BOOKS:

1. Alternative Fuels: Emissions, Economics, and Performance**,** Timothy T. Maxwell, Jesse C. Jones, SAE International (1991)
2. Nagpal - “Power Plant Engineering” - Khanna Publishers – 1991
3. Maheswar Dayal - Energy Today & Tomorrow - I & B Horishr India - 1982.
4. “Alcohols as motor fuels progress in technology” - Series No.19 - SAE Publication USE – 1980
5. SAE paper nos. 840367, 841333, 841334, 841156, Transactions, SAE, USA.

INCOMPRESSIBLE AND COMPRESSIBLE FLUID FLOWS

Course Code :15 ME 5213 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Definition and properties of Fluids, Fluid as continuum, Langragian and Eulerian description, Velocity and stress field, Fluid statics, Fluid Kinematics, Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equation, Couette flows, Poiseuille flows, Fully developed flows in non-circular cross-sections, Unsteady flows, Creeping flows, Revisit of fluid kinematics, Stream and Velocity potential function, Circulation, Irrotational vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Doublet, Superposition of basic plane potential flows, Flow past a circular cylinder, Magnus effect; Kutta-Joukowski lift theorem; Concept of lift and drag, Boundary layer equations, Boundary layer thickness, Boundary layer on a flat plate, similarity solutions, Integral form of boundary layer equations, Approximate Methods, Flow separation, Entry flow into a duct, Basic concepts of thermodynamics, governing equations in various forms, concept of Mach number, one dimensional flows and normal shock wave, Rayleigh and Fanno flows, Two dimensional flows and oblique shock waves, θ-B-M relations, understanding of shock interaction and shock reflection with various graphs, Prandtl- Mayer expansion, shock-expansion theory, quasi one dimensional flows, method of characteristics and, unsteady wave motion and introduction to various experimental facilities for these speed ranges.

TEXT BOOKS:

1. Boundary layer theory, H. Schlichting, and K. Gersten, Springer (2000)
2. Elements of gas Dynamics, H. W. Liepmann & A. Roshko, Dover Publications (2002)
3. Viscous fluid flow, F. M. White, Mc-Graw Hill (2005)

REFERENCE BOOKS:

1. Introduction to Fluid Mechanics, E. J. Shaughnessy, I. M. Katz and J. P. Schaffer, Oxford University Press (2004)
2. Compressible fluid flow, M. A. Saad, Prentice Hall (1985)
3. Incompressible flow, R. L. Panton, John Wiley & Sons (2005)
4. Advanced Fluid Mechanics, Som, and Biswas, Tata McGraw Hill (2008)
5. The dynamics and thermodynamics of compressible fluid flow, Vol. 1 & 2, A. H. Shapiro, Ronald Press (1954)

COMPUTATIONAL FLUID DYNAMICS

Course Code :15 ME 5214 **L-T-P : 3-0-2**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Introduction: Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description, Classification and Overview of Numerical Methods: Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods, Finite Difference Technique: Finite difference methods; different means for formulating finite difference equation; Taylor series expansion, integration over element, local function method; treatment of boundary conditions; boundary layer treatment; variable property; interface and free surface treatment; accuracy of FD method, Finite Volume Technique: Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem, Finite Element Methods: Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one and two dimensional elements; applications, Methods of Solution: Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform, Time integration Methods: Single and multilevel methods; predictor-corrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems, Numerical Grid Generation: Numerical grid generation; basic ideas; transformation and mapping, Navier-Stokes Equations: Explicit and implicit methods; SIMPLE type methods; fractional step methods, Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

TEXT BOOKS:

1. Numerical Computation of Internal and External Flows, C. Hirsch, Vols. I & II, John Wiley & Sons (2004)
2. An Introduction to Computational Fluid Dynamics, H. K. Versteeg & W. Malalasekera, Longman Scientific & Technical (1995)

REFERENCE BOOKS:

1. Computational Fluid Mechanics and Heat Transfer, J. C. Anderson, D. A. Tannehil and R. H. Pletcher, Taylor & Francis publications, USA (1997)
2. Fundamentals of CFD, T. K. Sengupta, Universities Press (2004)
3. Computational Fluid Dynamics, T. J. Chung, Cambridge University Press (2002)
4. Computational Methods for Fluid Dynamics, J. H. Ferziger and M. Peric, Springer (1997)
5. Computational Techniques for Fluid Dynamics, C. A. J. Fletcher, Vols. I & II, Springer-Verlag (1996)

REFRIGERATION AND CRYOGENICS

Course Code :15 ME 5215 **L-T-P : 3-2-0**

Pre-requisite: NIL **Credits: 4**

Syllabus:

