**ALGORITHMS DESIGN AND ANALYSIS**

An algorithm is a systematic method containing a sequence of instructions to solve a computational problem. It takes some inputs, performs a well defined sequence of steps, and produces some output. Once we design an algorithm, we need to know how well it performs on any input. In particular we would like to know whether there are better algorithms for the problem. So it demands a way to analyze an algorithm in a machine-independent way.

Algorithm design is a specific method to create a mathematical process in solving problems. It is identified and incorporated into many solution theories of operation research, such as dynamic programming and divide-and-conquer. Techniques for designing and implementing algorithm designs are algorithm design patterns such as template method pattern and decorator pattern, and uses of data structures, and name and sort lists. Some current day uses of algorithm design can be found in internet retrieval processes of web crawling, packet routing and caching.

Main frame programming languages such as ALGOL (for Algorithmic language), FORTRAN, COBOL, PL/I, SAIL, and SNOBOL are computing tools to implement an "algorithm design"... but, an "algorithm design" (a/d) is not a language. An a/d can be a hand written process, e.g. set of equations, a series of mechanical processes done by hand, an analog piece of equipment, or a digital process and/or processor.
Tutorial -1

1. Determine the asymptotic order of following:
   1. \( F (n) = 3x^2 + 5 \)
   2. \( F (n) = 2n + 5n + 3 \)
   3. \( F n = i2ni=1 \)

2. What is big ‘Oh’ notation?

3. What are the two different types of recurrence?

4. State the best case and worst case analysis for linear search.

5. Solve the recurrence equation:
   \( T (n) = 100T (n/99) + \log (n) \)

6. Write the complexity of divide and Conquer algorithms.

7. List out the disadvantage of merge sort.

8. List out any two drawbacks of binary search algorithm.

10. Explain the master theorem and solve the following:
    1) \( T n = T n + 1 \)
    2) \( T n = 2T n/4 + n \)
Tutorial 2

1. What are exponential growth functions?
2. What is amortized efficiency?
3. Define $\Omega$-notation?
4. Mention the useful property, which can be applied to the asymptotic notations and its use?
5. What is the recurrence relation to find out the number of multiplications and the initial condition for finding the $n$-th factorial number
6. Write an algorithm for finding maximum element of an array; perform best and average case complexity with appropriate order notations.
7. Using the recursive algorithm, explain how the tower of Hanoi problem can be solved. What will be time and space complexity for the algorithms.
8. What is the difference between quicksort and mergesort?
Tutorial 3

1. Give computing time for Binary search?
2. Give the recurrence relation of divide-and-conquer?
3. Explain the algorithm for maximum and minimum numbers in an array.
5. Write the difference between the Greedy method and Dynamic programming.
6. Define optimal finish time
8. List down the examples of backtracking.
Tutorial 4

1. How BFS works and compute its time complexity
2. Define connected component.
3. Define bi connected graph and bi connected component.
4. What is tree edge and cross edge?
5. Define live node, E-node and dead node
6. What are the types search strategies in branch and bound?
7. How divide and conquer technique can be applied to binary trees?
8. Explain Internal and External Nodes
9. Define the Internal Path Length
10. Define the External Path Length
Tutorial 5

1. Find shortest path using Floyd Warshall?

2. Find minimum cost spanning tree using Prim's and Kruskal

3. Find shortest path using Dijkstra

4. Illustrate the operation of RADIX-SORT on the following list of English words: COW, DOG, SEA, ROW, MOB, BOX, TAB, BAR, EAR, BIG, TEA, NOW. Apply BUCKET-SORT algorithm on the following array: 0.78, 0.17, 0.39, 0.26, 0.72, 0.94, 0.21, 0.21, 0.12, 0.23, 0.68.

