Details of B. Tech. (ECE) Program

The Course Structure: **Annexure 7.1**

Sem	1st#	2nd#	3rd	4th	5th	6th	7th	8th
1	SCDE 130C	SPSP 230C	EACN 332C	ESAS 430C	EDCN 532C	EVSD 632C	EESD 732C	EPRJ* 820P
2	SEGP 132C	EDES 232C	EAES 332C	EEMI 432C	ECSY 532C	EDSP 632C	EWCN 732C	
3	ECAS 130C	ICOA 230C	EEFW 330C	EMIP 432C	ECNW 532C	EOCN 632C	Elective 3	
4	EEDC 132C	IDST 232C	EBEE 332C	EICT 430C	EAWP 532C	Elective 1	Elective 4	
5	IIPG 123C	MPOM 220C	IOSY 332C	EMWE 432C	MMEF 520C	Elective 2	Elective 5	
6	IITC 102C	IDMS 230C		MMAM 420F	EPOP* 503P	EGPJ* 604P	EGPJ* 706P	
7	MPCN 102C	EEWS 203C						
191	**25**	**25**	**23**	**23**	**25**	**25**	**25**	**20**

ECE Courses:

ECAS130C	Circuit Analysis and Synthesis
EEDC132C	Electronic Devices and Circuits
EDES232C	Digital Electronics
EEWS203C	Electronics Workshop
EACN332C	Analog Communication
EAES332C	Analog Electronics
EEFW330C	Electromagnetic Field and Waves
EBEE332C	Basic Electrical Engineering
ESAS430C	Discrete Time Signals and Systems
EEMI432C	Electronics Measurement and Instrumentation
EMIP432C	Micro Processor Interface and Programming
EMWE432C	Microwave Engineering
EICT430C	Integrated Circuits Technology
EDCN532C	Digital Communication
ECSY532C	Control Systems
ECNW532C	Computer Networks
EAWP532C	Antenna and Wave Propagation
EDSP632C	Digital Signal Processing
EOCN632C	Optical Communication
EVSD632C	VLSI System Design
EESD732C	Embedded System Design
EWCN732C	Wireless Communication

Applied Science Courses:

SCDE130C	Mathematics-I
SEGP132C	Engineering Physics
SPAS230C	Probability and Statistics

*For 5th, 6th and 7th semesters Project work the students need to form groups of 5-6 students however individual projects should be done in 8th semester.

1st and 2nd semester is same as IT department.

IT Courses :

IIPG123C	Introduction to Programming
IITC102C	Introduction to Computers
ICOA230C	Computer Organization
IDST232C	Data Structures
IDMS230C	Discrete Mathematics
IOSY332C	Operating Systems

Management Courses:

MPCN102F	Professional Communication
MPOM220F	Principles of Management
MMAM420F	Marketing management
MMEC520F	Managerial Economics

Elective courses :

EPES630E	Power Electronics
EITC630E	Information Theory and Coding
IDPM632E	Database Programming and Management
EDIP730E	Digital Image Processing
EADS730E	Advanced Digital Signal Processing
EAIC730E	Analog Integrated Circuit Design
EMIC730E	Mixed Signal Integrated Circuit Design
ERFC730E	Radio Frequency Circuit Design
EMSD730E	Modeling Semiconductor Devices
EMES 730E	Micro Electromechanical Systems
EMCS730E	Modern Control Systems
ERSC730E	RADAR and Satellite Communication
EONW730E	Optical Networks
IDBM532E	Database Management System
ICIS730E	Cryptography & Information Security
IHUR730E	Humanoid Robotics
ICPM730E	Cognition & Cognitive Process Modeling
IABC730E	Mobile Data Management
IDCN730E	Data Compression

SCDE130C: Calculus and Differential Equations

Calculus: Definite Integral, Mean value theorem, Theorems of Integral calculus, Line, surface and volume Integrals, Asymptote, Power series method, Legendre's equation and Legendre polynomials, Bessels equation.

Differential Equation: First order differential equations, Separable equation, Exact differential equation, Linear differential equation, Bernoulli's equation and application to Electrical circuits. Linear differential equation of second and higher order, Homogeneous equation with constant coefficient, Euler-Cauchy equations, Solution by undetermined coefficient, Solutions by variation of parameters, Initial and boundary value problems, Partial derivative, Directional derivative, Linear, Non-linear, homogenous and non-homogeneous partial differential equations (first order and second order) and variable separable method. Modeling of electric circuits.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations

Books:
1. Mathematical Methods for Engineers and Scientists 1 by K.T. Tang
2. Mathematical Methods for Engineers and Scientists 2 by K.T. Tang

SEGP132C: Engineering Physics

Unit 1:- Semiconductors: Introduction, Energy Bands in conductors, semiconductors, insulators, intrinsic and extrinsic semiconductor, Carrier transport in semiconductor: diffusion current, drift current, mobility and resistivity. Generation and recombination of carriers in semiconductors. Thermal Noise, Shot Noise.

Electrons and Holes in semiconductors: Silicon crystal structure, Donors and acceptors in the band model, electron effective mass, Density of states, Thermal equilibrium, Fermi-Dirac distribution function for electrons and holes, Fermi energy. Equilibrium distribution of electrons & holes. The n-p product and the intrinsic carrier concentration at extremely high and low temperatures, Variation of Fermi energy with doping concentration and temperature.

Unit 2:- Motion and Recombination of Electrons and Holes: Carrier drift: Electron and hole mobilities, Mechanism of carrier scattering, Drift current and conductivity. Carrier diffusion: diffusion current, Total current density, relation between the energy diagram and potential, electric field, Einstein relationship between diffusion coefficient and mobility.

Unit 3:- PN Junction: Building blocks of the p-n junction theory: depletion layer, Reverse-biased PN junction; Capacitance-voltage characteristics, Junction breakdown, peak electric field.

Unit 4:- Classical Mechanics.
Conservation Laws; D'Álemberts Principle; Lagrange's Equations; Calculus of Variations; Hamilton's Principle; Simple problems.

Unit 5:-Basic ideas of Quantum Mechanics:-
Matter Waves; Wave and Group Velocities, Heisenberg Uncertainty Principle, Wave Function, its Interpretation and Normalization; Superposition of Amplitudes, Dynamical Variables as Operators; Expectation Values; Schrodinger Equation and its Simple Applications like Particle in a Box, Quantum Well, Potential Barrier Problem.

Suggested Books:

1. *Introduction to Electrodynamics: D J Griffiths (Text)*
2. *Classical Mechanics: H Goldstein (Text)*
3. *Perspectives on Modern Physics, A. Beiser (Text)*
4. *Feynman Lectures in Physics, by Feynman, Leighton and Sands, Vol 2 Atomic Physics, J B Rajam*
5. *Physics, Vol 2, Halliday, Resnick*
6. Streetman, Ben G., and Sanjay Banerjee. Solid state electronic devices. Vol. 4. Upper Saddle River, NJ: Prentice Hall, 2000.
7. Sze, Simon M., and Kwok K. Ng. Physics of semiconductor devices. John Wiley & Sons, 2006.
8. Integrated Electronics: *Analog and Digital Circuits and Systems* by J. Millman and C.C. Halkias

ECAS130C: Circuit Analysis and Synthesis

Network Theorems and Elements: Network graphs, matrices associated with graphs, incidence, fundamental cut set and fundamental circuit matrices, Kirchoff's Laws, Node Voltage and Mesh Current Analysis, Delta-Star and Star-Delta Transformation, Source Conversion. Thevenin's, Norton's, Reciprocity, Superposition, Compensation, Miller's, Tellegen's and Maximum power transfer Theorems, Networks with dependent sources, Inductively coupled circuits – mutual inductance, coefficient of coupling and mutual inductance between portions of same circuits and between parallel branches.

Transient and Steady State Analysis: Impulse, step, ramp and sinusoidal response. Analysis of first order and second order circuits. Time domain analysis of RLC circuits. Laplace transform in brief, transform domain (**Laplace**) analysis of RLC circuits, Initial and final value theorems, Different kind of symmetry, Power in a circuit.

Network Functions & **Two Port Networks**: Terminals and terminal pairs, driving point impedance transfer functions, state equations for networks, poles and zeros, Procedure of finding network functions for general two terminal pair networks, Stability & causality. Hurwitz polynomial, positive real function, Two port parameters and their interrelations – z-parameters, y-parameters, h-parameters, ABCD parameters.

Network Synthesis: RL & RC networks synthesis, Foster First & Second form, Cauer forms.

Books:

1. Network Analysis by M.E. Van Valkenburg, Third Edition, Prentice Hall.
2. Desoer C. A. and Kuh E. S., "Basic Circuit Theory", McGraw Hill International Book Company, 1984.
3. DeCarlo R. A. and Lin Pen-Min, "Linear Circuit Analysis", 2nd Ed., Oxford University Press.2001.
4. Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 6th Ed., Tata McGraw-Hill Publishing Company Ltd. 2008
5. Director S. W., "Circuit Theory: A Computational Approach", 2nd Ed., John Wiley and Sons Inc. 1993
6. Kuo F. F., "Network Analysis and Synthesis", 2nd Ed., Wiley India.

EEDC132C:Electronic Devices and Circuits

Semiconductor Diodes: Physical operation of p-n junction diodes, Characteristics of p-n junction diodes, Zener diode, Tunnel diode, Diode clipper and clamper circuits, Rectifier circuits (half-wave, full-wave, bridge and peak rectifiers), Power Supplies, Light emitting diodes, avalanche photo diode.

