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) We use dynamic programming approach when
(a) it provides optimal solution
(b) the solution has optimal substructure
(c) the given problem can be reduced to the 3-SAT problem
(d) it's faster than Greedy.

(ii) What is the running time of the Floyd Warshall algorithm?
(a) O (V) (b) Θ (V^2) (c) O (VE) (d) Θ (V^3).

(iii) What happens when the value of k is 0 in the Floyd Warshall algorithm?
(a) 1 intermediate vertex (b) 0 intermediate vertex
(c) N intermediate vertices (d) N-1 intermediate vertices.

(iv) Heap sort is found to be very efficient
(a) with regard to storage requirement (b) in time consumption
(c) regarding overheads involved (d) none of the above.

(v) Which of the following is the most commonly used data structure for implementing Dijkstra's algorithm?
(a) Max priority queue (b) Stack
(c) Circular queue (d) Min priority queue.

(vi) Consider the following statements:
S1. Kruskal's algorithm might produce a non-minimal spanning tree.
S2. Kruskal's algorithm can efficiently implemented using the disjoint-set data structure.
(a) S1 is true but S2 is false (b) Both S1 and S2 are false
(c) Both S1 and S2 are true (d) S2 is true but S1 is false.

(vii) Recursion is a method in which the solution of a problem depends on _____
(a) larger instances of different problems
(b) larger instances of the same problem
(c) smaller instances of the same problem
(d) smaller instances of different problems.

(viii) A person wants to visit some places. He starts from a vertex and then wants to visit every vertex till it finishes from one vertex, backtracks and then explore other vertex from same vertex. What algorithm he should use?

(a) Depth first search (b) Breadth first search
(c) Trim's algorithm (d) Kruskal's algorithm.

(ix) In how many directions do Queens attack each other?

(a) 1 (b) 2 (c) 3 (d) 4.

(x) Consider the matrices P, Q and R which are 10 × 20, 20 × 30 and 30 × 40 matrices respectively. What is the minimum number of multiplications required to multiply the three matrices?

(a) 18000 (b) 12000 (c) 24000 (d) 32000.

Group - B

2. (a) Construct a MaxHeap using following set of elements.
23 15 52 97 51 39 77 99 42 76
Also write an algorithm of build MaxHeap.
[(CO1,CO2,CO4)(Evaluate/HOCQ)(Understand/LOCQ)]

(b) Deduce the time complexity for the following recurrences:
$T(n)= 7T(n/3) + n^2$ using backward substitution method.
[(CO1,CO4)(Evaluate/HOCQ)]

(c) Prove that $3n^2 + 2 \neq \Omega(n^3)$. [(CO1,CO4)(Evaluate/HOCQ)]

(3 + 5) + 2 + 2 = 12

3. (a) Using divide and conquer method, step wise solve the following set of unsorted elements using Merge sort algorithm:
213 112 502 109 62 331 75 119.
Also deduce the best case time complexity of the merge sort algorithm using recursion tree method. [(CO1,CO2,CO4)(Evaluate/HOCQ)]

(b) Deduce the average case time complexity of the quick sort algorithm method.
[(CO1,CO2,CO4)(Evaluate/HOCQ)]

(5 + 4) + 3 = 12

Group - C

4. (a) Using permutation tree explain the 4 Queens problem and find out the possible number of solutions. [(CO2,CO3)(Understand/LOCQ)]

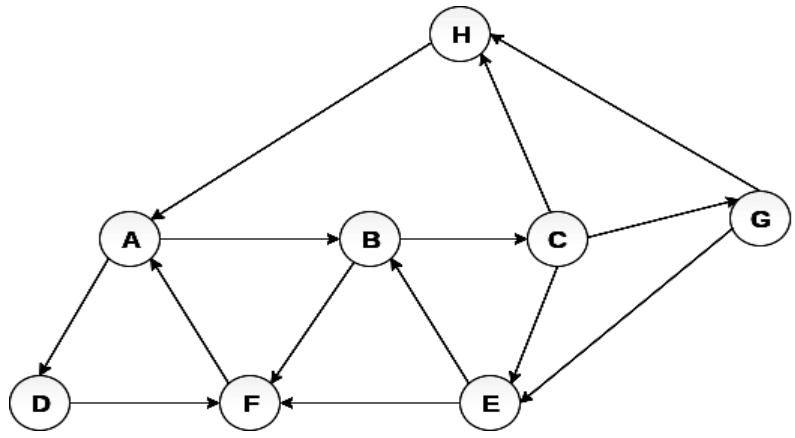
(b) Write an algorithm for finding the solution of a graph coloring problem.
[(CO3)(Understand/LOCQ)]

