Course Structure and Syllabus
For
M. Tech. (Digital Communication)
Two Year (Four Semester) Course
(w.e.f. July 2017)
M.Tech. (Digital Communication)

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 build 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. (Digital Communication) 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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</table>

* 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. RF and Microwave Circuit Design
B. Electromagnetic Interference and Compatibility
C. Mobile Communication
D. Synthesis & Optimization of Digital Circuits
E. Smart Antenna

Elective-II
A. Digital Image Processing
B. Multimedia Communications
C. Optical Fiber Communication
D. Statistical Signal Processing
E. Microelectronics

Elective-III
A. Multirate Digital Signal Processing
B. Wireless Sensor Network Design
C. Image and Video Processing
D. Multicarrier Communication
E. Optimization Techniques

Elective-IV
A. Advanced Biomedical Signal Processing
B. Adhoc Wireless Networks
C. Audio and Speech Processing
D. Radar Signal Processing
E. Electromagnetics, Antenna and Propagation

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
**Course Objectives:**

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<tbody>
<tr>
<td>A</td>
<td>To provide in depth understanding of random nature of a signal using probability and random experiments.</td>
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<tr>
<td>B</td>
<td>To prepare mathematical background for communication signal analysis.</td>
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<tr>
<td>C</td>
<td>To provide in depth understanding of random processes.</td>
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**Course Outcomes:**

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<tr>
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<tbody>
<tr>
<td>CO1</td>
<td>Learner will be able to apply knowledge of basic probability theory.</td>
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<tr>
<td>CO2</td>
<td>Learner will be able to understand concept of Random Variable.</td>
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<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>
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<tr>
<td>CO4</td>
<td>Learner will be able to distinguish multiple Random Variable and its properties.</td>
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<tr>
<td>CO5</td>
<td>Learner will be able to hypothesize nature of different Random Processes.</td>
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<tr>
<td>CO6</td>
<td>Learner will be able to adapt basic concepts of estimation on multiple and repeated data measurement.</td>
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</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
Introduction, Estimation, Parameter Estimation, Hypothesis Testing
General concept, Random walks and other applications, Spectral representation and estimation, Mean square estimation, Markov chains.

Text Books/Reference:
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
Course Objectives:

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<tbody>
<tr>
<td>A</td>
<td>To provide in depth understanding of fundamental antenna engineering parameters</td>
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<td>and terminology</td>
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<td>B</td>
<td>To provide in depth understanding of basic concepts of electromagnetic wave radiation and</td>
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<td>reception</td>
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<td>C</td>
<td>To develop the basic skills necessary for designing a wide variety of practical</td>
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<td>antennas and antenna arrays</td>
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</table>

Course Outcomes:

| CO1 | Learner will be able to analyze basic radiation mechanism and basic EM concepts.           |
| CO2 | Learner will be able to understand basic fundamentals of antenna.                          |
| CO3 | Learner will be able to understand various antennas, arrays and radiation pattern in antennas |
| CO4 | Learner will be able to design antennas for mobile communication                           |

UNIT I


UNIT II

Arrays: Array factor for linear arrays, uniformly excited, equally spaced Linear arrays, pattern multiplication, directivity of linear arrays, non-uniformly excited -equally spaced linear arrays, Mutual coupling, multidimensional arrays, phased arrays, feeding techniques, perspective on arrays.

UNIT III


UNIT IV

Aperture Antennas: Techniques for evaluating Gain, reflector antennas - Parabolic reflector antenna principles, Axisymmetric parabolic reflector antenna, offset parabolic reflectors, dual
reflector antennas, Gain calculations for reflector antennas, feed antennas for reflectors, field representations, matching the feed to the reflector, general feed model, feed antennas used in practice.

