Course Structure and Syllabus
For
M. Tech. (Electronics & Telecommunication Engineering)
Two Year (Four Semester) Course
(w.e.f. July 2017)
M.Tech. (Electronics & Telecommunication Engineering)

Objectives

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

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

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

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

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

Outcomes

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

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

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

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

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

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

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

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

IX. Postgraduate students will have an ability to solve contemporary social and industrial problems by engaging in life-long learning.
# Dr. Babasaheb Ambedkar Technological University

## Teaching and Examination Scheme for

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

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Hours/Week</th>
<th>Credit</th>
<th>Examination scheme</th>
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<tr>
<td>First Semester</td>
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</tr>
<tr>
<td>01</td>
<td>MTETC101</td>
<td>Signal Theory</td>
<td>03</td>
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<td>1</td>
</tr>
<tr>
<td>02</td>
<td>MTETC102</td>
<td>Radiation and Microwave Techniques</td>
<td>03</td>
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<td>1</td>
</tr>
<tr>
<td>03</td>
<td>MTETC103</td>
<td>Signal Processing Algorithms &amp; Applications</td>
<td>03</td>
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</tr>
<tr>
<td>04</td>
<td>MTETE114</td>
<td>Elective-I</td>
<td>03</td>
<td>--</td>
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<tr>
<td>05</td>
<td>MTETE125</td>
<td>Elective-II</td>
<td>03</td>
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<tr>
<td>06</td>
<td>MTETC106</td>
<td>Communication Skills</td>
<td>02</td>
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<tr>
<td>07</td>
<td>MTETL107</td>
<td>PG Lab-I*</td>
<td>--</td>
<td>03</td>
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<tr>
<td>Total for Semester I</td>
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<td>17</td>
<td>03</td>
<td>03</td>
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</table>

| Second Semester | | | | | | | | | |
| 01 | MTETC201 | Estimation and Detection Theory | 03 | -- | 1 | 04 | 60 | 20 | 20 | -- | 100 |
| 02 | MTETC202 | Information Theory and Coding | 03 | -- | 1 | 04 | 60 | 20 | 20 | -- | 100 |
| 03 | MTETE233 | Elective-III | 03 | -- | -- | 03 | 60 | 20 | 20 | -- | 100 |
| 04 | MTETE244 | Elective-IV | 03 | -- | -- | 03 | 60 | 20 | 20 | -- | 100 |
| 05 | MTETE255 | Elective-V-(Open to all) | 03 | -- | -- | 03 | 60 | 20 | 20 | -- | 100 |
| 06 | MTETS206 | Seminar-I | -- | 04 | -- | 02 | -- | -- | 50 | 50 | 100 |
| 07 | MTETP207 | Mini-Project | -- | 04 | -- | 02 | -- | -- | 50 | 50 | 100 |
| Total for Semester II | | | 15 | 08 | 02 | 21 | 300 | 100 | 200 | 100 | 700 |

| Third Semester | | | | | | | | | |
| 1 | MTETC301 | Project Management & Intellectual Property Rights (Self Study)# | -- | -- | -- | 02 | -- | -- | 50 | 50 | 100 |
| 2 | MTETP302 | Project-I | -- | -- | -- | 10 | -- | -- | 50 | 50 | 100 |
| Total for Semester III | | | -- | -- | -- | 12 | -- | -- | 100 | 100 | 200 |

| Fourth Semester | | | | | | | | | |
| 1 | MTETP401 | Project-II | -- | -- | -- | 20 | -- | -- | 100 | 100 | 200 |
| Total for Semester IV | | | -- | -- | -- | 20 | -- | -- | 100 | 100 | 200 |
| GRAND TOTAL | | | | | | | | | 1700 |

* PG Lab-I – Practical shall be based on courses of first semester.
# Student has to choose this course either from NPTEL/MOOC pool and submission of course completion certificate is mandatory.
Elective-I

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

Elective-II

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

Elective-III

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

Elective-IV

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

Elective-V (Open)

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

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

Course Objectives:

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

Course Outcomes:

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

UNIT I
Probability
The meaning of probability, the axioms of probability, repeated trials.

