Department of Electronics and Communication Engineering

Course Outcomes (M24)

III-Semester

S. No	Course Name	CO No	Course Outcome
1	Automatic Control Systems	CO1	Describe fundamental concepts of control systems including classification, test signals, and system components.
		CO2	Explain and interpret block diagrams, transient behaviour, and digital architecture.
		CO3	Apply mathematical tools for modelling and analyzing control systems in time and frequency domains.
		CO4	Analyze root locus, Nyquist and discrete system responses for system performance.
		CO5	Evaluate continuous and discrete control systems using state-space, frequency domain, and sampled data techniques.
2	Signals and Systems	CO1	Describe fundamental concepts of signals, systems, and transforms.
		CO2	Explain system classifications, Fourier series/transform concepts.
		CO3	Apply convolution, Z-transform, and Fourier techniques to analyze signals.
		CO4	Analyze system properties and evaluate performance using signal tools.
		CO5	Develop signal-processing systems based on specifications.
3	Smart Sensors and IOT	CO1	Identify various sensors, actuators, platforms protocols, and components used in IoT systems.
		CO2	Explain the architectural principles, enabling technologies, and communication methods in IoT
		CO3	Operate IoT hardware platforms, apply interfacing techniques, and test connectivity with communication and cloud systems.
		CO4	Evaluate the suitability of protocols, platforms, modules, and transmission methods for specific IoT applications.
		CO5	Design IoT systems with integrated sensors, communication, cloud connectivity, and data control.
4	Digital Logic Design using HDL	CO1	Describe fundamental concepts of Verilog, digital components, number systems, and FSMs.
		CO2	Explain digital design principles, modeling techniques, and system behavior.
		CO3	Apply HDL and logic design methods to implement digital systems.
		CO4	Analyze digital circuits and system models for functional and performance metrics.
		CO5	Evaluate multiple design approaches and create optimized systems using HDL and programmable devices.
5	Computer Organization and Architecture	CO1	Identify and recall fundamental concepts in computer architecture including evolution, instruction codes, CPU, memory hierarchy, and I/O modules.
		CO2	Explain key principles of computer organization such as number representation, stored program design, addressing modes, asynchronous data transfer, and memory interleaving.
		CO3	Apply algorithms and instructions to perform arithmetic operations, instruction cycles, data manipulation, I/O modes, and associative memory implementation.

		CO4	Analyze advanced computer organization components including division algorithms, microprogrammed control, CISC/RISC, priority interrupts, and cache performance.
		CO5	Interpret various techniques for efficient memory utilization to develop a system application.
6	Python Programming and Artificial Intelligence	CO1	Describe fundamental concepts in Python, AI, and logic.
		CO2	Explain programming logic, structures, and AI frameworks.
		CO3	Apply Python concepts and AI libraries to solve ECE-related problems.
		CO4	Analyze program behaviour and AI decision logic.
		CO5	Evaluate solutions and create intelligent systems using Python and AI models.
7	Probability Theory and Stochastic Processes	CO1	Explain the basic concepts of probability, random variables, and standard probability distributions.
		CO2	Apply statistical techniques to analyze functions of random variables and compute expectations and variances.
		CO3	Analyze joint distributions, conditional probabilities, and use the Central Limit Theorem in engineering problems.
		CO4	Evaluate the characteristics of stochastic processes in time domain using correlation and ergodicity concepts.
		CO5	Design models for noise and signal behaviour in communication systems using spectral analysis and stochastic concepts.
8	Control Systems and Signal Processing Simulation Lab	CO1	Identify and use MATLAB commands for modelling control systems and signals.
		CO2	Represent control systems in state-space and transfer function form, and generate standard signal sequences.
		CO3	Analyze system stability using Bode plots, Root Locus, and pole-zero maps.
		CO4	Design control system using pole placement technique to meet desired performance.
		CO5	Apply MATLAB to perform signal operations, compute Fourier/Z-transforms, and analyze LTI system responses.
9	Smart Sensors and IOT Lab	CO1	Identify basic electronic components and measuring tools used in embedded system applications.
		CO2	Explain the working principles of sensors and their interfacing techniques with microcontrollers.
		CO3	Use Arduino, Node MCU, or Raspberry Pi to interface sensors and control actuators in real-time IoT experiments.
		CO4	Analyze data collected from sensors and interpret outputs on cloud platforms like Thing Speak.
		CO5	Design and demonstrate a functional prototype for a real-life embedded or IoT-based project.
10	Python Programming and Artificial Intelligence Lab	CO1	Recall basic Python, data structures, and AI algorithm names.
		CO2	Understand Python programming concepts and AI approaches.
		CO3	Apply Python and AI programming to ECE problems.
		CO4	Analyze different algorithms, modules, and their impact.
		CO5	Evaluate code for efficiency and create integrated solutions for real-world ECE use cases.

