Advanced Communication System

(Core Subject-M.Tech, Elective Subject-B.Tech)

Course Code:	10M11EC111	**Semester:**	1 st Sem/7th sem , M.Tech/B.Tech (ECE)
Credits:	3	**Contact Hours:**	L-3, T-0, P-0

Course Objectives

The main objective of the course is to

1. Provide student with theoretical background and applied knowledge so that they can design an optimum Single and multi-carrier communication system under given power, spectral and error performance constraints.
2. Analyze the error performance of digital modulation techniques.
3. Explore M ary signaling

Course Outcomes

After studying this course the students would gain enough knowledge

1. Analyze the design parameters of a single and multi-carrier communication system.
2. Use mathematical tools to analyze the performance of communication systems.
3. Use probability theory and stochastic processes in communication system applications
4. Learn synchronization and adaptive equalization techniques.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	Introduction to analog and digital communication systems, communication channels and their characteristics, mathematical models for communication channels, deterministic and random signal analysis, baseband, band-pass and equivalent low-pass signal representations, orthogonal expansion of signals.	Proakis: Chapter 4	4
2.	Digital modulation Schemes: Gram Schmidt orthogonilazation procedure, Representations of digitally modulated signals, memory less modulation methods, PAM,PM,QAM, multidimensional signaling, Signaling scheme with memory, CPFSK,CPM, Power spectrum of Digitally modulated signals, PSD of a digitally modulated signals with memory, PSD of linearly modulated signals.	Proakis: Chapter 5	6
3	Optimum Receivers for AWGN Channels: Correlation demodulator, Matched filter	Proakis: Chapter 5	6

	demodulator, optimum detector, maximum likelihood sequence detector, A symbol by symbol MAP detector for signals, Probability of error calculations for binary modulation, M-ary PAM, M-ary PSK, QAM, orthogonal signals, biorthogonal signals. Optimum demodulation of CPM signals,		
4	Carrier and Symbol Synchronization: Likelihood function, carrier recovery and symbol synchronization in signal demodulation, ML carrier phase estimation, PLL, decision directed loops and non-decision directed loops, ML timing estimation, non-decision directed timing estimation, joint estimation of carrier phase and symbol timing.	Proakis: Chapter 6	6
5	Signal Design for Band Limited Channels: Characterization of band limited channels, design of band limited signals for no ISI, Design of band limited signals with controlled ISI, data detection for controlled ISI, signal design for channels with distortion, probability of error for detection of PAM with zero ISI and with partial response signals, .	Proakis: Chapter 10	6
6	Communication through Band Limited Linear Filter Channels: ML receiver for channels with ISI and AWGN, discrete time model for channel with ISI, Viterbi algorithm for discrete time white noise filter model, linear equalization – peak distortion criterion, MSE criterion and its performance, fractionally spaced equalizers, decision feedback equalization – coefficient optimization, performance characteristics.	Proakis: Chapter 11	6
7	Linear Predictive Coding (LPC): Basics of LPC, speech model-source filter model & signal processing consideration, LPC in voice conversion, vocoders, LPC analysis & synthesis filter, CELP (Code-Excited Linear Prediction), CSACELP(Conjugate-Structured Algebraic CELP).	B. P. Lathi: Chapter 3	5
8	Multicarrier Modulation Techniques: Multipath & fading in wireless communication systems, Doppler spread, delay spread, OFDM Vs (TDM, FDM, CDMA), building blocks of OFDM	Proakis: Chapter 12, 13	5

	transmitter & receiver, OFDM applications, direct sequence spread spectrum signals (DS-SS), frequency hopped spread spectrum signals (FH-SS), introduction to multicarrier (MC) DS-CDMA and time hopping TH/MC-CDMA.		
		Total Number of Lectures	44

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. Proakis, John G., Digital Communications, McGraw-Hill (2000).
2. Bernard SKLAR: “Digital communications”, Pearson

Reference Books

1. Simon Haykin: “Digital communications”, Wiley Publications
2. B.P Lathi: “Modern Analog & Digital Communication Systems”, Oxford Publication

Web resources

1. http://www.nptel.ac.in/courses/117101051/

ADVANCED SATELLITE AND FIBRE OPTIC COMMUNICATIONS

(Elective Subject)

Course Code:	**10M11EC112**	**Semester:**	**8th Semester, B. Tech (ECE)**
Credits:	**3**	**Contact Hours:**	**L-3**

Course Objectives

1. To introduce the concept of optical fiber communication system starting from the basics of electromangnetic engineering.
2. To make the students learn the basic characteristics of optical fibers and satellite communication systems.
3. Design a satellite communication system for given parameters.

Course Outcomes

After studying the course, the student would gain enough knowledge of

1. The working of optical and satellite communication systems.
2. The practical issues concerning the launch of satellites.
3. The modulation and multiplexing schemes involved in satellite communication systems.
4. The types of interference in launching the satellites.
5. The design of satellite communication system.

S.No	Unit	Content	Lecture
1	Introduction to optical communication system	Review of Maxell's Equations, wave propagation, boundary conditions, optical communication system, need of optical communication system, Advantage of optical fibre system, attenuation windows.	3
	Propagation in Dielectric Waveguides	Wave propagation in an inhomogeneous medium, planar and cylindrical optical waveguide, TE-mode of a symmetric step-index planar waveguide, power distribution and confinement factor,	5
2	Optical Fibre	Introduction, Step-index Fibres, Graded Index Fibres, Modes & Rays, Slab Wave Guide, Ray propagation in optical fibre, Ray propagation in step-index fibre, ray propagation in graded index fibre, modal analysis of an ideal step-index fibre, fractional modal power distribution, limitation of multimode fibre, effects of material dispersion, combine effects of multipath and material dispersion.	8
3	Characteristics, of optical fibre	Characteristic parameters of single mode fibre, dispersion in single mode fibre, attenuation in single-mode fibre, design of single mode fibre, signal degradation in optical fibre, attenuation, scattering losses, bending losses, dispersion.	6
4	Satellite Communication	Introduction to the satellite communication system, earth satellite geometry, orbits of the satellite communication, Geo-stationary and non-geostationary orbits, ground segment and space segment.	2
5	Launch vehicles	Principle of rocket propulsion, powered flight, injection into final orbit, propulsion system	2
6	Spacecraft	Design of spacecraft, primary power, thermal subsystem, telemetry, tracking and command, altitude control, system	3

		reliability, estimation of mass of communication satellite	
7	RF Link	General consideration of RF link, noise, limits of the link performance, satellite links: uplink and down link, composite performance, optimization of RF links, noise temperature, antenna temperature, overall system temperature and propagation factors	5
8	Modulation and multiplexing	System engineering consideration, FDMA, TDMA system, beam switching and satellite switched TDMA, comparisons of multiple access techniques	2
9	Satellite transponder	Function of the transponder, transponder implementation and its technical issues.	2
10	Earth station	Transmitters, receivers, antennas, tracking systems, terrestrial interface	2
11	Interference	Calculation of C/I for single interfering satellite, calculation of C/i for multiple interfering satellite, interference specifications and protection ratio, special problems of satellite communication: delay and data communication	4

Text books:

- J M senior, "Optical Fiber Communications: Principles and Practice", 3rd Edition Prentice Hall.
- Dennis Roddy, "Satellite Communications", 4th Edition, McGraw-Hill.

Reference Books:

- G E Keiser, "Optical Fiber Communication", McGraw-Hill.
- M Richharia, "Satellite Communication System", Macmillian.
- W L Pritchard et al, "Satellite Communication Systems Engineering", Pearson Education.

Evaluation Scheme

Test 1 - 15
Test 2 – 25
Test 3 - 35
Continuous Evaluation-25 (Att.-5, Assignments -10, Quiz/Presentation-10)
Total-100

Text Books

1. Fiber Optics and Optoelectronics, R.P. Khare Oxford University Press.
2. Fiber Optic Communication Systems, G. P. Agarwal, Third Edition, Wiley.

ADVANCED TELECOMMUNICATION NETWORKS

(Core Subject/Elective for B Tech)

Course Code:	10M11EC113	**Semester:**	1th Semester, M. Tech (ECE) 7th Semester, B. Tech (ECE)
Credits:	3	**Contact Hours:**	L-3, T-0, P-0

Course Objectives

1. Understand the fundamental terminology and architecture of data communication, and implementations of data communication.
2. Describe layered communication, the process of encapsulation, and message routing in network.
3. Understand the standards and protocols of data communication.
4. Identify several codes that are used for error detection and how error correction is accomplished. Describe a data link protocol and define how it controls the transfer of frames
5. Apply the knowledge to properly analyze and describe network performance issues.

Course Outcomes

At the end of this course a student should be able to

1. Identify, describe and give examples of the networking applications used in everyday tasks such as reading email or surfing the web.
2. Investigate the solutions to improve wireless network (from physical layer level to transport layer level) and discuss pros and cons.
3. Student will develop an understanding of the underlying structure of networks and how they operate.
4. Analyze the network and issues associated with it.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	Data Communication concepts and terminology, Wired vs Wireless, Circuit switching/ Packet switching, Transmission media, Connection oriented/connection less transmission, Errors.	Behrouz A. Forouzan Prakash C Gupta	5
2.	Network Architecture, OSI reference model, TCP/IP architecture, flow control and error control, Error detection and correction. Physical Layer: EIA-232-D	Behrouz A. Forouzan Prakash C Gupta	6
3	Data Link Layer: ARQ protocols – Stop and Wait ARQ, Go back N ARQ, Selective Repeat ARQ Transmission efficiency of ARQ protocols HDLC Data Link control. Random access – ALOHA, slotted ALOHA, CSMA, CSMA-CD and CSMA –CA. 4	Behrouz A. Forouzan Prakash C Gupta	6

4	Wireless LAN: Media Access control in wireless LAN, IEEE 802.11	Behrouz A. Forouzan Prakash C Gupta	5
5	Routing Protocols and Internet Protocols: IPv4-Addressing, Subnetting and Classless Addressing, Classless Inter-domain routing (CIDR). IPv6: Features and Addressing, IPv4 to IPv6 transition,	Behrouz A. Forouzan Prakash C Gupta	8
6	Transport Layer: TCP, UDP, Drawbacks of TCP for Reliable wireless Broadcast/Multicast, Congestion control.	Behrouz A. Forouzan Prakash C Gupta	6
7	Application Layer: DNS, FTP, SMTP and SNMP.	Behrouz A. Forouzan Prakash C Gupta	4
		Total Number of Lectures	**40**

Evaluation Scheme

1. Test 1 : 15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
   - 10 Marks : Class performance, Tutorials & Assignments
   - 10 Marks : Quizzes
   - 5 marks : Attendance

Text Books

1. Data Communication And Computer networks PHI : Prakash C Gupta.
2. Data communications and Networking Pearson Education: Behrouz A. Forouzan.

