Kuvempu University

Department of PG Studies and Research in Electronics

Broad outcome: Electronics has a profound impact on various aspects of modern society and culture, such as communication, entertainment, education, health care, industry, and security. Electronic devices have become an important part of our day-to-day life. It has become difficult for us to do work without using electronic devices. We live in a generation that uses electronics and technologies where robots and artificial intelligence are capable of doing human work with more ease and efficiency. The program helps in generating competent professionals with an aim to meet challenges in the field of Electronics.

Program specific outcome: With the degree of M.Sc. Electronics, students can get a variety of career options in Research and Development Laboratorial Organizations, IT Industry, Process and Manufacturing Industry, Electronics and Telecommunication Industry, etc. The M.Sc. Electronics syllabus delivers graduates a thorough learning of subjects with a realistic approach which includes practicals, internships, projects, industrial visits, etc.

Course outcome: The course has many advanced papers designed to expose the learners to all the industry-relevant knowledge and concepts. By the end of course, Student will acquire Analytical skills, Research skills, Hardware deployment skills, Operating system knowledge skills, Problem-Solving skills. Students can join institutions and industries as a Lecturers, Instrumentation engineers, R&D scientists, Programmers, service engineers etc.

M. Sc., Electronics Program and Course Outcome.

Program Specific Outcomes

After successful completion of program, students will be able to:

- The M.Sc. in Electronics program is designed to equip students with a comprehensive skill set and knowledge base in electronic research and development. Throughout the program, students are instilled with a strong commitment to safety measures, ethical practices, and responsible conduct in the field. The curriculum emphasizes advanced microelectronics skills, covering theoretical understanding, practical implementation, and research project execution. Graduates are equipped to innovate and contribute to cutting-edge electronic tools and technologies, enhancing efficiency across various domains.

- Expertise in microwave and antenna systems is a key outcome, with graduates demonstrating proficiency in understanding microwave properties, transmission media, and antenna selection for specific applications. The program places a significant emphasis on microcontroller programming, ensuring mastery in the architecture and programming of Basic Microcontrollers, PIC, and ARM microcontrollers. Signal processing competence is cultivated, with students showcasing their ability to classify and analyze signals and systems in time and frequency domains, employing techniques such as convolution and Z-transforms.

- The curriculum also delves into control systems knowledge, digital design, and Verilog proficiency, providing students with a solid foundation in fundamental electronics. Power electronics competency is developed, focusing on the design and operation of components, circuits, and systems, including converters, inverters, and motor control. Wireless communication and satellite understanding are integral components, contributing to advancements in communication technology.

- Advanced expertise in digital communication, computer networks, image processing, multimedia knowledge, information theory, and coding are emphasized, addressing real-world applications and security considerations. Additionally, the program imparts

VLSI design and testing skills, covering MOS transistor theory, CMOS technologies, architectural choices, and subsystem design processes.

- In response to emerging trends, students gain exposure to machine learning applications, embedded systems development using Cortex M3, and pattern recognition proficiency. Graduates are well-prepared to identify problems suitable for machine learning, design and develop embedded systems, and contribute to the design and implementation of pattern recognition systems.

- In essence, the M.Sc. in Electronics program produces graduates with a multidisciplinary skill set, blending theoretical knowledge with practical applications, innovation, and a commitment to ethical and responsible practices in the field of electronic research and development.

Semester I Paper Title- ELH: 1.1 PROGRAMMING IN C++

Student Learning Course Outcomes
After successful completion of this course, students will be able to: -

1. Explain the principles of object-oriented programming and identify characteristics of an object-oriented language.
2. Recognize and use C++ language components, including tokens, keywords, identifiers, and constants.
3. Apply basic data types, user-defined data types, and derived data types in C++.
4. Use arithmetic, relational, logical, assignment, increment, and decrement operators in programming.
5. Implement decision-making structures (if, if-else, else-if, switch) and loop constructs (for, while, do-while).
6. Define functions, handle function arguments, and explore function overloading and virtual functions.
7. Understand and apply data structures, including arrays, pointers, and dynamic memory allocation.

8. Explore object-oriented concepts such as classes, objects, constructors, destructors, and inheritance.
9. Manage console I/O operations and handle file stream operations, opening, closing, and detecting end-of-file.
10. Work with class templates, function templates, and understand non-type template arguments.
11. Familiarize the basics of exception handling, including throwing, catching, and rethrowing mechanisms.
12. Manipulate strings and understand components of the Standard Template Library (STL) for containers, algorithms, iterators, and function objects.

