Dr. Babasaheb Ambedkar Technological University

Course Structure and Syllabus

For

M. Tech. (Electronics Engineering)

Two Year (Four Semester) Course

(w.e.f. July 2017)

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY,

Lonere-402103, Raigad (MS)

M.Tech. (Electronics 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 Engineering.

III. To encourage the post-graduates students, to acquire the academic excellence and skills necessary to work as Electronics Engineering 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 Engineering 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 Engineering.

V. Learners of this program will have an ability to identify, formulate, and solve Engineering problems by applying mathematical foundations, algorithmic principles, and Electronics Engineering 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 Engineering practices.

VIII. Learners of this program will have an ability to evaluate Electronics 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 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	MTEEC101	Computational Methods	03	--	1	04	60	20	20	--	**100**
02	MTEEC102	Microelectronics	03	--	1	04	60	20	20	--	**100**
03	MTEEC103	VLSI System Design	03	--	1	04	60	20	20	--	**100**
04	MTEEE114	Elective-I	03	--	--	03	60	20	20	--	**100**
05	MTEEE125	Elective-II	03	--	--	03	60	20	20	--	**100**
06	MTEEC106	Communication Skills	02	--	--	02	--	--	25	25	**50**
07	MTEEL107	PG Lab-I*	--	03	--	02	--	--	25	25	**50**
		Total for Semester I	**17**	**03**	**03**	**22**	**300**	**100**	**150**	**50**	**600**
Second Semester											
01	MTEEC201	Advanced DSP	03	--	1	04	60	20	20	--	**100**
02	MTEEC202	Nano Electronics	03	--	1	04	60	20	20	--	**100**
03	MTEEE233	Elective-III	03	--	--	03	60	20	20	--	**100**
04	MTEEE244	Elective- IV	03	--	--	03	60	20	20	--	**100**
05	MTEEE255	Elective-V- (Open to all)	03	--	--	03	60	20	20	--	**100**
06	MTEES206	Seminar-I	--	04	--	02	--	--	50	50	**100**
07	MTEEP207	Mini-Project	--	04	--	02	--	--	50	50	**100**
		Total for Semester II	**15**	**8**	**02**	**21**	**300**	**100**	**200**	**100**	**700**
Third Semester											
1	MTEEC301	Project Management & Intellectual Property Rights (Self Study)#	--	--	--	02	--	--	50	50	**100**
2	MTEEP302	Project-I	--	--	--	10	--	--	50	50	**100**
		Total for Semester III	**--**	**--**	**-**	**12**	**--**	**--**	**100**	**100**	**200**
Fourth Semester											
1	MTEEP401	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

A. Digital System Design
B. Medical Electronics
C. Artificial neural networks and applications
D. Fault Tolerant Systems
E. Analog and Mixed Signal Processing

Elective-II

A. Embedded System Design
B. Speech Processing
C. ASIC & SOC
D. RF and Millimeter Wave circuit Design
E. Electromagnetic Interference and Compatibility

Elective-III

A. Multirate Digital Signal Processing
B. Wireless Sensor Network Design
C. Statistical Signal Processing
D. System On-Chip
E. Optical Fiber Communication

Elective-IV

A. Advanced Biomedical Signal Processing
B. Reconfigurable Computing
C. Radar Signal Processing
D. Electromagnetics, Antenna and Propagation
E. Numerical Methods in Electromagnetics

Elective-V (Open)

A. Internet of Things
B. Linear Algebra
C. Neural Networks in Embedded Applications
D. Research Methodology
E. Wavelet Transforms and its Applications

COMPUTATIONAL METHODS

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

Course Objectives

A	To introduce the mathematical and computer techniques and application skills needed to analyze problems in engineering and design algorithms and computer programs to run simulations which allow the numerical and graphical solution of said problems

Course Outcomes

CO1	Learner will be able to design programs which numerically compute derivatives and integrals of functions which model physical systems
CO2	Learner will be able to design programs incorporating loops in Matlab and C++ which numerically solve a plurality of problems using different methods
CO3	Learner will be able to design programs incorporating loops in Matlab and C++ which numerically solve a plurality of differential equations and integral equations
CO4	Learner will be able to solve Integration and Integral Equations.
CO5	Learner will be able to solve ODE.
CO5	Learner will be able to solve Partial Differential Equation.