UNIT II
The Concept of a Random Variable
Introduction, Distribution and density functions, Specific random variables, Conditional distributions, Asymptotic approximations for Binomial random variables.

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

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

UNIT V
Sequences of Random variables
General concepts conditional densities, Characteristic functions and normality, Mean square estimation stochastic convergence and limit theorem, Random Numbers: Meaning and Generation.
UNIT VI
Stochastic Processes

Textbooks / References:
1. Papoulis, S. Pillai, Probability, Random Variables and Stochastic Processes, Tata McGraw Hill
2. T Veerajan, Probability, Statistics and Random Processes
4. B.P.Lathi, Modern Digital and Analog Communication Systems, Third Ed
RADIATION AND MICROWAVE TECHNIQUES

Weekly Teaching Hours
TH: 03   Tut: 01

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

Review of EM Theory

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

UNIT II

Microwaves

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

UNIT III

Microstrip lines and Antennas

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

Microstrip Antennas: Principle of operation, Methods of analysis, feeding techniques, Polarization, Design considerations.
UNIT IV
Microwave Elements
Microwave integrated circuits, Active and passive microwave elements.

UNIT V
Microwave Communication Systems
Introduction, Analog and digital microwave communication systems, Satellite communication, Microwave antennas

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

Textbooks / References:
1. Guro, Hijiroglu; Electromagnetic Field Theory fundamentals ;Thomson Publication.
2. Annapurna Das, Sisir Das; Microwave Engineering ;TMH Publication
SIGNAL PROCESSING ALGORITHMS AND APPLICATIONS

Weekly Teaching Hours
TH : 03    Tut:  01

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

Course Objectives:

A  To instill research skills and bring in optimal solutions and novel products to signal processing and allied application areas using modern technology and tools that are technically sound, economically feasible and socially acceptable.

B  To enable the graduates to engage in signal processing and its broad range of applications to understand the challenges of the rapidly changing environment and adapt their skills through reflective and continuous learning.

C  To provide graduates strong mathematical skills and in depth knowledge in signal theory to analyze and solve complex problems in the domain of signal processing.

Course Outcomes:

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

UNIT I

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

UNIT II

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

UNIT III

Design of Digital Filters

**UNITIV**

**Multirate Signal Processing**

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

**UNITV**

**Signal Representation**

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

**UNITVI**

**Linear Prediction and Optimum Filter Design**

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

**Textbooks / References:**

1. Digital Signal Processing A Computer-Based Approach, SanjitMitra, MCG
2. Discrete Time Signal Processing; *A V Oppenheim, Schafer*; PHI.
4. Multirate systems and Filter Banks; *P Vaidyanathan*; Prentice Hall Eaglewood.
5. Digital Signal Processing : Principles, Algorithms and Applications; *John D Proakis*; PHI.
6. Adaptive Filter Theory; *S Hykin*; PHI.
ELECTIVE-I
ARTIFICIAL NEURAL NETWORKS AND APPLICATIONS

Weekly Teaching Hours
TH : 03  Tut:  --

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

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

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

Textbooks / References:

ELECTIVE-I

ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

Weekly Teaching Hours
TH : 03 Tut: --

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

Course Objectives:

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<tbody>
<tr>
<td>A</td>
<td>To familiarize with the fundamentals that are essential for electronics industry in the</td>
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<tr>
<td></td>
<td>field of EMI / EMC</td>
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<tr>
<td>B</td>
<td>To understand EMI sources and its measurements.</td>
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<tr>
<td>C</td>
<td>To understand the various techniques for electromagnetic compatibility.</td>
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Course Outcomes:

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

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

**Textbooks / References:**
ELECTIVE-I
MOBILE COMMUNICATION

Weekly Teaching Hours

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Scheme of Marking

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<th>Total</th>
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<tr>
<td>60</td>
<td>20</td>
<td>20</td>
<td>100</td>
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</table>

Course Objectives:

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

Course Outcomes:

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

UNIT I

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

UNIT II

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

UNIT III

Coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate. Capacity of flat and frequency selective channels.
UNIT IV
Antennas: antennas for mobile terminal- monopole antennas, PIFA, base station antennas and array, Multiple access schemes: FDMA, TDMA, CDMA and SDMA. Modulation schemes: BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM.