IV-Semester

S. No	Course Name	CO No	Course Outcome
1	Microelectronic Devices and Circuits	CO1	Recall core concepts of MOS devices, circuits, and logic families.
		CO2	Explain device operations and analog/digital behavior in CMOS systems.
		CO3	Apply design methods to implement analog and digital microelectronic blocks.
		CO4	Analyze electrical performance and frequency response of microelectronic circuits.
		CO5	Evaluate and design optimized circuits using CMOS technology principles.
2	Microcontrollers	CO1	Describe microprocessor and microcontroller architectures, instruction sets, and differences between Harvard and Von-Neumann models.
		CO2	Develop programs using 8051 timers, interrupts, and serial communication techniques.
		CO3	Interface 8051 microcontrollers with external peripherals and design simple embedded systems.
		CO4	Analyze ARM processor features, interrupt handling, and evaluate ARM Cortex-M3 processor architecture.
		CO5	Design and implement embedded applications using microcontrollers with Embedded C programming.
3	Electromagnetic Theory and Transmission Lines	CO1	Describe and list fundamental principles of electrostatics, magnetostatics, and transmission lines.
		CO2	Explain field behaviour and wave phenomena using established laws and boundary conditions.
		CO3	Apply electromagnetic concepts to solve practical engineering problems related to waves and transmission lines.
		CO4	Analyze wave reflection, transmission, and distortion less line conditions.
		CO5	Evaluate electromagnetic systems and matching techniques including stub matching for RF applications using chart-based tools.
4	Integrated Circuits and Applications	CO1	Describe and identify fundamental IC components and packages.
		CO2	Explain principles of op-amps, filters, converters, logic families.
		CO3	Apply linear/digital ICs to real-time applications.
		CO4	Analyze circuits using integrated ICs.
		CO5	Evaluate the systems using op-amps, regulators, and digital ICs.
5	Principles of Machine Learning and Deep Learning	CO1	Identify and recall foundational concepts in supervised, unsupervised learning, neural networks, and deep learning.
		CO2	Explain algorithms and structures for regression, classification, clustering, and neural networks.
		CO3	Apply machine learning and deep learning algorithms to real-world data problems.
		CO4	Analyze model performance, interpret results, and compare different approaches.
		CO5	Evaluate advanced ML/DL systems tailored to practical industry use-cases.
6	Human Values and Professional Ethics	CO1	Relate the significance of value inputs and start applying them in their life and profession.
		CO2	Compare and contrast between values and skills, happiness and accumulation of physical facilities with regard to the self and the body, intention and competence of an individual, etc.
		CO3	Apply ethical values in the light of the problems from the perspective of the social context.
		CO4	Evaluate the role of a human being in ensuring harmony in society and nature.
		CO5	Distinguish the difference between ethical and unethical practices, and apply ethical practices in personal and professional lives

7	Managerial Economics & Financial Accounting	CO1	Determine the responsibilities & decision making in the Organization
		CO2	Understand the various factors in fluencing demand & market structure
		CO3	Understand the principles of accounting & solve the problems
		CO4	Analyze the Financial performance.
		CO5	Understand the capital structure & to take decision on election of projects.
8	Microelectronic Devices and Circuits Lab	CO1	Recall basic electronic concepts related to amplifiers, oscillators, MOSFETs, and shaping circuits.
		CO2	Understand theory behind amplifier configurations, oscillators, and waveform control.
		CO3	Apply hardware implementation and simulation using SPICE for analog electronic systems.
		CO4	Analyze the performance of analog circuits and waveform behavior.
		CO5	Evaluate and design optimized analog solutions for signal amplification and conditioning.
9	Integrated Circuits Applications and HDL Lab	CO1	Recall syntax, IC types, HDL components, FSM structures.
		CO2	Explain working principles of linear and digital ICs
		CO3	Apply ICs and HDL to simulate real-time digital circuits.
		CO4	Analyze responses of circuits and simulation results.
		CO5	Evaluate circuit performance and create solutions using HDL and ICs.
10	Microcontrollers Lab	CO1	Identify and recall the functionalities of peripheral interfaces such as LEDs, switches, buzzers, and serial ports.
		CO2	Explain the working principles of LCDs, ADCs, sensors, and serial communication modules used in embedded systems.
		CO3	Implement embedded C programs to interface LEDs, buzzers, and LCDs on an ARM microcontroller kit.
		CO4	Analyze sensor outputs (e.g., LM35 temperature sensor) and debug hardware interactions using serial ports.
		CO5	Design and validate interfacing programs for real-time embedded system applications using ARM microcontroller.
11	Machine Learning Applications Lab	CO1	Identify fundamental concepts in ML, including regression, classification, clustering, ANN, and CNN.
		CO2	Explain supervised and unsupervised algorithms, data pre-processing, neural network structures.
		CO3	Apply ML and DL techniques to solve ECE-related data problems
		CO4	Analyze model performance, interpret results, and optimize model parameters.
		CO5	Evaluate and design industry-ready ML/DL solutions for real-world ECE projects.

