COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF ELECTRONICS

COCHIN – 682 022

Syllabus

M.Tech. (Electronics & Communication Engineering)

2016

Course structure

Semester I

Course Code	Name of the Course	C/E	Credits
ELE 3101	Microprocessor & Embedded Systems	C	3
ELE 3102	Digital Communication	C	3
ELE 3103	Advanced Digital Signal Processing	C	3
ELE 3101L	Microprocessors Laboratory	C	1
ELE 3102L	Signal Processing Laboratory	C	1
	Elective-I	E	3
	Elective-II	E	3
	Elective-Lab	E	1
List of Electives			
ELE 3104	VLSI Technology and Design	E	3
ELE 3105	Microwave Devices and Circuits	E	3
ELE 3106	Wireless Communications	E	3
ELE 3107	Microwave Networks	E	3
ELE 3104L	VLSI Laboratory	E	1
ELE 3105L	Microwave Laboratory	E	1
ELE 3106L	Wireless Communications Laboratory	E	1
	Total credits		18

Semester II

ELE 3201	Broad Band Communication	C	3
ELE 3202	Advanced Digital System Design	C	3
ELE 3203	Digital Image Processing	C	3
ELE 3204	Seminar	C	1
	Communication Laboratory	C	1
	Elective-I	E	3
	Elective-II	E	3
	Elective-Lab	E	1
List of Electives			
ELE 3205	Spectrum Analysis	E	3
ELE 3206	Adaptive Signal Processing	E	3
ELE 3207	Spread Spectrum Communication	E	3
ELE 3208	Neural Networks	E	3
ELE 3209	Antenna Theory	E	3
ELE 3210	Radar Systems	E	3
ELE 3211	RF MEMS	E	3
ELE 3212	Sonar Technology	E	3
ELE 3213	Underwater Communication	E	3
ELE 3207L	Spread Spectrum Communication Lab	E	1
ELE 3208L	Neural Networks Lab	E	1
ELE 3209L	Antenna Lab	E	1
ELE 3211L	RF MEMS Lab	E	1
	Total credits		18

Semester III

ELE 3301	Project Evaluation& Viva Voce	C	18

Semester IV

ELE 3401	Project Evaluation& Viva Voce	C	18

Total credits for the course =18+18+18+18 = 72

ELE 3101 MICROPROCESSORS & EMBEDDED SYSTEMS

1. **Review of Intel ISA-32 CPUs**: Programmers Model of Intel 80386, 486, Pentium- series of CPUs. Hyper Threading, Multi-core Architecture, Memory and I/O space Address Decoding- Memory Interfacing Dynamic RAM – I/O Interface.

2. **Data register set and addressing**: 80386/486 Registers, Data Organization Memory Addressing. Instruction Set: Data Movement, Integer Arithmetic, Boolean and Control Instructions, Instruction Formats, Real Addressing, Virtual 8086 Mode, System Registers – Memory Management Registers, Control, Debug, Test Registers and System Instructions.

3. **Pentium 4 CPU:** Hyper pipelined Technology, Enhanced floating point Unit, Rapid Execution Engine-Dynamic Execution, NetBurst Micro-architecture, In-order front end-Instruction TLB/Prefetcher, Branch Predictor. Out of Order Execution Engine, Memory Sub system- L1, L2, L3 caches,Static predictor, Branch target Buffer, Pipe line stages.

4. **Introduction to Embedded systems:** Microchip PIC16 family, PIC16F887 processor architecture- features, memory organization, on chip peripherals, Watchdog timer, ADC, Data EEPROM, Asynchronous serial port, SPI mode, I2C mode. Interfacing with LCD, ADC, sensors, stepper motor, PC key-board, Touch screen and MEMS accelerometer.

5. **Advanced embedded Systems**: Popular ARM architectures,Registers, Program status register (CPSR), Processor modes,Register organization, Instruction set overview, Interrupts, ARMv7- Cortex M3 programmer's model, LPC1768-Memory system, Bus structure, Clock Control & Internal Oscillators, Reset & Power management, Inbuilt peripherals.

References

1. Intel – 386 DX/486 Microprocessor Programmers Reference Manual.
2. Brey, Barry B., "The Intel Microprocessors – Architecture, Programming & Interfacing", Eighth edition, Prentice Hall.
3. A.K Ray, K.M. Bhurchandi, Advanced Microprocessors and Peripherals, Tata McGraw-Hill, 2006.
4. Microarchitecture of the Pentium 4 Processor. G. Hinton, D. Sager, M. Upton; Intel Technology Journal Q1, 2001.
5. IA-32 Intel Architecture Optimization Reference Manual. Intel Corporation, 2004.
6. IA-32 Intel Architecture Software Developer's Manual: Volume 1: Basic Architecture. Intel Corporation, 2004.
7. Hyper-Threading Technology in the NetBurstMicroArchitecture. D. Koufaty, D. Marr; IEEE Computer Society: 2003. pgs 56- 65.
8. Microchip Reference Manuals- www.microchip.com
9. ShyamSadasivan, White Paper "An Introduction to the ARM Cortex-M3 Processor", October 2006
10. NXP Semiconductors, LPC1768 User Reference Manuals.

