DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

M.TECH COMMUNICATION ENGINEERING & SIGNAL PROCESSING

(w.e.f. the batch of students admitted from the academic year 2017-2018)

COURSE STRUCTURE AND SCHEME OF EXAMINATION

I M.Tech I Semester

S. No	Code No & Subject	Hours / Week		Credits	Evaluation of Marks		Total
		L	P		INT	EXT	
1.	SP511 Advanced Digital Communication	4	–	4	40	60	100
2.	SP512 Coding Theory And Techniques	4	–	4	40	60	100
3	SP513 Speech Signal Processing	4	–	4	40	60	100
4.	Elective Subject – 1	4	–	4	40	60	100
5.	Elective Subject – 2	4	–	4	40	60	100
6.	Elective Subject – 3	4	–	4	40	60	100
7.	SP551 Communication Lab	–	3	2	40	60	100
8.	SP552 Seminar	–	3	2	100	–	100
Total		24	6	28	380	420	800

I M.Tech II Semester

S. No	Code No & Subject	Hours / Week		Credits	Evaluation of Marks		Total
		L	P		INT	EXT	
1.	SP521 Real Time Signal Processing	4	–	4	40	60	100
2.	SP522 Multirate Systems and Filter Banks	4	–	4	40	60	100
3	SP523 Wireless Communication	4	–	4	40	60	100
4.	Elective Subject–4	4	–	4	40	60	100
5.	Elective Subject–5	4	–	4	40	60	100
6.	Elective Subject–6	4	–	4	40	60	100
7.	SP561 Signal Processing Lab	–	3	2	40	60	100
8.	SP562 Mini Project / Term paper	–	3	2	100	–	100
Total		24	6	28	380	420	800

II M.Tech I Semester

S. No	Code No & Subject	Hours / Week		Credits	Evaluation of Marks		Total
		L	P		INT	EXT	
1.	SP611 MOOCS	–	–	2	–	100	100
2.	SP651 Internship	–	–	2	100	–	100
3.	SP652 Dissertation Review	–	–	4	100	–	100
Total		–	–	8	200	–	200

II M.Tech II Semester

S. No	Code No & Subject	Hours / Week		Credits	Evaluation of Marks		Total
		L	P		INT	EXT	
1.	SP661 Dissertation	–	–	10	40	60	100

LIST OF ELECTIVE SUBJECTS

Subject code	Subject Title	Subject Code	Subject Title
SP571	Random Variables & Random Processing	SP581	OFDM for Wireless Communication Systems
SP572	Wavelet Signal Processing	SP582	Global Positioning Systems
SP573	Radar Signal Processing	SP583	Spread Spectrum Communication
SP574	Signal Detection and Estimation Theory	SP584	Data Communications
SP575	Advanced Digital Signal Processing	SP585	Satellite Communication Systems
SP576	Adaptive Signal Processing	SP586	Fibre Optic Communication
SP577	Pattern Recognition	SP587	Embedded Systems
SP578	Video Processing	SP588	Optimization Techniques
SP579	Smart Antennas	SP589	Artificial Neural Networks
SP580	Microwave measurements	SP590	Fuzzy Techniques

SP511 ADVANCED DIGITAL COMMUNICATION

Course objective:
This course will enable students to

- update date knowledge of the techniques used in modern communications and principles underlying.
- study optimum receivers in combating the effect of both noise and ISI.
- be acquainted with PN sequence, spread spectrum techniques.
- understand different encryption & decryption processes.
- know the effect and type of fading channels.

Course outcomes:
After successful completion of the course,the students will be able to

- demonstrate basics of digital communications.
- analyze equalizer in receiver.
- demonstrate the spread spectrum techniques advantages provided in digital communications.
- to understand the fundamentals of Cryptography, to deploy encryption techniques to secure data in transit across the networks.
- demonstrate the effect of fading on digital communication systems, the ways of mitigating the effects.

UNIT-I [12]

Digital Modulation Techniques:
Intersymbol interference, Correlative - level coding: Duo-binary signaling and modified duo-binary signaling, Introduction to pass band data transmission, Coherent PSK: BPSK, QPSK, coherent BFSK, QAM, Non-coherent binary modulation techniques, Non-coherent orthogonal modulation: BFSK, DPSK, M-ary modulation techniques: M-ary PSK, M-ary FSK.

UNIT-II [8]

Optimum receivers for channels with ISI and AWGN, linear equalization and decision feed back equalization, adaptive linear and adaptive decision feed back equalizer.

UNIT-III [10]

Spread Spectrum Modulation:
PN sequences, A Notion of spread spectrum, Direct – Sequence spread coherent BPSK, Signal – space dimensionality and processing gain, probability of error, frequency – hop spread spectrum, synchronization of spread spectrum signals: Acquisition and tracking.

UNIT-IV [10]

Encryption and Decryption:
A model of the encryption and decryption process, Cipher systems, stream encryption and Public key encrypto system.

UNIT-V [10]

Fading Channels:
Characterization of mobile radio propagation, Signal time spreading, Time variance of the channel caused by motion, frequency selective, non-selective, Diversity Techniques for fading multi-path channels.

LEARNING RESOURCES

Text Books:

1. Simon Haykin, "Communication Systems", 4th edition, Wiley, 2011. ISBN-10: 9753316763.
2. Bernard Sklar "Digital Communications: Fundamentals and Applications", Second Edition, Pearson Education, 2016. ISBN 0134724054, 9780134724058.

References Books:

1. J.G.Proakis, "Digital Communications", 3rd edition, McGraw Hill,1995.
2. Taub and Schiling, "Principles of Communication Systems", 2nd edition, TMH, 1986.

SP512 CODING THEORY AND TECHNIQUES

Course objectives:
This course will enable students to

- provide the students with the knowledge of information theory.
- provide the students with an in-depth analysis of BCH-codes.
- provide the students with the elementary theory of error-correcting codes
- provide the students with several examples of linear, circular and convolution codes.
- create an appreciation for performance analysis and decoding algorithm.

Course outcomes:
After successful completion of the course,the students will be able to

- design the channel performance using information theory
- design BCH code for channel performance and implementation of Galois Field.
- apply linear block codes for error detection and correction
- apply cyclic codes for performance analysis, error detection and correction.
- apply convolution code for performance anlaysis and decoding algorithm

UNIT-I [12]

Source Coding:
Mathematical models of Information, A Logarithmic Measure of Information, Average and Mutual Information and Entropy, coding for Discrete memoryless Sources, Properties of Codes, Iluffman Code, Run Length Codes, Lempel-Ziv Codes, Shanon – Fano coding.

UNIT-II [12]

BCH Codes:
Groups Fields, Binary Field Arithmetic, Construction of Galois Field GF(2m), Basic properties of Galois Field GF(2m), Computations using of Galois Field GF(2m) Arithmetic. Description of the codes, Decoding of the BCH Codes, Implementation of Galois Field Arithmetic, Implementation of error correction.

UNIT-III [12]

Channel Coding:
Introduction to Linear Block Codes, Generated Matrix, Systematic Linear Block Codes, Encoder Implementation of Linear Block Codes, Parity Check Matrix, Syndrome Testing, Error Detecting and Correcting Capability of Linear Block Codes, Hamming Codes, Probability of an Undetected Error for Linear Codes Over a BSC- Perfect Codes.

UNIT-IV [12]

Cyclic codes:
Description of cyclic codes, Generator and parity check matrices of cyclic codes, encoding of cyclic codes, syndrome computation and error detection, decoding of cyclic codes, cyclic codes, cyclic hamming codes.

UNIT-V [12]

Convolutional Codes :
Encoding of Convolutional Codes, Structural Properties of Convolutional Codes, State Diagram, Tree Diagram, Trellis Diagram, Maximum, Likelihood Decoding of Convolutional Codes, Viterbi Algorithm, Sequential decoding algorithm.

LEARNING RESOURCES

Text Book:

SHU LIN and Daniel J. Costello, JR., "Error Control Coding-Fundamentals and Applications", Prentice Hall Inc.ISBN 013283796X.

Reference Books:

1. Bernard Sklar, "Digital Communications - Fundamentals and Applications", Pearson Education Asis, 2003.
2. Simon Haykin, "Communication Systems", 4th edition.
3. John G. Proakis, "Digital Communications", Mc. Graw Hill Publications.
4. J. Das, Sk. Mallik, PK Chattergee, "Princiiples of Digital Communication", NAI (P) Ltd, 2000.

SP513 SPEECH SIGNAL PROCESSING

Course objectives:
This course will enable students to

- study mathematical preliminaries for speech processing.
- study speech production mechanism and phonetics.
- learn time domain and frequency domain parameters.
- know speech processing applications like speech coding, speech enhancement.
- study networks for automatic speech recognition.

Course outcomes:
After successful completion of the course,the students will be able to

- Understand fundamentals of discrete - time signal processing.
- Understand mechanism and acoustics of human speech production.
- Represent speech information efficiently and discriminate voiced and unvoiced segments.
- Extract LPC and cepstral parameters for speech signal.
- Develop speech recognition systems.

UNIT-I [8]

Introduction:
What Is Speech Communication?, Developments in Speech Communication, speech communications applications.
Review of mathematics for speech processing:
Mathematical Preliminaries, Signals and Linear Systems, Frequency Analysis, Discrete-Time Signals and Systems.

UNIT-II [10]

Speech production and acoustic phonetics:
Introduction, Anatomy and physiology of speech organs, Articulatory phonetics, Acoustic phonetics.

UNIT-III [11]

Speech Analysis:
Introduction, Short-time speech analysis, Time-domain parameters,
Frequency domain parameters:
Filter-Bank Analysis, Short-Time Fourier Transform Analysis, Spectral Displays, Formant Estimation and Tracking.

UNIT-IV [11]

Linear predictive coding(LPC)Analysis:
Basic principles of LPC, Least-Squares Autocorrelation Method, Least-Squares Covariance Method, Computational Considerations, Spectral Estimation via LPC, window considerations, Cepstral analysis, F0 (“pitch”) estimation.