V – Semester

S. No	Course Name	CO No	Course Outcome
1	Digital Signal Processing	CO1	Recall the fundamentals of Discrete Fourier Transform, FFT algorithms, FIR and IIR filter characteristics, windowing techniques, decimation and interpolation concepts, and DSP processor architectural features.
		CO2	Explain the working principles of Radix-2 DIT and DIF FFT algorithms, FIR filter design using windowing methods, analog-to-digital filter transformation techniques (Impulse Invariant and Bilinear), multirate signal processing operations, and TMS320C67XX processor architecture including pipelining and addressing modes.
		CO3	Apply DFT computation, circular convolution, windowing techniques for FIR filter design, Bilinear and Impulse Invariant transformations for IIR filter design, sampling rate conversion methods, and DSP processor instructions to solve digital signal processing problems.
		CO4	Analyze the computational complexity of FFT algorithms, the impact of window functions on FIR filter performance, frequency warping and aliasing effects in IIR filter design, multistage multirate system efficiency, and DSP processor pipeline performance for real-time applications.
		CO5	Evaluate the performance of various FFT implementations, FIR and IIR filter design methods, and multirate system configurations; and design digital filters, sampling rate converters, and DSP-based real-time signal processing systems.
2	Analog Communication	CO1	Recall analog modulation schemes (AM, DSB-SC, SSB, VSB, FM, PM), pulse modulation techniques (PAM, PWM, PPM), transmitter/receiver architectures, and noise characterization parameters.
		CO2	Explain generation and detection of amplitude modulation, angle modulation, and pulse modulation systems; describe superheterodyne receiver operation, time division multiplexing, and noise mitigation using pre-emphasis and de-emphasis techniques.
		CO3	Compute modulation parameters (modulation index, power efficiency), signal bandwidth (Carson's rule, Bessel functions), sampling rates (Nyquist theorem), image rejection ratios, and SNR for analog systems.
		CO4	Analyze spectral characteristics of modulation schemes, receiver design trade-offs (sensitivity, selectivity, fidelity, AGC), sampling effects on signal reconstruction, and noise performance variations across AM, FM, and pulse modulation systems.
		CO5	Evaluate analog modulation and receiver systems based on figure of merit, bandwidth efficiency, and noise immunity; design superheterodyne receivers, FM links, TDM systems, and pre-emphasis/de-emphasis filters.
3	Data Communication and Networking Systems	CO1	Recall OSI and TCP/IP models, network types and topologies, data link layer protocols, routing algorithm types, transport layer services (TCP, UDP, ATM), application layer protocols (DNS, SNMP, SMTP, HTTP), cryptographic basics.
		CO2	Explain circuit/packet switching, data link layer flow control and error handling protocols, MAC layer access mechanisms (ALOHA, CSMA), routing and congestion control algorithms, TCP connection management and congestion control, application services and security.
		CO3	Apply protocol layering, compute CRC-based error detection, frame efficiency, and MAC throughput, execute Dijkstra's and Bellman-Ford

			routing algorithms with subnetting, perform TCP window calculations, implement encryption/decryption.
		CO4	Analyze switching trade-offs, channel utilization of MAC protocols, routing convergence behavior and loop problems, TCP congestion control dynamics, and security vulnerabilities across network layers.
		CO5	Evaluate topology suitability, LAN standard performance, congestion control effectiveness, transport protocol selection for applications, and cryptographic algorithm trade-offs; design complete network solutions with topology, routing, transport, and security.
4	Analog IC Design (PE-I)	CO1	Recall MOS device models (level 1, level 2), single-stage amplifier topologies (CS, CD, CG), differential pair configurations, current mirror types (basic, cascode, active), and CMOS op-amp architectures used in analog integrated circuit design.
		CO2	Explain the operating principles of MOSFET small-signal models, single-stage amplifiers with various loads, differential pairs with common mode response and Gilbert cell, current mirror implementation, and CMOS op-amp techniques including gain boosting, folded cascode, and CMFB.
		CO3	Apply MOSFET model equations and design formulas to compute small-signal parameters, amplifier gain and bandwidth, differential pair CMRR, current mirror output resistance and compliance voltage, and op-amp specifications (gain, UGB, phase margin, slew rate).
		CO4	Analyze short channel effects on MOSFET characteristics, gain-bandwidth trade-offs in single-stage amplifiers, transistor mismatch impact on differential pairs, current mirror large/small-signal behavior, and frequency response and stability of multi-stage CMOS op-amps.
		CO5	Evaluate and compare analog IC building blocks (MOS models, amplifier topologies, current mirrors, op-amp architectures) for performance metrics across PVT corners; and design layout-aware CMOS analog including differential amplifiers, current mirrors, and multi-stage operational amplifiers meeting specified requirements.
5	Electronic Measurements and Instrumentation (PE-I)	CO1	Recall measurement fundamentals including accuracy, precision, resolution, sensitivity, error types, and IEEE measurement standards.
		CO2	Explain the classification, selection criteria, and working principles of passive transducers (strain gauge, LVDT, capacitive) and active transducers (piezoelectric, photoconductive, photovoltaic).
		CO3	Apply sensor characteristics and measurement techniques for sound, pressure, temperature using microphones, resistance thermometers, semiconductor thermometers, and thermocouples.
		CO4	Analyze the design considerations and specifications of DVMs, spectrum analysers, oscilloscopes, GPIB interfaces, virtual instrumentation, SCADA, and data acquisition systems.
		CO5	Evaluate biomedical instrumentation systems (ECG, EEG, EMG, X-ray, CT, MRI, ultrasonic imaging) and design measurement solutions for physiological signal acquisition and processing.
6	Embedded System Design (PE-I)	CO1	Recall the fundamentals, classifications, characteristics, and design metrics of embedded systems.
		CO2	Explain the role of firmware components (reset, watchdog timers, RTC) and firmware design approaches in embedded systems.
		CO3	Apply knowledge of serial (I2C, CAN, USB), parallel (ISA, ARM Bus), and network protocols (HTTP, TCP/IP, Ethernet) to configure embedded communication interfaces.
		CO4	Analyze embedded software development tools, debugging techniques, and the interaction between host/target machines in embedded system

