



Syllabus of B.Tech Degree Programme in Electronics and Communication Engineering

Effective from Admission year 2023-24 & 2024-25
onwards



Department of Electronics & Communication Engineering
National Institute of Technology Sikkim
South Sikkim 737 139

ELECTIVES

Credit: 3

EC1*111: High Speed Semiconductor Devices

Module 1

Important parameters governing the high-speed performance of devices and circuits: Transit time of charge carriers, junction capacitances, ON-resistances and their dependence on the device geometry and size, carrier mobility, doping concentration and temperature;

Module 2

Materials properties: Merits of III –V binary and ternary compound semiconductors (GaAs, InP, InGaAs, AlGaAs, SiC, GaN etc.), different SiC structures, silicon-germanium alloys and silicon carbide for high speed devices, as compared to silicon based devices, outline of the crystal structure, dopants and electrical properties such as carrier mobility, velocity versus electric field characteristics of these materials, electric field characteristics of materials and device processing techniques, Band diagrams, homo and hetero-junctions, electrostatic calculations, Band gap engineering, doping, Material and device process technique with these III-V and IV – IV semiconductors,

Module 3

Metal semiconductor contacts and Metal Insulator Semiconductor and MOS devices: Native oxides of Compound semiconductors for MOS devices and the interface state density related issues. Metal semiconductor contacts, Schottky barrier diode, Metal semiconductor Field Effect Transistors (MESFETs): Pinch off voltage and threshold voltage of MESFETs. D.C. characteristics and analysis of drain current. Velocity overshoot effects and the related advantages of GaAs, InP and GaN based devices for high speed operation. Sub threshold characteristics, short channel effects and the performance of scaled down devices.

Module 4

High Electron Mobility Transistors (HEMT): Hetero-junction devices. The generic Modulation Doped FET(MODFET) structure for high electron mobility realization. Principle of operation and the unique features of HEMT, InGaAs/InP HEMT structures: Hetero junction Bipolar transistors (HBTs): Principle of operation and the benefits of hetero junction BJT for high-speed applications. GaAs and InP based HBT device structure and the surface passivation for stable high gain high-frequency performance. SiGe HBTs and the concept of strained layer devices; High Frequency resonant – tunneling devices, Resonant-tunnelling hot electron transistors

Books:

1. C.Y. Chang, F. Kai, GaAs High-Speed Devices: Physics, Technology and Circuit Applications Wiley
2. Cheng T. Wang, Ed., Introduction to Semiconductor Technology: GaAs and Related Compounds, John Wiley & Sons,
3. David K. Ferry, Ed., Gallium Arsenide Technology, Howard W. Sams & Co., 1985

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EC1*112: Nanoelectronics

Module I:

Free Electron Theory & The New Ohm's Law:

Why Electrons flow, Classical free electron theory, Sommerfeld's theory, The quantum of conductance, Coulomb blockade, Towards Ohm's law. The Elastic Resistor: Conductance of an Elastic Resistor, Elastic Resistor- Heat dissipation.

Materials for nanoelectronics:

Semiconductors, Crystal lattices: bonding in crystals, Electron energy bands, Semiconductor heterostructures, Lattice-matched and pseudo orphic heterostructures, Inorganic nanowires, Organic semiconductors, Carbon nanomaterials: nanotubes and fullerenes

Module II:

Ballistic and Diffusive Transport:

Ballistic and Diffusive Transfer Times, Channels for Conduction Conductivity, Conductivity: $E(p)$ or $E(k)$ Relations, Counting States, Drude Formula, Quantized Conductance, Electron Density - Conductivity

Electron transport in semiconductors and nanostructures:

Time and length scales of the electrons in solids, Statistics of the electrons in solids and nanostructures, Fermi statistics for electrons, the density of states of electrons in nanostructures, Electron transport in nanostructures.

Module III:

Electrons in traditional low-dimensional structures

Electrons in quantum wells: Single modulation-doped heterojunctions, Numerical analysis of a single heterojunction, Control of charge transfer, Electrons in quantum wires, Electron transport in quantum wires, Electrons in quantum dots.

Nanostructure devices

Resonant-tunnelling diodes, Field-effect transistors Single-electron-transfer devices.

Books:

1. Introduction to Nano Science and Technology by S.M. Lindsay.
2. Supriyo Dutta -Lessons from Nanoscience: A Lecture Note Series, World Scientific (2012).
3. Supriyo Dutta --Quantum Transport- Atom to Transistor, **Cambridge** University Press (2005).
4. Mircea Dragoman and Daniela Dragoman, Nanoelectronics –Principles & devices, Artech House Publishers, 2005.

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EC1*113: Power Electronics

Module 1:

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 2

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 3

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

Module 4

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

Books:

1. Ned Mohan et.al, Power Electronics, John Wiley and Sons, 1989
2. Sen P.C., Power Electronics, Tata McGraw Hill, 2003
3. Rashid, Power Electronics, Prentice Hall India, 1993

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EC1*114: Active Network Synthesis

Module 1

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

Module 2

Amplifiers and fundamental active building blocks - Opamps, OTAs, CCII, Integrators, gyrators and immittance converters

Module 3

Second-order filters - Single-amplifier RC biquads - Biquads based on general impedance converter – OTA based (two-integrator loop) filters -Higher order filter realization - Cascade realizations, pole-zero pairing - Fully integrated high-frequency filter realizations - Transconductance filters - Log-domain filters – Switched capacitor filters

Books:

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

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EC1*115: High Speed Digital Circuits

Module 1

Introduction to high-speed digital design: Frequency, time and distance - 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

Module 2

Power distribution and noise: Power supply network - local power regulation - IR drops - area bonding – on chip bypass capacitors - symbiotic bypass capacitors - power supply isolation - Noise sources in digital system - power supply noise - cross talk – inter symbol interference

Module 3

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 signalling terminations - transmitter and receiver circuits

Module 4

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

Books:

1. William S. Dally & John W. Poulton; Digital Systems Engineering, Cambridge Univ Press, 1998
2. Howard Johnson & Martin Graham; High Speed Digital Design: A Handbook of Black Magic, Prentice Hall PTR, 1993
3. Masakazu Shoji; High Speed Digital Circuits, Addison Wesley Publishing Company, 1996

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EC1*116: Modeling and Testing of Digital Systems

Module 1

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

Module 2

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

Module 3

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

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.

