Dr. Babasaheb Ambedkar Technological University

Course Structure and Syllabus

For

M. Tech. (Digital Communication)

Two Year (Four Semester) Course

(w.e.f. July 2017)

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY,

Lonere-402103, Raigad (MS)

M.Tech. (Digital Communication)

Objectives

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

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

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

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

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

Outcomes

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

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

III. Learners of this program will 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. (Digital Communication) 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	MTDCC101	Signal Theory	03	--	1	04	60	20	20	--	**100**
02	MTDCC102	Antenna Theory and Design	03	--	1	04	60	20	20	--	**100**
03	MTDCC103	Advanced Digital Communication	03	--	1	04	60	20	20	--	**100**
04	MTDCE114	Elective-I	03	--	--	03	60	20	20	--	**100**
05	MTDCE125	Elective-II	03	--	--	03	60	20	20	--	**100**
06	MTDCC106	Communication Skills	02	--	--	02	--	--	25	25	**50**
07	MTDCL107	PG Lab-I*	--	03	--	02	--	--	25	25	**50**
		Total for Semester I	**17**	**03**	**03**	**22**	**300**	**100**	**150**	**50**	**600**
Second Semester											
01	MTDCC201	Estimation and Detection Theory	03	--	1	04	60	20	20	--	**100**
02	MTDCC202	Information Theory and Coding	03	--	1	04	60	20	20	--	**100**
03	MTDCE233	Elective-III	03	--	--	03	60	20	20	--	**100**
04	MTDCE244	Elective- IV	03	--	--	03	60	20	20	--	**100**
05	MTDCE255	Elective-V- (Open to all)	03	--	--	03	60	20	20	--	**100**
06	MTDCS206	Seminar-I	--	04	--	02	--	--	50	50	**100**
07	MTDCP207	Mini-Project	--	04	--	02	--	--	50	50	**100**
		Total for Semester II	**15**	**8**	**02**	**21**	**300**	**100**	**200**	**100**	**700**
Third Semester											
1	MTDCC301	Project Management & Intellectual Property Rights (Self Study)#	--	--	--	02	--	--	50	50	**100**
2	MTDCP302	Project-I	--	--	--	10	--	--	50	50	**100**
		Total for Semester III	**--**	**--**	**-**	**12**	**--**	**--**	**100**	**100**	**200**
Fourth Semester											
1	MTDCP401	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. RF and Microwave Circuit Design
B. Electromagnetic Interference and Compatibility
C. Mobile Communication
D. Synthesis & Optimization of Digital Circuits
E. Smart Antenna

Elective-II

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

Elective-III

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

Elective-IV

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

Elective-V (Open)

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

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 antennas, 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, sleeve 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, Axisymmetric parabolic reflector antenna, offset parabolic reflectors, dual

reflector antennas, Gain calculations for reflector antennas, feed antennas for reflectors, field representations, matching the feed to the reflector, general feed model, feed antennas used in practice.

UNIT V

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

ADVANCE DIGITAL COMMUNICATION

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

Course Outcomes:

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

UNIT I

Introduction

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

UNIT II

Modulation

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

UNIT III

Receiver in additive white Gaussian noise channels

Coherent and noncoherent demodulation: Matched filter, Correlator demodulator, square-law, and envelope detection; Detector: Optimum rule for ML and MAP detection Performance: Bit-error-rate, symbol error rate for coherent and noncoherent schemes.

UNIT IV

Band-limited channels

Pulse shape design for channels with ISI: Nyquist pulse, Partial response signaling (duobinary and modified duobinary pulses), demodulation; Channel with distortion: Design of transmitting and receiving filters for a known channel and for time varying channel (equalization); Performance: Symbol by symbol detection and BER, symbol and sequence detection, Viterbi algorithm.

UNIT V

Synchronization

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

UNIT VI

Communication over fading channels

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

Text Books/Reference:

1. J. G. Proakis and M. Salehi, Fundamentals of Communication Systems, Pearson Education, 2005.
2. S. Haykins, Communication Systems, 5th ed., John wiley, 2008.
3. M. K. Simon, S. M. Hinedi and W. C. Lindsey, Digital Communication Techniques: Signaling and detection, Prentice Hall India, N. Delhi, 1995.
4. W. Tomasi, Advanced Electronic Communication Systems, 4th Ed., Pearson Education, 1998.
5. M. K. Simon and M. S. Alouini, Digital Communication over Fading Channels, 2000.

