Dr. Babasaheb Ambedkar Technological University

Course Structure and Syllabus

For

M. Tech. (Electronics & Telecommunication Engineering)

Two Year (Four Semester) Course

(w.e.f. July 2017)

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY,

Lonere-402103, Raigad (MS)

M.Tech. (Electronics & Telecommunication Engineering)

Objectives

I. To serve the society and nation, by providing high quality engineering educational programs to the students, engaging in research and innovations that will enhance the skill and knowledge and assisting the economic development of the region, state, and nation through technology transfer.

II. To equip the postgraduate students with the state of the art education through research and collaborative work experience/culture to enable successful, innovative, and life-long careers in Electronics and Telecommunication.

III. To encourage the post-graduates students, to acquire the academic excellence and skills necessary to work as Electronics and Telecommunication professional in a modern, ever-evolving world.

IV. To provide the broad understanding of social, ethical and professional issues of contemporary engineering practice and related technologies, as well as professional, ethical, and societal responsibilities.

V. To inculcate the skills for perusing inventive concept to provide solutions to industrial, social or nation problem.

Outcomes

I. Students of this program will have ability to apply knowledge of mathematics, sciences and engineering to Electronics and Telecommunication problems.

II. Postgraduate students will gain an ability to design and conduct experiments, as well as to analyze and interpret data/results.

III. Learners of this program will built an ability to design and develop a system, components, devices, or process to meet desired needs.

IV. Masters students of this program will have an ability to work on multi-disciplinary teams and also as an individual for solving issues related to Electronics and Telecommunication.

V. Learners of this program will have an ability to identify, formulate, and solve Engineering problems by applying mathematical foundations, algorithmic principles, and Electronics and Telecommunication theory in the modeling and design of electronics systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.

VI. Postgraduate students will have an ability to communicate effectively orally and in writing and also understanding of professional and ethical responsibility.

VII. Postgraduate students will have an ability to use the techniques, skills, and modern engineering EDA tools necessary for Electronics and Telecommunication practices.

VIII. Learners of this program will have an ability to evaluate Electronics and Telecommunication Engineering problems with cost effectiveness, features, and user friendliness to cater needs for innovative product development.

IX. Postgraduate students will have an ability to solve contemporary social and industrial problems by engaging in life-long learning.

Dr. Babasaheb Ambedkar Technological University

Teaching and Examination Scheme for

M.Tech. (Electronics & Telecommunication Engineering) w.e.f. July 2017

Sr. No.	Course Code	Name of the Course	Hours/Week			Credit	Examination scheme				
							Theory		IA	PR/OR	TOTAL
			L	P	T		TH	Test			
First Semester											
01	MTETC101	Signal Theory	03	--	1	04	60	20	20	--	**100**
02	MTETC102	Radiation and Microwave Techniques	03	--	1	04	60	20	20	--	**100**
03	MTETC103	Signal Processing Algorithms & Applications	03	--	1	04	60	20	20	--	**100**
04	MTETE114	Elective-I	03	--	--	03	60	20	20	--	**100**
05	MTETE125	Elective-II	03	--	--	03	60	20	20	--	**100**
06	MTETC106	Communication Skills	02	--	--	02	--	--	25	25	**50**
07	MTETL107	PG Lab-I*	--	03	--	02	--	--	25	25	**50**
		Total for Semester I	**17**	**03**	**03**	**22**	**300**	**100**	**150**	**50**	**600**
Second Semester											
01	MTETC201	Estimation and Detection Theory	03	--	1	04	60	20	20	--	**100**
02	MTETC202	Information Theory and Coding	03	--	1	04	60	20	20	--	**100**
03	MTETE233	Elective-III	03	--	--	03	60	20	20	--	**100**
04	MTETE244	Elective- IV	03	--	--	03	60	20	20	--	**100**
05	MTETE255	Elective-V- (Open to all)	03	--	--	03	60	20	20	--	**100**
06	MTETS206	Seminar-I	--	04	--	02	--	--	50	50	**100**
07	MTETP207	Mini-Project	--	04	--	02	--	--	50	50	**100**
		Total for Semester II	**15**	**8**	**02**	**21**	**300**	**100**	**200**	**100**	**700**
Third Semester											
1	MTETC301	Project Management & Intellectual Property Rights (Self Study)#	--	--	--	02	--	--	50	50	**100**
2	MTETP302	Project-I	--	--	--	10	--	--	50	50	**100**
		Total for Semester III	**--**	**--**	**-**	**12**	**--**	**--**	**100**	**100**	**200**
Fourth Semester											
1	MTETP401	Project-II	--	--	--	20	--	--	100	100	**200**
		Total for Semester IV	**--**	**--**	**--**	**20**	**--**	**--**	**100**	**100**	**200**
GRAND TOTAL											**1700**

* PG Lab-I –Practical shall be based on courses of first semester.

Student has to choose this course either from NPTEL/MOOC pool and submission of course completion certificate is mandatory.

Elective-I

1. Artificial Neural Networks and Applications
2. Electromagnetic Interference and Compatibility
3. Mobile Communication
4. Fault Tolerant Systems
5. Analog and Mixed Signal Processing

Elective-II

1. RF and Millimeter Wave circuit Design
2. System On-Chip
3. Optical Fiber Communication
4. Statistical Signal Processing
5. Microelectronics

Elective-III

1. Multirate Digital Signal Processing
2. Embedded System Design
3. Wireless Sensor Network Design
4. VLSI and Microsystems
5. Numerical Methods in Electromagnetics

Elective-IV

1. Advanced Biomedical Signal Processing
2. Reconfigurable Computing
3. Digital VLSI Design
4. Radar Signal Processing
5. Electromagnetics, Antenna and Propagation

Elective-V (Open)

1. Internet of Things
2. Linear Algebra
3. Neural Networks in Embedded Applications
4. Research Methodology
5. Wavelet Transforms and its Applications

SIGNAL THEORY

Weekly Teaching Hours	TH: 03	Tut: 01		
Scheme of Marking	TH: 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in depth understanding of random nature of a signal using probability and random experiments.
B	To prepare mathematical background for communication signal analysis.
C	To provide in depth understanding of random processes.

Course Outcomes:

CO1	Learner will be able to apply knowledge of basic probability theory.
CO2	Learner will be able to understand concept of Random Variable.
CO3	Learner will be able to estimate different aspects of Random Variable like Mean, Variance, Moments , distribution function, density function etc.
CO4	Learner will be able to distinguish multiple Random Variable and its properties..
CO5	Learner will be able to hypothesize nature of different Random Processes.
CO6	Learner will be able to adapt basic concepts of estimation on multiple and repeated data measurement.

UNIT I

Probability

The meaning of probability, the axioms of probability, repeated trials.

UNIT II

The Concept of a Random Variable

Introduction, Distribution and density functions, Specific random variables, Conditional distributions, Asymptotic approximations for Binomial random variables.

UNIT III

Functions of One Random Variable

The Random Variable g(X), The Distribution of g(X), Mean and variance, Moments, Characteristic functions.

UNIT IV

Two Random Variables

Bi-variable distribution, One function of two random variables, Two function of two random variables, Joint moments, Joint characteristic functions, Conditional distributions, Conditional expected values.

UNIT V

Sequences of Random variables

General concepts conditional densities, Characteristic functions and normality, Mean square estimation stochastic convergence and limit theorem, Random Numbers: Meaning and Generation.

UNIT VI

Stochastic Processes

Introduction, Estimation, Parameter Estimation, Hypothesis Testing General concept, Random walks and other applications, Spectral representation and estimation, Mean square estimation, Markov chains.

Textbooks / References:

1. Papoulis, S. Pillai, Probability, Random Variables and Stochastic Processes, Tata McGraw Hill

2. T Veerajan, Probability, Statistics and Random Processes

3. R.P.Singh, S.D. Sapre, Communication Systems,Analog &Digital

4. B.P.Lathi, Modern Digital and Anolog Communication Systems, Third Ed

RADIATION AND MICROWAVE TECHNIQUES

Weekly Teaching Hours TH: 03 Tut: 01

Scheme of Marking TH: 60 Tests: 20 IA: 20 Total: 100

Course Objectives:

A	To provide an insight into various aspects of the RF, microwave
B	To expose learners to the new emerging topics in the field of the RF involving the methodologies adopted for various applications
C	To provide brief theoretical foundation of Transmission line, RF, microwave techniques.

Course Outcomes:

CO1	Learner will be able to analyze EM Transmission characteristics of waveguide
CO2	Learner will be able to analyze Transmission line circuit at microwave frequency
CO3	Learner will be able to demonstrate use of smith chart for solving transmission line problem.
CO4	Learner will be able to analyze various microstrip line integrated networks and their parameters
CO5	Learner will be able to formulate microwave communication system such as satellite and microwave antennas
CO6	Learner will be able to demonstrate different applications of RF and Microwave.

UNIT I

Review of EM Theory

Introduction, Maxwell's equations, Wave equations, TEM/TE/TM/HE Wave definitions.

UNIT II

Microwaves

Introduction to microwaves, Microwave transmission lines, Smith chart and its applications at microwaves, Microwave measurements.

UNIT III

Microstrip lines and Antennas

Microstrip Lines : Types of microstrip lines, microwave components using strip lines, Methods of analysis, Design considerations, Microstrip arrays.

Microstrip Antennas : Principle of operation, Methods of analysis, feeding techniques, Polarization, Design considerations.

UNIT IV

Microwave Elements

Microwave integrated circuits, Active and passive microwave elements.

UNIT V

Microwave Communication Systems

Introduction, Analog and digital microwave communication systems, Satellite communication, Microwave antennas

UNIT VI

Radar

Introduction, Classifications, Radar range equation, Modulators, Displays, Scanning and tracking, Doppler effect, Blind speeds, FMCW radars, radar antennas.

Textbooks / References:

1. Guro, Hijiroglu; Electromagnetic Field Theory fundamentals ;Thomson Publication.
2. Annapurna Das, Sisir Das; Microwave Engineering ;TMH Publication
3. M. Kulkarni; Microwave and Radar Engineering ;Umesh Publications, 3rd Edition.

SIGNAL PROCESSING ALGORITHMS AND APPLICATIONS

Weekly Teaching Hours	TH : 03	Tut: 01		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To instill research skills and bring in optimal solutions and novel products to signal processing and allied application areas using modern technology and tools that are technically sound, economically feasible and socially acceptable.
B	To enable the graduates to engage in signal processing and its broad range of applications to understand the challenges of the rapidly changing environment and adapt their skills through reflective and continuous learning.
C	To provide graduates strong mathematical skills and in depth knowledge in signal theory to analyze and solve complex problems in the domain of signal processing

Course Outcomes:

CO1	Learner will be able to analyze the time and frequency response of discrete time system.
CO2	Learner will be able to design digital filters for various application .
CO3	Learner will be able to design FIR and IIR filters for various applications
CO4	Learner will be able to understand the fundamentals of multi rate signal processing and its application
CO5	Learner will be able to understand signal representation in terms of dimension, orthogonality etc.
CO6	Learner will be able to analyze least square method for power spectrum estimation

UNIT I

Introduction

Review of discrete time signals and systems, Different transforms, Filtering, Use of DFT in linear filtering, Filtering of long data sequences, Spectrum, Algorithm for convolution and DFT.

UNITII

LTI DT System in Transform Domain and Digital Filter Structures

Simple Digital Filters, All Pass, Linear Phase and Minimum & Maximum phase and Complementary transfer Functions. Basic FIR and IIR Digital Filter Structures, Linear Phase Structure IIR, FIR and Allpass Lattice Structure.