Books:

1. J. Bhasker; A VHDL Synthesis Primer, B.S. Publications 2001
2. Kenneth L Short, VHDL for Engineers, Pearson Education ,2006
3. MironAbramovici, et. al. Digital System Testing and Testable Design, Jaico Publishing, 2001

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EC1*117: Advanced Memory Architecture

Module 1

Review of MOS-based devices, band diagrams, threshold voltage, body bias effect, drain current and gate current characteristics, subthreshold slope, hot electron effect, various leakages in a MOSFET, tunnelling phenomenon, direct tunneling, Fowler-Nordheim tunnelling, direct band to band tunnelling, SOI MOSFET, PDSOI, FDSOI, current characteristics, Classification of memories

Module 2

Volatile memories: SRAM, functionality, architecture, timing diagrams, performance and timing specifications, Low voltage SRAMs, SOI SRAMs, Content addressable memories (CAM), 3-transistor DRAM, 1 transistor DRAM, functionality, architecture, timing diagrams, performance and timing specifications, sense amplifier, word line driver, leakage mechanisms in a DRAM, retention, retention time calculations

Module 3

Non-volatile memories: FLASH Memories, floating gate theory, structure and working of a SONOS cell, structure and working FLOTOX Memories, multi-level flash memories, NNOR-based flash memories, NAND-based flash memories

Module 4

SOI Based RAM: Parasitic BJTs in a SOI, Z-RAM, Thyristor RAM, Non-silicon-based memories: PCRAM, MRAM, FeRAM, array device considerations for non-silicon-based memories

Books:

1. Ashok K. Sharma, Semiconductor Memories: Technology, Testing and Reliability, Wiley IEEE Press, 1997, ISBN 0780310004
2. Ashok K. Sharma, Advanced Semiconductor Memories: Architectures, Design and Applications, 2003, Wiley- IEEE Press, ISBN 0471208132
3. William D. Brown, Joe Brewer, Nonvolatile Semiconductor Memory Technology: A Comprehensive Guide to Understanding and Using NVSM Devices, Wiley-IEEE Press, 1997, ISBN: 978-0-7803-1173-2

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EC1*118: Wavelet and their Applications

Module 1

Fourier and Sampling Theory: Generalized Fourier theory, Fourier transform, Short-time(windowed) Fourier transform, Time-frequency analysis - uncertainty relation, Fundamental notions of the theory of sampling.

Theory of Frames: Bases, Resolution of unity, Definition of frames, Geometrical considerations and the general notion of a frame, Frame projector, Example - windowed Fourier frames.

Module 2

Wavelets: The basic functions, Specifications, Admissibility conditions, Continuous wavelet transform (CWT), and Wavelet frames.

The multiresolution analysis (MRA) of $L^2(\mathbb{R})$: The MRA axioms, Construction of an MRA from scaling functions - The dilation equation and the wavelet equation, compactly supported orthonormal wavelet bases – Necessary and sufficient conditions for orthonormality.

Module 3

Construction of wavelets: Regularity and selection of wavelets - Smoothness and approximation order – Criteria for wavelet selection with examples; Splines, Cardinal B-spline MRA, Sub band filtering schemes, compactly supported orthonormal wavelet bases.

Wavelet transform: Discrete wavelet transform (DWT) - Wavelet decomposition and reconstruction of functions in $L^2(\mathbb{R})$, Fast wavelet transform algorithms - Relation to filter banks, Wavelet packets - Representation of functions, Selection of basis.

Module 4

Construction of wavelets: Biorthogonality and biorthogonal basis, Biorthogonal system of wavelets - construction, The Lifting scheme.

Books:

1. Stephen G. Mallat, "A Wavelet Tour of Signal Processing" 2nd Edition Academic Press, 2000.
2. M. Vetterli, J. Kovacevic, "Wavelets and Sub band Coding" Prentice Hall Inc, 1995.
3. Gilbert Strang and Truong Q. Nguyen, "Wavelets and Filter banks" 2nd Edition Wellesley-Cambridge Press, 1998.

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EC1*119: Advanced Antenna Systems

Module 1:

Antenna parameters: Radiation pattern, radiation power density, radiation intensity, directivity, gain, antenna efficiency, half-power beam width, bandwidth, polarization, input impedance, radiation efficiency, vector effective length and equivalent areas

Module 2:

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, Duality theorem, Reciprocity theorem.

Module 3:

Monopole and Dipole antennas, linear dipole antenna arrays-Broadside and End-fire Arrays, Binomial Array, Dolph-Tschebyscheff Array, loop antenna. Antenna Synthesis- Schelkunoff polynomial method, Fourier transform method

Helical antenna, Yagi – Uda antenna, parabolic antenna, Frequency independent antennas, Microstrip antenna, Fractal antenna, UWB antenna: antenna parameters and measurement; UWB antenna examples: bowtie, Vivaldi, valentine etc.

RF antennas –Smart Antennas- Principle, types, array design, antenna beamforming, direction-of-arrival algorithms, adaptive beamforming

Books:

1. C. A. Balanis, "Antenna Theory and Design", 3rd Ed., John Wiley & Sons., 2005.
2. W. L. Stutzman, and G. A. Thiele, "Antenna Theory and Design", 2nd Ed., John Wiley & Sons., 1998.
3. R. E. Collin, "Antennas and Radio Wave Propagation", McGraw-Hill., 1985.

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EC1*120: Quantum Computation

Module 1

Review of Linear Algebra. The postulates of quantum mechanics. Review of Theory of Finite Dimensional Hilbert Spaces and Tensor Products

Module 2

Complexity classes. Models for Quantum Computation. Qubits. Single and multiple qubit gates. Quantum circuit Bell states. Single qubit operations. Controlled operations and measurement. Universal quantum gates. Quantum Complexity classes and relationship with classical complexity classes

Module 3

Quantum Algorithms – Quantum search algorithm - geometric visualization and performance. Quantum search as a quantum simulation. Speeding up the solution of NP-Complete problems. Quantum search as an unstructured database. Grover's and Shor's Algorithms.

Module 4

Introduction to Quantum Coding Theory. Quantum error correction. The Shor code. Discretization of errors, Independent error models, Degenerate Codes. The quantum Hamming bound. Constructing quantum codes – Classical linear codes, Shannon entropy and Von Neuman Entropy.

Books:

1. Nielsen, Michael A., and Isaac L. Chuang, Quantum Computation and Quantum Information. Cambridge, UK, Cambridge University Press, September 2002
2. Gruska, J. Quantum Computing, McGraw Hill, 1999.
3. Halmos, P. R. Finite Dimensional Vector Spaces, Van Nostrand, 1958.

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EC1*121: Communication Switching Systems

Module 1

Electronic switching systems: basics of a switching system - stored program control –centralized SPC and distributed SPC, space division switching – strict-sense non-blocking switches - rearrangeable networks– Clos, Slepian-Duguid, Paull's Theorems - Synchronous transfer mode- asynchronous transfer mode - time division switching – TSI operation.

