

ECU 201 NETWORK THEORY

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Module I (15hours)

Review of Network Theorems: Thevenin's & Norton's theorem - Superposition theorem - Maximum power transfer theorem – Reciprocity Theorem - Millman's theorem.

Introduction to Network Topology: Definition of basic terms – Incidence matrix – Tie-sets - Cut-sets: Analysis and formulation of network equations using tie-set and cut-set.

Transients in linear circuits: Initial Conditions - Zero state response - Zero input response - Complete Response – Analysis of RC and RL circuits with impressed DC voltage – RC network as differentiator and integrator - Compensated Attenuators – DC transients in RLC circuits.

Module II (15 hours)

S-Domain Analysis of Circuits - Review of Laplace transform - Transformation of a circuit into S-domain - Transformed equivalent of inductance, capacitance and mutual inductance - Impedance and admittance in the transform domain - Node analysis and mesh analysis of the transformed circuit

Network functions - Impulse response and Transfer function - Poles and Zeros – Restriction of pole and zero locations of network functions - Steady state response and Frequency response from Laplace transform - Frequency response by transform evaluation on j-axis - Frequency response from pole-zero plot by geometrical interpretation. Bode plots.

Module III (15 hours)

Two port networks: Characterization in terms of impedance - Admittance - Hybrid and transmission parameters - Inter relationships among parameter sets - Interconnection of two port networks - Series, parallel and cascade.

Symmetrical two port networks: T and π Equivalent of a two port network - Image impedance - Characteristic impedance and propagation constant of a symmetrical two port network.

Symmetrical Two Port Reactive Filters: Filter fundamentals - Pass and stop bands - Constant - k low pass filter - Constant - k high pass filter-m-derived T and π sections and their applications for infinite attenuation and filter terminations - Band pass and band elimination filters.

Module IV (11 hours)

Synthesis: Positive real functions - Driving point functions - Brune's positive real functions - Properties of positive real functions.

Testing driving point functions - Application of maximum modulus theorems - Properties of Hurwitz polynomials - Even and odd functions - Strum's theorem - Driving point synthesis - RC elementary synthesis operations - LC network synthesis - Properties of RC network functions - Foster and Cauer forms of RC and RL networks.

Text books

1. Van Valkenburg M E, *Network Analysis 3rd Edition*, Prentice Hall 1974.
2. Van Valkenberg M.E., *Introduction to Modern Network Synthesis*, John Wiley and Sons, Inc, 1960.
3. Franklin. F. Kuo, *Network Analysis and Synthesis*, II Ed, 1999, John Wiley & sons.

Reference books

1. Hayt, Kimmerly, *Engineering Circuit Analysis*, 5th Ed., McGraw Hill.
2. Desoer C.A. & Kuh E.S., *Basic Circuit Theory*, McGraw-Hill, 1985.
3. Ryder J.D., *Networks, Lines and Fields*, Prentice Hall, 2nd Ed.
4. B. P. Lathi, *Linear Systems and Signals*, Oxford University Press, 2nd Ed.
5. Roy Choudhary, *Network and Systems*, Wiley Eastern, 2nd Ed.

ECU 202 LOGIC DESIGN

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Module I (12 hours)

Basic digital circuits: Review of number systems and Boolean algebra - Simplification of functions using Karnaugh map and Quine McCluskey methods - Boolean function implementation. . Variable Entered Mapping: VEM plotting theory – VEM Reading theory – Minimization and combinational design.

Examples of useful digital circuits: Arithmetic Circuits, Comparators and parity generators, multiplexers and demultiplexers, decoders and encoders.

Module II (11 hours)

Combinational logic design: Combinational circuit design using Multiplexer, ROM, PAL, PLA.

Introduction to Sequential circuits: Latches and flip-flops (RS, JK, D, T and Master Slave) - Design of a clocked flip-flop – Flip-flop conversion - Practical clocking aspects concerning flip-flops.

Module III (12 hours)

Design and analysis of sequential circuits: General model of sequential networks - State diagrams – Analysis and design of Synchronous sequential Finite State Machine – State reduction – Minimization and design of the next state decoder.

Counters: Design of single mode counters and multimode counters – Ripple Counters – Ring Counters – Shift registers counter design.

Module IV (7 hours)

Practical design aspects: Timing and triggering considerations in the design of synchronous circuits – Set up time - Hold time – Clock skew.

Asynchronous sequential logic: Analysis and Design – Race conditions and Cycles – Hazards in combinational circuits – Hazard free realization.

Text Books

1. Roth C.H., *Fundamentals of Logic Design*, Jaico Publishers. IV Ed.
2. W. I. Fletcher, *An Engineering Approach to Digital Design*, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1980
3. Tocci, R. J. and Widner, N. S., *Digital Systems - Principles and Applications*, Prentice Hall, 7th Ed.

Reference books

1. Wakerly J F, *Digital Design: Principles and Practices*, Prentice-Hall, 2nd Ed.
2. Mano M. M., *Computer System Architecture*, Prentice Hall 1993.
3. Katz R, *Contemporary Logic Design*, Addison Wesley, 1993.
4. Lewin D. & Protheroe D., *Design of Logic Systems*, Chapman & Hall, University and Professional Division, 1992, II Ed.
5. T. L. Floyd, *Digital Fundamentals*, Prentice Hall, June 2005.

ECU 203 SOLID STATE DEVICES I

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Band theory of solids: Review of quantum mechanics - wave nature of electron - time independent Schrödinger Equation - solutions for a free electron - electron trapped in finite potential well - Heisenberg's uncertainty principle - tunneling phenomenon - Band theory of solids - Electron effective mass - E. k diagram - energy band gap- Direct and indirect band gap semiconductors. **[12 hours]**

Carrier Statistics: Charge carriers in semiconductors - Fermi Dirac statistics - intrinsic and extrinsic semiconductors - carrier transport - mobility - conductivity - carrier life time - recombination - steady state carrier generation - quasi Fermi levels diffusion of carriers - continuity equation **[10 hours]**

PN Junction: PN junction at equilibrium - Forward and reverse bias junctions - steady state conditions - forward and reverse bias- break down of junctions - transient and AC conditions - non ideal junctions - Rectifying and ohmic contacts **[8 hours]**

Bipolar junction transistor: Fundamentals of BJT operation- saturation, active and cut off characteristics - switching characteristics - characteristics- minority carrier profiles -BJT models-Frequency limitations of BJTs. **[12 hours]**

Text Books

1. Ben G Streetman , 'Solid state devices', 5ed, 2002, Pearson Education

References

1. Donald A Neaman, 'Semiconductor physics and devices', McGraw Hill, 2003
2. Sheng. S.Li, 'Semiconductor physical electronics', Plenum press, 1993
3. S.M. Sze, 'Physics of semiconductor devices', McGraw Hill, 2nd edn
4. M. S. Thyagi, Introduction to Semiconductor Materials and Devices; John Wiley and Sons

ECU204 SIGNALS AND SYSTEMS

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1 General Notions: (3 Hours)

Examples of physical systems: Biological systems, Mechanical (dynamical) systems (e.g. Automobile damping system, Market as a dynamical system, Communication system); State of a physical system, measurement of the state of a physical system, Define Signal; Energy and its manifestations - basic notion of transducers, transducers as a probe.

2(a) Classes of Signals: (3 Hours)

Sinusoidal signals, periodic signals, bounded signals, Energy limited signals, Duration limited signals.

2(b) Signal space concepts (finite dimensional vector spaces): (7 Hours)

Signal as a point in the space, orthogonality, projection and inner product, notion of root mean square value of a signal, relate to the notion of length in signal space; the idea of norm; construct norm from inner product; Introduce series representation of a point in finite dimensional signal space; the notion of convergence, the ideas of Cauchy sequence and completeness, Introduce Hilbert space, Fourier series representation of a periodic signal.

2(c) Fourier transform: (5 Hours)

Introduce the notion of mappings; Develop the general idea of integral transforms, Introduce the complex exponential as the eigenfunction of the second order differential operator (use the notion of a dynamical system), Develop the idea behind Fourier transform; Introduce square integrability (finite energy) as a sufficient condition for the existence of Fourier transform of a signal.

3(a) Linear time-invariant continuous-time systems: (9 Hours)

Input/output description, Linearity and time-invariance, Dirac Delta (as the limit of a sequence of functions), Impulse response, Causality, Convolution, Steady state and transient analysis: Revisit Fourier transform, Establish the need for Laplace transform, Revisit Laplace transform; Transfer function and frequency response, Poles, zeros and system response, Introduce the concept of feedback systems and its elementary analysis, Introduce the notion of stability.

3(b) Representation of signals: (6 Hours)

Distinguish energy signals and power signals; Lowpass, bandpass and quadrature representations; Real and Complex signals, Introduce the notion of Hilbert transform to generate complex signals.

4 Linear shift-invariant discrete-time Systems and Signals: (9 Hours)

Sampling theory, Lowpass and bandpass cases, Sampling from the perspective of signal approximation, Laurent series and the z-transform, Inverse z-transform, Relation between Laplace transform and the z-transform, Input-output description of a discrete-time system, Causality, Transient and steady-state analysis.

Text books

1. B. P. Lathi, Linear Systems and Signals, Oxford University Press, 2002.
2. Alan V. Oppenheim, Alan S. Willsky, Ian T. Young, Signals and Systems, Prentice Hall of India, New Delhi, 1994.

Reference books

1. Chi-Tsong Chen, Analog and Digital Control System Design, Saunders College Publishing/Harcourt Brace Jovanovich College Publishers, NY, 1993.
2. David K. Cheng, Analysis of Linear Systems, Narosa Publishing House, New Delhi, 1995.
3. Douglas K. Lindner, Introduction to Signals and Systems, McGraw-Hill International Edition, 1999.
4. William H. Hayt Jr., Jack E. Kemmerly, Engineering Circuit Analysis, McGraw-Hill International, 5th edition, New York, 1993.
5. David F. Tuttle, Jr., Circuits, McGraw-Hill International Student Edition, Singapore, 1977.
6. A. Papoulis, Fourier Integral and its applications, McGraw-Hill International, New York, 1962.
7. A. Papoulis, Systems and Transforms with Applications in Optics, McGraw-Hill International Edition, New York, 1968.
8. Gilbert Strang, Linear Algebra and its Applications, 3rd edn., Brooks/Cole, US, 1998.
9. Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, 1989.

ECU205 RANDOM SIGNAL THEORY

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Module 1: (11 Hours)

Probability: Set definitions, sample points and sample spaces, probability of random events, laws of probability, joint, marginal and conditional probabilities, statistical independence.

Random variables: Probability distribution functions, Discrete random variables and probability mass function, Expected values; Continuous random variables, Probability density functions, complex random variables; moments and characteristic functions.

Random vectors: Joint probability distribution functions, joint probability densities, conditional probability distributions functions, conditional probability densities, independent random variables.

Transformations (functions) of random variables: scalar valued function of one random variable, functions of several random variables.

Module 2: (12 Hours)

Random processes: (i) Definition: The concept, probabilistic structure, Classification, formal definition. (ii) Description: Joint distribution, Analytical description using random variables, Average values: mean, auto-correlation, auto-covariance, Auto-correlation coefficient, Two or more random processes: Cross-correlation function, cross-covariance function, cross-correlation coefficient.

Special classes: Gaussian, Random binary waveform.

Stationarity and correlation theory: Strict-sense stationarity, wide-sense stationarity (WSS), Auto-correlation function of real WSS random process and its properties, cross-correlation function and its properties, Power spectral density function of a WSS random process and its properties, Wiener-Khinchine theorem; low-pass and band-pass processes, power and bandwidth calculations; cross-power spectral density function and its properties; power spectral density function of random sequences.

Time averaging and ergodicity: Time averages - interpretation, mean and variance; ergodicity: general definition, ergodicity of the mean, ergodicity of the auto-correlation function, ergodicity of the power spectral density function

Module 3: (11 Hours)

Response of LTI systems to random processes: Review of deterministic system analysis - discrete and continuous; mean and auto-correlation of the output, stationarity of the output, correlation and power spectral density of the output, mean-square value of the output, multiple input-output systems; Filtered Gaussian random process.

Module 4: (8 Hours)

Noise: Sources of noise - Thermal noise, Shot noise, Flicker noise - Filtered white noise – Narrow band noise - Quadrature representation - Envelope and phase representation; Signal to noise ratio - Noise equivalent bandwidth - Effective noise temperature - Noise calculation for cascaded stages.

Text Books

1. Yannis Viniotis, Probability and Random Processes for Electrical Engineers, Mc- Graw-Hill Book Company, 1998.
2. Peyton Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, 4th edn., Tata McGraw-Hill, New Delhi, 2002.

Reference books

1. Sheldon Ross, A first Course in Probability, Prentice Hall Inc. 4th edn. 1994
2. G. R. Grimmett, D. R. Stirzaker, Probability and Random Processes, Second Edition, Oxford Science Publications, 1995.
3. Wilbur B. Davenport, Jr., Probability and Random Processes, McGraw-Hill Book Company, 1970.
4. B. Davenport, William L. Root, An introduction to the theory of random signals and noise, Wilbur McGraw-Hill Book Company, 1958.
5. Thomas E. Kurtz, Basic Statistics, Prentice-Hall of India, 1964
6. Henry Stark, John W. Woods, Probability, Random Processes and Estimation Theory for Engineers, Prentice-Hall, 1986. OR Probability and Random Processes with Applications to Signal Processing, Prentice-Hall, 2003

ECU 291 WORKSHOP

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1. Test and Measurement tips.
2. Study of Electronic components, specifications and testing.
3. Circuit assembling, testing and fault finding methods
4. PCB designing and fabrication. Use of EDA tools and PCB proto typing machines.
5. Soldering methods.
6. Connecting methods of Micro motors and stepper motors
7. Batteries
8. Safety (Static protection etc)
9. Transformer winding (signal application)

ECU 292: DEVICE CHARACTERIZATION LAB

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1. Diode characteristics: silicon and germanium diodes , zener dides, forward and reverse characteristics.
2. BJT characteristics; CB, CE and CC configurations.
3. JFET characteristics
4. Uni-junction Transistor.
5. Design of filter circuits- passive filters- Low pass, high pass and band pass filters.
6. Rectifiers- Half wave and Full wave rectifiers- Bridge rectifiers-
7. Resonance circuits- Series and parallel resonance.
8. Voltage regulators- Zener regulator- Series voltage Regulator.

