Biju Patnaik University of Technology, Orissa
Rourkela

Syllabus
of
M.Tech

in

ELECTRONICS

&

COMMUNICATION ENGINEERING

(Specialization: Signal Processing & Engineering)

From 2014 -2015 Academic Session

BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ODISHA

Syllabus for M.Tech in Signal Processing & Engineering

Semester	Subject	Credit	Details of Subjects
I	SPPC101	4	Linear Algebra for Signal Processing
	SPPC 102	4	Speech &Audio Signal Processing
	SPPC 103	4	DSP Algorithms and Architectures
	ELECTIVES - I *(ANY ONE)*		
	VLPE102	3	VLSI Digital Signal Processing System
	SPPE101		Digital Communication Technique
	SPPE102		Wireless & Cellular Communication
	SPPE103		Biomedical Signal Processing
	SPPE104		Random Process
	ELECTIVES - II *(ANY ONE)*		
	SPPE105	3	Array Signal Processing
	SPPE106		Multirate Signal Processing
	SPPE107		Information Theory
	ETPC103		Telecommunication Switching and Networks
	SPPE108		Digital Signal Processors
	SPPR101	4	Lab-1-Signal Processing 1
	SPPT101	2	Seminar I- on Pre-Thesis Work-1
Semester Credits:		**24**	
II	SPPC201	4	Digital Image & Video Processing
	SPPC202	4	Detection & Estimation Theory
	ELECTIVES - III *(ANY ONE)*		
	VLPE208	3	Statistical Signal Processing
	SPPE201		Multidimensional Signal Processing
	SPPE202		Optical Signal Processing
	SPPE203		Radar & Sonar Signal Processing
	ELECTIVES - IV*(ANY ONE)*		
	ETPE205	3	Wireless Sensor Network
	SPPE204		Pattern Reorganization & Analysis
	SPPE205		Digital Filter Design and Applications
	VLPC202		RF and Mixed signal integrated circuit.
	ELECTIVES - V*(ANY ONE)*		
	SPPE206		Neural Network

	SPPE207	3	LabVIEW Digital Signal Processing
	SPPE208		Adaptive Signal Processing
	SPPR201	4	Lab-2-Signal Processing II
	SPPT201	2	Seminar on Pre-thesis work-2
	SPCV201	2	Comprehensive Viva-Voce - I
Semester Credits:		**25**	
Semester	**Subject**	**Credit**	**Details of Subjects**
III	Open Elective (any one)	3	Project Management / Project Costing / Technology Management / Research Methodology / Optimization Techniques
	Thesis-1	14	Thesis – I
Semester Credits:		**17**	
IV	SPPT401	20	Thesis – II
	SPCV401	2	Seminar
	SPCV402	2	Comprehensive Viva-Voce - II
Semester Credits:		**24**	
Total Credits		**90**	

Linear Algebra for Signal Processing

Module I

Algebraic Structures: - Sets, Functions, Cardinality of sets, Groups, Rings, Fields, Vector spaces, Subspaces, Basis and dimension, Finite and infinite dimensional vector spaces.

Linear transformations: Linear Transformations, Sum, product and inverse of Linear Transformations, Rank-nullity theorem, Isomorphism, Matrix representation of Linear Transformations, Four fundamental subspaces of Linear Transformations, Change of bases, Linear functional.

Module II

Metric space and Hilbert space : Metric space, Open sets, Closed sets, Neighborhoods, Sequences , Convergence, Completeness, Continuous mappings, Normed space, Banach space, L^pspace and l^pspace, Inner product space, Hilbert space, Signal space, Properties of inner product space, Orthogonal compliments and direct sums, Orthonormal sets, Gramm-chmidtorthonormalization process, Projections.

Module III

Matrix Theory –Matrix rank, Solving linear system of equations using matrices, LDU factorisation, QR decomposition, Least square approach, Eigen values, Eigen vectors and spectrum, Diagonalizability, Orthogonal diagonilization, Properties of Eigen values and Eigen vectors of Hermitian matrices, Normal matrices, Unitary matrices, Multiresolution analysis and wavelets.

References

1. Strang G, Linear Algebra and its Applications, 3rd edition, Saunders, 1988.
2. G.F.Simmons, Topology and Modern Analysis , McGraw Hill
3. Frazier, Michael W. An Introduction to Wavelets Through Linear Algebra, Springer Publications.
4. Hoffman Kenneth and Kunze Ray, Linear Algebra, Prentice Hall of India.

Speech & Audio Signal Processing

Module I (11hrs)

Digital models for the speech signal - mechanism of speech production - acoustic theory - lossless tube models - digital models - linear prediction of speech - auto correlation - formulation of LPC equation -solution of LPC equations - Levinson Durbin algorithm - Levinson recursion - Schur algorithm – latticeformulations and solutions - PARCOR coefficients - Spectral analysis of speech - Short Time Fourier analysis- filter bank design. Auditory Perception: Psychoacoustics- Frequency Analysis and Critical Bands – Maskingproperties of human ear:

Module II (20hrs)

Speech coding -subband coding of speech - transform coding - channel vocoder - formant vocoder– cepstralvocoder - vector quantizer coder- Linear predictive Coder. Speech synthesis - pitch extraction algorithms -gold rabiner pitch trackers - autocorrelation pitch trackers - voice/unvoiced detection -

homomorphic speechprocessing - homomorphic systems for convolution - complex cepstrums - pitch extraction usinghomomorphic speech processing. Sound Mixtures and Separation - CASA, ICA & Model based separation.

Speech Transformations - Time Scale Modification - Voice Morphing. Automatic speech recognition systems-isolated word recognition - connected word recognition -large vocabulary word recognition systems -pattern classification - DTW, HMM - speaker recognition systems - speaker verification systems – speakeridentification Systems.

Module III (11 hrs)

Audio Processing: Non speech and Music Signals - Modeling -Differential, transform and subband coding ofaudio signals & standards - High Quality Audio coding using Psychoacoustic models - MPEG Audio codingstandard. Music Production - sequence of steps in a bowed string instrument - Frequency responsemeasurement of the bridge of a violin. Audio Data bases and applications - Content based retrieval.

TEXT BOOKS:

1. Thomas F. Quatieri , "Discrete-time Speech Signal Processing: Principles and Practice" Prentice Hall, Signal Processing Series.
2. Ben Gold & Nelson Morgan , " Speech and Audio Signal Processing", John Wiley & Sons, Inc.

REFERENCE BOOKS:

1. A. M. Kondoz, "Digital Speech: Coding for Low Bit Rate Communication Systems
2. Rabiner L.R. & Schafer R.W., "Digital Processing of Speech Signals", Prentice Hall Inc.
3. O'Shaughnessy, D. "Speech Communication, Human and Machine". Addison-Wesley.
4. Dr. Shaila D. Apte, "Speech And Audio Processing, Willy India.
5. Deller, J., J. Proakis, and J. Hansen. "Discrete-Time Processing of Speech Signals." Macmillan.
6. Owens F.J., "Signal Processing of Speech", Macmillan New Electronics
7. Saito S. & Nakata K., "Fundamentals of Speech Signal Processing", Academic Press, Inc.
8. Papamichalis P.E., "Practical Approaches to Speech Coding", Texas Instruments, Prentice Hall
9. Rabiner L.R. & Gold, "Theory and Applications of Digital Signal Processing", Prentice Hall of India

DSP Algorithms and Architectures

Module I: DSP Algorithm & Architecture Design (24 hours)

DSP representations (data-flow, control-flow, and signal-flow graphs, block diagrams),fixed-point DSP design (A/D precision, coefficient quantization, round-off and scaling),filter structures (recursive, nonrecursive and lattice), algorithmic simulations of DSP systems in C , behavioral modeling in HDL. System modeling and performance measures.

