CHRIST
UNIVERSITY
BENGALURU, INDIA
Declared as Deemed to be University under Section 3 of UGC Act 1956

School of Engineering and Technology

Department of Electronics & Communication Engineering

MTech- Communication Systems (IC Design) Syllabus 2020-22

January 2020

Christ University, Bengaluru
Karnataka, India
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Syllabus for M.Tech- Communication Systems (IC Design) for the batch 2020-22 prepared by the Department of Electronics & Communication Engineering, Faculty of Engineering and approved by the Academic Council, Christ University, Bengaluru, India.

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1. DEPARTMENT OVERVIEW

The department of Electronics and Communication Engineering is well established with state of art technology to impart knowledge for future industrial and educational needs. It is furnished with sound laboratories outfitted with hi-tech instruments, internet and computer systems. The total campus is networked by wired and Wi-Fi system. It has well experienced faculties from reputed industries and institutions. It has personalized syllabus suited for global industrial and academic needs. It is well integrated by standalone seminar hall and support-ing auditorium to conduct seminars, workshops and training.

DEPARTMENT VISION

To emerge as a centre of academic excellence in the field of Electronics & Communication Engineering to address the dynamic needs of the industry upholding moral values

DEPARTMENT MISSION

- Impart in-depth knowledge in Electronics & Communication Engineering to achieve academic excellence.
- Develop an environment of research to meet the demands of evolving technology.
- Inculcate ethical values to promote team work and leadership qualities befitting societal requirements.
- Provide adaptability skills for sustaining in the dynamic environment.

PROGRAM EDUCATIONAL OBJECTIVES OF B.TECH IN ECE

PEO1 : Domain Knowledge
Apply the knowledge of Electronics & Communication Engineering to analyse, design and develop solutions for real time engineering problems

PEO2 : Research Oriented
Be competent to pursue higher learning and research
PEO3: Ethics & Teamwork
Assimilate technical skills with professional ethics

PEO4 : Life Long Learning
Be passionate to attain professional excellence through lifelong learning

2. INTRODUCTION TO PROGRAMME

It is a four year programme with higher emphasize to rigorously train the students in real life product design that make them to contribute to the industry, academia, start-ups and research bodies with great impact.

- Curriculum Attributes
- Interdisciplinary curriculum
- Project based pedagogy
- Domain and technology based research and specialization
- International exchange programme

3. PROGRAMME OBJECTIVE

The goal of the Department is to create professionals who are well versed with the study and application of electricity, electronics and electromagnetism so that mundane jobs are taken away from men or women to machines. The entertainment & leisure industries exist since Electronics & Communication engineers exist.

4. TEACHING PEDAGOGY

1. Team/Class room teaching.
2. PowerPoint presentations and handouts.
3. Simulated situations and role-plays.
4. Video films on actual situations.
5. Assignments.
6. Case Studies.
7. Exercises are solved hands on.
8. Seminars
9. Industry / Field visits.
10. Information and Communication Technology.
11. Project work.
12. Learning Management System- Moodle

5. COURSE STRUCTURE

SEMESTER – I

Sl.No	Course Code	Course Name	L	T	P	Hrs/ Week	Total Credits
1	MTEC131	Advanced Radiation Systems	3	0	0	3	3
2	MTEC132	Advanced Communication Networks	3	0	0	3	3
3	MTEC133	Elective – I	3	0	0	3	3
4	MTEC134	Elective – II	3	0	0	3	3
5	MTEC151	Antennas and Radiating Systems Lab	0	0	2	2	2
6	MTEC152	Communication Systems Lab	0	0	2	2	2
7	MLC131	Research Methodology and IPR	2	0	0	2	2
8	AC131	Audit Course I	2	0	0	2	0
9	HE171	Holistic Education-I	1	0	0	1	1
		Total				**21**	**19**

SEMESTER – II

Sl.No	Course Code	Course Name	L	T	p	Hrs/ Week	Total Credits
1	MTEC231	Wireless & Mobile Communication	3	0	0	3	3
2	MTEC232	Modern Digital Signal Processing	3	0	0	3	3
3	MTEC233	Elective – III	3	0	0	3	3
4	MTEC234	Elective – IV	3	0	0	3	3
5	MTEC251	Wireless & Mobile Communication Lab	0	0	2	2	2
6	MTEC252	Modern Digital Signal Processing Lab	0	0	2	2	2
7	MTEC253	Mini Project	0	0	4	4	2
8	AC231	Audit Course-2	2	0	0	2	0
9	HE271	Holistic Education-II	1	0	0	1	1
		Total				**23**	**19**

SEMESTER – III

Sl.No	Course Code	Course Name	Theory Hrs	Tutorial Hrs	Practical Hrs	Hrs/Week	Total Credits
1	MTEC331	Elective - V	3	0	0	3	3
2	MTEC332	Elective – VI	3	0	0	3	3
3	MTEC371	Dissertation Phase -I	0	0	20	20	10
		Total				**26**	**16**

SEMESTER – IV

Sl.No	Course Code	Course Name	Theory Hrs	Tutorial Hrs	Practical Hrs	Hrs/Week	Total Credits
1	MTEC471	Dissertation Phase – II	0	0	32	32	16
		Total				**32**	**16**

LIST OF PROGRAM ELECTIVES

Communication Systems Elective	
S.No	**Course Name**
1	Advanced Digital communication
2	Applied Mathematics for Electronics Engineers
3	Optical Communication Networks
4	Multimedia Compression Techniques
5	Space Time wireless communication
6	Communication Network Security
7	RF System Design
8	Advanced Microwave Systems
9	Communication protocol Engineering
10	Speech and Audio Signal Processing.
11	Network Routing Algorithms
12	Simulation of Communication Systems and Network
13	Detection and estimation theory
14	Digital Communication Receivers

15	Digital Image Processing
16	High Performance Communication Networks
17	Advanced Microstrip Antennas
18	Non-Linear Optical Networks

IC Design Electives	
S.No	**Course Name**
1	IC Process Technology and CMOS VLSI Design
2	Embedded System and SoC Design
3	Digital System Design using Verilog
4	CAD and EDA for VLSI Circuits
5	Low Power VLSI Design
6	Advanced Computer Architecture
7	Advanced Microprocessors and Microcontrollers
8	SoC Design for Embedded System and IoT
9	VLSI Signal Processing
10	Testing of VLSI Circuits (DFT)
11	Hardware Software Co-Design
12	CMOS Analog & IO Circuit Design
13	CMOS Mixed Signal Design
14	CMOS Digital Circuit Design and Characterization
15	Analog and Mixed Signal Verification
16	CMOS RF Circuit Design

LIST OF OPEN ELECTIVES

Sl No	**Course Name**	**M**	**C**
1	Business Analytics	100	3
2	Industrial Safety	100	3

3	Operations Research	100	3
4	Cost Management of Engineering Projects	100	3
5	Composite Materials	100	3
6	Waste to Energy	100	3

LIST OF AUDIT COURSES

Sl No	Course Name
1	English for Research Paper Writing
2	Disaster Management
3	Value Education
4	Constitution of India
5	Pedagogy Studies
6	Stress Management by Yoga
7	Personality Development through Life Enlightenment Skills

6. ASSESSMENT RULES

Assessment is based on the performance of the student throughout the semester.

Assessment of each paper

- Continuous Internal Assessment (CIA) for Theory papers: 50% (50 marks out of 100 marks)
- End Semester Examination(ESE) : 50% (50 marks out of 100 marks)

Components of the CIA

CIA I : Mid Semester Examination (Theory)	: 25 marks
CIA II : Assignments	: 10 marks
CIA III : Quizzes/Seminar/Case Studies/Project Work	: 10 marks
Attendance	: 05 marks
Total	**: 50 marks**

For subjects having practical as part of the subject

Assessment of Practical paper

Conduct of experiments	: 25 marks
Observations/Lab Record	: 15 marks
Viva voce	: 10 marks
Total	**: 50 marks**

(All the above assessments are carried for each experiment during regular lab classes and averaged to max 50 marks at the end of the semester)

❖ **Assessment of Project Work(Phase I)**

- Continuous Internal Assessment:100 Marks
  - ♦ Presentation assessed by Panel Members
  - ♦ Assessment by Guide

❖ **Assessment of Project Work(Phase II) and Dissertation**

- Continuous Internal Assessment:100 Marks
  - ♦ Presentation assessed by Panel Members
  - ♦ Assessment by Guide
- End Semester Examination:100 Marks
  - ♦ Viva Voce
  - ♦ Demonstration
  - ♦ Project Report
- Dissertation (Exclusive assessment of Project Report): 100 Marks
  - ♦ Internal Review : 50 Marks
  - ♦ External review : 50 Marks

❖ **Assessment of Seminar**

- Continuous Internal Assessment:50 Marks
  - Presentation assessed by Panel Members

❖ **Assessment of Internship (M.Tech)**

- All students should complete internship either in Industry/Research labs before 3rd semester. This component carries 2 credits.

7. QUESTION PAPER PATTERN:

End Semester Examination (ESE) :

Theory Papers:

The ESE is conducted for 100 marks of 3 hours duration.

The syllabus for the theory papers is divided into FIVE units and each unit carries equal weightage in terms of marks distribution.

Question paper pattern is as follows.

Two full questions with either or choice, will be drawn from each unit. Each question carries 20 marks. There could be a maximum of three sub divisions in a question. The emphasis on the questions is broadly based on the following criteria:

50 % - To test the objectiveness of the concept
30 % - To test the analytical skill of the concept
20 % - To test the application skill of the concept

Mid Semester Examination (MSE) :

Theory Papers:

The MSE is conducted for 50 marks of 2 hours duration.

Question paper pattern; Five out of Six questions have to be answered. Each question carries 10 marks.

Holistic Education:

End Semester Examination	25 Marks
Participation	25 Marks
Total	**50 Marks**

MTEC131 ADVANCED RADIATION SYSTEMS

Sub Code: MTEC131 L: T: P Total Lecture Hrs: 45
Exam Marks: 100 3: 0: 0 Exam Hours: 03Credits: 3

COURSE OBJECTIVE:

- To learn the fundamental of antenna radiation, different types of antenna and its design methodology.
- To impart the basic concepts of radiating structures and antenna parameters
- To give understanding about analysis of arrays and different types
- To give idea about different antennas for various applications
- To give idea about basic propagation mechanisms
- To give idea about antenna measurements

UNIT I CONCEPTS OF RADIATION 9

Retarded vector potentials – Heuristic approach and Maxwell's equation approach. The Lorentz gauge condition. Vector potential in Phasor form. Fields radiated by an alternating current element. Total power radiated and radiation resistance. Radiation from Half wave dipole from assumed current distribution. Power radiated in the farfield. Electric vector potential F for a magnetic current source M. Far zone fields due to magnetic source M.

UNIT II ANTENNA ARRAYS 9

N element linear arrays – uniform amplitude and spacing.Phasedarrays.Directivity of Broadside and End fire arrays.Three dimensional characteristics.Binomial arrays and Dolph-Tchebycheffarrays.Circulararray.Antenna Synthesis- Line source and discretization of continuous sources.Schelkunoff polynomial method. Fourier transform method.

UNIT III APERTURE ANTENNAS 9

Magnetic current – Duality.Electric and Magnetic current sheets as sources.Huyghenssource.Radiation through an aperture in an absorbing screen.Fraunhoffer and Fresnel diffraction.Cornu Spiral. Complimentary screens and slot antennas. Slot and dipoles as dual antennas.Babinets principle. Fourier transform in aperture antenna theory.

UNIT IV HORN, MICROSTRIP, REFLECTOR ANTENNAS 9

E and H plane sectoral Horns. Pyramidal horns.Conical and corrugated Horns.Multimode horns. Phase center.
Microstrip antennas – feeding methods.Rectangular patch- Transmission line model.
Parabolic Reflector antennas – Prime focus and cassegrainreflectors.Equivalent focal length of Cassegrainantennas.Spillover and taper efficiencies.Optimum illumination.

UNIT V ANTENNA POLARIZATION 9

Simple relationship involving spherical triangles.Linear, Elliptical and circular polarization.Development of the Poincare sphere.Representation of the state of polarization in the Poincare sphere.Random polarization – Stokes parameters.

COURSE LEARNING OUTCOMES:

- Able to design any type of antenna
- Students will be able to understand basic concepts of antenna radiation and its parameters.
- Students will be able to design and analysis of antenna arrays and its applications.
- Students will be able to develop the idea about the different antenna types and antennas for special applications
- Students will be able to develop concepts in antenna parameter measurements
- Students will be able to understand different propagation mechanisms namely ground, space and sky waves

REFERENCES

- Balanis, C.A., "Antenna Theory" Wiley, 2005
- Jordan, E.C., " Electromagnetic waves and Radiating systems". PHI 2008
- Krauss, J.D., "Radio Astronomy" McGraw-Hill
- Krauss, J.D.,,Fleisch,D.A., "Electromagnetics" McGraw-Hill,2001

MTEC132 ADVANCED COMMUNICATION NETWORKS

Sub Code: MTEC132 L: T: P Total Lecture Hrs: 45
Exam Marks: 100 3: 0: 0 Exam Hours: 03
Credits: 3

COURSE OBJECTIVE
This course aims at making the students understand the different communication protocols, understand advanced concepts in communication networking and also the concept of QoS in communication networks.

UNIT I 9 Hrs
Overview of -ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.

UNIT II 9 Hrs
Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP, Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP). Leaky bucket algorithm and its properties

UNIT III 9 Hrs
Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service Connections, IP address lookup-challenges. Packet classification algorithms, IPV4 and IPv6 address , .

UNIT IV 9 Hrs
Admission control in Internet. Concept of Effective bandwidth. Measurement based admission control. Differentiated Services in Internet (DiffServ). DiffServ architecture and framework.

UNIT V 9 Hrs
IPswitching and MPLS, Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS.

COURSE OUTCOME
Upon Completion of the course, the students will be able to

- Understand advanced concepts in Communication Networking.
- Design and develop protocols for Communication Networks.
- Understand the mechanisms in Quality of Service in networking.
- Optimize the Network Design.

REFERENCE BOOKS

- Jean Wairand and PravinVaraiya, "High Performance Communications Networks", 2nd edition, 2000.

- Jean Le Boudec and Patrick Thiran, "Network Calculus A Theory of Deterministic Queueing Systems for the Internet", Springer Veriag, 2001
- Zhang Wang, "Internet QoS", Morgan Kaufman, 2000.
- Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach", Morgan Kaufman Publishers, 2004.
- George Kesidis, "ATM Network Performance", Kluwer Academic, Research Papers, 2005.

MTEC151 ANTENNAS & RADIATING SYSTEMS LAB

Sub Code: MTEC151 L: T: P Total PracticalHrs: 30
Exam Marks: 100 0: 0: 2 Exam Hours: 03
Credits: 2

COURSE OBJECTIVE
This course aims to impart the practical knowledge required in the design of antennas and also make the students understand the tools required to do the same.

LIST OF EXPERIMENTS:

1. Simulation of half wave dipole antenna.
2. Simulation of change of the radius and length of dipole wire on frequency of resonance of antenna.
3. Simulation of quarter wave, full wave antenna and comparison of their parameters.
4. Simulation of monopole antenna with and without ground plane.
5. Study the effect of the height of the monopole antenna on the radiation characteristics of the antenna.
6. Simulation of a half wave dipole antenna array.
7. Study the effect of change in distance between elements of array on radiation pattern of dipole array.
8. Study the effect of the variation of phase difference 'beta' between the elements of the array on the radiation pattern of the dipole array.
9. Case study

COURSE OUTCOMES:

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

- Determine specifications, design, construct and test antenna.
- Explore and use tools for designing, analyzing and testing antennas. These tools include Antenna design and analysis software, network analyzers, spectrum analyzers, and antenna pattern measurement techniques

MTEC152 COMMUNICATION SYSTEMS LAB

Sub Code: MTEC152 L: T: P Total PracticalHrs: 30
Exam Marks: 100 0: 0: 2 Exam Hours: 03
Credits: 2

COURSE OBJECTIVE:
To produce graduates who understand how to analyze and manipulate antenna and radiation pattern for different distributions.