ECU 206 SOLID STATE DEVICES II

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Field Effect Transistors: The Junction FET - Pinch-off and Saturation- Gate control- transfer and drain characteristics. **[4hours]**

Metal Insulator semiconductor devices: The ideal MOS capacitor - band diagrams at equilibrium, accumulation, depletion and inversion - surface potential - CV characteristics - effects of real surfaces - work function difference - interface charge - threshold voltage- MOSFET- Output characteristics - transfer characteristics - substrate bias effects - sub threshold characteristics - short channel MOSFET - MOSFET scaling **[16 hours]**

Schottky barrier devices - The MESFET – HEMT **[4 hours]**

Hetero junctions - band diagram - hetero junction bipolar junction transistor **[6hours]**

Integrated Circuits: Integrated Circuit Fabrication - Silicon planner technology - crystal growth -wafers - epitaxial growth - oxidation - deposition - masking and lithography - etching diffusion - ion implantation - metallization - isolation - testing - mounting, bonding and packaging - Fabrication of p-n junctions- NMOS, PMOS and CMOS fabrication- BJT fabrication **[12hours]**

Text Books

1. 'Solid state devices', Ben G Streetman , 5e, 2002, Pearson Education
2. VLSI Technology, 2nd edition, S M Sze.

References

1. Donald A Neaman, 'Semiconductor physics and devices', McGraw Hill, 2003
2. Sheng. S.Li, 'Semiconductor physical electronics', Plenum press, 1993
3. S.M.Sze, 'Physics of semiconductor devices', McGraw Hill, 2nd ed.
4. M. S. Thyagi, Introduction to Semiconductor Materials and Devices; John Wiley and Sons.
5. S.K. Gandhi, VLSI Fabrication Principles, John Wiley Inc., New York, 1983.

ECU 207 ELECTRONIC CIRCUITS – I

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Pre-requisite: ECU 203

Module I (11 hours) - Basic BJT amplifiers: Biasing schemes - Load line concept - Bias stabilization - Stability factor - Bias compensation - Analyses and design of CC, CE and CB configurations - RC coupled and transformer coupled multistage amplifiers – Frequency response of amplifiers – Thermal runaway in BJT amplifiers

Module II (11 hours) - Feedback and stability – Introduction to negative feedback – Basic feedback concepts – Ideal feedback topologies - Voltage shunt, Voltage series, Current series and Current shunt feedback configurations – Loop gain – Stability of feedback circuit – Bode plots – Nyquist stability criterion – Phase and gain margins – Oscillators – Basic principles of oscillators – Analysis of RC Phase Shift, Wein bridge, Colpitts, Hartley and Crystal oscillators

Module III (10 hours) - Power amplifiers - Class A, B, AB, C, D & S power amplifiers - Harmonic distortion – Conversion efficiency and relative performance - Wide band amplifiers - Broad banding techniques - Low frequency and high frequency compensation – CC–CE cascade, cascode amplifier, Darlington pair – Broad banding using inductors.

Module IV (10 hours) - FET amplifiers: Biasing of JFET - Self bias and fixed bias - Biasing of MOSFETS - Feedback biasing and fixed biasing for enhancement and depletion mode MOSFETs - Analyses and design of common source, common drain and common gate amplifier configurations – Thermal runaway in MOS amplifiers – MOS Differential amplifier - Analysis

Text Book:

1. Donald A. Neamen, Electronic Circuit Analysis and Design, MCGraw Hill ,2nd Edition, 2005.

Reference:

1. Millman & Halkias : `Integrated Electronics`, MGH, 1999.
2. A S Sedra & K C Smith : `Microelectronic Circuits`, Oxford University Press, 5th Edn., 2005.
3. D L Schilling & C Belove : `Electronic Circuits`, MGH, 3rd Edn.,1989.
4. Robert Boylestad & Louis Nashelsky : `Electronic Devices & Circuit Theory`, Pearson education, 8th Edn., 2004.
5. William H Hayt Jr : `Electronic Circuit Analysis & Design`, Jaico, 2nd Edn., 2003.
6. Theodore F Bogart : `Electronic Devices & Circuits`, Pearson Education,6th Edn., 2004.
7. Mark N Horenstein : `Microelectronic Circuits & Devices`, Prentice Hall of India, 2nd Edn., 2002.
8. Millman & Grabel : Microelectronics : MGH, 2nd Edn.,2001.
9. Richard C. Jaeger : Microelectronic circuit design, MGH,2nd Edn., 2003.

ECU 208 MICROPROCESSORS & MICRO CONTROLLERS

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Module I (8 hours)

Basic ideas of computer architecture-Design ideology of CPU and control unit-CPU Memory Interaction-memory address mapping techniques-cache

Module II (13hours)

Intel 8086 processor- Architecture — addressing modes – Instruction set – assembly Language programming – Interrupts Pin configuration of 8086 – Timing diagrams – Minimum and maximum mode – Interfacing – address decoding – Interfacing chips – Programmable peripheral interface (8255) Programmable timer (8253)- -serial communication interface (8253)

Module III (10hours)

OS concepts: General idea of operating system design principles – types of OS- Process management – Multithreaded programming - Process scheduling. Process Coordination- Synchronisation-deadlocks- Memory management

Module IV (13 hours)

Intel 8051 microcontroller –architecture –ports, timers, interrupts, serial data transmission instruction set - programming

Text Books

1. Hall D V , Microprocessors & Interfacing , Second Edition ,1991 McGraw Hill
2. Brey B B , The Intel Microprocessors, Architecture , Implementation & Programming, 2005,7th edition, McGraw Hill
3. Operating System Principles – Abraham Silberschatz &Peter B.Galvin, Wiley Asia Student Edition, Seventh Edition, 2004
4. The 8051 Microcontroller and Embedded Systems, Second Edition, 2000 – Muhammad Ali Mazidi, Janice Gillispie Mazidi –Pearson Education

ECU 209 - ELECTROMAGNETIC FIELD THEORY

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Module 1: (15 hours)

Review of Vector Calculus: Orthogonal coordinate systems, Coordinate transformation, Gradient of scalar fields, Divergence and Curl of vector fields.

Electrostatics: Coulomb's law, electric field, flux and Gauss's law, curl and divergence of electrostatic fields, electric potential, Poisson's equation, Laplace's equation, solutions to electrostatic boundary problems, method of images, work and energy in electrostatics, induced dipoles and polarization, field inside a dielectric, electric displacement, electric susceptibility, permittivity and dielectric constant, boundary conditions, capacitors, surface charge and induced charge on conductors.

Module 2: (12 hours)

Magnetostatics: Lorentz force, Biot-Savart law, magnetic flux density, divergence and curl of flux density, Ampere's law, magnetic vector potential, magnetization, torque and force on magnetic dipoles, magnetic field inside matter, magnetic field intensity, magnetic susceptibility and permeability, magnetic materials, boundary conditions

Module 3: (16 hours)

Electrodynamics: Electromagnetic induction, inductance, continuity equation, displacement current, Maxwell's equations, boundary conditions, Poynting's theorem, energy and momentum in electromagnetic field.

Electromagnetic Waves: EM waves in vacuum and in matter, monochromatic plane waves, group velocity, wave polarization, Lorentz gauge, retarded potentials,

Module 4: (13 hours)

Reflection and transmission at interfaces: Normal and Oblique incidence of uniform plane electromagnetic waves at conducting boundary, dielectric boundary

Transmission lines: Quasi-TEM analysis, characteristic impedance, standing wave ratio, impedance matching techniques, Smith Chart

Text books :

1. David J Griffiths: *Introduction to Electrodynamics*, Third edition, PHI,1999
2. David Cheng: *Field and Wave Electromagnetics*, Second edition, Pearson Education Asia, 2001

References:

1. Branko D. Popovic: *Introductory Electromagnetics*, First Edition, Prentice Hall, 1999
2. Nannapaneni Narayana Rao: *Elements of Engineering Electromagnetics*, Fifth edition, Prentice Hall, 1999
3. Matthew N. O. Sadiku: *Elements of Electromagnetics*, Fourth Edition, Oxford University Press, 2006
4. J D Krauss: *Electromagnetics*, Fourth edition, MGH, 1992
5. J D Jackson: *Classical Electrodynamics*, Third Edition, John Wiley & Sons, 2001

ECU 210 ANALOG COMMUNICATION

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Module 1. Linear modulation (11 hours)

Amplitude modulation-spectrum of AM signals-power relations. Double sideband suppressed carrier and single sideband modulation- spectrum of DSB/SC and SSB signals. Vestigial sideband modulation and spectrum.

Modulators and transmitters- product modulators, square-law modulators and balanced modulators. Generation of AM signals. Frequency translation and frequency division multiplexing. Propagation characteristics of AM signals

Module 2. Angle modulation (10 Hours)

Frequency modulation-Narrowband FM and wideband FM- spectrum of FM signals-Transmission bandwidth. Generation of FM signals- direct and indirect methods- propagation characteristics of FM. Phase modulation-relationship between FM and PM signals.

Module 3. Receivers (10 Hours)

TRF and super-heterodyne receivers- Image frequency an Inter mediate frequency- Automatic gain control-coherent detection and envelope detection of AM signals.

FM detection-Basic FM demodulators-Amplitude limiting-ratio detector-PLL for FM detection-Pre-emphasis and de-emphasis. DSB-SC and SSB demodulation.

Module 4.Noise in analog communication (11 Hours)

Noise in base-band systems-SNR at the output of a base-band system-SNR improvement. Noise in linear CW modulation systems-noise in DSB/SC and SSB systems-noise in AM systems. Noise in angle modulated systems-Output SNR in angle modulated systems- threshold effects in angle modulated systems.

Text books

1. Simon Haykin, "Communication Systems", 3rd Edition, John Wiley & Sons
2. R.E. Ziemer and W.H. Tranter, "Principles of Communication", JAICOP Publishing House
3. K. Sam Shanmugam, "Digital and Analog Communication Systems", John Wiley & Sons
4. A.Bruce Carlson, " Communication systems", third edition, MGH,

References

1. Dennis Roddy, John Coolen, "Electronic Communications", PHI 1997
2. Yannic Viniotis, "Probability for Electrical Engineers", Mc Graw Hill International
3. B.P. Lathi, "Modern Digital and Anaalog Commmunication Systems" 3rd Ed. Oxford University Press.
4. Tomasi: Electronic communication: Fundamentals through advanced, Pearson Education
5. Couch: Digital and Analog Communication Systems, Pearson Education

ECU 293 LOGIC DESIGN LAB

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1. Combinational Logic design using basic gates (Code Converters, Comparators).
2. Combinational Logic design using decoders and MUXs.
3. Arithmetic circuits - Half and full adders and subtractors.
4. Arithmetic circuits – design using adder ICs, BCD adder.
5. Flip flop circuit (RS latch, JK & master slave) using basic gates.
6. Asynchronous Counters, Johnson & Ring counters.
7. Synchronous counters.
8. Sequential Circuit designs (sequence detector circuit).
9. ADC circuits.
10. DAC circuits

ECU 294 ELECTRONICS CIRCUITS LAB

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1. Feed back voltage regulator with short circuit protection.
2. Emitter follower with & without complementary transistors – Frequency and phase response driving a capacitive load..
3. Single stage BJT amplifier
4. Two stage RC coupled amplifier – Frequency response
5. Cascode amplifier – Frequency response
6. Phase shift oscillator using BJT
7. Hartley / Colpitts oscillator using BJT.
8. Power amplifier – Class A & Class AB.
9. JFET Characteristics
10. Single stage JFET amplifier
11. UJT Characteristics and Relaxation Oscillator.
12. Tuned amplifier

ECU 301 LINEAR INTEGRATED CIRCUITS

Pre-requisite: ECU 207

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Module I (11 hours)

Review of BJT differential amplifier - active load - current mirror - various stages of an operational amplifier - simplified schematic circuit of op-amp 741 - need for compensation – dominant pole compensation - typical op-amp parameters - slew rate - power supply rejection ratio - open loop gain - unity gain bandwidth - offset current & offset voltage – Review of MOS differential amplifier - source coupled pair - current source load and cascode loads - CMOS op-amp with and without compensation

Module II (11 hours)

Linear op-amp circuits - inverting and non-inverting configurations - analysis for closed loop gain - input and output impedances - virtual short concept - current to voltage and voltage to current converters - instrumentation amplifier - nonlinear op-amp circuits - log and antilog amplifiers - 4 quadrant multipliers and dividers - phase shift and wein bridge oscillators - comparators - astable and monostable circuits - linear sweep circuits

Module III (12 hours)

Butterworth, Chebychev and Bessel approximations to ideal low pass filter characteristics - frequency transformations to obtain HPF, BPF and BEF from normalized prototype LPF - active biquad filters - LPF & HPF using Sallen-Key configuration - BPF realization using the Delyannis configuration - BEF using twin T configuration - all pass filter (first & second orders) realizations - inductance simulation using Antoniou's gyrator – Switched capacitor filter

Module IV (8 hours)

Phase Locked Loop – Block schematic and analysis of PLL – Lock range and capture range – Typical applications of PLL (eg.565) – Basic principles of operation of VCO (eg. 566) and timer (555) and their applications – Voltage regulator ICs – Fixed and adjustable (723) regulators

Text books

1. Sergio Franco, '*Design with Operational Amplifiers and Analog Integrated Circuits*', Tata McGraw Hill Book Company, 3rd Edn., 2002.
2. Jacob Baker R., Li H.W. & Boyce D.E., '*CMOS- Circuit Design, Layout & Simulation*', PHI, 2000.

