

Suggested Teaching Guidelines for Algorithm and Data Structures – PG-DAC August 2019

Duration: 34 class room hours + 36 lab hours (70hrs)

Objective: To reinforce knowledge of Problem solving techniques, Data Structure Concepts and analysis of different Algorithm.

Prerequisites: Knowledge of Programming in C/C++ with Object Oriented concepts

Evaluation method: Theory exam– 40% weightage
Lab exam – 40% weightage
Internal exam– 20% weightage

List of Books / Other training material

Test Book:

1. Fundamentals of Data Structures in C++ by Horowitz, Sahani & Mehata / Orient Longman

Reference:

1. Problem Solving: Best Strategies to Decision Making, Critical Thinking and Positive Thinking by Thomas Richards / Kindle Edition
2. Data Structures, Algorithms and Applications in C++ by Sartaj Sahni
3. Object-oriented Analysis And Design Using Umlan Introduction To Unified Process And Design Patterns 1st Edition by [Mahesh P. Matha](#) / PHI
4. Introduction to Algorithms by Cormen, Leiserson, Rivest and Stein
5. Data Structures Via C++ Objects by Evolution by A Michael Berman / Oxford University Press
6. Design and Analysis of Algorithm by S Sridhar / Oxford University Press
7. Fundamentals of Computer Algorithms 2nd Edition by Sanguthevar Rajasekaran, Sartaj Sahni, Ellis Horowitz / Orient Longman
8. Introduction to Algorithms by Al. Cormen / PHI Learning
9. The Algorithm Design Manual by Steven S. Skiena / Springer
10. Algorithmic Puzzles by Anany Levitin, Maria Levitin / Oxford University Press

Session 1 & 2: Introduction to STL

Lecture

- Object Design and Templates
- STL (Standard Type Libraries)

Assignment – Lab:

- Find the number of students who are passes or failed using MAP.
- Find the prime numbers from 2 to n using sieves algorithm, use SET

Session 3 & 4: Problem Solving & Computational Thinking

Lecture

- Define the problem
 - Identify the problem

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- Introduction to Problem Solving
- Problem solving basics
- Defining creativity v/s innovation
- Find Creative Solutions using creativity tools
 - Effective problem solving approaches
 - Critical thinking and information analysis
 - Brainstorming, Reverse Brainstorming, Imagineering, Mind Mapping,
 - Six Thinking Hats: A Tool to Strengthen Critical Thinking, Collaboration, Communication, and Creativity Skills
 - Analyzing the situation, Gathering information, Identifying solution criteria
 - Decision Making Methods
 - Charts and Diagrams
 - Applying outcome-based thinking
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- Evaluate and Select solution
 - Pro's and Con's, Force field analysis, Feasibility/Capability Analysis,
 - Decision analysis, evaluating problems
 - Choosing among alternatives
 - Qualitative analysis, discussing qualitative analysis techniques
 - Establishing objectives
 - Assigning weight to objectives in order to make the best decision
 - Creating a satisfaction scale to choose between alternatives
- Implementing Decisions
 - Create an action plan
 - Break solution into action steps
 - Prioritize actions and assign roles (setting priorities for taking action)
 - Follow-up at milestones

Assignment – Lab:

- Faculties need to assign different problems, mostly real world problems
- Students (by team wise, there are two students in a team) need to analyze as per the techniques learned
- Students need to solve by the thinking approaches learned.
- Based on the above problems students need to select as per the selection criteria learned
- They need to implement the selected solution and need to do the documentations.

