Course Structure & Curriculum

for

M. Tech. Programme

in

Electronics Engineering

with specialization in

Signal Processing

Department of Electronics and Communication Engineering

Motilal Nehru National Institute of Technology Allahabad

Allahabad - 211004, Uttar Pradesh

MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY ALLAHABAD

VISION

To establish a unique identity for the Institute amongst National and International Academic and Research Organizations through knowledge creation, acquisition and dissemination for the benefit of Society and Humanity.

MISSION

To generate high quality human and knowledge resources in our core areas of competence and in emerging areas to make valuable contribution in technology for social and economic development of the Nation and to make organized efforts for identification, monitoring and control of objective attributes of quality for continuous enhancement of academic processes, infrastructure and ambiance.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION

To become a globally leading department of higher learning, building upon the culture, the values of universal science and contemporary education, and a center of research and education generating the knowledge and the technologies which lay the groundwork in shaping the future in the fields of Electronics and Communication Engineering.

MISSION

To provide quality education and research leading to B. Tech., M. Tech. and Ph. D. degree in the area of Electronics and Communication Engineering and Technology which may produce globally acceptable high quality skilled manpower.

To impart technical education which may provide innovative skills in their respective area of specialization for society in general with universal moral values, adherent to the professional ethical codes.

To generate and disseminate knowledge and technologies essential to the local and global needs in the field of Electronics and Communication Engineering.

M. Tech. (Electronics Engineering) with specialization in Signal Processing

Proposed Course Structure & Scheme of Evaluation

I Semester

Subject Code	Subject Name	L	T	P	Credits				Total Marks
						TA	MSE	ESE	
EC21105	Advanced Mathematics	3	1	0	4	20	20	60	**100**
EC21106	Advances in Digital Signal Processing	3	1	0	4	20	20	60	**100**
EC213xx	Elective I	3	1	0	4	20	20	60	**100**
EC213xx	Elective II	3	1	0	4	20	20	60	**100**
EC212xx	Elective III	0	0	6	4	50	-	50	**100**

Total Credits = 20

II Semester

Subject Code	Subject Name	L	T	P	Credits				Total Marks
						TA	MSE	ESE	
EC22105	DSP Processors and Architecture	3	1	0	4	20	20	60	**100**
EC22106	Adaptive Signal Processing	3	1	0	4	20	20	60	**100**
EC223xx	Elective IV	3	1	0	4	20	20	60	**100**
EC223xx	Elective V	3	1	0	4	20	20	60	**100**
EC222xx	Elective VI	0	0	6	4	50	-	50	**100**

Total Credits = 20

III Semester

Subject Code	Subject Name	Credits	Eval (100)
EC23601	Thesis	16	Marks
EC23651	Special Study/Industrial Training/Colloquium	4	Marks

Total Credits = 20

IV Semester

Subject Code	Subject Name	Credits	Eval (100)
EC24601	Thesis	20	Marks

Total Credits = 20

Note: The distribution of thesis evaluation marks will be as follows:
1. Supervisor(s) evaluation component 60%
2. Oral Board evaluation component 40%

List of Professional Electives for Signal Processing

Elective I (EC213xx)

1. EC21341 Digital IC Design
2. EC21303 System on Chip
3. EC21309 Architectural Design of ICs
4. EC21342 Microprocessor based System Design
5. EC21343 Solid State Circuits
6. EC21344 Digital Hardware Design
7. EC21123 Optimization Techniques
8. EC21345 Statistical Signal Processing

Elective II (EC213xx)

1. EC21325 Random Theory, Stochastic Process and Queueing Theory
2. EC21308 Reconfigurable Hardware Design
3. EC21346 Digital Transmission
4. EC21347 Advanced Computer Networks
5. EC21348 Mobile Communication
6. EC21349 Switching and Finite Automata Theory
7. EC21350 Expert Systems

Elective III (EC212xx)

1. EC21201 System Design using HDL
2. EC21203 Digital Signal Processing Lab
3. EC21221 Advanced Microprocessor Lab

Elective IV (EC223xx)

1. EC22306 Embedded Systems
2. EC22308 ASIC Design
3. EC22341 Interactive Computer Graphics
4. EC22342 Mobile Computing
5. EC22325 Detection and Estimation Theory
6. EC22243 Advanced Computer Architecture
7. EC22344 Multidimensional Digital Signal Processing

Elective V (EC223xx)

1. EC22345 VLSI Circuits and Systems
2. EC22322 Image Processing and Pattern Recognition
3. EC22346 Information Theory and Coding
4. EC22309 VLSI Testing and Testable Design
5. EC22347 Computer Network Performance and Modelling
6. EC22348 VLSI for Signal Processing
7. EC22349 Digital Control

Elective VI (EC22xx)

1. EC22201 FPGA / CPLD Lab
2. EC22221 Digital design & Simulation Lab
3. EC22222 Microcontroller Lab
4. EC22213 Advanced Digital Signal and Image Processing Lab

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	To excel in professional career and/or higher education by acquiring knowledge in area of Signal Processing
PEO 2	To analyze real time problems, design appropriate system to provide solutions that are technically sound, economically feasible and socially acceptable
PEO 3	To exhibit professionalism, ethical attitude, communication skills, team work in their profession and adapt to current trends by engaging in lifelong learning

Mapping of Mission statements with the PEOs

Key components from Department Mission	**PEO 1**	**PEO 2**	**PEO 3**
• To provide quality education and research leading to B. Tech., M. Tech. and Ph. D. degree in the area of Electronics and Communication Engineering and Technology which may produce globally acceptable high quality skilled technical manpower • To impart technical education which may provide innovative skills in their respective area of specialization for society in general with universal moral values, adherent to the professional ethical codes • To generate and disseminate knowledge and technologies essential to the local and global needs in the field of Electronics and Communication Engineering			
Quality education	YES		
Professional career	YES	YES	YES
Higher education	YES	YES	
Social responsibility			YES
Research		YES	

EC21105 Advanced Mathematics **FIRST SEMESTER**

Matrix Theory: QR EL decomposition, eigen values using shifted QR algorithm, singular value EL decomposition, pseudo inverse, least square approximations.

Calculus of Variations: concept of functional, Euler's equation, functional dependent on first and higher order derivatives, functionals on several dependent variables, isoperimetric problems, variational problems with moving boundaries.

Transform Methods: Laplace transform methods for one dimensional wave equation, displacements in a string, longitudinal vibration of an elastic bar, Fourier transform methods for one dimensional heat conduction problems in infinite and semi infinite rod.

Elliptic Equation: Laplace equation, properties of harmonic functions, Fourier transform methods for laplace equations, solution for Poisson equation by Fourier transforms method.

Linear and Non Linear Programming: Simplex Algorithm, two phase and Big M techniques, duality theory, dual simplex method. Non Linear Programming, constrained extremal problems, Lagranges multiplier method, Kuhn- Tucker conditions and solutions.

References:

1. Richard Bronson, *Schaum's Outlines of Theory and Problems of Matrix Operations*, McGraw-Hill, 1988.
2. Venkataraman M K, *Higher Engineering Mathematics*, National Pub. Co, 1992.
3. Elsgolts L., *Differential Equations and Calculus of Variations*, Mir, 1977.
4. Sneddon I.N., *Elements of Partial differential equations*, Dover Publications, 2006.
5. Sankara Rao, K., *Introduction to partial differential equations*, Prentice – Hall of India, 1995
6. Taha H A, *Operations research - An introduction*, McMilan Publishing co, 1982.

EC21106 Advances in Digital Signal Processing **FIRST SEMESTER**

Introduction and Review: Basic concepts and examples of Digital Signal Processing, overview of typical Digital Signal Processing in real-world applications. Sampling and Reconstruction of Signals: Sampling of band-pass signals, analog-to-digital and digital-toanalog conversions. Realization of digital linear systems: Basic structures for IIR and FIR filters. Design of IIR and FIR filters.

Multirate Digital Signal Processing: Introduction, decimation by a factor D, interpolation by a factor I, sampling rate conversion by a rational factor I/D, filter design and implementation for sampling rate conversion, multistage implementation of sampling rate conversion, sampling rate conversion of band-pass signals, sampling rate conversion by an arbitrary factor, applications.

Linear Prediction and Optimum Linear Filters: Representation of a random process, forward and backward linear prediction, solution of normal equations, properties of the linear error-prediction filters, AR lattice and ARMA lattice-ladder filters, Wiener filters for filtering and prediction.

Power Spectrum Estimation: Estimation of spectra from finite-duration observations of signals, non-parametric and parametric methods for power spectrum estimation, minimum variance spectral estimation, eigen analysis algorithm for spectral estimation.

Hardware and Software for Digital Signal Processors: Digital signal processor architecture and hardware units, fixed-point and floating-point formats.

