



**August-December
Semester**

E0 284 2:1 Digital VLSI Circuits - Viveka Konandur Rajanna

Introduction to MOS transistor theory, Circuit characterization & simulation, theory of logical effort, interconnect design and analysis combinational circuit design, sequential circuit design. Design methodology & tools, testing & verification, datapath subsystems, array subsystems, power and clock distribution, introduction to packaging.

Prerequisites: None

References: N. Weste and D. Harris, CMOS VLSI Design. A Circuits and Systems Perspective, Addison Wesley, 2005~J. M. Rabaey, A. Chandrakasan, and B. Nikolic, Digital Integrated Circuits~Current literature

E2 232 2:1 TCP/IP Networking - T. V. Prabhakar, Haresh Dagale, Joy Kuri

IP addressing, IP header; subnetting and supernetting, CIDR, routing table, Ethernet, ARP; Serial links, PPP, ICMP, UDP, TCP: header, connection establishment, ISN, half close, delayed acks, header flags, TCP state transitions, sliding window, Slow Start, Congestion Avoidance, Fast Retransmit, Fast Recovery; DNS; multicasting, IGMP; IEEE 802.11 wireless LANs; Bridges, L2 switches, Spanning Tree algorithm, VLANs; Mobile IP; Private IP; NAT; DHCP; http; routing protocols: RIP, OSPF, BGP; IPv6

Prerequisites: None

References: W. Richard Stevens, TCP/IP Illustrated, Vol I: The Protocols, Pearson Education Asia, 2000

E2 243 2:1 Mathematics for Electrical Engineers - Joy Kuri, Chandramani Singh

sequences and series, Limits, Continuity. Probability Theory: The axioms of probability theory, Independence and conditional probability, Random variables and their distribution, Expectation, Conditional distribution, Convergence of sequences of random variables, Laws of large numbers and Central limit theorem. Linear Algebra: Vector Spaces, Subspaces, Linear independence, Basis and dimension, Orthogonality; Matrices, Determinants, Eigenvalues and Eigenvectors, Positive definite matrices, Singular Value Decomposition.

Prerequisites: None

References: Rudin, W., Principles of Mathematical Analysis, McGraw-Hill, 1985~Strang G., Linear Algebra and Applications, Thomson Brooks/Cole, 4th Edition, 2006~D. P. Bertsekas, J. N. Tsitsiklis, Introduction to Probability, Athena Scientific Press, 2nd Edition, 2008

E3 200 1:2 Microelectronics Lab - Mayank Shrivastava

Device TCAD and Device Design Basics using TCAD: Device TCAD Models, Device Simulation Approach, Design of CMOS (nMOS/pMOS) devices using TCAD device simulations, Design of FinFET using device simulations, Analysis of Physical Parameters and Device Physics using TCAD, Parameter extraction from simulation results 2. CMOS Process Technology, Process Development, Integration and Simulation: Processing Steps - Lithography, Etching, Dopant Implantation, Material Deposition, Thermal annealing / Dopant Diffusion and Backend Metallization. TCAD Process simulation - Unit process simulation, process calibration, process integration, simulation of basic CMOS devices. TCAD simulation of standard cell library element, Advance CMOS device design, process simulation and process integration, Basics of 3D process simulation, Layout design for test chips development, Details of Mask writing and device fabrication 3. Semiconductor Device Characterization: Non-destructive and destructive characterization

Prerequisites: None

References: None

E3 220 3:0 Foundations of Nanoelectronics Devices - Kausik Majumdar

Mathematical foundations of quantum mechanics, operators, bra and ket algebra, time independent and time dependent Schrodinger equation, crystal lattice and Brillouin zone, Bloch theorem, band theory of solids, tight binding, band structure examples (Si, Ge, III-V) in E-k space, effective mass, principles of operation of p-n junction (homo and hetero junction) and MOSFET, single gate versus multiple gates, bound states, effect of confinement, subbands, quantum capacitance, strain effects, tunneling, tunnel diode, intra-band and band to band tunneling in MOSFET, quantum theory of linear harmonic oscillators, phonons in solids, carrier mobility in MOSFET, quantum theory of angular momentum, electron spin.