ELE 3102 DIGITAL COMMUNICATION

Review of Random variables. Moment generating function, Chernoff bound, Markov,s inequality, Chebyshev,s inequality, Central limit Theorem, Chi square, Rayleigh and Rician distributions, Correlation, Covariance matrix- Stationary processes, wide sense stationary processes, ergodic process, cross correlation and autocorrelation functions- Gaussian process

Characterization of Communication Signals and Systems- Signal space representation- Connecting Linear Vector Space to Physical Waveform Space- Scalar and Vector Communication over Memory less Channels. Optimum waveform receiver in additive white Gaussian noise (AWGN) channels - Cross correlation receiver, Matched filter receiver and error probabilities.

Optimum Receiver Signals with random phase in AWGN Channels- Optimum receiver for Binary Signals- Optimum receiver for M-ary orthogonal signals- Probability of error for envelope detection of M- ary Orthogonal signals. Optimum waveform receiver for coloured Gaussian noise channels- KarhunenLoeve expansion approach, whitening.

Carrier Recovery and Symbol Synchronization in Signal Demodulation- Carrier Phase Estimation- Effect of additive noise on the phase estimate- Maximum Likelihood phase estimation- Symbol Timing Estimation- Maximum Likelihood timing estimation- Receiver structure with phase and timing recovery-Joint Estimation of Carrier phase and Symbol Timing- Frequency offset estimation and tracking.

Communication over band limited Channels- Optimum pulse shaping- Nyquist criterion for zero ISI, partial response signaling- Equalization Techniques- Zero forcing linear Equalization- Decision feedback equalization- Adaptive Equalization..

References

1. J.G. Proakis and MasoudSalehi, “Digital Communication”, MGH 5TH edition, 2008..
2. Edward. A. Lee and David. G. Messerschmitt, “Digital Communication”, Allied Publishers (second edition).
3. J.Marvin.K.Simon, Sami. M. Hinedi and William. C. Lindsey, “Digital Communication Techniques”, PHI.
4. William Feller, “An introduction to Probability Theory and its applications”, Vol 11, Wiley 2000.
5. Sheldon.M.Ross, “Introduction to Probability Models”, Academic Press, 7th edition.
6. Ian A Glover and Peter M Grant “Digital Communication” 2nd edition Pearson education, 2008.

ELE 3103 ADVANCED DIGITAL SIGNAL PROCESSING

1. **Overview of Transforms** :Z – Transform, DFT, FFT, DCT, Hillbert Transform, Short-time Fourier Transom, Wavelet Transform.

2. **Filter Design** – LTI System as Freqruency Selective Filters - FIR Filters - Characteristics of FIR Filters with Linear Phase - Fourier Series Method of FIR Filter Design – Windows - Design of FIR Filters by Frequency Sampling Technique - IIR Filters - Impulse Invariant Transformation, Bilinear Transformation - Design of Lowpass Digital Butterworth Filter, Design of Lowpass Digital Chebyshev Filter , Frequency Transformations.

3. **Multidimensional Signal Processing**: 2-D Signals and Systems, Multi-dimensional Sampling, Difference Equations, Convolution, Fourier representation, 2-D DFT, Multidimensional FFT, z – Transforms.

4. **Multi-rate Signal Processing:** Sampling and Sampling rate Conversion, Decimation and Interpolation, FIR & IIR Decimators and Interpolators.

5. **Hardware:** Finite word length affect in Signal Processing, Signal Processing Hardware – TMS 320 Series Chips. Real-time Implementation Considerations.

References

1. Proakis, J.G., Manolakis, D.G. “Digital Signal Processing Principle Algorithms and Applications”. PHI 1996.
2. Dudgeon, D.E., Merseraus, R.M., “Multi Dimensional Digital Signal Processing”. Prentice-Hall, N.J., 1984.
3. Oppenheim, A.V., Schafer, R.W. , “Discrete – Times Signal Processing”.PHI, 1992
4. Crochiere, R.E., Rabiner, L.R., “Multi rate Digital Signal Processing, Prentice-Hall, N.J. 1983
5. Haddad, Richard A., Parsons, Thomas W., “Digital Signal Processing: Theory Applications & Hardware”, Computer Science Press, 1991.
6. Ahmed, N., Natarajan, T.R., “Theory and Applications of Digital Signal Processing.” Reston Publishing Co., 1983.

ELE 3104 VLSI TECHNOLOGY AND DESIGN

Basics of MOS, Bipolar and BiCMOS Device : MOS transistors, nMOS / CMOS device technology, Basic electrical properties of MOS transistor, V-I relationship, Threshold Voltage, MOS device as a resistor, MOS device as a capacitor, Transconductance, Conduction mechanisms in MOS device, Latch up in CMOS, Bipolar transistor – structure and conduction, BiCMOS device, Latch up susceptibility in BiCMOS.

MOS Circuit Design Processes and Subsystem Layout: MOS Layers, Stick Diagrams, Design Rules and Layout, General observations on the Design rules, Layout Diagrams, Basic Circuit concepts, Inverters. Architectural issues, Gate logic, Combinational logic, structured design processes, Clock sequential circuits, General considerations for bus lines, power dissipation, current limitations.

