Artificial Intelligence (AI)

• Explain artificial intelligence, its approaches and its foundations. • Critically evaluate the ethical implications of AI and its impact on society.	**1. Introduction to Artificial Intelligence (4 hrs)** 1.1. Intelligence 1.1.1. Types of Intelligence 1.1.2. Components of Intelligence 1.2. Artificial Intelligence 1.2.1. Approaches of AI 1.2.1.1. Acting Humanly 1.2.1.2. Thinking Humanly 1.2.1.3. Thinking Rationally 1.2.1.4. Acting Rationally 1.2.2. Foundations of AI 1.2.3. History of AI 1.2.4. Risk and Benefits of AI 1.3. Ethics and Societal Implications 1.3.1. Ethical Implications of AI 1.3.2. AI and Society: Work and Automation, Employment, Privacy and Security 1.3.3. Governance and Regulation
• Design and implement intelligent agents.	**2. Intelligent Agents (5 hrs)** 2.1. Agents and Environments 2.2. Concept of Rationality 2.2.1. Performance Measures 2.2.2. Rationality and Rational Agent 2.3. Task environment and its properties 2.4. Structure of Agents 2.4.1. Agent programs 2.4.2. Types of agent programs 2.5. Learning Agents
• Formulate the real world problems and apply the search algorithms to solve them.	**3. Problem Solving and Search Algorithms (10 hrs)** 3.1. Problem Solving 3.1.1. Problem Solving Agents 3.1.2. Problem solving process 3.1.3. Production System 3.1.4. Well-defined and ill-defined problems 3.1.5. Problem formulation 3.2. Search Algorithms 3.2.1. Uninformed Search 3.2.1.1. Breadth- First Search 3.2.1.2. Depth-First Search 3.2.1.3. Iterative Deepening Search 3.2.2. Informed Search 3.2.2.1. Heuristics 3.2.2.2. Greedy Best-First Search 3.2.2.3. A* Search 3.3. Local Search and Optimization Problems 3.3.1. Hill-Climbing Search and its problems (Local maxima, plateaus, and ridges) 3.3.2. Simulated Annealing

	3.3.3. Genetic Algorithms 3.3.4. Gradient Descent 3.4. Adversarial Search and Game Playing 3.4.1. Minimax algorithm 3.4.2. Alpha-beta pruning 3.5. Constraint Satisfaction Problems 3.5.1. Representation of CSPs 3.5.1.1. Variables 3.5.1.2. Domains 3.5.1.3. Constraints 3.5.2. Search Algorithms for CSPs 3.5.2.1. Backtracking search 3.5.2.2. Constraint propagation 3.5.3. Optimization Technique: Min-Conflicts Heuristic1
• Represent the knowledge of a domain and apply inference rules to draw conclusions.	**4. Knowledge Representation and Reasoning (10 hrs)** 4.1. Propositional Logic 4.1.1. Syntax 4.1.2. Semantics 4.1.3. Inference in Propositional Logic 4.1.4. Conjunctive Normal Form (CNF) 4.1.5. Resolution Theorem Proving 4.1.6. Limitations of Propositional Logic 4.2. Predicate Logic 4.2.1. Syntax 4.2.2. Semantics 4.2.3. Inference in Predicate Logic 4.2.4. Resolution in Predicate Logic 4.3. Reasoning Under Uncertainty 4.3.1. Probabilistic Reasoning 4.3.1.1. Bayesian Networks 4.3.2. Probabilistic reasoning over time 4.3.2.1. Hidden Markov Models 4.4. Other Approaches to Knowledge Representation 4.4.1. Semantic Nets and Frames 4.4.2. Rule-based Representation 4.4.3. Ontological-Based Representation
• Develop and apply the machine learning algorithms to classify and cluster the data. • Design an artificial neural network that can learn.	**5. Machine Learning (6 hrs)** 5.1. Definition and Evolution of Machine Learning 5.2. Learning by Analogy 5.3. Explanation-based learning 5.4. Supervised Learning Algorithms 5.4.1. Classification and Regression 5.4.2. Linear regression 5.4.3. K-Nearest Neighbour 5.5. Unsupervised Learning Algorithms 5.5.1. Clustering 5.5.2. K-means Clustering

