

SCHOOL OF ENGINEERING

DEPARTMENT OF ECE

B.Tech Electronics & Communication Engineering

THIRD SEMESTER

ECE2104 Data Structures and Algorithms [3 0 0 3]

Syllabus:

Introduction to C++/Python: An overview of C++/Python programming language, basic terms and operations. Linked List: Representing the linked list in memory with traversing and searching a linked list. Stack, Queues and Recursion: Array/ Linked representation of stack and queues with its applications. Trees: Tree Definitions, Type of Trees, Traversal Algorithms, Heaps and Priority Queues: Heaps, the Natural Mapping, Insertion into a Heap, Removal from a Heap, Path length: Huffman's algorithm. Sorting and Searching: Various sorting algorithms, Searching and data modification, Hashing. Graphs: Types of Graphs, Adjacency and Incidence Matrix for a Graph, Adjacency List for a Graph, Dijkstra's Algorithm, Graph Traversal Algorithms. Analysis of algorithm: Synergy between data structures and algorithm, Factors to be considered in the choice of data structures and algorithms.

References:

1. Yashavant Kanetkar, *Data Structures Through C++*, BPB Publications, 2023.
2. Adam Drozdek, *Data Structures and Algorithms in C++*, Cengage Learning, 2012.
3. David M. Reed , John Zelle, *Data Structures and Algorithms using Python and C++*, 1(e), illustrated Edition, Shroff/Franklin, Beedle & Associates, 2024.
4. Roberto Tamassia , Michael H. Goldwasser, Michael T. Goodrich, *Data Structures and Algorithms in Python*, Wiley, 1 (e), 2013.
5. E. Balagurusamy, *Object Oriented Programming with C++*, McGraw Hill, 2020.
6. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C++*, University Paperback, Pearson, 2014.

ECE2105 Digital Electronics [3 0 0 3]

Syllabus:

Introduction of Combinational logic design: Overview of Boolean Algebra and K-Map, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder. MSI devices: Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Barrel shifter and ALU. Sequential logic design: latch, Flip-flop, S-R FF, D FF, JK FF, T FF, and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Timing Analysis of sequential circuits. Designing of State Machines: Finite state machines, Design of synchronous FSM, State Reduction, Timing issues in synchronous circuits. Algorithmic State Machines, Designing synchronous circuits like Pulse train generator, Pseudorandom Binary Sequence generator, Clock generation. Design of asynchronous circuits. Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Concept of Programmable logic devices, Logic implementation using Programmable Devices.

References:

1. A. Kumar, *Fundamentals Of Digital Circuits*, Prentice Hall India Pvt., Limited, (2e), 2016.
2. R. P. Jain, *Modern Digital Electronics*, McGraw-Hill Education (India) Pvt Limited, (4e), 2009.
3. W.H. Gothmann, *Digital Electronics- An introduction to theory and practice*, PHI, (2e), 2006.
4. S. Brown and Z. Vranesic, *Fundamentals of Digital logic with Verilog Design*, McGraw Hill, (3e) 2013.

ECE2106 Electronic Devices & Circuits [3 0 0 3]

Syllabus:

Semiconductor Diodes: Semiconductor materials, energy levels. PN diode: equivalent circuits, capacitance, reverse recovery time. Zener diode, Light Emitting diode, Tunnel diode. Diode Circuits: Load-line, rectifier, clippers, clampers, voltage regulators. BJT: Introduction, Common-base, common-collector and common-emitter configuration & characteristic, Transistor Amplifying action, Emitter follower configuration. BJT biasing: operating point, Voltage divider bias configuration, bias stabilization. AC analysis: BJT model at low and high frequency, gains and resistances. FET: JFET-construction, operation and characteristics. MOSFET: structure and operation, IV Characteristics, Biasing in MOS Amplifier Circuits, DC analysis of MOSFET Circuits, Small Signal Operation and Models, Common Source (CS) amplifier, CS amplifier with degenerate source, Depletion-Type MOSFET. MOSFET scaling, short channel effects. FinFET: construction, operation and characteristics, subthreshold conduction. Multi-stage amplifiers and Frequency Analysis: RC coupling, frequency analysis of amplifiers, Miller effect capacitance. Feedback: Types of feedback, amplifiers with feedback. Oscillators, Barkhausen criteria, RC Phase shift oscillators, Crystal oscillators.

References:

1. Millman & Halkias, *Integrated Electronics*, McGraw Hill Publications, 2008.
2. Boylestad & Nashlesky, *Electronic Devices & Circuit Theory*, PHI, 10(e),
3. Albert Malvino & David J. Bates, *Electronic Principles*, Tata McGraw Hill, 7e, 2007.
4. Floyd, Thomas L., and David Buchla. *Electronics fundamentals: circuits, devices & applications*. Prentice Hall Press, 2009..
5. Sedra & Smith, *Microelectronic Circuits*, Oxford University Press, 5e, 2004.
6. Streetman, Ben G., and Sanjay Banerjee. *Solid state electronic devices*. Vol. 4. New Jersey: Prentice hall, 2000.

ECE2107 Circuits & Systems [3 0 0 3]

Syllabus:

Basic Circuit Elements and Laws: Voltage, current, power, energy, Ohm's law, KVL, KCL, Source transformation, Nodal and mesh analysis. Network Theorems: Superposition theorem, Thevenin's and Norton's theorems, Maximum power transfer theorem, Application to DC and AC circuits. Transient Analysis: First-order circuits (RL, RC): step, impulse, and sinusoidal inputs, Second-order circuits (RLC): underdamped, overdamped, critically damped response, Initial and final conditions. Sinusoidal Steady-State Analysis: Phasor representation, Power in AC circuits: instantaneous, average, and complex power, Resonance in series and parallel circuits. Laplace Transform and Its Applications: Laplace transform fundamentals, Inverse Laplace and partial fraction, Application to circuit analysis, Transfer function of circuits, System response using Laplace. Two-Port Networks: Z, Y, h, and T parameters, Interconnection of two-port networks.

References:

1. Charles K. Alexander, Matthew N. O. Sadiku, *Fundamentals of Electric Circuits*, 6 (e), McGraw-Hill Education.

2. William H. Hayt Jr., Jack E. Kemmerly, Steven M. Durbin, *Engineering Circuit Analysis*, 8 (e),, McGraw-Hill Education
3. A. Chakraborty, *Circuit Theory: Analysis and Synthesis*, Latest Edition, Dhanpat Rai & Co.
4. D. Roy Choudhury, *Networks and Systems*, 2 (e), New Age International
5. Van Valkenburg, M.E., *Network Analysis*, 3 (e), PHI Learning Pvt. Ltd.
6. Kuo, Franklin. *Network analysis and synthesis*. John Wiley & Sons, 2006.

ECE2108 Computer Architecture & Processor [3 0 0 3]

Syllabus:

Computer Architecture: Introduction, computer types, functional units, Von Neumann and Harvard architectures, RISC and CISC Architectures. Register Transfer and Microoperations, microprogrammed control Design of Basic Computer, Design of Accumulator Logic, Control unit design, Parallel Processing, Pipelining, Input-Output Organization, Memory Organization. 8086 Microprocessor: 8086 Architecture, 8086 Instruction Set: types of instructions and addressing modes, assembler and assembler directives, assembly language programming. RISC V: Introduction to the Reduced Instruction Set Computer, RISC V architecture and features.

References:

1. M. Morris Mano, *Computer System Architecture*, 3 (e), Pearson, 2008.
2. K. M . Bhurchandi, and A K Ray, *Advanced Microprocessors and Peripheral Devices*, 3 (e), McGraw Hill, 2018.
3. David A. Patterson, and John L. Hennessy, *Computer Organization and Design, The Hardware/Software Interface: RISC-V Edition*, Morgan Kaufmann, 2018.
4. Sonal Yadav, *Computer System Organization*, 1 (e), All India Council for Technical Education, 2024.
5. V.C. Hamacher, Z. Vranesic and S. Zaky, *Computer Organization*, 5(e), McGraw Hill, 2002.

ECE2132 Data Structures and Algorithms Lab [0 0 2 1]

Syllabus:

This laboratory course is designed to provide students with hands-on experience in implementing core data structures and algorithms using the C++/python programming language. It reinforces the theoretical knowledge gained in lectures by allowing students to apply data structures in solving real-world computational problems. Through various experiments, students will develop the ability to choose and implement appropriate data structures and understand their internal mechanisms. The course also familiarizes students with advanced concepts such as trees, heaps, graphs, and algorithm analysis, thereby laying a strong foundation for software development and competitive programming.

ECE2133 Digital Electronics Lab [0 0 2 1]

Syllabus:

Experiments of this lab are implemented at Hardware as well as software level. List of experiments include study of implementation of combinational and arithmetic circuits using logic gates and MSI chips, designing of sequential circuits and implementation of FSMs for their applications.

ECE2134 Electronics Devices & Circuits Lab [0 0 2 1]

Syllabus:

Experiments are carried out on hardware and software to analyze the characteristics of semiconductor devices like diodes, transistors and MOSFET. Circuits based on these devices are studied for various device and circuit parameters on hardware as well as software.