Fast filtering algorithms (Winograd's, FFT, short- length FIR), retiming and pipelining, block processing, folding, distributed arithmetic architectures, VLSI performance measures (area, power, and speed), structural modeling in VHDL. Analog signal processing for fast operation.Impact of nonideal characteristics of analog functional blocks on the system performance.

Module II: DSP Module Synthesis (16 hours)

Distributed arithmetic (DA).Advantageous of using DA?Size reduction of look-up tables. Canonic signed digit arithmetic. Implementation of elementary functions Table-oriented methods.Polynomial approximation Random number generators. Linear feedback shift register. High performance arithmetic unit architectures (adders, multipliers, dividers), bit-parallel, bit-serial, digit-serial, carry-save architectures, redundant number system, modeling for synthesis in HDL, synthesis place-and-route.

Module III: Parallel algorithms and their dependence (14 hours)

Applications to some common DSP algorithms.System timing using the scheduling vector. Projection of the dependence graph using a projection direction. The delay operator and z-transform techniques for mapping DSP algorithms onto processor arrays.Algebraic technique for mapping algorithms.The computation domain.The dependence matrix of a variable.The scheduling and projection functions.Data broadcast and pipelining.

Applications using common DSP algorithms.

Reference Books

1. Digital Signal Processors: Architectures, Implementations, and Applications SenM.Kuo , Woon-Seng S. Gan Prentice Hall 2004
2. VLSI Signal Processing Systems, Design and Implementation.Keshab K. Parhi, John Wiley & Sons,1999.
3. Digital Signal Processing with Field Programmable Gate Array, Uwe Meyer-Baese, Springer- Verlag 2001
4. DSP Principles, Algorithms and Applications, John G. Proakis , DimitrisManolakis K - Prentice Hall 1995
5. Architectures for Digital Signal Processing, Pirsch, John Wiley and Sons, 1998.
6. DSP Integrated Circuits, Lars Wanhammar, Academic Press, 1999
7. Computer Arithmetic: Algorithms and Hardware Designs, Parhami, Behrooz, Oxford University Press, 2000
8. Computer Arithmetic Algorithms, Israel Koren, A. K. Peters, Natick, MA, 2002

VLSI Digital Signal Processing Systems

MODULE – I (11 hours)

Introduction to DSP System: Typical DSP algorithms, DSP application demands and scaled CMOS technology, Representation of DSP algorithms.

Iteration Bound: Data-flow graph representations, Loop bound and iterartion bound, Algorithms for computing iteration bound, Iteration bound of multirate data-flow graphs.

Pipelining and Parallel Processing: Pipelining of FIR digital filters, Parallel processing, Pipelining and parallel processing for low power.

Retiming: Definitions and properties, Solving systems of inequalities, Retiming techniques.

MODULE – II (11 hours)

Unfolding: An algorithm for unfolding, Properties of unfolding, Critical path, unfolding and retiming, Applications of unfolding.

Folding: Folding transformation, Register minimization techniques, Register minimization in folding architectures, Folding of multirate systems.

Systolic Architecture Design: Systolic array design methodology, FIR systolic arrays, Selection of scheduling vector, Matrix-matrix multiplication and 2D systolic array design, Systolic design for space representations containing delays.

MODULE – III (12 hours)

Bit-Level Arithmetic Architecture: Parallel multipliers, Interleaved floor-plan and bit-plane-based digital filters, Bit-serial multipliers, Bit-serial filter design and implementation, Canonic signed digit arithmetic, Distributed arithmetic.

Programmable Digital Signal Processors: Evolution of programmable digital signal processors, Important features of DSP processors, DSP processors for mobile and wireless communications, Processors for multimedia signal processing.

Textbooks:

1. K. K. Parhi, ***VLSI Digital Signal Processing Systems, Design and Implementation***, Wiley India Pvt. Ltd., New Delhi

Recommended Reading:

1. K.P. Keshab, ***VLSI Digital Signal Processing Systems: Design and Implementation***, Jacaranda Wiley, 1999.
2. Richard J, Higgins, ***Digital Signal Processing in VLSI***, Prentice Hall, ISBN-10: 013212887X, ISBN-13: 9780132128872
3. M.A. Bayoumi, ***VLSI Design Methodology for DSP Architectures***, Kluwer, 1994.

Digital Communication Technique

Module I: Deterministic & Random Signal Analysis (12 hrs)

Bandpass&Lowpass Signals, Lowpass Equivalent of Bandpass Signals, Energy Considerations, Lowpass Equivalent of a Bandpass System. Vector Space Concepts, Signal Space Concepts, Orthogonal Expansions of Signals, Gram-Schmidt Procedure. Bounds on Tail Probabilities, Limit Theorems for Sum of Random Variables.Complex Random Vectors.WSS Random Process, Cyclostationary Random Process, Proper and Circular Random Process, Markov Chains.Sampling Theorem for Band-limited Random Process, The Karhunen-Loeve Expansion.Banpass and Lowpass Random Processes. [Proakis&Salehi Sections 2.1, 2.2, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9]

Module II: Digital Modulation Scheme (14 hrs)

Representation of Digitally Modulated Signals, Memoryless Modulation Methods; Pulse Amplitude Modulation, Phase Modulation, Quadrature Amplitude Modulation, Multidimensional Signaling. Signaling Schemes With Memory; Continuous-Phase Frequency-Shift Keying, Continuous-Phase Modulation. Power Spectrum of Digitally Modulated Signals; Power Spectral Density of a Digitally Modulated Signal With Memory, Power Spectral Density of Linearly Modulated Signals, Power Spectral Density of Digitally Modulated Signals With Finite Memory, Power Spectral Density of Modulated Schemes With a Markov Structure, Power Spectral Density of CPFSK and CPM Signals. [Proakis&Salehi Sections 3.1, 3.2, 3.3, 3.4, 3.5]

Carrier and Symbol Synchronization: Signal Parameter Estimation; The Likelyhood Function, Carrier Recovery and Symbol Synchronization in Signal Demodulation. Carrier Phase Estimation; Maximum Likelyhood Carrier Phase Estimation, The Phase-Locked Loop, Effect of Additive Noise in the Phase Estimate. Symbol Timing Estimation; Maximum Likelyhood Timing Estimation. [Proakis&Salehi Sections 5.1-1, 5.1-2, 5.2-1, 5.2-2,5.2-3]

Module III: Digital Communication Through Band-Limited Channels (12 hrs)

