M.Tech (Electronics) Course Syllabi (2017-2018)

ECE501 Modern Digital Design using Verilog (3-1-2-5)

Course Objectives:

1. To understand the representation and basic operations on numbers (Integer/Floating point/Double precision).
2. To develop an understanding of designing a digital logic circuit/Arithmetic circuits/ Datapaths based system to achieve a prescribed task on a generic platform/PLDs
3. To design a digital system, component (Processor), or process to meet a set of specifications using generic/Specific simulation and synthesis tools for PLDs
4. To understand the design flows for ASIC digital design
5. To understand and write codes for modeling of digital circuits both combinational (arithmetic) and sequential (FSM/ASM) using HDLs and simulate/synthesis the same using generic/PLD platform
6. To recognize the need to use modern tools to assist problem solving.

Review of logic design fundamentals: Combinational logic, logic simplification, Quine McClusky minimization, Hazards in combinational networks.

Sequential machines: Concept of memory, design of clocked flip flops, practical clocking aspects concerning flip flops, clock skew, traditional approaches in sequential machine analysis and design, Reduction of state tables and state assignments.

Asynchronous FSM: Designing, cycles and races, hazards-static, dynamic and essential Hazards.

Computer Arithmetic: Design of fixed point, floating point arithmetic units, MAC and SOP, CORDIC architectures.

Design using VHDL: Entities and architectures, Data objects, types, design description, libraries, synthesis basics, mapping statements to Gates, model optimization, verification, test benches, Architectural synthesis, optimization, data path synthesis, logic level synthesis and optimization Cell library binding

Hardware testing and design for testability (DFT), FPGA: Fundamental concepts, technologies, origin, alternative FPGA architectures, Configuration, Comparison with ASICs, Reconfigurable computing, Field Programmable node arrays, signal integrity and deep sub-micron delay effects.

Course Outcome (CO)

ECE501.1	An understanding the fundamentals of digital systems
ECE501.2	Ability to design arithmetic (fixed and floating point) circuits such as adders, Multipliers, Division Unit, square root, reciprocal, Sine-Cosine, Exponential etc.
ECE501.3	Ability to design a simple processor with few arithmetic operations
ECE501.4	Knowledge about Complete ASIC digital design flow and tools used in industry

ECE501.5 Write and simulate VHDL/Verilog models for digital systems

ECE501.6 Knowledge about programmable logic devices such as CPLDs and FPGAs

REFERENCES:

1. William I Fleatcher, An Engineering approach to digital design, PHI
2. Giovanni De Micheli, Synthesis amd optimizarion of digital circuite (McGraw Hill)
3. Charles H Roth, Jr., Fundamentals of Logic Design, Jaico Book
4. Charles H Roth, Jr., Digital System Design using VHDL, Brooks/Cole Thomson learning
5. Kevin Skahill, VHDL for programmable Logic, Addison Wesley
6. Clive Max Maxfield, The Design Worriors Guide to FPGA Devices, tools and flows, Elsevier
7. J.P. Hayes, Computer Architecture and Organization, Mc Graw Hill.

ECE502 Advanced Digital Signal Processing (3-2-4)

Course Objectives:

1. To analyse the fundamentals of discrete time signals and systems and fourier transform.
2. To Analyse FFT algorithm and its computational complexity.
3. To design FIR and IIR digital filters and its implementation.
4. To understand the fundamentals of multirate signal processing and wavelet transform.
5. To learn Matlab programming for filter design analysis and multirate signal processing.

Fundamentals of DSP background and review of discrete time random signals.

Discrete Fourier Transform: representation, properties and computation of the DFT (FFT), decimation in time and frequency.

Filter design techniques: Design of IIR filters, Impulse invariance, bilinear transformation, Design of FIR filters by windowing and frequency sampling

Quantization effects: Effect of round of noise in digital filter, zero input limit cycles in fixed point realization of IIR digital filters. Effects of finite register length in DFT computations.

Multirate digital signal processing: Fundamentals of Multirate systems, Basic multirate operations, Decimation, interpolation, filter design and implementation of sampling rate conversion, polyphase filter structures, time variant filter, structures, multistage implementation of sampling rate conversion of BP signals, sampling rate conversion by an arbitrary factor, interconnection of building blocks, polyphase representation, multistage implementations.

Wavelet Transform: Introduction to wavelets, wavelets and wavelet expansion systems, discrete wavelet transform, multiresolution formulation of wavelet systems, Haar Wavelet and other wavelet representations, scaling function, wavelet functions, Parseval's theorem,

Course Outcome (CO)

ECE502.1 An understanding the fundamentals of analysing discrete-time signals and systems and discrete time transforms.

ECE502.2 The ability to design and implement FIR and IIR filters

ECE502.3 Knowledge of Multirate signal processing systems and Wavelet Transform

ECE502.4 The ability to apply above knowledge and skills to engineering problems

ECE502.5 Be able to use Matlab/other platform for signal and filter design and analysis

REFERENCES:

1. S. K. Mitra, Digital signal processing: A computational approach, TMH
2. Johny Johnson, Introduction to digital signal processing, PHI.
3. Oppenheim, Schafer, and Buck, Discrete-time signal processing, Pearson Education LPE
4. P. P. Vaidyanathan, Multirate filters and Filter banks, PH International, Englewood Cliffs
5. Rabiner and Schafer, Multirate signal Processing, PH International, Englewood Cliffs
6. C. S. Burrus, Ramose and A. Gopinath, Introduction to Wavelets and Wavelet Transform, Prentice Hall Inc.

ECE503 Digital Image Processing (3-2-4)

Course Objectives:

1. Develop a theoretical foundation of digital image processing concepts including image acquisition, sampling, quantization and image storage formats
2. Provide mathematical foundation for image enhancement, restoration, segmentation, transform domain processing and compression
3. Gain experience and practical techniques to write programs using MATLAB/ C / python language for digital manipulation of images, preprocessing, segmentation, transform domain processing, feature extraction and compression
4. Get broad exposure to and understanding of various applications of image processing industry, medicine and defense

Introduction: Digital image representation, fundamental steps in image processing, elements of digital image processing systems, hardware for image processing system, Frame Graber, Characteristics of image digitizer, Types of digitizer, Image digitizing components, Electronic image tube cameras, solid state cameras, scanners.