UNIT I

Accuracy and precision; Truncation and round-off errors; Binary Number System; Error propagation.

UNIT II

Matrix representation; Cramer's rule; Gauss Elimination; Matrix Inversion; LU Decomposition; Iterative Methods; Relaxation Methods; Eigen Values. Algebraic Equations Bracketing methods: Bisection, Reguli- Falsi; Open methods: Secant, Fixed point iteration, Newton-Raphson; Multivariate Newton’s method.

UNIT III

Linear regression; Least squares; Total Least Squares; Interpolation; Newton’s Difference Formulae; Cubic Splines. Numerical Differentiation Numerical differentiation; higher order formulae.

UNIT IV

Integration and Integral Equations Trapezoidal rules; Simpson's rules; Quadrature.

UNIT V

Euler's methods; Runge-Kutta methods; Predictor-corrector methods; Adaptive step size; Stiff ODEs.

UNIT VI

Shooting method; Finite differences; Over/Under Relaxation (SOR); Introduction to Partial Differential Equations

Text Books/Reference:

1. Gupta S.K. (1995) Numerical Methods for Engineers, New Age International.
2. Chapra S.C. and Canale R.P. (2006) Numerical Methods for Engineers, 5th Ed; McGraw Hill

MICROELECTRONICS

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 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 (SiO_2), 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

Text Books/Reference:

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).

VLSI SYSTEM DESIGN

Weekly Teaching Hours TH : 03 Tut: 01

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

Course Objectives

A	The main objective of this course is to introduce basic concepts of microelectronics, layout designing, floor planning and algorithms used in the chip designing process.

Course Outcomes

CO1	Learner will be able to understand the concepts of and electrical properties of MOS technologies
CO2	Learner will be able to understand different types layout designing tools and floor planning methods used in chip design.
CO3	Learner will be able to design layout using simple gates.
CO4	Learner will be able to design combinational logic networks and sequential systems
CO5	Learner will be able to understand CAD algorithms used in chip design
CO6	Learner will be able to analyse various CAD tools for Layout synthesis and Analysis.

UNIT I

LAYOUT DESIGN AND TOOLS: Transistor Structures, Wires and Vias, Scalable Design Rules, Layout Design Tools.

UNIT II

LOGIC GATES & LAYOUTS: Static Complementary Gates, Switch Logic, Alternative Gate Circuits, Low Power Gates, Resistive and Inductive Interconnect Delays.

UNIT III

COMBINATIONAL LOGIC NETWORKS: Layouts, Simulation, Network delay, Interconnect Design, Power Optimization, Switch Logic Networks, Gate and Network Testing.

UNIT IV

SEQUENTIAL SYSTEMS: Memory Cells and Arrays, Clocking Disciplines, Design, Power Optimization, Design Validation and Testing.

UNITV

FLOOR PLANNING & ARCHITECTURE DESIGN: Floor Planning Methods, Off-Chip Connections, High Level Synthesis, Architecture for Low Power, SOCs and Embedded CPUs, Architecture Testing.

UNITVI

INTRODUCTION TO CAD SYSTEMS (ALGORITHMS) AND CHIP DESIGN: Layout Synthesis and Analysis, Scheduling and Printing; Hardware-Software Codesign, Chip Design Methodologies- A simple Design Example

Text Books/Reference:

1. D.A.JOHN & KEN MARTIN: Analog Integrated Circuit Design. John Wiley, 1997.
2. Behzad Razavi, Design of Analog CMOS Integrated Circuit Tata-Mc GrawHill, 2002.
3. Philip Allen & Douglas Holberg, CMOS Analog Circuit Design, Oxford University Press, 2002
4. GREGOLIAN &TEMES: Analog MOS Integrated Circuits, John Wiley, 1986

ELECTIVE-I

DIGITAL SYSTEM DESIGN

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

Course Objectives

A	The concept and theory of digital Electronics are needed in almost all electronics and telecommunication engineering fields and in many other engineering and scientific disciplines as well.
B	The main objective of this course is to lay the foundation for further studies in areas such as communication, VLSI, computer, microprocessor etc. One of the most important reasons for the unprecedented growth of digital electronics is the advent of integrated circuit.
C	This course will explore the basic concepts of digital electronics.