Propagation delays and Scaling in MOSFET : Propagation Delays, Gate delay, Interconnect delay, Effects of sheet resistance and capacitances, Parasitics and interconnect impedances, Scaling factors for device parameters, Limitations of scaling, Constant field and constant voltage scaling, Effects on threshold voltage, Short channel effects.

Basics of VLSI Device Fabrication : Basics of wafer fab processing, FEOL processing, Basics of oxidation / implantation / lithography / PVDs and CVDs, BEOL process, Interconnects, Process integration and in-line tests.

High Frequency VLSI Devices and Sub-Micron Trends: Direct band gap semiconductors, Basics of GaAs material and structure for high frequency applications, GaAs based devices, MESFETs, RF-CMOS devices, FinFETS, Strained Si and Si-Ge Devices.

References

1. Y Taur & T.H. Ning, Fundamentals of Modern VLSI Devices, Cambridge University Press, 2003.
2. D.S. Pucknell & K. Esharghian, Basic VLSI Design, Prentice Hall, 2000.
3. S. Wolf, Silicon Processing for VLSI Era, Lattice Press, 1990. (for Device Fabrication)
4. S. Oda & D. Ferry (eds), Silicon Nanoelectronics, Taylor & Francis, 2006 (for scaling in devices)
5. J. P. Colinge (ed), FinFETs and Other Multigate Transistors, Springer, 2008 (Chapters 1, 2,5)
6. R Doering & Y Nishi, Handbook of Semiconductor Manufacturing Technology, CRC Press, 2008.
7. Badih El-Kareh, Silicon Devices and Process Integration – Deep sub-micron and Nanoscale Technologies, Springer, 2009.
8. IEEE Transactions on Electron Devices (Reviews for trends in technology and device progression)

ELE 3105 MICROWAVE DEVICES AND CIRCUITS

1. **Microwave Solid state devices:** BJT, IMPATT devices, Transferred Electron devices, Gunn diodes, MESFET, HEMT, control devices, Varactors, PIN diodes, switches, phase shifters, modulators and attenuators.
2. **Detectors, Rectifiers and Mixers:** Detector operation, sensitivity, losses, detector circuits, mixers, mixer types, up convertors, down convertors, harmonic mixers, circuits design, conversion loss and noise figure, cascaded circuits, Inter modulation.
3. **Transistor Amplifiers:** stability consideration in active networks, Source stability and load stability circles, stability criteria, matching networks, power gain concepts, unilateral transistor, gain circles, noise figure circles, design aspects, bilateral design.
4. **RF oscillators:** Oscillation conditions, Two port and one port oscillators, Oscillator and stability conditions, design procedure for transistor oscillators, Fixed frequency oscillators, tunable oscillators.
5. **RF IC design:** Monolithic and hybrid MICs, Substrate and conductor materials, IC design, reproducibility and reliability issues, chip manufacturing aspects, RF MEMS

References:

1. Kai Chang, "Microwave Solid state circuits and applications", John Wiley, 1994
2. Matthew M. Radmanesh, "Radio frequency and microwave electronics illustrated", Pearson Education Inc, 2001.
3. Samuel Liao, "Microwave Circuit Analysis and amplifier design", Prentice Hall, 1987
4. R Ludwig &Bretchko, "RF circuit design, Theory ans applications", Pearson Education Inc, 2000.
5. J. Michael Golio, "Microwave MESFETs and HEMTs", Artech House, 1991.

ELE 3106 WIRELESS COMMUNICATION

Fading and Diversity: Wireless Channel Models-pathlossandshadowingmodels-statisticalfadingmodels-Narrowband 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- Spatial reuse-Co-channel interference Analysis-Handover Analysis-Erlang Capacity Analysis-Spectral efficiency and Grade of Service- Improving capacity- Cell splitting and sectorization.

Spread spectrum and CDMA: Motivation -Direct sequence spread spectrum-Frequency Hopping systems-Time Hopping.-Anti-jamming- Pseudo Random(PN) sequence-Maximal length sequences-Gold sequences-Generation of PN sequences.- Diversity in DSSS systems-Rake Receiver-Performance analysis. Spread Spectrum Multiple Access- CDMA Systems-Interference Analysis for Broadcast and Multiple Access Channels-Capacity of cellular CDMA networks-Reverse link power control- Hardand Soft hand off strategies.

Fading Channel Capacity: Capacity of Wireless Channels-Capacity of flat and frequency selective fading channels-Multiple Input Multiple output(MIMO)systems-Narrowband multiple antenna system model-Parallel Decomposition of MIMO Channels-Capacity of MIMO Channels.

Cellular Wireless Communication Standards: Second generation cellular systems: GSM specifications and Air Interface-specifications,IS95 CDMA-3G systems: UMTS & CDMA2000 standards and specifications

References :

1. Theodore S. Rappaport, “Wireless Communications: Principles & Practice”, Second Edition, Prentice Hall of India Pvt. Ltd. (Low Priced Edition – Pearson Education Asia), 2002.
2. William C.Y. Lee, “Mobile Communication Engineering: Theory & Applications”, Second Edition, McGraw Hill, 1998.
3. Gordon L. Stuber, “Principles of Mobile Communications”, Kluwer Academic Press,1996.
4. John G. Proakis, “Digital Communications”, Fourth Edition, McGraw Hill, 2001.
5. Jochan Schiller, “Mobile communications”, Addison-Wesley (Low Priced Edition – Pearson Education Asia), 2002.
6. SimonHaykin andMichaelMoher, “ Modern Wireless Communications”, Pearson Education.
7. Andrea Goldsmith, “Wireless Communications”,Cambridge Universitypress.
8. A.J.Viterbi,“CDMA- Principles of Spread Spectrum”,AddisonWesley, 1995.

