Second Year (Lateral entry)

Curriculum

Admission Year 2026-27

Bachelor of Technology (Lateral Entry)

CSE (Artificial Intelligence and Machine Learning)

Faculty of Engineering & Technology

Parul University

Vadodara, Gujarat, India

Semester 3

a. **Course Name: Operating System**

b. **Course Code:** 03010503PC05

c. **Prerequisite:** Fundamentals of Computer Systems

d. **Rationale:** This course is an introduction to the theory and practice behind modern computer operating systems. Topics will include what an operating system does (and doesn't) do, system calls and interfaces, processes, concurrent programming, resource scheduling and management, virtual memory, deadlocks, algorithms, programming, and security. The approach of the subject is from both a theoretical perspective as well as a practical one.

e. **Course Learning Outcomes:**

CLO 1	Distinguish different styles of operating system design.
CLO 2	Understand device and I/O management functions in operating systems as part of a uniform device abstraction.
CLO 3	Understand disk organization and file system structure
CLO 4	Give the rationale for virtual memory abstractions in operating systems.
CLO 5	Understand the main principles and techniques used to implement processes and threads as well as the different algorithms for process scheduling.
CLO 6	Understand the main mechanisms used for inter-process communication.

f. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**		**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

g. **Course Content:**

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	INTRODUCTION: Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS-Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine	10%	4
2	PROCESSES, THREAD & PROCESS SCHEDULINGProcesses: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching. Thread: Definition, Various	23%	11

Sr. No.	Content	Weightage	Teaching Hours
	states, Benefits of threads, Types of threads, Concept of multithreads. Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization,Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR.		
3	INTER-PROCESS COMMUNICATION:Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation, Petersoṅ s Solution, The Producer\ Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Readeṙ s & Writer Problem, Dinning Philosopher Problem etc	15%	7
4	DEADLOCKS: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Bankeṙ s algorithm, Deadlock detection and Recovery.	12%	5
5	MEMORY MANAGEMENT & VIRTUAL MEMORY:Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation, Fixed and variable partition, Internal and External fragmentation and Compaction; Paging: Page allocation, Hardware support for paging, Protection and sharing, Disadvantages of paging. Virtual Memory: Basics of Virtual Memory, Hardware and control structures, Locality of reference, Page fault , Working Set , Dirty page/Dirty bit, Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).	20%	10
6	I/O SYSTEMS, FILE & DISK MANAGEMENT:I/O Hardware: I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software. File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance. Disk Management: Disk structure, Disk scheduling algorithms - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks	20%	8

h. Text Book and Reference Book:

1. Operating System Concepts Essentials (TextBook) By byAviSilberschatz, Peter Galvin,Greg Gagne | 9th Edition Wiley Asia Student Edition.
2. Operating Systems Internals and Design Principles By William Stallings; PHI; 5th Edition | PHI | 5th Edition
3. Operating System: A Design-oriented Approach By Charles Crowley, | 1st Edition - Irwin Publishing
4. Operating Systems: A Modern Perspective (TextBook) By by Gary J. Nutt | Addison-Wesley; 2nd Edition | 2nd Edition
5. Design of the Unix Operating Systems By Maurice Bach, | Prentice-Hall of India | 8th Edition
6. Understanding the Linux Kernel By Daniel P. Bovet, Marco Cesati, | O'Reilly and Associates | 3rd Edition

a. **Course Name: Operating System Laboratory**
b. **Course Code:** 03010503PC06
c. **Prerequisite:** Data Structures and Algorithms, Good working knowledge of C, and Fundamentals of Computer Systems
d. **Rationale:** This course is an introduction to the theory and practice behind modern computer operating systems. Topics will include what an operating system does (and doesn't) do, system calls and interfaces, processes, concurrent programming, resource scheduling and management, virtual memory, deadlocks, and algorithms, programming, and security. We will approach the subject from both a theoretical perspective as well as a practical one
e. **Course Learning Outcomes:**

CLO 1	Experiment with Linux commands and shell programming.
CLO 2	Able to build shell program for process and file system management with system calls.
CLO 3	Able to implement and analyse the performance of CPU scheduling algorithm.
CLO 4	Able to implement and analyse the performance of page replacement algorithms.
CLO 5	Able to implement and analyse the performance of deadlock avoidance and detection algorithm

f. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

g. **Experiment List**

Sr. No.	**Experiment List**
1	**Study of Basic commands of Linux.**
2	**Study the basics of shell programming**
3	**Write a Shell script to print given numbers sum of all digits.**
4	**Write a shell script to validate the entered date. (eg. Date format is: dd-mm-yyyy).**
5	**Write a shell script to check entered string is palindrome or not.**
6	**Write a Shell script to say Good morning/Afternoon/Evening as you log in to system.**
7	**Write a C program to create a child process**
8	**Finding out biggest number from given three numbers supplied as command line arguments.**
9	**Printing the patterns using for loop.**
10	**Shell script to determine whether given file exist or not.**
11	**Write a program for process creation using C. (Use of gcc compiler.**
12	**Implementation of FCFS &Round Robin Algorithm**
13	**Implementation of Banker's Algorithm**

a. **Course Name: Data Structure and Algorithms**

b. **Course Code:** 03010503PC01

c. **Prerequisite:** Computer Programming and Basic Syntaxes

d. **Rationale:** Data structure is a subject of primary importance in Information and Communication Technology. Organizing or structuring data is important for implementation of efficient algorithms and program development. Efficient problem solving needs the application of appropriate data structure during program development.