5. How the results inserting the keys F, S, Q, K, C, L, H, T, V, W, M, R, N, P, A, B, X, Y, D, Z, E, G, I in order into an empty B-Tree only and the minimum degree of B-Tree is 3. Draw the configuration of some node must split and also draw the final configuration.
Tutorial 6

1. What is the concept of Convex Hull problem?
2. What is 0/1 Knapsack Problem.
3. Define Backtracking.
5. Define Hamiltonian Circuit problem in an undirected Graph.
7. Define depth first searching techniques.
9. What is a minimum cost spanning tree?
10. Example of Approximation algorithm and Randomized algorithms.
Tutorial 7

1. Write any four examples for Brute Force Approach.
2. Define Dynamic programming.
3. Define multistage graph problem.
4. Discuss any sorting technique having linear time complexity
5. Define all-pair shortest path problem.
7. What is 0/1 Knapsack.
8. What is the procedure to solve traveling Salesman problem.
9. Differentiate non preemptive & preemptive scheduling.
10. List out the advantages of Dynamic programming.
Tutorial 8

1. What are the two classes of non polynomial time problems?
2. What is meant by NP hard and NP complete problem?
3. What is meant by class P (Polynomial)?
4. How can we show that a problem is NP complete?
5. What do you understand by Polynomial time reducibility?
6. Write some applications of traveling salesperson problem.
8. Define sum of subsets problem?
9. What is meant by feasible solution?
10. Explain undecidable and halting problems
MCQs:

1. There are 5 items as follows

<table>
<thead>
<tr>
<th>Items</th>
<th>w_i</th>
<th>v_i</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item1</td>
<td>5 pounds</td>
<td>30$</td>
</tr>
<tr>
<td>Item2</td>
<td>10 pounds</td>
<td>20$</td>
</tr>
<tr>
<td>Item3</td>
<td>20 pounds</td>
<td>100$</td>
</tr>
<tr>
<td>Item4</td>
<td>30 pounds</td>
<td>90$</td>
</tr>
<tr>
<td>Item5</td>
<td>40 pounds</td>
<td>160$</td>
</tr>
</tbody>
</table>

The knapsack can hold 60 pounds find the optimal solution
(A) 250$  (B) 260 $  (C) 270 $  (D) 290$

2. What is an optimal Huffman code for alphabet of the following set of frequencies
   a: 05, b:48, c:07, d:17, e:10, f:13
   (A) 1010  (B)0101  (C) 1001  (D) 1100

3. The total running time of Huffman on the set of n characters is
   (A) O(n)  (B) O(n log n)  (C) O(n^2)  (D) O(log n)

4. The total running time of matrix chain multiplication of n matrices
   (A) Θ (n^4)  (B) Θ (n^3)  (C) Θ (n^2)  (D) Θ (n)

5. which of the following is true
   (A) P is subset of NP  (B) NP is subset of P
   (C) P and NP are equal  (D) NP is subset of NP hard

6. The total running time of optimal binary search tree of n nodes
   (A) O(n^2)  (B) O(n)  (C) O(n^3)  (D) O(n log n)

7. If every square of the board is visited, then the total number of knight moves of n-queen problem is
   (A) n^3-1  (B) n-1  (C)n^2-1  (D) log n-1

8. If every square of the board is visited, then the total number of knight moves of 4-queen problem is
   (A) 14  (B) 15  (C) 16  (D) 12

9. what is an optimal Huffman code for alphabet b of the following set of frequencies a: 45, b:13, c:12, d:16, e:9, f:5
   (A) 100  (B) 111  (C) 001  (D) 101
10. Which of the following method is taking overcharge for some operations in amortized analysis?
(A) Aggregate method    (B) accounting method
(C) potential method    (D) both (A) and (C)

11. Which of the following method is most flexible in amortized analysis?
(A) Aggregate method    (B) accounting method
(C) potential method    (D) both (A) and (B)

12. Which of the following method is computing total cost of an algorithm in amortized analysis?
(A) Aggregate method    (B) accounting method
(C) potential method    (D) both (C) and (B)

13. If all c(i, j)’s and r(i, j)’s are calculated, then OBST algorithm in worst case takes one of the following time.
   (a) O(n log n)
   (b) O(n^3)
   (c) O(n^2)
   (d) O(log n)
   (e) O(n^4).

