# Dr. Babasaheb Ambedkar Technological University

**Course Structure and Syllabus**

**For**

**M. Tech. (Communication Engineering)**

**Two Year (Four Semester) Course**

**(w.e.f. July 2017)**

**DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY,**

**Lonere-402103, Raigad (MS)**

## M.Tech. (Communication Engineering)

### Objectives

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

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

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

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

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

### Outcomes

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

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

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

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

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

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

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

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

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

# Dr. Babasaheb Ambedkar Technological University

**Teaching and Examination Scheme for**

**M.Tech. (Communication Engineering) w.e.f. July 2017**

| Sr. No. | Course Code | Name of the course | Hours/Week | | | Credit | Examination scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Theory | | IA | PR/OR | TOTAL |
| | | | L | P | T | | TH | Test | | | |
| **First Semester** | | | | | | | | | | | |
| 01 | MTCEC101 | Signal Theory | 03 | -- | 1 | 04 | 60 | 20 | 20 | -- | **100** |
| 02 | MTCEC102 | Antenna Theory and Design | 03 | -- | 1 | 04 | 60 | 20 | 20 | -- | **100** |
| 03 | MTCEC103 | Signal Processing Algorithms & Applications | 03 | -- | 1 | 04 | 60 | 20 | 20 | -- | **100** |
| 04 | MTCEE114 | Elective-I | 03 | -- | -- | 03 | 60 | 20 | 20 | -- | **100** |
| 05 | MTCEE125 | Elective-II | 03 | -- | -- | 03 | 60 | 20 | 20 | -- | **100** |
| 06 | MTCEC106 | Communication Skills | 02 | -- | -- | 02 | -- | -- | 25 | 25 | **50** |
| 07 | MTCEL107 | PG Lab-I* | -- | 03 | -- | 02 | -- | -- | 25 | 25 | **50** |
| | | **Total for Semester I** | **17** | **03** | **03** | **22** | **300** | **100** | **150** | **50** | **600** |
| **Second Semester** | | | | | | | | | | | |
| 01 | MTCEC201 | Advances in Wireless Networks | 03 | -- | 1 | 04 | 60 | 20 | 20 | -- | **100** |
| 02 | MTCEC202 | Fiber Optic Communication and Networks | 03 | -- | 1 | 04 | 60 | 20 | 20 | -- | **100** |
| 03 | MTCEE233 | Elective-III | 03 | -- | -- | 03 | 60 | 20 | 20 | -- | **100** |
| 04 | MTCEE244 | Elective- IV | 03 | -- | -- | 03 | 60 | 20 | 20 | -- | **100** |
| 05 | MTCEE255 | Elective-V- (Open to all) | 03 | -- | -- | 03 | 60 | 20 | 20 | -- | **100** |
| 06 | MTCES206 | Seminar-I | -- | 04 | -- | 02 | -- | -- | 50 | 50 | **100** |
| 07 | MTCEP207 | Mini-Project | -- | 04 | -- | 02 | -- | -- | 50 | 50 | **100** |
| | | **Total for Semester II** | **15** | **8** | **02** | **21** | **300** | **100** | **200** | **100** | **700** |
| **Third Semester** | | | | | | | | | | | |
| 1 | MTCEC301 | Project Management & Intellectual Property Rights (Self Study)# | -- | -- | -- | 02 | -- | -- | 50 | 50 | **100** |
| 2 | MTCEP302 | Project-I | -- | -- | -- | 10 | -- | -- | 50 | 50 | **100** |
| | | **Total for Semester III** | **--** | **--** | **-** | **12** | **--** | **--** | **100** | **100** | **200** |
| **Fourth Semester** | | | | | | | | | | | |
| 1 | MTCEP401 | Project-II | -- | -- | -- | 20 | -- | -- | 100 | 100 | **200** |
| | | **Total for Semester IV** | **--** | **--** | **--** | **20** | **--** | **--** | **100** | **100** | **200** |
| **GRAND TOTAL** | | | | | | | | | | | **1700** |

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

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

**Elective-I**

A. WDM Optical Networks
B. Electromagnetic Interference and Compatibility
C. Mobile Communication
D. Modern Satellite Communication
E. Information Theory and Coding

**Elective-II**

A. Coding for MIMO Communication
B. Multimedia Communication
C. High Performance Communication Network
D. Spectral Analysis of Signal
E. Digital Communication Receivers

**Elective-III**

A. Advanced Wireless Sensor Networks
B. Estimation and Detection Theory
C. Wireless Sensor Network Design
D. RF and Microwave Circuit Design
E. Microwave Integrated Circuits

**Elective-IV**

A. Advanced Biomedical Signal Processing
B. Digital Image Processing
C. Multirate Digital Signal Processing
D. Network and System Security
E. Smart Antennas

**Elective-V (Open)**

A. Internet of Things
B. Linear Algebra
C. RF MEMS
D. Research Methodology
E. Audio and Speech Processing

## SIGNAL THEORY

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

**Course Objectives:**

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

**Course Outcomes:**

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

**UNIT I**

**Probability**

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

**UNIT II**

**The Concept of a Random Variable**

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

**UNIT III**

**Functions of One Random Variable**

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

**UNIT IV**

**Two Random Variables**

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

**UNIT V**

**Sequences of Random variables**

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

**UNIT VI**

**Stochastic Processes**

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

**Text Books/Reference:**


1. Papoulis, S. Pillai, Probability, Random Variables and Stochastic Processes, Tata McGraw Hill
2. T Veerajan, Probability, Statistics and Random Processes
3. R.P.Singh, S.D. Sapre, Communication Systems,Analog &Digital
4. B.P.Lathi, Modern Digital and Anolog Communication Systems, Third Ed

## ANTENNA THEORY AND DESIGN

| | | | | |
|---|---|---|---|---|
| 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 antenna engineering parameters and terminology |
| B | To provide in depth understanding of basic concepts of electromagnetic wave radiation and reception |
| C | To develop the basic skills necessary for designing a wide variety of practical antennas and antenna arrays |

**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**

Antenna Fundamentals and Definitions: Radiation mechanism - over view, Electromagnetic Fundamentals, Solution of Maxwell's Equations for Radiation Problems, Ideal Dipole, Radiation Patterns, Directivity and Gain, Antenna Impedance, Radiation Efficiency. Antenna Polarization. Resonant Antennas: Wires and Patches, Dipole ntennas, Yagi - Uda Antennas, Micro strip Antenna.

**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**

Broad band Antennas: Traveling - wave antennas, Helical antennas, Biconical antennas, sleave antennas, and Principles of frequency - independent Antennas, spiral antennas, and Log - Periodic Antennas.