References:

1. John G. Proakis and Dimitris G. Manolakis, *Digital Signal Processing*, 3rd Edition, Pearson, 2003.
2. Li Tan, *Digital Signal Processing – Fundamentals and applications*, Elsevier, 2008.
3. Paulo S. R. Diniz, Eduardo A. B. da Silva And Sergio L. Netto, *Digital Signal Processing: System Analysis and Design*, Cambridge University Press, 2002.
4. Sanjit K. Mitra, *Digital Signal Processing - A Computer Based Approach*, Tata McGraw Hill, 2001.

EC22105 DSP Processors and Architecture **SECOND SEMESTER**

Introduction to Digital Signal Processing: A Digital Signal Processing System, The Sampling Process, The Convolution Theorem, The DFT and FFT, Decimation and Interpolation, Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/ A Conversion Errors.

Introduction of DSP Processors: Need for DSP Processors, MAC, Modified Bus Structures, Memory access schemes, Harvard architecture, VLIW architecture, On-chip peripherals, Addressing modes, Concept of Pipelining. Issues in Real Time DSP applications, Fixed point and Floating point Processors.

Programmable Digital Signal Processors : TMS320C54x Architecture, Interrupts and Interrupt Vector, TMS320C54x Peripherals, External Memory Interface, Direct Memory Access, Multi-Channel Buffered Serial Ports, Clock Generator and Timers, General Purpose Input/output Port, TMS320C54x Addressing Modes, Direct Addressing Modes, Pipeline, Instruction Set, Assembly Language Programming, Assembly Code Generation by C Compiler, Mixed C-and-Assembly Language Programming, Phase-Locked Loop and Timers, Direct Memory Access.

Implementation of Basic DSP Algorithms: Introduction, The Q-notation, FIR Filters, IIR Filters, Interpolation and Decimation Filters. An FFT Algorithm for DFT Computation, Overflow and Scaling, Bit-Reversed Index Generation & Implementation on the TMS32OC54xx.

Interfacing of Memory and Parallel I/O Peripherals to DSP Device: Introduction, Memory Space Organization, External Bus Interfacing Signals. Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and Direct Memory Access (DMA) interface.

References:

1. B. Venkataramani & M. Bhaskar, Digital Signal Processor, Architecture, Programming and Applications,(2/e), McGraw- Hill,2010
2. S. Srinivasan & Avtar Singh, Digital Signal Processing, Implementations using DSP Microprocessors with Examples from TMS320C54X, Brooks/Cole, 2004.

3. K Padmanabhan, R. Vijayarajeswaran, A Practical Approach to Digital Signal Processing, New Age International, 2006/2009
4. Sen M. Kuo & Woon-Seng S. Gan, Digital Signal Processors: Architectures, Implementations, and Applications, Prentice Hall, 2004

5. C. Marven & G. Ewers: A Simple approach to digital signal processing, Wiley Inter science, 1996.

EC22106 Adaptive Signal Processing **SECOND SEMESTER**

Introduction to Adaptive filtering: Introduction to stochastic processes, linear adaptive filter structure, real and complex forms of adaptive filter, non-linear adaptive filter, adaptation approaches: Wiener filter theory, method of least squares.

Optimal Wiener filtering and Kalman filtering: Mean-square error criterion, linear optimum filtering, principle of orthogonality, Wiener-Hopf equation, error performance surface, numerical examples, channel equalization, linear constrained minimum variance filter. Kalman filtering problem, estimation of state using innovation, variance of Kalman filtering, extended Kalman filtering.

Linear Adaptive filtering: Method of steepest descent, stability of steepest descent, least mean square algorithm, adaptive prediction, adaptive equalization, robustness of LMS algorithm, block adaptive filter, fast LMS algorithm, unconstrained frequency-domain adaptive filtering, methods of least squares.

Lattice filters: Forward linear prediction, backward linear prediction, prediction error filters, derivation of the lattice structure, all-pole lattice structure, pole-zero lattice structure, adaptive lattice structure, autoregressive modelling.

Recursive least squares (RLS): Matrix inversion lemma, weighted recursive least squares algorithm, adaptive noise canceller, convergence analysis of RLS algorithm, adaptive equalization, state-space formulation of RLS problem, adaptive beam-forming, order recursive adaptive filter.

Non-linear Adaptive filtering: Introduction to blind de-convolution, back-propagation learning, radial basis function learning, stochastic gradient approach, Markov model, singular value decomposition.

Applications of Adaptive Signal Processing: Adaptive modeling and system identification, inverse adaptive modeling, adaptive interference canceling, adaptive arrays and adaptive beam-forming.

References:

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*, Mc Graw Hill International Edition, 2000.
6. Ali H. Sayed, *Fundamentals of Adaptive Filtering*, Wiley, 1st Ed., 2003.

7. Farhang-Boroujeny B., *Adaptive Filters Theory and Applications*, John Wiley & Sons, 1st Ed., 1998.
8. Mohamed Ibnkahla (Edited), *Adaptive Signal Processing in Wireless Communications*, CRC Press, Taylor & Francis Group, 1st Ed., 2009.

EC21341 Digital IC Design **FIRST SEMESTER (E-I)**

Basic electrical properties of MOS circuits: MOS transistor operation in linear and saturated regions, MOS transistor threshold voltage, MOS switch and inverter, latch-up in CMOS inverter, sheet resistance and area capacitances of layers, wiring capacitances, CMOS inverter properties - robustness, dynamic performance, regenerative property, inverter delay times, switching power dissipation, cross talk, combinational logic design in CMOS. MOSFET scaling - constant-voltage and constant-field scaling, dynamic CMOS design: steady-state behavior of dynamic gate circuits, noise considerations in dynamic design, charge sharing, cascading dynamic gates, domino logic, NP-CMOS logic, problems in single-phase clocking, two-phase non-overlapping clocking scheme, Subsystem design: design of arithmetic building blocks like adders - static, dynamic, Manchester carry-chain, look-ahead, linear and square-root carry-select, carry bypass and pipelined adders and multipliers - serial-parallel Braun, Baugh-Wooley and systolic array multipliers, barrel and logarithmic shifters, areatime tradeoff, power consumption issues, designing semiconductor memory and array structures: memory core and memory peripheral circuitry. Virtual and high speed memory design. Custom cell based design. Digital circuit testing and testability.

References:

1. J. M. Rabaey, A. Chandrakasan and B. Nikolic, *Digital Integrated Circuits- A Design Perspective*
2. S. M. Kang and Y. Leblevici, *CMOS Digital Integrated Circuits Analysis and Design*
3. N. H. E. Weste and K. Eshraghian, *Principles of CMOS VLSI Design - a System Perspective*
4. Mead and Convay, *Introduction to VLSI Systems*
5. W. Wolf, *Modern VLSI Design - System on Chip design*
6. R. Jacob Baker, *CMOS Circuit Design, Layout, and Simulation*

EC21303 System on Chip **FIRST SEMESTER (E-I)**

Introduction to digital system and VLSI design, design techniques, fabrication processes and steps, wires and vias, design rules and layout. Logic gates, static complementary gates, nonconventional logic circuits, low power gate circuits, delay through interconnect. Combinational logic network, network delay, logic and interconnect design, power optimization and logic testing. Sequential machines, latches and flip-flops, clocking techniques, sequential system design, optimization, validation and testing.
Chip design: Design methodologies, timing specifications, architecture design layout with validation, data paths.

References:

1. Wayne Wolf, *Modern VLSI Design*, Third Edition
2. Neil Weste, *Principles of CMOS VLSI Design*

EC21309 Architectural Design of ICs **FIRST SEMESTER (E-I)**

Introduction, general design methodologies, datapath synthesis, mapping algorithms into architectures, control strategies, concepts of system analysis, hardware implementation of various control structures, microprogram control techniques, implementation of simple and nested subroutine calls, timing considerations, worst case system speed calculation, pipelined and parallel architectures, latency and throughput, dependency and dataflow, fault tolerance, fault-tolerant architectures.

References:

1. Sajjan G. Shiva, *Computer Organination, Design and Architecture*, 5th edition, CRC Press Taylor and Fransis group
2. Sung Kyu Lim, *Design for High Performance Low Power and Reliable 3D Integrated Circuits*, Springer

EC21342Microprocessor based System Design **FIRST SEMESTER (E-I)**

Review of 8086 & Programming through PC: BIU & EU, addressing modes & programming and CPU module design: Bus buffering and latching, fully buffered systems, bus timings, read & wait etc. Use of memory models, realization of array structures, display screen & keyboard processing with INT and BIOS functions calls, .COM and .EXE programs, use of macros, LOCAL, EXTRN and PUBLIC.

Interfacing with 8086: Memory Interfacing: physical memory organization, memory interfacing, parity error detection & correction, DRAM interfacing.
I/O Interfacing & Interrupts: Interfacing of 8255 PPI, interfacing of 8253/8254 timer devices, The 8279 controller, keyboard formats & display modes, interfacing keypad and alphanumeric displays, interrupt response of 8086, interfacing 8259 priority interrupt controller, interrupt modes, Master/Slave configuration.

DMA & Serial Communication Interface: DMA data transfer, interfacing 8237 DMA controller and DMA modes, serial communication formats and protocols, interfacing 8251 USART operating modes, modem control, serial transfer between two 8086 single board microcomputers.