ELCTIVE I

RF AND MICROWAVE CIRCUIT DESIGN

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

RF systems – basic architectures, Transmission media and reflections, Maximum power transfer.

Passive RLC Networks:

Parallel RLC tank, Q, Series RLC networks, Matching, Pi match, T match

UNIT II

Passive IC Components: Interconnects and skin effect, Resistors, capacitors, Inductors. Review of MOS, Device Physics**:** MOS device review

UNIT III

Distributed Systems: Transmission lines, reflection coefficient, The wave equation, Examples Lossy transmission lines, Smith charts – plotting, gamma.

UNIT IV

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 radio architectures

Text Books/Reference:

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

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, 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 rms delay spread

UNIT III

Coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate. Capacity of flat and frequency selective channels.

UNIT IV

Antennas: antennas for mobile terminal- monopole antennas, PIFA, base station antennas and array, Multiple access schemes: FDMA, TDMA, CDMA and SDMA. Modulation schemes: BPSK,QPSK and variants, QAM,MSK and GMSK, multicarrier modulation, OFDM.

UNIT V

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

UNIT VI

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

Text Books/Reference:

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

SYNTHESIS & OPTIMIZATION OF DIGITAL CIRCUITS

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 optimization and dimensions of optimization for digital circuits
B	To provide in-depth understanding of advanced tools and techniques in digital systems design.
C	To provide in-depth understanding for the concept of scheduling and resource binding for optimization

Course Outcomes:

CO1	Learner will be able to process of synthesis and optimization in a top down approach for digital circuits models using HDLs
CO2	Learner will be able to analyze terminologies of graph theory and its algorithms to optimize a Boolean equation.
CO3	Learner will be able to apply different two level and multilevel optimization algorithms for combinational circuits
CO4	Learner will be able to apply the different sequential circuit optimization methods using state models and network models.
CO5	Learner will be able to analyze different scheduling algorithms
CO6	Learner will be able to understand fundamental concepts of simulation

UNIT I

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

UNIT II

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

UNIT III

Hardware Modeling: Hardware Modeling Languages, distinctive features, structural hardware language, Behavioural hardware language, HDLs used in synthesis, abstract models, structures logic networks, state diagrams, dataflow and sequencing graphs, compilation and optimization techniques.

UNIT IV

Two Level Combinational Logic Optimization: Logic optimization, principles, operation on two level logic covers, algorithms for logic minimization, symbolic minimization and encoding property, minimization of Boolean relations.

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

UNIT V

Schedule Algorithms: A model for scheduling problems, Scheduling wither source and without resource constraints, Scheduling algorithms for extended sequencing models, Scheduling Pipe lined circuits. Cell Library Binding: Problem formulation and analysis, algorithms for library binding, specific problems and algorithms for library binding (lookup table F.P.G.As and Anti fuse based F.P.G.As), rule based library binding.

UNIT VI

Testing: Simulation, Types of simulators, basic components of a simulator, fault simulation Techniques, Automatic test pattern generation methods (ATPG), design for Testability (DFT) Techniques.

Text Books/Reference:

1. Giovanni De Micheli, Synthesis and Optimization of Digital Circuits,Tata McGraw-Hill, 2003.
2. Srinivas Devadas, Abhijit Ghosh, and Kurt Keuer, Logic Synthesis, McGraw-Hill, USA, 1994.
3. NeilWeste and K. Eshragian, Principles of CMOS VLSI Design: A System Perspective, 2nd edition, Pearson Education (Asia) Pte. Ltd., 2000.
4. KevinSkahill, VHDL for Programmable Logic, Pearson Education(Asia) Pvt. Ltd., 2000

ELECTIVE I

SMART ANTENNA

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 II

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 II
MULTIMEDIA 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 for multimedia communication standards and compression techniques
B	To provide in-depth understanding for representation of image, video

Course Outcomes:

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

UNIT I

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

UNIT II

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

UNIT III

Data Compression Huffman Coding, Shannon Fano Algorithm, Huffman Algorithms, Adaptive Coding, Arithmetic Coding Higher Order Modelling. Finite Context Modelling, Dictionary based Compression, Sliding Window Compression, LZ77, LZW compression, Compression, Compression ratio loss less & lossy compression.