UNITIII

Design of Digital Filters

General consideration, Design of FIR filters, Design of IIR filters from Analog filters, Frequency transformations, Design of Digital Filters Based on Least-square Method. Spectral Transformation of IIR Filters.

UNITIV

Multirate Signal Processing

Filter banks, Interpolators, Decimators, Polyphase decomposition, Analysis and synthesis, Orthogonal and orthonormal filter banks.

UNITV

Signal Representation

Representation of deterministic signals, orthogonal representation of signals, Dimensionality of signal spaces, Construction of orthogonal basis functions, Time-bandwidth relationship, RMS duration and bandwidth, Uncertainty relations, Multiresolution Analysis and Wavelet Transform.

UNITVI

Linear Prediction and Optimum Filter Design

Least square methods for system modeling, Adaptive filters, Power spectrum estimation.

Textbooks / References:

1. Digital Signal Processing A Computer-Based Approach, SanjitMitra, MCG
2. Discrete Time Signal Processing; *A V Oppenheim, Schafer*; PHI.
3. Advanced Digital Signal Processing; *Proakis*; McMillan.
4. Multirate systems and Filter Banks; *P PVaidyanathan*; Prentice Hall Eaglewood.
5. Digital Signal Processing : Principles, Algorithms and Applications; *John D Proakis*; PHI.
6. Adaptive Filter Theory; *S Hykin*; PHI.

ELECTIVE-I

ARTIFICIAL NEURAL NETWORKS AND APPLICATIONS

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding of fundamental theory and concepts of computational intelligence methods
B	To understand the fundamental theory and concepts of neural networks, neuro-modeling, several neural network paradigms and its applications.

Course Outcomes:

CO1	Learner will be able to articulate analogy of human neural network for understanding of artificial learning algorithms.
CO2	Learner will be able to analyze radial basis function network.
CO3	Learner will be able to analyze neural network architecture & basic learning algorithms.
CO4	Learner will be able to understand mathematical modeling of neurons, neural networks.
CO5	Learner will be able to analyze training, verification and validation of neural network models
CO6	Learner will be able to design Engineering applications that can learn using neural networks

UNIT I

Brain Style Computing: Origins and Issues**,** Biological neural networks, Neuron Abstraction, Neuron Signal.

UNIT II

Functions, Mathematical Preliminaries, Artificial Neurons, Neural Networks and Architectures Pattern analysis tasks: Classification, Clustering, mathematical models of neurons, Structures of neural networks, learning principles.

UNIT III

Feed forward neural networks: Pattern classification using perceptron, Multilayer feed forward neural networks (MLFFNNs), Pattern classification and regression using MLFFNNs, Error back-propagation learning, Fast learning methods: Conjugate gradient method.

UNIT IV

Auto-associative neural networks, Pattern storage and retrieval, Hopfield model, recurrent neural networks, Bayesian neural networks,

UNIT V

Radial basis function networks: Regularization theory, RBF networks for function approximation, RBF networks for pattern classification

UNITVI

Self-organizing maps: Pattern clustering, Topological mapping, Kohonen's self-organizing map Introduction to cellular neural network, Fuzzy neural networks, and Pulsed neuron models recent trends in Neural Networks

Textbooks / References:

1. Satish Kumar, Neural Networks, A Classroom Approach, Tata McGraw-Hill, 2003
2. JacekZurada, Introduction to Artificial Neural Networks, Jaico Publishing House, 1997.
3. S.Haykin, Neural Networks, A Comprehensive Foundation, Prentice Hall, 1998.
4. C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
5. B.Yegnanarayana, Artificial Neural Networks, Prentice Hall of India, 1999.
6. L.O. Chua and T. Roska, Cellular Neural Networks and Visual Computing Foundation and Applications, Cambridge Press, 2002.

ELECTIVE-I

ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To familiarize with the fundamentals that are essential for electronics industry in the field of EMI / EMC
B	To understand EMI sources and its measurements.
C	To understand the various techniques for electromagnetic compatibility.

Course Outcomes:

CO1	Learner will acquire knowledge of EMI / EMC sources and their standards
CO2	Lerner will be able to measure different parameters of interference in EM
CO3	Learner will be able to reduce the interference within EM devices
CO4	Lerner will be able to illustrate the physical and statistical model of EM devices
CO5	Lerner will be able to analyze the EM devices in terms of Computer Based Modeling and Simulation.
CO6	Learner will be able to design electronic systems that function without errors or problems related to electromagnetic compatibility.

UNIT I

Introduction to EMI / EMC:

EMI / EMC Standards, Introduction to E, H, Near and far field radiators, Receptors and antennas, Different types of EMI sources and possible remedies.

UNIT II

Measurement techniques in EMI:

Open area test sites, Radiated interference measurements, Conducted interference measurements, Interference immunity.

UNIT III

EMI reduction techniques:

Grounding, Shielding, Bonding, EMI filters.

UNITIV

Probabilistic and Statistical Physical Model :

Introduction, Probability considerations, Statistical Physical Models of EMI / EMC, EMC of terrestrial radio communication systems.

UNITV

Computer Based Modeling and Simulation :

Computer Based Modeling and Simulation of EMI Models and Signal Integrity.

Textbooks / References:

1. V. Prasad Kodali, Engineering Electromagnetic Compatibility, Principles and Measurement Technologies;; IEEE Press
2. Devid A. Weston, Marcol Dekker, Electromagnetic Compatibility, Principles and Applications; Inc New York.

ELECTIVE-I

MOBILE COMMUNICATION

Weekly Teaching Hours TH : 03 Tut: 01

Scheme of Marking TH :60 Tests : 20 IA: 20 Total : 100

Course Objectives:

A	To provide in-depth understanding of the cellular radio concepts such as frequency reuse, handoff and how interference between mobiles and base stations affects the capacity of cellular systems.
B	To provide in-depth understanding of how to measure and model the impact that signal bandwidth and motion have on the instantaneous received signal through the multipath channel.
C	To provide in-depth understanding of theoretical aspects (such as the capacity) of wireless channels and basic spread spectrum techniques in mobile wireless systems
D	To provide in-depth understanding of current and future cellular mobile communication systems.

Course Outcomes:

CO1	Learner will be able to analyze concept of basic cellular mobile system
CO2	Learner will be able to analyze multipath fading channel.
CO3	Learner will be able to distinguish types of fading channels with the concept of coherence time
CO4	Learner will be able to demonstrate the multiple access techniques.
CO5	Learner will be able to analyze diversity in multipath channels
CO6	Learner will be able to understand the various standards involve in evolution of communication system

UNIT I

Cellular concepts: Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; Wireless Standards: Overview of 2G and 3Gcellular standards. Signal propagation: Propagation mechanism reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing.

UNIT II

Fading channels: multipath and small scale fading-Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread

UNIT III

Coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate. Capacity of flat and frequency selective channels.

UNIT IV

Antennas: antennas for mobile terminal- monopole antennas, PIFA, base station antennas and array, Multiple access schemes: FDMA, TDMA, CDMA and SDMA. Modulation schemes: BPSK,QPSK and variants, QAM,MSK and GMSK, multicarrier modulation, OFDM.

UNIT V

Receiver structure: diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit diversity-Alamouti scheme. MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing tradeoff.

UNIT VI

Performance measures: outage, average SNR, average symbol/bit error rate. System examples: GSM, EDGE, GPRS, IS-95, CDMA2000 and WCDMA.

Textbooks / References:

1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005.
2. T. S. Rappaport, Wireless digital communications: Principles and practice, 2ndEd.,Prentice Hall India, 2007.
3. W. C. Y. Lee, Wireless and cellular tele communications, 3rd Ed., MGH, 2006.
4. G. L. Stuber, Principles of mobile communications, 2nd Ed., Springer, 2007.
5. Simon Haykin and Michael Moher, Modern Wireless Communication, Pearson education,

ELECTIVE-I

FAULT TOLERANT SYSTEMS

Weekly Teaching Hours TH : 03 Tut: 01

Scheme of Marking TH :60 Tests : 20 IA: 20 Total : 100

Course Objectives:

A	To provide in-depth understanding of the fundamental concepts of fault-tolerance.
B	To develop skills in modeling and evaluatingfault-tolerant architectures in terms of reliability, availability andsafety
C	To gain knowledge in sources of faults and means for their preventionand forecasting

Course Outcomes:

CO1	Learner will be able to analyze the risk of computer failures and their peculiarities compared with other equipment failures.
CO2	Learner will be able to analyze advantages and limits of fault avoidance and fault tolerance techniques.
CO3	Learner will be able to distinguish threat from software defects and human operator error as well as from hardware failures.
CO4	Learner will be able to analyze different forms of redundancy and their applicability to different classes of dependability requirements.
CO5	Learner will be able to choose among commercial platforms (fault-tolerant or non-fault-tolerant) on the basis of dependability requirements.
CO6	Learner will be able to demonstrate the use of fault tolerance in the design of application software.
CO7	Learner will be able to analyze relevant factors in evaluating alternative system designs for a specific set of requirements.
CO8	Learner will be aware of the subtle failure modes of "fault-tolerant" distributed systems, and the existing techniques for guarding against them.
CO9	Learner will be able to analyze cost-dependability trade-offs and the limits of computer system dependability.

UNIT I

Modelling and Logic Simulation:

Functional modeling at the logic and the register level, Structural models, Level of modelling. Type of simulation, unknown logic value, compiled simulation, Event-driven simulation, different delay models, Hazard Detection.

UNIT II

Fault Modelling and Fault Simulation:

Logical fault models, Fault detection and Redundancy, Fault equivalence and fault location, Fault Dominance, Single stuck-fault models, Multiple stuck fault model, stuck RTL variables, Fault variables. Testing for single stuck fault and Bridging fault, General fault simulation techniques, Serial and Parallel fault simulation, Deductive fault simulation, Concurrent fault simulation, Fault simulation for combinational circuits, Fault sampling, Statistical fault analysis.

UNIT III

Compression techniques and Self checking System:

General aspects of compression techniques, ones-count compression, transition –count compression, Parity –check compression, Syndrome testing and Signature Analysis,

UNIT IV

Self-checking Design, Multiple –Bit Errors, self–checking checkers, Parity –check function , totally self-checking m/n code checkers, totally self-checking equality checkers, Self-checking Berger code checkers and self-checking combinational circuits.

UNIT V

Testability: Testability, trade-offs, Ad hoc Design for Testability techniques, Introduction to BIST concept, Test pattern generation for BIST

UNIT VI

Self-testing circuits for systems, memory & processor testing, PLA-testing, automatic test pattern generation and Boundary Scan Testing JTAG.

Textbooks / References:

1. M.Abramovici, M.A. Breuer, A.D. Friedman, "Digital systems testing and testable design",Jaico Publishing House.

2. Kwang-Ting (Tim) Cheng and Vishwani D. Agrawal, "Unified Methods for VLSI Simulation and Test Generation "The Springer International Series in Engineering(Jun 30, 1989).

ELECTIVE-I

ANALOG AND MIXED SIGNAL PROCESSING

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding of the fundamental concepts of analog signal processing.
B	To provide in-depth understanding of data conversion, PLL design, filter design.

Course Outcomes:

CO1	Learner will be able to distinguish between fundamental concepts of analog an discrete time signal processing.
CO2	Learner will be able to design switched capacitor filters.
CO3	Learner will be able to demonstrate basics of analog to digital data conversion.
CO4	Learner will be able to design analog and digital PLLs
CO5	Learner will be able to understand fundamentals of green data converters.

