STUDENT HANDBOOK

Applicable for students admitted into

M.Tech Programs from 2014-2015

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 t**h**at 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.

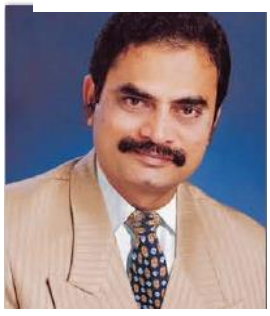
INNOVATION, INCUBATION AND ENTREPRENEURSHIP CENTER

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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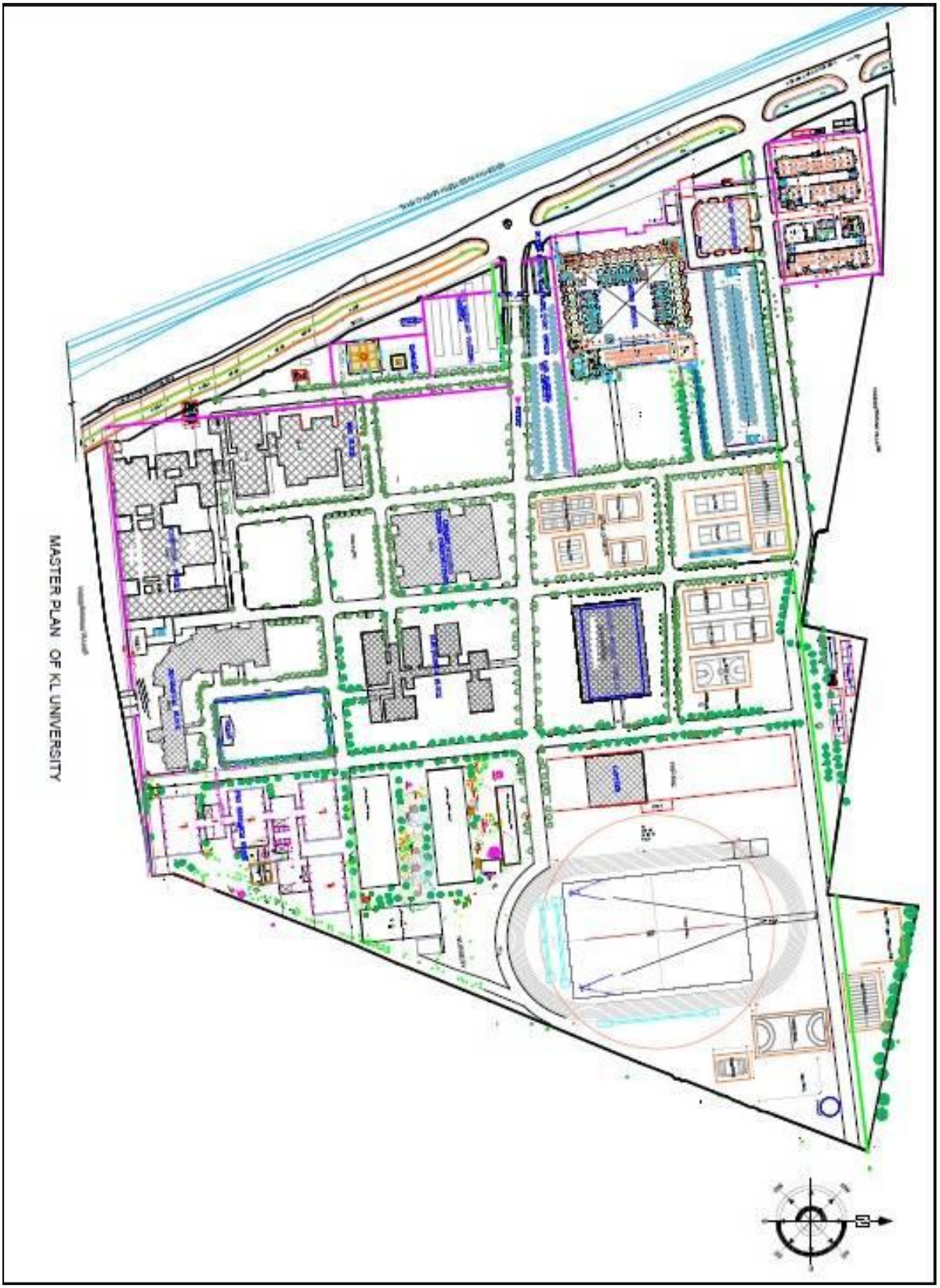
Foreign Student Admissions	Dr.J V Shanmukha Kumar	shanmukh_fed@kluniversity.in


MASTER PLAN OF KL UNIVERSITY

ACADEMIC REGULATIONS

1.0 INTRODUCTION TO THE PROGRAMME

The Koneru Lakshmaiah Education Foundation (K L University), Vaddeswaram shall confer M.Tech Post graduate degree to candidates who are admitted to the Master of Technology Programme and fulfill all the requirements for the award of the degree.

1. Student will be studying 8 CDC courses and 4 electives from the given courses.
2. Evaluation Component Seminar in semesters I/I and I/II will be 2 credits (0-0-2). The students will be registering in the courses of his choice where they will be presenting the seminar on any topic related to the subject but not from the syllabus.
3. Thesis component in 3rd semester should be continued in the 4th semester until unless a student opts for industry project.
4. The minimum credits required for graduation will be 85 – 90 credits.

2.0 BRANCHES OF STUDY

M.Tech duration: 2 Years with following specializations.

- Bio-Technology
- Computer Science & Engineering
- Computer Networks & Security
- Communication & Radar Systems
- VLSI
- Embedded Systems
- Power Electronics & Drives
- Power Systems
- Thermal Engineering
- Structural Engineering
- Mechatronics
- Wireless Sensor Networks
- Signal Processing

3.0 PROGRAMME MODEL

- The course duration of M.Tech is 2 years.
- KL University operates in the semester pattern.
- Each semester has 90 working days.
- The total number credits to earned is 85 to 90
- The University awards M.Tech for post graduate degree programme.
- The maximum course duration is 4 years
- Academic regulations are approved by the Academic Council.
- The medium of instruction is English.

4.0 PROGRAMME OBJECTIVES

The Programme Educational Objectives (PEOs) are the statements that describe the expected achievements from the programme. They are guided by global and local needs, vision of the Institution, long term goals etc. The Programme Educational Objectives of M.Tech Programme include:

I. To mould the students to become effective global science students in the competitive environment of modern society.

II. To provide students with strong foundation in contemporary practices of Science, different functional areas and scientific environment

III. To emphasize on application oriented learning.

IV. To develop communication, analytical, decision-making, motivational, leadership, problem solving and human relations skills of the students.

V. To inculcate professional and ethical attitude in students.

VI. To pursue lifelong learning as a means of enhancing knowledge and skills necessary to contribute to the betterment of profession.

5.0 PROGRAMME OUTCOMES

The M.Tech programme is designed to meet the following outcomes:

a. Ability to practically apply various technological concepts.
b. Demonstrate knowledge of innovative and modern engineering practices.
c. Ability to apply the specialized expertise in relevant practical fields.
d. Ability to communicate effectively and professionally.
e. Ability to solve critical practical oriented real time problems.
f. Ability to manage people effectively and become good leaders.

g. Develop professional and ethical attitude and become socially responsible citizens.
h. Ability to carry out cutting edge research in the emerging areas.
i. Understand the global business scenario.
j. Demonstrate their role as engineers or entrepreneurs and contribute to the society.

6.0 PROGRAMME STRUCTURE

6.1 Distribution of courses over the semesters

S No	Course code	SEMESTER – I	L	T	P	Cr
1.		Core Course - 1				
2.		Core Course - 2				
3.		Core Course - 3				
4.		Core Course 4				
5.		**ELECTIVE-I**	3	0	0	3
6.		**ELECTIVE-II**	3	0	0	3
7.		Seminar	0	0	4	2
		TOTAL CREDITS:				**24-26**

S No	Course code	SEMESTER – II	L	T	P	Cr
1.		Core Course - 5				
2.		Core Course - 6				
3.		Core Course - 7				
4.		Core Course 8				
5.		**ELECTIVE-III**	3	0	0	3
6.		**ELECTIVE-IV**	3	0	0	3
7.		Term Paper	0	0	4	2
		TOTAL CREDITS:				**24-26**

S.No	Course Code	Second Year	Credits
1		Dissertation	36
	TOTAL CREDITS:		**85-90**

6.2 Course Precedence

To impart quality higher education and to undertake research and extension with emphasis on application and innovation that caters 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.

6.3 Specialization Streams

A student will be awarded a *Degree with Specialization* if he/she completes 4 courses from a particular stream within the discipline. By a careful selection of electives within a particular stream, a student can get a degree with specialization. That is, a student can get a Degree with Specialization during regular M.Tech programme, without overloading himself / herself.

7.0 ELIGIBILITY CRITERIA

Admissions to the M.Tech programme shall be made subject to the eligibility, qualifications and specialization prescribed by the University for each Programme, from time to time.

Admissions shall be made either on the basis of merit rank obtained by the qualifying candidates at an Entrance Test conducted by the K.L.University or on the basis of GATE / PGECET score, subject to reservation prescribed by the University or Government policies from time to time.

8.0 ATTENDANCE AND DETENTION

Attendance

a) It is mandatory for, a student to attend all the classes, tutorials, laboratories and other evaluation components conducted by the University. A student may be detained from appearing for an examination on grounds of shortage of attendance.

b) In each course attendance will be treated as evaluation component and marks are awarded as shown below:

% of Attendance in Theory & Practical classes	Marks awarded
$\geq$ 95	5
$\geq$ 90 and < 95	4
$\geq$ 85 and < 90	3
$\geq$ 80 and < 85	2
$\geq$ 75 and < 80	1

Detention

a) 75% attendance and 40% internal marks (internal evaluation components) are mandatory to attain eligibility to appear for the comprehensive examination in a course. If a student fails to maintain 75% attendance and 40% internal marks in a course he/she will be awarded with *NA* Report in that course. In such cases, student will not be permitted to attend the comprehensive examination of that course(s) where he/she has obtained *NA* Report. He/she has to register and repeat the course whenever it is offered.

b) However, some relaxation to this rule is possible in the case of students participating in extra - curricular activities as identified below:

- One week for state level competitions.
- Two weeks for National level competitions and
- Three weeks for International events irrespective of the number of events and/the number of participations in a semester.

c) If the period of absence in a semester is for a short duration (of not more than one week) prior application for leave should be submitted to the Head of the Department clearly stating the reasons for absence along with supporting documents. The Head of the Department will grant such leave at his/her discretion. He/ She may be allowed for makeup of Laboratory/workshop classes conducted during the period of absence.

d) Absence for a period not exceeding one week in a semester due to sickness or any other unavoidable reason for which prior application could not be made may be condoned by the Dean-Academics, provided he is satisfied with the explanation.

e) If the period of absence is likely to exceed one week, a prior application for grant of leave should be submitted to the Head of the Department.

f) In special cases and for sufficient cause shown, the Dean-Academics on the recommendation of the Head of the Department may condone the deficiency not exceeding 10% in attendance due to ill-health, when the application submitted at the time of the actual illness is supported by a certificate from an authorized medical officer.

g) A student must intimate his/her absence to the Superintendent /Warden of the Hostel in which he/she is residing, before availing of any leave. Failing to do so will be construed as breach of discipline.

9.0 REGISTRATION

A student (newly admitted or on rolls) has to register for the course on the day of registration for each semester. Students failing to register for the course will not be permitted to attend classes.

Students will be permitted to register only if they have:

1. Cleared all the fees, outstanding dues of University and / or hostel of previous semesters, paid all prescribed fees for the current semester, and not been debarred from registering for a specified period on disciplinary or any other ground.
2. Normally, no late registration shall be permitted. However, considering any compelling reason, a student may be permitted for late registration (within one week of commencement of semester) with prior approval from the Director (Academic Registration). Late registration may be done with payment of requisite fine.
3. The University reserves the right to cancel the registration of a student from a course or semester or debar from the degree on disciplinary grounds.
4. Registration of students in each semester will be organized by the Academic Section. The registration will be done in respective departments; the course details being verified by the faculty mentor of the batch. Payment of dues etc., will be verified by the Academic Section.
5. A student who does not register on the day announced for the purpose may be permitted by Dean Registration, in consideration of any compelling reason, late registration within next 5 working days on payment of an additional fee as prescribed by the University.

   Normally no late registration shall be permitted after the fifth working day from the scheduled date, except in special cases, a serious medical problem, a family calamity or participation in a national event, to be approved by the Director on recommendation of Dean Registration.

9.1 Fees and payments

A student admitted to any course shall be required to pay, at the time of joining, and also in subsequent semesters, prevalent tuition and other fees as prescribed by the University till he/she is on roll including the period beyond the normal four-year duration.

There is no discount in fees for reduced academic load. Normally the fee structure will not change during the programme; but if the University revises the structure in the middle of a programme, a student is obliged to comply. The fee will be collected under the broad heads: Admission fee, Tuition fee, Student Activity fee, Hostel rent, Caution deposit, Convocation fee and miscellaneous fees. Caution deposit collected will be returned at the end of the programme after due adjustment, if any, except for those who leave the University prematurely.

When a student leaves the University on successful completion of the course, caution deposit is refundable after deduction of dues and charges, if any.

- If a student is removed or he withdraws/leaves the University in the mid-session without completing the entire course, all fees paid including the caution deposit will be forfeited by the University. Mess advance may be refunded after deduction of dues, if any.
- If a student does not register in three consecutive semesters his name will be struck off the rolls.

Exceptions

Notwithstanding anything stated in the rules, the Academic Council can make special provisions and exceptions depending on the merit of a case. Such cases shall not be cited as precedence in future occasions of similar nature.

9.2 Pre-Requisites

Admission to the M.Tech programme shall be made subject to the eligibility, qualifications and specialization prescribed by the University for each Programme, from time to time.

Admissions shall be made either on the basis of merit rank obtained by the qualifying candidates at an Entrance Test conducted by the K.L.University or on the basis of GATE / PGECET score, subject to reservations prescribed by the University or Government policies from time to time.

10.0 PROGRAMME DELIVERY SYSTEM

LTP Structure

Learning well is understood as acquiring knowledge and skills at higher cognitive levels, which include Apply, Analyze, Evaluate and Create. Such learning is ensured by making it heavily activity and practice oriented rather than lecture oriented.

Based on the nature of the course the learning pedagogy will change that is reflected by **L-T-P** structure for a course. **'L' (L**ecture classes) stands for class room contact sessions. **'T'** stands for **T**utorial sessions for reinforced learning through participatory discussion/self-study/desk work and such other novel methods that make a student absorb and assimilate more effectively the contents delivered in the lecture classes. '**P'** stands for **P**ractice/**P**ractical sessions for laboratory/field studies that equip students to acquire the much required skill component. A credit is defined to be as one hour of lecture or two hours of laboratory per week or one hour of tutorial per week over a semester.

11.0 BACKLOG COURSES

A course is considered to be a backlog if the student has obtained 'F' grade / *NA* Report in the course; the following regulations apply to a student who has backlog(s):

a) A student having backlogs has to clear backlog courses first.

b) If the backlog course(s) becomes prerequisite for any other course, he cannot register for those prescribed courses.

c) A student, who has backlog courses, when he/she appears in Academic Counseling Board, shall come under all regulations mentioned in ACB.

d) A student detained due to lack of credits / more number of backlogs in a semester has to register only for that semester after acquiring the eligibility for promotion. Under no circumstances he/she is allowed to register for next semester without registering for the detained one. This is applicable for those joined from 2010-11 academic year onwards.

12.0 GRADES AND REPORTS

A candidate shall be eligible for the award of the respective degree if he satisfies the minimum academic requirements in every course and secures 'satisfactory' or higher grade in the courses/report on his dissertation/dissertation and viva-voce.

For the award of M.Tech degree a student must have earned stipulated credits (as approved by respective B.O.S) and obtained a minimum CGPA of 5.5.

- M.Tech Degree with Second class will be offered to those having CGPA < 6.5.
- M.Tech Degree with First class will be offered to those having CGPA ≥ 6.5.
- First class with distinction will be offered to those having CGPA ≥ 7.5 provided the student has cleared all the courses in first attempt (Regular) within the stipulated time.

At the end of all evaluation - components based on the performance of the student in courses and seminars, each student is awarded with **letter grade** on a **relative scale**. The list of letter grades and its connotation are given below:

Grade	Qualitative Meaning	Grade
X	Excellent	10
A	Very Good	8
B	Good	7
C	Fair	6
D	Satisfactory	5
E	Pass	4
F	Fail	0

The grades '*X*' and *'F'* will be earned and remaining grades will be awarded. A student scoring 80% or more of overall score will earn an 'X' grade.

A student getting less than 50% of overall score and 40% in the comprehensive examination will be considered to have earned *F* grade.

a) To earn an *X* grade, the student should have scored aggregate marks of ≥ 80%.

b) A student who obtains '*F*' grade has to reappear for the comprehensive examination. However, such a student need not attend the classes and marks obtained in internal evaluation components and attendance will be carried forward to the subsequent attempts of the student.

c) In case of a student who has earned *F* grade, after the student has fulfilled all the requirements for passing it will be converted into a valid grade by considering grade cutoffs of the batch in which he/she had appeared for the course for 1st time.

d) The overall performance of the student is described by Cumulative Grade Point Average (*CGPA*) and is calculated taking into consideration grade obtained by the student in all credited courses and credits attached to it. It is the weighted average of the grade points of all the letter grades obtained in credited courses by the student from his entry into the University. *CGPA* is computed as follows:

where $c_1, c_2 \ldots\ldots c_g$ denotes credits associated with the course applied and $g_1, g_2 \ldots$ denotes grades

$$CGPA = \frac{c_1 g_1 + c_2 g_2 + \ldots\ldots + c_n g_n}{c_1 + c_2 + \ldots\ldots + c_n}$$

obtained by the student.

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

f) The Instructor/Course Coordinator can award the following reports depending on the cases:

(i) **NA (Not Attended)** is awarded to the student if the student has shortage of attendance. When student is given *NA* he/she has to repeat the course. It should be noted here that *NA* is different from *F* grade. For a student with *F* grade his/her internal marks, attendance and attendance marks will be carried forward. While for a student awarded with *NA* Report has to attend the classes.

(ii) **NR (Not Registered)** is awarded when a student has not registered for a course. When a student is given NR grade he/she has to register for the course when offered next. If a course in which a student is given NR grade is pre-requisite grade for another course, the student shall not be registered for such a course.

(iii) **GP (Grade Pending)** is awarded in situations where Course Coordinator cannot communicate the grade in time because of operational difficulties. The *GP* report has to be converted into valid grade by the Course Coordinator at a later stage.

(iv) **RC (Registration Cancelled)** is awarded to a student for various reasons when the registration for the course is cancelled by the University. Such a student will have a register for the course in subsequent semester / summer semester whenever the course is offered next.

(v) **DIP (Discontinued from Programme)** is awarded in situations where a student wants to discontinue with the prior approval of the University.

13.0 ACADEMIC COUNSELING BOARD (ACB)

1. A student will be put under Academic Counseling Board under the following circumstances:

   a. Has CGPA of less than 5.5 for Post graduate degree programmes.

   b. Has 'F' grade in more than two courses.

2. 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 Council Board. That is, University reserves all rights to decelerate the degree programme of the student.
3. Remedial classes will be conducted for students who are in ACB.

14.0 OVERLOADING AND UNDERLOADING

A student is permitted to overload himself/herself (registering for more courses) in a semester subject to certain restrictive conditions.