Measurement/Instrumentation: Interfacing A/D converters, analog multiplexers, sample and hold, D/A converters, measurement of frequency, measuring KWH, power factor, measurement & display of motor speed, microcomputer based smart scale etc.

Industrial Process Control: Overview, liquid level monitoring & control, microprocessor based protective relays, temperature control in vacuum furnaces, servo motor control etc.

References:

1. D.V. Hall, *Microprocessors and Interfacing*, 2nd Ed, TMH
2. Liu & Gibson, *Microcomputer Systems: The 8086/8088 Family Architecture, Programming and Design*, 2nd Ed, PHI

3. Barry B Brey, *The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, Pentium, and Pentium Pro Processors*, PHI
4. Jan Axelson, *Serial Port Complete Programming & Circuits for RS-232 and RS-485 Links and Networks*, Penram International
5. Peter Abel, *IBM PC Assembly Language and Programming*, 3rd Ed, PHI
6. *The Intel Handbook of peripheral devices*

EC21343 Solid State Circuits **FIRST SEMESTER (E-I)**

CMOS analog circuits: current sources and sinks, referenced biasing, Differential amplifiers performance characteristics: source coupled, cross coupled, cascode loads, Operational amplifiers: Basic CMOS Op-amp design, Analog devices and multipliers: CFAs and OTAs, CMOS digital circuits: Inverters, Ring oscillators, static logic gates, dynamic logic gates, pass transistor logic, low & high power circuits, phase Lock techniques, PLL design parameters & systems, data converter fundamentals and architectures.

References:

1. R. Jacob Baker, Harry- W.Li and David E. Boyce, *CMOS Circuit Design Layout & Simulation*, PHI, India
2. Sung - Mo Kang & Yusuf Leblebici, *CMOS Digital Integrated Circuits, Analysis & Design*, 3rdEditionTMH
3. Gray, P.R. & R.G. Meyer, *Analysis & Design of Analog Integrated Circuits*, 2nd Edition, John Wiley & Sons 1993
4. Franco, *S. Design With Operational Amplifiers & Analog Integrated Circuits*, McGraw Hill, New York 1988

EC21344 Digital Hardware Design **FIRST SEMESTER (E-I)**

Combinational and Sequential Logic: Review of POS and SOP minimization, multi output function, variable entered mapping, computer arithmetic, ASM, FSM, shift register, timing and triggering, clock skew, device technologies, system representation, levels of abstraction, development tasks and EDA software, development flow.

Hardware Description Languages: Hardware description languages, basic VHDL concept, basic language constructs of VHDL, concurrent signal assignment statements of VHDL, sequential statements of VHDL, synthesis of VHDL code.

Circuit Design with VHDL: Combinational circuit design, sequential circuit design, finite state machine, register transfer methodology, hierarchical design in VHDL, clock and synchronization.

Microprocessor Design using VHDL: Data path design, control unit design, example of dedicated processor (GCD), general purpose processor design.

FPGA based Design: Fundamental concept of FPGA, architecture of FPGA, FPGA programming, schematic and HDL based design flow, serial communication, memory, digital filters, DSP based design, IP.

References:

1. W. I. Fleccher, *An Engineering approach to Digital Design*
2. Zvi Kohavi, *Switching and finite automata theory*
3. Hwang, *Digital logic and microprocessor design with VHDL*
4. C H Roth, *Digital System design using VHDL*
5. P P Chu, *RTL Hardware design using VHDL*
6. Perry and Perry, *VHDL programming by example*

EC21323 Optimization Techniques **FIRST SEMESTER (E-I)**

Introduction and Basic Concepts: Historical development, Engineering applications of optimization, art of modelling, Objective function, constraints and constraint surface; formulation of design problems as mathematical programming problems, classification of optimization problems, Optimization techniques – classical and advanced techniques.

Optimization using Calculus: Stationary points, functions of single and two variables; Global optimum convexity and concavity of functions of one and two variables, Optimization of function of one variable and multiple variables, Gradient vectors, Examples, Optimization of function of multiple variables subject to equality constraints, Lagrangian function, Optimization of function of multiple variables subject to equality constraints, Hessian matrix formulation, eigen values, Kuhn-Tucker Conditions, Examples.

Linear Programming: Standard form of linear programming (LP) problem, Canonical form of LP problem, assumptions in LP Models, elementary operations, graphical method for two variable optimization problem, Examples, motivation of simplex method, simplex algorithm and construction of simplex tableau, simplex criterion, minimization versus maximization problems, revised simplex method; duality in LP, primal-dual relations, dual simplex method, sensitivity or post optimality analysis, other algorithms for solving LP problems – Karmarkar's projective scaling method.

Linear Programming Applications: Use of software for solving linear optimization problems using graphical and simplex methods, Examples for transportation, assignment, water resources, structural and other optimization problems.

Dynamic Programming: Sequential optimization, representation of multistage decision process, types of multistage decision problems, concept of sub optimization and the principle of optimality, recursive equations – forward and backward recursions, computational procedure in dynamic programming (DP). Dynamic Programming Applications: Discrete versus continuous dynamic programming, multiple state variables; curse of dimensionality in DP.

Dynamic Programming Applications: Problem formulation and application in design of continuous beam and optimal geometric layout of a truss.

Integer Programming: Integer linear programming, concept of cutting plane method. Mixed integer programming, solution algorithms, Examples.

Advanced Topics in Optimization: Piecewise linear approximation of a nonlinear function, Multi objective optimization – Weighted and constrained methods, Multi level optimization, Direct and indirect search methods. Evolutionary algorithms for optimization and search.

References:

1. S. S. Rao, *Engineering Optimization: Theory and Practice*, New Age International P Ltd., 2000.
2. G. Hadley, *Linear programming*, Narosa Publishing House, New Delhi, 1990.
3. H. A. Taha, *Operations Research: An Introduction*, 5th Edition, Macmillan, New York, 1992.
4. K. Deb, *Optimization for Engineering Design-Algorithms and Examples*, PrenticeHall of India Pvt. Ltd., 1995.
5. K. Srinivasa Raju and D. Nagesh Kumar, *Multicriterion Analysis in Engineering and Management*, PHI Learning Pvt. Ltd.

EC21345 Statistical Signal Processing **FIRST SEMESTER (E-I)**

Review of random variables: distribution and density functions, moments, independent, uncorrelated and orthogonal random variables, Vector-space representation of Random variables, Schwarz Inequality Orthogonality principle in estimation, Central Limit theorem, Random process, stationary process, autocorrelation and autocovariance functions, Spectral representation of random signals, Wiener Khinchin theorem, properties of power spectral density, Gaussian Process and White noise process.

Linear System with random input, Spectral factorization theorem and its importance, innovation process and whitening filter.

Random signal modelling: MA(q), AR(p) , ARMA(p,q) models.
Parameter Estimation Theory: Principle of estimation and applications, properties of estimates, unbiased and consistent estimators, MVUE, CR bound, Efficient estimators, Criteria of estimation: the methods of maximum likelihood and its properties, Baysean estimation: Mean Square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation.

Estimation of signal in presence of White Gaussian Noise (WGN) Linear Minimum MeanSquare Error (LMMSE) Filtering: Wiener Hoff Equation FIR Wiener filter, Causal IIR Wiener filter, Non-causal IIR Wiener filter Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters.

Spectral analysis: Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Parametric method, AR(p) spectral estimation and detection of Harmonic signals, MUSIC algorithm.

References:

1. M. Hays, *Statistical Digital Signal Processing and Modelling*, John Willey and Sons, 1996.
2. M. D. Srinath, P. K. Rajasekaran and R. Viswanathan, *Statistical Signal Processing with Applications*, PHI, 1996.

3. D. G. Manolakis, V. K. Ingle and S. M. Kogon, *Statistical and Adaptive Signal Processing*, McGraw Hill, 2000.
4. S. M. Kay, *Modern Spectral Estimation*, Prentice Hall, 1987.
5. S. J. Orfanidis, *Optimum Signal Processing*, Second Edition, MacMillan Publishing, 1989.
6. H. Stark and J.W. Woods, *Probability and Random Processes with Applications to Signal Processing*, Prentice Hall 2002.
7. A. Papoulis and S.U. Pillai, *Probability, Random Variables and Stochastic Processes*, 4th Edition, McGraw-Hill, 2002

EC21325 Random Theory, Stochastic Process and Queueing Theory FIRST SEMESTER (E-II)

Introduction to statistical communication theory, Simple binary hypothesis tests: Bayes criteria and Neyman-Pearson tests, receiver operating characteristic and M hypotheses, Classical estimation theory: Bayes estimation, maximum likelihood estimation, Cramer- Rao Inequality and multiple parameter estimation.

Representation of random processes: introduction to random variables, sequence of random variables, central limit theorem, transformation of random variables, characterization of random processes.

Gaussian processes and their properties, Wiener process, White noise processes, optimum linear filters, periodic random processes and vector random process. Detection of signals and estimation of signal parameters in white noise.