UNIT I

Switched Capacitor filters: Introduction to Analog and Discrete Time signal processing, sampling theory, Nyqist and over sampling rates, Analog filters, analog amplifiers, lock in amplifiers,

UNIT II

Analog integrated and discrete time switched capacitor filters, non-idealities in switched capacitor filters, architectures for switched capacitor filters and their applications and design. Switched capacitor amplifiers.

UNIT III

Data converters: Basics of data converters, Types of data converters, types of ADCs, Successive approximation, dual slope, Flash type, pipelined ADCs, hybrid ADCs, high resolution ADCs, parallel path ADCs like time-interleaved and multi-channel converters.

UNIT IV

Types of DACs and their architectures, binary weighted DACs. Performance metrics of data converters, SNR, SFDR, SNDR.

UNIT V

Background and foreground techniques to improve performance of data converters, Green data converters (low power design).

UNIT VI

Frequency synthesizers and synchronization: Analog PLLs, Digital PLLs design and architectures, Delay locked loops design and architectures. Direct Digital Synthesis.

Textbooks / References:

1. CMOS mixed-signal circuit design by R. Jacob Baker Wiley India, IEEE press, reprint 2008
2. Switched-Current Signal Processing and A/D Conversion Circuits: Design and Implementation, R. Jacob Baker, Wiley India IEEE press 2008.
3. Mixed Signal Systems: a guide to CMOS circuit design, Andrzej Handkiewicz, IEEE computer Society Press.
4. Mixed Signal and DSP Design techniques, Engineering Analog Devices Inc, Engineering Analog Devices Inc, Walt Kester, Publisher Newnes.
5. Digital Frequency Synthesis Demystified, Bar-Giora Goldberg, Published by Elsevier.

ELECTIVE-II

RF AND MILLIMETER WAVE CIRCUIT DESIGN

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide an insight into various aspects of the RF, mm-wave.
B	To provide brief theoretical foundation of RF, and mm-wave
C	To provide an in-depth understanding of effects of the parasitic parameters introduced from layout of a block of CMOS circuit.

Course Outcomes:

CO1	Learner will be able to distinguish the type of network and application frequencies.
CO2	Learner will be able to interpret the behavior of passive network components at RF and Millimeter wave frequencies.
CO3	Learner will be able to analyze distributed transmission media and prepare a smith chart of the same.
CO4	Learner will be able to categorize noise and to predict the effects of it on circuit performance.
CO5	Learner will be able to construct microwave amplifiers, oscillators and Mixer circuit for given specifications at RF and Millimeter wave frequencies.
CO6	Learner will be able to perform frequency synthesis for the development of wireless communication systems and allied areas.

UNIT I

RF systems – basic architectures, Transmission media and reflections, Maximum power transfer.

Passive RLC Networks:

Parallel RLC tank, Q, Series RLC networks, Matching, Pi match, T match

UNIT II

Passive IC Components: Interconnects and skin effect, Resistors, capacitors, Inductors. Review of MOS, Device Physics**:** MOS device review

UNIT III

Distributed Systems:

Transmission lines, reflection coefficient, The wave equation, Examples Lossy transmission lines, Smith charts – plotting, gamma.

UNIT IV

Noise: Thermal noise, flicker noise review, Noise figure, LNA Design: Intrinsic MOS noise ,Parameters Power match versus noise match, Large signal performance, design examples & Multiplier based mixers, Mixer Design: Subsampling mixers.

UNIT V

RF Power Amplifiers: Class A, AB, B, C, Amplifiers Class D, E, F amplifiers RF Power amplifier design examples. Voltage controlled oscillators: Resonators, Negative resistance oscillators, Phase locked loops: Linearized PLL models, Phase detectors, charge pumps, Loop filters, PLL design examples

UNIT VI

Frequency synthesis and oscillators: Frequency division, integer-N synthesis Fractional, frequency synthesis. Phase noise: General considerations, Circuit examples. Radio Architectures GSM radio architectures: CDMA, UMTS radio architectures

Textbooks / References:

1. The Design of CMOS Radio-Frequency Integrated Circuits by Thomas H. Lee. Cambridge University Press, 2004.
2. RF Microelectronics by Behzad Razavi. Prentice Hall,1997.

ELECTIVE-II

SYSTEM ON CHIP

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide an in-depth understanding of what SoC is and what are the differences between SoC and Embedded System.
B	To provide an in-depth understanding of basics of System on Chip and Platform based design.
C	To provide an in-depth understanding of issues and tools related to SoC design and implementation.

Course Outcomes:

CO1	Learner will be able to interpret nature of hardware and software, its data flow modeling and implementation techniques.
CO2	Learner will be able to analyze the micro-programmed architecture of cores and processors.
CO3	Learner will be able to demonstrate system on chip design models.
CO4	Learner will be able to hypothesize and synthesize working of advanced embedded systems.
CO5	Learner will be able to develop design SOC controller.
CO6	Learner will be able to design, implement and test SOC model.

UNIT I

Basic Concepts: The nature of hardware and software, data flow modelling and implementation, the need for concurrent models, analyzing synchronous data flow graphs, control flow modelling and the limitations of data flow models, software and hardware implementation of data flow, analysis of control flow and data flow, Finite State Machine with data-path, cycle based bit parallel hardware, hardware model , FSMD data-path , simulation and RTL synthesis, language mapping for FSMD.

UNIT II

Micro-programmed Architectures : limitations of FSM , Micro-programmed : control, encoding , data-path, Micro-programmed machine implementation , handling Micro-program interrupt and pipelining , General purpose embedded cores , processors, The RISC pipeline, program organization, analyzing the quality of compiled code,

UNIT III

System on Chip, concept, design principles, portable multimedia system, SOC modelling, hardware/software interfaces , synchronization schemes, memory mapped Interfaces , coprocessor interfaces, coprocessor control shell design, data and control design, Programmers model .

UNIT IV

RTL intent : Simulation race, simulation-synthesis mismatch, timing analysis, timing parameters for digital logic, factors affecting delay and slew, sequential arcs, clock domain crossing ,bus synchronization , preventing data loss through FIFO, Importance of low power, causes and factors affecting power, switching activity, simulation limitation, implication on synthesis and on backend.

UNIT V

Research topics in SOC design: A SOC controller for digital still camera, multimedia IP development image and video CODECS

UNIT VI

SOC memory system design, embedded software, and energy management techniques for SOC design, SOC prototyping, verification, testing and physical design.

Textbooks / References:

1. Patrick R. Schaumont, "A Practical Introduction to Hardware/Software Co-design", Springer
2. Sanjay Churiwala, SapanGarg , "Principles of VLSI RTL Design A Practical Guide", Springer
3. Youn-Long Steve Lin, "Essential Issues in SOC Design, Designing Complex Systems-on-Chip", Springer

ELECTIVE-II

OPTICAL FIBER COMMUNICATION

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.
B	To provide an in-depth understanding needed to perform fiber-optic communication system engineering calculations, identify system tradeoffs, and apply this knowledge to modern fiber optic systems.

Course Outcomes:

CO1	Learner will be able to recognize and classify the structures of Optical fiber and types.
CO2	Learner will be able to demonstrate electromagnetic and mathematical analysis of light wave propagation.
CO3	Learner will be able to analyze fabrication techniques of different optical fibers.
CO4	Learner will be able to interpret behavior of pulse signal and various loss mechanism.
CO5	Learner will be able to interpret Dispersion compensation mechanism, Scattering effects and modulation techniques.
CO6	Learner will be able to interpret working of Fiber based devices.

UNIT I

Introduction and importance of Fiber Optics Technology, Ray analysis of optical fiber: Propagation mechanism of rays in an optical fiber, Meridional rays, Skew rays, Fiber numerical aperture, dispersion.

UNIT II

Electromagnetic (modal) analysis of Step index multimode fibers: Wave equation and boundary conditions, Characteristics equation, TE, TH and Hybrid modes, Weakly guiding approximation,

linearly polarized modes, Single mode fiber, V parameter, Power confinement and mode cutoff, Mode field diameter.

UNIT III

Graded-index fiber: Modal analysis of graded index fiber, WKB analysis, Optimum profile.

Experimental techniques in fiber optics: Fiber fabrication (OVD, VAD, CVD, MCVD,PMCVD etc.) and characterization, Splices, Connectors and fiber cable.

UNIT IV

Loss mechanism in optical fiber: Absorption loss, scattering loss, bending loss, splice loss. Pulse propagation, Dispersion and chirping in single mode fibers: Pulse propagation in non-dispersive and dispersive medium, Pulse broadening and chirping, Group and phase velocity, Intermodal and intramodal dispersion, Group velocity (material and waveguide) dispersion, Higher order dispersion, Fiber bandwidth.

UNIT V

Dispersion compensation mechanism: Dispersion tailored and dispersion compensating fibers, Fiber Birefringence and polarization mode dispersion, Fiber bandwidth, Nonlinear effects in optical fiber: Stimulated Raman Scattering, Stimulated Brillouin Scattering, Self Phase, Modulation, Cross Phase Modulation, Optical Solitons.

UNIT VI

Fiber based devices: Erbium-doped fiber amplifiers and lasers, Fiber Bragg gratings, Optical Fiber Sensors. Photonic Crystal fibers.

Textbooks / References:

1. A. K. Ghatak& K. Thyagarajan, Introduction to Fiber Optics, Cambridge University Press (1998).
2. G. P. Agarwal, Fiber Optic Communication Systems, John Wiley Sons (1997).
3. John A. Buck, Fundamentals of Optical Fibers, Wiley Interscience, (2004).
4. J. M. Senior, Optical Fiber Communication, Prentice Hall (1999).
5. G. Keiser, Optical Fiber Communications, McGraw Hill (2000).
6. K. Okamoto, Fundamentals of Optical Waveguides, Academic Press, (2000).
7. K. Iizuka, Elements of Photonics Vol I &II, Wiley-Interscience (2002).
8. D. W. Prather et.al, Photonic Crystal, Wiley (2009).

ELECTIVE-II

STATISTICAL SIGNAL PROCESSING

Weekly Teaching Hours	TH : 03	Tut: 01		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding of more advanced probability theory, leading into random process theory and focus on discrete time methods.
B	To provide in-depth understanding of fundamental concepts of statistical signal processing,

Course Outcomes:

CO1	Learner will be able to generalize the properties of statistical models in the analysis of Signals using Stochastic processes.
CO2	Learner will be able to compare different Stochastic Processes and Models.
CO3	Learner will be able to demonstrate optimum linear filter algorithms and structures.
CO4	Learner will be able to Differentiate the prominence of various spectral estimation techniques for Achieving higher resolution in the estimation of power spectral density.
CO5	Learner will be able to visualize Least Square Filtering and Computation techniques.
CO6	Learner will be able to interpret adaptive filtering and its applications.

UNIT I

Introduction

Random Signals, Spectral Estimation, Adaptive Filtering, Random Variables, Distribution and Density Functions, Random Vectors: Definition, Transformation and Linear Combination of Random Vectors Linear System with Stationary Input, Innovations and Representation of Real Vectors, DT Stochastic Process: Stationarity, Ergodicity and Frequency Domain Representation of SP, Principles of Estimation.