Speech Enhancement:
Introduction, Nature of interfering sounds, speech enhancement techniques, spectral subtraction, Multi-Microphone Adaptive Noise Cancellation (ANC).

UNIT-V [11]

Auotmatic Speech Recognition:
Basic pattern recognition approaches, parametric representation, evaluating the similarity of speech patterns, spectral and temporal variability.

Networks for Speech Recognition:
Hidden Markov Models (HMMs), training markov models, Artificial Neural Networks.

LEARNING RESOURCES

Text Book:

Douglas O Shaughnessy, "Speech Communications", second Edition, Oxford University Press, 2000.ISBN 9780780334496.

Reference Books:

1. L.R Rabiner and S.W.Schafer, "Digital Processing of speech signals", Pearson
2. Thomas F. Quatieri, "Discrete Time Speech signal Processing principles and practice", Pearson Education.
3. Dellar and Proakis, "Digital Signal Processing", PHI

SP551 COMMUNICATION LAB

List of Experiments:

1. Time Division Multiplexing of signals and Framing in the TDM
2. Verification of Manchester Coder-Decoder
3. Forming a PC to PC Communication Link using Optical Fiber and RS 232 interface.
4. Comparative study of EMI in copper and Optical media
5. Modulation and detection of signals using QPSK
6. Measure the Scattering parameters of a Hybrid TEE
7. Measurement of Radiation Patterns of Horn Antenna in E-Plane and H-plane
8. Measurement of spectrum of an FM signal using spectrum analyzer
9. Measurement of Q-factor of cavity resonator
10. Transmission and Reception of signals using Cellular communication Systems
11. Study of Satellite communication Receiver
12. Experiments Based on Software Defined Radio.

NOTE: A minimum of 10 (ten) experiments have to be performed and recorded by the candidate to attain eligibility for the university practical examination.

SP521 REALTIME SIGNAL PROCESSING

Course objectives:
This course will enable students to

- learn about the real time concepts and architecture of TMS320C6x Processor
- acquire knowledge of instruction set for TMS320C6x Processor.
- learn different data formats of DSP processors.
- learn about the different realization methods of FIR and IIR filters.
- learn different types of adaptive filters.

Course outcomes:
After successful completion of the course,the students will be able to

- understand about the real world applications with DSP processors and architecture of TMS320C6x processor.
- apply the knowledge of instruction set for real time applications.
- represent and analyze the data formats.
- design FIR and IIR filters.
- design adaptive filters for different applications.

UNIT-I [11]
Introduction:
Introduction to real time concepts, Signal Processing and DSP systems, Comparison between general purpose and DSP processors.
Architecture:
TMS320C6x Architecture, Functional Units, Fetch and Execute, Packets, Pipelining, Registers.
Addressing modes:
Direct, Indirect Addressing Linear and Circular Addressing Modes, Circular Addressing.

UNIT-II [11]
Instruction Set of the C6x Processor :
TMS320C6x Instruction Set- Assembly Code Format, Types of Instructions , Assembler Directives, Timers, Interrupts- Interrupt Control Registers , Interrupt Acknowledgment, Multichannel Buffered Serial Ports , Direct Memory Access .

UNIT-III [10]
Data representation of DSP Processors :
Data Types, Floating-Point Format, Q-format Number Representation, Finite Word Length Effects on Fixed-Point DSPs, Overflow and Scaling, Real time implementation considerations, Memory Considerations, Code Improvement, Constraints: Memory Constraints, Cross-Path Constraints, Load/Store Constraints, Pipelining Effects with More Than One EP within an FP.

UNIT-IV [11]

Finite Impulse Response Filters:
Introduction to the z-Transform, Mapping from s-Plane to z-Plane, Difference Equations, Discrete Signals, FIR Filters, FIR Lattice Structure, Window Functions, Hamming Window, Hanning Window, Blackman Window, Kaiser Window.

Infinite Impulse Response Filters:
IIR Filter Structures, Direct Form I Structure, Direct Form II Structure, Direct Form II Transpose, Cascade Structure, Parallel Form Structure.

UNIT-V [10]

Adaptive Filters:
Introduction, Adaptive Structures, Adaptive Linear Combiner, Performance Function Searching for the Minimum.

Code Optimization:
Introduction to optimization, Optimization Steps, Procedure for Code Optimization, Software Pipelining for Code Optimization, and Execution Cycles for Different Optimization Schemes.

LEARNING RESOURCES

Text Book:

Rulph Chassaing and Donald Reay, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", Second edition, A John Wiley and Sons, Inc., Publication. ISBN 9780471704065.

Reference Books:

1. Kuo, woon seng-s gen, "Digital Signal Processors: Architectures, Implementations, and Applications", Pearson education.
2. B. Venkataramani, M. Bhaskar, "Digital signal processors architecture, programming and applications", TMH Edition.

SP522 MULTIRATE SYSTEMS AND FILTER BANKS

Course objectives:
This course will enable students to

- To understand the basic operations of multirate system operators.
- To understand the concepts of Polyphase decomposition concept and special filters.
- To understand the concepts of 2-channel QMF bank
- To understand the concepts of 2-channel Paraunitary QMF bank
- To understand the concepts of M-channel Pseudo QMF bank.

Course outcomes:
After successful completion of the course,the students will be able to

- understand decimation and interpolation of discrete-time signals and also to create efficient realizations for upsampling and downsampling of signals using the polyphase decomposition.
- understand and apply the concepts of half band and Mth band filters.
- analyze and design the two channel QMF banks along with multirate signal processing operators.
- analyze and design the two channel FIR Paraunitary QMF banks and lattice structures.
- analyze and design the M- channel Pseudo QMF bank.

UNIT-I [11]

Fundamentals of Multirate Systems:
Basic Multirate Operations : Decimation and Interpolation,Transform domain analysis of decimators and Expanders, Interconnection of Building Blocks,The Polyphase representation, Multistage Implementations.

UNIT-II [11]

Applications of Multirate Systems:
Digital Audio system,subband coding of speech and image signals, Analog voice privacy systems,TransMultiplexers. Special Filters: Mth band filter ,half band filters and Zero phase FIR half band filters . Filter Banks: Digital filter banks and Uniform digital filter banks.

UNIT-III [12]

Maximally Decimated Filter Banks:
Errors created in the QMF Bank, A Simple Alias Free QMF System, Power Symmetric QMF Banks, M-Channel Filter Banks,Polyphase representation, Perfect Reconstruction Systems, Alias Free Filter Banks, Tree Structured Filter Banks .

UNIT-IV [12]

Paraunitary Perfect Reconstruction (PR) Filter Banks:
Lossless Transfer Matrices,Filter Bank Properties Induced by Paraunitariness, Two channel FIR Para unitary QMF Banks, The Two channel Para unitary QMF Lattice, Transform Coding and the LOT.

UNIT-V [10]

Cosine Modulated Filter Banks:
The Pseudo QMF Bank, Design of Pseudo QMF Bank, Efficient Polyphase Structures, Cosine Modulated Perfect Reconstruction Systems.

LEARNING RESOURCES

Text Book:

P.P.Vaidyanathan, "Multirate Systems and Filter Banks", Pearson Education, Low Priced Edition, 2006. ISBN 9780136057185.

REFERENCE BOOKS:

1. F.J.Harris, "Multirate Signal Processing for Communication Systems", Pearson Education, Low Priced Edition.
2. Sanjit K Mitra, "Digital Signal Processing, A computer Based Approach", Tata McGraw Hill Publishing.

SP523 WIRELESS COMMUNICATION

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Course objectives:
This course will enable students to

- know the fundamentals of cellular radio system.
- know the three basic propagation mechanisms of radio waves.
- know the effects and models of small scale fading in radio wave propagation.
- know the fundamentals of equalization techniques and also to know the advantages of diversity.
- know various standards of most commonly used wireless network systems.

Course outcomes:
After successful completion of the course,the students will be able to

- understand the fundamentals of cellular radio systems.
- understand the three basic propagation mechanisms of radio waves.
- understand the effects of small scale fading on radio wave propagation and models used to estimate it.
- understand the advantages of equalization and diversity in mobile radio communication.
- understand the most popular standards of wireless networks.

UNIT-I [10]

The Cellular Concept-System Design Fundamentals:
Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies - Prioritizing Handoffs, Practical Handoff Considerations, Interference and system capacity - Co channel Interference and system capacity, Channel planning for Wireless Systems, Adjacent Channel interference, Power Control for Reducing interference, Trunking and Grade of Service, Improving Coverage & Capacity in Cellular Systems- Cell Splitting, Sectoring .

UNIT-II [12]

Mobile Radio Propagation: Large-Scale Path Loss:
Introduction to Radio Wave Propagation, Free Space Propagation Model, Relating Power to Electric Field, The Three Basic Propagation Mechanisms, Reflection-Reflection from Dielectrics, Brewster Angle, Reflection from prefect conductors, Ground Reflection (Two-Ray) Model, Diffraction-Fresnel Zone Geometry, Knife-edge Diffraction Model, Multiple knife-edge Diffraction, Scattering, Outdoor Propagation Models- Longley-Ryce Model, Okumura Model, Hata Model, PCS Extension to Hata Model, Walfisch and Bertoni Model, Wideband PCS Microcell Model, Indoor Propagation Models-Partition losses (Same Floor), Partition losses between Floors, Log-distance path loss model, Ericsson Multiple Breakpoint Model, Attenuation Factor Model, Signal penetration into buildings, Ray Tracing and Site Specific Modeling.

UNIT-III [10]

Mobile Radio Propagation:
Small Scale Fading and Multipath Small Scale Multipath propagation-Factors influencing small scale fading, Doppler shift, Impulse Response Model of a multipath channel- Relationship between Bandwidth and Received power, Small-Scale Multipath Measurements-Direct RF Pulse System, Spread Spectrum Sliding Correlator Channel Sounding, Frequency Domain Channels Sounding, Parameters of Mobile Multipath Channels-Time Dispersion Parameters, Coherence Bandwidth, Doppler Spread and Coherence Time, Types of Small-Scale Fading-Fading effects Due to Multipath Time Delay Spread, Flat fading, Frequency selective fading, Fading effects Due to Doppler Spread-Fast fading, slow fading, Statistical Models for multipath Fading Channels-Clarke's model for flat fading, spectral shape due to Doppler spread in Clarke's model, Simulation of Clarke and Gans Fading Model, Level crossing and fading statistics, Two-ray Rayleigh Fading Model.