15.0 ACCELERATION AND DECELERATION

University offers flexibility for M.Tech degree students in doing the courses. In addition to the prescribed courses, a student can register for more electives, summer term courses, evening courses provided his/her timetable and University facility permits. Any extra courses done by acceleration would be reflected in the transcript but not in the CGPA. The University permits a student to decelerate his degree programme as well. Any student is permitted to withdraw from the courses for which he/she has registered, owing to his personal problems or any other valid reason.

16.0 ELECTIVE COURSE

The University offers a pool of electives in all disciplines. A student is permitted to choose the elective courses of his/her choice within his own discipline.

17.0 RE-APPEARANCE

The University permits a student to repeat a course to improve the grade subject to certain restrictive conditions.

18.0 BETTERMENT BY RE-REGISTRATION

A candidate having low SGPA / CGPA can reappear in the end examination when he has obtained C or D grade for improvement before the completion of M.Tech programme. The internal evaluation components in such case will be carried forward and grading will be done with the current batch of students. However the grades obtained out of improvement will not be considered for award of distinction or Gold medal.

19.0 WITHDRAWAL AND SUBSTITUTION OF COURSE

a) A Student is permitted to withdraw from an elective course within one week after the commencement of the semester with the approval of Dean-Academics.
b) A Student is normally not permitted to withdraw from compulsory course(s) of the discipline. However if a student desires to withdraw from compulsory courses of the discipline, he/she should seek prior permission from Dean-Academics.

However, a student is not permitted to withdraw from compulsory course and substitute the same with an elective course.
In situations, when a student withdraws from a compulsory course, he/she must have to complete the course before graduation.

c) Whenever a student withdraws from compulsory course(s), the student has to register for the course(s) from which he/she is permitted to withdraw whenever the course(s) are offered. This implies, a student has to complete all the compulsory courses prescribed by the Department for graduation.

Within one week of the commencement of the semester, a student is permitted to substitute an elective course (substitution) with prior approval of Dean-Academics subject to availability.

20.0 SUMMER TERM AND EVENING COURSES

If the number of F grades and/or registration cancelled (detained) in a course taught in even or odd semester is significant, a department may offer the course during the summer vacation. When a summer course is offered, it will be compulsory for all students who have secured an 'F' grade in that course. There will be no alternative mid semester or supplementary examination in that course. Students who need to sit for supplementary or alternative mid semester exams on medical, family calamity or any other reason except poor academic performance may sit in the corresponding exams of the summer course, without attending classes if they satisfy the attendance requirement.

The summer courses will be identical in scope and manner of execution to the corresponding courses of regular semesters, except that the number of class hours per week may be higher. Attendance requirement will also be identical. The examinations will be conducted by the academic section in the usual manner. No separate examination will be arranged for students who miss the summer course, or any other examination.

21.0 DEGREE WITH SPECIALIZATION

A student will be awarded a *Degree with Specialization* if he/she completes courses from a particular stream within the discipline. By a careful selection of electives within a particular stream, a student can get a degree with specialization. That is, a student can get a Degree with Specialization during regular programme, without overloading himself / herself.

22.0 GRADUATION REQUIREMENTS

A student must fulfill the following requirements for graduating:

1. Must have cleared a minimum of 85-90 credits.
2. Cleared all the requirements of discipline.
3. Obtained a minimum GPA of 5.5.

4. Must have finished all the above mentioned requirements in less than twice the period mentioned in the Academic structure for each programme which includes deceleration period chosen by the student, deceleration imposed by University or debarred from the University.

Credit Distribution

The four semester M.Tech. Programmes offered in various disciplines and streams by different departments of the institute are based on the credit system and provide a student with wide choice of courses. Each programme comprises of several core and elective courses and project work. These programmes, along with the course structure, are indicated here under.

The Programme is spread over a period of four semesters that embodies 12 courses with a credit load of 85-87 credits.

S. No	Type of the course	Number	Credits	Percentage
1	Core courses	8	33-38	40.2
2	Professional electives	4	12-14	13.7
3	Term Paper	1	2	0.25
4	Seminar	6	2	0.25
5	Dissertation work	1	36	41.3
	Total	20	85-90	100

Core Courses

A paper which should compulsorily be studied by a candidate as a core-requirement to complete the requirements of a degree is defined as a Core Paper. A student has to compulsorily undergo 8 core courses.

Elective Courses

The students can pursue elective courses in different areas of his interest. Each student must choose four elective courses.

23.0 EXAMINATIONS

The Examination office of the Academic Section will centrally conduct the Mid-semester and End-semester Examinations in respect of theory courses unless otherwise arranged. The examinations will normally be “closed book type”, where the students are not permitted to bring any material. All necessary charts and tables will be provided by the University. It is the responsibility of the course faculty to recommend the material to be provided, and to check with the examination office that the arrangement has indeed been done.

While normal scientific calculators are permitted, other electronic devices such as programmable calculators and calculators containing communication devices are forbidden. Any exception to these provisions must be specially approved by the Academic Council.

24.0 EVALUATION

Teaching and Evaluation

I. Teaching

a. Course(s) taught by a single instructor (theory) is referred to as single section course and course(s) taught by group of instructors in more than one section is referred to as multi-section courses.

b. The teacher for single section courses or associated with multi-section courses is referred to as Instructor.

c. In case of multi- section courses, the team is led by an instructor known as Course Coordinator. For single section courses, an Instructor will be designated as Course Coordinator. Course Coordinator is also an instructor in multi-section course.

d. A team of instructors, under the leadership of Course Coordinator, work together for meeting all requirements of teaching, evaluation and administrative aspects of the course. The Course Coordinator has the responsibility of conducting the course with the cooperation of all instructors in the team.

e. Course Handout shall be given to the students. It shall also be placed on the E-Learning portal.

f. Students will be assessed on formative basis with a weightage of 40 per cent. The summative assessment carries a weightage of 60 per cent.

24.1 Evaluation of Internal Examinations

Evaluation Scheme

a) Formative Assessment: Max Marks: 40

S. No	Component	Duration	Weightage
1	Internal assessment Exams (Test 1 & 2) (75% of the higher score and 25% of the lower score will be considered)	1½ hours	15
2	Assignment/Assignment Test/Written Case Analysis/ Live Project/Reading Seminar/Mini-project/Paper Presentations/Operation workout		15
3	Surprise Test - Objective or Descriptive (Average of two tests will be considered)	10 to 20 minutes	5
4	Class attendance		5
		Total	**40**

i. Two internal assessment exams (Test 1 & Test 2) will be conducted for all courses during the semester. The internal exams will be conducted for 30 marks which in turn will be scaled to 15 marks. The schedule of exams will be notified by the Principal.

ii. A Surprise Test is of objective or subjective nature decided by the Course Coordinator and is conducted without prior intimation. There will be two such tests in a semester.

iii. Assignment /Assignment Test/ Live Project /Reading Seminar / Written Case Analysis/ Mini-project / Paper Presentations / Operation workout:

One or two of these components as detailed in Table No. 1 will be implemented for each course. Applicable component(s) will also be detailed in the Course Handout. Wherever applicable, presentation by a student would be integrated with the component.

iv. Class attendance is monitored by each Instructor and based on the percentage of attendance marks are awarded.

v. In order to maintain transparency in evaluation, the answer sheets of all formative assessment components shall be shown to the students within THREE days of conducting the tests. If a student is not convinced with the marks awarded he/she can apply for recheck. However, the student can apply for recheck on the day of returning the answer sheet within the classroom only.

vi. It shall be the responsibility of the Course Coordinator to display solution key on the notice board immediately after the evaluation component with evaluation scheme. The Instructor should stick to the evaluation scheme announced while checking the answer sheets.

vii. Where there are multiple Course Instructors, the Coordinator shall ensure that a common question paper is administered for Test 1 and Test 2.

Distribution of Weightage

<table>
<tr><th>S. No</th><th>Nature of xaminatio</th><th>Marks %</th><th colspan="2">Type of examination and mode of Assessment</th><th>Scheme of examination</th></tr>
<tr><td rowspan="7">1</td><td rowspan="7">* Theory</td><td>60</td><td colspan="2">Semester end examination (external evaluation)</td><td>This examination question paper in theory subjects will be for a maximum of 60 marks.</td></tr>
<tr><td rowspan="6">40</td><td rowspan="2">20</td><td>Test 1</td><td rowspan="2">2 mid - exams each for 20 marks and of 1 1/2 hr duration are to be conducted. For a total of 20 marks, 75% of better of the two and 25% of the other are added and reported.</td></tr>
<tr><td>Test2</td></tr>
<tr><td>5</td><td>Assignment Test</td><td>6 Question to be released in advance. 2 Questions allotted by Examiners choice to be answered. Duration 45 min.</td></tr>
<tr><td>5</td><td>Home Assignment</td><td>Average of Home Assignments minimum 2 per subject.</td></tr>
<tr><td>5</td><td>Surprise Quiz</td><td>A maximum of two surprise quizzes per subject</td></tr>
<tr><td>5</td><td>Attendance/ Class notes</td><td>5 marks are allotted for attendance and class notes</td></tr>
</table>

	* Practical	60	Semester end Lab exam (ext. evaluation)		60 marks are allotted for semester end laboratory/ drawing examination.
		40	20	Internal evaluation	Mid-term Lab Tests in lab experiments/ drawing/Job works and Record.
			15	Internal evaluation	Continuous Viva Voce evaluation.
			5	Attendance.	
3	Dissertation work Semester-IV	100%	300	Internal evaluation	Two Status reports and two seminars in first semester-50 marks Two Status reports and two seminars in second semester-50 marks Final report – 100 marks Viva-voce – 100 marks
				External evaluation	

*Note:

1. For pure Theory & pure Lab courses follow the above Evaluation.
2. For Combined Theory & Lab courses follow the proportion rule as given below:

a) 3-0-2 nature Theory Credits & Lab Credits are in 3:1 ratio Hence the Internal marks evaluated for Theory & Lab as above to be divided in the ratio 3:1 and clubbed.

b) 3-1-2 nature Theory & Lab credits are in 4:1 ratio. Hence the Internal marks evaluated for Theory & Lab as above to be divided in the ratio 4:1 and clubbed.

The performance of the candidate in each semester shall be evaluated course wise, with a maximum of 100 marks for pure Theory courses and 100 marks for theory and practicals, on the basis of continuous Internal Evaluation and Semester end comprehensive Examination.

Evaluation of Dissertation

Every candidate shall be required to submit dissertation after taking up a topic approved by the Department /University.

- A DAC consisting of HOD and Supervisor shall monitor the progress of the dissertation.
- The duration of the dissertation shall be two semesters. The candidate shall submit dissertation with the approval of DAC at the end of 4th semester.
- A candidate shall be allowed to take viva voce examination only after completion of all the course papers. The Viva-voce examination may be conducted once in two months for all the candidates submitted during that period.
- Three copies of the dissertation in the prescribed format certified by the supervisor & HOD shall be presented to DAC. One copy which is sent to the examiner will be forwarded to the dept. library after adjudication and one copy to the supervisor.

- Besides the supervisor, one senior faculty from the Department of English will adjudicate the dissertation.
- If the report of the examiner is favorable, Viva-voce examination shall be conducted by a board consisting of the Supervisor, HOD and an external examiner. The board shall jointly report on candidate's work based on the total marks obtained in dissertation through both internal evaluation and external evaluation.

If the report of the Viva-voce is not satisfactory the candidate will retake the Viva-voce examination after three months.

25.0 RUSTICATION

A Student may be rusticated from the University on disciplinary grounds based on the recommendations of a committee constituted by the Vice Chancellor.

26.0 AWARD OF DEGREE

A candidate shall be eligible for the award of respective degree if he satisfies the minimum academic requirements in every course and secures 'satisfactory' or higher grade in the courses/report on his Dissertation/dissertation and viva-voce.

- For the award of M.Tech degree a student must have earned stipulated credits (as approved by respective B.O.S) and obtained a minimum CGPA of 5.50.
- M.Tech Degree with Second class will be offered to those having CGPA < 6.5
- M.Tech Degree with First class will be offered to those having CGPA ≥ 6.5
- And first class with distinction will be offered to those having CGPA ≥ 7.5 provided the student has cleared all the courses in first attempt within the stipulated time.

With – Holding of Results

If the candidate has not paid dues to the University or if any case of in-discipline is pending against him, the result of the candidate shall be withheld and he will not be allowed/ promoted into the next/higher semester. The issue of degree is liable to be withheld in such cases.

DEPARTMENT OF BIOTECHNOLOGY
M.Tech- BIOTECHNOLOGY

DEPARTMENT OF BIOTECHNOLOGY				
S.No	**Course Code**	**Course Title**	**L-T-P**	**Credits**
Semester -1				
1	12BT501	Mathematics and Biostatistics	4-0-0	4
2	12BT502	Biochemical Reaction Engineering	3-1-2	5
3	12BT503	Molecular biology and rDNA Technology	3-1-2	5
4	12BT504	Applied bioinformatics	3-0-2	4
5	12BTE531	Food Biotechnology(Elective-1)	3-0-0	3
6	12BTE530	Medical Biotechnology(Elective-2)	3-0-0	3
7	KLUC501	Seminar	0-0-4	2
	Total Credits			26
Semester -2				
1	12BT505	Plant and Animal Biotechnology	3-0-2	4
2	12BT506	Immuno technology	3-0-2	4
3	12BT507	Bioreactor modeling and simulation	4-0-0	4
4	12BT508	Down stream Processing	3-0-2	4
5	12BTE534	Enzyme technology (elective-3)	3-0-0	3
6	12BTE533	Molecular modeling and drug design(Elective-4)	3-0-0	3
7	KLUC502	Term paper	0-0-4	2
	Total Credits			24
Semester -3				
1	14TM602	Internship		18
	Total Credits			18
Semester -4				
1	BTCT02			18
Total Credits				18
Total Course credits				**86**

MATHEMATICS & BIOSTATISTICS

Course Code: 12BT501 **L-T-P:** 4-0-0
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, variableseparable, homogeneous equation linear and enact equations. Linear differential equations ofhigher order with constant co efficient. Rules for finding complementary function and particular integral.

Presentation of data & Measures of central tendency-Frequency distribution, graphicalpresentation 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 testindependence 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: 12BT502 **L-T-P:** 3-1-2
Prerequisites: Nil **Credits:**5
Syllabus:

Introduction to Biochemical reactions : Types of reactions (Simple stepwise and Parallel) andtheir 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 bedbioreactor, 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 byconvection, 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

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MOLECULAR BIOLOGY & R-DNA TECHNOLOGY

Course Code: 12BT503 **L-T-P:** 3-1-2
Prerequisites: Nil **Credits:** 5
Syllabus:

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: 15BT504 **L-T-P:** 3-0-2

Prerequisites: Nil **Credits:**4

Syllabus:

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: 12BT505 **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

IMMUNO TECHNOLOGY

Course Code: 12BT 506 **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. MHCI 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 507 **L-T-P:** 4-0-0
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: 12 BT 508 **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

MEDICAL BIOTECHNOLOGY

Course Code: 12 BTE530 **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.

ENZYME TECHNOLOGY

Course Code: 12 BT E534 **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 includingwhite, red, blue and green biotechnology).

MOLECULAR MODELING AND DRUG DESIGN

Course Code: 12 BT E533 **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: 12BTE531 **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.

DEPARTMENT OF CIVIL ENGINEERING

M.Tech- STRUCTURAL ENGINEERING

First Year [First Semester]						
S No	**Code**	**Course Title**	**L**	**T**	**P**	**Cr**
1	11CE501	Applied Mathematics	3	2	0	4
2	11CE502	Theory of Elasticity	3	2	0	4
3	11CE503	Structural Dynamics	3	0	2	4
4	11CE504	Advanced Prestressed Concrete	3	0	2	4
5	11CE531	REPAIR AND REHABITAITON OF STRUCTURES	3	0	0	3
6	11CE541	GEO TECHNICAL EARTH QUAKE ENGINEERING	3	0	0	3
7	11CE551	Seminar	0	0	4	2
		Total Credits:				24

First Year [Second Semester]						
S No	**Code**	**Course Title**	**L**	**T**	**P**	**Cr**
1	11CE601	Finite Element Analysis	3	0	2	4
2	11CE602	Bridge Engineering	3	2	0	4
3	11CE603	Earthquake Resistant Design of Structures	3	0	2	4
4	11CE604	Theory of Plates and Shells	3	2	0	4
5	11CE631	INDUSTRIAL STRUCTURES	3	0	0	3
6	11CE643	GREEN BUILDINGS	3	0	0	3
7	11CE651	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

APPLIED MATHEMATICS

Course Code :11 CE 501 **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.
5. 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 :11 CE 502 **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 :11 CE 503 **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 :11 CE 504 **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 :11 CE 531 **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.

GEOTECHNICAL EARTHQUAKE ENGINEERING

Course Code :11 CE 541 **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.

FINITE ELEMENT ANALYSIS

Course Code :11 CE 601 **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 :11 CE 603 **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 :11 CE 603 **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 :11 CE 604 **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 :11 CE 631 **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.

GREEN BUILDINGS

Course Code :11 CE 643 **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.

Department of Computer Science and Engineering

M.Tech (CSE)

S.No	Course Code	Course Title	L-T-P	Credits
Semester -1				
1	14CS501	Mathematical methods for Computer Science	3-1-0	4
2	14CS502	Computer Organization & Architecture	3-1-0	4
3	14CS503	Data Structures and Algorithms	3-0-2	4
4	14CS504	Distributed Database Mgnt Systems	3-0-2	4
5	14CS505	Seminar		2
6	14CS530	Soft Computing	3-0-0	3
7	14CS535	Requirement Engineering	3-0-0	3
Total Number of Credits in the Semester				24
Semester -2				
1	14CS508	Object Oriented Software Engineering	3-0-2	4
2	14CS509	Enterprise Programming	3-0-2	4
3	14CS506	Operating Systems	3-1-0	4
4	14CS507	**Computer Networks and Security**	3-1-0	4
5	14CS539	Mobile Computing	3-0-0	3
6	14CS545	**Big Data Analytics**	3-0-0	3
7	14CS605	Term Paper		2
Total Number of Credits in the Semester				24
Semester -3				
1	Project	Project		48

Mathematical methods for Computer Science

Course Code :14CS501 **L-T-P : 3-1-0**
Pre-requisite: NIL **Credits: 4**

Syllabus

Foundations: Sets, Relations & functions, Proof & Problem Solving, Fundamentals of Logic, Logical Inferences, Methods of Proof of an implication, First Order Logic & Other methods of proof, Rules of Inference for quantified propositions, Mathematical Induction.**Recurrence relations:** Generating Functions, Solving recurrence relations, the methods of characteristics roots, undetermined coefficient method. **Relations & Digraphs:** Equivalence relations, ordering relations, Lattices & enumerations, Operations on Relations, Paths & Closures, Directed graphs & Adjacency matrices. **Automata: The Methods And The Madness:** Why Study Automata Theory? Introduction to Formal Proof, Additional Forms of Proofs, Inductive Proofs, the Central Concepts of Automata Theory, **Finite Automata:** An Informal Picture of Finite Automata, Deterministic Finite Automata, Nondeterministic Finite Automata, and An Application: Text Search, Finite Automata with Epsilon Transitions, **Regular Expressions And Languages:** Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions ,**Properties Of Regular Languages:** Proving Languages not to be Regular, Closure Properties of Regular Languages, Decision Properties of Regular Languages, Equivalence and Minimization of Automata, **Context-Free Grammars And Languages:** Context-Free Grammars, Parse Trees, Applications of Context-Free Grammars, Ambiguity in Grammars and Languages.**Pushdown Automata:** Definition of the Pushdown Automaton, The Language of a PDA, Equivalence of PDA's and CFG's, Deterministic Pushdown Automata, **Properties Of Context-Free Languages:** Normal Forms for Context-Free Grammars, The Pumping Lemma for Context-Free Languages, Closure Properties of Context-Free Languages, Decision Properties of CFL's, **Introduction To Turing Machines:** Problems that Computers Cannot Solve, The Turing Machine, Programming Techniques for Turing Machines, Extensions to the Basic Turing Machine, Restricted Turing Machines, Turing Machines and Computers.