Reference books

1. Gobind Daryanani, '*Principles of Active Network Synthesis & Design*', John Wiley & Sons, 2003.
2. Sedra A.S. & Smith K.C., '*Microelectronic Circuits*', Oxford University Press, 5th Edn., 2005.
3. Fiore J.M., '*Operational Amplifiers and Linear Integrated Circuits*', Jaico Publishing House, 1999.
4. Ramakant A. Gayakwad, '*Op- Amps and Linear Integrated Circuits*', Pearson Education, 1999.
5. Coughlin R.F. & Driscoll F.F., '*Operational Amplifiers and Linear Integrated Circuits*', Prentice Hall, 6th edition, 2000
6. Horenstein M.N., '*Microelectronic Circuits & Devices*', Prentice Hall of India, 2nd Edn., 2002.

ECU 302 DIGITAL COMMUNICATION

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Module I. Pulse modulation (10 hrs.)

Analog Pulse Modulation: Sampling theorem for base-band and pass-band signals, Pulse Amplitude modulation: generation and demodulation, PAM/TDM system, PPM generation and demodulation, PWM, Spectra of Pulse modulated signals, SNR calculations for pulse modulation systems.

Digital Pulse modulation: Quantization, PCM, DPCM, Delta modulation, Adaptive delta modulation- Design of typical systems and performance analysis.

Module II. Base-band communication (10 hrs.)

Signal space concepts: Geometric structure of the signal space, vector representation, distance, norm and inner product, orthogonality, Gram-Schmidt orthogonalization procedure.

Matched filter receiver, Inter symbol interference, Pulse Shaping, Nyquist criterion for zero ISI, Signaling with duobinary pulses, Eye diagram, Equalizer, Scrambling and descrambling.

Module III. Detection theory (10 hrs)

Review of Gaussian random process, Optimum threshold detection, Optimum Receiver for AWGN channel, Matched filter and Correlation receivers, Decision Procedure: Maximum a posteriori probability detector- Maximum likelihood detector, Probability of error, Bit error rate.

Module IV. Pass-band communication (12 hrs.)

Coherent Binary Schemes: ASK, FSK, PSK, MSK. Coherent M-ary Schemes, Calculation of average probability of error for different modulation schemes, Power spectra of digitally modulated signals, Performance comparison of different digital modulation schemes.

Text books

1. Communication Systems, 3rd ed., Simon Haykin, John Wiley & Sons.
2. Modern Digital and Analog Communication, 3rd Ed., B.P. Lathi, Oxford University Press.
3. Sklar: Digital Communication, 2nd Ed, Pearson Education.

References

1. Digital and Analog Communication Systems, K.Sam Shanmugham, John Wiley & Sons
2. Principles of Communications, R.E. Ziemer and W.H. Tranter, JAICO Publishing House.
3. Principles of Communication Systems, H.Taub and Schilling, TMH
4. Digital Communications, John G.Proakis, McGraw Hill.
5. Fundamental Concepts in Communication, Pierre Lafrance, Prentice Hall India.
6. Couch: Analog and Digital Communication.

ECU 303 DIGITAL SIGNAL PROCESSING

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Pre-requisites: ECU204, ECU205

1. Fourier analysis of discrete-time signals and systems: (9 Hours)

Discrete Fourier Series, Discrete Time Fourier Transform, Discrete Fourier Transform - Properties; Approximation of Fourier transform through DFT, Fast algorithms for DFT: The FFT algorithm - Prime factor algorithms, Convolution; Linear and circular convolution, Practical computation, Overlap save and overlap add methods, Short time Fourier transform.

2. Digital filters: (9 Hours)

FIR Filters: Impulse response, Transfer function, Linear phase properties, Design: window based design, frequency sampling design, minimax design.

IIR Filters: Impulse response, Transfer function, Pole-zero representation; Butterworth, Chebyshev, inverse Chebyshev and elliptic filter concepts, Approximation problem for IIR filter design: Impulse in variance method, Bilinear transform method, Matched z-transform method, Minimum mean squared error method; Frequency transformations.

3. Least squares filter design: (8 Hours)

Deterministic least squares: whitening problem: FIR case; Signal modelling: Spectral factorization
Statistical least squares: Non-causal case, FIR case, Causal IIR case, Adaptive filtering: concepts and algorithms

4(a) Internal descriptions of digital filters: (8 Hours)

Signal flow graphs, State variable descriptions, State variable descriptions from primitive signal flow graphs, Transfer function from state variable descriptions, difference equation from state variable description, Co-ordinate transformation, Poles, zeros and the state variable description.

4(b) Finite length register effects: (8 Hours)

Limit cycles, overflow oscillations, state variable model for overflow, round-off noise in IIR digital filters, computational output roundoff noise, methods to prevent overflow, scaling rules, and scaling operations, scaling state variable description, trade off between round off and overflow noise, measurement of coefficient quantization effects through pole-zero movement, dead band effects, constant input limit cycles.

Text Books

1. Boaz Porat, A course in Digital Signal Processing, Prentice Hall Inc, 1998.
2. Mitra S. K., Digital Signal Processing : A Computer Based Approach, McGraw-Hill Publishing company, 1998.
3. Richard A. Roberts, Clifford T. Mullis, Digital Signal Processing, Addison-Wesley Publishing Company, 1987.

Reference books

1. Oppenheim A. V., Schafer R. W., Discrete-Time Signal Processing, Prentice Hall India, 1996.
2. Chi-Tsong Chen, Digital Signal Processing: Spectral Computation and Filter Design, Oxford University Press, 2001.
3. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall of India Pvt. Ltd., 1997.
4. Lonnie C. Ludeman, Fundamentals of Digital Signal Processing, John Wiley & Sons, NY, 1986.
5. R. E. Bogner, A. G. Constantinidis, (Editors), Introduction to Digital Filtering, John Wiley & Sons, NY, 1975.
6. Emmanuel C. Ifeachor, Barry W. Jervis, Digital Signal Processing: A Practical Approach, 2nd edn., Pearson Education, 2004.

ECU 304 ELECTRONIC CIRCUITS – II

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Pre-requisites: ECU 203, ECU 206

Module I (10 hours)

Basic BJT Differential amplifier – DC transfer characteristics – Small signal equivalent circuit analysis – Load line analysis – Differential and Common mode gain – Concept of CMRR – Methods to improve CMRR – Constant current source – Differential and Common mode input impedances - Differential and Common mode frequency response – Emitter degeneration resistor

Module II (10 hours)

Switching characteristics of a BJT - BJT switches with inductive and capacitive loads - Non saturating switches - Astable, monostable and bistable multivibrators using BJT and negative resistance devices - Voltage and current time base generators - Miller & bootstrap configurations

Module III (11 hours)

Logic families - Fundamentals of RTL, DTL and ECL gates - TTL logic family - TTL transfer characteristics - TTL input and output characteristics - Tristate logic – Wired logic and bus oriented structure – Practical aspects - Shottkey and other TTL gates - MOS gates - MOS inverter - CMOS inverter - Rise and fall time in MOS and CMOS gates - Speed power product - Interfacing BJT and CMOS gates

Module IV (11 hours)

Digital to analog converters - R-2R ladder - Binary weighted - Current steering - Charge scaling - Cyclic & pipeline DACs - Accuracy - Resolution - Conversion speed - Offset error - Gain error - Integral and differential nonlinearity - Analog to digital converters – Track and hold operation - Track and hold errors - ADC conversion techniques - Flash converter - Two step flash - Pipeline – Integrating - Staircase converter - Successive approximation converter - Dual slope & oversampling ADCs - Sigma - Delta ADC

Text Book:

1. Donald A. Neamen, Electronic Circuit Analysis and Design, MCGraw Hill, 2nd Edition, 2005.
2. Jacob Millman & Herbert Taub: Pulse, Digital & Switching Waveforms, TMGH, 2005.
3. R Jacob Baker et al: CMOS – Circuit Design, Layout and Simulation, PHI, 2000.

Reference:

1. A S Sedra & K C Smith : 'Microelectronic Circuits', Oxford University Press, 5th Edn., 2005.
2. Taub & Schilling: Digital Integrated Electronics, MGH,1998.
3. Millman & Halkias : 'Integrated Electronics', MGH, 1999.
4. Robert Boylestad & Louis Nashelsky : 'Electronic Devices & Circuit Theory', Pearson education, 8th Edn., 2004.
5. Theodore F Bogart : 'Electronic Devices & Circuits', Pearson Education,6th Edn., 2004.
6. Bell David A: Solid State Pulse Circuits, Reston Publishing Company, PHI, 4th Edn., 2005.
7. D L Schilling & C Below : 'Electronic Circuits', MGH. 3rd Edn.,1989.

ECU391 MICROPROCESSORS AND MICROCONTROLLERS LAB

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- I. Assembly language programming of 8086
 - a) Sorting , code conversion, Pascal's triangle
 - b) Matrix multiplication
 - c) TSR programming
- II. Assembly language programming of the 8051
- III Interfacing experiments of 8051
 - a) Stepper motor interface
 - b) Display card interface
 - c) Hex key board interface
 - d) Parallel port interface (square wave generation)
 - e) ADC/DAC interface
 - f) Counter and timer interface (polling and using interrupts)
- IV .Project design and implementation

ECU 392: ANALOG COMMUNICATION LAB

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- 1. AM generation
- 2. AM detection with simple and delayed AGC
- 3. DSB/SC generation
- 4. RF Mixer using JFET/BJT
- 5. Implementation of intermediate frequency amplifier
- 6. FM generation (reactance modulator)
- 7. FM demodulation
- 8. PAM generation and demodulation
- 9. Generation and demodulation of PWM and PPM
- 10. PLL characteristics and FM modulation/demodulation using PLL

ECU 305 MICROWAVE DEVICES & CIRCUITS

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Pre-requisite: ECU 209

Modal analysis of rectangular and circular metallic waveguides– TE and TM modes, guide wavelength, cut-off, mode excitation, re-entrant cavity, Microwave Resonators – analysis, Q factor of resonators, Strip lines and microstrip lines – analysis, filter implementation with transmission lines and strip lines (10 hours)

Passive microwave components – S matrix formalism, directional coupler, waveguide tees, isolator, circulator, phase shifter, impedance matching – single stub and double stub (8 hours)

Vacuum tube microwave devices – Klystron - velocity modulation and bunching, Reflex klystron, traveling wave tube - slow wave structure and Brillouin diagram. (8 hours)

Semiconductor microwave devices – tunnel diode, Gunn diode, IMPATT diode, TRAPATT diode, heterojunction bipolar transistors – principle, characteristics, noise figure (8 hours)

Low noise microwave amplifiers and oscillators – masers – stimulated emission, noise figure, parametric amplifiers – Manley Rowe relations, up, down and negative resistance parametric amplifier (8 hours)

Reference

1. Rajeshwari Chatterji: Microwave, Millimeter wave and sub-millimeter wave vacuum electron devices, Affiliated East - West Press, 1994
2. R E Collin: Foundations for Microwave Engineering, Second Ed, IEEE-Wiley, 2000
3. David M Pozar: Microwave Engineering, Third edition, John Wiley, 2004
4. A S Gilmour: Microwave Tubes, Artech House, 1986
5. P A Rizzi: Microwave Engineering, Prentice Hall, 1988.
6. Sigfrid Yngyesson: Microwave Semiconductor Devices, Kluwer Academic.
7. Stephen C. C. Harsany: 'Principles of Microwave Technology', Prentice Hall, 1997

ECU 306 INFORMATION THEORY & CODING

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Prerequisite: ECU 205

Entropy and Loss less Source Coding: Entropy of a source- Properties- Entropy of a discrete Random variable- Joint, conditional and relative entropy- Mutual Information- Loss less Source Coding- Variable length coding- Uniquely decodable codes- Instantaneous codes- Kraft's inequality- Huffman coding; Shannon's Source Coding Theorem. [10 hrs]

Channel Capacity and Coding Theorem: Channel Capacity- Capacity computation for simple channels- Shannon's Channel Coding Theorem and its proof; Converse of Channel Coding Theorem- Continuous Sources and Channels: Differential Entropy- Mutual information- Waveform channels- Gaussian channels- Mutual information and Capacity calculation for Band limited Gaussian channels- Shannon limit. [12 hrs]

Channel Coding: Introduction- Characteristics of Finite fields- Construction and basic properties of Finite Fields- Computations using Galois Field arithmetic- Vector spaces- Linear independence- Linear Block codes- properties- Error detection and correction- Standard Array and Syndrome decoding- Cyclic codes – Construction- decoding- BCH codes – Construction- decoding - Reed Solomon codes- Convolutional codes – distance properties -Maximum likelihood decoding - Viterbi decoding. [14 hrs]

Modulation and Coding trade-off: Introductory Concepts- Bandwidth-Efficiency –plane- Case study of M-ary signaling- bandwidth limited systems; power limited systems; bandwidth efficient modulation schemes. [6hrs]

Text Books:

1. T. Cover and Thomas, "Elements of Information Theory", John Wiley & Sons 1991.
2. W.C. Huffman and Vera Pless, "Fundamentals of Error correcting codes", Cambridge University Press, 2003.
3. Norman Abramson, Information Theory, John Wiley

Reference Text books

1. Robert Gallager, "Information Theory and Reliable Communication", John Wiley & Sons, 1968.
2. Shu Lin and Daniel J. Costello Jr., "Error Control Coding: Fundamentals and applications", Prentice Hall Inc, 1983.
3. Sklar, ' Digital Communication', Pearson Education, second ed; 2001.