LIST OF EXPERIMENTS

1. Antenna Radiation Pattern measurement.
2. Performance evaluation of Digital Data Transmission through Fiber Optic Link.
3. Implementation of Video Link using Optical Fiber.
4. Generation of discrete time iid random processes with different distributions (Bernoulli, Binomial, Geometric, Poisson, Uniform, Gaussian, Exponential, Laplacian, Rayleigh, Rician)
5. Communication system Design for Band limited Channels - Signal Design for Zero ISI and Controlled ISI - Partial Response Signaling.
6. Carrier Phase Modulation and Quadrature Amplitude Modulation - BER Performance in AWGN channel.
7. Channel Coding: Linear Block code and Convolutional codes -Viterbi Decoding
8. Digital modulation and detection in SISO, SIMO, MISO and MIMO systems

COURSE LEARNING OUTCOMES:
Student will be able to

- Describe the video links using optical fiber.
- Determine the digital data transmission through fiber optic link.
- Be able to generate discrete time iid random processes with different distribution.

MLC131 RESEARCH METHODOLOGY & IPR

Sub Code: MLC131 L: T: P Total LectureHrs: 30
Exam Marks: 100 2: 0: 0 Exam Hours: 03
Credits: 2

COURSE OBJECTIVE
The objective of this course is to make the students understand the meaning of research and how to formulate the problem statement by undergoing different methodologies used I research. This course also gives an insight about the intellectual property rights which is very essential to any research engineer.

UNIT I
6Hrs
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis,interpretation, Necessary instrumentations, Effective literature studies approaches, analysis Plagiarism , Research ethics

UNIT II
6Hrs
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT III
6Hrs
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT IV
6Hrs
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT V
6Hrs
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs..

COURSE OUTCOME
At the end of this course, students will be able to

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand the importance of ideas, concept and creativity
- Explain the concepts of IPR in general and IPR in engineering in particular

REFERENCE BOOKS

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- Ranjit Kumar, 2 nd Edition , "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
- Mayall , "Industrial Design", McGraw Hill, 1992.
- Niebel , "Product Design", McGraw Hill, 1974.
- Asimov , "Introduction to Design", Prentice Hall, 1962.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

MTEC231 WIRELESS & MOBILE COMMUNICATION

Sub Code: MTEC231 L: T: P Total LectureHrs: 45
Exam Marks: 100 3: 0: 0 Exam Hours: 03
Credits: 3

COURSE OBJECTIVE
The objectives are to expose the students to various generations of wireless networks, operation of mobile networks, multiple access techniques, network architectures, Wireless Protocol and WAP concepts and security issues involved in wireless networks and IEE standards.

UNIT I
9Hrs
Cellular Communication Fundamentals:Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment.GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM
Logical Channels, Data Encryption in GSM, Mobility Management, Call Flows in GSM.2.5 G Standards: High speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS),
2.75 G Standards: EDGE

UNIT II **9**
Hrs
Spectral efficiency analysis based on calculations for Multiple access technologies:TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas.Wireless network planning, Equalization, Diversity:Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving

UNIT III **9**
Hrs
Mobile Radio Propagation:Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

UNIT IV **9**
Hrs
Code Division Multiple Access:Introduction to CDMA technology, IS 95 system Architecture, Air Interface, Physical and logical channels of IS 95, Forward Link and Reverse link operation, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels..

UNIT V **9**
Hrs

Higher Generation Cellular Standards:3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, introduction to 5G

COURSE OUTCOME

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

- Design appropriate mobile communication systems.
- Apply frequency-reuse concept in mobile communications, and to analyze its effects on interference, system capacity, handoff techniques
- Distinguish various multiple-access techniques for mobile communications e.g. FDMA, TDMA, CDMA, and their advantages and disadvantages.
- Analyze path loss and interference for wireless telephony and their influences on a mobile communication system's performance.
- Analyze and design CDMA system functioning with knowledge of forward and reverse

  channel details, advantages and disadvantages of using the technology
- Understanding upcoming technologies like 3G, 4G etc.

REFERENCE BOOKS

- V.K.Garg, J.E.Wilkes, "Principle and Application of GSM", Pearson Education, 5th edition, 2008.
- V.K.Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4th edition, 2009.
- T.S.Rappaport, "Wireless Communications Principles and Practice", 2nd edition, PHI,2002.
- William C.Y.Lee, "Mobile Cellular Telecommunications Analog and Digital Systems", 2nd edition, TMH.
- AshaMehrotra, "A GSM system Engineering" Artech House Publishers Bosten, London.

MTEC232 MODERN DIGITAL SIGNAL PROCESSING

Sub Code: MTEC232 L: T: P Total LectureHrs: 45
Exam Marks: 100 3: 0: 0 Exam Hours: 03
Credits: 3

COURSE OBJECTIVE
This course covers the techniques of modern digital signal processing that are fundamental to a wide variety of application areas.

UNIT I: DISCRETE-TIME RANDOM SIGNALS 9 Hrs
Discrete random process – Ensemble averages, Stationary and ergodic processes, Autocorrelation and Autocovariance properties and matrices, White noise, Power Spectral Density, Spectral Factorization, Innovations Representation and Process, Filtering random processes, ARMA, AR and MA processes.

UNIT II: SPECTRUM ESTIMATION 9 Hrs
Bias and Consistency, Periodogram, Modified periodogram, Blackman-Tukey method, Welch method, Parametric methods of spectral estimation, Levinson-Durbin recursion

UNIT III: LINEAR ESTIMATION AND PREDICTION 9 Hrs
Forward and Backward linear prediction, Filtering – FIR Wiener filter- Filtering and linear prediction, non-causal and causal IIR Wiener filters, Discrete Kalman filter.

UNIT IV: MULTIRATE SIGNAL PROCESSING 9 Hrs
Multirate Signal Processing: Introduction, Decimation, Interpolation, Fractional Sampling rate conversion, Multistage Implementation of Sampling Rate Conversion, Computational Efficiency. Filter design & Implementation for sampling rate conversion, Polyphase Implementation of FIR filters for decimation and interpolation. Applications of Multirate Signal Processing. Digital Filter Banks – Two Channel QMF – Perfect reconstruction two – channel FIR Filter Banks. L – Channel QMF Banks.

UNIT V : ADAPTIVE FILTERS 9 Hrs
Principles of adaptive filter – FIR adaptive filter – Newton‟s Steepest descent algorithm – LMS algorithm – Adaptive noise cancellation, Adaptive equalizer, Adaptive echo cancellers.

COURSE LEARNING OUTCOMES:
On completion of the program the students will
- have knowledge in processing of various types signals to apply in real time applications.
- have knowledge in multirate signal processing fundamentals.
- have knowledge in adaptive filtering techniques using LMS algorithm and to study the applications of adaptive filtering.

TEXT BOOK
1. John G. Proakis, Dimitris K Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, Fourth Edition, PHI

2. Monson H, Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc., New York, Indian Reprint, 2007.

REFERENCE BOOKS:

1. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", Fourth Edition, Mc. Graw Hill.
2. "Digital Signal Processing :Pronciples, Algorithms and Application", John G Proakis& D G Manolakis, PHI, 1998.
3. "Introduction to Digital Signal Processing",Johny R. Johnson, PHI
4. "Digital Signal Processing: Implementations using DSP Microprocessors with examples from TMS320C54x", Avatar Singh & S. Srinivasan, Thomson,Brooks/cole, 2004.
5. TI DSP Processor User Manuals.
6. "Digital Signal Processing; Analysis and Design", Paulo S.R.,Diniz& Sergio L. Netto, Cambridge University Press.

MTEC251 WIRELESS & MOBILE COMMUNICATION LAB

Sub Code: MTEC251 L: T: P Total PracticalHrs: 30
Exam Marks: 100 0: 0: 2 Exam Hours: 03
Credits: 2

COURSE OBJECTIVE:
To produce graduates who understand how to analyze and manipulate antenna and radiation pattern for different distributions.

LIST OF EXPERIMENTS

1. Understanding Cellular Fundamentals like Frequency Reuse, Interference, cell splitting, multi path environment, Coverage and Capacity issues using communication software.

2. Knowing GSM and CDMA architecture, network concepts, call management, call setup, call release, Security and Power Control, Handoff Process and types, Rake Receiver etc.

3. Study of GSM handset for various signalling and fault insertion techniques (Major GSM handset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).

4. To study transmitters and receiver section in mobile handset and measure frequency band signal and GMSK modulating signal.

5. To study various GSM AT Commands their use and developing new application using it.Understating of 3G Communication System with features like; transmission of voice andvideocalls, SMS, MMS, TCP/IP, HTTP, GPS and File system by AT Commands in 3G network.

6. Study of DSSS technique for CDMA, observe effect of variation of types of PN codes, chip rate, spreading factor, processing gain on performance.

7. To learn and develop concepts of Software Radio in real time environment by studying the building blocks like Base band and RF section, convolution encoder, Interleaver and DeInterleaver.

8. To study and analyze different modulation techniques in time and frequency domain using SDR kit

COURSE LEARNING OUTCOMES:

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

- Understanding Cellular concepts, GSM and CDMA networks
- To study GSM handset by experimentation and fault insertion techniques
- Understating of 3G communication system by means of various AT commands usage in GSM
- Understanding CDMA concept using DSSS kit

- To learn, understand and develop concepts of Software Radio in real time environment

MTEC252 MODERN DIGITAL SIGNAL PROCESSING LABORATORY

Sub Code: MTEC252 **L: T: P** **Total PracticalHrs: 30**
Exam Marks: 100 **0: 0: 2** **Exam Hours: 03**
Credits: 2

COURSE OBJECTIVES:
To produce graduates who understand how to analyze and manipulate digital signals and have the fundamental programming knowledge to do so.

LIST OF EXPERIMENTS
1. Basic Operations on Signals, Generation of Various Signals and finding its DTFT.
2. FIR filter design
3. IIR filter design
4. Decimation and Interpolation
5. Convert CD data into DVD data
6. Periodogram of a Noisy Signal and estimate PSD using Periodogram and Modified Periodogram methods
7. Estimation of Power Spectrum using Bartlett and Welch methods
8. Verification of Autocorrelation Theorem
9. Parametric methods (Yule-Walker and Burg) of Power Spectrum Estimation
10. Estimation of data series using Nth order Forward Predictor and comparing to the Original Signal
11. Design of LPC filters using Levinson-Durbin Algorithm.
12. Adaptive Noise Cancellation RLS and LMS Algorithm
13. Design and Simulation of Notch Filter to remove 50Hz Hum/any unwanted frequency component of given Signal (Speech/ECG)

Experiments Using TMS 320 C 6713 DSK
1. ADC : Characterization
2. Signal Generator
3. Filter design
4. Noise Cancellation and System Identification

Note: The course will have a project which is to be designed and developed in TMS 320 C 6713 DSK

COURSE LEARNING OUTCOMES:
Student will be able to

- Describe the Sampling Theorem and how this relates to Aliasing and Folding.
- Determine if a system is a Linear Time-Invariant (LTI) System.
- Be able to take the Z-transform of a LTI system
- Determine the frequency response of FIR and IIR filters.
- Understand the relationship between poles, zeros, and stability.
- Determine the spectrum of a signal using the DFT, FFT, and spectrogram.
- Be able to design, analyze, and implement digital filters in MatLab.
- Be able to implement filters on a digital signal processor.

DETAILED SYLLABUS OF PROGRAM ELECTIVES

ADVANCED DIGITAL COMMUNICATION

COURSE OBJECTIVE

- To understand the basics of signal space analysis and digital transmission.
- To understand the coherent and non coherent receivers and its impact on different channel characteristics.
- To understand carrier and symbol synchronization techniques.
- To understand the different block coded and convolutional coded digital communication systems.
- To understand the different spread spectrum techniques for digital communication.

UNIT I DIGITAL MODULATION SCHEMES

Representation of Digitally Modulated Signals, Memoryless Modulation Methods, Signaling Schemes with Memory, Power Spectrum of Digitally Modulated Signals.

UNIT II OPTIMUM RECEIVERS FOR AWGN CHANNEL

Waveform and Vector Channel Models, Waveform and Vector AWGN Models, Optimal Detection and Error Probability for Band-Limited Signaling, Optimal Detection and Error Probability for Power-Limited Signaling, Comparison of Digital Signaling Methods, Performance Analysis for Wireline and Radio Communication Systems.

UNIT III CARRIER AND SYMBOL SYCHRONIZATION

Signal Parameter Estimation, Carrier Phase Estimation, Symbol Timing Estimation, Joint Estimation of Carrier Phase and Symbol Timing, Performance Characteristics of Maximum Likelihood Estimators.

UNIT IV ERROR CONTROL CODING

Discrete Memoryless Channels, Linear Block Codes, Cyclic Block Codes, Convolution Codes, Maximum Likelihood Decoding of Convolutional codes-Viterbi Algorithm, Trellis codes, Applications.

UNIT V SPREAD SPECTRUM SIGNALS FOR DIGITAL COMMUNICATION

Model of Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum Signals, Frequency-Hopped Spread Spectrum Signals, Synchronization of Spread Spectrum Systems.

COURSE OUTCOME

Upon Completion of the course, the students will be able to

- Develop the ability to understand the concepts of signal space analysis coherent and non-coherent receivers in AWGN channel.
- Comprehend the synchronization of carrier and symbol of the received signal.
- Possess knowledge on different block codes and convolutional codes.
- Conceptually appreciate spread spectrum techniques.

REFERENCE BOOKS

1. John G. Proakis, "Digital Communication", McGraw Hill, 5th edition, 2008.
2. Simon Haykin, "Digital communications", John Wiley and Sons, Reprint 2009.
3. Bernard Sklar, "Digital Communication - Fundamental and applications", Pearson education (Asia), Pvt. Ltd., 2nd edition, 2001.
4. Andrew J. Viterbi, "CDMA: Principles of spread spectrum communications", Prentice Hall, USA, 1995

APPLIED MATHEMATICS FOR ELECTRONICS ENGINEERS

COURSE OBJECTIVE:

- Introduce the Concepts of CTFT, DTFT and Z-Transform with application to Communication.
- Introduce the Concepts of STFT, CWT, DWT with application to Compression Techniques.
- Introduce the Concepts of Linear Algebra with application to Communication.
- Introduce the basic Statistical Data Analysis.

UNIT – I Transforms – Part I

Continuous Time Fourier Transform (CTFT) – Properties of CTFT – Application to Communication Systems: Amplitude Modulation – DSB – SC, SSB. Sampling – Discrete Time Fourier Transform – Properties of DTFT. Z – Transform – Properties of Z – transform, Applications.

UNIT – II Transforms – Part II

STFT – Definition and Interpretations, General Properties, STFT Application, CWT – Definition and Interpretations, General Properties, Application, DWT – Definition and Interpretations, General Properties, Applications.

UNIT – III Linear Algebra

Linear Algebra - vector spaces, linear independence, bases and dimension, Orthonormal Basis function, Gram Schmidt Orthogonalization, linear maps and matrices, Eigenvalues and Eigenvectors, Positive Definite Matrix: Minima, Maxima and Saddle Points, Test for Positive Definiteness, Singular Value Decomposition and Finite Element Method, Examples and Applications.

UNIT – IV Probability and Stochastic Processes – Part – I

Axiomatic definitions of probability; conditional probability, independence and Bayes theorem, Bernoulli Trials, Concept of a Random Variable, Distribution and Density Functions, Mean Value and Moments, Gaussian Random Variable, Other Probability Density Function, Examples and Applications, Introduction to Two Random Variables.
Random Process, Stationarity, Ergodic and Nonergodic Random Process.

UNIT – V Probability and Stochastic Processes – Part – II

Autocorrelation Function, Properties and Measurements of Autocorrelation Functions, Crosscorrelation, Properties and Measurements of Crosscorrelation Functions, Examples and Applications of Autocorrelation and Crosscorrelation functions. Relation of Spectral Density to Fourier Transform, Relation of Spectral Density to the Autocorrelation function, White Noise, Periodogram Estimate of Spectral Density, Examples and Applications of Spectral Density.