**UNIT IV**

Aperture Antennas: Techniques for evaluating Gain, reflector antennas - Parabolic reflector antenna principles, Axi -symmetric 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**

Antenna Synthesis: Formulation of the synthesis problem, synthesis principles, line sources shaped beam synthesis, linear array shaped beam synthesis — Fourier Series, Woodward — Lawson sampling method, comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods Dolph Chebyshev linear array, Taylor line source method.

**UNIT VI**

Method of Moments : Introduction to method of Moments, Pocklington's integral equation, integral equations and Kirchoff's Networking Equations, Source Modeling Weighted residuals formulations and computational consideration, calculation of antenna and scatter characteristics. CEM for Antennas : Finite Difference Time Domain Method Geometrical Optics Wedge diffraction theory, ray fixed coordinate system, uniform theory of wedge diffraction, E - Plane analysis of Horn antennas. Cylindrical parabolic antenna, radiation by a slot on a finite ground plane, radiation by a monopole on a finite ground plane, equivalent current concepts, multiple diffraction formulation, by curved surfaces, physical optics, method of stationary phase, Physical theory of diffraction, cylindrical parabolic reflector antennas.

**Text Books/Reference:**

1. Stutzman and Thiele, Antenna Theory and Design, 2ndEd, John Wiley and Sons Inc.
2. C. A. Balanis: Antenna Theory Analysis and Design, John Wiley, 2nd Edition, 1997
3. Kraus, Antennas, McGraw Hill, TMH, 3 Edition, 2003
4. Kraus and R.J. Marhefka:, Antennas, McGraw Hil1, 2nd Edition, 1998

## SIGNAL PROCESSING ALGORITHMS AND APPLICATIONS

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

**Course Objectives:**

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

**Course Outcomes:**

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

**UNIT I**

**Introduction**

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

**UNIT II**

**LTI DT System in Transform Domain and Digital Filter Structures**

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

**UNIT III**

**Design of Digital Filters**

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

**UNIT IV**

**Multirate Signal Processing**

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

**UNIT V**

**Signal Representation**

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

**UNIT VI**

**Linear Prediction and Optimum Filter Design**

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

**Text Books/Reference:**


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

## ELECTIVE I

## WDM OPTICAL NETWORKS

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

**Course Objectives:**

| | |
|---|---|
| A | To learn the various optical source materials, LED structures, quantum efficiency, Laser diodes |
| B | To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures |
| C | To learn the fiber optical network components, variety of networking aspects, FDDI, SONET/SDH and operational principles WDM |

**Course Outcomes:**

| | |
|---|---|
| CO1 | Learner will be able to interpret evolution of WDM network. |
| CO2 | Learner will be able to compare working of optical devices. |
| CO3 | Learner will be able to analyze WDM network. |
| CO4 | Learner will be able to relate switching in WDM networks. |
| CO5 | Learner will be able to distinguish different network architectures. |
| CO6 | Learner will be able to identify multicast and broadcast system. |

**UNIT I**

Advantages of optical network, telecom network overview and architecture, WDM optical networks, WDM network evolution, WDM network construction, broadcast and select optical WDM network, wavelength routed optical WDM network, Challenges of optical WDM network

**UNIT II**

Optical transmitters, semiconductor laser diode, tunable and fixed laser, laser characteristics, photodectors, tunable and fixed optical filters, channel equalizers, optical amplifiers and its characteristics, semiconductor laser amplifier, Raman amplifier, doped fiber amplifier, various switching elements, OADM, OXC, CLOS architecture, MEMS, wavelength convertors.

**UNIT III**

Introduction to metro network, overview of traffic grooming in SONET ring, traffic grooming in WDM ring, Interconnected WDM networks, packet communication using tunable WADM, RINGOSTAR: architecture, proxy stripping, protectoration and network lifetime.

**UNIT IV**

Optical packet switching basics, slotted and unslotted networks, header and packet format, contention resolution in OPS networks, self routing, examples on OPS node architecture,

optical burst switching, signaling and routing protocols for OBS networks, contention resolution in OPS networks, multicasting, implementation and application. MEMs based switching, switching with SOAs.

**UNIT V**

Introduction to access network, PON, EPON and WDN EPON: overview, principal of operation, architecture; dynamic wavelength allocation, STARGATE: overview, need, architecture, operation and application, gigabit Ethernet, radio over fiber network.

**UNIT VI**

Introduction to multicasting, Multicast-capable switch architecture, unicast, broadcast and multicast traffic, multicast tree protection, traffic grooming overview, static and dynamic traffic grooming.

**Text Books/Reference:**


1. Biswanath Mukherjee, Optical Network Series:, Springer, 2006.
2. R.Ramaswami and K.Sivarajan, Optical Networks, Â Morgan Kaufmann Publishers, 2nd ed., 2002.
3. Mayer & Martin, Optical Switching Networks, Cambridge University Press, 2008.

## ELECTIVE I

## ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

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

**Course Objectives:**

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

**Course Outcomes:**

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

### UNIT I

**Introduction to EMI / EMC:**

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

### UNIT II

**Measurement techniques in EMI:**

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

### UNIT III

**EMI reduction techniques:**

Grounding, Shielding, Bonding, and EMI filters.

### UNIT IV

**Probabilistic and Statistical Physical Model:**

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

**UNIT V**

**Computer Based Modeling and Simulation:**

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

**Unit VI**

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

**Text Books/Reference:**


1. V. Prasad Kodali, Engineering Electromagnetic Compatibility, Principles and Measurement Technologies; IEEE Press
2. Devid A. Weston, Marcol Dekker, Electromagnetic Compatibility, Principles and Applications;, Inc New York.
3. Dipak L. Sengupta, Valdis V. Liepa, Applied Electromagnetics And Electromagnetic C0mpatibility, A John Wiley & Sons, Inc. Publication

## 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 3Gcellular standards. Signal propagation: Propagation mechanism reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing.

### UNIT II

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


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

## ELECTIVE I

## MODERN SATELLITE COMMUNICATION

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

**Course Objectives:**

| | |
|---|---|
| A | To get in depth knowledge of communication through satellite, to obtain appropriate background in satellite technology, link design, operation and to understand digital communication technologies used in satellite communications such as modulation techniques, multiple access, error correction, and voice coding. |
| B | To train the students on satellite communication systems, in Multiple access and error correction techniques. |

**Course Outcomes:**

| | |
|---|---|
| CO1 | Learner will be able to get familiar with emerging trends in satellite communication. |
| CO2 | Learner will be able to understand satellite constellations. |
| CO3 | Learner will be able to analyze radio link for satellite communication. |
| CO4 | Learner will be able to extend their knowledge about various systems in satellite. |
| CO5 | Learner will be able to understand working of various satellite services. |
| CO6 | Learner will be able to identify different satellite systems |

### UNIT I

Emerging Trends in communication Satellites: Geosynchronous spacecraft design, station keeping techniques, ground station design, orbital overcrowding and its proposed solutions,

Evolution of satellite based Mobile telecommunications: Terrestrial systems, satellite systems.