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

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

Textbooks / References:
5. Simon Haykin and Michael Moher, Modern Wireless Communication, Pearson education,
ELECTIVE-I

FAULT TOLERANT SYSTEMS

Weekly Teaching Hours
TH : 03   Tut: 01

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

Course Objectives:

A  To provide in-depth understanding of the fundamental concepts of fault-tolerance.
B  To develop skills in modeling and 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 Outcomes:

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

UNIT I

Modelling and Logic Simulation:

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

Fault Modelling and Fault Simulation:


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


UNIT V

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

UNIT VI

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

Textbooks / References:
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:

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<tbody>
<tr>
<td>A</td>
<td>To provide in-depth understanding of the fundamental concepts of analog signal processing.</td>
</tr>
<tr>
<td>B</td>
<td>To provide in-depth understanding of data conversion, PLL design, filter design.</td>
</tr>
</tbody>
</table>

Course Outcomes:

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

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

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

UNIT VI

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

Textbooks / References:
1. CMOS mixed-signal circuit design by R. Jacob Baker Wiley India, IEEE press, reprint 2008
4. Mixed Signal and DSP Design techniques, Engineering Analog Devices Inc, Engineering Analog Devices Inc, Walt Kester, Publisher Newnes.
5. Digital Frequency Synthesis Demystified, Bar-Giora Goldberg, Published by Elsevier.
ELECTIVE-II
RF AND MILLIMETER WAVE CIRCUIT DESIGN

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

Course Objectives:

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

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

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


Textbooks / References:
ELECTIVE-II
SYSTEM ON CHIP

Weekly Teaching Hours
TH : 03  Tut: --

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

Course Objectives:

<p>| | |</p>
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<tbody>
<tr>
<td>A</td>
<td>To provide an in-depth understanding of what SoC is and what are the differences between SoC and Embedded System.</td>
</tr>
<tr>
<td>B</td>
<td>To provide an in-depth understanding of basics of System on Chip and Platform based design.</td>
</tr>
<tr>
<td>C</td>
<td>To provide an in-depth understanding of issues and tools related to SoC design and implementation.</td>
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</table>

Course Outcomes:

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

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

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

**UNIT IV**

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

**UNIT V**

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

**UNIT VI**

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

**Textbooks / References:**

1. Patrick R. Schaumont, “A Practical Introduction to Hardware/Software Co-design”, Springer
ELECTIVE-II
OPTICAL FIBER COMMUNICATION

Weekly Teaching Hours
TH : 03          Tut:   --

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

Course Objectives:

A   To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

B   To provide an in-depth understanding needed to perform fiber-optic communication system engineering calculations, identify system tradeoffs, and apply this knowledge to modern fiber optic systems.

Course Outcomes:

CO1   Learner will be able to recognize and classify the structures of Optical fiber and types.

CO2   Learner will be able to demonstrate electromagnetic and mathematical analysis of light wave propagation.

CO3   Learner will be able to analyze fabrication techniques of different optical fibers.

CO4   Learner will be able to interpret behavior of pulse signal and various loss mechanism.

CO5   Learner will be able to interpret Dispersion compensation mechanism, Scattering effects and modulation techniques.

CO6   Learner will be able to interpret working of Fiber based devices.

UNIT I

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

UNIT II

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

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

UNIT III

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

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


UNIT V


UNIT VI


Textbooks / References:

ELECTIVE-II

STATISTICAL SIGNAL PROCESSING
Course Objectives:

<p>| | |</p>
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<tbody>
<tr>
<td>A</td>
<td>To provide in-depth understanding of more advanced probability theory, leading into random process theory and focus on discrete time methods.</td>
</tr>
<tr>
<td>B</td>
<td>To provide in-depth understanding of fundamental concepts of statistical signal processing.</td>
</tr>
</tbody>
</table>

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


UNIT II

Stochastic Processes and Models


UNIT III

Optimum Linear Filters

UNIT IV

Algorithms and Structures for Optimum Filters.