ELE 3107 MICROWAVE NETWORKS

1. **Transmission Lines:** Review of Transmission lines, Equivalent Transmission lines, Smith Chart and Double stub tuning.

2. **Planar Transmission lines.** Microstrip Line, Strip line, Coplanar line, Fin line. Basic theory and design of Low pass filters, Band pass filters, High pass filters and Coupled line filters.

3. **Integral Equation and Moment Method:** Electrostatic charge distribution, Integral equation, Radiation pattern, Point matching method, Basic functions, Application of point matching, Weighing function, Moment method.
4. **Finite Difference Time Domain Analysis :** Maxwells equations in Time Domain – One dimensional field problems finite difference Numerical solution – Propagation of a half sine pulse – Frequency domain

5. **Microwave Measurements:** S-Parameters, Impedance, Attenuation, Power, Automatic Network Analyser, Near field to Far field measurements, Anechoic Chamber. Dielectric constant measurement, RCS measurement.

References:

1 J.A. Seeger, "Microwave Devices and Circuits", Prentice Hall, Inc., 1986
2 Samuel, Y.Liao, "Microwave Devices and Circuits", Prentice Hall, 1980
3 E.A. Wolff and Roger Kaul, "Microwave Engineering and Systems Applications". John Wiley & Sons, 1988.
4 C.A. Balanis, "Advanced Engineering Electromagnetics", John Wiley & Sons, 1989.

ELE 3201 BROADBAND COMMUNICATION

Introduction: Network Architectures – Telephone Network – Internet and Intranets – Limitations of today's Network Infrastructure. Classification of Applications.Traffic Requirements and QoS Requirements.

Principle of ATM Network: Switched Point to Point Architecture, Packet Switching, Fast Packet Switching, Advantages of BISDN Technical & Strategic. Overview of BISDN – Basic Elements of BISDN Networks, Network Operations, Virtual Channel and Virtual Path. Traffic Management:

Residential Broadband Services: Connectivity and Functional Requirements. Residential Broadband Service Architecture – Residential Access Networks, CO and Headend Networks, Broadband Internet Access, In-Home Network and End-to-end Protocol/ model.

Broadband Over xDSL: Network Architecture – Subscriber Loop Architecture, xDSLcharacteristicsk, xDSL Technologies, HDSL, ADSL, SDSL and VDSL. ADSL based broadband service architecture – ADSL based ATM-to-the-Home Architecture – DSLAM and Broadband Internet.

Hybrid Fibre/ Coax Network Architecture: Legacy Cable Network Architecture – Hybrid Fibre Coax Network Architecture – Fibre Nodes – Residential Broadband Architecture – end-to-end Protocol Architecture.

References:

1. Kswok, Timothy, "ATM – The Paradigm for Internet, Intranet & Residential Broadband Services & Applications", Prentice Hall PTR, New Jersey (1998)
2. SumitKasera and PakajSethi, "ATM Networks: Concepts and Protocols" Tata McGraw – Hill Publishing Company Limited, New Delhi (2001)
3. Introduction to Broadband Communication systems, Cajetan M. Akujuobi, Matthew N.O. Sadiku, CRC press, 2007

ELE 3202 ADVANCED DIGITAL SYSTEM DESIGN

Combinational Logic Modules and Logic Families: Definition and specification; Truth table; Basic logic operation and logic gates, Decoders, encoders, multiplexers, demultiplexers and their applications; Parity circuits and comparators; Arithmetic modules-adders, subtractors, Propagation Delay. Basic postulates and fundamental theorems of Boolean algebra; Standard representation of logic functions - SOP and POS forms; Simplification of switching functions - K-map.

Introduction to different logic families; Operational characteristics of BJT in saturation and cut-off regions; Operational characteristics of MOSFET as switch; TTL inverter - circuit description and operation; CMOS inverter - circuit description and operation; Structure and operations of TTL and CMOS gates; Electrical characteristics of logic gates – logic levels and noise margins, fan-out, propagation delay

Sequential Circuits: Definition of state machines, state machine as a sequential controller; Basic sequential circuits- latches and flip-flops: SR-latch, D-latch, D flip-flop, JK flip-flop, T flip-flop; Timing hazards and races; Analysis of state machines using D flip-flops and JK flip-flops; Design of state machines - state table, state assignment, transition/excitation table, excitation maps and equations, logic realization

Sequential circuits and timing - Setup and hold times, Basics of static timing analysis, Setup and Hold time analysis.

System Design with VHDL : Introduction, Behavioral, Data flow, Structural Models, Process. Concurrent Statements, Sequential Statements, Loops. Sequential Circuits, FSM Coding. Library, Packages, Functions, Procedures.