			development.
		CO5	Evaluate hardware-software co-design trade-offs and design embedded systems following structured design flows for real-world applications including low power requirements.
7	Neural Networks and Deep Learning (PE-I)	CO1	Recall foundational neural network models (McCulloch-Pitts, Perceptron), CNN building blocks and architectures (LeNet, AlexNet, VGG, ResNet, GoogLeNet), RNN/LSTM/Transformer components, GPT architecture concepts, and autoencoder/GAN definitions and training objectives.
		CO2	Explain the mathematical principles of feedforward networks and XOR solution, architectural differences across CNN models, transfer learning and attention mechanisms, RNN sequential modeling with LSTMs and Transformers, GPT significance and prompt engineering strategies, and unsupervised learning with autoencoders and GANs.
		CO3	Apply Perceptron learning and RBF networks for classification, implement transfer learning using MobileNet/EfficientNet for image tasks, utilize RNN/LSTM for sequence prediction and Transformers for language modeling, employ prompt engineering and GPT fine-tuning, and implement autoencoders and GANs using frameworks like PyTorch/TensorFlow.
		CO4	Analyze decision boundaries and limitations of feedforward networks, compare CNN architectures by depth and computational cost, examine vanishing gradient solutions in LSTM and Transformer models, evaluate prompt strategy effects on GPT outputs, and investigate GAN training dynamics and batch normalization in deep learning models.
		CO5	Evaluate the performance of neural network architectures (feedforward, CNN, RNN, Transformer, GPT) and generative models (VAE, GAN) using appropriate metrics; and design end-to-end deep learning systems including CNN pipelines with transfer learning, sequence models, generative AI applications, and ECE domain projects integrating signal processing and computer vision.
8	Remote Sensing and GIS (OE-I)	CO1	Explain the fundamental concepts of remote sensing and the interaction of energy with the atmosphere and surface materials.
		CO2	Interpret the characteristics of remote sensing platforms and sensors to understand their roles in data acquisition.
		CO3	Summarize the development of GIS, its operations, data types, datum, coordinate systems, and map projections with their transformations.
		CO4	Illustrate GIS data models, spatial data creation methods and spatial analysis including terrain modelling using GIS software
		CO5	Explain UAV types and applications, and describe GNSS concepts, positioning modes.
9	Advanced Operating System (OE-I)	CO1	Explain the architecture, design principles, and functionalities of advanced operating systems.
		CO2	Analyze distributed and network operating system concepts for resource sharing and communication.
		CO3	Describe virtualization, cloud operating systems, and modern computing environments.
		CO4	Illustrate the role of operating systems in mobile, embedded, and IoT platforms.
		CO5	Evaluate security mechanisms, reliability issues, and emerging trends in operating systems.
10	Data Science (OE-I)	CO1	Understand the fundamental concepts, tools, and processes in data science using Python.
		CO2	Apply Python libraries to manipulate, visualize, and analyze data.

		CO3	Analyze statistical data, models, and clustering to interpret data patterns.
		CO4	Evaluate data hypotheses and models using statistical inference and metrics.
		CO5	Create data science applications using Python for real-world problem-solving.
11	Database Management Systems (OE-I)	CO1	Explain fundamental database concepts including data models, ER design, relational algebra, normalization, and transaction management principles.
		CO2	Apply SQL commands including DDL, DML, joins, nested queries and integrity constraints to solve data manipulation problems.
		CO3	Implement normalization techniques (up to BCNF) to optimize relational database schemas.
		CO4	Analyze concurrency control protocols and recovery techniques for maintaining transaction integrity.
		CO5	Compare indexing structures (tree-based vs hash-based) for efficient data retrieval in database systems.
12	Renewable Energy Systems (OE-I)	CO1	Understand the advantages, disadvantages and applications of different non-conventional sources.
		CO2	Analyze principle of operation and applications of different Fuel cells
		CO3	Analyze the principles of Solar and Wind Energy sources and its applications
		CO4	Understand the principles of OTEC and GTE
		CO5	Analyze the biomass conversion technologies, Biogas generation and Biogas plants
13	Digital Electronics for Engineers (OE-I)	CO1	Recall number systems, binary codes, Boolean algebra laws, logic gate truth tables, latch and flip-flop types, and memory classification.
		CO2	Explain number system conversions, canonical forms, universal gates, combinational design approach, flip-flop operation, and the purpose of memory and data converters.
		CO3	Demonstrate binary arithmetic, Boolean expression simplification using K-maps, truth-table-based analysis of adders and flip-flops, and classification of memory types.
		CO4	Differentiate signed number formats, compare circuit implementation approaches, distinguish counter types, and analyze memory trade-offs.
		CO5	Evaluate binary codes, simplification methods, circuit roles, and memory suitability; and recommend appropriate digital components for given application scenarios.
14	Start-Up Entrepreneurship (OE-I)	CO1	Understand Entrepreneurship and Economic growth, Small- and Large-Scale Industries, Types and forms of enterprises.
		CO2	Identify the characteristics of entrepreneurs, Emergence of first-generation entrepreneurs, Conception and evaluation of ideas and their sources.
		CO3	Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and technical analysis.
		CO4	Understand the concept of Intellectual Property Rights and Patents
		CO5	Comprehend the aspects of Start-Ups.
15	Constitution Of India	CO1	Explain the historical background, constituent assembly, and salient features of the Constitution of India.
		CO2	Describe the structure and functions of Union, State, and Local Governments in India.
		CO3	Interpret Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, and Union–State relations.
		CO4	Explain the role of statutory and non-statutory bodies in promoting