COURSE LEARNING OUTCOMES:

- Applying the appropriate Transform among CTFT, DTFT and Z Transform to analyze an application.
- Apply the concept of STFT and DWT for compression applications.
- Identify the concepts of Linear Algebra for Communication related applications.
- Employ the concepts of Probability, Random Variables and Stochastic Process for Statistical Signal Processing and Communication related applications.

TEXT/REFERENCE BOOKS

1. B. P. Lathi, *Principles of Linear Systems and Signals*, 2nd Edition, Oxford University Press, 2013.
2. K P Soman, K I Ramachandran, N G Resmi, *Insight into Wavelet from Theory and Practice*, Third Edition, PHI Publicaitons, 2007
3. G. Strang, *Linear Algebra and Its Applications*, Nelson Engineering, 2007.
4. S. Axler, *Linear Algebra Done Right*, 2nd Edn., Springer, 1997.
5. George R Cooper, Clare D. McGillem, *Probabilistic Methods of Signal and System Analysis*, Third Edition, Oxford University Press, 2008.

OPTICAL COMMUNICATION NETWORKS

COURSE OBJECTIVE:

- To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures
- To understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors
- To learn the various optical source materials, LED structures, quantum efficiency, Laser diodes
- To learn the fiber optical receivers such as PIN APD diodes, noise performance in photo detector, receiver operation and configuration
- To learn the fiber optical network components, variety of networking aspects, FDDI, SONET/SDH and operational principles WDM

UNIT I OPTICAL NETWORKING COMPONENTS 9

Optical Spectrum, Spectral band designations used in optical fiber communication, Evolution of fiber optic system: First Generation and Second-generation optical networks, Element of an Optical Fiber Transmission link, Couplers, Isolators and Circulators, Multiplexers and Filters filters, Optical Amplifiers, Switches, Wavelength converters.

UNIT II SONET AND SDH NETWORKS

9Integration of TDM signals, Electrical and Optical Signal, Layers, Framing, Transport overhead, Alarms, Multiplexing, Network elements, Topologies, Protection architectures, Ring architectures, Network Management.

UNIT III BROADCAST – AND- SELECT NETWORKS 9

Topologies, Single-hop, Multihop, and Shufflenetmultihop networks, Media-Access control protocols, Test beds.

UNIT IV WAVELENGTH-ROUTING NETWORKS 9

Node designs, Issues in Network design and operation, Optical layer cost Tradeoffs, Routing and Wavelength assignment, Wavelength routing test beds.

UNIT V HIGH CAPACITY NETWORKS 9

SDM, TDM, and WDM approaches, Application areas, Optical TDM Networks: Multiplexing and demultiplexing, Synchronization, Broadcast networks, Switch-based networks, OTDM test beds.

REFERENCES:

1. Gerd Keiser, "Optical Fiber Communications" Tata McGraw-Hill Eduction Private Limited, New Delhi, 5th ed., 2013
2. Rajiv Ramaswami and Kumar Sivarajan, Optical Networks: A practical perspective, Morgan Kaufmann, 3rd edition, 2010.
3. VivekAlwayn, Optical Network Design and Implementation, Pearson Education, 2004.
4. Hussein T.Mouftab and Pin-Han Ho, Optical Networks: Architecture and Survivability, Kluwer Academic Publishers, 2002.
5. Biswanath Mukherjee, Optical Communication Networks, McGraw Hill, 1997

MULTIMEDIA COMPRESSION TECHNIQUES

COURSE OBJECTIVES:
To provide in-depth knowledge about Data Compression, Text Compression andAudio Compression, Image and Video Compression

UNIT I: INTRODUCTION
Special features of Multimedia – Graphics and Image Data Representations – Fundamental Concepts in Video and Digital Audio – Storage requirements for multimedia applications -Need for Compression - Taxonomy of compression techniques – Overview of source coding, source models, scalar and vector quantization theory – Evaluation techniques – Error analysis and methodologies

UNIT II: TEXT COMPRESSION
Compaction techniques – Huffmann coding – Adaptive Huffmann Coding – Arithmatic coding – Shannon-Fano coding – Dictionary techniques – LZW family algorithms.

UNIT III: AUDIO COMPRESSION
Audio compression techniques - μ- Law and A- Law companding. Frequency domain and filtering – Basic sub-band coding – Application to speech coding – G.722 – Application to audio coding – MPEG audio, progressive encoding for audio – Silence compression, speech compression techniques – Formant and CELP Vocoders

UNIT IV: IMAGE COMPRESSION
Predictive techniques – DM, PCM, DPCM: Optimal Predictors and Optimal Quantization – Contour based compression – Transform Coding – JPEG Standard – Sub-band coding algorithms: Design of Filter banks – Wavelet based compression: Implementation using filters – EZW, SPIHT coders – JPEG 2000 standards - JBIG, JBIG2 standards.

UNIT V: VIDEO COMPRESSION
Video compression techniques and standards – MPEG Video Coding I: MPEG – 1 and 2 – MPEG Video Coding II: MPEG – 4 and 7 – Motion estimation and compensation techniques – H.261 Standard – DVI technology – PLV performance – DVI real time compression – Packet Video.

COURSE LEARNING OUTCOMES:
Students will be able to

1. Explain Scalar quantization theory and Rate distribution Theory
2. Understand different coding techniques
3. Describe Contour based compression and Motion estimation techniques

REFERENCES:

- Khalid Sayood : Introduction to Data Compression, Morgan Kauffman Harcourt India, 2nd Edition, 2000.
- David Salomon : Data Compression – The Complete Reference, Springer Verlag New York Inc., 4th Edition, 2006.
- Yun Q.Shi, HuifangSun : Image and Video Compression for Multimedia Engineering - Fundamentals, Algorithms & Standards, CRC press, 2008.

- Peter Symes : Digital Video Compression, McGraw Hill Pub., 2004.
- Mark Nelson : Data compression, BPB Publishers, New Delhi,1998.
- Mark S.Drew, Ze-NianLi : Fundamentals of Multimedia, PHI, 2nd Edition, 2004.
- Watkinson,J : Compression in Video and Audio, Focal press,London.1995.
- Jan Vozer : Video Compression for Multimedia, AP Profes, NewYork, 1995

SPACE TIME WIRELESS COMMUNICATIONS

COURSE OBJECTIVE:
To gain an understanding of the principles behind the design of wireless communication systems and technologies.

UNIT I: OVERVIEW OF WIRELESS COMMUNICATIONS AND CELLULAR CONCEPT

Evolution of Wireless Communications, Cellular Concept - Frequency Reuse, Channel assignment strategies, Handoff Strategies, Interference and system capacity, path loss, and Shadowing : Free-Space Path Loss, Two-Ray Model, Path Loss and Shadowing, Outage Probability under Path Loss and Shadowing.

UNIT II: STATISTICAL MULTIPATH CHANNEL MODELS
Statistical Multipath Channel models – Time varying Channel Impulse Response, Narrow Band Fading Models – Autocorrelation, Cross Correlation, and Power Spectral Density, Envelope and Power Distributions, Level Crossing Rate and Average Fade Duration, Finite-state Markov Channel Models, Wideband Fading Models - Power Delay Profile, Coherence Bandwidth, Doppler Power Spectrum and Channel Coherence Time.

UNIT III: DIVERSITY
Antenna array topology, Sampled signal model, Channel models for SISO, SIMO, MSIO, and MIMO, Realization of independent fading paths, Receive diversity – system model, Selection combining, Threshold Combining, Maximal – Ratio Combining, Equal – Gain Combining, Transmit Diversity – system model, Channel known at transmitter, Channel unknown at transmitter, Moment generating functions in diversity analysis – Diversity analysis for MRC, EGC and SC.

UNIT IV: BER ANALYSIS OF WIRELESS CHANNELS
BER: Error Probability for BPSK and QPSK in AWGN Channel (SISO, SIMO, MISO, MIMO), BER analysis of Fading Channels – Outage Probability, Average Probability of Error (SISO, SIMO, MISO, MIMO).

UNIT V: CHANNEL CAPACITY
Capacity in AWGN Channel, Capacity of Flat Fading Channels – Capacity of Frequency Selective Fading Channels, Water filling and inverse Water filling algorithms – Time-Invariant Channels, Time-Varying Channels, Narrowband MIMO model, Parallel Decomposition of the MIMO Channel, MIMO Channel Capacity – Static channels, Fading Channels – Channel known to the transmitter (Water Filling), Channel unknown to the transmitter (Uniform Power Allocation).

COURSE LEARNING OUTCOMES:
A student who successfully completes Wireless Communications will

- Understand the basics of propagation of radio signals.
- Understand how radio signals can be used to carry digital information in a spectrally efficient manner.
- Gain insights into how diversity afforded by radio propagation can be exploited to improve performance

- Have an understanding of design considerations for how to effectively share spectrum through multiple access
- Gain the experience of working in a group towards a final project that will involve experiments, analysis and the design of exemplary wireless communication techniques and/or systems.

REFERENCES:

1. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2009.
2. David Tse and PramodViswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2010.
3. Theodore S Rappaport, "Wireless Communications Principles and Practice", Pearson Education, Asia, New Delhi, Second Edition, 2009.
4. William C Y Lee, "Mobile Communications Engineering, Theory and Applications", Second Edition, McGraw Hill International editions, 1998.

COMMUNICATION NETWORK SECURITY

COURSE OBJECTIVE

This course introduces the various aspects of secured data transmission and reception. It deals with the study about various encryption and decryption techniques and standards. Finally it discusses about network security practices and system security.

UNIT I

SYMMETRIC CIPHERS (Techniques and Standards) –I

Introduction: Services, Mechanisms and Attacks, OSI security Architecture, Model for network Security; Classical Encryption Techniques:Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Stegnography;
Block Ciphers and Data Encryption Standard: Simplified DES, Block Cipher Principles, Data Encryption Standard, Strength of DES, Differential and Linear Crypt Analysis, Block Cipher Design Principles, Block Cipher Modes of Operation.

UNIT II

SYMMETRIC CIPHERS (Techniques and Standards) – II

Advanced Encryption Standard: Evaluation Criteria for AES, AES Cipher; More on Symmetric Ciphers: 2DES, Triple DES, Blowfish, RC5, Characteristics of Advanced Symmetric Block Ciphers, RC4 Stream Cipher; Confidentiality using Symmetric Encryption: Placement of Encryption Function, Traffic Confidentiality, Key Distribution, and Random Number Generation.

UNIT III

PUBLIC-KEY ENCRYPTION AND HASH FUNCTIONS

Public Key Cryptography and RSA: Principles of Public Key Cryptosystems, RSA Algorithm; Key Management and other public key cryptosystems: Key Management, Diffie-Hellman Key Exchange, Elliptic Curve arithmetic, Elliptic Curve Cryptography;
Message Authentication and Hash Functions: Authentication Requirements,

Authentication Functions, Message Authentication Codes, Hash Functions and MACs; Hash Algorithms- MD5 Message Digest Algorithm; Secure Hash Algorithm, RIPEMD 160, HMAC; Digital Signatures and Authentication Protocols- Digital Signatures, Authentication Protocols, Digital Signature Standards.

UNIT IV

NETWORK SECURITY PRACTICE

Authentication Applications- Kerberos, X.509 Authentication Service; Electronic Mail Security- Pretty Good Privacy, S/MIME;
IP Security- IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations; Web Security- Web Security Considerations, Secure Sockets Layer and Transport Layer Security, Secure Electronic Transaction.

UNIT V

SYSTEM SECURITY

Intruders- Intruder Detection, Password Management; Malicious Software- Virus and Related Threats, Virus Counter Measures; Firewalls- Firewall Design Principles, Trusted Systems.

COURSE LEARNING OUTCOMES

- Student will learn the various symmetric ciphers and its techniques & standards.
- Student will understand the key management and public key cryptosystem.
- Student will learn the Hash Functions, Authentication Protocol and Digital Signature.
- Student will learn the system security measures against Malicious Software.

REFERENCES

- William Stallings, "Cryptography and Network Security", 6th. Ed, Prentice Hall of India, New Delhi ,2013
- William Stallings, "Network Security Essentials", 5thed. Prentice Hall of India, New Delhi.
- Charlie Kaufman , "Network Security: Private Communication in Public World", 2 edition. Prentice Hall of India, New Delhi , 2004

RF SYSTEM DESIGN

COURSE OBJECTIVE:

The course objective is to introduce the concepts of RF systems, issues and design of RF filters, active components, amplifiers, oscillators, mixers and other applications

UNIT I: RF ISSUES
Importance of RF design, Electromagnetic Spectrum, RF behaviour of passive components, Chip components and Circuit Board considerations, Scattering Parameters, Smith Chart and applications.

UNITII: RF FILTER DESIGN
Overview, Basic resonator and filter configuration, Special filter realizations, Filter implementations, Coupled filter.

UNIT III: ACTIVE RF COMPONENTS & APPLICATIONS
RF diodes, BJT, RF FETs, High electron mobility transistors; Matching and Biasing Networks – Impedance matching using discrete components, Microstripline matching networks, Amplifier classes of operation and biasing networks.

UNIT IV: RF AMPLIFIER DESIGNS
Characteristics, Amplifier power relations, Stability considerations, Constant gain circles, Constant VSWR circles, Low Noise circuits, Broadband , high power and multistage amplifiers.

UNIT V: OSCILLATORS, MIXERS & APPLICATIONS
Basic Oscillator model, High frequency oscillator configuration, Basic characteristics of Mixers; Phase Locked Loops ; RF directional couplers and hybrid couplers ; Detector and demodulator circuits.

COURSE LEARNING OUTCOMES:

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

1. Understand the RF design issues
2. Understand Design aspects of RF components, amplifiers, oscillators and mixers and detectors
3. Become strong in formulating RF design issues and in the designs of RF systems

REFERENCES:

- Reinhold Ludwig and Powel Bretchko, RF Circuit Design – Theory and Applications, Pearson Education Asia, First Edition, 2001.
- Joseph . J. Carr, Secrets of RF Circuit Design , McGraw Hill Publishers, Third Edition, 2000.
- Mathew M. Radmanesh, Radio Frequency & Microwave Electronics, Pearson Education Asia, Second Edition, 2002.
- Ulrich L. Rohde and David P. NewKirk, RF / Microwave Circuit Design, John Wiley & Sons USA 2000.
- Roland E. Best, Phase - Locked Loops : Design, simulation and applications, McGraw Hill Publishers 5TH edition 2003.

ADVANCED MICROWAVE SYSTEMS

COURSE OBJECTIVE:

The objective of this course is to give exposure on the Microwave passive components, amplifiers, oscillators, resonators, antennas and radio systems using all these.

UNIT I: FIELD ANALYSIS OF PLANAR TRANSMISSION LINES

Microstrip Transmission Lines – Attenuation – High frequency properties of Microstrip lines. Coupled Microstrip lines – even and odd modes. Strip transmission lines – Coupled strip lines – Fin lines.

UNIT II: CIRCUIT THEORY FOR WAVE GUIDE SYSTEMS

Equivalent voltages and currents – Impedance description of waveguide elements and circuits – one port circuit. Foster's reactance theorem. N-port circuits. Two port junctions. Excitation of waveguides. Probe coupling in rectangular waveguide. Radiation from linear current elements and current loops.Waveguide coupling by apertures.

UNIT III: PERIODIC STRUCTURES AND FILTERS

Wave analysis of periodic structures. Periodic structures composed of Unsymmetrical two port networks. Terminated Periodic structures.Matching of Periodic structures.Floquet's theorem and spatial Harmonics. Microwave Filters – Image parameter method. Filter design by insertion loss method. Low pass filter design. Microstrip parallel coupled filter.

UNIT IV: MICROWAVE SOLID STATE AMPLIFIERS

S-parameters - Unilateral design of amplifiers – simultaneous conjugate match. Bilateral design of amplifiers.Amplifierstability.Conditional and unconditional stability criteria.Amplifier power gain.Constant gain circles.Noise temperature concept. Noise factor and noise figure. Noise temperature for cascaded stages.Constant noise figure circles. Design of single stage microwave amplifiers.