Course Outcomes

CO1	Learner will be able to Understand the basic logic gates and various variable reduction techniques of digital logic circuit in detail.
CO2	Learner will be able to understand, identify and design combinational and sequential circuits
CO3	Learner will be able to Design and implement hardware circuit to test performance and application for what it is being designed
CO4	Learner will be able to detect faults in logic circuits
CO5	Learner will be able to Simulate and verify using computer simulation software to obtain desired result
CO6	Learner will Understand and verify simulated circuit model with hardware implementation

UNIT I

Mapping algorithms into Architectures: Data path synthesis, control structures, critical path and worst case timing analysis. FSM and Hazards.

UNIT II

Combinational network delay. Power and energy optimization in combinational logic circuit. Sequential machine design styles. Rules for clocking. Performance analysis.

UNIT III

Sequencing static circuits. Circuit design of latches and flip-flops. Static sequencing element methodology. Sequencing dynamic circuits. Synchronizers.

UNIT IV

Data path and array subsystems: Addition / Subtraction, Comparators, counters, coding, multiplication and division. SRAM, DRAM, ROM, serial access memory, context addressable memory.

UNIT V

Reconfigurable Computing- Fine grain and Coarse grain architectures, Configuration Architectures.

UNIT VI

Single context, Multi context, partially reconfigurable, Pipeline reconfigurable, Block Configurable, Parallel processing

Text Books/Reference:

1. N. H.E.Weste, D. Harris, CMOS VLSI Design (3/e), Pearson, 2005.
1. W.Wolf, FPGA- based System Design, Pearson, 2004.
2. S.Hauck, A.DeHon, Reconfigurable computing: the theory and practice of FPGA-based computation, Elsevier, 2008.
3. F.P. Prosser, D. E. Winkel, Art of Digital Design, 1987.
4. R.F.Tinde, Engineering Digital Design, (2/e), Academic Press, 2000.
5. C. Bobda, Introduction to reconfigurable computing", Springer, 2007.
6. M.Gokhale, P.S.Graham, Reconfigurable computing: accelerating computation with field-programmable gate arrays", Springer, 2005.
7. C.Roth, Fundamentals of Digital Logic Design", Jaico Publishers, V ed., 2009.

Recent literature in Digital System Design

ELECTIVE-I

MEDICAL ELECTRONICS

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

Course Objectives

A	This course is tailored to the needs of both Engineers and Medicos. It seeks to encourage dialogue between both disciplines to enable Medicos and Engineers to appreciate more fully the applications, requirements, specifications, and limitations of medical electronic instrumentation. This is particularly important when multi-disciplinary teams liaise to specify, design and evaluate new medical technologies.

Course Outcomes

CO1	Learner will be able to analyze and evaluate the effect of different diagnostic and therapeutic methods, their risk potential, physical principles, opportunities and possibilities for different medical procedures.
CO2	Learner will be able to have a basic understanding of medical terminology, relevant for biomedical instrumentation.
CO3	Learner will be able to understand and describe the physical and medical principles used as a basis for biomedical instrumentation.
CO4	Learner will be able to understand the elements of risk for different instrumentation methods and basic electrical safety.
CO5	Learner will be able to understand the position of biomedical instrumentation in modern hospital care.
CO6	Learner will be able understand working and principle of various medical electronics instruments.

UNIT I

Overview of Medical Electronics Equipments, classification, application and specifications of diagnostic, therapeutic and clinical laboratory equipment, method of operation of these instruments.

UNIT II

Electrodes: Bioelectric signals, Bio electrodes, Electrode, Electrode tissue interface, contact impedance, Types of Electrodes, Electrodes used for ECG , EEG.

UNIT III

Transducers: Typical signals from physiological parameters, pressure transducer, flow transducer, temperature transducer, pulse sensor, respiration sensor.