Characterization of Band-Limited Channels. Signal Design for Band-Limited Channels; Design of Band-Limited Signals for No Intersymbol Interference-The Nyquist Criterion, Optimum Maximum-Likelihood Receiver. [Proakis&Salehi Sections 9.1, 9.2-1, 9.3-1]

Spread Spectrum Signals for Digital Communication: Model of Spread spectrum Digital Communication System. Direct Sequence Spread Spectrum Signals; Error Rate Performance of the Decoder, Some Applications of DS Spread Spectrum Signals. Frequency-Hopped Spread-Spectrum Signals; Performance of FH Spread Spectrum Signals in an AWGN Channel, A CDMA System Based on FH Spread Spectrum Signals. [Proakis&Salehi Section 12.1]

Text Book

1. 1.John G. Proakis and MasoudSalehi, Digital Communication, McGraw-Hill, 5th Edition

Reference Books

1. Simon Haykin, Digital Communication, Willy
2. Tube & Schilling, Principle of Communication, PHI
3. Edward A. Lee and David G. Messerschmitt, " Digital Communication", Allied Publishers (second edition)
4. J Marvin K. Simon, Sami M. Hinedi and William C Lindsey, " Digital communication techniques" PHI
5. William Feller, " An introduction to Probability Theory and its applications", vol 11, Wiley 2000
6. Sheldon M. Ross, " Introduction to probability models", Academic press, 7th edition

WIRELESS & CELLULAR COMMUNICATION

Module – I (18 hours)

A brief introduction to evolution of mobile radio communications, technologies and choices. Development of Wireless networks, Cellular Concept – System Design: Fundamentals: Frequency reuse, channel Assignment, Handoff Strategies, Interfaces and System Capacity, Trunking and Grade of Service; Improving coverage and capacity in Cellular Systems- Cell Splitting, Sectoring, Repeaters and Range Extension, Microcell &Picocell Zone Concept, multipath effects in mobile communication, mobile communication – antennas.

Module II (13 hours)

Fading and Diversity: Wireless Channel Models- path loss and shadowing models- statistical fading models- Narrow band and wideband Fading models- Review of performance of digital modulation schemes over wireless channels- Diversity- Repetition coding and Time Diversity- Frequency and Space Diversity- Receive

Diversity- Concept of diversity branches and signal paths- Combining methods- Selective diversity combining - Switched combining- maximal ratio combining- Equal gain combining- performance analysis for Rayleigh fading channels.
Cellular Communication: Cellular Networks- Multiple Access: FDM/TDM/FDMA/TDMA

Module III (15 hours)

Spread spectrum and CDMA: Overview of CDMA systems: Direct sequence and frequency hoped systems-spreading codes-code synchronization-Channel estimation-power control-Multiuser detection- Spread Spectrum Multiple Access- CDMA Systems- Interference Analysis for Broadcast and Multiple Access Channels- Capacity of cellular CDMA networks- Reverse link power control- Hard and Soft hand off strategies.
Cellular Wireless Communication Standards
Second generation cellular systems: Brief discussion specifications on GSM, CDMA, Wideband CDMA, Wi-Fi, Wi-max Introduction to multicarrier Communication: OFDM, MCCDMA

Text books:

1. Wireless Communications by T. S. Rappaport, 2nd Edition, Pearson Education.
2. Wireless Communications & Network 3G and beyond Itisaha Mishra, Tata Mc-Graw Hill Education Pvt. Ltd.
3. Mobile cellular Telecommunications by W. C. Y. Lee, 2nd Edition, McGraw Hill.
4. Andrea Goldsmith, "Wireless Communications", Cambridge University press.
5. Simon Haykin and Michael Moher, " Modern Wireless Communications", Pearson Education.

References:

1. T.S. Rappaport, "Wireless Communication, principles & practice".
2. G.L Stuber, "Principles of Mobile Communications", 2nd edition, Kluwer Academic Publishers.
3. KamiloFeher, 'Wireless digital communication', PHI.
1. R.L Peterson, R.E. Ziemer and David E. Borth, "Introduction to Spread Spectrum Communication", Pearson Education.
4. A.J.Viterbi, "CDMA- Principles of Spread Spectrum", Addison Wesley.

Biomedical Signal Processing

MODULE – I (10 hours)

Introduction to Biomedical Signals: Examples and acquisition 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

MODULE – II (12 hours)

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.

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.

MODULE – III (13 hours)

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

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

TextBooks:

1. R S Kandpur, ***Handbook of Biomedical Instrumentation***, 2^{nd} Edn, TMH Publication, 2003
2. E. N. Bruce, ***Biomedical Signal Processing and Signal Modelling***, John Wiley, 2001.
3. Rangaraj M. Rangayyan, "Biomedical signal analysis: a case-study approach, John Wiley.

References

1. Wills J. Tompkins, ***Biomedical Digital Signal Processing***, PHI.
2. M. Akay, ***Time Frequency and Wavelets in Biomedical Signal Processing***, IEEE Press, 1998.
3. Cromwell, ***Biomedical Instrumentation and Measurements***, 2^{nd} Edn, Pearson Education.

Random Processes

Module 1: **(13 hours)**

Probability axioms, conditional probability, discrete and continuous random variables, cumulative distribution function (CDF), probability mass function (PMF), probability density function (PDF), conditional PMF/PDF, expected value, variance, functions of a random variable, expected value of the derived random variable, multiple random variables, joint CDF/PMF/PDF, functions of multiple random variables, multiple functions of multiple random variables, independent/uncorrelated random variables, sums of random variables, moment generating function, random sums of random variables.

The sample mean, laws of large numbers, central limit theorem, convergence of sequence of random variables.

Module II: **(13 hours)**

Introduction to random processes, specification of random processes, *n*th order joint PDFs, independent increments, stationary increments, Markov property, Markov process and martingales, Gaussian process, Poisson process and Brownian motion, Mean and correlation of random processes, stationary, wide sense stationary, ergodic processes, Mean-square continuity, mean-square derivatives.

Module III: **(16 hours)**

Random processes as inputs to linear time invariant systems: power spectral density, Gaussian processes as inputs to LTI systems, white Gaussian noise.

Discrete-time Markov chains: state and n-step transition probabilities, Chapman-Kolmogorov equations, first passage probabilities, classification of states, limiting state probabilities.

Series representation of random process: Fourier series, Karhunen-Loeve expansion, Mercer's theorm, sampled band-limited processes, filtering using series representation

Reference

1. A. Papoulis and S. U. Pillai: "*Probability, Random Variables and Stochastic Processes*", 4th edition, 2002, McGraw Hill.
2. Geoffrey Grimmett: "Probability and Random Processes", 3rd edition, 2001, Oxford university Press
3. V. Krishnan: "Probability and Random Processes", 2006, John Wiley & Sons
4. Albert Leon Garcia: "Probability and Random Processes for Electrical Engineering", 1993, Prentice Hall

Array Signal Processing

Module I : **(10 hours)**

Spatial Signals: Signals in space and time. Spatial frequency, Direction vs. frequency.Wave fields. Far field and Near field signals.