Prerequisites: None

References: D. J. Griffiths, Introduction of Quantum Mechanics, Prentice Hall., A. Ghatak and S. Lokanathan, Quantum Mechanics, Trinity Press., V. K. Thankappan, Quantum Mechanics, New Age. Solid State Physics, N. W. Ashcroft and N. D. Mermin., S. M. Sze, Physics of Semiconductor devices, Wiley-Interscience., Y. Taur and T. H. Ning, Fundamentals of modern VLSI devices, Cambridge University

E3 235 2:1 Design for Analog Circuits - Naga Krishna Varati

Op-amp circuits: single-stage & multi-stage amplifiers; differential & instrumentation amplifiers; FB-topologies; i v, v-i & impedance converters; current amplifier; Error budgeting: static and dynamic errors in op-amp circuits; Power supplies: precision rectifiers; voltage regulators & protection circuits; Active filters: LPF, HPF, BPF, BRF & APF; 1-pole, 2-pole and Butterworth; Instability: GM, PM, dominant-pole, pole-zero & roc compensation; Nonlinear circuits: hysteresis, schmitt-triggers & exponential circuits; Oscillators: relaxation/phase-shift/wien bridge/voltage controlled oscillators; waveform generators; Practical designing: sensor amplifiers & damping; AGCs & compressor circuits; ADCs and DACs; photo-resistor & opto-coupler circuits; temperature indicators & PID-controllers; 4-20ma transmitters; ELF/VLF receivers. Lab exercises: understanding datasheets; circuit simulation using LTspice.

Prerequisites: None

References: Sergio Franco: "Design with Operational Amplifiers and Analog Integrated Circuits" McGraw-Hill Series; Peter D. Hiscocks: "Analog Circuit Design"; Online articles on: "Circuit Simulation with LTSpice"

E0 217 2:1 Efficient and Secure Digital Circuits and Systems - Utsav Banerjee

Circuits: overview of CMOS digital circuit design, logic gates, combinational and sequential logic, finite state machines, arithmetic circuits, memories, timing considerations, power consumption Systems: overview of computer architecture, instruction set, hardware-software interaction, micro-controllers, hardware acceleration, FPGA and ASIC design. Efficiency: gate-level optimization for power-performance-area, low-power versus energy-efficient implementation, pipelining, multi-level memories and caches. Security: introduction to cryptography and security protocols, implementation of multi-precision modular arithmetic, timing and power side-channel attacks and countermeasures.

Prerequisites: Basic understanding of digital electronic circuits.

References: 1.M.M.Mano and M.D.Ciletti, "Digital Design," Pearson Education, 2018. 2.J.M.Rabaey, A.P.Chandrakasan and B.Nikolic, "Digital Integrated Circuits: A Design Perspective," Pearson Education, 2016. 3.Journal/Magazine Articles and Conference Papers.

E3 238 2:1 Analog VLSI Circuits - Arup Polley

Review of MOS device characteristics, Long channel MOS, Second order effects, MOS small signal parameters and models, MOS capacitance. Concept of f_T , Bipolar transistors, Small signal parameters of BJTs, Common Emitter/Common source Amplifiers, CB/CG Amplifiers Emitter/Source followers, Source Degeneration, Cascodes, emitter/Source coupled pairs, Current Mirrors, Differential Pairs, Frequency Response, Noise, Feedback, Linearity, Operational Amplifiers: Telescopic and Folded Cascode, Stability and Compensation, Slew rate and setting, Common Mode Feedback.