UNIT-IV [10]

Equalization and Diversity :
Introduction, Fundamentals of Equalization, Training A Generic Adaptive Equalizer, Equalizers in a communication Receiver, Linear Equalizers, Non-linear Equalization-Decision Feedback Equalization (DFE), Maximum Likelihood Sequence Estimation (MLSE) Equalizer, Algorithms for adaptive equalization-Zero Forcing Algorithm, Least Mean Square Algorithm, Recursive least squares algorithm. Diversity Techniques-Derivation of selection Diversity improvement, Derivation of Maximal Ratio Combining improvement, Practical Space Diversity Consideration-Selection Diversity, Feedback or Scanning Diversity, Maximal Ratio Combining, Equal Gain Combining, Polarization Diversity, Frequency Diversity, Time Diversity, RAKE Receiver.

UNIT-V [10]

Wireless Networks:
Introduction to wireless Networks, Advantages and disadvantages of Wireless Local Area Networks, WLAN Topologies, WLAN Standard IEEE 802.11,IEEE 802.11 Medium Access Control, Comparision of IEEE 802.11 a,b,g and n standards, IEEE 802.16 and its enhancements, Wireless PANs, HiperLan, WLL.

LEARNING RESOURCES

TEXT BOOKS:

Theodore.S.Rappaport, "Wireless Communications, Principles, Practice", 2nd Edition, PHI, 2002.

REFERENCE BOOK:

1. William Stallings, "Wireless Communication and Networking", PHI, 2003.
2. Upen Dalal, "Wireless Communication", Oxford Univ. Press

SP561 SIGNAL PROCESSING LAB

List Of Experiments:

1. Program to implement various spatial and frequency domain filters for images.
2. Program to implement enhancement techniques for color images.
3. Program to separate the frames in a video and process them.
4. Implementation of Digital Data Scrambler.
5. Implementation of Digital Data Descrambler.
6. Implementation of Convolution Encoder
7. Implementation of Viterbi decoder
8. Implementation of Adaptive Filter.
9. Program to calculate Average energy for a given input speech signal.
10. Program to illustrate effect of window length for a given input speech signal
11. Program to find Zero crossings for a given input speech signal
12. Program to perform Linear convolution using DSP Processor.
13. Program to perform Circular convolution using DSP Processor.
14. Program to perform FFT operation using DSP Processor.
15. Program to perform DFT operation using DSP Processor.

NOTE: A minimum of 10 (ten) experiments have to be performed and recorded by the candidate to attain eligibility for the university practical examination.

SP571 RANDOM VARIABLES & RANDOM PROCESSING

Course objective:
This course will enable students to:

- To understand the principles of random signals and random processes.
- To be acquainted with systems involving multiple random variables.
- To know random phenomena which occur in engineering applications.
- To know the relation between signals.
- To understand the applications of random variables to Statistical Signal Processing.

Learning outcomes:
After successful completion of the course,Graduates will be able to

- define probability and interpret probability by modeling sample spaces. Construct the probability distribution of a random variable, based on a real-world situation, and use it to compute expectation and variance
- compute probabilities based on practical situations using the binomial, poison, Rayleigh, exponential, uniform and normal distributions.
- understand Stationary and Ergodic process, Evaluate response of a linear system to Random Process.
- understand the relation between signals.
- analyze the effect of white Gaussian noise on passive circuits and amplifier circuits.

UNIT-I [12]

The Random Variable: Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete and Continuous, Mixed Random Variable, Distribution and Density functions, Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, Conditional Distribution, Methods of defining Conditioning Event, Conditional Density, Properties.

Operation on One Random Variable-Expectations: Introduction, Expected Value of a Random Variable, Function of a Random Variable, Moments about the Origin, Central Moments, Variance and Skew, Chebychev's Inequality, Characteristic Function, Moment Generating Function, Transformations of a Random Variable: Monotonic Transformations for a Continuous Random Variable, Nonmonotonic Transformations of Continuous Random Variable, Transformation of a Discrete Random Variable.

UNIT-II [12]

Multiple Random Variables: Vector Random Variables, Joint Distribution Function, Properties of Joint Distribution, Marginal Distribution Functions, Conditional Distribution and Density – Point Conditioning, Conditional Distribution and Density – Interval conditioning, Statistical Independence, Sum of Two Random Variables, Sum of Several Random Variables, Central Limit Theorem, (Proof not expected).

Operations on multiple random variables: Expected Value of a Function of Random Variables: Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions, Jointly Gaussian Random Variables: Two Random Variables case, N Random Variable case, Properties, Transformations of Multiple Random Variables, Linear Transformations of Gaussian Random Variables.

UNIT-III [12]

Random processes-Temporal characteristics: The Random Process Concept, Classification of Processes, Deterministic and Nondeterministic Processes, Distribution and Density Functions, concept of Stationary and Statistical Independence. First-Order Stationary Processes, Second- Order and Wide-Sense Stationary, (N-Order) and Strict-Sense Stationary, Time Averages and Ergodicity, Mean-Ergodic Processes, Correlation-Ergodic Processes, Autocorrelation Function and Its Properties, Cross-Correlation Function and Its Properties, Covariance Functions, Gaussian Random Processes, Poisson Random Process.

UNIT-IV [12]

Random processes – Spectral characteristics: The Power Spectrum: Properties, Relationship between Power Spectrum and Autocorrelation Function, the Cross-Power Density Spectrum, Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function. Noise, Narrowband Noise, Representation of Narrowband Noise in terms of In-phase and Quadrature Components, Representation of a Narrowband Noise in terms of Envelope and Phase Components.

UNIT-IV [12]

Application to Statistical Signal Processing: Estimation of random variables, innovation sequences and Kalman filtering, wiener filters for random sequences, hidden markov models.

LEARNING RESOURCES

TextBooks:

1. Peyton Z. Peebles, “Probability, Random Variables and Random Signal Principles”, TMH, 4th Edition, 2001. ISBN 9780073660073.

2. Henry Stark and John W. Woods, “Probability and Random Processes with Application to Signal Processing”, Pearson Education, 3rd Edition.

ReferencesBook:

George R. Cooper, Clave D. MC Gillem, “Probability Methods of Signal and System Analysis”, Oxford, 3rd Edition, 1999.

SP572 WAVELET SIGNAL PROCESSING

Course objectives:
This course will enable students to:

- the concepts and theory, behind wavelets their harmonic analysis, filter banks (signal processing)
- the multiresolution analysis (MAR).
- decomposition & reconstruction algorithms
- about wavelet packets and their algorithms
- Apply wavelets, filter banks, and multiresolution techniques to a problem at hand, and justify why wavelets provide the right tool.

Course outcomes:
After successful completion of the course,the students will be able to

- understand about windowed Fourier transform identify various wavelets and evaluate their time- frequency resolution properties.
- identify various wavelets and evaluate their time- frequency resolution properties.
- Implement Multiresolution Analysis.
- apply Filter bank algorithms.
- implement wavelet packets algorithms.
- analyze signal processing applications.

UNIT-I [12]

Time-Frequency analysis:
Introduction to Fourier Series, Fourier Transform, DFT, Window function, Short-time Fourier Transform, DiscreteSTFT, Continuous wavelet transform, Discrete wavelet Transform, Wavelet series, Interpretation of frequency- Time plots

UNIT-II [10]

Multi Resolution Analysis:
Multiresolution Spaces, orthogonal, Biorthogonal and Semi orthogonal Decomposition, Two-scale relation, Decomposition relation, spline functions and their properties, Mapping a function in to MRA space

UNIT-III [10]

Discrete wavelet transform and Filter bank Algoirthms:
Decimation and Interpolation, signal representation in subspace, wavelet decomposition algorithm, Reconstruction Algorithm, Changes of Bases.

UNIT-IV [10]

Digital Signal Processing Applications:
Wavelet packet, wavelet packet, Algorithm, Thresholding, Fault bearing signal Identification, 2D-Wavelet and wavelet packet algorithm

UNIT-V [8]

Image Compression, Microcalcification Cluster detection, Multicarrier communication systems, 3D Medical image visualization.

LEARNING RESOURCES

Txt Book:

Jaideva C. Goswami, Andrew K. Chan, "Fundaments of Wavelets - Theory, Algorithms and Applications", John Wiley and Sons. ISBN 9788126510320.

REFERENCE BOOKS:

1. Raghuveer M. Rao, AjitBopardika, " Wavelet Transforms - Introduction to Theory and Applications", Pearson Education, Asia .
2. RobiPolikar, enquoteWavelet Tutorial, 2ndEdition , Part-1, Part-2, PART-3.
3. Stephen G. Mallat, "A wavelet tour of signal processing", 2nd Edition Academic Press.

SP573 RADAR SIGNAL PROCESSING

Course objectives:
This course will enable students to

- know about types of radars and their working, applications at different frequencies .
- understand Radar signal models.
- understand identification and detection of fixed and moving targets using different types of radars.
- understand Doppler estimation for moving targets.
- know about coding techniques in Radars signal transmission.

Course outcomes:
After successful completion of the course,the students will be able to

- To understand the basic principles of radar communication
- Understand the radar signaling models.
- Understand pulsed radar signals.
- Understand moving target radars.
- Detection of targets in noise environment.

UNIT-I [12]

Range equation and matched filter:
Radar Block Diagram, Radar Equation, Information Available from Radar Echo, Radar Range Performance- General Radar Range Equation, Radar Detection with Noise Jamming, Beacon and Repeater Equations, Bi-static Radar. Matched filter Receive-Impulse Response Frequency Response Characteristic and its Derivation, Matched Filter and Correlation Function, Correlation Detection and Cross-Correlation Receiver. Efficiency of Non-Matched Filters, Matched Filter for Non-White Noise.

UNIT-II [8]

Signal Models:
Amplitude model, Radar cross section, Statistical description, clutter: Noise model, Signal to Noise ratio, jamming. Frequency models: Doppler shift, Spatial Models: Variation with angel cross range multipath.