UNIT IV

Speech Compression & Synthesis Digital Audio concepts, Sampling Variables, Loss less compression of sound, loss compression & silence compression.

UNIT V

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

UNIT VI

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

Text Books/Reference:

1. Tay Vaughan, Multimedia, Making IT Work, McGraw Hill.
2. Buford, Multimedia Systems, Addison Wesley.
3. Mark Nelson, Data Compression Hand Book, BPB.
4. Sleinreitz, Multimedia System, Addison Wesley

ELECTIVE II

OPTICAL FIBER COMMUNICATION

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

Course Objectives:

A	To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.
B	To provide an in-depth understanding needed to perform fiber-optic communication system engineering calculations, identify system tradeoffs, and apply this knowledge to modern fiber optic systems.

Course Outcomes:

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

UNIT I

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

UNIT II

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

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

UNIT III

Graded-index fiber: Modal analysis of graded index fiber, WKB analysis, Optimum profile. Experimental techniques in fiber optics: Fiber fabrication (OVD, VAD, CVD, MCVD,PMCVD etc) and characterization, Splices, Connectors and fiber cable.

UNIT IV

Loss mechanism in optical fiber: Absorption loss, scattering loss, bending loss, splice loss. Pulse propagation, Dispersion and chirping in single mode fibers: Pulse propagation in non-dispersive and dispersive medium, Pulse broadening and chirping, Group and phase velocity, Intermodal and intra modal dispersion, Group velocity (material and waveguide) dispersion, Higher order dispersion, Fiber bandwidth.

UNIT V

Dispersion compensation mechanism: Dispersion tailored and dispersion compensating fibers, Fiber Birefringence and polarization mode dispersion, Fiber bandwidth, Nonlinear effects in optical fiber: Stimulated Raman Scattering, Stimulated Brillouin Scattering, Self Phase, Modulation, Cross Phase Modulation, Optical Solitons.

UNIT VI

Fiber based devices: Erbium-doped fiber amplifiers and lasers, Fiber Bragg gratings, Optical Fiber Sensors. Photonic Crystal fibers.

Text Books/Reference:

1. A. K. Ghatak & K. Thyagarajan, Introduction to Fiber Optics, Cambridge University Press (1998).
2. G. P. Agarwal, Fiber Optic Communication Systems, John Wiley Sons (1997).
3. John A. Buck, Fundamentals of Optical Fibers, Wiley Interscience, (2004).
4. J. M. Senior, Optical Fiber Communication, Prentice Hall (1999).
5. G. Keiser, Optical Fiber Communications, McGraw Hill (2000).
6. K. Okamoto, Fundamentals of Optical Waveguides, Academic Press, (2000).
7. K. Iizuka, Elements of Photonics Vol I &II, Wiley-Interscience (2002).
8. D. W. Prather et.al, Photonic Crystal, Wiley (2009)

ELECTIVE II

STATISTICAL SIGNAL PROCESSING

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

Introduction

Random Signals, Spectral Estimation, Adaptive Filtering, Random Variables, Distribution and Density Functions, Random Vectors: Definition, Transformation and Linear Combination of Random Vectors Linear System with Stationary Input, Innovations and Representation of Real Vectors, DT Stochastic Process: Stationarity, Ergodicity and Frequency Domain Representation of SP, Principles of Estimation.

UNIT II

Stochastic Processes and Models

Characterization of DT Stochastic Process, Correlation Matrix, Properties of Correlation Matrix, Stochastic Models: MA and AR Models, ARMA Models Hold Decomposition, Asymptotic Stationarity of AR Process, Yule Walker Equations, Power Spectral Density, Properties of Power Spectral Density Transmission of Stationary Process Through a Linear Filter, Other Statistical Characteristics of Stochastic Process Power Spectral Estimation, Spectral Correlation Density, Polyspectra

UNIT III

Optimum Linear Filters

Optimum Signal Estimation, Linear Mean Square Estimation, Solution of Normal Equations, Optimum FIR Filters, Linear Prediction: Linear Signal Estimation, Forward Linear Estimation, Backward Linear Estimation, Stationary Processes and Properties, Optimum IIR Filters, Inverse Filtering and Deconvolution.