**UNIT V**


**UNIT VI**


**Text Books/Reference:**


ADVANCE DIGITAL COMMUNICATION

Weekly Teaching Hours
TH : 03    Tut:  01

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

Course Objectives:

<table>
<thead>
<tr>
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<th>To provide in-depth understanding of different techniques in modern digital communications with applications to wireless transmission</th>
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<tr>
<td>B</td>
<td>To provide in-depth understanding of mathematical modeling to problems in digital communication, and to explain how this is used to analyze and synthesize methods and algorithms within the field.</td>
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</table>

Course Outcomes:

<table>
<thead>
<tr>
<th>CO1</th>
<th>Learner will be able to analyze different techniques in modern digital communication.</th>
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<tbody>
<tr>
<td>CO2</td>
<td>Learner will be able to compare different techniques in digital communication and judge the applicability of different techniques in different situations</td>
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<tr>
<td>CO3</td>
<td>Learner will be able to formulate advanced mathematical models which are applicable and relevant in the case of a given problem</td>
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<tr>
<td>CO4</td>
<td>Learner will be able to use a mathematical model to solve a given demanding engineering problem in the digital communication field, and analyze the result and its validity</td>
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<tr>
<td>CO5</td>
<td>Learner will be able to demonstrate time and frequency domain models for digital communications systems with linear channels and additive noise</td>
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</table>

UNIT I

Introduction
Digital communication system (description of different modules of the block diagram), Complex baseband representation of signals, Gram-Schmidt orthogonalization procedure. M-ary orthogonal signals, bi-orthogonal signals, simplex signal waveforms.

UNIT II

Modulation
Pulse amplitude modulation (binary and M-ary, QAM), Pulse position modulation (binary and M-ary), Carrier modulation (M-ary ASK, PSK, FSK, DPSK), Continuous phase modulation (QPSK and variants, MSK, GMSK).

UNIT III

Receiver in additive white Gaussian noise channels
Coherent and noncoherent demodulation: Matched filter, Correlator demodulator, square-law, and envelope detection; Detector: Optimum rule for ML and MAP detection Performance: Bit-error-rate, symbol error rate for coherent and noncoherent schemes.
UNIT IV
Band-limited channels
Pulse shape design for channels with ISI: Nyquist pulse, Partial response signaling (duobinary and modified duobinary pulses), demodulation; Channel with distortion: Design of transmitting and receiving filters for a known channel and for time varying channel (equalization); Performance: Symbol by symbol detection and BER, symbol and sequence detection, Viterbi algorithm.

UNIT V
Synchronization
Different synchronization techniques (Early-Late Gate, MMSE, ML and spectral line methods).

UNIT VI
Communication over fading channels
Characteristics of fading channels, Rayleigh and Rician channels, receiver performance-average SNR, outage probability, amount of fading and average bit/symbol error rate.

Text Books/Reference:
ELCTIVE I
RF AND MICROWAVE CIRCUIT DESIGN

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

Course Objectives:

| A | To provide an insight into various aspects of the RF, microwave. |
| B | To provide brief theoretical foundation of RF, and microwave |

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 micro 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

Text Books/Reference:
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 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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<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>
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<tr>
<td>CO2</td>
<td>Learner will be able to measure different parameters of interference in EM</td>
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<tr>
<td>CO3</td>
<td>Learner will be able to reduce the interference within EM devices</td>
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<tr>
<td>CO4</td>
<td>Learner will be able to illustrate the physical and statistical model of EM devices</td>
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<tr>
<td>CO5</td>
<td>Learner will be able to analyze the EM devices in terms of Computer Based Modeling 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 problems related to electromagnetic compatibility.</td>
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</table>

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.

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:**
ELECTIVE I
MOBILE COMMUNICATION

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 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.

Text Books/Reference:
5. Simon Haykin and Michael Moher, Modern Wireless Communication, Pearson education,
**ELECTIVE I**

**SYNTHESIS & OPTIMIZATION OF DIGITAL CIRCUITS**

Weekly Teaching Hours TH : 03 Tut: --

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

<table>
<thead>
<tr>
<th>Course Objectives:</th>
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<tr>
<td>A</td>
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<table>
<thead>
<tr>
<th>Course Outcomes:</th>
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<tbody>
<tr>
<td>CO1 Learner will be able to process of synthesis and optimization in a top down approach for digital circuits models using HDLs</td>
</tr>
<tr>
<td>CO2 Learner will be able to analyze terminologies of graph theory and its algorithms to optimize a Boolean equation.</td>
</tr>
<tr>
<td>CO3 Learner will be able to apply different two level and multilevel optimization algorithms for combinational circuits</td>
</tr>
<tr>
<td>CO4 Learner will be able to apply the different sequential circuit optimization methods using state models and network models.</td>
</tr>
<tr>
<td>CO5 Learner will be able to analyze different scheduling algorithms</td>
</tr>
<tr>
<td>CO6 Learner will be able to understand fundamental concepts of simulation</td>
</tr>
</tbody>
</table>

**UNIT I**

**Introduction:** Microelectronics, semiconductor technologies and circuit taxonomy, Microelectronic design styles, computer aided synthesis and optimization.