Reference Books

1. Data and Computer Communications, 9th edition, Pearson: William Stallings.
2. Computer Networks, Pearson Education, 4th edition: A. Tanenbaum.

VLSI Circuits and System Design (Core Subject)

Course Code:	10M11EC114	Semester:	M.Tech 1st Sem
Credits:	3	Contact Hours:	L-3, T-0,P-0

Course Objectives

The objectives are to study

1. To bring both Circuits and System views on design together.
2. It offers a profound understanding of the design of complex digital VLSI circuits, computer aided simulation and synthesis tool for hardware design.

Course Outcomes

After studying this course the students would gain enough knowledge

1. To learn concept of design rules.
2. To bring both Circuits and System views on design together. It offers a profound understanding of the design of complex digital circuits.
3. Synthesis of digital VLSI systems from register-transfer or higher level descriptions in hardware design languages.
4. To be aware about the trends in semiconductor technology, and how it impacts scaling and performance.
5. Understanding a hardware design language such as VHDL in detail – syntax as well as how it works under the hood for simulation and synthesis. To gain enough knowledge to design any circuit using CMOS and write HDL code for any circuit.

Course Contents

Unit	Topics	References (chapter number, page no. etc)	Lectures
1.	A Brief History and Need of Integrated Circuits, Complexity of VLSI Design: Design Hierarchy, VLSI Design Cycle, Physical Design Cycle, Analog Design Flow, Digital Design Flow, Introduction to MOS Technology and its Electrical Properties, Basic Logic gates : n FET, P FET, CMOS: NOT gate, NAND gate, NOR gate, Stick Diagram, Layout.	John P. Uyemura : Chapter 1, 2	2 4
2.	Basic MOS transistors, Enhancement mode transistor action, Depletion mode transistor action, nMOS fabrication, CMOS fabrication, Drain to source current I_{ds} versus voltage V_{ds} relationships (Non saturated region, Saturated region), MOS transistor transconductance g_m and output conductance g_{ds}, figure of merit, MOS resistance and capacitance, MOS transistor circuit model	Kang : Chapter 3	12
3	nMOS inverter, Determination of pull up and pull down ratio for an nMOS inverter driven by another n MOS inverter, CMOS inverter, DC Characteristics of the CMOS Inverter , Inverter Switching Characteristics, Power Dissipation, DC	Kang : Chapter 4, 5	8

	Characteristics: NAND and NOR Gates, NAND and NOR Transient Response, Analysis of Complex Logic Gates, Gate Design for Transient performance, MOS circuit design process(STICK DIAGRAMS)		
4	Transmission Gates **,** Gate Delays**,** Driving Large Capacitive loads**,** Logical Efforts**,** Mirror Circuits**,** Pseudo-nMOS**,** Tri State Circuits**,** Clocked CMOS**,** Dynamic CMOS Logic Circuits**,** Dual-Rail Logic Networks**,** BiCMOS	Uyemura : Chapter 4, 5	10
5	**System Specification Using Verilog HDL :** Basic Concepts, Structural Gate-Level Modeling**,** Switch-level Modeling**,** Design Hierarchies**,** Behavioral and RTL Modeling **General VLSI System Components:** Gates Adders (Half and Full)**,** Subtractors (Half and Full)**,** Multipliers**,** Binary Decoders**,** Equality Detectors and Comparators**,** Priority Encoder**,** Shift and rotation Operation**,** Latches**,** D Flip-Flop**,** Registers **System Specification using SPICE :** By programming and by circuit level **,**Gates (using Diodes, BJT and CMOS)	Uyemura : Chapter 6, 7	8
Total Number of Lectures			44

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
   - 10 Marks : Class performance & Assignments
   - 10 Marks : Quizzes
   - 5 marks : Attendance

Text Books

1. John P. Uyemura: Introduction to VLSI Circuits and Systems, Wiley Student Edition
2. Sung-Mo (Steve) Kang, Yusuf Leblebici, CMOS DIGITAL INTEGRATED CIRCUITS ANALYSIS & DESIGN 3rd Edition, Mc Graw-Hill 2003.J.

Reference Books

1. Bhasker , “A VHDL Primer”, Pearson Education, 3rd Edition
2. Adel S. Sedra, Kenneth C. Smith : Microelectronics Circuits, 5th Ed., Oxford University Press, 2004
3. Jan M. Rabaey et al , Digital Integrated Circuits : A design Perspective, 2nd Edition

Web Resources

1. URL1:- http://nptel.ac.in/courses/117106093/
2. URL2:- http://nptel.ac.in/courses/Webcourse-contents/IIT-Bombay/VLSI%20Design/Course%20Objective.html

ADVANCED DIGITAL SIGNAL PROCESSING

(Elective Subject)

Course Code:	10M11EC211	Semester:	7th Semester, B. Tech (ECE)
Credits:	3	Contact Hours:	L-3, T-0,P-0

Course Objectives

At the completion of this course, the student should have in depth knowledge of processing digital signals.

Course Outcomes

After the successful completion of the course, student should be able to:

1. Know the analysis of discrete time signals.
2. To study the modern digital signal processing algorithms and applications.
3. Have an in-depth knowledge of use of digital systems in real time applications
4. Apply the algorithms for wide area of recent applications.

Course Contents

Unit	Topics	References (chapter number, page no. etc)	Lectures
1.	Review of Discrete time signals and systems and frequency analysis of discrete time linear time invariant systems. Discrete time systems, analysis of discrete time linear invariant systems, implementation of discrete time systems, correlation of discrete time systems ,z-transforms, linear time invariant systems as frequency selective filters. Sampling	John G. Proakis	8
2.	The Discrete Fourier transforms its properties and applications. Frequency domain sampling, properties of DFT, linear filtering methods based on DFT, Frequency analysis of signals using the DFT,Radix-2 decimation in time domain and decimation in frequency domain algorithms.	John G. Proakis	8
3	Design of Digital filters, Design of FIR filters, Design of IIR filters, frequency transformations	R.Rabiner	6
4	Multirate digital signal processing, Decimation, interpolation, sampling rate conversion, filter	John G. Proakis	6

	design and implementation for multirate conversion, sampling rate conversion by an arbitrary factor, applications of multirate signal processing.		
5	Linear prediction and optimum linear filters, Forward and backward linear prediction, solution of the normal equations, wiener filters.	John G. Proakis	7
6	Power spectrum estimation, Non-parametric and parametric methods for power spectrum estimation.	John G. Proakis	7
		Total Number of Lectures	42

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. Digital Signal Processing Principles, Algorithms, and Applications John G. Proakis, Prentice-Hall International.Inc, 4th Edition, 2012.

2. Theory and Application of Digital Signal Processing by Lawrence R.Rabiner and Bernard Gold.

Reference Books

1. Oppenheim, Alan V. Discrete-time signal processing. Pearson Education India, 1999.

2. Mitra, Sanjit Kumar, and Yonghong Kuo. Digital signal processing: a computer-based approach. Vol. 2. New York: McGraw-Hill Higher Education, 2006.

Advanced Wireless and Mobile Communication

(Elective Subject)

Course Code:	10M11EC212	**Semester:**	2rd Sem. M. Tech (ECE) 8th Sem. B. Tech (ECE)
Credits:	3	**Contact Hours:**	L-3, T-0,P-0

Course Objectives

1. To make students familiar with fundamentals of mobile communication systems.
2. To identify the limitations of 2G and 2.5G wireless mobile communication and the design of 3G and beyond mobile communication systems.
3. To understand the fading and shadowing concept in wireless communication system.
4. To understand the multicarrier and multi-antenna advantages in wireless communication.
5. To become familiar with the diversity and equalization concepts in wireless channel.

Course Outcomes

Upon successful completion of this course the students will have developed following skills/abilities

1. Understanding of various generations of mobile communication technologies.
2. Concept of cellular communication technology.
3. Basics of wireless communication.
4. Knowledge of GSM mobile communication standard, its architecture, logical channels, advantages and limitations.
5. Knowledge of 3G and 4G mobile standards and their architectures.
6. The difference among the different generations of mobile standards.
7. Concept of multicarrier communication systems.
8. Multiple antenna concept in wireless communication to combat fading and to increase the channel capacity.