UNIT-III [12]

Sampling and Quantization Of Pulsed Radar Signals:
Domain criteria for sampling radar signals ,sampling in the fast time dimension ,Sampling in slow time ,Sampling the Doppler spectrum, spatial and angel dimension ,Quantization Radar Waveforms: Waveform Matched filter of moving targets Ambiguity function, Pulse burst Waveforms. Frequency Modulated pulse compression wave forms: Introduction, significance, Types. Linear FM Pulse Compression – Block Diagram, Characteristics reduction of Side lobes, Stretch Techniques. Generation and decoding of FM Waveforms-block, schematic and characteristics of passive system, digital compression.

UNIT-IV [8]

Doppler Processing:

Moving Target Indication: Pulse cancellers, matched filters for clutter suppression, blind speeds Pulse Doppler processing: DFT of moving targets, Sampling of DTFT, Fine Doppler estimation. Pulse pair processing .Detection Fundamentals: Neynan-PearsonDetection Rule, Threshold Detection of radar signals.

UNIT-V [10]

Phase Coding Techniques:

Principles, Binary Phase Coding, Barker Codes, Maximal Length Sequences (MLS/LRS/PN), Block Diagram of a Phase Coded CW Radar. Linear FM and Frequency Coding Techniques: Principles, Linear FM pulses, Generation and Decoding, Distortion effects on LFM Signals, Discrete Frequencies, Waveform Analysis, Capabilities, Resolution properties of Frequency Coded Pulses, Side lobe Reduction, Non-Linear FM.

LEARNING RESOURCES

Text Books:

1. Mark.A.Richards, Fred E, "Fundamentals of Radar Signal Processing", TMH, 2005. (Units-I,II,III,IV). ISBN 9780071798327.
2. Nathanson, "Radar Design Principles: Signal Processing and the Environment", 2nd ed., PHI, 1999.(Unit-V). ISBN 9788120325104.

Reference Books:

1. Peyton Z. Peebles Jr, "Radar Principles", John Wiley, 2004.
2. R. Nitzberg, "Radar Signal Processing and Adaptive Systems", Artech House, 1999.
3. F.E. Nathanson, "Radar Design Principles", 1st ed., McGraw Hill, 1969.
4. M.I. Skolnik, "Introduction to Radar Systems", 3rd ed., TMH, 2001.

SP574 SIGNAL DETECTION AND ESTIMATION THEORY

Course objectives:
This course will enable students to

- To know various random processes and models
- To know the basics of detection problem
- To know the fundamentals of mean square estimation
- To know the measurements and non parametric estimation of density and distribution functions
- To know model based and model free estimation of random processes

Course outcomes:
After successful completion of the course,the students will be able to

- understand most commonly used random processes.
- understand intricacies involved in the detection problem.
- estimate mean square error with linear and nonlinear estimators.
- estimate probability distribution and densities with parametric and non parametric approaches.
- estimate the parameters of random processes.

UNIT-I [8]

Random Processes: Discrete Linear Models, Markov Sequences and Processes, Point Processes, and Gaussian Processes.

UNIT-II [12]

Detection Theory: Basic Detection Problem, Maximum A posteriori Decision Rule, Minimum Probability of Error Classifier, Bayes Decision Rule, Multiple-Class Problem (Bayes)- minimum probability error with and without equal a priori probabilities, Neyman-Pearson Classifier, General Calculation of Probability of Error, General Gaussian Problem, Composite Hypotheses.

UNIT-III [12]

Linear Minimum Mean-Square Error Filtering: Linear Minimum Mean Squared Error Estimators, Nonlinear Minimum Mean Squared Error Estimators. Innovations, Digital Wiener Filters with Stored Data, Real-time Digital Wiener Filters, Kalman Filters.

UNIT-IV [12]

Statistics: Measurements, Nonparametric Estimators of Probability Distribution and Density Functions, Point Estimators of Parameters, Measures of the Quality of Estimators, Introduction to Interval Estimates, Distribution of Estimators, Tests of Hypotheses, Simple Linear Regression, Multiple Linear Regression.

UNIT-V [10]

Estimating the Parameters of Random Processes from Data: Tests for Stationarity and Ergodicity, Model-free Estimation, Model-based Estimation of Autocorrelation Functions, Power Special Density Functions.

LEARNING RESOURCES

Text Books:

1. K.SamShanmugam, Arthur M Breiphol, "Random Signals:Detection, Estimation and Data Analysis", John Wiley and Sons, 1998. ISBN 9780471815556
2. Lonnie C. Ludeman, "Random Processes: Filtering, Estimation and Detection", Wiley India Pvt. Ltd., 2010. ISBN 9780471259756.

Reference Books:

1. M. Hays, "Statistical Digital Signal Processing and Modelling", John Willey and Sons, 1996.
2. Steven.M.Kay, "Fundamentals of Statistical SignalProcessing", Volume I Estimation Theory, Prentice Hall,USA, 1998.
3. H. L. Van Trees, "Detection, Estimation and Modulation Theory: Part I, II, and III", John Wiley, 1968.
4. Louis L.Scharf, "Statistical Signal Processing: Detection, Estimation and Time Series Analysis", Addison Wesley,1991.
5. Mischa Schwartz, Leonard Shaw, "Signal Processing: Discrete Spectral Analysis - Detection and Estimation", McGraw Hill,1975.

SP575 ADVANCED DIGITAL SIGNAL PROCESSING

Course objectives:
This course will enable students to:

- To understand multirate structures, sampling rate converters.
- To understand multirate filter banks such as two channel QMF banks.
- To understand different non-parametric techniques for power spectral estimation.
- To understand various desing techniques and realisation methods of digital filters.
- To understand different parametric techniques for power spectral estimation.

Course Outcomes:
After successful completion of the course,the students will be able to

- Design multistage decimator and interpolator.
- Design multirate filter banks.
- Estimate power spectrum using non-parametric techniques.
- Realise digital filters using lattice structures.
- Estimate power spectrum using parametric techniques.

UNIT-I [10]

Multi Rate Signal Processing:
Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design and Implementation for sampling rate conversion.

UNIT-II [10]

Applications of Multi Rate Signal Processing:
Design of Phase Shifters, Interfacing of Digital Systems with Different Sampling Rates, Implementation of Narrow Band Low Pass Filters, Implementation of Digital Filter Banks, Sub-band Coding of Speech Signals, Quadrature Mirror Filters, Trans-multiplexers, Over Sampling A/D and D/A Conversion.

UNIT-III [10]

Non-Parametric Methods of Power Spectral Estimation:
Estimation of spectra from finite duration observation of signals, Non-parametric Methods: Bartlett, Welch and Blackman-Tukey methods, Comparison of all Non-Parametric methods.

UNIT-IV [10]

Implementation of Digital Filters:
Introduction to filter structures (IIR and FIR), Frequency sampling structures of FIR, Lattice structures, Forward prediction error, Backward prediction error, Reflection coefficients for lattice realization, Implementation of lattice structures for IIR filters, Advantages of lattice structures.

UNIT-V [10]

Parametric Methods of Power Spectrum Estimation:
Autocorrelation and Its Properties,Relation between auto correlation and model parameters, AR Models - Yule-Walker and Burg Methods, MA and ARMA models for power spectrum estimation, Finite word length effect in IIR digital Filters- Finite word-length effects in FFT algorithms.

LEARNING RESOURCES

Text Books:

1. J.G.Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", 4th Ed., PHI. ISBN 9789332535893.
2. Alan V Oppenheim and R. W Schaffer, "Discrete Time Signal Processing", PHI. ISBN 9780131988422
3. Emmanuel C. Ifeacher, Barrie. W. Jervis, "DSP A Practical Approach", 2 Ed., Pearson Education.

Reference Books:

1. S.M.Kay, "Modern Spectral Estimation: Theory and Application", 1988, PHI.
2. P.P.Vaidyanathan, "Multi Rate Systems and Filter Banks", Pearson Education.
3. S.Salivahanan, A.Vallavaraj, C.Gnanapriya, "Digital Signal Processing", 2000,TMH
4. Jr. Marple, "Digital Spectral Analysis"

SP576 ADAPTIVE SIGNAL PROCESSING

Course objectives:
This course will enable students to

- present the basic principles of adaptation and various adaptive signal processing algorithms
- study methods of searching the performance surface and properties of the Quadratic Performance Surface
- study gradient estimation and its effects on Adaptation
- study LMS algorithm
- deal with adaptive filters and related linear estimation techniques such as the Kalman filters.

Course outcomes:
After successful completion of the course,the students will be able to

- Comprehend design criteria and modeling adaptive systems and theoretical Performance evaluation and design a linear adaptive processor.
- Apply mathematical models for error performance and stability.
- Apply adaptive modeling systems for real time applications.
- Comprehend the estimation theory for linear systems and modeling algorithms.
- Design Kalman filter and extended Kalman filter.

UNIT-I [8]

ADAPTIVE SYSTEMS:
Definition and Characteristics, Areas of Application, General Properties, Open- and Closed-Loop Adaptation, Applications of Closed-Loop Adaptation, Example of an Adaptive System.

THE ADAPTIVE LINEAR COMBINER: General Description, Input Signal and Weight Vectors, Desired Response and Error, The Performance Function, The Performance Function , Gradient and Minimum Mean-Square Error, Example of a Performance Surface,Alternative Expression of the Gradient.

UNIT-II [12]

PROPERTIES OF THE QUADRATIC PERFORMANCE SURFACE:
Normal Form of the Input Correlation Matrix , Eigenvalues and Eigenvectors of the Input Correlation Matrix, An Example with Two Weights , Geometrical Significance of Eigenvectors and Eigenvalues.

SEARCHING THE PERFORMANCE SURFACE: Methods of Searching the Performance Surface,Basic Ideas of Gradient Search Methods , A Simple Gradient Search Algorithm and Its Solution , Stability and Rate of Convergenc ,The Learning Curve , Gradient Search by Newton's Method ,Newton's Method in Multidimensional Space,Gradient Search by the Method of Steepest Descent,Comparison of Learning Curves.