UNIT V

Least Square Filtering


UNIT VI

Adaptive Filtering


Textbooks / References:
1. S. Haykin Adaptive Filter Theory;; PHI.

ELECTIVE-II
MICROELCETRONICS
Weekly Teaching Hours   TH : 03   Tut:   --
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


UNIT II

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

UNIT III


UNIT IV

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


Textbooks / References:

COMMUNICATION SKILLS

Weekly Teaching Hours
TH: 03  Tut: --

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

Course Objectives:

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

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

30
UNIT IV

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

UNIT V

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

UNIT VI

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

Textbooks / References:

3. Covey, Stephen R., “Seven Habits of Highly Effective People: Powerful Lessons in Personal Change”.
## PG LAB-I

<table>
<thead>
<tr>
<th>Weekly Teaching Hours</th>
<th>TH: --</th>
<th>Practical: 03</th>
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<tr>
<td>Scheme of Marking</td>
<td>TH: --</td>
<td>IA: 25</td>
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<td>PR/OR: 25</td>
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Practical’s of the Lab - I shall be based on the courses of first semester. The lab work shall consists of hands on experiments on the different software and hardware platforms related to the syllabus.
ESTIMATION AND DETECTION THEORY

Weekly Teaching Hours
TH : 03    Tut:  01

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

Linear Algebra

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

UNIT II

Binary Decision: Single Observation

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

UNIT III

Binary Decision: Multiple Observations

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

UNIT IV

Multiple Decision: Multiple Decision

**UNIT V**

**Composite And Nonparametric Decision Theory**

Composite decisions Sign test, Wilsen test, problems

**UNIT VI**

**Fundamentals of Estimation**


**Textbooks / References:**

1. James Melsa and David Cohn, Decision and Estimation Theory, Mc-Graw Hill
INFORMATION THEORY AND CODING

Weekly Teaching Hours

TH: 03    Tut:  01

Scheme of Marking

TH:  60   Tests :  20   IA: 20    Total : 100

Course Objectives:

A  To provide in-depth understanding of principles and applications of information theory.

B  To provide in-depth understanding of how information is measured in terms of probability and entropy and how these are used to calculate the capacity of a communication channel.

C  To provide in-depth understanding of different coding techniques for error detection and correction.

Course Outcomes:

CO1  Learner will be able to formulate equations for entropy mutual information and channel capacity for all types of channels.

CO2  Learner will be able to distinguish between different types of error correcting codes based on probability of error

CO3  Learner will be able to design a digital communication system by selecting an appropriate error correcting codes for a particular application.

CO4  Learner will be able to explain various methods of generating and detecting different types of error correcting codes

CO5  Learner will be able to formulate the basic equations of linear block codes.

CO6  Learner will be able to compare the performance of digital communication system by evaluating the probability of error for different error correcting codes.

UNIT I

Theory of Probability and Random Processes

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

UNIT II

Random Processes

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

UNIT III

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

UNIT IV

Information Theory

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

UNIT V

Error Correcting Codes

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

UNIT VI

Speech Coding

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

Textbooks / References:

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

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<tr>
<td>A</td>
<td>To master the fundamentals of multirate signal processing and demonstrate the ability to solve problems in sample rate conversion, filter banks, and transmultiplexers.</td>
</tr>
</tbody>
</table>

Course Outcomes:

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

UNIT I

Fundamentals of Multirate Systems

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

UNIT II

Maximally Decimated 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


Textbooks / References:

1. P.P. Vaidyanathan, Multirate System and Filter Banks, PTR Prentice Hall, Englewood Cliffs, New Jersey,
2. N.J. Fliege, Multirate Digital Signal Processing, John Wiley & Sons
3. Raghuvendra Rao, Ajit Bopardikar, Wavelet Transforms Introduction to Theory and Application, Pearson Education Asia
ELECTIVE-III
EMBEDDED SYSTEM DESIGN

Weekly Teaching Hours
TH : 03  Tut:  --

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

Course Objectives:

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

Course Outcomes:

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

UNIT I
Fundamentals of Embedded System

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

UNIT II
Embedded System Hardware

Evaluation of Processors, Microprocessor architecture overview- CISC and RISC, Case study of Pentium processor architecture.
UNIT III  
Microcontroller Architecture and Interfacing  
Architecture of 8051, Instruction set, Addressing modes, Programming Examples. Interfacing of LED/LCD, keyboard, stepper motor, ADC/DAC and sensors, RTC, serial communication with micro-controller.