	5.6. Artificial Neural Network 5.6.1. Biological Inspiration 5.6.2. Basic Components of ANN 5.6.3. Training Neural Networks 5.6.3.1. Forward Propagation 5.6.3.2. Loss Function 5.6.3.3. Backward Propagation 5.6.3.4. Learning Rate 5.6.4. Single-Layer Perceptron 5.6.5. Multi-Layer Perceptron
• Apply the fuzzy logic for reasoning in an expert system.	**6. Fuzzy Logic (5 hrs)** 6.1. Classical vs Fuzzy Logic 6.2. Fuzzy Sets and Membership Functions 6.3. Fuzzy Operations 6.4. Fuzzy Rule-Based Systems 6.5. Fuzzification and Defuzzification 6.6. Fuzzy Inference System: Mamdani
• Design and develop an expert system to solve a real-world problem.	**7. Expert System (5 hrs)** 7.1. Definition and History of Expert System 7.2. Architecture of Expert Systems 7.3. Knowledge Representation in expert system 7.3.1. Logic based representation 7.3.2. Rule-based system 7.3.3. Semantic networks 7.3.4. Ontology-based Systems 7.3.5. Frame-based Systems 7.4. Inference Mechanisms 7.4.1. Forward Chaining 7.4.2. Backward Chaining 7.5. Knowledge Acquisition and Learning 7.6. Applications of Expert Systems

Digital Signal Analysis and Processing (DSAP)

• Learn about the basics of discrete time signals and its classification • Understand the concept of different types of discrete time systems • Analyze the signals in time domain and frequency domain • Comprehend the concept of discrete linear convolution and its properties	**1. Discrete Signals and systems: (8 hrs)** 1.1. Discrete time signal, basic signal 1.2. Energy signal, power signal 1.3. Periodicity of discrete time signal 1.4. Transformation of independent variable 1.5. Discrete time Fourier Series and properties 1.6. Discrete time Fourier Transform and properties 1.7. Discrete time system properties 1.8. Linear Time Invariant (LTI) system, convolution sum, properties of LTI system 1.9. Frequency response of LTI system 1.10. Sampling of continuous time signal, spectral properties of sampled signal
• Comprehend the concept of Z-Transform, ROC and properties of Z-transform • Learn to perform forward and inverse Z-transform • Understand the condition for causality, non-causality and stability with respect to ROC	**2. Z-transform (6 hrs)** 2.1. Definition, convergence of Z-transform and region of convergence 2.2. Properties of Z-transform (linearity, time shift, multiplication by exponential sequence, differentiation, time reversal, convolution, multiplication) 2.3. Inverse z-transform by long division and partial fraction expansion.
• Grasp the concept of plotting Magnitude and Phase Response of LTI system • Understand the concept of poles and zeros and their relationship to causality	**3. Analysis of LTI system in frequency domain (5 hrs)** 3.1. Frequency response of LTI system, response to complex exponential 3.2. Linear constant co-efficient difference equation and corresponding system function 3.3. Relationship of frequency response to pole-zero of system 3.4. Linear phase of LTI system and its relationship to causality.
• Learn to represent FIR and IIR filters in direct, cascade and lattice structure. • Understand the effect of Quantization and limit cycles	**4. Discrete filter structures (6 hrs)** 4.1. FIR filter, Structures for FIR filter (direct form, cascade, lattice) 4.2. IIR filter, Structures for IIR filter (direct form I, direct form II, cascade, lattice, lattice ladder) 4.3. Quantization effect (truncation, rounding), limit cycles and scaling
• Grasp the concept of designing analog Butterworth and Chebyshev filters. • Comprehend how analog IIR filter is converted to digital IIR filter • Understand the idea of converting LPF prototype filter to LP, HP, BP and BS filters • Learn the property of Butterworth, Chebyshev and Elliptical filters and their differences.	**5. IIR Filter Design (7 hrs)** 5.1. Filter design by impulse invariance method 5.2. Filter design using bilinear transformation method 5.3. Design of digital low pass Butterworth filter 5.4. Properties of Chebyshev filter, properties of elliptic filter, properties of Bessel filter, spectral transformation