Matched filters, correlation receivers, linear and nonlinear estimations, nonwhite Gaussian noise, detections and estimations in nonwhite noise estimation of signals with random amplitude and phase, Rayleigh channels, Rician channels, multiple channels.

Queueing theory, Queueing models, Kendall's notation, The M/M/1 Queueing system, Little law, M/M/1/N Queueing systems, The M/G/1, Queueing systems, Network of queues.
Discrete time Queueing systems, Queueing on space division packet switch, Queueing on single-buffered Banyan network.

References:

1. A. Papoulis & S. U. Pillai, *Probability, Random variables and stochastic processes*, 4th Edition, McGraw Hill
2. K. Sam Shanmugan & A. M. Breipohi, *Random Signals*, 2nd Edition, Wiley
3. John J. Proakis, *Digital communication*, Fourth Ed., MGH
4. Thomas G. Robertazzi, *Computer networks and systems: Queueing Theory and Performance Evaluation*, 3rd Edition, Springer.

EC21308 Reconfigurable Hardware Design FIRST SEMESTER (E-II)

Introduction to reconfigurable design, objectives, advantages and performance issues, classification/types of reconfigurability, details of logic reconfiguration, instruction set reconfiguration, static vs dynamic reconfiguration, full or partial reconfiguration, fine grained, medium grained and coarse grained reconfiguration. Hardware vs software configurability and reconfigurability. Flow of reconfigurable design including synthesis, program execution and reconfigurable processor, reconfigurable instruction cell array. Algorithms related to different design steps of reconfigurable architecture. Fault covering problem in reconfigurable VLSI, fault covers in heterogeneous and general arrays. Fault diagnosis in reconfigurable VLSI and WSI processors arrays. Reconfigurable architecture design for different applications including DSP and Communication. Testability for reconfigurable VLSI architecture. Network on Chips (NOC).

References:

1. P. -E. Gaillardon, *Reconfigurable Logic: Architecture, Tools, and Applications,* CRC Press
2. John V. Oldfield and Richard C. Dorf, *Field-Programmable Gate Arrays: Reconfigurable Logic for Rapid Prototyping and Implementation of Digital Systems,* Wiley Pub
3. Scott Hauck and André DeHon, *Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation*

EC21346 Digital Transmission **FIRST SEMESTER (E-II)**

Review of Digital Communication System and Random Process: Review of fourier techniques and their application for linear system analysis, fourier transform properties, characterization of communication signals and systems, spectral density, autocorrelation, random signals and random process, stationary processes, mean, correlation & covariance function, ergodic processes, transmission of a random process through a LTI filter, power spectral density, Gaussian process, noise, narrow band noise and its phase representation, elements of digital transmission systems, communication channel models and their characteristics.

Baseband Digital Transmission and Detection: M-ary PAM system, pulse shaping, Inter Symbol Interference (ISI), Nyquist's criterion for zero ISI, raised cosine spectrum, controlled ISI or partial response signaling, scrambling, equalization, eye pattern.
Detection Theory: MAP, LRT, minimum error test, error probability, ML estimation, signal space representation, Gram-Schmidt orthogonalization, conversion of continuous AWGN channel to vector channel, likelihood functions, coherent detection of binary signals in presence of noise, matched filter, probability of error of matched filter, correlation receiver.

Bandpass data transmission: Bandpass modulation and demodulation, Digital bandpass modulation techniques: binary PSK, DPSK, QPSK, M-ary PSK, QAM, M-ary FSK, MSK, GMSK, their generation, detection (coherent, non-coherent), performance analysis and comparison in presence of noise, **i**ntroduction to OFDM based communication system.

Spread Spectrum Communication: Introduction, pseudo noise sequences, direct sequence spread spectrum with coherent BPSK, signal space dimensionality & processing gain, probability of error, concept of jamming, frequency hop spread spectrum.

Information Theory and Error Control Coding: Introduction to information theory, The source coding theorem, source coding Algorithms, modeling of communication channels, channel capacity, bounds on communication, error free communication over a noisy channel, linear Block codes, encoding and syndrome decoding, cyclic codes, encoder and decoder for systematic cyclic codes, convolution codes, code tree and Trellis diagram, Viterbi and sequential decoding, burst error correction, Turbo codes, Trellis coded modulation.

Selected Topics in Digital Communication: Fading channels, digital transmission through fading multipath channels, types of fading, characterization of fading multipath channels, mitigating the effects of fading performance of fading multipath channels, digital signaling over a frequency selective slow fading channel, diversity techniques for fading multipath channels, introduction to multiuser communication systems and their applications. Multiple access techniques and their capacities, digital multiplexing, next generation communication systems.

References:

1. Simon Haykin, *Digital Communication Systems*, John Wiley & Sons, Fourth Edition
2. A. B. Carlson, P B Crully, J C Rutledge, *Communication Systems*, Fourth Edition, McGraw Hill Publication.
3. K. Sam Shanmugam, *Digital and Analog Communication Systems*, Wiley India Pvt. Ltd
4. B P Lathi, Zhi Ding, *Modern Analog and Digital Communication System*, Oxford University Press, Fourth Edition
5. Bernard Sklar, Prabitra Kumar Ray, *Digital Communications Fundamentals and Applications*, Second Edition, Pearson Education
6. Taub, Schilling, *Principles of Communication System*, Fourth Edition, McGraw Hill
7. T.S. Rappaport, *Wireless Communications: Principles and Practice*, Prentice Hall, 2004

EC21347 Advanced Computer Networks **FIRST SEMESTER (E-II)**

Review of Networking Concepts: MAC layer issues, Ethernet 802.3, ARP, IP addressing and subnetting, NAT and PAT, variable length subnet masking, CIDR.

End to End protocols: TCP connection establishment and termination, sliding window concepts, other issues: wraparound, silly window syndrome, Nagle’s algorithm, adaptive retransmission, TCP extensions. Congestion and flow control, queuing theory, TCP flavors: Tahoe, Reno, New-Reno, TCP-SACK, TCP-RED and TCP-Vegas. Transport protocol for real time (RTP), Quality of service: integrated services, differentiated services.

Routing and Multicast: Structure of internet: autonomous systems, Intra-domain routing: OSPF and RIP, Inter-domain routing: BGP. Multicasting: Group Management (IGMP), Internet scale multicasting: Reverse path broadcast, MOSPF, DVMPRP, PIM.

Peer to peer and overlay networks: Concept of overlays, Unstructured Overlays: Gnutella, concepts of distributed Hash Table, Structured Overlays: Chord, CAN, Pastry.

References:

1. Peterson and Davie, *Computer Networks: A Systems Approach*, 5th Ed., Morgan Kauffman, 2011
2. Kurose and Ross, *Computer Networking: Top Down Approach*, 6th Ed., Pearson, 2011
3. V. Paxson, *End-to-end Internet packet dynamics*, in IEEE/ACM Transactions on Networking, vol. 7, no 3, June 1999

4. W. Stevens, *TCP Slow Start, Congestion Avoidance, Fast Retransmit, and Fast Recovery Algorithms*, RFC2001
5. K. Fall and S. Floyd, *Simulation-based comparison of Tahoe, Reno, and SACK TCP*, Computer Communication Review, vol. 26, pp. 5-21, July 1996
6. L. Brakmo and L. Peterson, *TCP Vegas: End-to-End Congestion Avoidance on a Global Internet*, IEEE Journal on Selected Areas in Communications, 13 (8), October 1995, 1465-1480
7. Stoica, I., Morris, R., Karger, D., Kaashoek, F., Balakrishnan and H.: Chord: *A scalable peer-to-peer lookup service for Internet applications*
8. Rowstron, A., Druschel, P and Pastry: *Scalable, decentralized object location and routing for large-scale peer-to-peer systems*

EC21348 Mobile Communication **FIRST SEMESTER (E-II)**

Cellular Concepts – System Design Fundamentals: Cellular concept, channel reuse, handoff strategies, dynamic resource allocation, interference and system capacity, improving capacity and coverage of cellular systems.

Second and third generation network standards: GSM standardization, architecture and function partitioning, GSM radio aspects, security aspects, protocol model, call flow sequences, evolution to 2.5G mobile radio networks. IS-95 service and radio aspects, key features of IS-95 CDMA systems, ECWDMA-UMTS physical layer, UMTS network architecture, CDMA 2000 physical layer.

Radio Wave Propagation: Free space propagation model, basic propagation mechanisms, reflection, ground reflection model, diffraction, scattering, practical link budget design, outdoor and indoor propagation models.

Small scale fading and multipath: Small scale multipath propagation, impulse response model of a mulitpath channel, small scale multipath measurements, parameters of mobile multipath channels, types of small scale fading.

Capacity of Wireless Channel: Capacity of flat fading channel, channel distribution information known, channel side information at receiver, channel side information at transmitter and receiver, capacity with receiver diversity, capacity comparisons, capacity of frequency selective fading channels.

Diversity: Realization of independent fading paths, receiver diversity, selection combining, threshold combining, maximal-ratio combining, equal-gain combining, transmitter diversity, channel known at transmitter, Channel unknown at transmitter, The Alamouti scheme, basic concepts of RAKE receivers.