Course Contents

Unit	Topics	References	Lectures
1.	Introduction to Wireless Communication System: Evolution of Mobile Radio Communications, Cellular Phone Standards: 1G, 2G, 2.5G and 3G, FDD, TDD, FDMA, TDMA, CDMA, Cellular Telephone Systems, How a Cellular Telephone Call is Made.	T S Rappaport	2
2.	The cellular Concept – System Design Fundamentals: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity: co-channel interference, adjacent channel interference, Trunking and Grade of Services, Improving Coverage & Capacity in Cellular System: cell splitting, sectoring and microcell concept.	T S Rappaport	4
3.	Mobile Radio Propagation-Path Loss & Shadowing: Radio Wave Propagation, Transmit and Receive Signal Models, Free Space Path Loss, Indoor and	T S Rappaport, A. Goldsmith	7

	Outdoor Propagation Models, Combined Path Loss & Shadowing, Outage Probability under Path Loss & Shadowing.		
4.	Mobile Radio Propagation-Small Scale Fading and Multipath: Small Scale Multipath Propagation, Factors affecting Small Scale Fading, Doppler Shift, Impulse Response Model of a Multipath Channel, Parameters of Mobile Multipath Channel, Types of Small Scale Fading: flat fading, frequency selective fading, slow fading and fast fading, Capacity of AWGN, Flat Fading and Frequency Selective Channels.	T S Rappaport, A. Goldsmith	7
5.	Diversity & Equalization: Diversity System Model, Receiver Diversity: selection diversity, feedback diversity, maximal ratio combining, equal gain combining, Equalizers, Types of Equalizers: linear equalizers, non-linear equalizers.	T S Rappaport, A. Goldsmith	7
6.	GSM System Architecture: GSM Channel Types, Traffic Channel, Control Channel, Frame Structure for GSM, Authentication Mechanism in GSM.	T S Rappaport, A. Goldsmith, J. Schiller, J. Tisal	4
7.	Introduction to OFDM and MIMO wireless communication: Introduction to OFDM, OFDM Block Diagram, MIMO Wireless Communication, Benefits of MIMO Technology, MIMO OFDM Building Block, STBC: Almounti code, Capacity Comparisons of SISO, SIMO, MISO, and MIMO.	D.Tse & P. Viswanath, E. Biglieri	5
8.	3G and 4G Networks Architecture: UMTS Network Architecture, UMTS Radio Interface, UTRAN, Handover, LTE Network Architecture, Air Interface and Radio Network, LTE Advanced, 802.16 WiMAX: Network architecture, Air Interface and Radio Network, Basic procedures.	J. Schiller, M. Sauter, S. G. Glisic	6
		Total Number of Lectures	**42**

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Reference Books

1. T. S. Rappaport: Wireless Communications, PHI, 2002.
2. Jochen Schiller : Mobile Communication , Pearson.
3. Raymond Steel : GSM, cdma one and cdma 2000, Wiley.
4. Andrea Goldsmith : Wireless Communications , Cambridge University Press.
5. Jochim Tisal : GSM Network: GPRS evolution one step towards UMTS , John Wiley & Sons.
6. David Tse & Pramod Viswanath: Fundamentals of Wireless Communication , Cambridge University Press.
7. Ezio Biglieri : MIMO Wireless Communications, Cambridge University Press.
8. Martin Sauter: Beyond 3G Bringing Networks, Terminals and the Web Together , John Wiley & Sons.
9. Savo G. Glisic: Advanced Wireless Communications, John Wiley & Sons

INFORMATION AND CODING THEORY

(Core Subject)

Course Code:	10M11EC213	**Semester:**	2nd Semester, M. Tech (ECE)
Credits:	3	**Contact Hours:**	L-3, T-0, P-0

Course Objectives

The objectives are to study

1. To bring both Circuits and System views on design together.
2. It offers a profound understanding of the design of complex digital VLSI circuits, computer aided simulation and synthesis tool for hardware design.

Course Outcomes

After studying this course the students would gain enough knowledge

1. Understand the static and dynamic behavior of MOSFETs (Metal Oxide Semiconductor Field Effect Transistors) and the secondary effects of the MOS transistor model.
2. To be aware about the trends in semiconductor technology, and how it impacts scaling and its effect on device density, speed and power consumption.
3. To understand MOS transistor as a switch and its capacitance.
4. Student will be able to design digital systems using MOS circuits (Static and Switching characteristics of inverters)
5. Able to learn Layout, Stick diagrams, Fabrication steps.
6. Understand the concept behind ASIC (Application Specific Integrated Circuits) design and the different implementation approaches used in industry.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	Introduction to Information Theory, Uncertainty and information Theory, Average and mutual information, Entropy, information measures for continuous random variables, source coding theorem, Huffman coding, Shannon-Fano-Elias coding, Arithmetic Coding, Lempel-Ziv Algorithm, Run length encoding	Text Book 1: Chapter 1	6
2.	Channel capacity and Coding - Introduction, channel models, channel capacity, information capacity theorem, parallel Gaussian channels, Shannon limit, channel capacity for MIMO systems	Text Book 1 : Chapter 2	6
3	Error control coding (channel coding) - Linear	Text Book 1 : Chapter 3	10

	Block Codes for Error Correction: introduction, basic definitions, matrix description of linear block codes, equivalent codes, parity check matrix, decoding of linear block codes, syndrome decoding, error probability after coding, Hamming codes, Low Density Parity Check Codes, Optimal Linear Codes, Maximum distance separable codes, Space Time Block Codes.		
4	Cyclic Codes - Introduction, generation of cyclic codes, matrix description of cyclic codes fire codes, Golay codees, CRC codes.	Text Book 1 : Chapter 4	6
5	Bose-Chaudhuri Hocquenghem(BCH) codes - Introduction, Primitive elements, minimal polynomials, Reed-Solomom Codes	Text Book 1 : Chapter 5	6
6	Space-Time Codes - Introduction, Space-time code design criteria	Text Book 1: Chapter 6	4
7	Convolutional Codes - Introduction, Tree codes and Trellis codes, Matrix description, Viterbi decoding	Text Book 1: Chapter 6	4
		Total Number of Lectures	42

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. Information Theory, Coding and Cryptography, Ranjan Bose, Third edition, TMH.
2. Information theory and Reliable communication, Robert G. Gallager, Wiley.

ECE DESIGN AND SIMULATION LAB-1

(Core Subject)

Course Code:	10M17EC171	Semester:	1st Semester, M. Tech. (ECE)
Credits:	2	Contact Hours:	L-0, T-0,P-2

Course Objectives

The objectives are to study:

1. The steps involved in the designing and simulation of a communication system.
2. To know how to design model for a digital electronic circuit.

Course Outcome

1. To equip with engineering skills by way of breadboard circuit design with electronic devices and components.

2. Have confidence in designing an electronic circuit from scratch and able to demonstrate the practical aspects of basic electronics theory.

3. Simulate and test the Analog, Digital and mixed Electronics circuits using OrCAD/PSPICE software.

List of Experiments

1. Introduction to MATLAB programming.
2. To generate Amplitude modulated signal:
   i) To observe an under-modulated signal.
   ii) To observe a perfect modulated signal.
   iii) To observe an over modulated signal.

3. To generate a Frequency modulated signal:
   i) Vary the frequency deviation and observe the changes in modulated wave.

4. To generate a Pulse code modulated signal.
5. To study Huffman Coding.
6. To generate a Binary phase shift keying signal.
7. To make a project in MATLAB.
8. Introduction to XILINX Programming.
9. To write a Verilog HDL programme for half adder.

10. To write a Verilog HDL programme for full adder.
11. To write a Verilog HDL programme for full adder using half adders.
12. To write a Verilog HDL programme for 2:1 multiplexer and 4:1 multiplexer.
13. To write a Verilog HDL programme for 4:1 multiplexer where the inputs and output are 8 bits.
14. To write a Verilog HDL programme for 4 bit binary numbers addition and subtraction using conditional statement.
15. To make a project in Verilog HDL.

Evaluation Scheme

1.	Mid Sem Evaluation	20 Marks
2.	End Sem Evaluation	20 Marks
3.	Attendance	15 Marks
4.	Class response	30 Marks
5.	File	15 Marks
	Total Marks	**100 Marks**

Text Books

1. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”, Second Edition, Prentice Hall PTR (2003).

ECE DESIGN AND SIMULATIONS LAB-II

(Core Subject)

Course Code:	10M17EC271	Semester:	2nd Semester, M. Tech (ECE)
Credits:	2	Contact Hours:	L-0, T-0,P-2

Course Objectives

At the completion of this course, the student should be able to design and test the analog and digital circuits.

Course Outcomes

At the completion of this course, the student should be able to:

1. Analyze and synthesis analog and digital circuits by writing the PSPICE code and using the CAPTURE.
2. Use the knowledge acquired through this lab to design blocks that are used in communications systems and integrated circuits.
3. To use the knowledge acquired in this lab in the project related works in future.

List of Experiments

1 To perform different types of analysis on a given circuit which contains resistors and reactive elements.

2 To obtain the Thevenin's and Norton's equivalent circuits for a given circuit which contains dependent and independent sources.

3 To design simple RC/RL integrator and differentiation circuits for a given input signal. Obtain the frequency characteristics of integrator and differentiation as well.

4 To obtain the series resonant and shunt resonator circuits. To design different types of damping circuits using RLC series and shunt resonance.

5 To design an half-wave and full wave rectifier.

6 To design and obtain the voltage transfer characteristics of a positive, negative and double sided clippers.

7 To obtain the transistor input and output characteristics for common base, common emitter and common collector configurations.(Both npn and pnp transistors).

8 To design different transistor biasing circuits.

9 To obtain series and shunt feedback amplifiers-Frequency response, Input and output impedances.

10 Study transistor phase shift oscillator and observe the effect of variation in R andC on oscillator frequency and compare with theoretical value.

11 To design bi-stable and mono-stable and astable multi-vibrators using transistors.

12 To design inverting, non-inverting amplifiers using an op-amp. To obtain the transfer characteristic of an op-amp in open loop and design a voltage reference circuit.

13 To design active LPF and HPF using op-amp and to design a Schmitt trigger circuit.

14 To design Wien bridge, Colpits and Hartelys oscillators using op-amp.

15 To design astable and mono stable multi vibrator circuits using IC555 timer.

16 To design LC filters and compare their magnitude and phase responses.

17 To design a basic NAND and NOR TTL family circuits.

18 To design the basic CMOS NAND and NOR circuits and observe the wave forms.

19 To obtain the timing diagrams for basic gates and universal gates. To design a 4 to 1 multiplexer.

20 To design a digital to analogue converter.

Evaluation Scheme

1. Mid Sem Evaluation	20 Marks
2. End Sem Evaluation	20 Marks
3. Attendance	15 Marks
4. Class response	30 Marks
5. File	15 Marks
Total Marks	**100 Marks**

Text Books

1 Rashid, Muhammad H. Introduction to PSpice using OrCAD for circuits and electronics. Prentice-Hall, Inc., 2003.

2 Tobin, Paul. PSpice for Circuit Theory and Electronic Devices. Morgan & Claypool Publishers, 2007.

FAUT-TOLERANT SYSTEMS

(Elective Subject)

Course Code:	11M1WEC433	**Semester:**	3rd Semester, M. Tech (ECE)
Credits:	3	**Contact Hours:**	L-3, T-0, P-0

Course Objectives

The objectives are to study

1. This course focuses on the design of fault-tolerant and reliable systems.
2. It covers the concepts and terminologies of Fault-Tolerant System Design including: Reliability, Dependability, Maintainability etc.