UNIT II

Stochastic Processes and Models

Characterization of DT Stochastic Process, Correlation Matrix, Properties of Correlation Matrix, Stochastic Models: MA and AR Models, ARMA Models Hold Decomposition, Asymptotic Stationarity of AR Process, Yule Walker Equations, Power Spectral Density, Properties of Power Spectral Density Transmission of Stationary Process Through a Linear Filter, Other Statistical Characteristics of Stochastic Process Power Spectral Estimation, Spectral Correlation Density, Polyspectra

UNIT III

Optimum Linear Filters

Optimum Signal Estimation, Linear Mean Square Estimation, Solution of Normal Equations, Optimum FIR Filters, Linear Prediction: Linear Signal Estimation, Forward Linear Estimation, Backward Linear Estimation, Stationary Processes and Properties, Optimum IIR Filters, Inverse Filtering and Deconvolution.

UNIT IV

Algorithms and Structures for Optimum Filters.

Fundamentals of Order-Recursive Algorithms, Interpretation of Algorithmic Quantities, Order-Recursive Algorithms for Optimum FIR Filters, Algorithms of Levinson and Levinson-Durbin, Lattice Structure for Optimum Filters, Schur Algorithm, Triangularization and Inverse of Toeplitz Matrices, Kalman Filter Algorithm.

UNIT V

Least Square Filtering

Principle of LS, Linear Least Square Error Estimation, Least Square Filter, Linear Least Square Signal Estimation, LS Computation using Normal Equations, LS Computation using Orthogonalization Techniques, LS Computation using Singular Value Decomposition Techniques, Problems.

UNIT VI

Adaptive Filtering

Introduction, Typical Applications, Principles of Adaptive Filters, Method of Steepest Decent, LMS Algorithm, RLS Adaptive Filter, Fast RLS Algorithms for FIR Filtering, Frequency Domain and Sub-band Adaptive Filters.

Textbooks / References:

1. S. Haykin Adaptive Filter Theory;; PHI.
2. D. G. Manolakis, V. K. Ingle, S. M. Kogon;Statistical and Adaptive Signal Processing; McGraw Hill.

ELECTIVE-II

MICROELCTRONICS

Weekly Teaching Hours TH : 03 Tut: --

Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding and to be able to apply basic concepts of semiconductor physics relevant to devices
B	To be able to analyze and design microelectronic circuits for linear amplifier and digital applications

Course Outcomes:

CO1	Learner will be able to discuss MOS structure in terms of different parameters
CO2	Learner will be able to express different CMOS technologies
CO3	Learner will get knowledge of design rules for the CMOS design
CO4	Learner will be able to understand how devices and integrated circuits are fabricated and describe discuss modern trends in the microelectronics industry
CO5	Learner will be able to determine the frequency range of simple electronic circuits and understand the high frequency limitations of BJTs and MOSFETs
CO6	Learner will be able to design simple devices and circuits to meet stated operating specifications

UNIT I

Ideal I-V Characteristics, C-V Characteristics: MOS Capacitance models, MOS Gate Capacitance Model, MOS Diffusion Capacitance Model. Non ideal I-V Effects: Velocity Saturation and Mobility Degradation, Channel Length Modulation, Body Effect, Sub threshold Conduction, Junction Leakage, Tunneling, Temperature and Geometry Dependence. DC Transfer characteristics: Complementary CMOS Inverter DC Characteristics, Beta Ratio Effects, Noise Margin, Ratio Inverter Transfer Function, Pass Transistor DC Characteristics, Tristate Inverter, Switch- Level RC Delay Models

UNIT II

CMOS Technologies: Background, Wafer Formation, Photolithography, Well and Channel Formation, Silicon Dioxide (SiO2), Isolation, Gate Oxide, Gate and Source/Drain Formation, Contacts and Metallization, Passivation, Metrology.

UNIT III

Layout Design Rules: Design Rules Background, Scribe Line and Other Structures, MOSIS Scalable CMOS Design Rules, Micron Design Rules. CMOS Process Enhancements: Transistors, Interconnect, Circuit Elements, Beyond Conventional CMOS. CMOS Fabrication and Layout: Inverter Cross-section, Fabrication Process, Layout Design rules, Gate Layout, Stick Diagrams.

UNIT IV

Delay Estimation: RC Delay Models, Linear Delay Model, Logical Effort, Parasitic Delay. Logical Effort and Transistor Sizing: Delay in a Logic Gate, Delay in Multistage Logic Networks, choosing the Best Number of Stages. Power Dissipation: Static Dissipation, Dynamic Dissipation, Low-Power Design. Interconnect: Resistance, Capacitance, Delay, Cross talk. Design Margin: Supply Voltage, Temperature, Process Variation, Design Corners. Reliability, Scaling.

UNIT V

Static CMOS Logic : Inverter, NAND Gate, Combinational Logic, NOR Gate, Compound Gates, Pass Transistors and Transmission Gates, Tristates, Multiplexers, Latches and Flip-Flops, Circuit Families: Static CMOS, Ratioed Circuits,

UNIT VI

Cascode Voltage Switch Logic, Dynamic Circuits, Differential Circuits, Sense Amplifier Circuits, BiCMOS Circuits, Low Power Logic Design, Comparison of Circuit Families, Analog Circuit Designs, MOS Small-signal Models, Common Source Amplifier, The CMOS Inverter as an Amplifier, Current Mirrors, Differential Pairs, CMOS Operational Amplifier topologies, Digital to Analog Converters, switched capacitors, Analog to Digital Converters, RF Circuits

Textbooks / References:

1. J. M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits : A Design Perspective, Pearson/PHI (Low Price Edition)
2. S-M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits : Analysis and Design, Third Edition, McGraw-Hill
3. B. Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill
4. P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, Second Edition, Oxford University Press
5. P. Gray, P. J. Hurst, S. H. Lewis and R. Meyer, Analysis and Design of Analog Integrated Circuits, Fourth Edition, Wiley, 2001. (Low Price Edition)

COMMUNICATION SKILLS

Weekly Teaching Hours	TH: 03	Tut: --		
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:

A	To become more effective confident speakers and deliver persuasive presentations
B	To develop greater awareness and sensitivity to some important considerations in interpersonal communication and learn techniques to ensure smoother interpersonal relations

Course Outcomes:

CO1	Learner will be able to understand the fundamental principles of effective business communication
CO2	Learner will be able to apply the critical and creative thinking abilities necessary for effective communication in today's business world
CO3	Learner will be able to organize and express ideas in writing and speaking to produce messages suitably tailored for the topic, objective, audience, communication medium and context
CO4	Learner will be able to demonstrate clarity, precision, conciseness and coherence in your use of language
CO5	Learner will be able to become more effective confident speakers and deliver persuasive presentations

UNIT I

Introduction to communication, Necessity of communication skills, Features of good communication, Speaking skills, Feedback & questioning technique, Objectivity in argument

UNIT II

Verbal and Non-verbal Communication, Use and importance of non-verbal communication while using a language, Study of different pictorial expressions of non-verbal communication and their analysis

UNIT III

Academic writing, Different types of academic writing, Writing Assignments and Research Papers, Writing dissertations and project reports

UNIT IV

Presentation Skills: Designing an effective Presentation, Contents, appearance, themes in a presentation, Tone and Language in a presentation, Role and Importance of different tools for effective presentation

UNIT V

Motivation/ Inspiration: Ability to shape and direct working methods according to self-defined criteria Ability to think for oneself, Apply oneself to a task independently with self-motivation, Motivation techniques: Motivation techniques based on needs and field situations

UNIT VI

Self Management, Self Evaluation, Self discipline, Self criticism, Recognition of one's own limits and deficiencies, dependency, etc. Self Awareness, Identifying one's strengths and weaknesses, Planning & Goal setting, Managing self-emotions, ego, pride, Leadership & Team Dynamics

Textbooks / References:

1. Mitra, Barun, "Personality Development and Soft Skills", Oxford University Press, 2016
2. Ramesh, Gopalswamy, "The Ace of Soft Skills: Attitude, Communication and Etiquette for Success," Pearson Education, 2013
3. Covey, Stephen R., "Seven Habits of Highly Effective People: Powerful Lessons in Personal Change".
4. Rosenberg Marshall B., "Nonviolent Communication: A Language of Life".

PG LAB-I

Weekly Teaching Hours	TH: --		Practical: 03	
Scheme of Marking	TH: --	IA: 25	PR/OR: 25	Total: 50

Practical's of the Lab - I shall be based on the courses of first semester. The lab work shall consists of hands on experiments on the different software and hardware platforms related to the syllabus.

ESTIMATION AND DETECTION THEORY

Weekly Teaching Hours	TH : 03	Tut: 01		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding basics of detection and estimation theory.
B	To be able to design and analyze optimum detection schemes

Course Outcomes:

CO1	Learner will have basic knowledge of linear algebra.
CO2	Acquire basics of statistical decision theory used for signal detection and estimation.
CO3	Examine the detection of deterministic and random signals using statistical models.
CO4	Examine the performance of signal parameters using optimal estimators.
CO5	Study different estimation schemes such as ML and MMSE estimators.

UNIT I

Linear Algebra

Vector space : linear dependence, Basis and dimension, vector subspace, inner product spaces, orthonormal basis and Gram- Schmidt Process of orthogonalisation, computation of linear dependence, linear transformation and matrices, change of basis, orthogonal and unitary transformation, Eigenvalue, Eigen vectors and characteristics equation. Systems theory, stochastic processes, Gauss Markov models, representation of stochastic processes, likelihood and sufficiency.

UNIT II

Binary Decision: Single Observation

Introduction to structure ofdecision and estimation problems.MaximumLikelihood decision criterian, Neyman-person criterian, Probability of error criterian, Bays risk criterian, Min-Max criterian, problems

UINT III

Binary Decision: Multiple Observations

Vector observation, The general Gaussion problem, Waveform observations and additive Gaussion noise, problems

UNIT IV

Multiple Decision: Multiple Decision

Bays risk, Probability of error: General case, Probability of error: Gaussion case, Ensure decision problems.

UNIT V

Composite And Nonparametric Decision Theory

Composite decisions Sign test, Wilason test, problems

UNIT VI

Fumdamentals of Estimation

Maximum likelihood method, Bays cost method, Relationship of Estimation, Linear minimum, Variance and Least-square methods. Properties of Estimations: Unbiased estimators, Efficient estimators, Asymphotic properties.

Textbooks / References:

1. James Melsa and David Cohn, Decision and Estimation Theory, Mc-Graw Hill
2. Harry L, Van Trees, Detection, Estimation, and Modulation Theory , John Wiley and Sons Inc

INFORMATION THEORY AND CODING

Weekly Teaching Hours	TH: 03	Tut: 01		
Scheme of Marking	TH: 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding of principles and applications of information theory.
B	To provide in-depth understanding of how information is measured in terms of probability and entropy and how these are used to calculate the capacity of a communication channel.
C	To provide in-depth understanding of different coding techniques for error detection and correction.

Course Outcomes:

CO1	Learner will be able to formulate equations for entropy mutual information and channel capacity for all types of channels.
CO2	Learner will be able to distinguish between different types error correcting codes based on probability of error
CO3	Learner will be able to design a digital communication system by selecting an appropriate error correcting codes for a particular application.
CO4	Learner will be able to explain various methods of generating and detecting different types of error correcting codes
CO5	Learner will be able to formulate the basic equations of linear block codes.
CO6	Learner will be able to compare the performance of digital communication system by evaluating the probability of error for different error correcting codes

UNIT I

Theory of Probability and Random Processes

Concept of probability, Random variables, Probability models, Statistical averages, Central limit theorem, Correlation, Linear mean square estimation.

UNIT II

Random Processes

Random variable and random process, Power spectral density of a random process, Multiple random processes, Transmission of random processes through linear systems, Band-pass random processes, Optimum filtering.