Module 2

Multi stage switching networks: Two-dimensional switching, Multi-stage time and space switching, implementation complexity of the switches - blocking probability analysis of multistage switches – lee approximation - improved approximate analysis of blocking switch - examples of digital switching systems (eg: AT & T No.5 ESS)

Module 3

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

Module 4

Signalling: customer line signaling – out-band signalling – in band signalling - PCM signalling - inter register signalling - common channel signalling principles-CCITT signalling system No: 7 - signalling system performance.

Introduction to ATM switching –Fast packet switching – self routing switches – Banyan network – ATM switches – Design of typical switches.

Books:

1. John C. Bellamy, Digital Telephony, third edition, Wiley Inter Science Publications, 2000
2. Schwartz M., Telecommunication Networks - Protocols, Modelling and Analysis, Pearson Education, 2004
3. Joseph Y Hui, Switching and Traffic Theory for Integrated Broadband Networks, Kluwer Academic Publishers, 1990.

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EC1*122: Advanced Communication Networks

Module I

Overview of Internet-Concepts, challenges and history. Overview of high speed networks-ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.;Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (IntServ). Resource reservation in Internet.

Module 2

RSVP.; Characterization of Traffic by Linearly Bounded arrival Processes (LBAP). Concept of (o, p) regulator. Leaky bucket algorithm and its properties.;Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic.;Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management.

Module 3

IP address lookup-challenges. Packet classification algorithms and Flow Identification- Grid of Tries, Cross producting and controlled prefix expansion algorithms.;Admission control in Internet. Concept of Effective bandwidth. Measurement based admission control.

Module 4

Differentiated Services in Internet (DiffServ). DiffServ architecture and framework.;IP switching and MPLS-Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS. [P control of Optical Routers. Lambda Switching, DWDM Networks.

Books:

1. Jean Wairand and PravinVaraiya, High Performamnce Communications Networks, Second Edition, 2000.
2. Jean Le Boudec and Patrick Thiran, Network Calculus A Theory of Deterministic Queueing Systems for the Internet, Springer Veriag, 2001.
3. Zhang Wang, Internet Qo,5, Morgan Kaufman 2001.

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EC1*123: Opto-electronic Devices and Systems

Module 1

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

Module 2

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

Module 3

Optical detection – PIN, APD, modulated barrier photodiode, Schottky barrier photodiode, wavelength selective detection, microcavity photodiodes.

Module 4

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. Optoelectronic ICs – hybrid and monolithic integration, materials and processing, integrated transmitters and receivers, guided wave devices

Books:

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

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EC1*124: Reliability of Semiconductor Devices

Module 1

Introduction to Reliability Physics, Reliability definition, dielectrics, critical field in a dielectric, generation and recombination of carriers, life time of carriers, diffusion length, Types of Defects in a Semiconductor, Avalanche break down, Zener break down, MOSFET scaling, Hot electron effect, velocity saturation, GIDL, Mathematics of Reliability: Weibull statistics, PDF

Module 2

Kinetics of Negative Bias Temperature Instability: Stress Phase, NBTI: Relaxation, Freq. Independence, and Duty Cycle Dependence, Field Acceleration of Negative Bias Temperature Instability, Dispersive vs. Arrhenius Diffusion, Circuit Implications of NBTI

Module 3

Scaling Theory of Hot Carrier Degradation, Voltage Dependence of Trap Generation: Lucky Electron Model, On-State Hot Carrier Degradation, Off-State Hot Carrier Degradation , Characterization of Interface Traps, Subthreshold and linear drain current Measurements, Charge-pumping, DC-IV, and GIDL Techniques for Interface Traps, Spin-Dependent Recombination

Module 4

Breakdown mechanisms of thick dielectrics and thin dielectrics, Time-Dependent Dielectric Breakdown, Kinetics of Trap Generation, Field-dependence of TDDB, Statistics of Oxide Breakdown: Cell percolation model, Theory of Soft and Hard Breakdown, Statistics of Soft-breakdown by Markov Chain, Measurement Techniques: VT, SILC, QY, and Floating Probe, TDDB and Circuits, Theory of Thick dielectrics, Spatial and Temporal Characteristics of dielectric breakdown, Theory of Radiation Damage, Sources of radiation flux and its characteristics, Soft error due to radiation effects, Radiation and hard errors, Radiation, error correction, Stress migration, Electro migration. Introduction to Electro static discharge (ESD), human body model, machine model, methods to contain ESD

Books:

1. Y. Taur and T.H. Ning, Fundamentals of Modern VLSI Devices Cambridge University Press, 1998, ISBN: 0-521-55959-6
2. R.F. Pierret, Semiconductor Device Fundamentals, Addison-Wesley, 1996, ISBN: ISBN 0-201-54393-1
3. D. K. Schroder, Semiconductor Material and Device Characterization, John Wiley and Sons, 1996, ISBN: 0-471-73906-5

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EC1*125: Operating Systems

Module 1

Review of operating system strategies - resources - processes - threads - objects - operating system organization –design factors - functions and implementation considerations - devices - characteristics - controllers - drivers –device management - approaches - buffering - device drivers - typical scenarios such as serial communications –storage devices etc

Module 2

Process management - system view - process address space - process and resource abstraction - process hierarchy -scheduling mechanisms - various strategies - synchronization - interacting & coordinating processes - semaphores -deadlock - prevention - avoidance - detection and recovery

Module 3

Memory management - issues - memory allocation - dynamic relocation - various management strategies –virtual memory - paging - issues and algorithms - segmentation – typical implementations of paging & segmentation systems

Module 4

File management - files - implementations - storage abstractions - memory mapped files - directories and their implementation - protection and security - policy and mechanism - authentication - authorization - case study of Unix kernel and Microsoft Windows NT (concepts only) Virtual machines – virtual machine monitors – issues in processor, memory and I/O virtualization, hardware support for virtualization.

Books:

1. Silberschatz, Galvin and Gagne, Operating System Principles, 7/e, 2006, John Wiley
2. William Stallings, Operating Systems, 5/e, Pearson Education
3. Crowley C., Operating Systems- A Design Oriented Approach, Tata McGraw Hill, New Delhi

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EC1*126: Cryptography & Network Security

Module 1

Divisibility – Prime numbers – Euclidean Algorithm – Diophantine equations - Congruence – Euler function - Fermat's little theorem – Euler theorem - Groups and fields - Polynomial ring – Field extension

Module 2

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

Module 3

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 4

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

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.
3. Lawrence C. Washington, "Elliptic Curves", Chapman & Hall, CRC Press Company, Washington., 2003

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EC1*127: Multirate Systems

Module 1

Multirate System Fundamentals: 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.

Module 2

Multirate Filter Banks: 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

Module 3

M-channel Perfect Reconstruction Filter Banks: 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

Module 4

Linear Phase Perfect Reconstruction (LPPR) Filter Banks: 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.