Review of Basic Thermodynamics, Properties of Cryogenic fluids, First and Second Law approaches to the study of thermodynamic cycles, Isothermal, Adiabatic and Isenthalpic processes. Production of Low Temperatures: Liquefaction systems, ideal, Cascade, Linde Hampson and Claude cycles and their derivatives; Refrigerators: Stirling, Gifford-McMahon cycles and their derivatives. Cryogenic Insulations: Foam, Fibre, powder and Multilayer. Applications of Cryogenics in Industry, Space Technology, Nuclear Technology, Biology and Medicine, Matter at low temperatures: specific heat, thermal conductivity, electrical conductivity, magnetic and mechanical properties; Review of free electron and band theory of solids: Basic properties of Superconductors; out lines of Ginzbarg Landau and Bardeen-Cooper-Schrieffer theories of superconductivity: Super-conducing tunneling phenomena; Introduction to type II superconductivity including flux flow and critical current density: High temperature superconductivity. Properties of liquid ^{4}He and ^{3}He; Production of very low temperatures by Adiabatic demagnetization, dilution refrigeration and nuclear demagnetization and their measurements.

TEXT BOOKS:

1. Refrigeration and Air conditioning, Stoecker, and Jones ()
2. Cryogenics Systems, R. F. Barron, Oxford Univesity Press (1985)
3. Cryogenics: Theory, Processes and Applications, Allyson E. Hayes, Nova Science Pub Incorporated (2010)

REFERENCE BOOKS:

1. Refrigeration and Air Conditioning, Jordan, and Priester, Prentice Hall India ()
2. A text book of Cryogenics, V. V. Kostionk, Discovery publishing house pvt. Ltd. (2003)
3. Principles of Refrigeration by Dossat. , Thomas J. Horan: Books.
4. Heating, Ventilating, Air-Conditioning and Refrigeration by Billy C. Langley, Prentice Hall
5. Haselden, G. G. (1971) *Cryogenic fundamentals* Academic Press, New York

MEASUREMENTS IN THERMAL ENGINEERING

Course Code :15 ME 5216 L-T-P : 3-2-0

Pre-requisite: NIL Credits: 4

Syllabus:

Introduction to measurements for scientific and engineering applications - need and goal - broad category of methods for measuring field and derived quantities; Principles of measurement - parameter estimation - regression analysis - correlations - error estimation and data presentation - analysis of data; Measurement of field quantities - thermometry - heat flux measurement - measurement of force, pressure, flow rate, velocity, humidity, noise, vibration - measurement of the above by probe and non intrusive techniques; Measurement of derived quantities - torque, power, thermo-physical properties - radiation and surface properties; Analytical methods and pollution monitoring - mass spectrometry -chromatography - spectroscopy.

TEXT BOOKS:

1. Measurement in fluid mechanics, S. Tauvulorais, Cambridge University Press (2009)
2. Experiments and Uncertainty Analysis for Engineers, H.W. Coleman and W.G. Steele Jr., Wiley & Sons, New York, (1989)
3. Fundamentals of temperature, pressure and flow measurement, R. P. Benedict, John Wiley and Sons (2003)

REFERENCE BOOKS:

1. Fluid mechanics and measurements, R. J. Goldstein, Taylor & Francis (1996)
2. Hand book of experimental fluid mechanics, C. Tropea, Y. Alexander, J. F. Foss, Springer (2007)
3. The measurement of turbulent fluctuations, Smolyakov, and Tkachenko, Springer-Verlag (1983)
4. Thermal and flow measurements, T. W. Lee, CRC Press (2008)

PRINCIPLES OF TURBO MACHINERY

Course Code :15 ME 52G1 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Classification - Specific work - Representation of specific work in T-s and h-s diagrams - Internal and external losses - Euler's equation of turbo-machinery - Ideal and actual velocity triangles - Slip and its estimation - Impulse and reaction type machines - Degree of reaction - Effect of outlet blade angle on blade shape - Model laws, specific speed and shape number - Special features of hydro, steam and gas turbines - Performance characteristics of turbo-machines - Cavitation, Surge and Stall - Thin aerofoil theory - Cascade mechanics. Use of CFD for Turbo-machinery analysis and design.