Digital image fundamentals: Elements of visual perception, a simple image model sampling and quantization some basic relationship between pixels, image geometry, Basic transformations, perspective transformation, camera model and calibration, stereo imaging.

Image transforms: 2-D Fourier transform, Fast Fourier transform, other separable transforms, Walsh Transform, Hadamard Transform, Discrete Cosine Transform, wavelet Transform, Haar function, Gabor Transform, Hotelling transforms.

Image enhancement: Enhancement by point processing, spatial filtering, enhancement in the frequency domain, Color image processing.

Image restoration: Degradation model, diagonalization of circulate and block-circulate matrices, algebraic approach to restoration, inverse filtering, least mean square (wiener) filter, constrained least squared restoration, invractive restoration.

Image compression: Redundancies, image compression models, elements of information theory, errorfree compression variable length coding, bit plane coding, lossless predictive coding, lossy compression, predictive coding, transform coding, video compression, image compression standards- JPEG, MPEG.

Image Analysis: Segmentation, detection of discontinuities, edge linking and boundary detection, thresholding, region -oriented segmentation, Representation and description: Representation schemes, descriptors, regional descriptors, pattern and pattern classes, Classifiers.

Course Outcome (CO)

ECE503.1 Describe different digital image representation schemes and current techniques in image acquisition.

ECE503.2 Analyze digital images using various transforms

ECE503.3 Learn signal processing algorithms and techniques in image enhancement, restoration, in spatial and frequency domain

ECE503.4 Analyze the constraints in image processing when dealing with larger dataset (efficient storage and compression) and apply the concept of region segmentation and feature extraction algorithm.

ECE503.5 Acquire an appreciation for the image processing issues and techniques and be able to apply these techniques to real world problem.

REFERENCES:

1. R. C. Gonzalez and R. E. Woods, Digital image processing, Addison-Wesley Publishing House.
2. A. K. Jain, Fundamentals of digital image processing, Prince-Hall India.
3. K. R. Castleman, Digital Image Processing, Prince-Hall International.

ECE504A Information Theory and Coding (3-2-4)

Course Objective:

1. To be able to understand the basic concepts of information theory and coding
2. To study information, source coding, channel model, channel capacity, channel coding and so on.
3. To complete the understanding of the wireless communication system with other advanced courses in wireless communication

Introduction to Information theory and coding, Probability, random variables, probability distribution and probability densities, functions of random variables, statistical averages of random variables, some useful probability distributions.

Fundamental Limits on Performance: Mathematical models for information sources, a logarithmic measure of information, average mutual information and entropy, information measures for continuous random variables, coding for discrete sources, coding for discrete memoryless sources, Lempel-Ziv algorithm.

Source Coding: Coding for analog sources-optimum quantization, scalar quantization, vector quantization, coding techniques for analog sources, temporal waveform coding, PCM, DPCM, adaptive PCM and DPCM, DM, spectral waveform coding, model based source coding. Channel models and channel capacity

Error Control Coding: Linear block codes, generator matrix and parity check matrix, some specific linear block codes, cyclic codes, transfer function of a convolution code, optimum decoding of convolution codes-Viterbi algorithm, BCH codes.

Coded Modulation technique: BPSK, QPSK, 8PSK, QAM and Trellis coded modulation techniques. Advances in Information theory and coding.

Course Outcome (CO)

ECE504A.1	It introduces the concept of information theory i.e. entropy, self and mutual information
ECE504A.2	Understanding and practicing, designing source encoding and decoding
ECE504A.3	To understand characterization of information channels and its applications.
ECE504A.4	Understanding and practicing, designing information channel encoding and decoding.
ECE504A.5	To understand characterization of coded modulation techniques and its applications

REFERENCES:

1. Ranjan Bose, Information Theory, Coding and Cryptography, TMH.
2. G. A. Jones and J.M. Jones, Information Theory and Coding, Springer.
3. J. G. Proakis, Digital Communication, Fourth Edition, McGraw Hill
4. Simon Haykin, Digital Communication, John Wiley and Sons.
5. J. G. Proakis and M. Salehi, Communication Systems, 2nd Ed.

ECE504B Pattern Recognition (3-2-4)

Course Objectives (CO)

1. To study basic concepts in pattern recognition
2. To provide knowledge of models, methods and tools used to solve regression, classification, feature selection and density estimation problems.
3. To understand pattern recognition theories, such as Bayes classifier, linear discriminant analysis.
4. To explore knowledge of recognition, decision making and statistical learning

problems.

5. To provide hands-on experience in analyzing and applying pattern recognition techniques in practical problems

Pattern recognition overview: Engineering approach to PR relationship of PR to other areas Pattern recognition applications, pattern techniques, pattern recognition approaches (StatPR, SyntPR, NeurPR).

Features and feature extractions techniques: Introduction, zoned features, Graph representation techniques, sequentially detected features, feature extraction, feature vector and feature space.

Bays decision theory: Introduction, bays decision theory continuous case, two category classification, minimum error rate classification, classifier, discriminate functions and decision surfaces (multicategory and two category case). The normal density function (Univariate and multivariate normal density function)

Parameter estimation and supervised learning: maximum likelihood estimation, Bayes classifier, general Bayesian learning, problem of dimensionally, non-paramateric techniques, density estimation, Parzen window, k-nearest estimation, nearest neighbor rule.

Linear discriminate functions: Linear discriminate functions and decision surface, two category and multi-category case generalized linear discriminate functions, minimizing the perception criteria functions, relaxation procedure.

Learning: Unsupervised learning, automatic determination of features, a relational system, transference of learning, associative memory, scientific basis for automatic pattern recognition.

Contextual: Linguistic and array techniques, context, scene, analysis, picture syntax, analysis of synthesis, iterate array techniques.