Course Outcomes

After studying this course the students would gain enough knowledge

1. Introduction to availability, reliability, dependability etc.
2. Evaluation of dependability and reliability.
3. Knowledge about reliability block diagram and fault tree.
4. Application of fault-tolerance techniques.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	Define common terms such as availability, reliability, dependability etc.	Shooman: Chapter 2, 3	6
2.	List common threats to dependability and their mitigation methods	Shooman : Chapter 4	11
3	Solve reliability block diagrams involving series, parallel and networks of components. Apply the laws of discrete probability to evaluating systems	Shooman : Chapter 5	11
4	Evaluate simple redundancy schemes through the laws of continuous probability, provided the failures are exponentially distributed.	Shooman : Chapter 6 Uymera : Chapter 10	11
5	Apply fault-tolerance techniques such as error correcting circuits and duplicate execution to the design of hardware systems.	Shooman : Chapter 7	8

		Total Number of Lectures	47

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. Martin L. Shooman, Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design, Wiley 2002.

Reference Books

1. Israel Koren C. Krishna, Fault-Tolerant Systems 1st Edition, Morgan Kaufmann

REAL-TIME EMBEDDED SYSTEM

(Elective Subject)

Course Code:	12M1WEC232	**Semester:**	B.Tech.(8th Sem.), M.Tech. (2nd Sem.)
Credits:	3	**Contact Hours:**	L-3, T-0, P-0

Course Objectives

The objectives are to study

1. Introduction of the real-time systems.
2. Computing required for the real-time embedded systems.
3. Communication required for the real-time embedded systems.

Course Outcomes

After studying this course the students would gain enough knowledge

1. To present the mathematical model of the system.
2. To develop real-time algorithm for task scheduling.
3. To understand the working of real-time operating systems and real-time database.
4. To work on design and development of protocols related to real-time communication.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	**Introduction:** Applications of real-time systems, basic model and characteristics of a real-time system, safety and reliability, types of real-time tasks.	[1,chapter 1(1-22)], [2,3]	3
2.	**Modeling Timing constraints:** Timing constraints, events, classifications, modeling timing constraints.	[1,chapter 1(23-40)], [2,3]	3
3	**Scheduling Real-Time Tasks:** Task scheduling types, Types of Schedulers, clock driven, table-driven, Cyclic, EDF, RMA	[1,chapter 2(41-73)], [2,3]	5
4	**Handling Resource sharing among real-time tasks:** Resource sharing among real-time tasks, inversion, HLP,PCP	[1,chapter 3(74-97)], [2,3]	5
5	**Scheduling Real-Time Tasks in Multiprocessor and Distributed systems:** Multiprocessor task allocation, dynamic allocation of tasks, fault-tolerant scheduling of tasks, clocks in distributed real-time systems	[1,chapter 4(98-104)], [2,3]	5
6	**Real-time operating systems:** Features of real-time operating systems, time services	[1,chapter 5(1-40)], [2,3]	4
7	**Real-Time Communication:** Types of networks, QoS, traffic categorization, LAN architecture, soft and hard real-time	[1,chapter 7(139-177)], [2,3]	5

	communication, QoS framework, routing, resource reservation, rate control, QoS models.		
8	**Real-Time Databases:** Review, design issues, consistency, concurrency control, commercial real-time databases.	[1,chapter 8(178-190)], [2,3]	4
9	**Study of Practical Systems:** Networked control systems, cyber-physical system, controller area network.	[1,chapter 8], [2,3]	3
		Total Lecture	**42**

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. Rajib Mall, Real-Time Systems: Theory and Practice, Pearson Education, 2007.

Reference Books

1. C. Siva Ram Murthy and G. Manimaran, 'Resource Management in Real Time Systems and Networks', the MIT Press, 2001.

Fundamentals of MIMO Systems

(Core Subject)

Course Code:	12M1WEC432	Semester:	4th Sem. M. Tech (ECE)/DD
Credits:	3	Contact Hours:	L-3, T-0, P-0

Course Objectives

The main objective of the course is to

1. To make students familiar with fundamentals of wireless communication systems.
2. To understand the diversity and spatial multiplexing phenomenon in MIMO system.
3. To understand the receiver system design for MIMO.
4. To become familiar with OFDM and MIMO-OFDM systems.

Course Outcomes

After studying this course the students would gain enough knowledge of

1. Emerging issues for implementing MIMO wireless channels.
2. Different fading channel distributions in multipath wireless channel.
3. OSTBC design for multiple antenna system.
4. Computation of performance parameters of MIMO wireless system.

Course Contents

Unit	Topics	References (chapter number, page no. etc)	Lectures
1.	Overview of Probability and Stochastic Processes: Probability distributions, Statistical averages and Random variables, Binomial distribution, Chi-square distribution, Rayleigh distribution, Rice distribution, Nakagami m-distribution, Central limit theorem, etc.	Haykin: Chapter 8	2
2.	Overview of Wireless Channel and Fading: Multi-path and Time-varying channel impulse response, Inter-Symbol-Interference, Narrowband fading, Envelope and power distribution, Level-crossing Rate and Average fading duration, Wideband fading, slow and fast-fading, Delay Spread and Coherence Bandwidth, Doppler Spread and Channel Coherence Time, Rayleigh fading, Rician fading, m-Nakagami fading	Goldsmith: Chapter 3	5
3	MIMO-I: Diversity: Temporal diversity, Frequency diversity, Spatial diversity, Multiplexing gain, Diversity gain, Analysis of receiver diversity, Combining schemes :	Goldsmith: Chapter 7, Kshetrimayum: Chapter 1	8

	Selection, Threshold, Maximal ratio, Equal gain, Transmitter diversity: with and without channel state information, Alamouti scheme, Diversity Analysis		
4	MIMO-II: Principles: Multi-antenna system and its advantages, MIMO channel and signal model, MIMO channel capacity, MIMO system model, Analysis of BER of multiple antenna system with diversity, Zero-forcing receiver; drawbacks, MIMO-MMSE receiver; properties and advantages	Goldsmith: Chapter 7, 10, Kshetrimayum: Chapter 3,5	8
5	MIMO-III: Multiplexing Architectures: Decomposition of MIMO channel; Singular value decomposition (SVD), Optimal MIMO power allocation, MIMO system capacity, Transmit beamforming, Orthogonal space-time code (OSTBC), Alamouti code, Non-linear MIMO receiver; V-BLAST; SIC, MIMO beamforming; maximal ratio transmission.	Kshetrimayum: Chapter 7,8, 9, 10	9
6	Orthogonal Frequency Division Multiplexing (OFDM): Multicarrier modulation (MCM); schematic; detection, Comparison of single carrier and multicarrier transmission, bottleneck in MCM, OFDM schematic and cyclic prefix, Loss in efficiency, Frequency offset in OFDM; ICI, Peak to average power ratio (PAPR) in ODFM, Single-carrier (SC)- FDMA; schematic, subcarrier mapping, BER performance of OFDM. MIMO-ODFM; schematic.	Goldsmith: Chapter 12	5
7	Applications of MIMO and OFDM: Long term evolution (LTE) and WiMAX; features, OFDMA, Channel dependent scheduling, Resource allocation, Puncturing, H-ARQ, Frequency shift transmit diversity, Network architecture, frame structure, Protocol stack	Kshetrimayum: Chapter 4, 12	5
		Total Number of Lectures	42

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks

- 10 Marks : Class performance, Tutorials & Assignments
- 10 Marks : Quizzes
- 5 marks : Attendance

Text Books

1. Goldsmith, Andrea, "Wireless Communications", Cambridge University press (2005).
2. Rakhesh. S. Kshetrimayum: "Fundamentals of MIMO Wireless Communications", Cambridge University press, 2017
3. Haykin, Simon, "An introduction to analog and digital communications" John Wiley & Sons.

Reference Books

1. Space-Time coding: theory and Practice, Hamid Jafarkhani, Cambridge University Press, 2005.
2. MIMO: From Theory to Implementation, ALain Sibille, Claude Oestges, and Alberto Zanella, Academic Press, 2013.
3. Fundamentals of Wireless Communication, David Tse and Pramod Viswanath, Cambridge University Press, 2005.
4. MIMO Wireless Communications, Ezio Biglieri, Robert Calderbank, Anthony Constantinides, Andrea Goldsmith, Arogyaswami Paulraj, and H. Vincent Poor, Cambridge University Press, 2007.

Web resources

1. nptel lecture on MIMO, OFDM and wireless.

MATHEMATICAL TECHNIQUE FOR ENGINEERS

Course Code:	13M1WEC132	Semester:	1st Semester, M. Tech. (ECE)
Credits:	3	Contact Hours:	L-3, T-0,P-0

Pre-requisites: Higher Engineering Mathematics

Course Objectives:

The primary objective of this course is to provide the knowledge of mathematical tools which are useful for engineers.

Course Outcomes

Upon successful completion of this course the students will be able:

1. To develop a mathematical model for different physical problems.
2. To understand the vector spaces, and vectors, and their properties.
3. To understand the different decomposition methods.
4. To develop an algorithm using mathematical technique for the solution of the research problems of the areas like biomedical signal processing, radar signal processing, and communications etc.