Module II : **(16 hours)**

Sensor Arrays: Spatial sampling, Nyquist criterion. Sensor arrays.Uniform linear arrays, planar and random arrays.Array transfer (steering) vector.Array steering vector for ULA.Broadband arrays.

Spatial Frequency: Aliasing in spatial frequency domain. Spatial Frequency Transform, Spatial spectrum.Spatial Domain Filtering.Beam Forming.Spatially white signal.

Module III : **(12 hours)**

Direction of Arrival Estimation: Non parametric methods - Beam forming and Capon methods. Resolution of Beam forming method. Subspace methods - MUSIC, Minimum Norm and ESPRIT techniques. Spatial Smoothing.

Reference

1. Dan E. Dugeon and Don H. Johnson. (1993). Array Signal Processing: Concepts and Techniques. Prentice Hall.
2. PetreStoica and Randolph L. Moses. (2005, 1997) Spectral Analysis of Signals. Prentice Hall.
3. Bass J, McPheeters C, Finnigan J, Rodriguez E. Array Signal Processing [Connexions Web site]. February 8, 2005. Available at: http://cnx.rice.edu/content/col10255/1.3/

Multirate Signal Processing

Module 1: **(12 hours)**

The sampling theorem - sampling at subnyquist rate - Basic Formulations and schemes.

Basic Multirate operations- Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank- Identities- Polyphase representation

Maximally decimated filter banks: Polyphase representation - Errors in the QMF bank- Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank

Module II: **(16 hours)**

Uniform band and non uniform filter bank - tree structured filter bank- Errors created by filter bank system- Polyphase representation- perfect reconstruction systems

Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Two channel FIR paraunitary QMF Bank- Linear phase PR Filter banks- Necessary conditions for Linear phase property- Quantization Effects: -Types of quantization effects in filter banks. - coefficient sensitivity effects, dynamic range and scaling.

Module III:

Cosine Modulated pseudo QMF Bank- Alas cancellation- phase - Phase distortion- Closed form expression- Polyphase structure- PR Systems

Text Books

1. P.P. Vaidyanathan. “Multirate systems and filter banks.” Prentice Hall. PTR. 1993.
2. N.J. Fliege. “Multirate digital signal processing .” John Wiley 1994.

Reference Books

1. Sanjit K. Mitra. “ Digital Signal Processing: A computer based approach.” McGraw Hill. 1998.
2. R.E. Crochiere. L. R. “Multirate Digital Signal Processing”, Prentice Hall. Inc.1983.
3. J.G. Proakis. D.G. Manolakis. “Digital Signal Processing: Principles. Algorithms and Applications”,3rd Edn. Prentice Hall India, 1999.

Information Theory

Module I **(13 hours)**

Information and Sources: Zero Memory sources- Concepts of entropy-Extension of a Zero memory source-Markov information sources- Entropy calculation- Entropy of a discrete Random variable- Joint, conditional and relative entropy- Mutual Information and conditional mutual information.

Module II **(13 hours)**

Source Coding: Uniquely decodable codes- Instantaneous codes- Kraft’s inequality – McMillan’s inequality-Average length of a code-Optimal codes- Shannon codes-Fano codes-Huffman Coding –Optimality of Huffman Codes-Lempel Ziv codes- Shannon’s source coding theorem–Arithmetic coding.

Channel Capacity: Properties-Data transmission over Discrete Memoryless Channels-Capacity of Binary symmetric and Binary Erasure channels-Computing channel capacity-Arimoto-Blahut algorithm-Fano’s inequality- Shannon’s Channel Coding Theorem

Module III **(14 hours)**

Continuous Sources and Channels: Information measure for Continuous sources and channels-Differential Entropy- Joint, relative and conditional differential entropy- Mutual information- Waveform channels- Gaussian channels- Mutual information and Capacity calculation for Band limited Gaussian channels- Shannon limit. Rate Distortion Theory: Rate Distortion Function - Properties – Calculation of Rate Distortion Function for binary source Gaussian

Recommended Reading:

1. T. Cover and Thomas, "Elements of Information Theory", John Wiley & Sons
2. R. Avudaiammal, **Information Coding Techniques**, 2nd Edn., Tat McGraw-Hill Education Pvt. Ltd., New Delhi.
3. *Ranjan Bose, **Information Theory, Coding and Cryptography**, 2nd Edn., Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2008. ISBN-10: 0-07-066901-5, ISBN-13: 978-0-07-066901*
4. J. G. Proakis, **Digital Communication**, 3rd Edition, McGraw-Hill Publication
5. Robert Gallager, "Information Theory and Reliable Communication", John Wiley & Sons.

Telecommunication Switching & Networks

MODULE I **(16 hours)**

Introduction: Evolution, simple telephone communication, basis of switching system, telecommunication networks.

Electronic space division switching: Stored program control, centralized and distributed SPC, software architecture, application software, enhanced software, two and three stage networks.

Time Division Switching: Basic time division space switching, basic time division time switching, time multiplexed space and time switching, combination switching, three-stage combination switching.

MODULE – II **(12 hours)**

Traffic Engineering: Network traffic load and parameters, Grade of service, modelling switching systems, incoming traffic, blocking models and loss estimates.

Telephone Networks: Subscriber loop systems, switching hierarchy and routing, transmission plan, transmission systems, signalling techniques

MODULE III **(12 hours)**

Data Networks: Data transmission in PSTN, switching techniques, Data communication architecture, link-to-link layers, end-to-end layers, satellite based data networks, LAN, MAN, Fibre optic networks, an overview of data network standards

Integrated Service Digital Network, motivation, new services, transmission channels, signalling, service characterization, ISDN standards, broad band ISDN, voice data integration.

Textbooks:

1. *ThiagarajanViswanathan, **Telecommunication Switching Systems and Networks** by, PHI Learning Pvt. Ltd., New Delhi.*

2. *Alberto Leon-Gracia and IndraWidjaja,* ***Communication Networks****, Tata McGraw Hill Education Pvt. Ltd., New Delhi.*

Digital Signal Processors

Module 1

DSPs and Conventional Microprocessors, Circular Buffering, Architectural features of DSP- Von Neumann,Harvard, Super Harvard architectures, Fixed vs. Floating point DSPprocessors, Programming in C vs Programming in assembly, speed benchmarks for DSPs, Multiprocessing for high speed DSP applications.

TMS 320 C 55 x Digital Signal Processor: Architecture overview, Buses, memory maps, software development tools- C compiler, assembler, linker, Code Composer studio,Addressing modes and instruction set, pipelining and parallelism in TMS 320C 55X, Mixed C and Assembly programming

Module II

TMS 320 C 6x: Architecture, Functional Units, Fetch and Execute Packets, Pipelining, Registers, Linear andCircular Addressing Modes, Indirect Addressing, CircularAddressing,TMS320C6x Instruction Set, AssemblyCode Format, Types of Instructions, Assembler Directives, Linear Assembly, ASM Statement within C, CCallable Assembly Function, Timers, Interrupts, Multichannel Buffered Serial Ports, Direct Memory Access,

Memory Considerations, Fixed- and Floating-Point Formats, Code Improvement, Constraints

Module III

SHARC Digital Signal Processor: - Architecture - IOP Registers - Peripherals - Synchronous Serial Port - Interrupts -Internal/External/Multiprocessor Memory Space - Multiprocessing - Host Interface - Link Ports

Some Practical applications of Digital Signal Processors: Sine wave generators, Noise generators, DTMF Tone detection, Adaptive echo cancellation, Acoustic echo cancellation, Speech enhancement

Text Books:

1. Digital Signal Processing: A Practical guide for Engineers and scientists, Steven W Smith, Newness(Elsevier), 2003
2. Digital Signal Processing and applications with the C6713 and C6416 DSK, RulfChassaing, Wiley-Interscience, 2005
3. Real time Digital Signal Processing, Sen M Kuo, Bob H Lee, John Wiley and Sons, 2001.