ECU307 CONTROL SYSTEMS

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Prerequisite: ECU 204

Module I (10 hours)

General schematic diagram of control systems - open loop and closed loop systems – concept of feedback - modeling of continuous time systems – Review of Laplace transform - transfer function - block diagrams – signal flow graph - mason's gain formula - block diagram reduction using direct techniques and signal flow graphs - examples - derivation of transfer function of simple systems from physical relations - low pass RC filter - RLC series network - spring mass damper

Module II (11 hours)

Analysis of continuous time systems - time domain solution of first order systems – time constant - time domain solution of second order systems - determination of response for standard inputs using transfer functions - steady state error - concept of stability - Routh- Hurwitz techniques - construction of bode diagrams - phase margin - gain margin - construction of root locus - polar plots and theory of nyquist criterion - theory of lag, lead and lag-lead compensators

Module III (11 hours)

Basic elements of a discrete time control system - sampling - sample and hold - Examples of sampled data systems – pulse transfer function - Review of Z-transforms - system function - mapping between s plane and z plane - analysis of discrete time systems – examples - stability - Jury's criterion - bilinear transformation – stability analysis after bilinear transformation - Routh-Hurwitz techniques - construction of bode diagrams - phase margin - gain margin - digital redesign of continuous time systems

Module IV (9 hours)

Introduction to the state variable concept - state space models - phase variable and diagonal forms from time domain - diagonalization - solution of state equations - homogenous and non homogenous cases - properties of state transition matrix - state space representation of discrete time systems - solution techniques - relation between transfer function and state space models for continuous and discrete cases - relation between poles and Eigen values – Controllability and observability

Reference books

1. Ziemer R.E., Tranter W.H. & Fannin D.R., "*Signals and Systems*", Fourth Edition, Pearson Education Asia, 1998
2. Ogata K., "*Modern Control Engineering*", Prentice Hall India, 1994
3. Dorf R.C. & Bishop R.H., "*Modern Control Systems*", Ninth Edition, Addison Wesley, 2001
4. Kuo B.C., "*Digital Control Systems*", Second Edition, Oxford University Press, 1992
5. Ogata K., "*Discrete Time Control Systems*", Pearson Education, 2001
6. Nagarath I.J. & Gopal M., "*Control System Engineering*", Wiley Eastern Ltd, 1995

ECU 308 COMPUTER NETWORKS

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Introduction: Building blocks- links, nodes; Layering and protocols; OSI architecture; Internet architecture; Multiplexing; Circuit switching vs packet switching. (4hrs)

Direct link Networks: Framing; Error detection; Reliable transmission; Multiple access protocols; Ethernet (IEEE 802.3); Token Rings (IEEE 802.5 & FDDI); wireless LAN (IEEE 802.11). (6hrs)

Packet switching: Switching & forwarding; Datagram Networks; Virtual Circuit networks; Bridges and LAN switches; ATM networks. (6hrs)

Internetworking: IPv4- addressing, datagram forwarding, ARP; Routing- distance vector (RIP), Link state (OSPF), routing for mobile hosts; Global Internet- subnetting, CIDR, inter-domain routing (BGP), IPv6. (9hrs)

End to End protocols: Simple demultiplexer (UDP); Reliable byte stream (TCP)- segment format, connection management, sliding window, flow control, adaptive retransmission, congestion control, TCP extension, performance. (9hrs)

Broadband services and QoS issues: Quality of Service issues in networks- Integrated service architecture- Queuing Disciplines- Weighted Fair Queuing- Random Early Detection- Differentiated Services- Protocols for QoS support- Resource reservation-RSVP- Multi protocol Label switching- Real Time transport protocol. (8hrs)

Textbook:

1. Peterson L.L. & Davie B.S., "Computer Networks: A System Approach", Morgan Kaufman Publishers, 3rd edition, 2003.

References:

1. James. F. Kurose and Keith.W. Ross, "Computer Networks, A top-down approach featuring the Internet", Addison Wesley, 3rd edition, 2005.
2. D. Bertsekas and R. Gallager, "Data Networks", PHI, 2nd edition, 2000.
3. S. Keshav, "An Engineering Approach to Computer Networking", Addison Wesley, 1st edition, 1997.

ECU 393 LINEAR INTEGRATED CIRCUITS LAB

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1. Characteristics of TTL gates
2. Measurement of op-amp parameters - CMRR, slew rate, open loop gain, input and output impedances
3. Inverting and non-inverting amplifiers, integrators and differentiators – frequency response
4. Instrumentation amplifier - gain, CMRR and input impedance
5. Single op-amp second order LPF and HPF - Sallen-Key configuration
6. Narrow band active BPF - Delyiannis configuration
7. Active notch filter realization using op-amps
8. Wein bridge oscillator with amplitude stabilization using op-amp
9. Astable and monostable multivibrators using op-amps
10. Square, triangular and ramp generation using op-amps
11. Astable, monostable multivibrators and sweep generator using IC 555
10. Design of PLL for given lock and capture ranges & frequency multiplication
11. Precision limiters using op-amps.

ECU394 SIGNAL PROCESSING LAB

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Pre-requisites: MATLAB, C/C++, ECU 208

Module 1: Simulation Experiments (using MATLAB, C/C++)

Experiments involving concepts from FFT - Windowing Techniques - Aliasing effects – Filter Design - DTMF generation and detection - Adaptive processing - Multirate processing and echo cancellation - Error correction coding - Modulation and demodulation and line coding with carrier recovery.

Module 2: Hardware Experiments (using assembly/C/C++/MATLAB)

Interface to DSP kit (TMS 320C6711 or similar - Application oriented experiments like FSK, DPSK - Modem and signal compression algorithms.

ECU 401 ELECTRONIC INSTRUMENTATION

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Measurement of voltage, current, power, noise, resistance, capacitance, inductance, time, frequency, charge and pulse energy (14 hours)

Designing for EMC - EMC regulations, typical noise path, methods of noise coupling, methods of reducing interference in electronic systems. (7 hours)

Capacitive coupling, inductive coupling, effect of shield on capacitive and inductive coupling, effect of shield on magnetic coupling, magnetic coupling between shield and inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, shielding properties of various cable configurations, coaxial cable versus shielded twisted pair, braided shields, ribbon cables. (7 hours)

Safety grounds, signal grounds, single-point ground systems, multipoint-point ground systems, hybrid grounds, functional ground layout, practical low frequency grounding, hardware grounds, grounding of cable shields, ground loops, shield grounding at high frequencies, guarded instruments. (7 hours)

Protection Against Electrostatic Discharges: Static generation, human body model, static discharge, ESD protection in equipment design (7 hours)

Reference

1. Electronic Instrument handbook: Clyde F Jr Coombs, Amazon, 1999
2. Joseph J. Carr: Elements of Electronic Instrumentation and Measurements, 3rd Ed, Prentice Hall, 1995
3. Kim R. Fowler: Electronic Instrument Design, Oxford University Press, 1996.
4. Henry W.Ott : Noise Reduction Techniques in Electronic Systems, 2nd Ed; John Wiley & Sons, 1988.

ECU 492 DIGITAL COMMUNICATION LAB

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1. Pulse code modulation
2. Delta modulation
3. Manchester encoder and timing recovery
4. Linear block codes-generation and detection
5. Cyclic encoder and decoder
6. BPSK generation and detection
7. Differential encoder and decoder
8. Digital microwave links
9. Digital TDM
10. CDMA spreader and despreader

ECU 321 TELEVISION ENGINEERING

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Module I (10 hours)

Principles of television - image continuity - interlaced scanning - blanking - synchronizing - video and sound signal modulation - channel bandwidth - vestigial sideband transmission – television signal propagation –antennas.

VSB correction - positive and negative modulation - transmitter block diagram- CCD camera

Module II (12 hours)

Television receiver circuits – IF section, video detector-video amplifiers-AGC ,Sync processing and AFC- Horizontal and vertical deflection circuits –sound section-tuner .

Module III(12 hours)

Colour TV - Colour perception - luminance, hue and saturation - colour TV camera and picture tube - colour signal transmission - bandwidth - modulation - formation of chrominance signal - principles of NTSC, PAL and SECAM coder and decoder

Module III (8 hours)

Digital TV - composite digital standards - 4 f sc NTSC standard - general specifications - sampling structure - digital transmission

Cable TV - cable frequencies - co-axial cable for CATV - cable distribution system - cable decoders - wave traps and scrambling methods

Text books

1. Gulati R.R., *Modern Television Engineering*, Wiley Eastern Ltd.
2. Michael Robin & Michael Poulin, *Digital Television Fundamentals*, McGraw Hill
3. Bernard Grob & Charles E. Herndon, *Basic Television and Video Systems*, McGraw Hill International

Reference books

1. Dhake A.M., *Television Engineering*, Tata McGraw Hill
2. Damacher P., *Digital Broadcasting*, IEE Telecommunications Series

ECU 322 COMPUTER ARCHITECTURE

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Pre-requisite: ECU 202

Module 1: (10 hours) Introduction to Processor Architecture – Design Methodology- System Representation – Gate level – Register level – Processor level – CPU Organization – Data Representation – Basic Formats – Fixed Point Numbers – Floating Point Numbers – Instruction Sets – Instruction Formats – Instruction Types – Programming Considerations.

Module II: (12 hours) Datapath Design – Fixed Point Arithmetic – Addition and Subtraction – Multiplication – Division – Arithmetic Logic Units – Combinational ALUs – Sequential ALUs – Floating Point Arithmetic – Pipeline Processing – Control Design : Basic Concepts – Introduction – Hardwired Control – Design Examples – Microprogrammed Control – Basic Concepts – Multiplier Control Unit – CPU Control Unit – Pipeline Control – Instruction Pipelines – Pipeline Performance – Superscalar Processing

Module III: (10 hours) Memory Organisation – Memory Hierarchy – Main memory – RAM and ROM chips – Memory Address Map – Memory Connection to CPU – Auxiliary Memory – Magnetic disks – Magnetic Tape – Associative Memory – Hardware Organization - Read Operation – Write Operation – Cache Memory : Associative Mapping – Direct Mapping – Set Associative Mapping –Virtual Memory – Address Space and Memory Space – Address Mapping Using Pages – Associative Memory Page Table – Page Replacement – Memory Management Hardware – Segmented Page Mapping

Module IV: (10 hours) System Organization – Communication Methods – Basic Concepts – Bus Control – I/O and System Control – I/O Organization – Isolated Versus Memory Mapped I/O - Programmed I/O – DMA and Interrupts – I/O Processors – Operating Systems – Parallel Processing – Processor Level Parallelism – Multiprocessors – Fault Tolerance.

Text Books

1. John.P.Hayes “Computer Architecture and Organization”, McGraw-Hill International Editions, Computer Science Series.
2. Morris Mano “Computer System Architecture”, Prentice-Hall India, Eastern Economy Edition.

References

1. Carl Hamacher, Zvonko Vranesic & Safwat Zaky, “Computer Organization”, Mc Graw Hill.
2. Pal Choudhuri P., "*Computer Organization and Design*", Prentice-Hall India
3. Patterson D.A. & Hennessy J.L., "*Computer Organization and Design*", Morgan Kaufmann Publishers
4. William Stallings, "*Computer Organization and Architecture*", Pearson Education

ECU 323: POWER ELECTRONICS

Pre-requisite: ECU 201

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Module I

(10 hours)

Power diodes - basic structure and V-I characteristics - various types - power transistors - BJT, MOSFET and IGBT - basic structure and V-I characteristics - thyristors - basic structure - static and dynamic characteristics - device specifications and ratings - methods of turning on - gate triggering circuit using UJT - methods of turning off - commutation circuits - TRIAC

Module II

(10 hours)

Line frequency phase controlled rectifiers using SCR - single phase rectifier with R and RL loads - half controlled and fully controlled converters with continuous and constant currents - SCR inverters - circuits for single phase inverters - series, parallel and bridge inverters - pulse width modulated inverters - basic circuit operation

Module III

(10 hours)

AC regulators - single phase ac regulator with R and RL loads - sequence control of ac regulators - cycloconverter - basic principle of operation - single phase to single phase cycloconverter - choppers - principle of operation - step-up and step-down choppers - speed control of DC motors and induction motors

Module IV

(12 hours)

Switching regulators - buck regulators - boost regulators - buck-boost regulators - cuk regulators - switched mode power supply - principle of operation and analysis - comparison with linear power supply - uninterruptible power supply - basic circuit operation - different configurations - characteristics and applications

Text/Reference books

1. Ned Mohan et.al, *Power Electronics*, John Wiley and Sons, 1989
2. Sen P.C., *Power Electronics*, Tata Mc Graw Hill, 2003
3. Rashid, *Power Electronics*, Prentice Hall India, 1993
4. G.K. Dubey et.al, *Thyristorised Power Controllers*, Wiley & Sons, 2001
5. Dewan & Straughen, *Power Semiconductor Circuits*, Wiley & Sons, 1984
6. Singh M.D & Khanchandani K.B., *Power Electronics*, Tata Mc Graw Hill, 1998

ECU 324: MICROELECTRONICS TECHNOLOGY

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Pre-requisite: ECU 201

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| Material properties-planes and directions- Orientation dependent properties of Silicon | [6hours] |
| Crystal growth-Bridgmann Technique- CZ process- Float-zone process | [4hours] |
| Epitaxy : Vapour phase Epitaxy- impurity redistribution- doping during Epitaxy | [4hours] |
| Oxidation :.Kinetics of Silicon dioxide growth -orientation Dependant effects | [4hours] |
| Diffusion :modeling and technology; Ion Implantation modeling, damage annealing | [6hours] |
| Lithography: Photo Lithography; E-beam lithography | [5hours] |
| Etching- Wet etching- Plasma etching and RIE techniques | [5hours] |
| Metal interconnects; Multi-level metallization schemes. | [4hours] |
| Process integration-NMOS, CMOS and Bipolar process. | [4hours] |

Text Books

1. S.K. Ghandhi, VLSI Fabrication Principles, John Wiley Inc., New York, 1983.
2. S.M. Sze (Ed), VLSI Technology, 2nd Edition, McGraw Hill, 1988.