Course Contents :

Unit	Topics	Text book	Lectures
1.	Introduction to Systems of Linear Equations Gaussian Elimination Matrices and Matrix Operations Inverses; Algebraic Properties of Matrices Elementary Matrices and a Method for Finding More on Linear Systems and Invertible Matrices Diagonal, Triangular, and Symmetric Matrices Applications of Linear Systems Network Analysis (Traffic Flow) Electrical Circuits Balancing Chemical Equations Polynomial Interpolation Leontief Input-Output Models	**[1] [5]**	**08**
2.	Euclidean Vector Spaces Vectors in 2-Space, 3-Space, and n-Space Norm, Dot Product, and Distance in Rn Orthogonality The Geometry of Linear Systems	**[1] [5]**	**06**

	Cross Product		
3.	Real Vector Spaces, Subspaces, Linear Independence, Coordinates and Basis, Dimension, Change of Basis, Row Space, Column Space, and Null Space, Rank, Nullity, and the Fundamental Matrix Spaces, Matrix Transformations from to Properties of Matrix Transformations,	**[1] [5]**	**08**
4.	Eigen values and Eigenvectors, Diagonalization, Complex Vector Spaces, Differential Equations, Inner Products, Angle and Orthogonality in Inner Product Spaces, Gram–Schmidt Process; QR-Decomposition, Best Approximation; Least Squares Least Squares Fitting to Data, Function Approximation; Fourier Series, Orthogonal Matrices, Orthogonal Diagonalization Quadratic Forms, Optimization Using Quadratic Forms, Hermitian, Unitary, and Normal Matrices	**[1] [5]**	**08**
5.	Laplace Transform, Z-transform, Fourier Transform, DTFT, DFT, DCT, DST, STFT, and CWT with applications	**[2][4]**	**06**
6.	Basic Probability Concepts, Random variables, Special Probability Distributions	**[3][6]**	**06**
	Total Lectures		**42**

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Evaluation Scheme

1. Test 1 : 15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    1. 10 Marks : Class performance, Tutorials & Assignments
    2. 10 Marks : Quizzes
    3. 5 marks : Attendance

Text Books

1. Harword & Chriss Rorrers, "Elementary Linear Algebra".John Wiley & Sons,
2. Proakis, John G. Digital signal processing: principles algorithms and applications. Pearson Education India.
3. Oliber C. lbe "Fundamentals of Applied Probability and Random Processes" 2nd Edition, Academic Press is an imprint of Elsevier
4. S.Salivahanan, A, Vallavaraj, C Gnanapriya, "Digital Signal Processing", ,Tata McGraw-Hill Education, 2010

REFERENCE BOOKS

5. Kenneth Hoffman, "Linear Algebra" 2nd edition, PHI Publishers
6. Hayes, Monson H. Digital signal processing Tata McGraw-Hill edition 2004

ADVANCE NEURAL NETWORKS

(Elective Subject)

Course Code:	13M1WEC231	**Semester:**	M. Tech. (ECE), 2nd year
Credits:	3	**Contact Hours:**	L-3, T-0, P-0

Course Objectives

1. To understand the fundamental theory and concepts of neural networks, neuro-modeling, several neural network paradigms and its applications.
2. Expose the students to neural network applications in engineering design.

Course Outcomes

Upon completion of the course, the student are expected to

1. Comprehend the fundamental theory and concepts of neural networks, and compare Biological neuron and artificial neuron networks.
2. Assess the power and usefulness of artificial neural networks and identify different neural network architectures, algorithms, applications and their limitations.
3. Select appropriate neural network architectures for a given application (i.e. they shall recognize the class of applications and relate it to specific architectures).
4. To understand Reveal different applications of these models to solve engineering and other problems as pattern matching, control, optimization, and other areas.
5. Study and analyze a research paper on application of Neural networks and must orally present their projects in the class.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	INTRODUCTION TO NEURAL NETWORKS: Artificial Neural Networks (ANN) and their biological roots and motivations. Comparison Between Artificial and Biological Neural Networks, Applications of Neural network. Network Architecture, Taxonomy of neural networks: feed forward and recurrent networks.	Haykins Chapter 1 Sivanandam Chapter 1 and 2	6
2.	LEARNING PROCESS: Types of learning, Error Correction learning, Memory based learning, Boltzmann learning, Credit Assignment Problem. Learning paradigms: supervised and unsupervised learning laws. Learning Laws : Hebb's rule, Delta rule, Widrow - Hoff (The Least-Mean-Square) learning rule, correlation learning rule, instar	Haykins Chapter 2 Sivanandam Chapter 2 and 3	10

	and outstar learning rules, Competitive learning, Learning Tasks.		
3.	SUPERVISED LEANING: The Perceptron and its learning law, Classification of linearly separable patterns, Multi-Layer Perceptron, Supervised Learning, Back-Propagation Learning law. Feed forward networks, Recurrent Networks. RADIAL BASIS FUNCTION Neural Networks, Memory based learning, , Boltzmann learning.	Sivanandam Chapter 3,4 Haykin Chapter 3 ,4, 5	12
4.	UNSUPERVISED LEANING: Winner takes-all Networks, Competitive Learning, Kohonen's Self organizing Maps Self-organizing Feature-Mapping Algorithm; Properties of SOM algorithms; Examples of Feature Maps; Applications and Adaptive Resonance Theory.	Sivanandam Chapter 5 Haykin Chapter 9,14	8
5.	APPLICATIONS OF NN:ANNs as signal processing devices: Classification, Function approximation and pattern recognition problems. Solving Optimization Problems, Solving Traveling Salesman Problems. Application in Handwritten Character Recognition, Biomedical, Communication, and Healthcare.	Sivanandam Chapter 5,6	5
6.	One project- Research paper or design engineering problem		3
		Total Number of Lectures	**44**

Evaluation Scheme

1. Test 1 : 15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
   - 10 Marks : Class performance, Tutorials & Assignments
   - 10 Marks : Quizzes
   - 5 marks : Attendance

Text Books

1. Simon Haykin, "Artificial Neutral Networks".
2. Yegna Narayanan, "Artificial Neural Networks".
3. S.N.Sivanandam, S.Sumathi, "Introduction to Neural Networks using MATLAB".

4. S.N.Sivanandam, S.N Deepa, “Principles of Soft Computing”.

Reference Books

1. L. Fausett, “Fundamentals of Neural Networks: Architectures, Algorithms, and Applications”, Prentice-Hall, 1994
2. Jack M. Zurada, “Introduction to Artificial Neural Systems”, PWS Publishing Co., Boston, 2002.

ONLINE MATERIAL

http://nptel.ac.in/courses/117105084/

http://nptel.ac.in/courses/106105079/

ANTENNA THEORY AND TECHNIQUES
(Elective Subject)

Course Code:	13M1WEC334	**Semester:**	3rd Semester, M. Tech (ECE)
Credits:	3	**Contact Hours:**	L-3

Course Objectives

1. Understanding of antenna fundamentals
2. Ability to design, synthesize and analyze the performance of various antenna types.

Course Outcomes

1. The ability to understand important and fundamental antenna engineering parameters and terminology.
2. To learn the basic concepts of electromagnetic wave radiation and reception.
3. Be familiar with important classes of antennas and their properties and to gain the ability to pick a particular class of antenna for given specifications.
4. To develop the basic skills necessary for designing a wide variety of practical antennas and antenna arrays.
5. Be familiar with techniques for estimating the propagation performance of a communication channel.
6. Be able to define specifications for a communications system based on a set of requirements.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	Electromagnetic Radiation: Radiation phenomenon from an oscillation dipole in free space, induction and radiation fields, Retarded potentials, Radiated power and radiation resistance from a short dipole , half wave dipole and quarter wave monopole.	C. A. Balanis J. D. Kraus and R. J. Marhefka	
2.	Antenna Basics: Directional properties of antennas, Radiation patterns, antenna gain and aperture, antenna terminal impedance, self and mutual impedance, front to back ratio, antenna beam width and bandwidth, antenna efficiency, antenna beam area, polarization linear polarization, circular and elliptic polarization, antenna temperature and Reciprocity properties of antennas, Friss equation.	C. A. Balanis J. D. Kraus and R. J. Marhefka	
3	Auxilliary Potentials Functions and Linear Wire Antennas: Vector potential A and F, Electric and Magnetic Fields for Electric and Magnetic	C. A. Balanis J. D. Kraus and R. J. Marhefka	

	Current sources, Duality Theorem, Reciprocity and Reaction Theorem, Infinitesimal Dipole, Finite length dipole, Half wave dipoles.		
4	Antenna Arrays: Classification of arrays, linear arrays of two point sources, linear arrays of n-point sources, pattern multiplication, array factor, linear arrays of equal amplitude and spacing (Broadside and end fire arrays) of n-point sources, directivity and beam width.	C. A. Balanis J. D. Kraus and R. J. Marhefka	
5	Antenna Arrays: Analysis and Synthesis: Linear arrays, circular array, planar (2D) arrays, sum and difference patterns, Effect of mutual couplings, Phased array antennas, scan principles, Non-uniform arrays, Dolph-Chebyshev Arrays, Binomial Arrays.	C. A. Balanis J. D. Kraus and R. J. Marhefka	
6	Analysis and Design of Anteena: Resonant Antennas: Wires and Patches, Yagi - Uda Antennas, Micro strip Antenna, horn antennas, Parabolic reflector antenna principles, offset parabolic reflectors, dual reflector antennas, Gain calculations for reflector antennas, feed antennas for reflectors, field representations, matching the feed to the reflector, general feed model, feed antennas used in practice. Broad band Antennas: Traveling - wave antennas, helical antennas, Biconical antennas, sleave antennas, and Principles of frequency - independent Antennas, spiral antennas, Log – Periodic antenna, fractal antenna.	C. A. Balanis J. D. Kraus and R. J. Marhefka	
		Total Number of Lectures	

Evaluation Scheme

1. Test 1 : 15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
   - 10 Marks : Class performance, Tutorials & Assignments
   - 10 Marks : Quizzes
   - 5 marks : Attendance

Text Book

1. Antenna Theory Analysis and Design, C. A. Balanis, 3rd Ed, 2005, John Wiley & Sons Inc.

2. Antennas for All Applications, J. D. Kraus and R. J. Marhefka, 3rd Ed., 2002, McGraw-Hill, Inc.

Reference Books

1. Antennas and Radio wave Propagation, R. E. Collin, 1985, McGraw-Hill, Inc.
2. Antenna Theory and Microstrip Antennas, D. G. Fang, 2010, CRC Press.
3. Electromagnetic waves and Radiating Systems, E. C. Jordan and Balmain, Pearson Education.