14. The upper bound on the time complexity of the nondeterministic sorting algorithm is
   (a) O(n)
   (b) O(n log n)
   (c) O(1)
   (d) O(log n)

15. The worst case time complexity of nondeterministic dynamic knapsack algorithm is
   (a) O(n log n)
   (b) O(log n)
   (c) O(n^2)
   (d) O(n)

16. The time complexity of the normal quick sort, randomized quick sort algorithms in the worst case is
   (a) O(n^2), O(n log n)    (b) O(n^2), O(n^2)
   (c) O(n log n), O(n^2)    (d) O(n log n), O(n log n)

17. Let there be an array of length ‘N’, and the selection sort algorithm is used to sort it, how many times a swap function is called to complete the execution?
   (a) N log N times        (b) log N times
   (c) N^2 times            (d) N-1 times
18 The Sorting method which is used for external sort is
(a) Bubble sort (b) Quick sort (c) Merge sort (d) Radix sort

19. In analysis of algorithm, approximate relationship between the size of the job and the amount of work required to do is expressed by using ________
(a) Central tendency (b) Differential equation (c) Order of execution (d) Order of magnitude

20 P, Q and R are pointer variables. The statements below are intended to swap the contents of the nodes pointed to by P and Q. rewrite it so that it will work as intended.
P = Q; R = Q; Q = R;
(a) R=Q; P=R; Q=R; (b) R=P; P=P; Q=Q;
(c) P=P; P=Q; R=Q; (d) R=P; P=Q; Q=R;

21 Consider the usual algorithm for determining whether a sequence of parentheses is balanced. What is the maximum number of parentheses that will appear on the stack AT ANY ONE TIME when the algorithm analyzes: (())(()(()))
(a) 1 (b) 2 (c) 3 (d) 4

22. The Knapsack problem where the objective function is to minimize the profit is ______
(a) Greedy (b) Dynamic 0 / 1
(c) Back tracking (d) Branch & Bound 0/1

23 Choose the correct answer for the following statements:
I. The theory of NP–completeness provides a method of obtaining a polynomial time for NP algorithms.
II. All NP-complete problem are NP-Hard.
(a) I is FALSE and II is TRUE
(b) I is TRUE and II is FALSE
(c) Both are TRUE
(d) Both are FALSE

24. For 0/1 KNAPSACK problem, the algorithm takes ________ amount of time for memory table, and ______time to determine the optimal load, for N objects and W as the capacity of KNAPSACK.
(a) O(N+W), O(NW) (b) O(NW), O(N+W)
(c) O(N), O(NW) (d) O(NW), O(N)
25. What is the type of the algorithm used in solving the 8 Queens problem?
(a) Greedy
(b) Dynamic
(c) Branch and Bound
(d) Backtracking.

26. Sorting is not possible by using which of the following methods?
(a) Insertion
(b) Selection
(c) Deletion
(d) Exchange

27. Graph G is ............... if for any pair u, v of nodes in G there is a path from u to v or path from v to u.
(a) Laterally connected
(b) Widely Connected
(c) Unilaterally connected
(d) Laterally connected

28. The post order traversal of binary tree is DEBFCA. Find out the pre order traversal.
(a) ABFCDE
(b) ADBFEC
(c) ABDECF
(d) ABDCEF

29. The in-order traversal of tree will yield a sorted listing of elements of tree in ........
(a) binary trees
(b) binary search trees
(c) heaps
(d) binary heaps

30. In a binary tree, certain null entries are replaced by special pointers which point to nodes higher in the tree for efficiency. These special pointers are called ........
(a) Leaf
(b) Branch
(c) Path
(d) Thread