**B.TECH/IT/4TH SEM/INFO 2202 (BACKLOG)/2022**

# DESIGN & ANALYSIS OF ALGORITHMS
**(INFO 2202)**

**Time Allotted : 3 hrs** **Full Marks : 70**

***Figures out of the right margin indicate full marks.***

***Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.***

***Candidates are required to give answer in their own words as far as practicable.***

## Group – A
**(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Which of the following algorithm design techniques is used in the quick sort algorithm?
(a) Dynamic programming (b) Backtracking
(c) Divide and conquer (d) Greedy method.

(ii) Ω-Notation provides an asymptotic
(a) upper bound
(b) lower bound
(c) one that is sandwiched between the two bounds
(d) none of these.

(iii) Which is the safest method to choose a pivot element in quick sort?
(a) Choosing a random element as pivot
(b) Choosing the first element as pivot
(c) Choosing the last element as pivot
(d) Median-of-three partitioning method.

(iv) Which type of best first search algorithm was used to predict the closeness of the end of path and its solution?
(a) Greedy BFS (b) Divide and Conquer
(c) Heuristic BFS (d) Combinatorial.

(v) Time complexity of non-deterministic algorithm is always
(a) Less than deterministic algorithm
(b) Greater than deterministic algorithm
(c) Equal to deterministic algorithm
(d) None of these.

(vi) Which of the following is false about Prim's algorithm?
(a) It is a greedy algorithm
(b) It constructs MST by selecting edges in increasing order of their weights
(c) It never accepts cycles in the MST
(d) It can be implemented using the Fibonacci heap.

(vii) Dijkstra's Algorithm is used to solve _____ problems.
(a) all pair shortest path (b) single source shortest path
(c) network flow (d) sorting

(viii) The travelling salesman problem can be solved in
(a) Polynomial time using dynamic programming algorithm
(b) Polynomial time using branch-and-bound algorithm
(c) Exponential time using dynamic programming algorithm or branch-and-bound algorithm
(d) Polynomial time using backtracking algorithm.

(ix) Which of the following is false in the case of a spanning tree of a graph G?
(a) It is tree that spans G (b) It is a subgraph of the G
(c) It includes every vertex of the G (d) It can be either cyclic or acyclic.

(x) If every square of the board is visited, then the total number of moves of n-queen problem is
(a) $n^3$-1 (b) n-1 (c) $n^2$-1 (d) log n-1.

## Group - B

2. (a) State master's theorem and find the time complexity for the following recurrences:
(i) $T(n) = 4T(n/4) + 1$
(ii) $T(n)= 8T(n/2) + n^2$. [(CO1,CO2)(Evaluate/HOCQ)]
(b) Write an algorithm of heap sort and deduce its' time complexity.
[(CO1,CO2)(Evaluate/HOCQ)]
**(2 + 2 +2) + (4 + 2) = 12**

3. (a) Deduce the time complexity for the following recurrences:
(i) $T(n) = 2T(n/4) + n$ using recursion tree
(ii) $T(n)= 4T(n/3) + n^2$ using backward substitution method.
[(CO1,CO2)(Evaluate/HOCQ)]
(b) Deduce the time complexity of Binary Search. [(CO1,CO2)(Evaluate/HOCQ)]
(c) Derive the lower bound for comparison sort is O(nlgn).
[(CO2)(Evaluate/HOCQ)]
**(3 + 3) + 3 + 3 = 12**

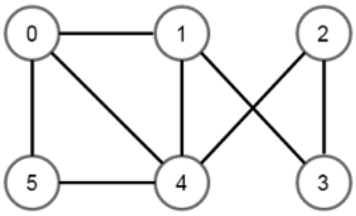
## Group - C

4. (a) Using permutation tree explain the 4 Queens problem and find out the possible no of solutions. [(CO3)(Understand/LOCQ)]

(b) Explain the two different properties of flow graph and define Ford-Fulkerson algorithm. [(CO3)(Understand/LOCQ)]

**6 + (2 + 4) = 12**

5. (a) By considering the following graph shows all possible solutions of m-coloring using a state space tree. [(CO3)(Understand/LOCQ)]

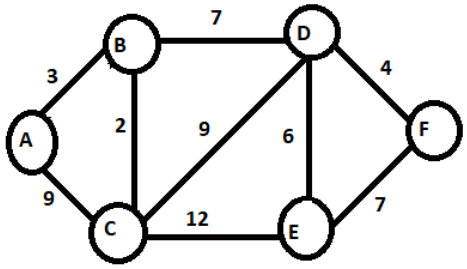



(b) Compare between DFS and BFS. [(CO3)(Evaluate/HOCQ)]

**8 + 4 = 12**

## Group - D

6. (a) Find out the shortest-path of the following graph using Dijkstra algorithm where source vertex is A. [(CO3,CO4)(Understand/LOCQ)]




(b) Compare between Prim's and Kruskal's algorithm. [(CO4)(Analyze/IOCQ)]

**8 + 4 = 12**

7. (a) Find an optimal parenthesization of a matrix-chain product whose sequence of dimensions is {15, 10, 25, 20, 30} also show the number of multiplication of different length of matrices. [(CO3,CO4)(Understand/LOCQ)]

(b) What is Spanning Tree? Compare the algorithms that were used to find the Minimum Cost Spanning Tree. [(CO3,CO4)(Understand/LOCQ)(Analyze/IOCQ)]

**8 + (1 + 3) = 12**

## Group - E

8. (a) Show that 2SAT is in P but 3SAT is NP-complete. [(CO5) (Analyze/IOCQ)]

(b) Write a short note on approximation schemes. [(CO5) (Analyze/IOCQ)]

(c) Discuss diagrammatically the relations among P class, NP class, NP hard and NP complete. [(CO5)(Understand/LOCQ)]

**5 + 4 + 3 = 12**

9. (a) Write a non deterministic algorithm to search an element X on A[1:n] where n>=1. [(CO6)(Evaluate/HOCQ)]

(b) Explain how you attempt to solve 15-puzzle problem using Branch and Bound strategy. Draw a portion of the state space generated by it.

[(CO5)(Understand/LOCQ)]

**(6 + 2) + 4 = 12**

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| Cognition Level | LOCQ | IOCQ | HOCQ |
|---|---|---|---|
| Percentage distribution | 44.79 | 17.71 | 37.50 |

**Course Outcome (CO):**

After the completion of the course students will be able to

1. Demonstrate how the worst-case time complexity of an algorithm is defined and compare the efficiency of algorithms using asymptotic complexity;
2. Argue the correctness of algorithms using inductive proofs and invariants.
3. Explain the major graph algorithms and their analyses. Employ graphs to model engineering problems, when appropriate. Synthesize new graph algorithms and algorithms that employ graph computations as key components, and analyze them.
4. Describe the (divide-and-conquer, Dynamic programming and Greedy) paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize the above algorithms and analyze them.
5. Explain what amortized running time is and what it is good for. Explain what an approximation algorithm is, and the benefit of using approximation algorithms.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question