References:

1. Digital Signal Processing Implementation using the TMS320C6000 DSP Platform, 1st Edition; NaimDahnoun
2. Digital Signal Processing - A Student Guide,1st Edition, T.J. Terrel and Lik-Kwan Shark; Macmillan Press Ltd.
3. Digital Signal Processing: A System Design Approach, 1st Edition, David J Defatta J, Lucas Joseph G &Hodkiss William S ; John Wiley

4. Digital Signal Processing- A Practical approach, E C Elfeachor and B W Jervis, Pearson, 2005.
5. A Simple approach to Digital Signal processing, 1st Edition, KreigMarven& Gillian Ewers; Wily Interscience
6. DSP FIRST - A Multimedia Approach, 1st Edition, James H. McClellan, Ronald Schaffer and Mark A. Yoder; Prentice Hall

Digital Image & Video Processing

Module I: **(15Hrs)**

Digital Image Fundamentals, Image Transforms: Fourier, Hadamard, Walsh, Discrete cosine and Hotelling Transforms; Image Enhancement: Histogram modification, Histogram equalisation, Smoothing, Filtering, Sharpening, Homomorphic filtering. ; Image restoration, Segmentation: Pixel classification, Bi-level thresholding, Multi-level thresholding, P-tile method, Adaptive thresholding, Spectral & spatial classification, Edge detection, Hough transform, Region growing.

Module II: **(15Hrs)**

Matching and Registration: Image modeling, Stereo mapping, Landmark matching, Rectification in geometric transformations, Match measurement, Matching of binary pattern, Distortion tolerant matching; Digital geometry and its applications: Neighborhood, Path, Connectedness, Holes and Surroundness, Borders, Distances, Medial Axis Transform (MAT), Shrinking and Expanding, Thinning. Introduction to Mathematical morphology and its application, Morphological Operations, Dilation, Erosion, Opening, Closing, Smoothing, Extraction of connected components, Thinning.

Module III: **(10 Hrs)**

Video Processing: Representation of Digital Video, Spatio-temporal sampling; Motion Estimation; Video Filtering; Video Compression, Video coding standards.

Texts Book

1. A. K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.
2. R. C. Gonzalez, R. E. Woods, *Digital Image Processing,* Pearson Education. II Ed.,2002
3. W. K. Pratt, Digital image processing, Prentice Hall, 1989

References Book

1. A. Rosenfold and A. C. Kak, Digital image processing, Vols. 1 and 2, Prentice Hall, 1986.
2. H. C. Andrew and B. R. Hunt, Digital image restoration, Prentice Hall, 1977
3. R. Jain, R. Kasturi and B.G. Schunck, Machine Vision, McGraw-Hill International Edition, 1995
4. A. M. Tekalp, Digital Video Processing , Prentice-Hall, 1995
5. A. Bovik, Handbook of Image & Video Processing, Academic Press, 2000

Detection and Estimation Theory

Module 1: Fundamentals of Detection Theory

Hypothesis Testing: Bayes' Detection, MAP Detection, ML Detection, MinimumProbability of Error Criterion, Min-Max Criterion, Neyman-Pearson Criterion, Multiple

Hypothesis, Composite Hypothesis Testing: Generalized likelihood ratio test (GLRT),

Receiver Operating Characteristic Curves.

Module 2: Fundamentals of Estimation Theory

Role of Estimation in Signal Processing, Unbiased Estimation, Minimum varianceunbiased(MVU) estimators, Finding MVU Estimators, Cramer-Rao Lower Bound, LinearModeling-Examples, Sufficient Statistics, Use of Sufficient Statistics to find the MVUEstimator

Module 3: Estimation Techniques

Deterministic Parameter Estimation: Least Squares Estimation-Batch Processing,

Recursive Least Squares Estimation, Best Linear Unbiased Estimation, Likelihood and Maximum Likelihood Estimation

Random Parameter Estimation: Bayesian Philosophy, Selection of a Prior PDF,

Bayesian linear model, Minimum Mean Square Error Estimator, Maximum a Posteriori Estimation

State Estimation: Prediction, Single and Multistage Predictors, Filtering, TheKalman Filter

References:

1. M D Srinath, P K Rajasekaran, R Viswanathan, Introduction to Statistical Signal Processing with Applications, “Pearson”
2. Steven M. Kay, “Statistical Signal Processing: Vol. 1: Estimation Theory, Vol. 2: Detection Theory," Prentice Hall Inc., 1998.
3. Jerry M. Mendel, “Lessons in Estimation Theory for Signal Processing, Communication and Control," Prentice Hall Inc., 1995
4. Ralph D. Hippenstiel, “Detection Theory- Applications and Digital Signal Processing”, CRC Press, 2002.
5. Bernard C. Levy, “Principles of Signal Detection and Parameter Estimation”, Springer, New York, 2008.
6. Harry L. Van Trees, “Detection, Estimation and Modulation Theory, Part 1 and 2," John Wiley & Sons Inc. 1968.
7. Neel A. Macmillan and C. Douglas Creelman, “Detection Theory: A User's Guide (Sec. Edn.)” Lawrence Erlbaum Associates Publishers, USA, 2004.
8. Monson H. Hayes, “Statistical Digital Signal Processing and Modelling," John Wiley & Sons Inc., 1996.

Statistical Signal Processing

Module 1 **(10 hours)**

Discrete Random Process: Random Process- Ensemble Average, Gaussian Process, Stationary Process, The Autocorrelation and Autocovariance Matrix, Ergodicity, White Noise, The Power Spectrom, Filtering Random Process, Special Types of Random Process-ARMV Process, AR Process, MA Process, Harmonic Process. [Read Hayes Chapter 3.3.1 – 3.3.8, 3.4, 3.6.1 – 3.6.4]

Signal Modeling: Introduction, Stochastic Models- ARMA Models, AR Models, MA Models, Application: Power Spectrum Estimation. [Read Hayes Chapter 4.1, 4.7.1 – 4.7.4]

Module II **(18 hours)**

Winer Filtering: Introduction, The FIR Wiener Filter- Filtering, Linear Prediction, Noise Cancellation, IIR Wiener Filter- Noncausal IIR Wiener Filter, The Causal IIR Wiener Filter, Causal Wiener Filtering, Causal Linear Prediction, Wiener Deconvolution, Discrete Kalman Filter. [Read Hayes Chapter 7.1, 7.2.1 – 7.2.3, 7.3.1 – 7.3.5, 7.4)

Spectrum Estimation: Introduction, Nonparametric Method- The Periodogram, Performance of Periodogram. Parametric Methods- AR Spectrum Estimation, MA Spectrum Estimation, ARMA Spectrum Estimation.