			democratic governance and social justice.
		CO5	Apply knowledge of contemporary governance mechanisms and legal frameworks such as NITI Aayog, RTI, PIL, and POCSO Act in civic and professional contexts.
16	Digital Signal Processing Applications Lab	CO1	Identify the fundamental properties of circular convolution, DFT, IDFT, FFT, IFFT, standard window functions for FIR design, Butterworth and Chebyshev IIR filter characteristics, multirate processing concepts, and the architecture of the TMS320C67XX DSP processor.
		CO2	Explain the working principles of DFT/IDFT domain transformations, decimation-in-time and decimation-in-frequency FFT algorithms, window-based FIR filter design, analog-to-digital IIR filter conversion techniques (Impulse Invariant and Bilinear Transformation), and the spectral effects of interpolation and decimation in multirate systems.
		CO3	Implement circular convolution, DFT, IDFT, FFT, IFFT, FIR and IIR digital filters, and multirate processing systems using MATLAB programs and on the TMS320C67XX DSP processor, measuring key parameters including frequency response, filter coefficients, and spectral characteristics.
		CO4	Analyze the output sequences, magnitude and phase spectra, frequency response plots, pole-zero locations, and spectral effects of multirate operations to verify correctness, assess filter performance, and identify design trade-offs in digital signal processing implementations.
		CO5	Evaluate DSP algorithms and filter designs across MATLAB and DSP processor platforms in terms of computational efficiency, frequency response accuracy, and signal fidelity; and design experiments for spectral analysis, optimal filter selection, and multirate system verification.
17	Data Communication and Networking Systems Lab	CO1	Identify network devices, HDLC frame structures, routing algorithm steps (Distance Vector, Dijkstra's), TCP/UDP protocol parameters, LAN/WLAN simulation parameters.
		CO2	Explain device OSI roles, the purpose of bit/character stuffing for frame synchronization, the iterative operation of routing algorithms, TCP/UDP agent behavior in network simulators, error/data rate effects on LAN throughput.
		CO3	Configure topologies, implement stuffing/routing in C, set up TCP/UDP point-to-point network simulations in NS2/NS3; conduct LAN/WLAN simulations.
		CO4	Analyze topology impact, overhead trade-offs in framing techniques, routing convergence behavior and scalability, TCP/UDP performance under varying queue and bandwidth conditions, LAN throughput vs error rate/nodes.
		CO5	Evaluate network topologies, framing methods, routing protocols, and transport layer protocols from experimental and simulation results; and design comprehensive network simulation experiments incorporating topology selection, routing configuration, congestion analysis, and LAN performance benchmarking for given network requirements.
18	ECE Computing Skills Lab	CO1	Recall Linux file system, CLI commands, permissions, networking utilities, shell scripting, Git commands, HTML elements and CSS properties.
		CO2	Explain Linux CLI file management, permission/ownership access control, shell script flow, Git staging/branching workflow, and HTML/CSS page structure.
		CO3	Execute Linux file/network operations, set permissions, write shell

			scripts, perform Git branching/merging, and create styled HTML/CSS web pages.
		CO4	Analyze CLI outputs for file location, permission effects on access, shell script debugging, Git history tracing, and HTML/CSS rendering via browser tools.
		CO5	Evaluate CLI efficiency, permission security, script correctness, and page quality; create directory structures, automation scripts, Git repositories, and styled web pages.
19	Soft Skills Laboratory	CO1	Listen to a variety of speakers and texts and will be able to comprehend and perform the required tasks.
		CO2	Interact in a group professionally and communicate confidently in terms of both the spoken and written communication.
		CO3	Develop the skills and strategies of reading and writing.
		CO4	Face any Interview confidently by managing time, making decisions by speaking appropriately according to the context.
		CO5	Demonstrate right attitude and right skills to cope with team and communicate professionally.
20	Mini Project	CO1	Identify domains, components, design standards, testing parameters, and documentation practices for electronic product design with ICs, microcontrollers, PCB, and instruments.
		CO2	Explain end-to-end product development: problem formulation via literature survey/need analysis, design planning, component selection, PCB layout, and report structure.
		CO3	Implement a working electronic product prototype / algorithm by conducting literature survey, developing design specifications, building hardware/software, performing systematic testing, and preparing comprehensive project documentation.
		CO4	Analyze design feasibility, HW-SW interactions, test results, and performance to identify power budget, signal integrity, mechanical, and execution issues.
		CO5	Evaluate project outcomes vs specifications (manufacturability, reliability, team performance); design PCB layouts, propose improvements, deliver reports and presentations.

VI-Semester

S. No	Course Name	CO No	Course Outcome
1	Digital Communication	CO1	Recall elements of digital communication systems, definitions of entropy, channel capacity, error control coding types, Nyquist ISI criterion, and properties of PN sequences.
		CO2	Explain the principles of pulse digital modulation (PCM, DPCM, DM, ADM), source coding algorithms (Shannon-Fano, Huffman), channel coding structures (LBC, BCC, Convolutional), digital carrier modulation schemes (ASK, FSK, PSK, QPSK), and spread spectrum (DSSS, FHSS) system operation.
		CO3	Apply quantization noise and SNRQ calculations, source coding algorithms, syndrome decoding for error correction, Gaussian error probability for BER computation, and PN sequence generation with processing gain evaluation for spread spectrum systems.
		CO4	Analyze the effects of quantization and companding on waveform coding performance, channel capacity under various channel models, error correction capabilities using minimum distance, matched filter optimality for ISI-free reception, and acquisition/tracking mechanisms in spread spectrum receivers.
		CO5	Evaluate waveform coding techniques, source/channel coding schemes, and digital modulation methods; design PCM encoders, Viterbi decoders, modulation systems, and spread spectrum links.
2	VLSI Design	CO1	Recall the MOS/CMOS fabrication technologies, basic electrical properties of MOS transistors, CMOS inverter characteristics, VLSI design flow, logic gate types, and sequential circuit elements including latches, flip-flops, and memory cells.
		CO2	Explain the Ids-Vds characteristics of MOS transistors, operation of CMOS logic gates (NAND, NOR, AOI, OAI), lambda-based design rules, stick and layout diagrams, combinational circuit architectures (adders, shifters), and sequential elements (D-latch, flip-flops, RAM/ROM cells).
		CO3	Apply MOS device equations to compute threshold voltage, transconductance, propagation delay, power dissipation, sheet resistance, and area capacitance; and construct stick diagrams and layout designs using lambda-based design rules.
		CO4	Analyze the impact of body effect, scaling, and short-channel effects on MOS circuit performance; evaluate noise margins and voltage transfer characteristics of CMOS inverters; and examine timing constraints and carry propagation delays in sequential and combinational.
		CO5	Evaluate CMOS technology trade-offs, alternate gate implementations, and memory cell architectures; and design CMOS logic gates, combinational (adders, barrel shifters), sequential (flip-flops), and memory systems (SRAM, DRAM, ROM) meeting specified performance requirements.
3	Antenna and Wave Propagation	CO1	Recall antennas including radiation mechanism, antenna parameters (gain, directivity, effective aperture, beamwidth, polarization), types of wire antennas, array configurations, VHF/UHF antenna types, and modes of radio wave propagation.
		CO2	Explain the radiation mechanisms of dipole, loop, and helical antennas; describe array pattern formation using amplitude and phase variation; interpret the operating principles of horn, reflector, microstrip, and smart antennas; and explain ground wave, sky wave,