TEXTBOOK:

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

REFERENCE:

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',

5. PHI.Discrete and Combinational Mathematics- An Applied Introduction-5th Edition – Ralph. P.Grimaldi. Pearson Education

Computer Organization & Architecture

Course Code: 14-CS-502 **L-T-P: 3-1-0**

Prerequisite:Nil **Credits :4**

Syllabus:

Introduction: Function and structure of a computer, Functional components of a computer. Interconnection of components, Performance of a computer. Representation of Instructions: Machine instructions, Operands, Addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures. Processing Unit: Organization of a processor - Registers, ALU and Control unit, Data path in a CPU, Instruction cycle, Organization of a control unit - Operations of a control unit, Hardwired control unit, Microprogrammed control unit. Memory Subsystem: Semiconductor memories, Memory cells - SRAM and DRAM cells, Internal Organization of a memory chip, Organization of a memory unit, Error correction memories, Interleaved memories, Cache memory unit - Concept of cache memory, Mapping methods, Organization of a cache memory unit, Fetch and write mechanisms, Memory management unit - Concept of virtual memory, Address translation, Hardware support for memory management. **Input/Output** Subsystem: Access of I/O devices, I/O ports, 1/0 control mechanisms -Program controlled I/0, Interrupt controlled 110, and DMA controlled 110, I/O interfaces- Serial port, Parallel port, PCI bus, SCSI bus, USB bus, I/Operipherals - Input devices, Output devices, Secondary storage devices.

Text Book:

1. Computer Organization and Design, Third Edition, by David Patterson and John Hennessy Morgan Kaufmann Publishers, 2013(Chapters 1 to 8 and Appendixes A,B,C,D)

References:

1. M.Morris Mano, "Computer System Architecture ", 3m Edition, Prentice Hall, 1993
2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw- Hill, 2002.
3. W. Stallings, "Computer Organization and Architecture - Designing for Performance", Prentice Hall of India, 2002.
4. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design The Hardware/Software Interface", Morgan Kaufmann,1998.
5. J .P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998.

Data Structures and Algorithms

Course Code: 14CS503 **L-T-P : 3-0-2**

Prerequisite: Nil **Credits :4**

Introduction: Algorithms from ancient to modern times: Evaluating powers, Binary Exponentiation, The Euclidean Algorithm, Babylonian square roots, Evaluating Polynomials, Horner's Rule **(Ref:1,2) Algorithms**, Algorithms as a technology, Insertion Sort, Merge Sort, Analyzing algorithms, Designing algorithms, Asymptotic notations, standard notations, common functions **Recurrences:** substitution method, recursion-tree method, master method. **Heap sort:** Heaps, Maintaining the Heap property, Building the heap, Heap Sort Algorithm **Quick sort:** Description, Performance **Sorting in linear time:** Lower bounds in Sorting**,** Counting Sort, Radix Sort, Bucket Sort, **Medians and Order statistics:** Minimum and Maximum, Selection in Worst case Linear Time**.Elementary Data Structures:** –Stacks, Queues, Linked lists, **Hash Tables**: Direct address tables, **Hash tables,** Collision resolution by chaining, **Hash functions:** Good hash function, Division, multiplication method**, Open addressing:** Linear probing, Quadratic probing, Double hashing, **Binary search trees**: Quering, Insertion, Deletion, AVL Trees, Splay Trees, Red-Black Trees, **Advanced Data Structures:** B – Trees, Binomial Heaps **Advanced Design and Analysis Techniques: Greedy Algorithms:** Fractional knapsack Problem, An activity-selection Problem, Elements of greedy strategy, Huffman codes. **Dynamic Programming:** 0/1 knapsack Problem, Computing Fibonacci numbers **(Ref:3)**, Matrix Chain multiplication, Memoization, Elements of Dynamic Programming, Optimal Binary Search Trees **Amortized Analysis:** Aggregate analysis, The Accounting Method, The Potential Method **Ex:** Multi pop, Binary Counter, Splay trees, Binomial queues. **Graph Algorithms: Elementary graph algorithms:** Representation of graphs, BFS, DFS, Topological Sort.**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. **String Matching:** The naïve string matching algorithm, Rabin-Karp algorithm, Knuth-Morris-Pratt algorithm.

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. Algorithms, Kenneth A. Berman and Jerome L. Paul Course Technology, a part of Cengage Learning, 2002
2. Introduction to Design and Analysis of Algorithms, Anany Levitin Second edition 2008, Pearson Education
3. Algorithms, Richard Johnsonbaugh and Marcus Schaefer 2004, Pearson Education
4. Data structures and Algorithm Analysis in C, Allen Weiss, Second edition, Pearson education.
5. Algorithm Design: Foundations, Analysis and Internet examples, M.T.Goodrich and R.Tomassia,John wiley and sons.
6. Fundamentals of Computer Algorithms, Ellis Horowitz, Satraj Sahni and S.Rajasekharam, Second edition Universties press.
7. Design and Analysis of algorithms, Aho, Ullman and Hopcroft, Pearson education.

DATABASE MANAGEMENT SYSTEMS

Course Code : 14CS504 **L-T-P: 3-0-2**

Prerequisite : Nil **Credits : 4**

Syllabus

Introduction to DBMS and ER Model: File Systems versus DBMS, Advantages of DBMS, Database Design and E -R Diagrams, Entities, Attributes and Entity Sets, Relationships and Relationship Sets, Additional Features of the ER Model, Conceptual Design with the ER Model. **The Relational Model:** Introduction to the Relational Model, Integrity Constraints over Relations, logical Database Design (ER to Relational) introduction to views, Destroying/Altering Tables & views .**Schema Refinement and Normal Forms:** Schema Refinement, Functional Dependencies, Normal Forms, Normalization, Schema Refinement in Database Design. **Relational Algebra and calculus:** Preliminaries, Relational Algebra Relational Calculus, Expressive Power of Algebra and calculus. **SQL: Queries, Constraints, Triggers:** The Form of Basic SQL Query, Set Operators, Nested Queries, Aggregate Operators, Null Values, Triggers and Active Databases, Designing Active Databases, Accessing Databases from Applications using Embedded SQL, Cursors, Dynamic SQL. **Overview of Storage and Indexing:** File Organizations and Indexing, Index Data Structures, Comparison Files Organizations. **Tree -Structured indexing:** Indexed Sequential Access Method (ISAM) B+ Trees, Search, Insert, delete, B+ Trees in Practice. **Hash -Based Indexing:** Static Hashing, Extendable Hashing, Linear Hashing, Extendible Hashing versus Linear Hashing. **Transaction Management:** ACID Properties, Transactions and schedules, Concurrent, Execution of Transactions, Lock-Based Concurrency, Control. **Concurrency Control:** 2PL, Serializablity, and Recoverablity, Introduction to Lock Management, Dealing with Deadlock, Specialized Locking Tenchniques, Concurrency Control without Locking. **Crash Recovery:** Introduction to ARIES, The Log, Other Recovery Related Structures, The WAL, Check pointing, Recovering from a System Crash, Media Recovery. **Security and Authorization:** Introduction to Database Security, Access Control, Discretionary Access Control, Mandatory Access Control, Additional Issues related to Security

TEXT BOOKS :

1. Data base Management Systems, Raghurama Krishnan, Johannes Gehrke, TATA McGrawHill 4th Edition

REFERENCES :

1. Fundamentals of Database Systems, Ramez Elmasri and Navate Pearson Education, 5th edition
2. ata base System Concepts, Silberschatz, Korth, McGraw hill, V edition.
3. Introduction to Database Systems, C.J.Date Pearson Education

SOFT COMPUTING

Course Code : 14CS530 **L-T-P: 3-0-0**

Prerequisite : Nil **Credits : 3**

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 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: Training algorithms, fields of applications of RNN, 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.

Text Books:

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

2.J.S.R.Jang, C.T. Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI / Pearson Education,(2004).

Reference Books:

1.Laurene Fausett, "Fundamentals of Neural Networks", Pearson, (2004).

Requirement Engineering

Course Code : 14CS534 **L-T-P: 3-0-0**

Prerequisite : 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.

3. The Requirements engineering handbook by Ralph R Young, Artech House, 2004.

4. Dines Bjorner, Software Engineering Vol-2, Do mains, Requirements, Software Design, Springer, 2004

Course Code : 14-CS-508
Course Title : Object Oriented Software Engineering
L-T-P : 3-0-2
Credits : 4
Prerequisite : NIL

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

Course Code : 14-CS-507
Course Title : Computer Networks and Security
L-T-P : 3-1-0
Credits : 4
Prerequisite : NIL

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).

Course Code : 14-CS-508
Course Title : Object Oriented Software Engineering
L-T-P : 3-0-2
Credits : 4
Prerequisite : NIL

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

Course Code : 14-CS-509
Course Title : Enterprise Programming
L-T-P : 3-0-2
Credits : 4
Prerequisite : NIL

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.

Course Code : 14-CS-545
Course Title : Big Data Analytics
L-T-P : 3-0-0
Credits : 3
Prerequisite : NIL

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

Course Code : 14-CS-539
Course Title : Mobile Computing
L-T-P : 3-0-0
Credits : 3
Prerequisite : NIL

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

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
(CNS)

S.No	Course Code	Course Title	L-T-P	Credits
Semester -1				
1	14CN501	Data Networks	3-1-0	4
2	14CN502	Unix Network Programming	3-0-2	4
3	14CN503	Applied Cryptography	3-0-2	4
4	14CN504	Secure Coding	3-1-0	4
5	14CN505	Seminar		2
6	14CN530	Network Routing	3-0-0	3
7	14CN535	Adhoc Networks	3-0-0	3
Total Number of Credits in the Semester				24
Semester -2				
1	14CN507	WWIRELESS NETWORKS AND MOBILE COMPUTING	3-0-2	4
2	14CN508	Network Security	3-0-2	4
3	14CN506	Performance analysis of computer networks	3-1-0	4
4	14CN509	**Wireless Network Security**	3-0-2	4
5	14CN542	**Cyber Forensics**	3-0-0	3
6	14CN543	**Intrusion Detection and Prevention System**	3-0-0	3
7	14CN605	Term Paper		2
Total Number of Credits in the Semester				24
Semester -3				
1	Project	Project		48

Course Code	**: 14-CN-501**
Course Title	**: Data Network**
L-T-P	**: 3-1-0**
Credits	**: 4**
Prerequisite	**:**

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. Behrouz A. Forouzan , "Data Communication and Networking", TMH, 5th Edition 2012
2. Kurose, J and Ross, K Computer Networking: A Top-Down Approach Addison-Wesley- 6th 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 (2004) Computer Networks and Internets with Internet Applications (4th edition) Prentice Hall (Most recent edition is 5th edition, 2009)
5. Comer, DE (1995) Internetworking with TCP/IP vol I (3rd edition) Prentice Hall (Most recent edition is 5th edition, 2006)
6. Tanenbaum, Computer Networks, 4th Edition, (Pearson Education / PHI)

Course Title : Network Programming

Course Code: 14CN502 **L-T-P: 3-0-2**

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.

Course Code	**: 14-CN-503**
Course Title	**: Applied Cryptography**
L-T-P	**: 3-0-2**
Credits	**: 4**
Prerequisite	**:**

Syllabus:

Classical Cryptography-The Shift Cipher, The Substitution Cipher, Cryptanalysis Of Substitution Cipher, Cryptanalysis Of The Vigenere Cipher, Shannon's Theory. **Symm Techniques:** Block Cipher and the Advanced Encryption Standard-Substitution –Permut Networks, Linear Cryptanalysis, Differential Cryptanalysis, The Data Encryption Standard, Advanced Encryption Standard, Modes Of Operation Definition – Substitution Ciphe Transposition Ciphers - Stream And Block Ciphers. **Asymmetric Techniques:** Introductio Public –Key Cryptography, Number Theory, Principles Of Public Key Cryptosystems, The Cryptosystem,Key Management – Diffie Hellman Key Exchange – The Elgamal Cryptosys Finit Fields, Elliptic Curves Over The Reals, Signature Scheme –Digital Signature Algori **Key Management:** Key Distribution- Diffie-Hellman Key, Predistribution, Unconditio Secure Key Predistribution, Key Agreement Scheme-Diffie-Hellman Key Agreement, Pu Key Infrastructure-PKI, Certificates, Trust Models. **Message Authentication:** Authentica Requirements – Authentication Functions – Message Authentication Codes (MAC) – H Functions – Security Of Hash Functions And Macs. **Hash and Digital Signatures:** M Message Digest Algorithm – Secure Hash Algorithm (SHA) –RIPMED160 - HMAC - Di 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, Chapma Hall/CRC,2006

References:

1. Menges A. J , Oorschot P, Vanstone S.A,"Handbollk of Appliled Cryptography" C Press,1997.
2. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, New De 2006.

14CN504	Secure Coding	3-1-0	4

Course Title : Secure Coding
Course Code: 14CN504 **L-T-P: 3-1-0**
Credits : 4
Syllabus:

Introduction ,Risk Analysis, Security Concepts,C and C++, Platforms, **Software Security Assessment, Strings,Pointer Subterfuge,Dynamic Memory Management**, **Integer Security, Formatted Output**,**File I/O 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.

Textbook:-

Robert C. Seacord: Secure Coding in C and C++. SEI Series (CERT Book), Addison-Wesley, 2006.

Network Routing

Course Code : 14CN530 **L-T-P : 3-0-0**
Prerequisite: Data Networks **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.

Adhoc Networks

Course Code : 14CN535 ***L-T-P :*** *3-0-0*

Credits:3 **Prerequisite:Data Networks**

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

1. 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

Course Code : 14-CN-506
Course Title : Performance Analysis of Computer Networks
L-T-P : 3-1-0
Credits : 4
Prerequisite :14-CN-501

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.

Course Code : 14-CN-508
Course Title : Network Security
L-T-P : 3-0-2
Credits : 4
Prerequisite :14-CN-503

Syllabus:
Introduction to Network Security: Attacks, services, Security. A model of Inter network Security, Principles of Symmetric and public key cryptography, Steganography, One time PADS. **Crypto Graphic Algorithms (Block Cipher):** RC2, GOST, CAST, BLOW FISH, SAFEER, RC5, NEWDES, CRAB, Theory of Block Cipher design.**Key Management and digital Signature Algorithms :**.Key lengths, Generating Keys, Transferring, Verification, Updating, Storing, Backup, Compromised, Lifetime of, Destroying Keys, key Exchange Protocols, Secure multiparty Communication, Public key Management. Authentication, Formal Analysis of Authentication, Digital Signature, DSA, DSA variants,One – Schnorr – Shamir digital Signatures, Esign. **IP and Web security:** IP Security Architecture, Authentication Header, Encapsulating Security, Pay load Key Management Issues. Web Security Web Security requirements, Secure Sockets Layer and Transport Layer Security, Secure Electronic Transaction. **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.

Text Book
1. Cryptography and Network Security, William Stallings, PHI.

References:
1. Introduction to cryptography with coding Theory, 7/e, Wade Trappe, C. Washington, PEA.
2. Cryptography and Information Security, V.K. Pachghare, PHI.
3. Cryptography and Network Security, Forouzan, TMH, 2007.
4. Cryptography and Network Security, 2/e, Kahate , TMH.
5. Modern Cryptography, Wenbo Mao, PEA

Course Code : 14-CN-507
Course Title : Wireless Networks & Mobile Computing
L-T-P : 3-0-2
Credits : 4
Prerequisite :NIL

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

Course Code : 14-CN-509
Course Title : Wireless Network Security
L-T-P : 3-0-2
Credits : 4
Prerequisite :14-CN-503

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:

1. 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

Course Code : 14-CN-542
Course Title : Cyber Forensics
L-T-P : 3-0-0
Credits : 3
Prerequisite :11-CN-503

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:

1. 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

Course Code : 14-CN-543
Course Title : Intrusion Detection and Prevention System
L-T-P : 3-0-0
Credits : 3
Prerequisite :14-CN-503

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.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
(CLOUD COMPUTING)

S.No	Course Code	Course Title	L-T-P	Credits
Semester -1				
1	14CC503	Cloud computing	3-0-2	4
2	14CC504	Web application development	3-0-2	4
3	14CC501	Enterprise devices and networks	3-1-0	4
4	14CC502	Enterprise Storage systems	3-1-0	4
5	14CC534	Big Data Analytics	3-0-0	3
6	14CC536	Application development frameworks	3-0-0	3
7	14CC505	Seminar	0-0-4	2
Total Number of Credits in the Semester				24
Semester -2				
1	14CC506	Parallel Algorithms	3-0-2	4
2	14CC508	Mobile Cloud	3-0-2	4
3	14CC509	**Data Center Virtualization**	3-1-0	4
4	14CC507	**Cloud Security**	3-1-0	4
5	14CC540	**Cloud Application Architectures**	3-0-0	3
6	14CC543	Object Oriented Software Engineering	3-0-0	3
7	14CC605	Term Paper		2
Total Number of Credits in the Semester				24
Semester -3				
1	Project	Project		48

Code:-14-CC536

Course Title	**Application Development Frameworks**
L-T-P	**3-0-0**
Credits	**3**

Syllabus:

Spring Framework Fundamentals: Inversion of Control and Containers, Using Spring to configure an application: Bean Configuration in spring, Understanding the bean life-cycle, Simplifying application configuration, Annotation-based dependency injection. **Effective Middle-Tier Architecture:** Adding behavior to an application using aspects, Introducing data access with spring, Simplifying JDBC-based data access, Driving database transactions in a Spring environment. **Implementing Enterprise Information Connectivity:** Introducing object-to-relational mapping (ORM), Getting started with Hibernate in a spring environment, Effective web application architecture, Getting started with Spring MVC. **Integration with Enterprise Services:** Securing web applications with Spring Security, Understanding Spring's remoting framework, Simplifying message applications with Spring JMS, Adding manageability to an application with Spring JMX.

Text Book:

1. **Rod Johnson [**et al.] 2005, Professional Java development with the Spring Framework, Wiley Pub. Indianapolis

References:

1. Mark Fisher 2011, Spring Integration in Action, 1st Ed., Manning Publications
2. Craig Walls, Ryan Breidenbach, Spring in Action, 2011.
3. Paul Fisher, Solomon Duskis, Spring Persistence with Hibernate, 2010.
4. Gary Mak, Spring Recipes: A Problem-Solution Approach, Apress Publication, 2008.

Course Code	**14 CC 534**
Course Title	**Big Data Analytics**
L-T-P	**3-0-0**
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, Creating a Culture of Innovation and Discovery, Think Bigger. Choices in Setting up R for Business Analytics, R Interfaces, Manipulating Data, Exploring Data, Building Regression Models, Forecasting and Time Series Models.

Text Books:

1. Data Warehousing in the Age of Big Data by Krish Krishnan, Morgan Kaufmann,2013.
2. Ohri, "R for Business Analytics", Springer, 2012.
3. Big Data Analytics with R and Hadoop by Vignesh Prajapati,2013.