TEXT BOOKS:

1. Fundamentals of Turbomachinery by William W. Peng, John Wiley & Sons
2. Principles of turbomachinery, D. G. Shepherd, Macmilan, 1969

REFERENCE BOOKS:

1. Ahmed F. El-Sayed; Aircraft Propulsion and Gas Turbine Engines; CRC press, 2008.
2. Turbine, Compressors and Fans by S.M.Yahya, TMH
3. Hydraulic and Compressible Flow Turbomachines by A.T.Sayers, Mc-Graw Hill
4. Principles of Turbomachinery by Seppo A. Korpella, John Wiley & Sons
5. Nicholas Cumpsty, Compressor Aerodynamics, 2004, Kreiger Publications, USA.
6. Elements of gastubine technology, J. D. Mattingly, Tata McGrawHill (2005)

GAS TURBINE ENGINEERING

Course Code :15 ME 52G2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Thermodynamics of gas turbines: Cycle analysis; Gas Turbine Components: compressor, combustor, heat exchangers, turbine - description: analytical considerations, performance; Matching of compressor and turbine: cooling of turbine blades. Compressor and turbine impeller construction, blade fixing details, sealing; Material selection for components, Protective coating for hot turbine parts, Components fabrication techniques, Gas turbine turbocharger, gas turbine power generation, turbo expander, gas turbine application, Closed cycle gas turbines, Co-generation - Introduction, Thermodynamics of co-generation, Criteria for component performance, Some practical schemes.

TEXT BOOKS:

1. Elements of gas turbine technology, J. D. Mattingly, Tata McGrawHill (2005)
2. Gas turbine theory, Cohen, Rogers, Saravanamutto, Pearson education (2001)

REFERENCE BOOKS:

1. Ahmed F. El-Sayed; Aircraft Propulsion and Gas Turbine Engines; CRC press, 2008.
2. Turbine, Compressors and Fans by S.M.Yahya, TMH

TURBO COMPRESSORS

Course Code :15 ME 52G3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Thermodynamics of fluid flow and thermodynamic analysis of compression and expansion processes: Sonic velocity and Mach number; Classification of fluid flow based on Mach number; Stagnation and static properties and their relations; Compression process – Overall isentropic efficiency of compression; Stage efficiency; Comparison and relation between overall efficiency and stage efficiency; Polytropic efficiency; Preheat factor; Expansion Process – Overall isentropic efficiency for a turbine; Stage efficiency for a turbine; Comparison and relation between stage efficiency and overall efficiency for expansion process; polytropic efficiency of expansion; Reheat factor for expansion process. Axial flow compressors, propellers, centrifugal compressors. Equations of motion in axial and radial turbomachines. Operation and performance of compressors. Compressor cascades and loss correlations. Compressor instrumentation and testing. Supersonic compressors. Special aspects. Future trends.

TEXT BOOKS:

1. Hydraulic and Compressible Flow Turbomachines by A.T.Sayers, Mc-Graw Hill
2. Aerodynamics of turbines and compressors, (Ed.) W. R. Hawthorne, Vol. 10, Princeton university press, 1964

REFERENCE BOOKS:

1. Turbine, Compressors and Fans by S.M.Yahya, TMH
2. Theory of turbo machinery, G.T. Csandy, McGrawHill, 1964
3. J H Horlock, Axial Flow Turbines, Butterworths, 1965, UK.

ENERGY CONSERVATION, MANAGEMENT AND AUDIT

Course Code :15 ME 52H1 **L-T-P : 3-0-0**
Pre-requisite: NIL **Credits: 3**
Syllabus:

Energy Scenario - Basics of Energy and its various forms - Energy Management and - Audit - Material and Energy Balance - Energy Action Planning - Financial Management –Project Management - Energy Monitoring and Targeting - Global Environmental Concerns. Energy Efficiency in Thermal Utilities - Fuels and Combustion – Boilers - Steam System - Furnaces - Insulation and Refractory - FBC Boilers -Cogeneration - Waste heat recovery. Energy Efficiency in Electrical Utilities - Electrical Systems - Electric Motors - Compressed Air System - HVAC and Refrigeration System - Fans and Blowers - Pumps and Pumping System - Cooling Tower - Lighting System - Diesel Generating System - Energy Efficient Technologies in Electrical Systems
Energy Performance Assessment for Equipment and Utility systems – Boilers – Furnaces - Cogeneration, Turbines (Gas, Steam) - Heat Exchangers - Electric Motors and Variable Speed Drives - Fans and Blowers - Water Pumps – Compressors. HVAC Systems - Lighting Systems - Performing Financial Analysis - Applications of Non - Conventional and Renewable Energy Sources - Waste Minimization and Resource Conservation

TEXT BOOKS

1. CB Smith, Enegy Management Principles, Pergamon Press, NewYork, 1981
2. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management & Case study, Hemisphere, Washington, 1980

REFERENCES:

1. Trivedi, PR, Jolka KR, Energy Managemnent, Commonwealth Publication, NewDelhi, 1997
2. Witte, Larry C, Industrial Energy Management & Utilization, Hemisphere Publishers, Washington,1988
3. Diamant, RME, Total Energy, Pergamon, Oxford, 1970.
4. Guide book for National Certification Examination for Energy Managers and Energy Auditors, Bureau of energy efficiencies, 2005.