**UNIT II**

**Graphs:** Notation, undirected graphs, directed graphs, combinatorial optimization, Algorithms, tractable and intractable problems, algorithms for linear and integer programs, graph optimization problems and algorithms, Boolean algebra and Applications.

**UNIT III**

**Hardware Modeling:** Hardware Modeling Languages, distinctive features, structural hardware language, Behavioural hardware language, HDLs used in synthesis, abstract models, structures logic networks, state diagrams, dataflow and sequencing graphs, compilation and optimization techniques.
UNIT IV
Two Level Combinational Logic Optimization: Logic optimization, principles, operation on two level logic covers, algorithms for logic minimization, symbolic minimization and encoding property, minimization of Boolean relations.

Multiple Level Combinational Optimizations: Models and transformations for combinational networks, algebraic model, Synthesis of testable network, algorithm for delay evaluation and optimization, rule based system for logic optimization.

UNIT V

UNIT VI

Text Books/Reference:
ELECTIVE I

SMART ANTENNA

Weekly Teaching Hours

<table>
<thead>
<tr>
<th>Course Hours</th>
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<td>TH : 03</td>
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Scheme of Marking

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<th>TH:</th>
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<th>Total:</th>
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<tbody>
<tr>
<td>60</td>
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<td>100</td>
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</tbody>
</table>

Course Objectives:

<table>
<thead>
<tr>
<th>A</th>
<th>To provide in-depth understanding of modern antenna concepts, and practical antenna design for various applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>To provide in-depth understanding of of smart antenna concept with a view that the student can further explore the topic for research purpose.</td>
</tr>
</tbody>
</table>

Course Outcomes:

<table>
<thead>
<tr>
<th>CO1</th>
<th>Learner will be able to compare the performances of digital radio receivers and software radios.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Learner will be able to understand the CDMA spatial processors to analyze the multi-cell systems.</td>
</tr>
<tr>
<td>CO3</td>
<td>Learner will be able to analyze the channel models for smart antenna systems.</td>
</tr>
<tr>
<td>CO4</td>
<td>Learner will be able to understand the environmental parameters for signal processing of smart antenna systems.</td>
</tr>
<tr>
<td>CO5</td>
<td>Learner will be able to evaluate the requirements for the design and implementation of smart antenna systems</td>
</tr>
</tbody>
</table>

UNIT I
Introduction to Smart Antennas, Need for Smart Antennas, Smart Antenna Configurations.

UNIT II

UNIT III

UNIT IV
UNIT V

UNIT VI
Data Rates in MIMO Systems, Single-User Data Rate Limits, Multiple Users Data Rate Limits, Data Rate Limits Within a Cellular System, MIMO in Wireless Local Area Networks, Mobile Stations’ Smart Antennas, Combining Techniques, Selection (Switched) Diversity, Maximal Ratio Combining, Adaptive Beam forming or Optimum Combining, RAKE Receiver Size, Mutual Coupling Effects, Dual-Antenna Performance Improvements, Downlink Capacity Gains

Text Books/Reference:
ELECTIVE II
DIGITAL IMAGE 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 for fundamental concepts of Digital Image Processing.</td>
</tr>
<tr>
<td>B</td>
<td>To provide in-depth understanding for image analysis algorithms.</td>
</tr>
<tr>
<td>C</td>
<td>To provide exposure to current applications in the field of digital image processing.</td>
</tr>
</tbody>
</table>

Course Outcomes:

| CO1 | Learner will be able to understand different fundamentals of image processing. |
| CO2 | Learner will be able to analyze different image enhancement and restoration techniques. |
| CO3 | Learner will be able to analyze fundamental concepts of image compression techniques. |
| CO4 | Learner will be able to develop and implement their own algorithms for digital image processing. |
| CO5 | Learner will be able to apply image processing algorithms for practical object recognition applications. |