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.
3. Sanjit K. Mitra, Digital Signal Processing: A Computer based Approach, 3rd Edition, McGraw Hill, 2001.

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EC1*128: Digital Image Processing

Module 1

Digital image representation: 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 2

Image transforms: 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 3

Image enhancement & Restoration: 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 4

Image compression: 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.

Books:

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.
3. Jae S. Lim, Two-Dimensional Signal and Image Processing, Prentice-Hall, Inc, 1990.

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EC1*129: Opto-electronic Communication Systems

Module 1

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, optical link design using power budget and rise-time budget, nonlinear Schrodinger equation (no derivation). Introduction to optical line coding and modulation for optical communication.

Module 2

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

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).

Module 3

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)

Module 4

Introduction to optical networking: SONET and SDH standards. Wavelength Division Multiplexing (WDM) systems.

Books:

1. Gerd Keiser, 'Optical Fiber Communications', 4th edition, McGraw-Hill Education, 2010.
2. Leonid Kazovsky, Sergio Benedetto and Alan Willner: 'Optical Fiber Communication Systems', Artech House, 1996.
3. G.P.Agrawal: 'Nonlinear Fiber Optics', 3rd Ed; Academic Press, 2004.
4. G.P.Agrawal : 'Fiber optic communication systems', 3rd Ed; Wiley-Interscience, 2002.

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EC1*130: Radar Engineering

Module1

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

Module 2

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 lobbing-Conical Scan- Monopulse – Acquisition

Module 3

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

Module 4

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 .

Books:

1. Introduction to Radar Systems –Merrill I. Skolnik, 3rd Edition, MacGraw Hill, 2002.
2. Radar Handbook -MerrillI.Skolnik , McGraw Hill Publishers, 1990
3. Radar Principles for the Non-Specialist, by J. C. Toomay, Paul Hannen Sol Tech 2004
4. Radar systems- MerrillI.Skolnik, McGraw Hill Publishers, 2005.

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EC1*131: Computational Electromagnetics

Module 1

Introduction: Applications of electromagnetics in research and industry. Historical development of Computational Methods.

Numerical Methods: ODE solvers, Euler, Runge – Kutta, Boundary conditions, Propagation of errors, Survey of numerical packages, Scientific programming with Python and Matlab.

Cauchy's integral theorem, Fourier transform integrals with singularity, Singularity extraction technique, Branch point integrals. Saddle point, Stationary phase method for evaluation of radiation integrals. Special functions : Bessel functions, Fresnel integrals.

Module 2

Method of Curvilinear Squares. Finite Element Method (FEM): overview of FEM, Variational and Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations.; Method of Moments (MOM): integral formulation, Green's functions and numerical integration, other integral methods: boundary element method, charge simulation method.. Finite Difference Method. Monte Carlo Method. Understanding boundary conditions.

Module 3

Classification based on integral and differential equation solution, time domain and frequency domain solutions.

Time varying Electromagnetic Fields: **FDTD** simulations with the Yee cell. Courant's stability condition. Eddy currents and skin depth. Multi-resolution Time Domain Methods. Introduction to wavelets. Families of wavelets and orthogonality conditions.

Books:

1. Introduction to the Finite-Difference Time-Domain (FDTD) Method for Electromagnetics, S. D. Gedney, Morgan and Claypool Publishing, 2011.
2. M. V. K. Chari and S. J. Salon, Numerical methods in electromagnetism, Academic Press, 2000.
3. M. N. O. Sadiku, Numerical techniques in electromagnetics, CRC Press, 1992.

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EC1*132: Signal Compression

Module 1

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 2

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 3

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 4

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.

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.
3. Toby Berger, “Rate Distortion Theory: A Mathematical Basis for Data Compression”, Prentice Hall, Inc., 1971.

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EC1*133: Advanced Wireless Communications

Module1

Capacity of AWGN Wireless Channel. Introduction to OFDM; Multicarrier Modulation and Cyclic Prefix; Channel model and SNR performance; OFDM Issues – PAPR; Frequency and Timing Offset Issues.

Module 2

Introduction to MIMO, MIMO Receiver Design: Zero Forcing and MMSE Receiver; MIMO channel decomposition, Optimal Power Allocation strategy; MIMO Spatial Multiplexing – VBLAST; MIMO Diversity – Alamouti Code, OSTBC.

Module 3

Basic Concept of Adhoc Wireless Communication: WLAN, Bluetooth, Zigbee, UWB. Basic concept of cognitive radio. Advanced antennas for wireless communication: UWB antenna, MIMO antenna, Smart Antenna, Antenna for CR.

Books:

1. Andrea Goldsmith, Wireless Communications, Cambridge University Press.
2. Wireless Communications, “Andreas Molisch “Wiley IEEE Press.
3. MIMO Wireless Communications “ EzioBiglieri“ Cambridge University Press.

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EC1*134: Neural Networks and Genetic Algorithms

Module 1

Introduction to Artificial Neural Networks - Introduction to network architectures - knowledge representation - Learning Process. Learning algorithms.

Module 2

Neural Network Architectures-MLFFN-Recurrent NN- RBF Network structure - separability of patterns - RBF learning strategies - comparison of RBF, RNN and MLP networks- Hopfield networks.

Module3

Genetic Algorithm- Application to Engineering problems -Concept of neuro-fuzzy and neuro-genetic systems- GA as an optimization tool for ANN-Application of ANN in forecasting-Signal Characterization-Fault diagnosis-Neuro-Fuzzy-Genetic Systems- Case Studies in solving Engineering problems of control, signal/image processing etc.

EC1*135: Wireless Adhoc and Sensor Networks

Module 1

Introduction of ad-hoc/sensor networks; Advantages of ad-hoc/sensor networks; Unique constraints and challenges; Driving Applications; Wireless Communications/Radio Characteristics;

Module 2

Ad-Hoc wireless networks; Media Access Control (MAC) Protocols Issues in designing MAC protocols Classifications of MAC protocols MAC protocols; Routing Protocols; Issues in designing routing protocols Classification of routing protocols Routing protocols. Networking Sensors Unique features Deployment of ad-hoc/sensor network.