Bipolar Junction Transistors (BJTs): Simplified structure and physical operation of n-p-n and p-n-p transistors in the active region, Current-voltage characteristics of BJT, BJT as an amplifier and as a switch. BJT Circuits at DC, Biasing in BJT amplifier circuits, Small Signal Operation of BJT: Simplified model (h-parameters and y-parameters) and its application to single stage BJT amplifiers (Common-Emitter, Common-Base and Common-Collector configurations).

Small Signal Analysis of BJTs: Small-Signal Equivalent-Circuit Model, Small Signal Analysis of CE, CC, CB Amplifier with and without RE, Effect of RS and RL on CE Amplifier, Emitter Follower, Analysis of Cascade, Darlington Connection and Current Mirror Circuits using BJTs.

MOS Transistor: The MOS structure, Energy band diagrams, Flat-band condition and flat-band voltage, Surface accumulation, surface depletion, Threshold condition and threshold voltage, MOS C-V characteristics, Introduction to the MOSFET, Complementary MOS (CMOS) technology, V-I Characteristics, Surface mobilities and high-mobility, Threshold voltage, Body effect and steep retrograde doping, pinch-off voltage.

Small Signal Analysis of MOSFETs: Small-Signal Equivalent-Circuit Model, Small Signal Analysis of CS, CD, CG Amplifier with and without RS, Effect of RS and RL on CS Amplifier, Analysis of Source Follower and Cascaded System.

Books:

1.Electronic Devices and Circuit Theory by R. Boylestead and Louis Nashelsky. Prentice Education.
2. Streetman, B.G. and Banerjee, S.K, “Solid State Electronic Devices”, 6th Ed., Pearson Education.
3. Tyagi, M.S., “Introduction to Semiconductor Materials and Devices”, John Wiley & Sons.

IIPG123C: Introduction to Programming

MPCN102C: Professional Communication

English grammar, Sentence Completion, Verbal Analogies, Word Groups, Instructions, Critical Reasoning, Verbal Deduction, Essay Writing, Letter Writing, Report Writing, Group Discussions.

SPSP230C: Probability and Statistics

Probability and Statistics: Probability, Conditional probability, Bayes' theorem, mutually exclusive events, independent events.

Random Variables: Random variables: continuous and discrete, Discrete and continuous probability density functions and cumulative density functions, expectation, moment function, Mean, median, standard deviation, variance, auto and cross correlation, auto and cross covariance, Probability density functions: Poisson, Binomial, Uniform, Normal/Gaussian, Rayleigh, joint probability density function, Central Limit Theorem, Chebyshev’s inequality, Cauchy Schwartz inequality,.

Stochastic Processes: Introduction to Stochastic Processes: discrete and continuous; Types of Stochastic Processes: stationary, wide sense stationary: Wiener Khinchin Theorem, non-stationary, Stochastic Processes with independent identically distributed random variables; Stochastic Processes with random variables having following distribution: Binomial, Poisson, Gaussian/Normal, Uniform. White Noise, Random signals through linear systems

Books: Probability, Random Variables and Stochastic Processes, Fourth Edition by A. Papoulis and S. Unikrishnan Pillai

EDES232C: Digital Electronics

Number System: Introduction to Binary Numbers, Data Representation, Binary, Octal, Hexadecimal and Decimal Number System and their Conversion.

Boolean Algebra and Logic Gates: Basic Logic Operation and Identities, Algebraic Laws, AND, OR, NOR, NAND, EX-OR, EX-NOR Gates, Useful Boolean Identities, Algebraic Reduction, Complete Logic Sets, Arithmetic Operation using 1's and 2's Compliments, Signed Binary and Floating Point Number Representation, Introduction to logic families: DTL, TTL, MOS, CMOS, ECL.

Combinational Logic Design: Specifying the Problem, Canonical Logic Forms, Extracting Canonical Forms, EX-OR Equivalence Operations, Logic Array, K-Maps: Two, Three and Four variable K-maps, NAND and NOR Logic Implementations, Concept of Digital Components, An Equality Detector, Line Decoder, Multiplexers and De-multiplexers, Code converters, Binary Adders, Subtraction and Multiplication.

Sequential Network: Concepts of Sequential Networks, Latches, Flip Flops, Analysis of Sequential Networks: Single State and Multivariable Networks, Sequential Network Design, Binary Counters and Shift Registers, Importance of state machine.

Memory Elements and Arrays: General Properties, Latches, Flip Flops: RS Flip Flop, D Flip Flop, T Flip Flop, JK Flip Flop, Clock and Synchronization, Master-Slave and Edge-triggered Flip-flops, Registers, RAM and ROMs: different types, Programmable logic array, C-MOS Memories.

Sample and Hold circuits, Analog to Digital Converters and Digital to Analog Converters.

Books:

1. Digital Design by M. Morris Mano

2. Digital Logic and Computer Design by M. Morris Mano

3. Balabanian, N. and Carlson, B., “Digital Logic Design Principles”, JohnWiley & Sons.

4. Malvino, A.P. and Leach, D.P., “Digital Principles and Applications”, 6th Ed., Tata McGraw- Hill. 2008.
5. Floyd, T.L., “ Digital Fundamentals “, 8th Ed., Pearson Education.

ICOA230C: Computer Organization and Architecture

Basic structures of Computers: Functional units, operational concepts, Bus structures, Software, Performance, Computer Architecture vs Computer Organization.

Machine Instruction and Programs: Memory location and addresses, Big-endian and Little-endian representation, Memory Operations, Instructions and instruction Sequencing, Addressing modes, Assembly Language, Basic Input/output operations, subroutine, additional Instructions.

Arithmetic: Addition and subtraction of signed Numbers, Design of Fast Adders, Multiplication of positive Numbers, Signed-operand multiplication, Fast multiplication, Integer Division, Floating point Numbers and operations.

Basic Processing units: Fundamental concepts, execution of complete Instructions, Multi bus organization, Hardwired control, Micro programmed control, RISC vs CISC architecture.

Memory System: Basic Concepts, cache Memory, Cache memory mapping policies, Cache updating schemes, performance consideration, Virtual memories, Paging and Page replacement policies, Memory Management requirement, secondary storage.

Books:

1. Tanenbaum, Andrew S., Structured computer organization. Prentice Hall PTR, 1984.

2. Patterson, David A., and John L. Hennessy. Computer organization and design: the hardware/software interface. Newnes, 2013.

IDST232C: Data Structures

MPOM220C: Principles of Management (to be designed)

IDMS230C: Discrete Mathematics

EEWS203C: Electronics Workshop

EACN332C: Analog Communication

Review of Random Variables And Processes: Probability, Random variables, Useful Probability Density functions, Useful Properties and Certain Application Issues.

Signals and Spectra: An Overview of Electronic Communication Systems, Signal and its Properties. Orthogonal Representation of Signal. The Continuous-Time Fourier Series**:** Basic Concepts and Development of the Fourier, Properties. Parseval's theorem, Power Spectral Density;Continuous-Time Fourier Transform: Basic signals: rectangular, triangular, Gaussian, unit step, impulse, sign function and their Fourier Transform, Properties, Parseval's theorem, Autocorrelation and Cross Correlation, Power and Energy Spectral Density, Wiener Khinchin Theorem, Hilbert transform, complex envelope of signals, canonical representation of bandpass signals, phase and group delay.

Amplitude Modulation Systems: Need for Frequency translation, Amplitude Modulation, DSB-SC modulation, Single Sideband Modulation(SSB), Other AM Techniques (Vestigial side band modulation), Frequency Division Multiplexing, Radio Transmitter and Receiver.

Angle Modulation: Angle Modulation (Frequency and Phase modulation), Tone Modulated FM Signal, NBFM, WBFM, Arbitrary Modulated FM signal, FM Modulator, Approximately Compatible SSB Systems

Pulse Modulation And Digital Transmission Of Analog Signal: Analog to Digital (Noisy Channel and Role of Repeater), Pulse Amplitude Modulation and Concept of Time division multiplexing ,Pulse Width Modulation and Pulse Position Modulation, Digital Representation of Analog Signal.

Noise: In Amplitude Modulation System: Mathematical Representation Of Noise: Some Sources of Noise, Frequency-domain Representation of Noise, Superposition of Noises, Linear Filtering of Noise. Framework for Amplitude Demodulation, Single Sideband Suppressed Carrier(SSB-SC), Double Sideband Suppressed Carrier(DSB-SC), Double Sideband With Carrier(DSB-C). **Noise In Frequency Modulation System:** An FM Receiving System, Calculation of Signal to Noise Ratio, Comparison of FM and AM, Preemphasis and Deemphasis and SNR Improvement, Noise in Phase Modulation and Multiplexing Issues, Threshold in Frequency Modulation, Calculation of Threshold in an FM Discriminator, The FM Demodulator using Feedback, Phase Locked Loop. Super heterodyne receivers and their characteristics; Different receiver architectures; RF and IF amplifiers, mixers.

Books:

1. Communication Systems, Fifth Edition by Simon Haykins

2. Communication Systems Engineering, Second Edition by Proakis and Salehi

3. Lathi, B.P. and Ding, Zhi, "Modern Analog and Digital Communication Sytems", 3rd Ed., Oxford University Press.

EBEE332C: Basic Electrical Engineering

Introduction to DC and AC circuits: DC and AC circuit Analysis, Writing differential equations for circuits, steady state solutions of circuits, Transient Response of first order and second order circuits.

Transformer: Inductively and conductively coupled circuits, Transformer equivalent, Open circuit test and short circuit test, Three phase transformer, Auto-transformer.

3-phase systems: Three phase voltages and currents, Star connection, Delta connection, Three phase power, Three phase circuit analysis, Power measurement methods.