### UNIT II

Satellite constellations: Selecting proper constellation architectures, Mobile communication satellites at Geosynchronous, Low altitude voice messaging systems, Medium altitude constellations.

### UNIT III

Radio Link in Satellite communication: spectrum issues, propagation, characteristics, radio link analysis, modulation, coding

### UNIT IV

Multi Access and communicators: Gateways, mobile terminals, environmental issues, next generation technology.

**UNIT V**

Space borne Land Mobile communication Systems: The critical importance of digital data relay, geostar's geosynchronous messaging services, Omni TRAC's Mobile communication services, satellite based paging services.

**UNIT VI**

Related Satellite systems: Distress and safety systems, Navigation systems, Direct satellite sound Broadcast, Direct Television Broadcast systems, Very small aperture Terminal systems, Terrestrial cellular systems, Satellite Mobile communication Networks Beyond UMTS.

**Text Books/Reference:**


1. Dennis Roddy, Satellite Communication, McGraw Hill International, 4th Edition, 2006.
2. Wilbur L. Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, Satellite Communication Systems Engineering, Prentice Hall/Pearson, 2007.
3. N.Agarwal, Design of Geosynchronous Space Craft, Prentice Hall, 1986.
4. Bruce R. Elbert, The Satellite Communication Applications Hand Book, Artech HouseBostan London, 1997.
5. Tri T. Ha, Digital Satellite Communication, II edition, 1990.
6. Emanuel Fthenakis, Manual of Satellite Communications, McGraw Hill Book Co., 1984.
7. Robert G. Winch, Telecommunication Trans Mission Systems, McGraw-Hill Book Co., 1983.
8. Brian Ackroyd, World Satellite Communication and earth station Design, BSP professional Books, 1990.
9. G. B. Bleazard, Introducing Satellite communications, NCC Publication, 1985.
10. M. Richharia, Satellite Communication Systems-Design Principles, Macmillan 2003

## ELECTIVE I

## INFORMATION THEORY AND CODING

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

**Course Outcomes:**

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

### UNIT I

**Theory of Probability and Random Processes**

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

### UNIT II

**Random Processes**

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

**UNIT III**

**Noise in Communication Systems**

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

**UNIT IV**

**Information Theory**

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

**UNIT V**

**Error Correcting Codes**

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

**UNIT VI**

**Speech Coding**

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

**Text Books/Reference:**


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

## ELECTIVE II

## CODING FOR MIMO COMMUNICATION

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

**Course Objective:**

| | |
|---|---|
| A | To learn about basic MIMO communication systems, Space-time block codes, Space-time trellis codes, MIMO systems for frequency-selective (FS) fading channels, Turbo codes and iterative decoding for MIMO systems |

**Course Outcomes:**

| | |
|---|---|
| CO1 | Learner will be able to interpret the wireless channels. |
| CO2 | Learner will be able to apply techniques to improve channel capacity. |
| CO3 | Learner will be able to relate same time block. |
| CO4 | Learner will be able to apply concatenated codes and iterative decoding |
| CO5 | Learner will be able to implement space-time coding for frequency selective fading channels |
| CO6 | Learner will be able to apply the methods for performance analysis and design of advanced wireless communication systems |

### UNIT I

**FADING CHANNELS AND DIVERSITY TECHNIQUES**

Wireless channels – Error/Outage probability over fading channels – Diversity techniques – Channel coding as a means of time diversity – Multiple antennas in wireless communications.

### UNIT II

**CAPACITY AND INFORMATION RATES OF MIMO CHANNELS**

Capacity and Information rates of noisy, AWGN and fading channels – Capacity of MIMO channels– Capacity of non-coherent MIMO channels – Constrained signaling for MIMO communications.

### UNIT III

**SPACE-TIME BLOCK**

Transmit diversity with two antennas: The Alamouti scheme – Orthogonal and Quasi-orthogonal space-time block codes – Linear dispersion codes .

### UNIT IV

**TRELLIS CODES**

Generic space-time trellis codes – Basic spacetime code design principles – Representation of space-time trellis codes for PSK constellation –Performance analysis for space-time trellis codes – Comparison of space-time block and trellis codes.

**UNIT V**

**CONCATENATED CODES AND ITERATIVE DECODING**

Development of concatenated codes – Concatenated codes for AWGN and MIMO channels – Turbo coded modulation for MIMO channels – Concatenated space-time block coding.

**UNIT VI**

**SPACE-TIME CODING FOR FREQUENCY SELECTIVE FADING CHANNELS**

MIMO frequency-selective channels – Capacity and Information rates of MIMO FS fading channels – Space-time coding and Channel detection for MIMO FS channels – MIMO OFDM systems.

**Text Books/Reference:**


1. Tolga M. Duman and Ali Ghrayeb, Coding for MIMO Communication systems, John Wiley & Sons, West Sussex, England, 2007.
2. A. B. Gershman and N.D. Sidiropoulus, Space-time processing for MIMO communications, Wiley, Hoboken, NJ, USA, 2005.
3. E. G. Larsson and P. Stoica, Space-time block coding for Wireless communications, Cambridge University Press, 2003.
4. M. Janakiraman, Space-time codes and MIMO systems, Artech House, 2004.
5. H. Jafarkhani, Space-time coding: Theory & Practice, Cambridge University Press, 2005.

## ELECTIVE II

## MULTIMEDIA COMMUNICATION

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

**Course Objectives:**

| | |
|---|---|
| A | To understand the multimedia communications systems, application and basic principles |
| B | To provide in-depth understanding for multimedia communication standards and compression techniques |
| C | To provide in-depth understanding for representation of image, video. |
| D | To understand the basics of analog and digital video: video representation and transmission and perform the analysis of the multimedia streaming, |

**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 format, animations Images standards, JPEG Compression, Zig Zag Coding, Multimedia Database, Content based retrieval for text and images, Video: 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.

**Unit VI**

Multimedia Operating Systems: Process Management, Inter-process Communication and Synchronization, Memory Management, Device Management, System Architecture.

**Text Books/Reference:**

1. Tay Vaughan, "Multimedia, Making IT Work", McGraw Hill.
2. John F. Koegel Buford, "Multimedia Systems", Addison Wesley.
3. Mark Nelson, "Data Compression Hand Book", BPB Publication.
4. Steinmetz, Ralf, Nahrstedt, Klara, "Multimedia System", Springer Publications.