References:

1. Principles of Big Data Preparing, Sharing, and Analyzing Complex Information, 1st Edition, by J Berman, published by Morgan Kaufmann,2013
2. "Big Data Analytics - From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph" By David Loshin, Morgan Kaufmann,2013.
3. Franks, Bill, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", Wiley, 1st Edition, 2012.
4. Big Data Application Architecture Q&A: a Problem - Solution Approach Nitin Sawant, Himanshu Shah,2013.
5. Big Data Now: Current Perspectives from O'Reilly Radar By O'Reilly Radar Team, 2011.

CODE:-14CC503

Course Title	**Cloud Computing**
L-T-P	**3-0-2**
Credits	**4**

Syllabus:

Cloud Computing Basics-Overview, Applications, Intranets and the Cloud. **Your Organization and Cloud Computing-** Benefits, Limitations, Security Concerns. **Hardware and Infrastructure-** Clients, Security, Network, Services. **Software as a Service (Saas)-**

Understanding the Multitenant Nature of SaaS Solutions, Understanding SOA. **Platform as a Service (PaaS)-**IT Evolution Leading to the Cloud, Benefits of Paas Solutions, Disadvantages of Paas Solutions. **Infrastructure as a Service (Iaas)-**Understanding IaaS,

Improving Performance through Load Balancing, System and Storage Redundancy, Utilizing Cloud-Based NAS Devices, Advantages, Server Types. **Identity as a Service (IDaaS)-** Understanding Single Sign-On (SSO), OpenID, Mobile ID Management. **Cloud Storage-** Overview, Cloud Storage Providers. **Virtualization-**Understanding Virtualization, History, Leveraging Blade Servers, Server Virtualization, Data Storage Virtualization. **Securing the Cloud**- General Security Advantages of Cloud-Based Solutions, Introducing Business Continuity and Disaster Recovery. **Disaster Recovery-** Understanding the Threats. **Service Oriented Architecture-**Understanding SOA, Web Services Are Not Web Pages, Understanding Web Service Performance, Reuse and Interoperability. **Developing Applications-**Google, Microsoft, Cast Iron Cloud, Bungee Connect, Development. **Migrating to the Cloud-**Cloud Services for Individuals, Cloud Services Aimed at the Mid-Market, Enterprise-Class Cloud Offerings, and Migration. **Designing Cloud Based Solutions-**System Requirements, Design Is a Give-and-Take Process. **Coding Cloud Based Applications-**Creating a Simple Yahoo Pipe, Using Google App Engine and creating a Windows Azure Application. **Application Scalability-**Load-Balancing Process, Designing for Scalability, Capacity Planning Versus Scalability, Scalability and Diminishing Returns and Performance Tuning.

Text Books:

1. Cloud Computing : A Practical Approach by Anthony T. Velte Toby J. Velte, Robert Elsenpeter, 2010 by The McGraw-Hill.
2. Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more. by Dr. Kris Jamsa.

References:

1. Cloud Computing Bible by Barrie Sosinsky, Published by Wiley Publishing, 2011.
2. Cloud Computing for Dummies by Judith Hurwitz, Robin Bloor, Marcia Kaufman, and Dr. Fern Halper, Wiley Publishing, 2010.
3. Moving to The Cloud, Dinakar Sitaram, Elsevier, 2014.
4. Cloud Computing Theory And Practice Danc.Marinercus, Elsevier, 2013.

Course Code	**14CC501**
Course Title	**Enterprise Devices & Networks**
L-T-P	**3-1-0**
Credits	**4**

Syllabus:

Introduction to Cloud Networking: Networking Basics, The network stack, Packets and frames, Network equipment, Interconnect, Cloud Data Center, Cloud Networking, Characteristics of Cloud Networking, Ethernet usage, Virtualization, Convergence, Scalability, Software. **Data Center Evolution:** Mainframes to the Cloud: The Data Center Evolution, Computer Networks, Ethernet, Enterprise versus Cloud Data Centers, Movement to the Cloud. **Switch Fabric Technology:** Switch Fabric Architecture Overview, Switch Fabric Topologies, Congestion Management, Flow Control, Traffic Management, Switch Chip Architecture Examples. **Cloud Data Center Networking Topologies:** Traditional Multitiered Enterprise Networks, Data Center Network Switch Types, Flat Data Center Networks, Rack Scale Architectures, Network Function Virtualization. **Data Center**

Networking Standards: Ethernet Data Rate Standards, Virtual Local Area Networks, Data Center Bridging, Improving Network Bandwidth, Remote Direct Memory Access. **Server Virtualization and Networking:** VM Overview, Virtual Switching, PCI Express, Edge Virtual Bridging, VM Migration. **Network Virtualization:** Multi-tenant Environments, Traditional Network Tunneling Protocols, VXLAN, NVGRE, Tunnel Locations, Load Balancing **Storage Networks:** Storage Background, Advanced Storage Technologies, Storage Communication Protocols, Network Convergence, Software-Defined Storage, Storage in Cloud Data Centers. **Software-Defined Networking:** Data Center Software Background, OpenStack, OpenFlow, Network Function Virtualization, SDN Deployment.

Text Books:

1. Gary Lee, "Cloud Networking - Understanding Cloud-based Data Center Networks", Elsevier, 2014

References:

1. Computer networks, Andrew Tanenbaum, 3/e, PHI, 1996.
2. Computer Networks – a system approach – Larry L. Peterson, Bruce S. Davie, 2/e,2007,Harcourt Asia PTE LTD.

Course Code	**14CC 502**
Course Title	**Enterprise Storage Systems**
L-T-P	**3-1-0**
Credits	**4**

Syllabus:

Storage Systems: Data Classification, Storage Evolution and Data Center infrastructure. Host components, Connectivity, Storage, and Protocols. Components of a disk drive, physical disk and factors affecting disk drive performance. RAID level performance and availability considerations. Components and benefits of an intelligent storage system. **Storage Networking Technologies**: Direct-Attached Storage (DAS)architecture, Storage Area Network (SAN) attributes, components, topologies, connectivity options and zoning. FC protocol stack, addressing, flow control, and classes of service. Networked Attached Storage (NAS)components, protocols, IP Storage Area Network (IP SAN) iSCSI, FCIP and FCoE architecture. Content Addressed Storage (CAS) elements, storage, and retrieval processes. **Virtualization:** Block-level and file-level storage virtualization technology, virtual provisioning and cloud computing. **Business Continuity:** Business Continuity measurement, terminologies, and planning. Backup designs, architecture, topologies, and technologies in SAN and NAS environments. Local and Remote replication using host and array-based replication technologies such as Synchronous and Asynchronous methods. **Storage Security and Management:** Storage security framework and various security domains. Security implementation in SAN, NAS, and IP-SAN networking. Monitoring and Storage management activities and challenges

Text Book:

1.Somasundaram Gnanasundaram, Alok Shrivastava Information Storage and Management, Wiley Publishing Inc, 2009

Reference:

1. Richard Barker, Paul Massiglia 2002, Storage area network essentials, Wiley New York

2. Ulf Troppens, Rainer Erkens, Wolfgang Mueller-Friedt, Rainer Wolafka, Nils Haustein, Storage Networks Explained, July 2009

3. W. Curtis Preston 2002, Using SANs and NAS, O'Reilly & Associates Sebastopol, Calif.

4. Himanshu Dwivedi 2006, Securing storage, Addison-Wesley Upper Saddle River, NJ

Course Code	14CC504
Course Title	**Web Application Development**
L-T-P	**3-0-2**
Credits	**4**

Syllabus:

Introduction to HTML5:Introduction, Editing HTML5,First HTML5 example,W3C html5 validation service, Heading, linking, Images, Special Characters and Horizontal rules, Lists, Tables, Forms, Internal linking, Meta elements, New HTML5 Form input types, input and datalist elements and autocomplete attribute, Page structure elements, **Introduction to Cascading Style Sheets:** Inline styles, embedded style sheets, Positioning elements, Backgrounds, Elements Dimensions, Box model and text flows, Media types and media queries, Drop down menus, Text Shadows, Rounded corners, Color, Box shadows, Linear Gradients, Radial gradients, Multiple background images, Image Borders, Animation selectors, Transitions and Transformations, **Java Script**: Introduction to Scripting, Control Statements, Functions, Arrays, Objects, **Javascript Event handling:** Reviewing the load Event, Event mousemove and the event Object, Rollovers with mouseover and mouseout, Form Processing with focus and blur, More Form Processing with submit and reset, Event Bubbling, More Events **Introduction to canvas** : Canvas coordinate system, Rectangles, Using paths to draw lines, Drawing arcs and circles, Shadows, Quadratic curve, Bezier curves, Linear gradients, Radial Gradients, Images, image Manipulation, Patterns, Transformations, resizing the canvas to fill the browser, Alpha transparency, Compositing, Save and restore methods, Note on canvas SVG and Canvas 3D,

Ajax-Enabled Rich Internet Applications with XML and JSON: Introduction, Rich Internet Applications (RIAs) with Ajax,history of Ajax, "Raw" Ajax Example Using the XMLHttpRequest Object,using XML and the DOM, Creating a Full-Scale Ajax-Enabled Application, **Web Servers:** Introduction, HTTP transactions, Multitier Application Architecture, Client-Side Scripting versus Server-Side Scripting, Accessing Web Servers, Apache, MySQL and PHP Installation, Microsoft IIS Express and Web Matrix, **PHP:** Introduction, simple PHP program, converting between data types, arithmetic operators, initializing and manipulating Arrays, String comparision, String Processing with Regular Expressions, Form Processing and Business Logic, Reading from a Database, Using Cookies, Dynamic Content .

Text Book

1. Paul 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,2010, Kogent Solutions Inc, Dreamtech Press
5. AJAX black book, new edition, Kogent Solutions Inc, Dreamtech Press

Course Code **14-CC-507**

Course Title **Cloud Security**

L-T-P **3-1-0** **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:

1. Tim Mather, SubraKumaraswamy, ShahedLatif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, O'ReillyMedia Inc, 2009

References:

2. Ronald L. Krutz, Russell Dean Vines, Cloud Security,2010.
3. John Rittinghouse, James Ransome, Cloud Computing,2009.
4. J.R. ("Vic") Winkler, Securing the Cloud,2011.

Course Code **14-CC-509**
Course Title **Data Center Virtualization**
L-T-P **3-1-0**
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.

Course Code	**14-CC-540**
Course Title	**Cloud Application Architectures**
L-T-P	**3-0-0**
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:

1. 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.

Course Code	**14-CC-508**
Course Title	**Mobile Cloud**
L-T-P	**3-0-2**
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:

1. 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.

Course Code	**14-CC-543**
Course Title	**Object oriented Software Engineering**
L-T-P	**3-0-0**
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.

Course Code	**14-CC-506**	**Course Title**	**Parallel Algorithms**
L-T-P	**3-0-2**	**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

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

(VLSI)

S.NO	COURSE CODE	COURSE TITLE	L-T-P	CREDITS
	SEMESTER1			
1	13EC550	MOS CIRCUIT DESIGN	3-1-2	5
2	13EC551	ALGORITHMS FOR VLSI DESIGN AUTOMATION	3-1-0	4
3	13EC552	HDL AND PLD ARCHITECTURES	3-1-2	5
4	13EC553	IC FABRICATION TECHNOLOGY	3-1-0	4
5		ELECTIVE1	3-0-0	3
6		ELECTIVE2	3-0-0	3
7	KLU C503	SEMINAR	0-0-4	2
				26

S.NO	COURSE CODE	COURSE TITLE	L-T-P	CREDITS
	SEMESTER2			
1	13EC555	LOW POWER VLSI CIRCUITS	3-0-2	4
2	13EC556	VLSI SYSTEM DESIGN	3-1-0	4
3	13EC570	ADVANCED ANALOG IC DESIGN	3-1-2	5
4	13EC571	TESTING OF VLSI CIRCUITS	3-1-0	4
5		ELECTIVE3	3-0-0	3
6		ELECTIVE4	3-0-0	3
7	KLU C504	TERMPAPER	0-0-4	2
				25

S.NO	COURSE CODE	COURSE TITLE	L-T-P	CREDITS
	SEMESTER3			
1	14TM602	INTERNSHIP	0-0-36	18
S.NO	**COURSE CODE**	**COURSE TITLE**	**L-T-P**	**CREDITS**
	SEMESTER4			
1	KLU C502	THESIS	0-0-36	18
		TOTAL CREDITS		87

		ELECTIVE1		
1	13EC559	VLSI SIGNAL PROCESSING	3-0-0	3
2	13EC562	CMOS MIXED SIGNAL CIRCUITS	3-0-0	3
3	13EC575	CAD TOOLS FOR VLSI	3-0-0	3
4	13EC590	EMBEDDED SYSTEM DESIGN	3-0-0	3
5	13EC591	NANO ELECTRONICS	3-0-0	3

		ELECTIVE2		
1	13EC520	IMAGE AND VIDEO PROCESSING	3-0-0	3
2	13EC560	MEMORY DESIGN AND TESTING	3-0-0	3
3	13EC565	RECONFIGURABLE COMPUTING	3-0-0	3
4	13EC573	BICMOS TECHNOLOGY AND APPLICATIONS	3-0-0	3

5	13EC592	SEMICONDUCTOR DEVICE MODELLING	3-0-0	3

		ELECTIVE3		
1	13EC563	PROCESS AND DEVICE CHARACTERIZATION & MEASUREMENTS	3-0-0	3
2	13EC564	ADVANCED VLSI DESIGN	3-0-0	3
3	13EC574	VLSI FOR WIRELESS COMMUNICATION	3-0-0	3
4	13EC593	NANO SENSORS AND ITS APPLICATIONS	3-0-0	3

		ELECTIVE4		
1	13EC558	ADVANCED DIGITAL IC DESIGN	3-0-0	3
2	13EC561	OPTIMIZATION TECHNIQUES AND APPLICATIONS IN VLSI DESIGN	3-0-0	3
3	13EC566	CMOS RF CIRCUIT DESIGN	3-0-0	3
4	13EC568	ASIC DESIGN FLOW	3-0-0	3

COURSE CODE: 13EC550

MOS CIRCUIT DESIGN

L	T	P	C
3	1	2	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.

COURSE CODE: 13EC551

ALGORITHMS FOR VLSI DESIGN AUTOMATION

L	T	P	C
3	1	0	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
Modelling: Gate Level Modelling and Simulation, Switch level modelling 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: 13EC552

L	T	P	C
3	1	0	4

Syllabus

Introduction to Verilog HDL: Basic concepts, Design modelling, 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: 13EC553

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 modelling and technology; Ion Implantation modelling, technology and damage annealing, characterization of Impurity profiles

Oxidation: Kinetics of Silicon dioxide growth both for thick, thin and ultrathin 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: modelling 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(2nd 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

VLSI SIGNAL PROCESSING

COURSE CODE: 13EC559

L	T	P	C
3	0	0	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: 13EC562

L	T	P	C
3	0	0	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.

CAD TOOLS FOR VLSI

COURSE CODE: 13EC575

L	T	P	C
3	0	0	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, Behavioural 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 modelling.

Text Books

1. Stephen Trim Berger," 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.

EMBEDDED SYSTEM DESIGN

COURSE CODE: 13EC590

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 Vx 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.
2. Microcontrollers Architecture Programming Interfacing and System Design by Raj Kamal, Pearson Education.

COURSE CODE: 13EC591

NANO ELECTRONICS

L	T	P	C
3	0	0	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 Nano patterning 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

IMAGE AND VIDEO PROCESSING

COURSE CODE: 13EC520

L	T	P	C
3	0	0	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

MEMORY DESIGN AND TESTING

COUSE CODE: 13EC560

L	T	P	C
3	0	0	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: 13EC565

L	T	P	C
3	0	0	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 .

BICMOS TECHNOLOGY & APPLICATIONS

COUSE CODE: 13EC573

L	T	P	C
3	0	0	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: 13EC592

L	T	P	C
3	0	0	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.

LOW POWER VLSI CIRCUITS

COURSE CODE: 13EC555

L	T	P	C
3	0	2	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: 13EC556

L	T	P	C
3	1	0	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.

ADVANCED ANALOG IC DESIGN

COURSE CODE: 13EC570

L	T	P	C
3	1	0	4

Syllabus

Small Signal & large signal Models of MOS & BJT transistor. Analog MOS Process

Passive & Active Current Mirrors: Basic current mirrors, Cascade 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.

TESTING OF VLSI CIRCUITS

COURSE CODE: 13EC571

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.

CMOS MIXED SIGNAL CIRCUITS

COURSE CODE: 13EC562

L	T	P	C
3	0	0	3

Syllabus

Data Converter Modelling 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.

PROCESS AND DEVICE CHARACTERIZATION & MEASUREMENTS

COURSE CODE: 13EC563

L	T	P	C
3	0	0	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: 13EC564

L	T	P	C
3	0	0	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

VLSI FOR WIRELESS COMMUNICATION

COURSE CODE: 13EC574

L	T	P	C
3	0	0	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

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.

NANO SENSORS AND ITS APPLICATIONS

COURSE CODE: 13EC593

L	T	P	C
3	0	0	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.

ADVANCED DIGITAL IC DESIGN

COURSE CODE: 13EC558

L	T	P	C
3	0	0	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: Introduction, 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.

OPTIMIZATION TECHNIQUES AND APPLICATIONS IN VLSI DESIGN

COURSE CODE: 13EC561

L	T	P	C
3	0	0	3

Syllabus

Statistical Modelling: Modelling sources of variations, Monte Carlo techniques, Process variation modelling- Pelgroms model, principal component based modelling, Quad tree based modelling, Performance modelling-Response surface methodology, delay modelling, 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: 13EC566

L	T	P	C
3	0	0	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 behaviour at RF Frequencies: BJT and MOSFET behaviour at RF frequencies, modelling 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 & modelling, 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

ASIC DESIGN FLOW

COURSE CODE: 13EC568

L	T	P	C
3	0	0	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

NANO SENSORS AND ITS APPLICATIONS

COURSE CODE: 13EC593

L	T	P	C
3	0	0	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.

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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.