Magnetic Circuits: Electricity and Magnetism, Magnetic force, flux density, field intensity, Faraday's law, B-H curves, Analogy of electric and magnetic circuits, Magnetic circuit analysis, Electromechanical Energy Conversion

Introduction to Electric Machines: Rotating Electric machines, DC Machines, DC Generators, DC Motors, AC machines, Alternator.

Books:

1. Fitzgeraid A. E., Kingsley C. and Kusko A., "Electric Machinery",6th Ed., McGraw-Hill International Book Company.2008

2. Fundamentals of Electrical Drives by G.K. Dubey

3. Say M. G. and Taylor E. O., "Direct Current Machines", 3rd Ed.,ELBS and Pitman.1986

4. Nagrath I. J. and Kothari D. P., "Electrical Machines", 3rd Ed., TataMcGraw-Hill Publishing Company Limited.2008

EEFW330C: Electromagnetic Fields and Waves

Coordinate systems and transformation: Cartesian, cylindrical and spherical coordinates.
Review of vector calculus:Del operator, gradient of a scalar, divergence of a vector and divergence theorem, curl of a vector and Stoke's theorem, Laplacian of a scalar.

Electrostatics: Coulomb's law and field intensity, Electric field due to charge distribution, Electric flux density, Gauss Law – Maxwell's equation, Electric dipole and flux lines, energy density in electrostatic fields.
Electric field in material space: Properties of materials, convection and conduction currents, continuity equation and relaxation time, boundary condition. Electrostatic boundary value problems: Poission's and Laplace's equations, general procedures for solving Poission's or Laplace's equations, method of images.

Magnetostatics: Biot-Savart's Law, Ampere's circuit law, application of ampere's law, magnetic flux density, Maxwell's equation for static fields, magnetic scalar and vector potential.
Magnetic forces, materials and devices: Forces due to magnetic field, magnetic torque and moment, a magnetic dipole, magnetization in materials, magnetic boundary conditions, inductors and inductances, magnetic energy.

Waves and applications: Time Harmonic Fields, Maxwell's equation, Faraday's Law, displacement current, Maxwell's equation in final form.
Electromagnetic wave propagation:Helmholtz equation, uniform plane wave, plane wave in lossymedium, plane waves in lossless medium, reflection of a plain wave in a normal and oblique incidence. Poynting Vector and Energy Storage, Polarization of a plane wave.

Microwave Transmission Lines: Transmission-Line's general equation and solutions, parameters and constants, Wave characteristics on Finite Transmission Line, Reflection Coefficient and Standing-Wave Ratio (SWR), Smith Chart calculations - Graphical method for determination of Transmission Line parameters, Lumped matching, Impedance Matching – Single-stub and Double-stub matching.

Books

1. Engineering Electromagnetics by William Hayt

EAES332C: Analog Electronics

High Frequency Response of BJTs and MOSFETs: Low and High Frequency Response of BJTs and MOSFETs, The Unit gain - frequency, Frequency Response of Frequency Response of Amplifier for different configurations using BJT and MOSFET, Multistage Frequency Effects, Miller Effect Capacitance, Square Wave Testing.

Feedback Amplifiers: General feedback structure, Properties and advantages of negative feedback, Four Basic Feedback Topologies, Practical Feedback Circuits, Feedback Amplifier Stability using Nyquist Plot, , The Barkhausen criterion.

The Operational Amplifier (Op-Amp): Differential Amplifier, passive and active current mirror circuits, differential amplifier as a building block for operational amplifier; Ideal Op-Amp,Op-Amp Characteristics: Slew rate, CMRR, Inverting and non-inverting configurations, Concept of feedback; Topologies: Voltage-voltage, current-voltage, voltage-current, current-current; Stability and compensation.

Applications of Op-Amp (Instrumentation amplifier, Summing amplifier, Integrator and Differentiator). , voltage to frequency converters, log and antilog amplifiers, and multipliers. Filter specifications, design of low

pass, high pass, band pass and band reject filters using operational amplifiers; Design of Butterworth and Chebyshev filters, higher order filters; State variable filters.

Oscillators: Basic principles of sinusoidal oscillators, Op-Amp Oscillator circuits: Operational amplifier based Schmitt trigger, half and full wave rectifiers, square wave and triangular wave generators, Wien-Bridge oscillator, RC phase-shift oscillator and Crystal oscillator. Multivibrators: Bistable, Monostable, Astable. IC555 Timer: operation in different modes. Phase locked loop: voltage controlled oscillator.

Power Amplifiers: Class A, Class B, Class C.

Books

1. Integrated Electronics by MillmanHalkies2. Microelectronics by Millman and Grabel3. Razavi, B., "Design of Analog CMOS Integrated Circuits", Tata McGraw-Hill. 20024. Gregorian, R., "Introduction to CMOS Op-Amp and Comparators",John Wiley & Sons. 1999 5. Gray, P.R., Hurst, P.T., Lewis, S.H. and Meyer, R.G., "Analysis and Design of Analog Integrated Circuits", 4th Ed., John Wiley & Sons. 2001
6. Gayakwad, R., "Op-amp and Linear Integrated Circuits", 4th Ed.,Pearson Education.2005 7. Coughline, R.F. and Driscoll, F.F., "Operational Amplifier and Linear Integrated Circuits", 6th Ed., Prentice-Hall of India.2002 8. Stanley, W.D., "Operational Amplifier with Linear Integrated Circuits", 3rd Ed., Merril.1993

IOSY332C: Operating Systems

ESAS430C: Signals and Systems

Continuous-Time Signals and Systems:
Some Elementary Continuous-Time signals: sinusoidal, exponential, unit step, unit impulse, triangular, Gaussian pulse. Classification of Continuous-Time Signals: periodic and non-periodic, random and deterministic, energy and power signals, causal, anti-causal and non-causal signals, Cross-correlation, Autocorrelation and Properties.

Continuous-Time Systems: Input-Output Description, Block Diagram Representation, Classification of Continuous-time systems: Static and Dynamic, Linear and Non-linear, Time variant and Time invariant, Causal and Non-causal, BIBO stability. Interconnection.

Analysis of Continuous -Time LTI Systems: Impulse Response, Properties of unit impulse function: sifting, replication, area within the unit impulse function, multiplication property (sampling property). Properties of Convolution, Causal LTI Systems, Stability of LTI Systems;

Review of Fourier Transform, Laplace transform: Definition, Properties, Continuous-Time Systems Described by Differential Equations. Solving Differential equation by Laplace transform, Laplace transform of unit impulse and unit step functions.

Discrete-Time Signals and Systems: Nyquist Sampling Theorem**,** Discrete-Time Signals: Some Elementary Discrete-Time signals, Classification of Discrete-Time Signals: periodic and non-periodic, random and deterministic, energy and power signals, causal, anti-causal and non-causal signals, Cross-correlation, Autocorrelation and Properties.

Discrete-Time Systems : Input-Output Description, Block Diagram Representation, Classification of Discrete-time systems: Static and Dynamic, Linear and Non-linear, Time variant and Time invariant, Causal and Non-causal, BIBO stability. Interconnection.

Analysis of Discrete-Time LTI Systems: Impulse Response, Properties of Convolution, Causal LTI Systems, Stability of LTI Systems; Discrete-Time Systems Described by Difference Equations; Implementation of Discrete-Time Systems;

The Z-Transform and Its Application to the Analysis of LTI Systems: The Z-Transform: The Direct Z-Transform, Properties of the Z-Transform, Rational Z-Transforms: Poles and Zeros, Pole Location and Time-Domain Behavior for Causal Signals, Analysis of LTI Systems in the z-Domain: The System Function, Response of Systems with rational System Functions, Transient and Steady-State Responses, Causality and Stability, Pole-Zero Cancellations.; Inversion of the Z-Transforms: The Inversion of the Z-Transform: Power Series Expansion, Partial-Fraction Expansion; The One-sided Z-Transform: Definition and Properties, Solution of Difference Equations.

The Discrete Time Fourier Series: Definition, Properties, Parseval's theorem, Power Spectral Density.
Discrete Time Fourier Transform: Definition**,** Sampling Theorem Revisited: Relation between Continuous time Fourier transform and Discrete-time Fourier Transform of a signal, Aliasing, Ideal Interpolation, Properties. Parseval's theorem, Autocorrelation and Energy Spectral Density, Wiener Khinchin Theorem.

Books

1. Signals and Systems by Oppenheim and Schafer
2. Digital Signal Processing: Principles, Algorithms and Applications by J.G. Proakis and D.G. Manolakis
3. Haykin, Simon and Van Been, B., "Signals and Systems" 2nd Ed., John Wiley & Sons. 2003
4. Ziemer, R.E., Tranter, W.H. and Fannin, D.R., "Signals and Systems: Continuous and Discrete", 4th Ed., Pearson Education.2001
5. Lathi, B. P., "Linear Systems and Signals", 2nd Ed., Oxford University Press.

EEMI432C: Electronic Measurement and Instrumentation

Theory Of Errors: Accuracy & precision, Repeatability, Limits of errors, Systematic & random errors Modeling of errors, Probable error & standard deviation, Gaussian error analysis, Combination of errors.

Electronic Instruments For Measuring Basic Parameters: Electronic Voltmeter, Electronic Millimeters, Digital Voltmeter, Component Measuring Instruments, Q meter, Vector Impedance meter, RF Power & Voltage Measurements, Measurement of frequency, Introduction to shielding & grounding.

Oscilloscopes: CRT Construction, Basic CRO circuits, CRO Probes, oscilloscope Techniques of Measurement of frequency, Phase Angle and Time Delay, Multibeam, multi trace, storage & sampling Oscilloscopes. Curve tracers.