References:

1. Andrea Goldsmith, *Wireless Communications,* Cambridge University Press, 2005
2. T.S. Rappaport, *Wireless Communications*, Pearson Education, 2003
3. Raj Pandya, *Mobile and Personal Communication Systems and Services,* Prentice Hall of India, 2002
4. William C.Y. Lee, *Wireless and Cellular Telecommunications,* Third edition, Mc. Graw Hill, 2006

EC21349 Switching and Finite Automata Theory **FIRST SEMETER (E-II)**

Switching Algebra and Minimization of Switching Functions: Switching algebra and functions, boolean algebra and functions, K-map method, minimization of booleans function using tabulation method, relation and lattices, Venn diagram, sets theory.

Functional Decomposition and Symmetric Functions: Design of combinational logic circuits, contact networks, functional decomposition and symmetric functions.

Threshold Logic: Threshold logic, threshold elements, capabilities and limitations of threshold logic, elementary properties, unate functions, synthesis of threshold functions, cascading of threshold elements.

Finite State Machine (FSM): Finite state model, capabilities and limitation of FSM, state equivalence and machine minimization, sequence detector, simplification of incompletely specified machines, asynchronous sequential circuit- modes of operation, hazards.

Structure of Sequential Machine: Structure of sequential machine, lattice of closed partitions, state assignment using partitions, reduction of output dependency, input independence and autonomous clock, homing sequence, synchronizing sequence, adaptive distinguishing experiments.

Reliable Design and Fault Diagnosis: Reliable design and fault diagnosis, fault detection in combinational circuits, fault location experiments, fault detection by boolean differences, path, sensitizing method, multiple fault detection using map method failure- tolerant design.

References:

1. Z V I Kohavi, *Switching and Finite Automata Theory*, 2nd Edition, TMH
2. S. C. Lee, *Modern Switching Theory*
3. Peter Linz. *An Introduction to Finite Languages and Automata*, Narosa Publishing House
4. M. Morris Mano, *Digital Design*, 3rd Edition, Pearson Education
5. Donald D.Givone, *Digital principles and Design*, TMH
6. Anand Kumar, *Fundamentals of Digital Circuits*, PHI
7. R. P. Jain, *Modern Digital Electronics*, 2nd Edition, TMH
8. C V S Rao, Switching Theory & Logic Design
9. Jaakko T. Astola, *Fundamental of Switching Theory And Logic Design*

EC21350 Expert Systems **FIRST SEMETER (E-II)**

Introduction, expertise and heuristic knowledge, knowledge based system, structure of knowledge based systems, logic and automated reasoning, predicate logic, logical inference, Resolution. Truth maintenance systems, rules based reasoning, forward chaining, backward chaining, rule based architectures, conflict resolution schemes, associative networks, frames and objects, uncertainty management, Bayesian approaches, certainty factors, DempsterShafer theory of evidence fuzzy sets and fuzzy logic, knowledge acquisition search strategies and matching techniques.

References:

1. Peter Jackson, *Introduction to Expert Systems*
2. Archino J. Gonzalez, Douglas and Dankel, *The Engg. of Knowledge Based Systems*
3. Dan W. Patterson, *An Introduction to Artificial Intelligence*

EC21201 System Design using HDL **FIRST SEMESTER (E-III)**

List of Experiments:

1. Design and simulation of half-adder and full-adder using different modelling
2. Design and simulation of half-subtractor and full-subtractor
3. Design and simulation of 4-bit parallel adder
4. Design and simulation of full adder using half-adder
5. Design and simulation of 4:1 multiplexer
6. Design and simulation of 16:1 multiplexer using 4:1 multiplexer
7. Design and simulation of 3:8 decoder
8. Design and simulation of D, T, SR, JK & Master-slave Flip-flops
9. Design and simulation of Ring and Johnson counter
10. Design and simulation of up, down, up/down counter
11. Design and simulation of universal Shift-register
12. Design and simulation of 3-bit Gray counter
13. Design and simulate given problem
14. Design and simulate sequence detector
15. Draw the state diagram, state table of given circuit
16. Design and simulate the sequence detector given in state diagram
17. Design and simulate mod-3 counting with half duty cycle

List of experiments:

1. Write a Matlab program to generate the following sequence.
   a) Unit sample sequence [$\delta(n)$].
   b) Unit step sequence [$u(n)-u(n-m)$].
   c) Unit ramp sequence
   d) Sine wave
   e) Cosine wave
2. Write a Matlab program to generate an exponential sequence.

   $X(n)=(a)^n \quad for \quad (a)0\le a\le 1 \quad (b)-1\le a\le 0 \quad (c)a\le -1 \quad (d)a>1$
3. Write a Matlab program to generate the signal $\mathrm{S(n) = 2 * n * (0.8\wedge n)}$ corrupted by the noise d(n) resulting the signal X(n). X (n) = s (n) +d (n)

   Also down sample the corrupted signal
4. Generate a Gaussian number with mean = 20 and variance = 40. Also plot the PDF of generated number
5. Generate Gaussian number with mean = 0 and variance = 1. Plot the generated number and calculate 3rd moment i.e. skewness using

$$\mathrm{Skew}\,(X_1, X_2,..., X_n) = \frac{1}{N}\sum_{j=0}^{1}\left[\frac{Xj - mean}{\sigma}\right]\text{^}3$$

6. Plot the following expressions for $H(z)$ in Z-plane

   a) $\dfrac{2Z^{-1}+9Z^{-2}+18^{-3}+48^{-4}}{3Z^{-1}+3Z^{-2}+15Z^{-3}-12Z^{-4}}$

   b) $\dfrac{5Z^{-1}-9Z^{-2}+16Z^{-3}-14Z^{-4}}{Z^{-1}-2Z^{-2}+10Z^{-3}-4Z^{-4}+64Z^{-5}}$

7. Determine the factor form of following Z-transforms

a) $G(z)=\dfrac{2Z^4+7Z^3+48Z^2+56Z}{32Z^4+3Z^3-15Z^2+18Z\ \ -12}$

b) $G(z)=\dfrac{4Z^4-9Z^3+15Z^2-7}{Z^4-2Z^3+10Z^2+6Z\ \ +64}$

8. Plot the following functions:

h(n)={4rn cos[pi*n(1+r)/m]+m sin[pi*n(1-r)/m]}/[1-4rn/m)^2]*pi*nm

h (0)=(1/m)+(r/(m * 4/pi -1))

h (|m/4|)=(-r/m)*[(2*cos{(pi/4*r)*(1+4)}-cos{pi*(1-r)/4*r}]

Given: m = 4, r = 0.1

9. A LTI system is given by

$$y(n)+0.75y(n-1)-0.48y(n-2)-0.9y(n-3)=$$
$$0.58x(n)+0.95x(n-1)+0.49x(n-2)+x(n-3)$$

Write the program to compute and plot the impulse response of the system

10. Write a program to compute M-point DFT of following N-point sequence

$$x(n)=\begin{cases} n & 0<=n<=N-1 \\ 0 & otherwise \end{cases}$$

Assume N = 16 and M = 32

11. Write a program to compute M-point IDFT of following N- point sequence

$$X(k)=\begin{cases} k/N & 0<k<N-1 \\ 0 & otherwise \end{cases}$$

Assume N = 16 and M = 32

12. Write a MATLAB program to develop a signal y(n) generated by a convolution of two sequences x(n) and h(n). Also verify the result using in-built functions

13. Generate Gaussian distributed numbers and uniformly distributed numbers and find the correlation between them

14. Write a Matlab program to perform circular convolution of two finite unequal length sequences

15. Design a FIR lowpass filter with given specifications and verify the magnitude, phase, impulse response using FDA toolbox.

Order = 100

Window = Rectangular window

Cut off frequency in radian/sec = 0.4

16. Design a IIR lowpass Butterworth filter with following specifications and verify magnitude, phase, impulse response using FDA toolbox.