Coefficient analysis: Higher moments, slit scanning techniques, Fourier transformation, pattern
Recognition by Fourier optics, autocorrelation, speech recognition.

Course outcomes:

1. Describe basic concepts of Pattern Recognition and its system, learning and adaptation for the classification.
2. Analyze features and feature extraction techniques
3. Understand the principles of Bayesian and Maximum-likelihood parameter estimation and apply them in relatively simple probabilistic models such as Gaussian Model, linear discriminate functions.
4. Perform data clustering in an unsupervised manner by means of various algorithms, such as parzen window density estimate.
5. Understand the concept of classification using K-means and K-nearest neighbor and its applications.
6. Analyze different learning methods, contextual techniques and coefficient analysis

REFERENCES:

1. R. O. Duda and P. E. Hart, Pattern classification and scene analysis, Wiley Interscience publications.
2. Robert Schaloff, Pattern recognition: statistical, structural and neural approaches, John Wiley and Sons. Inc.
3. J.R. Ullamann, Pattern recognition techniques, Butterworths publications, London
4. Don Person (ed.), Image processing, MGH.

ECE504C Neural Networks and its Applications (3-2-4)

Course Objectives:

1. To understand the fundamental theory and concepts of neural networks.
2. To provide knowledge of neural network modeling, several neural network paradigms, its applications and recent trends.
3. To analyze feed forward and feedback neural networks.
4. To describe auto associative and recurrent neural networks for pattern storage and retrieval
5. To understand self organizing maps

Brain Style Computing: Origins and Issues**,** Biological neural networks, Neuron Abstraction, Neuron Signal Functions, Mathematical Preliminaries, Artificial Neurons, Neural Networks and Architectures Pattern analysis tasks: Classification, Clustering, mathematical models of neurons, Structures of neural networks, Learning principles.

Feed forward neural networks: Pattern classification using perceptron, Multilayer feedforward neural networks (MLFFNNs), Pattern classification and regression using MLFFNNs, Error backpropagation learning.

Fast learning methods: Conjugate gradient method. Autoassociative neural networks, Pattern storage and retrieval, Hopfield model, recurrent neural networks Bayesian neural networks, Radial basis function networks: Regularization theory, RBF networks for function approximation, RBF networks for pattern classification

Self-organizing maps: Pattern clustering, Topological mapping, Kohonen's self-organizing map, Introduction to cellular neural network, Fuzzy neural networks, Pulsed neuron models. Recent trends in Neural Networks

Course Outcomes:

1. Understand the basic structures of artificial neural network, their limitations, basic pattern analysis tasks such as classification and clustering, learning and adaptation using the learning rules, implementation of learning rule.
2. Describe the concepts of feed forward neural networks using single layer and multilayer networks to solve classification problem, and its implementation, single

layer feedback networks to study the concept of memory using neural networks.

3. Analyze and implement the applications of neural networks in character recognition and control systems.
4. Understand Auto associative neural networks, Pattern storage and retrieval, Hopfield model, recurrent neural networks
5. Analyze Bayesian neural networks, Radial basis function networks
6. Understand self-organizing maps, Introduction to cellular neural network, Fuzzy neural networks, Pulsed neuron models, recent trends in neural networks

REFERENCES:

1. Satish Kumar, Neural Networks, A Classroom Approach, Tata McGraw-Hill, 2003 2. Jacek Zurada, Introduction to Artificial Neural Networks, Jaico Publishing House, 1997.
3. S.Haykin, Neural Networks, A Comprehensive Foundation, Prentice Hall, 1998.
4. C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
5. B.Yegnanarayana, Artificial Neural Networks, Prentice Hall of India, 1999.
6. L.O. Chua and T. Roska, Cellular Neural Networks and Visual Computing Foundation and Applications, Cambridge Press, 2002.

ECE504D Semiconductor Devices and Technology (3-2-4)

Course Objectives:

1. To study about fundamental analysis and discussion on various semiconductor devices.
2. To study characteristics and operation principle of diode, Bipolar junction transistor (BJT), metal-oxide semiconductor field effect transistor (MOSFET) and heterojunction devices.
3. To be able to apply the knowledge to the development of new and novel devices for different applications.

Review of Physics of Semiconductor Theory: Introduction, crystal structure of solids, theory of solids, semiconductor in equilibrium, charge carriers in semiconductors, dopant atoms and energy levels, carrier distributions in extrinsic semiconductors, effects of doping on carrier concentration, effects of doping and temperature on the position of Fermi-Energy level, carrier transport and excess carrier phenomena, carrier drift and diffusion, Carrier generation and recombination, Hall effect.

Semiconductor Devices: pn-junction diode, metal-semiconductor contact, two-terminal MOS capacitor, potential differences in MOS capacitor, CV-characteristics of MOS capacitor, fundamentals of Metal Oxide Semiconductor, Field Effect Transistor (MOSFET), MOSFET additional concepts, Longchannel and Short-channel MOSFET.

Additional topics in semiconductor physics: Non-equilibrium excess carriers in semiconductors, Carrier generation and recombination, analysis of excess carriers, ambipolar transport, HaynesShockley experiment, quasi-Fermi energy levels, excess carrier lifetime, surface effects.

Other Semiconductor Devices: Bipolar Junction Transistor, BJT additional concepts, JFET, ere.

Modeling of Semiconductor Devices: Low frequency and High-frequency models of *pn*-junction, MOSFET, and BJT

Semiconductor Technology: Electronic Grade Silicon, Crystal Growth, Oxidation techniques and

Systems, Oxide Properties, Lithography Techniques, Etching Mechanisms, Diffusion, Models of Diffusion in Solids, Flick's One Dimensional and 2-D diffusion equations, Implantation, Deposition Processes, poly-silicon.

Process Integration and IC Manufacturing: IC Technology, NMOS IC Technology, CMOS IC Technology, Bipolar IC Technology, MEMS technology, IC Fabrication, VLSI Assembly technology, Package Fabrication Technology, Future trends like SOC, low-power, new materials, etc.