UNIT IV

Algorithms and Structures For Optimum Filters.

Fundamentals of Order-Recursive Algorithms, Interpretation of Algorithmic Quantities, Order-Recursive Algorithms for Optimum FIR Filters, Algorithms of Levinson and Levinson-Durbin, Lattice Structure for Optimum Filters, Schur Algorithm, Triangularization and Inverse of Toeplitz Matrices, Kalman Filter Algorithm.

UNIT V

Least Square Filtering

Principle of LS, Linear Least Square Error Estimation, Least Square Filter, Linear Least Square Signal Estimation, LS Computation using Normal Equations, LS Computation using Orthogonalization Techniques, LS Computation using Singular Value Decomposition Techniques, Problems.

UNIT VI

Adaptive Filtering

Introduction, Typical Applications, Principles of Adaptive Filters, Method of Steepest Decent, LMS Algorithm, RLS Adaptive Filter, Fast RLS Algorithms for FIR Filtering, Frequency Domain and Subband Adaptive Filters.

Text Books/Reference:

1. S. Haykin, Adaptive Filter Theory, PHI.
2. D. G. Manolakis, V. K. Ingle, S. M. Kogon, Statistical and Adaptive Signal Processing, McGraw Hill

ELECTIVE-II

MICROELCTRONICS

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

Ideal I-V Characteristics, C-V Characteristics: MOS Capacitance models, MOS Gate Capacitance Model, MOS Diffusion Capacitance Model. Non ideal I-V Effects: Velocity Saturation and Mobility Degradation, Channel Length Modulation, Body Effect, Sub threshold Conduction, Junction Leakage, Tunneling, Temperature and Geometry Dependence. DC Transfer characteristics: Complementary CMOS Inverter DC Characteristics, Beta Ratio Effects, Noise Margin, Ratio Inverter Transfer Function, Pass Transistor DC Characteristics, Tristate Inverter, Switch- Level RC Delay Models

UNIT II

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

UNIT III

Layout Design Rules: Design Rules Background, Scribe Line and Other Structures, MOSIS Scalable CMOS Design Rules, Micron Design Rules. CMOS Process Enhancements: Transistors, Interconnect, Circuit Elements, Beyond Conventional CMOS. CMOS Fabrication

and Layout: Inverter Cross-section, Fabrication Process, Layout Design rules, Gate Layout, Stick Diagrams.

UNIT IV

Delay Estimation: RC Delay Models, Linear Delay Model, Logical Effort, Parasitic Delay. Logical Effort and Transistor Sizing: Delay in a Logic Gate, Delay in Multistage Logic Networks, choosing the Best Number of Stages. Power Dissipation: Static Dissipation, Dynamic Dissipation, Low-Power Design. Interconnect: Resistance, Capacitance, Delay, Cross talk. Design Margin: Supply Voltage, Temperature, Process Variation, Design Corners. Reliability, Scaling.

UNIT V

Static CMOS Logic : Inverter, NAND Gate, Combinational Logic, NOR Gate, Compound Gates, Pass Transistors and Transmission Gates, Tristates, Multiplexers, Latches and Flip-Flops, Circuit Families: Static CMOS, Ratioed Circuits,

UNIT VI

Cascade Voltage Switch Logic, Dynamic Circuits, Differential Circuits, Sense Amplifier Circuits, BiCMOS Circuits, Low Power Logic Design, Comparison of Circuit Families, Analog Circuit Designs, MOS Small-signal Models, Common Source Amplifier, The CMOS Inverter as an Amplifier, Current Mirrors, Differential Pairs, CMOS Operational Amplifier topologies, Digital to Analog Converters, switched capacitors, Analog to Digital Converters, RF Circuits

Text Books/Reference:

1. J. M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits : A Design Perspective, Pearson/PHI (Low Price Edition)
2. S-M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits : Analysis and Design, Third Edition, McGraw-Hill
3. B. Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill
4. P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, Second Edition, Oxford University Press
5. P. Gray, P. J. Hurst, S. H. Lewis and R. Meyer, Analysis and Design of Analog Integrated Circuits, Fourth Edition,Wiley, 2001. (Low Price Edition)