Module 3

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Sensor tasking and control Transport layer and security protocols Sensor Network Platforms and Tools Berkley Motes Sensor network programming challenges Embedded Operating Systems Simulators Applications of Ad-Hoc/Sensor Network and Future Directions.Ultra wide band radio communication Wireless fidelity systems

EC1*136: Architecture of Advanced Processors

Module 1

Fundamentals: Technology trend -Performance measurement –Comparing and summarizing performance- quantitative principles of computer design –Amdahl’s law-Case studies. Principles of processor performance - Processor performance optimization- Performance evaluation methods

Module 2

Features of advanced Intel processors: Enhancements of 80386 and Pentium -Hardware Features, PVAM,-Memory management unit-Virtual Memory and concepts of cache -32 bit programming

Module 3

Instruction and thread level parallelism: Instruction level parallelism and concepts - - Limitations of ILP- Multiprocessor and thread level parallelism- Pipelining: Issues and solutions- Instruction flow techniques -Program control flow and control dependences

Module 4

Superscalar and multi core techniques: General principles of superscalar architecture - -Basics ,Pipelining, The in-order front end, The out-of-order core, The reorder buffer, Memory subsystem-Multi core processing – facts and figures - Virtualization –concepts

Books:

1. John Shen and Mikko H Lipasti, Modern Processor Design: Fundamentals of Superscalar Processors, McGraw Hill Publishers, 2005
2. LylaB.Das, The x86 Microprocessors, Architecture, Programming and Interfacing Pearson Education, 2010
3. Hennessy J. L. & Patterson D. A., Computer Architecture: A Quantitative approach, 4/e, Elsevier Publications, 2007.

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EC1*137: Antenna and Wave Propagation

Module 1

Some types of practical radiating systems – Field and power calculations with currents assumed on the antenna - electric and magnetic dipole radiators - Radiation patterns and antenna gain - radiation resistance – antennas above earth or conducting plane traveling wave on a straight wire – V and rhombic antennas – methods of feeding wire antennas

Module 2

Radiation from fields over an aperture – fields as sources of radiation – Plane wave sources – Examples of radiating apertures excited by plane waves – electromagnetic horns – arrays of elements – radiation intensity with superposition of effects – array of two half-wave dipoles – linear arrays - Yagi - Uda arrays – frequency-independent arrays

Module 3

Antenna temperature - signal-to-noise ratio – far field, near field and Fourier transform – receiving antennas and reciprocity – reciprocity relations

Module 4

Effect of earth's conductivity on antenna pattern, effect of earth's conductivity and shape on surface wave propagation, effect of earth's magnetic field on EM waves in ionosphere, plasma and cyclotron frequencies, skip distance, maximum usable frequency

Books:

1. Simon Ramo, John R Whinnery, and Theodore Van Duzer, Fields and Waves in Communication Electronics, John Wiley and Sons, Third Edition, 2003.
2. John D. Kraus and Daniel A. Fleisch, Electromagnetics with Applications, McGraw-Hill, Fifth Edition, 1999.
3. C A Balanis: Antenna Theory, John Wiley, Second Edition, 2003.

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EC1*138: VLSI Design

Module 1

Introduction MOSFET, threshold voltage, current, Channel length modulation, body bias effect and short channel effects, MOS switch, MOSFET capacitances, MOSFET models for calculation-Transistors and Layout, CMOS layout elements, parasitic, wires and vias-design rules-layout design SPICE simulation of MOSFET I-V characteristics and parameter extraction

Module 2 (10 hours)

CMOS inverter, static characteristics, noise margin, effect of process variation, supply scaling, dynamic characteristics, inverter design for a given VTC and speed, effect of input rise time and fall time, static and dynamic power dissipation, energy & power delay product, sizing chain of inverters, latch up effect-Simulation of static and dynamic characteristics, layout, post layout simulation

Module 3 (13 hours)

Static CMOS design, Complementary CMOS, static properties, propagation delay, Elmore delay model, power consumption, low power design techniques, logical effort for transistor sizing, ratioed logic, pseudo-NMOS inverter, DCVSL, PTL, DPTL & Transmission gate logic, dynamic CMOS design, speed and power considerations, Domino logic and its derivatives, C2MOS, SPC registers, NORA CMOS –Course project

Module 4 (8 hours)

Circuit design considerations of Arithmetic circuits, shifter, CMOS memory design – SRAM and DRAM, BiCMOS logic - static and dynamic behavior -Delay and power consumption in BiCMOS Logic

Books:

1. Sung-Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits - Analysis & Design, MGH, Third Ed., 2003
2. Jan M Rabaey, Digital Integrated Circuits - A Design Perspective, Prentice Hall, Second Edition, 2005
3. David A. Hodges, Horace G. Jackson, and Resve A. Saleh, Analysis and Design of Digital Integrated Circuits, Third Edition, McGraw-Hill, 2004

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EC1*139: Silicon on Insulator and Advanced MOSFET based structures

Module 1

Review of MOS device: band diagrams, drain current and subthreshold characteristics, drain conductance, transconductance, substrate bias, mobility, low field mobility, high field mobility, mobility various models, scaling of MOSFET, short channel and narrow channel MOSFET, high-k gate dielectrics, ultra-shallow junctions, source, and drain resistance

Module 2

The SOI MOSFE: comparison of capacitances with bulk MOSFET, PD and FD SOI devices, short channel effects, current-voltage characteristics: Lim & Fossum model and $C-\infty$ model, transconductance, impact ionization and high field effects: Kink effect and Hot-carrier degradation, Floating body and parasitic BJT effects, self-heating

Module 3

Multiple gate SOI MOSFETs: double gate, FINFET, triple gate, triple-plus gate, GAA, device characteristics, short channel effects, threshold effect, volume inversion, mobility, FINFET

Module 4

Physical view of nanoscale MOSFET, Nator's theory of the ballistic MOSFET, role of quantum capacitance, scattering theory, MOSFET physics in terms of scattering, transmission coefficient under low and high drain biases, silicon nanowires, evaluation of the I-V characteristics, I-V characteristics of non-degenerate and degenerate carrier statistics

Books:

1. Jean-Pierre Colinge, Physics of Semiconductor Devices, Kluwer Academic Publishers, eBook ISBN: 0-306- 47622-3, Print ISBN: 1-4020-7018-7, access online at (NITC intranet) <http://www.springerlink.com/content/978-1-4020-7018-1/>
2. Y. Taur and T.H. Ning, Fundamentals of Modern VLSI Devices Cambridge University Press, 1998, ISBN: 0-521-55959-6
3. Jean-Pierre Colinge, FinFETs and Other Multi-Gate Transistors Springer, 2008, ISBN 978-0-387-71751-7 e-ISBN 978-0-387-71752-4, <http://www.springerlink.com/content/978-0-387-71751-7/contents/>

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EC1*140: Speech Processing

Module 1

Digital models for the speech signal - mechanism of speech production - acoustic theory – Portnoff's equations-lossless tube models – complete speech production model- digital models

Module 2

Speech analysis: -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 3

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. Spectral analysis of speech - short time Fourier analysis – STFT interpretations-filter bank summation method of short time synthesis

Module 4

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.