UNIT III

Noise in Communication Systems

Behavior of analog and digital communication systems in the presence of noise, Sources of noise, Noise representation, Noise filtering, Noise bandwidth, Performance of analog and digital communication systems in the presence of noise.

UNIT IV

Information Theory

Measure of information, Joint entropy and conditional entropy, Relative entropy and mutual information, Markov sources, Source encoding, Shannon-Fano coding and Huffman coding, Shannon's first and second fundamental theorems, Channel capacity theorem.

UNIT V

Error Correcting Codes

Galois fields, Vector spaces and matrices, Block codes, Cyclic codes, Burst-error detecting and correcting codes, Multiple error correcting codes, Convolutional codes, ARQ, Performance of codes, Comparison of coded and un-coded systems.

UNIT VI

Speech Coding

Characteristics of speech signal, Quantization techniques, Frequency domain coding, Vocoders, Linear predictive coders, Codecs for mobile communication, GSM codec, USDC codec, Performance evaluation of speech coders.

Textbooks / References:

1. B. P. Lathi; Modern Digital and Analog Communication Systems; Oxford Publication.
2. Das, Mullick, Chaterjee; Principles of Digital Communication; New Age International.
3. Taub, Schilling, Principles of Communication Engineering (2nd Edition); TMH.
4. Thomas M. Cover, Joy A. Thomas, Elements of Information Theory; Wiley Inter science.
5. R.P.Singh, S.D. Sapre; Communication systems : Analog and Digital; TMH.
6. Theodore S. Rappaport; Wireless Communication : Principles and Practice (2nd Edition); Pearson India.

ELECTIVE-III

MULTIRATE DIGITAL SIGNAL PROCESSING

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To master the fundamentals of multirate signal processing and demonstrate the ability to solve problems in sample rate conversion, filter banks, and transmultiplexers.

Course Outcomes:

CO1	Learner will be able to develop efficient realizations for up sampling and down sampling of signals using the polyphase decomposition
CO2	Learner will be able to design and implement Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) digital filters to meet specifications
CO3	Learner will be able to design digital filter banks based on the techniques presented
CO4	Learner will be able to analyze fundamental concepts of wavelets.
CO5	Learner will be able to distinguish between wavelets and multirate filter banks, from the point of view of implementation.

UNIT I

Fundamentals of Multirate Systems

Introduction, Basic multirate operations, Interconnection of building blocks, Polyphase representation, Mulstage implementation, Some application of multirate systems, Special filter and filter banks.

UNIT II

Maximally Decimaled Filter Banks

Introduction, Errors created in the QMF bank, A simple alias free QMF system, Power symmetric QMF banks, M-channel filter banks, Polyphase representation, Perfect reconstruction system, alias free filter banks, Tree structured filter banks, Transmultiplexer.

UNIT III

Paranitary Perfect Reconstruction Filter Banks

Introduction, Lossless transfer matrices, Filter banks properties induced by paraunitariness, Two channel FIR paraunitary QMF banks, Two channel paraunitary QMF lattice, M - channel FIR paraunitary filter banks, Tranform coding and LOT.

UNIT IV

Linear Phase and Cosine Modulated Filter Banks

Introduction, Some necessary conditions, Lattice structure for linear phase FIR PR banks, formal synthesis of linear phase FIR PR QMF Lattice. Pseudo QMF banks, Design of the pseudo QMF bank, Efficient polyphase structure, Cosine modulated perfect reconstruction system.

UNIT V

The Wavelet Transform and its Relation to Multirate Filter Banks

Introduction, Background and outline, Short time fourier transform, The Wavelet transform, DT orthonomal Wavelets, Continuous time orthonormal Wavelet basis.

UNIT VI

Multidimensional, Multivariable and Lossless Systems

Introduction, Multidimensional signals, Sampling a multidimensional Signals, Multirate fundamentals. Review of discrete time multi-input multi-output LTI System, ParaUNITary and lossless system.

Textbooks / References:

1. P.P.Vaidyanathan , Multirate System and Filter Banks, PTR Prentice Hall, Englewood Cliffs , New Jersey,
2. N.J.Fliege, Multirate Digital Signal Processing , John Wiley & Sons
3. Raghuveer Rao, Ajit Bopardikar,Wavelet Transforms Introduction to Theory and Application, Pearson Education Asia
4. C. Sidney Burrus , R.A.Gopianath , Pretice Hall, Introduction to wavelet and wavelet Transform

ELECTIVE-III

EMDEDDED SYSTEM DESIGN

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To introduce students to the modern embedded systems and to show how to understand and program such systems using a concrete platform built around a modern embedded processor.

Course Outcomes:

CO1	Learner will have understanding of fundamental embedded systems design paradigms, architectures, possibilities and challenges, both with respect to software and hardware
CO2	Learner will be able to analyze a wide competence from different areas of technology, especially from computer engineering, study of processor for deep understanding analyze case study of Pentium processor
CO3	Learner will be able to demonstrate architecture of 8051, Instruction set, Addressing modes. Programming8051 for various applications. Interfacing of LED/LCD, keyboard, stepper motor, ADC/DAC and sensors, RTC, serial communication with micro-controller.
CO4	Learner will be able to analyze deep state-of-the-art theoretical knowledge in the areas of real-time systems, artificial intelligence, learning systems, sensor and measuring systems, and their interdisciplinary nature needed for integrated hardware/software development of embedded systems.
CO5	Learner will have ability to analyze a system both as whole and in the included parts, to understand how these parts interact in the functionality and properties of the system, and understanding and experience of state-of-the-practice industrial embedded systems and intelligent embedded system development.

UNIT I

Fundamentals of Embedded System

Embedded System overview, Design challenges, Processor Technology, IC Technology, Design Technology.

UNIT II

Embedded System Hardware

Evaluation of Processors, Microprocessor architecture overview- CISC and RISC, Case study of Pentium processor architecture.

UNIT III

Microcontroller Architecture and **Interfacing**

Architecture of 8051, Instruction set, Addressing modes, Programming Examples. Interfacing of LED/LCD, keyboard, stepper motor, ADC/DAC and sensors, RTC, serial communication with micro-controller.

UNIT IV

Study of semiconductor memory

Memory device characteristics, SRAM, DRAM, SSRAM, SDRAM, RDRAM, FLASH, Smart card memory and interfacing of memory with micro-controller.

UNIT V

Introduction to DSP Processors

Architecture, features, instruction set, typical applications (TMS320XX or ADSP 21010).

UNIT VI

Embedded software and Applications

Introduction to software Engg, C cross compiler, Computational models, FSM, Concurrent state model, Concurrent Processes, Communication among processes, synchronization among processes. Introduction to RTOS: Windows CE, VX works.

Applications: Network protocols- TCP/IP, Embedded Ethernet, CANBUS, I2C bus, Mod Bus, Digital Camera.

Textbooks / References:

1. Frank Vahid and Tony Givargis, "EMBEDDED SYSTEM DESIGN A Unified Hardware/Software Introduction", John Wiley and sons ltd., 2002
2. M.A. Mazidi and J.G. Mazidi, "The 8051 Micro-controller and Embedded System" Pearson Education Asia, 2000
3. K.J. Ayala, "The 8051 Micro-controller", Penram International Pub., 1996
4. INTEL Microcontroller Manual
5. J. Zimmermann: "Fuzzy set theory and its applications, second edition, Allied Publishers limited, New Delhi, 1996.

ELECTIVE-III

WIRELESS SENSOR NETWORK DESIGN

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding of design and implementation of WSN
B	To provide ability to formulate and solve problems creatively in the area of WSN
C	To provide in-depth understanding of various applications of WSN.

Course Outcomes:

CO1	Student will understand the need of WSN and also will analyze the challenges in creating WSN
CO2	Student will be able to design the architecture of WSN
CO3	Student will be able analyze the power and security constraints in WSN
CO4	Student will study different operating system to operate WSN
CO5	Student will be able to understand the basic functioning of WSN at physical layer
CO6	Student will understand different protocols at network layer to for multiple channel accessing

UNIT I

Introduction: Motivation for a Network of Wireless Sensor Nodes , Sensing and Sensors, Wireless Networks, Challenges and Constraints. Applications: Health care, Agriculture, Traffic and others.

UNIT II

Architectures: Node Architecture, the sensing subsystem, processor subsystem, communication, interface, LMote, XYZ, Hogthrob node architectures

UNIT III

Power Management-Through local power, processor, communication subsystems and other means, time Synchronization need, challenges and solutions overview for ranging techniques

Security Fundamentals, challenges and attacks of Network Security, protocol mechanisms for security.

UNIT IV

Operating Systems-Functional and non-functional Aspects, short overview of prototypes – TinyOS, SOS, Contiki, Lite OS, sensor grid.

UNIT V

Physical Layer –Basic Components, Source Encoding, Channel Encoding, Modulation, Signal Propagation

UNIT VI

Medium Access Control–types, protocols, standards and characteristics, challenges, Network Layer-Routing Metrics, different routing techniques.

Textbooks / References:

1. Dargie, W. and Poellabauer, C., "Fundamentals of wireless sensor networks: theory and practice", John Wiley and Sons, 2010
2. Sohraby, K., Minoli, D., Znati, T. "Wireless sensor networks: technology, protocols, and applications, John Wiley and Sons", 2007
3. Hart, J. K. and Martinez, K. (2006) Environmental Sensor Networks: A revolution in the earth system science? Earth-Science Reviews, 78.
4. Andreas Willig, Protocols and Architectures for Wireless Sensor Networks-Holger Karl, 08-Oct 2007

ELECTIVE-III

VLSI AND MICROSYSTEMS

Weekly Teaching Hours	TH : 03	Tut: 00		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in depth understanding of the principals involved in the latest hardware required for designing and critically analyzing electronic circuits relevant to industry need and society
B	To provide in depth understanding of microfabrication process, packaging

Course Outcomes:

CO1	The student will learn the different abstract levels in Verilog for modeling digital circuits.
CO2	The student will learn the designing of combinational and sequential circuits in CMOS.
CO3	The student will be able to understand CMOS analog circuits design.
CO4	The student will be able to understand the impact of the physical and chemical processes of integrated circuit fabrication technology on the design of integrated circuits.
CO5	The student will be able to understand physics of the Crystal growth, wafer fabrication and basic properties of silicon wafers.
CO6	The student will be able to understand implementation of finite element method for different semiconductor devices.

UNIT I

VHDL Modeling and PLD Architectures

Data objects, Data types, Entity, Architecture & types of modeling, Sequential statements, Concurrent statements, Packages, Sub programs, Attributes, VHDL Test bench, Test benches using text files. VHDL modeling of Combinational, Sequential logics & FSM, Meta-stability, PROM, PLA, PAL: Architectures and applications. Software Design Flow, CPLD Architecture, Features, Specifications, Applications. FPGA Architecture, Features, Specifications, Applications.

UNIT II

SoC, Interconnect and Digital CMOS Circuits

Clock skew, Clock distribution techniques, clock jitter. Supply and ground bounce, power distribution techniques. Power optimization. Interconnect routing techniques; wire parasitic, Signal integrity issues. I/O architecture, pad design, Architectures for low power, MOS Capacitor, MOS Transistor theory, C-V characteristics, Non ideal I-V effects, Technology Scaling. CMOS inverters, DC transfer characteristics, Power components, Power delay product. Transmission gate. CMOS combo logic design. Delays: RC delay model, Effective resistance, Gate and diffusion capacitance, Equivalent RC circuits; Linear delay model, Logical effort, Parasitic delay, Delay in a logic gate, Path logical efforts.