e. **Course Learning Outcomes:**

CLO 1	Apply basic data structure operations on arrays, structures, and unions to solve computational problems.
CLO 2	Implement stack operations using static and dynamic arrays and apply stacks to solve expression evaluation and notation conversion problems.
CLO 3	Analyze memory management issues including garbage collection in linked list implementations.
CLO 4	Implement and compare sorting algorithms including selection sort, insertion sort, bubble sort, quick sort, and merge sort.
CLO 5	Understand the main principles and techniques used to implement processes and threads as well as the different algorithms for process scheduling.
CLO 6	Construct and perform operations on AVL trees to maintain height-balanced binary search trees.

f. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**		**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

g. **Course Content:**

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**Introduction:** Data Structures, Classifications (Primitive & Non-Primitive), Data structure Operations, Review of Arrays, Structures, Self-Referential Structures, and Unions. Pointers and Dynamic Memory Allocation Functions. Representation of Linear Arrays in Memory, dynamically allocated arrays. Performance analysis of an algorithm and space and time complexities	10%	6
2	**Stacks, Recursion and Queue: Stacks**: Definition, Stack Operations, Array Representation of Stacks, Stacks using Dynamic Arrays, Stack Applications: Polish notation, Infix to postfix conversion, evaluation of postfix expression. **Recursion** -Factorial, GCD, Fibonacci Sequence, Tower of Hanoi, **Queues**: Definition, Array Representation, Queue Operations, Circular Queues, Circular queues using Dynamic arrays, Deque, Priority Queues and its Application.	15%	8

Sr. No.	Content	Weightage	Teaching Hours
3	**Linked Lists:** Definition, Representation of linked lists in Memory, Memory allocation; Garbage Collection. Linked list operations: Traversing, Searching, Insertion, and Deletion In Singly Linked List, Doubly Linked lists, Circular linked lists. Implementation of Stacks and Queues using Linked List.	10%	5
4	**Searching and Sorting:** Searching: Linear Search, Binary Search, and Interpolation Search. Sorts: Selection Sort,Insertion Sort, Bubble Sort, Quick Sort, Merge Sort.	10%	5
5	**Trees:** Terminology, Binary Trees, Properties of Binary trees, Array and linked Representation of Binary Trees, Binary Tree Traversals - In Order, Post Order, Pre Order; Binary Search Trees – Definition, Insertion, Deletion, Traversal, Searching, Height of tree, Evaluation of Expression, Balanced Binary Tree and its operations	15%	9
6	**Red Black Trees and AVL Trees:** AVL tree Construction, Operations on AVL Trees, Introduction to Red Black Tree, and Operations on Red Black Trees.	10%	4
7	**Hashing:** Hash Table organizations, Hashing Functions, Static and Dynamic Hashing	15%	3
8	**Graphs:** Definitions, Terminologies, Matrix and Adjacency List Representation of Graphs, Elementary Graph operations, Traversal methods: Breadth First Search and Depth First Search.	15%	5

h. Text Book and Reference Book:

1. **Fundamentals of Data Structures in C, 2ND eDITION, E.Horowitz, S,.Sahni and Susan Anderson- Freed, Universities Press**
2. **Seymour Lipschutz, Data Structures Schaum's Outlines, Revised 1st Ed, McGraw Hill, 2014.**

a. **Course Name: Data Structure and Algorithms Laboratory**
b. **Course Code:** 03010503PC02
c. **Prerequisite:** Basic knowledge of Data Structures
d. **Rationale:** This course provides a broad introduction to Data Structures The various Data structures and its analysis of working design and development.
e. **Course Learning Outcomes:**

CLO 1	Use different types of data structures, operations and algorithms
CLO 2	Apply searching and sorting operations on file
CLO 3	Use stack, Queue, Lists, Trees and Graphs in problem solving
CLO 4	Implement all data structures in a high-level language for problem.

f. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
-	**-**	**4**	**2**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

g. **Experiment List**

Sr. No.	**Experiment List**
1	**Implement Stack and its operations like (creation push pop traverse peek search) using linear data structure**
2	**Implement Infix to Postfix Expression Conversion using Stack**
3	**Implement Postfix evaluation using Stack.**
4	**Implement Towers of Hanoi using Stack**
5	**Implement queue and its operations like enqueue, dequeue, traverse, search.**
6	**Implement Single Linked lists and its operations (creation insertion deletion traversal search reverse)**
7	**Implement Double Linked lists and its operations (creation insertion deletion traversal search reverse**
8	**Implement Circular Linked lists and its operations (creation insertion deletion traversal search reverse)**
9	**Implement Linear Search, binary search and interpolation search.**
10	**Implement Bubble sort, selection sort, Insertion sort, quick sort , merge sort.**
11	**Implement Binary search Tree and its operations (creation, insertion, deletion).**
12	**Implement Traversals Preorder, Inorder, Postorder on BST.**
13	**Implement Graphs and represent using adjacency list and adjacency matrix and implement basic operations with traversals (BFS and DFS).**

a. Course Name: Java Programming

b. Course Code: 03010503PC03

c. Prerequisite: Basic knowledge of Problem Solving,

d. Rationale: This course introduces Java programming and object-oriented concepts to build a strong foundation for developing reliable, platform-independent software applications and for pursuing advanced studies in software development.