UNIT IV

Bio Medical Recorders : Block diagram description and application of following instruments

ECG Machine, EEG Machine, EMG Machine.

UNIT V

Patient Monitoring Systems: Heart rate measurement, Pulse rate measurement, Respiration rate measurement, Blood pressure measurement, Principle of defibrillator and pace mark, Use of Microprocessor in patent monitoring.

UNIT VI

Safety Aspects of Medical Instruments: Gross current shock, Micro current shock, Special design from safety consideration, Safety standards.

Text Books/Reference:

1. RS Khandpur, Handbook of biomedical Instrumentation.

2. Cromwell, Biomedical Instrumentation

3. RS Khandpur, Modern Electronics Equipment , TMMH, New Delhi

4. Edward J. Perkstein,Introduction to BioMedical Electronics Howard, Bj, USA

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 objective

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 Outcome:

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

UNIT VI

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

Text Books/Reference:

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

FAULT TOLERANT SYSTEMS

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

Course Objective:

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

Course Outcome:

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 modelling 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.

Text Books/Reference:

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 the background and the methods for the understanding of the operation of basic analogue CMOS cells, and how to design common functions.
B	The emphasis is placed on design of analogue functions specifically as part of mixed signal systems.

Course Outcomes:

CO1	To understand behavior and design of basic analogue circuit primitives, including quantitative treatment of matching
CO2	Learner will be able to distinguish between fundamental concepts of analog an discrete time signal processing.
CO3	Learner will be able to design switched capacitor filters.
CO4	Learner will be able to demonstrate basics of analog to digital data conversion.
CO5	Learner will be able to design analog and digital PLLs
CO6	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.

Text Books/Reference:

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

ELECTIVE-II

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 processors, Instruction set, Addressing modes. Programming 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 be able 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.
CO6	Learner will be able to understand and experience of state-of-the-practice industrial embedded systems and intelligent embedded system development.

UNIT I

Introduction to embedded computing: Complex systems and microprocessors – Design example: Model train controller –Embedded system design process – Formalism for system design – Instruction sets Preliminaries – ARM Processor – CPU: Programming input and output – Supervisor mode, exception and traps – Coprocessor – Memory system mechanism – CPU performance – CPU power consumption.

UNIT II

Computing platform and design analysis CPU: buses – Memory devices – I/O devices – Component interfacing – Design with microprocessors – Development and Debugging – Program design Model of programs

UNIT III

Assembly and linking: Assembly and Linking – Basic compilation techniques – Analysis and optimization of execution time, power, energy, program size – Program validation and testing.

UNIT IV

Process and operating systems : Multiple tasks and multi processes – Processes – Context Switching – Operating Systems –Scheduling policies - Multiprocessor – Inter Process Communication mechanisms – Evaluating operating system performance – Power optimization strategies for processes.

UNIT V

Hardware accelerates & networks : Accelerators – Accelerated system design – Distributed Embedded Architecture –Networks for Embedded Systems – Network based design – Internet enabled systems.

UNIT VI

Case study: Hardware and software co-design - Data Compressor - Software Modem – Personal Digital Assistants – Set Top Box. – System-on-Silicon – FOSS Tools for embedded system development.

Text Books/Reference:

1) Wayne Wolf, Computers as Components - Principles of Embedded Computer System Design, Morgan Kaufmann Publisher, 2006.
2) K.V.K.K.Prasad, Embedded Real-Time Systems: Concepts, Design & Programming, dreamtech press, 2005.
3) Tim Wilmshurst, An Introduction to the Design of Small Scale Embedded Systems, Palgrave Publisher, 2004.
4) Sriram V Iyer, Pankaj Gupta, Embedded Real Time Systems Programming, Tata Mc-Graw Hill, 2004.
5) Tammy Noergaard, Embedded Systems Architecture, Elsevier,2006
6) David E-Simon, An Embedded Software Primer, Pearson Education, 2007.

ELECTIVE-II

SPEECH PROCESSING

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

Course Objectives

A.	To characterize the speech signal as generated by a speech production model
B.	To understand the mechanism of speech and audio perception
C.	To perform the analysis of speech signal using LPC
D.	To extract the information of the speech or audio signals in terms of cepstral features
E.	To provide a foundation for developing applications in this field.

