SVKM'S
NMIMS
Deemed to be UNIVERSITY

Mukesh Patel School of Technology Management and Engineering

B Tech (Electronics & Telecommunication Engineering)

- **Program Educational Objectives (PEOs)**
- **Program Outcomes (POs)**
- **Course Outcomes (COs)**

Program Educational Objectives (PEOs):

1. **Professional Skills**
2. **Career Growth**
3. **Higher Studies**

Program Outcomes (POs):

PO-1: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO-2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO-3: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO-4: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO-5: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO-6: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO-7: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO-8: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO-9: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO-10: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO-11: Recognize the need for, and have the preparation and ability for independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

Courses and Course Outcomes (COs):

English Communication

- **CO-1:** Use their knowledge of vocabulary and grammar to articulate their ideas effectively
- **CO-2:** Demonstrate effective listening and speaking skills in oral communication situations such as speeches, conversations, power-presentations, etc.
- **CO-3:** Apply different reading techniques as needed to read passages effectively

Constitution of India

- **CO-1:** Recall the historical evolution of India's democratic values, emphasizing the foundational principles of justice, equality, and liberty as enshrined in the Preamble of the Constitution.
- **CO-2:** Understand the fundamental rights enshrined in the Constitution, their permissible restrictions, and how these rights are balanced with duties, to grasp their application within societal and professional frameworks.
- **CO-3:** Apply the knowledge of the structure of India's polity and the role of the Judiciary in maintaining the basic structure of the Constitution in real-world professional contexts

Critical Thinking

- **CO-1:** solve problems or take decisions by processing information in a clear, logical, reasoned and reflective manner.
- **CO-2:** recognise, build and appraise arguments
- **CO-3:** analyse contexts effectively
- **CO-4:** recognise bias and its impact on decision making

Data Structures and Algorithms

- **CO-1:** Define the fundamental concepts of data structures, including classification, operations, and performance analysis. (L1- Remembering)
- **CO-2:** Demonstrate basic operations on linear data structures such as arrays, stacks, and queues, and use in problem-solving scenarios like expression evaluation and balanced parenthesis checking. (L2- Understanding)
- **CO-3:** Explain the concept of linked lists, including their representation and operations for polynomial addition.(L2- Understanding)
- **CO-4:** Explain binary trees and binary search trees, and implement tree traversal techniques and operations like insertion and deletion. (L2- Understanding)
- **CO-5:** Identify graph representations, traversal techniques (BFS and DFS) and algorithms like Dijkstra's and Minimum Spanning Tree to solve real-world problems. (L1- Remembering)
- **CO-6:** Perform searching techniques (linear and binary) and execute sorting algorithms (selection, insertion, and merge) to organize data effectively. (L3- Applying)

Digital Logic Design

- **CO-1:** Translate different number systems and binary codes, including weighted and non-weighted codes. (L2 - Understanding)
- **CO-2:** Simplify Boolean expressions using De Morgan's Theorem, SOP, POS, and Karnaugh maps. (L4 - Analyzing)
- **CO-3:** Build combinational logic circuits such as adders, multiplexers, decoders, and encoders. (L3 - Applying).
- **CO-4:** Analyze sequential circuits, including flip-flops, registers, and counters. (L4 - Analyzing)
- **CO-5:** Make use of VHDL for realizing basic digital logic circuits in different modeling styles. (L3 - Applying)

Circuit and Network Theory

- **CO-1:** Identify the methods of mesh and node analysis for circuits with independent and dependent AC and DC sources. (L1- Remembering)
- **CO-2:** Explain the use of network theorems, including Thevenin's, Norton's, and superposition theorems, in analyzing electrical circuits. (L2- Understanding)
- **CO-3:** Apply graph theory principles, including trees, cut sets, and tie sets, to model and analyze electrical networks. (L3- Applying)
- **CO-4:** Solve first- and second-order differential equations to evaluate transient and steady-state responses in electrical circuits. (L3-Applying)
- **CO-5:** Determine the parameters and functions of two-port networks, including Z, Y, ABCD, and hybrid parameters, for analyzing circuit behavior. (L5- Evaluating)

Signals and Systems

- **CO-1:** Illustrate the fundamental concepts of signals and systems, including classification and operations on signals. (L2 - Understanding)
- **CO-2:** Explain the properties of Linear Time-Invariant (LTI) systems and apply convolution techniques. (L2 - Understanding)
- **CO-3:** Illustrate the Fourier series representation of periodic signals, analyze their magnitude, and phase spectra. (L2 - Understanding)
- **CO-4:** Utilize Fourier and Laplace transforms, their properties for system analysis applications. (L3 - Applying)
- **CO-5:** Apply Z-transform in solving difference equations for discrete-time systems. (L3 - Applying)

Electromagnetic Wave Theory

- **CO-1:** Explain the fundamental concepts of control systems, including industrial control examples, control hardware, transfer function models, and the benefits of feedback.