Semester I Paper Title- ELH - 1.2 MICROWAVES AND ANTENNAS

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Apply the knowledge gained to design and analyze microwave systems and devices.
2. Analyze the working principles of microwave tubes, focusing on Reflex Klystron Oscillator and its modes of oscillations.
3. Understand microwave network theory, using Symmetrical Z and Y-Parameters for Reciprocal Networks and S matrix representation.
4. Familiarize with microwave passive devices, including Coaxial Connectors, Attenuators, Phase Shifters, and Waveguide Tees.
5. Explore microwave transmission lines, reviewing equations, reflection coefficient, transmission coefficient, and impedance matching using the Smith Chart.
6. Describe fundamental antenna parameters, patterns, beam area, radiation intensity, directivity, and gain.
7. Analyze characteristics of electric dipoles, including short electric dipoles and thin linear antennas.
8. Explore point sources and arrays, understanding power patterns, radiation intensity, field patterns, and arrays of isotropic point sources.
9. Classify and describe different antenna types, including loop antennas, horn antennas, helical antennas, Yagi-Uda arrays, and parabolic antennas.
10. Analyze loop antennas, including far-field patterns and radiation resistance.

11. Understand the design considerations and properties of helical antennas and explore strip lines, including microstrip lines, parallel strip lines, and coplanar strip lines.

Semester I Paper Title- ELH: 1.3 PIC & ARM MICROCONTROLLER

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Understand the architecture of basic microcontrollers, including PIC and ARM.
2. Program PIC and ARM microcontrollers.
3. Interface microcontrollers with various peripherals and devices.
4. Demonstrate knowledge of different microcontroller architectures, processor types, and memory organization.
5. Apply programming skills for controlling stepper motors, generating waveforms, displaying information on different interfaces, and implementing serial communication.
6. Utilize ARM processors for embedded systems, understanding registers, instruction sets, and architectural support for high-level languages.
7. Implement practical projects involving microcontroller interfacing for real-world applications.

Semester I Paper Title- ELH - 1.4 SIGNALS AND SYSTEMS

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Define and classify signals as even, odd, periodic, non-periodic, deterministic, non-deterministic, energy, and power signals.
2. Familiarize and analyze elementary signals/functions, including exponential, sine, impulse, step, ramp, rectangular, triangular, signum, and sync functions.
3. Define and categorize systems as linear/non-linear, time variant/invariant, causal/non-causal, static/dynamic, stable/unstable, and invertible.
4. Explain convolution, impulse response representation, and properties of impulse response for Linear Time-Invariant (LTI) systems.

5. Discuss Fourier representations of discrete-time periodic signals, Discrete Time Fourier Series (DTFS), continuous-time periodic signals, Fourier series, and transforms.
6. Apply Fourier transform representations for periodic signals, convolution, modulations, and Fourier transform representation for discrete-time signals.
7. Lead Z-Transform, its properties, Region of Convergence (ROC), inversion, and its application in transform analysis of LTI systems.
8. Demonstrate the ability to analyze signals and systems using different representations, including Fourier transforms and Z-Transforms.
9. Formulate mathematical models for signals and systems, solving problems involving convolution, Fourier representations, and Z-Transforms.
10. Apply the acquired knowledge to solve real-world problems in communication and control systems.
11. Demonstrate proficiency in analyzing and designing linear systems using time and frequency domain techniques.

Semester II Paper Title- ELH 2.1 CONTROL SYSTEMS

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Identify and explain the fundamental features, configurations, and applications of control systems.
2. Define and apply various terminologies related to control systems, establishing a comprehensive understanding of the subject.
3. Formulate mathematical models for electrical, mechanical, and electro-mechanical systems, emphasizing the importance of differential equations.
4. Determine time and frequency responses from the transfer function, illustrating the connection between mathematical modeling and system behavior.
5. Evaluate stability in both time and frequency domains, employing concepts such as Routh stability criterion and frequency domain analysis.
6. Utilize block diagrams and signal flow graphs to represent and analyze control systems, including transfer functions and algebraic manipulations.