Frequency Estimation- Eigendecomposition of the Autocorrelation Matrix, MUSIC. [Read Hayes Chapter 8.1, 8.2.1, 8.2.2, 8.5.1 – 8.5.3, 8.6.1, 8.6.3]

Module III **(11 hours)**

Adaptive Filtering: Introduction, FIR Adaptive Filters- The Steepest Descent Adaptive Filter, The LMS Algorithm, Convergence of LMS Algorithm, NLMS, Noise Cancellation, LMS Based Adaptive Filter, Channel Equalization, Adaptive Recursive Filter, RLS- Exponentially Weighted RLS, Sliding Window RLS. [Read Hayes Chapter 9.1, 9.2.1 – 9.2.6, 9.2.9, 9.3, 9.4]

Text Book

1. Monson H. Hayes, Statistical Digital Signal Processing & Modeling, John Wiley & Sons

Reference Books

1. Steven M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall.

Multidimensional Signal Processing

Module 1

Multidimensional Discrete Signals and Multidimensional Systems: Frequency domain characterization of multidimensional signals and systems, sampling two dimensional signals, processing continuous signals with discrete systems,

Discrete Fourier Analysis of Multidimensional Signals: Discrete Fourier series representation of rectangularly periodic sequences, Multidimensional DFT, definition an properties, Calculation of DFT, Vector radix FFT, Discrete Fourier transforms for general periodically sampled signals, relationship between M dimensional and one dimensional DFTs.

Module II

Design and Implementation of two Dimensional FIR Filters: Implementation, Design using windows, Optimal FIR filter design- least squares design, Design of cascaded and parallel 2 D FIR filters, Design and implementation of FIR filters using transformations

Multidimensional Recursive Systems: Finite order difference equations- realizing LSI systems using difference equations, recursive computability, boundary conditions, ordering the computation of output samples, Multidimensional Z Transforms, stability of 2 D recursive systems, stability theorems, Two dimensional complex cepstrum.

Module III

Design and Implementation of two Dimensional IIR filters: classical 2 D IIR filter implementations,

Iterative implementation of 2 D IIR filters, signal flow graphs- circuit elements and their realizations, state variable realizations, Space domain Design techniques- Shank's method, Descent methods, Iterative prefiltering design method, Frequency domain design techniques, stabilization techniques.

Text Book

1. Multidimensional Digital Signal Processing - Dan E Dudgeon and R M Mersereau, Prentice Hall

References

1. Digital Signal and Image Processing- Tamal Bose, John Wiley publishers.
2. Two dimensional signal and Image Processing- J S Lim, Prentice Hall.

Optical Signal Processing

Module 1:

Need for OSP, Fundamentals of OSP, The Fresnel Transform, Convolution and impulse response, Transform of a slit, Fourier Transforms in Optics, Transforms of aperture functions, Inverse Fourier Transform.Resolution criteria.A Basic Optical System, Imaging and Fourier Transform conditions. Cascaded systems, scale of Fourier Transform Condition. Maximum information capacity and optimum packing density.Chirp, Z transform and system Coherence.

Module II:

Spectrum Analysis, Spatial light Modulators, special detector arrays.Performance parameters for spectrum analyzers.Relationship between SNR and Dynamic range.The 2 D spectrum Analyzer.Spatial Filtering, Linear Space Invariant systems, Parseval'stheorem ,Correlation,

Input/Output Spectral Densities, Matched filtering, Inverse Filtering. Spatial Filters.Interferometers.Spatial filtering systems. Spatial Modulators .Applications of OpticalSpatial Filtering, Effects of small displacements.

Module III:

Heterodyne systems. Temporal and spatial interference.Optimum photo detector size,Optical radio.Direct detection and Hetero dyne detection. Heterodyne spectrum Analysis.Spatial and temporal Frequencies. The CW signal and a short pulse. Photo detectorgeometry and bandwidth.Power spectrum analyzer using a CCD array.

Text book:

1. Anthony VanderLugt, *Optical Signal Processing*, John Wiley & Sons. 2005.
2. D. Casasent, *Optical data processing-Applications* Springer-Verlag, Berlin, 1978
3. P.M. Dufffieux, *The Fourier Transform and its applications to Optics*, John Wiley and sons 1983
4. J.Horner, *Optical Signal Processing* AcademicPress1988

References:

1. Dr. Hiroshi Ishikawa , Ultrafast All-Optical Signal Processing Devices: Wiley
2. Francis T. S. Yu, SugandaJutamulia,Optical Signal Processing, Computing, and Neural Networks: Krieger Publishing Company
3. H.J. Caulfield, Handbook of holography, Academic Press New York
4. Joseph W. Goodman, Introduction to Fourier Optics, second edition McGraw Hill.
5. Govind p. Agrawal, "Fiber-Optic Communication Systems", 3rd ed, Wiley india.
6. Dr. R.k. Singh, "Fiber-Optic Communication Systems", Wiley india.

Radar and Sonar Signal Processing

Module I: Introduction to Radar Systems

Introduction: History and applications of radar, basic radar functions, elements of pulsed radar, review of selected signal processing concepts and operations. 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, spatial models, spectral model.

Sampling and Quantization of Pulsed Radar Signals: Domains and criteria for sampling radar signals. Sampling in the fast time domain, sampling in slow time domain, sampling the Doppler spectrum. Sampling in the spatial and angle dimensions, quantization.

Module II: Doppler Processing & Detection

Alternate forms of Doppler spectrum, Moving Target Indication (MIT), pulse Doppler processing, pulse pair processing, clutter mapping and the moving target detector.

Radar detection as hypothesis testing, Threshold detection in coherent systems, Threshold detection of radar signals, binary integration.

Module III: Overview of sonar systems

Sonar Basics: Propagation of sound in the ocean, noise in the ocean.

Analysis of Sonar Signals: The sonar equation, signal/noise considerations, Generation of underwater sound, Nonlinear effect of depth

Detection of Sonar signals: Threshold concept, Various types of detector, Typical problems in detection of sonar signals, Adaptive digital filters, Digital Doppler nullification

Text Books:

1. Mark A. Richards, "Fundamentals of Radar Signal Processing", McGraw-Hill, 2005.
2. Fred E.Nathanson, "Radar Design Principles", 2nd Edition, Prentice-Hall of India, New Delhi, 2004.
3. Fracois Le Chevalier, "Principles of Radar and Sonar Signal Processing", ARTECH House, 2002.

Reference Books:

1. Byron Edde, “Radar Principles, Technology, Applications”, Prentice-Hall of India
2. Peyton Z.Peebles, “Radar Principles”,Jr. John-Wiley & Sons Inc., 2004.
3. Roger J.Sullivan, “Radar Foundations for Imaging and Advanced Concepts”, Prentice-Hall of India, New Delhi-2004.
4. R.Urick: Principles of under water sound, McGraw Hill, 1983
5. A.D.Waite: Sonar for Practicing Engineers, 2002.