DEPARTNET OF ELECTRONICS AND COMMUNICATION ENGINEERING
COMMUNICATION AND RADAR SYSTEMS

S.NO	COURSE CODE	COURSE TITLE	L-T-P	CREDITS
	SEMESTER1			
1	13EC501	MODERN DIGITAL COMMUNICATION	3-1-2	5
2	13EC502	RADIATION SYSTEM	3-1-0	4
3	13EC503	MICROWAVE AND MILLIMETERWAVE CIRCUITS	3-1-2	5
4	13EC520	IMAGE AND VIDEO PROCESSING	3-1-0	4
5		ELECTIVE1	3-0-0	3
6		ELECTIVE2	3-0-0	3
7	KLU C503	SEMINAR	0-0-4	2
				26

S.NO	COURSE CODE	COURSE TITLE	L-T-P	CREDITS
	SEMESTER2			
1	13EC521	ADVANCED DIGITAL SIGNAL PROCESSING	3-1-2	5
2	13EC522	RADAR SIGNAL PROCESSING	3-1-0	4
3	13EC504	WIRELESS CELLULAR COMMUNICATION	3-1-0	4
4	13EC566	CMOS RF CIRCUIT DESIGN	3-1-0	4
5		ELECTIVE3	3-0-0	3
6		ELECTIVE4	3-0-0	3
7	KLU C504	TERMPAPER	0-0-4	2
				25

S.NO	COURSE CODE	COURSE TITLE	L-T-P	CREDITS
	SEMESTER3			
1	14TM602	INTERNSHIP	0-0-36	18
S.NO	COURSE CODE	COURSE TITLE	L-T-P	CREDITS
	SEMESTER4			
1	KLU C502	THESIS	0-0-36	18
		TOTAL CREDITS		87
		ELECTIVE1		
1	13EC523	ARRAY SIGNAL PROCESSING	3-0-0	3
2	13EC524	SPEECH PROCESSING	3-0-0	3
3	13EC533	CODING THEORY	3-0-0	3
4	13EC559	VLSI SIGNAL PROCESSING	3-0-0	3
5	13EC580	BRAODBAND ACCESS TECHNOLOGIES	3-0-0	3
		ELECTIVE2		
1	13EC508	FUNDAMENTALS OF ELECTRONIC WARFARE	3-0-0	3
2	13EC525	WIRELESS COMMUNICATION SIGNAL PROCESSING	3-0-0	3
3	13EC526	BIO-MEDICAL SIGNAL PROCESSING	3-0-0	3
4	13EC550	MOS CIRCUIT DESIGN	3-0-0	3

5	13EC582	OPTICAL NETWORKS	3-0-0	3
		ELECTIVE3		
1	13EC506	ESTIMATION AND DETECTION THEORY	3-0-0	3
2	13EC530	ADAPTIVE SIGNAL PROCESSING	3-0-0	3
3	13EC556	VLSI SYSTEM DESIGN	3-0-0	3
4	13EC574	VLSI FOR WIRELESS COMMUNICATION	3-0-0	3
5	13EC581	HIGH PERFORMANCE COMMUNICATION NETWORKS	3-0-0	3
		ELECTIVE4		
1	13EC505	RF AND MW SYSTEM DESIGN	3-0-0	3
2	13EC509	ANTENNA MEASUREMENTS	3-0-0	3
3	13EC534	OPTICAL SIGNAL PROCESSING	3-0-0	3
4	13EC555	LOW POWER VLSI DESIGN CIRCUITS	3-0-0	3
5	13EC583	WIRELESS SENSOR NETWORKS	3-0-0	3

MODERN DIGITAL COMMUNICATION

COURSE CODE: 13EC501

L	T	P	C
3	**1**	**2**	**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
4. Ravindranathan" Communication Systems Modeling Using Matlab & Simulink" Universities Press

RADIATION SYSTEMS

COURSE CODE: 13EC502

L	T	P	C
3	1	2	5

Syllabus

Basics Concepts of Radiation

Radiation from surface current and current line current distribution, Basic antenna parameters, Radiation mechanism-Current distribution of Antennas, Impedance concept-Balanced to Unbalanced transformer

Radiation from Apertures

Field equivalence principle, Rectangular and circular apertures, Uniform distribution on an infinite ground plane, Aperture fields of Horn antenna-Babinets principle, Geometrical theory of diffraction, Reflector antennas, and Design considerations - Slot antennas

Synthesis of Array Antennas

Types of linear arrays, current distribution in linear arrays, Phased arrays, Optimization of Array patterns, Continuous aperture sources, Antenna synthesis techniques

Micro Strip Antennas

Radiation mechanisms, Feeding structure, Rectangular patch, Circular patch, Ring antenna. Input impedance of patch antenna, Microstrip dipole, Microstrip arrays

EMI/EMC/Antenna Measurements:

Log periodic, Bi-conical, Log spiral ridge Guide, Multi turn loop, Traveling Wave antenna, Antenna measurement and instrumentation, Amplitude and Phase measurement, Gain, Directivity, Impedance and polarization measurement, Antenna range, Design and Evaluation

Text Books

1. Kraus.J.D.,"Antennas"II Edition, John wiley and Sons.
2. Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, New York, 1982

References

1. RF System Design**,** Peter Kinget Bell Laboratories, Lucent Technologies Murray Hill,
2. Practical RF system design, Wiley-IEEE, 2003 - Technology & Engineering

MICROWAVE AND MILLIMETER WAVE CIRCUITS

COURSE CODE: 13EC503

L	T	P	C
3	0	0	3

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.Analysis Methods for RF, Microwave, and Millimeter-Wave Planar Transmission Line Structures by Cam Nguyun

IMAGE AND VIDEO PROCESSING

COURSE CODE: 13EC520

L	T	P	C
3	**1**	**2**	**5**

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

ARRAY SIGNAL PROCESSING

COURSE CODE: 13EC523

L	T	P	C
3	0	0	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.

SPEECH PROCESSING

COURSE CODE: 13EC524

L	T	P	C
3	0	0	3

Syllabus

Basic Concepts: Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

Speech Analysis: Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.

Speech Modeling: Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

Speech Recognition: Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – n-grams, context dependent sub-word units; Applications and present status.

Speech Synthesis: Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness – role of prosody, Applications and present status.

Text Books

1.Lawrence Rabinerand Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.

2.Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education.

References

1.Steven W. Smith, "The Scientist and Engineer's Guide to Digital Signal Processing", California Technical Publishing.

2.Thomas F Quatieri, "Discrete-Time Speech Signal Processing – Principles and Practice", Pearson Education.

3.Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, 1999.

4.Ben gold and Nelson Morgan, “Speech and audio signal processing”, processing and perception of speech and music, Wiley- India Edition, 2006 Edition.
5.Frederick Jelinek, “Statistical Methods of Speech Recognition”, MIT Press.

CODING THEORY

COURSE CODE: 13EC533

L	T	P	C
3	0	0	3

Syllabus

Coding for Reliable Transmission: Mathematical model of Information, A Logarithmic Measure of Information, Average and Mutual Information, Types of Errors, Error Control Strategies. Linear Block Codes: Introduction to Linear Block Codes, Syndrome and Error Detection, Minimum Distance of a Block code, Error-Detecting and Error-correcting Capabilities of a Block code, Standard array and Syndrome Decoding, Probability of an undetected error for Linear Codes over a BSC, Hamming Codes.

Cyclic codes: Description, Generator and Parity-check Matrices, Encoding, Syndrome Computation and Error Detection, Decoding ,Cyclic Hamming Codes, Shortened cyclic codes, Majority logic decoding for cyclic codes.

Convolution codes: Encoding of Convolution Codes, Structural and Distance Properties, maximum likelihood decoding, Sequential decoding, Majority- logic decoding of Convolution codes. Application of Viterbi Decoding and Sequential Decoding

Burst –Error-Correcting codes: Decoding of Single-Burst error Correcting Cyclic codes, Single-Burst-Error-Correcting Cyclic codes, Burst-Error-Correcting Convolutional Codes, Bounds on Burst Error-Correcting Capability, Interleaved Cyclic and Convolution Codes , Phased-Burst –Error-Correcting Cyclic and Convolution codes.

BCH – Codes: BCH code- Definition, Minimum distance and BCH Bounds, Decoding Procedure for BCH Codes- Syndrome Computation and Iterative Algorithms, Error Location Polynomials and Numbers for single and double error correction

Text Books

1.K. Sam Shanmugam **,''Digital and analog communication systems'',** John Wiley, 1996.
2.Simon Haykin **,”Digital communication''** , John Wiley, 2003.
3.Shu Lin, Daniel J.Costello, Jr, "Error Control Coding- Fundamentals and Applications" – Prentice Hall, Inc.
4.Error Correcting Coding Theory-Man Young Rhee- 1989, McGraw-Hill Publishing.

References

1.Digital Communications-Fundamental and Application - Bernard Sklar, PE.
2.Digital Communications- John G. Proakis, 5th ed., 2008, TMH.
3.Introduction to Error Control Codes-Salvatore Gravano-oxford
4.Error Correction Coding – Mathematical Methods and Algorithms – Todd K.Moon, 2006, Wiley
5.Information Theory, Coding and Cryptography – Ranjan Bose, 2ndEdition, 2009, TMH.

VLSI SIGNAL PROCESSING

COURSE CODE: 13EC559

L	T	P	C
3	0	0	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

BROAD BAND ACCESS TECHNOLOGIES

COURSE CODE: 13EC580

L	T	P	C
3	0	0	3

Syllabus

Review Of Access Technologies: Phone-Line modem, cable-access, ISDN, Emerging Broad band Technologies, Cable DSL, Fiber and Wireless

Digital Subscriber Lines: Asymmetric Digital subscriber lines (ADSL) – Rate Adaptive subscriber line (RADSL)-ISDN Digital subscriber line (IDSL) - High bit rate DSL (HDSL)- Single line DSL (SDSL)- very high bit rate DSL (VDSL)- Standards for XDSL & Comparison.

Cable Modem: Cable Modem, DOCSIS – Physical Cabling, Dual Modem Operation, Hub Restriction, Upstream Operation – Downstream operation – Access control – framing Security sub layer – Data link layer – LLC & Higher layers – ATM centric VS IP – centric cable modem.

Fiber Access Technologies: Optical Fiber in access networks, Architecture and Technologies- Hybrid fiber – Coax (HFC) system, Switched Digital Video (SDV) – Passive optical networks (PON) – FTTX (FTTH, FTTB, FTTC, FTT cab) comparison.

Broad Band Wireless: Fixed Wireless, Direct Broadcast Satellite (DBS), Multi channel multi point distribution services (MMDS), Local multi point distribution services (LMDS), and Wideband integrated Digital Interactive Services (WIDIS), Mobile Wireless 3G – IMT 2000.

Text Books

1.Niel Ransom and Albert A. Azzam, “Broadband Access Technologies: ADSL, VDSL Cable Modem, Fiber and LMDS, McGraw Hill 1999.
2.Gilbert Held, “Next Generation Modems: A Professional Guide to DSL and cable modems”, John Wiley & sons.

Reference Books

1.Walter j Woralski, “ADSL and DSL Technologies”, McGraw Hill computer Communication series, 1998.
2.William Webb, “Introduction to Wireless Local Loop broadband and narrow band system”, Artech House, 2000.
3.Martin P. Clarke, “Wireless Access Network: Fixed Wireless Access and WLL network Design and operation”, John Wiley & Sons 2000.

FUNDAMENTALS OF ELECTRONIC WARFARE

COURSE CODE: 13EC508

L	T	P	C
3	0	0	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

Passive and Active-Passive Radar Jamming - The Jamming Equation: Types of Passive Jamming - Chaff, Formation Dynamics and Statistical Characteristics of Chaff Clouds, The Equation for Radar Jamming Using Passive Jamming, - The Jamming Coefficient for Noncoherent Radar, The Jamming Coefficient Using Passive Jamming for Coherent Pulse-Radar, Effectiveness of Radar Jamming Using Passive Jamming - Determination of the Required Quantity of Chaff, Active-Passive Jamming

False Radar 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

WIRELESS COMMUNICATION SIGNAL PROCESSING

COURSE CODE: 13EC525

L	T	P	C
3	0	0	3

Syllabus

Linear Diversity Techniques for Fading Channels System and Fading Channels Models: Transmission with out Diversity, Spectral Diversity, Temporal Diversity, spatial Diversity, Diversity methods for multiuser system

Adaptive Interference Suppression: Multiple Access Signal Model, Elements of multiuser detection, Linear interference suppression, Application to DS-CDMA, Adaptive algorithms

Equalization of Multiuser Channels: Characterization of wireless channels, equalization of known multipath fading, Blind equalization in multipath slowly time varying channel

Blind Space Time Signal Processing : The wireless propagation environment, signal model and structure, channel identification & equalization, Blind techniques

Network Capacity, Power control & effective Bandwidth: Basic spread spectrum model & the MMSE Receiver, performance under random spreading sequences, Capacity and performance under power control, Multiple classes, maximum power constraints, effective Bandwidth

Text Book

1. H V Poor & G W Wornell, "Wireless Communication Signal Processing Perspectives", PHI

BIOMEDICAL SIGNAL PROCESSING

COURSE CODE: 13EC526

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

MOS CIRCUIT DESIGN

COURSE CODE: 13EC550

L	T	P	C
3	0	0	3

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

2. Etienne Sicard, Sonia Delmas Bendhia, "Basics of CMOS Cell Design", TMH, EEE, 2005.

OPTICAL NETWORKS

COURSE CODE: 13EC582

L	T	P	C
3	0	0	3

Syllabus

Optical System Components And Network Design: Optical System Components – Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters; Transmission System Engineering – System model, Power penalty - transmitter, receiver, Optical amplifiers, crosstalk, dispersion; Wavelength stabilization ; Overall design considerations.

Optical Network Architectures: Introduction to Optical Networks; SONET / SDH, Metropoliton-Area Networks, Layered Architecture; Broadcast and Select Networks – Topologies, Media-Access Control Protocols and Testbeds; Wavelength Routing Architecture.

Wavelength Routing Networks: WDM Network Elements; WDM Network Design - Cost tradeoffs, Virtual Topology Design, Routing and wavelength assignment, Statistical Dimensioning Models.

Packet Switching And Access Networks: Photonic Packet Switching – OTDM, Multiplexing and Demultiplexing, Synchronisation, Header Processing, Buffering, Burst Switching, Testbeds; Access Networks.

Network Management And Survivability: Control and Management – Network management functions, Configuration management, Performance management, Fault management, Optical safety, Service interface; network Survivability- Protection in SONET / SDH and IP Networks, Optical layer Protection, Interworking between layers.

Text Books

1.Rajiv Ramaswami and Kumar N. Sivarajan, "Optical Networks : A Practical Perspective", Harcourt Asia Pte Ltd., Second Edition 2006.

References Books

1.C. Siva Ram Moorthy and Mohan Gurusamy, "WDM Optical Networks : Concept, Design and Algorithms", Prentice Hall of India, Ist Edition, 2002.

2.P.E. Green, Jr., "Fiber Optic Networks", Prentice Hall, NJ, 1993.

3.Biswanath Mukherjee, "Optical WDM Networks", Springer, 2006.

WIRELESS CELLULAR COMMUNICATION

COURSE CODE: 13EC504

L	T	P	C
3	1	0	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.

ADVANCED DIGITAL SIGNAL PROCESSING

COURSE CODE: 13EC521

L	T	P	C
3	1	2	5

Syllabus

Multirate Digital Signal Processing Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for sampling rate Conversion

Multirate Digital Signal Processing Multistage Implementation of Sampling Rate Conversion, Applications of Multirate Signal Processing, Sampling Rate Conversion of Bandpass Signals

Linear Prediction And Optimum Linear Filters: Innovations Representation of a Stationary Random Process, Forward and Backward linear prediction, Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters.

Power Speciral Estimation: Estimation of Spectra from Finite Duration Observations of a signal, the Periodogram, Use DFT in power Spectral Estimation, Bartlett, Welch and Blackman, Tukey methods, Comparison of performance of Non-Parametric Power Spectrum Estimation Methods

Parametric Method Of Power Spectrum Estimation: Parametric Methods for power spectrum estimation, Relationship between Auto-Correlation and Model Parameters, AR (Auto-Regressive) Process and Linear Prediction, Yule-Walker, Burg and Unconstructrained Least Squares Methods, Sequential Estimation, Moving Average(MA) and ARMA Models

Minimum Variance Method, Piscaranko's Harmonic Decomposition Methods, MUSIC Method**.**

Text Books

1.Proakis JG and Manolakis DG Digital Signal Processing Principles, Algorithms and Application, PHI.
2.Openheim AV & Schafer RW, Discrete Time Signal Processing PHI.

Simulation Text Books

1.Samuel D Stearns, "Digital Signal Processing with examples in Matlab. " CRC Press.
2.ES Gopi. "Algorithm collections for Digital Signal Processing Applications using Matlab, " Springer.
3.Taan S.Elali, "Discrete Systems and Digital Signal Processing with Matlab, " CRC Press,2005.

RADAR SIGNAL PROCESSING

COURSE CODE: 13EC522

L	T	P	C
3	1	0	4

Syllabus

Angle-of-Arrival Estimation in the Presence of Multipath: The Low-Angle Tracking Radar Problem, Spectrum Estimation Background, Thomson's Multi-Taper Method, Test Dataset and a Comparison of Some Popular Spectrum Estimation Procedures, Multi-taper Spectrum Estimation, *F*-Test for the Line Components, Experimental Data Description for a Low-Angle Tracking Radar Study

Time–Frequency Analysis of Sea Clutter: An Overview of Non-stationary Behaviour 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, Evidence for Amplitude Modulation, Frequency Modulation, and More, Modelling 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, Parametric Analysis of Texture Process

Two New Strategies for Target Detection in Sea Clutter: Bayesian Direct Filtering Procedure, Operational Details, Experimental Results on the Bayesian Direct Filter, Additional Notes on the Bayesian Direct Filter, Correlation Anomally Detection Strategy

Text Books

1. I. Haykin, Simon S,"Radar Adaptive signal processing", John Wiley & Sons
2. Mark A Richards, "Fundamentals of Radar signal processing", M C Graw Hill

CMOS RF CIRCUIT DESIGN

COURSE CODE: 13EC566

L	T	P	C
3	1	0	4

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

ESTIMATION AND DETECTION THEORY

COURSE CODE: 13EC506

L	T	P	C
3	0	0	3

Syllabus

Detection Theory: Maximum likelihood decision criterion; Neumann-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 asymptotic 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.

ADAPTIVE SIGNAL PROCESSING

COURSE CODE: 13EC530

L	T	P	C
3	0	0	3

Syllabus

Complex-Valued Adaptive Signal Processing: Optimization in the Complex Domain, Widely Linear Adaptive Filtering, Nonlinear Adaptive Filtering with Multilayer Perceptrons, Complex Independent Component Analysis

Robust Estimation Techniques for Complex-Valued Random Vectors: Statistical Characterization of Complex Random Vectors, Complex Elliptically Symmetric (CES) Distributions, Tools to Compare Estimators, Scatter and Pseudo-Scatter Matrices Array Processing Examples, MVDR Beamformers Based on M-Estimators

Turbo Equalization: Communication Chain, Turbo Decoder: Overview, Forward-Backward Algorithm, Simplified Algorithm: Interference Canceler, Capacity Analysis, Blind Turbo Equalization, Convergence, Multichannel and Multiuser Settings

Subspace Tracking for Signal Processing: Linear Algebra Review, Observation Model and Problem Statement, Preliminary Example: Oja's Neuron, Subspace Tracking,, Eigenvectors Tracking, Convergence and Performance Analysis Issues

Particle Filtering: The Basic Idea, The Choice of Proposal Distribution and Resampling, Some Particle Filtering Methods, Handling Constant Parameters, Rao–Blackwellization, Prediction, Smoothing,

Text Books

1. Tu¨lay Adalı ,Simon Haykin," Adaptive Signal Processing", John Wiley & Sons

VLSI SYSTEM DESIGN

COURSE CODE: 13EC556

L	T	P	C
3	0	0	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.

VLSI FOR WIRELESS COMMUNICATION

COURSE CODE: 13EC574

L	T	P	C
3	0	0	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
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.

HIGH PERFORMANCE COMMUNICATION NETWORKS

COURSE CODE: 13EC581

L	T	P	C
3	0	0	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),Token bus (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: 13EC505

L	T	P	C
3	0	0	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, and 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 5TH

4.Devendra K.Misra ,"Radio Frequency and Microwave Communication Circuits – Analysis and Design "John Wiley & Sons, Inc.

5. Jon B. Hagen, " Radio Frequency Electronics ", Cambridge university press, Cambridge, 1996.

6. James Hardy, " High Frequency Circuit Design ", Resto Publishing Co., NewYork, 1979.

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.

ANTENNA MEASUREMENTS

COURSE CODE: 13EC509

L	T	P	C
3	0	0	3

Syllabus

Antenna Pattern Measurements: Basic Considerations, Pattern Formats, Fresnel Region Measurements, Modelling Techniques

Antenna Range Design and Evaluation: Introduction, Electromagnetic Design Consideration, Antenna Range Evaluation.