FOURTH SEMESTER

ECE2203 Analog Integrated Circuits [3 0 0 3]

Syllabus:

Differential Amplifiers: Need of differential amplifiers, basic differential pair- qualitative and quantitative analysis, Current mirror. Operational Amplifiers: Introduction, voltage transfer characteristics, op-amp parameters, open loop configurations. Op-amp with negative feedback, Inverting & Non-inverting voltage amplifiers. Linear op-amp applications: Voltage follower, DC and AC amplifiers; summing, scaling and averaging amplifiers; integrator, Differentiator; Voltage to current converter. Non-linear applications: Filters, Precision Rectifiers, OTA, comparators, Schmitt trigger. Oscillator, triangular, sawtooth and square waveform generator. Digital-to-Analog Conversion: specifications, Weighted Resistor, R-2R Ladder, Monolithic DAC. Analog-to-Digital conversion: specifications, Ramp Type, Successive Approximation, Dual Slope, Flash Type, Monolithic ADC. Timer IC555: circuit and working, 555 as monostable and astable multivibrator. Voltage regulators: Linear Voltage Regulators, IC Regulators, Switching Regulators. Phase locked loop: Operation of basic PLL, closed loop analysis of PLL, Voltage Controlled Oscillator, PLL applications, IC 565.

References:

1. Roy Choudhury and Shail Jain, *Linear Integrated Circuits*, 2 (e), New Age International Publishers, 2003.
2. S.Salivahanan and V.S. Kanchana Bhaaskaran, *Linear Integrated Circuits*, 6 (e), Tata McGraw-Hill, 2011.
3. Ramakant A.Gayakwad, *Op-Amps and Linear Integrated Circuits*, 4 (e), Prentice Hall, 2000.
4. Robert F. Coughlin, Frederick F. Driscoll, *Operational-Amplifiers and Linear Integrated Circuits*, 6 (e), Prentice Hall, 2001.
5. Sergio Franco, *Design with operational amplifier and analog integrated circuits*, McGraw Hill, 1997
6. Behzad Razavi, *Analog CMOS Integrated circuits*, McGraw-Hill, 2017.

ECE2204 System Design using HDL [3 0 0 3]

Syllabus:

Introduction to Verilog HDL, Hardware Simulation & Synthesis, Design Abstraction Levels: Switch-level, Gate-level, Dataflow, Behavioral modeling. Dataflow, Top-Down design with Verilog, Subprograms, Operators, Syntax and constraints, Delays. Characterization of HDL: Timing Analysis, concurrency, data types, nets, Verilog primitives. Modelling of Test Bench. Combinational and Sequential Design, task and functions. Usage of subprograms, parametrization and specifications, path delay specification. Modelling for State Machines. Interface design & Modelling.

References:

1. K. S. Kundert and O. Zinke, *The Designer's Guide to Verilog-AMS*. Springer, (1e) 2004.
2. S. Palnitkar, *Verilog HDL*, (2e), Pearson education, 2003.
3. J. Bhasker, *A Verilog HDL Primer*, Star Galaxy Pub., (3e), 2005.
4. S. Brown and Z. Vranesic, *Fundamentals of Digital logic with Verilog Design*, McGraw Hill, (3e) 2013.
5. M. Morris Mano, Michael D. Ciletti, *Digital Design: With an introduction to Verilog HDL*, Pearson, (6e), 2017.

ECE2205 Digital Signal Processing [3 0 0 3]

Syllabus:

Review of signals and systems: Time and frequency analysis. Transform Analysis of LTI Systems: The frequency Response of LTI systems, Inverse system, All- Pass system, Minimum Phase system, Linear systems with Generalized Linear Phase. Frequency domain sampling and reconstruction of discrete time signals: Discrete-Time Processing of continuous-time Signals, Continuous- Time Processing of Discrete-Time Signals, Changing the Sampling Rate Using Discrete-Time Processing. Discrete Fourier transform: Introduction, properties of the DFT, use of DFT in linear filtering, filtering of long data sequences, DFT as linear transformation, Computation of DFT, Decimation-in- Time and Decimation-in-frequency Algorithms. Implementation of discrete time systems: Structures for FIR systems - Direct form, cascade form, Frequency sampling and lattice structures. Structures for IIR systems - Direct form, cascade and parallel form. Design of IIR filters and digital FIR filters: Classical design by impulse invariance, bilinear transformation and matched Z- transform, characteristics and design of commonly used filters - Butterworth, Chebyshev, elliptical.

References:

1. A.V. Oppenheim & R.W. Schaffer, *Discrete-Time Signal Processing*, (2e), Pearson education, 2001.
2. S. Salivahanan, C. Gnanpriya, *Digital Signal Processing*, (2e), Tata McGraw-Hill Education, 2011.
3. J.G. Proakis, D.G. Manolakis, D. Mimitris, *Introduction to Digital Signal Processing- Principles, Algorithms and Applications*, (3e), Prentice Hall, India 2007.
4. Sanjit K. Mitra, *Digital Signal Processing- A Computer Based Approach*, (4e), Mc Graw Hill Education, 2013.
5. L.R. Rabiner & D.J. Gold, *Theory and applications of digital signal processing*, (3e), Prentice Hall, India, 2007.

ECE2206 Electromagnetic Field Theory [3 0 0 3]

Syllabus:

Coordinate systems and transformation, Vector fields-Gradient, Divergence, Curl-theorems and applications. Electrostatic Field: Coulomb's Law, Electric field intensity, flux density. Electric field due to various charge configurations, Potential functions and displacement vectors, Gauss 's law, Laplace's and Poisson's equations, Uniqueness theorem, Continuity equation, Capacitances, Energy density in an electric field, Boundary conditions. Magnetostatic Field: Magnetic field intensity, flux density and magnetization, Biot- savart law, Ampere's circuit law, Magnetic static and Vector potential, Energy stored in Magnetic field and boundary conditions. Electromagnetic fields: Analogy between electric and magnetic field, Field mapping and concept of field cells, Time varying fields, Displacement current, Maxwell's equations. Electromagnetic Waves: Uniform Plane Wave in free space, dielectrics and conductors, skin depth, Plane wave reflection and refraction, Standing Wave ratio, Radiation, EMI and EMC.

References:

1. Mathew N.O. Sadiku, *Elements of Electromagnetics*, (4e), Oxford university press, 2007 .
2. W. H. Hayt & J.A. Buck, *Engineering Electromagnetics*, (7e), TMH, 2005
3. J. D. Krause, *Electromagnetic with application*, (5e), TMH, 2010.
4. A.V. Bakshi, U.A. Bakshi, *Electromagnetic Field Theory*, (1e) , Technical Publications, 2020.
5. N.N. Rao, *Elements of Engineering Electromagnetic*, (6e), Pearson Education, 2006.
6. Edminister, *Theory and problems of Electromagnetic*, (2e), TMH, 2016

ECE2232 Integrated Circuits Lab [0 0 2 1]

Syllabus:

Experiments of this lab are implemented at hardware as well as software level based on op-amp 741 and timer IC 555. Opamp will be used for measurement of parameters and implementing circuits for linear and non-linear applications. Circuits will be implemented using Timer IC.

ECE2233 System Design using HDL Lab [0 0 2 1]

Syllabus:

The objective of this lab is to equip students with practical skills in designing, modelling, and verifying digital systems using Verilog Hardware Description Language (HDL). Through hands-on experiments, students will learn to implement combinational and sequential circuits employing various modelling styles such as gate-level, dataflow, and behavioural. The lab also aims to develop proficiency in creating modular, parameterized designs and writing effective testbenches for functional verification.

ECE2234 Digital Signal Processing Lab [0 0 2 1]

Syllabus:

Experiments of this lab are implemented using MATLAB software. The list of experiments includes: Time domain and Frequency Domain Analysis of signals and systems, Analysis in z-domain, Filter Design, Filter Implementation.

ECE2271 Project Based Learning - 1 [0 0 6 3]

Syllabus:

Based on identification of a research problem/latest innovation, literature review, planning and designing of the solution. Evaluation will be based on report/draft and presentation.

FIFTH SEMESTER

ECE3103 Optical Communication [3 0 0 3]

Syllabus:

Introduction to optical communication: Propagation of Light in an Optical Fiber: Ray Model, Numerical aperture, phase-front (wavefront) based study of Total Internal Reflection, Wave Model and its Analysis, V-number of an Optical fiber. Attenuation, Signal distortion on optical fibers: Material Dispersion, Intermodal Dispersion, Intermodal Dispersion, Material Attenuation, Microbending, Macrobending, fiber materials, fiber fabrication, Analysis of Signal distortion in optical fibers using OTDR, Practical issues in implementation of fiber link. Optical Sources: Introduction of Optical sources. Light Emitting Diode: Quantum Efficiency, material, electrical and spectral characteristics, modulation. Lasers: Introduction to Laser, Spontaneous emission, Absorption, Stimulated emission, Different type of lasers: ruby laser, He-Ne laser, semiconductor laser. Optical Receiver: Photon detector, Photo Diodes, Photo detector and its noise Analysis, Optical Receiver, Digital data transmission in optical domain, SNR, BER analysis, Performance

Analysis and the EYE-diagram, Receiver Sensitivity Degradation, Fiber Optic link Design, power penalty, EDFA.