UNIT-III [11]

GRADIENT ESTIMATION AND ITS EFFECTS ON ADAPTATION:
Gradient Component Estimation by Derivative Measurement ,The Performance Penalty,Derivative Measurement and Performance Penalties with Multiple Weights , Variance of the Gradient Estimate ,Effects on the Weight-Vector Solution,Excess Mean-Square Error and Time Constants , Misadjustment , Comparative Performance of Newton's and Steepest-Descent Methods , Total Misadjustment and Other Practical Considerations.

UNIT-IV [11]

THE LMS ALGORITHM:
Derivation of the LMS Algorithm, Convergence of the Weight Vector, An Example of Convergence, Learning Curve, Noise in the Weight-Vector Solution , Misadjustment

APPLICATIONS: Adaptive Modelling of a Multipath Communication Channel, Adaptive Modelling in Geophysical Exploration, Adaptive Modelling in FIR Digital Filter Synthesis.

UNIT-V [11]

KALMAN FILTERS:
Recursive Mean Square Estimation for Scalar Random Variables, Statement of Kalman Filtering Problem, Innovation Process. Estimation of State using the Innovation Process, Filtering, Initial Conditions, Summary of Kalman Filters, Variants of the Kalman Filtering the Extend Kalman Filtering.

LEARNING RESOURCES

Text Books:

1. Bernand Widrow& Samuel D.Stearns, "Advaptive Signal Processing", Pearson Education,2006. (Units: I,II,III,IV). ISBN 978013000299.

2. Simon Haykins, "Adaptive filter Theory", Pearson Education (Unit-V). ISBN 9780130901262.

Reference Books:

1. Sophocles J. Orfamidis, "Optimum Signal Processing - An Introduction", 2nd Edition, McGraw Hill

2. S.Thomas Alexander, "Adaptive Signal Processing - Theory and Applications", Springer - Verlag.

SP577 PATTERN RECOGNITION

COURSE OBJECTIVES:
This course will enable students to

- To introduce pattern recognition and the probability concepts related to it.
- To provide knowledge on linear classification.
- To provide knowledge on neural networks.
- To introduce linear discriminant functions and SVM.
- To introduce Algorithm independent machine learning and Unsupervised learning.

Learning outcomes:
After successful completion of the course,the students will be able to

- Understand design cycle, Applications of pattern recognition and the probability concepts related to pattern recognition.
- Understand the parametric and linear models for classification.
- Design neural network and train them.
- Understand linear discriminant functions and working of SVM.
- Develop machine independent learning techniques and unsupervised learning techniques.

UNIT-I [10]

Introduction to Pattern Recognition: Problems, applications, design cycle, learning and adaptation, examples, Probability theory, Linear algebra, Probability Distributions.
Bayesian Decision Theory - Bayes rule, Minimum-Error-Rate Classification, Classifiers, Discriminants and Decision Surfaces.

UNIT-II [8]

Maximum likelihood and Bayesian parameter Estimation : Maximum Likelihood Estimation - The General Principle, The Gaussian Case, Bayesian estimation - The Class-Conditional Densities, The Parameter Distribution.
Linear models: Linear Models for Regression, linear regression, logistic regression, Linear Models for Classification.

UNIT-III [11]

Neural Network : Introduction, Early models, perceptron, multi-layer perceptron, backpropagation algorithm, error surfaces, practical techniques for improving backpropagation, additional networks and training methods, Adaboost, Deep Learning.

UNIT-IV [11]

Linear discriminant functions : Linear discriminant functions - Decision surfaces, two-category, multi-category, minimum squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine.

UNIT-V [12]

Algorithm independent machine learning : Lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers.
Unsupervised learning and clustering : K-means clustering, fuzzy K-means clustering, hierarchical clustering.

LEARNING RESOURCES

Text Books:

1. Richard O. Duda, Peter E. Hart, David G. Stork - "Pattern Classification", 2nd Edition John Wiley & Sons, 2001. (Unit-I, III,IV & V).

2. C.Bishop - "Pattern Recognition and Machine Learning", Springer, 2006. (Unit-II).

Reference Books:

1. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman - "The Elements of Statistical Learning", 2nd Edition, Springer, 2009.

2. Tom Mitchell - "Machine Learning", First Edition, McGraw- Hill, 1997.

SP578 VIDEO PROCESSING

Course objectives:

- To learn the standards of analog video and digital video formats.
- To know the sampling process of video signal and also to convert a digital video signal from one format to another.
- To learn different parametric models, principles and methods of motion/optical flow estimation.
- To learn different video coding techniques used for the communication systems.
- To learn different types of video compression standards while comparing their intended applications and relative performance.

Course outcomes:
After successful completion of the course,the students will be able to

- Understand the standards of analog video and digital video formats.
- Analyze the sampling process of video signal and also to convert a digital video signal from one format to another.
- Understand about different parametric models that describes the real world and image generation process.
- Analyze different video coding techniques.
- Understand different types of video compression standards while comparing their intended applications and relative performance.

UNIT-I [11]

Video formation, perception and representation – color perception and specification – video capture and display – Analog video raster – Analog color television systems, Digital video, Frequency Domain characterization of Video Signals.

UNIT-II [11]

Video sampling – Basics of the Lattice theory, Sampling of Video Signals, Conversion of Signals Sampled on Different Lattices, Sampling Rate Conversion of Video Signals.

UNIT-III [11]

Video modeling-Camera model, Illumination model, Object model and Scene model, Two dimensional models, Two Dimensional motion estimation-Types, Optical Flow, Pixel Based Motion, Block matching Algorithm.

UNIT-IV [12]

Waveform Based Video Coding- Region based video coding, Object based video coding, Predictive coding, Video coding using Temporal prediction and transform coding, Content Dependent Video Coding – Two dimensional shape coding, Texture coding for Arbitrarily shaped Regions.

UNIT-V [10]

Video Compression Standards- Standardization, Video Telephony with H.261 and H.263, Standards for Visual Communication systems, Consumer Video Communications with MPEG-I, Digital TV with MPEG-2, Coding of Audio Visual Objects with MPEG-4, Multimedia Content Description using MPEG-7.

LEARNING RESOURCES

Text Book:

Yao Wang, J.Ostermann, Ya Zhang, "Video Processing and Communication", 1st edition, Prentice Hall, 2001. ISBN 9780130175472.

Reference Book:

Woods, "Multidimensional, signal, image and video processing and coding", Elsevier, Academic press, 2006.

SP579 SMART ANTENNAS

Course objective:
This course will enable students to

- provide Basic Knowledge on Smart Antennas, Configurations, and their Architectures
- provide knowledge on mutual coupling effects in smart antennas.
- provide the Knowledge on DOA estimation methods .
- understand the Smart Antennas Design Techniques and Mutual Coupling Effects.
- understand and analyze space - time Processing Techniques.

Course outcomes:
After successful completion of the course,the students will be able to

- demonstrate the Smart Antenna Configurations and their architectures.
- analyse mutual coupling effects in smart antennas.
- perform different DOA estimation methods.
- analyze Adoptive Signal Processing Algorithms and Mutual Coupling Effects.
- demonstrate Different Space – Time Processing Methods networks.

UNIT-I [11]

Smart Antennas:
Introduction, Need for smart antennas, Overview, Smart Antenna Configurations, Switched-beam Antennas, Adaptive Antenna Approach, Space Division Multiple Access (SDMA), Architecture of a Smart Antenna System, Receiver, Transmitter, Benefits and Drawbacks, Basic Principles, Mutual Coupling Effects.

UNIT-II [11]

DOA Estimation Fundamentals:
Introduction, Array Response Vector, Received Signal Model, Subspace-Based Data Model, Signal Auto covariance, Conventional DOA Estimation Methods, Conventional Beamforming Method, Capon's Minimum Variance Methods, Subspace Approach to DOA Estimation, MUSIC Algorithm, ESPRIT Algorithm, Uniqueness of DOA Estimates.

UNIT-III [11]

Beam forming Fundamentals:
Classical Beam former, Statistically Optimum Beamforming Weight Vectors, Maximum SNR Beam former, Multiple Sidelobe Canceller and Maximum, SINR Beam former, Minimum Mean Square Error (MMSE), Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV), Adaptive Algorithms for Beamforming.

UNIT-IV [11]

Integration and Simulation of Smart Antennas:
Overview, Antenna Design, Mutual coupling, Adaptive Signal Processing Algorithms, DOA Adaptive Beam forming, Beam forming and Diversity Combining for Rayleigh-Fading, Channel, Trellis-coded Modulation (TCM) for Adaptive Arrays, Smart Antennas Systems for Mobile Ad Hoc Networks (MANETs) Protocol, Simulations.

UNIT-V [11]

Space – Time Processing:
Introduction, Discrete Space – Time Channel and Signal Models, Space – time beam forming Intersymbol and Co-Channel Suppression, Space – Time Processing for DS- CDMA, Capacity and Data Rates in MIMO Systems

LEARNING RESOURCES

Text Books:

1. Constantine A,balanis and Panayiotis I.Loannides, "Introduction to Smart Antennas", Morgan and Claypool Publishers Series,2007. ISBN 9781598291773.

2. Joseph C.Liberti, Jr.Theodore S Rappaport, "Smart Antennas for Wireless Communications IS-95 and third Generation CDMA Applications, PTR", 1st Edition, PH publishers, 1989. ISBN 9780137192878.

ReferencesBooks:

1. T.S.Rappaport, "Smart Antennas Adaptive Arrays Algorithms and Wireless Position Location", IEEE Press 1998, PTR-PH publishers 1999

2. Lal Chand godara, "Smart Antennas", CRC Press, LLC, 2004.

SP580 MICROWAVE MEASUREMENTS

Course objectives:
This course will enable students to understand the measurement of

- wavelength and frequency using different techniques.
- VSWR, impedance using smith chart.
- Scattering coefficients and directive of microwave devices.
- attenuation and microwave power at microwave frequencies.
- parameters relating to antenna at microwave frequencies.