Antenna Testing: Introduction, Types 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

OPTICAL SIGNAL PROCESSING

COURSE CODE: 13EC534

L	T	P	C
3	0	0	3

Syllabus

Basics of signal processing and optics, Characterization of a General signal, examples of signals, Spatial signal. Basic laws of geometrical optics, Refractions by mirrors, the lens formulas, General Imaging conditions, the optical invariant, Optical Aberrations.

Physical Optics, The Fresnel Transforms, the Fourier transform, Examples of Fourier transforms, the inverse Fourier transform, Extended Fourier transform analysis, Maximum information capacity and optimum packing density, System coherence.

Spectrum Analysis and Spatial Filtering, Light sources, spatial light modulators, and the detection process in Fourier domain, System performance parameters, and Dynamic range. Some fundamentals of signal processing, Spatial Filters

Binary Spatial Filters, Magnitude Spatial Filters, Phase Spatial Filters, Real valued Spatial Filters, Interferometric techniques for constructing Spatial Filters. Optical signal processor and filter generator, Applications for optical signal processing.

Acousto-optic cell spatial light modulators, Applications of acousto-optic devices. Basic Acousto-optic power spectrum analyser. Heterodyne systems: Interference between two waves, the optical Radio.

Text Books

1. Anthony Vanderlugt ,"Optical signal processing" ,Wiley-Interscience
2. Hiroshi Ishikawa ,"Ultrafast All-Optical Signal Processing Devices",Wiley

References

1. D. Casasent, "Optical data processing-Applications", Springer-Verlag, Berlin,
2. H.J. Caulfield, "Handbook of holography", Academic Press New York 1979
3. P.M. Dufffieux, "The Fourier Transform and its applications to Optics", John Wiley and sons
4. J. Horner ,"Optical Signal Processing ",Academic Press 1988
5. Joseph W. Goodman," Introduction to Fourier Optics", second edition Mc Graw Hill.
6. Francis T. S. Yu, Suganda Jutamulia, "Optical Signal Processing, Computing, and Neural Networks", Krieger Publishing Company; 2nd edition

LOW POWER VLSI CIRCUITS

COURSE CODE: 13EC555

L	T	P	C
3	0	0	3

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

WIRELESS SENSOR NETWORKS

COURSE CODE: 13EC583

L	T	P	C
3	0	0	3

Syllabus

Characteristics of WSN: Characteristic requirements for WSN - Challenges for WSNs – WSN vs Adhoc Networks - Sensor node architecture – Commercially available sensor nodes –Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot -Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations.
Medium Access Control Protocols: Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts - Contention-based protocols - Schedule-based protocols - SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol.
Routing And Data Gathering Protocols Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing - Gradient-based routing - Rumor Routing – COUGAR – ACQUIRE – Hierarchical Routing - LEACH, PEGASIS – Location Based Routing – GF, GAF, GEAR, GPSR – Real Time routing Protocols – TEEN, APTEEN, SPEED, RAP - Data aggregation - data aggregation operations - Aggregate Queries in Sensor Networks - Aggregation Techniques – TAG, Tiny DB.

Embedded Operating Systems: Operating Systems for Wireless Sensor Networks – Introduction - Operating System Design Issues - Examples of Operating Systems – TinyOS – Mate – MagnetOS – MANTIS - OSPM - EYES OS – SenOS – EMERALDS – PicOS – Introduction to Tiny OS – NesC – Interfaces and Modules- Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM.

Applications of WSN: WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling.

Text Books

1.Kazem Sohraby, Daniel Minoli and Taieb Znati, " Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007.

2.Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.

Reference Books

1.K. Akkaya and M. Younis, "A survey of routing protocols in wireless sensor networks", Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325--349

2.Philip Levis, " TinyOS Programming"

3.Anna Ha´c, "Wireless Sensor Network Designs", John Wiley & Sons Ltd.

DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING

(Embedded Systems)

S No	Course Code	Semester: - 1	L	T	P	Cr
1	11-EM501	Microcontrollers for Embedded System Design.	**3**	**1**	**2**	**5**
2	12-EM502	Real Time Concepts for Embedded Systems	**3**	**1**	**0**	**4**
3	13-EM503	VLSI Technology & Design	**3**	**1**	**2**	**5**
4	12-EM504	Wireless Communications & Networks	**3**	**1**	**0**	**4**
5		Elective – 1 –GROUP-A	**3**	**0**	**0**	**3**
6		Elective – 2 –GROUP-B	**3**	**0**	**0**	**3**
7	13EM501	Seminar	**0**	**0**	**4**	**2**
		Total Credits				**26**
S No	**Course Code**	**Semester: - 2**	**L**	**T**	**P**	**Cr**
1	11-EM601	Advanced Embedded Processor Architectures	**3**	**1**	**2**	**5**
2	13-EM602	Digital Signal Processors and Architectures	**3**	**1**	**0**	**4**
3	11-EM603	Hardware Software Co –Design	**3**	**1**	**0**	**4**
4	13-EM604	Linux System Concepts	**3**	**1**	**2**	**5**
5		Elective – 3 --GROUP-A	**3**	**0**	**0**	**3**
6		Elective -4 --GROUP-B	**3**	**0**	**0**	**3**
7	13EM601	Term Paper	**0**	**0**	**4**	**2**
		Total Credits				**26**

S.No.	Course Code		Credits
		SEMESTER-3	
1	14TM602	Internship	18
		SEMESTER -4	
2	EMCT01	Thesis	18
Total Credits			**88**

COURSE CODE	GROP-A
13-EM-E30	CPLD & FPGA Architectures and Applications
11-EM-E31	Network Security & Cryptography
13-EM-E32	Embedded Networking
11-EM-E33	Ad-hoc & Wireless Sensor Networks
11-EM-E34	Robotics
11-EM-E35	System Modeling and Simulation
	GROUP-B
11-EM-E40	Embedded Linux
12-EM-E41	System On Chip Architecture
11-EM-E42	Advanced Computer Networks
11-EM-E43	Image and Video Processing
12-EM-E44	Real Time Operating Systems
12-EM-E45	Object Oriented Analysis and Design

Course No. **: 11-EM501**

Course Title **: Micro Controllers for Embedded System Design**
Course Structure **: 3-1-2**
SYLLABUS:
UNIT – I: 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.
UNIT – II: Microcontrollers and Processor Architecture & Interfacing
8051 Architecture. Real world interfacing, Introduction to advanced architectures, processor & memory organization, Instruction-level parallelism, and performance metrics.
UNIT – III: PIC Microcontroller Hardware
Introduction, Architectural overview, Memory organization, interrupts and reset, I/O ports, Timers
Unit – IV: 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
UNIT – V: 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
Project Based Lab: The students will do five basic experiments to gain the knowledge and hands on experience with IDE's and Simulators of basic CISC and RISC microcontrollers and the Develop an application using this knowledge.

Course No. **: 12-EM502**
Course Title **: REAL TIME CONCEPTS FOR EMBEDDED SYSTEMS**
Course Structure **: 3-1-0**
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

Course No. **: 13-EM503**
Course Title **: VLSI Technology & Design**
Course Structure **: 3-1-2**

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.

Project Based Lab: The students will do five basic experiments to gain the knowledge and hands on experience using VHDL and FPGB boards and the Develop an application using this knowledge.

Course No. **: 12-EM504**
Course Title **: Wireless Communications & Networks**
Course Structure **: 3-1-0**

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.

Course No. **: 11-EM601**
Course Title **: Advanced Embedded Processor Architecture**
Course Structure **: 3:1:2**

SYLLABUS:

ARM Processor as System-on-Chip: Acorn RISC Machine – Architecture inheritance – ARM programming model. 3 and 5 stage pipeline ARM organization – ARM instruction execution and implementation – ARM Co-processor interface

ARM Assembly Language Programming: ARM instruction types – data transfer, data processing and control flow instructions – ARM instruction set – Co-processor instructions, Thumb Instruction Set.

Architectural Support for System Development: Advanced Microcontroller bus architecture – ARM memory interface – ARM reference peripheral specification – Hardware system prototyping tools – ARMulator – Debug architecture.

ARM Processor Cores: ARM7TDMI, ARM8, ARM9TDMI, ARM10TDMI, the AMULET Asynchronous ARM Processors- AMULET1

Embedded ARM Applications: The VLSI Ruby II Advanced Communication Processor, The VLSI ISDN Subscriber Processor, The OneC™ VWS22100 GSM chip, The Ericsson-VLSI, Bluetooth Baseband Controller, The ARM7500 and ARM7500FE.

Text Books:

1. ARM System on Chip Architecture – Steve Furber – 2nd ed., 2000, Addison Wesley Professional.
2. Design of System on a Chip: Devices and Components – Ricardo Reis, 1st ed., 2004, Springer

References:

1. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology) – Jason Andrews – Newnes, BK and CDROM
2. System on Chip Verification – Methodologies and Techniques –Prakash Rashinkar, Peter Paterson and Leena Singh L, 2001, Kluwer Academic Publishers.

Project Based Lab: The students will do five basic experiments to gain the knowledge and hands on experience with IDE's and Simulators of 32 bit RISC processor (ARM) and then Develop an application using this knowledge.

Course No. **: 13-EM602**
Course Title **: Digital Signal Processors and Architectures**
Course Structure **: 3-1-0**

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.

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.

Course No. **: 11-EM603**
Course Title **: Hardware Software Co -Design**
Course Structure **: 3-1-0**
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

Course No. **: 13-EM604**
Course Title **: Linux System Concepts**
Course Structure **: 3-1-2**
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.

Project Based Lab: The students will do five basic experiments to gain the knowledge and hands on experience with Linux environment and then develop an application using Resebery PI by porting Linux OS.

Course No. : 13-EM-E30
Course Title : CPLD and FPGA Architecture and Applications
Course Structure : 3-0-0
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.

Course No. : 11-EM-E31
Course Title : Network Security & Cryptography
Course Structure : 3-0-0

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

Course No. : 13-EM-E32
Course Title : Embedded Networking
Course Structure : 3-0-0
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

Course No. : 11-EM-E33
Course Title : Ad-hoc Wireless & Sensor Networks
Course Structure : 3-0-0
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)

Course No. **: 11-EM-E34**
Course Title **: Robotics**
Course Structure **: 3-0-0**
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.

Course No. **: 11-EM-E35**
Course Title **: System Modeling and Simulation**
Course Structure **: 3-0-0**
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:

1. Systems Simulation-Geoffery Gordan, PHI.

Course No. **: 11-EM-E40**
Course Title **: Embedded Linux**
Course Structure **: 3-0-0**

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

Course No. : 12-EM-E41
Course Title : System On – Chip Architecture
Course Structure : 3-0-0

SYLLABUS:

Introduction ,Design Methodology for Logic cores : SoC Design flow, General guide lines for design reuse, design process for soft, firm and hard cores, system integration.

Design Methodology for Memory Cores and Analog cores: Design methodology for embedded memories, specifications of analog circuits Design Validation: core level validation, core interface verification SoC design validation.

On-chip communication Architectures: A quick overlook, Basic concepts of bus based communication Architectures: Terminology, characteristics of Bus based communication architectures, data transfer modes, Bus topology types.

On chip Communication Architecture Standard: standard on chip bus based communication architectures; socket based on chip interface standards.

Verification and security Issues in On chip communication Architectures: verification of on chip communication protocols, compliance verification for IP block integration, basic concepts for SoC security, security support in standard bus protocols Networks on chip: network topology, switching strategies, routing algorithms, flow control, clocking schemes, NOC architectures.

Text Books:

1. System On a Chip Design and Test? by Rochit Rajsuman, Library of Congress Cataloging-in-Publication Data,2000.

2. On chip communication Architectures? by Sudeep Pasricha and Nikil Dutt , Morgan Kaufmann Publishers,2008

Course No. : 11-EM-E42
Course Title : Advanced Computer Networks
Course Structure : 3-0-0
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, John
Wiley & Sons, 2004.

Course No. **: 11-EM-E43**
Course Title **: Image and Video Processing**
Course Structure **: 3-0-0**
SYLLABUS:

Fundamentals of Image Processing and Image Transforms: Basic steps of Image Processing System Sampling and Quantization of an image – Basic relationship betweenpixelsImage Transforms: 2 D- Discrete Fourier Transform, Discrete Cosine Transform (DCT), Wavelet Transforms:Continuous Wavelet Transform, 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, Compressionmodels: Lossy& Lossless, Huffman 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: Three-Dimensional Motion Models,Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations.

2-DMotion Estimation: Optical flow, General Methodologies, Pixel Based Motion Estimation, Block- Matching Algorithm, and Mesh basedMotion 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. Digital Image Processing – Gonzaleze and Woods, 3rd ed., Pearson.
2. Video processing and communication – Yao Wang, JoemOstermann and Ya–quin Zhang. 1st Ed., PH Int.

References :

1. Digital Video Processing – M. Tekalp, Prentice Hall International

Course No. **: 12-EM-E44**
Course Title **: Real Time Operating Systems**
Course Structure **: 3-0-0**
SYLLABUS:

Review of Operating Systems:- What Operating Systems Do? , Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Operating-System Services, System Calls, Types of System Calls, Distributed Systems.

Overview of RTOS:-

Introduction to Real-Time Operating Systems: A Brief History of Operating Systems, Defining an RTOS, the Scheduler, Preemptive Priority-Based Scheduling, Key Characteristics of an RTOS. **Tasks:** Defining a Task, Task States and Scheduling, Typical Task Operations, Typical Task Structure, Synchronization, Communication, and Concurrency.

Real Time Kernel Objects:-

Semaphores: Defining Semaphores**,** Typical Semaphore Operations, Typical Semaphore Use, **Message queues:** Defining Message Queues, Message Queue States, Message Queue Content, Message Queue Storage, Typical Message Queue Operations, Typical Message Queue Use **Other kernel Objects:** Pipes, Event Registers, Signals, Condition Variables

RTOS Design Considerations:-

Timer and Timer Services: Real-Time Clocks and System Clocks, Programmable Interval Timers, Timer Interrupt Service Routines, a Model for Implementing the Soft-Timer Handling Facility, Timing Wheels,**I/O sub system**: Basic I/O Concepts, the I/O Sub system.

Memory Management: Dynamic Memory Allocation, Fixed-Size Memory Management, Blocking vs. Non-Blocking Memory Functions, Hardware Memory Management Units

Tasks Communication and Synchronization:-

Synchronization and Communication: Synchronization, Communication, Resource Synchronization Methods, Common Practical Design Patterns.

Common Design Problems: Resource Classification, Deadlocks, Priority inversion

RTOS Programming-I**: MicroC/OS-II and VxWorks**

Text Books:

1. Abraham Silberschatz, Peter Baer Galvin, Burlington, Greg Gagne, "Operating System Concepts", 8th edition, Wiley.
2. Qing Li with Caroline Yao, "Real-Time Concepts for Embedded Systems", Published by CMP Books,2011
3. Raj Kamal, "Embedded Systems- Architecture, Programming and Design" Tata McGraw Hill, 2006.

REFERENCES:

1. Charles Crowley, "Operating Systems-A Design Oriented approach" McGraw Hill 1997.
2. Raymond J.A.Bhur, Donald L.Bailey, "An Introduction to Real Time Systems", PHI 1999.
3. Mukesh Sighal and Shi.N.G "Advanced Concepts in Operating System", McGraw Hill 2000.

Course No. : 12-EM-E45
Course Title : Object Oriented Analysis & Design
Course Structure : 3-0-0

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.

DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING

Wireless Communication & Sensor Networks

S No	Course	Semester: - 1	L	T	P	Cr
1	13EM511	Computational Methods and Error	**3**	**1**	**0**	**4**
2	13EM512	Wireless Communications & Networks	**3**	**1**	**2**	**5**
3	13EM513	Sensors and Sensing Principles	**3**	**1**	**0**	**4**
4	13EM514	Data Acquisition and Hardware Networks	**3**	**1**	**2**	**5**
5		Elective – 1	**3**	**0**	**0**	**3**
6		Elective – 2	**3**	**0**	**0**	**3**
7	13EM610	Seminar	**0**	**0**	**4**	**2**
		Total Credits				**26**
S No	**Course**	**Semester: - 2**	**L**	**T**	**P**	**Cr**
1	13EM515	MEMS & NEMS	**3**	**1**	**0**	**4**
2	13EM516	Communications Protocols and Standards	**3**	**1**	**2**	**5**
3	13EM517	Wireless Sensor Networks	**3**	**1**	**2**	**5**
4	13EM518	Design and Analysis of Algorithms	**3**	**1**	**0**	**4**
5		Elective – 3	**3**	**0**	**0**	**3**
6		Elective -4	**3**	**0**	**0**	**3**
7		Term Paper	**0**	**0**	**4**	**2**
		Total Credits				**26**

S.No.	Course Code		Credits
		SEMESTER-3	
1	14TM602	Internship	18
		SEMESTER -4	
2	EMCT01	Thesis	18
		TOTAL	**36**
		TOTAL CREDITS	**88**

COURSE CODE	ELECTIVE-1
13EM531	Ad hoc and Vehicular Networks
13EM532	Cryptography Wireless Security
13EM533	Advanced Data Communications
13EM534	Probability and Stochastic Process
	ELECTIVE-2
13EM535	Database management systems
13EM536	Software Engineering & Usability Engineering
13EM537	RF System Design for Wireless Communications
13EM538	Optical Networks
	ELECTIVE-3
13EM539	Advanced Digital Communications
13EM540	Sensor web services –case studies
13EM541	Advanced Wireless Networks
13EM542	CDMA and OFDM for Wireless Communications
	ELECTIVE-4
13EM543	Advanced Techniques for Wireless Reception
13EM544	Fuzzy logic and Neural Networks
13EM545	Reliability Engineering

13EM546	Advanced Microcontroller and its Applications

COMPUTATIONAL METHODS AND ERROR ANALYSIS

13 EM 511

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 enghineering mathematics by B.S. Grewal, 40rd edn, Khanna publishers.
2. Advanced Engineering Mathematics by Erwin Kreyszig, 8^{th} Edn, Wiley publishers. dory.

Course No. : 13-EM512
Course Title :Wireless Communications & Networks
Course Structure : 3-1-2
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:

2. 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 Edition, 2007.

5.JimGeier, "Wireless Networks first-step", Pearson, 2005.

ADVANCED COMPUTER NETWORKS

CONGESTION AND QUALITY OF SERVICE (QoS): Data traffic, congestion, Congection control, Open loop and Closed Loop Congestion control I TCP and Frame Relay, Quality of Service, Flow Characterization, Flow Classes, Need For Qos, Resource Allocastion, Best Effort Service Features, Techniques to Improve QoS.

QUEUE MANAGEMENT: Queue management schemes, Scheduling, traffic Shapin, Resource Reservation and Admission Control Scheduling, Integratedand differential Service.

SIMPLE INTERNETWORKING (IP): What is an Internet, Service Model, Global Addresses, Datagram Forwarding in IP, Address Translation (ARP), Hostconfiguration (DHCP), Error Reporting (ICMP), Virtual Networks and Tunnels.

ROUTING: Network as Graph, Distance Vector (RIP), Link State (OSPF), Metrics, Routing for Mobile Hosts.

GLOBAL INTERNET: Sub netting, Classless Routing (CIDR), Inter domain Routing (BGP), Routing Aress, IP Version 6 (IPv6).

MULTICAST: Link state Multicast, Distance Vector Multicast, Protocal Independent Multicast (PIM).