## ELECTIVE II

## HIGH PERFOMANCE COMMUNICATION NETWORKS

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

**Course Objectives:**

| | |
|---|---|
| A | To understand the different terminologies of the broadband communication. |
| B | To study the different switching techniques used in the broadband communication system. |
| c | To understand the different concepts of the ATM and the optical communications. |

**Course Outcomes:**

| | |
|---|---|
| CO1 | Learner will be able to describe the architecture of the Internet. |
| CO2 | Learner will be able to differentiate the different switching techniques and its applications. |
| CO3 | Learner will be able to explain the different functionalities of the ATM network. |

**UNIT I**

Packet switched networks: OSI & IP models – Ethernet (IEEE 802.3) – Token Ring (IEEE 802.5) Wireless LAN (IEEE 802.11), FDDI-DQDB-SMDS: Internetworking with SMDS

**UNIT II**

ISDN and broadband ISDN: Interfaces and functions- Layers and Services – Signaling System 7- Broadband ISDN architecture and protocols.

**UNIT III**

ATM and frame relay: Main features, addressing, signaling & routing, ATM header structure adaptation layer management & control ATM switching & transmission. Frame relay Protocols & services, congestion control, internetworking with ATM, Internet and ATM Frame relay via ATM

**UNIT IV**

Optical networks: Optical Links, WDM system, Optical cross-connects, Optical LANs, Optical paths and networks

**UNIT V**

Bluetooth technology: Overview, protocol stack, link manager, Host controller interface, Service discovery protocol, WAP Applications, encryption and security, QoS.

**UNIT VI**

Advanced network architecture: IP forwarding architectures overlay model: Multi-protocol Label switching (MPLS) – integrated services in the Internet – Resource Reservation Protocol (RSVP): Differentiated services, Application Layer Protocols: FTP – File access and transfer, online shared access, sharing by file transfer, The Major view of FTP TFTP, SMTP, and HTTP.

**Text Books/Reference:**

1. Jean Walrand, PravinVaraiya , High performance communication networks,2nd edition, Morgan Kaufmann Publication
2. William Stallings, ISDN and Broadband ISDN with Frame Relay and ATM, 4th Edition, Pearson Education.
3. Jennifer Bray and Charles Sturman, Bluetooth connect without cables, Pearson education Asia, LPE.
4. Leon Gracia, IndraWidjaja, Communication Networks-Fundamental concepts and Key architectures, McGraw Hill Companies.
5. Douglas Comer , Internetworking with TCP/IP – Principles, Protocols and Archtecture, 5th Edition , PHI Learning.
6. Behrouz Forouzan , Data Communications and Networking, 4th Edition , McFraw Hill.

## ELECTIVE II

## SPECTRAL ANALYSIS OF SIGNAL

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

**Course Objective:**

| | |
|---|---|
| A | To review classical and modern methods and algorithms for computer-based spectral analysis of signals. Also, it gives an overview of various applications in communications, systems engineering, radar, and biomedicine. |
| B | To master several non-parametric methods for spectral estimation, both periodogram and correlogram-based methods as well as data adaptive filter-bank methods, and be able to use this knowledge to solve real-world problems. |

**Course Outcomes:**

| | |
|---|---|
| CO1 | Learner will be able to understand the spectral estimation problem and the meaning of spectrum. |
| CO2 | Learner will be able to understand the differences between non-parametric and parametric approaches to the spectral estimation problem. |
| CO3 | Learner will be able to apply various estimators. |
| CO4 | Learner will be able to interpret various filtering techniques. |
| CO5 | Learner will be able to Principle and Application LMS Algorithm. |
| CO6 | Learner will be able to be prepared to use the tools of spectral analysis of signals for solving practical problems in a diversity of area |

**UNIT I**

Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Schwarz Inequality Orthogonal principle in estimation, Central Limit theorem, Random processes, wide-sense stationary processes, autocorrelation and auto covariance functions

**UNIT II**

Spectral representation of random signals, Wiener Khinchin theorem Properties of power spectral density, Gaussian Process and White noise process, Linear System with random input, Spectral factorization theorem and its importance, innovation process and whitening filter, .Random signal modelling: MA(q), AR(p) , ARMA(p,q) models.

**UNIT III**

Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Cramer Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties ;

Baysean estimation : Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation.

**UNIT IV**

Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter, Noncausal IIR Wiener filter, Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters.

**UNIT V**

Principle and Application, Steepest Descent Algorithm Convergence characteristics; LMS algorithm, convergence, excess mean square error, Leaky LMS algorithm; Application of Adaptive filters ;RLS algorithm, derivation, Matrix inversion Lemma, Initialization, tracking of nonstationarity.

**UNIT VI**

State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Prametric method, AR(p) spectral estimation and detection of Harmonic signals, MUSIC algorithm

**Text Books/Reference:**


1. M. Hays: Statistical Digital Signal Processing and Modelling, John Willey and Sons, 1996.
2. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan: Statistical Signal Processing with Applications, PHI, 1996.
3. Simon Haykin: Adaptive Filter Theory, Prentice Hall, 1996.
4. D.G. Manolakis, V.K. Ingle and S.M. Kogon: Statistical and Adaptive Signal Processing, McGraw Hill, 2000.
5. S. M. Kay: Modern Spectral Estimation, Prentice Hall, 1987

## ELECTIVE II

## DIGITAL COMMUNICATION RECEIVERS

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

**Course Objective:**

| | |
|---|---|
| A | To review classical and modern methods and algorithms for digital communication receivers. |

**Course Outcomes:**

| | |
|---|---|
| CO1 | Learner will be able to understand various modulation techniques used in digital communication. |
| CO2 | Learner will be able to interpret various digital communication components. |
| CO3 | Learner will be able to perform Characterization of fading multiple channels |
| CO4 | Learner will be able to apply Carrier and signal synchronization |
| CO5 | Learner will be able to differentiate various algorithms in digital communication. |
| CO6 | Learner will be able to familiar with optimal receivers. |

**UNIT I**

Base band communication; signal space representation, linear and nonlinear modulation techniques, Error tracking and Spectral characteristics of digital modulation.

**UNIT II**

Correlation demodulator, matched filter , maximum likelihood sequence detector,optimum receiver for CPM signals, M-ary orthogonal signals, envelope detectors for Maryand correlated binary signals.

**UNIT III**

Characterization of fading multiple channels, statistical models, flat and frequency selective fading, diversity technique, coded waveform for fading channel.

**UNIT IV**

Carrier and signal synchronization, carrier phase estimation-PLL, Decision directedloops, symbol timing estimation, maximum likelihood and non-decision directed timing estimation, joint estimation.

**UNIT V**

Zero forcing algorithm, LMS algorithm, adaptive decision-feedback equalizer and Equalization of Trellis-coded signals. Kalman algorithm, blind equalizers and stochastic gradient algorithm.