• Understand Gibbs phenomena • Grasp the concept of designing FIR filters using Windowing and frequency sampling methods. • Understand the concept of designing optimum FIR filters	**6. FIR Filter Design (7 hrs)** 6.1. Filter design by window method, commonly used windows (rectangular window, Hanning window, hamming window) 6.2. Filter design by Kaiser window 6.3. Filter design by frequency sampling method 6.4. Filter design using optimum approximation, Remez exchange algorithm
• Understand the concept of Discrete Fourier Transform and its properties • Grasp the concept of circular convolution • Learn about FFT, DIT, DIF algorithms. • Comprehend the computational complexity of FFT algorithm	**7. Discrete Fourier Transform (6 hrs)** 7.1. Discrete Fourier transform (DFT) representation, properties of DFT (linearity, time shift, frequency shift, conjugation and conjugate symmetry, duality, convolution, multiplication), circular convolution 7.2. Fast Fourier Transform (FFT) algorithm (decimation in time algorithm, decimation in frequency algorithm) 7.3. Computational complexity of FFT algorithm.

Embedded System (ES)

Specific Objectives	Contents
• Define components, and list the characteristics of embedded systems • Differentiate between embedded systems and general-purpose computing systems • Learn the various applications and use cases of embedded systems (e.g., automotive, IoT, consumer electronics) • Gain knowledge about key components of Embedded System.	**Unit I: Introduction to Embedded Systems (3 hrs.)** 1.1 Definition and Overview of Embedded Systems 1.2 Embedded Systems vs. General-Purpose Systems 1.3 Applications and Domains (Automotive, Healthcare, Industrial Control, IoT, etc.) 1.4 Key Components: Microcontrollers, Sensors, Actuators, Peripherals
• Provide in-depth knowledge of programming languages commonly used in embedded systems, such as Embedded C. • Design, write, test, and debug software for embedded systems that meet specific functional requirements	**Unit II: Programming for Embedded Systems (5 hrs.)** 2.1 Overview of AVR Architecture 2.2 Embedded C Programming for Microcontroller: • Introduction to C for Embedded Systems. • Data Types, Control Structures, and Pointers • Memory Management • AVR Interrupt Handling • Input and output ports interfacing on AVR • Timers and Counters in AVR • Serial Communication in AVR