Test bench, Realization of combinational and sequential circuits using HDL – Registers – counters – sequential machine

Logic Design with Programmable Devices: Designing with Programmable Logic Devices: Read – Only Memories, Programmable Array Logic PALs, Programmable Logic Arrays PLAs – PLA minimization and PLA folding, Other Sequential PLDs, Design of combinational and sequential circuits using PLD's. MUX based digital design , Design using ROM, Programmable Logic Arrays (PLA) and Programmable Array Logic (PAL), Sequential circuit design - design of Moore and Mealy circuits , Design of a pattern sequence detector using MUX, ROM and PAL FPGA Simulation, Synthesis, Place and Route.

Fault Diagnosis and Testability

Testing combinational and sequential logic , Boundary scan testing, and Built-in self test .
Test Generation, DFT Schemes.

References

1. Charles H.Roth Jr "Fundamentals of Logic Design" Thomson Learning 2004
2. Nripendra N Biswas "Logic Design Theory" Prentice Hall of India, 2001
3. Parag K.Lala "Fault Tolerant and Fault Testable Hardware Design" B S Publications, 2002
4. Parag K.Lala "Digital system Design using PLD" B S Publications, 2003
5. Charles H Roth Jr."Digital System Design using VHDL" Thomson learning, 2004
6. Douglas L.Perry "VHDL programming by Example" Tata McGraw.Hill - 2006

ELE 3203 DIGITAL IMAGE PROCESSING

1. **Fundamentals of Digital Image Processing:** Image enhancement – Enhancement by Point Processing, Spatial Filtering, Frequency Domain Filtering, Colour Image Processing, Wavelet Transforms - 1D and 2D-fundamentals.
2. **Image Restoratio:** Degradation Models**,** Algebraic approach to Restoration, Inverse Filtering, Wiener Filter, Constrained Least Squares and Interactive Restoration, Restoration in Spatial Domain, Geometric Transformation.
3. **Image Compression:** Error-Free Compression, Lossy Compression - Lossy Predictive Coding, Transform Coding, Wavelet Coding. Lossless Compression - Variable Length Coding, Arithmetic Coding, Lossless Predictive Coding.Image Compression Standards.
4. **Image Segmentation, Representation and Description:** Detection of Discontinuities and Boundary, Region Oriented Segmentation, Use of Motion in Segmentation. Representation Schemes; Boundary, Regional and Relational Descriptors.Morphological Operations.
5. **Recognition and Interpretation :** Pattern Classes, Decision-Theoretic Methods, Structural Methods; Interpretation - Knowledge types, Logical Systems, Semantic Networks, Production Systems, Statistical Pattern, Recognition, Supervised/Unsupervised learning etc.

Reference:

1. Gonzalez, Rafael.C. & Woods, Richard.E.,"Digital Image Processing" - Pearson Education Asia, 1992, 2002
2. Anil K. Jain, " Fundamentals of Digital Image Processing", PHI, 1995.
3. B.Chanda&D.DuttaMajumder, "Digital Image Processing & Analysis" , Prentice Hall of India, 2001
4. S. Jayaraman, S. Esakkirajan & T. Veerakumar," Digital Image Processing", Mcgraw Hill, 2009.

ELE 3205 SPECTRUM ANALYSIS

Power Spectral Density: Energy spectral density of deterministic signals, Power spectral density of random signals, Properties of PSD

PSD Estimation -Non-parametric methods. Estimation of PSD from finite data, Non-parametric methods: Periodogram properties, bias and variance analysis, Blackman-Tuckey method, Window design considerations, time-bandwidth product and resolution-variance trade-offs in window design, Refined periodogram methods :Bartlet method, Welch method.

Parametric method for rational spectra:- Covariance structure of ARMA process, AR signals, Yule- Walker method, Least square method, Levinson-Durbin Algorithm, MA signals, Modified Yule-Walker method, Two-stage least square method, Burg method for AR parameter estimation.

Parametric method for line spectra:- Models of sinusoidal signals in noise, Non-linear least squares method, Higher order Yule-Walker method, MUSIC and Pisayenko methods, Min-norm method, ESPIRIT method.

Filter bank methods: Filter bank interpretation of periodogram, Slepia base-band filters, refined filter bank method for higher resolution spectral analysis, Capon method, Introduction to higher order spectra.

References

1. Steven M. Kay, “Modern Spectral Estimation Theory & Application”, Prentice-Hall Publishers, Englewood Cliffs, New Jersey USA, (1999).
2. Julius S. Bendat and Allan G. Piersol ,”Engineering Application of Correlation and Spectral Analysis”, John Wiley & Sons, Inc. ,New York (1993)
3. William A. Gardner ,”Statistical Spectral Analysis”, Prentice Hall Inc., New Jersey(1988)
4. Steven M .Kay and Stanley Lawrence Marple Jr., “ Spectrum Analysis – A Modern Perspective”, Proceedings of the IEEE , 69(11), pp.1380-1419,(1981)

ELE 3206 ADAPTIVE SIGNAL PROCESSING

Introduction : Adaptive Systems - Definition and Characteristics - Open-and Closed-Loop Adaptation - Adaptive Linear Combiner - Input Signal and Weight Vectors - Desired Response and Error - Performance Function

Theory of Adaptation - Properties of the Quadratic Performance Surface - Normal Form of the Input Correlation Matrix - Eigenvalues and Eigenvectors of the Input - Correlation Matrix - Geometrical Significance of Eigenvectors and Eigenvalues

Performance Surface - Methods of Searching the Performance Surface - Basic Ideas of Gradient Search Methods - simple Gradient Search Algorithm - Gradient Estimation and its Effects on Adaptation - Gradient Component Estimation by Derivative Measurement - Derivative Measurement and Performance Penalties with Multiple Weights

Adaptive Algorithms - 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.