**UNIT VI**

Optimal receivers for data detection and synchronization parameter estimation

**Text Books/Reference:**


1. Heinrich Meyer, Mare Moeneclacy, Stefan.A.Fechtel, " Digital communication receivers ", Vol I & Vol II, John Wiley, New York, 1997.
2. U.Mengali & A.N.D'Andrea, Synchronization Techniques for Digital Receivers, Kluwer, 1997.
3. John.G.Proakis, "Digital communication "4th Edition, McGraw-Hill, New York, 2001.
4. E.A.Lee and D.G. Messerschmitt, "Digital communication ", 2nd Edition, Allied Publishers, New Delhi, 1994.
5. Simon Marvin, "Digital communication over fading channel; An unified approach to performance Analysis ", John Wiley, New York, 2000.
6. H.Meyr & G.Ascheid, Synchronization in Digital Communications, John Wiley, 1990.
7. R. G. Gallager, Principles of Digital Communication, Cambridge University Press, 2008

## COMMUNICATION SKILLS

| | | | | | |
|---|---|---|---|---|---|
| Weekly Teaching Hours | TH : 02 | Tut: -- | | | |
| Scheme of Marking | TH : -- | Tests :-- | 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 organise and express ideas in writing and speaking to produce messages suitably tailored for the topic, objective, audience, communication medium and context |
| CO4 | Learner will be able to demonstrate clarity, precision, conciseness and coherence in your use of language |
| CO5 | Learner will be able to become more effective confident speakers and deliver persuasive presentations |

**UNIT I**

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

**UNIT II**

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

**UNIT III**

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

**UNIT IV**

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

**UNIT V**

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

**UNIT VI**

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

Leadership & Team Dynamics

**Text Books/Reference:**


1. Mitra, Barun, Personality Development and Soft Skills, Oxford University Press, 2016.
2. Ramesh, Gopalswamy, The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education, 2013.
3. Covey, Stephen R., Seven Habits of Highly Effective People: Powerful Lessons in Personal Change, Simon and Schuster, 09-Nov-2004
4. Rosenberg Marshall B., Nonviolent Communication: A Language of Life, PuddleDancer Press, 01-Sep-2003

**PG Lab-I**

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

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

## ADVANCES IN WIRELESS NETWORKS

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

**Course Objectives:**

| | |
|---|---|
| A | To study the different generations of mobile networks, WAN and PAN. |
| B | To understand the concepts of basic cellular system, frequency reuse, channel assignment strategies, handoff strategies, interference. |
| C | To understand the FDMA, TDMA, spread spectrum multiple access. |
| D | To study the Wireless Networking: Difference between wireless and fixed telephone networks, development of wireless networks. |

**Course Outcomes:**

| | |
|---|---|
| CO1 | Learner will be able to understand the second generation cellular networks, third generation wireless networks, wireless in local loop, wireless local area networks, Bluetooth and personal area networks. |
| CO2 | Learner will be able to apply various multiple accesses techniques: FDMA, TDMA, spread spectrum multiple access, SDMA. |
| CO3 | Learner will be able to infer the communication in the infrastructure , iIS-95 CDMA forward channel, IS-95 CDMA risers channel, packet and frame formats in IS-95,IMT -20000, forward channel in W-CDMA. |
| CO4 | Learner will be able to interpret MIMO stsyem. |
| CO5 | Learner will be able to get familiar with concept of UWB. |
| CO6 | Learner will be able to extend their knowledge about advance generations of mobile networks. |

**UNIT I**

**Wireless Communications and Diversity**

Fast Fading Wireless Channel Modeling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Diversity modeling for Wireless Communications, BER Performance Improvement with diversity,Types of Diversity – Frequency, Time, Space

**UNIT II**

**Cellular Communications**

Introduction to Cellular Communications, Frequency reuse, Multiple Access Technologies, Cellular Processes , Call Setup, Handover etc., Teletraffic Theory

**UNIT III**

**CDMA and OFDM**

Introduction to CDMA, Walsh codes, Variable tree OVSF, PN Sequences, Multipath diversity, RAKE Receiver, CDMA Receiver Synchronization

Introduction to OFDM, Multicarrier Modulation and Cyclic Prefix, Channel model and SNR performance, OFDM Issues – PAPR, Frequency and Timing Offset Issues

**UNIT IV**

**MIMO**

Introduction to MIMO, MIMO Channel Capacity, SVD and Eigenmodes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST, MIMO Diversity – Alamouti, OSTBC, MRT, MIMO-OFDM

**UNIT V**

**UWB (Ultrawide Band)**

UWB Definition and Features, UWB Wireless Channels, UWB Data Modulation, Uniform Pulse Train, Bit-Error Rate Performance of UWB

**UNIT VI**

**3G and 4G Wireless Standards**

GSM, GPRS, WCDMA, LTE,WiMAX

**Text Books/Reference:**


1. David Tse and Pramod Viswanath, Fundamentals of Wireless Communications, Publisher Cambridge University Press.
2. Andrea Goldsmith, Wireless Communications:, Cambridge University Press.
3. Theodore Rappaport, Wireless Communications: Principles and Practice, Prentice Hall.
4. Ezio Biglieri, MIMO Wireless Communications, Cambridge University Press

## FIBER OPTICS COMMUNICATION AND NETWORKS

| | | | | |
|---|---|---|---|---|
| Weekly Teaching Hours | TH : 03 | Tut: 01 | | |
| 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**

Overview of optical fiber communications, Optical transmitter components--lasers and optical modulators, General digital communication system, Line coding and Pulse shaping, Signal space representation

**UNIT II**

Digital modulation formats: ASK, PSK, and QAM,, Matlab models, Optical implementation, Matlab models

**UNIT III**

Optical receivers I: Photodetectors and its performance characteristics, noise in photo detection, common types of photodetectors.

**UNIT IV**

Optical receivers II: Direct detection, self-homodyne (differential) detection, and coherent detection, Sensitivity, Impact of noise

**UNIT V**

Lasers, rate equations, RIN and phase noise, Optical amplifiers: EDFA and SOA, ASE, system impact

**UNIT VI**

Optical fiber modes, single and multi-mode fibers, single and multi-core fibers, attenuation and dispersion

**Text Books/Reference:**


1. David Tse and Pramod Viswanath, Fundamentals of Wireless Communications, Publisher - Cambridge University Press.
2. Andrea Goldsmith, Wireless Communications, Cambridge University Press

## ELCTIVE III

## ADVANCED WIRELESS SENSOR NETWORKS

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

**Course Objectives:**

| | |
|---|---|
| A | The course provides a broad coverage of challenges and latest research results related to the design & management of wireless sensor networks & understanding of network architectures, node discovery & localization, deployment strategies, node coverage, routing protocols, medium access arbitration, fault-tolerance. |

**Outcome**

| | |
|---|---|
| CO1 | Learner will be able to recognize and classify the applications of sensor network |
| CO2 | Learner will be able to interpret design constraints and architecture of the network |
| CO3 | Learner will be able to visualize different protocols for WSN |
| CO4 | Learner will have knowledge of data compression and aggregation technology |
| CO5 | Learner will be able to apply WSN for various practical applications |

**Unit I**

Introduction: Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc NETworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks

**Unit II**

Sensor Node Hardware and Network Architecture: Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC, Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.