UNIT V: MICROWAVE APPLICATIONS

Frequency ranges, Applications of Microwaves in Satellite Communication – GEO, MEO and LEO Satellites, Satellite-to-Satellite Communication; Microwave Oven and Food Processing, Mammography, Microwave Imaging for Medical Diagnosis.

COURSE LEARNING OUTCOMES:

The course is planned in such a way that the students would become

1. Familiar with all microwave passive components
2. Known about amplifiers and oscillators
3. Learnt the concepts of Resonators
4. good in the usage of various antennas and
5. clear in concepts about the microwave radio systems

REFERENCES

- Roddy.D., "Microwave Technology" Reston Publications.1986.
- R.E.Collin, " Foundations for Microwave Engineering", 2nd Edition, McGraw-Hill, 2002.

- Ramo, Whinnery and Van Duzer : "Fields and Waves in communication electronics". 3rdEdition., Wiley, 1997.
- Chatterjee R. "Microwave Engineering "East West Press. 1988.
- Rizzi.P."Microwave Engineering Passive circuits". Prentice Hall.1987
- Tomasi.W "Advanced Electronic communication systems "6th Edition, Prentice Hall, 2003.
- Samuel Liao "Microwave Devices and Circuits"3rd Edition, Pearson education, 1990.
- Combes, Graffewil and Sauterean "Microwave Components, Devices and Active Circuits".John wiley.1987.
- AnnapuranaDas.Sisir.K.Das,"Microwave Engineering" Tata McGraw Hill, 2000.
- David Pozar, "Microwave Engineering", 4th Edition, John Wiley and sons, 2012

COMMUNICATION PROTOCOL ENGINEERING

COURSE OBJECTIVE:

The objective of the course is to ensure that students have the necessary networking skills to design, implement, and analyze communication protocol networks. Various standards and protocols will be covered.

UNIT INETWORK REFERENCE MODEL
Communication model-software, subsystems, protocol, protocol development methods, Protocol engineering process, Layered architecture, Network services and Interfaces, Protocol functions, OSI model ,TCP/IP protocol suite

UNIT IIPROTOCOL SPECIFICATION
Components of protocol, Specifications of Communication service, Protocol entity, Interface, Interactions, Multimedia protocol, Internet protocol, SDL, SDL based protocol- other protocol specification languages

UNIT IIIPROTOCOL VERIFICATION/VALIDATION
Protocol verification, Verification of a protocol using finite state machines, Protocol validation, protocol design errors, Protocol validation approaches, SDL based protocol verification and validation

UNIT IV PROTOCOL CONFORMANCE/PERFORMANCE TESTING
Conformance testing methodology and frame work, Conformance test architectures, Test sequence generation methods, Distributed architecture by local methods, Conformance testing with TTCN, systems with semi controlLaboratoryle interfaces - RIP,SDL based tools for conformance testing, SDL based conformance testing of MPLS Performance testing, SDL based performance testing of TCP and OSPF, Interoperability testing, SDL based interoperability testing of CSMA/CD and CSMA/CA protocol using Bridge, ScaLaboratoryility testing

UNIT VPROTOCOL SYNTHESIS AND IMPLEMENTATION
Protocol synthesis, Interactive synthesis algorithm, Automatic synthesis algorithm, Automatic synthesis of SDL from MSC, Protocol Re-synthesis; Requirements of protocol implementation, Object based approach to protocol implementation, Protocol compilers, Tool for protocol engineering

COURSE LEARNING OUTCOMES:

Upon completion of the course, students should possess the following skills:

- Understand the fundamentals of data communication protocols.
- Have the capability of designing and analyzing data transmission protocols and data link control protocols.
- Have knowledge of various network protocols including TCP/IP, and demonstrate the skills to design and evaluate network protocols.
- Be able to discuss major trends in industry and current research activities within the discipline.

REFERENCES

- PallapaVenkataram and SunilkumarS.Manvi, "Communication protocol Engineering", Eastern Economy edition, 2004

- Richard Lai and Jirachiefpattana, "Communication Protocol Specification and Verification", Kluwer Publishers, Boston, 1998.
- Tarnay, K., "Protocol Specification and Testing", Plenum, New York, 1991.
- Mohamed G. Gouda, "Elements of Network Protocol Design", John Wiley & Sons, Inc. New York, USA, 1998
- V.Ahuja, "Design and Analysis of Computer Communication networks", McGraw-Hill, London, 1982.
- G.J.Holtzmann, "Design and validation of Computer protocols", Prentice Hall, New York, 1991.

SPEECH AND AUDIO SIGNAL PROCESSING

COURSE OBJECTIVE:
To introduce the characteristics of Speech signals and the related time and frequency domain methods for speech analysis and speech compression

UNIT I: MECHANICS OF SPEECH **9+3**
Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Representation of Speech signals – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features.
Music production – Auditory perception – Anatomical pathways from the ear to the perception of sound – Peripheral auditory system – Psycho acoustics

UNIT II:TIME DOMAIN METHODS FOR SPEECH PROCESSING **9+3**
Time domain parameters of Speech signal – Methods for extracting the parameters Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy – Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function

UNIT III:FREQUENCY DOMAIN METHOD FOR SPEECH PROCESSING **9+3**
Short Time Fourier analysis – Filter bank analysis – Formant extraction – Pitch Extraction – Analysis by Synthesis- Analysis synthesis systems- Phase vocoder—Channel Vocoder. Homomorphic speech analysis: Cepstral analysis of Speech – Formant and Pitch Estimation – HomomorphicVocoders.

UNIT IV:LINEAR PREDICTIVE ANALYSIS OF SPEECH **9+3**
Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP.

UNIT V:APPLICATION OF SPEECH & AUDIO SIGNAL PROCESSING **9+3**
Algorithms: Spectral Estimation, dynamic time warping, hidden Markov model – Music analysis – Pitch Detection – Feature analysis for recognition – Music synthesis – Automatic Speech Recognition – Feature Extraction for ASR – Deterministic sequence recognition – Statistical Sequence recognition – ASR systems – Speaker identification and verification – Voice response system – Speech Synthesis: Text to speech, voice over IP.

COURSE LEARNING OUTCOMES:
At the end of the course, student will

- Know the models for speech production
- Be able to develop time and frequency domain techniques for estimating speech parameters
- Know predictive technique for speech compression
- understand speech recognition, synthesis and speaker identification.

REFERENCE BOOKS

1. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons Inc. , Singapore, 2nd Edition, 2011
2. L.R.Rabiner and R.W.Schaffer – Digital Processing of Speech signals – Prentice Hall -1978
3. Quatieri – Discrete-time Speech Signal Processing – Prentice Hall – 2001.
4. J.L.Flanagan – Speech analysis: Synthesis and Perception – 2nd edition – Berlin – 1972
5. I.H.Witten – Principles of Computer Speech – Academic Press – 1982

NETWORK ROUTING ALGORITHMS

COURSE OBJECTIVE:

- To expose the students to the layered architecture for communication networks and the specific functionality of the network layer.
- To enable the student to understand the basic principles of routing and the manner this isimplemented in conventional networks and the evolving routing algorithms based onInternetworking requirements, optical backbone and the wireless access part of the network.
- To enable the student to understand the different routing algorithms existing and theirperformance characteristics.

UNIT I INTRODUCTION

ISO OSI Layer Architecture, TCP/IP Layer Architecture, Functions of Network layer, General Classification of routing, Routing in telephone networks, Dynamic Non-hierarchical Routing (DNHR), Trunk status map routing (TSMR), real-time network routing (RTNR), Distance vector routing, Link state routing, Hierarchical routing.

UNIT II INTERNET ROUTING

Interior protocol : Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Bellman Ford Distance Vector Routing. Exterior Routing Protocols: Exterior Gateway Protocol (EGP) and Border Gateway Protocol (BGP). Multicast Routing.Pros and cons of Multicast and Multiple Unicast Routing, Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), MBONE, Core Based Tree Routing.

UNIT III ROUTING IN OPTICAL WDM NETWORKS

Classification of RWA algorithms, RWA algorithms, Fairness and Admission Control, Distributed Control Protocols, Permanent Routing and Wavelength Requirements, Wavelength Rerouting- Benefits and Issues, Light-path Migration, Rerouting Schemes, Algorithms- AG, MWPG.

UNIT IV MOBILE - IP NETWORKS

Macro-mobility Protocols, Micro-mobility protocol: Tunnel based : Hierarchical Mobile IP, Intra domain Mobility Management, Routing based: Cellular IP, Handoff Wireless Access Internet Infrastructure (HAWAII).

UNIT V MOBILE AD –HOC NETWORKS

Internet-based mobile ad-hoc networking communication strategies, Routing algorithms – Proactive routing: destination sequenced Distance Vector Routing (DSDV), Reactive routing: Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing (AODV), Hybrid Routing: Zone Based Routing (ZRP).

COURSE LEARNING OUTCOMES:

- Given the network and user requirements and the type of channel over which the network has to operate, the student would be in a position to apply his knowledge

for identifying a suitable routing algorithm , implementing it and analyzing itsperformance.

- The student would also be able to design a new algorithm or modify an existing algorithm to satisfy the evolving demands in the network and by the user applications.

REFERENCES

1. William Stallings, ' High speed networks and Internets Performance and Quality of Service', 2nd Edition, Pearson Education Asia. Reprint India 2002
2. M. Steen Strub, ' Routing in Communication network, Prentice –Hall International, Newyork,1995.
3. S. Keshav, 'An engineering approach to computer networking' Addison Wesley 1999.
4. William Stallings, 'High speed Networks TCP/IP and ATM Design Principles, Prentice-Hall, New York, 1st edition, 1997
5. C.E Perkins, 'Ad Hoc Networking', Addison – Wesley, 2001.
6. Ian F. Akyildiz, Jiang Xie and ShantidevMohanty, " A Survey of mobility Management in Next generation All IP- Based Wireless Systems", IEEE Wireless Communications Aug.2004, pp 16-27. 26
7. A.T Campbell et al., " Comparison of IP Micromobility Protocols," IEEE Wireless Communications Feb.2002, pp 72-82.
8. C.Siva Rama Murthy and Mohan Gurusamy, " WDM Optical Networks – Concepts, Design and Algorithms", Prentice Hall of India Pvt. Ltd, New Delhi –2002

SIMULATION OF COMMUNICATION SYSTEMS & NETWORKS

COURSE OBJECTIVES:
The course will cover both analytical methods (Markov Models and Queuing Networks) and simulation techniques (Monte Carlo Techniques and Event Driven Simulation) applied in performance modeling of communication systems and networks.

UNIT I MODELLING OF COMMUNICATION SYSTEM 9 + 3
Model of speech and picture signals, Pseudo noise sequences, Non-linear sequences, Analog channel model, Noise and fading, Digital channel model-Gilbert model of bursty channels, HF, Troposcatter and satellite channels, Switched telephone channels, Analog and Digital communication system models, Light wave system models.

UNIT IISIMULATION OF RANDOM VARIABLES AND RANDOM PROCESS
Univariate and multivariate models, Transformation of random variables, Bounds and approximation, Random process models-Markov and ARMA Sequences, Sampling rate for simulation, Computer generation and testing of random numbers

UNIT III ESTIMATION OF PERFORMANCE MEASURES 9 + 3
Quality of an estimator, estimator for SNR, Probability density functions of analog communication system, BER of digital communication systems, Monte Carlo method and Importance of sampling method, estimation of power spectral density

UNIT IV COMMUNICATION NETWORKS 9 + 3
Queuing models, M/M/I and M/M/I/N queues, Little formula, Burke's theorem ,M/G/I queue, Embedded Markov chain analysis of TDM systems, Polling, Random access systems

UNIT V NETWORK OF QUEUES 9 + 3
Queues in tandem, store and forward communication networks, capacity allocation, Congestion and flow chart, Routing model, Network layout and Reliability

COURSE LEARNING OUTCOMES:
1. Describe the role of important elements of simulation and modeling paradigm.
2. Analyze and design Monte Carlo simulation algorithms.
3 Analyze and design discrete-event simulation algorithms.
4. Output analysis for discrete-event simulation algorithms.

REFERENCES

- M.C.Jeruchim,PhilipBaLaboratoryan and K.SamShanmugam, "Simulation of communication systems", Plenum Press, New York,1992
- A.M.Law and W.DavidKelton, "Simulation Modelling and analysis", McGraw Hill Inc., New York ,3rd Edition,2000
- J.F.Hayes, “Modelling and Analysis of Computer Communication networks”, Plenum Press, New York,1984

- Jerry Banks and John S.Carson, "Discrete-event System Simulation", 5th Edition, Prentice Hall Inc., New Jersey 2009.

DETECTION AND ESTIMATION THEORY

COURSE OBJECTIVE:
To enable the student to understand the basic principles of random signal processing, spectral estimation methods and their applications. To enable the student to understand the different signal detection and estimation methods used in communication system design and the implications of proper synchronization methods for proper functioning of the system.

UNIT I: STATISTICAL DECISION THEORY:
Bayesian Hypothesis Testing - Likelihood Ratio Tests - Minimax Hypothesis Testing - Neyman Pearson Hypothesis Testing - Composite Hypothesis Testing - M'ary Hypothesis Testing.

UNIT II: SIGNAL DETECTION IN DISCRETE TIME:
Deterministic Signals - Stochastic Signals – Models and Detector Structures – Performance Evaluation - Chernoff Bounds - Applications of Detection in Signal Processing.

UNIT III: PARAMETER ESTIMATION:
Fundamentals of Estimation Theory - Minimum Variance Unbiased Estimation – Cramer Rao Lower bound – Best Linear Unbiased Estimators - Linear Least Squares Estimation – Nonlinear Least Squares Estimation - Maximum Likelihood Estimation.

UNIT IV: BAYESIAN ESTIMATION:
Bayesian philosophy – General Bayesian Estimators - Minimum Mean Square Error Estimators – Maximum A Posteriori Estimators – Linear MMSE Estimation .

UNIT V: DISTRIBUTION-FREE ESTIMATION:
Orthogonality Principle – Autoregressive Techniques - Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations, Kalman Filter, Extended Kalman Filter - Applications of Estimation in Signal Processing.

COURSE LEARNING OUTCOMES:
- The student would be able to demonstrate an understanding of the basic principles of random signal processing, spectral estimation methods and their applications.
- The student would be able to demonstrate an understanding of the different signal detection and estimation methods used in communication system design and the implications of proper synchronization methods for proper functioning of the system.
- The student would be in a position to apply his knowledge for designing a baseband system addressing the channel impairments

REFERENCES:

1. Thomas Schonhoff and Arthur A.Giordano, "Detection and Estimation Theory", Prentice Hall, 2007.
2. Kay S M, "Fundamentals of Statistical Signal Processing, Volume 1: Estimation Theory", Prentice Hall, 1993.

3. Kay S M, "Fundamentals of Statistical Signal Processing, Volume 2: Detection Theory", Prentice Hall, 1998.

4. Poor H V, "An Introduction to Signal Detection and Estimation", Springer-Verlang, 1994.

5. Scharf L L, "Statistical Signal Processing", Addison Wesley, 1991.

6. Sam Shanmugam K and Breipohl A M, "Random Signals: Detection, Estimation and Data Analysis", John Wiley, 1988.

DIGITAL COMMUNICATION RECEIVERS

COURSE OBJECTIVES:
For students to be able to understand, analyze, and design fundamental digital communication systems.

UNIT I - REVIEW OF DIGITAL COMMUNICATION TECHNIQUES

Base band and band pass communication, signal space representation, linear and non- linear modulation techniques, and spectral characteristics of digital modulation.

UNIT II - RECEIVERS FOR AWGN CHANNEL
Correlation demodulator, matched filter, maximum likelihood sequence detector, Optimum receiver for CPM signals, M-ary orthogonal signals, envelope detectors for M-ary and correlated binary signals, Receiver design for AWGN channel using USRP & GNU Radio.

UNIT III - RECEIVERS FOR FADING CHANNELS
Characterization of fading multiple channels, statistical models, slow fading, frequency selective fading, diversity technique, RAKE demodulator, coded waveform for fading channel, Receiver design for AWGN channel using USRP & GNU Radio.