Course Outcomes

CO1	Learner will be able to understand basic concepts and methodologies for the analysis and modeling of speech signal.
CO2	Learner will be able to understand the motivation of short-term analysis of speech and audio
CO3	Learner will be able to design and implement algorithms for processing speech and audio signals considering the properties of acoustic signals and human hearing.
CO4	Learner will be able to analyze speech signal to extract the characteristic of vocal tract (formants) and vocal cords (pitch).
CO5	Learner will be able to write a program for extracting LPC Parameters using Levinson Durbin algorithm.
CO6	Learner will be able to formulate and design a system for speech recognition and speaker recognition.

UNIT I

The Speech Production mechanism: Physiological and Mathematical Model, Relating the physiological and mathematical model, Categorization of Speech Sounds based on the source-system and the articulatory model.

UNIT II

Basic Speech Signal Processing Concepts: Discrete time speech signals, relevant properties of the fast Fourier transform and Z-transform for speech recognition, convolution, linear and non linear filter banks,Spectral estimation of speech using the Discrete Fourier transform, Pole-zero modeling of speech and linear prediction (LP) analysis of speech, Homomorphic speech signal de convolution, real and complex spectrum, application of cepstral analysis to speech signals.

UNIT III

The Speech Recognition Front End: Feature extraction for speech recognition, Static and dynamic features for speech recognition, robustness issues, discrimination in the feature space, feature selection. Mel frequency cepstral co-efficients (MFCC), Linear prediction cepstral coefficients (LPCC), Perceptual LPCC.

UNIT IV

Distance measures for comparing speech patterns: Log spectral distance, cepstral distances, weighted cepstral distances, distances for linear and warped scales, Dynamic Time Warping for Isolated Word Recognition.

UNIT V

Statistical models for speech recognition: Vector quantization models and applications in speaker recognition. Gaussian mixture modeling for speaker and speech recognition. Discrete and Continuous Hidden Markov modeling for isolated word and continuous speech recognition.

UNIT VI

Using the HTK toolkit for building a simple speech recognition system

Text Books/Reference:

1. Thomas F. Quatieri Discrete-Time Speech Signal Processing: Principles and Practice, Cloth, 816 pp. ISBN: 013242942X Published: OCT 29, 2001.
2. L. Rabiner and B. Juang Fundamentals of Speech Recognition, Prentice-Hall Signal Processing Series, Pages: 507, Year of Publication: 1993, ISBN:0-13-0151572.
3. B. Gold and N. Morgan, Speech and Audio Signal Processing: Processing and perception of speech and music,Wiley 2000, ISBN: 0-471-35154-7.
4. Steve Young, Corpus-Based Methods in Language and Speech Processing, editors, 234 pages, Kluwer, ISBN 0-7923-4463-4.
5. JR Deller, JG Proakis, Discrete Time Processing of Speech Signals, , JH Hansen, Year of Publication: 1993, ISBN:0023283017.
6. XD Huang, Y Ariki, MA Jack Hidden Markov Models for Speech Recognition, Edinburgh University Press.
7. LR Rabiner and RW Schafer, Digital Processing of Speech Signals, Pearson Education

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ELECTIVE-II

ASIC AND SOC

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

Course Objectives

A.	To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.
B.	To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
C.	To give the student an understanding of basics of System on Chip and Platform based design.

Course Outcomes

CO1	Learner will be able to demonstrate VLSI tool-flow and appreciate FPGA architecture.
CO2	Learner will be able to understand the issues involved in ASIC design, including technology choice, design management, tool-flow, verification, debug and test, as well as the impact of technology scaling on ASIC design.
CO3	Learner will be able to understand the algorithms used for ASIC construction
CO4	Learner will be able to understand the basics of System on Chip
CO5	Learner will be able to tackle system level design issues

<u>Unit I</u>

Types of ASICs – Design flow – Economics of ASICs – ASIC cell libraries – CMOS logic cell data path logic cells – I/O cells – cell compilers.