COMMUNICATION SKILLS

Weekly Teaching Hours TH: 02 Practical: -

Scheme of Marking TH: -- IA: 25 PR/OR: 25 Total: 50

Course Objectives:

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

Course Outcomes:

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

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

Text Books/Reference:

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

PG Lab-I

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

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

ESTIMATION AND DETECTION THEORY

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

Linear Algebra

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

UNIT II

Binary Decision: Single Observation

Introduction to structure 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

INFORMATION THEORY AND CODING

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

Course Objectives:

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

Course Outcomes:

CO1	Learner will be able to formulate equations for entropy mutual information and channel capacity for all types of channels.
CO2	Learner will be able to distinguish between different types 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. Modern Digital and Analog Communication Systems; B. P. Lathi; Oxford Publication.
2. Principles of Digital Communication; Das, Mullick, Chaterjee; New Age International.
3. Principles of Communication Engineering (2^{nd}Edition); Taub, Schilling; TMH.
4. Elements of Information Theory; Thomas M. Cover, Joy A. Thomas; Wiley Inter-science.
5. Communication systems : Analog and Digital; R.P.Singh, S.D. Sapre; TMH.
6. Wireless Communication : Principles and Practice (2^{nd} Edition); Theodore S. Rappaport; Pearson India.

ELECTIVE III

MULTIRATE DIGITAL SIGNAL PROCESSING

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

Fundamentals of Multirate Systems

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

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

IMAGE AND VIDEO PROCESSING

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

Course Objectives:

A	To provide in depth understanding of image and video processing.
B	To perform mathematical analysis of image and video processing and implement it.
C	To provide solutions to real time problems using knowledge of subject.

Course Outcomes:

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

UNIT I

Fundamentals of Image processing and Image Transforms: Basic steps of Image processing system sampling and quantization of an Image – Basic relationship between pixels Image Transforms: 2 – D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms.

UNIT II

Image Processing Techniques: Image Enhancement: Spatial Domain methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering Image Segmentation: Segmentation concepts, point, line and Edge detection, Thresholding, region based segmentation.

UNIT III

Image Compression Image compression fundamentals – coding Redundancy, spatial and temporal redundancy. Compression models : Lossy and Lossless, Huffmann coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, transform coding, predictive coding , wavelet coding, JPEG standards.

UNIT IV

Basic Steps of Video Processing: Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals, filtering operations.

UNIT V

2-D Motion Estimation: Optical flow, general methodologies, pixel based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding.

UNIT VI

3-D Motion Estimation.

Text Books/Reference:

1. Gonzaleze and Woods ,Digital Image Processing , 3rd edition , Pearson

2. Yao wang, Joem Ostarmann and Ya – quin Zhang, Video processing and communication ,1st edition , PHI

3. M. Tekalp ,Digital video Processing, Prentice Hall International

4. Relf, Christopher G.,Image acquisition and processing with LabVIEW, CRC press

5. Aner ozdemi R, Inverse Synthetic Aperture Radar Imaging with MATLAB Algorithms, John Wiley & Sons

6. Chris Solomon, Toby Breckon ,Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab, John Wiley & Sons,

ELECTIVE-III

MULTICARRIER COMMUNICATION

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

Course Objectives:

A	To provide in-depth understanding of basic concepts of Multicarrier techniques
B	To make students familiar with modern communication system

Course Outcomes:

CO1	Learner will be able to understand practical limits on CDMA & OFDM systems
CO2	Learner will be able to understand basic principles of CDMA & OFDM systems
CO3	Learner will be able to perform analysis of CDMA & OFDM systems
CO4	Learner will be familiar with other modern communication systems
CO5	Learner will be able to design CDMA & OFDM systems

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Channel coding: Need for coding block, coding in OFDM convolution encoding, concatenated coding, coding in OFDM

UNIT V

PAPR Reduction Techniques: Peak power reduction techniques PAPR properties of OFDM signals, PAPR reduction with and without signal distortion PAPR reduction for multi-carrier CDMA

UNIT VI

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

Text Books/Reference:

1.Bahai, Saltzberg, Ergen : Multi-carriers Digital communications, Springer

2.Rappaport, T.S, Wireless communication, Prentice Hall

3.Heiskala, J., Terry J., OFDM wireless LANs: A Theoretical and practical guide. Samps Publishing 2002

4.Haykinls, Communication system, John Wiley & Sons.