    Order Minimum

    Pass Band attenuation in dB: 0.36

    Stop Band attenuation in dB: 36

    Pass Band frequency in Hz: 1500

    Stop Band frequency in Hz: 2000

    Sampling frequency in Hz: 6000
17. Design the following circuits using simulink tool box on Matlab
    a) Half adder and Full adder
    b) Half wave rectifier and Full wave bridge rectifier
18. Design the following circuits using simulink tool box on Matlab
    a) Amplitude modulation and demodulation
    b) Frequency modulation and demodulation
19. Write a program to read a RGB image and perform the following operations on the image
    a) Extract Red, Green and Blue components of the image and then combine them to get the original image
    b) Convert the RGB image into Grey Scale image
    c) Resize the image to 512 X 512
    d) Add and subtract another RGB image to the original image.
    e) Calculate the sizes of all the images
20. Write a program to read a RGB image and perform the following operations on the image:
    a) Calculate the discrete cosine transform of the image and then recover the original image
    b) Add Gaussian noise to gray scale image and then recover the original gray scale image
21. Plot Sine and Cosine waves using TMS-320C6713
22. Find the Linear convolution of any two sequences and plot the output using TMS-320C6713

List of Experiments:

Programming Experiments on TASM/MASM Assembler:

1. Write a program to add the two data tables stored in memory. Assume 8-bit data and store the result in another table present in Data Segment
2. Write a program to ADD/ SUBTRACT two BCD numbers, stored in Data Segment, via BCD instructions
3. Write a program to Sort a data array in ascending and descending order
4. Write a program to read the keyboard entries and display on the screen by using INT Function Calls
5. Write a user interactive program to find factorial of an 8-bit integer, recursively
6. Write a user interactive program to multiply two 3 X 3 matrices stored in Data Segments

Experiments on SDK-86:

7. Familiarization with SDK-86
   a) Storing and Executing programs in SDK-86 trainer kit: Register Addition, Indirect Subtraction and Immediate Add with Carry
   b) Obtaining PSW Status at the end of execution
8. Write a program to verify the INT instructions for (i) Overflow and (ii) Divide by Zero error
9. Write a program to ADD a series of 16-bit numbers stored in memory via LEA
10. Write a program to find out square of an integer from a look table via XLAT.
11. Write a program to transfer a table from one memory location to another location in Extra Segment by using string instructions of 8086
12. Write a program to search a character in a given table, stored in Extra Segment by using string instructions of 8086
13. Interface 8 serial switches and 8 LEDs to 8086 through 8255 and write a program to display the status of switches on LEDs continuously
14. Write a program to transfer 10 bytes from one SDK-86 kit to another by using MODE-1 operation of 8255
15. Interface an 8259 Priority Interrupt Controller to 8086 and write a program to verify the Fully Nested Mode and AEOI mode of operation of 8259
16. Interface two 8259 Priority Interrupt Controllers to 8259 and write a program to verify the master/slave operation of 8259
17. Write a program to display ‘8086’ on the 7-segment display digits by using the 8279 programmable keyboard/display controller IC

18. Write a program for the moving display ‘8086’ on the 7-segment display digits by using the 8279 programmable keyboard/display controller IC
19. Interface an 8251 to 8086 and write a program to verify the asynchronous mode of operation of 8251
20. Interface an 8251 to 8086 and write a program to verify the synchronous mode of operation of 8251
21. Interface an 8257 to 8086 and write a program to transfer a data block from one memory location to another by using the DMA
22. Interface an Analog to Digital converter and write a program to verify the operation of ADC
23. Interface a Digital to Analog converter and write a program to verify the operation of DAC
24. Study & Verification of (i) DC Motor Control (ii) Stepper Motor Control
25. Measurement of frequency of an unknown sinusoid
26. Measurement of a electrical quantity such as voltage and current
27. Measurement of a physical quantity such as temperature, pressure etc

EC22306 Embedded Systems **SECOND SEMESTER (E-IV)**

Introduction to Embedded systems: Introduction, categorization of embedded systems, exemplary systems, selection of processor and memory for embedded systems, DMA, I/O devices, interrupt service handling for embedded systems, embedded tools in C/C++, memory optimization.

8-bit Microcontrollers: Introduction to MCS-51 family, architectural features, organization of data & program memories, orthogonal architectural features, addressing modes, instruction set, programming, 8051 interrupts, writing ISRs, SFRs, programming on-chip devices, UART and serial port programming, power saving modes.

Interfacing & Applications: External memory interfacing, interfacing ADC, display systems (7-Seg & LCDs)**,** potentiometer position measurements, temperature monitoring/control for ACs, light sensors for Robotics, ultrasonic sistance measurements, PWM motor control, RS-232 interface, servo positioning system.

Enhanced MCS-51 Features: Architectural enhancements in scratchpad RAM, Watchdog timers, onboard PWM, HSM controllers, high speed serial port, introduction to MCS—151/251.

Real Time Operating System: Introduction to OS concept, system services, RTOS basics, task scheduling, interrupt latency, example RTOS for MCS-51: RTOSLITE & FULLRTOS.

References:

1. Raj Kamal, *Embedded System Architecture, Programming and Design*, 2nd Ed, Tata McGraw Hill
2. Myke Predko, *Programming and Customizing the 8051 Microcontroller*, Tab Books/ Tata McGraw Hill
3. M. A. Mazidi, J.G. Mazidi and R. D. McKinlay, *The 8051 Microcontrollers and Embedded Systems: Using Assembly and C*, 2nd Ed, Pearson Education
4. John Catsoulis**,** *Designing Embedded Hardware*, O'Reilly Media, Inc
5. K. J. Ayala, *The 8051 Microcontrollers Architecture Programming & Applications*, 2nd Ed, Penram International
6. L. B. Das, *Embedded Systems: An Integrated Approach*, Pearson Education

EC22308 ASIC Design **SECOND SEMESTER (E-IV)**

Types of ASICs, design flow, economics of ASICs, ASIC cell libraries, CMOS logic cell, data path logic cells, I/O cells, cell compilers.

ASIC Library design: Transistors as resistors, parasitic capacitance, logical effort, Programmable ASIC design software: design system, logic synthesis, half gate ASIC.

Low level design entry: schematic entry, low level design languages, PLA tools, EDIF - an overview of VHDL and Verilog.

Logic synthesis in Verilog and VHDL simulation.

ASIC construction, floor planning & placement, routing.

References:

1. J.S. Smith, *Application specific Integrated Circuits*, Addison Wesley, 1997

EC22341Interactive Computer Graphics **SECOND SEMESTER (E-IV)**

Graphics input and output devices, display processors, Raster graphics fundamentals, plotting displays, vector generation, line and circle drawings algorithms, scaled area. Scan conversion, picture transformations windowing and dipplings 3-D graphics, dimensional transformation and perspective, perspective depth, hidden surface elimination, curves and surface generation, shading, a simple graphics packages, segmented display, titles display, file compilation, Genetic models of picture surface.

References:

1. James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes, *Computer Graphics: Principles and Practice*, Addison-Wesley, 2nd edition
2. Donald Hearn and M. Pauline Baker, *Computer Graphics*, C version, 2nd edition, Printice-Hall, latest version
3. Edward Angle, *Interactive Computer Graphics: A Top-Down Approach with OpenGL*, Addison Wesley. Cornel Pokorny, *COMPUTER GRAPHICS: an ObjectOriented Approach to the Art and Science*, Franklin, Beedle & Associates, Incorporated

4. Jim X. Chen, Foundation of 3D Graphics Programming Using JOGL and Java3D, Springer Verlag, 2006
5. Jim X. Chen, *Guide to Graphics Software Tools*, Springer Verlag, 2002
6. Mason Woo, Jackie Neider, and Tom Davis, *OpenGL Programming Guide*, Addison Wesley

EC22342 Mobile Computing **SECOND SEMESTER (E-IV)**

Mobile Communications and Computing: Introduction to Mobile computing (MC), novel applications, limitations, and architecture. GSM: Mobile services, system architecture, radio interface, protocols, localization and calling, handover, security, and new data services.

(Wireless) Medium Access Control: Motivation for a specialized MAC (hidden and exposed terminals, near and far terminals), SDMA, FDMA, TDMA, CDMA.

Mobile Network Layer: Mobile IP (goals, assumptions, entities and terminology, IP packet delivery, agent advertisement and discovery, registration, tunneling and encapsulation, optimizations), Dynamic Host Configuration Protocol (DHCP).

Mobile Transport Layer: Traditional TCP, indirect TCP, snooping TCP, mobile TCP, fast retransmit/fast recovery, transmission/time-out freezing, selective retransmission, transaction oriented TCP.

Data Dissemination: Communications asymmetry, classification of new data delivery mechanisms, push-based mechanisms, pull-based mechanisms, hybrid mechanisms, selective tuning (indexing) techniques.

Mobile Ad-hoc Networks (MANETs): Overview, properties of a MANET, spectrum of MANET applications, routing and various routing algorithms, security in MANETs.

References:

1. Mazliza Othman, *Principles of Mobile Computing & Communications*, SPD publications
2. Rajkamal, *Mobile Computing*, 2/e, Oxford University Press.
3. KumkumGarg, *Mobile Computing: Theory and Practice*, Pearson Education India, 2010
4. Asoke K. Talukdar, *Mobile Computing*, 2E, Tata McGraw-Hill Education, 2010
5. Reza B'Far, *Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML*, Cambridge University Press, 2005
6. J. Schiller, *Mobile Communications*, Pearson Education.

EC22325 Detection and Estimation Theory **SECOND SEMESTER (E-IV)**

Review of Gaussian variables and processes; problem formulation and objective of signal detection and signal parameter estimation in discrete-time domain.

Statistical Decision Theory: Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio, receiver operating characteristics, composite hypothesis testing, locally optimum tests, detector comparison techniques, asymptotic relative efficiency.

Detection of Deterministic Signals: Matched filter detector and its performance; generalized matched filter; detection of sinusoid with unknown amplitude, phase, frequency and arrival time, linear model.

Detection of Random Signals: Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection.

Nonparametric Detection: Detection in the absence of complete statistical description of observations, sign detector, Wilcoxon detector, detectors based on quantized observations, robustness of detectors.