Applications: Adaptive Modeling and System Identification - Adaptive Modeling of a Multipath Communication Channel. Inverse Adaptive Modeling Deconvolution and Equalization - General Description of Inverse Modeling- Adaptive Equalization of Telephone Channels - The Concept of Adaptive Noise Canceling - Stationary Noise-Canceling Solutions, Filtered-X LMS Algorithm - Adaptive Arrays - Sidelobe Cancellation - Beam forming with a Pilot Signal- Spatial Configurations, Adaptive Algorithms

References:

1. Bernad, Widrow, Stearns, .S.D, “Adaptive Signal Processing”. Prentice – Hall, N.J. 2009
2. TülayAdali, Simon Haykin, “Adaptive Signal Processing: Next Generation Solutions”, John Wiley & Sons, 2010
3. Ali H. Sayed, “Fundamentals of Adaptive Filtering”, John Wiley & Sons, 2003
4. John R. Treichler, C. Richard Johnson, Michael G. Larimore, “Theory and design of adaptive filters”, Wiley, 1987
5. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, “Statistical and adaptive signal processing: spectral estimation, signal modeling, adaptive filtering, and array processing” McGraw-Hill, 2000
6. Jacob Benesty, Yiteng Huang, “Adaptive Signal Processing: Applications to Real-World Problems” Springer,

ELE 3207 SPREAD SPECTRUM COMMUNICATION

Fundamentals of Spread Spectrum : Introduction to spread spectrum communication, pulse noise jamming, low probability of detection, direct sequence spread spectrum, frequency-hopping and time-hopping spread spectrum systems, correlation functions, spreading sequences-maximal-length sequences, gold codes, Walsh orthogonal codes-properties and generation of sequences , Synchronization and Tracking: delay lock and tau-dither loops, coarse synchronization- principles of serial search and match filter techniques.

Performance Analysis of SS system : Performance of spread spectrum system under AWGN, multi-user Interference, jamming and narrowband interferences, Low probability of intercept methods, optimum intercept receiver for direct sequence spread spectrum, Error probability of DS-CDMA system under AWGN and fading channels, RAKE receiver

Capacity, Coverage and Control of Spread Spectrum Multiple Access Networks .
Basics of spread spectrum multiple access in cellular environments, reverse Link power control, multiple cell pilot tracking, soft and hard handoffs, cell coverage issues with hard and soft hand off, spread spectrum multiple access outage, outage with imperfect power control, Erlang capacity off or ward and reverse links.

Multi-user Detection-MF detector, decorrelating detector, MMSE detector. Interference Cancellation: successive, Parallel Interference Cancellation, performance analysis of multiuser detectors and interference cancellers.

CDMA Systems General aspects of CDMAcellular systems, IS-95 standard, Downlink and uplink, Evolution to Third Generation systems, WCDMA and CDMA-2000 standards, Principles of Multicarrier communication, MC- CDMA and MC-DS-CDMA.

References

1. R.L.Peterson,R.Ziemer and D.Borth,"Introduction to Spread Spectrum Communications," Prentice Hall, 1995.
2. A.J. Viterbi,"CDMA- Principlesof Spread Spectrum Communications," Addison-Wesley, 1997.
3. Vijay K. Garg, Kenneth Smolik, Joseph E. Wilkes, Applications of CDMA Wireless/ Personal Communications, Prentice Hall, 1995
4. S.Verdu, "Multiuser Detection" , Cambridge University Press-1998
5. M.K.Simon, J.K. Omura, R.A. Scholts and B.K.Levitt,"Spread Spectrum Communications Handbook", McGraw- Hill, Newyork-1994
6. Cooper and McGillem, "Modern Communications and Spread Spectrum" McGraw-Hill,1985
7. J. G. Proakis, "Digital Communications," McGrawHill,4th ed.
8. S.Glisic and B.Vucetic, "Spread Spectrum CDMA Systems for Wireless Communications," Artech House, 1997.

ELE 3208 NEURAL NETWORKS

Neural networks characteristics: History of development in neural networks principles, Artificial neural net terminology, Model of a neuron, Topology, Learning, types of learning, Supervised, Unsupervised, Re-inforcement learning. Knowledge representation and acquisition.

Basic Hop field model: Basic learning laws, Unsupervised learning, Competitive learning, K-means clustering algorithm, Kohonen`s feature maps.

Radial basis function neural networks: Basic learning laws in RBF nets, Recurrent back propagation, Introduction to counter propagation networks, CMAC network, and ART networks.

Applications of neural nets: Pattern recognition, Optimization, Associative memories, speech and decision-making. VLSI implementation of neural networks.

Fuzzy Logic: Basic concepts of fuzzy logic, Fuzzy vs. Crisp set, Linguistic variables, Membership functions, Operations of fuzzy sets, Fuzzy IF- THEN rules, Variable inference techniques, De-Fuzzification, Basic fuzzy inference algorithm, Fuzzy system design, FKBC & PID control, Antilock Breaking system (ABS), Industrial applications.