Prerequisites: None

References: Behzad Razavi, Design of Analog CMOS Integrated Circuits~Grey, Hurst, Lewis and Meyer, Analysis and Design of Analog Integrated Circuits~Selected Papers and Patents.

E3 245 2:1 Processor System Design - Kuruvilla Varghese

Introduction: Basic Processor Architecture, Instruction Set Design, Datapath and Controller, Timing, Pipelining. CISC Processor Design: Architecture, Design. RISC Processor Design: single cycle implementation, multi cycle implementation, pipelined implementation, exception and hazards handling, RISC-V. Memory Hierarchy: Cache, Paging, TLB. Bus: Bus Topologies, AXI, PCIe, Bus Bridges, BFM, Network-on-Chip. Superscalar Processors Design: Superscalar organization, superscalar pipeline overview, VLSI implementation of dynamic pipelines, register renaming, reservation station, reordering buffers, branch predictor, and dynamic instruction scheduler etc.

Prerequisites: None

References: Computer Organization and Design: The Hardware/Software Interface, The Morgan Kaufmann, By David A. Patterson and John L. Hennessy~Computer Architecture: A Quantitative Approach, The Morgan Kaufmann By John L. Hennessy and David A. Patterson~Modern Processor Design: Fundamentals of Superscalar Processors, McGraw-Hill By John P. Shen ~Current Literature.

E3 258 2:1 Design for Internet of Things - T V Prabhakar

Introduction to IoT, Challenges in IoT - Power, Security, Identification, Location, Low Power Design, Energy harvesting systems, Power management algorithms, Working with ADC, DC-DC and LDO component datasheets, ARM processor low power features, multiprocessor systems, Lifetime estimation, RFID and its applications, Backscattering techniques, Working with protocols such as MQTT, COAP, for low power and energy harvesting sensor nodes, Low power wireless networks - Bluetooth Low Energy (BLE), and IEEE 802.15.4e TSCH. Low Power Wide Area Networks - LORA, NB-IoT and power-saving modes, CAT-LTE-M1.

Prerequisites: None

References: RFCs, Application notes, Standards, Handbooks, Recent papers on selected topics.

E3 282 3:0 Basics of Semiconductor Devices and Technology

- Mayank Shrivastava

- 1) Device TCAD and Device Design Basics using TCAD: Device TCAD Models, Device Simulation Approach, Design of CMOS (nMOS/pMOS) devices using TCAD device simulations, Design of FinFET using device simulations, Analysis of Physical Parameters and Device Physics using TCAD, Parameter extraction from simulation results
- 2) CMOS Process Technology, Process Development, Integration and Simulation: Processing Steps - Lithography, Etching, Dopant Implantation, Material Deposition, Thermal annealing / Dopant Diffusion and Backend Metallization. TCAD Process simulation - Unit process simulation, process calibration, process integration, simulation of basic CMOS devices. TCAD simulation of standard cell library element, Advance CMOS device design, process simulation and process integration, Basics of 3D process simulation, Layout design for test chips development, Details of Mask writing and device fabrication
- 3) Semiconductor Device Characterization: Non-destructive and destructive characterization

Prerequisites: None

References: S. M. Sze, Physics of Semiconductor Devices, John Wiley, Donald Neamen, Semiconductor Physics and Devices

E3 273 2:1 Microcontroller and its Application

- Ramachandran P

Microcontroller and its Applications Microcontroller COTS boards Architecture: Raspberry Pi. AURDUINO, and others Raspberry Pi Board, Software Systems & Applications Arduino Boards, Software Systems & Applications Using Arduino with Raspberry Pi for Real Time Applications Laboratory: Using Raspberry Pi, Arduino Boards and Sensors for Engineering Applications. Ramachandran P.

Prerequisites: None

References: Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux Book by Derek Molloy.