RENEWABLE ENERGY TECHNOLOGY

Course Code :15 ME 52H2 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Sources: Renewable Energy Sources in India - Potential sites, availability. Solar Energy: Measurement and collection, flat plate collectors, concentrating collectors, solar ponds, photovoltaic conversion, Thermal energy storage. Ocean Energy: Principles of OTEC; wave energy, tidal energy, energy conversion systems. Wind Energy: Principle, potential and status; Wind Characteristics; National Wind Atlas; Theory of wind turbine blades; Types of wind turbines and their characteristics. Biofuels: Sources and potential, properties and characterization; Biogas generation through aerobic and anaerobic digestion; Thermochemical methods of biofuel utilization: Combustion and gasification; Status of biofuel technology. Geothermal Energy-Nature, types and utilization. Applications: Applications of renewable energy sources - Typical examples.

TEXT BOOKS

1. Renewable Energy Resources, Twidell & Wier, CRC Press
2. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K., 1996.

REFERENCE BOOKS:

1. L.L. Freris, Wind Energy Conversion systems, Prentice Hall, UK, 1990
2. Renewable energy resources - Tiwari and Ghosal - Narosa.
3. Renewable Energy Technologies - Ramesh & Kumar - Narosa
4. Non-Conventional Energy Systems / K Mittal /Wheeler
5. Renewable energy sources and emerging technologies by D.P.Kothari,K.C.Singhal, P.H.I
6. Non-Conventional EnergySources - G.D.Rai, KhannaPublishers

SOLAR ENERGY AND WIND ENERGY

Course Code :15 ME 52H3 **L-T-P : 3-0-0**

Pre-requisite: NIL **Credits: 3**

Syllabus:

Solar Radiation: Availability - Measurement and Estimation - Isotropic and an Isotropic Models – Introduction to Solar Collectors (Liquid Flat - Plate Collector, Air Heater and Concentrating Collector) and Thermal Storage - Steady State Transient Analysis - Solar Pond - Solar Refrigeration. **Modeling of Solar Thermal Systems And Simulations In Process Design:** Design of Active Systems by f-chart and Utilizability Methods - Water Heating Systems - Active and Passive - Passive Heating and Cooling of Buildings - Solar Distillation - Solar Drying. **Photovoltaic Solar Cell:** P-N Junction - Metal - Schottky Junction, Electrolyte - Semiconductor Junction, Types of Solar Cells - their Applications - Experimental Techniques to determine the Characteristics of Solar Cells - Photovoltaic Hybrid Systems Photovoltaic Thermal Systems – Storage Battery - Solar Array and their Characteristics Evaluation - Solar Chargeable Battery. **Wind:** Its Structure - Statistics - Measurements and Data Presentation - Wind Turbine Aerodynamics - Momentum Theories - Basics Aerodynamics - Airfoils and their Characteristics - HAWT - Blade Element Theory - Prandtl's Lifting Line Theory (prescribed wake analysis) - VAWT Aerodynamics - Wind Turbine Loads - Aerodynamic Loads in Steady Operation - Wind Turbulence - Yawed Operation and Tower Shadow. **Wind Energy Conversion System (WECS):** Siting - Rotor Selection - Annual Energy Output - Horizontal Axis Wind Turbine (HAWT) Vertical Axis Wind Turbine - Rotor Design Considertions - Number of Blades – Blade Profile -2/3 Blades and Teetering - Coning - Upwind/Downwind - Power Regulation - Yaw System - Tower - Synchronous and Asynchronous Generators and Loads – Integration of Wind Enengy Converters to Electrical Networks - Inverters - Testing of WECS - WECS Control System - Requirements and Startegies - Miscellaneous Topics - Noise etc - Other Applications.

TEXT BOOKS:

1. L.L.Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.
2. J.A.Duffie and W.A.Beckman-Solar Engineering of Thermal Processes-John Wiley (1991).

REFERNECE BOOKS:

1. S.P.Sukhatme-Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).
2. J.F.Kreider and F.Kreith-Solar Energy Handbook McGraw-Hill (1981).
3. D.A.Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press.