Estimation of Signal Parameters: Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics, minimum statistics, complete statistics; linear models; best linear unbiased estimation; maximum likelihood estimation, invariance principle; estimation efficiency; Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation.
Signal Estimation in Discrete-Time: Linear Bayesian estimation, Weiner filtering, dynamical signal model, discrete Kalman filtering.

References:

1. H. L. Van Trees, *Detection, Estimation and Modulation Theory: Part I, II, and III*, John Wiley, NY, 1968.
2. H. V. Poor, *An Introduction to Signal Detection and Estimation*, Springer, 2/e, 1998.
3. S. M. Kay, *Fundamentals of Statistical Signal Processing: Estimation Theory*, Prentice Hall PTR, 1993.
4. S. M. Kay, *Fundamentals of Statistical Signal Processing: Detection Theory*, Prentice Hall PTR, 1998.

EC22343 Advanced Computer Architecture **SECOND SEMESTER (E-IV)**

Parallel Computer Model: The state of computing, classification of parallel computers, multiprocessors and multicomputer, multi-vector and SIMD computers. Program and network properties: conditions of parallelism, data and resources dependences, hardware and software parallelism, program partitioning and scheduling, program flow mechanism, system inter connect architectures.

Advanced Processors: Advance processor technology, instruction-set architecture, CISC scalar processors, RISC scalar processors, super scalar processor, vector and symbolic processors, VLIW processors.

Memory Organizations: Memory hierarchy technology, virtual memory technology, cache memory organization, shared memory organization, bus system, I/O sub system.

Pipelining: Linear pipeline processor, nonlinear pipeline processor, Instruction pipeline design: mechanism of instruction pipelining, dynamic instruction scheduling, branch handling techniques, branch predictions, Arithmetic pipeline design: computer arithmetic principles, static arithmetic pipeline, multifunctional arithmetic pipelining, super scalar and super pipeline design.

Multiprocessor: Multiprocessor systems interconnect, cache coherence and synchronization mechanisms, message-passing mechanism, scalable, vector processing pipeline, SIMD computer organization.

Parallel Models, Languages and Compilers: Parallel programming model, parallel language and compiler, dependence analysis of data arrange code optimization architectures, parallel program development and environment.

References:

1. Kai Hawang, *Advance Computer Architecture*, TMH
2. Hwang Briggs, *Computer Architecture and Parallel processing*, MCH
3. D. A. Patterson and J. L Hennessey, *Computer organization and design*, Morgan Kaufmanns, 2nd Edition

EC22344 Multidimensional Digital Signal Processing **SECOND SEMESTER (E-IV)**

Introduction to Multidimensional Discrete signals and 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 rectangular periodic sequences, Multidimensional DFT, definition and properties, Calculation of DFT, Vector radix FFT, Discrete Fourier transforms for general periodically sampled signals, relationship between M-dimensional and one-dimensional DFTs.

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.

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 pre-filtering design method, Frequency domain design techniques, stabilization techniques.

Multidimensional Spectral Estimation, Two-Dimensional Kalman Filtering.

Applications: Applications of Multidimensional Signal Processing in Radar, Seismology and Image Processing etc.

References:

1. Dan E Dudgeon and R M Mersereau, *Multidimensional Digital Signal Processing*, Prentice Hall
2. Tamal Bose, *Digital Signal and Image Processing*, John Wiley publishers.
3. J S Lim, *Two dimensional signal and Image Processing*, Prentice Hall.

EC22345 VLSI Circuits and Systems **SECOND SEMESTER (E-V)**

Designing High-Speed CMOS Logic Networks: Gate delays, driving large capacitive loads, logical effort, optimizing number of stages, branching, BiCMOS drivers.

Advanced Techniques in CMOS Logic Circuits: Mirror circuits, Pseudo-nMOS, domino logic, adiabatic logic, tri-state circuits, clocked CMOS, dynamic CMOS logic Circuits, dualrail logic networks.

System Specifications using Verilog Codes: Basic concepts, structural, gate level modeling, switch level modeling, design hierarchies, behavioral, dataflow modeling and RTL.

General VLSI System Components using Verilog Codes: Multiplexers, binary decoders, equality detectors and comparators, priority encoder, shift and rotation operations, latches, D flip-flop, registers and their structural description using Verilog.

Arithmetic Circuits in CMOS VLSI using Verilog Codes: Bit adder circuits, ripple-carry adders, carry look-ahead adders, other high-speed adders, and their Verilog implementation, Booth algorithm and Booth encoded digit operations and array multipliers.
Reliability and Testing of VLSI Circuits: General concepts, reliability modeling and performance metrices, CMOS testing, test generation methods: logical effects of faults, the D-Algorithm, path sensitization and basic networks for deriving the boolean difference.

References:

1. Neil H. E. Weste and David M. Harris, *CMOS VLSI Design: A Circuits and Systems Perspective*, Addison-Wesley
2. John P. Uyemura, *Introduction to VLSI Circuits and Systems*, John Wiley & Sons, INC
3. Neil H. E. Weste and Kamran Eshraghian, *Principles of CMOS VLSI Design*, Addison-Wesley, MA

EC22322 Image Processing and Pattern Recognition **SECOND SEMESTER (E-V)**

Human visual system and image perception, image representation and modelling, image sampling and quantization, 2D systems, Image transforms: KLT, DFT, DCT, DST, Hadamard, Harr and Slant transform, image data compression, pixel coding, predictive coding and transform coding, JPEGF Standard, image representation by stochastic model, image enhancement, filtering and restoration, image analysis using multi restoration techniques, texture analysis and synthesis, scene analysis decision theory, parametric and nonparametric procedures for classifying patterned data sets, sets clustering and unsupervised learning, knowledge based pattern recognition.

References:

1. Rafael C. Gonzalez and Richard E. Woods, *Digital Image Processing*, Pearson, Second Edition, 2004
2. Kenneth R. Castleman, *Digital Image Processing*, Pearson, 2006
3. William K. Pratt, *Digital Image Processing*, John Wiley, New York, 2002
4. Rafeal C. Gonzalez, Richard E. Woods, *Digital Image Processing*, Second Edition, Pearson Education

EC22346 Information Theory and Coding **SECOND SEMESTER (E-V)**

Information theory: Information, entropy, information rate, classification of codes, Kraft McMillan inequality, sources, memoryless and Markov, source coding theorem, ShannonFano coding, Huffman coding, Extended Huffman coding - joint and conditional entropies, mutual information, discrete memoryless channels – BSC, BEC – channel capacity, Shannon limit.

Source coding: text, audio and speech: Text: adaptive Huffman coding, arithmetic coding, LZW algorithm – Audio: perceptual coding, masking techniques, psychoacoustic model, MEG audio layers I,II,III, Dolby AC3 - Speech: channel vocoder, linear predictive coding.

Source coding: Image and Video: Image and video formats – GIF, TIFF, SIF, CIF, QCIF, Image compression: READ, JPEG, Video compression: principles- I,B,P frames, motion estimation, motion compensation, H.261, MPEG standard.
Error control coding - Block codes: Definitions and principles: Hamming weight, Hamming distance, Hamming Bound, minimum distance decoding, single parity codes, Hamming codes, repetition codes, linear block codes, cyclic codes, syndrome calculation, encoder and decoder, CRC.

Error control coding - Convolutional codes: Convolutional codes, code tree, trellis, state diagram, encoding, decoding: sequential search and Viterbi algorithm, principle of Turbo coding.

References:

1. R Bose, *Information Theory, Coding and Crptography*, TMH 2007
2. Fred Halsall, *Multidedia Communications: Applications, Networks, Protocols and Standards*, Pearson Education Asia, 2002
3. K Sayood, *Introduction to Data Compression*, 3/e, Elsevier 2006
4. S Gravano, *Introduction to Error Control Codes*, Oxford University Press 2007
5. Amitabha Bhattacharya, *Digital Communication*, TMH 2006
6. B. P. Lathi, *Modern Digital and Analog Communications Systems*, The Oxford Series in Electrical and Computer Engineering, Third Edition
7. Thamas Cover, *Information theory and Coding*, 2nd Edition, Prentice Hall

EC22309 VLSI Testing and Testable Design **SECOND SEMESTER (E-V)**

The need for testing, the problems of digital and analog testing, design for test, software testing.

Faults in Digital circuits: General introduction, controllability and observability. Fault models - stuck-at faults, bridging faults, intermittent faults.

Digital test pattern generation: Test pattern generation for combinational logic circuits, manual test pattern generation, automatic test pattern generation - Roth's D-algorithm, developments following Roth's D-algorithm, pseudo random test pattern generation, test pattern generation for sequential circuits, exhaustive, non-exhaustive and pseudo random 70 test pattern generation, delay fault testing.

Signatures and self test: Input compression Output compression arithmetic, Reed-Muller coefficients, spectral coefficients, coefficient test signatures, signature analysis and online self test.