References

1. C.Y. Chang and S.M.Sze (Ed), ULSI Technology, McGraw Hill Companies Inc, 1996.
2. James Plummer, M. Deal and P. Griffin, Silicon VLSI Technology, Prentice Hall Electronics and VLSI series, 2000
3. Stephen Campbell, The Science and Engineering of Microelectronics, Oxford University Press, 1996

ECU 325 MODELLING AND TESTING OF DIGITAL SYSTEMS

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Pre-requisite: ECU 202

Module 1 (12 Hours)

Introduction to HDL based Digital Design: – Basic VHDL terminology – basic language elements – Data objects and types – Behavioural modelling – Process constructs – Complex signal assignments – Dataflow modelling – delay models – Structural modelling – resolving signal values

Module 2 (12 Hours)

Advanced VHDL features: Generics and Configurations – Subprograms and Overloading – Packages and Libraries – Advanced features – simulation semantics – modelling examples – state machine modelling using VHDL- review of FPGA architectures and design using FPGA. Practical design exercises on VHDL simulator /synthesizer

Module 3 (10 Hours)

Digital System Testing: Fault models – fault equivalence – fault location fault dominance – single and multiple stuck faults – Testing for single stuck faults – Algorithms – random test generation – Testing for bridging faults

Module 4 (8 Hours)

Design for Testability: Ad-hoc design for testability techniques – Classical scan designs – Boundary scan standards – Built-in-self-test – Test pattern generation – BIST architecture examples

Textbooks

1. J. Bhasker; A VHDL Primer, Addison-Wesley, Third Edition
2. J. Bhasker; A VHDL Synthesis Primer, B.S. Publications 2001
3. Miron Abramovici et. al. Digital System Testing and Testable Design, Jaico Publishing House, 2001
4. Parag K. Lala, Digital Circuit Testing and Testability, Academic Press 1997
5. Charles H. Roth Jr; Digital System Design Using VHDL, PWS Pub. Co., 1998

ECU 331 DESIGN OF VLSI SYSTEMS

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Pre-requisite: ECU 202

Module 1(8 hours):

Integrated circuit layers - CMOS layers – stick diagram – layout of basic structures – design rules – designing FET arrays – wires and vias – cell concepts

Module 2(13 hours):

Interconnect – metal and poly silicon – parasitic estimation – resistance and capacitance – electrical wire models – lumped and distributed models – transmission line model -wire length design – interconnect layer sizing and scaling – packages - I/O circuits - floor planning and routing – power distribution design – clocking and timing issues

Module 3(10 hours):

Data path design – memory – control logic – system considerations – programmable logic – cell based design – standard, compiled and macro cells - array based design – pre diffused and pre wired arrays - low power and high speed design

Module 4(11 hours):

Introduction to CAD systems – logic and switch simulation – timing analysis and optimization – logic synthesis – hardware description languages – behavioral and structural models - RTL design – design verification – CMOS testing – test generation methods

Reference

1. Wayne Wolf, *Modern VLSI Design system on chip design*, Prentice Hall of India, Third Edition 2005
2. John P.Uyemura, *Introduction to VLSI Circuits and Systems*, John Wiley & Sons, 2002
3. Neil H. E. Weste and David Harris, *Principles of CMOS VLSI Design*, Second edition Pearson education, 2005

ECU 332 DIGITAL INTEGRATED CIRCUITS

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Pre-requisites: ECU 202, ECU 203, ECU 206

Module 1(10 hours):

MOS capacitor – MOSFET – threshold voltage – body effect – unified current model – switch model – MOSFET capacitances – scaling and short channel effects – latch up - MOS inverters – active and passive load inverter configurations

Module 2(8 hours):

CMOS inverter – DC characteristics – switching characteristics – output capacitance - power consumption – supply voltage scaling – inverter chain delay optimization – CMOS ring oscillator - tri state inverter

Module 3(13 hours):

Complementary CMOS circuits – basic gate design and performance analysis – method of logical effort - ratioed logic – pass transistor and transmission gate logic – dynamic CMOS design and issues – domino – NORA logic– sequential circuits – C²MOS circuits - TSPC logic

Module 4(11 hours):

General VLSI system components - Arithmetic and logic circuits – circuit design and logic design – memory design – SRAM and DRAM – BiCMOS inverter – BiCMOS switching characteristics – basic gates using BiCMOS logic – low power design techniques

Reference Books:

1. Sung-Mo Kang & Yusuf Leblebici, *CMOS Digital Integrated Circuits - Analysis & Design*, Third edition, Tata McGraw Hill, 2003
2. Jan M Rabaey, *Digital Integrated Circuits - A Design Perspective*, Second edition, Prentice Hall of India, 2005
3. Ken Martin, *Digital Integrated Circuit Design*, First Indian edition, Oxford Univ. Press, 2004
4. Jacob Baker R., Harry W Li & David E Boyce, *CMOS - Circuit Design, Layout & Simulation*, PHI, 2005

ECU 333 WIRELESS AND MOBILE COMMUNICATION

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Pre-requisite: ECU302

Module I (11 hours)

Mobile radio propagation - free space propagation model - ground reflection model – large scale path loss - small scale fading and multipath propagation - impulse response model of a multipath channel - parameters of a mobile multipath channel - multipath delay spread - doppler spread - coherence band width - coherence time - time dispersion and frequency selective fading - frequency dispersion and time selective fading - concepts of level crossing rate and average fade duration

Module II (11 hours)

Digital communication through fading multipath channels - frequency non selective, slowly fading channels - frequency selective, slowly fading channels- calculation of error probabilities - tapped delay line model - the RAKE receiver performance – diversity techniques for mobile wireless radio systems concept of diversity branch and signal paths -combining methods - selective diversity combining - pre-detection and post detection combining - switched combining - maximal ratio combining- equal gain combining

Module III (10 hours)

Cellular concept - frequency reuse – cochannel interference - adjacent channel interference -power control for reducing interference - improving capacity in cellular systems – cell splitting - sectoring - hand off strategies - channel assignment strategies - call blocking in cellular networks

Module IV (10 hours)

Fundamental concepts of spread spectrum systems - pseudo noise sequence - performance of direct sequence spread spectrum systems - analysis of direct sequence spread spectrum systems - the processing gain and anti jamming margin - frequency hopped spread spectrum systems - time hopped spread spectrum systems - synchronization of spread spectrum systems

Text books

1. Kamilo Feher, '*Wireless Digital Communications*', PHI
2. Rapport T.S., '*Wireless Communications, Principles and Practice*', PHI
3. Lee W.C.Y., '*Mobile Cellular Telecommunication*', MGH
4. Proakis J.G., '*Digital Communications*', third edition, MGH

ECU 334 - ACTIVE NETWORK SYNTHESIS

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Pre-requisites: ECU 201, ECU 301

Network functions - Frequency and impedance denormalization - Types of filters (filter magnitude specs, phase specs, second-order filter functions) - Butterworth, Chebyshev, Elliptic and Bessel filters - Sensitivity - Definition and basic properties - Function sensitivity - Coefficient sensitivity - Q and ω_0 sensitivity (10 hours)

Amplifiers and fundamental active building blocks - Opamps, OTAs, CCII, Integrators, gyrators and immittance converters (9 hours)

Second-order filters - Single-amplifier RC biquads - Multiple amplifier biquads (Kerwin-Huelsman-Newcomb filter, Tow-Thomas filter, Akerberg-Mossberg filter) - Biquads based on general impedance converter - OTA-based (two-integrator loop) filters - effects of active nonidealities (9 hours)

Higher order filter realization - Cascade realizations, pole-zero pairing - Multiple-loop feedback realizations - LC ladder simulations (6 hours)

Fully integrated high-frequency filter realisations - Transconductance filters - Log-domain filters - Switched-capacitor filters (8 hours)

Reference

1. P V Ananda Mohan: Current mode VLSI Analog filters; Springer, 2004
2. Gobind Daryanani: Principles of Active Network Synthesis and Design, John Wiley, 1978
3. M E Van Valkenberg: Analog Filter Design; Oxford Univ Press, 1995
4. Sedra & Brackett: Filter theory & Design – Active & Passive; Matrix Publishers, 1978

ECU 335 EMBEDDED SYSTEMS

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Pre-requisites: ECU 208

Module 1: Microcontrollers (10 hours)

Study of the PIC microcontroller architecture and programming.

Module 2: Introduction to Embedded Systems (12 hours)

Characteristics of Embedded systems, Software embedded into a system-General ideas of Processor and Memory organization - Processor and memory selection, Interfacing to Memory and I/O devices- Devices and Buses- Device Drivers and Interrupt Servicing mechanisms –special requirement of real Time Operating Systems

Module 3:(10 hours) The ARM processor – architecture – applications

Module 4: (10 hours)

Study of VX works - Case Studies of programming with RTOS - Case study /design using ARM processor/PIC microcontroller

Text Books:

1. “Embedded Systems Architecture; Programming and Design”; Rajkamal Tata McGraw Hill Publications.,2004
2. ARM System –on-chip ,Steve Farber ,Second Edition,2000 Pearson Education
3. Embedded /Real-Time systems :Concepts ,Design &Programming:Dr K.V.K.K..Prasad, DreamTech Publishers.,2004
4. VxWorks Programmers guide
5. VxWorks Reference manual
6. Microchip Manual for PIC 18F 452

ECU 336 MULTIRATE SYSTEMS

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Pre-requisites: ECU 303, MAU 102

1. Multirate System Fundamentals (12 hours)

Sampling theorem: Sub-Nyquist sampling, generalization; Basic multirate operations: up sampling and down sampling - time domain and frequency domain analysis; Identities of multirate operations; Interpolator and decimator design; Rate conversion; Polyphase representation of signals and systems; uniform DFT filter bank, decimated uniform DFT filter bank – polyphase representation.

2. Multirate Filter Banks (10 hours)

Maximally decimated filter banks: Quadrature mirror filter (QMF) banks - Polyphase representation, Errors in the QMF - Aliasing and imaging; Methods of cancelling aliasing error, Amplitude and phase distortions; Perfect reconstruction (PR) QMF bank - PR condition; Design of an alias free QMF bank; Power symmetry in QMF bank.

3. M-channel Perfect Reconstruction Filter Banks (10 hours)

Filter banks with equal pass bandwidth, filter banks with unequal pass bandwidth – Errors created by the filter banks system - Aliasing and imaging - Amplitude and phase distortion, polyphase representation - polyphase matrix. Perfect reconstruction system - Necessary and sufficient condition for perfect reconstruction, FIR PR systems, Factorization of polyphase matrices, Design of PR systems, Calculation of sub-band coding gain.

4. Linear Phase Perfect Reconstruction (LPPR) Filter Banks (10 hours)

Necessary conditions for linear phase property; Lattice structures for LPPR FIR QMF banks - Synthesis, M-channel LPPR filter bank, Quantization effects - Types of quantization effects in filter banks - Implementation - Coefficient sensitivity effects, round off noise and limit cycles, dynamic range and scaling.

Text books

1. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Prentice Hall, PTR, 1993.
2. N. J. Fliege, Multirate Digital Signal Processing, John Wiley, 1994.

Reference books

1. Sanjit K. Mitra, Digital Signal Processing: A Computer based Approach, McGraw Hill, 1998.
2. R. E. Crochiere, L. R. Rabiner, Multirate Digital Signal Processing, Prentice Hall Inc, 1983.
3. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications 3rd Edn. Prentice Hall India, 1999.
4. Boaz Porat, Digital Signal Processing Prentice Hall Inc, 1998.
5. Ali N. Akansu, Richard A. Haddad, Multiresolution Signal Decomposition: Transforms, Subbands and Wavelets, Academic Press 1992.

ECU 337 DIGITAL IMAGE PROCESSING

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Pre-Requisite: ECU 303

Module I Digital image representation: (8 hrs.)

Basic ideas in digital image processing: problems and applications - Image representation and modeling - Sampling and quantization - Basic relationships between pixels - Two dimensional systems - shift invariant linear systems - Separable functions; 2-D convolution; 2-D correlation.

Image perception - light, luminance, brightness and contrast - MTF of the visual system - visibility function - monochrome vision models - image fidelity criteria - colour representation - colour matching and reproduction - colour co-ordinate systems - colour difference measures - colour vision models.

Module II Image transforms: (8 hrs.)

2-D Discrete Fourier transform - properties; Walsh, Hadamard, Discrete Cosine, Haar and Slant transforms; The Hotelling transform. Matrix theory - block matrices and Kronecker products - Circulant matrix formulation for complexity reduction; Algebraic methods - random fields - spectral density function

Module III Image enhancement & Restoration: (10 hrs.)

Image enhancement: Basic gray level transformations – Histogram processing : histogram equalization and modification - Spatial operations - Transforms operations - Multispectral image enhancement - Colour image enhancement

Image restoration: Degradation model; Restoration in presence of noise only – Estimating the degradation function - Inverse filtering - Wiener filtering – Constrained Least Squares filtering.

Module IV Image compression: (9 hrs.)

Fundamental concepts of image compression - Compression models - Information theoretic perspective - Fundamental coding theorem – Lossless Compression: Huffman Coding- Arithmetic coding – Bit plane coding – Run length coding - Lossy compression: Transform coding – Image compression standards.

Module V: (7 Hours)

Image segmentation: Detection of Discontinuities – Edge linking and boundary Description: Local processing – Global processing – Hough transform – Thresholding – Region based segmentation.

Textbook:

1. R. C. Gonzalez, R. E. Woods, *Digital Image Processing*, Pearson Education. II Ed.,2002
2. Jain A.K., "*Fundamentals of Digital Image Processing*", Prentice-Hall, 1989.

References:

1. Jae S. Lim, *Two Dimensional Signal And Image Processing*, Prentice-Hall, Inc, 1990.
2. Pratt W.K., "*Digital Image Processing*", John Wiley, 1991.
3. Netravalli A.N. & Hasbell B.G., "*Digital Pictures-Representation Compression and Standards*", Plenum Press, New York, 1988.
4. Rosenfeld & Kak A.C., "*Digital Picture Processing*", Vol.1&2, Academic Press, 1982.