Course Outcome (CO)

ECE504D.1	To develop insight into the semiconductor in equilibrium.
ECE504D.2	To study Device fabrication technology and carrier transport and excess carrier phenomena in semiconductors
ECE504D.3	To study and apply MOS/BJT transistors for building circuits and the pn junction and metal semiconductor contact.
ECE504D.4	Understanding Non equilibrium excess carriers in semiconductors.
ECE504D.5	Analyze the heterojunction and heterojunction devices and optical devices.

REFERENCES:

1. Donald Neamen, Introduction to semiconductor devices, International Edition, McGraw Hill, 2006
2. Ben G. Streetman and Sanjay Banergee, Solid Slate Electronic Devices, Prentice Hall, 1999
3. Simon M. Sze, Physics of Semiconductor Devices, John Wiley and Sons, 1999
4. Gary S. May and Simon M. Sze, Fundamentals of Semiconductor Fabrication,Wiley,2004
5. Bebrad Razavi, Fundamentals of Micro-electronics, Wiley, 2008

ECE504E Advanced Computer Architecture (3-2-4)

Fundamentals of Computer Design: Introduction to computer design, Changing face of computing and task of computer designer, Technology trends, Cost, price and their trends, Measuring and reporting performance, Quantitative principles of computer design, RISC versus CISC, Major organizational issues of processor design: data path and control design.

Instruction set principles: Introduction, Classifying instruction set architectures, Memory addressing, Addressing modes for signal processing, Type and size of operands and operations, type of operands and operations for media and signal processing, Instructions for control flow, encoding of an instruction set, Role of compilers, MIPS architecture, fallacies and pitfalls.

Instruction level parallelism and its dynamic exploitation:
Instruction level parallelism concepts and challenges, overcoming data hazards with dynamic scheduling, Basic and intermediate concepts of pipelining: Introduction, the major hurdle of pipelining, RISC pipelined data path.

Memory Hierarchy Design: Introduction, Review of ABCs of caches, cache performance, reducing cache miss penalty, reducing cache miss rate, reducing cache hit time, virtual memory: protection and examples of virtual memory.

Parallel processing: Trends towards parallel processing, parallelism in uniprocessor systems, classification of parallel computers and their structures, applications of parallel processing.

Storage Systems: Introduction, types of storage devices, I/O performance measures, RAID: Redundant array of inexpensive disks, errors and failures in real systems.

REFERENCES:

1. John L. Hennessy and David A. Patterson, Computer Architecture, a Quantitative Approach (2nd. Ed.), Morgan Kaufmann
2. P. Chaudhuri, Computer Organization and Design (2nd Ed.), PHI
3. J.P.Hays, Computer Architecture and Organization (3rd Ed.), Mc Graw Hill
4. Kai Hwang and Fay'e A. Briggs, Computer Architecture and Parallel Processing, Mc Graw Hill.

ECE505 Seminar –I (0-2-1)

The seminar should be done on any topic in Electronics Engineering to be decided by the students and the supervisor concerned. Seminar work shall be in the form of report to be submitted by the student at the end of the semester. The candidate will deliver the talk on the topic for half an hour and assessment will be made by two internal examiners appointed by DPGPC, one of them will be supervisor. Usually MEC110 will be related to the dissertation topic.

ECE506 Modern Wireless Communication (3-0-3)

Course Objectives:

1. To understand the examples of wireless communication systems, paging systems, cordless telephone systems.
2. To study the different generations of mobile networks, WAN and PAN.
3. To understand the concepts of basic cellular system, frequency reuse, channel assignment strategies, handoff strategies, interference.
4. To study the concepts mobile environment, communication in the infrastructure, iIS-95
5. CDMA and GSM network and forward channel, packet and frame formats in GSM and CDMA.

Wireless Transmission: Frequencies for radio transmission, Signals, Signal propagation, Multiplexing, Modulation techniques: modulation schemes such as ASK, FSK, PSK, DPSK, BPSK, QPSK, Advanced frequency shift keying, Advanced phase shift keying, Gaussian minimum shift keying., Spread spectrum such as DSSS, FHSS, and Cellular systems.

Medium access control: Motivation for a specialized MAC, SDMA, FDMA, TDMA, CDMA, and Comparison of S/T/F/CDMA.

Introduction to wireless communication stems: Examples of Wireless communication systems, Paging systems, Cordless telephone systems, and Cellular telephone systems.

Cellular Telephony: Frequency reuse principle, Transmitting, Receiving, Handoff, Roaming, First, Second, and third wireless generation systems. The Cellular concepts – System design fundamentals: Channel assignment strategies, Interference and system capacity, SIR calculations, Trunking and grade of service, and improving coverage & capacity in cellular systems,

Telecommunication systems: GSM, DECT and Tetra.

Wireless LAN: Infra-red vs. radio transmission, Infrastructure and ad-hoc network, IEEE 802.11-System architecture protocol architecture HIPERLAN, Bluetooth-User scenarios, Architecture, and IEEE 802.15.

Mobile network Layer: Mobile IP, Mobile ad-hoc networks: Routing, Destination sequence distance, Dynamic source routing, alternative metrics and overview ad-hoc routing protocols. Wireless Application protocol: architecture, WDP, WTLS, WTP, WSP, WAE, WML, WML Scripts, WTA, WAP 2.0 architecture, and I-mode

Course Outcome (CO)

ECE506.1	Follow Fundamentals of Wireless communications and cellular communication
ECE506.2	Overview and study of Digital cellular technologies including GSM, CDMA etc. and of emerging wireless technologies like IEEE 802.11x, WMAN, Wi-Max etc.
ECE506.3	Study script languages such as WML, and WML languages and Wireless protocols.
ECE506.4	To create innovation and creativity among students in the subject by giving opportunities in doing projects, Paper presentation, Assignments, Conducting Tests, MCQ etc.
ECE506.5	Understand the GSM and CDMA networks.

REFERENCES:

1. Rappoport, Wireless Communications (Principles and Practices), Prentice Hall.
2. Jochen Schiller, Mobile Communications, Pearson Education, 2004.
3. William Stallings, Wireless Communication and Networks, Pearson Education, 2003.
4. Fourozan, Data communications and Networking, third edition, Tata McGraw-Hill-2004.
5. Fourozan, TCP/IP Suite.

