

**DESIGN AND ANALYSIS OF ALGORITHMS
(CBS2201)**

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

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

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) What is the worst-case space complexity of quicksort?
(a) $O(1)$ (b) $O(\log n)$
(c) $O(n)$ (d) $O(n \log n)$
- (ii) In heap sort, after deleting the last minimum element, the array will contain elements in?
(a) increasing sorting order (b) decreasing sorting order
(c) tree inorder (d) tree preorder
- (iii) Depth First Search is equivalent to which of the traversal in the Binary Trees?
(a) Pre-order Traversal (b) Post-order Traversal
(c) Level-order Traversal (d) In-order Traversal
- (iv) Which of the following statement about 0/1 knapsack and fractional knapsack problem is correct?
(a) In 0/1 knapsack problem items are divisible and in fractional knapsack items are indivisible
(b) Both are the same
(c) 0/1 knapsack is solved using a greedy algorithm and fractional knapsack is solved using dynamic programming
(d) In 0/1 knapsack problem items are indivisible and in fractional knapsack items are divisible
- (v) Which of the following in dynamic programming fit the complexity of $O(n^2)$?
(a) 0/1 Knapsack (b) Binary Search
(c) Traveling Salesperson (TSP) (d) Longest Common Subsequence (LCS)
- (vi) What is the Bellman-Ford algorithm used for in Dynamic Programming?
(a) Finding the shortest path in a weighted graph
(b) Finding the maximum flow in a network
(c) Solving the Matrix Chain Multiplication problem
(d) Solving the Longest Common Subsequence problem

- (vii) The complement of an NP-Complete problem is:
 (a) Always in NP (b) Always NP-Complete
 (c) Always in P (d) Always undecidable
- (viii) Which of the following is an example of a problem that can be solved using backtracking?
 (a) Matrix Chain Multiplication
 (b) Binary search in a sorted list
 (c) Sudoku puzzle solving
 (d) Implement the divide and conquer method
- (ix) Which data structure is most suitable for implementing best first branch and bound strategy?
 (a) stack (b) queue
 (c) priority queue (d) linked list
- (x) Which of the following problems is classified as NP-complete?
 (a) Sorting
 (b) 8-Queens problem
 (c) Traveling Salesman Problem (decision version)
 (d) Matrix multiplication

Fill in the blanks with the correct word

- (xi) The _____ algorithm is used to find the maximum flow in a flow network.
- (xii) _____ algorithm is used for solving the single-source shortest path problem in a graph with non-negative edge weights.
- (xiii) A problem is classified as _____ if its solution can be verified in polynomial time, but it is not known whether there exists a polynomial-time solution.
- (xiv) Prim's algorithm is used to find the _____ of a connected, weighted, undirected graph.
- (xv) If an algorithm is said to have $O(1)$ time complexity, it is said to run in _____ time, meaning its execution time does not depend on the size of the input.

Group - B

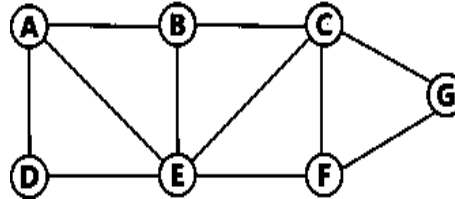
2. (a) Perform a step-by-step analysis to the calculate order of time complexity of the merge sort algorithm. [[C03](Understand/LOCQ)]
 (b) Perform a step-by-step analysis of the quick sort algorithm on the array [10, 80, 30, 90, 40, 50, 70]. What is the time complexity in the best, worst, and average case? [[C02](Remember/LOCQ)]
 (c) Explain stable and in-place sorting algorithm with example. [[C05] (Understand/LOCQ)]
5 + 4 + 3 = 12
3. (a) Solve the recurrence relation using Master Theorem $T(n) = 2T(n/4) + n^{0.51}$ [[C04](Analyse/IOCQ)]
 (b) Compare and contrast between Strassen's matrix multiplication method and standard matrix multiplication method using Divide & Conquer. [[C01](Analyse/IOCQ)]

- (c) Discuss the difference between Big O, Big Omega, and Big Theta with respect to algorithm analysis and their mathematical significance. [[CO2](Understand/LOCQ)]

