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

<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></th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>MTEEC101</td>
<td>Computational Methods</td>
<td>03 -- 1</td>
<td>04</td>
<td>60 20 20 -- 100</td>
</tr>
<tr>
<td>02</td>
<td>MTEEC102</td>
<td>Microelectronics</td>
<td>03 -- 1</td>
<td>04</td>
<td>60 20 20 -- 100</td>
</tr>
<tr>
<td>03</td>
<td>MTEEC103</td>
<td>VLSI System Design</td>
<td>03 -- 1</td>
<td>04</td>
<td>60 20 20 -- 100</td>
</tr>
<tr>
<td>04</td>
<td>MTEEE114</td>
<td>Elective-I</td>
<td>03 --</td>
<td>03</td>
<td>60 20 20 -- 100</td>
</tr>
<tr>
<td>05</td>
<td>MTEEE125</td>
<td>Elective-II</td>
<td>03 --</td>
<td>03</td>
<td>60 20 20 -- 100</td>
</tr>
<tr>
<td>06</td>
<td>MTEEC106</td>
<td>Communication Skills</td>
<td>02 --</td>
<td>02</td>
<td>-- -- 25 25 50</td>
</tr>
<tr>
<td>07</td>
<td>MTEEL107</td>
<td>PG Lab-I*</td>
<td>-- 03</td>
<td>02</td>
<td>-- -- 25 25 50</td>
</tr>
</tbody>
</table>

**Total for Semester I** 17 03 32 300 100 150 50 600

### Second Semester

<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></th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>MTEEC201</td>
<td>Advanced DSP</td>
<td>03 -- 1</td>
<td>04</td>
<td>60 20 20 -- 100</td>
</tr>
<tr>
<td>02</td>
<td>MTEEC202</td>
<td>Nano Electronics</td>
<td>03 -- 1</td>
<td>04</td>
<td>60 20 20 -- 100</td>
</tr>
<tr>
<td>03</td>
<td>MTEEE233</td>
<td>Elective-III</td>
<td>03 --</td>
<td>03</td>
<td>60 20 20 -- 100</td>
</tr>
<tr>
<td>04</td>
<td>MTEEE244</td>
<td>Elective- IV</td>
<td>03 --</td>
<td>03</td>
<td>60 20 20 -- 100</td>
</tr>
<tr>
<td>05</td>
<td>MTEEE255</td>
<td>Elective- V- (Open to all)</td>
<td>03 --</td>
<td>03</td>
<td>60 20 20 -- 100</td>
</tr>
<tr>
<td>06</td>
<td>MTEES206</td>
<td>Seminar-I</td>
<td>-- 04</td>
<td>02</td>
<td>-- -- 50 50 100</td>
</tr>
<tr>
<td>07</td>
<td>MTEEP207</td>
<td>Mini-Project</td>
<td>-- 04</td>
<td>02</td>
<td>-- -- 50 50 100</td>
</tr>
</tbody>
</table>

**Total for Semester II** 15 8 02 21 300 100 200 100 700

### Third Semester

<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></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MTEEC301</td>
<td>Project Management &amp; Intellectual Property Rights (Self Study)#</td>
<td>-- -- --</td>
<td>02</td>
<td>-- -- 50 50 100</td>
</tr>
<tr>
<td>2</td>
<td>MTEEP302</td>
<td>Project-I</td>
<td>-- -- -- 10</td>
<td>-- --</td>
<td>50 50 100</td>
</tr>
</tbody>
</table>

**Total for Semester III** -- -- -- 12 -- -- 100 100 200

### Fourth Semester

<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></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MTEEP401</td>
<td>Project-II</td>
<td>-- -- -- 20</td>
<td>-- --</td>
<td>100 100 200</td>
</tr>
</tbody>
</table>

**Total for Semester IV** -- -- -- 20 -- -- 100 100 200

### Grand Total

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sr. No.</td>
<td>Course Code</td>
<td>Name of the Course</td>
</tr>
<tr>
<td>1</td>
<td>MTEEP401</td>
<td>Project-II</td>
</tr>
</tbody>
</table>