7. Analyze time responses of feedback control systems using standard test signals, focusing on first and second-order systems.
8. Assess steady-state errors and error constants in control systems, understanding their significance in system performance.
9. Apply stability analysis techniques, including the Routh stability criterion and frequency domain analysis with Bode plots and Nyquist stability criterion.
10. Introduce concepts of digital control systems, sampling processes, and state variable analysis. Design control systems using various controllers, including PD, PI, PID, Phase-Lead, and Phase-Lag controllers.

Semester II Paper Title- ELH - 2.2 Digital design using Verilog

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Differentiate between Verilog and VHDL descriptions for digital design.
2. Acquire various Verilog HDL constructs and understand their application in digital systems.
3. Familiarize with different levels of abstraction in Verilog, including data flow, behavioral, and structural modeling.
4. Gain knowledge of Verilog tasks and directives, and their role in digital circuit design.
5. Understand timing and delay simulation in the context of digital design.
6. Acquire a comprehensive overview of digital systems, embedded systems, and real-world circuits.
7. Master combinational basics, including components and verification of combinational circuits.
8. Explore sequential basics, covering sequential data paths, control clocked synchronous timing methodology.
9. Comprehend lexical conventions, data types, system tasks, and compiler directives in Verilog HDL.
10. Apply gate-level modeling techniques, dataflow modeling, and behavioral modeling in Verilog for effective digital circuit design.

Semester II Paper Title- ELH - 2.3 DIGITAL SIGNAL PROCESSING

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Understand the frequency domain representation of discrete time signals, including the Discrete Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT).
2. Comprehend the properties and algorithms for efficiently computing the DFT, including the Fast Fourier Transform (FFT) and its decimation-in-time and decimation-in-frequency variants.
3. Realize the implementation of Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters using different structural forms.
4. Learn the design procedures for IIR filters through impulse invariance and bilinear transformation methods.
5. Gain knowledge of digital filter characteristics, including simple digital filters, all-pass functions, complimentary transfer functions, and digital two pairs.
6. Understand the concepts of sampling and reconstruction in the context of digital filters.
7. Explore analog filter design principles, including maximally flat low-pass filter approximation, Chebyshev filter approximation, and frequency transformations.
8. Familiarize oneself with various digital filter structures, such as direct, parallel, cascade, ladder, and lattice for IIR, as well as possible realizations for FIR, including polyphase and all-pass structures.
9. Acquire skills in IIR filter design using impulse invariance and bilinear transformations, spectral transformations, and FIR filter design using methods like windowing, frequency sampling, and computer aids.
10. Differentiate between IIR and FIR filters, understanding their respective characteristics and applications.

Semester II Paper Title- ELE - 2.5 BASIC ELECTRONICS (ELE)

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Understand the principles of amplifiers and oscillators, including the concept of decibels, half-power points, and the Barkhausen Criterion for oscillations.
2. Gain knowledge of operational amplifiers (OPAMPs), including their ideal properties, inverting and non-inverting circuits, and various applications such as voltage follower, addition, subtraction, integration, and differentiation.
3. Explore communication systems, covering elements of communication, modulation techniques (amplitude, frequency, and phase modulation), spectrum power, and amplitude modulation detection (demodulation).
4. Gain insights into transducers, including passive electrical transducers like resistance thermometers and thermistors, as well as active electrical transducers like piezoelectric and photoelectric transducers. Understand the functioning of basic measuring instruments such as voltmeters, ammeters, multimeters, and oscilloscopes.
5. Learn about flip-flops, including NAND Gate Latch, NOR Gate Latch, and RS Flip-Flop, and their applications in digital electronics.
6. Introduce microcontrollers and their architecture, with a specific focus on the 8051 microcontroller. Understand the block diagram approach in the context of a microcontroller-based stepper motor control system.
7. Apply the knowledge gained in this course to comprehend the building blocks of electronic devices and systems.
8. Demonstrate an understanding of the qualitative aspects of single-stage and two-stage CE amplifiers, negative feedback effects, and various types of oscillators.
9. Gain familiarity with communication system components and modulation techniques, specifically amplitude modulation and its detection.
10. Apply the knowledge of transducers to recognize and understand passive and active electrical transducers, as well as basic measuring instruments used in electronics.