STATISTICAL SIGNAL PROCESSING

(Elective Subject)

Course Code:	**13M1WEC431**	**Semester:**	**4th Semester, M. Tech. (ECE)**
Credits:	**3**	**Contact Hours:**	**L-3, T-0,P-0**

Pre-requisites: Signals & Systems, Digital Signal Processing

Course Objectives:

The objective of this course to provides well understanding of

1. The random signals, random process and their statistical properties
2. Spectral methods signal analysis
3. Weiner filtering and adaptive filetring of the signals

Course Outcomes

At the end of the Statistical Signal Processing course, a student should be able to:

1. Comprehend the random variable random process and statistical feature of random signals.
2. Analyze and understand the modeling styles or methods of the random signals.
3. Analyze and understand the FIR , IIR Wiener filtering, and Kalman filtering.
4. Analyze and understand the various power spectral estimation methods of the statistical signals.
5. Understand the least mean square (LMS), Recursive least square, and others adaptive filtering methods.

Course Contents :

Unit	Topics	Text book	Lectures
1	**DISCRETE-TIME RANDOM PROCESSES** **Random Variables**: Ensemble Averages , Jointly Distributed Random Variables, Joint Moments, Independent, Uncorrelated and Orthogonal Random Variables, Linear Mean Square Estimation, Gaussian Random Variables, Parameter Estimation: Bias and Consistency, **Random Processes:** Ensemble Averages, Gaussian Processes, Stationary Processes, The Autocovariance and Autocorrelation Matrices, Ergodicity White Noise, The Power Spectrum **Filtering Random Processes**: Spectral Factorization, Special Types of Random Processes , Autoregressive Moving Average Processes ,Autoregressive Processes, Moving Average Processes, sHarmonic Processes	[1]	**10**
2	**SIGNAL MODELING** The Least Squares (Direct) Method, The Pade Approximation, **Prony's Method:** Pole-Zero Modeling , Shanks' Method, All-Pole Modeling, Linear Prediction, Application: FIR Least Squares	[1]	**06**

	Inverse Filters Iterative Prefiltering, **Finite Data Records**: The Autocorrelation Method,The Covariance Method, **Stochastic Models:** Autoregressive Moving Average Models, Autoregressive Models, Moving Average Models, Application : Power Spectrum Estimation		
3	**WIENER FILTERING** The FIR Wiener Filter: Filtering, Linear Prediction, Noise Cancellation, Lattice Representation for the FIR Wiener Filter The IIR Wiener Filter: Noncausal IIR Wiener Filter , The Causal IIR Wiener Filter, Causal Wiener Filtering , Causal Linear Prediction, Wiener Deconvolution , Discrete Kalman Filter	[1] & [2]	**08**
4	**SPECTRUM ESTIMATION** **Nonparametric Methods:** The Periodogram, Performance of the Periodogram, The Modified Periodogram, Bartlett's Method Welch's Method, Blackman-Tukey Approach Performance Comparisons **Minimum Variance Spectrum Estimation**, **The Maximum Entropy Method,** **Parametric Methods**: Autoregressive Spectrum Estimation, Moving Average Spectrum Estimation, Autoregressive Moving Average Spectrum Estimation: **Frequency Estimation**: Eigendecomposition of the Autocorrelation Matrix, Pisarenko Harmonic Decomposition MUSIC, Other Eigenvector Methods **Principal Components Spectrum Estimation**: Bartlett Frequency Estimation, Minimum Variance Frequency Estimation, Autoregressive Frequency Estimation	[1],& [2]	**10**
5.	**ADAPTIVE FILTERING** **FIR Adaptive Filters** :The Steepest Descent Adaptive Filter, The LMS Algorithm, Convergence of the LMS Algorithm , Normalized LMS, Application : Noise Cancellation, Other LMS-Based Adaptive Filters, Gradient Adaptive Lattice Filter, Joint Process Estimator, Application : Channel Equalization , **Adaptive Recursive Filters** ,**Recursive Least Squares**: Exponentially Weighted RLS, Sliding Window RLS ,	[2], & [1]	**08**
	Total Lecture Hours		**42**

Evaluation Scheme

1. Test 1 : 15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    1. 10 Marks : Class performance, Tutorials & Assignments
    2. 10 Marks : Quizzes
    3. 5 marks : Attendance

Text Books

1. Hayes, M.H.,"Statistical digital signal processing and modeling" Willey publishers
2. Proakis, John G. Digital signal processing: principles algorithms and

applications. Pearson Education India.
3. P.Stoica,and Randolph Moses "Spectral analysis of signals " PHI, Publishers

Reference Book

1. Oppenheim, Alan V., Ronald W. Schafer, and John R. Buck. Discrete-time signal processing, 2nd edition, Pearson Education.
2. Mitra, Sanjit Kumar, and Yonghong Kuo. Digital signal processing: a computer- based approach, 2nd edition, Tata McGraw-Hill.
3. Mitra, Sanjit Kumar, and Yonghong Kuo. Digital signal processing, 3rd edition, Tata McGraw-Hill.

RADAR AND SONAR SIGNAL PROCESSING

(Elective Subject)

Course Code:	13M1WEC432	**Semester:**	4th Semester, M. Tech (ECE)
Credits:	3	**Contact Hours:**	L-3, T-0, P-0

Course Objectives

The objectives are to study the basics of a radar systems and its components and to aanalyse of radar systems..

Course Outcomes

After the successful completion of the course student should be able to:

1. Know the basic building blocks of a radar system.
2. Have an in-depth knowledge on different types of signals that are used.
3. Know about the ambiguity function and its significance in radar signal processing.
4. To know the principle of operation of sonar and sound propagation in water.
5. Apply the knowledge acquired in this course in real time applications.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	Introduction to radar and radar equation, radar wave propagation. Radar block diagram, resolutions in range velocity, radar equation, types of radars. Atmospheric effects on radar wave propagation. Radar cross section, radar displays.	Peebles	6
2.	CW and FM radar and MTI radar: Doppler radar, CW radar, FMCW radar, multiple frequencies CW radar, MTI radar, delay line cancellers, staggered pulse repetitive frequencies, pulse Doppler radar, limitations of MTI radar.	Skolnik	8
3	Radar waveforms: Matched filter, Pulse compression, ambiguity function, LFMCW, HFM waveforms, Doppler invariant waveforms.	Peebles	8
4	Radar antennas and radar tracking: Radar antennas and radar tracking Antenna basics, antenna arrays, analysis and synthesis of	Elliot	9

	antenna arrays. Buttler's matrix, tracking of radar. Synthetic aperture radar.		
5	Radar transmitters and receivers: Noise figure, amplifiers, mixers, power dividers and phase shifters.	Pozar	8
6	Introduction to sonar: Under water propagation, types of sonar, sonar transducers.	Hansen	3
		Total Number of Lectures	42

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. Peebles, Peyton Z. *Radar principles*. John Wiley & Sons, 2007.
2. Skolnik, Merrill I. "Introduction to radar." *Radar Handbook* 2 (1962).
3. Elliot, Robert S. *Antenna theory and design*. John Wiley & Sons, 2006.
4. Pozar, David M. *Microwave engineering*. John Wiley & Sons, 2009.
5. Hansen, Roy Edgar. "Introduction to sonar." *Course Material to INF-GEO4310, University of Oslo,(Oct. 7, 2009)* (2009).

Reference Books

1. Stutzman, Warren L., and Gary A. Thiele. *Antenna theory and design*. John Wiley & Sons, 2012. Cheng, David Keun. *Field and wave electromagnetics*. Pearson Education India, 1989.
2. Hodges, Rich`ard P. "Introduction to Sonar." *Underwater Acoustics: Analysis, Design and Performance of Sonar*: 1-15.
3. Navigation, Guidance and control, NPTEL lectures by Debasish Ghose.

ADVANCED CMOS DIGITAL DESIGN TECHNIQUES

(Core/ Elective Subject)

Course Code:	14M1WEC231	**Semester:**	2nd Semester, M.Tech (ECE) and 8th Semester, B. Tech (ECE)
Credits:	3	**Contact Hours:**	L-3, T-0, P-0

Course Objectives

1. To study advanced concepts of CMOS Digital Design. It will be helpful for the students when they work in VLSI industries or in R&D's.
2. To cover crucial real world system design issues such as signal integrity, power dissipation, interconnect packaging, timing and synchronization.
3. To provide unique coverage of the latest design methodologies and tools.
4. To learn Low-power design concepts and voltage-frequency scaling.

Course Outcomes

This course provides the knowledge of Advanced CMOS Digital Design Techniques. After study through lectures and assignments, students will be able to do the

1. Modeling and estimation of R, C, and L parasitics, effect of technology scaling, sheet resistance, techniques to cope with ohmic drop and capacitive cross talk, estimating RC delay, and inductive effects.
2. Several lab team assignments to design actual VLSI subsystems from high level specifications, culminating in a course project involving the software design of a modest complexity chip.
3. Several homework assignments based on core concepts and reinforcing analytical skills learned in class.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	Introduction, The Wire, Coping with Interconnect: Impact of Interconnect Parasitic, Impact of Resistance, Impact of Capacitance, Cross-talk, Reducing RC-delay, Dealing with inductance.	Rabaey (Page 135-148, 445- 475)	5
2.	Designing Sequential Logic Circuits: Self Timed Circuit Design, Self Timed Signaling, Muller-C Element, Two Phase Handshake Protocol, Self Resetting CMOS, Synchronizer, Designing Latch and Edge triggered Register using different approach, Clock Overlaps, C2MOS Logic, TSPC Logic, Specialized edge triggered TSPCR, Pulse Registers, Pipelining, Designing Schmitt Trigger and multi-vibrators, Design Techniques for large Fan in, Sizing	Rabaey (Chapter 10.4, 10.5, Chapter 7) Rabaey Page (261-273)	16

	combinational circuits for minimum delay, Ratioed Logic: DCVSL, Pass transistor Logic, Differential Pass transistor Logic.		
3	Arithmetic Circuits: Adders (Ripple-Carry Adder, Complimentary Static CMOS FullAdder, Mirror Adder, Transmission Gate Full Adder, Carry-Bypass Adder, Carry-Select Adder, Logarithmic Look-Ahead Adder, Tree Adders). Multipliers (Array Multiplier, Wallace-Tree Multiplier, Booths Multiplier Algo), Shifters (Barrel Shifter, Logarithmic Shifter).	Rabaey (Chapter 11) Uyemura (Chapter 12)	11
4	Semiconductor Memories: Memory Timing, Memory Architecture, Read-Only Memory Cells, MOS OR ROM, MOS NOR ROM, MOS NAND ROM, Dual Data rate Synchronous Dynamic RAM, DRAM Timing, Sources of Power Dissipation in Memories, Data Retention in SRAM, Suppressing Leakage in SRAM, Data Retention in DRAM.	Rabaey (Chapter 12)	9
		Total Number of Lectures	**41**

Evaluation Scheme

1. Test 1 : 15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
   - 10 Marks : Class performance, Tutorials & Assignments
   - 10 Marks : Quizzes
   - 5 marks : Attendance

Text Books

1. J. Rabaey, A. Chandrakasan; "Digital Integrated Circuits: A Design Perspective", 3rd and B. Nikolic Edition 2003.
2. John P. Uyemura;"Introduction to VLSI Circuits and Systems", John Wiley & Sons, Inc, 2002.