			and space wave propagation phenomena.
		CO3	Apply antenna theory to compute radiation resistance, directivity, gain, and effective aperture of wire antennas; apply pattern multiplication for array pattern synthesis; calculate slot antenna impedance, horn and reflector gain; and determine MUF, skip distance, and LOS range for radio wave propagation links.
		CO4	Analyze the radiation patterns, polarization, and impedance characteristics of wire antennas and arrays; examine the performance trade-offs of reflector, lens, and microstrip antennas; and analyze the effects of ionospheric structure and atmospheric conditions on sky wave propagation and signal fading.
		CO5	Evaluate antenna types and array configurations based on gain, bandwidth, directivity, and polarization for specific applications; and design antenna systems including helical antennas, Yagi-Uda arrays, microstrip patches, and communication links with specified radiation and propagation requirements.
4	CMOS VLSI Design (PE-II)	CO1	Recall the MOS transistor I-V and C-V characteristics, CMOS fabrication process steps, structured design strategies (hierarchy, regularity, modularity), combinational circuit families (static CMOS, CVSL, dynamic, pass-transistor), and sequential circuit sequencing methods with timing constraints.
		CO2	Explain MOS capacitance models and inverter DC characteristics, CMOS processing technology operations, design approaches (gate array, standard cell, full-custom), combinational circuit operation and pitfalls, and latch/flip-flop functionality with clock skew and time borrowing effects.
		CO3	Apply MOS device equations to compute drain current, threshold voltage, noise margin, and beta ratio; determine CMOS fabrication sequences; partition digital systems using structured design principles; implement combinational logic using various circuit families; and calculate timing constraints for sequential.
		CO4	Analyze the effects of beta ratio and capacitance on MOS transistor behavior, impact of process parameters on CMOS device performance, trade-offs among CMOS design methodologies, dynamic circuit vulnerabilities (charge sharing, leakage, supply noise), and sequential circuit timing considering clock skew and time borrowing.
		CO5	Evaluate the performance of CMOS circuit families, process enhancements, and design methodologies for given specifications; and design CMOS inverters, fabrication process flows, chip floor plans, combinational logic blocks, and clocked sequential systems meeting specified noise margin, timing, and performance constraints.
5	Digital Image Processing and Its Applications (PE-II)	CO1	Recall the fundamentals of digital image formation, sampling, quantization, 2D transforms (DFT, DCT, Haar), spatial and frequency domain filters, edge detection operators, morphological operations, compression models, and computer vision techniques including object detection and motion analysis.
		CO2	Explain the principles of image enhancement using histogram processing and spatial/frequency domain filtering, image restoration techniques for noise removal, segmentation methods (edge-based and region-based), morphological processing operations, scale-space concepts, and pattern recognition approaches using clustering and classification.

		CO3	Apply image transforms (DFT, DCT, Haar) for frequency analysis, spatial and frequency domain methods for image enhancement and restoration, edge detection and Hough Transform for segmentation, morphological operations for shape extraction, Huffman coding for compression, and K-Means clustering for pattern recognition tasks.
		CO4	Analyze the spectral characteristics of image transforms, frequency response of enhancement and restoration filters, performance of edge detection and segmentation algorithms under varying conditions, effect of structuring elements on morphological processing, and accuracy of computer vision algorithms for object detection and motion analysis.
		CO5	Evaluate and compare image processing techniques (transforms, filters, compression schemes, feature descriptors) for performance, efficiency, and robustness; and design end-to-end image processing and computer vision solutions integrating preprocessing, segmentation, feature extraction, and recognition for real-world engineering applications.
6	Real Time Operating Systems (PE-II)	CO1	Recall the structure of UNIX OS (monolithic/microkernel), file system operations, and process management concepts (fork, exec, wait); define hard and soft real-time systems; and identify RTOS kernel components, synchronization problems, IPC mechanisms, and features of VxWorks, µC/OS-II, and RT Linux.
		CO2	Explain the differences between hard and soft real-time systems; describe scheduling algorithms (FCFS, SJF, Priority, Round Robin, Multiprocessor scheduling); discuss RTOS kernel multitasking, deadlock principles, and the architecture of commercial RTOS platforms.
		CO3	Apply RTOS kernel concepts including task management (priorities, context switching, ISRs) to configure and manage multitasking environments; use UNIX system calls for process management; and apply scheduling algorithms and synchronization primitives in real-time system scenarios.
		CO4	Analyze synchronization problems (Reader-Writer, Dining Philosopher, deadlock) and IPC mechanisms (semaphores, mutex, mailboxes, message queues, pipes); examine context switching overhead, scheduling impacts on deadline satisfaction, and comparative characteristics of RTOS platforms.
		CO5	Evaluate and compare commercial RTOS platforms (VxWorks, µC/OS-II, RT Linux) for embedded applications based on determinism, footprint, and tool support; and design embedded real-time systems with proper task decomposition, scheduling strategies, IPC schemes, and synchronization for given requirements.
7	Quantum Technologies (PE-II)	CO1	Recall quantum computation including qubits, multi-qubit states, Dirac notation (kets, bras, operators), Bloch sphere representation, quantum gate matrices, quantum communication protocol steps, major quantum algorithms, and current quantum hardware platforms and software frameworks.
		CO2	Explain the principles of quantum gates and circuit operations, quantum communication protocols (teleportation, superdense coding, BB84), the working of quantum algorithms (Deutsch–Jozsa, QFT, phase estimation, Grover's search), and the concepts of noise, decoherence, and variational algorithms in the NISQ era.
		CO3	Apply quantum gate operations to compute circuit outputs, implement quantum protocols (Bell state preparation, teleportation,