- **CO-2:** Analyze the time response of first- and second-order systems for standard test inputs, and evaluate system stability using Routh-Hurwitz criteria and Root-Locus methods. (L3-Analyzing)
- **CO-3:** Interpret the relationship between time and frequency responses and evaluate system stability using Polar plots, Bode plots, and Nyquist criteria. (L2-Understanding)
- **CO-4:** Design feedback controllers using Root-Locus and frequency-domain methods, and implement Proportional, Integral, and Derivative controllers for achieving stability and transient accuracy. (L3-Applying)
- **CO-5:** Solve state-space equations for linear systems, and evaluate stability, controllability, and observability using state variable analysis. (L3-Applying)

Control System Engineering

- **CO-1:** Analyze the time response of first- and second-order systems for standard test inputs, and evaluate system stability using Routh-Hurwitz criteria and Root-Locus methods. (L3-Analyzing)
- **CO-2:** Analyze the time response of first- and second-order systems for standard test inputs, and evaluate system stability using Routh-Hurwitz criteria and Root-Locus methods. (L3-Analyzing)
- **CO-3:** Interpret the relationship between time and frequency responses and evaluate system stability using Polar plots, Bode plots, and Nyquist criteria. (L2-Understanding)
- **CO-4:** Design feedback controllers using Root-Locus and frequency-domain methods, and implement Proportional, Integral, and Derivative controllers for achieving stability and transient accuracy. (L3-Applying)
- **CO-5:** Solve state-space equations for linear systems, and evaluate stability, controllability, and observability using state variable analysis. (L3-Applying)
- **CO-6:** Define performance indices for optimal control and explain basic concepts of nonlinear systems in the context of regulator and tracking problems. (L1-Remembering)

Communication Theory and Systems

- **CO-1:** Illustrate the elements of a communication system, modulation techniques (AM, FM, PM), and their applications in electronic communications. (L2 - Understanding)
- **CO-2:** Classify pulse modulation techniques (PAM, PWM, PPM) and multiplexing methods (TDM, FDM) with their advantages and applications. (L2- Understanding)
- **CO-3:** Identify different waveform coding techniques, including PCM, DPCM, Delta Modulation, and their impact on signal quality. (L3 - Applying)
- **CO-4:** Explain the concept of inter-symbol interference (ISI), eye patterns, and their role in baseband data transmission. (L2 - Understanding)
- **CO-5:** Demonstrate digital modulation techniques such as FSK, PSK, and QPSK through basic circuit implementations and signal representation. (L2 - Understanding)
- **CO-6:** Summarize source coding concepts, entropy, and error control coding techniques like Linear Block Codes and Cyclic Codes. (L2 - Understanding)
- **CO-7:** Illustrate the fundamentals of spread spectrum modulation, including direct sequence and frequency hopping techniques, and their applications. (L2 - Understanding)

Analog Circuits Analysis and Design

- **CO-1:** Illustrate the small-signal and large-signal models of BJTs and JFETs, including their high-frequency behavior and hybrid-π model. (L2 - Understanding)
- **CO-2:** Design of single-stage and multistage amplifiers using BJT and FET transistor considering temperature drift, midpoint biasing. (L6- Creating)
- **CO-3:** Design Power Supply Circuit Analysis and Design. (L6- Creating)
- **CO-4:** Analyze the effects of negative feedback on amplifier circuits and oscillator circuits. (L4 - Analyzing).
- **CO-5:** Demonstrate the design and working of linear and non-linear op-amp circuits, including inverting, non-inverting, summing, differentiator,

integrator, Schmitt trigger, and waveform generators. (L2 - Understanding)

- **CO-6:** Explain the principles, classifications, and performance parameters of power amplifiers (Class A, B, AB, and C) along with their circuit topologies. (L2 - Understanding)