Signal Generation: - Sine wave generators, Frequency synthesized signal generators, Sweep frequency generators. Signal Analysis - Measurement Technique, Wave Analyzers, and Frequency - selective wave analyzer, Heterodyne wave analyzer, Harmonic distortion analyzer, Spectrum analyzer.

Transducers - Classification, Selection Criteria, Characteristics, Construction, Working Principles, Application of following Transducers- RTD, Thermocouples, Thermistors, LVDT, RVDT, Strain Gauges, Bourdon Tubes, Bellows, Diaphragms, Seismic Accelerometers, Tachogenerators, Load Cell, Piezoelectric Transducers, Ultrasonic Flow Meters.

Books:

1. Electrical and Electronics Measurement and Instrumentation by A.K. Sawhney

2. Electronic Instrumentation by P.S. Kalsi

EMIP432C: Microprocessor Interfacing and Programming

Introduction to microprocessor and microcomputer: VLSI technology fundamentals, Basics of logic gates, Overview of digital systems, Arithmetic logic unit and control unit, Central Processing Unit (CPU), Architecture comparison (Von-Neumann and Harvard), Memory hierarchy**,** CISC and RISC.

80x86 processors: 8086 Architecture, Pin Configuration, 8086 Minimum and Maximum mode configurations, Addressing modes, Basic Instructions, 8086 Interrupts, Assembler language programming, Modular Programming.

Peripherals and Interfacing: Microcomputer system organization with peripherals, Clock generator, Programmable interval timer, Programmable Interrupt controller, Polled method, Interrupt method, synchronous and asynchronous bus, Programmable peripheral interface, Programmable communication interface.

Other 16 Bit, 32 Bit Microprocessors and Microcontrollers: Basics of 80186, 80286, 80386, 80486 and Pentium processors, PIC, ARM families (ARM 7, ARM 9, ARM 11), Instruction sets, Microprocessor based systems and the applications.

Books

1. Microprocessors and Interfacing, 3rd Edition (English) 3rd Edition, by D.V. Hall
2. Microprocessor Architechture, programming and Application with 8085 by R. Gaonkar, Prentice Hall

EICT430C: Integrated Circuit Technology

Introduction: Semiconductors and Insulators, Definition, crystal structures, physical properties, Wafer Fabrication, Czochralski (CZ), Float Zone (FZ), Molecular Beam Epitaxy, Principles and practices of clean environment for fabrication.

Crystal Defects: Monovacancy, Divacancy, Microvoids, Voids, Antisites, Interstitials, Dislocation, Stacking fault, Grain Boundaries, Precipitates.

Diffusion: Fick's first and second law and their solutions, Mechanism of diffusion, Profile and Junction Depth and techniques of their determination, Effect of electric field on diffusion process, Impurity diffusion in IC fabrication (Boron, Phosphorus, Ar), Principles of process simulation, Diffusion Systems [equipment, sources (gas, liquid, solid)], Measurement techniques.

Thermal Oxidation and Nitridation of Silicon: Oxidation kinetics (general solution, Parabolic and linear growth and empirical modifications to the growth rate of SiO2 and its kinetics), Thermal Nitridation, Factors in oxidation, Applications of oxide and nitride layers in IC fabrication, SiO2/Si interface, charge traps and impurities redistribution at the interface, Oxidation systems, Measurement techniques

Ion Implantation: Dose, Beam Current, Range and Projected Range, Projected and Lateral Straggle, Ion Stopping (nuclear and electronic energy loss mechanism), Implantation in amorphous and single crystal (channeling effect), Ion implantation damage, Electrical activation and implantation damage recovery (Annealing and RTP), Ion Implantation equipment, Masking layers, Shallow Junction, Measurement techniques.

Photolithography: Photolithography steps (Coat, Soft bake, Patterning and Exposure, Post Exposure Bake, Develop, Inspection), Photoresists (positive and negative), Resist chemistry (Photo sensitive and base), Physical properties (Sensitivity, Photo Speed, Resolution, etc.), Coat and Coaters (Thickness control, uniformity, etc.), Soft Bake and its effects on the film properties and consequent steps, Patterning and exposure, Criteria, limits, resist dependency, equipment, alignment, etc.),Bosung Curves, Focus-exposure matrix, Post Exposure Bake, and its effects on the pattern, Develop (batch, spray, and puddle), Developer chemistry, develop time l) Critical Dimensions (CD) and Inspection (pattern integrity, notching, bridging, etc.)

Interconnects: CVD and PVD techniques and systems, Sputter Deposition for VLSI (glow discharge, RF sputter, magnetron sputter, mechanism, deposition rate, advantages and disadvantages, etc.), Contacts and Vias, Morphology and Step Coverage, Aspect Ratio, Refractory Metals and applications, Barrier metals,Ohmic and Schottky contacts, Silicide formation, Effects of contamination (water, carbon, etc..), Planarization and Passivation, Chemical Mechanical Polishing

Etch: Etch type (wet, dry), Dry Etch, Plasma etch (Process, mechanism, its chemistry and physics), Reactive Ion Etching (Process, mechanism, characteristics. damage etc.), Wet Etching (chemical and chemistry, etch rate, application and process, etc.), Process Integration and Device Fabrication.

Process Technology: n-tub, p-tub and twin tub CMOS process and packaging

Books

1.

2.

EMEN432C: Microwave Engineering

Introduction to Microwaves: Microwave Frequency bands and applications.

Rectangular and Cylindrical waveguide: Design & analysis to support various modes, Field solution for TE and TM modes, Field patterns of power flow through waveguide, Attenuation due to conductor and dielectric losses.CavitiesResonator.

Passive microwave devices: Microwave Hybrid Circuits, Terminations, Attenuators, Phase Shifters, Power Divider, Directional Couplers, Hybrid Couplers, Isolators, Circulators, S parameter analysis of all components.

Microwave Tubes: Two Cavity Klystron, Reflex Klystron, Magnetron, Traveling Wave Tube: Their Schematic, Principle of Operation, Performance Characteristic and their applications.

Solid state amplifiers and oscillators: Microwave Bipolar Transistor, Microwave tunnel diode, Microwave Field-effect Transistor, Transferred electron devices: Gunn diode, Avalanche Transit –time devices: IMPATT Diode, TRAPPAT Diode.

Strip Lines: Microstrip Lines, Parallel Strip Lines, Microstrip Component.

Books
1. Microwave Engineering by D.M. Pozar
2. Microwave Solid State Devices by S.Y. Liao

IDBM532C: Database Management Systems

Unit–I
Introduction to Databases:What is database system, purpose of database system, view of data, relationaldatabases, databasearchitecture?

Unit-II
Data Models, The importance of data models, Basic building blocks, Business rules, The evolutionof data models, Degrees of data abstraction.

Unit-III
Database Design ,ER-Diagram and Unified Modeling Language
Database design and ER Model:overview, ER-Model, Constraints, ER-Diagrams, ERDIssues, weak entity sets, Codd's rules, Relational Schemas,
Relational database model:Logical view of data, keys, integrity rules.
Relational Database design: features of good relational database design, atomicdomain and Normalization (1NF, 2NF, 3NF, BCNF).

Unit-IV
Relational Algebraand CalculusRelational algebra: introduction, Selection and projection, set operations, renaming,Joins, Division, syntax, semantics. Operators, grouping and ungrouping,relationalcomparison.

Unit-V
Transaction management and Concurrencycontrol
Transaction management: ACID properties, serializability and concurrency control,Lock based concurrency control (2PL, Deadlocks),Time stamping methods,optimistic methods, database recovery management.

Lab session with Oracle/Mysql
Constraints, Views and SQL
What is constraints, types of constrains, Integrity constraints,
Views: Introduction to views, data independence, security, updates on views,comparison between tables and views
SQL: data definition, aggregate function, Null Values, nested sub queries, Joinedrelations. Triggers. PL/SQL

Text Books:
1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2. ElmasriRamez and NovatheShamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing.Company.
3. Ramakrishnan: Database Management System , McGraw-Hill

EDCN532C: Digital Communication

Introduction: Digital communication system model, modulation process, Comparison: analog vs. digital communication; Fundamental limitations of communication systems.

Digital Baseband Transmission: Brief review of sampling theorem, Uniform quantization and its noise analysis, non-uniform quantization, Companding, A-law, μ-law; PCM, signal to noise ration in PCM, DPCM, Delta modulation, Adaptive Delta Modulation, Line encoding

Digital Modulation Techniques: Digital Modulation Techniques: Generation and Detection of ASK, BPSK, DPSK, QPSK, OQPSK, M-ary PSK, QASK, BFSK, M-ary FSK, MSK (minimum shift keying), Constellation diagram, Power Spectrum of Digitally Modulated Signals.

Optimum Receivers for AWGN Channels
Sources of Noise in Communication Systems, Characteristics of AWGN (additive white Gaussian noise), Receiving Filter–Correlator type, The Optimum Filter in the presence of White Noise: Matched Filter; Equalizing Filter, ISI elimination, Eye Pattern analysis; Detector –Maximum Likelihood Detector, Coherent detection of PSK, FSK, Non-coherent detection of FSK, Error Probability calculation: BPSK, BFSK, QPSK, Comparison of different modulation techniques. Bit versus symbol error probabilities.

Introduction to Information Theory: Mathematical model for information sources, Logarithmic measure of information, lossless coding for information sources, channel model and Shannon channel capacity theorem, Channel reliability function, channel cutoff rate.