5. Oppenheim, A.V., Schafer R.W., Discrete – Time signal processing New Jerssey : Prentice Hall Inc.

6.Bingham, J.A.C., ADSL, VDSL and multi-carrier modulation New York Wiley.

7.OFDM orthogonal frequency Division Multiplexing. Nova Engineering.

ELECTIVE-III

OPTIMIZATION TECHNIQUES

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

Course Objectives:

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

Course Outcomes:

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

UNIT I:

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

UNIT II

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

UNIT III

Duality Theory, Dual Simplex Method, Sensitivity Analysis

UNIT IV:

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

UNIT V

Transportation Problems and Assignment Problems.

UNIT VI

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

Text Books/Reference:

1 Taha, H.A., Operations Research: An Introduction, MacMillan Pub Co., NY, Ninth Edition

2. Ravindran, A., Phillips, D.T. and Solberg, J.J., Operations Research: Principles and Practice, John Wiley and Sons, NY, Second Edition.

3. Pant, J.C., Introduction to Optimization, Jain Brothers, 2012

4. Hillier, F. S. and Lieberman, G. J., Introduction to Operations Research, 9th 2009 Edition, McGraw-Hill

5. Mittal, K.V. and Mohan, C., Optimization Methods in System Analysis and Operations Research

6. Mohan C. and Deep K., Optimization Techniques 2009

ELECTIVE-IV

ADVANCED BIOMEDICAL SIGNAL PROCESSING

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

Text Books/Reference:

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

ELECTIVE-IV

ADHOC WIRELESS NETWORKS

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

MAC PROTOCOLS FOR AD HOC WIRELESS NETWORKS: Introduction, Issues in designing a MAC protocol for Adhoc wireless Networks, Design goals of a MAC protocol for Adhoc wireless Networks, Classification of MAC protocols.

UNIT II

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

UNIT III

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

UNIT IV

Hybrid routing protocol, Routing protocols with effective flooding mechanisms, Hierarchical routing protocols, Power aware routing protocols.

UNIT V

TRANSPORT LAYER PROTOCOLS FOR ADHOC WIRELESS NETWORKS: Introduction, Issues in designing a transport layer protocol for Ad hoc wireless Networks, Design goals of a transport layer protocol for Ad hoc wireless Networks..

UNIT VI

SECURITY: Security in wireless Adhoc wireless Networks, Network security requirements, Issues & challenges in security provisioning.

Text Books/Reference:

1. C. Siva Ram Murthy & B. S. Manoj, Ad hoc wireless Networks, Pearson Education, 2nd Edition, reprint 2005.
2. Ozan K. Tonguz and Gianguigi Ferrari, Ad hoc wireless Networks, Wiley
3. Xiuzhen Cheng, Xiao Hung, Ding- Zhu Du, Ad hoc wireless Networking, Kluwer Academic publishers.

ELECTIVE-IV

AUDIO AND SPEECH PROCESSING

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

Course Objectives:

A	To provide in-depth understanding about fundamental concepts of audio and speech processing
B	To provide in-depth understanding for challenges in designing network

Course Outcomes:

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

UNIT I

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/Reference:

1. Udo Zölzer, A John, Digital Audio Signal Processing, Second Edition, Wiley& sons Ltd Publicatioons
2. Mark Kahrs, Karlheinz Brandenburg, Applications of Digital Signal Processing to Audio And Acoustics, Kluwer Academic Publishers New York, Boston, Dordrecht, London, Moscow.
3. L. R. Rabiner and R.W. Schaffer, Digital Processing of Speech signals, Prentice Hall – 1978

ELECTIVE-IV

RADAR SIGNAL PROCESSING

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

Course Objectives:

A	To provide in-depth understanding of working principle of basic RADAR. List RADAR terminologies. Derive the simple form of RADAR range equation.
B	To provide in-depth understanding of deifferent types of RADAR and its performance parameters

Course Outcomes:

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

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Radar waveforms, Introduction, The waveform matched filter, Matched filtering of moving targets, The radar ambiguity function, The pulse burst waveform, frequency-modulated pulse compression waveforms, The stepped frequency waveform, Phase-modulated pulse compression waveforms, Costas frequency codes.