UNIT III

Analog CMOS Design and Testability

Current sink and source, Current mirror. Active load, Current source and Push-pull inverters. Common source, Common drain, Common gate amplifiers, Cascode amplifier, Differential amplifier, Operational amplifier, Types of fault, Need of Design for Testability (DFT), Testability, Fault models, Path sensitizing, Sequential circuit test, BIST, Test pattern generation, JTAG & Boundary scan, TAP Controller.

UNIT IV

Microfabrication processes

Glimpses of Microsystems, scaling effects, Smart materials and systems: an overview, Microsensors: some examples, Microactuators: some examples, Microsystems: some examples, Examples of smart systems: structural health monitoring and vibration control, Structure of silicon and other materials, Silicon wafer processing; Thin-film deposition, Lithography, wet etching and dry etching Bulk micromachining and Surface micromachining, Wafer-bonding; LIGA and other moulding techniques, Soft lithography and polymer processing, Thick-film processing; Low temperature co-fired ceramic Processing, Smart material processing.

UNIT V

Mechanics of Solids

Stresses and deformation: bars and beams, Micro device suspensions: lumped modeling, Residual stress and stress gradients, Poisson effect; Anticlastic curvature; examples of micromechanical structures, Thermal loading; bimorph effect, Dealing with large displacements; in-plane and 3D elasticity equations, Vibrations of bars and beams, Gyroscopic effect, Frequency response; damping; quality factor, Basic micro-flows for damping calculation.

UNIT VI

Finite element method and Electronics and packaging

Types of numerical methods for solving partial differential equations, What is finite element method? Variational principles, Weak form; shape functions, Isoparametric formulation and numerical integration, Implementation of the finite element method, FEM for piezoelectrics, Semiconductor devices: basics, OpAms and OpAmp circuits, Signal conditioning for microsystems devices, Control and microsystems, Vibration control of a beam, Integration of microsystems and microelectronics, Packaging of Microsystems: why and how, Flip-chip, ballgrid, etc., reliability, Case-study 1 (Pressure sensor), Case-study 2 (Accelerometer)

Textbooks / References:

1. K. Eshraghian, Eshraghian. D, A. Pucknell, Essentials of VLSI Circuits and Systems, , 2005, PHI. 2. Modern VLSI Design – Wayne Wolf, 3rd Ed., 1997, Pearson Education.
2. Ming-BO Lin, Introduction to VLSI Systems: A Logic, Circuit and System Perspective –CRC Press, 2011.
3. N.H.E Weste, K. Eshraghian, Principals of CMOS VLSI Design –, 2nd Ed., Addison Wesley.

ELECTIVE-III

NUMERICAL METHODS IN ELECTROMAGNETICS

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide the mathematical foundation for the development of numerical methods in Electromagnetics
B	To formulate Finite Difference (FD) schemes for the solution of parabolic, elliptic, and hyperbolic PDEs with emphasis on the truncation boundaries, accuracy, and stability
C	To solve a variety of electromagnetic problems ranging from scattering and radiation to waveguide propagation and eigenvalue problems.

Course Outcomes:

CO1	To understand the main principles and laws that govern electromagnetic wave propagation
CO2	To identify the most suitable numerical technique for the solution of a particular problem in Electromagnetics
CO3	To understand the basic properties of transmission lines; analyze electromagnetic wave propagation in generic transmission line geometries.
CO4	To learn how to use numerical methods to solve for electric fields from charge distributions and conducting boundaries.
CO5	To understand the behavior of magnetic and electric fields in the presence of dielectric and magnetic materials; appreciate how to simply modify expressions for capacitance and inductance from free space expressions.
CO6	To understand the behavior of magnetic and electric fields in the presence of dielectric and magnetic materials.

UNIT I

Review of Analytical Methods

Separation of variables, conformal transformation – Green's function. Finite difference method – iterative solution, relaxation and acceleration crocesses : different boundary conditions. Review and Introduction to Numerical Analysis: example boundary value problems; numerical tessellation, interpolation and shape functions; splines, extrapolation method; numerical integration and differentiation; linear system solutions (direct and iterative); sparse system storage schemes

UNIT II

Discretization of solution region: Shape functions, element matrices and global matrix, method of solution, Method of moments, Basis functions; weighted residuals, method of least squares, numerical integration.

UNIT III

Variational Method Derivation of variational expression, Euler-lagrange equation , Rayleigh-Ritz method.

UNIT IV

Finite Element Method: Discretization of solution region: Shape functions, element matrices and global matrix, method of solution, Method of moments, Basis functions; weighted residuals, method of least squares, numerical integration. One- and two-dimensional finite element method: linear and quadratic shape functions, meshing; system construction and assembly; element matrix for the wave equation; boundary condition enforcement/condensation of boundary conditions; absorbing boundary conditions; perfectly matched layers(PML); boundary integral truncation; mesh generation issues; capacitance, inductance, propagation constant computations; shielded and open transmission lines; Inhomogeneous guides and cavities; magnetic circuits (permanent magnets, windings)

UNIT V

One- and two-dimensional finite differences: iterative solution; cavity field computations; field mapping, equipotentials; capacitance computations for shielded transmission lines Microsoft Excel (spreadsheet); microstrip line analysis and material interface treatment; magnetic fields in motor windings; Finite difference time domain method and the Yee marching scheme (2D); gridding and stability conditions; absorbing boundary conditions

UNIT VI

Integral equation methods: boundary integral equations (2D and 3D); weighted residual method and system construction;capacitance computations using a supplied PC program; modeling various transmission lines; magnetic field and inductance computations (6)

Textbooks / References:

1. Electromagnetic concepts and applications, Skitele C.G, PHI Inc., Englewood Cliffs N.J.,1982

2. Electromagnetic energy transmission and radiation, Adder R.B.,MIT press, Cambridge, 1969

3. Microwave Engineers handbook, Vol.I, SAAD T. and Hansen, Artech house, 1971.

4. Space charge waves and slow EM waves, Beck, A.H.U., Pergamon press, 1950

ELECTIVE-IV

ADVANCED BIOMEDICAL SIGNAL PROCESSING

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To introduce students to the principles of signal processing techniques when applied specifically to biomedical signals
B	To provide in depth understanding of methods and tools for extracting information from digitally acquired biomedical signals.

Course Outcomes:

CO1	Learner will be able to demonstrate a systematic knowledge of the complex physical and physiological principles that underpin the measurement of biomedical signals.
CO2	Learner will be able to demonstrate an advanced understanding of the principles of digital signal processing.
CO3	Learner will be able to systematically apply advanced methods to extract relevant information from biomedical signal measurements.
CO4	Learner will be able to critically assess the appropriateness of cutting-edge biomedical signal processing techniques for various problems in the field.
CO5	Learner will be able to evaluate the effectiveness of techniques applied to biomedical signals against specific benchmarks.

UNIT I

Introduction To Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG etc - Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio potentials - Review of linear systems - Fourier Transform and Time Frequency Analysis (Wavelet) of biomedical signals- Processing of Random & Stochastic signals – spectral estimation – Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments

UNIT II

Concurrent, Coupled And Correlated Processes - illustration with case studies – Adaptive and optimal filtering - Modeling of Biomedical signals - Detection of biomedical signals in noise -removal of artifacts of one signal embedded in another -Maternal-Fetal ECG - Muscle-contraction interference. Event detection - case studies with ECG & EEG - Independent component Analysis - Cocktail party problem applied to EEG signals - Classification of biomedical signals.

UNIT III

Cardio Vascular Applications : Basic ECG - Electrical Activity of the heart- ECG data acquisition – ECG parameters & their estimation - Use of multiscale analysis for ECG parameters estimation - Noise & Artifacts- ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection - Arrhythmia analysis

UNIT IV

Data Compression: Lossless &Lossy- Heart Rate Variability – Time Domain measures - Heart Rhythm representation - Spectral analysis of heart rate variability - interaction with other physiological signals.

UNIT V

Introduction to EEG: The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface.

UNIT VI

EEG Modeling - linear, stochastic models – Non linear modeling of EEG - artifacts in EEG & their characteristics and processing – Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis – correlation analysis of EEG channels - coherence analysis of EEG channels.

Textbooks / References:

1. D.C.Reddy ,Biomedical Signal Processing: Principles and techniques ,Tata McGraw Hill, New Delhi, 2005
2. Willis J Tompkins , Biomedical Signal Processing -, ED, Prentice – Hall, 1993
3. R. Rangayan, Biomedical Signal Analysis, Wiley 2002.
4. Bruce, Biomedical Signal Processing & Signal Modeling, Wiley, 2001
5. Sörnmo, Bioelectrical Signal Processing in Cardiac & Neurological Applications, Elsevier
6. Semmlow, Bio-signal and Biomedical Image Processing, Marcel Dekker
7. Enderle, Introduction to Biomedical Engineering, 2/e, Elsevier, 2005

ELECTIVE-IV

RECONFIGURABLE COMPUTING

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To learn the basics of field of reconfigurable computing
B	To learn Advance digital design skills by developing a reconfigurable computing application Learn a hardware design language Chisel - An introduction to research methodology

Course Outcomes:

CO1	The student will understand concept of static and dynamic reconfiguration.
CO2	The student will use the basics of the PLDs for designing reconfigurable circuits.
CO3	The student will understand the reconfigurable system design using HDL
CO4	The student will demonstrate different architecyres of reconfigurable computing.
CO5	The student will understand different applications of reconfigurable computing

UNIT I

Types of computing and introduction to RC: General Purpose Computing, Domain-Specific Processors, Application Specific Processors; Reconfigurable Computing, Fields of Application; Reconfigurable Device Characteristics, Configurable, Programmable, and Fixed-Function Devices; General-Purpose Computing, General-Purpose Computing Issues;

UNIT II

Metrics: Density, Diversity, and Capacity; Interconnects, Requirements, Delays in VLSI Structures; Partitioning and Placement

UNIT III

Routing; Computing Elements, LUTs, LUT Mapping, ALU and CLBs; Retiming, Fine-grained & Coarse-grained structures; Multi-context;

UNIT IV

Different architectures for fast computing viz. PDSPs, RALU, VLIW, Vector Processors, Memories, CPLDs, FPGAs, Multi-context FPGA, Partial Reconfigurable Devices; Structure and Composition of Reconfigurable Computing Devices: Interconnect, Instructions, Contexts, Context switching, RP space model;

UNIT V

Reconfigurable devices for Rapid prototyping, Non-frequently reconfigurable systems, Frequently reconfigurable systems; Compile-time reconfiguration, Run-time reconfiguration

UNIT VI

Architectures for Reconfigurable computing: TSFPGA, DPGA, Matrix; Applications of reconfigurable computing: Various hardware implementations of Pattern Matching such as the Sliding Windows Approach, Automaton-Based Text Searching. Video Streaming

Textbooks / Referencess:

1. Andre Dehon, "Reconfigurable Architectures for General Purpose Computing".
2. IEEE Journal papers on Reconfigurable Architectures.
3. "High Performance Computing Architectures" (HPCA) Society papers.
4. Christophe Bobda, "Introduction to Reconfigurable Computing", Springer Publication.
5. Maya Gokhale, Paul Ghaham, "Reconfigurable Computing", Springer Publication

ELECTIVE-IV

DIGITAL VLSI DESIGN

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand different abstract levels in Verilog for modeling digital circuits.
B	To know the design of MOS memories and the various precautionary methods to be used in their design.