• Emphasize the development of both practical and theoretical understanding of real-time systems • Gain proficiency in utilizing a leading Real-Time Operating System (RTOS) such as VxWorks • Evaluate the advantages and disadvantages of various concepts, including task scheduling, context switching, task synchronization, resource sharing, deadlock, priority inversion, multithreading, and multitasking	Unit III: Real-Time Operating Systems (RTOS)(5 hrs.) 3.1 Concepts of Real-Time Systems 3.2 Introduction to RTOS (e.g., FreeRTOS, VxWorks) 3.3 Task Scheduling, Context Switching, Task Synchronization 3.4 Resource Sharing, Deadlock, and Priority Inversion 3.5 Multithreading and Multi-tasking in RTOS
• Gain insight about VHDL Programming, different modeling styles, data types, sub program and packages, test benches. • Learn to program in VHDL for combinational and sequential cicuits	Unit IV: Embedded System Design using VHDL (5 hrs.) 4.1 Introduction to VHDL 4.2 Different Modelling styles in VHDL for combinational and sequential circuits 4.3 Data types in VHDL 4.4 Sub program and Packages 4.5 VHDL realization for combinational and sequential circuits
• Understand the distinction between serial and Wireless communication and when to use each in embedded applications. • Explore the different types of communication (e.g., device-to-device, device-to-network, and device-to-cloud) that are essential for embedded systems. • Understand Wireless Communication Protocols such as Bluetooth and BLE (Bluetooth Low Energy), Wi-Fi, ZigBee and LoRa	**Unit V: Communication Protocols (3 hrs.)** 5.1 Serial Communication: UART, SPI, I2C 5.2 Wireless Communication: Bluetooth, ZigBee, Wi-Fi, LoRa, GSM/GPRS 5.3 Networking: TCP/IP Basics in Embedded Systems
• Learn the types of peripherals commonly used in embedded systems, including input devices (e.g., sensors, switches), output devices (e.g., displays, actuators), and communication devices (e.g., serial interfaces).	**Unit VI: Peripherals and Interfacing (4 hrs.)** 6.1 Sensor Interfacing:Analog and Digital Sensors (e.g., temperature, humidity, motion) 6.2 Actuator Interfacing: • Motor Control (DC, Stepper, Servo) • PWM for controlling brightness, speed, etc. 6.3 Display Interfacing: • LCD, and Seven Segment Displays
• Understand the various communication protocol used in IoT, such as MQTT • Understand common used hardware platforms in IoT. •	**Unit VII: Internet of Things (IoT) and Embedded Systems (3 hrs.)** 7.1 Introduction to IoT Concepts and Embedded System's Role in IoT. 7.2 IoT communication protocol: MQTT(Basic Concept) 7.3 Overview of common IoT hardware platforms: Arduino, ESP32, and Raspberry Pi. (Basic Introduction)

Engineering Management (EM)

Specific Objectives	Contents
To develop a foundational understanding of management, organization and engineering management	**Unit I: Introduction** **(6 Hrs.)** 1.1 Management 1.1.1 Functions of management 1.1.2 Level and scope of management 1.1.3 Principles of management 1.2 Organization 1.2.1 Characteristics of organization 1.2.2 Types of organization: formal and informal organizations, virtual organization 1.3 Engineering Management 1.3.1 Importance of management in technology-driven environments 1.3.2 Engineering functions in organizations: product development, operations, IT systems, quality assurance and others 1.3.3 Roles and responsibilities of an engineering manager
To familiarize students with the planning and organizing and identify their emerging issues in ICT enterprises	**Unit II: Planning and Organizing** **(6 Hrs.)** 2.1 Planning 2.1.1 Levels of planning: strategic, tactical and operational 2.1.2 Steps in planning 2.1.3 Tools for planning 2.1.4 Importance of planning 2.2 Organizing 2.2.1 Process of organizing 2.2.2 Organization structure 2.2.3 Types of organization structure 2.2.2.1 Traditional structure: line and functional 2.2.2.2 Modern structure: matrix, network, hybrid 2.4 Emerging planning and organizing issues for ICT enterprises
To enable students to analyze and address key issues in motivating and leading a technical workforce	**Unit III: Motivation and Leadership** **(6 Hrs.)** 3.1 Motivation 3.1.1 Theories of motivation: Maslow's hierarchy, Herzberg's two factor, Expectancy, Equity 3.1.2 Techniques for motivation 3.2 Leadership 3.2.1 Leadership styles: autocratic, democratic, servant and transformational 3.2.2 Characteristics of learning organization in the ICT industry 3.3 Challenges and strategies for motivating and leading technical workforce

To enhance students' knowledge of human resource management and control functions, emphasizing their practical application for managing ICT organization	**Unit IV: Human Resource Management and Control (8 Hrs.)** 4.1 Human Resource Management 4.1.1 Functions of human resource management 4.1.2 Job analysis, job specification, job description 4.1.3 Recruitment and selection 4.1.4 Human resource training (on the job and off the job) 4.1.5 Performance appraisal and methods 4.1.6 Challenges in managing people in ICT workforce 4.2 Control 4.2.1 Importance 4.2.2 Process and types 4.2.3 Techniques 4.2.4 ICT tools for effective control of engineering projects and organizations.
To expose students to emerging trends in engineering management and their application in ICT driven organizations	**Unit V: Emerging trends in engineering management (4 Hrs.)** 5.1 Participative management, conflict resolution, change management, quality management, innovation management and disruption 5.2 Recent engineering management concepts for managing ICT based projects and organizations