6 + 6 = 12

5. (a) Briefly explain the following: Residual networks, Augmenting path, Max-flow min-cuts theorem. [(CO3)(Understand/LOCQ)]

(b) Write the Ford Fulkerson algorithm. [(CO3)(Remember/LOCQ)]

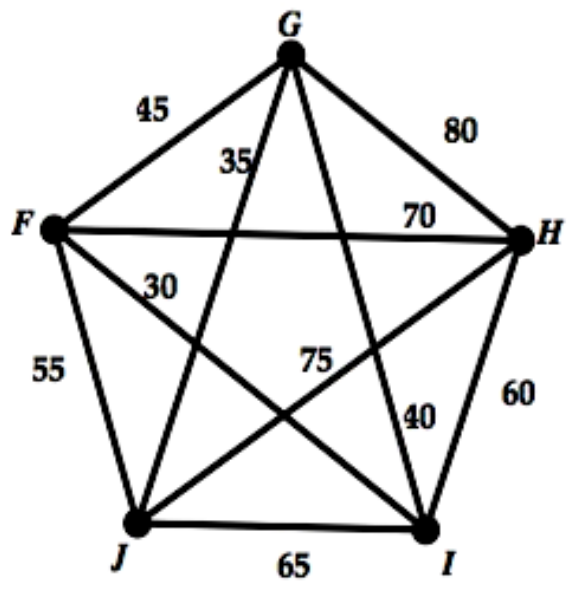
(c) Construct the BFS tree of the given graph and show the discovery of each vertex and classify the edges where node B is the start vertex.



[(CO3)(Evaluate/HOCQ)]
(3 × 2) + 3 + 3 = 12

Group - D

6. (a) Using dynamic programming solve the travelling salesman problem of the following graph:

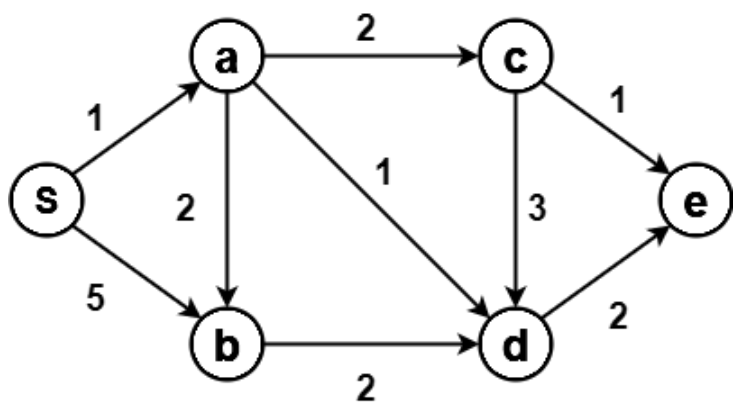


[(CO2)(CO3) (Analyze/IOCQ)]

(b) Write an algorithm of job sequencing with deadline and also find out the solution generated by this when n = 6, (p1, p2, p3, p4, p5, p6) = (30, 40, 20, 24, 22, 54) and (d1, d2, d3, d4, d5, d6) = (5, 1, 1, 2, 5, 2).
Explain each step of solution to process job. [(CO2)(Understand/LOCQ)]
6 + (3 + 3) = 12

7. (a) Write an algorithm of MATRIX-CHAIN-ORDER (p) and also write a recursive algorithm MATRIX-CHAIN-MULTIPLY(A, s, i, j) that actually performs the optimal matrix-chain multiplication, given the sequence of matrices (A1, A2,……..,An), the s table computed by MATRIX-CHAIN-ORDER, and the indices i and j . (The initial call would be MATRIX-CHAIN-MULTIPLY(A, s, 1, n)). [(CO2,CO3)(Understand/LOCQ)]

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



[(CO2) (CO3) (Understand/LOCQ)]
(4 + 2) + 6 = 12

Group - E

8. (a) Explain how you attempt to solve 15-puzzle problem using branch and bound strategy. Draw a portion of the state space generated by it. [(CO2,CO3)(Evaluate/HOCQ)]

   (b) Prove that CDP (Clique Decision Problem) is NP-complete. [(CO5)(Analyze/IOCQ)]

7 + 5 = 12

9. (a) What is polynomial reduction? [(CO6)(Understand/LOCQ)]

   (b) What is Cook's theorem? Draw a diagram depicting the relationship between P, NP, NP-hard and NP-complete. [(CO5)(Understand/LOCQ)]

   (c) What do you mean by *f*(n) - polynomial time approximation algorithm? Describe approximation algorithm for TSP. [(CO6)(Understand/IOCQ)]

2 + (2 + 2) + (2 + 4) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	55.21	17.71	27.08

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