UNIT V

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

UNIT VI

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

Text Books/Reference:

1. Mark A. Richards, Fundamentals of Radar Signal Processing, 2005
2. Simon Haykin, Adaptive Radar Signal Processing, 2006
3. Skolnik, M.I., Introduction to Radar Systems, 2nd Ed., McGraw-Hill. 1997

ELECTIVE-IV

ELECTROMAGNETICS, ANTENNA AND PROROGATION

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

Course Objectives:

A	To provide in-depth understanding of the fundamental solutions of time-varying Maxwell's equations, and applies them to design antennas.
B	To provide in-depth understanding of radio wave propagation phenomena in modern communication systems, and fundamentals of electromagnetic radiation with application to antenna theory and design.

Course Outcomes:

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

UNIT I

Introduction, Vector Analysis, Coordiante systems and Transformations, Line, surface and volume integrals, Divergence Theorem, Stoke's theorem, Coulomb's Law, Electric Field, Electric flux density, Gauss's Law with Application, Electrostatic Potential and Equipotential Surfaces, Boundary conditions for Electrostatic fields, Capacitance and Capacitors, Electrostatic Energy and Energy Density, Poisson's and Laplace's Equations, Uniqueness Theorem, Method of Images, Electrostatic boundary value problem

UNIT II

Introduction, Current Density and Ohm's Law, Electromagnetic force and Kirchoff's Voltage Law, Continuity Equation and Kirchoff's Current Law, Power Dissipation and Joule's law, Biot- Savart Law and its Applications,,Ampere's Circuital Law and its Applications, Magnetic Flux Density, Magnetic Scalar and Vector Potentials, Boundary Condition for Magnetic Fields, Inductance and Inductor, Energy stored in Magnetic Field, Faraday's Law of electromagnetic Induction, Maxwell's Equation, Boundary Conditions for Electromagnetic fields, Time Harmonic Fields, The Helmhotz Equation, Plane waves in Lossless medium, Plane waves in a lossy medium, Poynting Vector and Power Flow in Electromagnetic Fields, Polarization of plane wave, Behaviour of Plane waves at the interface of two media

UNIT III

Introduction, Fundamentals of Radiation, Radiated field of an Herzian dipole, Basic Antenna Parameters, Half Wave Dipole Antenna, Quarter Wave Monopole Antenna, Small Loop Antennas, Introduction to Antenna Arrays, Finite difference Method, Basic Concepts of the Method of Moments, Method of Moment for Wire Antennas and Wire Scatterers

UNIT IV

Planar Antennas – Microstrip rectangular and circular patch antennas- Analysis and Design , feeding methods; circularly polarized microstrip antennas, broadbanding techniques. Printed slot antennas.

Array theory- linear array: broad side and end fire arrays; self and mutual impedance of between linear elements, grating lobe considerations.

UNIT V

Planar Array- array factor, beam width, directivity. Example of microstrip patch arrays and feed networks electronics scanning.

Broadband antennas- folded dipole, sleeve dipole, Biconical antenna – Analysis, characteristics, matching techniques. Yagi array of linear elements and printed version, Log-Periodic dipole array.

UNIT VI

Frequency Independent Antennas- planar spiral antennas, log periodic dipole array. Aperture antennas- field equivalence principle, Babinet's principle. Rectangular waveguide horn antenna, parabolic reflector antenna.

Antennas for mobile communication- handset antennas, base station antennas. Beam-steering and antennas for MIMO applications. Active and smart microstrip antennas. Design and analysis of microstrip antennas arrays.

Text Books/Reference:

1. C. A. Balanis, Antenna Theory and design, John Wiley and sons, 1997.
2. J. D. Kraus, antennas, Mc-Graw-Hill, 1988.
3. R. A. Sainathi, CAD of microstrip antennas for wireless applications, Artech House, 1996.

ELECTIVE V

INTERNET OF THINGS

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

Text/ Reference Books:

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

ELECTIVE V

LINEAR ALGEBRA

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

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

UNIT II

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

UNIT III

Linear transformations and matrices, equivalence, similarity.