References:

1. G.P Agrawal, *Fiber optics communication*, 3 (e), John Wiley & sons, 2002 .
2. Keiser, *Optical Fiber Communication*, 4 (e), Mc Graw Hill, 2017.
3. M.N. Islam (Ed), *Raman Amplifiers for communications*, Springer-verlag, New York, 2003.
4. J.Senior, *Optical Communication, Principles and Practice*, Prentice Hall of India, 3 (e), 2008.

ECE3104 Analog and Digital Communication [3 0 0 3]

Syllabus:

Introduction: Historical perspective and standards, elements of communications systems, signals & spectra, transmission media. Analog Communication: Linear & exponential continuous wave modulation, transmitters and receivers, frequency conversion & demodulation. Digital Communication: Baseband digital transmission, sampling, quantization & pulse modulation, digitization techniques for analog messages, Bandpass digital transmission, concept and analysis of PCM, DPCM, DM and ADM, M-ary modulation. Noise: Review of probability theory, random variables, random processes. Random signals & noise, performance evaluation of communication systems corrupted by noise. Case study: FM radio broadcasting.

References:

- 1 Bruce Carlson, Paul B. Crilly, Janet C. Rutledge, *Communication Systems*, 4(e), Mc Graw Hill, 2002.
- 2 Behrouz A. Forouzan, *Data Communications and Networking*, 5(e), McGraw-Hill, 2013.
- 3 Simon Haykin and Michael Moher, *Communication Systems*, (4e), John Wiley, 2009.
- 4 B. P. Lathi & Z. Ding, *Modern Digital and Analog Communication Systems*, Oxford, 2010.
- 5 Herbert Taub, Donald L. Schilling, and Goutam Saha, *Principles of Communication Systems*, (3e), McGraw Hill, 2008.

ECE3105 Digital VLSI Design [3 0 0 3]

Syllabus:

Introduction: VLSI technology trends, VLSI Design flow and Design Styles. MOS devices: MOS transistors- construction & operation, Threshold voltage. Scaling in MOS, second order effects in MOSFETs. CMOS Inverter: Static characteristics- VTC, noise margins, Dynamic behavior, Power dissipation. MOS Circuit design: Implementation of Boolean functions and combinational using CMOS logic family, Pass transistors and Transmission gates, dynamic and clocked CMOS. Clocking strategies. Design of sequential circuits. Circuit performance estimation: Estimation of delay in CMOS circuits, Logical effort. interconnects and delay models. Sizing and optimization. Fabrication and layout: MOS & CMOS fabrication, twin tub processes, Latch-up in CMOS, SOI process, VLSI Yield and economics. Stick diagram and Layout. Sub-system design: Adders, multipliers, and shifters. Static and dynamic RAM.

References:

1. S. M. Kang & Y. Leblebici, *CMOS digital Integrated circuits design and analysis*, Tata McGraw Hill, 4 (e), 2018.
2. Jan. M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, *Digital Integrated Circuits*, (2e), Pearson, 2003.
3. Neil H. E. Weste & Kamran Eshraghian, *Principles of CMOS VLSI Design*, 4 (e), Addison Wesley, 2010.

ECE3106 Microcontroller and Applications [3 0 0 3]

Syllabus:

Microcontroller Overview and 8051 Architecture: Features and selection factors for Microcontroller, Block diagram of 8051 Microcontroller, Comparison of Microcontroller and Microprocessor with examples. Architectures of 8051 Microcontroller: Architecture, Pin Configuration, Memory Organisation, Power saving options, Concept of pipelining. 8051 Programming: Software Development Cycle, Addressing Modes, Instruction set, Assembler Directives. 8051 Timers, Interrupts, Serial and Parallel Communication: Configuration and Programming of Timer/Counter, Interrupts, Serial Communication, and I/O Port using Special Function Registers [SFRs], Serial Communication, Modes of serial communication. 8051 Interfacing: I/O Interfacing, Interfacing ADC/DAC 0808/09 with 8051, Memory Interfacing. 8051 Applications: Square and Triangular waveform generation using DAC, Temperature sensor (LM35) interfacing using ADC to 8051, Water Level controller design using 8051, Stepper Motor Interfacing to 8051 to rotate in clockwise and anticlockwise direction.

References:

1. Mazidi Muhammad Ali, Mazidi Janice Gillispe, Mckinlay Rolin D, *The 8051 Microcontroller and Embedded Systems: Using Assembly and C*, 2 (e), Pearson Publication, 2017
2. Ayala Kenneth J, *The 8051 Microcontroller*, 3 (e), Thomson Delmar Learning, 2005,
3. Deshmukh Ajay V, *Microcontroller: Theory and Application*, 1 (e),, McGraw Hill, 2011,
4. Pal Ajit, *Microcontrollers: Principle and Application*, 1 (e), PHI Learning, 2014.
5. Chattopadhyay Santanu, *Microcontroller and Applications*, 1 (e), All India Council for Technical Education, 2023.

ECE3107 *Display Technologies [3 0 0 3]

Syllabus:

Introduction to Display Technologies: Overview, OLEDs and LCDs. Historical development and evolution of OLED and LCD technologies. Principles of OLEDs: Working principles of OLEDs, Types of OLEDs, Emissive layer materials and device structure. OLED Fabrication and Design: Thin film deposition techniques for OLEDs, Patterning methods and post-processing steps, Design considerations. Principles of LCDs: Working principles of Liquid Crystal Displays. Types of LCDs: Twisted Nematic (TN), In-Plane Switching (IPS), and Vertical Alignment (VA) Liquid crystal alignment and color filters. LCD Fabrication and Design: Fabrication processes for LCDs. Backlighting techniques and advancements. Design considerations for LCD-based display systems. Electrical and Optical Characterization: Measurement techniques for OLED and LCD parameters, Evaluating luminance, color accuracy, contrast ratio, and response times. Comparative analysis of OLED and LCD performance. Applications and Emerging Trends: Diverse applications of OLEDs and LCDs in electronic devices, Emerging trends.

References:

1. Lee, Jiun-Haw. Introduction to Flat Panel Displays, 2 (e), John Wiley & Sons, 2020.
2. Linliu, Kung. Micro-Led Display, 2 (e),, 2018.
3. Tsujimura, Takatoshi. OLED Display Fundamentals and Applications, 2(e), John Wiley & Sons, 2017.
4. Linliu, Kung. A Perfect Display, Micro-LED, OLED, LCD and CRT, 2(e), John Wiley & Sons, 2017.

ECE3132 Optical Communication Lab [0 0 2 1]

Syllabus:

Optical Fiber: Study various types of Optical fibers, optical sources and their radiation patterns, understand use of OTDR for various optical measurements and link analysis, study transmission and reception of analog and digital signals on an optical fiber link, determine the numerical aperture and

attenuation constant of fibers. Study of Optical Laser Source, Optical Power Meter, Variable Optical Attenuator, Optical connector certification system, attenuation in optical fiber through, Splice & Connector joints and their losses, Identification of fault location (distance) in the optical fiber, Measurement of fiber losses of single mode fiber due to bending, study the operation of optical fusion splicer, wavelength separation properties of a WDM coupler, study the isolation properties of optical isolators, circulators

ECE3133 Analog & Digital Communication Lab [0 0 2 1]

Syllabus:

Experiments of this lab are to demonstrate & analyse the following in hardware: Analog communication: Modulation schemes, Transmission and Reception, Sampling Techniques and Time division multiplexing, Digital communication: Modulation schemes, Transmission and Reception, Advanced Modulation Formats, Data transmission using Line coding techniques.

ECE3134 VLSI Design Lab [0 0 2 1]

Syllabus:

The lab covers schematic design and simulation of CMOS circuits using EDA tools. It includes analysis of DC, transient, power, and delay characteristics under various load conditions. Students will design transistor-level layouts using lambda-based rules, perform DRC and LVS checks, and compare pre- and post-layout simulation results. The course also explores dynamic logic design and comparative analysis with CMOS logic.

ECE3171 Project Based Learning - 2 [0 0 6 3]

Syllabus:

Based on project implementation and execution. Evaluation will be based on report/draft and presentation. Based on application of the project. Evaluation will be based on the outcomes of the project in the form of research articles or draft, IPR, app/product development. A+ grade may be awarded for SCOPUS indexed publication or published patent or functional product/prototype/app development etc. A departmental PBL evaluation committee will evaluate the outcomes of the PBL courses and to award grades based on the merit of the project.