Wireless Sensor Network

Module -I

Introduction and Overview of Wireless Sensor Networks: Introduction, Brief Historical Survey of Sensor Networks, and Background of Sensor Network Technology, Ah-Hoc Networks, Applications of Wireless Sensor Networks: Sensor and Robots, Reconfigurable Sensor Networks, Highway Monitoring, Military Applications, Civil and Environmental Engineering Applications, Wildfire Instrumentation, Habitat Monitoring, Nanoscopic Sensor Applications, Another Taxonomy of WSN Technology, Basic Sensor Network Architectural Elements, Home Control, Medical Applications, Basic Wireless Sensor Technology : Introduction, Sensor Node Technology, Sensor Taxonomy, WN Operating Environment, WN Trends, Wireless Network Standards: IEEE 802.15.4, ZigBee, IEE 1451

Module -II

Medium Access Control Protocols for Wireless Sensor Networks: Introduction, Background, Fundamentals of MAC Protocols, MAC Protocols for WSNs: Schedule-Based Protocols, Random Access-Based Protocols, Coordination, Schedule Synchronization, Adaptive Listening, Access Control and Data Exchange (B-MAC,Box-MAC, Bit-MAC, H-MAC, I-MAC, O-MAC, S-MAC. Ri-MAC, T-MAC, Q-MAC (Querry MAC), Q-MAC (QoS MAC), X-MAC)

Module -III

Routing Protocols for Wireless Sensor Networks: Introduction, Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless Sensor Networks Network Scale and Time-Varying Characteristics, Resource Constraints, Sensor Applications Data Models, Routing Strategies in Wireless Sensor Networks: WSN Routing Techniques, Flooding and Its Variants, Sensor Protocols for Information via Negotiation, Low-Energy Adaptive Clustering Hierarchy, Power-Efficient Gathering in Sensor Information Systems, Directed Diffusion, Geographical Routing,

Reference Books:

1. Wireless Sensor Network by KazemSohraby, Daniel Minoli, TaiebZnati, Wiley publication.
2. Wireless Sensor Networks Signal Processing and Communications by Ananthram Swami, Qing Zhao, Yao-Win Hong, Lang Tong, John Wiley & Sons.
3. Ad Hoc Wireless Networks: Architectures And Protocols By Murthy, Pearson Education
4. Wireless sensor networks Edited by C. S. Raghavendra, Springer publication
5. Fundamentals of Sensor Network Programming: Applications and Technology By Sridhar S. Iyengar, NandanParameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley publication

Pattern Recognition and Analysis

Module 1: (12 hrs)

Introduction - features, feature vectors and classifiers, Supervised versus unsupervised pattern recognition. Classifiers based on Bayes Decision theory- introduction, discriminant functions and decision surfaces, Bayesian classification for normal distributions, Estimation of unknown probability density functions, the nearest neighbour rule. Linear classifiers,- Linear discriminant functions and decision hyper planes, The perceptron algorithm, MSE estimation, Logistic determination, Support Vector machines.

Module II: (18hrs)

Non-Linear classifiers- Two layer and three layer perceptrons, Back propagation algorithm, Networks with Weight sharing, Polynomial classifiers, Radial Basis function networks, Support Vector machines-nonlinear case, Decision trees, combining classifiers, Feature selection, Receiver Operating Characteristics (ROC) curve, Class separability measures, Optimal feature generation, The Bayesian information criterion.

Feature Generation 1- Linear transforms-KLT, SVD, ICA, DFT, DCT, DST, Hadamard Transform, Wavelet Transform, Wavelet Packets etc- Two dimensional generalizations - Applications. Feature Generation 2-regional features, features for shape and characterization, Fractals, typical features for speech and audio classification, Template Matching, Context dependent classification-Bayes classification, Markov chain models, HMM, Viterbi Algorithm. System evaluation - Error counting approach, Exploiting the finite size of the data.

Module III: (6 hrs)

Clustering- Cluster analysis, Proximity measures, Clustering Algorithms - Sequential algorithms, Neural Network implementation.Hierarchical algorithms - Agglomerative algorithms, Divisive algorithms. Schemes based on function optimization - Fuzzy clustering algorithms, Probabilistic clustering, K - means algorithm. Clustering algorithms based on graph theory , Competitive learning algorithms, Binary Morphology Clustering Algorithms Boundary detection methods, Valley seeking clustering, Kernel clustering methods. Clustering validity.

References

1. SergiosTheodoridis, KonstantinosKoutroumbas, "Pattern Recognition", Academic Press, 2006.
2. Duda and Hart P.E, Pattern classification and scene analysis, John Wiley and sons, NY, 1973.
3. Earl Gose, Richard Johnsonbaugh, and Steve Jost; Pattern Recognition and Image Analysis, PHI Pvte. Ltd., NewDelhi-1, 1999.
4. Fu K.S., Syntactic Pattern recognition and applications, Prentice Hall, Eaglewood cliffs, N.J., 1982
5. Andrew R. Webb, " Statistical Pattern Recognition", John Wiley & Sons, 2002

Neural Network

Module I:

Introduction to neural networks.Artificial intelligence and neural networks.The human brain and the nervous system.The biological neuron.Models of the single neuron. Neural networks viewed as directed graphs. Network architectures.Knowledge representation in neural networks.Applications of neural networks.

Module II:

Learning in neural networks.Types of learning methods.Classification of learning methods.Statistical nature of the learning processs.Statistical learning theory.The Probably Approximately Correct (PAC) model.Learning in a single layer perceptron.Adaptive filtering and the LMS algorithm.Learning rate annealing techniques.Perceptron convergence theorem. Multilayer perceptron: the error back-propagation learning method. Accelerated convergence in back-propagation learning.Radial basis function network.The counter-propagation network.

Module III:

Support vector machines. Optimal hyperplane for non-separable patterns. Building support vector machines. Principal component analysis (PCA).Hebbian based and lateral inhibition based adaptive PCA. Kernel based PCA. Self Organization Maps.Learning vector quantization.Information theoretic models.Maximum Entropy Principle. Mutual information and Kullback-Leibler divergence

References :

1. Simon Haykin, Neural Networks - A comprehensive foundation, Pearson Education Asia, 2001.
2. Frederic M. Ham &IvicaKostanic, Principles of Neuro-computing for Science and Engineering, Tata McGraw hill, 2002.
3. Kumar S, Neural Networks : A Classroom Approach, TMH
4. J.S.R. Jjang, C.T. Sun and E. Mizutani, Neuro fuzzy and Soft Computing : A computational approach to learning and machine intelligence, Prentice Hall of India,2002
5. YegnaNarayana B – Artificial Neural Networks – PHI

6. Timothy J Ross – Fuzzy logic with Engineering Applications
7. Christopher Bishop, Neural Networks for Pattern Recognition, Oxford University Press
8. J M Zurada, Introduction to Atificial Neural Networks, Jaico Publishing House

LabVIEW Digital Signal Processing

Module I:

Digital Communications and LabVIEW: Conventional Digital Receiver, Subsampling Receiver