Session 5 & 6: Algorithm design

Lecture

- How to write efficient Algorithm
- Introduction to algorithm design techniques
- Algorithm Design techniques
- Analysis of an Algorithm
 - Asymptotic analysis
 - Algorithm analysis
- Analysis of different type of Algorithms

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- Divide and Conquer Algorithm
- Greedy Algorithm
- Dynamic Programming Algorithm
- Brute force Algorithm
- Backtracking algorithms
- Branch-and-bound algorithms
- Stochastic algorithms
- Complexity
 - Complexity Analysis
 - Space complexity of algorithm
 - Time complexity of algorithm
- Case study on Algorithm Design techniques
- Application of Data structures

Assignment – Read:

- Study on different Algorithms
- Compare different Algorithms previously programmed and do the analysis

Session 7 & 8: Algorithm & Data Structures

Lecture:

- Introductory Concepts
- Algorithm Constructs
- OO design: Abstract Data Types (ADTs)
- Basic Data Structures
 - Arrays
 - Stacks
 - Queues
 - Circular Queues
 - Priority Queues
 - Deques

Assignment – Lab:

- Implement Stack through Array
- Implement C-Stack, C2-Stack and CN-Stack in same memory block.
- Implement Queues with inserting element at different location (First, Last and at specific location)
- Implement circular queue, Priority Queues and Dqueue
- Implement program to convert infix expression into postfix expression & evaluate postfix expression.

Session 9 & 10: Linked List Data Structures

Lecture

- Linked lists
 - Single Linked Lists
 - Double Linked Lists
 - Circular Linked Lists

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- Node-based storage with arrays

Assignment – Lab:

- Implement circular queue using linked list
- Design an iterator using circular linked list

Session 11 & 12: Trees & Applications

Lecture

- Introduction to trees
- Trees and Terminology
- Tree traversals
- Ordered trees
- Binary trees
- Complete binary trees
- Search trees
- Binary search trees
- Introduction to self balancing tree & variants

Assignment – Lab:

- Write a program to implement a binary search tree and the following operations on it:
 - Create()
 - InsertNode()
 - Tree traversals (Inorder(), Preorder(), Postorder())
 - deleteNode()
- Design a threaded binary tree and implement the orders.

Session 13 & 14: Searching & Sorting algorithms

Lecture

- Objectives of Searching
 - The Sequential Search
 - Analysis of Sequential Search
 - The Binary Search
- Analysis of Binary Search
- Introduction to sorting
 - Selection sort
 - Insertion sort
 - Bubble sort
 - Heap sort
 - Merge sort
 - Quick sort
- Analysis of sorting algorithms

Assignment – Lab:

- Writing program to search an item through sequential search technique.
- Implement to find an item in a list through binary search
- Implement sorting algorithm for selection sort, Bubble sort, heap sort and quick sort

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- Write a program to merge two sorted linked lists

Session 15: Hash functions and hash tables**Lecture**

- Hashing & Introduction to hash tables
- Hash functions
- Mapping down to $0 \dots M - 1$
- Chained hash tables
- Scatter tables
- Open addressing
- Linear probing
- Quadratic probing
- Double hashing
- Poisson distribution
- Collision Resolution
- Analysis of Hashing

Assignment – Lab:

- Implement hashing techniques in different programs solved earlier
- Implement collision and solution to it on any previous solved problem
- Write a program to implement Hash table

Session 16 & 17: Graph & Applications**Lecture**

- Introduction to graph theory
- Graph Terminology
- Different types of Graphs
- Representation of Graphs
 - Connectedness, Single source un-weighted path length, identifying bipartite graphs
 - Graph Traversal Algorithms (Breadth First Search, Depth First Search)
 - Single-source shortest path algorithms, Dijkstra's algorithm, A* search algorithm, Bellman-Ford algorithm
 - All-pairs shortest path, Floyd-Warshall algorithm, Johnson's algorithm
 - Maximum flow algorithms, Ford-Fulkerson algorithms
- Spanning Trees
 - Minimum spanning tree algorithms, Prim's algorithm, Kruskal's algorithm

Assignment – Lab:

- Implement a graph using adjacency links and traverse using Depth First Search.
- Write a program using STL to implement Dijkstra's Shortest Path Algorithm.