			superdense coding) for information transfer, execute quantum algorithms for specified problem instances, and use quantum software frameworks (Qiskit, Cirq) to build and simulate quantum.
		CO4	Analyze quantum circuit decompositions and unitary transformations, examine the security foundations of quantum key distribution, evaluate computational speedups of quantum algorithms over classical counterparts, and assess the strengths and limitations of different quantum hardware technologies.
		CO5	Evaluate and compare the performance of quantum algorithms, communication protocols, and hardware platforms for given computational and communication tasks; and design quantum, protocol implementations, and solution architectures selecting appropriate frameworks and error mitigation strategies for practical quantum computing applications.
8	Green Building Techniques (OE-II)	CO1	Define sustainability and green buildings, including their features, benefits, and the role of emerging technologies.
		CO2	Describe sustainable site planning concepts and water efficiency strategies.
		CO3	Explain energy efficiency concepts and net-zero building approaches.
		CO4	Describe sustainable materials, waste management practices, and circular economy principles.
		CO5	Explain indoor environmental quality concepts and green building performance assessment methods.
9	Software Engineering (OE-II)	CO1	Explain foundational software engineering concepts, including process models, requirement engineering, and UML diagrams.
		CO2	Describe software testing strategies, product metrics, and risk management frameworks.
		CO3	Select appropriate process models and architectural styles for given project scenarios.
		CO4	Compare the effectiveness of validation testing techniques and metrics for software quality assessment.
		CO5	Assess risk management strategies and their impact on software project success
10	Prompt Engineering (OE-II)	CO1	Explain the concepts, capabilities, models, and applications of Large Language Models.
		CO2	Describe prompt engineering concepts, structures, and elements used in LLM interaction.
		CO3	Apply prompt design techniques for solving tasks such as summarization, classification, and information extraction.
		CO4	Analyze advanced prompting strategies and their impact on reasoning and output quality.
		CO5	Examine LLM configuration parameters and their influence on performance in real-world applications.
11	Big Data Analytics (OE-II)	CO1	Explain the foundations, definitions, the 5Vs, and challenges of Big Data, and describe the Apache Hadoop ecosystem.
		CO2	Demonstrate proficiency in using Hadoop Distributed File System (HDFS) interfaces and I/O mechanisms.
		CO3	Implement MapReduce programs incorporating Mapper, Reducer, Combiner, and Partitioner components.
		CO4	Analyse large datasets using Hadoop Ecosystem tools — Pig Latin scripts and HiveQL queries.
		CO5	Design comprehensive Big Data solutions by integrating advanced frameworks and evaluate their performance.

12	Electric Vehicle Technology (OE-II)	CO1	To identify and describe the history and evolvement of electric & hybrid electric vehicles to emphasize on the need and importance of EV/HEV for sustainable future.
		CO2	To identify and describe the principles of various EV/HEVs drive train topologies along with their power flow control and fuel efficiency estimation.
		CO3	To design and select electric propulsion system components for EV/HEV drives suitability for the desirable performance and control.
		CO4	To compare and evaluate various energy sources and energy storage components for EV and HEV applications.
		CO5	Select various types of propulsion units and their control depending upon the application.
13	Principles of Communication Systems (OE-II)	CO1	Recall the communication system model, signal types and parameters, AM and FM characteristics, Nyquist sampling theorem, digital modulation schemes, and mobile communication generations.
		CO2	Explain the need for modulation, AM spectral composition, FM constant-envelope property, PCM sampling-quantization-encoding process, and multiplexing and cellular communication concepts.
		CO3	Classify signals and noise types, illustrate AM and FM spectral behavior, demonstrate the PCM process, and categorize communication systems by medium and application.
		CO4	Analyze noise effects on SNR, modulation index impact on AM power distribution, FM bandwidth-noise trade-offs, PCM quality factors, and fiber versus copper transmission advantages.
		CO5	Compare analog and digital modulation schemes by efficiency, bandwidth, and noise performance; and recommend suitable modulation and communication technologies for given application scenarios.
14	3D Printing Technologies (OE-II)	CO1	Describe the fundamentals, process chain, classification, advantages, and limitations of 3D printing technologies.
		CO2	Select and analyze appropriate CAD data formats, software tools, and identify STL file errors with suitable correction techniques.
		CO3	Explain the operating principles, process parameters, capabilities, and limitations of liquid, solid, and powder based 3D printing technologies.
		CO4	Compare different 3D printing technologies based on process characteristics, material compatibility, and application suitability.
		CO5	Apply 3D printing knowledge and techniques to diverse industrial sectors for
15	Effective Technical Communication	CO1	Handle Technical Communication effectively by overcoming barriers to communication.
		CO2	Demonstrate different types of Oral and Written Communication.
		CO3	Use different types of Business letters and Inter office correspondence.
		CO4	Acquire adequate skills to draft efficient technical reports.
		CO5	Enhance their skills of technical presentations and information transfer.
16	Essence Of Indian Traditional Knowledge	CO1	Understand the concepts of Indian culture and Traditions and their Importance
		CO2	Distinguish the Indian Languages
		CO3	Show the basic understanding of Indian religion and Philosophy
		CO4	Show the basic understanding about the fine arts in India
		CO5	Analyze and apply the principles of traditional Indian Education to