**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

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

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:
MICROELECTRONICS

Weekly Teaching Hours
TH : 03  Tut: 01

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

Course Objectives:

<p>| | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>To provide in-depth understanding and to be able to apply basic concepts of semiconductor physics relevant to devices</td>
</tr>
<tr>
<td>B</td>
<td>To be able to analyze and design microelectronic circuits for linear amplifier and digital applications</td>
</tr>
</tbody>
</table>

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

Text Books/Reference:
VLSI SYSTEM DESIGN

Weekly Teaching Hours
TH : 03  Tut: 01

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

Course Objectives

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>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.</td>
</tr>
</tbody>
</table>

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


UNIT II


UNIT III


UNIT IV

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

UNIT V


UNIT VI

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:
**ELECTIVE-I**

**DIGITAL SYSTEM DESIGN**

Weekly Teaching Hours  
TH : 03  
Tut:  --

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

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### Course Objectives

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>This course will explore the basic concepts of digital electronics.</td>
<td></td>
</tr>
</tbody>
</table>

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### 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 |

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**UNIT I**

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

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**UNIT II**


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**UNIT III**

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

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:

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

**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 patient 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

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<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 Outcome:

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

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

Text Books/Reference:
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:

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

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:

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.

Text Books/Reference:
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

<table>
<thead>
<tr>
<th>A</th>
<th>To provide the background and the methods for the understanding of the operation of basic analogue CMOS cells, and how to design common functions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>The emphasis is placed on design of analogue functions specifically as part of mixed signal systems.</td>
</tr>
</tbody>
</table>

Course Outcomes:

<table>
<thead>
<tr>
<th>CO1</th>
<th>To understand behavior and design of basic analogue circuit primitives, including quantitative treatment of matching</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Learner will be able to distinguish between fundamental concepts of analog and discrete time signal processing.</td>
</tr>
<tr>
<td>CO3</td>
<td>Learner will be able to design switched capacitor filters.</td>
</tr>
<tr>
<td>CO4</td>
<td>Learner will be able to demonstrate basics of analog to digital data conversion.</td>
</tr>
<tr>
<td>CO5</td>
<td>Learner will be able to design analog and digital PLLs</td>
</tr>
<tr>
<td>CO6</td>
<td>Learner will be able to understand fundamentals of green data converters.</td>
</tr>
</tbody>
</table>

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.

Text Books/Reference:
1. R. Jacob Baker CMOS mixed-signal circuit design Wiley India, IEEE press, reprint 2008
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

UNIT V

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:

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

UNIT VI
Using the HTK toolkit for building a simple speech recognition system

Text Books/Reference:

7. LR Rabiner and RW Schafer, Digital Processing of Speech Signals, Pearson Education
**ELECTIVE-II**
**ASIC AND SOC**

Weekly Teaching Hours

<table>
<thead>
<tr>
<th></th>
<th>TH : 03</th>
<th>Tut:  --</th>
</tr>
</thead>
</table>

Scheme of Marking

<table>
<thead>
<tr>
<th></th>
<th>TH :60</th>
<th>Tests : 20</th>
<th>IA: 20</th>
<th>Total : 100</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Course Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.</td>
</tr>
<tr>
<td>B. To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.</td>
</tr>
<tr>
<td>C. To give the student an understanding of basics of System on Chip and Platform based design.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1 Learner will be able to demonstrate VLSI tool-flow and appreciate FPGA architecture.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>CO3 Learner will be able to understand the algorithms used for ASIC construction</td>
</tr>
<tr>
<td>CO4 Learner will be able to understand the basics of System on Chip</td>
</tr>
<tr>
<td>CO5 Learner will be able to tackle system level design issues</td>
</tr>
</tbody>
</table>

**Unit I**

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

**Unit II**

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

**Unit III**


**Unit IV**
**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:**
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:

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<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:

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

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

Text Books/Reference:

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

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

Course Outcomes

<table>
<thead>
<tr>
<th>Course</th>
<th>Outcomes</th>
</tr>
</thead>
<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>
</tbody>
</table>
Lerner will be able to illustrate the physical and statistical model of EM devices.