Testability techniques: Partitioning and ad-hoc methods and scan-path testing, boundary scan and IEEE standard 1149.1, offline Built in Self Test (BIST), hardware description languages and test.

Testing of analog and digital circuits: testing techniques for filters, A/D converters, RAM, programmable logic devices and DSP.

References:

1. Stanley L. Hurst, *VLSI Testing: digital and mixed analogue digital techniques*, Pub: Inspec / IEE, 1999
2. Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, *Testing & Testable Design*

EC22347 Computer Network Performance and Modelling **SECOND SEMESTER (E-V)**

Queueing theory, queueing models, The M/M/1 queueing system, Little's law, M/M/1/N queueing systems, M/G/1 queueing systems, network of queues, product-form solution, queueing networks with negative customers, closed queueing networks, mean value analysis, product-form solution, simulation of networks, discrete time queueing systems, queueing on space division packet switch, queueing on single-buffer Banyan network, Petri nets and their applications.

References:

1. R. K. Jain, *The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation and Modeling*
2. Arnold O. Allen, *Probability, Statistics and Queuing Theory with Computer Science Applications*

EC22348 VLSI for Signal Processing **SECOND SEMESTER (E-V)**

VLSI implementation and design issues related to discrete fourier transform, digital filter design techniques; computation of discrete fourier transform; discrete Hilbert transform; discrete random signals; effect of finite register length in digital signal processing; homomorphic signal processing; power spectrum estimation. Design issues related to VLSI for signal processing.

References:

1. Jose Epifanio Franca and Yannis Tsividis, *Design of Analog-Digital VLSI Circuits for Telecommunications and Signal Processing*, Second Edition, Prentice Hall
2. Keshab K. Parhi, *VLSI Digital Signal Processing Systems: Design and Implementation*, First Edition, Wiley-Interscience
3. Richard J. Higgins, *Digital signal processing in VLSI*, Prentice Hall

EC22349 Digital Control **SECOND SEMESTER (E-V)**

Introduction: Basic Elements of discrete data control systems, advantages of discrete data control systems, examples.

Signal conversion & processing: Digital signals & coding, data conversion & quantization, sample and hold devices, mathematical modeling of the sampling process, Data reconstruction and filtering of sampled signals: zero-order hold, first-order Hold and polygonal hold.

Review of Z-transforms, applications of Z-transforms to difference equations and ladder network problem, signal between sampling instants using sub multiple sampling method, modified Z- transforms.
Transfer functions, block diagrams, signal flow graphs: introduction, pulse transfer function, and Z-transfer function, discrete data system with cascaded elements separated by a sampler and not separated by a sampler. Closed loop systems, characteristic equation in discrete domain, causality and physically realizable systems, the sampled signal flow graph, modified Z-transfer function, multirate discrete data systems (slow rate and fast rate), closed loop multirate sampled systems.

Comparison of time response of continuous data and discrete data, steady state error analysis of digital control systems, correlation between time response and root locations in s-plane and z-plane, Root loci for digital control systems, effects of adding poles and zeros to open loop transfer function, discrete data systems: Stability tests of discrete data systems: Bilinear transformation method, extension of RH criterion, Jury's stability test.

Frequency domain analysis: Polar plot of GH(z), Nyquist stability criterion, Bode plot, gain Margin and phase margin, Nicholas chart, bandwidth considerations, sensitivity analysis.

Review of state space techniques to continuous data systems, state equations of discrete data systems with sample and hold devices, state diagrams of digital systems, decomposition of discrete data transfer function, state variable analysis of response between sampling instants, controllability, observability of LTI discrete data systems.

Design of digital control systems with digital controllers through bilinear transformation. Digital PID controller, design for dead beat response, pole placement design by incomplete feedback or output feedback.

References:

1. Kuo, *Digital control systems*, Second Edition, Oxford University Press
2. Ogatta, *Discrete Time control systems*, 2nd ed., PHI 3. M. Gopal, *Digital Control Engineering*, New Age Publ.
4. Nagrath & Gopal, *Control System Engineering*, Wiley Eastern

5. John Dorsey, *Continuous & Discrete Control Systems*, MGH

EC22201 FPGA / CPLD Lab **SECOND SEMESTER (E-VI)**

List of experiments:

1. Design & simulation of AND, NAND, NOR, EX-OR, EX-NOR gate using Verilog HDL and VHDL
2. Design & simulation of half and full adder, half and full subtractor
3. Design & simulation of 4-bit parallel-adder
4. Design & simulation of full adder using half adder
5. Design & simulation of 4:1 multiplexer
6. Design & simulation of 16:1 multiplexer using 4:1 multiplexer
7. Design & simulation of 3:8 decoder
8. Design & simulation of D, T, SR, JK & master-slave Flip-Flops
9. Design & simulation of ring and Johnson-counter
10. Design & simulation of universal shift-register
11. Design & simulation of 3-bit Gray counter
12. Verify all the above experiments on FPGA kit

EC22221 Digital design & Simulation Lab **SECOND SEMESTER (E-VI)**

List of experiments:

1. Write a hardware description of 4-bit adder and subtractor and test their operations
2. Write a hardware description of degree to radian convertor
3. Write a hardware description of 4-bit mod-13 counter and test its operation
4. Write a hardware description of 8-bit register with shift left and shift right and test its operation
5. Write a hardware description of 4-bit array multiplier
6. Write a hardware description of 4-bit Booth multiplier
7. Design NOT, NOR, NAND gates using MENTOR GRAPHICS and compute the delay between input and output waveforms
8. Design 2:1 MUX using MENTOR GRAPHICS and compute the delay between input and output waveforms
9. Design XOR, NOR and NAND gates with CMOS and pseudo nMOS techniques using MENTOR GRAPHICS and compute the delay between input and output waveforms and compare them

10. Design XNOR gate using CMOS and pseudo nMOS techniques using MENTOR GRAPHICS and compute the delay between input and output waveforms and compare them
11. Design and simulate D-Flip Flop as a master-slave configuration using MENTOR GRAPHICS
12. Design and simulate ring oscillator using MENTOR GRAPHICS
13. Design 2:1 MUX using transmission gate and simulate using MENTOR GRAPHICS
14. Design and simulate 6T SRAM using MENTOR GRAPHICS

EC22222 Microcontroller Lab **SECOND SEMESTER (E-VI)**

List of experiments:

1. Introduction to kit, Software, Inline Assembly
2. Verification of various addressing modes, Manipulating register banks etc
3. Write ALP for data transfer between internal RAM and code memory
4. Use of Lookup table for binary to ASCII conversions
5. Write ALP for Binary to BCD and BCD to Binary Conversions
6. Write ALP to find smallest number in a table
7. Write ALP to sort a data table in ascending order
8. Write ALP for LED and Button Interfacing
9. Write ALP for Seven Segment interfacing with concept of ghost imaging
10. Write ALP for single digit Seven segment counter using Hardware interrupt
11. Write ALP to generate a Square wave of approx. 1 KHz with Timer with and without interrupt Interfacing
12. Write ALP for serial communication using UART
13. Introduction to Embedded C and interface LED and Button with 8051
14. Write C Program to interfacing LCD with 8051
15. Write C program to interface Seven Segment with microcontroller with concept of Ghost imaging
16. Write C program for LCD Based Visitor Counter using Hardware interrupt
17. Write C Program to generate PWM Wave generation using timer and timer interrupt
18. Write C Program for Serial Communication using UART
19. Write C Program to interface ADC with microcontroller
20. Write C Program to interface DC Motor with 8051 and interface on Proteus ISIS

21. Write C Program to implement Digital Clock on LCD

22. Project

EC22213 Advanced Digital Signal and Image Processing Lab **SECOND SEMESTER (E-VI)**

Experiment 1: Speech Processing

A speech processing experiment, separated to two parts:

- In this experiment, the students will become familiar with speech signals, their statistical properties and with a model that represents the production of such a signal. o An encoder-decoder system will be built and tested using Matlab.
- The blocks that assemble such systems are a VAD (Voice Activity Detection), a voiced/unvoiced classifier, a pitch (the basic frequency of speech) detector and a parametric model of a speech signal.

Experiment 2: Real-time Implementation of Digital Filters

A Real-Time experiment based on Texas Instrument's TMS320C6713 (well known and wide used DSP). The experiment is separated into two parts:

- Digital filter (FIR) design, with special attention to quantization and fixed-point implementation.
- Comparison of FIR and IIR filters design, with DFT/FFT usage example, by tuning piano tones.

Experiment 3: Image Compression

In this experiment, the students will become familiar with the basics and principles of image processing and compression techniques, specifically with the well known and widely used JPEG standards. The experiment is separated into two parts:

- Feature extraction and other image processing operations
- Image basics, terminology and techniques used for image processing and compression are learned. This part includes a "JPEG-like" Matlab based implementation of these basic ideas.

Experiment 4: Wavelet and Multirate Signal Processing

- Up-sampler and down-sampler, filters in sampling rate alternation systems; multistage design of decimator and interpolator, polyphase decomposition; arbitrary sampling rate converter, digital filter banks, uniform DFT filter banks, Wavelet transform and its applications.