<u>Unit II</u>

ASIC Library design: Transistors as resistors – parasitic capacitance – logical effort programmable ASIC design software: Design system – logic synthesis – half gate ASIC, ASIC Construction – Floor planning & placement – Routing

<u>Unit III</u>

System on Chip Design Process: A canonical SoC design, SoC Design Flow – Waterfall vs Spiral, Top-Down versus Bottom-Up. Specification requirements, Types of Specifications, System Design Process,

<u>Unit IV</u>

System level design issues- Soft IP vs. Hard IP, Design for Timing Closure- Logic Design Issues, Physical Design Issues; Verification Strategy, On-Chip Buses and Interfaces; Low Power, Manufacturing Test Strategies. MPSoCs. Techniques for designing MPSoCs

Unit V

SoC Verification: Verification technology options, Verification methodology, Verification languages, Verification approaches, and Verification plans. System level verification, Block level verification, Hardware/software co-verification, and Static net list verification.

Text Books/Reference:

1. Prakash Rashinkar, Peter Paterson and Leena Singh, SoC Verification-Methodology and Techniques,Kluwer Academic Publishers, 2001.
2. Michael Keating, Pierre Bricaud, Reuse Methodology manual for System-On-A-Chip Designs, Kluwer Academic Publishers, second edition, 2001
3. Smith, Application Specific Integrated Circuits, Addison-Wesley,2006

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 radioarchitectures

Text Books/Reference:

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

ELECTIVE-II

ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

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

Course Objective

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.

UNIT IV

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

UNIT V

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

Unit VI

Electrostatic Discharge (ESD): Introduction, Accumulation of Static Charge on Bodies Charging and Charge Separation, Human Body as Source of ESD, ESD Waveforms, Human Body Circuit Model, ESD Generator and ESD Test

Text Books/Reference:

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.
3. Dipak L. Sengupta, Valdis V. Liepa, Applied Electromagnetics And Electromagnetic C0mpatibility, A John Wiley & Sons, Inc. Publication

COMMUNICATION SKILLS

Weekly Teaching Hours	TH: 02		Practical: -	
Scheme of Marking	TH: --	IA: 25	PR/OR: 25	Total: 50

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

Text Books/Reference:

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, Simon and Schuster, 09-Nov-2004
4. Rosenberg Marshall B., Nonviolent Communication: A Language of Life, PuddleDancer Press, 01-Sep-2003

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.

ADVANCE DIGITAL SIGNAL PROCESSING

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

Course Objectives:

A.	The purpose of this course is to provide in-depth treatment on methods and techniques in Discretetime signal transforms, digital filter design, optimal filtering Power spectrum estimation, multi-rate digital signal processing DSP architectures which are of importance in the areas of signal processing, control and communications.

Course Outcomes:

CO1	Learner will be able to design adaptive filters for a given application
CO2	Learner will be able to design multirate DSP systems.
CO3	Learner will be able to understand different models for spectrum estimation.
CO4	Learner will be able to understand different methods for Random signal processing.
CO5	Learner will be able to perform linear estimation and prediction of random signal.
CO6	Learner will be able to perform various operations on given signal.

UNIT I

DISCRETE RANDOM SIGNAL PROCESSING

Weiner Khitchine relation-Power spectral density–filtering random process, Spectral FactorizationTheorem, special types of random process,Signal modeling-Least Squares method, Padeapproximation, Prony's method, iterative Prefiltering, Finite Data records, Stochastic Models.

UNIT II

SPECTRUM ESTIMATION

Non-Parametric methods-Correlation method-Co-variance estimator-Performance analysis ofestimators–Unbiased consistent estimators-Periodogram estimator -Barlett spectrum estimation-Welch estimation-Model based approach-AR, MA, ARMA Signal modeling-Parameter estimationusing Yule-Walker method.

UNIT III

LINEAR ESTIMATION AND PREDICTION

Maximum likelihood criterion-Efficiency of estimator-Least mean squared error criterion-Wienerfilter-Discrete Wiener Hoff equations-Recursive estimators-Kalman filter-Linear prediction,Prediction error-Whitening filter, Inverse filter-Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.