Lerner will be able to analyze the EM devices in terms of Computer Based Modeling and Simulation.

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

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
COMMUNICATION SKILLS

Weekly Teaching Hours

| TH: 02 | Practical: - |

Scheme of Marking

| TH: -- | IA: 25 | PR/OR: 25 | Total: 50 |

Course Objectives:

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<tr>
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<th>A</th>
<th>B</th>
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<tbody>
<tr>
<td></td>
<td>To become more effective confident speakers and deliver persuasive presentations</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>
</tbody>
</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

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:
**PG Lab-I**

<table>
<thead>
<tr>
<th>Weekly Teaching Hours</th>
<th>Practical: 03</th>
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</thead>
<tbody>
<tr>
<td>Scheme of Marking</td>
<td>TH: -- IA: 25 PR/OR: 25 Total: 50</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Course</th>
<th>TH</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Scheme of Marking</td>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>-----</td>
</tr>
</tbody>
</table>

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:

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

UNIT I

DISCRETE RANDOM SIGNAL PROCESSING


UNIT II

SPECTRUM ESTIMATION


UNIT III

LINEAR ESTIMATION AND PREDICTION


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 -

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:
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


UNIT III

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

Text Books/Reference:
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:

<table>
<thead>
<tr>
<th>CO1</th>
<th>Learner will be able to develop efficient realizations for upsampling and downsampling of signals using the polyphase decomposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Learner will be able to design and implement Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) digital filters to meet specifications</td>
</tr>
<tr>
<td>CO3</td>
<td>Learner will be able to design digital filter banks based on the techniques presented</td>
</tr>
<tr>
<td>CO4</td>
<td>Learner will be able to analyze fundamental concepts of Wavelets.</td>
</tr>
<tr>
<td>CO5</td>
<td>Learner will be able to distinguish between Wavelets and multirate filter banks, from the point of view of implementation.</td>
</tr>
</tbody>
</table>

UNIT I
Fundamentals of Multirate Systems
Introduction, Basic multirate operations, Interconnection of building blocks, Polyphase representation, Multistage 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, Transform 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

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
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 analyze 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


UNIT II

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

UNIT III


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.
Text Books/Reference:
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:

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

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

Text Books/Reference:
1. S. Haykin Adaptive Filter Theory;PHI.
**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**


**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 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
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:

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

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

Text Books/Reference:
ADVANCED BIOMEDICAL SIGNAL PROCESSING

Weekly Teaching Hours
TH : 03   Tut: --

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

Course Objectives:

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>A</td>
<td>To introduce students to the principles of signal processing techniques when applied specifically to biomedical signals</td>
</tr>
<tr>
<td>B</td>
<td>To provide in depth understanding of methods and tools for extracting information from digitally acquired biomedical signals.</td>
</tr>
</tbody>
</table>

Course Outcomes:

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

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.

**Text Books/Reference:**

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

**ELECTIVE-IV**

**RECONFIGURABLE COMPUTING**
Weekly Teaching Hours

<table>
<thead>
<tr>
<th>TH</th>
<th>Tut</th>
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<tr>
<td>03</td>
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</table>

Scheme of Marking

<table>
<thead>
<tr>
<th>TH</th>
<th>Tests</th>
<th>IA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>20</td>
<td>20</td>
<td>100</td>
</tr>
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</table>

**Course Objectives:**

<table>
<thead>
<tr>
<th>A</th>
<th>To learn the basics of field of reconfigurable computing</th>
</tr>
</thead>
<tbody>
<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>
</tbody>
</table>