Semester II Paper Title- ELS: 2.4.1 POWER ELECTRONICS

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Demonstrate an understanding of power semiconductor devices and their control characteristics.
2. Design and analyze thyristor circuits for converters, inverters, and motors.
3. Apply knowledge of controlled rectifiers, AC voltage controllers, and cycloconverters in power electronics systems.
4. Implement control strategies for choppers and analyze step-up and step-down chopper circuits.
5. Classify different types of motors and explain their working principles.
6. Design and analyze DC motor drives, including closed-loop and PLL control.
7. Analyze AC motor drives, including torque-speed characteristics, speed control, and synchronous motors.
8. Apply the principles of power electronics in real-world applications and solve related engineering problems.

Semester II Paper Title- ELS: 2.4.2 WIRELESS COMMUNICATION AND SATELLITE COMMUNICATION

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Understand the evolution of mobile radio communications and recognize examples of wireless communication systems, including paging and cordless telephone systems.
2. Differentiate between various wireless systems, with a focus on second-generation cellular networks, third-generation wireless networks, and wireless local area networks.
3. Comprehend the fundamentals of cellular system design, including spectrum allocation, frequency reuse, channel assignment strategies, handoff strategies, and interference management.
4. Explore multiple access techniques in wireless communication, such as FDMA, TDMA, spread spectrum multiple access, and space division multiple access.

5. Compare wireless and fixed telephone networks, analyze the development of wireless networks, and understand traffic routing in wireless networks.
6. Study the principles of Orthogonal Frequency Division Multiplexing (OFDM) and its application in wireless communication systems.
7. Examine satellite orbits and trajectories, including orbital parameters, injection velocity, types of satellite orbits, and orbital effects on satellite performance.
8. Understand the subsystems of communication satellites, including power supply, attitude and orbit control, tracking, telemetry, command subsystems, and payload.
9. Explore earth stations, their types, architecture, design considerations, testing, hardware, and satellite tracking.
10. Analyze communication satellites, their applications in satellite telephony, television, radio, regional satellite systems, and national satellite systems.

Semester III Paper Title- ELH –3.1: ADVANCED DIGITAL COMMUNICATION

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Apply knowledge of digital modulation techniques in real-world communication scenarios.
2. Analyze and design convolutional codes for channel coding.
3. Evaluate the impact of channel characteristics on communication performance.
4. Implement and analyze spread spectrum digital communication systems.
5. Demonstrate an understanding of advanced techniques for mitigating channel impairments, such as equalization and adaptive filtering.
6. Apply coding techniques for error detection and correction in digital communication.
7. Design and implement communication systems in the presence of noise, interference, and fading channels.
8. Evaluate the performance of various modulation and coding schemes in practical communication scenarios.

Semester III Paper Title- ELH – 3.2 ADVANCED COMPUTER NETWORKS

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Gain a thorough understanding of computer network protocols, standards, and architectures, including the OSI and TCP/IP reference models.
2. Demonstrate knowledge of hardware components such as connectors, transceivers, and networking devices, and comprehend principles underlying telephone networks.
3. Understand packet switching protocols like X.25, their operational theory, and functions at the network layer. Grasp internetworking protocols, SMDS, addressing, and traffic control.
4. Acquire multiplexing techniques (FDM, TDM, SM) and different types of LANs (Ethernet, token ring, FDDI), as well as the concepts of switching, circuit switching, packet switching, and multicasting.
5. Explore SONET/SDH standards, DWDM in optical networking, and the history and layers of Integrated Service Digital Network (ISDN).
6. Understand the basics of Internet protocols, including IP, TCP, UDP, ICMP, HTTP, and the World Wide Web. Gain insights into internet security and email security.
7. Comprehend ATM protocols, operations, WAN aspects, and the B-ISDN reference model. Explore ATM layers, traffic descriptors, congestion control, AAL protocol, and network management in ATM.
8. Acquire about network management concepts, SNMP components, SMI, MIB, and SNMP message formats.
9. Understand cryptography, symmetric and public key algorithms, digital signatures, management of public keys, communication security, web security, and basics of traffic management.
10. Gain insights into QoS, queue analysis, and the basics of traffic management, including requirements for web security and the use of Secure Socket Layer (SSL).