UNIT IV

ADAPTIVE FILTERS

FIR Adaptive filters-Newton's steepest descent method-Adaptive filters based on steepest descent method -Widrow Hoff LMS Adaptive algorithm- Adaptive channel equalization -

Adaptive echocanceller-Adaptive noise cancellation-RLS Adaptive filters-Exponentially weighted RLS-Slidingwindow RLS -Simplified IIR LMS Adaptive filter.

UNIT V

MULTIRATE DIGITAL SIGNAL PROCESSING

Mathematical description of change of sampling rate-Interpolation and Decimation-Continuous timemodel-Direct digital domain approach-Decimation by integer factor -Interpolation by an integer factor-Single and multistage realization-Poly phase realization-Applications to sub band coding- Wavelet transform and filter bank implementation of wavelet expansion of signals.

Text Books/Reference:

1. Monson H. Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons Inc., New York, 2006.

2. Sophoncles J. Orfanidis, Optimum Signal Processing , McGraw-Hill, 2000.

3. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Prentice Hall of India, New Delhi, 2005.

4. Simon Haykin, Adaptive Filter Theory, Prentice Hall, Englehood Cliffs, NJ1986.

5. S. Kay, Modern Spectrum Estimation Theory and Application, prentice hall, englehood cliffs, nj1988.

6. P. P. Vaidyanathan, multirate systems and filter banks, prentice hall, 1992

NANO ELECTRONICS

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

Course Objectives:

A	To convey the basic concepts of Nano electronics to engineering students with no background in quantum mechanics and statistical mechanics.
B	Main objective of this is to provide the basic platform and deep information of different Nano electronics devices like MOSFET, FINFET, Nano metrology tools used to design the recently developing VLSI applications.
C	This subject gives idea about the role and importance of the Nano electronic devices system in engineering world to develop the research ideas in VLSI.
D	Recent technology proceeds with MOSFET with 64nm technology, the need Nano electronic Devices and Material subject to achieve transistor size which is less than current technology.
E	The content of this course gives platform to the Nano electronics world and innovative ideas to ensure the knowledge of real time applications which helps students to stand them in Indian and multinational industries.

Course Outcomes:

CO1	Learner will be able to acquire basics knowledge of engineering in the field Nano electronics.
CO2	Learner will be able to acquire ,basic knowledge of MOSFET, FINFET, SOI-MOSFET which are new generation transistor technology.
CO3	Learner will get ability to research and development in field of Nano electronics Devices and Materials which is recent trends in technology.
CO4	Learner will be the part of emerging trends of Nano electronics devices.
CO5	Learner will be able to understand all the recent applications, Engineering Tools and research views to the students.
CO6	Learner will be able to understand data transmission, interfaces and displays design

UNIT I

TECHNOLOGY AND ANALYSIS: Film Deposition Methods, Lithography, Material Removing Technologies, Etching and Chemical, Mechanical Processing, Scanning Probe Techniques.

UNIT II

CARBON NANO STRUCTURES: Carbon Clusters, Carbon Nano tubes, Fabrication, Electrical, Mechanical and Vibrational Properties, Applications of Carbon Nano Tubes.

UNIT III

LOGIC DEVICES: Silicon MOSFETS, Novel Materials and Alternative Concepts, Ferro Electric Filed Effect Transistors, Super Conductor Digital Electronics, Carbon Nano Tubes for Data Processing.

UNIT IV

RADOM ACESS MEMORIES: High Permitivity Materials for DRAMs, Ferro Electric Random Access Memories, Magneto-Resistive RAM.

UNIT V

MASS STORAGE DEVICES: Hard Disk Drives, Magneto Optical Disks, Rewriteable DVDs based on Phase Change Materials, Holographic Data Storage.

UNIT VI

DATA TRANSIMISSION, INTERFACES AND DISPLAYS: Photonic Networks, Microwave Communication Systems, Liquid Crystal Displays, Organic Light Emitting Diodes.

Text Books/Reference:

1. Rainer Waser, Nano Electronics and Information Technology, Wiley VCH, April 2003.
2. Charles Poole, Introduction to Nano Technology, Wiley Interscience, May 2003

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 upsampling and downsampling 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.