e. Course Learning Outcomes:

CLO 1	Develop and execute basic Java programs by following standard program structure and compilation steps.
CLO 2	Apply arithmetic, relational, logical, assignment, unary, and bitwise operators while considering operator precedence.
CLO 3	Create and manipulate one-dimensional and multi-dimensional arrays and perform common array operations in Java.
CLO 4	Analyze and handle runtime errors using Java exception handling mechanisms to develop robust and reliable applications.
CLO 5	Design and use custom exceptions and apply exception-handling best practices in Java programs.
CLO 6	Develop Java applications using advanced features such as multithreading, file handling, modern Java APIs, and demonstrate awareness of Java frameworks

f. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**		**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

g. Course Content:

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	Overview of OOP and Java:Programming Paradigms, Procedural vs Object-Oriented Programming, OOP Features, History of Java, Feature of Java, JVM Architecture, JRE, JDK, Java Program Structure, Compilation and Execution Process, Java Environment Setup, JDK Installation, PATH and CLASSPATH, Introduction to IDEs.	10%	4
2	Java Language Basics:Variables, Scope of Variables, Primitive Data Types, Reference Data Types, Type Casting, Wrapper Classes, Autoboxing and Unboxing, Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Unary Operators, Bitwise Operators, Operator Precedence, if Statement, if-else Statement, Nested if, switch Statement, for	15%	7

Sr. No.	Content	Weightage	Teaching Hours
	Loop, while Loop, do-while Loop, for - Each Loop, break Statement, continue Statement.		
3	Arrays and StringArrays, One-Dimensional Arrays, Multi-Dimensional Arrays, Array Operations, String Class, StringBuffer, StringBuilder, String Comparison, String Manipulation Methods	12%	6
4	Object-Oriented Programming (OOP)Classes and Objects, Constructors, Access Specifiers, Encapsulation, Inheritance, Types of Inheritance, super Keyword, Polymorphism, Method Overloading(Compile time Polymorphism), Method Overriding (Runtime Polymorphism), Abstraction, Abstract Classes, Interfaces, Functional Interfaces, this Keyword, final Keyword, Object Class and its Methods.	30%	12
5	Exception HandlingErrors and Exceptions, Checked Exceptions, Unchecked Exceptions, try-catch Block, Multiple catch Blocks, finally Block, throw Keyword, throws Keyword, Custom Exceptions, Exception Handling, Best Practices	15%	6
6	Collection Frame work in JavaIntroduction to Collections Framework, List Interface, ArrayList, LinkedList, Set Interface, HashSet, TreeSet, Map Interface, HashMap, TreeMap, Iterators, Generics	10%	5
7	Advanced Foundations and Java FrameworksProcess Vs Thread, Thread Creation, Thread Life Cycle, Multithreading Concepts, Synchronization, Inter-thread Communication, File Handling, File Class, Byte Streams, Character Streams, Buffered Streams, Serialization, Deserialization, Lambda Expressions, Stream API, Optional Class	8%	5

h. Text Book and Reference Book:

a. Java: The Complete Reference By Herbert Schildt | Tata McGraw Hill | 7TH
b. Object Oriented Programming Through Java — P. Radha Krishna Publisher: Universities Press (India) Pvt. Ltd. (TextBook)
c. Thinking in Java — Bruce Eckel Publisher: Prentice Hall (Pearson)
d. Core Java, Volume I & Volume II — Cay S. Horstmann & Gary Cornell Publisher: Prentice Hall / Pearson
e. JAVA8 Core Java Black Book — R. Nageswara Rao Publisher: Black Book Series (Dreamtech Press) (TextBook)

a. **Course Name: Java Programming Laboratory**
b. **Course Code:** 03010503PC04
c. **Prerequisite:** Basic knowledge of Problem Solving
d. **Rationale:** This course introduces Java programming and object-oriented concepts to build a strong foundation for developing reliable, platform-independent software applications and for pursuing advanced studies in software development. management, virtual memory.
e. **Course Learning Outcomes:**

CLO 1	Develop basic Java programs demonstrating program structure, variables, data types, type casting, operators, and control statements.
CLO 2	Implement iterative and recursive solutions using looping constructs, methods, and recursion to solve computational problems.
CLO 3	Design and manipulate one-dimensional and multi-dimensional arrays and perform array-based applications such as sorting, searching, and matrix operations.
CLO 4	Apply string handling techniques using String, StringBuffer, and StringBuilder classes and solve string-based problems
CLO 5	Develop object-oriented Java programs using classes, objects, constructors, inheritance, polymorphism, abstraction, encapsulation, and keywords such as this and super.
CLO 6	Implement advanced Java features including exception handling, custom exceptions, collections framework, and multithreading for robust application development.

f. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

g. **Experiment List**

Sr. No.	**Experiment List**
1	**Write a Java program to display "Hello World" and demonstrate the Java program structure and demonstrate use of variables, data types, and type casting.**
2	**Write a Java program to perform arithmetic, relational, and logical operations, bitwise and other operators.**
3	**Write a Java program using below conditional statements. a) Even or Odd using if.. else statement. b) Roots of Quadratic Equation using else if ladder. c) Largest of three numbers using nested if else. d) Find out the week day using switch statement.**
4	**Write a Java program to demonstrate looping constructs: a) Reverse of a number using while loop. b) Prime number using do while loop. c) nth term of fibonacci sequence using for loop.**
5	**Write a Java program to perform methods and example on recursion.**
6	**Write a Java program to perform operations on one-dimensional and multi-dimensional arrays.**
7	**Write a Java program to demonstrate 1D - Arrays & 2-D Arrays. a) Maximum value and Second**

Sr. No.	Experiment List
	Maximum value without duplicates. b) Sort the names in Ascending Order. c) Addition of two matrix. d) 3x3 Matrix Multiplication.
8	**Write a Java program to demonstrate string handling using String, StringBuffer, and StringBuilder.**
9	**Write a Java program to check the word is palindrome or not.**
10	**Write a Java program to create a class and object and demonstrate constructors.**
11	**Write a Java program to demonstrate encapsulation using access specifiers.**
12	**Write a Java program to demonstrate inheritance: a) Single Inheritance. b) MultiLevel Inheritance. c) Hierarchial Inheritance. d) Hybrid Inheritance.**
13	**Write a Java program to demonstrate use of the this and super keywords**
14	**Write a Java program to demonstrate polymorphism (method overloading and overriding).**
15	**Write a Java program to implement abstraction using abstract classes and interfaces(Multiple Inheritance).**
16	**Write a Java program to demonstrate exception handling using try-catch-finally blocks**
17	**Write a Java program to demonstrate exception handling using try-catch-finally blocks**
18	**Write a Java program to implement List interface using ArrayList and LinkedList**
19	**Write a Java program to implement Set interface using HashSet and TreeSet.**
20	**Write a Java program to implement Queue interface using Priority Queue and Deque.**
21	**Write a Java program to implement map interface using HashMap and LinkedHashMap.**
22	**Write a Java program to demonstrate multithreading using Thread class and Runnable interface.**

a. **Course Name:** Discrete Mathematics

a. **Course Code:** 03019103BS01

b. **Prerequisite:** Basic set theory and elementary programming logic

c. **Rationale:** This course enhances employability skills by integrating emotional intelligence, professional writing, networking, leadership communication, and interview readiness.

d. **Course Learning Objective:**

CLOBJ 1	Understand the properties of functions, relations, and lattice structures including Hasse diagrams.
CLOBJ 2	Develop proficiency in propositional logic, propositional equivalences, and various proof techniques.
CLOBJ 3	Apply number theory concepts, modular arithmetic, and base conversion algorithms in cryptography.
CLOBJ 4	Analyze Boolean functions and logic circuits for computational design and minimization.
CLOBJ 5	Apply mathematical structures and logic to solve problems related to Computer Engineering.

e. **Course Learning Outcomes:**

CLO 1	Apply set theory, relations and functions to model computational problems.
CLO 2	Use induction, recursion and counting techniques to analyze algorithms.
CLO 3	Construct valid logical arguments and mathematical proofs.
CLO 4	Identify and apply algebraic and Boolean structures in computing systems.
CLO 5	Analyze graphs and trees to solve problems related to connectivity and optimization

f. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

g. **Course Content:**

Sr. No.	**Topics**	**Weightage**	**Teaching Hours**
1	Sets, Relations and Functions Sets and Operations on Sets Finite and Infinite Sets Countable and Uncountable Sets Cantor's Diagonal Argument Power Set Theorem, Cartesian Products Relations: Reflexive, Symmetric, Transitive Equivalence Relations and Partial Order Relations Functions: One–One, Onto and Bijective Schroeder–Bernstein Theorem (statement and intuition)	20%	9
2	Mathematical Induction, Recursion and Counting Techniques Principle of Mathematical Induction Well Ordering Principle	20%	9