UNIT I
Fundamentals of Image Processing

UNIT II
Image Enhancement and Restoration
UNIT III
Image Compression

UNIT IV
Image Segmentation and Morphological Operations

UNIT V
Representation and Description

UNIT VI
Object Recognition and Applications
Feature extraction, Patterns and Pattern Classes, Representation of Pattern classes, Types of classification algorithms, Minimum distance classifier, Correlation based classifier, Bayes classifier. Applications: Biometric Authentication, Character Recognition, Content based Image Retrieval, Remote Sensing, Medical application of Image processing.

Text Books/Reference:
ELECTIVE II
MULTIMEDIA COMMUNICATION

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 for multimedia communication standards and compression techniques</td>
</tr>
<tr>
<td>B</td>
<td>To provide in-depth understanding for representation of image, video</td>
</tr>
</tbody>
</table>

Course Outcomes:

| CO1 | Learner will be able to understand different multimedia communication devices. |
| CO2 | Learner will be able to analyze different multimedia compression techniques. |
| CO3 | Learner will be able to analyze fundamental concepts of multimedia building blocks. |
| CO4 | Learner will be able to demonstrate a diverse portfolio that reflects multimedia aesthetic proficiency. |
| CO5 | Learner will be able to demonstrate a set of professional skills and competencies in their practice of multimedia communication. |

UNIT I
Introduction to Multimedia, Multimedia Information, Multimedia Objects, Multimedia in business and work. Convergence of Computer, Communication and Entertainment products Stages of Multimedia Projects Multimedia hardware, Memory & storage devices, Communication devices, Multimedia software's, presentation tools, tools for object generations, video, sound, image capturing, authoring tools, card and page based authoring tools.

UNIT II
Multimedia Building Blocks: Text, Sound MIDI, Digital Audio, audio file formats, MIDI under windows environment Audio & Video Capture.

UNIT III
Data Compression Huffman Coding, Shannon Fano Algorithm, Huffman Algorithms, Adaptive Coding, Arithmetic Coding Higher Order Modelling, Finite Context Modelling, Dictionary based Compression, Sliding Window Compression, LZ77, LZW compression, Compression, Compression ratio loss less & lossy compression.
UNIT IV
Speech Compression & Synthesis Digital Audio concepts, Sampling Variables, Loss less compression of sound, loss compression & silence compression.

UNIT V
Images Multiple monitors, bitmaps, Vector drawing, lossy graphic compression, image file formatic animations Images standards, JPEG Compression, Zig Zag Coding, Multimedia Database.Content based retrieval for text and images,Video:

UNIT VI
Video representation, Colors, Video Compression, MPEG standards, MHEG Standard Video Streaming on net, Video Conferencing, Multimedia Broadcast Services, Indexing and retrieval of Video Database, recent development in Multimedia.

Text Books/Reference:
3. Mark Nelson, Data Compression Hand Book, BPB.
4. Sleinreitz, Multimedia System, Addison Wesley


**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**

**Text Books/Reference:**
ELECTIVE II
STATISTICAL SIGNAL PROCESSING

Weekly Teaching Hours

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

Course Objectives:

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

Course Outcomes:

|   | Learner will be able to generalize the properties of statistical models in the analysis of Signals using Stochastic processes. |
|   | Learner will be able to compare different Stochastic Processes and Models. |
|   | Learner will be able to demonstrate optimum linear filter algorithms and structures. |
|   | Learner will be able to Differentiate the prominence of various spectral estimation techniques for Achieving higher resolution in the estimation of power spectral density. |
|   | Learner will be able to visualize Least Square Filtering and Computation techniques. |
|   | 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

Text Books/Reference:
1. S. Haykin, Adaptive Filter Theory, PHI.
ELECTIVE-II
MICROELECTRONICS

Weekly Teaching Hours
TH : 03    Tut: --

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

Course Objectives:

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

Course Outcomes:

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

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:**
COMMUNICATION SKILLS

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

Course Objectives:

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

Course Outcomes:

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

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

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

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

UNIT IV
Presentation Skills: Designing an effective Presentation, Contents, appearance, themes in a presentation; Tone and Language in a presentation, Role and Importance of different tools for effective presentation
UNIT V
Motivation/ Inspiration: Ability to shape and direct working methods according to self-defined criteria; Ability to think for oneself, Apply oneself to a task independently with self-motivation, Motivation techniques: Motivation techniques based on needs and field situations

UNIT VI
Self-management, Self-evaluation, Self-discipline, Self-criticism, Recognition of one’s own limits and deficiencies, dependency etc. Self-awareness, Identifying one’s strengths and weaknesses, Planning & Goal setting, Managing self-emotions, ego, pride leadership & Team dynamics

Text Books/Reference:
**PG Lab-I**

<table>
<thead>
<tr>
<th>Weekly Teaching Hours</th>
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<td>Scheme of Marking</td>
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<td>PR/OR: 25</td>
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<td>Total: 50</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:

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<tbody>
<tr>
<td>A</td>
<td>To provide in-depth understanding basics of detection and estimation theory.</td>
</tr>
<tr>
<td>B</td>
<td>To be able to design and analyze optimum detection schemes</td>
</tr>
</tbody>
</table>

Course Outcomes:

| CO1 | Learner will be able to acquire basic knowledge of linear algebra |
| CO2 | Learner will be able to acquire basics of statistical decision theory used for signal detection and estimation. |
| CO3 | Learner will be able to examine the detection of deterministic and random signals using statistical models. |
| CO4 | Learner will be able to examine the performance of signal parameters using optimal Estimators |
| CO5 | Learner will be able to understand different estimation schemes such as ML and MMSE estimators |

UNIT I
Linear Algebra

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

UNIT II
Binary Decision: Single Observation

Introduction to structure 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, Wilason test, problems

UNIT VI

Fundamentals of Estimation

Text Books/Reference:
1. James Melsa and David Cohn, Mc-Graw Hill, Decision and Estimation Theory
INFORMATION THEORY AND CODING

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 principles and applications of information theory.</td>
</tr>
<tr>
<td>B</td>
<td>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.</td>
</tr>
<tr>
<td>C</td>
<td>To provide in-depth understanding of different coding techniques for error detection and correction.</td>
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Course Outcomes:

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

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.

Text Books/Reference:

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

A  

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

Course Outcomes:

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

UNIT I
Fundamentals of Multirate Systems

Introduction, Basic multirate operations, Interconnection of building blocks, Polyphase 
representation, Multstage 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

Text Books/Reference:
1. P.P.Vaidyanathan , PTR Prentice Hall, Englewood Cliffs , New Jersey, Multirate System and Filter Banks
2. N.J.Fliege , John Wiley & Sons, Multirate Digital Signal Processing
3. Raghuveer Rao, Ajit Bopardikar, Pearson Education Asia, Wavelet Transforms Introduction to Theory and Application
4. C. Sidney Burrus , R.A.Gopianath , Pretice Hall, Introduction to wavelet and wavelet Transform
ELCTIVE 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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<tbody>
<tr>
<td>A</td>
<td>To provide in-depth understanding of design and implementation of WSN</td>
</tr>
<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>
</tbody>
</table>

Course Outcomes:

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

UNIT I

UNIT II
Architectures: Node Architecture, the sensing subsystem, processor subsystem, communication, interface, Lmote, XYZ, Hogthrob node architectures

UNIT III
Power Management-Through local power, processor, communication subsystems and other means, time Synchronization need, challenges and solutions overview for ranging techniques; Security Fundamentals, challenges and attacks of Network Security, protocol mechanisms for security.

