24PC1002 ADVANCED DATA STRUCTURES AND ALGORITHMS (3-0-0)

Objective:

- Understand and apply the Divide-and-Conquer paradigm to solve complex problems, such as Strassen's matrix multiplication.
- Analyze the performance of algorithms using probabilistic and randomized techniques.
- Understand the properties of Binary Search Trees (BST) and Red-Black Trees.
- To introduce the concept of parallel algorithms, focusing on how parallelism can be exploited to improve the efficiency of classical algorithms like matrix multiplication and merge sort.
- To prepare students for the challenges of designing and analyzing algorithms for complex computational problems, particularly in parallel and real-time environments.

MODULE – I

Divide-and-Conquer: Strassen's algorithm for matrix multiplication. Probabilistic Analysis and Randomized Algorithms: The hiring problem, Indicator random variables, Randomized algorithms, A randomized version of quicksort, Analysis of quicksort.

MODULE – II

Hash Tables: Direct-address tables, Hash tables, Hash functions, Open addressing. Binary Search Trees, Red-Black Trees: Properties of red-black trees, Rotations, Insertion, Deletion. Augmenting Data Structures: Dynamic order statistics, Interval trees, B-Trees.

MODULE – III

Dynamic Programming: Rod cutting, Optimal binary search trees. Amortized Analysis: Aggregate analysis, The accounting method, The potential method, Number-Theoretic Algorithms: Greatest common divisor, Modular arithmetic, The Chinese remainder theorem, The RSA public-key cryptosystem.

MODULE – IV

Parallel Algorithms: Parallel matrix multiplication, Parallel merge sort , Online Algorithms: Waiting for an elevator, Maintaining a search list, Online caching, Machine-Learning Algorithms: Clustering, Multiplicative-weights algorithms, Gradient descent.NP-Completeness: NP-completeness and reducibility, NP-completeness proofs.

Outcome:

1. Understand and apply the Divide-and-Conquer paradigm to solve complex problems, such as Strassen's matrix multiplication.
2. Analyze the performance of algorithms using probabilistic and randomized techniques.
3. Develop the ability to design and analyze randomized algorithms, including randomized quicksort,with probabilistic analysis techniques.
4. Understand and apply parallel algorithms, such as parallel matrix multiplication and parallel merge sort, to solve computational problems efficiently.
5. Analyze machine learning algorithms, Understand the theory of NP-completeness, reducibility, and NP-completeness proofs to identify and classify computationally intractable problems.

Books Recommended:

1. Introduction to Algorithms, Thomas H.Corman, Charles E.Leiserson, Ronald L.Rivest, Clifford Stein Fourth Edition, The MIT Press 2022.
2. Data Structures and Algorithm Analysis in C++, Mark Allen Weiss, Pearson, 4th Edition (2013)
3. Advanced Data Structures, Peter Brass, Cambridge University Press, 1st Edition (2008)