Microprocessor and Microcontroller

- **CO-1:** Explain the core (hardware architecture and programming model of 8051 microcontroller and 8086 microprocessors. (L2 - Understanding)
- **CO-2:** Develop assembly language programs for 8051 and 8086 using arithmetic, logical, and control instructions. (L3- Applying)
- **CO-3:** Analyze the interfacing of 8051 with external peripherals such as LCD, ADC, DAC, stepper motors, and keyboards to design embedded applications. (L4 - Analyzing)
- **CO-4:** Build assembly language programs for 8086 using appropriate addressing modes, instruction sets, and interfacing techniques with 8255A and 8087. (L3 - Applying)
- **CO-5:** Examine the architecture, register model, and pipeline stages of ARM7 microcontrollers to evaluate their efficiency in embedded system design. (L4 - Analyzing)
- **CO-6:** Design an embedded system using ARM7 microcontrollers with various I/O peripherals and communication protocols. (L6 - Creating)

Discrete Time Signal Processing

- **CO-1:** Analyze the frequency response, pole-zero plots, and phase distortion of LTI systems to determine system characteristics. (L4 - Analyzing)
- **CO-2:** Apply Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) techniques for efficient signal processing and filtering applications. (L3 - Applying)

- **CO-3:** Design FIR and IIR filters using appropriate techniques such as windowing, bilinear transformation, and frequency transformation for various applications. (L6 - Creating)
- **CO-4:** Evaluate the computational complexity of DFT and FFT algorithms, comparing their efficiency in signal processing applications. (L5 - Evaluating)
- **CO-5:** Implement FIR and IIR digital filters using different structures (Direct Form, Cascade, and Parallel) to achieve desired frequency response. (L3 - Applying)
- **CO-6:** Examine the impact of finite word-length effects such as quantization, truncation, and round-off noise on digital filter performance. (L4 - Analyzing)

Stochastic Processes

- **CO-1:** Define the fundamental concepts of stochastic processes and classify different types of stochastic processes. (L1- Remembering, L2- Understanding)
- **CO-2:** Explain stationarity, ergodicity, and correlation functions in random processes. (L2- Understanding)
- **CO-3:** Compute the power spectral density and autocorrelation functions for given stochastic processes. (L3- Applying)
- **CO-4:** Analyze the response of linear systems to random inputs using autocorrelation and spectral properties. (L4- Analyzing)
- **CO-5:** Distinguish between discrete and continuous Markov chains and illustrate their transition properties. (L2 -Understanding, L4- Analyzing)
- **CO-6:** Apply probability models to solve queueing theory problems such as M/G/1 and G/M/1 systems. (L3 -Applying)

Microwave and Antenna Theory

- **CO-1:** Define the fundamental concepts of microwaves, including frequency bands,
  applications, and radiation hazards. (L1-Remembering)

- **CO-2:** Explain the principles of microwave transmission lines, including modes of propagation, impedance matching, and waveguide characteristics. (L2-Understanding)
- **CO-3:** Compare different passive and active microwave devices such as directional couplers, circulators, and microwave tubes. (L2-Understanding)
- **CO-4:** Compute antenna parameters such as directivity, gain, beamwidth, and input impedance for various antenna types. (L3-Applying)
- **CO-5:** Analyze the performance of antenna arrays using pattern multiplication and array factor concepts. (L4-Analyzing)
- **CO-6:** Apply measurement techniques for microwave and antenna parameters such as VSWR, radiation pattern, and polarization. (L3-Applying)

Elements of Biology

- **CO-1:** Identify the principles of biomimicry and explain their applications in engineering and sustainable design, demonstrating an understanding of biologically inspired solutions.
- **CO-2:** Classify the fundamental building blocks of life (carbohydrates, proteins, lipids, and nucleic acids) and describe their structural and functional roles in cellular processes and metabolism.
- **CO-3:** Explain the molecular basis of genetic information transfer, including DNA replication, transcription, and translation, and interpret Mendel's laws and their significance in genetics.
- **CO-4:** Describe the mechanisms of enzyme action, enzyme-substrate interactions, and enzyme inhibition, and discuss their industrial and biological applications.
- **CO-5:** Explain the principles of metabolism and energy transactions, and categorize microorganisms based on their characteristics, growth kinetics, and applications in biotechnology and drug discovery.