UNIT IV
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:
ELCTIVE III
IMAGE AND VIDEO PROCESSING

Weekly Teaching Hours

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

Course Objectives:

<p>| | |</p>
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<tbody>
<tr>
<td>A</td>
<td>To provide in depth understanding of image and video processing.</td>
</tr>
<tr>
<td>B</td>
<td>To perform mathematical analysis of image and video processing and implement it.</td>
</tr>
<tr>
<td>C</td>
<td>To provide solutions to real time problems using knowledge of subject.</td>
</tr>
</tbody>
</table>

Course Outcomes:

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<tbody>
<tr>
<td>CO1</td>
<td>Learner will be able to basics of correlation and convolution in image processing.</td>
</tr>
<tr>
<td>CO2</td>
<td>Learner will be able to understand concept Noise characterization, and Noise restoration filters.</td>
</tr>
<tr>
<td>CO3</td>
<td>Learner will be able to estimate different aspects of LZW coding, Transform Coding.</td>
</tr>
<tr>
<td>CO4</td>
<td>Learner will be able to start to learn Analog video and Digital Video.</td>
</tr>
<tr>
<td>CO5</td>
<td>Learner will be able to estimate 2-D Motion.</td>
</tr>
<tr>
<td>CO6</td>
<td>Learner will be able to lean various types of coding.</td>
</tr>
</tbody>
</table>

UNIT I

UNIT II

UNIT III
UNIT IV

UNIT V

UNIT VI
3-D Motion Estimation.

Text Books/Reference:
2. Yao Wang, Joem Ostarmann and Yuan Zhang, Video processing and communication, 1st edition, PHI
4. Relf, Christopher G., Image acquisition and processing with LabVIEW, CRC press
ELECTIVE-III
MULTICARRIER COMMUNICATION

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 basic concepts of Multicarrier techniques
B  To make students familiar with modern communication system

Course Outcomes:

<table>
<thead>
<tr>
<th>CO1</th>
<th>Learner will be able to understand practical limits on CDMA &amp; OFDM systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Learner will be able to understand basic principles of CDMA &amp; OFDM systems</td>
</tr>
<tr>
<td>CO3</td>
<td>Learner will be able to perform analysis of CDMA &amp; OFDM systems</td>
</tr>
<tr>
<td>CO4</td>
<td>Learner will be familiar with other modern communication systems</td>
</tr>
<tr>
<td>CO5</td>
<td>Learner will be able to design CDMA &amp; OFDM systems</td>
</tr>
</tbody>
</table>

UNIT I
Introduction to digital communication: Introduction to digital communication, high rate wireless application, wireless channel fundamentals, digital communication system fundamentals, Multi-Carrier system fundamentals, comparison with single carrier communication system.

UNIT II
System Architecture: Basics of OFDM, FFT implementation, power spectrum, efficiency Impairments of wireless channels to OFDM, signals Performance optimization, clipping in multi-carrier system, channel partitioning, optimization through coding.

UNIT III
Performance, Channel Estimation and Equalization Synchronization, channel estimation & equalization: Timing & frequency offset, synchronization and system architecture, timing and frame synchronization frequency offset estimation. Channel Estimation and equalization Coherent detection, noncoherent detection, performance, channel estimation for MIMO-OFDM

UNIT IV
Channel coding: Need for coding block, coding in OFDM convolution encoding, concatenated coding, coding in OFDM
UNIT V
PAPR Reduction Techniques: Peak power reduction techniques PAPR properties of OFDM signals, PAPR reduction with and without signal distortion PAPR reduction for multi-carrier CDMA

UNIT VI
Applications of multi-carrier communication Coding in OFDM, wireless LAN, digital audio & video broadcasting OFDM based multiple access techniques, mitigation of clipping effects)

Text Books/Reference:
1. Bahai, Saltzberg, Ergen : Multi-carriers Digital communications, Springer
7. OFDM orthogonal frequency Division Multiplexing. Nova Engineering.
ELECTIVE-III
OPTIMIZATION TECHNIQUES

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 acquaint the students with the basic concepts of Optimization</td>
</tr>
<tr>
<td>B</td>
<td>To introduce methods of optimization to engineering students, including linear programming, nonlinear programming, and heuristic methods</td>
</tr>
<tr>
<td>C</td>
<td>To provide in-depth understanding about balance between theory, numerical computation, problem setup for solution by optimization software, and applications to engineering systems</td>
</tr>
</tbody>
</table>

Course Outcomes:

| CO1 | Learner will be able to identify real-world objectives and constraints based on actual problem descriptions. |
| CO2 | Learner will be able to create mathematical optimization models. |
| CO3 | Learner will be able to analyze optimization algorithm; necessary and sufficient conditions for optimality |
| CO4 | Learner will be able to make recommendations based on solutions, analyses, and limitations of models |

UNIT I:
Different Types of OR Models, Case studies in engineering applications.