SIXTH SEMESTER

ECE3202 Embedded & RTOS [3 0 0 3]

Syllabus:

Introduction: Definition and classification of embedded systems, Characteristics: real-time operation, low power, size constraints, dedicated function, Embedded system components, Embedded system design process and development lifecycle. STM32 Hardware Architecture: Overview (ARM Cortex-M series), Internal architecture: ALU, registers, buses, stack, system clock, NVIC, Memory hierarchy, I/O peripherals: GPIOs, Timers, Counters, ADC, DAC, Watchdog, Communication interface protocols, Interrupts and NVIC configuration. Embedded Software for STM32: Embedded C programming, STM32CubeIDE: code generation using STM32CubeMX, Peripheral initialization and HAL libraries, programming for debugging and interrupts. RTOS Basics: Introduction to RTOS and FreeRTOS, FreeRTOS components: Inter-task communication: semaphores, queues, mutexes, Time management and task priorities, Debugging and analyzing RTOS behavior using STM32 tools, Interfacing and Application Development: Sensor and actuator interfacing with STM32, UART to PC, SPI sensors RTOS-based application.

References:

1. Raj Kamal, *Embedded Systems: Architecture, Programming and Design*, 1 (e), McGraw-Hill, 2009.
2. James Peckol, *Embedded Systems: A Contemporary Design Tool*, 1 (e), John Wiley & sons, 2019.
3. Qing Li, *Real-Time Concepts for Embedded Systems*, 1 (e), CMP Books, 2003.
4. Yifeng Zhu, *Embedded Systems with ARM Cortex-M Microcontrollers in Assembly and C*, 1 (e).
5. Elecia White, *Making Embedded Systems*, 2 (e), O'Reilly Media, 2024.
6. STM32CubeMX and STM32CubeIDE Official Documentation.

ECE3203 Antennas [3 0 0 3]

Syllabus:

Introduction: Radiation Mechanism, current distribution, Antenna parameters. Vector potentials: Electric and magnetic vector potentials, solutions for wave equations, far-field radiation, Duality theorem, Reciprocity theorem. Linear wire Antennas: Infinitesimal, small and finite dipole Antennas, Region separation, Half wavelength dipole. Loop Antennas: Small circular loop Antenna, circular loop with constant current, Ferrite loop. Antenna Arrays and other types of antennas: Two element array, N-element array - uniform, broadside, ordinary end-fire, Non-uniform Amplitude Arrays, planar and circular arrays. Qualitative study of Folded dipole, long wire, V, Rhombic, Helical, Yagi Uda, log-periodic, Aperture antennas, and horn Antennas, Babinet's principle, Huygens's principle, Rectangular and Circular Microstrip Patch antenna, Quality Factor, Bandwidth, Efficiency. Antenna Measurements: Propagation of EM waves: Ground wave Propagation, Space Wave Propagation, Troposphere and ionosphere propagation and its effect on Radio Waves.

References:

1. C. A. Balanis, *Antenna Theory*, (3e), John Wiley & Sons, New Delhi, 2010.
2. J. Kraus, *Antenna and wave Propagation*, (4e), Tata McGraw - Hill, New Delhi, 2010.
3. K. D. Prasad, *Antenna and Wave Propagation*, (3e), Satya Prakashan, New Delhi, 2009.
4. F. E. Termen, *Radio Engineering*, (1e), Tata McGraw - Hill, New Delhi, 1995.

ECE3204 Control Theory [3 0 0 3]

Syllabus:

Introduction to Control Systems: Definition and classification of control systems, Open-loop vs. closed-loop systems, Applications of control systems in electronics and communication, Modelling of physical systems (electrical, mechanical, and electromechanical). Mathematical Modelling and Transfer Function: Transfer function concept, Block diagram representation and reduction, Signal flow graph and Mason's gain formula. Time-Domain Analysis: Standard test signals (step, ramp, impulse), Time response of first-order and second-order systems, Transient response specifications (rise time, settling time, peak time, overshoot), Steady-state error and error constants, Concept of stability, Routh-Hurwitz criterion. Stability and Root Locus Technique: Concept of root locus, Rules for root locus construction, Effects of adding poles and zeros, Stability analysis using root locus. Frequency-Domain Analysis: Frequency response specifications, Bode plot, Nyquist plot, Polar plot and Nichols chart, Gain margin and phase margin, Relative stability. State-Space Analysis (Basics): State variables and state-space modelling, Solution of state equations, Conversion of transfer function to state-space, Concepts of controllability and observability.

References:

1. I.J. Nagrath, M. Gopal, *Control Systems Engineering*, 6 (e), New Age International, 2017.

2. Katsuhiko Ogata, *Modern Control Engineering*, 5(e), Pearson Education, 2015.
3. Benjamin C. Kuo, Farid Golnaraghi, *Automatic Control Systems*, 9 (e), Wiley India
4. Gene F. Franklin, J.D. Powell, M. Workman, *Feedback Control of Dynamic Systems*, 8 (e), PHI Learning Pvt. Ltd, 2019.
5. Anand Kumar, M.E., *Control Systems*, 3 (e), PHI Learning Pvt. Ltd, 2007.

***ECE3205 *VLSI DSP Architecture [3 0 0 3]**

Syllabus:

Introduction: DSP algorithms, Data flow and Dependence graphs, critical path, Loop bound, iteration bound, Accuracy in DSP Implementations. Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters. Retiming: Solving System of Inequalities, Retiming Techniques. Unfolding: Algorithms, Properties. Folding: Folding Transformation, Register Minimization, Folded Architectures, Multirate Systems. Systolic Architecture Design: Introduction, Systolic Array Design, FIR Systolic Arrays, 2D Systolic Array Design. Fast Convolution: Algorithms, Iterated and Cyclic Convolution, Design of Fast Convolution Algorithm. Bit-level arithmetic architectures: Parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon's bit-serial multipliers using Horner's rule, bit-serial FIR filter. Programmable Digital Signal Processors: Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation UNIT, Programmability and Program Execution, Speed Issues, Features for External interfacing. Commercial Digital Signal-Processing Devices, Case study: TMS320C54XX Processors

References:

1. Keshab K. Parhi. *VLSI Digital Signal Processing Systems*, 1st Ed., Wiley-Inter Sciences, 2007.
2. Mohammed Ismail, Terri, Fiez, *Analog VLSI Signal and Information Processing*, 1st Ed, McGraw Hill, 1994.
3. Kung. S.Y., H.J. While house T.Kailath, *VLSI and Modern Signal Processing*, 1st Ed., Prentice Hall, 1985.
4. Jose E. France, YannisTsividls, *Design of Analog Digital VLSI Circuits for Telecommunications and Signal Processing*, 1st Ed., Prentice Hall, 1994.
5. Texas Instrument "*Digital Signal Processing Applications with the TMS320 Family*", 1st Ed., Prentice-Hall, 1988.

ECE3232 Embedded & RTOS Lab [0 0 2 1]

Syllabus:

Experiments of this lab are related to embedded system design using Keil/Arduino software and its implementation on Hardware Kit. Experiments embedded C/Arduino programming for hardware interfacing to various sensors and actuators and implementation of communication protocols like RS-232 communication, SPI, I2C, etc. for embedded systems. Lab also introduces to Linux commands, Shell programming, etc. with introduction to basic concepts of Real Time Operating Systems like Process, Thread, Semaphores, Mutex, IPC, scheduling, etc.

ECE3233 Antenna Simulation & Measurement Lab [0 0 2 1]

Syllabus:

Experiments of this lab are based on Antenna Systems: study of different types of antennas, resonant and non-resonant antennas, reciprocity theorem, current distribution, etc. Measurement of the radiation pattern of various types of antennas, half power points, gain, beam width and bandwidth etc. and understand its significance in EM wave propagation, antenna simulation software.

PROGRAM ELECTIVES

PROGRAM ELECTIVES-I

ECE3146 FPGA based System Design [3 0 0 3]

Syllabus:

Introduction: Digital systems implementation using MSI/LSI circuits: PLDs, PLAs, and PALs. Overview of full-custom, semi-custom, and standard-cell-based design approaches. Introduction to programmable ASICs—CPLDs, MPGAs, and FPGAs. Overview of FPGA design flow. FPGA Architecture: Architecture of FPGAs including logic blocks, interconnects, and I/O. Classification into SRAM, antifuse, and flash-based types. Basics of multi-FPGA systems, on-chip buses. Synchronous Sequential Circuit Design: Design of circuits: BCD decoders, adders, and array multipliers. FSM-based systems: sequence detectors, vending machines, and serial adders. ASM charts-based designs: vending machines and traffic light controllers. Design examples using HDL. FSM design and optimization. Digital System Design Approaches: Top-down and bottom-up methods. Integration of datapath and control units. Behavioral modeling, timing analysis, pipelining, resource sharing. HDL-based implementation on FPGA platforms.

References:

1. Zvi Kohavi, *Switching and Finite Automata Theory*, (2e), Tata McGraw-Hill, 2008.
2. Navabi, *Analysis and modeling of digital systems*, (2e) McGraw Hill, 1998.
3. Douglas Perry, *Modeling with VHDL*, (3e), McGraw Hill, 1994.
4. Navabi, *Verilog Digital Design*, (2e), McGraw Hill, 2007.