MULTIPROTOCAL LABEL SWITCHING (MPLS): Destination based Forwarding, Explicit Routing, Virtual Private Networks and Tunnels.

SIMPLE DE MULTIPLEXER (UDP), RELIABLE BYTE STREAM (TCP): End to End Issues, Segment Fromat, Connection Estiblishment and Termination, Sliding |Window Revisited, Triggering Transmision, Adaptive Retransmission, Recodr boundaries, TCP Extensions, Alternative Design Choices.

REMOTE PROCEDURE CALL: Bilk Transfer (BLAST), Request/Reply(CHAN), Dispatchers (SELECT), Performance.

VIRTUAL PRIVATE NETWORKS (VPN): Types of VPN,VPN General Architectures, Disadvantages, VPN Security Issues, VPN Standards.

ATM PROTOCOL REFERENC MODEL: Introduction, Transmission Convergence (TC), Sub layer, Physical Medium Dependent (PMD) sub layer Standards for ATM.
LAYERS: ATM Cell Header Structure at UNI, ATM Cell Header Structure at NNI, ATM Layer Functions.
ATM ADAPTER LAYER: Service Clases and ATM Adaptation Layer, ATM Adaptation Layer1 (AAL1), ATM Adaptation Layer 2 (AAL2), ATM Adaptation Layer ¾ (AAL3/4), ATM Adaptation Layer 5 (AAL5).
SONET/SDH: SONET/SDH Architecture, SONET Layers, SONET Frames, STS Multiplexing, SONET Networks.

Text Books:

1. Computer networks: ASystem Approach By Larry L.Peterson, Bruce S. Davie.
2. Data Communication and Networking – B. A. Forouzan, 2nd updating,2204 TMH.
3. ATM Networks Concepts and Protocals By Sumit Kasera.

References Books:

1. Computr Networks by Andrew S. Tanenbaum.

DATA ACQUISITION AND HARDWARE NETWORKS

POWER SUPPLIE AND FILTERS: Amplifiers – Instrumentation of amplifiers-isolation-chopper and low drift amplifer-Lock-in amplifiers electrometer and trans-impedance amplifiers-modulation-filters-constant voltage and constant current regulators, DC-DC concverter, smps. D/A converters, Comparator, PLL.
SENSOR SIGNAL CONDITIONING CIRCUITS: Signal conditioninig for resistive sensors, Reactive variation sensors and Self generating sensors Error budget analysis.
BASIC SIGNAL CONSERVATIONA AND COMMUNICATION: RS232 interface standard, RS485 interface standard. Distributed and stand alone data loggers, IEEE488 standard. Methods of frequency-to-codeconversion-standrad, indirect and combined countin method, two wire transimisiion-four, six wire sensing.
DATA ACQUISITION METHODS FOR MULTI CHANNEL SENSOR SYSTEMS: Data Acquisiton method with time-division channeling, data acquisition with space-divison channeling, and main errors of multi channel data-acquisition systems, data transmission and error protection.
SERIAL COMMUNICATION AND NETWORK: Serial data communication – transmission modes, SPI,IC, CAN Example 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 ed., Springer, 2003.
2. Jon S. Wilson, "Sensor Technology Hand Book", Eleservier Inc., 2005.

Reference Books:

1. Pallas Areny R, Webster. J. G. "Sensor Signal Conditioning", 2nd ed. John Wiley and Sons, 2001.
2. Tsylor H Rosemary, "Data Acquisition for Sensor systems" , Kluwer Academic Publishers Group, 1997.
3. Microcontroller(Theory & application) – A.V. Deshmuk, WTMH 2005.
4. Embedded Systems Architecture, programming and Design 2nd ed.Rajkamal McGraw – Hill.

DATA BASE MANAGEMENT SYSTEM

BASIC CONCEPTS: Database and Need for DBMS, Characteristics of DBMS, Database Users, 3-tire architecture of DBMS (its advantages over 2-tier), Data Models, Views of data schemes and instances, Data Independence.

DATABASE DESIGN USING ER MODELS: Entites, Reletionships, Repesentation of entites, attributes, relationship attributes, relationship, Generalization, aggregation, Relatiional algebra, Structure of relation Database and different types of keys, Codd's rules, ER to Relational model.

RELATIONAL MODEL: Relational model concepts, Relational model constraints, DatadefinationinSQL,Views and Queries in SQL Specifying constraints and Indexes in SQL., Functional Dependencies, Normalization, Normal forms baed 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, Deadlocks.

STORAGE AND FILE STRUCTURE: Overview of Physical storage media,Tertiary storage, Storage acces, 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 concepts Korth.
2. Introduction to database Management Systems C.J.Date.

Reference Books:

1. Database Management Systems Bipin Desai.
2. Database Management Systems Ramakrishnan & Gehrke.

RF SYSTEM DESIGN FOR WIRELESS COMUNICATION

FUNDAMENTALS OF SYSTEM DESIGN: Linear System, Fourier Series and Transformation, Frequency Response of LTI Systems, Brand Pass to Low Pass equivalent Mapping nad Hilbert Transform.

NON LINEAR SYSTEM REPRESENTATIN AND ANALYSIS APPROACHES: Representation for memory Less Nonlinear systems. Multiple Input Effects in Nonlinear Syatem, Memory less Brand Pass Nonlinearities and Their Low Pass Equivalents.

RADIO ARCHITECTURE AND DESIGN CONSIDERATION

SUPER HETERODYNE ARCHITECTURE: Confuguration of Super Radio, Frequency Planning, Design consideration of Superheterodyne Transciver.

DIRECT CONSERVATION (ZERO IF) ARCHITECTURE: Cofiguration of Direct Conversion Radio.

LOW IF ARCHITECTURE: Configuration of Low IF Radio, Approach 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, Formual of Adjaced

Alternative Channel Selectivity and BlockingCharacterists, 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 AND RANDOM PROCESS: Noise Power and Spectral Representation, Noise and Random Process Through Linear System, Narrow Band Noise Representation, Noise Figure and Noise Temperature.
NOISE EMISSION CALCULATION: Formulas for Noise Emission Calculation, Some Important Notes in Noise Estimation 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,479p. 125 illus.,Hardcover, Springer, ISBN: 978-0-387-24161

Reference Books:

1. D.K. Misra, "Radio Frequence and Microwave Communication Circuits, Analysis and Design", John wiley & Sons., inc, 2004, kundli.
2. Pozar, D.M. "Microwave Engineering," Adison Wesley, 3rd Edition, 1990.

SENSORS AND SENSING PRINCIPLES

SENSOR FUNDAMENTALS: Basic sensor technology – sensor characteristics – statics dynamic – principles of sensing – capacitance – magnetic and electromagnetic induction resistance piezoelectric effect Pyroelectric effect Hall effect See eck and Pettier effect heat transfer light.
PHYSICAL SENSORS: Position, Displacemetns and level Sensor, Velocity and Acceleratin sensors Force, Strain, Tactile and pressure sensors.
CHMICAL SENSOR: Classification of chemical sensing, Mechanism, Potentiometric sensors, Conduct metric sensors, Amperometric Sensors, Enhanced Catalytic gas sensor.
OPTICASL SENSORS: Optical Radiation Electromagnatic Spectrum, Snell's Law and Total internal reflection, Diffraction principles, Optical Detectors and Sources Photo dides and transistors, Photo darling ton pairs, Photoconductive sensors, CCD sensors, Fiber optic sensors. Solid state light sources LED, Diode lasers, Semiconductor laser.
BIO SENSORS: Origin and Transmission of bioelectrical Signals, The Electromyogtram (EMG) & the Electrocardiogram (ECG) The Electroencephalogram (EEG) & Blood pressure measurements, Catalytic biosensors, mono enzyme lectrodes, bi enzyme electrodes. Cell based biosensors, biochips and biosensor arrays, problem and limitations.

Text Books:

1. Biosensor principles and applications, Edited by Loic J. Blum, Pierre R. Coulet Agarwal, Govind P , " Fiber Optic Communication Systems", 2nd edition, Wiley, New York,1997.
2. Principles of Biochemistry Albert L.Lehninger, David Lee Nelson, Michael M. 2005, 4th Edition.
3. Sensor and Transducers D. Patranbis Prentice – Hall of India Pvt.Ltd(Aug 15, 2004).

4. Jacob Fraden, " Hand Book of Modern Sensors: physics, Designs and Applications" ,3rd ed., Springer, 2003.

CDMA and OFDM for Wireless Communications

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

Communication Protocols and Standards

13-EM516

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

Design & Analysis of Algorithms

13-EM518

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.

MEMS and NEMS

13-EM515

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

RELIABILITY ENGINEERING

Concept of reliability: What is Reliability, Mathematics of reliability:- Variation, Probability concept, Rules of probability, Continuous variation, Continuous distribution functions, Variation
in engineering, Discrete variation, Statistical confidence, Statistical hypothesis testing, Nonparametric
inferential methods, Goodness of fit Series of events, Computer software for

statistics, Practical conclusions.
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, Load strength analysis, Failure mode effect and criticality analysis, Reliability prediction, Hazard and operability study, Parts material and process review.
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,
Reliability Management: Corporate policy for reliability, integrated reliability programs, Reliability and cost, Standards for quality reliability and safety, contracting for reliability achievement, managing lower level supply, Customer management of reliability, Organization
for reliability,
Text Books:
1. Practical Reliability Engineering -Patrick D. T. O' Connor, IV Edition
2. Electronic Safety Systems - Josef Borcsok
Reference Books:
1. Reliability Engineering- E.Balagurusamy Tata McGraw-Hill
2. Reliability Engineering Theory and practice-A.Birolini, IV Edition
3. Reliability Engineering-L.S.Srinath, IV Edition

WIRELESS SENSOR NETWORKS

13-EM517
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 Adhoc
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 Kauffma

Course No. : 12-EM504
Course Title :Wireless Communications & Networks
Course Structure : 3-1-0
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 Edition, 2007.
5.JimGeier, “Wireless Networks first-step”, Pearson, 2005.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
POWER SYSTEMS

S.No	Course Code	Course Title	L-T-P	Credits
Semester -1				
1	14EE511	POWER SYSTEM DYNAMICS & STABILITY	3-1-0	4
2	14EE512	ADVANCED POWER SYSTEM ANALYSIS	3-1-2	5
3	14EE503	OPTIMIZATION TECHNIQUES	3-1-0	4
4	14EE504	MODERN CONTROL THEORY	3-1-0	4
5		ELECTIVE-1	3-0-0	3
6		ELECTIVE-2	3-0-0	3
7	14EE509	SEMINAR	0-0-4	2
		TOTAL CREDITS		25
Semester -2				
1	14EE513	REAL TIME CONTROL OF POWER SYSTEM	3-1-2	5
2	14EE506	MICRO CONTROLLERS & EMBEDDED SYSTEMS	3-1-0	4
3	14EE514	EHVAC&HVDC TRANSMISSION	3-1-0	4
4	14EE515	POWER SYSTEMS DIGITAL PROTECTION	3-1-0	4
5		ELECTIVE-3	3-0-0	3
6		ELECTIVE-4	3-0-0	3
7	14EE609	TERM PAPER	0-0-4	2
		TOTAL CREDITS		25
Semester -3&4				
1		THESIS		36

Elective-1				
1	14EE541	REACTIVE POWER COMPENSATION & MANAGEMENT	3-0-0	3
2	14EE542	DISTRIBUTION SYSTEM PLANNING & AUTOMATION	3-0-0	3
3	14EE543	POWER SYSTEM RELIABILITY	3-0-0	3
Elective-2				
1	14EE544	POWER SYSTEM RESTRUCTURING, DEREGULATION & POWER MARKETS	3-0-0	3
Elective-3				
1	14EE545	ENERGY CONSERVATION & AUDIT	3-0-0	3
Elective-4				
1	14EE546	AL TECHNIQUES IN POWER SYSTEMS	3-0-0	3

POWER SYSTEM DYNAMICS & STABILITY

Course Code : 14EE511 **L-T-P : 3-1-0**
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 : 14EE512 **L-T-P : 3-1-2**
Credits : 5

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).

OPTIMIZATION TECHNIQUES
(Common to Both PED & PS)

Course Code : 14EE503 **L-T-P : 3-1-0**
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 : 14EE504 **L-T-P : 3-1-0**
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".

REAL TIME CONTROL OF POWER SYSTEMS

Course Code : 14EE513 **L-T-P : 3-1-2**
Credits : 5

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. I. 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).

MICROCONTROLLERS & EMBEDDED SYSTEMS
(Common to Both PED & PS)

Course Code : 14EE506 **L-T-P : 3-1-0**
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).

EHVAC & HVDC TRANSMISSION

Course Code : 14EE514 **L-T-P : 3-1-0**
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 : 14EE515 **L-T-P : 3-1-0**
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 : 14 EE 541 **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 : 14EE542 **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 : 14 EE 543 **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)

DIGITAL SIGNAL PROCESSOR
(Common to Both PED & PS)

Course Code : 14EE534 **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
(Common to Both PED & PS)

Course Code : 14EE533 **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).

POWER SYSTEM RESTRUCTURING, DEREGULATION & POWER MARKETS

Course Code : 14EE54 **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).

FLEXIBLE AC TRANSMISSION SYSTEMS
(Common to Both PED & PS)

Course Code : 14EE536 **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:

a. Ned Mohan et.al "Power Electronics"2 nd edition John wiley & Sons,(2002).
b. T.J.E Miller, "Reactive power control in electric Systems" John willey & sons,(1982).

POWER QUALITY
(Common to Both PED & PS)

Course Code : 14EE537 **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).

ENERGY CONSERVATION & AUDIT

Course Code : 14EE545 **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)

SMART GRIDS
(Common to Both PED & PS)

Course Code : 14EE539 **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

(Common to Both PED & PS)

Course Code : 14EE540 **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”, 2nd 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).

AI TECHNIQUES IN POWER SYSTEMS

Course Code : 15 EE 546 **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).

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
(POWER ELECTRONICS AND DRIVES)

S.No	Course Code	Course Title	L-T-P	Credits
Semester -1				
1	14EE501	DESIGN OF POWER CONVERTERS	3-1-2	5
2	14EE502	POWER ELECTRONIC CONTROL OF DRIVES	3-1-0	4
3	14EE503	OPTIMIZATION TECHNIQUES	3-1-0	4
4	14EE504	MODERN CONTROL THEORY	3-1-0	4
5		ELECTIVE-1	3-0-0	3
6		ELECTIVE-2	3-0-0	3
7	14EE509	SEMINAR	0-0-4	2
		TOTAL CREDITS		25
Semester -2				
1	14EE505	ADVANCED POWER CONVERTERS	3-1-2	5
2	14EE506	MICRO CONTROLLERS AND EMBEDDED SYSTEMS	3-1-0	4
3	14EE507	MODELLING AND SIMULATION OF POWER ELECTRONIC SYSTEMS	3-1-0	4
4	14EE508	INDUSTRIAL APPLICATIONS OF ELECTRONICS	3-1-0	4
5		ELECTIVE-3	3-0-0	3
6		ELECTIVE-4	3-0-0	3
7	14EE609	TERM PAPER	0-0-4	2
		TOTAL CREDITS		25
Semester -3&4				
1		PROJECT		36

Elective-1				
1	14EE531	INSTRUMENTATION & CONTROL	3-0-0	3
2	14EE532	SPECIAL MACHINES	3-0-0	3
3	14EE535	ELECTRIC AND HYBRID VEHICLES	3-0-0	3
Elective-2				
1	14EE534	DIGITAL SIGNAL PROCESSING**(COMMON FOR PED & PS)**	3-0-0	3
2	14EE533	NON-CONVENTAIONAL ENERGY RESOURCES**(COMMON FOR PED & PS)**	3-0-0	3
3	14EE538	AI TECHNIQUES IN POWER ELECTRONICS & DRIVES	3-0-0	3
Elective-3				
1	14EE536	FACTS**(COMMON FOR PED & PS)**	3-0-0	3
2	14EE537	POWER QUALITY**(COMMON FOR PED & PS)**	3-0-0	3
3	14EE547	EMBEDDED CONTROL OF ELECTRIC DRIVES	3-0-0	3
Elective-4				
1	14EE539	SMART GRIDS**(COMMON FOR PED & PS)**	3-0-0	3
2	14EE540	STATE ESTIMATION & ADAPTIVE CONTROL**(COMMON FOR PED & PS)**	3-0-0	3
3	14EE548	ADVANCE PWM TECHNIQUES	3-0-0	3

DESIGN OF POWER CONVERTERS

Course Code : 14 EE501 **L-T-P : 3-1-2**
Credits : 5

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 : 14EE502 **L-T-P : 3-1-0**
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).
2. GK Dubey, "Fundamentals of Electrical Drives" , 2 nd edition ,Narosa Publishers, (20020.

OPTIMIZATION TECHNIQUES
(Common to Both PED & PS)

Course Code : 14EE503 **L-T-P : 3-1-0**
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:

3. S.D. Sharma, "Operations Research", Kedarnath & Ramnath Publishers, Delhi.

4. Hiller and Liberman , “Introduction to operations research”, McGrawHill Eduction Pvt Ltd, (2010).

MODERN CONTROL THEORY
(Common to Both PED & PS)

Course Code : 14EE504 **L-T-P : 3-1-0**
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:

4. M. Gopal , “Modern Control System Theory”, New Age International (2005).
5. Ogata. K , “Modern Control Engineering”,Prentice Hall (2006).
6. Kirck , “Optimal control”.

ADVANCED POWER CONVERTERS

Course Code : 14EE505 **L-T-P : 3-1-2**
Credits : 5

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
(Common to Both PED & PS)

Course Code : 14EE506 **L-T-P : 3-1-0**
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 : 14EE507 **L-T-P : 3-1-0**
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. Issa Batarseh, 'Power Electronic Circuits', John Wiley,(2004).
3. Simulink Reference Manual, Math works, USA.

INDUSTRIAL APPLICATIONS OF ELECTRONICS

Course Code : 14EE508 **L-T-P : 3-1-0**
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).

INSTRUMENTATION AND CONTROL

Course Code : 14EE531 **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 : 14EE532 **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 : 14EE535 **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
(Common to Both PED & PS)

Course Code : 14EE534 **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:

3. Sanjit K Mitra, "Digital Signal Processing", Tata MCgraw Hill Publications.
4. J G Proakis, D G Manolokis, "Digital Signal Processing Principles, Algorithms, Applications" PHI.
5. 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.
3. S. M .Kay , "Modern spectral Estimation techniques",PHI,(1997).

NON CONVENTIONAL ENERGY RESOURCES
(Common to Both PED & PS)

Course Code : 14EE533 **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*:*

3. Godfrey Boyle "Renewable Energy", Oxford Publications, Second edition,(2004).
4. G. D. Rai, "Non-Conventional Energy Sources", First edition, Khanna Publishers,(2004).

Reference Books*:*

4. Roger H.Charlier, Charles W. "Ocean Energy- Tide and Tidal Power"ISBN: Library of Congress Control Number: 2008929624_c Springer-Verlag Brerlin Heidelberg (2009).
5. John Twidell & Toney Weir: E&F.N. Spon, "Renewable Energy Sources", 2nd edition ,Taylor & Francis New York.
6. 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 : 14EE538 **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
(Common to Both PED & PS)

Course Code : 14EE536 **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:

3. N.G Hingorani & L.Gyugyi " Understanding FACTS: Concepts and Technology of Flexible AC Transmission System" , IEEE Press,(2000).
4. K.R.Padiyar "FACTS Controller in power Transmission and Distribution" New Age Int Publisher,(2007).