Text Books/Reference:

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

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	Learner will be able to understand the need of WSN and also will analyze the challenges in creating WSN
CO2	Learner will be able to design the architecture of WSN
CO3	Learner will be able to analyze the power and security constraints in WSN
CO4	Learner will be able to understand different operating system to operate WSN
CO5	Learner will be able to understand the basic functioning of WSN at physical layer
CO6	Learner will be able to 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.

Text Books/Reference:

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. Protocols and Architectures for Wireless Sensor Networks-Holger Karl, Andreas Willig 08-Oct 2007

ELECTIVE-III

STATISTICAL 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 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 Subband Adaptive Filters.

Text Books/Reference:

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-III

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, Programmer’s 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.

Text Books/Reference:

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-III

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.

Text Books/Reference:

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-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.

Text Books/Reference:

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

   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	Learner will be able to understand concept of static and dynamic reconfiguration.
CO2	Learner will be able to understand basics of the PLDs for designing reconfigurable circuits.
CO3	Learner will be able to understand the reconfigurable system design using HDL
CO4	Learner will be able to demonstrate different architectures of reconfigurable computing.
CO5	Learner will be able to 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

Text Books/Reference:

1. Andre Dehon, Reconfigurable Architectures for General Purpose Computing.
2. IEEE Journal papers on Reconfigurable Architectures. High Performance Computing Architectures, (HPCA) Society papers.
3. Christophe Bobda, Introduction to Reconfigurable Computing, Springer Publication.
4. Maya Gokhale, Paul Ghaham, Reconfigurable Computing, Springer 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 deifferent 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 demonstrate the radar system and analyze the signal in it noise

UNIT I

Introduction to radar systems, History and applications of radar, Basic radarfunction, 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: theDoppler shift, spatial models.

UNIT III

Sampling and quantization of pulsed radar signals, Domains and criteria forsampling radar signals, Sampling in the fast time dimension, Sampling inslow time: selecting the pulse repetition interval, Sampling the Dopplerspectrum,

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.

Text Books/Reference:

1. , Mark A. Richards, Fundamentals of Radar Signal Processing 2005

2. Simon Haykin , Adaptive Radar Signal Processing, 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 understand various antennas, arrays and radiation pattern in antennas
CO4	Learner will be able to understand the basic working of antenna
CO5	Learner will be able to understand 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.

Text Books/Reference:

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-IV

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	Learner will be able to understand the main principles and laws that govern electromagnetic wave propagation
CO2	Learner will be able to identify the most suitable numerical technique for the solution of a particular problem in Electromagnetics
CO3	Learner will be able to understand the basic properties of transmission lines; analyze electromagnetic wave propagation in generic transmission line geometries.
CO4	Learner will be able to learn how to use numerical methods to solve for electric fields from charge distributions and conducting boundaries.
CO5	Learner will be able 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	Learner will be able 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, equi potentials; 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)

Text Books/Reference:

1. Skitele C.G, Electromagnetic concepts and applications, PHI Inc., Englewood Cliffs N.J.,1982
2. R.B.,MIT press, Electromagnetic energy transmission and radiation, Adder, Cambridge, 1969
3. SAAD T. and Hansen, Microwave Engineers handbook, Vol.I, SAAD T. and Hansen, Artech house, 1971.
4. Beck, A.H.U, Space charge waves and slow EM waves, Pergamon press, 1950

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.

Text/ Reference Books:

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 be able to solve and analyze linear system of equation
CO2	Learner will be able to analyze the direct notations, duality, adjointness, bases, dual bases in linear algebra
CO3	Learner will be able to 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 be able to find the singular value decomposition of the matrix
CO6	Learner will be able 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, Jordon canonical form

UNIT V

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

UNIT VI

System of equations, generalized inverses.

Text Books/Reference:

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

Text Books/Reference:

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, TonyGivargis, 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 be able to understand 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 be able to 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 Objectives, Types of research

Meaning of Research, 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.

Text Books/Reference:

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 understand the meaning of wavelet transform
CO2	Learner will be able to 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 be able to understand bases , orthogonal bases in wavelet transform
CO5	Learner will be able to understand 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 ImageCompression, 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.

Text Books/Reference:

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, modelling, 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.