Sr. No.	Topics	Weightage	Teaching Hours
	Recursive Definitions Recurrence Relations (linear recurrences, basic solutions) Division Algorithm Prime Numbers Euclidean Algorithm for GCD Fundamental Theorem of Arithmetic Counting Techniques: Inclusion–Exclusion Principle Pigeonhole Principle Permutations and Combinations		
3	Propositional Logic and Proof Techniques Propositional Logic: Syntax and Semantics Truth Tables and Logical Connectives Validity and Satisfiability Logical Equivalence and Laws of Logic Rules of Inference Predicate Logic and Quantifiers Proof Techniques: Direct Proof Proof by Contradiction Proof by Contraposition Proof of Necessity and Sufficiency Logic in Program Reasoning: Preconditions and Postconditions Introduction to Loop Invariants	20%	9
4	Algebraic Structures and Boolean Algebra Algebraic Structures with One Binary Operation: Semigroups Monoids Groups (basic properties) Subgroups and Normal Subgroups Cyclic and Permutation Groups (introductory) Congruence Relations Lattices: Definition, Properties, Hasse Diagrams Boolean Algebra and Boolean Rings Identities and Principle of Duality Boolean Functions Disjunctive Normal Form (DNF) Conjunctive Normal Form (CNF)	18%	8
5	Graph Theory and Trees Graphs: Definitions and Properties Degree, Paths, Cycles, Connectivity Subgraphs and Graph Isomorphism Eulerian and Hamiltonian Graphs Graph Colouring: Vertex Colouring Edge Colouring Map Colouring Planar Graphs and Perfect Graphs Trees and Rooted Trees Weighted Trees Prefix Codes (Huffman Coding) Graph Algorithms: Breadth First Search (BFS) Depth First Search (DFS) Shortest Path Concepts	22%	10

h. Text Book and Reference Book:

1. Discrete Mathematics and its Applications (TextBook) By Kenneth H. Rosen | Tata McGraw – Hill
2. Discrete Mathematical Structure and It's Application to Computer Science (TextBook) By J.P. Tremblay and R. Manohar
3. Graph Theory with Applications to Engineering and Computer Science (TextBook) By Narsingh Deo | PHI Elements of Discrete Mathematics A Computer Oriented Approach By C. L. Liu and D P Mohapatra | Tata McGraw – Hill |
4. Elements of Discrete Mathematics A Computer Oriented Approach By C. L. Liu and D P Mohapatra | Tata McGraw – Hill | 3
5. Discrete Mathematics with Applications By Susanna S. Epp | Wadsworth Publishing Co. Inc. | 4

a. Course Name: Functional Communication Skills

b. Course Code: 03010003HM01

c. Prerequisite: Knowledge of Advanced Communication and Interpersonal Skills

d. Rationale: This course develops workplace-oriented communication skills by bridging academic language competence with professional communication requirements.

e. Course Learning Objectives:

CLOBJ 1	Develop grammatical accuracy and logical reasoning skills through sentence correction, para jumble, and statement–assumption analysis.
CLOBJ 2	Strengthen advanced reading and analytical skills to interpret complex texts, infer meaning, and evaluate authorial intent.
CLOBJ 3	Apply professional writing skills in creating resumes, cover letters, emails, and reports suitable for workplace communication.
CLOBJ 4	Enhance digital and verbal communication skills through LinkedIn profile building, JAM activities, and telephone/video call etiquette.
CLOBJ 5	Improve clarity, coherence, and professionalism in oral and written communication through structured practice and workplace-oriented tasks.

f. **Course Learning Outcomes:**

CLO 1	Identify grammatical, usage, and style errors; logically reorder sentences; and differentiate facts from assumptions in workplace problem scenarios.
CLO 2	Understand the usage of grammatical rules, cohesion markers, professional writing formats, and communication etiquette to produce accurate workplace communication.
CLO 3	Apply principles of professional communication to ensure clarity, coherence, time management, and etiquette in both written and spoken workplace contexts.
CLO 4	Analyse effective verbal, digital, and virtual communication skills through JAM participation, LinkedIn profile optimization, and telephone/video call interactions.
CLO 5	Create ATS-friendly resumes, customized cover letters, professional emails,structured reports, optimized LinkedIn profiles.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
1	**0**	**2**	**2**	**40**	**-**	**20**	**60**	**30**	**150**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Topics	Weightage	Teaching Hours
1	**Sentence Correction** Error identification (grammar, usage, style) Common workplace errors Contextual grammar usage	10%	2
2	**Para Jumbles & Sentence Reordering** Logical sequencing Cohesion markers Theme identification	8%	1
3	**Statement and Assumptions** Fact vs assumption Logical reasoning basics Workplace problem scenarios	10%	1
4	**Reading Comprehension** (Level of Difficulty - Advanced Inferential questions Author's tone & intent Vocabulary in context	12%	2
5	**Resume and Cover Letter Writing Resume formats** Achievement-based bullet points Customizing cover letters	14%	2
6	**Building a Professional LinkedIn Profile Professional headline** Summary writing Digital networking ethics	8%	1
7	**Just a Minute (JAM) Idea organization** Fluency techniques Time management in speech	8%	1
8	**Telephone and Video Call Etiquette** Opening & closing calls Voice modulation Virtual meeting etiquette	8%	1
9	**Email Writing Format** Professional tone Subject lines Email etiquette	10%	2
10	**Report Writing Report Writing** Types of reports Structure & formatting Use of visuals & data	12%	2

i. **Text Book and Reference Book:**

2. **Business Communication Today.** By Bovee, Courtland L., and John V. Thill. | Pearson Education,, Pub. Year 2019
3. **Essentials of Business Communication** By Guffey, Mary Ellen, and Dana Loewy. | Cengage Learning, Pub. Year 2018
4. **Advanced Grammar in Use** By Hewings, Martin. | Cambridge University Press, Pub. Year 2013
5. **English Vocabulary in Use: Advanced** By McCarthy, Michael, and Felicity O'Dell | Cambridge University Press, Pub. Year 2017
6. **Personality Development and Soft Skills.** By Mitra, Barun K | Oxford University Press, Pub. Year 2011