4 + 4 + 4 = 12

Group - C

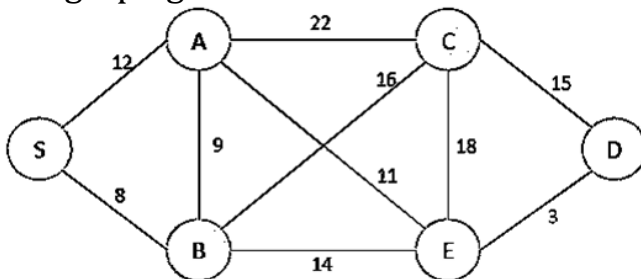
4. (a) Perform Heap Sort algorithm on the given array $L=\{81, 89, 9, 11, 14, 76, 54, 22\}$. Illustrate each step to create the MAX-Heap and then removing the elements repeatedly to finally get the sorted array. [[CO5](Understand/LOCQ)]
- (b) Traverse the following graph using BFS and DFS (show it's data structure updating in each step) where start node is 'A'.



[[CO6](Evaluate/HOCQ)]

6 + 6 = 12

5. (a) Explain every steps to find the minimum spanning tree using Prim's algorithm for the graph given below with S as the arbitrary root.



[[CO5](Evaluate/HOCQ)]

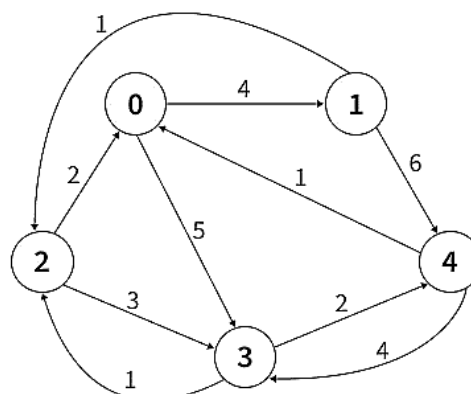
- (b) Prove that the time complexity of Dijkstra's algorithm for finding out the shortest path is $O(E \log V)$. How can it be modified to handle negative weight edges?

[[CO2](Understand/LOCQ)]

6 + (4 + 2) = 12

Group - D

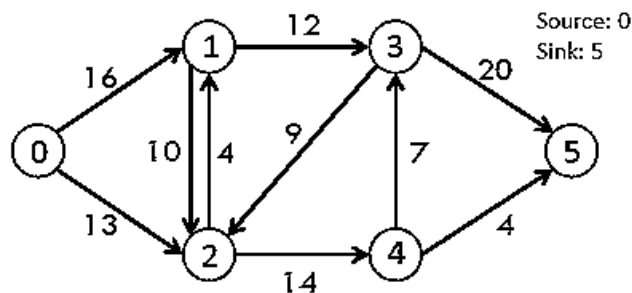
6. (a) Define Dynamic Programming? Describe the applications of Dynamic Programming. [[CO4](Understand/LOCQ)]
- (b) Consider the following graph and apply Floyd-Warshall algorithm to find out the shortest-path from source vertex s.



[[CO4](Remember/LOCQ)]

(3 + 3) + 6 = 12

7. (a) Find the maximum flow through the given network using Ford-Fulkerson algorithm. Consider Source = 0 and Sink = 5.



[[CO3](Evaluate/HOCQ)]

- (b) Explain the Matrix Chain Multiplication problem. How is it solved using Dynamic Programming?

[[CO5](Apply/IOCQ)]

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

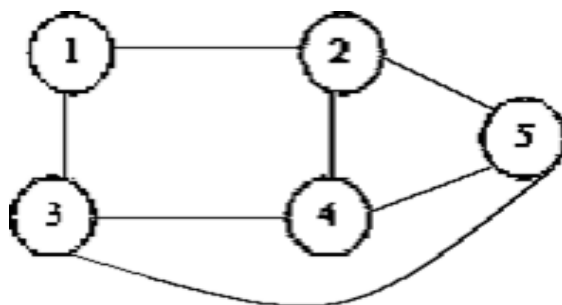
Group - E

8. (a) Explain with example of the basic method of backtracking? Explain how the concept of “backtracking” allows you to undo decisions and try alternative choices.

[[CO1](Remember/LOCQ)]

- (b) By considering the following graph shows all possible solutions of m-coloring using a state space tree.

[[CO3](Evaluate/HOCQ)]



$$(3 + 3) + 6 = 12$$

9. (a) Write a non-deterministic algorithm of clique decision problem.

[[CO4](Remember/LOCQ)]

- (b) Explain Polynomial-time approximation scheme (PTAS).

[[CO6](Remember/LOCQ)]

- (c) Explain the significance of SAT in NP-complete problem.

[[CO6](Remember/LOCQ)]

$$4 + 4 + 4 = 12$$

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	60.42	14.58	25