Course outcomes:
After successful completion of the course,the students will be able to

- measure wavelength and frequency at microwave frequencies.
- measure ESWR, impedance using microwave techniques and smith chart.
- measure scattering coefficient and directivity for a given microwave devices.
- measure attenuation and microwave power and microwave frequencies.
- measure various parameters of an antenna at microwave frequencies.

UNIT-I [11]

Measurement of wavelength and frequency, Equivalent circuit of the cavity wave meters, Typical wave meters, Resonant cavities.
Methods of Frequency Measurements: Direct measurement, Interpolation method, Additive frequency method.

UNIT-II [11]

Measurement of Impedance :
Constructional details of slotted section and its limitations, standing wave detector, Techniques in standing wave detector measurements, Measurement of low and high VSWR., Location of voltage minims, Use of Smith chart in impedance measurements, Errors in standing wave detector impedance measurements, Reflectometers. Dielectric Measurement for Solids.

UNIT-III [11]

Measurements on Microwave circuits and components, T and P network, Measurement of scattering coefficients, Graphical determination of scattering coefficients, Coupling and Directivity of directional coupler.

UNIT-IV [11]

Measurement of Attenuation:
Insertion of Power ratio method, substitution method, scattering coefficient method, Return Loss.
Measurement of Power:
Methods of power measurement, Typical barrette elements, thermistor, bolometer bridge circuits, Extending the range of Bolometer devices, Crystal Detector.

UNIT-V [11]

Antenna Measurements:
Measurement of radiation patterns, Antenna gain measurements, Antenna impedance Measurements, Polarization Measurements.

LEARNING RESOURCES

Text Books:

1. E.L. Ginzton, "Microwave Measurements", McGraw Hill. ISBN 9781258279585.
2. Annapurna Das and Sisir K Das, "Microwave Engineering", TMH, 2000. ISBN 9789332902879.
3. P. Rizzi, "Microwave Engineering Passive Circuits", Prentice Hall, 1987. ISBN 9780135867020.
4. D.M. Pozar, "Microwave Engineering", John Wiley, 1998. ISBN 9780470631553.

Reference Books:

1. M.L. Sisodia and GS Raghuvanshi, "Basic Microwave Techniques and Laboratory Manual", Wiley Eastern, 1987.
2. Dennis Roddy, "Microwave Technology", PHI, 1986

SP581 OFDM FOR WIRELESS COMMUNICATION SYSTEMS

Course objective:
This course will enable students to

- describe the evolution of radio technologies and applications of OFDM.
- list the key attributes of OFDM and understand the frequency domain orthogonality.
- describe the principles in OFDM modulation and channel modeling.
- describes OFDM in wideband channels.
- analyze the effect of time & frequency domain synchronization in OFDM.

Course outcomes:
After successful completion of the course,the students will be able to

- know the role of OFDM in developing wireless WWAN,WLAN,WPAN
- know different channel models for OFDM systems
- know the OFDM performance over AWGN channel
- analyze both OFDM frequency and time domain synchronization
- know PAPR reduction techniques

UNIT-I [12]

Introduction
Wireless Technology in the Future- Orthogonal Frequency-Division Multiplexing- WLANs: MAC in WLAN Standards, QoS over WLANs, Security in IEEE 802.11- WPANs: Technical Challenges of a WPAN Technology, Enabling Technologies.

UNIT-II [10]

Basics of OFDM: Introduction, Principles of QAM-OFDM, Modulation by DFT
Channel Model for OFDM Systems: Introduction, Characterization of the Mobile Radio Channel, FD Channel Modeling, FD Channel Simulation,Application to Millimeter-Wave Radio Channels.

UNIT-III [10]

OFDM Transmission overwideband channels:
Evolution and Applications of OFDM - Choice of OFDM – Modulation - Performance over AWGN channels - Clipping amplification – A/D conversion - Phase noise - Wideband channel models - Effects of time dispersive channels - Channel transfer function estimation

UNIT-IV [10]

OFDM Time and Frequency domain Synchronization:
System Performance with Frequency and Timing Errors,Synchronization Algorithms, Comparison of Frequency Acquisition Algorithms, BER performance with frequency synchronization.

UNIT-V [8]

Peak Power Problem:
Introduction, Distribution of the PAPR, Clipping and Peak Windowing: Required Back-off with a Non ideal Power Amplifier, Coding and Scrambling, Peak Cancellation, PAPR Reduction Codes.

LEARNING RESOURCES

Text Books:

1. Ramjee Prasad, "OFDM for wireless Communication Systems", Artech House Publishers, 2004. (Units I,II,V). ISDN 9781630812072.

2. LajosHanzo, M.Yunster, B.J.Choi and T. Keller, "OFDM and MC-CDMA for Broadband Multiuser Communication, WLANs and broadcasting", John Wiley and Sons, IEEE press, 2003. (Units-III,IV). ISDN 9780470858790.

Reference Books:

1. Henrik Schulze and Christian Lueders, "Theory and Applications of OFDM and CDMA", John Wiley and Sons, Ltd, 2005.

2. L. Hanzo, M. Münster, B.J. Choi and T. Keller, "OFDM and MC-CDMA for broadband multiuser communication, WLANs and broadcasting", John Wiley and Sons, 2012.

3. Richard D. J. Van Nee and Ramjee Prasad, "OFDM for Wireless Multimedia Communication", Artech House, 1999.

SP582 GLOBAL POSITIONING SYSTEMS

Course Objective:
This course will enable students to

- To To understand the evolution of GPS
- To Know the GPS signals and various global navigational satellite systems such as GPS, GALILEO
- To Understand different coordinate systems in GPS.
- To Understand the GPS orbits and satellite position determination
- To Understand the various errors sources in GPS.

Course Outcomes:
After successful completion of the course,the students will be able to

- Explore the evolution of GPS
- Distinguish between various global navigational satellite systems
- Represent various coordinate systems used in GPS
- Apply GPS for civilian and military applications
- Perform various error sources in GPS receivers

UNIT-I [11]

Overview of GPS : Basic concept, system architecture, space segment, user segment, GPS aided Geo-augmented navigation (GAGAN) architecture.

UNIT-II [11]

Overview of GPS :GPS Signals, Signal structure, anti spoofing (AS), selective availability, Difference between GPS and GALILEO satellite construction.

UNIT-III [11]

GPS coordinate frames, Time references : Geodetic and Geo centric coordinate systems, ECEF coordinate world geodetic 1984 (WGS 84), GPS time.

UNIT-IV [11]

GPS orbits and satellite position determination : GPS orbital parameters, description of receiver independent exchange format (RINEX) – Observation data and navigation message data parameters, GPS position determination.

UNIT-V [11]

GPS Errors : GPS error sources – clock error, ionospheric error, tropospheric error, multipath, ionospheric error estimation using dual frequency GPS receiver.

LEARNING RESOURCES

Text Book:

B. Hoffman, Wellenhof, H. Liehtenegger and J. Collins, “GPS - Theory and Practice”, Springer-Wien, New York (2001). ISBN 9783211824771.

Reference Book:

James Ba, Yen Tsui, “Fundamentals of GPS receivers – A software approach”, John Wiley and Sons, 2001.

SP583 SPREAD SPECTRUM COMMUNICATIONS

Course objectives:
This course will enable students to

- understand the concept of Spread Spectrum and study various types of Spread spectrum sequences and their generation.
- understand the principles of Code Division Multiple Access (CDMA) and use of Spread spectrum concept in CDMA
- understand various Code tracing loops for optimum tracking of wideband signals viz spread spectrum signals
- understand the procedure for synchronization of receiver for receiving the Spread spectrum signal.
- study the performance of spread spectrum systems in Jamming environment, systems with Forward Error Correction and Multiuser detection in CDMA cellular radio.

Course outcomes:
After successful completion of the course,the students will be able to understand the

- types of spread spectrum and means of generating spread spectrum
- role of tracking loops with respect to spread spectrum communications
- means of synchronization in spread spectrum communications
- principles of CDMA signal and detection methods
- performance of spread spectrum in jamming environments

UNIT-I [10]

Introduction to Spread Spectrum Systems: Fundamental Concepts of Spread Spectrum Systems, Pseudo Noise Sequences, Direct Sequence Spread Spectrum, Frequency Hop Spread Spectrum, Hybrid Direct Sequence Frequency Hop Spread Spectrum, Code Division Multiple Access.
Binary Shift Register Sequences for Spread Spectrum Systems:Introduction, Definitions, Mathematical Background and Sequence Generator Fundamentals, Maximal Length Sequences, Gold Codes.

UNIT-II [10]

Code Tracking Loops: Introduction, Optimum Tracking of Wideband Signals, Base Band Delay-Lock Tracking Loop, Tau-Dither Non- Coherent Tracking Loop, Double Dither Non-Coherent Tracking Loop.

UNIT-III [12]

Initial Synchronization of the Receiver Spreading Code: Introduction, Problem Definition and the Optimum Synchronizer, Serial Search Synchronization Techniques, Synchronization using a Matched Filter, Synchronization by Estimated the Received Spreading Code.

UNIT-IV [12]

Cellular Code Division Multiple Access (CDMA) Principles: Introduction, Wide Band Mobile Channel, The Cellular CDMA System, Single User Receiver in a Multi User Channel, CDMA System Capacity.
Multi-User Detection in CDMA Cellular Radio: Optimal Multi-User Detection, Linear Suboptimal Detectors, Interference Combat Detection Schemes, Interference Cancellation Techniques.

UNIT-V [12]

Performance of Spread Spectrum Systems in Jamming Environments: Spread Spectrum Communication System Model, Performance of Spread Spectrum Systems without Coding. Performance of Spread Spectrum Systems with Forward Error Correction: Elementary Block Coding Concepts, Optimum Decoding Rule, Calculation of Error Probability, Elementary Convolution Coding Concepts, Viterbi Algorithm, Decoding and Bit-Error Rate.

LEARNING RESOURCES

Text Books:

1. Rodger E Ziemer, Roger L. Peterson and David E Borth, “Introduction to Spread Spectrum Communication”, Pearson Education, 1st Edition, 1995.

