ADVANCED DATA STRUCTURES & ALGORITHMS

Subject Code: CS35113CS	**Subject Type:** DC	**Evaluation Scheme:** MSE (30), TA (20), ESE (50)	**L-T-P:** 2-0-2 (3)

Pre-Requisites: Basic Data Structures

Course Objective: Design and analysis of complex data structures and high-performance algorithms using advanced paradigms to solve computationally intensive optimization and decision problems.

Course Outcomes: At the end of the course, the student will be able to

CO	Course Outcomes
CO-1	Understand the basic Complexity analysis & elementary data structures
CO-2	Understand the key data structures and Hashing Techniques
CO-3	Understand to design and evaluate efficient solutions for complex optimization problems
CO-4	Understand to design and evaluate optimized solutions for sorting, geometric, and graph-connectivity problems.

Syllabus:

Unit 1: Complexity Analysis & Elementary Data Structures

Asymptotic Notations: Properties of Big-O, Omega, Theta, Definition by Limits, Inequalities, Recursive Equation, Recursion Tree, Masters Theorem, NP Hard and NP Complete. Data Structures: Arrays, Stack, Queue and Linked Lists.

Unit 2: Heap Structures and Trees

Heaps: Min-Max heaps, Binomial heaps, Fibonacci heaps. Trees: Binary Search Trees, Red-Black Trees, AVL Trees, Splay Trees, B+ Tree, B Tree, 2-3 Tree, 2-3-4 Tree. Hashing: Hashing Function, Linear Probing, Quadratic Probing, Double Hashing, Chaining.

Unit 3: Programming Paradigms

Greedy: Fractional Knapsack, Minimum Spanning Trees, Dijkstra, Huffman Coding, Job Sequencing. Dynamic Programming: 0/1 Knapsack, Floyd-Warshall, Matrix Chain Multiplication, Bellman-Ford, Multistage Graph, TSP. Branch and Bound: TSP, Job Shop Scheduling, Integer Linear Programming.

Unit 4: Decision Problems and D&C Paradigm

Backtracking: DFS, Strongly Connected Components, Bi-Connected Graphs, Graph Coloring, Sum of Subsets, N-Queens Problem. Divide and Conquer: Quick Sort, Merge Sort, Binary Search, Convex Hull.

Learning Resources:

Text Books:

1. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2022). Introduction to Algorithms (4th ed.). MIT Press.
2. E. Horowitz, S. Sahni, and D. P. Mehta, Fundamentals of Data Structures in C++, 2nd ed. Universities Press/Silicon Press, 2007.
3. Lipschutz, S. (2014). Data Structures (Revised 1st ed.). Tata McGraw Hill.
4. Pai, G. A. V. (2008). Data Structures and Algorithms: Concepts, Techniques and Applications. Tata McGraw Hill.

Reference Books:

1. G. Brassard and P. Bratley, Algorithmics: Theory and Practice, Prentice Hall, 1988.
2. Horowitz, E., Sahni, S., & Rajasekaran, S., Fundamentals of Computer Algorithms (2nd ed.). Universities Press 2008.
3. Mark Allen Weiss, Data Structure and Algorithms Analysis in C++, Pearson Education 2002.
4. Aho, Ullman, Data Structure and Algorithms Analysis in C++, Pearson Education 2002.