ECU 421 SELECTED TOPICS IN COMMUNICATION

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Equalization: Zero forcing equalizer, fractionally spaced equalizer, transversal filter equalizer, constrained complexity equalizer, adaptive linear equalizer, adaptive DFE, pass band equalization (10 hours)

Spectrum control: Line codes, line code options, filtering for spectrum control, continuous phase modulation, scrambling (10 hours)

Detection: Detection of single real valued symbol, detection of a signal vector, known signals in Gaussian noise, optimal incoherent detection, optimal detector for PAM with ISI, sequence detection, Viterbi algorithm, general ML and MAP detectors (10 hours)

MIMO Systems: Multiple Input Multiple output (MIMO) systems- Narrow band multiple antenna system model- Parallel decomposition of MIMO Channels- Capacity of MIMO Channels, Space-time codes for MIMO wireless communication- Alamouti code- Diversity-on-receive and Diversity-on-transmit schemes- Generalized complex orthogonal space-time block codes- Differential Space time block codes, Trellis coded modulation (TCM)-TCM encoding & decoding (12 hours)

References

1. Edward A Lee & David G Messerschmitt: Digital Communication, 3rd Ed; Kluwer Academic Publishers, 2003
2. Andrea Goldsmith, "Wireless Communications", Cambridge University press, 2005.
3. Simon Haykin and Michael Moher, "Modern Wireless Communications", Person, 2004.

ECU 422 MICROWAVE COMMUNICATION

| L | T | P | C |
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Pre-requisite: ECU 210

Module I. Satellites and orbits (11 hours)

Communication satellites –Space-craft subsystems, payload – repeater, antenna, attitude and control systems, telemetry, tracking and command, power sub-system and thermal control. Orbital parameters, satellite trajectory, period, geostationary satellites, non-geostationary constellations.

Module II. Earth stations and terrestrial links (10 hours)

Antenna and feed systems, satellite tracking system, amplifiers, fixed and mobile satellite service earth stations. Terrestrial microwave links-line of sight transmission, Transmitters, receivers and relay towers - distance considerations, Digital links.

Module III. Communication link design (11 hours)

Frequency bands used, antenna parameters, transmission equations, noise considerations, link design, propagation characteristics of fixed and mobile satellite links, channel modeling, very small aperture terminals, VSAT design issues.

Module IV. Multiple access techniques (10 hours)

Frequency division multiple access, time division multiple access, code division multiple access.

Text books

1. M Richharia: ‘Satellite Communication Systems’, (2nd. Ed.),Macmillan Press Ltd, 1999.
2. Dennis Roddy: ‘Satellite Communications’, 4th Ed, MGH, 2006

References

1. Robert M Gagliardi: ‘Satellite Communication’, Van Nostrand Reinhold
2. Tri T Ha: ‘Digital Satellite Communication’, MGH
3. Miller, Vucetic and Berry: ‘Satellite Communication Techniques’, Kluwer
4. Ferdo Ivanek (Editor): ‘Terrestrial Digital Microwave Communications’, Artech House
5. George M. Kizer: ‘Microwave Communication’, IEEE Press
6. E. Hund: ‘Microwave Communications’, IEEE Press
7. P.V. Sreekant: Digital Microwave Communication Systems, Universities Press.
8. Freemann: “Telecommunication system Engineering”.

ECU 423 SPEECH PROCESSING

| L | T | P | C |
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Pre Requisite: ECU 303

Module I (12 hours)

Digital models for the speech signal - mechanism of speech production - acoustic theory - lossless tube models - digital models - linear prediction of speech - auto correlation - formulation of LPC equation - solution of LPC equations - levinson durbin algorithm - levinson recursion - schur algorithm - lattice formulations and solutions – PARCOR coefficients.

Module II (10 hours)

Spectral analysis of speech - short time fourier analysis - filter bank design - speech coding -subband coding of speech - transform coding - channel vocoder - formant vocoder - cepstralvocoder - vector quantizer coder- Linear predictive Coder.

Module III (10 hours)

Speech synthesis - pitch extraction algorithms - gold rabiner pitch trackers – autocorrelation pitch trackers - voice/unvoiced detection - homomorphic speech processing – homomorphic systems for convolution - complex cepstrums - pitch extraction using homomorphic speech processing.

Module IV (10 hours)

Automatic speech recognition systems - isolated word recognition - connected word recognition -large vocabulary word recognition systems - pattern classification - DTW, HMM - speaker recognition systems - speaker verification systems - speaker identification Systems.

Text books

1. Rabiner L.R. & Schafer R.W., “Digital Processing of Speech Signals”, Prentice Hall Inc., 1978.
2. O’Shaughnessy, D. “Speech Communication, Human and Machine”. John Wiley & Sons; 2nd Edn, 1999.
3. Thomas F. Quatieri, “Discrete-time Speech Signal Processing: Principles and Practice” Prentice Hall, Signal Processing Series, 1st Edn., 2001.
4. Deller, J., J. Proakis, and J. Hansen. “Discrete-Time Processing of Speech Signals.” Wiley-IEEE Press, Reprint edition, 1999.

Reference books

1. Owens F.J., “Signal Processing of Speech”, Macmillan New Electronics, 1993.
2. Saito S. & Nakata K., “Fundamentals of Speech Signal Processing”, Academic Press, Inc., 1985.
2. Papamichalis P.E., “Practical Approaches to Speech Coding”, Texas Instruments, Prentice Hall, 1987.
3. Rabiner L.R. & Gold, “Theory and Applications of Digital Signal Processing”, Prentice Hall of India, 1975.
5. Jayant, N. S. and P. Noll. “Digital Coding of Waveforms: Principles and Applications to Speech and Video. Signal Processing Series”, Englewood Cliffs: Prentice-Hall, 2004.
6. Thomas Parsons, “Voice and Speech Processing”, McGraw Hill Series, 1986.
7. Chris Rowden, “Speech Processing”, McGraw-Hill International Limited, 1992.

ECU 424 WAVELET THEORY

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Pre-requisite: ECU 336

Module I (10 hours)

Fundamentals of Signal Decomposition – Introduction to Fourier Series & Orthogonal Systems – Brief Overview of Fourier Transform and Short Time Fourier Transform – Time Frequency Analysis – Introduction to Wavelets – Basis Functions – Specifications – Admissibility Condition – Continuous Wavelet Transform – Definition – CWT as a correlation – Constant Q Factor Filtering Interpretation and Time Frequency Resolution – Inverse CWT.

Module II (12 hours)

Introduction to Discrete Wavelet Transform and Orthogonal Wavelet Decomposition – Approximation of Vectors in Nested Linear Vector Spaces – Multiresolution Analysis – Dilation Equation & Wavelet Equation – Orthogonal Wavelet Decomposition based on Haar Wavelet – DWT and Filter Banks – Mallat's Algorithm – Signal Decomposition (Filtering and Down Sampling) – Signal Reconstruction – (Upsampling and Filtering)

Module III (10 hours)

Construction of a General MRA – Formal Definition – Implication of the Dilation Equation and Orthogonality – Two Scale Relation for the Wavelet Function – Digital Filter Implementation – Restrictions on Filter Coefficients – Regularity and Vanishing Moments – Biorthogonal Wavelet Bases – Filtering Relationship for Biorthogonal Filters – Examples of Biorthogonal Scaling Functions and Wavelets – Lifting Scheme – Two Dimensional Wavelets.

Module IV (10 hours)

Wavelet Packet Analysis (1D & 2D) – Wavelet Packet Algorithms – Haar Wavelet Packets -Best Basis Selection – Applications: Image Compression – Embedded Zero Tree Wavelet Coding (EZW) – Set Partitioning in Hierarchical Tree (SPIHT) – Audio Compression – Signal Denoising: Hard Thresholding & Soft Thresholding – Medical and Bio-medical Signal and Image Processing Applications – Advanced Topics: Introduction to Multiwavelets, Ridgelets and Curvelets.

Text books

- 1.R. M. Rao and A. Bopardikar, "Wavelet Transforms: Introduction to Theory and Applications" Addison-Wesley, 1998.
- 2.Christian Blatter, "Wavelets: A primer" A. K. Peters, Massachusetts, 1998.
- 3.Burrus.C.S., Ramesh A. Gopinath and Haitao Guo, " Introduction to Wavelets and Wavelet Transforms: A Primer", Prentice Hall, 1997
- 4.J. C. Goswami and A. K. Chan, "Fundamentals of Wavelets: Theory, Algorithms and Applications" Wiley-Interscience Publication, John Wiley & Sons Inc., 1999.
- 5.Candes, E.J., Ridgelets: Theory and Applications, Ph.D. Dissertation, Stanford University, 1998
- 6.Donoho, D.L. and M.R. Duncan, Digital Curvelet Transform: Strategy, Implementation and Experiments, Technical Report, Stanford University, 1999
- 7.Candes, E.J., L.Demanet, D.L.donoho and L.Ying, Fast Discrete Curvelet Transforms, Technical Report, Stanford University, July 2005, Revised March 2006.

Reference books

1. Mark A. Pinsky, "Introduction to Fourier Analysis and Wavelets," Brooks/Cole Series in Advanced Mathematics, 2002
2. M. Holschneider, "Wavelets: An analysis tool" Oxford Science Publications, 1998.
3. M. Vetterli, J. Kovacevic, "Wavelets and Subband Coding" Prentice Hall Inc, 1995.
4. Stephen G. Mallat, "A Wavelet Tour of Signal Processing" 2nd Edition Academic Press, 2000.
5. Gilbert Strang and Truong Q. Nguyen, "Wavelets and Filter Banks" 2nd Edition Wellesley-Cambridge Press, 1998

6. L. Prasad and S. S. Iyengar, "Wavelet Analysis with Applications to Image Processing", CRC Press, 1997.
7. Ingrid Daubechies, "Ten Lectures on Wavelets" SIAM, 1990.
8. H. L. Resniko and R. O. Wells, Jr., "Wavelet Analysis: The Scalable Structure of Information" Springer, 1998.
9. P. P. Vaidyanathan, "Multirate Systems and Filter Banks" Prentice Hall P T R, 1993.
10. P. Wojtaszczyk, "A Mathematical Introduction to Wavelets" Cambridge University Press 1997.
11. Michael W. Frazier, "An Introduction to Wavelets Through Linear Algebra" Springer-Verlag ,1999.
12. Anthony N. Michel and Charles J. Herget, "Applied Algebra and Functional Analysis" Dover Publications Inc., 1993.
13. K.P.Soman, K.I.Ramachandran, "Insight into Wavelets: From Theory to Practice" Second Edition, Prentice Hall of India Pvt.Ltd., 2005.
14. Jean-Luc Starck, E.J.Candes, and D.L.Donoho, The Curvelet Transform for Image Denoising , IEEE Transactions on Image Processing, Vol.11, No.6, June 2002.
15. Transactions on Image Processing, Vol.11, No.6, June 2002.
16. Do,Minh N. and M.vetterli, Image Denoising using Orthogonal Finite Rdgelet Transform, Proc. Of SPIE Conf. On Wavelet Applications in Signal and Image Processing VIII, San Diego, 2000.

ECU 425 RF CIRCUITS

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Pre-requisites: ECU 207, ECU 210, ECU 302, ECU 304, ECU 305

Characteristics of passive IC components at RF frequencies – interconnects, resistors, capacitors, inductors and transformers – Transmission lines (6 hours)

Noise – classical two-port noise theory, noise models for active and passive components (3 hours)

High frequency amplifier design – zeros as bandwidth enhancers, shunt-series amplifier, f_T doublers, neutralization and unilateralization (6 hours)

Low noise amplifier design – LNA topologies, power constrained noise optimization, linearity and large signal performance (7 hours)

Mixers – multiplier-based mixers, subsampling mixers, diode-ring mixers (5 hours)

RF power amplifiers – Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, linearity considerations (7 hours)

Oscillators & synthesizers – describing functions, resonators, negative resistance oscillators, synthesis with static moduli, synthesis with dithering moduli, combination synthesizers – phase noise considerations. (8 hours)

Reference

1. Thomas H. Lee, The Design of CMOS Radio-Frequency Integrated Circuits, 2nd ed., Cambridge, UK: Cambridge University Press, 2004.
2. Behzad Razavi, RF Microelectronics, Prentice Hall, 1998.
3. A.A. Abidi, P.R. Gray, and R.G. Meyer, eds., Integrated Circuits for Wireless Communications, New York: IEEE Press, 1999.
4. R. Ludwig and P. Bretchko, RF Circuit Design, Theory and Applications, Pearson, 2000.