Probability and Random Variables

- **CO-1:** Know the concept of probability and random variables.
- **CO-2:** Solve problems involving conditional probability and moments.
- **CO-3:** Demonstrate understanding of the applications of various probability distributions, measures of central tendency to solve real life problems.
- **CO-4:** Analyse the different probability density functions and their applications.

Wireless Communication Technology

- **CO-1:** Understand fundamental wireless network concepts, ITU-T & TRAI regulations, cellular system principles, and multiple access technologies. (L2 - Understanding)
- **CO-2:** Analyze large-scale and small-scale radio propagation effects, including path loss models and multipath fading. (L4 - Analyzing)
- **CO-3:** Evaluate different diversity techniques and MIMO configurations for wireless communication performance enhancement. (L5 - Evaluating)
- **CO-4:** Compare LTE advancements such as Carrier Aggregation, enhanced MIMO, CoMP, and heterogeneous networks. (L4 - Analyzing)
- **CO-5:** Assess 5G and 6G network architectures, radio access technologies, and propagation models for next-generation communication. (L5 - Evaluating)

Fiber Optic Communication and Networks

- **CO-1:** Explain the fundamental principles of optical fiber communication, including waveguides, fiber types, and transmission theories. (L2 - Understanding)
- **CO-2:** Analyze fiber transmission characteristics such as attenuation, dispersion, and losses, along with fiber connections and splicing techniques. (L4 - Analyzing)

- **CO-3:** Explain the working principles of optical sources (LEDs, LASER diodes) and detectors (PIN, Avalanche photodiodes) with their characteristics. (L2 - Understanding)
- **CO-4:** Evaluate different optical amplification techniques, including SOA, fiber amplifiers, and Raman amplifiers, for communication applications. (L5 - Evaluating)
- **CO-5:** Determine link power budget, rise time budget calculations in optical fiber systems, and perform optical measurements using OTDR and other techniques. (L5 - Evaluating
- **CO-6:** Differentiate optical network architectures, including SONET/SDH, WDM, and soliton-based communication, for high-speed data transmission. (L4 - Analyzing)

Interpersonal Skills

- **CO-1:** Demonstrate awareness of business networks and communicate appropriately in various contexts. (L2- Understanding)
- **CO-2:** Illustrate the knowledge of team dynamics to work productively in teams and participate effectively in contexts such as group discussions. (L2- Understanding)
- **CO-3:** Apply persuasive communication strategies to articulate themselves in situations such as personal interviews. (L3-Applying)
- **CO-4:** Create social media plans and employment related documents to showcase their personal brand. (L6- Creating)

Image and Video Processing

- **CO-1:** Explain the fundamentals of digital images, including pixel relationships, resolution, distance measures, and file formats. (L2 - Understanding)
- **CO-2:** Apply image enhancement techniques such as point processing, spatial filtering, and histogram equalization for image improvement. (L3 - Applying)

- **CO-3:** Analyze morphological image processing techniques and edge detection methods for feature extraction. (L4 - Analyzing)
- **CO-4:** Compare different image segmentation methods, including thresholding, region-based segmentation, and the Otsu method. (L4 - Analyzing)
- **CO-5:** Explain video representation concepts and motion estimation techniques used in digital video compression. (L2 - Understanding)

Speech Processing

- **CO-1:** Explain the fundamentals of speech and audio signals, including their representation and characteristics. (L2- Understanding)
- **CO-2:** Explain time-domain analysis techniques for speech signal processing. (L2- Understanding)
- **CO-3:** Apply frequency-domain analysis methods to extract features from speech signals. (L3- Applying)
- **CO-4:** Analyze different speech enhancement techniques for improving signal quality. (L4-Analyzing)
- **CO-5:** Demonstrate applications of speech processing in areas such as speech recognition and speaker identification. (L2- Understanding)

Information Theory and Coding

- **CO-1:** Explain the fundamental concepts of information theory, entropy, Shannon's theorem, and channel capacity. (L2-Understanding)
- **CO-2:** Apply lossless source coding techniques such as Huffman and Shannon-Fano coding for data compression. (L3- Applying)
- **CO-3:** Implement lossy source coding techniques using transform-based methods such as DCT, DWT, and Walsh Hadamard transform. (L3-Applying)
- **CO-4:** Analyze the performance of various linear block codes, including cyclic codes and Hamming codes, for error detection and correction. (L4-Analyzing)