ECE507 Wavelets (3-2-4)

Fundamentals of Linear Algebra:

Vector spaces, Bases, Orthogonality, Orthonormality, Projection, Functions and function spaces

Orthogonal functions, Orthonormal functions, Orthogonal basis functions

Signal Representation in Fourier Domain

Fourier series, Orthogonality, Orthonormality and the method of finding the Fourier coefficients Complex Fourier series, Orthogonality of complex exponential bases, Mathematical preliminaries for continuous and discrete Fourier transform, limitations of Fourier domain signal processing.

Short Time Fourier Transform (STFT):

Signal representation with continuous and discrete STFT, concept of time-frequency resolution, Resolution problem associated with STFT, Heisenberg's Uncertainty principle and time frequency tiling, Why wavelet transform?

Introduction to Wavelet Transform:

The origins of wavelets, Wavelets and other wavelet like transforms, History of wavelet from Morlet to Daubechies via Mallat, Different communities and family of wavelets, Different families of wavelets within wavelet communities

Continuous Wavelet Transform:

Wavelet transform-A first level introduction, Continuous time-frequency representation of signals, Properties of wavelets used in continuous wavelet transform, Continuous versus discrete wavelet transform

Discrete Wavelet Transform:

Haar scaling functions and function spaces, Translation and scaling of $\phi(t)$, Orthogonality of translates of $\phi(t)$, Function space V_0 , Finer Haar scaling functions, Concepts of nested vector spaces, Haar wavelet function, Scaled and translated Haar wavelet functions, Orthogonality of $\phi(t)$ and $\psi(t)$, Normalization of Haar bases at different scales, Refinement relation with respect to normalized bases, Support of a wavelet system, Daubechies wavelets, Plotting the Daubechies wavelets,

Designing Orthogonal Wavelet Systems-A Direct Approach:

Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, **Condition-1:** Unit area under scaling function, **Condition-2:** Orthonormality of translates of scaling functions, **Condition-3:** Orthonormality of scaling and wavelet functions, **Condition-4:** Approximation conditions (Smoothness conditions), Designing Daubechies orthogonal wavelet system coefficients, Constraints for Daubechies' 6 tap scaling function.

Discrete Wavelet Transform and Relation to Filter Banks:

Signal decomposition (Analysis), Relation with filter banks, Frequency response, Signal reconstruction: Synthesis from coarse scale to fine scale, Upsampling and filtering, Perfect reconstruction filters, QMF conditions, Computing initial s_{j+1} coefficients, Concepts of Multi-Resolution Analysis (MRA) and Multi-rate signal processing.

Biorthogonal Wavelets:

Biorthogonality in vector space, Introduction to Biorthoeonal Wavelet Systems, Signal Representation Using Biorthogonal Wavelet System,

Wavelet Packets and M-Band Wavelets:

Wavelet Packet Analysis: Signal representation using Wavelet Packet Analysis, Selection of best basis, Introduction of M-Band wavelet system, Signal representation using M-Band wavelet systems.

Applications of Wavelets:

Applications of wavelets in signal and image processing and other related engineering Fields.

Course Outcome (CO)

ECE507.1 Understand the terminology that are used in the wavelets literature.

ECE507.2 Explain the concepts, theory, and algorithms behind wavelets from an interdisciplinary perspective that unifies harmonic analysis (mathematics), filter banks (signal processing), and multiresolution analysis (computer vision).

ECE507.3 Understand how to use the modern signal processing tools using signal spaces, bases, operators and series expansions.

ECE507.4 Apply wavelets, filter banks, and multiresolution techniques to a problem at hand, and justify why wavelets provide the right tool.

ECE507.5 Think critically, ask questions, and apply problem-solving techniques.

REFERENCES:

1. K. P. Soman, K. I. Rmachandran, N. G. Resmi, "Insight into Wavelets: From Theory to Practice, (Third Edition)", PHI Learning Pvt. Ltd., 2010.
2. A.N. Akansu and R.A. Haddad, "Multiresolution signal Decomposition: Transforms, Subbands and Wavelets", Academic Press, Oranld, Florida, 1992.
3. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Prentice Hall, 2007.
4. Rafael C. Gonzalez, Richard E. Woods "Digital Image Processing (Third Edition)", Pearson International Edition, 2009.
5. C. S. Burrus, Ramose and A. Gopinath, Introduction to Wavelets and Wavelet Transform, Prentice Hall Inc.

Wavelet links:

1. **http://users.rowan.edu/~polikar/WAVELETS/WTtutorial.html**
2. **http://www.wavelet.org/**
3. **http://www.math.hawaii.edu/~dave/Web/Amara's%20Wavelet%20Page.htm**

ECE508 Embedded systems Design (3-2-4)

Course Objectives:

1. Understand basics of embedded systems
2. Study the architecture of ARM series microprocessor
3. Understand need and application of ARM Microprocessors in embedded system.
4. Learn external interfacing of real world input and output devices with ARM

5. Understand the need of Embedded operating system Learn to develop engineering application using operating system

Introduction: Embedded systems overview, Design Challenges, Processor Technology, IC Technology, Design Technology, Trade-offs, Custom Single purpose processors, RT level Custom Single purpose processor design, Optimization, General Purpose processors: pipelining, superscalar and VLIW architectures, Programmers view: Instruction set, program and data memory space, I/O, interrupts, operating system, Development environment: design flow and tools, testing and debugging, Application specific instruction set processors (ASIPs), microcontrollers, digital signal processors, less-general AIP environments, selecting microprocessors, general purpose processor design

ARM Processors, Architecture of ARM7TDMI processor, Programming model, Registers, operating modes, Instruction set, Addressing modes, memory interface

Standard single purpose processors: peripherals: Introduction, timers, counters and watchdog timers, UART, Pulse width modulators, controlling a DC motor using PWM, LCD controllers, Keypad controllers, stepper motor controllers, ADCs, Real time clocks

Memory: memory write ability and storage permanence, common memory types, composing memory, memory hierarchy and cache, advanced RAM.

