

# ADVANCE DATA STRUCTURES AND ALGORITHMS

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|----------------------------------------------------|---------------------------|
| <b>Subject Code:</b> CS34113CS                     | <b>Subject Type:</b> Core |
| <b>Evaluation Scheme:</b> MSE(30), TA(20), ESE(50) | <b>L-T-P:</b> 2-0-2       |

**Pre-Requisites:** Data Structures and Algorithms

**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-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 how to design and evaluate optimized solutions for sorting, geometric, and graph-connectivity problems. |

**Course Articulation Matrix:**

| CO/PO | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 |
|-------|------|------|------|------|------|------|
| CO-1  | 3    | 2    | 1    | -    | -    | -    |
| CO-2  | 3    | 2    | 1    | -    | 1    | -    |
| CO-3  | 3    | 2    | -    | -    | 3    | 1    |
| CO-4  | 3    | 2    | 1    | 1    | -    | 1    |

1 - Slightly; 2 - Moderately; 3 – Substantially

**Syllabus:**

## UNIT 1: Complexity Analysis and Fundamental Data Structures

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: Advanced Trees, Heaps, and Hashing Techniques

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: Algorithmic Paradigms for Optimization Problems

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: Advanced Problem-Solving Paradigms

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. Bangalore, India: 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, printice –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.