

Masterclass in Data Structure and Algorithms

The course contents

- **Part 1: Searching and Sorting Algorithms:**
 - **Sorting algorithms:** Insertion sort
 - Merge sort
 - Quick sort
 - Heap sort
 - Bucket sort
 - Shell sort
 - Counting sort
 - Radix sort
 - **Searching algorithms:** Linear Search
 - Binary Search
 - More advanced search techniques will be covered with the help of data structures
- **Part 2: Fundamental Data Structures**
 - **Basic Data Structures:** Array as a data structure.
 - Array Based Data Structures:
 - Stack,
 - Queue,
 - Dequeue,
 - Priority Queue.
 - Linked Lists:
 - Singly Linked List,
 - Singly Circular Linked List,
 - Doubly Linked List,
 - Doubly Circular Linked List
 - List Based
 - Stack,
 - Queue,
 - Dequeue,
 - Priority Queue.
 - Dynamic disjoint sets
 - Hash tables

- Basic Indexing Techniques

- **Part 3: The World of Trees:**

- **Binary Search Tree:**

- create,
- insert,
- search,
- remove,
- destroy,
- recursive preorder recursive,
- recursive postorder recursive,
- recursive inorder traversal,
- nonrecursive preorder traversal,
- nonrecursive postorder traversal,
- nonrecursive inorder traversal,
- predecessor,
- successor

- **Height & Weight Balanced Trees:**

- Red Black Tree
- AVL Tree
- Radix Tree
- B Tree
- Finger Tree
- Skip Lists

- **Tree Structures for the sets of intervals:**

- Interval Trees
- Segment Trees

- **Heaps:**

- Binomial Heap
- Fibonacci Heap

- **Part 4: The World of Graph:**

- **Graph management algorithms:**

- Create_graph
- Add_vertex
- Add_edge
- Remove_vertex
- Remove_edge

- Print_graph
 - Destroy_graph
 - **Graph Traversal Algorithms:**
 - Depth First Search
 - Breadth First Search
 - **Shortest Path Algorithms:**
 - Dijkstra's shortest path algorithm
 - Bellman Ford Algorithm
 - **Minimum Spanning Tree:**
 - Prim's Algorithm
 - Kruskal's Algorithm
- **Part 5: Design of Algorithms: Algorithm Design Strategies:**
 - **Divide and Conquer:** General solution, case studies with merge sort, quick sort.
 - **Greedy:** General Solution, case study with Prim's and Kruskal
 - **Dynamic Programming:**
 - Introduction through ROD cutting problem.
 - recursive top-down implementation
 - Bottom up cut rod
 - memoized cut rod
 - Applying dynamic programming technique to matrix multiplication
 - **Elements of dynamic programming:**
 - Optimal substructure
 - Overlapping subproblems
 - Reconstructing optimal solution
 - Longest common subsequence
 - Optimal Binary Search Tree
 - **Backtracking:** General strategy and case study with 8 queens' problem.
 - **Introduction and solution to some well-known algorithmic problems:**
 - 0/1 knapsack,
 - Hamiltonian graph problem,

- Satisfiability problem.

- **Part 6: Analysis of algorithms:**

- Time complexity.
- Asymptotic notation to measure time complexity
 - Big Theta
 - Big O
 - Big omega
 - Small O
 - Small omega
- Time Complexity of Non-recursive algorithms
 - Computing Complexity of non-recursive algorithms via step counting
 - Converting step counting output into asymptotic notation
 - Time Complexity of Recursive algorithms
- Computing Complexity of recursive algorithms
 - Step counting
 - Generate RECURSIVE EQUATION
 - Solving RECURSIVE EQUATION
 - Converting solution to recursive equation into asymptotic notation
- Theory of recursive equations
 - Master Theorem
 - Other forms of recurrence relations & solving techniques