DESIGN AND ANALYSIS OF ALGORITHMS
(INF2202)

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) 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) 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) Prim's algorithm (d) Kruskal's Algorithm

(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) Which of the following condition is sufficient to detect cycle in a directed graph?
(a) There is an edge from currently being visited node to an already visited node.
(b) There is an edge from currently being visited node to an ancestor of currently visited node in DFS forest.
(c) Every node is seen twice in DFS.
(d) None of the above

(vi) 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

(vii) 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.

(viii) 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

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

(x) Travelling sales man problem belongs to which of the class?
(a) P (b) NP (c) Linear (d) None of the mentioned

Fill in the blanks with the correct word

(xi) The average running time of a quick sort algorithm is _____.

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

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

(xiv) A major difference between dynamic programming and divide and conquer is that dynamic programming
solves overlapping _____.

(xv) Kruskal's algorithm uses a _____ data structure to check for cycles and manage the connected components.

Group - B

2. (a) Deduce the time complexity for the following recurrences using master theorem:
(i) $T(n) = 4T(n/3) + \log n$
(ii) $T(n)= 7T(n/3) + n^2$

[(CO1) (CO4) (Evaluate/HOCQ)]

(b) Deduce the time complexity of Binary Search. *[(CO1, CO4) (Evaluate/HOCQ)]*

(c) Derive the lower bound for comparison sort is O(nlgn).

[(CO3) (Evaluate/HOCQ)]

(3 + 3) + 3 + 3 = 12

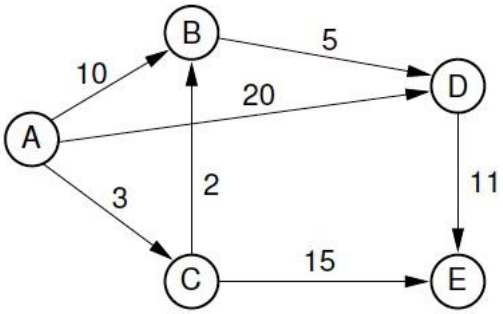
3. (a) What is heap? Write an algorithm of Priority Queue and deduce it's time complexity. *[(CO1) (Understand/LOCQ) (Analyse/IOCQ)]*

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

(1 + 4 + 3) + 4 = 12

Group - C

4. (a) Consider the following flow graph and find out the maximum flow using Ford-Fulkerson algorithm where source node is A and sink node is E.

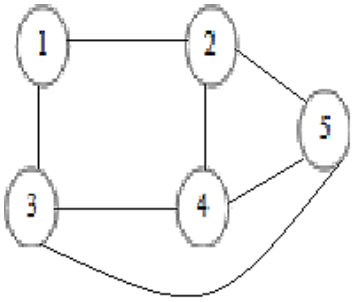


[(CO3)(Understand/LOCQ)]

(b) Compare between BFS and DFS. *[(CO3) (Analyze/IOCQ)]*

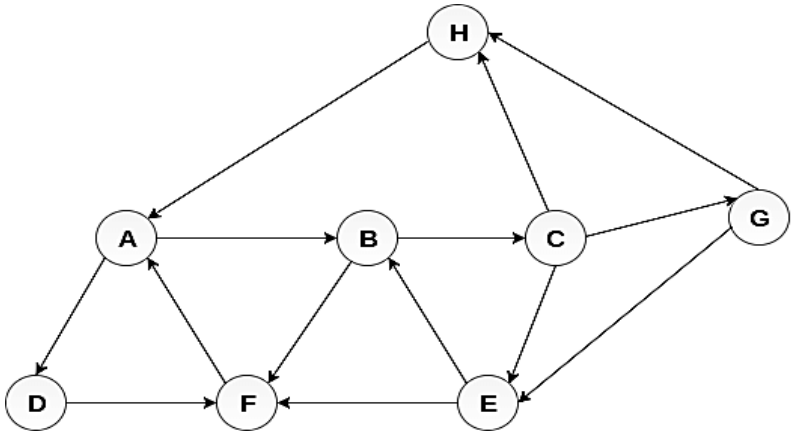
9 + 3 = 12

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



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

(b) Construct 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.

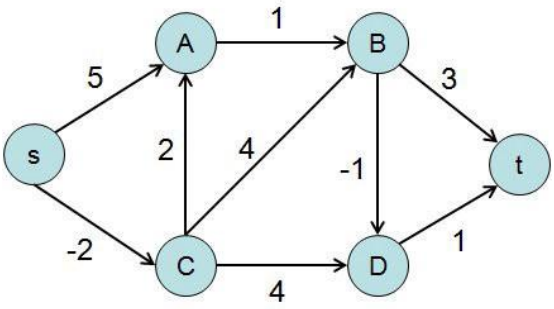


[(CO3) (Evaluate/HOCQ)]

8 + 4 = 12

Group - D

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

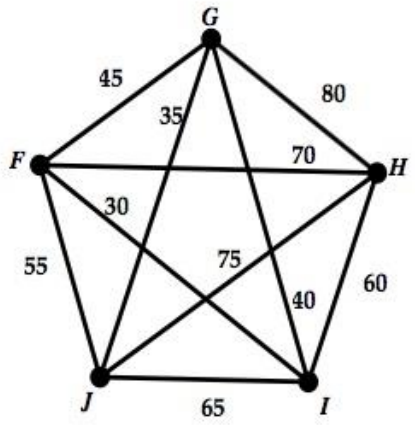


[(CO2) (CO3) Understand/LOCQ)]

(b) Why does Dijkstra's algorithm fail on negative weight? Explain with an example.
[(CO2) (CO3) (Analyze/IOCQ)]

8 + 4 = 12

7. (a) Using Dynamic Programming solve the Travelling Salesman Problem of the following graph



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

(b) Compare the algorithms that were used to find the minimum spanning tree.
[(CO2) (CO3) (Analyze/IOCQ)]

8 + 4 = 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) What is Polynomial Reduction? *[(CO5)(Understand/LOCQ)]*

6 + 4 + 2 = 12

9. (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) What is NP class? *[(CO6)(Understand/LOCQ)]*

10 + 2 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	26.04	46.88	27.08