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

UNIT V  
Introduction to DSP Processors  
Architecture, features, instruction set, typical applications (TMS320XX or ADSP 21010).

UNIT VI  
Embedded software and Applications  

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

Textbooks / References:  
4. INTEL Microcontroller Manual  

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:

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

Course Outcomes:

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

UNIT I


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


UNIT IV

**UNIT V**

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

**UNIT VI**

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

**Textbooks / References:**

ELECTIVE-III
VLSI AND MICROSYSTEMS

Weekly Teaching Hours
TH : 03   Tut: 00

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

VHDL Modeling and PLD Architectures


UNIT II

SoC, Interconnect and Digital CMOS Circuits

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

UNIT III

Analog CMOS Design and Testability


UNIT IV

Microfabrication processes

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

UNIT V

Mechanics of Solids

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

UNIT VI

Finite element method and Electronics and packaging

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

Textbooks / References:

ELECTIVE-III
NUMERICAL METHODS IN ELECTROMAGNETICS

Weekly Teaching Hours
TH : 03   Tut: --

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

Course Objectives:

A  To provide the mathematical foundation for the development of numerical methods in Electromagnetics

B  To formulate Finite Difference (FD) schemes for the solution of parabolic, elliptic, and hyperbolic PDEs with emphasis on the truncation boundaries, accuracy, and stability

C  To solve a variety of electromagnetic problems ranging from scattering and radiation to waveguide propagation and eigenvalue problems.

Course Outcomes:

CO1  To understand the main principles and laws that govern electromagnetic wave propagation

CO2  To identify the most suitable numerical technique for the solution of a particular problem in Electromagnetics

CO3  To understand the basic properties of transmission lines; analyze electromagnetic wave propagation in generic transmission line geometries.

CO4  To learn how to use numerical methods to solve for electric fields from charge distributions and conducting boundaries.

CO5  To understand the behavior of magnetic and electric fields in the presence of dielectric and magnetic materials; appreciate how to simply modify expressions for capacitance and inductance from free space expressions.

CO6  To understand the behavior of magnetic and electric fields in the presence of dielectric and magnetic materials.

UNIT I

Review of Analytical Methods

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

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

**UNIT III**

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

**UNIT IV**

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

**UNIT V**

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

**UNIT VI**

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

**Textbooks / References:**


**ELECTIVE-IV**

ADVANCED BIOMEDICAL SIGNAL PROCESSING

47
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**


**UNIT III**

UNIT IV

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

UNIT V

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

UNIT VI

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

Textbooks / References:

2. Willis J Tompkins , Biomedical Signal Processing -, ED, Prentice – Hall, 1993
5. Sörnmo, Bioelectrical Signal Processing in Cardiac & Neurological Applications, Elsevier
6. Semmlow, Bio-signal and Biomedical Image Processing, Marcel Dekker
7. Enderle, Introduction to Biomedical Engineering, 2/e, Elsevier, 2005
ELECTIVE-IV
RECONFIGURABLE COMPUTING

Weekly Teaching Hours
TH: 03    Tut: --

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

Course Objectives:

<table>
<thead>
<tr>
<th>A</th>
<th>To learn the basics of field of reconfigurable computing</th>
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<tr>
<td>B</td>
<td>To learn Advance digital design skills by developing a reconfigurable computing application Learn a hardware design language Chisel - An introduction to research methodology</td>
</tr>
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</table>

Course Outcomes:

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

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

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

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

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

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

UNIT VI

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

Textbooks / References:
1. Andre Dehon, “Reconfigurable Architectures for General Purpose Computing”.
2. IEEE Journal papers on Reconfigurable Architectures.
**ELECTIVE-IV**  
**DIGITAL VLSI DESIGN**

Weekly Teaching Hours  
TH : 03  Tut: --

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

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

**Course Outcomes:**

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

**UNIT I**

**Introduction to VLSI Circuits**

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

Textbooks / References:

5. Data Sheets of PLDs.
**ELECTIVE-IV**

**RADAR SIGNAL PROCESSING**

Weekly Teaching Hours

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Scheme of Marking

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**Course Objectives:**

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<tr>
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<th>To provide in-depth understanding of working principle of basic RADAR. List RADAR terminologies. Derive the simple form of RADAR range equation.</th>
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<tr>
<td>A</td>
<td>To provide in-depth understanding of different types of RADAR and its performance parameters</td>
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</table>

**Course Outcomes:**

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

**UNIT I**

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

**UNIT II**

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

**UNIT III**

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

**UNIT IV**

UNIT V

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

UNIT VI

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

Textbooks / References:

1. Fundamentals of Radar Signal Processing, Mark A. Richards 2005
ELECTIVE-IV
ELECTROMAGNETICS, ANTENNA AND PROPAGATION

Weekly Teaching Hours
TH : 03  Tut: --

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

Course Objectives:

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<tr>
<td>A</td>
<td>To provide in-depth understanding of the fundamental solutions of time-varying Maxwell's equations, and applies them to design antennas.</td>
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<tr>
<td>B</td>
<td>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.</td>
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</table>

Course Outcomes:

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

UNIT I


UNIT II

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


UNIT V


UNIT VI


Textbooks / References:

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


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


UNIT VI

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

Textbooks / References:

2. Daniel Minoli, Building the Internet of Things with IPv6 and MIPv6 The Evolving World of M2M Communications, 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:

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<tr>
<td><strong>A</strong></td>
<td>To provide in-depth understanding of fundamental concepts of linear algebra</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>To understand the importance of linear algebra and learn its applicability to practical problems</td>
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</table>

### Course Outcomes:

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

**UNIT I**
Fields Fq, R, C. Vector Spaces over a field, Fn, F[α]=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, Jordan canonical form

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

**UNIT VI**
System of equations, generalized inverses.
REFERENCES BOOKS:
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

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

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

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

UNIT VI

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

Textbooks / References:
2. Simon Haykin, “Neural Networks: Comprehensive foundation”, Prentice Hall Publication
## ELECTIVE V
### RESEARCH METHODOLOGY

**Weekly Teaching Hours**

| TH: 03 | Tut: -- |

**Scheme of Marking**

| TH: 60 | Tests : 20 | IA: 20 | Total : 100 |

### Course Objectives:

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

### Course Outcomes:

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

### UNIT I

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

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

### UNIT II

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

### UNIT III


### 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

TEXTBOOKS / REFERENCES:

1. J.P. Holman., Experimental Methods for Engineers
2. C.R. Kothari, Research Methodology, Methods & Techniques
ELECTIVE V
WAVELET TRANSFORMS AND ITS APPLICATIONS

Weekly Teaching Hours
TH : 03  Tut: --

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

Course Objectives:

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<tr>
<td>A</td>
<td>To provide in-depth understanding of fundamental concepts of Wavelets.</td>
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<tr>
<td>B</td>
<td>To study wavelet related constructions, its applications in signal processing, communication and sensing.</td>
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Course Outcomes:

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

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

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

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

UNIT IV
Digital Filtering Interpretation, Examples of Orthogonal Basic Generating Wavelets, Interpreting Orthonormal MRAs for Discrete-Time signals, Miscellaneous Issues Related to PRQME Filter Banks, generating Scaling Functions and wavelets from Filter Coefficient, Problems.
UNIT V
Wavelet Transform And Data Compression: Introduction, Transform Coding, DTWT for Image Compression, Audio Compression, And Video Coding Using Multiresolution Techniques: a Brief Introduction.

UNIT VI

Textbooks / References:
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
4. Raghuveer Rao, Ajit Bopardikar, Pearson Education Asia, Wavelet Transforms Introduction to Theory and Application
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

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<th>Practical: 04</th>
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Scheme of Marking

| IA: 50            | PR/OR: 50 | Total: 100 |

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

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Scheme of Marking

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<th>IA: 100</th>
<th>PR/OR: 100</th>
<th>Total: 200</th>
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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.