Semester III Paper Title- ELH – 3.3: IMAGE PROCESSING

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Develop a comprehensive understanding of Digital Image Processing, including elements of visual perception, image sensing, and acquisition.
2. Apply mathematical tools in Digital Image Processing and grasp the fundamental algorithms related to intensity transformations and spatial filtering.
3. Gain proficiency in frequency domain filtering, including concepts of Fourier Transform, DFT of two variables, and properties of 2D DFT.
4. Acquire skills in image restoration and reconstruction, considering models of image degradation/restoration processes and addressing noise reduction.
5. Understand morphological image processing techniques such as erosion, dilation, opening, closing, and the Hit or Miss Transformation.
6. Explore advanced morphological algorithms and grasp the concepts of gray-scale morphology.
7. Develop expertise in image segmentation, covering point, line, and edge detection, as well as thresholding and region-based segmentation.
8. Gain insights into color image processing, including color fundamentals, color models, and transformations for smoothing and sharpening.
9. Implement image processing algorithms to solve real-world problems, demonstrating practical application.
10. Be prepared to engage with current image processing research literature and stay updated with advancements in the field.

Semester III Paper Title- ELS-3.4.1: INFORMATION THEORY & CODING

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Acquire a deep understanding of information and entropy, assessing average information content in independent and dependent symbol sequences.
2. Gain expertise in source coding methods, including encoding of source output, application of Shannon's encoding algorithm, and implementation of Huffman coding and the Source Coding Theorem.
3. Grasp the core principles of channel coding, including mutual information and the channel capacity theorems for discrete memoryless channels.
4. Demonstrate proficiency in block codes, covering Hamming weight, minimum distance decoding, and types of errors. Evaluate examples such as Single Parity Codes, Hamming Codes, and Repetition Codes.
5. Apply knowledge in linear block codes, matrix descriptions, and error detection and correction techniques.
6. Implement binary cyclic codes, understand algebraic structures, and apply encoding using (n-k) bit shift registers. Implement Syndrome calculation and BCH codes.
7. Apply advanced coding techniques including Reed-Solomon (RS) codes, Golay Codes, shortened cyclic codes, particularly in the context of correcting burst and random errors.
8. Understand convolution codes and their representation in both time and transform domains.
9. Demonstrate proficiency in designing encoders and decoders, and evaluate the efficacy of different code types in information transmission.
10. Apply acquired knowledge practically in designing, analyzing, and implementing error control codes for efficient communication across various channels.

Semester III Paper Title- ELS – 3.4.2: MULTIMEDIA

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Define Multimedia Communication Models and understand the principles of multimedia information representation.

2. Explain Multimedia Transport in Wireless Networks, including issues related to quality of service (QoS) at both the network and application levels.
3. Solve security issues in multimedia networks, demonstrating an understanding of measures to ensure the confidentiality and integrity of multimedia data.
4. Illustrate real-time multimedia network applications, emphasizing the practical implementation of multimedia in various scenarios.
5. Understand and apply application and networking terminology relevant to multimedia networks.
6. Discuss and analyze network QoS (Quality of Service) and its impact on application QoS in the context of multimedia.
7. Explain the principles of digitization for text, images, audio, and video in the context of multimedia networks.
8. Demonstrate knowledge of compression techniques for text, images, audio, and video, including standards such as Runlength, Huffman, LZW, GIF, TIFF, JPEG, DPCM, ADPCM, and MPEG.
9. Explore video compression standards (H.261, H.263, MPEG, MPEG-1, MPEG-2, MPEG-4) and understand the process of multimedia content description standardization (MPEG-7).
10. Introduce the concept of synchronization, presentation requirements, and the reference model for synchronization, including an overview of multimedia operating systems, resource management, and process management techniques.

Semester III Paper Title-ELE 3.5 FUNDAMENTALS OF DIGITAL ELECTRONICS

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Understand the fundamentals of binary systems, including binary numbers, conversions, octal and hexadecimal numbers, complements, binary codes, storage, and registers in digital computers.
2. Gain proficiency in Boolean algebra, logic gates, and the axiomatic definition of Boolean algebra. Apply theorems and properties, simplify Boolean functions using the map method, and implement them with NAND and NOR gates.