UNIT IV - SYNCHRONIZATION TECHNIQUES
Carrier and symbol synchronization, carrier phase estimation – PLL, Decision directed loops, symbol timing estimation, maximum likelihood and non-decision directed timing estimation, joint estimation, Implementation of Synchronization techniques using USRP & GNU Radio.

UNIT V - ADAPTIVE EQUALIZATION
Zero forcing algorithm, LMS algorithm, Adaptive decision – feedback equalizer, and equalization of Trellis-coded signals, Kalman algorithm, blind equalizers, and stochastic gradient algorithm, Echo cancellation

COURSE OUTCOMES:
1. Students are able to analyze digital communication signals as vectors.
2. Students understand the principles of maximum a posteriori and maximum likelihood detection.
3. Students understand the basics of PAM, QAM, PSK, FSK, and MSK. They can analyze probability of error performance of such systems and are able to design digital communication systems based on these modulation techniques as block diagrams.
4. Students understand and are able to analyze equalizers.
5. Students understand and are able to analyze synchronization systems.

REFERENCES

- Heinrich Meyer, Mare Moeneclacy and Stefan.A. Fechtel, "Digital Communication Receivers", Vol I & II, John Wiley, New York, 1997
- John. G. Proakis, "Digital Communication", 5thed., McGraw Hill, New York, 2013
- E.A. Lee and D.G. Messerschmitt, "Digital Communication", 2nd edition, Allied Publishers, New Delhi, 1994
- Simon Marvin, "Digital Communication Over Fading channel; An unified approach to performance Analysis", John Wiley, New York, 2000

- Bernard Sklar, "Digital Communication Fundamentals and Applications, 2nd Edition, Prentice Hall, 2001

DIGITAL IMAGE PROCESSING

COURSE OBJECTIVE:
- To understand the image fundamentals and mathematical transforms necessary for image processing and to study the image enhancement techniques.
- To understand the image segmentation and representation techniques.
- To understand how image are analyzed to extract features of interest.
- To introduce the concepts of image registration and image fusion.
- To understand the uses of pseudo-color. Know how to use it in both the spatial and frequency domains.
- To know about the 2-D Fourier, discrete cosine, Walsh-Hadamard and wavelet transforms; including implied symmetry, phase, and circular convolution, vector inner and outer products and filtering.
- To analyze the constraints in image processing when dealing with 3D data sets.

UNIT I
INTRODUCTION: What is Digital Image Processing, Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, and Components of an Image Processing System.
DIGITAL IMAGE FUNDAMENTALS: Elements of Visual Perception, A Simple Image Formation Model, Basic Concepts in Sampling and Quantization, Representing Digital Images, Spatial and Gray-level Resolution, Zooming and Shrinking Digital Images, Some Basic Relationships between Pixels, Linear and Nonlinear Operations.

UNIT II
IMAGE ENHANCEMENT IN THE SPATIAL DOMAIN: Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.
IMAGE ENHANCEMENT IN THE FREQUENCY DOMAIN:
Introduction to the Fourier Transform and the Frequency Domain, Smoothing Frequency-Domain Filters, Sharpening Frequency-Domain Filters, Homomorphic Filtering.

UNIT III
IMAGE RESTORATION: A Model of the Image degradation/Restoration process, Noise Models, Restoration in the Presence of Noise Only–Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering ,Minimum Mean Square Error (Wiener) Filtering, Constrained Least Square Filtering, Geometric Mean Filter, Image reconstruction: Basics on Radon transform and X-ray computed tomography reconstruction.

UNIT IV
COLOR FUNDAMENTALS: Color Models, Pseudocolor Image Processing, Basics of Full-Color Image Processing, Color Transformations, Smoothing and Sharpening, Color Segmentation, Noise in Color Images, Color Image Compression.
WAVELETS AND MULTIRESOLUTION PROCESSING: Image Pyramids, Subband coding, The Haar Transform, Multiresolution Expansions, Wavelet Transforms in one Dimension, Fast Wavelet Transform, Wavelet Transforms in Two Dimensions, Wavelet Packets.

UNIT V:

MORPHOLOGICAL IMAGE PROCESSING: Preliminaries, Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms.
IMAGE SEGMENTATION: Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation.

COURSE LEARNING OUTCOMES:
The students will be able to:

- Understand image formation and the role human visual system play in perception ofgray and color image data.
- Apply image processing techniques in both the spatial and frequency domains.
- Design image analysis techniques in the form of image segmentation and to evaluatethe Methodologies for segmentation.
- Conduct independent study and analysis of feature extraction techniques.
- Understand the concepts of image registration and image fusion.
- Understand the concept of entropy and its relation to image compression.
- Understand the concepts of image smoothing in both the spatial and spectral domains.
- Understand circular convolution, its relationship to linear convolution, and how linearconvolution can be achieved via the discrete Fourier transform.
- Analyze the constraints in image processing when dealing with 3D data sets and toapply image.

TEXT BOOKS

- Rafael C Gonzalez and Richard E. Woods: Digital Image Processing, PHI 3rdEdition

REFERENCES:

- K. Jain: Fundamentals of Digital Image Processing, Pearson, 2004.
- Scott.E.Umbaugh: Digital Image Processing and Analysis, 2nd Edition, CRC Press, 2014.
- S.Jayaraman, S.Esakkirajan, T.Veerakumar: Digital Image Processing, McGraw Hill, 2013.

HIGH PERFORMANCE COMMUNICATION NETWORKS

COURSE OBJECTIVE:

·To develop a comprehensive understanding of multimedia networking.
·To study the types of VPN and tunneling protocols for security.
·To learn about network security in many layers and network management**.**

UNIT I: PACKET SWITCHED NETWORKS

OSI and IP models, Ethernet (IEEE 802.3), Token ring (IEEE 802.5), Wireless LAN (IEEE 802.11) FDDI, DQDB, SMDS: Internetworking with SMDS

UNIT II: **ISDN AND BROADBAND ISDN**

ISDN - overview, interfaces and functions, Layers and services - Signaling System 7 (SS7)- Broadband ISDN architecture and Protocols.

UNIT III: **ATM AND FRAME RELAY**

ATM: Main features-addressing, signaling and routing, ATM header structure-adaptation layer, management and control, ATM switching and transmission.
Frame Relay: Protocols and services, Congestion control, Internetworking with ATM, Internet and ATM, Frame relay via ATM.

UNIT IV: **ADVANCED NETWORK ARCHITECTURE**

IP forwarding architectures overlay model, Multi-Protocol Label Switching (MPLS), integrated services in the Internet, Resource Reservation Protocol (RSVP), Differentiated services. MPLS/GMPLS.

UNIT V: **BLUE TOOTH TECHNOLOGY**

The Blue tooth module-Protocol stack Part I: Antennas, Radio interface, Base band, The Link controller, Audio, The Link Manager, The Host controller interface; The Blue tooth module-Protocol stack Part I: Logical link control and adaptation protocol, RFCOMM, Service discovery protocol, Wireless access protocol, Telephony control protocol.

REFERENCES

- William Stallings,"ISDN and Broadband ISDN with Frame Relay and ATM", 4th edition, Pearson education Asia, 2002.
- Leon Gracia, Widjaja, "Communication networks ", 2nd Edition, Tata McGraw-Hill, New Delhi, 2003.
- Jennifer Bray and Charles F.Sturman,"Blue Tooth" Pearson education Asia, 2001.
- SumitKasera, PankajSethi, "ATM Networks ", Tata McGraw-Hill, New Delhi, 2000.
- Rainer Handel, Manfred N.Huber and Stefan Schroder ,"ATM Networks",3rd edition, Pearson education asia,2002.
- Jean Walrand and Pravinvaraiya ,"High Performance Communication networks",2nd edition, Harcourt and Morgan Kauffman,London,2000.
- William Stallings,"High-speed Networks and Internets", 2nd edition, Pearson education

ADVANCED MICROSTRIP ANTENNAS

COURSE OBJECTIVE:

The objective of the course is to provide the scholar with the essence of how microstrip antenna can be designed, developed, analyzed and concept can be made practically possible.

UNIT I

HISTORY AND EVOLUTION OF MICS, AND MATERIALS FOR MICROSTRIPS

Microwave Frequency band designations, properties of microwaves, Historical Development of Microwave Integrated Circuits (MICs) – Transition from Tubes through Solid State Devices, Integrated Circuits to Microwave Integrated Circuits, Concept of Stripline and Microstrip, Microstrip materials and selection. IEEE Standards and Antenna requirements for Various Wireless Applications – MICS, ISM, GPS, GSM, Bluetooth, ZigBee, RF ID, WLAN, WPAN, Wi-Fi, WiMAX&Gi-Fi

UNIT II

MICROSTRIP FEEDS AND DESIGN OF MICROSTRIP ANTENNAS

Various feeds – Microstrip, coaxial, proximity, aperture-coupled and CPW feeds, Advantages, Applications and Limitations of Microstrip feeds, Design of Microstrip Antennas - Basic structure: Rectangular, Circular and Triangular shaped antennas, Advantages, Applications and Limitations of Microstrip Antennas

UNIT III
ANTENNA FABRICATION/PRINTING METHODS AND MEASUREMENTS

Antenna Fabrication and Printing Methods, Measurement of antenna parameters:, Return Loss [S11(dB)], Resonant Frequency, Bandwidth, VSWR, Impedance, Gain, Directivity, Efficiency, Axial Ratio, Mode, 2D and 3D Radiation Patterns of microstrip antennas, Role of Network Analyzer and Anechoic Chamber in antenna measurements.

UNIT IV
PERFORMANCE IMPROVEMENT METHODS
(Array, Slot, EBG, Fractal, Metamaterial and ANN concepts)
Performance improvement methods of Microstrip antennas: Microstrip arrays, Slotted Antennas, EBG structures; Overview of Fractal Antennas- types, properties, advantages and applications, Design aspects; Overview of Metamaterials – properties, types, advantages and applications- Metamaterial property verification - Overview of Metamaterial loaded Microstrip antenna designs, Overview of Dielectric Resonator Antennas

UNIT V
MICROSTRIP ARRAYS, OPTIMIZATION AND ANALYSIS
Overview of Microstrip Arrays- Planar Array Theory, Design of Linear arrays, Linear Array design with Patches, Array Broadbanding-Effects of substrate parameters on Bandwidth, Selection of suitable patch shape, Feeding Technique, Overview of ANN - Concepts and Types – Application of ANN in microstrip antenna, Overview of Computational

Electromagnetic methods in design and analysis of microstrip antenna - FDTD, FEM, MoM Techniques.

COURSE LEARNING OUTCOMES:

The course is designed in such a way that the students will be able to gain knowledge on

- Become familiar with microstrip antenna fundamentals, materials used, methods of
- feeds and various IEEE standards for wireless applications.
- Can design & simulate different antenna structures.
- Understand the fabrication requirements and important parameters of antenna for measurements and will know how to analyze these measured results.
- Understand the ideas on performance improvement methods.
- Be able to design arrays with opt feeds, know about ANN and CEM methods their
- Applications.
- Finally become confident to take up core jobs and aware of the advancements in microstrip antennas & their applications and gain strong foundation on the research trends/avenues.

REFERENCES

1. Randy Bancraft, "Microstrip and Printed Antenna Design",2nd Edition, Prentice-Hall of India, 2009
2. Ramesh Garg, PrakashBhartia, InderBaul and ApisakIttipiboon, "Microstrip Antenna Design Handbook", Artech House, 2001
3. Mathew N. O. Sadiku, "Numerical Techniques in Electromagnetics", CRC Press, Second Edition, 2009.
4. Thomas A. Milligan, "Modern Antenna Design", John Wiley & Sons Inc., Second Edition
5. Kin-Lu Wong, "Compact and Broadband Microstrip Antennas", John Wiley & Sons Inc., 2002
6. Vijay Garg, "Wireless Communications & Networking", Morgan and Kauffmann, 2009
7. Annapurna Das, Sisir K. Das, "Microwave Engineering", Tata McGraw-Hill Education, 2000
8. Samuel Y Liao, "Microwave Devices and Circuits", Prentice Hall, 3rd Edition
9. J R James, P S Hall, C Wood, "Microstrip Antenna Theory and Design", Peter Peregrinus Ltd., 1981.
10. Research Papers on Microstrip Arrays, Fractal Antennas, Metamaterial Antennas, ANN Optimized Microstrip Antennas, CEM & Dielectric Resonator Antennas.

NON-LINEAR OPTICAL NETWORKS

COURSE OBJECTIVE:

This course is intended for specialized degree of ECE students at senior levels. This course covers a detailed discussion on optical communication & networking concepts, in light of various non-linear effects. The goal of this course is to (1) acquire an overall understanding of the origin, magnitude and importance of non-linear optical effects, (2) become well

acquainted with the principles of non-linear optics, and (3) obtain a working knowledge of fundamental concepts and modern applications of non-linear optics.

UNIT I INTRODUCTION

Need for Fiber-Optic communications, Evolution of Lightwave Systems, Optical Communication Systems, Lightwave System Components, optical Fibers as a Communication Channel, Optical Transmitters, Optical Receivers, Optical Amplifiers (EDFAs), and introduction to Optical networks, Overview of Nonlinear Optics.

UNIT II WDM LIGHT WAVE SYSTEMS AND WAVE PROPAGATION IN OPTICAL FIBERS

Transmission Engineering and design, WDM system performance issues, Point-to-point optical links, Wide-area and metro-area networks. WDM Network design: RWA problem, Wavelength routing networks.Group-Velocity Dispersion (GVD), Third-Order Nonlinear Susceptibility. Different Propagation Regimes Dispersion-Induced Pulse Broadening, Dispersion Management

UNIT III SELF PHASE MODULATION AND CROSS PHASE MODULATION

SPM-Induced Spectral Broadening, Effect of Group-Velocity Dispersion, Higher-Order Nonlinear Effects.XPM-Induced Nonlinear Coupling, XPM-Induced Modulation Instability, XPM-Paired Solitons, Spectral and Temporal Effects, Applications of XPM.

UNIT IV STIMULATED RAMAN SCATTERING AND FOUR WAVE MIXING

Basic Concepts, Raman-Gain Spectrum, Quasi-Continuous SRS, SRS with Short Pump Pulses, Soliton Effects. Origin of Four-Wave Mixing, Theory of Four-Wave Mixing, Phase-Matching Techniques, Parametric Amplification, FWM Applications, Second-Harmonic Generation.

UNIT V OPTICAL SOLITONS AND POLARIZATION EFFECTS

Modulation Instability, Fiber Solitons, Types of Solitons, Perturbation of Solitons, Higher-Order Effects, Nonlinear Birefringence, Nonlinear Phase Shift, Evolution of Polarization State, Vector Modulation Instability, Birefringence and Solitons, Random Birefringence.

TEXT BOOKS

- G.P. Agrawal, 'Nonlinear Fiber Optics', 2nd, 3rd or 4th Edition, Academic Press.

REFERENCE BOOKS

- R. Ramaswami, K.N. Sivarajan and G.H. Sasaki, 'Optical Networks: A Practical Perspective', 3rd Edition, Morgan Kaufmann Publishers.
- R.W. Boyd, 'Nonlinear Optics', 3rd Edition, Academic Publishers.
- G.P. Agrawal, 'Fiber-optic Communication Systems', 3rdEdition, John Wiley&Sons.
- G. Kaiser, 'Optical Fiber Communications', 4th edition, Tata McGraw Hill.
- J.G. Proakis, 'Digital Communications', 5th edition, Tata McGraw Hill, 2007.
- S. Haykin, 'Communication Systems', 5th edition, John Wiley & Sons,2009.

COURSE NAME: IC PROCESS TECHNOLOGY AND CMOS VLSI DESIGN						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- This course deals with the concepts of Integrated circuit process technologies and MOS system in digital VLSI design and modern tools to simulate Schematic and Layout of Digital circuits.