Software Engineering (SE)

The chapter intends to provide a brief introduction of the field of software engineering and software project management and ethics Students make use of the management aspect of software engineering required to undertake software related projects like estimation, measurement, risk management and ethics	**Chapter 1: Software Engineering and Project Management (7 Hrs)** 1.1 Nature and Characteristics of Software 1.2 Software versus System Engineering 1.3 Software Crisis and Myths 1.4 Four Ps of Software Project Management 1.5 Process and Project Metrics 1.6 Measurement of Software: Metrics, Measure, Indicator 1.7 Project Estimation, Empirical Estimation Models 1.8 Software Risks, Assumption, Issues, Dependency 1.8.1 Identification 1.8.2 Mitigation 1.8.3 Monitoring 1.8.4 Management 1.9 Software Engineering Ethics and Professional Practice

In this chapter students learn about different types of software process models, their strength and weaknesses and their applicability Students also learn to make use of Agile development strategies for software development process	**Chapter 2: Software Process Models and Agility (5 Hr)** 2.1 Software Development Lifecycle (SDLC) 2.2 Waterfall, Incremental, Prototyping, Iterative, Spiral, Rapid Application Development, Aspect Oriented Software Engineering 2.3 Agile Software Development 2.3.1 Extreme Programming 2.3.2 Scrum 2.3.3 Agile Project Management and Scaling Agile Methods 2.4 Pros and Cons of Process Models and their Applicability
This chapter helps students learn how to gather, analyze, and specify software requirements Students make use of various techniques like structured and object oriented approaches for requirements modeling and management	**Chapter 3: Requirements Engineering and Principles (7 Hr)** 3.1 Types of Requirements 3.2 Requirements Modeling Principles 3.3 Domain Analysis and System Models 3.3.1 Context Models 3.3.2 Behavioural Models 3.3.3 Data Models
	3.4 Requirements Engineering Process 3.4.1 Feasibility Study 3.4.2 Requirements Elicitation, Analysis, 3.4.3 Requirements Validation 3.5 Object Oriented Analysis
This chapter intends to get students well acquainted with software design principles and patterns. Students use various architectural styles and design patterns including object oriented approach for designing software systems	**Chapter 4: Software Design, Architecture and Principles (7 Hr)** 4.1 Design Modeling Principles 4.2 Design Process 4.3 Architectural design 4.3.1 Layered 4.3.2 Repository 4.3.3 Client Server 4.3.4 Pipe and Filter 4.4 Interface, Component, Database Design 4.5 Design Patterns 4.6 Security by Design 4.7 Object Oriented Design 4.8 Embedded System Design

This chapter imparts knowledge regarding various testing techniques used for proper validation and verification of software. It also lets students become aware of the inevitable changes that occur and ways of maintaining software systems Students design test cases for proper validation and verification of the software product	**Chapter 5: Testing Techniques and Maintenance (7 Hr)** 5.1 Validation and Verification 5.2 Testing Phases 5.2.1 Development Testing 5.2.1.1 Unit Testing 5.2.1.2 Component Testing 5.2.1.3 System Testing 5.2.2 Release Testing 5.2.2.1 Requirements-based Testing 5.2.2.2 Scenario Testing 5.2.2.3 Performance Testing 5.2.3 User Testing 5.2.3.1 Alpha Testing 5.2.3.2 Beta Testing 5.2.3.3 Acceptance Testing 5.3 Test Case Development Strategies 5.3.1 Boundary Value Analysis 5.3.2 Equivalence Partitioning 5.3.3 Basis Path Testing 5.3.4 Control structure Testing 5.4 Software Changes and Evolution 5.5 Maintenance Process and Reengineering
This chapter focuses on quality management of software and the existing standards for compliance and assessing capability In this chapter, students make use of ways of ensuring quality in process and product by adhering to the standards which is essential in producing good software	**Chapter 6: Software Quality Assurance Process (4 Hr)** 6.1 Software Quality Concepts, Software Reliability 6.2 Software Quality Management and Planning 6.3 Software Standards and their Compliance 6.3.1 ISO, CMMI 6.4 Capability Assessment and Process Improvement 6.5 Process and Product Standards 6.6 Reviews and Inspections
This chapter focuses on the need and process of proper management of software configuration items produced as deliverables during the software development process Students use the techniques and tools that exist for keeping track of the software configuration items	**Chapter 7: Software Configuration Management (4 Hr)** 7.1 Software Configuration Items 7.2 Configuration Management Activities 7.2.1 Change Management 7.2.2 Version Management 7.2.3 System Building 7.2.4 System Release