Digital Communication through Band-Limited Channels: Characterization of Band-Limited Channels, Pulse shaping filters, Signal design for Band-Limited Channels, Optimum Receiver for Channels with ISI and AWGN, Linear Equalization, Decision-feedback Equalization.

Spread Spectrum Signal for Digital Communication: Models of spread spectrum communication, Generation and characteristic of p-n sequence, Code division multiple access, Direct sequence spread spectrum signals, frequency hopping spread spectrum signals, synchronization of spread spectrum system.

Books:

1. Principles of Communication Systems by Taub and Schilling, Tata Mc-Graw-Hill.2. Digital Communications by Simon Haykins3. Modern Digital and Analog Communication Systems by B.P. LAthi and Zhi Ding, Oxford University Press.

ECSY532C: Control Systems

Introduction to Control Systems: Basic Concepts of Control Systems, Open loop and closed loop systems, Servo Mechanism/Tracking System, Regulators, Mathematical Models of Physical Systems: Differential Equations of Physical Systems: Mechanical Translational Systems, Mechanical Acceloroments, Retational systems, Analogy between Mechanical and electrical quanties, Derivation of Transfer functions, Block Diagram Algebra, Signal flow Graphs, Mason's Gain Formula. Feedback characteristics of Control Systems: Effect of negative feedback on sensitivity, bandwidth, Disturbance, linearizing effect of feedback, Regenerative feedback.

Time response Analysis: Standard Test Signals. Time response of first order systems to unit step and unit ramp inputs. Time Response of Second order systems to unit step input, Time Response specifications, Steady State Errors and Static Error Constants of different types of systems. Generalised error series and Gensalised error coefficients, Stability and Algebraic Criteria, concept of stability, Necessary conditions of stability, Hurwitz stability criterion, Routh stability criterion, Application of the Routh stability criterion to linear feedback system, Releative stability by shifting the origin in s-plane.

Root locus Technique: Root locus concepts, Rules of Construction of Root locus, Determination of Roots from Root locus for a specified open loop gain, Root contours, Systems with transportation lag. Effect of adding open loop poles and zeros on Root locus.

Frequency Response Analysis: Frequency domain specifications, correlation between Time and Frequency Response with respect to second order system, Polar plots, Bode plot. Determination of Gain Margin and Phase Margin from Bode plot.

Stability in frequency domain: Principle of argument, Nyquist stability criterion, Application of Nyquist stability criterion for linear feedback system.ConstantMcircles, Constant N-Circles, Nichol's chart.

Controllers: Concept of Proportional, Derivative and Integral Control actions, P, PD, PI, PID controllers. Zeigler-Nichols method of tuning PID controllers.

Books
1. Control Systems Engineering by Norman S Nise
2. Modern Control Systems by Richard Dorf
3. Control Systems Engineering by I.J. Nagrath

EAWP532C: Antennas and Wave Propagation

Introduction: Wave equation in terms of potential functions; Vector potential A for an electric current source J &Vector potential F for a magnetic current source M.

Fundamental parameters of Antenna: Principle of Radiation, Radiation Pattern - Isotropic, Directional and omni directional patterns; Principle Patterns and Secondary lobes: Field regions: radiation field and Steradian. Radiation Power Density; Radiation Intensity, Directivity, Gain, Antenna Efficiency, HPBW, Beam efficiency, Bandwidth, Polarization - Linear, Circular and Elliptical Polarization. Noise Figure and Noise Temperature.Effects of antenna height and effect of ground on performance of antenna.Antenna effective length.

Short Dipole and half wavelength Dipole - Current distribution, Radiated Fields, Power density and Radiation resistance; radiating near field (Fresenel) and reactive near field region, intermediate field and far field (Fraunhofer) region, Ground effects - vertical and horizontal electric dipole, earth curvature.

Loop Antenna and Horn Antenna (basics). Frequency independent Antennas: Log periodic Dipole antenna and helical antenna (basics).Antenna Arrays: Uniform linear arrays of isotropic elements, array factor and directivity. Broadside &Endfire array, principle of pattern multiplication. Binomial array. Microstrip Antenna - Basic Characteristics, Rectangular Patch, Circular Patch, Quality factor bandwidth and efficiency, Feed to microstrip antenna: probe feed, microstrip line feed, aperture feed (basic ideas).

Ground Wave, Sky Wave, Space Wave & Scatter Propagation with general application: Propagation with general applications: Propagation Equations in Ground Waves: Attenuation Factor, Transmission Coverage, Receiving Antenna for ground wave. Sky Wave Propagation: Attenuation, Refractive Index, Conductivity and Permittivity, Electron Collision Frequency, D, E & F Layers, Critical Frequency & MUF, skip distance, Curved Ionosphere, Propagation Equation, Antennas for Sky Wave reception. Space Wave Propagation in the Troposphere: LOS Range, Flat Earth Reflection with variable wavelengths and heights, Inverse Distance Equation, Point of reflection on curved Earth, Curvature of space Waves in the Troposphere, Diffraction of space waves, Duct Propagation, Fading of Space Waves. Antennas for Space wave Propagations.

Books
1. Antenna Theory by C.A. Balanis
2. Antennas by J.D. Kraus
3. Antenna and Wave Propagation by K.D. Prasad

ECNW532C: Computer Networks

Introduction
Network vs. distributed system, Point to point Network vs. Multipoint Network, Classify networks, Network performance measures, OSI Reference Model, TCP/IP Reference Model, Multiplexing, circuit switching, message switching, packet switching

Physical Layer
baud {modulation rate}, data rate {capacity}, bandwidth, Nyquist Theorem, Shannon's Result, Data Encoding Techniques, digital data, analog signals, digital data, digital signals, Transmission Media

Data Link Layer
Transmission Errors, error detection and error correction, Hamming Codes, Parity Checks, Checksum, CRC, Framing, bit stuffing, byte stuffing, Data Link protocols such as PPP, BYSYNC, DDCMP, HDLC, Stop-and-

Wait, sliding window protocols, MAC Layer Protocols such as Aloha (Pure Aloha & Slotted Aloha), Persistent and Non persistent CSMA, CSMA/CD, LAN Standards, 802.1 to 802.5 and 802.11

Network Layer
IPv4 details, Routing Protocols, Distance Vector Routing (RIP), Link State Routing (OSPF), Border Gateway Protocols (BGPv4), Network Layer Utility Protocols like ICMP, Ping, ARP, RARP, DHCP, Traceroute, IPv6 details

Transport Layer
Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), End to End Issues, Connection Establishment and Termination of TCP, TCP Sliding Windows

Congestion Control
TCP Congestion Control, AIMD, Slow Start, Fast Transmit and fast recovery, Congestion Avoidance Mechanism DECbit and Random Early Detection(RED)

Network Security
Cryptographic Algorithms, Security Mechanism like Authentication, Authorization, Protocols like SSH, rlogin, IPSec, Firewalls

Recommended Books

Text Books

1. Computer networks – Larry L. Peterson and Bruce S. Davie
2. Computer Networks – Andrew S. Tenenbaum

Reference Books

1. Data and Computer Communications – William Stallings
2. Internetworking with TCP/IP – Douglas E. Comer Vol. II and I.
3. Computer Networks and Internet – Douglus E. Coumer
4. Unix Network Programming – Richards Steavens
3. Cryptography and Network security – William Stallings

Lab Guidelines

Before Mid Semester Exam

Set of Socket Programming Assignments in C or C++.

After Mid Semester

A project in a group of 2 to 3 students based on the technology learned before mid semester examination.

MMEC520C: Managerial Economics

EPOP503P: Project oriented Practices

EDSP532C: Digital Signal Processing

Review of Z-Transform and Its Application to the Analysis of LTI Systems: The Z-Transform, The Inverse Z-Transform; Properties of the Z-Transform; Inversion of the Z-Transforms: Analysis of Linear Time-Invariant Systems in the z-Domain, Transient and Steady-State Responses, Causality and Stability, Pole-Zero Cancellations.

Frequency Domain Sampling: Frequency-Domain Sampling and Reconstruction of Discrete--Time Signals, The Discrete Fourier Transform, The DFT as a Linear Transformation, Relationship of the DFT to other Transforms; Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties; Linear Filtering Methods Based on the DFT: Use of the DFT in Linear Filtering, Filtering of Long Data Sequences; Frequency Analysis of Signals using the DFT; The Discrete Cosine Transform: Forward DCT, Inverse DCT, DCT as an Orthogonal Transform.

Efficient Computation of the DFT: Fast Fourier Transform Algorithms. Efficient Computation of the DFT: FFT Algorithms: Direct Computation of the DFT, Radix-2 FFT Algorithms: Decimation-In-Time (DIT), Decimation-In-Time (DIF); Applications of FFT Algorithms: Efficient Computation of the DFT of two Real Sequences, Efficient Computation of the DFT a 2N-Point Real Sequence, Use of the FFT Algorithm in Linear Filtering and Correlation.

Implementation of Discrete-Time Systems: Structure for the Realization of Discrete-Time Systems, Structure for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures; Structure for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures.

Design of Digital Filters: General Considerations: Causality and Its Implications, Characteristics of Practical Frequency-Selective Filters; Design of FIR Filters: Symmetric and Anti-symmetric FIR Filters, Design of Linear-Phase FIR Filters by using Windows, Design of Linear-Phase FIR Filters by the Frequency-Sampling Method; Design of IIR Filters from Analog Filters: IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation.

Books
1. Digital Signal Processing: Principles, Algorithms and Applications by J.G. Proakis and Manolakis
2. Digital Signal Processing by Oppenheim and Schafer
3. Digital Signal Processing by S.K. Mitra

EVSD632C: VLSI System Design

Introduction: Historical Perspective, VLSI Design Methodologies, VLSI Design Flow, Design Hierarchy, Concept of Regularity, Modularity and Locality, VLSI Design Styles, Computer-Aided Design Technology,

MOSFET Scaling and Small-Geometry Effects.