3. Explore combinational logic, covering design procedures, adders (binary parallel and decimal), subtractors, code conversion, magnitude comparators, decoders, and multiplexers.
4. Delve into sequential logic, including flip flops (SR, JK, D & T types), triggering mechanisms, analysis of clocked sequential circuits, state reduction and assignment, flip-flop excitation tables, shift registers, and counters.
5. Apply the tabulation method for simplifying Boolean functions and understand the use of don't care conditions in logic design.
6. Demonstrate the ability to work with multi-variable maps (Two-Three-Four-Five-Six variable maps) for Boolean function simplification.
7. Develop skills in determining and selecting prime implicants in Boolean function simplification.
8. Apply knowledge of sequential logic to design shift registers and counters.
9. Gain hands-on experience in analyzing and designing digital circuits using integrated circuits.
10. Demonstrate a comprehensive understanding of digital electronics principles and apply them to real-world problems in computer systems and digital technology.

Semester III Paper Title- ELR-3.9 Industrial Training

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. **Practical Application:** Apply theoretical knowledge gained during the academic program to real-world industrial scenarios.
2. **Professional Skills:** Develop and enhance professional skills such as teamwork, communication, time management, and problem-solving in an industrial setting.
3. **Industry Exposure:** Gain exposure to industry practices, standards, and processes relevant to the field of electronics.
4. **Hands-on Experience:** Acquire hands-on experience with industrial tools, equipment, and technologies used in the electronics industry.
5. **Project Execution:** Demonstrate the ability to plan, execute, and manage a project within the constraints of an industrial environment.
6. **Adaptability:** Adapt to the work culture, environment, and dynamics of an industrial organization.
7. **Networking:** Establish professional networks and connections within the industry.
8. **Critical Analysis:** Analyze and evaluate real-world challenges and propose practical solutions based on acquired knowledge.
9. **Professional Ethics:** Understand and adhere to professional and ethical standards in the workplace.
10. **Documentation and Reporting:** Develop effective documentation and reporting skills for tasks and projects undertaken during the industrial training period.

These outcomes reflect the typical goals of industrial training, where students are expected to bridge the gap between theoretical knowledge and practical application, preparing them for future professional roles in the electronics industry.

Semester III Paper Title- ELH – 4.1: VLSI Design

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Understand the fundamentals of MOS transistor theory and its application in CMOS technologies.
2. Analyze architectural choices and performance tradeoffs in the design and realization of circuits using CMOS technology.
3. Demonstrate knowledge of subsystem design processes in VLSI design.
4. Explain the concepts of CMOS testing, including semiconductor technology overview and process considerations.
5. Discuss the characteristics and design aspects of CMOS inverters, including static load, differential, tristate, and BiCMOS inverters.
6. Comprehend the CMOS process technology, covering semiconductor technology overview, p/n well processes, and current CMOS enhancement techniques.
7. Understand the basics of digital CMOS design, including combinational and sequential MOS logic circuits.
8. Explore dynamic logic circuits, including pass transistor circuits, voltage bootstrapping, and dynamic CMOS circuit techniques.
9. Discuss sheet resistance, standard unit capacitance concepts, and factors affecting delay in dynamic CMOS circuits.
10. Gain knowledge of clocking techniques in VLSI design, covering clock generation, distribution, clocked storage elements, and the advantages of CMOS over NMOS.

Semester IV Paper Title- ELH -4.2: MACHINE LEARNING

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Identify and articulate problems suitable for machine learning applications, selecting appropriate paradigms (supervised, unsupervised, or reinforcement learning).

2. Apply foundational principles of probability and statistics to machine learning, utilizing these concepts in model development and evaluation.
3. Implement and understand concept learning algorithms, including Find-S, Candidate Elimination, and concepts like Version Space and inductive bias.
4. Apply decision tree learning algorithms to solve practical problems, considering hypothesis space search and inductive bias.
5. Demonstrate a fundamental understanding of artificial neural networks (ANN), construct neural network representations, and implement Perceptrons and Backpropagation for training.
6. Apply Bayesian learning, utilizing Bayes theorem, maximum likelihood, and least squares error hypotheses, implementing practical applications like Naive Bayes classifier and Bayesian belief networks.
7. Justify the importance of hypothesis evaluation, estimate accuracy, derive confidence intervals, and compare learning algorithms.
8. Understand instance-based learning, implement k-nearest neighbor learning, and explore locally weighted regression, radial basis function, and case-based reasoning.
9. Grasp the fundamentals of reinforcement learning, formulate learning tasks, and implement the Q Learning algorithm for sequential decision-making.