2. Mosa Ali Abu-Rgheff, “Introduction to CDMA Wireless Communications”, Elsevier Publications, 2008. ISBN 9780750652520.

Reference Books:

1. George R. Cooper, Clare D. Mc Gillem, “Modern Communication and Spread Spectrum”, McGraw Hill, 1986.

2. Andrew j. Viterbi, “CDMA : Principles of spread spectrum communication”, Pearson Education, 1 st Edition, 1995.

SP584 DATA COMMUNICATIONS

Course objectives:
This course will enable students to know

- protocols used in data communication networks
- digital T carrier signals and systems
- signal and instruments used in telephone networks
- switching hierarchies used in public telephone network

Course outcomes:
After successful completion of the course,the students will be able to understand the

- components, interfaces and modems used in data communication networks
- types of protocols used and their role in data communication networks
- format of T carrier signals
- hardware components used in telephone networks
- necessity of switching hierarchies in public telephone network

UNIT-I [10]

Introduction to Data Communications and Networking: History of Data communications, Data Communications Network Architecture, Protocols and Standards, Standards Organisations for Data Communications, Layered Network Architecture, Systems Interconnection, Data Communications Circuits, Serial and Parallel Data Transmission, Data Communications Circuit Arrangements, Data Communications Networks, Alternative Protocol Suites.
Fundamental Concepts of Data Communications: Data Communicstions Codes, Character Synchronization, Data Communicstions Hardware, Data Communications Circuits, Line Control Unit, Serial Interfaces, Data Communications Modems.

UNIT-II [12]

Data Link Protocols and Data Communications Networks: Data Link Protocol Functions, Character and Bit Oriented Data Link Protocols, Asynchronous Data Link Protocols, Synchronous Data Link Protocols, Synchronous Data Link Control, High Level Data Link Control, Public Switched Data Networks, X.25 User to Network Interface Protocol, Integrated Services Digital Network, Asynchronous Transfer Mode, Local Area Networks, Ethernet.

UNIT-III [12]

Digital T-Carriers and Multiplexing: Time Division Multiplexing, T1 Digital Carrier, North American Digital Hierarchy, Digital Carrier Line Encoding, T Carrier Systems, Digital Carrier Frame Synchronization, Bit Versus Word Interleaving, Frequency Division Multiplexing, FDM Hierarchy, Formation of a Master group.

UNIT-IV [8]

Telephone Instruments and Signals: The Subscriber Loop, Standard Telephone Set, Basic Telephone Call Procedures, The Local Subscriber Loop, Voice Frequency Circuit Arrangements, Crosstalk.

UNIT-V [8]

The Public Telephone Network: Telephone Transmission Environment, Instruments, Local Loops, Trunk Circuits, and Exchanges, Local Central Office Telephone Exchanges, Operator Assisted Local Exchanges, Automated Central Office Switches and Exchanges, North American Telephone Switching Hierarchy, SS7 and The North American Switching Hierarchy .

LEARNING RESOURCES

Text Books:

Wayne Tomasi, "Advanced Electronic Communications Systems", 6th Edition, Pearson Education, 2004. ISBN 9780130453501.

Reference Books:

1. Stallings W., "Data and Computer Communications", 7th Edition, PHI, 2007.
2. Tananbaum A.S., "Computer Networks", 3rd Edition, PHI, 1999.

SP585 SATELLITE COMMUNICATION SYSTEMS

Course objectives:
This course will enable students to

- understand the orbital aspects of satellite communication
- understand satellite subsystems and multiple access techniques used in satellite communication
- provide an ability to design satellite links and earth stations
- understand the concept of satellite packet switching
- understand the implementation of VSAT system

Course outcomes:
After successful completion of the course,the students will be able to

- Locate satellite in the orbit and assess the orbital effects on satellite communicaitons
- Analyze the various parameters related to multiple access techniques
- Perform and verify link budget calculations
- Various message transmission in satellite packet communications
- Know the functioning of VSAT systems

UNIT-I [11]

INTRODUCTION AND ORBITAL ASPECTS OF SATELLITE COMMUNICATIONS:
A brief history of Satellite Communications, Types of Orbits, Orbital Mechanics: Developing the Equation of the orbit, Kepler's laws of planetary motion, locating the satellite in the orbit, locating the Satellite with respect to the Earth, Orbital elements, Look angle determination, Orbital perturbations, launch and launch vehicles, Orbital effects in Communication System performance.

UNIT-II [11]

SATELLITE SUBSYSTEMS: Introduction, Attitude and Orbit Control System (AOCS), Telemetry, Tracking, Command and Monitoring (TTC&M), Power Systems, Communication Subsystems, Satellite Antennas.
MULTIPLE ACCESS TECHNIQUES: Introduction, FDMA, TDMA, DAMA and CDMA Satellite Systems Encoder, Decoder, Comparison between FDMA, TDMA & CDMA.

UNIT-III [11]

SATELLITE LINK DESIGN : Basic transmission theory,System Noise Temperature and G / T ratio, Design of Uplink and Down link models, Design of Satellite links for specified C / N ratio.
EARTH STATION TECHNOLOGY : Earth Station Design, Design of large antennas, Small earth station Antennas, Propagation Effects on Satellite: Quantifying Attenuation and Depolarization, Rain and Ice Effects, Prediction of Rain Attenuation..

UNIT-IV [11]

SATELLITE PACKET COMMUNICATIONS : Message transmission by FDMA: The M/G/1 Queue, Message transmission by TDMA - Pure ALOHA: Satellite packet switching - slotted ALOHA -Packet Reservation – Tree algorithm.

UNIT-V [11]

VSAT SYSTEMS :
Introduction, overview of VSAT Systems, Network Architectures, One – way Implementation, Split – Two-Way (Split IP) Implementation, Two-Way Implementation, Access Control Protocols, Delay Considerations, Basic Techniques: Multiple Access Selection, Signal Formats, Modulation, Coding, and Interference Issues.

LEARNING RESOURCES

Text Books:

1. T Pratt and W Bostiain, “Satellite Communications”, 2nd Edition, John Wiley. ISBN 9780471370079.
2. Tri T. Ha, “Digital Satellite communications”, 2nd Edition, McGraw Hill. ISBN 9780070077522.
3. Taub and Schilling, “Principles of Communication Systems”, TMH, 2003. ISBN 9780070648111.
4. Simon Haykin, “Communication Systems”, 4th Edition, John Wiley & Sons, 2004. ISBN 9788126509041.

Reference Books:

1. D C Agarwal, “Satellite Communications”, Khanna Publishers, 2003
2. Robert M Gagliardi, “Satellite Communications”

SP586 FIBRE OPTIC COMMUNICATION

Course objectives:
This course will enable students to understand the

- basic structures of optical fibre and the preferable materials for the fibre and also understand the concepts of various losses in a fibre.
- basic operations of Light sources and detectors.
- structures of Wavelength division multiplexing.
- operation and the structures of optical Networks.
- concepts of measurements in a fibre.

Course outcomes:
After successful completion of the course,the students will be able to

- understand the various types of fiber structures and fibre materials
- understand and analyze the structures of light sources and detectors.
- understand the operation of optical receiver, various pre amplifiers & WDM components.
- understand the operation of SONET/SDH networks.
- understand the concepts of fibre measurements.

UNIT-I [11]

Optical Fibers: Optical Fiber Modes and Configurations: Fiber Types, Rays and Modes, Step-Index Fiber Structure, Graded – Index Fiber Structure. Fiber materials: Glass Fibers, Plastic Optical Fibers, Signal Degradation in Optical Fibers.
Attenuation:
Attenuation Units, Absorption, Scattering Losses, Bending Losses, Core and Cladding Losses. Signal Distortion in Optical Waveguides: Information Capacity Determination, Group Delay, Material Dispersion, Waveguide Dispersion, intermodal Dispersion..

UNIT-II [11]

Optical Sources: Efficiency, Resonant F Light-Emitting Diodes (LEDs), LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation of an LED. Laser Diodes: Laser Diode Modes and Threshold Conditions, Laser Diode Rate Equations, External Quantumrequencies, Laser Diode Structures and Radiation Patterns, Single-Mode Lasers.

Photo detectors: Physical Principles of Photodiodes, The pin Photo detector, Avalanche Photodiodes, Photo detector Noise, Detector Response Time.

UNIT-III [11]

Optical Receiver Operation: Fundamental Receiver operation, Digital Signal Transmission, Error Sources, Receiver Configuration, Preamplifiers.
Digital Transmission Systems: Point –to-Point Links, System Considerations, Link Power Budget, Rise – Time Budget WDM Concepts and Components.

Operational Principles of WDM: Passive Components, The 2 x 2 Fiber Coupler, Scattering Matrix Representation, The 2 x 2 Waveguide Coupler, Star Couplers ,MZI Multiplexers.

UNIT-IV [11]

Optical Networks: Basic Networks, Network Topologies, Performance of Passive Linear Buses Performance of Star Architectures.
SONET/SDH: Transmission Formats and Speeds, Optical Interfaces, SONET / SDH Rings, SONET / SDH Networks, FDDI Optical fiber.

UNIT-V [11]

Measurements: Introduction, Fiber attenuation measurements, Fiber dispersion measurements, Fiber cutoff wavelength measurements, Fiber numerical aperture measurements, Optical Time Domain Reflectometer (OTDR).

LEARNING RESOURCES

Text Books:

1. Gerd Keiser, "Optical Fiber Communications", 3rd Edition, McGraw Hill. ISBN 9787040111736.
2. John M.Senior, "Optical Fiber Communications", 2nd Edition, PHI. ISBN 0136354262.

Reference Books:

1. 1986

SP587 EMBEDDED SYSTEMS

Course Objectives:
This course will enable students to

- familiar with the concepts necessary for designing sophisticated embedded systems.
- study interrupt servicing mechanism and IPC.
- exposed to the basic concepts of real time Operating system.
- learn RTOS Programming.
- exposed to case studies of program modeling using μ COS-II.