ECU 426 HIGH SPEED DIGITAL CIRCUITS

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Pre-requisite: ECU 202, ECU 209

Introduction to high-speed digital design - Capacitance and inductance effects, High speed properties of logic gates, Speed and power, Modelling of wires, Geometry and electrical properties of wires, Electrical models of wires, transmission lines, lossless LC transmission lines, lossy LRC transmission lines, special transmission lines (10 hours)

Power distribution and noise - Power supply network, local power regulation, IR drops, area bonding, onchip bypass capacitors, symbiotic bypass capacitors, power supply isolation, Noise sources in digital system, power supply noise, cross talk, intersymbol interference (10 hours)

Signalling convention and circuits - Signalling modes for transmission lines, signalling over lumped transmission media, signalling over RC interconnect, driving lossy LC lines, simultaneous bi-directional signaling, terminations, transmitter and receiver circuits (10 hours)

Timing convention and synchronisation - Timing fundamentals, timing properties of clocked storage elements, signals and events, open loop timing level sensitive clocking, pipeline timing, closed loop timing, clock distribution, synchronisation failure and metastability, PLL and DLL based clock aligners (12 hours)

Reference

1. William S. Dally & John W. Poulton; Digital Systems Engineering, Cambridge University Press, 1998
2. Masakazu Shoji; High Speed Digital Circuits, Addison Wesley Publishing Company, 1996
3. Jan M, Rabaey, et al; Digital Integrated Circuits: A Design perspective, Second Edition, 2003

ECU 427 SELECTED TOPICS IN CIRCUIT DESIGN

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Bandwidth estimation techniques – method of open circuit time constants, method of short circuit time constants – accuracy of these methods (6 hours)

Linearization and efficiency boosting of RF power amplifiers – envelope feedback, feedforward, pre and post distortion, polar feedback, Cartesian feedback, Doherty amplifier, PWM, injection locking, corporate combiner (12 hours)

Cascaded amplifiers – bandwidth shrinkage, optimum gain per stage, super-regenerative amplifier, gain-delay tradeoff, distributed amplifier (12 hours)

Current conveyors – CC implementation, current mode filter design, switched current filters (12 hours)

Reference

1. Thomas H. Lee, The Design of CMOS Radio-Frequency Integrated Circuits, 2nd ed., Cambridge University Press, 2004.
2. P V Ananda Mohan: Current mode VLSI analog filters, Springer International, 2004

ECU 428 ANTENNA THEORY

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Pre-requisite: ECU 209

Potentials and radiation fields - Retarded potentials, Lienard - Wiechert potentials for a moving charge, fields of a moving point charge, electric dipole radiation, magnetic dipole radiation, radiation from an arbitrary source, power radiated by a point charge, radiation reaction (12 hours)

Antenna parameters - Directivity, gain, radiation resistance, beam width, input impedance, antenna noise and temperature, radiation pattern. (6 hours)

Antennas - Dipole and monopole antennas, linear dipole arrays, loop antenna, helical antenna, Yagi – Uda antenna, parabolic antenna, Cassegrain antenna (12 hours)

Design of linear array antennas - Dolph - Tchebycheff design, binomial design, Fourier transform based design (6 hours)

RF antennas – Microstrip antenna, fractal antenna (6 hours)

Reference:

1. C A Balanis: Antenna Theory, 3rd Ed; John Wiley, 2005
2. J D Krauss: Antennas, 2nd Ed; 1988, MGH
3. David J Griffiths: Introduction to Electrodynamics, Third edition, PHI, 1999
4. Jordan and Balmain: Electromagnetic waves and radiating systems, PHI, 1968

ECU 430 ANALOG MOS INTEGRATED CIRCUITS

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Pre-requisite: ECU 206, ECU 207

Module 1 (7 hours):

Analog MOS models – low frequency model – MOS in saturation – channel length modulation - high frequency model – temperature effects in MOST – noise in MOST – shot, flicker and thermal noise – MOS resistors and resistor circuits

Module 2 (13 hours):

Current sources and sinks – current mirror – cascode current source – Wilson current mirror – regulated cascode current source/sink – common source –common gate – common drain amplifiers, cascode and folded cascode structures – frequency response - noise in single stage amplifiers

Module 3 (12 hours):

Differential amplifiers – common mode response - one stage and two stage opamps - Frequency compensation of opamps - nonlinearity of differential circuits – effect of feedback on nonlinearity – offset cancellation - bandgap reference – biasing schemes for voltage references

Module 4 (10 hours):

Mixed signal circuits – CMOS comparator design – analog multiplier – dynamic analog circuits – charge injection and capacitive feed through in MOS switch – sample and hold circuits – introduction to switched capacitor circuits – switched capacitor filters

Reference books

1. Jacob Baker R., Li H.W.& Boyce D.E., 'CMOS - Circuit Design, Layout & Simulation', PHI,2005.
2. Behzad Razavi, 'Design of Analog CMOS Integrated Circuit' Tata-Mc GrawHill, 2002.
3. Roubik Gregorian & Gabor C Temes, Analog MOS Integrated Circuits for Signal Processing, John Wiley, 1986.

ECU 440: HIGH SPEED SEMICONDUCTOR DEVICES

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Pre-requisite: ECU 203, ECU 206

MESFETs: Basic concept, models for terminal characteristics; accounting for velocity saturation. Dynamic models: large signal switching transients; small signal, high f models. [8 hours]

HBTs: Concept: emitter efficiency, base transport, base resistance, junction capacitance. HJ collector and collector-up refinements. Applications of graded layers: control of HJ spikes; ballistic injection; problems with upper-valley minima [8 hours]

MODFETs — basic device, theory. Deep level problem (transconductance collapse); pseudomorphic solution. Telecommunications applications — key features: gain, bandwidth, linearity, noise [8 hours]

Light Emitting Diodes: LEDs — structure, materials, characteristics (i-v, I-i, I-I), performance. Light extraction, current spreading, photon recycling. [4 hours]

Laser Diodes: Feedback and stimulated emission. Cavity design; double heterostructure concept. Quantum well, wire, dot active regions. Strained layers; pseudomorphic active regions. [6 hours]

Detectors: Structure and theory of basic types: p-i-n (conventional and unicarrier), APD, Schottky diode, m-s-m; resonant cavity concepts. [4 hours]

Quantum Effect Devices: Electron waveguides, single electron transistors, [4 hours]

Text Books:

1. GaAs High-Speed Devices: Physics, Technology and Circuit Applications C.Y. Chang, F. Kai, Wiley
2. Compound Semiconductor Device Physics, Sandip Tiwari, Academic Press (1991), ISBN 0-12-691740-X

References:

1. Cheng T. Wang, Ed., Introduction to Semiconductor Technology: GaAs and Related Compounds, John Wiley & Sons,
2. David K. Ferry, Ed., Gallium Arsenide Technology, Howard W. Sams & Co., 1985
3. Avishay Katz, Ed., Indium Phosphide and Related materials: Processing, Technology and Devices, Artech House, 1992.
4. High Speed Semiconductor Devices, S.M. Sze, Wiley (1990) ISBN 0-471-62307-5

ECU 441 NANO ELECTRONICS

| L | T | P | C |
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Pre-requisite: ECU 203, ECU 206

Challenges going to sub-100 nm MOSFETs – Oxide layer thickness, tunneling, power density, non-uniform dopant concentration, threshold voltage scaling, lithography, hot electron effects, sub-threshold current, velocity saturation, interconnect issues, fundamental limits for MOS operation. (8 hours)

Novel MOS-based devices – Multiple gate MOSFETs, Silicon-on-insulator, Silicon-on-nothing, FinFETs, vertical MOSFETs, strained Si devices (10 hours)

Alternate devices –

Quantum structures – quantum wells, quantum wires and quantum dots, Single electron devices – charge quantization, energy quantization, Coulomb blockade, Coulomb staircase (8 hours)

Heterostructure based devices – Type I, II and III heterojunctions, Si-Ge heterostructure, heterostructures of III-V and II-VI compounds - resonant tunneling devices (diodes & transistors) (8 hours)

Carbon nanotubes based devices – CNFET, characteristics (4 hours)

Spintronics - Spin-based devices – spinFET, characteristics (4 hours)

Reference

1. Mircea Dragoman and Daniela Dragoman: Nanoelectronics – Principles & devices; Artech House Publishers, 2005
2. Karl Goser: Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, Springer 2005
3. Mark Lundstrom and Jing Guo: Nanoscale Transistors: Device Physics, Modeling and Simulation, Springer, 2005
4. Vladimir V Mitin, Viatcheslav A Kochelap and Michael A Stroscio: Quantum heterostructures; Cambridge University Press, 1999
5. S M Sze (Ed): High speed semiconductor devices, Wiley, 1990

ECU 442 OPTO-ELECTRONIC COMMUNICATION SYSTEMS

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Pre-requisites: ECU 209, ECU 210, ECU 302

Optical fiber fundamentals - Solution to Maxwell's equation in a circularly symmetric step index optical fiber, linearly polarized modes, single mode and multimode fibers, concept of V number, graded index fibers, total number of guided modes (no derivation), polarization maintaining fibers, attenuation mechanisms in fibers, dispersion in single mode and multimode fibers, dispersion shifted and dispersion flattened fibers, attenuation and dispersion limits in fibers, Kerr nonlinearity, self phase modulation, combined effect of dispersion and self phase modulation, nonlinear Schrodinger equation (no derivation), fundamental soliton solution (13 hours)

Optical sources - LED and laser diode, principles of operation, concepts of line width, phase noise, switching and modulation characteristics – typical LED and LD structures. (8 hours)

Optical detectors - PN detector, pin detector, avalanche photodiode – Principles of operation, concepts of responsivity, sensitivity and quantum efficiency, noise in detection, typical receiver configurations (high impedance and transimpedance receivers). (9 hours)

Optical amplifiers– Semiconductor amplifier, rare earth doped fiber amplifier (with special reference to erbium doped fibers), Raman amplifier, Brillouin amplifier – principles of operation, amplifier noise, signal to noise ratio, gain, gain bandwidth, gain and noise dependencies, intermodulation effects, saturation induced crosstalk, wavelength range of operation. (12 hours)

Reference

1. Leonid Kazovsky, Sergio Benedetto and Alan Willner: 'Optical Fiber Communication Systems', Artech House, 1996.
2. G.P.Agrawal: 'Nonlinear Fiber Optics', 3rd Ed; Academic Press, 2004.
3. G.P.Agrawal : 'Fiber optic communication systems', 3rd Ed; Wiley-Interscience, 2002.

ECU 443 COMMUNICATION SWITCHING SYSTEMS

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Pre-requisite: ECU 205, ECU 302

Module I

(11 hours)

Electronic switching systems: basics of a switching system - stored program control –centralized SPC and distributed SPC, space division switching - two-stage network - three-stage network - n-stage network - non-blocking switches - blocking probability analysis of multistage switches – lee approximation - improved approximate analysis of blocking switch - time division switching – TSI operation

Module II

(11 hours)

Multi stage switching networks: Two dimensional switching, Multi-stage time and space switching, implementation complexity of the switches, examples of digital switching systems (eg: AT & T No.5 ESS and NTI - DMS 100)

Introduction to ATM switching – Strict sense non block switch – self routing switches – Banyan network – ATM routers – Design of typical switches.

Module III

(12 hours)

Traffic Analysis: traffic measurements, arrival distributions, Poisson process, holding/service time distributions, loss systems, lost calls cleared – Erlang-B formula, lost calls returning and lost calls held models, lost calls cleared and held models with finite sources, delay systems, Little’s theorem, Erlang-C formula, M/G/1 model.

Module IV

(8 hours)

Routing in Circuit- Switched Networks: Hierarchical Routing, Nonhierarchical Routing, Control of alternatively routed traffic

Signaling: customer line signaling - outband signaling - inband signaling - PCM signaling - inter register signaling - common channel signaling principles-CCITT signaling system No: 7

Text books

1. John C. Bellamy, *Digital Telephony*, Third edition, Wiley Inter Science Publications, 2000
2. Schwartz M., *Telecommunication Networks - Protocols, Modeling and Analysis*, First Edition, Addison Wesley Publishing Company, 1987

Reference books

1. Viswanathan T., *Telecommunication Switching Systems and Networks*, Prentice Hall of India Pvt. Ltd, 1992
2. Flood J.E., *Telecommunications Switching Traffic and Networks*, Pearson Education Pvt.Ltd,2001
3. C.Dhas, V.K.Konangi and M.Sreetharan, *Broadband Switching, architectures, protocols, design and analysis*, IEEE Computer society press, J. Wiely & Sons INC, 1991
4. Freeman R.L., *Telecommunication System Engineering*, John Wiley & Sons, 1989
5. DasJ, *Review of Digital Communication 'State of the Art' in Signalling Digital Switching and Data Networks*, Wiley Eastern Ltd., New Delhi, 1988.

ECU 444 RADAR ENGINEERING

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Pre requisite: ECU 209, ECU 210, ECU 302

Module 1: (10hours)

Introduction-Radar Equation-Block diagram-Radar frequencies- Applications- Prediction of range performance –Pulse Repetition Frequency and Range ambiguities –Antenna parametes-System losses-

Module 2: (12 hours)

CW Radar-The Doppler Effect- FM-CW radar- Multiple frequency radar – MTI Radar- Principle- Delay line cancellors- Staggered PRF – Range gating-Noncoherent MTI-Pulse Doppler radar- Tacking Radar – Sequential lobing-Conical Scan- Monopulse – Acquisition- Comparison of Trackers

Module 3:(10 hours)

Radar Transmitters- Modulators-Solid state transmitters
Radar Antennas- Parabolic-Scanning feed-Lens-Radomes
Electronically steered phased array antenna-Applications
Receivers-Displays-Duplexers

Module 4: (10 hours)

Detection of Radar signals in noise –Matched filter criterion-detection criterion – Extraction of information and waveform design
Propagation of radar waves –Radar clutter
Special purpose radars-Synthetic aperture radar- HF and over the horizon radar- Air surveillance radar- Height finder and 3D radars – Bistatic radar-Radar Beacons- Radar Jamming and Electronic Counters .

Text Books

1. Introduction to Radar Systems –Merrill I. Skolnik,3rd Edition ,2002, MacGraw Hill

Reference Books

1. Radar Handbook -Merril I.Skolnik ,1990, McGraw Hill Publishers
2. Radar Principles for the Non-Specialist, by J. C. Toomay, Paul Hannen SolTech Publishers,2004

ECU 445 CRYPTOGRAPHY: THEORY AND PRACTICE

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Module I (10 hours)

Divisibility – Prime numbers – Perfect numbers – Congruence – Euler function - Fermat’s little theorem - Groups and fields - Polynomial ring – Field extension

Module II (11 hours)

Classical Cryptography – Substitution and Transposition Cipher – Modern Cryptographic Techniques – Private Key Cryptosystems – Block cipher – Standards – Data Encryption Standard – AES – Stream cipher – Key stream generators – Linear feed back shift registers and sequences – RC4 cryptosystem

Module III (11 hours)

Public key cryptosystems – One way functions – Factorization problem – RSA crypto system – Discrete logarithm problem – Elgamal crypto system – Key management – Diffie Hellmann key exchange – Elliptic curves – arithmetic – cryptographic applications of elliptic curves

Module IV (10 hours)

Message authentication requirements – Hash function – features of MD5 and SHA algorithms – Security of Hash function – Message Authentication Codes – Digital Signatures – Elgamal DSA – Applications of authentication – Electronic mail security – PGP – Secret sharing

Text Books:

1. Douglas A. Stinson, “Cryptography, Theory and Practice”, Chapman & Hall, CRC Press Company, Washington, Second Edn., 2002
2. William Stallings, “Cryptography and Network Security”, Pearson Education, Second Edn., 2000.