Reference Books:

a. Ned Mohan et.al "Power Electronics"2 nd edition John wiley & Sons,(2002).
b. T.J.E Miller, "Reactive power control in electric Systems" John willey & sons,(1982).

POWER QUALITY
(Common to Both PED & PS)

Course Code : 14EE537 **L-T-P : 3-0-0**
Credits : 3

Syllabs:

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:

3. Math H J Bollen, "Understanding Power Quality Problems: voltage sags and interruptions", Wiley-IEEE Press, (2000), Indian Reprint (2013).
4. Roger C Dugan, Surya Santoso, Mark F. Mc Granaghan, H. Wayne Beaty, "Electrical power systems quality", Second edition, (2002).

Reference Books:

5. Angelo Baggini, "Hand book of power quality", Wiley publications,(2008).
6. Arindam Ghosh, Gerard Ledwich, "Power Quality Enhancement using Custom Power Devices" Springer International Edition,(2009).
7. C. Sankaran, "Power Quality", CRC Press, Indian Reprint – (2011).
8. 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 : 14EE547 **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
(Common to Both PED & PS)

Course Code : 14EE539 **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:

3. James Momoh, "Smart Grid Fundamentals of Design and Analysis", Wiley IEEE Press, Ed (2012).
4. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Nick Jenkins, "Smart Grid Technology and Applications", Wiley Press, Ed (2012).

Reference Books:

2. Aranya Chakraborthy, "Control and Optimization Methods for Electric Smart Grids", Marija D llic Editor, Springer Publications.

STATE ESTIMATION & ADAPTIVE CONTROL

(Common to Both PED & PS)

Course Code : 14EE540 **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:

3. Dan Simon, "Optimal State Estimation", Wiley Intersience, (2006).
4. S. Sastry and M. Bodson, "Adaptive Control: Stability, Convergence, and Robustness", Prentice-Hall, (1989).

Reference Books:

6. K.J. Astrom and B. Wittenmark, "Adaptive Control", 2nd edition, Addison-Wesley, (1995).
7. I.D. Landau, R. Lozano, and M. M'Saad, "Adaptive Control", Springer Verlag, London, (1998).
8. Meditch, "Stochastic Optimal Linear Estimation and Control" Mc-Graw Hill Company, (1969).
9. K.S. Narendra and A.M. Annaswamy, "Stable Adaptive Systems", Prentice-Hall,(1989).
10. P.E. Wellstead & M.B. Zarrop, "Self-Tuning Systems: Control and Signal Processing", J. Wiley & Sons, Chichester, England,(1991).

ADVANCED PWM TECHNIQUES

Course Code : 14EE548 **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).

DEPARTMENT OF MECHANICAL ENGINEERING (MECHATRONICS)

S.No	Course Code	Course Title	L-T-P	Credits
Semester -1				
1	13-MT501	Fundamentals of Mechatronics	3-0-0	3
2	13-MT502	Advanced Engineering Mathematics	3-1-0	4
3	13-MT503	Sensors and Actuators	3-0-0	3
4	13-MT504	Modeling and Simulation of Mechatronic Systems	3-1-0	4
5	13-MT534	MEMS & NEMS (Elective I- I)	3-0-0	3
6	13-MT631	Industrial Automation (Elective II-I)	3-0-0	3
7	13-MTL550	Mechatronics Lab-I	0-0-4	2
8	13-MT551	Seminar	0-0-4	2
Semester -2				
1	13-MT601	Robotics: Advanced Concepts and Analysis	3-0-0	3
2	13-MT602	Control of Mechatronic Systems	3-0-0	3
3	13-MT603	Mechatronics Product Design	3-1-0	4
4	13-MT604	Precision Engineering	3-1-0	4
5		Elective I-II	3-0-0	3
6		Elective II-II	3-0-0	3
7	13-MTL650	Mechatronics Lab II	0-0-4	2
8	13-MT651	Term Paper	0-0-4	2
Semester -3,4				
	MT	THESIS/PROJECT		36

Elective-I

1	13-MT531	Computational Fluid Dynamics –	3-0-0	3
2	13-MT532	Signal Processing in Mechatronic Systems –	3-0-0	3
3	13-MT533	Nonlinear Optimization –	3-0-0	3
4	13-MT534	MEMS and NEMS –	3-0-0	3

Elective-II

1	13-MT631	Industrial Automation	3-0-0	3
2	13-MT632	Vehicle Dynamics and Multi-body Systems	3-0-0	3
3	13-MT633	Emerging Smart Materials for Mechatronics Applications	3-0-0	3
4	13-MT634	Intelligent Visual Surveillance	3-0-0	3
5	13-MT635	Microprocessors and Embedded Systems	3-0-0	3
6	13-MT636	Fuzzy Sets and Artificial Intelligence	3-0-0	3

Fundamentals of Mechatronics

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

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:
1. H. Kreyszig, "Advanced Engineering Mathematics", Wiley, (2006).

2. Gilbert Strang, “Linear Algebra and Its Applications”, 4th edition, Thomson Brooks/Cole, India (2006).
3. J. W. Brown and R. V. Churchill, “Complex Variables and Applications”, McGraw-Hill Companies, Inc., New York (2004).
4. J. W. Brown and R. V. Churchill, “Fourier Series and Boundary Value Problems”, McGraw-Hill Companies, Inc., New York (2009).
5. G. F. Simmons, “Differential Equations with Applications and Historical Notes”, Tata McGraw-Hill Edition, India (2003).
6. S. L. Ross, “Differential Equations” 3rd edition, John Wiley & Sons, Inc., India (2004).
7. K. S. Rao, “Introduction to Partial Differential Equations”, PHI Learning Pvt. Ltd (2005).
8. R. Courant and F. John, “Introduction to Calculus and Analysis, Volume I and II”, Springer-Verlag, New York, Inc. (1989).
9. K. Atkinson and W. Han, “Elementary Numerical Analysis” 3rd edition, John Wiley & Sons, Inc., India (2004).
10. R. A. Johnson and G. K. Bhattacharya, “Statistics, Principles and Methods”, Wiley (2008).

Sensors and Actuators

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;shapememoryalloys.

Text Books

1. John G. Webster, Editor-in-chief, “Measurement, Instrumentation, and Sensors Handbook”, CRC Press (1999).
2. Jacob Fraden, “Handbook of modern Sensors”, AIP Press, Woodbury (1997).
3. Nadim Maluf, “An Introduction to Microelectromechanical Systems Engineering”, Artech House Publishers, Boston (2000).
4. Marc Madou, “Fundamentals of Microfabrication”, CRC Press, Boca Raton (1997).
5. Gregory Kovacs, “Micromachined Transducers Sourcebook”, McGraw-Hill, New York (1998).
6. E. O. Deobelin and D. Manik, “Measurement Systems – Application and Design”, Tata McGraw-Hill (2004).
7. D. Patranabis, “Principles of Industrial Instrumentation”, Tata McGraw-Hill, eleventh reprint (2004).
8. B. G. Liptak, “Instrument Engineers’ Handbook: Process Measurement and Analysis”, CRC (2003).

Modeling and Simulation of Mechatronic Systems

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:

1. Pure mechanical models
2. Models for electromagnetic actuators including the electrical drivers
3. Models for DC-engines with different closed loop controllers using operational amplifiers
4. Models for transistor amplifiers
5. Models for vehicle system

Text Books:

1. L. Ljung, T. Glad, "Modeling of Dynamical Systems", Prentice Hall Inc. (1994).
2. D.C. Karnopp, D.L. Margolis and R.C. Rosenberg, "System Dynamics: A Unified Approach", 2nd Edition, Wiley-Interscience (1990).
3. G. Gordon, "System Simulation", 2nd Edition, PHI Learning (2009).
4. V. Giurgiutiu and S. E. Lyshevski, "Micromechatronics, Modeling, Analysis, and Design with MATLAB", 2nd Edition, CRC Press (2009).

Robotics: Advanced Concepts and Analysis

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

1. M. P. Groover, M. Weiss, R. N. Nagel and N. G. Odrey, "Industrial Robotics-Technology, Programming and Applications", McGraw-Hill Book and Company (1986).
2. S. K. Saha, "Introduction to Robotics", Tata McGraw-Hill Publishing Company Ltd. (2008).
3. S. B. Niku, "Introduction to Robotics–Analysis Systems, Applications", Pearson Education (2001).
4. . A. Ghosal, Robotics: "Fundamental Concepts and Analysis", Oxford University Press (2008).
5. Pires, "Industrial Robot Programming–Building Application for the Factories of the Future", Springer (2007).
6. Peters, "Image Guided Interventions – Technology and Applications", Springer (2008).
7. K. S. Fu, R. C. Gonzalez and C.S.G. Lee, "ROBOTICS: Control, Sensing, Vision and Intelligence", McGraw-Hill (1987).
8. J. J. Craig, "Introduction to Robotics: Mechanics and Control", 2nd edition, Addison-Wesley (1989).

Control of Mechatronic Systems

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:

1. K. Ogata, "Modern Control Engineering", Prentice Hall India (2002).
2. Gene F. Franklin, J. D. Powell, A E Naeini, "Feedback Control of Dynamic Systems", Pearson (2008).
3. John Van De Vegte, "Feedback Control Systems", Prentice Hall (1993).
4. Thomas Kailath, "Linear Systems", Prentice Hall (1980).
5. Alok Sinha, "Linear Systems: Optimal and Robust Control", Taylor & Francis (2007).
6. Brian D. O. Anderson and John B. Moore, "Optimal Control: Linear Quadratic Methods", Dover Publications (2007).
7. K. Ogata, "Discrete-Time Control Systems", PHI Learning (2009).
8. H.K. Khalil, "Nonlinear Systems", Prentice Hall (2001).

Mechatronic Product Design

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

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

Elective Courses (Elective I)

Computational Fluid Dynamics

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:

1. J. D. Anderson, “Computational Fluid Dynamics”, McGraw-Hill Inc. (1995).
2. S. V. Patankar, “Numerical Heat Transfer and Fluid Flow”, Hemisphere Pub. (1980).
3. K. Muralidhar, and T. Sundarajan, “Computational Fluid Flow and Heat Transfer”, Narosa (2003).
4. D. A. Anderson, J. C. Tannehill and R. H. Pletcher, “Computational Fluid Mechanics and Heat Transfer”, Hemisphere Pub. (1984).
5. M. Peric and J. H. Ferziger, “Computational Methods for Fluid Dynamics”, Springer (2001).
6. H. K. Versteeg and W. Malalaskera, “An Introduction to Computational Fluid Dynamics”, Dorling Kindersley (India) Pvt. Ltd. (2008).

7. C. Hirsch, “Numerical Computation of Internal and External Flows”, Butterworth-Heinemann, (2007).
8. J. M. Jaile, “Molecular Dynamics Simulation: Elementary Methods”, Willey Professional, 1997.
9. A. Mohamad, “Lattice Boltzman Method: Fundamentals and Engineering Applications with Computer Codes”, Springer (2011).

Signal Processing in Mechatronic Systems

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:

1. S. K. Mitra, Digital Signal Processing: A computer-Based Approach, 3/e, TMcHl, 2006.
2. Oppenheim and R. W. Shafer, Discrete-Time Signal Processing, Prentice Hall India, 2/e, 2004.
3. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 4/e, Pearson Education, 2007.

References:

1. V.K. Ingle and J.G. Proakis, “Digital signal processing with MATLAB”, Cengage, 2008.
2. T. Bose, Digital Signal and Image Processing, John Wiley and Sons, Inc., Singapore,04.
3. L. R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, PH, 2005.
4. Antoniou, Digital Filters: Analysis, Design and Applications, Tata McH, 2003.

Nonlinear Optimization

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:

1. Mokhtar S. Bazaaraa, Hanif D. Shirali and M.C.Shetty, Nonlinear Programming, Theory and Algorithms, John Wiley & Sons, New York (2004).

Reference Books:

1. D. G. Luenberger, Linear and Nonlinear Programming, Second Edition, Addison Wesley (2003).
2. R. E. Steuer, Multi Criteria Optimization, Theory, Computation and Application, John Wiley and Sons, New York (1986).

MEMS and NEMS

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

1. Electromechanical Sensors and Actuators, Ilene J. Busch-Vishniac, Springer, 2008.
2. Introduction to Microelectronics Fabrication, Vol. V, G. W. Neudeck and R. F. Pierret (eds.), Addison – Wesley, 1988.

3. Introduction to Microelectromechanical Microwave Systems, H. J. De Loss Santos, 2nd edition, Norwood, MA: Artech, 2004.
4. Microsystems Design, S. D. Senturia, Kluwer – Academic Publishers, Boston MA, 2001.
5. Principles and Applications of Nano-MEMS Physics, H. J. Delos Santos, Springer, 2008.
6. Materials and Process Integration for MEMS Microsystems, Vol. 9, Francis E. H. Tay, Springer, 2002.

REFERENCE BOOKS

1. Quantum Mechanical Tunneling and its Applications, D. K. Roy, World Scientific, Singapore, 1986
2. Encyclopedia of Nanoscience and Technology, Vol. 5, H. S. Nalwa (ed.), American scientific Publishers, 2004
3. Carbon Nanotubes and Related Structures, P. J. F. Harris, Cambridge University Press, UK, 1986.
4. Carbon Nanoforms and Applications, M Sharon and M. Sharon, Mc Graw Hill, 2010
5. VLSI Technology, S. M. Sze (eds.), Mc-Graw Hill, NY, 1983
6. Quantum Phenomena, S. Datta, Addison – Wesley, 1989.

Elective Courses (Elective II)
Industrial Automation

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

1.M.P. Groover, Automation, "Production Systems and Computer Integrated manufacturing", 2nd Edition, Pearson Education (2004).

References Books

1. Vajpayee, "Principles of CIM", PHI, 1992.
2. Viswanathan and Narahari, "Performance Modeling of Automated Manufacturing Systems", PHI, 2000.
3. R.S. Pressman, "Numerical Control and CAM, John Wiley , 1993.

VEHICLE DYNAMICS AND MULTI-BODY SYSTEMS

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

1. T.D. Gillespie, "Fundamental of Vehicle Dynamics", SAE Press (1995) .
2. J.Y. Wong, "Theory of Ground Vehicles", 4th Edition, John Wiley & Sons (2008).
3. Reza N. Jazar, "Vehicle Dynamics: Theory and Application", 1st Edition, 3rd Printing, Springer (2008).
4. R. Rajamani, "Vehicle Dynamics and Control", Springer (2006).
5. A.A. Shabanna, "Dynamics of Multibody Systems", 3rd Edition, Cambridge University Press (2005).

Reference Books

1. G. Genta, "Motor Vehicle Dynamics", World Scientific Pub. Co. Inc. (1997).
2. H.B. Pacejka, "Tyre and Vehicle Dynamics", SAE International and Elsevier (2005).
3. Dean Karnopp, "Vehicle Stability", Marcel Dekker (2004).
4. U. Kiencke and L. Nielsen, "Automotive Control System", Springer-Verlag, Berlin.
5. M. Abe and W. Manning, "Vehicle Handling Dynamics: Theory and Application", 1st Edition, Elsevier (2009).
6. L. Meirovitch, "Methods of Analytical Dynamics", Courier Dover (1970).
7. H. Baruh, "Analytical Dynamics", WCB/McGraw-Hill (1999).

Emerging Smart Materials for Mechatronics Applications

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:

1. Jose L. Pons, Emerging Actuator Technologies, a Micromechatronics Approach, John Wiley & Sons Ltd, 2005. .
2. Ralph Smith, Smart Material Systems: Model Development, SIAM, Society for Industrial and Applied Mathematics, 2005. .
3. F. Carpi, D. De Rossi, R. Kornbluh, R. Pelrine, P. Sommer-Larsen, Dielectric Elastomers as Electromechanical Transducers, Elsevier, Hungry, 2008. .
4. Y. B. Cohen, Electroactive Polymer (EAP) Actuators as Artificial Muscles Reality, Potential and Challenges, SPIE press, USA, 2004.

Intelligent Visual Surveillance

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

1. Murat A. Tekalp, "Digital Video Processing", Prentice Hall, 1995.
2. Y. Ma and G. Qian (Ed.), "Intelligent Video Surveillance: Systems and Technology", CRC Press, 2009.

Microprocessors and Embedded Systems

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:

1. Introduction to Embedded Systems: Shibu K V, McGRAW Hill Publications.
2. Embedded Systems: Raj Kamal, TATA McGRAW Hill Publications.
3. Computer System Architecture: M. Morris Mano.
4. 8086 Microprocessors and Interfacings: D. Hall, TATA McGRAW Hill .
5. The Intel Microprocessors: B. Brey, Prentice Hall Publications.
6. PIC Microcontrollers and Embedded Systems: M. A. Mazidi, R.D. Mckinlay and D. Casey, Pearson Publications.
7. Programming and Customizing the PIC Microcontroller: M. Predko, McGRAW Hill Publications.
8. Embedded C Programming and Microchip PIC: R. Barnett, L. O'Cull and S. Cox

Fuzzy Sets and Artificial Intelligence

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:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 2nd Ed, Prentice Hall, 2003.
2. H.J.Zimmermann, Fuzzy Set Theory and Its Applications, 2nd Ed., Kluwer Academic Publishers, 1996.
3. D.Dubois and H. Prade, Fuzzy Sets and Systems: Theory and Applications, Academic Press, 1980.

References:

1. E. Charniak and D. McDermott, Introduction to Artificial Intelligence, Addison-Wesley, 1985.

2. E. Rich, Artificial Intelligence, McGraw-Hill, 1983.
3. P. H. Winston, Artificial Intelligence, Addison Wesley, 1993.
4. J.Yen and R.Langari, Fuzzy Logic Intelligence, Control, and Information, Pearson Education, 2005.
5. T.J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1997.
6. J.Kacprzyk, Multistage Fuzzy Control, Wiley, 1997.

Mechatronic Laboratory-I

Demonstration of mechatronics hardware; servo- position and velocity control; process control; basic programming using microprocessor/microcontroller; ADC and DAC interfacing with microcontroller/microprocessor; machine condition monitoring; development of multiple sensor fusion; image based navigation and control of robot; control of non-linear systems; machine vision inspection and image surveillance; mini-projects on mechatronic system design

Mechatronic Laboratory-II

NC machine tool; sequence planning in CIM; automatic quality inspection in CIM; micro-processor/microcontroller based control; 3 DOF gyroscope; design and fabrication of piezo-actuator; hydraulic actuator; pneumatic actuator; design and characterization of optical sensor.

DEPARTMENT OF MECHANICAL ENGINEERING
(THERMAL ENGINEERING)

NUMERICAL METHODS IN THERMAL ENGINEERING

L-T-P :3-1-0

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

L-T-P:3-1-0

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

L-T-P :3-1-0

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

L-T-P :3-1-0

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)

INCOMPRESSIBLE AND COMPRESSIBLE FLUID FLOWS

L-T-P :3-1-0

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

L-T-P :3-0-2

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

L-T-P :3-1-0

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

L-T-P:3-1-0

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)

HEAT EXCHANGER DESIGN

L-T-P:3-0-0

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

L-T-P:3-0-0

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

L-T-P:3-0-0

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

L-T-P:3-0-0

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

L-T-P:3-0-0

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

L-T-P:3-0-0

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.

PRINCIPLES OF TURBO-MACHINERY

L-T-P:3-0-0

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

L-T-P:3-0-0

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

L-T-P:3-0-0

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

L-T-P:3-0-0

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

L-T-P:3-0-0

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

L-T-P:3-0-0

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.