Prerequisites: VLSI Design, Digital Circuits

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1CRYSTAL GROWTH, WAFER PREPARATION, EPITAXY& ION IMPLANTATION		
Lithography: Introduction, Optical Lithography, Electron Lithography, X-ray Lithography, Ion Lithography. Reactive Plasma Etching: Introduction, Plasma Properties, Feature-Size Control and Anisotropic Etch Mechanisms, Other Properties of Etch Processes, Reactive Plasma-Etching Techniques and Equipment, Specific Etch Processes.Ion Implantation: Introduction, Range Theory, Implantation Equipment, Annealing, Shallow Junctions, High-Energy Implantation.	10	L1
Unit-2DIELECTRIC AND POLYSILICON FILM DEPOSITION, METALLIZATION, VLSI PROCESS INTEGRATION& PACKAGING OF VLSI DEVICES		

Dielectric and Polysilicon Film Deposition: Introduction, Deposition Processes, Polysilicon, Silicon Dioxide, Silicon Nitride, Plasma-Assisted Depositions, Other Materials. Metallization: Introduction, Metallization Applications, Metallization Choices, Physical Vapour Deposition, Patterning, Metallization Problems, New Role of Metallization. VLSI Process Integration: Introduction, Fundamental Considerations for IC Processing, NMOS IC technology, CMOS, BiCMOS IC Technology. MOS Memory IC Technology, Bipolar IC Technology, IC Fabrication. Packaging of VLSI Devices: Introduction, Package Types, Packaging Design Considerations.	10	L2
Unit-3MOS TRANSISTOR THEORY AND DEVICE SCALING		
n-MOS / p-MOS transistor, Threshold voltage equation, Body effect, MOS device design equation, Sub-threshold region, Channel length modulation. Mobility variation, Tunneling, punch through, Hot electron effect MOS models, Small signal AC Characteristics, CMOS inverter, βn/βp ratio, Noise margin, Static load MOS inverters, Differential inverter, Transmission gate, Tri-state inverter, Bi-CMOS inverter.Lambda Based Design rules, Scaling factor, Current CMOS enhancement (oxide isolation, LDD. Refractory gate, Multilayer inter connect), Circuit elements, Resistor, Capacitor, Interconnects, Sheet resistance & Standard unit capacitance concepts delay unit time, Inverter delays, Driving capacitive loads, Propagate delays, MOS mask layer, Stick diagram, Design rules and layout, Symbolic diagram, Scaling of MOS circuits.	15	L3
Unit-4DIGITAL CMOS DESIGN		

Advantages of CMOS over NMOS, CMOS\SOS technology, CMOS\bulk technology, Latch up in bulk CMOS, Combinational MOS Logic circuits-Introduction, CMOS logic circuits with a MOS load, CMOS logic circuits, complex logic circuits, Transmission Gate. Sequential MOS logic Circuits - Introduction, Behaviour of hi stable elements, SR latch Circuit, Clocked latch and Flip Flop Circuits, CMOS D latch and triggered Flip Flop. Dynamic Logic Circuits - Introduction, Principles of pass transistor circuits, Voltage boot strapping synchronous dynamic circuit's techniques, Dynamic CMOS circuit techniques, Static CMOS design, Domino CMOS structure and design, Charge sharing, Clocking- clock generation, Clock distribution, Clocked storage elements.	15	L4
Unit-5CMOS ANALOG DESIGN		
Introduction, Single Amplifier, Differential Amplifier, Current mirrors, Band gap references, Basics of cross operational amplifier.	10	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to do: • Apply the concepts of MOS system in digital VLSI design. • Analyse the electrical and physical properties, Switching characteristics and interconnect effect of a MOS system in digital VLSI design. • Design dynamic logic circuits, Semiconductors Memory circuits, and different CMOS logic circuits.		
Text Books: 1. The textbook for the course is Weste& Harris, CMOS VLSI Design: A Circuits andSystems Perspective, 3rd ed, Addison Wesley, 2005		
Reference Books: 1. Digital Design, 3rd edition by M. Morris Mano. 2. Principles of CMOS VLSI design by N H E Weste& K Eshraghian 3. Modern VLSI Design: System on Silicon by Wayne Wolf		

Online Resources: Nil

COURSE NAME: EMBEDDED SYSTEM AND SOC DESIGN						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					
Course objectives: To study the hardware and software used in Embedded Systems.						
Prerequisites: Microcontroller, Microprocessor, Digital Circuits						

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1INTRODUCTION TO EMBEDDED SYSTEMS		
Definition and Classification – Overview of Processors and hardware units in an embedded system – Software embedded into the system – Exemplary Embedded Systems – Embedded Systems on a Chip (SoC) and the use of VLSI designed circuits.	5	L1
Unit-2DEVICES AND BUSES FOR DEVICES NETWORK		
I/O Devices - Device I/O Types and Examples – Synchronous - Iso-synchronous and Asynchronous Communications from Serial Devices - Examples of Internal Serial-Communication Devices - UART and HDLC - Parallel Port Devices - Sophisticated interfacing features in Devices/Ports- Timer and Counting Devices - '12C', 'USB', 'CAN' and advanced I/O Serial high speed buses- ISA, PCI, PCI-X, cPCI and advanced buses.	15	L2

Unit-3PROGRAMMING CONCEPTS AND EMBEDDED PROGRAMMING IN C, C++		
Programming in assembly language (ALP) vs. High Level Language - C Program Elements, Macros and functions -Use of Pointers - NULL Pointers - Use of Function Calls – Multiple function calls in a Cyclic Order in the Main Function Pointers – Function Queues and Interrupt Service Routines Queues Pointers – Concepts of EMBEDDED PROGRAMMING in C++ - Objected Oriented Programming – Embedded Programming in C++, 'C' Program compilers – Cross compiler – Optimization of memory codes.	10	L3
Unit-4SYSTEM ARCHITECTURE		
Components of the system – Processor architectures – Memory and addressing – system level interconnection – SoC design requirements and specifications – design integration – design complexity – cycle time, die area and cost, ideal and practical scaling, area-time-power tradeoff in processor design, Configurability.	10	L4
Unit-5PROCESSOR SELECTION FOR SOC, MEMORY DESIGN AND INTERCONNECT BUS		
Overview – soft processors, processor core selection. Basic concepts – instruction set, branches, interrupts and exceptions. Basic elements in instruction handling – Minimizing pipeline delays – reducing the cost of branches – Robust processors – Vector processors, VLIW processors, Superscalar processors. SoC external memory, SoC internal memory, Scratch pads and cache memory – cache organization and write policies – strategies for line replacement at miss time – split I- and D- caches – multilevel caches – SoC memory systems – board based memory systems – simple processor/memory interaction. Bus architectures – SoC standard buses – AMBA, AHB.	20	L5
List of Experiments (if any)		

Self-study: Nil

Site/Industrial Visits: Nil

Course outcomes:

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

- Describe characteristics of embedded systems and its hardware and software.
- Categorize the devices and buses used for embedded networking.
- Demonstrate the programming concepts and embedded programming in C and C++.
- Examine the concepts of real time operating systems, inter-task communication and an exemplary case of MUCOS – IIRTOS.

Text Books:

1. Rajkamal, Embedded Systems Architecture, Programming and Design, TATA McGraw-Hill, Education 2011

Reference Books:

1. Steve Heath, Embedded Systems Design, Second Edition-2003, Newnes,
2. David E.Simon, An Embedded Software Primer, Pearson Education Asia, Twelfth Indian Reprint 2005.
3. Wayne Wolf, Computers as Components; Principles of Embedded Computing System Design – Harcourt India, Morgan Kaufmann; 2 edition (8 July 2008)
4. Frank Vahid and Tony Givargis, Embedded Systems Design – A unified Hardware /Software Introduction, John Wiley &Sons 2002.

Online Resources:

Nil

COURSE NAME: DIGITAL SYSTEM DESIGN USING VERILOG						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- This course is an introduction to the VHDL language. The emphasis is on writing synthesizable code and enough simulation code to write a viable test-bench.
- The information gained can be applied to any digital design by using a top-down synthesis design approach.

Prerequisites: Digital Circuits, VLSI Design

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1INTRODUCTION AND METHODOLOGY		
Digital Systems and Embedded Systems, Boolean Functions and Boolean algebra, Binary Coding, Combinational Components and Circuits, Verification of Combinational Circuits.Number Basics: Unsigned and Signed Integers, Fixed and Floating-point Numbers, Binary representation and Circuit Elements, Real-World Circuits, Models, Design Methodology.	9	L1
Unit-2SEQUENTIAL BASICS& MEMORIES		
Storage elements, Counters, Sequential Data paths and Control, Clocked Synchronous Timing Methodology.Memories: Concepts, Memory Types, Error Detection and Correction.	9	L2
Unit-3IMPLEMENTATION FABRICS & PROCESSOR BASICS		
ICs, PLDs, Packaging and Circuit Boards, Interconnection and Signal Integrity.Processor Basics: Embedded Computer Organization, Instruction and Data, Interfacing with memory.	9	L3
Unit-4 I/O INTERFACING, ACCELERATORS & DESIGN METHODOLOGY		

I/O devices, I/O controllers, Parallel Buses, Serial Transmission, I/O software.Accelerators: Concepts, case study, Verification of accelerators. Design Methodology: Design flow, Design optimization, Design for test.	9	L4
Unit-5 SIMPLE SINGLE CYCLE AND MULTI CYCLE PROCESSOR DESIGN		
Introduction of Simple Single Cycle and Multi Cycle Processor Design.	9	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		

Course outcomes:
At the end of the course, the student will be able to do:
- Implement the VHDL portion of coding for synthesis.
- Identify the differences between behavioral and structural coding styles.
- Understand the basic principle of circuit design and analysis.

Text Books:
1. C. H. Roth, Digital Systems Design Using VHDL, Thomson Publications, Fourth Edition, 2002.
2. V. A. Pedroni, Circuit Design with VHDL, MIT Press/PHI, 2004.

Reference Books:
2. Parhami, Behrooz, Computer Arithmetic: Algorithms and Hardware Designs, Oxford University Press, 2009.
3. Z. Navabi, Verilog Digital System Design, Second Edition, Tata McGrawHill, 2008.
4. R. C. Cofer and B. F. Harding, Rapid System Prototyping with FPGAs: Accelerating the Design Process, Elsevier/Newnes, 2005.
5. Peter J. Ashenden, "Digital Design: An Embedded Sytems Approach Using VERILOG", Elesvier, 2010

Online Resources:

Nil

COURSE NAME: CAD AND EDA FOR VLSI CIRCUITS						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- To discuss the basics of VLSI Design Automation.
- To understand the concepts of physical design process
- To gain the knowledge on Simulation and Synthesis in VLSI Design Automation**.**

Prerequisites: Digital Circuits, VLSI Design

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1VLSI DESIGN METHODOLOGIES		
Introduction to VLSI Design methodologies - Review of Data structures and algorithms - Review of VLSI Design automation tools - Algorithmic Graph Theory and Computational Complexity - Tractable and Intractable problems.	10	L1
Unit-2DESIGN RULES & FLOOR PLANNING		
Layout Compaction - Design rules - problem formulation - algorithms for constraint graph compaction - placement and partitioning - Circuit representation - Placement algorithms – partitioning. Floor planning concepts - shape functions and floorplan sizing - Types of local routing problems- Area routing - channel routing - global routing - algorithms for global routing.	8	L2
Unit-3SIMULATION, MODELLING AND SYNTHESIS		

Simulation - Gate-level modeling and simulation - Switch-level modeling and simulation- Combinational Logic Synthesis - Binary Decision Diagrams - Two Level Logic Synthesis. High level Synthesis - Hardware models - Internal representation - Allocation - assignment and scheduling - Simple scheduling algorithm - Assignment problem - High level transformations.	10	L3
Unit-4 AN OVERVIEW OF OS COMMANDS AND SCRIPTING		
System settings and configuration. Introduction to UNIX commands. Writing Shell scripts, VLSI design automation tools, Basics of TCL-TK Scripting Language, Basics of PERL Scripting, Basics of Python Scripting.	20	L4
Unit-5 OVERVIEW OF THE FEATURES OF PRACTICAL CAD TOOLS		
Logic synthesis using verilog, Memory and FSM synthesis. Performance driven synthesis, Simulation- Types of simulation.Static timing analysis. Formal verification.Switchlevel and transistor level simulation. Circuit description.AC, DC and transient analysis. Advanced spice commands and analysis. Models for diodes, transistors	12	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to do: • .Design advanced electronics systems • Evaluate and analyze the systems in VLSI design environments. • Apply advanced technical knowledge in multiple contexts • Conduct an organized and systematic study on significant research topic within the field of VLSI and its allied field.		
Text Books: 1. . S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons,2002		

Reference Books:

1. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.

Online Resources:

Nil

COURSE NAME: LOW POWER VLSI DESIGN						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- This course addresses a profound analysis on the development of the CMOS &BiCMOS digital circuits for a low voltage low power environment.
- To study the concepts of device behavior and modelling.
- To study the concepts of low voltage, low power logic circuits.

Prerequisites: Digital Circuits, VLSI Design

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1POWER DISSIPATION IN CMOS CIRCUITS		
Hierarchy of limits of power – Sources of power consumption – Physics of power dissipation in CMOS FET devices – Basic principle of low power design.	9	L1
Unit-2 POWER OPTIMIZATION		
Logic level power optimization – Circuit level low power design – Circuit techniques for reducing Power consumption in adders and multipliers.	9	L2
Unit-3 DESIGN OF LOW POWER CIRCUITS		
Computer arithmetic techniques for low power system – reducing power consumption in memories – low power clock, Inter connect and layout design – Advanced techniques –Special techniques.	9	L3
Unit-4 POWER ESTIMATION		
Power Estimation technique – logic power estimation – Simulation power analysis –Monte-Carlo power Estimation, Advanced sampling Techniques, Vector Compaction – Probabilistic power analysis–combinational circuits, Real-Delay gate power Estimation, Sequential Circuits.	9	L4
Unit-5 SYNTHESIS AND SOFTWARE DESIGN		

Synthesis for low power – Behavioral level transforms, logic level optimization, Circuit level – software design for low power- sources of software power dissipation, software power estimation, software power optimizations, Automated low power code generation.	9	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to do: • Recognize advanced issues in VLSI systems, specific to the deepsubmicron silicon technologies. • Understand deep submicron CMOS technology and digital CMOS design styles. • Design chips used for battery-powered systems and high performance circuits.		
Text Books: 1. Kaushik Roy and S.C.Prasad, "Low power CMOS VLSI circuit design", Wiley, 2000. 2. DimitriosSoudris, Christians Pignet, Costas Goutis, "Designing CMOS Circuits for Low Power",Kluwer, 2002.		
Reference Books: 1. J.B.Kulo and J.H Lou, "Low voltage CMOS VLSI Circuits", Wiley 1999. 2. A.P.Chandrasekaran and R.W.Broadersen, "Low power digital CMOS design", Kluwer,1995 3. Gary Yeap, "Practical low power digital VLSI design", Kluwer, 1998 4. AbdelatifBelaouar, Mohamed.I.Elmasry, "Low power digital VLSI design", Kluwer, 1995 5. James B.Kulo, Shih-Chia Lin, "Low voltage SOI CMOS VLSI devices and Circuits", JohnWiley and sons, inc. 2001.		
Online Resources: Nil		

COURSE NAME: ADVANCED COMPUTER ARCHITECTURE

	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- Study of parallel processing and program flow control in a processor.
- Study of multiprocessor and multicomputer.
- To be acquainted with memory organization of processors.