Course Outcomes:

CO1	Learner will be able to understand MOSFET device structures their physical operations, Current voltage characteristics. Fabrication process of MOS device, Making circuit with MOS devices their design equation. designing layout of such circuits, studying pass transistors
CO2	Learner will be able to understand VHDL language for synthesizing Digital Circuits. Digital circuits include asynchronous and synchronous design issues and state machine synthesizing this circuits. Building state machines with Moore and mealy machines. Understanding how to write package,sub program and test benches.
CO3	Learner will be able to understand Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, and Applications of FPGAs.
CO4	Learner will be able to understand designing of SRAM and DRAM.
CO5	Learner will be able to implement Floor planning concepts, shape functions and floor plan sizing, understanding types of local routing problems Area routing, channel routing, global routing, algorithms for global routing.
CO6	Learner will be able to analyze Need of Design for Testability (DFT), Controllability, predictability, testability, built in Self Test (BIST), Partial and full scan check. Understanding the system which connects host to target and need of boundary scan check, JTAG, Test Access Port (TAP) controller.

UNIT I

Introduction to VLSI Circuits

Introduction to MOSFETs**:** MOS Transistor Theory –Device Structure and Physical Operation, Current Voltage Characteristics, Fabrication, MOS Capacitor, Body Effect, Temperature Effects,Channel Length Modulation, Latch-up. MOS Inverter: MOS Transistors, MOS Transistor Switches, CMOS Logic, Circuit and System Representations, Design Equations, Transistor Sizing, Voltage Transfer Characteristics, Power Dissipation, Noise Margin, Power Delay Product, Energy dissipation. MOS Layers Stick/Layout Diagrams; Layout Design Rules, Issues of Scaling, Scaling factor for device parameters. Combinational

MOS Logic Circuits: Pass Transistors/Transmission Gates; Designing with transmission gates: Primitive Logic Gates.

UNIT II

Digital Circuit Design using VHDL Design of sequential circuits, asynchronous and synchronous design issues, state machine modeling (Moore and mealy machines), packages, sub programs, attributes, test benches.

UNIT III

Programmable Logic Devices Complex Programmable Logic Devices – Architecture of CPLD, Organization of FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, and Applications of FPGAs.

UNIT IV

CMOS Subsystem Design Semiconductor memories, memory chip organization, Random Access Memories (RAM), Static RAM (SRAM), standard architecture, 6T cell, sense amplifier, address decoders, timings. Dynamic RAM (DRAM), different DRAM cells, refresh circuits, timings.

UNIT V

Floor Planning and Placement Floor planning concepts, shape functions and floor plan sizing, Types of local routing problems Area routing, channel routing, global routing, algorithms for global routing.

UNIT VI

Fault Tolerance and Testability Types of fault, stuck open, short, stuck at 1, 0 faults, Fault coverage, Need of Design for Testability (DFT), Controllability, predictability, testability, built in Self Test (BIST), Partial and full scan check, Need of boundary scan check, JTAG, Test Access Port (TAP) controller.

Textbooks / Referencess:

1. Neil H. Weste and Kamran, Principles of CMOS VLSI Design, Pearson Publication
2. John F. Wakerly, Digital Design, Principles and Practices, Prentice Hall Publication
3. Douglas Perry, VHDL, McGraw Hill Publication.
4. Charles Roth, Digital System Design using VHDL, McGraw Hill Publication.
5. Data Sheets of PLDs.
6. Sung-Mo (Steve) Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata McGraw Hill Publication.

ELECTIVE-IV

RADAR SIGNAL PROCESSING

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding of working principle of basic RADAR. List RADAR terminologies. Derive the simple form of RADAR range equation.
B	To provide in-depth understanding of different types of RADAR and its performance parameters

Course Outcomes:

CO1	Learner will be able to understand the history and application of radar system
CO2	Learner will be able to understand the signal models of radar system
CO3	Learner will be able to sample and quantize the signals in radar system
CO4	Learner will be able to analyze the different waveforms and match filters in radar system
CO5	Learner will be able to modify the radar system models by analyzing the Doppler frequency
CO6	Learner will be able to model the radar system and analyze the signal in it noise

UNIT I

Introduction to radar systems, History and applications of radar, Basic radar function, Radar classifications, elements of pulsed radar, The radar equation,

UNIT II

A preview of basic radar signal processing, Signal models, Components of a radar signal, Amplitude models, Clutter, Noise model and signal-to-noise ratio, Jamming, Frequency models: the Doppler shift, spatial models.

UNIT III

Sampling and quantization of pulsed radar signals, Domains and criteria for sampling radar signals, Sampling in the fast time dimension, Sampling in slow time: selecting the pulse repetition interval, Sampling the Doppler spectrum,

UNIT IV

Radar waveforms, Introduction, The waveform matched filter, Matched filtering of moving targets, The radar ambiguity function, The pulse burst waveform, frequency-modulated pulse compression waveforms, The stepped frequency waveform, Phase-modulated pulse compression waveforms, Costas frequency codes.

UNIT V

Doppler processing, Alternate forms of the Doppler spectrum, Moving target indication (MTI), Pulse Doppler processing, Dwell-to-dwell stagger, Additional Doppler processing issues, Clutter mapping and the moving target detector,

UNIT VI

Detection of radar signals in noise: detection fundamentals, detection criteria, Threshold detection in coherent systems, Threshold detection of radar signals, binary integration, CFAR detection, CA CFAR, Additional CFAR topics.

Textbooks / Referencess:

1. Fundamentals of Radar Signal Processing, Mark A. Richards 2005
2. Adaptive Radar Signal Processing, Simon Haykin 2006
3. Skolnik, M.I., "Introduction to Radar Systems", 2nd Ed., McGraw-Hill. 1997

ELECTIVE-IV

ELECTROMAGNETICS, ANTENNA AND PROROGATION

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding of the fundamental solutions of time-varying Maxwell's equations, and applies them to design antennas.
B	To provide in-depth understanding of radio wave propagation phenomena in modern communication systems, and fundamentals of electromagnetic radiation with application to antenna theory and design.

Course Outcomes:

CO1	Learner will be able to gain the knowledge of basic electric field theory.
CO2	Learner will be able to understand basic magnetic field and combine EMF theory.
CO3	Learner will be able to study various antennas, arrays and radiation pattern in antennas.
CO4	Learner will be able to learn the basic working of antenna.
CO5	Learner will be able to learn planar and broadband antennas.
CO6	Learner will be able to design antennas for mobile communication.

UNIT I

Introduction, Vector Analysis, Coordiante systems and Transformations, Line, surface and volume integrals, Divergence Theorem, Stoke's theorem, Coulomb's Law, Electric Field, Electric flux density, Gauss's Law with Application, Electrostatic Potential and Equipotential Surfaces, Boundary conditions for Electrostatic fields, Capacitance and Capacitors, Electrostatic Energy and Energy Density, Poisson's and Laplace's Equations, Uniqueness Theorem, Method of Images, Electrostatic boundary value problem

UNIT II

Introduction, Current Density and Ohm's Law, Electromagnetic force and Kirchoff's Voltage Law, Continuity Equation and Kirchoff's Current Law, Power Dissipation and Joule's law, Biot- Savart Law and its Applications,,Ampere's Circuital Law and its Applications, Magnetic Flux Density, Magnetic Scalar and Vector Potentials, Boundary Condition for Magnetic Fields, Inductance and Inductor, Energy stored in Magnetic Field, Faraday's Law of electromagnetic Induction, Maxwell's Equation, Boundary Conditions for Electromagnetic fields, Time Harmonic Fields, The Helmhotz Equation, Plane waves in Lossless medium, Plane waves in a lossy medium, Poynting Vector and Power Flow in Electromagnetic Fields, Polarisation of plane wave, Behaviour of Plane waves at the inteface of two media

UNIT III

Introduction, Fundamentals of Radiation, Radiated field of an Herzian dipole, Basic Antenna Parameters, Half Wave Dipole Antenna, Quarter Wave Monopole Antenna, Small Loop Antennas, Introduction to Antenna Arrays, Finite difference Method, Basic Concepts of the Method of Moments, Method of Moment for Wire Antennas and Wire Scatterers

UNIT IV

Planar Antennas – Microstrip rectangular and circular patch antennas- Analysis and Design , feeding methods; circularly polarized microstrip antennas, broadbanding techniques. Printed slot antennas. Array theory- linear array: broad side and end fire arrays; self and mutual impedance of between linear elements, grating lobe considerations.

UNIT V

Planar Array- array factor, beam width, directivity. Example of microstrip patch arrays and feed networks electronics scanning. Broadband antennas- folded dipole, sleeve dipole, Biconical antenna – Analysis, characteristics, matching techniques. Yagi array of linear elements and printed version, Log- Periodic dipole array.

UNIT VI

Frequency Independent Antennas- planar spiral antennas, log periodic dipole array. Aperture antennas- field equivalence principle, Babinet's principle. Rectangular waveguide horn antenna, parabolic reflector antenna. Antennas for mobile communication- handset antennas, base station antennas. Beam-steering and antennas for MIMO applications. Active and smart microstrip antennas. Design and analysis of microstrip antennas arrays.

Textbooks / Referencess:

1. C. A. Balanis, Antenna Theory and design, John Wiley and sons, 1997.
2. J. D. Kraus, antennas, Mc-Graw-Hill, 1988.
3. R. A. Sainathi, CAD of microstrip antennas for wireless applications, Artech House, 1996.
4. R. Garg, P. Bharhia, I. Bahl, and A. Ittipiboo, Microstrip antenna design handbook, Artech House.

ELECTIVE V

INTERNET OF THINGS

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	Students will be explored to the interconnection and integration of the physical world and the cyber space.
B	To provide ability to design and develop IOT devices.

Course Outcomes:

CO1	Learner will be able to understand the meaning of internet in general and IOT in terms of layers, protocols, packets peer to peer communication
CO2	Learner will be able to interpret IOT working at transport layer with the help of various protocols
CO3	Learner will be able to understand IOT concept at data link layer
CO4	Learner will be able to apply the concept of mobile networking to the internet connected devices
CO5	Learner will be able to measure and schedule the performance of networked devices in IOT
CO6	Learner will be able to analyze the challenges involve in developing IOT architecture

UNIT I

Introduction: What is the Internet of Things: History of IoT, about objects/things in the IoT, Overview and motivations, Examples of applications, IoT definitions, IoT Frame work, General observations, ITU-T views, working definitions, and basic nodal capabilities.

UNIT II

Fundamental IoT Mechanisms & Key Technologies : Identification of IoT objects and services, Structural aspects of the IoT, Environment characteristics, Traffic characteristics ,scalability, Interoperability, Security and Privacy, Open architecture, Key IoT Technologies ,Device Intelligence, Communication capabilities, Mobility support, Device Power, Sensor Technology, RFID technology, Satellite Technology.

UNIT III

Radio Frequency Identification Technology: Introduction, Principles of RFID, Components of an RFID system, Reader, RFID tags, RFID middleware, Issue. Wireless Sensor Networks: History and context, node, connecting nodes, networking nodes, securing communication.

UNIT IV

Wireless Technologies For IoT : Layer ½ Connectivity : WPAN Technologies for IoT/M2M, Zigbee /IEEE 802.15.4, Radio Frequency for consumer Electronics (RF4CE), Bluetooth and its low-energy profile , IEEE 802.15.6 WBANS, IEEE 802.15 WPAN TG4j, MBANS, NFC, dedicated short range communication(DSRC) & related protocols. Comparison of WPAN technologies cellular & mobile network technologies for IoT/M2M.

