B.TECH/IT/5TH SEM/INFO 3103/2021

DESIGN & ANALYSIS OF ALGORITHMS
(INFO 3103)

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) Master's theorem is used for?
(a) Solving recurrences
(b) Solving iterative relations
(c) Analysing loops
(d) Calculating the time complexity of any code.

(ii) On which algorithm is heap sort based on?
(a) Fibonacci heap (b) Binary tree (c) Priority queue (d) FIFO

(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) Consider a binary max-heap implemented using an array. Which one of the following array represents a binary max-heap?
(a) 25, 14, 16, 13, 10, 8, 12 (b) 25, 12, 16, 13, 10, 8, 14
(c) 25, 14, 12, 13, 10, 8, 16 (d) 25, 14, 13, 16, 10, 8, 12

(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) Match the following:

Group A	Group B
(a) Dijkstra's single shortest path algorithm	(p) Dynamic Programming
(b) Bellmen Ford's single shortest path algorithm	(q) Backtracking
(c) Floyd Warshell's all pair shortest path algorithm	(r) Greedy Algorithm

(a) a-r, b-q, c-p (b) a-p, b-p, c-p
(c) a-r, b-p, c-p (d) a-p, b-r, c-q

(viii) Let S be an NP-complete problem and Q and R be two other problems not known to be in NP. Q is polynomial time reducible to S and S is polynomial-time reducible to R. Which one of the following statements is true?
(a) R is NP-complete (b) R is NP-hard
(c) Q is NP-complete (d) Q is NP-hard

(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 G
(c) It includes every vertex of 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) Using divide and conquer method solve the following set of unsorted elements using quicksort algorithm.

423 115 52 79 56 319 775 89

Also deduce the average case time complexity of the quicksort algorithm using backward substitution method. [(CO1) (CO2) (CO4) (Evaluate/HOCQ)]

(b) Deduce time complexity of the merge sort algorithm using recursion tree method. [(CO1) (CO2) (CO4) (Evaluate/HOCQ)]

(5 + 4) + 3 = 12

3. (a) State master's theorem and deduce the time complexity for the following recurrences using master's theorem:
(i) T(n) = 6T(n/4) + 2n
(ii) T(n)= 8T(n/2) + n^2. (CO1) (CO4) (Evaluate/HOCQ)]

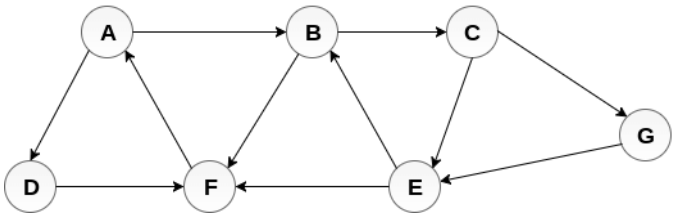
(b) Compare Strassen's Matrix multiplication method with conventional matrix multiplication method. [(CO2) (Analyze/IOCQ)]

(c) Deduce the time complexity for the following recurrence using recursion tree:
T(n) = 4T(n-2) + n. [(CO1) (CO4) (Evaluate/HOCQ)]

(2 + 2 + 2) + 3 + 3 = 12

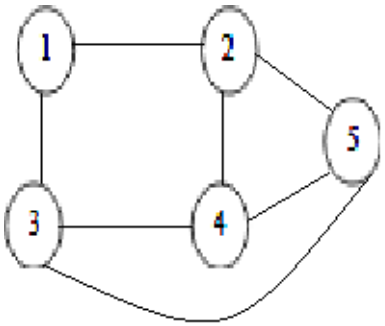
Group - C

4. (a) Compute the DFS tree of the given graph and show the discovery of each vertex and classify the edges where node B is the start vertex.



[(CO3) (Evaluate/HOCQ)]

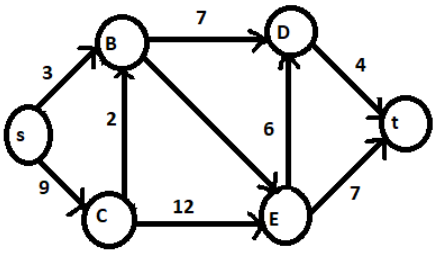
(b) By considering the following graph shows all possible solutions of m-coloring using a state space tree.