UNIT II
Convex Sets, Graphical Method, Simplex Method, Big – M Method, Two Phase Method, Revised Simplex Method.

UNIT III
Duality Theory, Dual Simplex Method, Sensitivity Analysis

UNIT IV:
Cutting Plane and Branch and Bound Techniques for all Integer and Mixed Integer Programming Problems, 0-1 Integer Problems, Travelling Salesman Problem, Cargo Loading Problem.

UNIT V
Transportation Problems and Assignment Problems.
UNIT VI
Game Theory: Rectangular Games, Minmax Theorem, Graphical Solution of 2 X n and m X 2 games, Reduction to Linear Programming Problems. Sequencing and Scheduling: Processing of Jobs through Machines, CPM and PERT

Text Books/Reference:
3. Pant, J.C., Introduction to Optimization, Jain Brothers, 2012
ELECTIVE-IV
ADVANCED BIOMEDICAL SIGNAL PROCESSING

Weekly Teaching Hours
TH : 03  Tut: --

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

Course Objectives:

A  To introduce students to the principles of signal processing techniques when applied specifically to biomedical signals

B  To provide in depth understanding of methods and tools for extracting information from digitally acquired biomedical signals.

Course Outcomes:

CO1  Learner will be able to demonstrate a systematic knowledge of the complex physical and physiological principles that underpin the measurement of biomedical signals.

CO2  Learner will be able to demonstrate an advanced understanding of the principles of digital signal processing.

CO3  Learner will be able to systematically apply advanced methods to extract relevant information from biomedical signal measurements.

CO4  Learner will be able to critically assess the appropriateness of cutting-edge biomedical signal processing techniques for various problems in the field.

CO5  Learner will be able to evaluate the effectiveness of techniques applied to biomedical signals against specific benchmarks.

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

UNIT II
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
7. Enderle, Introduction to Biomedical Engineering, 2/e, Elsevier, 2005

48
ELECTIVE-IV
ADHOC WIRELESS NETWORKS

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 about fundamental concepts of adhoc wireless networks
B  To provide in-depth understanding for challenges in designing network
C  To provide in-depth understanding for various sensor network platforms

Course Outcomes:

| CO1  | Learner will be able to describe the unique issues in ad-hoc/sensor networks |
| CO2  | Learner will be able to analyze current technology trends for the implementation and deployment of wireless ad-hoc/sensor networks |
| CO3  | Learner will be able to analyze challenges in designing MAC, routing and transport protocols for wireless ad-hoc/sensor networks |
| CO4  | Learner will be able to analyze challenges in designing routing and transport protocols for wireless Ad-hoc/sensor networks |
| CO5  | Learner will be able to Comprehend the various sensor network Platforms, tools and Applications |
| CO6  | Learner will be able to analyze issues & challenges in security provisioning |

UNIT I

UNIT II
Contention – based MAC protocols with scheduling mechanism, MAC protocols that use directional antennas, Other MAC protocols.

UNIT III
ROUTING PROTOCOLS FOR AD HOC WIRELESS NETWORKS: Introduction, Issues in designing a routing protocol for Adhoc wireless Networks, Classification of routing protocols, Table drive routing protocol, On-demand routing protocol.

UNIT IV
Hybrid routing protocol, Routing protocols with effective flooding mechanisms, Hierarchical routing protocols, Power aware routing protocols.
UNIT V
TRANSPORT LAYER PROTOCOLS FOR ADHOC WIRELESS NETWORKS:
Introduction, Issues in designing a transport layer protocol for Ad hoc wireless Networks, Design goals of a transport layer protocol for Ad hoc wireless Networks.