UNIT V

Governance of The Internet of Things: Introduction, Notion of governance, aspects of governance, Aspects of governance Bodies subject to governing principles, private organizations, International regulation and supervisor, substantive principles for IoT governance, Legitimacy and inclusion of stakeholders, transparency, accountability. IoT infrastructure governance, robustness, availability, reliability, interoperability, access. Future governance issues, practical implications, legal implications.

UNIT VI

Internet of Things Application Examples: Smart Metering, advanced metering infrastructure, e-Health/Body area network, City automation, automotive applications. Home automation, smart cards, Tracking, Over-The-Air passive surveillance/Ring of steel, Control application examples.

Textbooks / Referencess:

1. Hakima Chaouchi, The Internet of Things, Connecting Objects to the Web, Wiley Publications
2. Daniel Minoli,Building the Internet of Things with IPv6 and MIPv6 The Evolving World of M2M Communications, Wiley Publications
3. Bernd Scholz-Reiter, Florian Michahelles, Architecting the Internet of Things, ISBN 978- 3842-19156-5, Springer.
4. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things Key Applications and Protocols, ISBN 978-1-119-99435-0, Wiley Publications.

ELECTIVE V

LINEAR ALGEBRA

Weekly Teaching Hours	TH : 03	Tut: 01		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding of fundamental concepts of linear algebra
B	To understand the importance of linear algebra and learn its applicability to practical problems

Course Outcomes:

CO1	Learner will learn to solve and analyze linear system of equation
CO2	Learner will analyze the direct notations, duality, adjointness, bases, dual bases in linear algebra
CO3	Learner will understand the concept of Linear transformations and matrices, equivalence, similarity.
CO4	Learner will be able to find eigen values and eigen vectors using characteristics polynomials
CO5	Learner will learn to find the singular value decomposition of the matrix
CO6	Learner will be to find the inverse of matrix

UNIT I

Fields Fq, R, C. Vector Spaces over a field, Fn, F[ɵ]=Polynomials in one Variable.

UNIT II

Direct Notations, Ket, bra vector, duality, adjointness, linear transformations, bases, dual bases.

UNIT III

Linear transformations and matrices, equivalence, similarity.

UNIT IV

Eigenvalues, eigenvectors, diagonalization, Jordoncanonical form

UNIT V

Bilinear and sesquilinear forms, inner product, orthonormal, bases, orthogonal decomposition, projections

UNIT VI

System of equations, generalized inverses.

TEXT/REFERENCES BOOKS:

1. Ronald Shaw, Linear Algebra and Group Representations, AcademicPress, Volume I-1982.

2. Ronald Shaw, Linear Algebra and Group Representations, AcademicPress, Volume II-1983.

3. A. R. Rao, Bhima Sankaran, Linear Algebra, TRIM, 2nd Edition, Hindustan

ELECTIVE V

NEURAL NETWORKS IN EMBEDDED APPLICATIONS

Weekly Teaching Hours	TH: 03	Tut: --		
Scheme of Marking	TH: 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To be able to use analogy of human neural network for understanding of artificial learning algorithms.
B	To give in-depth understanding of fundamental concepts of neural network
C	To exhibit the knowledge of radial basis function network

Course Outcomes:

CO1	Learner will be able to understand concept of fuzzy logic.
CO2	Learner will be able to understand embedded digital signal processor, Embedded system design and development cycle, applications in digital camera
CO3	Learner will be able to understand embedded systems, characteristics, features and applications of an embedded system
CO4	Learner will be able to design and utilization of fuzzy logic controller for various industrial applications
CO5	Learner will be able to implement of radial basis function, neural network on embedded system: real time face tracking and identity verification, Overview of design of ANN based sensing logic and implementation for fully automatic washing machine

UNIT I

Introduction to artificial neural networks, Fundamental models of artificial neural network, Perceptron networks, Feed forward networks, Feedback networks, Radial basis function networks, Associative memory networks

UNIT II

Self-organizing feature map, Learning Vector Quantization, Adaptive resonance theory, Probabilistic neural networks, neocgnitron, Boltzmann Machine.

UNIT III

Optical neural networks, Simulated annealing, Support vector machines, Applications of neural network in Image processing,

UNIT IV

Introduction to Embedded systems, Characteristics, Features and Applications of an embedded system

UNIT V

Introduction to embedded digital signal processor, embedded system design and development cycle, ANN application in digital camera,

UNIT VI

Implementation of Radial Basis Function, Neural Network on embedded system: real time face tracking and identity verification, Overview of design of ANN based sensing logic and implementation for fully automatic washing machine

Textbooks / Referencess:

1. S N Sivanandam, S Sumathi, S N Deepa, "Introduction to Neural Networks Using Matlab 6.0", Tata McGraw Hill Publication
2. Simon Haykin, "Neural Networks: Comprehensive foundation", Prentice Hall Publication
3. Frank Vahid, Tony Givargis, "Embedded System Design A unified Hardware/ Software Introduction", Wiley India Pvt. Ltd.
4. Rajkamal, "Embedded Systems Architecture, Programming and Design," Tata McGraw-Hill

ELECTIVE V

RESEARCH METHODOLOGY

Weekly Teaching Hours	TH: 03	Tut: --		
Scheme of Marking	TH: 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To develop a research orientation among the scholars and to acquaint them with fundamentals of research methods.
B	To develop understanding of the basic framework of research process.
C	To identify various sources of information for literature review and data collection.
D	To understand the components of scholarly writing and evaluate its quality.

Course Outcomes:

CO1	Learner will learn the meaning, objective , motivation and type of research
CO2	Learner will be able to formulate their research work with the help of literature review
CO3	Learner will be able to develop an understanding of various research design and techniques
CO4	Learner will have an overview knowledge of modeling and simulation of research work
CO5	Learner will be able to collect the statistical data with different methods related to research work
CO6	Learner will be able to write their own research work with ethics and non-plagiarized way

UNIT I

Introduction: Defining research, Motivation and Course Objectives:, Types of research

Meaning of Research, Course Objectives: of Research, Motivation in Research, Types of Research

UNIT II

Research Formulation: Formulating The research Problem, Literature Review, Development of Working Hypothesis

UNIT III

Research Design: Important Concept in Research Design, Research Life Cycle, Developing Research Plan

UNIT IV

Overview of Modeling and Simulation: Classification of models, Development of Models, Experimentation, Simulation.

UNIT V

Statistical Aspects: Methods of Data Collection, Sampling Methods, Statistical analysis, Hypothesis testing.

UNIT VI

Research Report: Research Ethics, Plagiarism, Research Proposal, Report Writing and Writing Research Papers.

TEXTBOOKS / REFERENCES:

1. J.P. Holman., Experimental Methods for Engineers
2. C.R. Kothari, Research Methodology, Methods & Techniques

ELECTIVE V

WAVELET TRANSFORMS AND ITS APPLICATIONS

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding of fundamental concepts of Wavelets.
B	To study wavelet related constructions, its applications in signal processing, communication and sensing.

Course Outcomes:

CO1	Learner will be able to understand the meaning of wavelet transform
CO2	Learner will understand the terminologies used in Wavelet transform with its properties
CO3	Learner will be able to model various filter bank using wavelet transformation
CO4	Learner will understand bases , orthogonal bases in wavelet transform
CO5	Learner will learn different types of wavelet transform
CO6	Learner will be able to design practical system using wavelet transform

UNIT I

Continuous Wavelet Transform Introduction, Continuous-time wavelets, Definition of the CWT, the VWT as a Correlation, Constant-Factor Filtering Interpretation and Time-Frequency Resolution, the VWT as an Operator, Inverse CWT, Problems.

UNIT II

Introduction to Discrete Wavelet Transform And Orthogonal Wavelet Decomposition: Introduction, Approximation of Vectors in Nested Linear Vector Subspaces, Examples of an MRA, Problems.

UNIT III

MRA, Orthonormal Wavelets, And Their Relationship To Filter Banks: Introduction, Formal Definition of an MRA, Construction of General Orthonormal MRA, a wavelet Basic for the MRA,

UNIT IV

Digital Filtering Interpretation, Examples of Orthogonal Basic Generating Wavelets, Interpreting Orthonormal MRAs for Discrete-Time signals, Miscellaneous Issues Related to PRQME Filter Banks, generating Scaling Functions and wavelets from Filter Coefficient, Problems.

UNIT V

Wavelet Transform And Data Compression: Introduction, Transform Coding, DTWT for Image Compression, Audio Compression, And Video Coding Using Multiresolution Techniques: a Brief Introduction.

UNIT VI

Other Application 0f Wavelet Transforms: Introduction, Wavelet denoising speckles Removal, Edge Detection and Object Isolation, Image Fusion, Object Detection by Wavelet Transform of Projections, Communication application.

Textbooks / Referencess:

1. C. Sidney Burrus, R. A. Gopianath, Pretice Hall, Introduction to Wavelet and Wavelet Transform
2. P.P.Vaidyanathan , PTR Prentice Hall, Englewood Cliffs , New Jersey, Multirate System and Filter Banks
3. N.J.Fliege , John Wiley & Sons, Multirate Digital Signal Processing
4. Raghuveer Rao, Ajit Bopardikar, Pearson Education Asia,Wavelet Transforms Introduction to Theory and Application
5. James S. Walker, “A Primer on Wavelets and their Scientific Applications”, CRC Press, (1999).
6. Rao, “Wavelet Transforms”, Pearson Education, Asia.

SEMINAR I

Weekly Teaching Hours	TH: -	Practical: 04	
Scheme of Marking	IA: 50	PR/OR: 50	Total: 100

The seminar shall be on the state of the art in the area of the wireless communication and computing and of student's choice approved by an authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work duly signed by the concerned guide and head of the Department/Institute.

MINI PROJECT

Weekly Teaching Hours	TH: -	Practical: 04	
Scheme of Marking	IA: 50	PR/OR: 50	Total: 100

The mini project shall be based on the recent trends in the industry, research and open problems from the industry and society. This may include mathematical analysis, modeling, simulation, and hardware implementation of the problem identified. The mini project shall be of the student's choice and approved by the guide. The student has to submit the report of the work carried out in the prescribed format signed by the guide and head of the department/institute.

PROJECT MANAGEMENT AND INTELLECTUAL PROPERTY RIGHTS

Weekly Teaching Hours	TH: -	Practical: -	
Scheme of Marking	IA: 50	PR/OR: 50	Total: 100

The Student has to choose this course either from NPTEL/MOOCs/SWAYAM pool. It is mandatory to get the certification of the prescribed course.

PROJECT-I

Weekly Teaching Hours	TH: -	Practical: -	
Scheme of Marking	IA: 50	PR/OR: 50	Total: 100

Project-I is an integral part of the final project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation that may include mathematical model/SRS/UML/ERD/block diagram/ PERT chart, and layout and design of the proposed system/work. As a part of the progress report of project-I work; the candidate shall deliver a presentation on progress of the work on the selected dissertation topic.

It is desired to publish the paper on the state of the art on the chosen topic in international conference/ journal.

The student shall submit the duly certified progress report of project -I in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.

PROJECT-II

Weekly Teaching Hours	TH: -	Practical: -	
Scheme of Marking	IA: 100	PR/OR: 100	Total: 200

In Project - II, the student shall complete the remaining part of the project which will consist of the simulation/ analysis/ synthesis/ implementation / fabrication of the proposed project work, work station, conducting experiments and taking results, analysis and validation of results and drawing conclusions.

It is mandatory to publish the paper on the state of the art on the chosen topic in international conference/ journal.

The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.