[(CO2) (CO3) (Understand/LOCQ)]

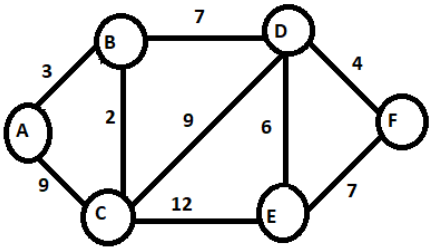
4 + 8 = 12

5. (a) Consider the following graph and find out the maximum flow using Ford-Fulkerson algorithm.



[(CO3) (Understand/LOCQ)]

(b) Find out the shortest path of the following graph using Bidirectional search where source node is A and target node is F.

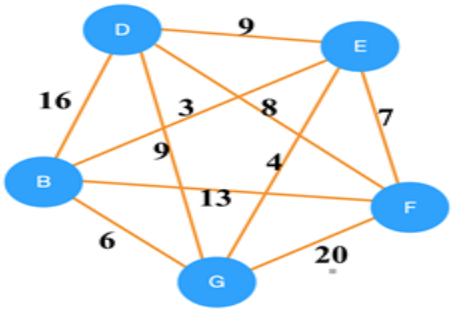


[(CO3) (Understand/LOCQ)]

8 + 4 = 12

Group - D

6. (a) Consider the following graph and apply Dijkstra algorithm using heap data structure to find out the shortest-path from source vertex B.

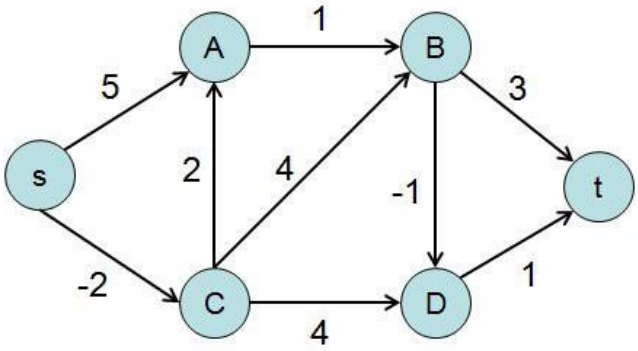


[(CO2) (CO3) (Understand/LOCQ)]

(b) Compare the algorithms that are used to solve the Single Source Shortest Path problem. [(CO2) (CO3) (Analyze/IOCQ)]

8 + 4 = 12

7. (a) Consider the following graph and apply Bellman-Ford algorithm to find out the shortest-path from source vertex s.



[(CO2) (CO3) Understand/LOCQ)]

(b) What is Spanning Tree? Compare the algorithms that are used to find the Minimum Cost Spanning Tree.

[(CO2) (CO3) (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 non-deterministic algorithm of clique decision problem.

[(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) Describe approximate algorithm for TSP & calculate its performance ratio.
[(CO6) (Evaluate/HOCQ)]

(b) Explain Branch and Bound method with an example.
[(CO2) (Understand/LOCQ)]
(6 + 2) + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	45.8%	19.8%	34.4%

Course Outcome (CO):

After the completion of the course students will be able to

1. Demonstrate how the time complexity of an algorithm is defined and analyze the asymptotic performance of algorithms.
2. Understand basic algorithm designing techniques such as divide and conquer, greedy, dynamic programming, branch and bound, backtracking and analyze them.
3. Explain the graph algorithms such as BFS, DFS, Ford Fulkerson Method, etc and analyze them.
4. Synthesize efficient algorithms in common engineering design situations.
5. Exploration of various research problems in algorithm like NP-hard and NP-complete problems.
6. 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

Department & Section	**Submission Link**
IT	https://classroom.google.com/c/NDA1MzIzMzczNjU3/a/NDYzNjcyNTM2MTg0/details