Prerequisites: Digital Circuits

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1 PARALLEL COMPUTER MODELS		
Thestate of computing, Classification of parallel computers, Multiprocessors and multicomputer, Multifactor and SIMD computers. Program and network properties: Conditions of parallelism, Data and resource Dependences, Hardware and software parallelism, Program partitioning and scheduling, Grain Size and latency, Program flow mechanisms, Control flow versus data flow, Data flow Architecture, Demand driven mechanisms, Comparisons of flow mechanisms.	9	L1
Unit-2 SYSTEM INTERCONNECT ARCHITECTURES		
Network properties and routing, Static interconnection Networks, Dynamic interconnection Networks, Multiprocessor system Interconnects, Hierarchical bus systems, Crossbar switch and multiport memory, Multistage and combining network.	9	L2
Unit-3 CACHE MECHANISM		
Introduction to cache memory, memory hierarchy and cache memory, Cache architecture and cache policies. CONCEPT OF FLUSHING AND CLEANING CACHE: Flushing and Cleaning ARM cache core.CONCEPT OF CACHE LOCKDOWN: Locking Code and Data in Cache. Cache and write buffer.	9	L3
Unit-4 PIPELINING		

Linear pipeline processor, nonlinear pipeline processor, Instruction pipeline Design, Mechanisms for instruction pipelining, Dynamic instruction scheduling, Branch Handling techniques, branch prediction, Arithmetic Pipeline Design, Computer arithmetic principles, Static Arithmetic pipeline, Multifunctional arithmetic pipelines Memory Hierarchy Design: Cache basics & cache performance, reducing miss rate and miss penalty, multilevel cache hierarchies, main memory organizations, design of memory hierarchies.	9	L4
Unit-5 MULTIPROCESSOR ARCHITECTURES		
Symmetric shared memory architectures, distributed shared memory architectures, models of memory consistency, cache coherence protocols (MSI, MESI, and MOESI), scalable cache coherence, overview of directory based approaches, design challenges of directory protocols, memory based directory protocols, cache based directory protocols, protocol design tradeoffs, and synchronization. Scalable point –point interfaces: Alpha364 and HT protocols, high performance signalling layer. Enterprise Memory subsystem Architecture: Enterprise RAS Feature set: Machine checks, hot add/remove, domain partitioning, memory mirroring/migration, patrol scrubbing, fault tolerant system.	9	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to do: • They can apply new data-path algorithms to implement a processor more efficiently. • They can measure the fault tolerance and reliability of a processor.		
Text Books: 1. Advanced Computer Architecture, by Kai Hwang McGraw Hill. 2. Introduction to Parallel Computing, 2nd Edition, Pearson Education by AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar.		

Reference Books:

1. Computer Architecture – A quantitative approach By J.L Hennessy and D.A.Patterson (Morgan)

2. Computer Architecture and Parallel Processing, by K.Hwang and F.A. Briggs. McGraw Hill, International

Online Resources:

Nil

COURSE NAME: ADVANCED MICROPROCESSORS AND MICROCONTROLLERS						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:
To learn the architecture and programming of advanced microprocessors and microcontrollers.

Prerequisites: Microprocessors, Microcontrollers

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1 ADVANCED MICROPROCESSOR ARCHITECTURE		
Internal Microprocessor Architecture-Real mode memory addressing – Protected Mode Memory addressing –Memory paging - Data addressing modes – Program memory addressing modes – Stack memory addressing modes – Data movement instructions – Program control instructions-Arithmetic and Logic Instructions.	9	L1
Unit-2 MODULAR PROGRAMMING AND ITS CONCEPTS		
Modular programming – Procedures – Macro - Interrupts - Interrupt service routines – keyboard and Video display –Data Conversions using assembly languages with C/ C++.	9	L2
Unit-3 PENTIUM & SUPER COMPUTER ARCHITECTURE		
Special Pentium registers- Pentium memory management – New Pentium Instructions –Pentium Processor –Basic and additional features of Pentium Pro, Pentium II, Pentium III, Pentium IV -SUPERCOMPUTERS ARCHITECTURE: Elements in the system architecture of a supercomputer, shared memory in multiprocessor- interconnection network - distributed memory cluster - enclosure and cooling infrastructures - cluster management and monitoring software - parallel programming models.	9	L3

Unit-4 MOTOROLA 68HC11 MICROCONTROLLERS		
Instructions and addressing modes – operating modes – Hardware reset – Interrupt system – Parallel I/O ports – Flags – Real time clock – Programmable timer – pulse accumulator – serial communication interface – A/D converter – hardware expansion – Assembly language Programming.	9	L4
Unit-5 PIC MICRO CONTROLLER AND RASBERRY-PI		
CPU architecture – Instruction set - Interrupts – Timers – I/O port expansion –I2C bus for peripheral chip access – A/D converter – UART Introduction to Raspberry pi – configuration of Raspberry pi – programming raspberry pi - Implementation of IOT with Rasberry pi.	9	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to do: • Outline the basic architecture of Pentium family of processors, MOTOROLA 68HC11 MICROCONTROLLERS, PIC and Rasberry pi. • Demonstrate concepts in internal programming model of microprocessors and microcontrollers. • Describe the programming techniques using MASM, DOS and BIOS function calls. • Demonstrate the concepts and application of advanced microprocessors and microcontrollers.		
Text Books: 1. Bamett,Cox&O'Cull"Embedded C Programming and the MicrochipPlC" Thomson India Edition, 2007 2. Andrew N.Sloss,DonimicSymes, Chris Wright, "ARM System Developer's Guide", Elsevier,2007.(For Unit IV,V)		
Reference Books: 1. Steve Heath "Embedded Systems Design", 2" Edition, Elsevier, 2008. 2. Arnold S. Berger," Embedded Systems Design-An Introduction to Processes, Tools, & Techniques", CMP Books, 2005.		

COURSE NAME: SoC DESIGN FOR EMBEDDED SYSTEMS & IOT						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- Understand SoC and differences between SoC and EmbeddedSystem.
- Learn to employ specialized knowledge of subsystems like processor cores andother SoC components to design an embedded SoC.
- Analyze the architecture, peripherals, programming, and CAD tools to design SoC

Prerequisites: Digital Circuits, VLSI Design

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1SYSTEM ARCHITECTURE: OVERVIEW AND INTRODUCTION TO IOT		
Components of the system – Processor architectures – Memory and addressing – system level interconnection – SoC design requirements and specifications – design integration – design complexity – cycle time, die area and cost, ideal and practical scaling, area-time-power tradeoff in processor design, Configurability. Definition of IoT. Applications and Verticals. System Architecture.Typical Process Flows. Technological Enablers. The Open Standard Reference Model.IoT Software Stack. Design Constraints and Considerations. Sensors and Actuators. IoT Security. Analytics for IoT. Experiments using Wisense Platform.	16	L1
Unit-2 PROCESSOR SELECTION FOR SoC		
Overview – soft processors, processor core selection. Basic concepts – instruction set, branches, interrupts and exceptions. Basic elements in instruction handling – Minimizing pipeline delays – reducing the cost of branches – Robust processors – Vector processors, VLIW processors, Superscalar processors.	12	L2

Unit-3MEMORY DESIGN		
SoC external memory, SoC internal memory, Scratch pads and cache memory – cache organization and write policies – strategies for line replacement at miss time – split I- and D- caches – multilevel caches – SoC memory systems – board based memory systems – simple processor/memory interaction.	12	L3
Unit-4 INTERCONNECT ARCHITECTURES AND SOC CUSTOMIZATION		
Bus architectures – SoC standard buses – AMBA, CoreConnect – Processor customization approaches – Reconfigurable technologies – mapping designs onto reconfigurable devices - FPGA based design – Architecture of FPGA, FPGA interconnect technology, FPGA memory, Floor plan and routing.	10	L4
Unit-5 PIC MICRO CONTROLLER AND RASBERRY-PI		
Hardware software task partitioning – FPGA fabric Immersed Processors – Soft Processors and Hard Processors – Tool flow for Hardware/Software Co-design –Interfacing Processor with memory and peripherals – Types of On-chip interfaces – Wishbone interface, Avalon Switch Matrix, OPB Bus Interface, Creating a Customized Microcontroller - FPGA-based Signal Interfacing and Conditioning.	10	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to do: • Design and develop embedded systems (hardware, peripherals andfirmware). • Demonstrate embedded system applications. • Possess analytical and problem solving skills.		
Text Books: 1. Michael J. Flynn and Wayne Luk, "Computer System Design: System-on-Chip", John Wiley and sons, 2011.		

Reference Books:

1. Rahul Dubey, "Introduction to Embedded System Design Using Field Programmable Gate Arrays", Springer Verlag London Ltd., 2009.
2. SudeepPasricha and NikilDutt, On-Chip Communication Architectures - System on Chip Interconnect, Elsevier, 2008.

Online Resources:

Nil

COURSE NAME: VLSI SIGNAL PROCESSING						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- To make an in depth study of DSP structures amenable to VLSI implementation.
- To enable students to design VLSI system with high speed and low power.
- To make the students to implement DSP algorithm in an optimized method.

Prerequisites: Digital Circuits, VLSI Design

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1INTRODUCTION		
Overview of DSP – FPGA Technology – DSP Technology requirements – Design Implementation.	12	L1
Unit-2 METHODS OF CRITICAL PATH REDUCTION		
Binary Adders – Binary Multipliers – Multiply-Accumulator (MAC) and sum of product (SOP) – Pipelining and parallel processing – Retiming – Unfolding – Systolic architecture design.	12	L2
Unit-3ALGORITHMIC STRENGTH REDUCTION METHODS AND RECURSIVE FILTER DESIGN		
Fast convolution-Pipelined and parallel processing of recursive and adaptive filters – Fast IIR filters design.	12	L3
Unit-4 DESIGN OF PIPELINED DIGITAL FILTERS		
Designing FIR filters – Digital lattice filter structures – Bit level arithmetic architecture – redundant arithmetic – Scaling and round-off noise.	12	L4
Unit-5 SYNCHRONOUS ASYNCHRONOUS PIPELINING AND PROGRAMMABLE DSP		

Numeric strength reduction – Synchronous – Wave and asynchronous pipelines – Low power design – Programmable DSPs – DSP architectural features/ alternatives for high performance and low power.	12	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to: • Use DSP structures amenable to VLSI implementation. • Design VLSI system with high speed and low power. • Implement DSP algorithm in an optimized method.		
Text Books: 1. KeshabK.Parhi, "VLSI Digital Signal Processing Systems, Design and Implementation", John Wiley, Indian Reprint, 2007.		
Reference Books: 1. U. Meyer – Baese, "Digital Signal Processing with Field Programmable Arrays", Springer, Second Edition, Indian Reprint, 2007. 2. S.Y.Kuang, H.J. White house, T. Kailath, "VLSI and Modern Signal Processing", Prentice Hall, 1995.		
Online Resources: Nil		

COURSE NAME: TESTING OF VLSI CIRCUITS (DFT)						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:
To introduce the technology, Subsystem design concepts and testing of Very Large Scale Integrated Circuits.

Prerequisites: Digital Circuits, VLSI Design

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1BASICS OF TESTING AND FAULT MODELING		
Introduction - Need for testing - VLSI Testing Process and Test Equipment - Types of testing - ATE – ADVANTEST model T6682-Block Diagram and Specification– Electrical parametric testing – Single Stuck at faults.	9	L1
Unit-2 TEST GENERATION		
Faults in Digital circuits-failures and faults. Algorithms and Representations - Redundancy Identification (RID) - Test generation for combinational logic circuits-combinational ATPG-Boolean Difference Method-D-Algorithm-PODEM - FAN Algorithm.	9	L2
Unit-3 DESIGN FOR TESTABILITY		
Design for Testability – Ad-hoc design – generic scan based design – classical scan based design – system level DFT approaches.	9	L3
Unit-4 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.	9	L4
Unit-5 FAULT DIAGNOSIS		

Logical Level Diagnosis – Diagnosis by UUT reduction – Fault Diagnosis for Combinational Circuits – Self-checking design – System Level Diagnosis.	9	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to do: • Understand the basics of CMOS circuits and CMOS process technology • Identify the CMOS inverters and logic gates • Strategy for estimating the parameter from the characteristics • Design VLSI subsystems • Test the CMOS circuits.		
Text Books: 1. M.Abramovici, M.A.Breuer and A.D. Friedman, "Digital systems Testing and Testable Design", Jaico Publishing House, 2002. 2. M.L.Bushnell and V.D.Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers, 2002.		
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 HallInternational, 2002. 3. Neil H.E. Weste, "Principles of CMOS VLSI Design A Systems Perspective" Second Edition, 2000.		
Online Resources: Nil		

COURSE NAME: HARDWARE-SOFTWARE CO-DESIGN						
	L	**T**	**P**	**S**	Course Code	

Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- To introduce students to the process of designing application specific hardware implementations of algorithms for ASICs.
- Students will work with commercial computer aided design tools to synthesize designs described in hardware description languages.

Prerequisites: Digital Circuits, VLSI Design

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1SYSTEM SPECIFICATION AND MODELLING		
Embedded Systems, Hardware/Software Co-Design, Co-Design for System Specification and Modeling, Co-Design for Heterogeneous Implementation - Processor Synthesis, Single – Processor Architectures with one ASIC, Single-Processor Architectures with many ASICs, Multi-Processor Architectures, Comparison of Co-Design Approaches, Models of Computation, Requirements for Embedded System Specification.	9	L1
Unit-2HARDWARE/SOFTWARE PARTITIONING		
The Hardware/Software Partitioning Problem, Hardware-Software Cost Estimation, Generation of the Partitioning Graph, Formulation of the HW/SW Partitioning Problem, Optimization, HW/SW Partitioning based on Heuristic Scheduling, HW/SW Partitioning based on Genetic Algorithms.	9	L2
Unit-3HARDWARE/SOFTWARE CO-SYNTHESIS		
The Co-Synthesis Problem, State - Transition Graph, Refinement and Controller Generation, Distributed System Co-Synthesis.	9	L3
Unit-4 PROTOTYPING AND EMULATION		

Introduction, Prototyping and Emulation Techniques, Prototyping and Emulation Environments, Future Developments in Emulation and Prototyping, Target Architecture, Architecture Specialization Techniques, System Communication Infrastructure, Target Architectures and Application System Classes, Architectures for Control-Dominated Systems, Architectures for Data-Dominated Systems, Mixed Systems and Less Specialized Systems.	9	L4
Unit-5 DESIGN SPECIFICATION AND VERIFICATION		
Concurrency, Coordinating Concurrent Computations, Inter facing Components, Verification, Languages for System-Level Specification and Design System- Level Specification, Design Representation for System Level Synthesis, System Level Specification Languages, Heterogeneous Specification and Multi-Language Co-simulation.	9	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to do: • Design and synthesize a complex digital functional block, containing over 1,000 gates, using Verilog HDL. • Demonstrate an understanding of how to optimize the performance, area, and power of a complex digital functional block, and the tradeoffs between these.		
Text Books: 1. Ralf Niemann, "Hardware/Software Co-Design for Data Flow Dominated Embedded Systems", Kluwer Academic Pub, 1998.		
Reference Books: 1. Jorgen Staunstrup, Wayne Wolf, "Hardware/Software Co-Design: Principles and Practice" Kluwer Academic Pub, 1997. 2. Giovanni De Micheli, Rolf Ernst Morgon, "Reading in Hardware/Software Co-Design" Kaufmann Publishers, 2001.		

Online Resources:
Nil

COURSE NAME: CMOS ANALOG AND IO CIRCUIT DESIGN						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- This course aims to introduce the problems in implementing Analog and I/O circuits using CMOS.