Books:

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

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EC1*141: Data Base Management System

Module 1

Database System concepts and architecture, Data modeling using Entity Relationship (ER) model and Enhanced ER model, Specialization, Generalization, Data Storage and indexing, Single level and multi-level indexing, Dynamic Multi level indexing using B Trees and B+ Trees.

Module 2

The Relational Model, Relational database design using ER to relational mapping, Relational algebra and relational calculus, Tuple Relational Calculus, Domain Relational Calculus, SQL.

Module 3

Database design theory and methodology, Functional dependencies and normalization of relations, Normal Forms, Properties of relational decomposition, Algorithms for relational database schema design.

Module 4

Transaction processing concepts, Schedules and serializability, Concurrency control, Two Phase Locking Techniques, Optimistic Concurrency Control, Database recovery concepts and techniques, Introduction to database security.

Books:

1. RamezElmasri and Shamkant B. Navathe, Fundamentals of Database Systems (5/e), Pearson Education, 2008.
2. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems (3/e), McGraw Hill, 2003.
3. Peter Rob and Carlos Coronel, Database Systems- Design, Implementation and Management (7/e), Cengage Learning, 2007.

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EC1*142: Ultra-Wideband Communication

Module 1

Introduction; Definition of UWB; International regulations for UWB signals; UWB standards; Comparison with narrowband; UWB channel characterization and measurement; Channel estimation errors and reliability; Different methods of UWB signal generation; UWB circuits, transceivers and systems; High rate UWB system design; Channel estimation for high rate systems; Adaptive Modulation, coding, MIMO techniques for high rate communication; Zigbee networks and low-rate UWB communication; Cooperative communication for reliability;

Module 2

UWB antenna design parameters; special features of UWB antenna; Example of UWB antenna design- bowtie, Vivaldi, rugby ball, valentine etc; UWB antenna applications.

Module 3

Position estimation techniques; time-based ranging via UWB radios; Ranging protocols; Practical consideration for UWB system design; Recent trends of UWB communication in research and industry.

Books:

1. RanjitGharpurey, Peter Kinget, “Ultra Wideband Circuits, Transceivers and Systems”, Springer 2007.
2. ZaferSahinoglu, SinanGezici, Ismail Guvenc, “Ultra Wideband Positioning Systems”, Cambridge University Press.
3. Ismail Guvenc, SinanGezici, ZaferSahinoglu and Ulas C. Kozat “Reliable Communications for short-range Wireless Systems”, Cambridge University Press.

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EC1*143: Software Engineering

Module 1

Introduction to Software Engineering – Reasons for software project failure – Similarities and differences between software and other engineering products.
Software Development Life Cycle (SDLC) – Overview of Phases.
Detailed Study of Requirements Phase: Importance of Clear Specification – Formal specification methods including algebraic specification in detail.

Module 2

Problem partitioning (subdivision) - Power of Abstraction
Concept of functional decomposition – process modeling - DFDs
Concept of data modeling – ER diagrams
Class and component level designs – Object Oriented Design - UML and Design Patterns (only introduction)

Module 3

Coding and Testing: Structured programming – internal documentation and need for standards – Methods of version control - Maintainability. Introduction to secure programming.
Types of testing – Specification of test cases – Code review process

Module 4

Software Project Management: Introduction to metrics. Software Process Models. Costing, Scheduling and Tracking techniques. Software configuration management - versioning. Reusable components. Mathematical methods of risk assessment and management. Methods of software licensing and introduction to free software.

Books:

1. Roger S Pressman, Software Engineering: A Practitioner's Approach (6/e.), McGraw Hill, 2008.
2. T C Lethbridge and R Laganier, Object Oriented Software Engineering (1/e), Tata McGraw Hill, 2004.
3. Pankaj Jalote, Software Engineering: A Precise Approach (1/e), Wiley India, 2010.

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EC1*144: Internet of Things

Module 1

Wireless Technologies for IoT: Wireless Ad-hoc network protocols standards- WLAN, Zigbee, Bluetooth, UWB- applications. Bluetooth Low Energy (BLE). Wireless Sensors for IoT- Synchronization and Localization, Reconfigurable Sensor Networks

Module 2

Embedded systems for IoT- Overview, characteristics and architecture, Processor basics and System-On-Chip. Sensor based applications through embedded system - Home control, Building automation, Industrial automation, Medical applications.

Module 3

Characteristics, Architectural overview and Functional blocks of IoT. Physical and Logical Design of IoT. IoT architecture outlines and standards. M2M and IoT Technology Fundamentals and differences, Local and wide area networking, Communication models and APIs.

Books:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1 st Edition, Academic Press, 2014.
2. Peter Waher, “Learning Internet of Things”, PACKT publishing, Birmingham – Mumbai
3. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer

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EC1*145: EMI and EMC

Module 1

Introduction To EMI - Definitions, Different Sources of EMI(Electro-magnetic Interference), Electro-static discharge(ESD),Electro-magnetic pulse(EMP),Lightning, Mechanism of transferring Electro-magnetic Energy: Radiated emission, radiated susceptibility, conducted emission,conducted susceptibility, Differential & common mode currents.

Module 2

Introduction to EMC - Concepts of EMC, EMC units.EMC requirements for electronic systems - World regulatory bodies- FCC, CISPR etc. Class-A devices, class-B devices, Regulations of the bodies on EMC issues.

Different Mitigation Techniques For preventing EMI Grounding: Fundamental grounding concepts, Floating ground, Single-point & Multi-point ground, advantages & disadvantages of different grounding processes.

Shielding: Basic concepts of shielding, Different types of shielding, Shielding effectiveness (S.E),S.E of a conducting barrier to a normal incident plane wave, multiple reflection within a shield, mechanism of attenuation provided by shield, shielding against magnetic field & Electric fields' for Electronic metal & Magnetic metal, Skin-depths' for far-field sources, shield seams.

Module 3

Cross-talks & Coupling, Measurement set for measuring Cross-talk. Filtering & decoupling.

Non-ideal behavior of different electronic components - Examples: Microwave oven, Personal Computers, Health Hazards-limits, EMC in healthcare environment.

Antennas for EMI Measurements - Broadband antenna measurements, antenna factor.

EMI-EMC Measurements - EMC measurement set, Power losses in cable, calculation of signal source output for a mismatched load, Measuring &Test systems, Test facilities, measurements of radiated emission in open test range & in Anechoic chamber, Conducted emission testing by Line Impedance Stabilization network (LISN).

Module 4

Time-domain & Frequency-domain Analysis of Different Signals - Fourier series & Fourier transform of different signals, identifying the frequency, phase& power spectrum of different signals. Time-domain Reflectometry (TDR) basics for determining the properties of a transmission line.

System Design For EMC - Simple susceptibility models for wires & PCB, Simplified lumped model of the pick-up of incident field for a very short two conductor line. Biological effects of electromagnetic radiation, SAR and SAR measurements, Phantom models.