E6 203 1:2 Mechatronics System Design - Umanand L

Mechatronics intro, bond graph modelling of mechatronic systems, sensors and circuits - voltage, current, temperature, pressure, velocity, position, angular velocity, flow, flow rate, torque, stress, strain, etc., electrical actuators and drive - moving iron, solenoids, relays, electric motors, servo motor, stepper motor, motor selection, mechanical actuators - kinematic chains, cam, gears, ratchet, clutches, flexible elements, brakes etc., interfacing microcontrollers with actuators, control of actuators, robotic manipulator, differential dynamic mobile robot

Prerequisites: None

References: 1. System dynamics: A unified approach, Dean Karnopp and Ronald Rosenberg, John Wiley and Sons 2. Mechatronics: Principles and Applications, Godfrey C Onwubolu, Elsevier publishers, 2005, 3. Digital control of dynamic systems, Franklin, Powell and Workman, Addison-Wesley, 3ed.

E3 260 2 :1 Embedded System Design-II - Haresh Dagale, Chandramani Singh

Review of an embedded system without OS, Software components: startup code, boot loader, kernel, applications. Realtime concepts for embedded systems, Basic OS constructs Semaphores, Mutex, Queues, Tasks, and Scheduler, Introduction to a real-time kernel, scheduling policies, mutual exclusion, and synchronization, inter-task control flow, inter-task data flow, memory management, interrupt processing. Linux for embedded applications: an overview of Linux kernel architecture; system call interface. Process management; memory management; file system architecture. Linux for micro- controllers and real-time applications. Device driver: character, block and network drivers. Designing a real-time system: development life cycle, modeling a real-time system, Case studies.

Prerequisites: None

References: Real Time Concepts for Embedded Systems by Qing Li and Caroline Yao, ELSEVIER~Embedded Systems - Real-Time Operating Systems by Jonathan W. Valvano~Understanding Linux Kernel by Bovet, D., and Cesati, M. O'Reilly Publication.

E2 221 3:0 Communication Networks - Chandramani Singh

Introduction to networking. TCP and UDP, TCP analysis. IP, optimal routing, algorithms for shortest path routing, routing protocols, Mobile IP. ARQ schemes and analysis, random access, random/slotted ALOHA, splitting algorithms, CSMA-CD, wireless LANs CSMA/CA, IEEE 802.11 MAC. Modelling and performance analysis in networks; deterministic analysis, scheduling; stochastic analysis - traffic models, performance measures, Little's Theorem, M/G/1 model, Priority queueing.

Prerequisites: None

References: A. Kumar, D. Manjunath, and J. Kuri, Communication Networking: An Analytical Approach, Morgan Kaufman Publishers, 2004.~D. Bertsekas and R. Gallager, Data Networks, 2nd Edition, Prentice-Hall India, 2002.~J.F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, Pearson Education Asia, 2001.

E3 276 2:1 Process Technology and System Engineering for Advanced Microsensors and Devices - Hardik J Pandya

Introduction and Overview of Microfabrication Process Technology: Classification of Cleanrooms, Standard Operating Procedures for Working in a Conventional Clean Room Environment: Gowning Procedure, Operating Conditions, Clean Room Protocols, Safety and Contamination Issues in a Cleanroom, Overview of Cleanroom Hazards, Overview of Processes used in the Fabrication of Microsensors and Devices; Silicon Wafers - From Sand to the Laboratory: Silicon Growth Techniques: Czochralski and Float Zone, Wafer Processing from Si Ingot, Wafer Types: Crystallographic Planes, Physics of Silicon as a Semiconductor, Crystal Defects, Silicon Wafer Cleaning Methods: Piranha, RCA-1, RCA-2 using Wet-Benches; Thin Film Growth and Deposition Techniques: Thermal Oxidation, The Deal-Grove Model of Oxidation, Rate coefficients, Wet and Dry Oxidation, Overview of Oxidation Furnaces, Oxide Defects and ways of Mitigating it During Process Run, Contamination Control in the Furnace, Vacuum Systems: Construction and

Prerequisites: None

References: None