MOS Inverters - Static Characteristics: Introduction, Resistive-Load Inverters, Inverters with n-Type MOSFET Load, CMOS Inverter. Dynamic characteristics and interconnect effect: Introduction, Delay-Time Definitions, Calculation of Delay-Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters.

Combinational and Sequential Circuits: Introduction, MOS Logic Circuits with Depletion NMOS Loads, CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates (Pass Gates),Behavior of Bistable Elements, SR Latch Circuits, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge-Triggered Flip-Flop.

Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High Performance Dynamic CMOS Circuits.

Semiconductor Memories: Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM), Non-volatile Memory, Flash Memory.

Books

Rabaey, Jan M., Anantha P. Chandrakasan, and Borivoje Nikolic. Digital integrated circuits. Vol. 2. Englewood Cliffs: Prentice hall, 2002.

Kang, Sung-Mo, and Yusuf Leblebici. CMOS digital integrated circuits. Tata McGraw-Hill Education, 2003.

EOCN632C: Optical Communication

Unit-I

Overview of Optical Fiber Communications (OFC): Motivation, optical spectral bands, key elements of optical fiber systems. Optical fibers: basic optical laws and definitions, optical fiber modes and configurations, mode theory for circular waveguides, single mode fibers, graded-index fiber structure, fiber materials, photonic crystal fibers, fiber fabrication, fiber optic cables.

Unit-II

Optical sources: Light emitting diodes (LED): structures, materials, quantum efficiency, LED power, modulation of an LED. Laser diodes: modes, threshold conditions, laser diode rate equations, external quantum efficiency, resonant frequencies, structure and radiation patterns, single mode lasers, modulation of laser diodes. Power launching and coupling: source to fiber power launching, fiber to fiber joints, LED coupling to single mode fibers, fiber splicing, optical fiber connectors.

Unit-III

Photo detectors: pin photo detector, avalanche photodiodes, photo detector noise, detector response time, avalanche multiplication noise. Signal degradation in optical fibers: Attenuation: units, absorption, scattering losses, bending losses, core and cladding losses. Signal distortion in fibers: overview of distortion origins, modal delay, factors contributing to delay, group delay, material dispersion, waveguide dispersion, polarization-mode dispersion. Characteristics of single mode fibers: refractive index profiles, cutoff wavelength, dispersion calculations, mode field diameter, bending loss calculation.

Unit-IV

Optical receivers: fundamental receiver operation, digital receiver performance, eye diagrams, coherent detection: homodyne and heterodyne, burst mode receiver, analog receivers. Digital links: point to point links, link power budget, rise time budget, power penalties. Analog links: overview of analog links, carrier to noise ratio, multi channel transmission techniques.

Unit-V

Optical technologies Wavelength division multiplexing (WDM) concepts: operational principles of WDM,SONET, passive optical star coupler, isolators, circulators, active optical components: variable optical attenuators, tunable optical filters, dynamic gain equalizers, polarization controller, chromatic dispersion compensators., Optical amplifiers: basic applications and types of optical amplifiers, Erbium Doped Fiber Amplifiers (EDFA): amplification mechanism, architecture, power conversion efficiency and gain. Amplifier noise, optical SNR, system applications. Performance Measurement and monitoring: measurement standards, basic test equipment, optical power measurements, optical fiber characterization, eye diagram tests, optical time-domain reflectometer, optical performance monitoring.

Books

1. Senior, J.M., “Optical Fiber Communications”, 2nd Ed., Prentice-Hall of India. 1999
2. Keiser, G., “Optical Fiber Communications”, 3rd Ed., McGraw-Hill. 2000

IDPM632C: Database Programming and Management

EEPE632E: Power Electronics

Introduction: Introduction to Power Electronics, Overview and Applications of power devices.

Power semiconductor devices: Power diodes, SCR: Device structure, Static characteristic, dynamic characteristic,constraints of Turn on and Turn off time, Power MOSFET, IGBT.

Dc-Dc Converters: DC- DC Power Converters, Limitations of Linear Power supplies Switched Power Power supplies (Buck, Buck-Boost, Boost, Cuk, Fly-back and Forward Converters), Transfer function for these converters.

Inverters: Principle of operation of Inverters, Half bridge, full bridge, three phase- six step operation,voltage control, PWM techniques.

Rectifiers: Diode rectifiers Applications: Power Supplies, chemical process, Single phase Half wave with R load, Single phase Half wave with R-L load, Single phase Full bridge rectifier with DC link capacitive filter, issue of harmonics, Three phase Full bridge rectifier with DC link capacitive filter, issue of harmonics.

Books:

1. Mohan N., Undeland T. M. and Robbins W. P., “Power Electronics- Converters, Applications and Design”, 3rd Ed., Wiley India.
2. Dubey G. K., Doradla S. R., Joshi A. and Sinha R. M. K., “Thyristorised Power Controllers”, New Age International Private Limited.
3. Rashid M. H., “Power Electronics Circuits Devices and Applications”, 3rd Ed., Pearson Education.

EPRJ603P: Project 2

EESD732C: Embedded System Design

Introduction: Evolution of processors for embedded application; High performance computing and low power computing; Moore’s law and Amdahl’s law; Brief overview of performance estimation; Performance gap in microprocessor and memory; Introduction of Cache hierarchy in processors; Memory elements and hierarchy (SRAM, DRAM, Flash, Hard Disk).Techniques to improve the hardware Performance; Design Process of embedded system; Hardware/Software Interface; Instruction Set Architecture; CISC and RISC approach;

Architecture comparison (Von-Neumann, Harvard); Introduction to basic architectures (Intel 8086, Power PC, ADSP, ARM), Pipelining and parallel processing.

Implementation of Embedded Systems: Hardware implementation methodologies; ASIC and FPGA; RTL-GDSII flow in ASIC design; Various abstraction levels in the system implementation; Techniques to improve hardware performance per unit power; Performance Analysis and Optimization : Speed, Power and Area optimization; Reliability of systems; Hardware-Software productivity gap; Techniques to Improve the software performance; Embedded system design challenges: Constraints in design, Heterogeneity, Constructivity; Execution and Interaction Semantics.

Embedded Processor: Performance and efficiency of ARM architecture (ARM 7, ARM 9, ARM 11). Thumb and ARM Instruction set and Programming; Data processing, Data transfer and Control flow instructions. Data Level Parallelism and Thread level parallelism.

Interfacing: Memory Interfacing,, I/O interfacing, Interface IP: AMBA, DDR, Ethernet, USB, Analog IP: Data Converter and PLL, Embedded Memory IP; Serial Communication and Parallel Communication,

Miscellaneous: Real Time Operating systems, Scheduling, Memory and I/O management, Bus I/O and networking considerations, System verification, Testing of embedded systems.

Books

1. Heath, Steve. Embedded systems design. Newnes, 2002.

2. Hennessy, John L., and David A. Patterson. Computer architecture: a quantitative approach. Elsevier, 2012.

3. Wolf, Wayne. FPGA-based system design. Pearson education, 2004.

EWCE732C: Wireless Communication Engineering

Introduction to Personal Communications Services (PCS): PCS Architecture, mobility management, Networks signaling.

Global System for Mobile Communication (GSM) System: GSM Architecture, Mobility management, Network signaling.

General Packet Radio Services (GPRS): GPRS Architecture, GPRS Network Nodes, Mobile Data Communication; WLANs (Wireless LANs) IEEE 802.11 standard, Mobile IP.

Wireless Application Protocol (WAP): The Mobile Internet standard, WAP Gateway and Protocols, wireless mark up Languages (WML).

Wireless Local Loop (WLL): Introduction to WLL Architecture, wireless Local Loop Technologies. Third Generation (3G) Mobile Services: Introduction to International Mobile Telecommunications 2000 (IMT 2000) Vision, IS-95, Wideband Code Division Multiple Access (W-CDMA), and CDMA 2000.

Global Mobile Satellite Systems: case studies of the IRIDIUM, ICO and GLOBALSTAR systems. Wireless Enterprise Networks, Introduction to Virtual Networks, Bluetooth technology, Bluetooth Protocols.

Books

1. Wireless Communications: Principles and Practice **by Rappaport**

EADS730E: Advanced Digital Signal Processing

Multirate DSP: Donwsampling, Upsampling, Decimation, Interpolation, Application in sampling rate conversion and high quality A/D and D/A conversion.

Filter banks: Polyphase structures; Quadrature-mirror filter bank: Two-channel and L-channel, applications to speech and audio coding.

Adaptive Filters: System Identification or System Modeling, Adaptive Direct-Form FIR Filters, Wiener filter, MMSE and LMS algorithm; Kalman filter, Applications of adaptive filtering to echo cancellation and equalization. Linear Prediction Analysis.

DSP Hardware: General and special purpose hardware for DSP; Digital signal processor trends, software radio.

