DESIGN & ANALYSIS OF ALGORITHMS
(INFO 2203)

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) Which of the following is true?
(a) Prim's algorithm initialises with a vertex
(b) Prim's algorithm initialises with an edge
(c) Prim's algorithm initialises with a vertex which has smallest edge
(d) Prim's algorithm initialises with a forest.

(ii) In n-queen problem, how many values of n does not provide an optimal solution?
(a) 1 (b) 2 (c) 3 (d) 4.

(iii) Consider the matrices P, Q and R which are 10 x 20, 20 x 30 and 30 x 40 matrices respectively. What is the minimum number of multiplications required to multiply the three matrices?
(a) 18000 (b) 12000 (c) 24000 (d) 32000.

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

(v) 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.

(vi) In what time can a binary heap be built?
(a) O(N) (b) O(N log N) (c) O(log N) (d) $O(N^2)$

(vii) 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.

(viii) To which of the following class does a CNF-satisfiability problem belong?
(a) NP class (b) P class
(c) NP complete (d) NP hard.

(ix) What is the condition for proper coloring of a graph?
(a) Two vertices having a common edge should not have same color
(b) Two vertices having a common edge should always have same color
(c) All vertices should have a different color
(d) All vertices should have same color.

(x) How many solution/solutions are available for a graph having negative weight cycle?
(a) One solution (b) Two solutions
(c) No solution (d) Infinite solutions.

Fill in the blanks with the correct word

(xi) The main time taking step in fractional knapsack problem is _____

(xii) In dynamic programming, the technique of storing the previously calculated values is called_____.

(xiii) Strassen's matrix multiplication algorithm follows _____ technique.

(xiv) _____ is the class of decision problems that can be solved by non-deterministic polynomial algorithms.

(xv) Dijkstra's Algorithm is the prime example for _____ method.

Group - B

2. (a) Write an algorithm of binary search of unsorted inputs and print the index of the searching element with respect to unsorted inputs order. Deduce it's time complexity. *[(CO1)(CO2)(CO4)(Understand/LOCQ)(Analyse/IOCQ)]*

(b) Compare between Merge sort and Quick sort with respect to the time complexities. *[(CO2)(Analyse/IOCQ)]*

(c) Construct a MaxHeap using following set of elements and deduce it's time complexity.
52 25 50 88 24 33 99 36 90 *[(CO1)(CO3)(CO4)(Understand/LOCQ)(Apply/IOCQ)]*

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

3. (a) Write an algorithm of Priority Queue and deduce it's time complexity.
[(CO1)(Understand/LOCQ)(Analyse/IOCQ)]

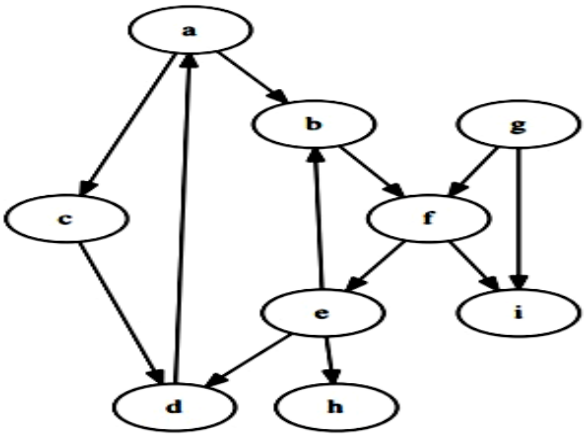
(b) Explain Union-Find algorithm with an example. *[(CO4)(Understand/LOCQ)]*

(c) Prove that the lower bound for any comparison sort algorithm is O(nlgn).
[(CO1)(Understand/LOCQ)]

(3 + 2) + 3 + 4 = 12

Group - C

4. (a) Traverse the following graph using BFS and DFS(show it's data structure updating in each step) where start node is 'b'. *[(CO3)(Apply/IOCQ)]*



(b) Write an algorithm for n queens problem. *[(CO2)(Understand/LOCQ)]*

(c) Explain Max-Flow Min-Cuts theorem. *[(CO3)(Understand/LOCQ)]*

(3 + 3) + 3 + 3 = 12

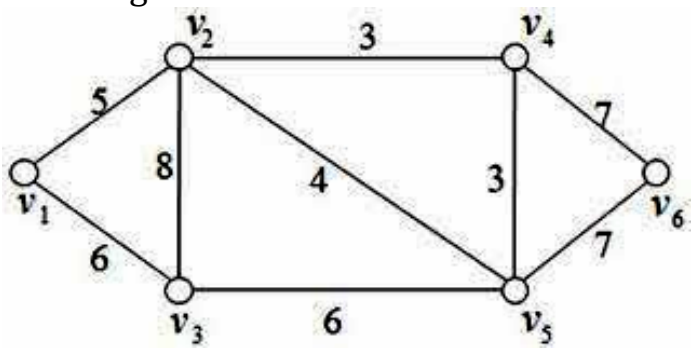
5. (a) Using backtracking method write an algorithm for graph coloring problem. Comment about the time complexity of this algorithm. *[(CO2)(Understand/LOCQ)]*

(b) Explain with an example the Ford-Fulkerson algorithm. *[(CO3)(Understand/LOCQ)]*

(5 + 2) + 5 = 12

Group - D

6. (a) Find the minimum spanning tree of the following graph using Prim's (solve using heap data structure where start node is 'v_2') and Kruskal algorithm. Compare both the algorithms. *[(CO2)(CO3)(Apply/IOCQ)]*



(b) Write a Bellman-Ford algorithm to solve single source shortest path problem using dynamic programming. *[(CO2)(Understand/LOCQ)]*

(5 + 3) + 4 = 12

7. (a) Given the weight vector (4,2,3,4,6,2,2) and the profit vector (15,12,9,15,8,11,10) and a knapsack of capacity 16, find at least two feasible solution including optimal one for the knapsack problem of seven object. *[(CO2)(CO4)(Analyse/IOCQ)]*

(b) Deduce the time complexity of Matrix-chain multiplication algorithm. *[(CO1)(CO2)(Analyse/IOCQ)]*

(c) Write a Floyd-Warshall algorithm to solve all pairs shortest path problem using dynamic programming. *[(CO2)(Understand/LOCQ)]*

6 + 3 + 3 = 12

Group - E

8. (a) Write a non-deterministic algorithm of satisfiability problem and deduce it's time complexity. *[(CO1)(CO5)(CO6)(Understand/LOCQ)(Apply/IOCQ)]*

(b) Compare between P and NP class of problems. *[(CO5)(Apply/IOCQ)]*

(c) "All NP complete problems are NP hard but the reverse is not true" — Justify. *[(CO5)(Evaluate/HOCQ)]*

(4 + 1) + 3 + 4 = 12

9. (a) Explain the necessity of approximation scheme. *[(CO6)(Understand/LOCQ)]*

(b) Apply branch and bound method to solve the 15 puzzle problem. *[(CO2)(Understand/LOCQ)]*

(c) Prove that clique decision problem is NP complete. *[(CO5)(Evaluate/HOCQ)]*

3 + 4 + 5 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	40.63	50	9.37

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.*