**Unit III**

Deployment and Configuration: Localization and positioning, Coverage and connectivity, Single-hop and multihop localization, self-configuring localization systems, sensor management

**Unit IV**

Network Protocols: Issues in designing MAC protocol for WSNs, Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and Zig Bee, Dissemination protocol for large sensor network.

Routing protocols: Issues in designing routing protocols, Classification of routing protocols, Energy-efficient routing, Unicast, Broadcast and multicast, Geographic routing.

**Unit V**

Data Storage and Manipulation: Data centric and content based routing, storage and retrieval in network, compression technologies for WSN, Data aggregation technique.

**Unit VI**

Applications: Detecting unauthorized activity using a sensor network, WSN for Habitat Monitoring.

**Text Books/Reference:**

1. Holger Kerl, Andreas Willig, Protocols and Architectures for Wireless Sensor Network, John Wiley and Sons, 2005 (ISBN: 978-0-470-09511-9)

2. Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, Wireless Sensor Network, Springer 1st Ed. 2004 (ISBN: 978-4020-7883-5).

3. Feng Zhao, Leonidas Guibas, Wireless Sensor Network",Elsevier, 1st Ed. 2004 (ISBN: 13-978-1-55860-914-3)

4. Kazem, Sohraby, Daniel Minoli, Taieb Zanti, Wireless Sensor Network: Technology, Protocols and Application, John Wiley and Sons 1st Ed., 2007 (ISBN: 978-0-471-74300-2).

5. B. Krishnamachari, Networking Wireless Sensors", Cambridge University Press.

6. N. P. Mahalik, Sensor Networks and Configuration: Fundamentals, Standards, Platforms, and Applications Springer Verlag.

## ELCTIVE III

## ESTIMATION AND DETECTION THEORY

| | | | | |
|---|---|---|---|---|
| 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 basics of detection and estimation theory. |
| B | To be able to design and analyze optimum detection schemes |

**Course Outcomes:**

| | |
|---|---|
| CO1 | Learner will have basic knowledge of linear algebra |
| CO2 | Learner will be able to acquire basics of statistical decision theory used for signal detection and estimation. |
| CO3 | Learner will be able to understand the detection of deterministic and random signals using statistical models. |
| CO4 | Learner will be able to understand 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 ofdecision and estimation problems.MaximumLikelihood decision criterian, Neyman-person criterian, Probability of error criterian, Bays risk criterian, Min-Max criterian, problems

**UINT III**

**Binary Decision: Multiple Observations**

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

**UNIT IV**

**Multiple Decision: Multiple Decision**

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

**UNIT V**

**Composite And Nonparametric Decision Theory**

Composite decisions Sign test, Wilason test, problems

**UNIT VI**

**Fumdamentals of Estimation**

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

**Text Books /Reference:**


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

## 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:**

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

**Course Outcomes:**

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

### UNIT I

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

### UNIT II

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

### UNIT III

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

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

### UNIT IV

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

**UNIT V**

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

**UNIT VI**

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

**Text Books/Reference:**


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

## ELCTIVE III

## 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**

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

**UNIT V**

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

**UNIT VI**

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

**Text Books/Reference:**


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

## ELCTIVE III

## MICROWAVE INTEGRATED CIRCUITS

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

**Course Objectives:**

| | |
|---|---|
| A | Design of microwave amplifiers including low-noise amplifiers, multiple stage amplifiers, power amplifiers, and introduction to broadband amplifiers. |
| B | The goal is to provide the basic knowledge for the design of microwave amplifiers ranging from wireless system to radar system. |

**Course Outcomes:**

| | |
|---|---|
| CO1 | Learner will be able to understand the concept of distributed circuits versus lumped circuits. |
| CO2 | Learner will be able to Design matching circuits using lumped or discrete components working on the Smith chart |
| CO3 | Learner will be able to Use microstrip lines to design matching circuits |
| CO4 | Learner will be able to Design microwave amplifiers for a desired gain, based on the small signal scattering parameters of the active device for specific configuration and bias condition |
| CO5 | Learner will be able to Perform tradeoff between amplifiers parameters such as noise figure, VSWR gain and stability to meet the desired amplifiers specifications |
| CO6 | Learner will be able to Understand design limitations and validity of design technique |

### UNIT I

Frequency Bands – Lumped versus Distributed Circuits - Behavior of finite length transmission lines – General Characteristics of PC Boards – Transmission Lines on PC Boards – Passives made from Transmission Lines – Resonators - Combiners, Splitters and Couplers

### UNIT II

Circuit Representation of two port RF/Microwave Networks: Low Frequency Parameters, High Frequency Parameters, Transmission Matrix, ZY Smith Chart, Design of Matching Circuits using Lumped Elements, Matching Network Design using Distributed Elements,Filter design.

### UNIT III

Stability considerations in active networks – Gain Consideration in Amplifiers – Noise Consideration in active networks – Broadband Amplifier design – Low Noise Amplifier Design,

**UNIT IV**

Osclillator versus Amplifier Design – Oscillation conditions – Design and stability considerations of Microwave Transistor Oscillators.

**UNIT V**

Mixer Types – Conversion Loss – SSB and DSB Mixers – Design of Mixers: Single Ended Mixers – Single Balanced Mixers - Sub Harmonic Diode Mixers,Microwave Diodes, Phase Shifters – PIN Diode Attenuators

**UNIT VI**

Microwave Integrated Circuits – MIC Materials- Hybrid versus Monolithic MICs – Multichip Module Technology - Fabrication Techniques, Miniaturization techniques, Introduction to SOC, SOP, Test fixture measurements, probe station measurements, thermal and cryogenic measurements, experimental field probing techniques.

**Text Books/Reference:**


1. Thomas H.Lee, Planar Microwave Engineering‖, Cambridge University Press, 2004
2. Matthew M. Radmanesh, Radio Frequency and Microwave Electronics‖, Pearson Education, II Edision 2002
3. Guillermo Gonzalez, Microwave Transistor Amplifiers – Analysis and Design‖, II Edition, Prentice Hall, 1996.
4. Ravender Goyal, Monolithic MIC; Technology & Design‖, Artech House, 1989.
5. Gupta K.C. and Amarjit Singh, Microwave Integrated Circuits‖, John Wiley, New York, 1975.
6. Hoffman R.K. Handbook of Microwave Integrated Circuits‖, Artech House, Boston, 1987.
7. Ulrich L. Rohde and David P.N., RF / Microwave Circuit Design for Wireless Applications‖, John Wiley, 2000.
8. C. Gentili, Microwave Amplifiers and Oscillators‖, North Oxford Academic, 1986.
9. Samuel. Y. Liao, Microwave Circuit Analysis and Amplifier Design‖, Prentice Hall. Inc., 1987.