Course Outcomes:
After successful completion of the course,the students will be able to

- Understand hardware components of embedded system.
- Explain interrupt servicing and handling mechanism and Understand important aspects of real - time programming like inter-process communications
- Describe RTOS concepts
- Describe the RTOS tool μCOS-II.
- Describe sophisticated Embedded systems

UNIT-I [8]

Introduction to Embedded Systems : Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software in a System, Examples of Embedded Systems, Design Process in Embedded System, Design Process and Design Examples, Classification of Embedded Systems, Skills Required for an Embedded System Designer.

UNIT-II [12]

Device Drivers and Interrupt Servicing Mechanism : Programmed-l/O Busy-wait Approach without Interrupt Service Mechanism, ISR Concept, Interrupt Sources, Interrupt Servicing (Handling) Mechanism, Multiple Interrupts, Context and the Periods for Context Switching, Interrupt Latency and Deadline, Direct Memory Access, Device Driver Programming.

Inter-Process Communication and sychronization of processess Threads and Tasks: Multiple Processes in an Application, Threads in an Application ,Tasks ,Task States ,Task and Data ,Clear-cut Distinction between Functions, ISRS and Tasks by their Characteristics Concept of Semaphores, Shared Data, Interprocess Communication, Signal Function, Semaphore Functions, Message Queue Functions.

UNIT-III [10]

Real-Time Operating Systems: OS Services, Interrupt Routines in RTOS Environment and Handling of Interrupt Source Calls, Real-time Operating Systems, Basic Design Using an RTOS. RTOS Task Scheduling Models, Interrupt Latency and Response of the Tasks as Performance Metrics: Cooperative Scheduling Model, Cyclic and Round robin with Time slicing Scheduling Models, Preemptive Scheduling Model.

UNIT-IV [11]

Real-TimeOperating System Programming-1- Microc/OS-II : Basic Functions and Types of RTOSES, RTOS μ COS-II.

UNIT-V [11]

Design Examples and Case Studies Of Program Modelling and Programing with RTOS-1 : Case Study of Embedded System Design and Coding for an Automatic Chocolate Vending Machine (ACVM) Using Mucos RTOS, Case Study of Digital Camera Hardware and Software Architecture.

LEARNING RESOURCES

TextBook:

Raj Kamal, "Embedded Systems: Architecture, Programming and design", Second Edition, Tata McGraw Hill Education Private Limited. ISBN 9780070151253.

Reference Books:

1. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2009.
2. David E. Simon, "An Embedded software primer by ", Pearson Education.
3. K.V.K.K. Prasad, "Embedded / Real-time systems: Concepts, Design and programming Black book", Dreamtech press

SP588 OPTIMIZATION TECHNIQUES

Course objective:
This course will enable students to

- understand the theory of optimization methods
- algorithms developed for solving various types of optimization problems
- apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems
- apply the various algorithms
- apply natural process in optimization techniques

Course outcomes:
After successful completion of the course,the students will be able to

- understand optimization problem with single and multi variables.
- solve a multi-objective problem through weighted and constrained methods.
- interpret programming problems.10
- understand different algorithms.
- understand Genetic algorithm.

UNIT-I [10]

Classical Optimization Techniques Single variable optimization – Multivariable optimization with no constraints – Hessian matrix – Multivariable saddle point – Optimization with equality constraints – Lagrange multiplier method – Multivariable optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT-II [12]

One dimensional unconstrained minimization, Elimination methods – unrestricted search method – Fibonacci method – Interpolation methods – Quadratic interpolation and cubic interpolation methods, Unconstrained minimization, Gradient of a function – steepest descent method – Newton's method – Powell's method – Hooke and Jeeve's method.

UNIT-III [10]

Integer – Linear programming problem Gomory's cutting plane method – Gomory's method for all integer programming problems, mixed integer programming problems, Network techniques.

UNIT-IV [10]

Shortest path model –Dijkstra's algorithm – Floyd's algorithm – minimum spanning tree problem – PRIM algorithm – Maximal flow problem algorithm.

UNIT-V [10]

Genetic Algorithms, Basic Concepts, Working Principle, Encoding, Fitness Function, Reproduction.

LEARNING RESOURCES

Text Books:

1. Singiresu S. Rao, "Optimization theory and application", 4th ed., John Wiley and Sons. ISBN 9780470183526.

2. S.Rajasekaran, G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Applications", Prentice Hall of India,2007. ISBN 9788120321861.

Reference Books:

A. D.Belegundu, T.R.Chandrupatla, "Optimisation concepts and applications in Engineering", Pearson Education Asia.

SP589 ARTIFICIAL NEURAL NETWORKS

Course objectives:
This course will enable students to

- understand supervised and unsupervised learning in neural networks.
- familiar with Signal Layer perceptron.
- understand multilayer feed forward networks and error back-propagation training.
- study associative memories.
- study Self-organizing networks.

Course outcomes:
After successful completion of the course,the students will be able to

- Understand basic neural network architecture their learning rules.
- Design feedforward single-layer architectures with continuous perceptron.
- Understand generalized delta learning rule using steepest descent minimization rule.
- Understand Hopfield model of content-addressable memory.
- Understand unsupervised learning for architectures such as MAXNET and ART.

UNIT-I [11]

Artificial Neural Systems: Preliminaries
Neural Computation: Some Examples and Applications , History of Artificial Neural Systems Development.

Fundamental Concepts and Models of Artificial Neural Systems:
Biological Neurons and Their Artificial Models, Models of Artificial Neural Networks, Neural Processing, Learning and Adaptation, Neural Network Learning Rules, Overview of Neural Network.

UNIT-II [10]

Single-Layer Perceptron Classifiers:
Classification Model, Features, and Decision Regions , Discriminant Functions , Linear Machine and Minimum Distance Classification , Nonparametric Training Concept , Training and Classification Using the Discrete Perceptron , Single-Layer Continuous Perceptron Networks for Linearly Separable Classifications , Multicategory Single-Layer Perceptron Networks .

UNIT-III [10]

Multilayer Feedforward Networks:
Linearly Nonseparable Pattern Classification , Delta Learning Rule for Multiperceptron Layer , Generalized Delta Learning Rule , Feedforward Recall and Error Back-Propagation Training, Learning Factors.

UNIT-IV [11]

Single-Layer Feedback Networks:
Basic Concepts of Dynamical Systems, Mathematical Foundations of Discrete-Time Hopfield Networks.
Associative Memories:
Basic Concepts, Linear Associator, Basic Concepts of Recurrent Autoassociative Memory.
Bidirectional Associative Memory:
Memory Architecture, Association Encoding and Decoding, Stability Considerations.

UNIT-V [10]

Matching and Self-Organizing Networks :
Hamming Net and MAXNET, Unsupervised Learning of Clusters, Counterpropagation Network, Feature Mapping, Self-organizing Feature Maps, Cluster Discovery Network (ART1).

LEARNING RESOURCES

Text Books:

Jacek M. Zurada, "Introduction to Artificial Neural Systems", JAICO Publications. ISDN 9788172246501.

Reference Books:

1. Kishan Mehrotra, Chelkuri K. Mohan, Sanjav Ranka, "Elements of Artificial Neural Networks", Tenram International.
2. S.N.Sivanandam, S.Sumathi, S.N.Deepa, "Introduction to Neural Networks using MATLAB 6.0", TATA Mc Graw Hill, 2006.
3. B.Yegnanarayana, "Artificial Neural Networks", PHI, New Delhi.
4. Waserman, "Neural Computing - Theory and Practice."

SP590 FUZZY TECHNIQUES

Course objectives:
This course will enable students to

- To know the fundamental concepts such as fuzzy sets, operations and fuzzy relations.
- T0 learn about the fuzzification of scalar variables and the defuzzification of membership functions.
- To design fuzzy rule based system.
- To learn fuzzy decision making and also Bayesian decision methods.
- To learn different fuzzy classification methods.

Course outcomes:
After successful completion of the course,the students will be able to

- Understand the basic ideas, operations and properties of fuzzy sets and also about fuzzy relations.
- Understand the basic features of membership functions, fuzzification process and defuzzification process.
- Design fuzzy rule based system.
- Know how to combine fuzzy set theory with probability to handle random and non-random uncertainty and the decision making process
- Apply fuzzy C-Means clustering algorithm.

UNIT-I [11]

Classical and Fuzzy sets:
Classical sets - Operations and properties of classical sets, Mapping of classical sets to the functions. Fuzzy sets – Membership functions, Fuzzy set operations, Properties of fuzzy sets. Classical and Fuzzy relations: Cartesian product, crisp relations-cardinality, operations and properties of crisp relations. Fuzzy relations-cardinality, operations, properties of fuzzy relations, fuzzy Cartesian product and composition, Fuzzy tolerance and equivalence relations, value assignments.

UNIT-II [10]

Fuzzification and Defuzzification: Features of the membership functions, various forms, fuzzification, defuzzification to crisp sets, λ-cuts for fuzzy relations, Defuzzification to scalars. Fuzzy logic and approximate reasoning, Other forms of the implication operation.

UNIT-III [12]

Fuzzy Systems: Natural language, Linguistic hedges, Fuzzy (Rule based) System, Aggregation of fuzzy rules, Graphical techniques of inference.Membership value assignments: Intution, Inference, rank ordering, Fuzzy Associative memories.

UNIT-IV [11]

Fuzzy decision making: Fuzzy synthetic evaluation, Fuzzy ordering, Preference and consensus, Multi objective decision making, Fuzzy Bayesian, Decision method, Decision making under Fuzzy states and fuzzy actions.

UNIT-V [11]

Fuzzy Classification: Classification by equivalence relations-crisp relations, Fuzzy relations, Cluster analysis, Cluster validity, C-Means clustering, Hard C-Means clustering, Fuzzy C-Means algorithm, Classification metric, Hardening the Fuzzy C-Partition.

LEARNING RESOURCES

TextBooks:

1. Timothy J.Ross, "Fuzzy logic with engineering applications", 3rd edition, Wiley. ISBN 9780470743768.

2. George J.Klir/Bo Yuan "Fuzzy sets and Fuzzy logic theory and Applications", PHI, New Del,hi. ISBN 9780131011717.

ReferencesBooks:

S.Rajasekaran, G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy logic and Genetic Algorithms, Synthesis and Applications", PHI, New Delhi.