ECE3147 Machine Learning [3 0 0 3]

Syllabus:

Introduction: Informed and Uninformed Searching solutions and strategies, Alpha - Beta pruning. Knowledge Representation & Reasoning, Utility theory, Hidden Markov Models (HMM), Bayesian Networks. Machine Learning : Supervised and unsupervised learning, Decision trees, Statistical learning models, Learning with complete data - Naive Bayes models, Learning with hidden data - EM algorithm, Reinforcement learning. Pattern Recognition : Introduction, Design principles of pattern recognition system, Statistical Pattern recognition, Parameter estimation methods - Principle Component Analysis (PCA) and Linear Discriminant Analysis (LDA), Classification Techniques - Nearest Neighbor (NN) Rule, Bayes Classifier, Support Vector Machine (SVM), K - means clustering.

References:

1. Stuart Russell, Peter Norvig, *Artificial Intelligence - A Modern Approach*, (3e), Pearson Education, 2009.
2. Elaine Rich and Kevin Knight, *Artificial Intelligence*, (1e), McGraw-Hill, 1990.
3. E Charniak and D McDermott, *Introduction to Artificial Intelligence*, (1e), Pearson Education, 2016.
4. Dan W. Patterson, *Artificial Intelligence and Expert Systems*, (1e), Prentice Hall of India, 1990.

ECE3148 MEMS [3 0 0 3]

Syllabus:

Overview of MEMS and its significance in various industries. Historical context and evolution of MEMS technology. Introduction to key concepts: sensing, actuation, and microfabrication. MEMS Technology Principles. MEMS Design and Fabrication Techniques. Principles of MEMS design and design considerations.

Fabrication techniques: bulk micromachining, surface micromachining. Sensing and Actuation Mechanisms in MEMS. Principles of sensing mechanisms in MEMS devices. MEMS Accelerometers. MEMS Energy Harvesters. MEMS Modeling & Simulation. Materials used in MEMS fabrication and their properties. Processes such as lithography, deposition, and etching in MEMS fabrication. Integration of MEMS devices into larger systems. System-level considerations and challenges in MEMS applications.

References:

1. Gad-el-Hak, Mohamed. *MEMS: introduction and fundamentals*, 1st Ed., CRC press, 2005.
2. Ta i-Ran Hsu. *MEMS and Microsystems: Design, Manufacture and Nanoscale Engineering*, 1st Ed., John Wiley and Sons Inc., 2020.
3. Zhuoqing Yang, *Advanced MEMS/NEMS Fabrication and Sensors*, 1st Ed., Springer, 2022.
4. C. Liu, *Foundations of MEMS*, 1st Ed., Upper Saddle River, 2012.
5. Madou, Marc J. *Fundamentals of microfabrication: the science of miniaturization*, 1st Ed., CRC press, 2018.

PROGRAM ELECTIVE-II

ECE3149 CAD for VLSI [3 0 0 3]

Syllabus:

Introduction to CAD tools: Evolution of Design Automation, Types of CAD tools. Algorithmic Graph Theory: Graphs, graph optimization, basic algorithms. Architectural Synthesis: Constraints and problem formulation, Datapath and control unit synthesis, Scheduling, resource sharing and binding, Area/latency/Cycle time optimization. Combinational Logic Synthesis: Binary Decision Diagrams, positional cube notation, Two Level Logic Synthesis, Unate Recursive Paradigm, logic minimization algorithms, Multiple-Level Combinational Logic Optimization. Sequential logic optimization: State minimization and encoding, retiming. Logical Effort and delay optimization: Logical Effort, Multistage Logic Networks, Logical Effort Optimizing performance. Cell-library Binding: problem formulation, covering algorithms.

References:

1. G. D. Micheli, *Synthesis and optimization of digital circuits*, (1e), Mc Graw Hill, 2003.
2. S. Imam, M. Pedram, *Logic Synthesis for Low Power VLSI Designs*, (1e), Kluwer, 1997.
3. M. J. S. Smith, *Application Specific ICs*, (1e), Pearson, 1997.
4. Rabaey, J. M., Chandrakasan, A. P., & Nikolic, B., *Digital integrated circuits* (2e), Englewood Cliffs, Prentice hall, 2002.

ECE3150 Principles of Nanomaterials & Quantum dots [3 0 0 3]

Syllabus:

Introduction to nanomaterials: Scaling Laws, nanomaterials, Three-, two-, one- and zero-dimensional nanomaterials, size in nanomaterials, nanoparticles, nanowires, nanoclusters, quantum wells, conductivity and enhanced catalytic activity. Synthesis of metal nanoparticles: Top down and bottom up approaches, physical, chemical and biological methods. Anisotropic nanoparticles. Metal nanoclusters, Metallic and Bimetallic nanoparticles: Surface plasmon resonance. Quantum Dots: Quantum confinement, Band gap tuning, properties of quantum dots. Surface defects, Doping in Quantum dots. Carbon nanomaterials: graphene oxide, graphene, fullerenes, carbon nanotubes and carbon dots. Composites of carbon nanomaterials. Characterization of nanomaterials: analytical methods, optical characterization, spectroscopy, structural characterization, imaging techniques. Applications of nanomaterials in various fields.

References:

- 1 M. S. Ramachandra Rao, S. Singh. , *Nanoscience & Nanotechnology: Fundamentals of Frontiers*; 1st Ed., John Wiley & Sons, 2017.
- 2 Schmid, Günter, ed. *Nanoparticles: from theory to application*, 1st Ed., John Wiley & Sons, 2011.
- 3 Kumar, Challa SSR, ed. *Nanomaterials for medical diagnosis and therapy*, 1st Ed., John Wiley & Sons, 2007.
- 4 G. Cao, Y. Wang, *Nanostructures and Nanomaterials: Synthesis, Properties, and Application*; 1st Ed., 2003.
- 5 L. Rogach, *Semiconductor nanocrystal quantum dots synthesis, assembly, spectroscopy and applications*, 1st Ed., Springer, Wien; London, 2008.
- 6 E. Gazit, *Plenty of room for biology at the bottom: an introduction to bionanotechnology*, 1st Ed., Imperial College Press ; Distributed by World Scientific Pub. in the USA, London : Hackensack, NJ, 2007.

ECE3151 Microwave Engineering [3 0 0 3]

Syllabus:

Introduction: Transverse Electric, Transverse Magnetic and Transverse Electromagnetic waves in conducting planes, characteristics of TE, TM and TEM waves, wave impedance, attenuation , TE, TM and TEM waves. Transmission line equations & solutions: reflection and transmission coefficient, standing wave and standing wave ratio, line impedance and admittance, impedance matching, using stub line, application of smith chart in solving transmission line problems. Rectangular and circular waveguides: theory and analysis, characteristics of TE and TM mode and excitation of waveguides. Passive components: Resonators, Directional Couplers, E-plane Tee, H-plane Tee and Hybrid Tee, Hybrid ring, Attenuators, Circulator, Faraday rotation principle, Isolators. Microwave active Devices: Limitations of conventional vacuum tube devices. Two cavity klystron: Re-entrant cavities, velocity modulation process, bunching process. Reflex klystron: Velocity modulation, power output and efficiency and electronic admittance. Traveling wave tube: Slow wave structure, amplification process, convection current, axial electric field, wave modes and gain consideration. Magnetron: Mode of oscillation, Types of Magnetron, Strapping and Rising Sun Magnetron. Microwave diodes and transistors: Tunnel diode, Varactor diode, Gunn diode, IMPATT diode, Microwave transistors and FETs.

References:

1. S. Liao, *Microwave Devices and Circuits*, (3e), Prentice Hall, 1990.
2. D. M. Pozar, *Microwave Engineering*, (4e) John Wiley & Sons, 2012.
3. J. Ryder, *Network lines and Fields*, (2e), Prentice Hall, 2015.
4. Jordan & Balmain, *Electromagnetic waves and Radiating System*, (2e), Prentice Hall, 1968.

PROGRAM ELECTIVE-III

ECE3249 Design for Testability [3 0 0 3]

Syllabus:

Introduction: Verification vs Testing, Need for testing, Level of testing, Cost of testing, Roles of testing. Fault modelling: Stuck at Faults, Bridging Faults; Fault collapsing; Transistor (switch) faults. Fault Simulation: Deductive, Parallel and Concurrent Fault Simulation, Critical Path Tracing. SCOAP Controllability and Observability: significance and calculation of SCOAP measures. ATPG for Combinational Circuits: D-Algorithm, PODEM, Random pattern generation, Boolean difference symbolic method, Path sensitization method. Scan chain: Concept of scan chains for serial testing. Sequential Circuit ATPG: Time frame expansion, Nine-valued logic, Drivability, Complexity of ATPG, Test generation system. Compaction Techniques: General Aspects of Compaction Techniques; Ones-Count, Transition Count and Parity Check

Compression; Syndrome Testing; Signature Analysis. Memory Testing: Fault models, March tests. Built-In Self-Test (BIST) concept: BIST pattern generation, BIST response compaction, Aliasing definition. BIST Architecture.