Interfacing: introduction, Communication basics, Basic protocol concepts, ISA bus protocol: memory access, Arbitration, Priority arbiter, Daisy chain Arbitration, Network oriented Arbitration methods, multilevel bus architectures, Advanced communication principles, Parallel and serial communication, wireless communication, Layering, error detection and correction, serial protocols, parallel protocols, wireless protocols: IrDA, Bluetooth, IEEE802.11

Digital camera example: Introduction to simple digital camera, requirement specification, design

IC Technology: Full custom, Semi Custom, Gate array semi custom IC technology, Standard cell semi custom IC technology, PLDs

Design Technology: Automation, synthesis, verification: H/W and S/W cosimulation, IP Cores, design process models

Real Time operating systems, introduction, process scheduling, examples of RTOS.

Microprocessor and microcontroller based system design, typical design examples, system design and

Simulation using simulation software such as Proteus VSM.

Course Outcome (CO)

ECE508.1	Understand the hardware and software components as well as their development cycles
ECE508.2	Able to understand architecture of ARM7, built-in peripherals of LPC2148 and write program for the interfacing peripherals
ECE508.3	Understand the deployment of embedded processors and supporting devices in real-world applications
ECE508.4	Understand RTOS concepts and porting RTOS (MUCOS-II) on ARM7

ECE508.5 Interpret application specifications and make practical recommendations on resource selection for embedded systems.

REFERENCES:

01. Frank Vahid and Tony Givargis, Embedded system design: A unified hardware/software introduction, John Wiley and Sons, 2002
02. Rajkamal, Embedded System, Tata-Mc Graw Hill Publications

ECE509A Soft Computing and Applications (3-2-4)

Soft Computing: Introduction, requirement, different tools and techniques, usefulness and applications.

Fuzzy sets and Fuzzy logic: Introduction, Fuzzy sets versus crisp sets, operations on fuzzy sets, Extension principle, Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables, Fuzzy logic, Linguistic hedges, Applications, fuzzy controllers, fuzzy pattern recognition, fuzzy image processing, fuzzy database.

Fuzzy inference and decision making: natural language, linguistic hedges, rule based systems, decomposition of compound rules, likelihood and truth quantification, aggregation of fuzzy rules, synthetic evaluation, preferences and consequences, multi-objective decision making.

Granular Computing: introduction, its importance, data granulation, Applications of granular computing, granular neural network and its different forms.

Hybrid Systems: Neural-Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks,

Rough Set: Introduction, Imprecise Categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables, and Applications, Rough Fuzzy Neural Networks.

Application of soft computing in pattern recognition. New trends in Soft Computing.

REFERENCES:

1. Klir & Yuan, Fuzzy Sets and Fuzzy Logic, PHI, 1997.
2. J.-S. R. Jang, C.-T. Sun, E. Mizutani: Neuro- Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, PHI, 2005.
3. Learning and Soft Computing, V. Kecman, MIT Press, 2001.
4. Rough Sets, Z. Pawlak, Kluwer Academic Publisher, 1991.
5. Intelligent Hybrid Systems, D. Ruan, Kluwer Academic Publisher, 1997.
6. Timothy J Ross: Fuzzy logic with engineering applications, TMH, 2000.

ECE509B Data Warehousing and Data Mining (3-2-4)

Course Objective:

1. To introduce the basic concepts of Data Warehouse and Data Mining techniques.

2. To be able to examine the types of the data to be mined and apply pre-processing methods on raw data.
3. To discover interesting patterns, analyse supervised and unsupervised models and estimate the accuracy of the algorithms.

Data Warehouse : Introduction, A Multi-dimensional data model, Data Warehouse Architecture, Data Warehouse Implementation.

Data Mining: Introduction, Data Mining, on what kind of Data, Data Mining Functionalities, Classification of Data Mining Systems, Major issues in Data Mining.

Data Preprocessing: Data cleaning, Data Integration & Transformation, Data Reduction, Discretization & Concept Hierarchy Generation, Data Mining Primitives. Mining Association roles in large databases: Association rule mining, mining single-dimensional Boolean Association rules from Transactional Databases, Mining Multi-dimensional Association rules from relational databases & Data Warehouses.

Classification & Prediction: Introduction, Classification by Decision tree induction, Bayesian Classification. Other Classification Methods, Classification by Back propagation, Prediction, Classifier accuracy.

Cluster Analysis: Introduction, Types of data in Cluster analysis, A categorization of major clustering methods, partitioning methods, Hierarchical methods, Density-Based Methods: DBSCAN, Gridbased Method: STING; Model-based Clustering Method: Statistical approach, Outlier analysis.

Course Outcome (CO)

ECE509B.1	Introduction to basic concepts of Data Warehousing.
ECE509B.2	Understand the data mining concepts and techniques
ECE509B.3	Examine the types of the data to be mined and apply preprocessing methods on raw data.
ECE509B.4	Be able to efficiently design and manage data storages using data warehousing and data mining techniques.
ECE509B.5	Select and apply appropriate data mining techniques for different applications.

REFERENCES:

1. Data Mining Concepts & Techniques, Jiawei Han Micheline Kamber, Morgan Kaufmann Publishers.
2. Data Warehouse Toolkit, Ralph Kinball, John Wiley Publishers.
3. Data Mining, Introductory and Advanced Topics, Margaret H.Dunham, Pearson Education.
4. Data Warehousing in the real world, A Practical guide for Building decision support systems, Sam Anahory, Dennis Murray, Pearson Education.

ECE509C Multimedia Systems and Application (3-2-4)

Introduction to multimedia: video, audio, still images, graphics, text, etc.

Concepts of image compression: lossless/lossy compression, entropy coding. Predictive coding, DPCM, image transforms (DCT, wavelet, principal component analysis).

Quantization: uniform, Lioyd's, etc. Image compression standards (JPEG, JPEG-2000), vector quantization, concepts of video compression, motion estimation and motion compession.