## ELECTIVE-IV

## ADVANCED BIOMEDICAL SIGNAL PROCESSING

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

**Course Objectives:**

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

**Course Outcomes:**

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

### UNIT I

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

### UNIT II

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

**UNIT III**

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

**UNIT IV**

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

**UNIT V**

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

**UNIT VI**

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

**Text Book /Reference:**


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

## ELECTIVE IV

## DIGITAL IMAGE 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 for fundamental concepts of Digital Image Processing. |
| B | To provide in-depth understanding for image analysis algorithms. |
| C | To provide exposure to current applications in the field of digital image processing. |

**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**

Steps in image processing, Human Visual System, Sampling & quantization, Representing digital images, Spatial & gray-level resolution, Image file formats, Basic relationships between pixels, Distance Measures. Basic operations on images-image addition, subtraction, logical operations, scaling, translation, rotation. Image Histogram. Color fundamentals & models – RGB, HSI YIQ.

**UNIT II**

**Image Enhancement and Restoration**

Spatial domain enhancement: Point operations-Log transformation, Power-law transformation, Piecewise linear transformations, Histogram equalization. Filtering operations- Image smoothing, Image sharpening. Frequency domain enhancement: 2D DFT, Smoothing and Sharpening in frequency domain. Homomorphic filtering. Restoration: Noise models, Restoration using Inverse filtering and Wiener filtering.

**UNIT III**

**Image Compression**

Types of redundancy, Fidelity criteria, Lossless compression – Runlength coding, Huffman coding, Bit-plane coding, Arithmetic coding. Introduction to DCT, Wavelet transform. Lossy compression – DCT based compression, Wavelet based compression. Image and Video Compression Standards – JPEG, MPEG.

**UNIT IV**

**Image Segmentation and Morphological Operations**

Image Segmentation: Point Detections, Line detection, Edge Detection-First order derivative – Prewitt and Sobel. Second order derivative – LoG, DoG, Canny. Edge linking, Hough Transform, Thresholding – Global, Adaptive. Otsu's Method. Region Growing, Region Splitting and Merging. Morphological Operations: Dilation, Erosion, Opening, Closing, Hit-or-Miss transform, Boundary Detection, Thinning, Thickening, Skeleton.

**UNIT V**

**Representation and Description**

Representation – Chain codes, Polygonal approximation, Signatures. Boundary Descriptors – Shape numbers, Fourier Descriptors, Statistical moments. Regional Descriptors – Topological, Texture, Principal Components for 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:**


1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Third Edition, - Pearson Education.
2. S Sridhar, Digital Image Processing, Oxford University Press.
3. Rafael C. Gonzalez, Richard E. Woods, and Steven L. Eddins, Digital Image Processing Using MATLAB, Second Edition, - Tata McGraw Hill Publication.
4. S Jayaraman, S Esakkirajan, T Veerakumar, Digital Image Processing, Tata Mc Graw Hill Publication.

## ELECTIVE IV

## MULTIRATE DIGITAL SIGNAL PROCESSING

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

**Course Objectives:**

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

**Course Outcomes:**

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

### UNIT I

**Fundamentals of Multirate Systems**

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

### UNIT II

**Maximally Decimaled Filter Banks**

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

### UNIT III

**Paranitary Perfect Reconstruction Filter Banks**

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

**UNIT IV**

**Linear Phase and Cosine Modulated Filter Banks**

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

**UNIT V**

**The Wavelet Transform and its Relation to Multirate Filter Banks**

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

**UNIT VI**

**Multidimensional, Multivariable and Lossless Systems**

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

**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

## ELECTIVE IV

## NETWORK SECURITY AND CRYPTOGRAPHY

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

**Course Objective:**

| | |
|---|---|
| A | To provide students with concepts of computer security, cryptography, digital money, secure protocols, detection and other security techniques. |

**Course Outcomes:**

| | |
|---|---|
| CO1 | Learner will acquire knowledge of various data hiding techniques |
| CO2 | Learner will be able identify malicious/harmful programs and concept of firewall |
| CO3 | Learner will be able to express OSI layer and protocols and IP security |
| CO4 | Learner will be able to interpret authentication applications |
| CO5 | Learner will be able to relate security protocols to wireless networks |

### UNIT I

**Introduction:** Attacks, Services and Mechanisms, Security attacks, Security services, A Model for Internetwork security.Classical Techniques: Conventional Encryption model, Steganography, Classical Encryption Techniques.

### UNIT II

**Modern Techniques:** Simplified DES, Block Cipher Principles, Data Encryption standard, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and Modes of operations.

**Algorithms:** Triple DES, International Data Encryption algorithm, Blowfish, RC5, CAST-128, RC2, Characteristics of Advanced Symmetric block cifers.

**Conventional Encryption:** Placement of Encryption function, Traffic confidentiality, Key distribution, Random Number Generation.

**Public Key Cryptography:** Principles, RSA Algorithm, Key Management, Diffie-Hellman Key exchange, Elliptic Curve Cryptography.

### UNIT III

**Number Theory:** Prime and Relatively prime numbers, Modular arithmetic, Fermat's and Euler's theorems, Testing for primality, Euclid's Algorithm, the Chinese remainder theorem, Discrete logarithms.

**Message authentication and Hash Functions:** Authentication requirements and functions, Message Authentication, Hash functions, Security of Hash functions and MACs.

**UNIT IV**

**Hash and Mac Algorithms**: MD File, Message digest Algorithm, Secure Hash Algorithm, RIPEMD-160, HMAC.

**Digital signatures and Authentication Protocols:** Digital signatures, Authentication Protocols, Digital signature standards.

**Authentication Applications:** Kerberos, X.509 directory Authentication service.

**Electronic Mail Security:** Pretty Good Privacy, S/MIME.

**UNIT V**

**IP Security:** Overview, Architecture, Authentication, Encapsulating Security Payload, Combining security Associations, Key Management**.**

**Web Security:** Web Security requirements, Secure sockets layer and Transport layer security, Secure Electronic Transaction.

**UNIT VI**

**Intruders, Viruses and Worms:** Intruders, Viruses and Related threats.

**Fire Walls:** Fire wall Design Principles, Trusted systems.

**Text Books/Reference:**


1. William Stallings, Cryptography and Network Security: Principles and Practice -, 2000, PE.
2. Mark Burgess, John Wiely, Principles of Network and Systems Administration,

## ELECTIVE IV

## SMART ANTENNAS

| | | | | |
|---|---|---|---|---|
| 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 modern antenna concepts, and practical antenna design for various applications |
| B | To provide in-depth understanding of of smart antenna concept with a view that the student can further explore the topic for research purpose. |

**Course Outcomes:**

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

**UNIT I:**

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

**UNIT II:**

Switched-Beam Antennas, Adaptive Antenna Approach, Space Division Multiple Access (SDMA), Architecture of a Smart Antenna System, Receiver, Transmitter, Benefits and Drawbacks, Mutual Coupling Effects, DOA Estimation Fundamentals, Introduction to Array Response Vector, Received Signal Model, The Subspace Based Data Model, Signal Auto-covariance Matrices.