References:

1. Neural Networks - by Simon Haykins
2. Fuzzy logic with engineering application - by ROSS J.T (Tata Mc)
3. Neural Networks & Fuzzy Logic - by Bart Kosko
4. Neural computing theory & practice - by P.D. wasserman (ANZA PUB).
5. Introduction to applied Fuzzy Electronics-Ahmad M.Ibrahim (PHI)
6. Introduction to artificial neural systems - by J.M. Zurada.(Jaico Pub)
7. An introduction to Fuzzy control - by D. Driankor, H. Hellendorn, M.Reinfrank (Narosa Pub.)
8. Fuzzy Neural Control - by Junhong NIE & DEREK LINKERS (PHI)
9. Fuzzy System Design Principles, Building Fuzzy IF-THEN Rule Bases, Riza C.Berkiu & Trubatch, IEEE Press
10. Gupta Madan M, Knopf. George K, "Neuro-Vision Systems - Principles and Applications" IEEE Press. 1994
11. Freeman, James A. Skapura, David M "Neural Networks-Algorithms, Applications and Programming Techniques". Addison- Weley publishing Co. 1992
12. Zurada. Jacek M , "Introduction to Arificial Neural Networks", Jaico Publishing House, Bombay, 1994
13. Anderson James A. "An introduction to Neural Networks" Prentice all of India, 1998

ELE 3209 ANTENNA THEORY

1 **Overview of Antennas**: Antenna arrays – Broadside array – end fire array – directivity of the array – 3 dimensional characteristic – Design procedure – Non uniform array – Binomial array – Chebyscheff array – Planar array – Array factor – beam width – directivity.

2 **General Antennas**: Travelling wave antennas – Helical Antennas – Yagi – Uda antenna – spiral antenna – Log periodic antenna – Dipole array – Design of Dipole array – Horn antennas – Sectoral horns – pyramidal horns – Corrugated horn antenna.

3 **Reflector Antennas**: Plane reflector – Corner reflector – Parabolic reflector – Patterns of large circular aperture – Parabolic cylinder – Cassigrain antennas, Babinet principle and complementary antennas.

4 **Antenna Synthesis**: Continuous sources, Schelkunoff Polynomial method, Fourier transform method – Woodward method – Taylor Line source method – Triangular, Cosine and Cosine squared amplitude distribution – Line source phase distribution – Continuous aperture sources.

5 **Microstrip Antennas and Smart Antennas**: Basic characteristics – Feeding techniques – Rectangular and circular patch antennas – Smart Antenna analogy – Cellular radio system evolution – Signal propagation – Antenna beamforming – Mobile Adhoc Networks (MANETs), System design.

References:

1. Constantine A Balanis, Antenna Theory – Analysis and design, Third Edition, John Wiley and Sons, 2005
2. John D Kraus – Antennas, Fourth Edition, Tata McGraw Hill, 2010
3. John L Volakis, Antenna Engineering Hand Book – Fourth Edition, Tata McGraw Hill Companies, 2007

ELE 3210 RADAR SYSTEMS

1. **Radar fundamentals and operation:** Introduction, principles, types of radar, transmitter functions, wave form spectra, receiver functions, signal processing, Radar equation, Radar cross section.
2. **Radar Systems:** Pulse, CW, FM-CW, MTI, Doppler Radar, Tracking Radar: Tracking system parameters, Conical Scan, amplitude comparison and phase comparison monopulse, Range and velocity tracking, Tracking accuracy.
3. **Detection of Radar Signals and information extraction and estimation:** Detection introduction, threshold detection, Signal integration, Binary integrators, CFAR, Theoretical accuracy of radar measurements, ambiguity function and radar waveform design, correlation detection and matched filter receiver.
4. **Radar signal processing:** Signal integration, spectrum analysis, windows and resolution, MTI principles and methods, De staggering and processing, Moving Radars and moving clutter, Doppler processing.
5. **Radar Applications:** Direction finders, instrument landing systems, Radar beacons, Electronic Warfare, ECM and ECCM, high resolution radar, range and Doppler resolution, Pulse compression (analog and digital), Synthetic aperture radar.

References:

1. Skolnik M.M., "Introduction to Radar systems", McGraw Hill, (Second Edition) 1981.
2. Byron Edde. 'Radar: principles, technology and applications", Pearson Education Inc., 1995.
3. D.CurtisScheleher, "Introduction to Electronic Warfare", Artech House Inc., 1986.
4. Wheeler G.J., "Radar Fundamentals", Prentice Hall Inc. NJ 1967.
5. LavanonNadav, "Radar Principles" john Wiley & Sons, 1988.

ELE 3211 RF MEMS

RF MEMS relays and switches. Switch parameters. Actuation mechanisms.Bistable relays and micro actuators. Dynamics of switching operation.

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

Micromachined RF filters. Modeling of mechanical filters.Electrostatic comb drive. Micromechanical filters using comb drives. Electrostatic coupled beam structures.

MEMS phase shifters. Types.Limitations. Switched delay lines. Micromachined transmission lines.Coplanar lines.Micromachined directional coupler and mixer.