Getting a Signal into LabVIEW: Conventional Digital Receiver, Subsampling Digital Receiver, Choosing a sample rate, Subsampling SNR, Subsampling signal placement, ther Sampling Methods, Digital oscilloscope, RF spectrum analyzer, Analog sampling card, Soundcard

Module II: Building Blocks

Spectral Analysis: Low-Level Frequency Domain Functions, Simple FFT, Improved FFT, Analyzing the DFT Results, Spectral leakage, Sampling window shape, High-Level Spectral Functions, Adding C Routines to LabVIEW, Spectral Measurements Toolset

Digital Filters: Filter Types, FIR Filters, FIR filter design by windowing, Equiripple FIR filters, IIR Filters, Comparing IIR and FIR Filters, IIR versus FIR magnitude, Effects of filter-phase response, Pulse-Shaping Filter

Multirate Signal Processing in LabVIEW: Upsampling, Downsampling, Resampling Filters, Halfband filters, Polyphase filters

Generating Signals with LabVIEW: Basic Functions, Sinusoids, Complex mixer, Sinc function, Chirp sequence, Generating Channel Models, Rayleigh fading, White gaussian noise, Generating Symbols

Module III: Building a Communication System

Assembling the Pieces: Modulator, Demodulator, Channel Impairments, Signal Detection and Recovery, Matched filter detection, Threshold decisions

Synchronization: Time synchronization, Frequency synchronization, NI Modulation Toolset

System Performance: Performance Measurements, Bit-error rate, Error vector magnitude, Improving System Performance, Channel estimation, Channel coding, Viterbi decoder

Optimizing LabVIEW Signal Processing: General LabVIEW Coding Guidelines, Signal Processing Tips, Linear convolution with the FFT, Fast real FFT

More LabVIEW DSP Applications, Roots of difference equations, Linear predictive speech coder

Text book

1. Cory L. Clark, “LabVIEW Digital Signal Processing and Digital Communications” McGraw-Hill, 2005
2. Nasser Kehtarnavaz and Namjin Kim, “Digital Signal Processing System-Level Design Using LabVIEW”, Elsevier publication, 2005.
3. Nasser Kehtarnavaz, “Digital Signal Processing System Design: LabVIEW - Based Hybird Programming”, 2nd Edition, Elsevier, ISBN 13 : 9788131222478.

LabVIEW Signal Processing Course Manual

Recommended Reading:

1. Jerome Jovitha, ***Virtual Instrumentation Using Labview***, PHI Learning,, 2010, **ISBN-10:** 8120340302, **ISBN-13:** 9788120340305, 978-8120340305.
2. Sanjay Gupta and Joseph John, ***Virtual Instrumentation Using LabVIEW***, 2nd Edn., Tata McGraw-Hill, 2010, **ISBN-10:** 0-07-07002**8-1**, **ISBN-13:** 978-0-07-070028-4.
3. Gary W. Johnson and Richard Jeninngs, ***LabVIEW Graphical Programming***, 4th Edn.,McGrawHill, 2006.
4. J. Travis and J. Kring, ***LabVIEW for Everyone***, 3rd Edn., Prentice Hall, 2006.
5. Peter A. Blume, ***TheLabVIEW Style Book***, Prentice Hall, 2007.

Adaptive Signal Processing

MODULE I: (10 HOURS)

Adaptive systems - definitions and characteristics - applications - properties-examples - adaptive linear combiner-input signal and weight vectors - performance function-gradient and minimum mean square error - introduction to filtering-smoothing and prediction - linear optimum filtering-orthogonality - Wiener – Hopf equation-performance surface

MODULE II: (16 HOURS)

Searching performance surface-stability and rate of convergence - learning curve-gradient search - Newton's method - method of steepest descent - comparison - gradient estimation - performance penalty - variance - excess MSE and time constants - misadjustments

LMS algorithm convergence of weight vector-LMS/Newton algorithm - properties - sequential regression algorithm - adaptive recursive filters - random-search algorithms - lattice structure - adaptive filters with orthogonal signals

Module III: (10 hours)

Applications-adaptive modeling and system identification-adaptive modeling for multipath communication channel, geophysical exploration, FIR digital filter synthesis, inverse adaptive modeling, equalization, and deconvolution-adaptive equalization of telephone channels-adapting poles and zeros for IIR digital filter synthesis

Reference Books

1. Bernard Widrow and Samuel D. stearns, “Adaptive Signal Processing”, Person Education, 2005.
2. Simon Haykin, “ Adaptive Filter Theory”, Pearson Education, 2003.
3. John R. Treichler, C. Richard Johnson, Michael G. Larimore, “Theory and Design of Adaptive Filters”, Prentice-Hall of India, 2002
4. S. Thomas Alexander, “ Adaptive Signal Processing - Theory and Application”, Springer-Verlag.
5. D. G. Manolokis, V. K. Ingle and S. M. Kogar, “Statistical and Adaptive Signal Processing”, McGraw Hill International Edition, 2000.

RF and Mixed Signal Integrated Circuit

MODULE – I (11 hours)

Introduction: Overview of wireless principles, Characteristics of passive IC components – resistors, Capacitors, Inductors, Transformers, Interconnect at RF and high frequencies, Skin effect.

Bandwidth Estimation Techniques: Method of open-circuit time constants, Method of short-circuit time constants, Rise time, Delay and Bandwidth.

High-frequency Amplifier Design: Zeros as bandwidth enhancers, Shunt-series amplifier, Bandwidth enhancement with f_T doublers, Tuned amplifiers, Neutralization andunilateralization, Cascaded amplifiers, AM-PM conversion.

MODULE – II (11 hours)

Voltage Reference: Review of diode behavior, Diodes and Bipolar Transistors in CMOS technology, Supply-independent bias circuits, Bandgap voltage reference, Constant-g_m bias.

Noise: Thermal noise, Short noise, Flicker noise, Popcorn noise, Classical two-port noise theory, Examples of noise calculations.

Low-Noise Amplifier (LNA) Design: Derivation of intrinsic MOSFET two-port noise parameters, LNA topologies – Power match Vs. Noise match, Power-constrained noise optimization, Design Example, Linearity and large signal performance, Spurious-free dynamic range.

MODULE – III (12 hours)

Mixers: Mixer fundamentals, Non-linear systems as linear mixers, Multiplier-based mixers, Sub-sampling mixers, Diode-ring mixers.

RF Power Amplifiers: Classes of power amplifiers, RF power amplifier design example, Power amplifier characteristics and Design consideration.

Phase-Locked Loops (PLL): Introduction to PLL, Linearized PLL models, Some noise properties of PLLs, Phase detectors, Sequential phase detectors, Loop filters and charge pumps, PLL design examples.

Oscillators and Synthesizers: Problems with purely linear oscillators, Describing functions, Resonators, Tuned oscillators, Negative resistance oscillators, Frequency synthesis.

Textbooks:

1. Thomas H. Lee, "***The Design of CMOS Radio-Frequency Integrated Circuits*",** 2ndEdn. Cambridge University Press, 2004.

Recommended Reading:

1. E.N. Farag and M.I. Elmasry, "Mixed Signal VLSI Wireless Design: Circuits & Systems", Kluwer, 1999.