- **CO-5:** Evaluate convolutional coding techniques and apply the Viterbi decoding algorithm for error correction in communication systems. (L5-Evaluating)

Satellite Communication

- **CO-1:** Explain the basic concepts of satellite communication, including orbital mechanics and frequency allocations. (L2: Understanding)
- **CO-2:** Explain link budget calculations and propagation effects in satellite communication. (L2: Understanding)
- **CO-3:** Classify different satellite subsystems and analyze their roles in communication. (L2- Understanding)
- **CO-4:** Evaluate satellite communication systems based on Quality-of-Service parameters. (L5- Analyzing)
- **CO-5:** Apply satellite-based navigation technologies in real-world applications. (L3-Applying)

Machine Learning

- **CO-1:** Identify different machine learning techniques and their applications. (L3- Applying)
- **CO-2:** Explain data preprocessing techniques for effective model training. (L2- Understanding)
- **CO-3:** Apply classification and regression techniques to solve real-world problems. (L3- Applying)
- **CO-4:** Analyze the performance of machine learning models using evaluation metrics. (L4-Analyzing)
- **CO-5:** Develop a machine learning-based application. (L6- Creating)

Artificial Intelligence

- **CO-1:** Explain AI concepts, including agents, environments, and search algorithms. (L2- Understanding)

- **CO-2:** Explain knowledge representation techniques and logical reasoning. (L2- Understanding)
- **CO-3:** Apply heuristic search strategies and problem-solving techniques. (L3-Applying)
- **CO-4:** Analyze machine learning approaches in AI applications. (L4-Analyzing)
- **CO-5:** Design an expert system for a real-world application. (L6- Creating)

Embedded System Design

- **CO-1:** Identify the components of embedded systems and their design requirements. (L3- Applying)
- **CO-2:** Explain embedded system communication protocols such as I2C, SPI, and CAN. (L2- Understanding)
- **CO-3:** Apply real-time operating system (RTOS) concepts to manage multitasking in embedded systems. (L3- Applying)
- **CO-4:** Analyze embedded firmware and hardware co-design for system optimization. (L4- Analyzing)
- **CO-5:** Develop an embedded system for a specific application using an Integrated Development Environment (IDE). (L6- Creating)

Internet of Things (IoT)

- **CO-1:** Explain the fundamentals of IoT and its architecture. (L2-Understanding)
- **CO-2:** Explain IoT communication protocols and their applications. (L2-Understanding)
- **CO-3:** Apply IoT cloud services and data analytics techniques. (L3-Applying)
- **CO-4:** Analyze security challenges in IoT networks and propose solutions. (L4- Analyzing)
- **CO-5:** Design an IoT-based project using appropriate hardware and software tools. (L6-Creating)

Digital Voice and Broadband Communication

- **CO-1:** Explain telephone traffic theory concepts, including Erlang formulas, network blocking, and grade of service. (L2 - Understanding)
- **CO-2:** Demonstrate network synchronization methods, clock instability, signaling techniques, and SS7 protocol. (L2 - Understanding)
- **CO-3:** Analyze VoIP architecture, protocols (RSVP, MPLS, RTP, SIP), and voice digitization techniques. (L4 - Analyzing)
- **CO-4:** Compare broadband technologies such as DSL, cable modem services, and optical fiber networks. (L4 - Analyzing)
- **CO-5:** Evaluate broadband access techniques, including PON, GPON, EPON, LoRaWAN, and NB-IoT. (L5 - Evaluating)

Biometrics

- **CO-1:** Identify the fundamental concepts of biometrics, including biometric attributes, privacy concerns, authentication, and identification techniques. (L2- Understanding)
- **CO-2:** Explain different types of biometric systems such as fingerprint recognition, iris recognition, facial recognition, and speech-based biometrics. (L2- Understanding)
- **CO-3:** Analyze the working principles, advantages, and challenges of multimodal biometric systems and their combination techniques. (L4- Analyzing)
- **CO-4:** Evaluate biometric performance metrics, including false match rate, equal error rate, ROC curves, and statistical measures. (L5- Evaluating)
- **CO-5:** Apply biometric recognition techniques in network security applications such as surveillance and authentication systems. (L3- Applying)