Micromachined antennas.Microstrip antennas – design parameters.Micromachining to improve performance.Reconfigurable antennas.

References

1. H.J.D.Santos, RF MEMS Circuit Design for Wireless Communications, Artech House ,2002.
2. G.M.Rebeiz , RF MEMS Theory , Design and Technology, wiley , 2003.
3. Stephen D Senturia, “Microsystem Design”, Kluwer Academic Publishers, 2001.
4. Marc Madou, “Fundamentals of Microfabrication”, CRC Press, 1997.
5. V.K.Varadan, K.J Vinoy & K.A. Jose, RF MEMS and their Applications, Wiley,2003.
6. Gregory Kovacs, “Micromechanised Transducers Source Book”, WCB McGraw Hill, Boston, 1998.
7. M H Bao, “Micromechanical Transducers, Pressure Sensors, Accelerometers and Gyroscopes” Elsevier, Newyork, 2000.

ELE 3212 SONAR TECHNOLOGY

1. **Transducers and array systems** :piezopolymer transducers - linear and planar arrays-limitations of arrays - shading and super directivity - array gain - array sensitivity - synthetic aperture arrays - random arrays - Transducer performance evaluation techniques.
2. **Types of sonar systems :** active and passive - sonar equations - propagation characteristics of the medium - transmission loss and spreading effects - beam forming and steering - detection threshold - square law detector - cross-correlation detector.
3. **Ambient noise :** sources of ambient noise - shallow water ambient noise - effect of depth- directional characteristics of deep water ambient noise - electrical noise, machinery noise, flow noise, propeller noise, self-noise and radiated noise.
4. **Modern sonar systems :** signal and noise models - temporal sampling and quantization-spatial sampling and beam forming, band shifting, filtering and smoothing, decision processing, block diagram of active and passive sonars.
5. **Correlation receivers and matched filters :** Advanced Sonar Signal Processing functions – adaptive beam forming - synthetic aperture arrays - automated decision making.

References:

1. 'Principles of Underwater Sound' Robert J. Urick, McGraw Hill Book Company, New York (1975) Chapters: 2,3,4,5,6,7,9 and 10.
2. SONAR for Practicing Engineers, A.D. Waite John, Wiley & Sons, Ltd.,(1998)
3. 'Array Signal Processing'. Simon Haykin (Ed.) Prentice Hall, Inc., Englewood Cliffs (1998) pp. 115-193.
4. 'Applications of Digital Signal Processing', Alan, V .Oppenheim, Prentice Hall, Inc., Englewood Cliffs (1995), pp. 331-438.
5. 'Digital Signal Processing for Sonar' W.C.Knight, R.G. Pridham and S.M. Kay, Proceedings of IEEE, Vol. 69, No: 11, 1981, pp. 1451-1507.

ELE 3213 UNDERWATER COMMUNICATION

1. **Adaptive Signal Processing**: Adaptive Systems, Open Loop and Closed loop Adaptations, Adaptive Linear Combiner, Theory of Adaptation with stationary Signals, Adaptive Algorithms and Structures, Applications.
2. **Applications of Digital Signal Processing to Sonar**: Characteristics of Sonar Signal propagation, Digital signal Processing for active sonar system and digital signal processing for passive sonar systems, Signal Processing Hardware -TMS 320 Series Signal Processors, real-time implementation considerations.
3. **Orthogonal Frequency division multiplexing**: Key features, characteristics and principle of operation of OFDM, Channel coding and interleaving System model, Enhancement of spectral efficiencies, Transmission/ Reception of OFTD - OFDM Simulations.
4. **Acoustic Modem**: Underwater Wireless Modem- Sweep spread carrier signal-transmission characteristics in shallow water channel-separation of time varying multipath arrivals-Typical acoustics modems-characteristics and specifications-Applications, Acoustic Releases-Real time wireless current monitoring system.
5. **Underwater Sensor Network**: Underwater Networking- Ocean Sampling Networks, Pollution Monitoring, Environmental Monitoring and Tactical surveillance systems, Major challenges in design of Underwater Sensor Networks, Factors that affect the UWSN- Sensor Node Architecture- GIBS, VRAP, DABSRAPT. etc.

References:

1. Digital Spectral Analysis with applications- S. Lawrence Marple Jr. Prentice Hall. Signal Processing Series, 1987.
2. Alan. V. Oppenhein (Ed), Applications of Digital Signal Processing, Prentice Hall, Inc., Engliwood Cliffs, NJ 07632,978.
3. Andreas Antoniou, “Digital Filters, Analysis, Design & Applications”, Tata Mcgraw-Hill, 1999.
4. Richard A. Haddad and Thomas W Parsons, “Digital Signal Processing: Theory Applications and Hardware”, Computer Science Press, 1991.
5. ‘Real time Deepwater Current Profiling Systems’, Michael Uogel, etal, Marine Technology Symposium.
6. ‘Acoustic Modems’ Hydro International, June 2007, www.ece.gatech.edu.
7. ‘Underwater Acoustics Sensor Network: Research Challenges: Ian F Akyildizetal, Elsevier, 3 (2005), pp 257-279.
8. ‘Data Collection, Storage and Retrieval with an Underwater Sensor Network, Vasilescu, etal, Sensys’ 05, Nov. 2-4, 2005, San Diego, CA.