Video coding and motion estimation, Video coding standards (MPEG-1, MPEG-2, H261/263/26L), object/model based video coding, video object planes, MPEG-4 standards.

Multimedia synchronization and streaming (audio packet, video packet, time stamping, etc.), inter-media synchronization and intra-media continuity, audio coding, content-based multimedia.

Indexing and retrival, upcoming multimedia standards- MPEG-7, MPEG-21 Multimedia applications: video conferencing, video-on-demand, multimedia networking.

REFERENCES:

1. Murat Tekalp, Digital Video Processing, PH-PTR
2. Khalid Sayood, Data Compression, PHI

ECE509D Computer Vision (3-2-4)

Course Objectives:

1. To introduce students with practice and theory of low level and high level computer vision.
2. To learn various feature extraction techniques in Computer Vision
3. To learn and apply decision making concepts with applications to computer vision.
4. To study dynamic scene analysis techniques.
5. To provide students with necessary theory and skills for automatic analysis of digital images, and thereby to construct representations of physical objects and scenes, and to make useful decisions based on them.

Introduction: Overview of Computer Vision, Low level and High level Computer Vision, Applications of Computer vision

Early Image Preprocessing: Scale in image processing, canny edge detection, parametric edge models, edge in multi spectral image, other local preprocessing operators, adoptive neighbourhood preprocessing.

Shape Representation And Description: Region identification, contour based shape representation and description, region based shape representation and description, shape classes.

Object Recognition: Knowledge representation, statistical pattern recognition, syntactic pattern recognition, recognition as a graph matching, recognition by using neural network and fuzzy logic.

Image Understanding: Image understanding, control strategies, active contour models – shapes, point distribution models, pattern recognition methods in image understanding, scene labeling and constraint propagation, semantic image segmentation and understanding.

3D Vision, Geometry And Radiometry, Use Of 3d Vision Motion Analysis: Differential motion analysis methods, optical flow analysis based on correspondence of interest points, Kalman filters.

Course Outcome (CO)

ECE509D.1 Understand the difficulties that the vision problem involves.
ECE509D.2 Design a simple vision system.
ECE509D.3 Understand the various techniques of low level, mid level and high level computer vision.
ECE509D.4 Implement several image filtering algorithms.
ECE509D.5 Understand the different ways recognition of patterns in computer vision
ECE509D.6 Appreciate the issues involved in color, texture, and motion

REFERENCES:

1. Milan Sonka, V. Hlavac and Roger Boyle, Image Processing, Analysis and Machine Vision, Second edition, Thomson Asia Pvt. Ltd., ISBN -981 -240- 061 -3.
2. Forsyth and Ponce, Computer Vision: A modern vision, PHI.
3. R. Jain, Computer Vision, TMH.

ECE509E Advanced VLSI Design (3-2-4)

Course Objective:

1. To understand the concept behind ASIC (Application Specific Integrated Circuits) design and the different implementation approaches used in industry.
2. To learn the static and dynamic behavior of MOSFETs (Metal Oxide Semiconductor Field Effect Transistors) and the secondary effects of the MOS transistor model.
3. To study the consequence of scaling down the dimensions of transistors and its affect on device density, speed and power consumption.
4. To design high performance digital systems with operating speed in the multiple hundred of MHZ and even the GHz range using Bi-CMOS, ECL and Gallium Arsenide Design techniques.
5. To use different analysis and verification tools, implementation and synthesis methodologies and testability techniques that will enable them to design high performance and efficient digital systems.

Review of MOS Transistor Theory: nMOS and pMOS Enhancement transistor, Threshold voltage equations, Body effects, MOS device Design equations, Basic DC equations, Latch-up in CMOS circuits and other second order effects, MOS Models, depletion MOS.

Introduction to CMOS circuits: CMOS Logic- Complementary CMOS inverter- DC Characteristics, Noise margin, Static load MOS Inverters, Differential Inverter, the transmission gate, Tristate Inverter, Bi-CMOS Inverters, SPICE Model; Combination logic- static and dynamic design strategies, The NAND and NOR Gates, Compound gates, Multiplexers.

Designing Sequential logic circuits: Static latches and registers, Dynamic latches and registers, non bistable sequential circuits.

CMOS subsystem design: Adder, Multiplier, Shifter, other arithmetic operators; power and speed tradeoffs; Memory cells and Arrays, ROM, RAM- SRAM, DRAM, clocking disciplines; Design, power optimization, case studies in memory design.

CMOS Processing Technology: Basic CMOS technology, n and p well processes, CMOS Process Enhancements, Layout design rules, layouts of various gates, Technology related CAD issues.

Circuit Performance Parameters: Resistance and capacitance estimation, Inductance; Switching characteristics- analytical, empirical delay models, gate delays, CMOS Gate transistor sizing, Zpu/Zpd, Power dissipation, Sizing routing conductors, Charge sharing, Yield, reliability, Scaling of MOS Transistor dimensions.

Layout Design and Tools: Transistor structures, Wires and Vias , Scalable Design rules , Layouts of various gates; CMOS logic structures, Clocking strategies, I/O structures, Low power design.

Floor Planning and Architecture Design: Floor planning methods, off-chip connections, High level synthesis, Architecture for low power, SOCs and Embedded CPUs, Architecture testing.

Course Outcome (CO)

ECE509E.1 Develop insight into the working of MOS transistors.

ECE509E.2 Apply principles of digital CMOS VLSI from transistor up to the system level.

ECE509E.3 Apply the models of VLSI components and study of economics of design and manufacturing costs.

ECE509E.4 Design simulated experiments using CAD tool and verify integrity of CMOS circuit and its layout and digital circuits that are manufacturable in CMOS.

ECE509E.5 Apply the CAD VLSI tool suite layout digital circuits for CMOS fabrication and verify circuits with layout parasitic elements.