References:

1. M. Bushnell and V. Agrawal, *Essentials of Electronic Testing for Digital, Memory, and Mixed-Signal VLSI Circuits*, 1st Ed., Kluwer Academic Publishers, 2000.
2. M. Abramovichi, M. Breuer and A. Friedman, *Digital Systems Testing and Testable Design*, 1st Ed., IEEE Press, 1999.
3. L. T. Wang, C. W. Wu and X. Wen, *VLSI Test Principles and Architectures*, 1st Ed., Elsevier, 2006

ECE3250 Information Theory & Coding [3 0 0 3]

Syllabus:

Random Signal Theory: Introduction to random variables and random processes, probability distribution- Binomial, Poisson and Normal distributions, Cumulative Distribution Function, Joint Distribution, Independent random variable and conditional distribution, Characteristics of random variable-Mean, variance and standard deviation. Information Theory: Introduction to information theory and probability, entropy, rate of information, Joint and conditional entropy. Mutual information: noise free channel, channel with independent input and output. Channel capacity: Binary symmetric channel, binary erasure channel, noise free channel, cascaded channels, and binary channel. Coding: Introduction, code efficiency, Shannon theorem, capacity of Gaussian channel, Bandwidth and S/N trade off Shannon-Fano coding, Huffman coding, Error control coding, Block codes and parity check codes, Hamming Weight, Hamming Distance, Minimum distance decoding, Single Parity codes, Repetition Codes, Hamming Codes, Linear block codes, Cyclic code, Convolution code.

References:

1. M. Kulkarni & K. S. Shivaprakash, *Information Theory and Coding*, (1e), Wiley India Pvt. Ltd, 1 (e), 2014.
2. A. Saha, N. Manna and S. Mandal, *Information Theory and Coding*, (1e), Pearson Education, 1 (e), 2013.
3. P.Z. Peebles, *Probability, Random Variables and Random Signal Principles*, (4e), Mc-Graw Hill, 2000.
4. F.M. Reza, *Information Theory*, (1e), Tata McGraw Hill, 1961.
5. R D Singh and S D Sapre, *Communication Systems*, (2e), Tata McGraw Hill, 1995.
6. R. Bose, *Information Theory, Coding and Cryptography*, (2e), Tata McGraw Hill, 2001.

ECE3251 Wireless Communication [3 0 0 3]

Syllabus:

Introduction to wireless channels and wireless networks: wireless channel as a random linear time varying system, Wireless channel modeling, WLAN Topologies, WLAN Standards. Outdoor Propagation Models- Longley Ryce Model, Okumura Model, Hata Model, PCS Extension to Hata Model, Walfisch and Bertoni Model, Indoor Propagation Models, Ericsson Multiple Breakpoint Model. Wireless Systems: Radio interface, Protocols, Authentication and security in GSM, Concept of spread spectrum, Fading and diversity techniques, Maximal Ratio Combining, RAKE Receiver, Wireless channel capacity, ergodic capacity and outage capacity. Recent Trends: Introduction to Wi-Fi, WiMAX, ZigBee Networks, Software Defined Radio, UWB Radio, Wireless Adhoc Network and Mobile Portability, MIMO systems, Security issues and challenges in a Wireless network, case study.

References:

1. Upena Dalal, *Wireless Communication*, (1e), Oxford University Press, 2009.
2. T. S. Rappaport, *Wireless Communication: Principles and Practice*, (2e), Pearson, 2010.
3. Andreas. F. Molisch, *Wireless Communications*, (2e), John Wiley - India, 2013.

4. William Stallings, Wireless Communications & Networks, (2e), Pearson, 2005

PROGRAM ELECTIVE-IV

ECE4148 Cyber-Physical System [3 0 0 3]

Syllabus:

Introduction: Applications, Motivating Example, The Design Process. Modelling Dynamic Behaviours: Continuous Dynamics, Discrete Dynamics, Hybrid Systems, Composition of State Machines, Concurrent Models of Computation. Design of Embedded Systems: Embedded Processors, Memory Architectures, Input and Output, Multitasking, Scheduling. Analysis and Verification: Invariants and Temporal Logic, Equivalence and Refinement, Reachability Analysis and Model Checking, Quantitative Analysis.

References:

1. E. A. Lee and S. Seshia, *Introduction to Embedded Systems – A Cyber-Physical Systems Approach*, 2nd Ed., MIT Press, 2011.
2. R. Alur, *Principles of Cyber-Physical Systems*, 1st Ed., MIT Press, 2015.
3. W. M. Taha, A. E. M. Taha, J. Thunberg, *Cyber-Physical Systems: A Model-Based Approach*, 1st Ed., Springer Nature, 2021.
4. Coursera, “Cyber-Physical Systems: Modeling and Simulation”, [Link to the course](#), Accessed on: June 2025.
5. SWAYAM/NPTEL, “Foundations of Cyber Physical Systems”, [Link to the course](#), Accessed on: January 2025.

ECE4149 Digital Image Processing [3 0 0 3]

Syllabus:

Fundamentals of digital image processing: image perception, sensing and acquisition, sampling and Quantization, image representation, basic relationship between pixels. Image enhancement and restoration: grey level transformation, Histogram processing, Image arithmetic, Spatial smoothing and sharpening filters, Laplacian filters, Frequency domain smoothing and sharpening filters, Homomorphic filtering, Image restoration. Image transforms: Fourier transform, Cosine Transform, Wavelet transform. Image Compression Algorithms and standards: Image compression standards, Lossless and lossy compression. Morphological processing and segmentation: Preliminaries, erosion, dilation, Hit-And-Miss transformation, Basic Morphological Algorithms; Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation; Color image processing: Color Fundamentals, Color Models, Pseudo color Image Processing, processing basics of full color image processing; Applications: Character recognition, Biomedical Image processing, Watermarking, multi-resolution analysis, video processing.

References:

1. R. C. Gonzalez, R. E. Woods, “*Digital Image Processing*” ed. 4 - Pearson Education 2018.
2. S. Sridhar, *Digital Image Processing*. Oxford University Press, 2011
3. W. K. Pratt, “*Digital Image Processing*” John Willey, Ed. 4, 2007
4. A.K. Jain, “*Fundamentals of Digital Image Processing*” PHI, New Delhi, Ed. 1, reprint 2015.

ECE4150 Internet of Things [3 0 0 3]

Syllabus

Fundamentals of Internet of Things: Beginner's Idea for IoT, Definition of IoT, Evolution of IoT, Conceptual Framework of IoT, IoT elements, architecture of IoT, Sensing and Actuation in IoT. IoT Communications Protocols: Introduction to IoT Communications Protocols, IoT Communication Protocols, IoT Network Topologies. Arduino Programming: Introduction, Arduino Hardware, Arduino Software (IDE), Examples of Arduino Programming, Introduction to Sensors and Actuators. Implementation of IoT with advanced microcontroller: Introduction, Introduction to Python Programming, Data Collection and Storage, Data Processing and Analytics, Visualization and Reporting. IoT Applications with Case Studies: Smart Agriculture, Smart Healthcare, Activity Monitoring.

References:

1. R. Kamal, *Internet of Things - Architecture and Design Principles*, (1e), McGraw Hill, 2017.
2. R. Buyya A. V. Dastjerdi, *Internet of Things: Principles and Paradigms*, (1e), Morgan Kaufmann, 2016.
3. Adrian McEwen, Hakim Cassimally, *Designing the Internet of Things*, Wiley, 2015.
4. Samuel Greengard, *The Internet of Things*, The MIT Press, 2015.
5. Gaston C. Hillar Gaston C, *Internet of Things with Python, Ingram short title*, 2016.
6. Anita Gehlot, Rajesh Singh, Bhupendra Singh, Praveen Kumar Malik, Lovi Raj Gupta, *Internet of Things with 8051 and ESP8266*, CRC Press; 1 (e), 2020.

PROGRAM ELECTIVE-V

ECE4151 VLSI Physical Design [3 0 0 3]

Syllabus:

VLSI Physical Design Introduction: VLSI Design Process, difficulties in Physical design, Graph theory; Circuit Partitioning: Problem definition, cost functions and constraints, Partitioning algorithms; Floorplanning: Problem definition, cost functions and constraints, Floorplanning algorithms; Placement: Problem definition, cost functions and constraints, Placement algorithms; Routing: Problem definition, cost functions and constraints, Global routing algorithms, Channel routing algorithms, switchbox routing, Clock Tree Synthesis and Routing; Layout generation and Compaction: Layout generation, layout compaction. Physical design verification and tape-out: Methods for physical design verification, Overview of tape-out process, Introduction to Design for Testability (DFT) and Design for Manufacturability (DFM) principles.

References:

1. Naveed Sherwani, "Algorithms for VLSI Physical Design Automation" (3e) Kluwer Academic Publishers. 2002.
2. S.H. Gerez, "Algorithms for VLSI Design Automation", (1e), John Wiley & Sons, 2008
3. C. J. Alpert, D. P. Mehta, S. S. Sapatnekar, "Handbook of Algorithms of Physical design Automation", (1e), CRC press, 2009.
4. S. M. Sait, H. Youssef, "VLSI Physical design automation theory and Practice", (1e), World Scientific Publishing, 1999.