Books:

1. Introduction to Electromagnetic compatibility-Clayton R.Paul(John wiley& Sons)
2. EMC Analysis Methods & Computational Models-Frederick M Tesche, Michel V.Ianoz, Torbjorn Karlsson(John Willey & Sons, Inc)
3. The ARIAL RFI Book-Hare,WIRFI published by-The American Radio Relay League Newington.

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EC1*146: Satellite Communication

Module 1

Introduction to Satellite Communication, Satellite orbits- Geo-stationery and Geo-synchronous satellites, communication subsystems: antennas, attitude and control systems, telemetry, tracking and command, power sub-system, transmitter, transponder and receiver.

Satellite link design- system noise temperature, G/T ratio of Earth station, uplink and downlink budgets, combined C/N ratio for uplink, transponder and downlink. System design examples.

Module 2

Analog and digital communication on satellite links- Modulation schemes, noise considerations, propagation effects- rain attenuation.

Multiple access techniques: Frequency division multiple access, time division multiple access, code division multiple access.

Module 3

VSAT systems- design issues, Global Positioning System (GPS), Low Earth Orbit systems- examples of contemporary satellite systems (Iridium).

Books:

1. T. Pratt, C. Bostian, J. Allnutt, 'Satellite Communications', 2nd edition, Wiley, 2008.
2. M Richharia: 'Satellite Communication Systems', (2nd. Ed.), Macmillan Press Ltd, 1999.
3. Dennis Roddy: 'Satellite Communications', 4thEd; MGH, 2006

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EC1*147: MEMS/NEMS

Module 1

An introduction to Micro sensors and MEMS, Evolution of Micro sensors & MEMS, Micro sensors & MEMS applications

Module 2

Microelectronic technologies for MEMS, Micromachining Technology, Surface and Bulk Micromachining, working principle of various MEMS.

Module 3

Micro machined Micro sensors: Mechanical, Inertial, Biological, Chemical, Acoustic, Microsystems Technology, Integrated Smart Sensors and MEMS.

Module 4

Interface Electronics for MEMS, MEMS Simulators, MEMS for RF Applications, Bonding & Packaging of MEMS, Conclusions & Future Trends.

Books:

1. Tai-ran Su, MEMS and Microsystems: design and Manufacture, Tata McGraw Hill.
2. S.K. Ghandhi, VLSI Fabrication Principles, John Wiley Inc., New York, 1983.
3. S.M. Sze (Ed), VLSI Technology, McGraw Hill, 1988.

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EC1*148: Modern Antennas and Applications

Module 1

Review of antenna radiation mechanism and fundamental antenna parameters. Conventional antennas: Microstrip antenna: Basic characteristics, feeding methods, methods of analysis, design of rectangular and circular patch antennas, application of microstrip antennas. Design, performance study and applications of broadband Antennas, frequency independent antennas, Ultra-wideband antennas.

Module 2

Array antenna design and applications. Design and applications of advanced antennas for wireless communication: Smart Antenna, MIMO antenna, Antenna for cognitive radio, Multiband antennas, Circular polarized antennas, Antennas for 4th and 5th generation mobile communication.

Module 3

Antenna performance improvement strategies: Integration of metamaterials, ACM, FSS, Superstrate. Frequency notch generation mechanism: slot, resonator, parasitic load. Antenna miniaturization, Antenna for radar. Wearable antenna, Antennas for Bio-medical applications. IoT antenna.

Books:

1. C A Balanis: Antenna Theory, John Wiley, Second Edition.
2. F. B. Gross, "Smart Antennas for Wireless Communications", McGraw-Hill.
3. D. Guha, Y. M. M. Antar, "Microstrip and Printed Antennas New Trends, Techniques and Applications," Wiley.

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EC1*149: Electronic Measurements and Instrumentation

Module 1

Basic Measurement Techniques: Moving coil, Moving Iron, dynamometer, Wattmeter, Electro-static Instruments. Errors in Measurement: Definition of accuracy, precision speed of response, non-linearity, techniques of linearization, classification of errors. Statistical analysis. Introduction to reliability.

Module 2

AC Bridges: Wheatstone Bridge Principle, Kelvin, Wein, Anderson Desauty and Scherring Bridges, measurement of inductance, capacitance and frequency.

Module3

Cathode Ray Oscilloscope: Construction and principle of operation. Sweep and sweep synchronization. Measurement of various parameters by CRO. High frequency and low frequency limitations – sampling and storage oscilloscopes.

Frequency domain instruments: Wave analyser, spectrum analyser,

Module 4

Digital Instrumentation – DVM, DMM, frequency counter, Transducers and actuators: piezoelectric sensors, LVDT, Measurement of pressure, Temperature and flow Special Purpose Instruments: Signal generators, Q-meter

Books:

1. Electronic Instrumentation – by Kalsi (2/e) (TMH)
2. Modern Electronic Instrumentation and Measuring Instruments: by Helpic& Cooper – PHI/Pearson Education
3. A course in Electrical & Electronic Measurement & Instruments – A.K. Sawhany (Dhanpat Rai)

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EC1*150: Computer Organization & Architecture

Module 1

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 2

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 3

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 4

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.

Books:

1. Patterson D.A. & Hennessy J.L., "Computer Organization and Design", Morgan Kaufmann Publishers, 2002
2. John.P.Hayes "Computer Architecture and Organization", McGraw-Hill International Editions, Computer Science Series, 1998.
3. Morris Mano "Computer System Architecture", Prentice-Hall India, Eastern Economy Edition, 2009

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EC1*151: MOS Device Modeling

Module 1

Semiconductor surfaces, Ideal MOS structure, MOS device in thermal equilibrium, Non-Ideal MOS: work function differences, charges in oxide, interface states, band diagram of non-ideal MOS, flat band voltage, electrostatics of a MOS (charge-based calculations), calculating various charges across the MOSC, threshold voltage, MOS as a capacitor (2 terminal device), Three terminal MOS, effect on threshold voltage

Module 2

MOSFET (Enhancement and Depletion MOSFETs), mobility, on current characteristics, off current characteristics, sub threshold swing, effect of interface states on subthreshold swing, drain conductance and transconductance, effect of source bias and body bias on threshold voltage and device operation, Scaling, Short channel and narrow channel effects- High field effects

Module 3

MOS transistor in dynamic operation, Large signal Modeling, small signal model for low, medium and high frequencies.

Module 4

SOI concept, PD SOI, FD SOI and their characteristics, threshold voltage of a SOI MOSFET, Multi-gate SOIMOSFETs, Alternate MOS structures.