**UNIT III:**

Conventional DOA Estimation Methods: Conventional Beam forming Method, Capon's Minimum Variance Method, Subspace Approach to DOA Estimation, The MUSIC Algorithm, The ESPRIT, Algorithm, Uniqueness of DOA Estimates,

**UNIT IV:**

Beam forming Fundamentals, The Classical Beam former-Statistically Optimum Beam forming Weight Vectors, The Maximum SNR Beam former, The Multiple Side lobe Canceller and the Maximum, SINR Beam former- Minimum Mean Square Error (MMSE),.

**UNIT V:**

Direct Matrix Inversion, (DMI), Linearly Constrained Minimum Variance (LCMV), Adaptive Algorithms for Beam forming, The Least Mean Square (LMS) Algorithm, The Recursive Least Squares (RLS) Algorithm, Space–Time Processing: Introduction, Discrete Space–Time Channel and Signal Models, Space–Time, Beam forming, Inter symbol and Co-Channel Suppression, ISI Suppression, CCI, Suppression,

**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:**


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

## ELECTIVE V

## INTERNET OF THINGS

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

**Course Objectives:**

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

**Course Outcomes:**

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

**UNIT I**

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

**UNIT II**

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

**UNIT III**

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

**UNIT IV**

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

**UNIT V**

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

**UNIT VI**

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

**Text Books/Reference:**


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

## ELECTIVE V

## LINEAR ALGEBRA

Weekly Teaching Hours TH : 03 Tut: --

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

**Course Objectives:**

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

**Course Outcomes:**

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

**UNIT I**

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

**UNIT II**

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

**UNIT III**

Linear transformations and matrices, equivalence, similarity.

**UNIT IV**

Eigenvalues, eigenvectors, diagonalization, Jordoncanonical form

**UNIT V**

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

**UNIT VI**

System of equations, generalized inverses.

**Text Books/Reference:**

1. Linear Algebra and Group Representations, Ronald Shaw, AcademicPress, Volume I-1982.
2. Linear Algebra and Group Representations, Ronald Shaw, AcademicPress, Volume II-1983.
3. Linear Algebra, A. R. Rao, Bhima Sankaran, TRIM, 2nd Edition, Hindustan

## ELECTIVE-V

### RF MEMS

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

**Objective:**

| | |
|---|---|
| A | To impart knowledge on basics of MEMS and their applications in RF circuit design |

**Course outcomes**

| | |
|---|---|
| **CO1** | Learner will be able to understand the Micromachining Processes |
| **CO2** | Learner will be able to understand the design and applications of RF MEMS inductors and capacitors |
| **CO3** | Learner will be able to understand RF MEMS Filters and RF MEMS Phase Shifters |
| **CO4** | Learner will be able to understand the suitability of micro-machined transmission lines for RF MEMS |
| **CO5** | Learner will be able to understand Micro-machined Antennas and Reconfigurable Antennas |

**UNIT I**

Micromachining Processes - methods, RF MEMS relays and switches. Switch parameters. Actuation mechanisms. Bistable relays and micro actuators. Dynamics of switching operation

**UNIT II**

MEMS inductors and capacitors. Micro-machined inductor. Effect of inductor layout. Modeling and design issues of planar inductor. Gap-tuning and area-tuning capacitors. Dielectric tunable capacitors

**UNIT III**

MEMS phase shifters. Types. Limitations. Switched delay lines. Fundamentals of RF MEMS Filters

**UNIT IV**

Micro-machined transmission lines. Coplanar lines. Micro-machined directional coupler and mixer.

**UNIT V**

Micro-machined antennas. Microstrip antennas – design parameters.

**UNIT VI**

Micromachining to improve performance. Reconfigurable antennas.

**Text Books/Reference:**


1. Vijay. K. Varadan, K.J. Vinoy, and K.A. Jose, “RF MEMS and their Applications”, Wiley-India, 2011.
2. H. J. D. Santos, “RF MEMS Circuit Design for Wireless Communications”, Artech House, 2002.
3. M. Rebeiz, “RF MEMS Theory, Design, and Technology”, Wiley, 2003.

## ELECTIVE-V

## RESEARCH METHODOLOGY

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

**Course Objectives:**

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

**Course Outcomes:**

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

**UNIT I**

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

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

**UNIT II**

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

**UNIT III**

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

**UNIT IV**

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

**UNIT V**

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

**UNIT VI**

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

**Text Books/References:**


1. J.P. Holman, Experimental Methods for Engineers, Mcgraw-Hill publication.
2. C.R. Kothari, Research Methodology Methods & Techniques, New Age International publication.

## ELECTIVE-V

## 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

Introduction - Review Of Signal Processing Theory-Speech production mechanism – Nature of Speech signal– Discrete time modelling of Speech production – Classification of Speech sounds – Phones – Phonemes –Phonetic and Phonemic alphabets – Articulatory features. 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

Introduction -Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters- Tree-Structured QMF and CQF M-band Banks - Cosine Modulated “Pseudo QMF” M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banks and the Modified Discrete Cosine Transform (MDCT) - Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion- Preecho Control Strategies

**UNIT III**

Lossless Audio Coding-Lossy Audio Coding- ISO-MPEG-1A,2A,2A Advanced, 4Audio Coding – Optimum Coding in the Frequency Domain - Perceptual Transform Coder - Brandenburg-Johnston Hybrid Coder – CNET Coders - Adaptive Spectral Entropy Coding - Differential Perceptual Audio Coder - DFT Noise Substitution -DCT with Vector Quantization -MDCT with Vector Quantization

**UNIT IV**

Time domain parameters of Speech signal – Methods for extracting the parameters :Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy Short Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods HOMOMORPHIC SPEECH ANALYSIS: Cepstral analysis of Speech – Formant and Pitch Estimation – Homomorphic Vocoders.

**UNIT V**

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods.

**UNIT VI**

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

**Text Books/References:**

1. Udo Zölzer, Digital Audio Signal Processing, Second Edition, A John Wiley& sons Ltd Publicatioons
2. Mark Kahrs, Karlheinz Brandenburg And Acoustics Kluwer, Applications of Digital Signal Processing to Audio Academic Publishers New York, Boston, Dordrecht, London, Moscow.
3. L. R. Rabiner and R.W. Schaffer, Digital Processing of Speech signals –- Prentice Hall

## SEMINAR I

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

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

## MINI PROJECT

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

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

## PROJECT MANAGEMENT AND INTELLECTUAL PROPERTY RIGHTS

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

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

## PROJECT-I

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

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

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

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

## PROJECT-II

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

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

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

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