Books

1. Mitra, S.K., "Digital Signal Processing-A Computer Based Appraoach",3rd Ed., Tata Mcgraw-Hill. 2005

2. Oppenheim, A.V. and Schafer, R.W. with Buck, J.R., "Discrete Time Signal Processing", 2nd Ed., Prentice-Hall of India. 2002

3. Proakis, J.G. and Manolakis, D.G., "Digital Signal Processing: Principles, Algorithm and Applications", 4th Ed., Pearson Education. 2007

4. Ifeachor, E.C. and Jervis, B.W., "Digital Signal Processing: A Practical Approach", 2nd Ed., Pearson Education. 2002

5. Jeffrey, H.R., "Software Radio: A Modern Approach to Radio Engineering", Pearson Education. 2002

EDIP730E: Digital Image Processing

Introduction: Digital Image Processing (DIP) Introduction, examples of fields that use DIP, fundamental steps in DIP, components of an image processing system. Digital Image Fundamentals: elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels.
Image Transforms: Image Transforms Two-dimensional (2D) impulse and its shifting properties, 2D continuous Fourier Transform pair, 2D sampling and sampling theorem, 2D Discrete Fourier Transform (DFT), properties of 2D DFT. Other transforms and their properties: Cosine transform, Sine transform, Walsh transform, Hadamard transform, Haar transform, KL transform.

Binarization and Segmentation of Grey Level Images: Histogram of grey level images, optimal thresholding, multilevel thresholding; Segmentation of grey level images, watershed algorithm for segmenting grey level images.
Detection of Edges and Lines in 2D Images: First order and second order edge operators, multi-scale edge detection, Canny's edge detection algorithm, Hough transform for detecting lines and curves, edge linking.

Image Enhancement: Spatial domain methods: basic intensity transformation functions, fundamentals of spatial filtering, smoothing spatial filters (linear and non-linear), sharpening spatial filters (unsharp masking and high boost filters), combined spatial enhancement method. Frequency domain methods: basics of filtering in

frequency domain, image smoothing filters (Butterworth and Gaussian low pass filters), image sharpening filters (Butterworth and Gaussian high pass filters), selective filtering.

Image Restoration: Image degradation/restoration, noise models, restoration by spatial filtering, noise reduction by frequency domain filtering, linear position invariant degradations, estimation of degradation function, inverse filtering, Wiener filtering, image reconstruction from projection.

Image Compression: Fundamentals of data compression: basic compression methods: Huffman coding, Golomb coding, LZW coding, Run-Length coding, Symbol based coding, JPEG. Digital image watermarking, representation and description- minimum perimeter polygons algorithm (MPP).

Books

1. Digital Image Processing by A.K. Jain
2. Gonzalez, R. C., Woods, R. E. and Eddins, S. L., "Digital image Processing Using MATLAB", 3rd Ed., Prentice-Hall.2008
3.. Jahne, B., "Digital Image Processing", 5th Ed., Springer. 2003
4. Pratt, W. L., "Digital Image Processing", 3rd Ed., John Wiley & Sons. 2001
5. Sonka, M., Hlavac, V. and Boyle, R., "Image Processing, Analysis and Machine Vision", 3rd Ed., PWS Publishing.1998

EAIC730E: Analog Integrated Circuit Design

Semiconductor device basics: Review of integrated circuit device characteristics & models.

Review of basic transistor amplifiers: CS, CG and CD amplifier, Differential amplifier, Current mirror, active loads, Output Stages, Frequency response of CS, CG and CD amplifier.

Operational Amplifiers: Multistage amplifiers, Frequency Response of amplifiers, feedback techniques, Frequency Response & Stability of Feedback Amplifiers

Practical application: OPAMP in amplifiers and filters etc, Noise, non-linearity, mismatch, MOS vs Bipolar OPAMP

Books

1. Gray, Paul R., and Robert G. Meyer. Analysis and design of analog integrated circuits. John Wiley & Sons, Inc., 1990.
2. Razavi, Behzad. Design of analog CMOS integrated circuits. 2005.

ERFC732E: Radio Frequency Circuit Design

Introduction:RF systems, Basic radio architectures, Process design kit, Passive and active components, Thermal Noise and Flicker Noise, Noise figure.

CMOS and BiCMOS Technology: Introduction to MOSFETs and HBTs, Small signal and large signal analysis, Nonlinearity.

Amplifiers: High frequency amplifiers, Low noise amplifiers, Power Amplifiers.

Mixer: Up convertion and down conversion mixer design.

Active filter: High speed OPAMP, OTA, negative feedback, active inductor, first order and second order low pass, high pass, band pass and band reject filter design.

Phase lock loop: Voltage controlled oscillator, Phase detector, charge pump, phase lock loop.

Books

1. Lee, Thomas H. The design of CMOS radio-frequency integrated circuits. Cambridge university press, 2004.
2. Razavi, Behzad, and Razavi Behzad. RF microelectronics. Vol. 1. New Jersey: Prentice Hall, 1998.

EMIC730E: Mixed Signal Integrated Circuit Design

Unit 1: Noise in MOS Circuits

Unit 2: Current and Voltage Sources

Unit 3: CMOS OP-AMPS

Unit 4: Data Conversion Circuits- Analog to digital converters (ADC).

Unit 5: Data Conversion Circuits- Digital to analog converters (DAC).

Unit 6: Analog and discrete-time signal processing**,** Analog integrated continuous-time and discrete-time filters. Switched-capacitor

Unit 6: Filters

Unit 7: Clock Generation for Mixed Signal System ICs, PLL etc

Unit 8: Mixed-Signal layout

Books

1. CMOS mixed-signal circuit design by R. Jacob BakerWiley India, IEEE press, reprint 2008.
2. CMOS circuit design, layout and simulation by R. Jacob BakerRevised second edition, IEEE press, 2008.
3. Design of analog CMOS integrated circuits by BehadRazaviMcGraw-Hill, 2003.

EMSD730E: Modeling and Analysis of Semiconductor devices

Quantum Mechanical Concept: Schrodinger's equation and quantum well problems, Fermi energy and carrier concentration, Fermi golden rule, Boltzman transport equation, Relaxation time approximations, Scattering rates and mobility.

Nanoscale device modeling: Landaur transport formalism, mobility model, transmission coefficient, 1D and 2D MOS electrostatics, Non equilibrium green's function formalisms, scattering matrix, self-energies.

Bulk device modeling: Injection and transport model, continuity equation, planar double gate MOSFET transistor current and threshold voltage modeling.

Current model: Ebers and moll and gummelpoone model, depletion type MOSFET, depletion capacitance, series resistance, early effect.

Books

1. M. Lundstrom, Fundamentals of carrier transport, Cambridge University press, 2000.

2. Y. Tsividis, Operation and modeling of MOS transistors, oxford press.

EMES730E: Micro electromechanical systems

Unit 1: Introduction to MEMS and Basic electrical and Mechanical concepts,

Unit 2: Transduction methods and MEMS devices based on Electrostatic, Thermal Sensing and Actuation Piezoresistive, Piezoelectric, Magnetic Sensing and Actuation,

Unit 3: Materials for MEMS, micromaching (Bulk, Surface, LIGA)

Unit 4: RF MEMS (Switches, Varactors, Inductors and phase shifters)

Unit 5: Optical MEMS (DMD, GLV, optical switches, variable optical attenuators, IR radiation Imagers and tunable LASERS)

Unit 6: Bio MEMS and Micro Fluidics

Unit 7: MEMS Packaging & Testing

EMCS730E: Basics of Modern Control Systems

Introduction: Vector spaces, Linear systems, similarity transformations, Canonical forms, Controllability, Observability, Realisability etc. Minimal realization, Digital systems

Analysis of Nonlinear system: Nonlinear systems, Phase-plane analysis, Poinc`are theorems, Lyapunov theorem, Circle and Popov criterion.

Design of Observers and Estimators: Linear Quadratic Regulator (LQR), Linear Quadratic Gaussian (LQG) control, Loop Transfer Recovery (LTR)

Robust control: Introduction to Robust Control, H-infinity control, sliding mode control.

Books

1. **Modern Control Theory by William L. Brogan, Pearson Education India,**
2. **Applied Nonlinear Control, Jean-Jacques E. Slotine, Weiping Li, Prentice Hall, 1991**
3. **Control Systems Engineering by Norman S Nise.**

EOPNW730E: Optical Networks

1. **Optical Networking: Introduction and Challenges**

   Advantages of optical network, Telecom network overview and architecture, WDM optical networks, WDM network evolution, Challenges of Optical WDM network.

2. **Introduction of Signals in Optical Fiber and Components**

   Loss and Bandwidth Windows, Bending Loss, Intermodal Dispersion, Couplers, Isolators and Circulators, Multiplexers and Filters: Gratings & Diffraction Pattern, Fiber Bragg Gratings, Fabry-Perot Filters, Multilayer Dielectric, Mach-Zehnder Interferometers, LASER & LED, Detectors, Erbium-Doped Fiber Amplifiers and Semiconductor Optical Amplifiers, Switches, Fiber Nonlinearities, System model & Power penalty.

3. **Photonic Packet Switching**

   Optical-TDM, Synchronization, Packet Switching and Buffering, Burst Switching

4. **Client Layers of the Optical Layer**

   SONET/SDH, Optical Transport Network, Ethernet, Multiprotocol Label switching

5. **Broadcast and Select & Wavelength Routing Networks**

   Topologies for Broadcast networks, MAC Protocols, Routing and Wavelength Assignment, Statistical Dimensioning Models

6. **Optical Access Networks**

   Introduction to access network, PON, EPON and WDN, STARGATE gigabit Ethernet, radio over fiber network.

7. **On-Chip Photonic Links and Networks**

   Transceivers (point-to-point link based), Many Core Machines, Interconnect Bottlenecks, Silicon Photonic WDM, Basic Optical Switches, Basic Structures of On-chip Wavelength Routed Optical Network (WRON), Routing Scheme of WRON and its System Organization, Fully-Functional Digital Circuit with MUX, DEMUX and Memory.

Text Books:

1. "**Optical Networks**" by R. Ramaswami, Kumar N. Sivarajan, Galen H. Sasaki.