UNIT IV

Eigenvalues, eigenvectors, diagonalization, Jordon canonical form

UNIT V

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

UNIT VI

System of equations, generalized inverses.

Text Books/Reference:

1. Ronald Shaw, Linear Algebra and Group Representations, ,AcademicPress, Volume I-1982.

2. Ronald Shaw, Linear Algebra and Group Representations, AcademicPress, Volume II-1983.

3. A. R. Rao, Bhima Sankaran, Linear Algebra, TRIM, 2nd Edition, Hindustan

ELECTIVE-V

NEURAL NETWORKS IN EMBEDDED APPLICATIONS

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

Course Objectives:

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

Course Outcomes:

CO1	Learner will be able to understand concept of fuzzy logic.
CO2	Learner will be able to understand embedded digital signal processor, Embedded system design and development cycle, applications in digital camera
CO3	Learner will be able to understand embedded systems, characteristics, features and applications of an embedded system
CO4	Learner will be able to design and utilization of fuzzy logic controller for various industrial applications
CO5	Learner will be able to implement of radial basis function, neural network on embedded system: real time face tracking and identity verification, Overview of design of ANN based sensing logic and implementation for fully automatic washing machine

UNIT I

Introduction to artificial neural networks, Fundamental models of artificial neural network, Perceptron networks, Feed forward networks, Feedback networks, Radial basis function networks, Associative memory networks

UNIT II

Self organizing feature map, Learning Vector Quantization, Adaptive resonance theory, Probabilistic neural networks, neocgnitron, Boltzmann Machine.

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

Text Books/Reference:

1. S N Sivanandam, S Sumathi, S N Deepa, Introduction to Neural Networks Using Matlab 6.0, Tata McGraw Hill Publication
2. Simon Haykin, Neural Networks: Comprehensive foundation, Prentice Hall Publication
3. Frank Vahid, TonyGivargis, Embedded System Design A unified Hardware/ Software Introduction, Wiley India Pvt. Ltd.
4. Rajkamal, Embedded Systems Architecture, Programming and Design, Tata McGraw-Hill

ELECTIVE-V

RESEARCH METHODOLOGY

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

Course Objectives:

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

Course Outcomes:

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

UNIT I

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

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

Text Books/Reference:

1. J.P. Holman, Experimental Methods for Engineers.
2. C.R. Kothari, Research Methodology, Methods & Techniques.

ELECTIVE-V

WAVELET TRANSFORMS AND ITS APPLICATIONS

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

Course Objectives:

A	To provide in-depth understanding of fundamental concepts of Wavelets.
B	To study wavelet related constructions, its applications in signal processing, communication and sensing.

Course Outcomes:

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

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Digital Filtering Interpretation, Examples of Orthogonal Basic Generating Wavelets, Interpreting Orthonormal MRAs for Discrete-Time signals, Miscellaneous Issues Related to PRQME Filter Banks, generating Scaling Functions and wavelets from Filter Coefficient, Problems.

UNIT V

Wavelet Transform And Data Compression: Introduction, Transform Coding, DTWT for ImageCompression, Audio Compression, And Video Coding Using Multiresolution Techniques: a Brief Introduction.

UNIT VI

Other Application 0f Wavelet Transforms: Introduction, Wavelet denoising speckles Removal, Edge Detection and Object Isolation, Image Fusion, Object Detection by Wavelet Transform of Projections, Communication application.

Text Books/Reference:

1. C. Sidney Burrus, R. A. Gopianath, Pretice Hall, Introduction to Wavelet and Wavelet Transform
2. P.P.Vaidyanathan , PTR Prentice Hall, Englewood Cliffs , New Jersey, Multirate System and Filter Banks
3. N.J.Fliege , John Wiley & Sons, Multirate Digital Signal Processing
4. Raghuveer Rao, Ajit Bopardikar, Pearson Education Asia,Wavelet Transforms Introduction to Theory and Application
5. James S. Walker, A Primer on Wavelets and their Scientific Applications, CRC Press, (1999).
6. Rao, Wavelet Transforms, Pearson Education, Asia.

SEMINAR I

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

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

MINI PROJECT

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

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

PROJECT MANAGEMENT AND INTELLECTUAL PROPERTY RIGHTS

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

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

PROJECT-I

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

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

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

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

PROJECT-II

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

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

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

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