Cryptography and Network Security

- **CO-1:** Identify fundamental cryptographic techniques and explain their significance in secure communication. (L3- Applying)

- **CO-2:** Compare various encryption and decryption methods and demonstrate their applications in network security. (L2- Understanding)
- **CO-3:** Analyze security vulnerabilities and cryptographic protocols to mitigate risks in communication networks. (L4- Analyzing)
- **CO-4:** Evaluate authentication mechanisms and their effectiveness in securing network transactions. (L5 - Evaluating)
- **CO-5:** Explain modern security challenges and cryptographic solutions for emerging threats in digital networks. (L2 - Understanding)

Deep Learning

- **CO-1:** Explain the fundamental concepts of deep learning and its applications in various domains. (L2- Understanding)
- **CO-2:** Apply optimization and regularization techniques for training deep neural networks. (L3- Applying)
- **CO-3:** Analyze different neural network architectures, including convolutional and recurrent networks. (L4- Analyzing)
- **CO-4:** Design simple deep learning models using modern frameworks and tools. (L6- Creating)
- **CO-5:** Implement convolutional and recurrent neural networks for real-world applications. (L3- Applying)

Robotics and Automation

- **CO-1:** Illustrate the fundamentals of robotics, including classification, specifications, and applications. (L2 - Understanding)
- **CO-2:** Apply direct and inverse kinematics concepts to determine arm configurations of three and four-axis robots. (L3 - Applying)
- **CO-3:** Analyze robot vision techniques, including image representation, template matching, and shape analysis. (L4 - Analyzing)
- **CO-4:** Explain automation principles, sensor-actuator systems, and hydraulic/pneumatic components for industrial applications. (L2 - Understanding)

- **CO-5:** Develop simple PLC-based logic circuits using Ladder Diagrams for automation tasks. (L3 - Applying)

Computer Vision

- **CO-1:** Explain fundamental image processing techniques required for computer vision. (L2-Understanding)
- **CO-2:** Apply feature extraction and image segmentation techniques. (L3-Applying)
- **CO-3:** Understand the concept of image classification and image recognition. (L2- Understanding)
- **CO-4:** Analyze applications of computer vision techniques in real-time scenarios. (L4- Analyzing)
- **CO-5:** Implement computer vision techniques using appropriate tools and frameworks. (L3- Applying)

Wireless Ad hoc Networks

- **CO-1:** Explain the fundamental concepts of wireless/mobile Ad-hoc Networks (MANETs), including their classification, associated issues, and challenges. (L2- Understanding)
- **CO-2:** Analyze MAC layer protocols such as CSMA, MACA, and MACAW for (L3- Analyzing)
- **CO-3:** Evaluate routing protocols in Ad-hoc networks, including table-driven, hybrid, location-aided, and multicast protocols, addressing the challenges in their design and implementation. (L5- Evaluating)
- **CO-4:** Assess transport layer issues in Ad-hoc networks, including congestion control, data flow mechanisms, and security concerns. (L5-Evaluating)
- **CO-5:** Explain multimodal communication technologies for IoT, such as SigFox, NB-IoT, and IEEE standards, and their applications in diverse communication scenarios. (L2- Understanding)

- **CO-6:** Compare WiMAX (IEEE 802.16) and UWB (IEEE 802.20) technologies, emphasizing physical layers, architecture, interworking with WiFi, and quality of service. (L2- Understanding)

Predictive Analytics

- **CO-1:** Explain the fundamental concepts, processes, and challenges of data mining, including the KDD process model and CRISP-DM framework. (L2- Understanding)
- **CO-2:** Analyze data understanding and preparation techniques, including visualization, segmentation, outlier detection, handling missing values, and partitioning data. (L3- Analyzing)
- **CO-3:** Apply model development techniques such as neural networks, decision trees, logistic regression, and support vector machines to build predictive models. (L3- Applying)
- **CO-4:** Evaluate model performance using validation methods, comparison metrics, and evaluation charts to ensure reliable predictions. (L5- Evaluating)
- **CO-5:** Design meta-level models and automate rule induction for both categorical and continuous targets, optimizing model deployment processes. (L6- Creating)
- **CO-6:** Discuss the deployment and updating of data mining models in real-world scenarios, ensuring continuous model assessment and performance improvement. (L6- Creating)