ECE4152 Mobile Communication [3 0 0 3]

Syllabus

Introduction: Evolution and fundamentals of wireless Communication Systems, Cellular network systems, Trends in Cellular Radio and Personal Communication Systems; Cellular Concepts: Frequency for Radio Transmission, Frequency Reuse, Channel Assignment Strategies. Handoff Strategies, Interference and System Capacity, Cell Splitting, Sectoring. Medium Access Control, Hidden, Exposed and Capture nodes, Far and Near Problem, MAC protocol; Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Ground Reflection Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models. Multipath Measurements, Parameters of Multipath Measurements. Modulation Techniques used for Mobile Radio, System Architecture, Radio Subsystem Wireless Systems and Standards; Channel Types, Frame Structure, Signal Processing in GSM and CDMA; Emerging technologies including 4G and 5G, and infrastructure less networks, Future advancement in Mobile Network.

References:

1. T. S. Rappaport, *Wireless Communications Principles and Practice*, (2e), Pearson Education, Asia, 2002.
2. K. Feher, *Wireless Digital Communications, Modulation and Spread Spectrum Applications*, (1e), Eastern Economy Edition, 1995.
3. W. C. Y. Lee, *Mobile Cellular Telecommunications*, (2e), McGraw Hill International, NY, 1995.
4. J. H. Schiller, *Mobile Communication*, (2e), Harlow: Addison-Wesley, 2003.

ECE4153 Low Power VLSI Design [3 0 0 3]

Syllabus:

Introduction: Need for Low Power VLSI chips, Sources of power dissipation in Digital Integrated circuits. Overview of the importance of low-power circuit design in CMOS and FinFET technologies. Device & Technology Impact on Low Power: Physics of power dissipation in CMOS devices & FinFET Devices; Dynamic and static power dissipation, Transistor sizing & gate oxide thickness; Impact of technology Scaling and Device innovation. Power estimation, Simulation and Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis. Circuit level Power reduction techniques: Power consumption in circuits; Design of Flip Flops and Latches; Low Power Dynamic logic families & adiabatic logic families. Logic level Power reduction techniques: logic encoding, state machine encoding, reduction of power in address and data buses. Low power Architecture and Systems: Power and performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design. Emerging trends in low-power circuit design with CMOS and FinFET, Optimization techniques for minimizing power consumption in advanced semiconductor designs

References:

1. G. K. Yeap, *Practical Low Power Digital VLSI Design*, 1 (e), KAP, 2002.
2. Rabaey, Pedram, *Low power design methodology*, 1 (e), Kluwer Academic, 1997.
3. K. Roy, Sharat Prasad, *Low Power CMOS VLSI Circuit Design*, 1 (e), John Wiley, 2000.
4. Samar K. Saha. *FinFET Devices for VLSI Circuits and Systems*, 1 (e), Taylor and Francis Group, 2020.

PROGRAM ELECTIVE-VI

ECE4154 System Verilog for Verification [3 0 0 3]

Syllabus:

Introduction to System Verilog, System Verilog declaration Spaces, System Verilog Literal Values and Built in Data types: assignments, variables, models. System Verilog user defined data types and enumerated types, Arrays, Queues. Procedural Blocks, Tasks and Functions. System Verilog Procedural Statements. Modeling FSMs with System Verilog. Introduction to System Verilog assertion, Testbench Architecture and Basic UVM.

References:

1. Christian B. Spear, System Verilog for Verification: A Guide to Learning the Testbench Language Features, 1st Ed., Springer 2012
2. Mark Glasser, Harry Foster, Tom Fitzpatrick, Adam Rose, Dave Rich, Open Verification Methodology Handbook: Creating Testbenches in System Verilog and System-C, Morgan Kaufmann, 2009
3. Faisal Haque, Jonathan Michelson, Khizar Khan, The Art of Verification with System Verilog Assertions, 1st Ed., Verification Central, 2006.

ECE4155 Introduction to Robotics [3 0 0 3]

Syllabus:

Introduction: Brief History of Robotics, Types of Robots, Technology of Robots, Basic Principles in Robotics. Mathematical Representation of Robots: Position and Orientation of a Rigid Body, Transformation Between Coordinate Systems, Homogeneous transformation matrices, Link Transformation Matrices, examples, Python/MATLAB programming for frame transformations and coordinate plotting. Kinematics of Manipulators: Degrees of Freedom of a Manipulator, Kinematics of Manipulators, , Representation of Links Using Denavit-Hartenberg (D-H) Parameters convention, Python/MATLAB programming for Kinematics of Robot Manipulator, Examples. Robot Dynamics and Trajectory Planning: Newton-Euler and Lagrangian formulations, Dynamic equations of motion for simple manipulators, Joint space and Cartesian space trajectories, Trajectory generation using quintic polynomials in MATLAB/Python, simulating dynamic equations using ODE solvers in MATLAB/Python, Examples. Control of Robotic Systems: Basics of control: open-loop vs closed-loop, PID control for joint actuators, Feedback linearization, computed torque control (intro only), PID control of simulated robot joint using Python, Control system design and simulation using MATLAB.

References:

1. John J. Craig - Introduction to Robotics: Mechanics and Control, 3(e), Pearson, 2005.
2. Peter Corke - Robotics, Vision and Control: Fundamental Algorithms in MATLAB, 2 (e), Springer, 2017
3. Lentin Joseph - Learning Robotics Using Python, 2 (e),, Packt Publishing, 2018,
4. Bruno Siciliano and Lorenzo Sciavicco - Robotics: Modelling, Planning and Control, 1 (e), Springer, 2000.
5. Kevin M. Lynch and Frank C. Park - Modern Robotics: Mechanics, Planning, and Control, 1 (e), Cambridge University Press, 2017.

ECE4156 Fundamental of Quantum Optics [3 0 0 3]

Syllabus:

Introduction to Quantum Computation: Quantum bits, Bloch sphere representation of a qubit, multiple qubits. Linear operators and spectral decomposition, Operator functions and tensor products. Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis. Quantum Circuits: single and

multiple qubit gates, design of quantum circuits. Quantum Information and Cryptography: Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem. Quantum Algorithms: Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search. Multi-Mode Quantum Systems. Field quantization; quantum photodetection Nonlinear Optics Phase-matched interactions; optical parametric amplifiers; generation of squeezed states, photon-twin beams, non-classical fourth-order interference, and polarization entanglement.

References:

1. Meystre, Pierre, and Murray Sargent. *Elements of quantum optics*. Springer Science & Business Media, 4th Ed., Springer, 2007.
2. Fox, Anthony Mark. *Quantum optics: an introduction*. Vol. 15, 1 (e), Oxford university press, 2006.
3. Mermin, N. David. *Quantum computer science: an introduction*, 1 (e), Cambridge University Press, 2007.
4. Lambropoulos, Peter, and David Petrosyan. *Fundamentals of Quantum Information*, 1 (e), Springer Berlin Heidelberg, 2007.
5. Nielsen, Michael A., and Isaac L. Chuang. *Quantum computation and quantum information*, 1 (e), Cambridge university press, 2010.

ECE4157 System Verilog for Design & Verification [3 0 0 3]

Syllabus:

Introduction to SystemVerilog; SystemVerilog declaration spaces; literal values and built-in data types including assignments, variables, and data models. User-defined data types and enumerated types. Arrays, structures, and unions. Procedural blocks, tasks, and functions. SystemVerilog procedural statements. Modeling of finite state machines (FSMs) using SystemVerilog. SystemVerilog testbench architecture and basic verification components. Introduction to SystemVerilog assertions and functional coverage concepts.

References:

1. Christian B. Spear, *System Verilog for Verification: A Guide to Learning the Testbench Language Features*, Springer 2012
2. Mark Glasser, Harry Foster, Tom Fitzpatrick, Adam Rose, Dave Rich, *Open Verification Methodology Handbook: Creating Testbenches in System Verilog and SystemC*, Morgan Kaufmann, 2009
3. Faisal Haque, Jonathan Michelson, Khizar Khan, *The Art of Verification with System Verilog Assertions*, Verification Central, 2006.

SEVENTH SEMESTER

*ECE4101 *Mixed Signal Design [3 0 0 3]

Syllabus:

Linearity, noise in mixed signal systems. Operational amplifier: block diagram, characteristics, circuit applications. Comparator design. Preamplifier design. Active analog filters. Switched capacitor circuits. Analog-to-Digital conversion (ADC) and Digital-to-Analog Conversion (DAC): Basics of data conversion systems, Sampling theory, Sample and hold circuits. ADC topologies. DAC architecture. Data Converter Signal to Noise Ratio. Phase Locked Loops: Simple PLL, Charge - Pump PLL, VCO : Ring Oscillator, LC Oscillator, Applications in PLL.