Semester III Paper Title-ELH – 4.3: EMBEDDED SYSTEMS

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Understand the core components of embedded systems, including processors, memory, sensors, actuators, and communication interfaces.
2. Demonstrate knowledge of hardware-software co-design principles and computational models in embedded system design.
3. Apply Unified Modeling Language (UML) concepts for hardware-software trade-offs in embedded systems.

4. Utilize Electronic Design Automation (EDA) tools for schematic design, printed circuit board (PCB) layout, and netlist creation.
5. Design and develop embedded firmware using appropriate approaches and programming languages.
6. Comprehend the basics of the ARM Cortex-M3 architecture, including operation modes, registers, and data types.
7. Implement interrupt controllers, understand exception handling, and program ARM Cortex-M3 for real-time applications.
8. Explore advanced programming features and the Memory Protection Unit in ARM Cortex-M3 microcontrollers.
9. Familiarize with the embedded system development environment, including Integrated Development Environment (IDE), cross-compilation, and debugging tools.
10. Apply knowledge through case studies on target hardware debugging, boundary scan, and real-world embedded system development scenarios.

Semester III Paper Title- ELH – 4.4: PATERN RECOGNITION

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. Understand the basics of pattern recognition systems, including their applications and the pattern recognition life cycle.
2. Design and construct a pattern recognition system, applying major approaches in statistical and syntactic pattern recognition.
3. Demonstrate knowledge of probability theory, Gaussian distribution, and Bayes decision theory for statistical pattern recognition.
4. Implement optimal solutions for minimum error and minimum risk criteria, considering decision surfaces.
5. Apply parameter estimation methods such as Maximum-Likelihood estimation, Expectation-maximization method, and Bayesian parameter estimation.

6. Comprehend the concept of feature extraction, dimensionality, and dimension reduction methods, including Fisher discriminant analysis and Principal component analysis.
7. Understand Hidden Markov Models (HMM) and Gaussian mixture models as non-parametric methods for pattern recognition.
8. Apply non-parametric techniques for density estimation, such as the Parzen-window method and K-Nearest Neighbour method.
9. Implement decision trees, linear discriminant-based algorithms (Perceptron, Support Vector Machines), and classifier ensembles (Bagging, Boosting/Ada Boost).
10. Demonstrate proficiency in unsupervised learning, particularly clustering techniques like K-means and Hierarchical methods, along with cluster validation.

Semester III Paper Title- ELP- 4.7 Project Work

Student Learning Course Outcomes

After successful completion of this course, students will be able to: -

1. **Project Planning and Management:**
    - Develop the ability to plan and manage a project, including defining objectives, scope, and timelines.
2. **Technical Proficiency:**
    - Demonstrate enhanced technical skills relevant to the chosen project, showcasing expertise in the application of electronics concepts.
3. **Problem Identification and Solving:**
    - Identify and analyze problems related to the project, applying critical thinking and problem-solving skills to propose effective solutions.
4. **Team Collaboration:**

- Work collaboratively within a team, demonstrating effective communication, teamwork, and coordination to achieve project goals.

5. **Documentation and Reporting:**
   - Develop skills in documenting project progress, methodologies, and outcomes, and present findings in a structured and coherent manner.
6. **Innovation and Creativity:**
   - Encourage innovative thinking and creativity in approaching project challenges, fostering a spirit of exploration and experimentation.
7. **Adaptability:**
   - Adapt to unforeseen challenges and changes in project requirements, showcasing flexibility and resilience in the face of evolving circumstances.
8. **Presentation Skills:**
   - Present the project outcomes effectively, including the ability to communicate complex technical information to both technical and non-technical audiences.
9. **Quality Assurance:**
   - Implement quality assurance measures to ensure the reliability and robustness of the project deliverables.
10. **Professional Ethics:**
    - Apply ethical considerations in decision-making and project execution, adhering to professional standards and integrity.
11. **Project Evaluation:**
    - Evaluate the success of the project based on predefined criteria, reflecting on lessons learned and areas for improvement.
12. **Integration of Learning:**
    - Integrate knowledge gained from various courses throughout the academic program into the project work, showcasing a holistic understanding of electronics.

These outcomes reflect the broader skills and competencies that students might be expected to develop as a result of completing a project work course. The specific outcomes may vary depending on the nature and scope of the projects undertaken by the students.

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