**Course Outcomes:**

<table>
<thead>
<tr>
<th>CO1</th>
<th>Learner will be able to understand concept of static and dynamic reconfiguration.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Learner will be able to understand basics of the PLDs for designing reconfigurable circuits.</td>
</tr>
<tr>
<td>CO3</td>
<td>Learner will be able to understand the reconfigurable system design using HDL</td>
</tr>
<tr>
<td>CO4</td>
<td>Learner will be able to demonstrate different architectures of reconfigurable computing.</td>
</tr>
<tr>
<td>CO5</td>
<td>Learner will be able to understand different applications of reconfigurable computing</td>
</tr>
</tbody>
</table>

**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:
4. Maya Gokhale, Paul Ghamah, Reconfigurable Computing, Springer Publication

ELECTIVE-IV
RADAR SIGNAL PROCESSING
Weekly Teaching Hours TH : 03 Tut: --
Course Objectives:

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

Course Outcomes:

<p>| | | |</p>
<table>
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</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Learner will be able to understand the history and application of radar system</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Learner will be able to understand the signal models of radar system</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Learner will be able to sample and quantize the signals in radar system</td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Learner will be able to analyze the different waveforms and match filters in radar system</td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Learner will be able to modify the radar system models by analyzing the Doppler frequency</td>
<td></td>
</tr>
<tr>
<td>CO6</td>
<td>Learner will be able to demonstrate the radar system and analyze the signal in it noise</td>
<td></td>
</tr>
</tbody>
</table>

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.

Text Books/Reference:
1. , Mark A. Richards, Fundamentals of Radar Signal Processing 2005
**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**


**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**

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.

UNIT VI

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:
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:

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

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


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:
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:

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

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 Framework, 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.

Text/ Reference Books:

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

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[ө]=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:
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

Text Books/Reference:
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.
ELECTIVE-V
RESEARCH METHODOLOGY

Weekly Teaching Hours

TH : 03  Tut:  --

Scheme of Marking

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

Course Objectives:

<p>| | |</p>
<table>
<thead>
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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>
</tr>
<tr>
<td>C</td>
<td>To identify various sources of information for literature review and data collection.</td>
</tr>
<tr>
<td>D</td>
<td>To understand the components of scholarly writing and evaluate its quality.</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, objective, motivation and type of research</td>
</tr>
<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 be able to 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>
</tr>
</tbody>
</table>

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

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

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:

<p>| | |</p>
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<thead>
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<tbody>
<tr>
<td>A</td>
<td>To provide in-depth understanding of fundamental concepts of Wavelets.</td>
</tr>
<tr>
<td>B</td>
<td>To study wavelet related constructions, its applications in signal processing, communication and sensing.</td>
</tr>
</tbody>
</table>

Course Outcomes:

<p>| | |</p>
<table>
<thead>
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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 be able to 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>
</tr>
<tr>
<td>CO4</td>
<td>Learner will be able to understand bases, orthogonal bases in wavelet transform</td>
</tr>
<tr>
<td>CO5</td>
<td>Learner will be able to understand different types of wavelet transform</td>
</tr>
<tr>
<td>CO6</td>
<td>Learner will be able to design practical system using wavelet transform</td>
</tr>
</tbody>
</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

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.Fliefge, John Wiley & Sons, Multirate Digital Signal Processing
4. Raghuveer Rao, Ajit Bopardikar, Pearson Education Asia, Wavelet Transforms Introduction to Theory and Application
### SEMINAR I

<table>
<thead>
<tr>
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<th>TH: -</th>
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<td>Scheme of Marking</td>
<td>IA: 50</td>
<td>PR/OR: 50</td>
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</tbody>
</table>

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.
<table>
<thead>
<tr>
<th>MINI PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly Teaching Hours</td>
</tr>
<tr>
<td>Scheme of Marking</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Weekly Teaching Hours</th>
<th>TH: -</th>
<th>Practical: -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme of Marking</td>
<td>IA: 50</td>
<td>PR/OR: 50</td>
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<tr>
<td></td>
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<td>Total: 100</td>
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</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Weekly Teaching Hours</th>
<th>TH: -</th>
<th>Practical: -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme of Marking</td>
<td>IA: 50</td>
<td>PR/OR: 50</td>
</tr>
</tbody>
</table>

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.