Books:

1. E.H. Nicollian, J. R. Brews, Metal Oxide Semiconductor - Physics and Technology, John Wiley and Sons, 2003.
2. Jean- Pierre Colinge, Silicon-on-insulator Technology: Materials to VLSI Kluwer Academic publishers group, 2004.
3. Yannis Tsividis, Operation and Modeling of the MOS transistor: Oxford University Press, 2010.

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EC1*152: Microelectronics Technology

Module 1

Material properties, crystal structure, lattice, basis, planes, directions, angle between different planes, characterization of material based on band diagram and bonding, conductivity, resistivity, sheet resistance, phase diagram and solid solubility, Crystal growth techniques, wafer cleaning, Epitaxy, Clean room and safety requirements

Module 2

Oxidation: Kinetics of Silicon dioxide growth both for thick, thin and ultra thin films, thickness characterization methods, multi dimension oxidation modeling
Diffusion and Ion Implantation.

Module 3

Deposition & Growth: Various deposition techniques CVD, PVD, evaporation, sputtering, spin coating, epitaxy, MBE, MOCVD, materials used in cleaning, various cleaning methods, Wet etch, Dry etch, Plasma etching, RIE etching, etch selectivity/selective etching.

Photolithography: Positive photo resist, negative photo resist, comparison of photo resists, components of a resist, light sources, exposure, Resolution, Depth of Focus, Numerical Aperture (NA), sensitivity, contrast, need for different light sources, masks, Contact, proximity and projection lithography, step and scan, optical proximity correction, develop (development of resist), Next generation technologies: Immersion lithography, Phase shift mask, EUV lithography, X-ray lithography, e-beam lithography, ion lithography.

Module 4

Planarization Techniques: Need for planarization, Chemical Mechanical Polishing Metallization and Interconnects: Copper damascene process, Metal interconnects; Multi-level metallization schemes, Process integration: NMOS, CMOS and Bipolar process.

Books:

1. M. Deal and P.Griffin, Silicon VLSI Technology, James Plummer, Prentice Hall Electronics, 2010.
2. Stephen Campbell, The Science and Engineering of Microelectronics Oxford University Press, 1996.
3. S.M. Sze, VLSI Technology, 2nd Edition, McGraw Hill, 1988.

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EC1*153: Computer Networks

Module 1

Introduction: Building blocks- links, nodes - Layering and protocols - OSI architecture - Internet architecture – Multiplexing -Circuit switching vs. packet switching - Datagram Networks - Virtual Circuit networks.

Module 2

Direct link Networks: Framing - Error detection - Reliable transmission - Multiple access protocols – Ethernet (IEEE 802.3) - Token Rings (IEEE 802.5) - Bridges and LAN switches.

Module 3

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. 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.

Module 4

Broadband services and QoS: Quality of Service issues in networks. Application layer protocol: DNS, Remote Login protocol, File transfer Protocols, Message Transfer Protocol

Books:

1. Peterson L.L. & Davie B.S., “Computer Networks: A System Approach”, Morgan Kaufman, 3rded, 2003.
2. James. F. Kurose and Keith.W. Ross, “Computer Networks, A top-down approach featuring the Internet”, Addison Wesley, 3rd edition, 2005.
3. D. Bertsekas and R. Gallager, “Data Networks”, PHI, 2nd edition, 2000.

EC1*154: VLSI Physical Design

Module 1

Introduction to physical design automation, Partitioning, Floor planning and Placement, Grid Routing and Global Routing, Detailed Routing and Clock Design, Clock Routing and Power/Ground

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Module 2

Static Timing Analysis and Timing Closure, Physical Synthesis and Performance Driven Design Flow, Interconnect Modeling and Layout Compaction

Module 3

Introduction to Testing, Fault Modeling and Simulation Test Pattern Generation, DFT and BIST Low Power Design Techniques, Low Power Design Techniques

Books:

1. Andrew B. Kahng, Jens Lienig , et al. VLSI Physical Design: From Graph Partitioning to Timing Closure, Springer, 2014
2. Lim, “Practical Problem in VLSI Physical Design Automation”, Springer, 2011

EC1*155: RF Integrated Circuits

Module 1

RF systems – basic architectures, Transmission media and reflections, Maximum power transfer

Module 2

Parallel RLC tank, Q, Series RLC networks, matching, Pi match, T match. Interconnects and skin effect, Resistors, capacitors, Inductors

Module 3

MOS device review, Bandwidth estimation using open-circuit time constants, Bandwidth estimation using short-circuit time constants. Noise analysis, Thermal noise, flicker noise review, Noise figure, Intrinsic MOS noise parameters, Power match versus noise match, Large signal performance, design examples & Multiplier based mixers

Module 4

Class A, AB, B, and C amplifiers, Class D, E, and F amplifiers, and RF Power amplifier design examples. PLL design, GSM radio architectures, CDMA, and UMTS radio architectures

Books:

1. Behzad Razavi, “RF Microelectronics” by Pearson, 2013
2. Thomas H. Lee, “The Design of CMOS Radio-Frequency Integrated Circuits”, by Cambridge University Press, 2004.

EC1*156: Optimization Techniques

Module 1

Introduction to Optimization-Generate and Test-Objective Function and Principle of Duality-Objective Landscape and Hardness-Traps-The No Free Lunch Theorem - Constraint Functions-Generate and Test

Gradient Descent method, Introduction to Linear Programming Model, Graphical Method, Transportation Methods, Simplex Method, Nonlinear Optimization, Salient Features of Metaheuristic Optimization Algorithms-Introduction to Nature Inspired Algorithms

Module 2

Internal Parameters of Metaheuristic Algorithms, Topology and Memory, Mating Restriction, Selection Tool: Natural Selection, Mate Selection and Survivor Selection, Selection Operators, Elitism, Local Search Tool: Single point, Two point, Binomial and Simulated Binary Crossover, Tool for Global Search: Mutation and Turbulence Operators, External Archives.

Generalist vs Specialist Algorithms, Parameter Tuning and Controlling Operators and Internal Parameters: Population and Topology, Selection, Local and Global Search, Hybridization

Module 3

Real Parameter Optimization: Random Walk, Simulated Annealing, Evolutionary Algorithms: Differential Evolution, Genetic Algorithms, Evolution Strategy, Swarm Intelligence: Particle Swarm Optimization

Module 4

Application of Optimization algorithms: Digital Filter Design, Antenna Pattern Synthesis, Hybridization with Neural Network, Fuzzy Logic.

Books:

1. A. E. Eiben, and J. E. Smith, "Introduction to Evolutionary Computing", Vol. 53. Springer: Berlin, 2003.
2. D. E. Goldberg, "Genetic Algorithms", Pearson Education India, 2006
3. R. L. Haupt, and D. H. Werner, "Genetic Algorithms in Electromagnetics", Wiley, 2007