Prerequisites:

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1MOS DEVICE ELECTRICAL OPERATION		
A Review of Electrical Operation. MOS Controlled Switch, MOS Diode. MOS Capacitor. MOS Active Resistor. Circuit Design Considerations for MOS. Supply Variation Effect. Device Size Effect. Temperature Variation Effect. High Frequency Effect. Device Noise. Current and Voltage Reference. MOS Current Mirrors. Supply-independent Biasing. Temperature-independent Biasing. Circuits using BiCMOS Device. Implementation and Case Studies. Circuit Layout Techniques. Supply Variation Effect. Device Sizing Effect. Temperature Variation Effect. Noise.	9	L1
Unit-2CMOS AMPLIFIER CIRCUITS		
Performance Metrics of Amplifier Circuits. Single-stage Inverting Amplifier Circuits. Two-stage Amplifier Circuits: Analysis and Design. Feedback Techniques. Phase-margin, Stability and Compensation. Cascode Device based Design. Circuits using BiCMOS Device. Special Purpose OPAMPs. High Frequency OPAMP. Low Voltage OPAMP. High Output Current OPAMP. Low Noise OPAMP. Implementation and Case Studies. Circuit Layout Techniques. Supply Variation Effect. Device Sizing Effect. Temperature Variation Effect. High Frequency Effect. Noise.	9	L2

Unit-3CMOS COMPARATOR CIRCUITS		
Performance Metrics of Comparator. Two-stage Comparator: Analysis and Design. Auto-zeroing of Comparator. Hysteresis of Comparator. Circuits using BiCMOS Device. Special Purpose Comparators. Regenerative Comparator. High Output Current Comparator. High Speed Comparator. Implementation and Case Studies. Circuit Layout Techniques. Supply Variation Effect. Device Sizing Effect. Temperature Variation Effect. High Frequency Effect. Noise.	9	L3
Unit-4 CMOS OSCILLATOR CIRCUITS		
Performance Metrics of Oscillator, Ring Oscillator. LC Oscillators. Voltage Controlled Oscillator. Frequency Coarse and Fine Tuning. Amplitude Calibration. Circuits using BiCMOS Device. Implementation and Case Studies. Circuit Layout Techniques. Supply Variation Effect. Device Sizing Effect. Temperature Variation Effect. High Frequency Effect. Noise.	9	L4
Unit-5 PACKAGING AND I/O PADS		
Integrated Circuit Packaging for Analog Circuits. Package Parasitics and Modelling. I/O Pad and ESD Structure. Implementation and Case Studies. Circuit Layout Techniques. Supply Variation Effect. Device Sizing Effect. Temperature Variation Effect. High Frequency Effect. Noise. Measurement of Circuit Specifications. Measurement Fixture Design. Supply-current and Return-current Path. Shielding, Sensing and Guard Voltage/Current. Special-purpose Measurement Techniques. OPAMP Specifications. Comparator Specifications. VCO Specifications.	9	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to do: • Implement Analog and I/O circuits using CMOS.		

Text Books: 1. "CMOS Analog Circuit Design," P. Allen and D. Holberg, Oxford University Press. 2. "Design of Analog CMOS Integrated Circuits," B. Razavi, Tata McGrawHill.
Reference Books: 1. "Analysis and Design of Analog Integrated Circuits," P. Gray, P. Hurst, S. Lewis and R. Meyer, Wiley. 2. "The Art of Analog Layout," A. Hastings, Prentice Hall.
Online Resources: Nil

COURSE NAME: CMOS MIXED SIGNAL DESIGN						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- This course aims to introduce the problems in implementing both in a single silicon wafer using analog and digital circuits.

Prerequisites: Digital Circuits, VLSI Design, Digital Signal Processing

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1NON-LINEAR ANALOG CIRCUITS		
Characterization of a comparator, basic CMOS comparator design, analog multiplier design, PLL – simple PLL, charge-pump PLL, applications of PLL. Switched Capacitor circuits – basic principles, some practical circuits such as switched capacitor integrator, biquad circuit, switched capacitor filter, switched capacitor amplifier, non-filtering applications of switched capacitor circuit such as programmable gate arrays, DAC and ADC, MOS comparators, modulators, rectifiers, detectors, oscillators.	9	L1
Unit-2SAMPLING CIRCUITS		
Basic sampling circuits for analog signal sampling, performance metrics of sampling circuits, different types of sampling switches. Sample-and-Hold Architectures: Open-loop & closed-loop architectures, open-loop architecture with miller capacitance, multiplexed-input architectures, recycling architecture, switched capacitor architecture, current- mode architecture.	9	L2
Unit-3DIGITAL TO ANALOG CONVERSION		

Input/output characteristics of an ideal D/A converter, performance metrics of D/A converter, D/A converter in terms of voltage, current, and charge division or multiplication, switching functions to generate an analog output corresponding to a digital input. D/A Converter architectures: Resistor-Ladder architectures, current-steering architectures.	9	L3
Unit-4 ANALOG TO DIGITAL CONVERSION		
Input/output characteristics and quantization error of an A/D converter, Performance metrics of A/D converter.A/D converter architectures: Flash architectures, two-step architectures, interpolate and folding architectures, pipelined architectures, Successive approximation architectures, interleaved architectures.	9	L4
Unit-5 ANALOG CMOS FILTERS		
Low Pass filters, active RC integrators, MOSFET-C integrators, transconductance-c integrator, discrete time integrators. Filtering topologies – bilinear transfer \function and biquadratic transfer function.	9	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to do: • Understand mixed signal circuits like DAC, ADC, PLL etc. • Apply the knowledge on filter design in mixed signal mode. • Design different architectures in mixed signal mode.		
Text Books: 1. Razavi, "Design of analog CMOS integrated circuits", McGraw Hill, 2001. 2. Razavi, "Principles of data conversion system design", S.Chand and company ltd, 2000		
Reference Books: 1. Jacob Baker, "CMOS Mixed-Signal circuit design", IEEE Press, 2002. 2. Gregorian, Temes, "Analog MOS Integrated Circuit for signal processing", John Wiley & Sons. 3. Baker, Li, Boyce, "CMOS : Circuit Design, layout and Simulation", PHI, 2000		

Online Resources: **Nil**

COURSE NAME: CMOS DIGITAL CIRCUIT DESIGN AND CHARACTERIZATION						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- This course aims to introduce the problems in implementing digital circuits using CMOS.

Prerequisites:

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1IMPLEMENTATION STRATEGIES FOR DIGITAL ICS		
Introduction, From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design Methodology, Standard Cell, Macrocells, Semi-Custom Design Flow, Array-Based Implementation Approaches, Pre-diffused (or Mask-Programmable) Arrays, Prewired Arrays, Perspective-The Implementation Platform of the Future.	8	L1
Unit-2 INTERCONNECTS		
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.	8	L2
Unit-3 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.	12	L3
Unit-4 DESIGNING BOOLEAN, SEQUENTIAL AND ARITHMETIC BUILDING BLOCKS		
Concept of Logical Effort based design, Design of Basic logic gates, Multiplexers using TG and CMOS logic, Sequential circuits like D-Flip Flop, Syncronous/Asyncronous Set and Reset circuits, Setup and Hold time calculation, Circuit Characterization. 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.	16	L4
Unit-5 DESIGNING MEMORY AND ARRAY STRUCTURES		
Introduction, Memory Classification, Memory Architectures andBuilding Blocks, The Memory Core, ReadOnly Memories, Non-volatile Read-Write Memories, Read-Write Memories (RAM), ContentsAddressable or Associative Memory (CAM), Memory Peripheral Circuitry, The Address Decoders, Sense Amplifiers, Voltage References, Drivers/Buffers, Timing and Control, Memory Characterization	12	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		

Course outcomes:
At the end of the course, the student will be able to do:

- Applythe concepts of CMOS for designing digital circuits.

Text Books:

1. Neil H. E. Weste and David. Harris Ayan Banerjee,, "CMOS VLSI Design" - Pearson Education.

Reference Books:
1. Sung-Mo Kang, Yusuf Leblebici,"CMOS Digital Integrated Circuits" TMH 2003
2. Jan M. Rabaey, "Digital Integrated Circuits" Pearson Education, 2003
3. Characterization and Modelling of Digital Circuits, by Rohit Sharma, Paripath.com (Available - Amazon.com)

Online Resources:

Nil

COURSE NAME: ANALOG AND MIXED SIGNAL VERIFICATION						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- This course aims to introduce the Analog and Mixed Signal Verification techniques.

Prerequisites:

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1INTRODUCTION TO ANALOG MIXED SIGNAL VERIFICATION		
Evolution of the verification methodologies, history of analog-mixed signal designs, applications, and future trends.Analog design fundamentals for digital design background engineers. Major focus is given on analog behavior, design criteria and their concept rather than design themselves, such as voltage/current reference, some of the basic key analog design properties such as gain, band width, basics of jitter, eye diagram, etc. Digital design flow, combinational and sequential logic design fundamentals, design for testability, concepts of timing, and timing verification.	12	L1
Unit-2ANALOG AND DIGITAL DESIGN VERIFICATION		

Analog performance verification and functional verification under the context of mixed signal design hierarchical verification rather than the detail performance analysis of the designs themselves. Tools and Methodologies that are evolved over the period that are predicated on predictable quality and verification efficiency. The chapter contains the sections on the coverage driven verification (CDV) methodology, assertion based verification (ABV) methodology, and overview of the CDV using Open Verification Methodology (OVM).	16	L2
Unit-3ANALOG MIXED SIGNAL VERIFICATION		
AMS verification phases, choosing the right abstraction of DUT for a given verification challenge, AMS verification planning, testplanning for AMS design verification, and testbench development with re-use in mind.	16	L3
Unit-4 ANALOG BEHAVIORAL MODELING		
Applications of analog behavioral models, modeling methodology, simple examples of various analog behavioralmodeling styles, selection of accuracy level of the models based on the verification plan, model verification, and signoff.	8	L4
Unit-5 LOW POWER VERIFICATION		
The purpose of this chapter is to explain the low power design verification challenges, key low power design elements, low power design techniques, low power design and verification cycle, testplanning for low power design verification, power aware digital, and AMS simulations.	8	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		

Course outcomes:
At the end of the course, the student will be able to do:

- Use the Analog and Mixed Signal Verification techniques to design digital circuits.

Text Books:

1. Analog-Mixed Signal Verification by BramhanandaMarathe (Available in Amazon)

Reference Books:

1. Analog-Mixed Signal Verification by BramhanandaMarathe (Available in Amazon)

Online Resources:

Nil

COURSE NAME: CMOS RF CIRCUIT DESIGN						
	L	**T**	**P**	**S**	Course Code	
Contact Hrs./Week	**3**	**0**	**0**	**0**	CIA Marks	**50**
Contact Hrs./Sem.	**45**				ESE Marks	**50**
Total Contact Hrs.	**45**				Exam Hours	**3 Hrs**
Credits.	**3**					

Course objectives:

- To educate students fundamental RF circuit and system design skills.
- To introduce students, the basic RF electronics utilized in the industry and how to build up a complex RF system from basis.
- To offer students experience on designing and simulating RF circuits in computer.

Prerequisites: Digital Circuits, VLSI Design

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy(RBT) Level**
Unit-1INTRODUCTION TO RF DESIGN AND WIRELESS TECHNOLOGY		
Design and Applications, Complexity and Choice of Technology. Basic concepts in RF design: Nonlinearly and Time Variance, Intersymbol interference, random processes and noise. Sensitivity and dynamic range, conversion of gains and distortion.	12	L1
Unit-2RF 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.	12	L2
Unit-3BJT 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.	12	L3
Unit-4 DESIGN OF CIRCUITS		

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.	12	L4
Unit-5 OSCILLATORS AND RF SYNTHESIZERS		
Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Resonator VCO designs, Quadrature and single sideband generators. Radio frequency Synthesizers- PLLS, Various RF synthesizer architectures and frequency dividers, Power Amplifier design, Liberalization techniques, Design issues in integrated RF filters.	12	L5
List of Experiments (if any)		
Self-study: Nil		
Site/Industrial Visits: Nil		
Course outcomes: At the end of the course, the student will be able to do: • Conduct simulations and experiments. • Design a system, component or process to meet desired needs. • Become proficient with computer skills (eg.,Multisim, HSPICE, Virtuoso) for the analysis and design of circuits.		
Text Books: 1. B. Razavi, "RF Microelectronics" PHI 1998.		
Reference Books: 1. R. Jacob Baker, H.W. Li, D.E. Boyce "CMOS Circuit Design, layout and Simulation", PHI 1998.		
Online Resources: Nil		

DETAILED SYLLABUS OF OPEN ELECTIVES

BUSINESS ANALYTICS

COURSE OBJECTIVE

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyse business data.
5. Use decision-making tools/Operations research techniques.
6. Manage business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

UNIT I

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics.
Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview

UNIT II

*Trendiness and Regression Analysis:*Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, visualizing and Exploring Data, Business Analytics Technology

UNIT III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.
Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model

UNIT V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism

COURSE LEARNING OUTCOMES:

The students will be able to

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modelling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights

TEXT BOOKS

- Business Analytics by James Evans, Pearson Education, II edition, 2016
- Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press, 2015

COST MANAGEMENT OF ENGINEERING PROJECTS

COURSE OBJECTIVE

Prepare engineering students to analyse cost/revenue data and carry out make economic analyses in the decision making process to justify or reject alternatives/projects on an economic basis

UNIT I

Introduction and Overview of the Strategic Cost Management Process

UNIT II

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making

UNIT III

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities.Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts.Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

UNIT IV

Cost Behaviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems.Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector.Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.
Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis

UNIT V

Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets.Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

COURSE LEARNING OUTCOMES:

The students will be able to

1. Carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives.

2. Perform and evaluate payback period and capitalized cost on one or more economic alternatives.

3. Perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives.

TEXT BOOKS

- Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 2009.
- N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2011.
- Charles T. Horngren,Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2012.
- Charles T. Horngren and George Foster, Management Accounting, Pearson Education Jan 2012.
- Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, Pearson Education Jan 2014.

COMPOSITE MATERIALS

COURSE OBJECTIVE

The course aims to teach students Principles of structural composite structures, combination of materials and rheological properties. Able to design composite structures, select composite materials, and to familiarise with properties and response of composite structures subjected to mechanical loading under static and cyclic conditions

UNIT I

INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites.Functional requirements of reinforcement and matrix.Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II

REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions

UNIT III

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostaticpressing.Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications

UNIT IV

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications

UNIT V

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

COURSE LEARNING OUTCOMES:

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

1. Identify, describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites. {L1}

2. Develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of fibre-reinforced composite products. {L4}

3. Analyse the elastic properties and simulate the mechanical performance of composite laminates; and understand and predict the failure behaviour of fibre-reinforced composites {L4}

4. Apply knowledge of composite mechanical performance and manufacturing methods to a composites design project {L3}
5. Critique and synthesise literature and apply the knowledge gained from the course in the design and application of fibre-reinforced composites.{L3}

TEXT BOOKS

- Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
- Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, Pearson Education Jan 2014.
- Hand Book of Composite Materials-ed-Lubin
- Composite Materials – K.K.Chawla.
- Composite Materials Science and Applications – Deborah D.L. Chung.
- Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi

INDUSTRIAL SAFETY

COURSE OBJECTIVE

The aim of this subject is to teach students about industrial safety and the fundamentals of maintenance engineering

UNIT I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment

UNIT III

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods

UNIT IV

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler,
vi. Electrical motors, Types of faults in machine tools and their general causes

UNIT V

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

COURSE LEARNING OUTCOMES:

TEXT BOOKS

- Higgins & Morrow, Maintenance Engineering Handbook, Da Information Services.

- H. P. Garg, Maintenance Engineering, S. Chand and Company.
- Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication.
- Winterkorn, Hans, Foundation Engineering Handbook, Chapman & Hall London

OPERATIONS RESEARCH

COURSE OBJECTIVE

- Define and formulate linear programming problems and appreciate their limitations.
- Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action.
- Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship.

UNIT I

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

UNIT II

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT III

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

UNIT IV

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming

UNIT V

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

COURSE LEARNING OUTCOMES:

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

- Apply the dynamic programming to solve problems of discrete and continuous variables.
- Apply the concept of non-linear programming.
- Carry out sensitivity analysis

TEXT BOOKS

- Pannerselvam, Operations Research: Prentice Hall of India 2010.
- J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008.
- H.A. Taha, Operations Research, An Introduction, PHI, 2008.
- H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.

- Hitler Libermann Operations Research: McGraw Hill Pub. 2009.
- Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010.

WASTE TO ENERGY

COURSE OBJECTIVE

The course deals with the production of energy from different types of wastes through thermal, biological and chemical routes

UNIT I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

UNIT II

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications

UNIT III

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation

UNIT IV

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors

UNIT V

*Biogas***:** Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

COURSE LEARNING OUTCOMES:

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

1. Classify different type of waste.{L1}
2. Understand the production of energy from different types of wastes through thermal, biological and chemical routes {L1}
3. Understand the properties of Biomass {L1}

TEXT BOOKS

- Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
- Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
- Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
- Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.