			contemporary learning systems
17	Analog and Digital Communication Lab	CO1	Identify hardware, functional blocks, and simulation tools for analog modulation (AM, FM), pulse modulation (PAM, PWM, PPM), baseband digital (PCM, DM, ADM), and digital carrier modulation (ASK, FSK, BPSK, QPSK).
		CO2	Explain the working principles of analog and digital modulation/demodulation, pre-emphasis/de-emphasis, multiplexing techniques, data format encoding, and the mathematical representation of these systems in MATLAB/Simulink models.
		CO3	Set up and operate modulation/demodulation hardware and simulation models for AM, FM, PAM, PWM, PPM, PCM, DM, ADM, ASK, FSK, BPSK, and QPSK systems; measure modulation index, BER, spectra.
		CO4	Analyze experimental waveforms, constellations, eye patterns to assess modulation depth, signal reconstruction quality, quantization noise, and inter-symbol interference.
		CO5	Evaluate analog and digital modulation techniques through experimental measurements (SNR, BER, bandwidth); design experiments and testbenches for system verification.
18	VLSI Design Lab	CO1	Identify the circuit configurations, design rules, and functional blocks used in CMOS logic gates, arithmetic, amplifiers, combinational/sequential, memory cells, and layout design.
		CO2	Explain the working principles of CMOS pull-up/pull-down networks, amplifier small-signal behavior, transmission gate operation, flip-flop clocking mechanisms, dynamic memory charge storage, and layout design process.
		CO3	Design and simulate CMOS logic gates, adders, amplifiers, decoder, multiplexer, flip-flop, and memory; perform layout design and verify functional correctness through simulation.
		CO4	Analyze voltage transfer characteristics, propagation delay, power dissipation, gain-bandwidth product, timing parameters, parasitic effects, and fault coverage of VLSI from simulation results.
		CO5	Evaluate the performance of VLSI circuit implementations based on delay, power, area, and noise metrics; and design optimized, layouts, and test patterns for fault detection and performance validation.
19	ECE Software Tools Lab	CO1	Recall GitHub features, CSS layout/responsive properties, JS types and DOM methods, Python data types/file I/O, SQL CRUD, and static deployment components.
		CO2	Explain GitHub clone/push/pull with PRs, flexbox/media query layouts, JS control flow and DOM, Python scripting with file I/O, SQL query mechanics, and HTML/CSS/JS integration.
		CO3	Manage GitHub repos with collaborative workflows, build responsive flexbox layouts, write JS with DOM/events, develop Python file-processing scripts, execute SQL operations, and deploy on GitHub Pages.
		CO4	Analyze GitHub history, inspect CSS layouts via dev tools, trace JS execution, verify Python/SQL outputs, and diagnose deployment issues.
		CO5	Evaluate collaborative workflows, responsiveness, script correctness, and query accuracy; design GitHub projects, responsive layouts, JS pages, Python scripts, and a deployed portfolio.
20	Technical Seminar	CO1	Recall seminar topic identification steps, scholarly source types (journals, conferences, patents), IEEE citation, report structure, slide design, and ECE evaluation criteria.

		CO2	Explain ECE topic selection, reviewed technical concepts, report writing conventions, presentation techniques, and critical evaluation methods for research.
		CO3	Apply literature survey via databases (IEEE Xplore, Google Scholar, Scopus); prepare structured seminar report with IEEE citations; deliver a technical presentation.
		CO4	Analyze literature depth, methodologies, strengths/limitations; assess report coherence/accuracy; evaluate presentation strategies for complex ECE concepts.
		CO5	Evaluate research quality based on rigor and ECE trends; produce comprehensive seminar deliverables including report, presentation, and scholarly defense.
21	Summer Internship	CO1	Recall organizational structures, safety protocols, project workflows, engineering principles, report conventions, and presentation techniques for Industrial/R&D practice.
		CO2	Understand Industrial/R&D working practices: organizational domains, project planning, industry tools, documentation, teamwork, ethics, and workplace communication.
		CO3	Acquire practical experience through background research, project planning, executing industry tasks using engineering tools, maintaining documentation, and delivering seminar presentations.
		CO4	Analyze project requirements, feasibility, results, data, and mentor feedback to identify scope, troubleshoot issues, draw conclusions, and improve performance.
		CO5	Evaluate project outcomes, approaches, and professional growth; prepare technical reports, propose innovations, and demonstrate communication skills integrating industry and academic knowledge.