Reference Books

1. Sung-Mo Kang, Yusuf Leblebici,: CMOS Digital Integrated Circuits Analysis and Design",Tata McGraw-Hill Edition 2003

Web Resources

1. URL1:- http://nptel.ac.in/courses/117106092/
2. URL2:- http://nptel.ac.in/courses/117106093/

FAULT-TOLERANT COMMUNICATION NETWORKS

(Elective Subject)

Course Code:	14M1WEC331	**Semester:**	**M.Tech. 3rd Sem.**
Credits:	3	**Contact Hours:**	L-3, T-0, P-0

Course Objectives

The objectives are to study

1. Define common terms such as availability, reliability, dependability etc.
2. Induction with the service-based network design approach.
3. Terminology related to network pathology.
4. Role of reliability engineering in fault-tolerant network design.
5. Methodology of protection and restoration.
6. Implementation of fault-tolerant scheme for: (i) optical networks, (ii) SONET/SDH network, (iii) MPLS based network, (iv) adhoc networks
7. Planning for mission-critical networks.

Course Outcomes

After studying this course the students would gain enough knowledge

1. Apply the concepts of reliability and fault-tolerance for the network design.
2. Grade the network services on the basis of predictable.
3. Apply the knowledge for various networks viz. (i) optical networks, (ii) SONET/SDH network, (iii) MPLS based network, (iv) adhoc networks
4. Extend the knowledge for the mission-critical networks.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	**Background of Fault-tolerance in Communication Network:** Historical perspective of fault-tolerance in communication, performance predictability, best-effort service, guaranteed service, QoS Fault, Failure and Error: reliability engineering in network design, causes of network failure, uncertainty in network, Imperfections in network design, performance failure, breakdown failure, reliability evaluation, failure distribution, MTTR, MTTF. Concepts of reliability, survivability, dependability, resiliency, recovery, continuity and performability	[1,2,3,7,8]	9

2.	**Network Availability, Protection & Restoration** Continuity and availability in communication network, transition from acceptable to unacceptable service state and Vice-Versa, Concepts and methodology of protection and restoration. [1,2,5]	Kang : Chapter 3	8
3	Fault-tolerant schemes for Optical networks, [2,4]	Kang : Chapter 5 Pucknell : Chapter 2	5
4	Fault-tolerant schemes for SONET/SDH network, [2]	Kang : Chapter 7 Uymera : Chapter 10	5
5	Fault-tolerant schemes for MPLS based network, [2]	Pucknell : Chapter 3 Kang : Chapter 2 (Fabricarion)	5
6	Fault-tolerant schemes for adhoc networks [6]		5
7	Mission-critical network planning [5]		5
		Total Lectures	**42**

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. Martin L. Shooman, Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design, John Wiley & Sons.
2. Jean-Philippe Vasseur, Mario Pickavet, Piet Demeester Network Recovery: Protection and Restoration of Optical, SONET-SDH, IP, and MPLS, Elsevier.
3. James D. McCabe, Network Analysis, Architecture, and Design, Elsevier
4. Arun K. Somani, Survivability and Traffic Grooming in WDM Optical Networks, Cambridge University Press.
5. Mathew Liotine, Mission-Critical Network Planning, Artech House.

Reference Articles:

1. Xing, Liudong, Haoli Li, and Howard E. Michel. "Fault-tolerance and reliability analysis for wireless sensor networks." International Journal of Performability Engineering 5.5 (2009): 419.

2. Malec, Henry A. "Communications reliability: a historical perspective."Reliability, IEEE Transactions on 47, no. 3 (1998): SP333-SP345.

3. Bjarne E. Helvik, Perspectives on the Dependability of Networks and Services, Telektronikk (100th Anniversary Issue: Perspectives in telecommunications), (3):27 – 44, 2004.

BIOMEDICAL SIGNAL AND IMAGE PROCESSING

(Core Subject)

Course Code:	15M1WEC231	**Semester:**	2th Semester, M. Tech (ECE)
Credits:	3	**Contact Hours:**	L-3, T-0, P-0

Course Objectives

The objectives are to:

1. Introduce various bioelectric signals and medical imaging modalities.
2. Implementation of different signal and image processing techniques on the acquired biomedical signals and images.

Course Outcomes

After studying this course the students would gain enough knowledge

1. Able to understand different types of bioelectric signals and their acquisition from human body.
2. Able to understand different types of medical imaging modalities and would be able to differentiate them with respect to their advantages and limitations.
3. Acquire an ability to analyze and process bioelectric signals.
4. Acquire an ability to analyze and process medical images.
5. Understand different feature extraction techniques and classifiers used for image classification.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	Bioelectric signals: Electrical activities of the cell and propagation of electric potential as a wave, Acquisition of bioelectric signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), other biomedical signals: blood pressure, blood flow, Electrooculogram, respiratory signals, and ERG.	Kayvan: Chapter 8-12	12
2.	Medical Imaging modalities: Working principle, application and limitation of Computed tomography (CT), X-ray, Magnetic resonance imaging (MRI) , Ultrasound imaging, and Positron emission tomography (PET).	Kayvan: Chapter 13-17	8
3	Digital Signal Processing: Introduction to processing and transformation of signals, Data Acquisition: Sampling in time, aliasing,	Kayvan: Chapter 1-2 Tamal: Chapter 1-2	10

	interpolation, and quantization, Difference equations, FIR and IIR filters, basic properties of discrete-time systems, convolution, Discrete-time Fourier transform and its properties. FIR filter design using windows, discrete Fourier transform and its properties, fast Fourier transform (FFT), Sampling and aliasing in time and frequency, spectral analysis.		
4	Image Processing I: Extension of filtering and Fourier methods to 2-D signals and systems, Image enhancement and restoration, Edge Detection and Image Segmentation Techniques.	Kayvan: Chapter 3-4	10
5	Image Processing II: Introduction to feature extraction techniques, Clustering and classification of images.	Kayvan: Chapter 7	5
		Total Number of Lectures	45

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. Kayvan Najarian, Robert Splinter: Biomedical Signal and Image Processing. CRC Press, 2012
2. Tamal Bose: Digital Signal and Image Processing. John Wiley & Sons, 2004

Reference Books

1. Biomedical Image Analysis, Rangaraj M. Rangayyan, CRC Press, New York
2. Digital Image Processing, RC Gonzalez & RE Woods, Pearson Publishers, Third Edition

ADVANCED DIGITAL IMAGE PROCESSING

(Elective Subject)

Course Code:	16M1WEC231	**Semester:**	8th Semester, B. Tech (ECE)/ 2nd semester M. Tech
Credits:	3	**Contact Hours:**	L-3, T-0, P-0

Course Objectives

Major Learning Objectives are:

1. Describe and explain basic principles of digital image processing;
2. Design and implement algorithms that perform basic image processing (e.g., noise removal and image enhancement);
3. Design and implement algorithms for advanced image analysis (e.g., image compression, image segmentation)
4. Assess the performance of image processing algorithms and systems.

Course Outcomes

After Completing this course students will be able to:

1. Analyze general terminology of digital image processing.
2. Examine various types of images, intensity transformations and spatial filtering.
3. Develop Fourier transform for image processing in frequency domain.
4. Evaluate the methodologies for image segmentation, restoration etc.
5. Implement image process and analysis algorithms.
6. Apply image processing algorithms in practical applications.

Course Content

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1	Digital image fundamentals Fundamental steps in DIP, Components of digital image processing system, elements of visual perception, Structure of the human eye, Image formation in the eye, Brightness adaptation and discrimination, light, Image sensing and acquisition, Image formation model, definition and some properties of two dimensional system, Discrete 2D convolution, 2D discrete Fourier transform and its properties, optical and modulation transfer function, Spectral density function. Sampling and quantization of images, Two dimensional	Gonzalez and Woods Chapter -1 Pg 1 - 29 Chapter -2 Pg 34 - 70	**7**

	sampling theory, representation of digital image, Spatial and gray level resolution, Zooming and shrinking, some basic relationships between pixels.	Chapter -4 Pg 149 - 166	
2	Image Enhancement in spatial domain Gray level transformations, Piecewise linear transformation, Histogram processing, enhancement using Arithmetic/ logic operations, Basics of spatial filtering, Smoothing and sharpening spatial filters, Use of first order and second order derivative in enhancement.	Gonzalez and Woods Chapter -3 Pg 76 - 130	**7**
3	Image Enhancement in frequency domain Two dimensional Fourier transform, properties of frequency domain, correspondence between filtering in spatial and frequency domain, Smoothing and Sharpening frequency domain filters, Homomorphic filtering	Gonzalez and Woods Chapter -4 Pg 148 - 193	**6**
4	Image Restoration Model of image degradation/ Restoration process, Noise models, Noise reduction in spatial domain and frequency domain, Inverse filtering, Wiener filtering.	Gonzalez and Woods Chapter -5 Pg 221 - 261	**7**
5	Image compression Fundamentals of Image compression, Types of redundancy. Image compression model, concepts of information theory, Fundamental coding theorems, Estimation of entropy, Variable length coding, Huffman coding, Near optimal variable length coding, Arithmetic coding, LWZ coding, Bit plane coding , constant area coding, run length coding, Lossless predictive coding, image compression standards (JPEG, JPEG2000)	Gonzalez and Woods Chapter -8 Pg 411 - 456	**7**
6	Image Segmentation Detection of discontinuities (point, line edge), Edge linking and boundary detection, Thresholding, Basic global thresholding, Adaptive thresholding, Region based segmentation, region growing, splitting and merging.	Gonzalez and Woods Chapter-10 Pg 568 - 615	**6**

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. R.C.Gonzalas and R.E.Woods: Digital Image Processing, Prentice Hall, 3rd Ed

Reference Books

1. A.K.Jain, Fundamentals of Digital Image Processing, Prentice Hall.
2. S.Sridhar, Digital Image Processing, Oxford University Press.