UNIT VI

Text Books/Reference:
2. Ozan K. Tonguz and Gianguigi Ferrari, Ad hoc wireless Networks, Wiley
ELECTIVE-IV
AUDIO AND SPEECH 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 about fundamental concepts of audio and speech processing
B To provide in-depth understanding for challenges in designing network

Course Outcomes:

| CO1 | Learner will be able to analyze the fundamentals of audio and speech signal processing and associated techniques. |
| CO2 | Learner will be able to demonstrate how to solve practical problems with some basic audio and speech signal processing techniques |
| CO3 | Learner will be able to design simple systems for realizing some multimedia applications with some basic audio and speech signal processing techniques. |
| CO4 | Learner will be able to analyze different audio coding techniques. |
| CO5 | Learner will be able to formulate linear Prediction problem in Time Domain |
| CO6 | Learner will be able to analyze various applications of LPC parameter. |

UNIT I
Absolute Threshold of Hearing - Critical Bands-Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- Non simultaneous Masking - Perceptual Entropy Basic measuring philosophy -Subjective versus objective perceptual testing – The perceptual audio quality measure (PAQM) - Cognitive effects in judging audio quality.

UNIT II
UNIT III

UNIT IV

UNIT V

UNIT VI
Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis VELP – CELP.

Text Books/Reference:
ELECTIVE-IV
RADAR 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 working principle of basic RADAR. List RADAR terminologies. Derive the simple form of RADAR range equation.</td>
</tr>
<tr>
<td>B</td>
<td>To provide in-depth understanding of different types of RADAR and its performance parameters</td>
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Course Outcomes:

<table>
<thead>
<tr>
<th>CO</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Learner will be able to understand the history and application of radar system</td>
</tr>
<tr>
<td>CO2</td>
<td>Learner will be able to understand the signal models of radar system</td>
</tr>
<tr>
<td>CO3</td>
<td>Learner will be able to sample and quantize the signals in radar system</td>
</tr>
<tr>
<td>CO4</td>
<td>Learner will be able to analyze the different waveforms and match filters in radar system</td>
</tr>
<tr>
<td>CO5</td>
<td>Learner will be able to modify the radar system models by analyzing the Doppler frequency</td>
</tr>
<tr>
<td>CO6</td>
<td>Learner will be able to demonstrate the radar system and analyze the signal in noise</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:
ELECTIVE-IV
ELECTROMAGNETICS, ANTENNA AND PROROGATION

Weekly Teaching Hours
TH : 03 Tut: --

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

Course Objectives:

A
To provide in-depth understanding of the fundamental solutions of time-varying Maxwell's equations, and applies them to design antennas.

B
To provide in-depth understanding of radio wave propagation phenomena in modern communication systems, and fundamentals of electromagnetic radiation with application to antenna theory and design.

Course Outcomes:

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

UNIT I


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:
ELECTIVE V
INTERNET OF THINGS

Weekly Teaching Hours
TH : 03  Tu: --

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

Course Objectives:

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<tbody>
<tr>
<td>A</td>
<td>Students will be explored to the interconnection and integration of the physical world and the cyber space.</td>
</tr>
<tr>
<td>B</td>
<td>To provide ability to design and develop IOT devices.</td>
</tr>
</tbody>
</table>

Course Outcomes:

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<table>
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<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 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.

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:

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

Course Outcomes:

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

UNIT I
Fields Fq, R, C. Vector Spaces over a field, Fn, F[σ]=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.

Text Books/Reference:

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:

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

Course Outcomes:

<p>| | |</p>
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<tbody>
<tr>
<td>CO1</td>
<td>Learner will be able to understand concept of fuzzy logic.</td>
</tr>
<tr>
<td>CO2</td>
<td>Learner will be able to understand embedded digital signal processor, Embedded system design and development cycle, applications in digital camera</td>
</tr>
<tr>
<td>CO3</td>
<td>Learner will be able to understand embedded systems, characteristics, features and applications of an embedded system</td>
</tr>
<tr>
<td>CO4</td>
<td>Learner will be able to design and utilization of fuzzy logic controller for various industrial applications</td>
</tr>
<tr>
<td>CO5</td>
<td>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</td>
</tr>
</tbody>
</table>

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:**

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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>
</tr>
</tbody>
</table>

**Course Outcomes:**

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<tr>
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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:

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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:

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</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Learner will be able to understand 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 ImageCompression, 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
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 | TH: - | Practical: 04
Scheme of Marking | IA: 50 | PR/OR: 50 | Total: 100

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

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

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

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

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

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.