Reference Books:

1. "***WDM Optical Networks : Concept, Design and Algorithms***" by C. Siva Ram Moorthy and Mohan Gurusamy, Prentice Hall of India, Ist Edition, 2002.
2. "***Fiber Optic Networks***" by P.E. Green, Jr., Prentice Hall, NJ, 1993.
3. "***Optical WDM Networks***" by Biswanath Mukherjee, Springer, 2006.
4. "***Optical Switching Networks***" by Mayer & Martin, Cambridge University Press, 2008.

EODC730E: Optoelectronic Devices and Circuits

Introduction: Review of Semiconductor Device Physics**,** Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level and quasi Fermi levels, p-n junctions, Schottky junction and Ohmic contacts, Semiconductor optoelectronic materials, Bandgap modification, Heterostructures and Quantum Wells.

Interaction of photons with electrons and holes in a semiconductor: Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier.

Semiconductor Photon Sources: Electroluminescence. The LED: Device structure, materials and characteristics. The Semiconductor Laser: Basic structure, theory and device characteristics; direct current modulation, Quantum-well lasers; DFB-, DBR- and vertical-cavity surface-emitting lasers (VCSEL); Laser diode arrays. Device packages and handling.

Semiconductor Photodetectors: Types of photodetectors, Photoconductors, Single junction under illumination: photon and carrier-loss mechanisms, Noise in photodetection, Photodiodes, PIN diodes and APDs: structure, materials, characteristics, and device performance, Photo-transistors, solar cells, and CCDs, Optoelectronic integrated circuits - OEICs.

Books

Chuang, Shun Lien. Physics of photonic devices. Vol. 80. John Wiley & Sons, 2012.

EVTV730E: VLSI Testing and Verification

VLSI Design: High level Synthesis, Verilog RTL Design, Combinational and Sequential Synthesis Logic Synthesis (for large circuits).

Verification Techniques: Introduction to Hardware Verification and methodologies, Binary Decision Diagrams(BDDs) and algorithms over BDDs, Combinational equivalence checking, Temporal Logics, Modeling sequential systems and model checking, Symbolic model checking.

VLSI Testing: Introduction, Fault models, Fault Simulation, Test generation for combinational circuits, Test generation algorithms for sequential circuits and Built in Self test.

Books

Bushnell, Michael, and Vishwani D. Agrawal. Essentials of electronic testing for digital, memory and mixed-signal VLSI circuits. Vol. 17. Springer Science & Business Media, 2000.

ERSC730E: RADAR & Satellite Communication

I. RADAR

Unit 1: *Introduction*: Principle of detection and ranging, Radar frequencies and bands. Block diagram and operation, Applications.

Unit 2: *Radar Range Equation*: Radar Ranging and prediction, Minimum detectable signal, Receiver SNR, Radar cross section of targets, Transmitter Power, System losses and Propagation effects.

Unit 3: *CW and FM Radar*: Doppler effect, CW Radar, Frequency-modulated CW Radar, Multiple-frequency CW Radar.

Unit 4: *MTI and Pulse Doppler Radar*: MTI delay lines, Delay line Cancelers, Coherent and Non-Coherent MTI, Pulse Doppler Radar.

Unit 5: *Tracking Radar*: Tracking with Radar, Sequential Lobbing, Conical Scanning, Mono-Pulse tracking Radar

II. SATELLITE

Unit 1: *Introduction*: Brief History and overview of Satellite system, Orbiting satellites, Frequency ranges, Multiple access formats.

Unit 2: *Orbital aspects of Satellite communication*: Orbiting mechanism, Look angle determination, Launches and Launch Vehicles, orbital effects if system performance.

Unit 3: *Satellite channel and Link design*: Power flow, Antennas, Atmospheric losses, System noise temperature and G/T ratio, CNR, Satellite link analysis for uplinks and downlinks.

Unit 4: *Satellite Transponder*: Transponder model, Satellite Front-end, Satellite signal processing.

Text Books:

1. Introduction to Radar Systems - M. I. Skolnik
2. Satellite Communication - T. Pratt, C. W. Boston & J. E. Allnutt
3. Satellite Communication - R. M. Gagliardi

Reference Books:

1. Radar Principles – Peyton Z. Peebles, Jr.
2. Radar Systems Analysis and Design Using MatLab – Bassem R. Mahafza
3. Digital Satellite Communication – Tri T. Ha

EAWC730E: Advanced Wireless Communications

Wireless Communications and Diversity: Fast Fading Wireless Channel Modeling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Diversity modeling for Wireless Communications, BER Performance Improvement with diversity, Types of Diversity – Frequency, Time, Space.

Broadband Wireless Channel Modeling: WSSUS Channel Modeling, RMS Delay Spread, Doppler Fading, Jakes Model, Autocorrelation, Jakes Spectrum, Impact of Doppler Fading.

Cellular Communications: Introduction to Cellular Communications, Frequency reuse, Multiple Access Technologies, Cellular Processes - Call Setup, Handover etc. ,Teletraffic Theory

CDMA: Introduction to CDMA, Walsh codes, Variable tree OVSF, PN Sequences, Multipath diversity, RAKE Receiver, CDMA Receiver Synchronization.

OFDM: Introduction to OFDM, Multicarrier Modulation and Cyclic Prefix, Channel model and SNR performance, OFDM Issues – PAPR, Frequency and Timing Offset Issues.

MIMO: Introduction to MIMO, MIMO Channel Capacity, SVD and Eigenmodes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST, MIMO Diversity – Alamouti, OSTBC, MRT, MIMO - OFDM

UWB: UWB Definition and Features, UWB Wireless Channels, UWB Data Modulation, Uniform Pulse Train, Bit-Error Rate Performance of UWB.

3G and 4G Wireless Standards: WCDMA, LTE,WiMAX.

EWSN730E: Wireless Sensor Networks

Sensor Network Concept: Introduction, Networked wireless sensor devices, Advantages of Sensor networks, Applications, Key design challenges.

Network deployment: Structured versus randomized deployment, Network topology, Connectivity, Connectivity using power control, Coverage metrics, Mobile deployment.

Localization and Tracking: Issues and approaches, Problem formulations: Sensing model, collaborative localization. Coarse-grained and Fine-grained node localization, Tracking multiple objects, State space decomposition, Synchronization**,** Issues and Traditional approaches, Fine-grained clock synchronization, and Coarse-grained data synchronization.

Wireless Communications: Link quality, shadowing and fading effects.

Medium-access and sleep scheduling: Traditional MAC protocols, Energy efficiency in MAC protocols, Asynchronous sleep techniques, Sleep-scheduled techniques, and Contention-free protocols, Routing**,** Metric-based approaches, Multi-path routing, Lifetime-maximizing energy-aware routing techniques, Geographic routing.

Sensor network Databases: Data-centric routing, Data-gathering with compression, Querying, Data-centric storage and retrieval, the database perspective on sensor networks, Security**,** Privacy issues, Attacks and countermeasures.

EDET730E:Detection and Estimation Theory

Introduction: Basics of Random Signals and Probability Analysis, Introduction to Signal Estimation, Parameterized Likelihood Formulation, Optimal Estimation, Mean and Variance Characterization.

Scalar Parameter Cramer-Rao Lower Bound: CRLB Derivation, CRLB for Gaussian Estimation, Practical Example: Communication Synchronization, CRLB

Vector Parameter Cramer-Rao Lower Bound: Vector parameter estimation formulation, Brief introduction to properties of positive definite and semi definite matrices, Vector parameter CRLB derivation, CRLB for Linear estimation in White Gaussian Noise, Practical Example: Image Filtering

Maximum-Likelihood Estimation: Optimal estimators for White and Colored Noise, Examples and Applications, MLE for parameter functions, Sequential Least Squares, Expectation-Maximization Algorithm and Examples.

Bayesian Estimation: Minimum Mean Squared Estimation, Linear MMSE Approximation, Wiener and Optimal MMSE filtering, Bayesian Cramer-Rao Lower Bounds, Maximum Aposteriori Estimation.

Kalman Filtering: Introduction to State-Space Modeling, Introduction to Kalman estimation and tracking, Derivation of the Forward and Backward Scalar Kalman Filter, Extension to vector Kalman filter, Practical examples from Computer vision, robotics and Wireless Communications.

Introduction to Signal Detection: Formulation of the binary hypothesis testing problem, Maximum Likelihood based Optimal Detection, Likelihood Ratio Test and Performance,Neyman Pearson Criterion for optimal detection, Minimum probability of error detector, Bayesian minimum risk detector.

Detection of Deterministic Signals: Matched Filter Detector, Development of the optimal detector in white and colored Noise, Performance of MF detection, Multiple Hypothesis testing and asymptotic performance, Practical examples: Synchronization, Face detection, Wireless Sensor Networks etc. **Detection of Random Signals:** Introduction of Random Signal Detection, Derivation of the energy detector, EstimatorCorrelator for Arbitrary covariance based optimal detection, Performance analysis of Random signal detection, Practical examples: Cognitive radio scenarios.

Signals with unknown Parameters: Deterministic Signals with unknown parameters, Generalized Loglikelihood Ratio Test (GLRT), Bayesian Approach,Practical Examples: Sinusoidal Detection e. GLRT for the Linear Model, Asymptotic Performance of Energy Detection, Asymptotic performance of GLRT for Linear Model, Incompletely known Signal covariance based detection, Weak signal detection.

Sequential and Model Change Detection: Sequential Likelihood Ratio Test, Average number of Required Observations for Sequential Testing, Introduction to Model Change detection, Multiple Change time detection, Time varying statistics based process detection.