VLSI IN BIOMEDICAL SIGNAL PROCESSING

(Elective Subject)

Course Code:	17M1WEC331	**Semester:**	3rd Semester, M. Tech (ECE) PhD
Credits:	3	**Contact Hours:**	L-3, T-0,P-0

Course Objectives

The objective of the VLSI in Biomedical Signal Processing is to address the research, development and design problems and advance their solutions in VLSI circuits for embedded system and ubiquitous computing applications. The areas are Embedded System design, Power Electronics, Wireless networks; Signal processing, Biomedical Electronics, Electronic Instrumentation, and Audio and Speech Processing.

Course Outcomes

After studying this course the students would gain enough knowledge

1. Basic concepts in Digital CMOS circuit design.
2. To make an in depth study of DSP structures amenable to VLSI implementation.
3. To enable students to design VLSI system with high speed and low power.
4. Improve the speed of digital system through transformation techniques.
5. Perform pipelining and parallel processing in FIR/IIR systems to achieve high speed and low power.
6. Have knowledge of the principle operation and design and the background knowledge of biomedical instruments and specific applications of Biomedical engineering.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	**INTRODUCTION TO COMPUTERS IN MEDICINE** : Characteristics of medical data**,** What is a medical instrument? Iterative definition of medicine, Evolution of microprocessor-based systems, The microcomputer-based medical instrument, Generalised Instrumentation system, The Biopotential Amplifier, The Instrumentation Amplifier, Characteristics of bio medical signal, Circuit Enhancements, Electrical Interference Reduction, Filtering, Artifact Reduction	Veeramachaneni : Chapter 1	2
2.	**ADDERS :** Review of Existing Adder Designs : Ripple Carry Adder (RCA), Carry Select Adder (CSA), Carry Look-Ahead Adder (CLA), Parallel Prefix- based Adder (PPA); Design and Implementation of Efficient Sum Computation Block for Higher Bit Sparse Adders; Design and Implementation of Higher Bit Sparse Adder	Veeramachaneni : Chapter 2	6

3	**COMPRESSORS AND COUNTERS :** Existing Compressor Designs : 3-2 Compressor , 4-2 Compressor , 5-2 Compressor; Efficient Compressor Designs using CMOS ; Designs of Counters : (3, 2) Counter, (7, 3) Counter , (15, 4) Counter , (31, 5) Counter; Design and Implementation of Efficient Parallel Counters	Veeramachaneni : Chapter 3	8
4	**SIGNAL PRE-PROCESSING** *SIGNAL CONVERSION* : Sampling basics, Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits, Lab: Signal conversion *SIGNAL AVERAGING* : Basics of signal averaging , Signal averaging as a digital filter, A typical averager , Software for signal averaging , Limitations of signal averaging . *SIGNAL COMPRESSOR/ DECOMPRESSOR* *DATA REDUCTION TECHNIQUES* : Turning point algorithm, AZTEC algorithm , Fan algorithm , Huffman coding *OTHER TIME- AND FREQUENCY-DOMAIN TECHNIQUES* **:** The Fourier transform , Correlation, Convolution , Power spectrum estimation	TOMPKINS : Chapter 3, 4	7
5	**BASICS OF FILTERING** : Digital filters, The *z* transform, Elements of a digital filter, Types of digital filters, Transfer function of a difference equation, The *z*-plane pole-zero plot, The rubber membrane concept *FINITE IMPULSE RESPONSE FILTERS* : Characteristics of FIR filters, Smoothing filters, Notch filters, Derivatives, Window design, Frequency sampling, Min-max design , Lab: FIR filter design *INFINITE IMPULSE RESPONSE FILTERS* **:** Generic equations of IIR filters , Simple one-pole example, Integrators , Design methods for two-pole filters, Lab: IIR digital filters for ECG analysis *INTEGER FILTERS* **:** Basic design concept, Low-pass integer filters, High-pass integer filters, Bandpass and band-reject integer filters, The effect of filter cascades, Other fast-operating design techniques, Design examples and tools, Lab: Integer filters for ECG analysis *ADAPTIVE FILTERS***:** Principal noise canceller model, 60-Hz adaptive cancelling using a sine wave model , Other applications of adaptive filtering	TOMPKINS : Chapter 5, 6, 7, 8	12
6	**VLSI IN BSP** : Digital signal processors, High-performance VLSI signal processing, VLSI applications in medicine , VLSI sensors for biomedical signals, VLSI tools, Choice of custom, ASIC, or off-the-shelf components		**7**
		Total Number of Lectures	42

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. W.J. TOMPKINS , "BIOMEDICAL DIGITAL SIGNAL PROCESSING : C-Language Examples and Laboratory Experiments for the IBM® PC", 2000.

Reference Books

1. Sreehari Veeramachaneni , "Design of Efficient VLSI Arithmetic Circuits", PhD Thesis, International Institute of Information Technology, Hyderabad
2. K.K.Parhi, "VLSI Digital Signal Processing Systems", John-Wiley, 2007
3. U. Meyer -Baese," Digital Signal Processing with FPGAs", Springer, 2004
4. W.Burleson, K. Konstantinides, T.H. Meng," VLSI Signal Processing"",1996.
5. R.J. Higgins, "Digital signal processing in VLSI", 1990.
6. S.Y.Kung, H.J. Whitehouse, "VLSI and modern signal processing", 1985
7. Carr and Brown, Biomedical Instrumentation.
8. Cromwell, Biomedical Instrumentation and Measurement, PHI.
9. Neil Weste and David Harris, "CMOS VLSI Design", 4th Ed., Addison Wesley, 2011.
10. Douglas A Pucknell et al, "Basic VLSI Design", 3rd Ed., Prenctice Hall, 2004
11. Sung-Mo Kang, Yusuf Leblebici : CMOS Digital Integrated Circuits Analysis and Design",Tata McGraw-Hill Edition 2003

COMPUTATIONAL INTELLIGENCE AND APPLICATIONS

(Elective Subject)

Course Code:	17M1WEC332	**Semester:**	3rd Semester, M. Tech (CSE/IT)
Credits:	3	**Contact Hours:**	L-3

Course Objectives

1. Fundamentals of key intelligent systems technologies including knowledge-based systems, neural networks, fuzzy systems, and evolutionary computation, and
2. Practice in integration of intelligent systems technologies for engineering applications.

Course Outcomes

This course provides the knowledge of analog and digital communication system analysis and design. After study through lectures and assignments, students will be able to

1. Gain a working knowledge of knowledge-based systems neural networks, fuzzy systems, and evolutionary computation;
2. Apply intelligent systems technologies in a variety of engineering applications;
3. Implement typical computational intelligence algorithms in MATLAB;
4. Present ideas and findings effectively; and
5. Think critically and learn independently

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	Introduction: Intelligence machines, Computational intelligence, paradigms Short history	Eberhart& Shi S. Haykin N. Sivanandam, S. N. Deepa	5
2.	Fuzzy Expert Systems: Rule-based expert system. Uncertainty management. Fuzzy Logic and Fuzzy Relationships. Fuzzy sets and operations of fuzzy sets. Fuzzy rules and fuzzy inference. Fuzzy expert systems. Adaptation of fuzzy systems. Case Studies	Eberhart& Shi S. Haykin N. Sivanandam, S. N. Deepa	7
3	Artificial Neural Networks: Fundamental neuro computing concepts: artificial neurons, activation functions, neural network architectures, learning rules. Supervised learning neural networks: multi-layer feed forward neural networks, simple recurrent neural networks, time-delay neural networks, supervised learning algorithms. Unsupervised learning neural networks: self-organizing feature maps. Radial	Eberhart& Shi S. Haykin N. Sivanandam, S. N. Deepa	9

	basis function networks. Deep neural networks and learning algorithms. Case studies		
4	Evolutionary computation: Chromosomes, fitness functions, and selection mechanisms. Genetic algorithms: crossover and mutation, Genetic programming. Evolution strategies. Case studies	Eberhart& Shi S. Haykin N. Sivanandam, S. N. Deepa	7
5	Swarm Intelligence: Foundations. cAnts, Termites, Gnats, Birds. Applications. Case Studies.	Eberhart& Shi S. Haykin N. Sivanandam, S. N. Deepa	7
6	Hybrid Intelligent Systems: Neural expert systems. Neuro-fuzzy systems. Evolutionary neural networks.	Eberhart& Shi S. Haykin N. Sivanandam, S. N. Deepa	7
		Total Number of Lectures	**42**

Evaluation Scheme

1. Test 1 : 15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
   - 10 Marks : Class performance, Tutorials & Assignments
   - 10 Marks : Quizzes
   - 5 marks : Attendance

Text Books

1. 1 Computational Intelligence - Concepts to Implementations by Eberhart& Shi
2. S. Haykin, Neural Networks – A Comprehensive Foundation, Prentice Hall, 1999
3. N. Sivanandam, S. N. Deepa," Principals of soft Computing", Wiley India

Reference Books

1. Introduction to Genetic Algorithms by Melanie Mitchell
2. S. Russell and P. Norvig. Artificial Intelligence – A Modern Approach, Prentice Hall, 2010
3. A.P. Engelbrecht, Computational Intelligence: An Introduction, 2nd Edition, John Wiley & Sons, 2012.
4. H.K. Lam, S.S.H. Ling, and H.T. Nguyen, Computational Intelligence and Its Applications: Evolutionary Computation, Fuzzy Logic, Neural Network and Support Vector Machine, Imperial College Press, 2011.