This chapter deals with the recent trends and advancements in the field of software engineering This chapter enables students to make use of contemporary techniques for reusing software and software components and use advanced technologies for software development	**Chapter 8: Advanced Software Engineering Concepts (4 Hr)** 8.1 Software Reuse 8.1.1 Application Frameworks 8.1.2 Software Product Lines 8.1.3 COTS Product Reuse 8.2 Cloud Based Software Engineering 8.3 Artificial Intelligence in Software Engineering

Probability and Statistics (PNS)

Specific Objectives	Contents
• Identify concepts of statistics and its application in the field of engineering • Summarize, present and compute various descriptive statistics	**Unit I: Introduction and Descriptive Statistics (3 hrs)** 1.1 Introduction of statistics and its applications in engineering 1.2 Collection and presentation of data (Diagrammatic as well as graphical presentation) 1.3 Measure of central tendency, location and Measures of variability
• Identify basic probability concepts • Define conditional probability and use Bayes' theorem to revise probabilities • Define random variable and compute expected value and variance of a probability distribution	**Unit II: Probability (5 hrs)** 2.1 Basic probability, additive law, multiplicative law and Bayes' theorem 2.2 Random variables (Discrete and Continuous) and probability distribution function, 2.3 Mathematical expectation of random variables

• Explain and apply discrete probability distributions (Binomial, Poisson distribution, Negative Binomial and Hyper geometric distribution)	**Unit III: Discrete Probability Distributions (3 hrs)** 3.1 Binomial distribution, 3.2 Poisson distribution 3.3 Negative Binomial distribution 3.4 Hyper geometric distribution
• Explain and apply the Normal distribution and other continuous probability distributions (uniform distribution, Gamma and Beta distributions, and Exponential distribution)	**Unit IV: Continuous Probability Distributions (4 hrs)** 4.1 Rectangular or uniform distribution 4.2 Normal distribution 4.3 Gamma and Beta distributions 4.4 Exponential distribution
• Define the concept of bivariate random variables and joint probability distribution • Explain and calculate joint probability mass, marginal probability and density function	**Unit V: Bivariate Random Variables and Joint Probability Distribution (2 hrs)** 5.1 Joint probability mass function, marginal probability mass function, 5.2 Joint probability density function, marginal probability density function
• Define and apply sampling, sampling distribution, and central limit theorem • Construct and interpret confidence interval estimate for the means and proportion	**Unit VI: Sampling Distribution and Estimation (5 hrs)** 6.1 Review of terms used in sampling 6.2 Probability and non-probability sampling 6.3 Sampling distribution of mean and standard error 6.4 Central limit theorem 6.5 Concept of point and interval estimation 6.6 Sample size determination 6.7 Confidence interval for single mean and difference of two population means and population proportion
• Describe and apply the procedures hypothesis testing of various tests.	**Unit VII: Hypothesis Testing (5 hrs)** 7.1 Basic concept in hypothesis testing 7.2 One sample test for mean and proportion 7.3 Two sample tests for mean and proportions 7.4 Paired t – test 7.5 Chi-square test of independence
• Define and apply correlation and regression in the field of engineering	**Unit VIII: Correlation and Regression (3 hrs)** 8.1 Simple correlation and its properties 8.2 Simple linear regression