REFERENCES :

01. Jan M Rabaey, Digital integrated circuits: a design perspective. PHI Publications
02. Neil Weste, Kamran Eshrghian, Principles of CMOS VLSI design: a systems perspective, 2nd ed., Addison Wesley Publishing company, 1993.
03. Wayne Wolf, Modern VLSI design, Pearson Education.
04. Sung-Mo Kang and Y. Leblebici, CMOS digital Integrated Circuits.
05. Ivan Sutherland. Logical effort, Morgan Kaufeman, CA.

ECE509F: ANALOG IC DESIGN (3-2-4)

1. Introduction to Analog Design, MOS FET as analog device, MOS Device Models, Single Stage Amplifiers, Common Source, Source Follower, Common Gate, Cascode, Folded Cascode
2. Differential Amplifiers, Single ended Differential operation, Basic Differential pair, qualitative and quantitative analysis, Common mode response, Differential pair with MOS loads
3. Passive and active current mirrors, Basic current mirrors, Cascode Current Mirrors, Active current mirrors, Large and small signal analysis, Common Mode properties
4. Frequency response of Amplifiers: General Considerations, Miller effect, Association of poles with nodes, Common Source stage, Source Followers, Common gate stage, Cascode stage, differential pair
5. Noise: Representation of noise in circuits, Noise ins single stage amplifiers, Common source, common gate, Source followers, cascade stage, noise in differential pairs, noise bandwidth
6. Feedback: General considerations, Feedback topologies, Effect of loading, effect of feedback on noise
7. Operational amplifiers: One stage and two stage op amps, gain boosting, Common mode feedback, Input range limitation, Slew rate, Power supply rejection, Noise in Opamp
8. Stability and Frequency compensation: Multi pole system, Phase margin, Frequency compensation, Compensation of two stage opamps, other compensation techniques
9. Bandgap references: Supply independent biasing, temperature independednt references, PTAT current generation, speed and noise issues
10. Phase locked loops: Simple PLL, Charge pump PLLS, Nonideal effects in PLL, delay locked loops, applications

Reference Books:

1. Behzad Razavi, Design of Analog CMOS integrated circuits, Tata McGraw Hill Edition, 2002
2. Philip E Allen, Douglas R. Holberg, CMOS Analog Circuit Design, Oxford, 2002

David A Johns, Ken Martin, Analog Integrated Circuit Design, Wiley Students edition, 2002

ECE509G Adaptive Signal Processing (3-2-4)

Course Objectives:

1. To analyse and understand lattice realization of FIR and IIR digital filter.
2. To learn/overview the linear algebra concepts and probability theory.
3. To learn random variables and various PDF function for random variable.
4. To learn statistical modelling of discrete time systems like Yule Walker equations, Levinson Durbin Algorithm and Schur Algorithm.
5. To learn LMS algorithm and Wiener Filters. To learn/write Matlab program for implementation of system and algorithm.

Introduction to adaptive signal processing and adaptive filters, mathematical preliminaries, Wiener filtering and MMSE estimates. Linear prediction, Levinsion-durbin algorithm and lattice Filters: Overview of spectral estimation methods. Adaptive algorithms: LMS algorithms, convergence analysis, adaptive noise canceller, Least squares algorithm: general weighted least squares method, recursive least squares algorithm, fast least square algorithm for AR modeling case. Special topics

Course Outcome (CO)

Course Outcomes (CO) :

ECE509G.1 An understanding the fundamentals of class of All pass, Generalised Linear Phase, Minimum Phase systems, FIR and IIR Lattice structures (Analyze)

ECE509G.2 Understand the fundamentals of Linear Algebra and its applications

ECE509G.3 Understand Random Variables and Processes and their applications

ECE509G.4 The ability to understand statistical modelling of discrete time systems such as Yule Walker equations, Linear prediction etc and apply the same to real life problems

ECE509G.5 Understand the algorithms for solving Yule Walker Equations such as Levinson Durbin, Schur algorithms

ECE509G.6 Understand LMS Algorithm and Wiener Filters

ECE509G.7 To apply above knowledge and skills to engineering problems

ECE509G.8 To use Matlab for implementation of systems and algorithms

REFERENCES:

01. Monson H. Hays, Statistical Digital Signal Processing, John Wiley and Sons, Inc.
02. Simon Haykin, Adaptive Filter Theory (4th Edition), Prentice Hall
03. Bernard Widrow and Samuel Stearns, Adaptive Signal Processing, Prentice Hall

ECE510 SEMINAR (0-2-1)

The seminar should be delivered on any topic in Computer Vision / VLSI Engineering as per the specialization selected by a student and the teachers concerned. Seminar work shall be in the form of report to be submitted by the student at the end of the semester. The candidate will deliver the talk on the topic for half an hour and assessment will be made by two internal examiners appointed by DPGPC, one of them will be supervisor. Usually the seminar ECE510 will be related to the dissertation topic.

ECE601 DISSERTATION PART-I (0-24-24)

Dissertation shall consist of: Research work done by the candidate in the areas related to the chosen specialization, or Comprehensive and critical review of any recent development in the chosen specialization, orDesign and/or development of a product related to the programme done by the candidate.

Following shall be the guidelines for evaluation of dissertation part I

Dissertation Part I shall consist of the following components (whichever applicable) Extensive literature survey, Data collection from R&D organizations, Industries, etc.

Study of the viability, applicability and scope of the dissertation

Detailed Design (H/W and S/W as applicable), Partial implementation

A candidate should prepare the following documents for examination

A term paper in the format of any standard journal based on the work

A detailed report of the work done by the candidate related to dissertation

Every candidate should present himself (for about 30 min.) before the panel of examiners (which will evaluate the dissertation I for TW and Oral marks) consisting of Head of Department, M. Tech. Coordinator or his nominee, all supervisors.

ECE602 DISSERTATION PART-II (0-24-24)

The dissertation shall be assessed internally by a panel of examiners (similar to the one in dissertation part- I) before submission. The candidate shall submit the dissertation in triplicate to the Head of the institution, duly certified that the work has been satisfactorily completed. The Practical examination (viva-voce) shall consist of a defense presented by the candidate or his/her work in the presence of examiners appointed by the University one of whom will be the supervisor and the other an external examiner.