Semester 4

a. **Course Name:** Probability, Statistics and Numerical Method

b. **Course Code:** 03016101PC01

c. **Prerequisite:** Basic knowledge of algebra, calculus, and elementary differential equations.

d. **Course Learning Objective**

CLOBJ 1	Understand the fundamental concepts of probability theory, random variables, probability distributions, and statistical measures.
CLOBJ 2	Apply statistical methods and hypothesis testing techniques for analyzing engineering and scientific data.
CLOBJ 3	Develop numerical solutions for interpolation, differentiation, and integration problems using standard numerical methods.
CLOBJ 4	Analyze and solve systems of linear equations using iterative numerical techniques.
CLOBJ 5	Apply numerical methods for solving ordinary differential equations arising in engineering and mathematical applications.
CLOBJ 6	Interpret computational and statistical results for problem solving and decision making in real-world applications.

e. **Course Learning Outcomes:**

CLO 1	Explain fundamental concepts of probability, random variables, probability distributions, and basic statistical measures.
CLO 2	Perform statistical analysis and hypothesis testing for data-driven decision-making.
CLO 3	Solve interpolation, numerical integration techniques, systems of linear equations, and ordinary differential equations using appropriate numerical methods.
CLO 4	Analyse the accuracy, convergence, and limitations of numerical techniques for given problems.

f. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**0**	**0**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

g. **Course Content:**

Sr.	**Topics**	**Weightage %**	**Teaching hours**
1	**Basis Probability and Probability Distribution** Introduction to probability, axioms, and events, Conditional probability and Bayes' theorem, Random variables (discrete and continuous), Probability mass and density functions, Mathematical expectation and variance, Standard distributions: Binomial, Poisson, and Normal.	**25%**	**11**

2	**Basic Statistics and Testing of Hypothesis** Measure of central tendency: Ungrouped and Grouped Data, Standard deviation, variance and standard error, Population and Sample, Large sample tests (one mean test, two mean test), Small sample test (one mean test, two mean test, paired t-test), Chi-square test for goodness of fit and independence of attributes.	**30%**	**13**
3	**Numerical Methods I (Interpolation and Integration)** Finite difference, Relationship between operators, Error Analysis, Interpolation using Newton's forward and backward formulae, Lagrange's formulae for unequal interval Numerical Integration: Trapezoidal rule, Simpson's $1/3^{rd}$ rule, and Simpson's $3/8^{th}$ rule.	**20%**	**10**
4	**Numerical Methods II (Linear Systems and ODEs)** Solution of system of linear equations: Gauss Jacobi and Gauss seidel methods Numerical solution of Ordinary Differential Equations: Euler and Modified Euler's methods, Runge-Kutta method of second order and fourth order.	**25%**	**11**

h. Text Books:

- Erwin Kreyszig, "Advanced Engineering Mathematics" (8^{th} addition), Willey India Edition.
- S. S. Shastry, Introductory Methods of Numerical Analysis, Prentice Hall India Learning Private Limited.

i. Reference Books:

- Dr. B.S. Grewal "Higher Engineering Mathematics", Khanna Publishers, New Delhi
- Murray Spiegel, "Advanced Mathematics for Engineering & Science: Schaum's Outline Series", Tata McGraw Hill Publication
- Merel C Potter, J.L. Goldberg, "Advanced Engineering Mathematics" (3^{rd} Edition), Oxford India Publication

a. Course Name: Programming in Python with Full Stack Development

b. Course Code: 03010504PE03

c. Prerequisite: Basic knowledge of Programming and web applications

d. Course Learning Objective

CLOBJ 1	Understand the fundamental concepts of Python programming, including syntax, data types, and data structures.
CLOBJ 2	Apply object-oriented programming principles and implement exception handling techniques in Python applications.
CLOBJ 3	Utilize modules, packages, and database connectivity for efficient program development and data management
CLOBJ 4	Develop interactive frontend applications using JavaScript for dynamic user interfaces..
CLOBJ 5	Build and deploy web applications using the Django framework following best development practices.
CLOBJ 6	Design and implement RESTful APIs for communication between web services and applications.

e.Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**		**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

f. Course Content:

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**Introduction to python programing:** Introduction to Python and basic programming concepts, variables, data types, conditionals statements and loops Lists,Sets,Tuples,Dictionaries: Working with strings, lists, sets, tuples and dictionaries, including common operations and built-in functions	15	6
2	**Functions :**Defining and using functions, including the use of arguments and return values OOPS Concepts : Object,class,abstraction,encapsulation, polymorphism, Inheritence. Exceptions and File handling:Handling exceptions and working with	20	5

	files		
3	**Modules and Packages:** Working with modules and packages in Python Introduction to popular Python libraries for specific tasks, such as data analysis, web development, or game development. PyCharm IDE : GIT- Git Integration with PyCharm IDE, PyTests. Python connectivity with Databases MYSQL, MongoDB CRUD operations.	15	5
4	**Core Frontend Technology:** JavaScript: Introduction to scripting for web, variables and data types, operators, control structures, functions, arrays and objects, DOM manipulation, event handling, form validation, and basics of asynchronous programming using Fetch API.	20	10
5	**Django Framework:** Introduction to Django framework, Django Project Installation in Virtual Environment. Phases in Django Project Creation Create a Project. Creation of Apps and their Structure. Working with ADMIN Console. Creating Views URLMapping. Template System Working with Models. Form Processing static, media files, Django App Deployment.	20	10
6	**RESTful APIs:** Introduction to RESTful APIs and the REST architectural style Understanding the HTTP protocol and its role in RESTful APIs Designing and implementing RESTful APIs using common HTTP methods, such as GET, POST, PUT, and DELETE Using URLs and resource representations to identify and transfer data in RESTful APIs Implementing best practices for designing and implementing RESTful APIs, such as using HTTP status codes,versioning, and error handling Consuming RESTful APIs using common tools and libraries, such as cURL, Postman, and the requests library in Python Building scalable and secure RESTful APIs using common frameworks and FastAPI.	10	6

g. Text Books:

Learning Python, O'Reilly Publications.
Python Crash Course, No Starch Press.
Django for Beginners, Self-Published.

h. Reference Books:

Fluent Python, O'Reilly Publications.

JavaScript: The Good Parts, O'Reilly Publications.

RESTful Web APIs, O'Reilly Publications.

Two Scoops of Django, Two Scoops Press.

Sr. No.	Experiment List
1	Write a program to convert temperature from Fahrenheit to Celsius and vice versa.
2	Write a program to calculate the area and perimeter of a rectangle and generate a random password of given length
3	Write a program to calculate the average of numbers, check leap year, and find factorial of a number.
4	Write a program to check palindrome string, sort numbers (ascending/descending), and generate multiplication table
5	Write a program for number base conversion and implement file handling operations (word count from text file, CSV average calculation).
6	Develop object-oriented programs such as bank account system and school management system..
7	Create basic and multi-page websites using HTML and apply CSS for styling and layouts..
8	Develop responsive web pages and implement JavaScript features such as form validation, DOM manipulation, and event handling.
9	Build interactive web applications like calculator, to-do list, and fetch data from public APIs.
10	Develop backend applications and RESTful APIs including CRUD operations, authentication (JWT), pagination, and error handling.

a. Course Name: Artificial Intelligence
b. Course Code: 03012404PE01
c. Prerequisite: Knowledge of Computer and Information System

d.Course Learning Objective

CLOBJ 1	Understand the fundamental concepts, goals, and historical development of Artificial Intelligence.
CLOBJ 2	Understand intelligent agents, their types, and interaction with different environments.
CLOBJ 3	Apply various search algorithms including brute force and heuristic methods to solve AI problems..
CLOBJ 4	Understand fuzzy logic concepts including membership functions, fuzzification, and defuzzification.
CLOBJ 5	Understand the structure and working of neural networks including perceptron and backpropagation algorithms.
CLOBJ 6	Apply AI techniques to solve real-world problems in different application domains.

h. Course Learning Outcomes:

i. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**0**	**0**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

j. Course Content:

Sr.	**Topics**	**Weightage %**	**Teaching hours**
1	**Introduction** Overview and Historical Perspective, • Artificial Intelligence (AI) definition, Goals of AI, History of AI, Applications of AI, Agents, Difference between human intelligence vs. artificial intelligence	**10**	**7**
2	**Agents and Environments** Agent Terminology, Types of Agents − Simple Reflex Agents, Model Based Reflex Agents, Goal Based Agents, Nature of Environments, Properties of Environments	**25**	**10**
3	**Search Algorithms** Terminology, Brute Force Search Strategies − Breadth First Search, Depth First Search. Heuristic Search Strategies, Local Search Algorithms.	**25**	**10**
4	**Fuzzy Logic Systems** Introduction to Fuzzy Logic and Fuzzy systems, Membership functions, Fuzzification,	**9**	**20**

	Defuzzification		
5	**Neural Networks**Basic structure of Neural Networks, Neural Network Elements, Perceptron, Back-propagation, Application of neural network	**9**	**20**

j. Text Books:

- Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson
- Elaine Rich & Kevin Knight, Artificial Intelligence, McGraw Hill

k. Reference Books:

- Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI
- Nils J. Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann
- S. Rajasekaran & G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI

a. Course Name: Artificial Intelligence Laboratory
b. Course Code: 03012404PE01
c. Prerequisite: Knowledge of Computer and Information System

d. Rationale:

This course provides an introduction to the fundamental concepts and techniques of Artificial Intelligence. It covers topics such as intelligent agents, search algorithms, knowledge representation, fuzzy logic, and neural networks. The course aims to develop problem-solving abilities by applying AI techniques to real-world scenarios. It also helps students understand the difference between human intelligence and artificial intelligence, along with the practical implementation of AI in various domains. The subject is designed to build both theoretical understanding and practical skills required for developing intelligent systems.

d.Course Learning Outcomes:

CLO 1	Explain the basic concepts, history, and applications of Artificial Intelligence and differentiate between human and artificial intelligence.
CLO 2	Analyze different types of intelligent agents and their interaction with environments.
CLO 3	Apply search algorithms such as BFS, DFS, and heuristic methods to solve problem-solving tasks.
CLO 4	Understand and apply fuzzy logic systems and neural networks for solving real-world problems.

f. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P**- Practical; **C**- Credit; **MSE**- Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE**- End Semester Examination

g. Experiment List

Sr. No.	**Experiment List**
1	Write a program that takes two inputs (0 or 1) and simulates the behavior of AND, OR, and NOT gates using ifelse statements
2	Create a list of 10 numbers. Write a script to find the maximum, minimum, and the average without using builtin functions like max() or sum().
3	Create a "Dictionary" that stores 5 AI terms and their definitions. Allow the user to type a term to "look up" the definition.
4	Install the NumPy library. Create two 2 X 2 matrices and perform addition and matrix multiplication.
5	Write a prolog program for Temperature Conversion
6	Write a program to implement Water Jug Problem.
7	Write a prolog program to Calculate Factorial.
8	Write a prolog program to Create Fibonacci Series.
9	Write a program to implement N Queens Problem
10	Write a prolog program to Create a text file

a. Course Name: Computer Networks

b. Course Code:

c. Prerequisite: Knowledge of Computer and Information System

d. Course Learning Outcomes:

CLO 1	Explain fundamental concepts of data communication, networking models, protocols, and transmission media.
CLO 2	Analyze and apply data link layer mechanisms such as error detection, error correction, and flow control techniques.
CLO 3	Understand and apply network layer concepts including IP addressing, routing protocols, and packet forwarding.
CLO 4	Analyze transport layer protocols and evaluate network performance using congestion control and quality of service techniques.

e. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	2	4	20	20	20	60	30	150

L- Lectures; **T**- Tutorial; **P**- Practical; **C**- Credit; **MSE**- Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE**- End Semester Examination

f. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**DATA COMMUNICATION COMPONENTS:** Representation of data and its flow Networks, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum	25%	11
2	**DATA LINK LAYER AND MEDIUM ACCESS SUB LAYER:** Error Detection and Error Correction -Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back ′N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols - Pure ALOHA, Slotted ALOHA,CSMA/CD,CDMA/CA	25%	11
3	**Network Layer:** Switching, Logical addressing ′IPV4, IPV6; Address mapping ′ARP, RARP, BOOTP and DHCP′ Delivery, Forwarding and Unicast Routing	20%	10

	protocols, IP Routing – Intra Domain Routing Protocols, Inter Domain Routing Protocols (BGP)		
4	**Transport Layer:** Process to Process Communication, User Datagram Protocol(UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.	15%	7
5	**IApplication Layer:** Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography	15%	6

g. Text Books:

- Andrew S. Tanenbaum and David J. Wetherall, Computer Networks, Pearson Edition.
- Douglas E. Comer, Internetworking with TCP/IP.

h. Reference Books:

- Richard Stevens, TCP/IP Illustrated.
- Behrouz A. Forouzan, Data Communication and Networking.
- William Stallings, Data and Computer Communications

a. **Course Name: Computer Network Laboratory**

b. **Course Code:** 03010504PC02

c. **Prerequisite:** Knowledge of Computer and Information System

d. **Rationale:**This course provides practical exposure to computer networking concepts. It includes hands-on experiments on network configuration, protocols, and services. Students will learn to implement, analyze, and troubleshoot networks.

e. **Course Learning Outcomes:**

CLO 1	Understand and perform basic network configuration and troubleshooting.
CLO 2	Analyze and implement networking protocols in practical scenarios..
CLO 3	Configure network services such as DNS, FTP, HTTP
CLO 4	Apply network security and monitoring techniques.
CLO 5	Apply network security practices including firewall configuration and basic monitoring to ensure secure communication.

f.Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE**- Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE**- End Semester Examination

g. **Experiment List**

Sr. No.	**Experiment List**
1	Design and Simulation of Computer Network Topologies using Cisco Packet Tracer
2	Packet Capture and Protocol Analysis using Wireshark
3	Study of Generic Networking Devices using Cisco Packet Tracer
4	Study of Error Detection and Error Correction Techniques at the Data Link Layer
5	Design and Configuration of Virtual Local Area Networks (VLANs)
6	Design and Configuration of Wireless Local Area Network (WLAN)
7	Perform Internetworking using Routers
8	Implementation of IP Addressing Scheme using Subnetting
9	Study of Routing Mechanisms at the Network Layer.
10	Study of Transport Layer Protocols and Services