References:

1. R. Jacob Baker, *CMOS Mixed-Signal Circuit Design*, (2e), Wiley, 2008.
2. Karl D. Stephan, *Analog and Mixed- Signal Electronics*, (1e), Wiley, 2014
3. R. Jacob Baker, *CMOS - Circuit Design, Layout and Simulation*, (3e), Wiley ,1964.
4. Behzad Razavi, *Design of Analog CMOS Integrated Circuits*, (2e), McGraw Hill , 2017.

***ECE4102 *Static Timing Analysis [3 0 0 3]**

Syllabus:

Introduction to STA: Importance & Classification. Timing Parameters: Timings paths, Arrival time, Required Time, Basics of hold time & set up time, Skews & Jitter. Static Timing analysis of combinational circuits: Delay modelling and calculation: gate, interconnect, cell delays, analysis of critical paths, Timing analysis in multi-path combinational logic. Static Timing Analysis of Sequential Circuits: Clocking strategies: single-phase, multi-phase, and derived clocks, Setup and Hold timing violations, Maximum operating frequency estimation, Impact and analysis of clock skew in sequential circuits, Setup and Hold analysis considering clock skew. Timing Checks: Setup Timing Checks, Hold Timing Checks, On-Chip Variation (OCV): sources, modelling, and impact, OCV-aware timing analysis: derating, pessimism removal

References:

1. S. S. Sapatnekar, *Timing*, (1e), Springer, 2004.
2. J. Bhasker, R. Chadha, *Static Timing Analysis for Nanometer Designs: A Practical Approach*, (1e), Springer, 2009.
3. K. Golshan, *Timing Verification of Application-Specific Integrated Circuits (ASICs)*, (1e), Springer, 2003.

ECE4171 Internship (Industry/ Research/ Industry Certification) [0 0 4 2]**Syllabus:**

Each student must undergo internship for a period of 4-6 weeks. This may be taken in a phased manner during the vacation period of the Semester IV/VI. The student must submit an internship report in the prescribed format to the department. The student also will present the outcomes of the internship followed a by viva voce. The report should include the certificates issued by the industry/institution. The evaluation will be done in the Semester VII in their concerned branch.

EIGHTH SEMESTER**ECE4271 Capstone Project [0 0 24 12]****Syllabus:**

Project work should be carried out for a minimum duration of 16 weeks at the institution/ industry research laboratory or any other institution where facilities exist, with approval of the parent Department. The grade awarded to the student will be based on the total marks obtained by him/ her. There will be a mid-semester evaluation will be carried out at the parent department to assess the work done on the project after 8-10 weeks. In case of external projects, the qualitative feedback of the external guide shall be taken. The final evaluation and viva-voce will be conducted after the completion of the project work and submission of the project report, by a panel of examiners including the internal guide.

ECE4272 Honors (Research Project) [0 0 4 2]**Syllabus:**

The student shall take up a problem/topic of engineering branches (inter-disciplinary nature) and apply the knowledge which they acquired while pursuing their engineering branch. The student shall i) Identify a research topic, analyze the problem, carryout the experiments, write a technical paper and publish in/communicate for a SCOPUS indexed journal/any reputed journal as first author, or ii) Demonstrate a talent/an idea/development of an innovative product.

The evaluation shall be done by the department committee, which is constituted for project evaluation, along with the final semester project work.

OPEN ELECTIVES

ECE0001 Introduction to Communication Systems [3 0 0 3]

Syllabus:

Introduction to communication system: A general model of communication systems-transmitter, communication channel, receiver, attenuation, noise; Telecommunication systems: Basic Telephone system, signaling tones, DTMF, Cordless Telephones, Private branch Exchange (PBX); Optical fiber communication: fundamental laws of optics, principal of ray propagation, basics of optoelectronics sources and detectors; Satellite communication systems: Principles of Orbital mechanics, Kepler's law of planetary motion, Look angle, Angle of elevation, Basics of Satellite subsystem; Radar Systems: Introduction to Radar systems, Pulse Radar, Duplexer. Radar displays; Wireless Communication Systems: Concept of cellular mobile communication-frequency reuse; Wireless technologies: Wireless LAN, PAN and Bluetooth.

References:

- 1 S.S. Haykin, John Wiley & Sons, *An Introduction to Analog and Digital Communication Systems*, 2(e), 2012
- 2 B.P. Lathi, *Communication Systems*, BSP PUBLICATION (2001).
- 3 G. Kennedy and B. Davis, S.R. M. Prasanna, *Electronic Communication System*, Tata McGraw-Hill, 2011.
- 4 Timothy Pratt, *Satellite Communications*, 2(e), Wiley, 2017

ECE0002 Introduction to Game Theory [3 0 0 3]

Syllabus:

Introduction Examples: Markets/ Politics/ Auctions; Prisoners' Dilemma, Best Response and Nash Equilibrium, Dominant Strategies, Stag Hunt - Coordination and Bank Runs. Multiple Nash Equilibria, Tragedy of Commons, Cournot Duopoly, Mixed Strategies, Battle of Sexes, Best Response Dynamic, Paying Taxes; Portfolio Management Game, Rationality, Choice and Common Knowledge, Iterated Elimination of Domination Strategies, Auction: As a Normal Form Game, Traffic at Equilibrium and Braess's Paradox; Extensive Form Games, Strategies in Extensive form Games, Sub Game Perfect Equilibrium, The Art of War, Ultimatum Game, Stackelberg Model, Bayesian Games, Bayesian Nash Equilibrium, Yield vs Fight, Bayesian Cournot Game, Bayesian Games with mixed strategies, Auctions, Sealed Bid First Price Auction, Expected Revenue, Bayesian Second Price Auction, Second Price Auction, All Pay Auction; Evolutionary Biology, Evolutionary stable Strategy (ESS), Repeated Games, Multiple Equilibriums, Chain-Store Paradox, Non - Cooperative Bargaining; Extensive Form Game with Incomplete Information, Introduction to perfect Bayesian Equilibrium, Obtaining PBE, Gift Game.

References:

1. *An Introduction to Game Theory*, Martin Osborne, Oxford University Press.
2. *Game Theory: A Very Short Introduction*, Ken Binmore, Oxford University Press.

ECE0003 Stress-free living [3 0 0 3]

(in collaboration with Abhigya Club & faculty from AkshayPatra foundation)

Syllabus:

Introduction, Overview: Objectives and Learning Outcomes, The Science of Relaxation: Benefits of a Calm Mind, Time Management: Importance of Time Management, Tools and Techniques, Creating a Balanced Schedule, Stress Management: Mindfulness and Meditation, Breathing Techniques, Enhancing Relationships: Healthy Communication, Building Strong Relationships, Conflict Resolution, Lifestyle and Well-Being: Nutrition and Sleep, Digital Detox, Sustainable Habits

ECE0051 Excel Fundamentals for Data Analysis [3 0 0 3]

Syllabus:

Data analysis: Overview, data analysis with Excel. Conditional formatting, sorting and filtering data, Cleaning and manipulating text data. Working with numbers and dates. Calculation with named ranges. Automating data validation. Working with Tables. Logical and lookup function. Data visualization and validation.

References:

1. L. Winston Wayne, *Microsoft Excel: Data Analysis & Business Model*, 1 (e),, PHI, 2019.
2. *Data Analysis with Excel*, *tutorialspoint*, https://www.tutorialspoint.com/excel_data_analysis

ECE0052 Introduction to word Processing [3 0 0 3]

Syllabus:

MS WORD basics: Getting Started, Explore Window, Backstage View, Entering Text, Move Around, Save Document, Opening a Document, Closing a Document, Context Help, Hands-on session Exercises. Editing Documents: Text Insert/Select/Delete/Move/Copy & Paste/Find & Replace/ Spell Check/ Zoom In-Out/ Special Symbols/ Undo Changes operations. Hands-on session Exercises. Formatting Text: Setting Text Fonts, Text Decoration, Change Text Case, Change Text Color, Text Alignments, Indent Paragraphs, Create Bullets, Set Line Spacing, Borders and Shades, Set Tabs, Apply Formatting, Hands-on session Exercises. Formatting Pages: Adjust Page Margins, Header and Footer, Add Page Numbers, Insert Page Breaks, Insert Blank Page, Cover Pages, Page Orientation, Hands-on session Exercises. Working With Tables: Create a Table, Rows & Columns, Move a Table, Resize a Table, Merging Cells, Split a Table, Split Cells, Add Formula, Borders & Shades, Hands-on session Exercises. Advanced Operations: Quick Styles, Use Templates, Use Graphics, Auto Correction, Auto Formatting, Table of Contents, Preview Documents, Printing Documents, Email Documents, Translate Document, Compare Documents, Document Security, Set Watermark, Hands-on session Exercises.

References:

1. Al Sweigart, *Word For Dummies*, 1 (e),, Wiley India Pvt Ltd., 2021.
2. Peter John , *Microsoft Word & Excel 2021 For Beginners & Advanced Learners*, 1 (e), Wiley India Pvt Ltd, 2016.
3. James Holler , *Microsoft Word 2023: The Most Updated Crash Course from Beginner to Advanced*, Independently published, 2022.