References:

1. Lawrence C. Washington, “Elliptic Curves”, Chapman & Hall, CRC Press Company, Washington., 2003
2. David S. Dummit, Richard M. Foote, “Abstract Algebra”, John Wiley & Sons, 3rd Edn., 2003
3. Evangelos Kranakis, “Primality and Cryptography”, John Wiley & Sons, 1991.
4. Rainer A. Ruppel, “Analysis and Design of Stream Ciphers”

ECU 446 OPTO-ELECTRONIC DEVICES AND SYSTEMS

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Pre-requisite: ECU 203

Optical processes in semiconductors – electron hole recombination, absorption, Franz-Keldysh effect, Stark effect, quantum confined Stark effect, deep level transitions, Auger recombination (10 hours)

Lasers – threshold condition for lasing, line broadening mechanisms, axial and transverse laser modes, heterojunction lasers, distributed feedback lasers, quantum well lasers, tunneling based lasers, modulation of lasers. (8 hours)

Optical detection – PIN, APD, modulated barrier photodiode, Schottky barrier photodiode, wavelength selective detection, microcavity photodiodes. (8 hours)

Optoelectronic modulation - Franz-Keldysh and Stark effect modulators, quantum well electro-absorption modulators, electro-optic modulators, quadratic electro-optic effect quantum well modulators, optical switching and logic devices (8 hours)

Optoelectronic ICs – hybrid and monolithic integration, materials and processing, integrated transmitters and receivers, guided wave devices (8 hours)

Reference

1. Pallab Bhattacharya: Semiconductor Optoelectronic Devices, 2nd Ed; Pearson Education, 2002
2. Amnon Yariv & Pochi Yeh– Photonics: Optical Electronics in modern communication, 6th Ed; Oxford Univ. Press, 2006
3. Fundamentals of Photonics : B E Saleh and M C Teich, Wiley-Interscience; 1991

ECU 447 SIGNAL COMPRESSION

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Pre-Requisites: ECU 303, ECU 306

Module I: (9 hours) Compression Techniques – Lossless and Lossy Compression – Modeling and Coding – Mathematical Preliminaries for Lossless Compression – Huffman Coding – Minimum Variance Huffman Codes – Extended Huffman Coding – Adaptive Huffman Coding – Arithmetic Coding – Application of Huffman and Arithmetic Coding, Golomb Codes, Run Length Coding, Tunstall Codes

Module II: (9 hours) Dictionary Techniques – Static Dictionary – Adaptive Dictionary- LZ77, LZ78, LZW - Applications – Predictive Coding – Prediction with Partial Match – Burrows Wheeler Transform – Sequitur- Lossless Compression Standards (files, text, and images, faxes), Dynamic Markov Compression

Module III: (12 hours) Mathematical Preliminaries for Lossy Coding – Rate distortion theory: Motivation; The discrete rate distortion function $R(D)$; Properties of $R(D)$; Calculation of $R(D)$; $R(D)$ for the binary source, and the Gaussian source, Source coding theorem (Rate distortion theorem); Converse source coding theorem (Converse of the Rate distortion theorem) - Design of Quantizers: Scalar Quantization – Uniform & Non-uniform – Adaptive Quantization – Vector Quantization – Linde Buzo Gray Algorithm – Tree Structured Vector Quantizers – Lattice Vector Quantizers – Differential Encoding Schemes.

Module IV: (12 hours) Mathematical Preliminaries for Transforms, Subbands, and Wavelets – Karhunen Loeve Transform, Discrete Cosine Transform, Discrete Sine Transform, Discrete Walsh Hadamard Transform – Transform coding - Subband coding – Wavelet Based Compression – Analysis/Synthesis Schemes – Speech, Audio, Image and Video Compression Standards.

Text books:

1. Khalid Sayood, “Introduction to Data Compression”, Morgan Kaufmann Publishers., Second Edn., 2005.
2. David Salomon, “Data Compression: The Complete Reference”, Springer Publications, 4th Edn., 2006.

Reference books:

1. Toby Berger, “Rate Distortion Theory: A Mathematical Basis for Data Compression”, Prentice Hall, Inc., 1971.
2. K.R.Rao, P.C.Yip, “The Transform and Data Compression Handbook”, CRC Press., 2001.
3. R.G.Gallager, “Information Theory and Reliable Communication”, John Wiley & Sons, Inc., 1968.
4. Ali N. Akansu, Richard A. Haddad, “Multiresolution Signal Decomposition: Transforms, Subbands and Wavelets”, Academic Press., 1992
5. Martin Vetterli, Jelena Kovacevic, “Wavelets and Subband Coding”, Prentice Hall Inc., 1995.

ECU448 STATISTICAL SIGNAL PROCESSING

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Pre-requisites: ECU 205, MAU 102, Calculus

Detection Theory

(1) Binary decisions - Single observation: (10 hours)

Maximum likelihood decision criterion; Neymann-Pearson criterion; Probability of error criterion; Bayes risk criterion; Minimax criterion; Robust detection; Receiver operating characteristics.

(2) Binary decisions - Multiple observations (10 hours)

Vector observations; the general Gaussian problem; Waveform observation in additive Gaussian noise; the integrating optimum receiver; Matched filter receiver.

Estimation Theory

(3a) Methods (7 hours)

Maximum likelihood estimation; Bayes cost method - Bayes estimation criterion- Mean square error criterion; Uniform cost function; absolute value cost function; Linear minimum variance - Least squares method; Estimation in the presence of Gaussian noise - Linear observation; Nonlinear estimation.

(3b) Properties of estimators (5 hours)

Bias, efficiency, Cramer Rao bound, asymptotic properties; Sensitivity and error analysis.

(4a) State Estimation: Prediction; Kalman filter. (5 hours)

(4b) Sufficient statistics and Statistical Estimation of Parameters: (5 hours)

Concept of sufficient statistics; Exponential families of distributions; Exponential families and Maximum likelihood estimation; Uniformly minimum variance unbiased estimation.

Text books

1. Steven M. Kay, Statistical Signal Processing: Vol. 1: Estimation Theory, Vol. 2: Detection Theory, Prentice Hall Inc., 1998.
2. Louis L. Scharf, Statistical Signal Processing: Detection, Estimation and Time Series Analysis, Addison-Wesley Publishing Company, 1991

Reference books

1. Boaz Porat, Digital Processing of Random Signals: Theory and Methods, 4th edn., Prentice Hall Inc., 1994.
2. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogan, Statistical and Adaptive Signal Processing, McGraw-Hill International Editions, 2000.
3. Harry L. Van Trees, Detection, Estimation and Modulation Theory - Part 1, John Wiley & Sons Inc., 1968.
4. Jerry M. Mendel, Lessons in Estimation Theory for Signal Processing, Communication and Control, Prentice Hall Inc., 1995.
5. Sophocles J. Orfanidis, Optimum Signal Processing, 2nd edn., McGraw-Hill, 1988.
6. Monson H. Hayes, Statistical Digital Signal Processing and Modelling, John Wiley & Sons Inc., 1996.
7. Dimitri Kazakos, P. Papantoni Kazakos, Detection and Estimation, Computer Science Press, 1990.
8. James L. Melsa and David L. Cohn, Decision and Estimation Theory, McGraw- Hill, 1978.

ECU 450: COMPOUND SEMICONDUCTOR DEVICES

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Pre-requisites: ECU 203, ECU 206

Compound Semiconductors: The families (III-V's, II-VI's, IV-VI's, IV-IV's), alloys, E_g vs a ; band structures (E vs k ; Γ , L, X minima; direct vs. indirect gaps); crystal lattices, electrical properties, optical properties; trends in properties and the periodic table. The useful compounds. **[10 hours]**

Metal-Semiconductor Interfaces (Schottky Barriers): The compound semiconductor surface; Fermi level pinning. Theories of barrier formation and of current flow; diffusive vs. ballistic flow; contrasts with p-n diodes. Theory and practice of ohmic contacts. **[7hours]**

Heterostructures: E-x Profiles: ΔE_c , ΔE_v , $E_c(x)$, $E_v(x)$; $n_o(x)$, $p_o(x)$; modulation doping. Conduction parallel to heterojunction; mobility in semiconductors and carrier scattering mechanisms. **[7 hours]**

Heterojunctions: Conduction normal to junction: I-V models and characteristics. Theory of graded layers; creation of internal carrier-specific fields. **[6 hours]**

Quantum Effect Structures: Coupled quantum structures: super lattices. Resonant tunneling: RTD structure and concept. I-V theory. Related devices and applications: RTD-load logic, memory cells. **[8hours]**

Epitaxy: Concerns / constraints — lattice-matched systems; strained layers (pseudomorphic) — limits of thickness; impact of strain on bands, properties -Techniques — MOCVD, CBE, MBE **[4 hours]**

Text Book

1. GaAs High-Speed Devices: Physics, Technology and Circuit Applications C.Y. Chang, F. Kai ,Wiley
2. Compound Semiconductor Device Physics, Sandip Tiwari, Academic Press (1991), ISBN 0-12-691740-X

References

1. Cheng T. Wang, Ed., Introduction to Semiconductor Technology: GaAs and Related Compounds, John Wiley & Sons,
2. David K. Ferry, Ed., Gallium Arsenide Technology, Howard W. Sams & Co., 1985
3. Avishay Katz, Ed., Indium Phosphide and Related materials: Processing, Technology and Devices, Artech House, 1992.
4. High Speed Semiconductor Devices, S.M. Sze, Wiley (1990) ISBN 0-471-62307-5

ECU 451 QUANTUM COMMUNICATION

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Quantum mechanics basics: Hilbert Space, density matrices, projective measurements, Pure states and mixed states. Observables and commutivity. Heisenberg uncertainty principle, Quantum state preparation. Open and closed Quantum System Dynamics – Definition, unitary evolution of density matrices, requirements of closed and open system quantum maps, reduced density matrices, partial trace operator, open system measurements and Positive Operator Valued Measurements, Stinespring theorem, Kraus Representation theorem for open system quantum evolution. (7 hrs)

Quantum Communication Theory - transmission of classical information over quantum channels, classical bits encoded into the Z axis spin projection of an electron, quantum state encoding and decoding (5 hrs)

Quantum Information Theory - von Neumann entropy, Holevo's theorem on mutual information for ensembles of quantum states. (5 hrs)

Quantum State Compression - compressing ensembles of quantum states, relation of pure state ensemble compression with von Neumann entropy, relationship between mixed state compression and Holevo's theorem, connections between compression ideas and communication channel capacities. (5 hrs)

Holevo-Schumacher-Westmoreland theorem for classical channel capacities of quantum channels, King-Ruskai-Swartz-Werner Qubit Channel Representation Theorem, Kraus channel representation, channel capacities and their relation to the von Neumann entropy. (5 hrs)

Entanglement and Quantum Channel Capacity – entanglement, scaling issues in Hilbert space, notion of channel additivity and the role of entanglement in quantum channel capacity calculations (5 hrs)

Quantum Communication over Quantum Channels - notion of quantum communication over quantum channels, Shor result on entanglement assisted channel capacities for the transmission of quantum states over quantum channels. (5 hrs)

Quantum Coding Theory - Shor 9 qubit code to protect against bit flips and phase flips, Calderbank-Shor-Steane (CSS) codes, stabilizer code construction technique. (5 hrs)

Text book

1. Michael Nielsen and Issac Chuang : Quantum Computation and Quantum Information, Cambridge University Press, 2000

ECU 452 NONLINEAR DYNAMICAL SYSTEMS, FRACTALS AND CHAOS

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Pre-requisite: ECU 207, ECU 307

State space concepts - Ordinary differential equation description of nonlinear state space systems, stable and unstable limit cycles, phase portraits, periodic orbits, Poincare sections, attractors and aperiodic attractors, KAM theorem, logistic maps and chaos, characterization of chaotic attractors, Benard-Rayleigh convection, Lorenz system, fractals (13 hours)

Concepts of stability - Lyapunov stability for autonomous and nonautonomous systems, the centre manifold theorem, La Salle theory, regions of attraction, invariance theorems, stability of perturbed systems for vanishing and nonvanishing perturbations, slowly varying systems, input-output stability. (9 hours)

Absolute stability – Circle criterion, Popov criterion, small gain theorem, passivity approach, Input-output stability, absolute stability. Stability of interconnected systems: Feedback stabilization of nonlinear systems, exact feedback linearization of nonlinear systems. (10 hours)

Nonlinear theory of oscillators - Pendulum equation with friction and nonlinearity, Van der Pol equation, stabilization of oscillations, attractors, basins and bifurcations of driven oscillators, global topology of the phase space. (10 hours)

Reference

1. Hassan K Khalil: ‘Nonlinear Systems’, Second edition, Prentice Hall, 2002
2. Heinz-Otto Peitgen, Hartmut Jurgens and Dietmar Saupe: ‘Chaos and Fractals- New Frontiers of Science’, Springer-Verlag, 1992
3. Vidyasagar: ‘Nonlinear Systems Analysis’, Second Ed; Prentice-Hall, 1992
4. John Guckenheimer and Philip Holmes: ‘Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields’, Springer-Verlag, 2002
5. D K Arrowsmith and C M Place: ‘An Introduction to Dynamical Systems’, Cambridge University Press, 1990