(vii) Let G be an undirected graph. Consider a depth-first traversal of G, and let T be the resulting depth-first search tree. Let u be a vertex in G and let v be the first new (unvisited) vertex visited after visiting u in the traversal. Which of the following statements is always true?
(a) {u,v} must be an edge in G, and u is a descendant of v in T
(b) {u,v} must be an edge in G, and v is a descendant of u in T
(c) If {u,v} is not an edge in G then u is a leaf in T
(d) If {u,v} is not an edge in G then u and v must have the same parent in T.

(viii) The travelling salesman problem can be solved in:
(a) polynomial time using dynamic programming algorithm
(b) polynomial time using branch-and-bound algorithm
(c) exponential time using dynamic programming algorithm or branch-and-bound algorithm
(d) polynomial time using backtracking algorithm.

(ix) If a problem can be broken into subproblems which are reused several times, the problem possesses _____ property.
(a) overlapping subproblems
(b) optimal substructure
(c) memorization
(d) greedy.

(x) Which of the following is true about NP-Complete and NP-Hard problems?
(a) If we want to prove that a problem X is NP-Hard, we take a known NP-Hard problem Y and reduce Y to X.
(b) The first problem that was proved as NP-complete was the circuit satisfiability problem.
(c) NP-complete is a subset of NP Hard
(d) all of the above.

Group – B

2. (a) Write an Union-Find algorithm to detect a cycle in an undirected graph and deduce its time complexity.

(b) An algorithm with time complexity O(f(n)) and processing time T(n) = cf(n), where f(n) is a known function of n, spends 10 seconds to process 1000 data items. How much time will be spent to process 100,000 data items if f(n) = n and f(n) = n^3 ?

(c) Solve the following recurrence relations using masters theorem:
i) $T(n)=4T(n/2)+n^3$
ii) $T(n)=2T(n/2)+n\log n$
iii) $T(n)=5T(n/2)+n$

(2 + 2) + 2 + (3 × 2) = 12

3.(a) Write an algorithm to implement priority queue using heap. What will be the time complexity to build a head?

(b) A pair contains two numbers, and its second number is on the right side of the first one in an array. The difference of a pair is the minus result while subtracting the second number from the first one. Using the concept of divide and conquer method find the maximal difference of all pairs in an array.

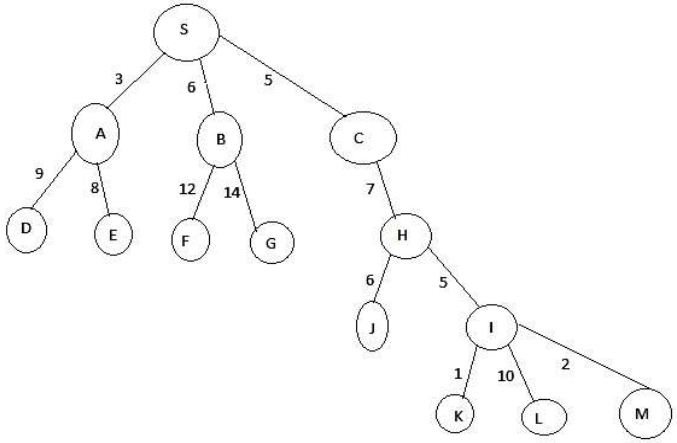
(6 + 2) + 4 = 12

Group – C

4.(a) Write an algorithm to find a path between two vertices in a directed graph using Depth First Search.

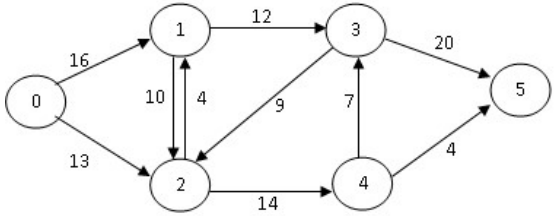
(b) Deduce the time complexity of nQueens problem.

(c) Explain Best First Search using priority queue of the following graph, considering node S as start node:



5 + 2 + 5= 12

5.(a) State and explain Max-Flow-Min-Cut Theorem.



(b) Considering the above mentioned graph, find the maximum flow between 0 and 5 using Ford-Fulkerson algorithm. Find out the time complexity of this algorithm.

(c) Using bidirectional search find out the smallest path from source to terminal vertex of the following undirected graph (adjacency matrix given):

i/j	A	B	C	D	E	F
A	0	4	2	0	0	0
B	4	0	1	5	0	0
C	2	1	0	8	10	0
D	0	5	8	0	2	6
E	0	0	10	2	0	3
F	0	0	0	6	3	0

2 + (4 + 2) + 4 = 12

Group – D

6. (a) Find out minimal spanning tree using Prims' algorithm of the following graph (adjacency matrix given). Show step by step solution using min heap. Consider node 1 as a first node.

i/j	1	2	3	4	5
1	0	2	2	3	0
2	2	0	2	0	2
3	2	2	0	3	4
4	3	0	3	0	1
5	0	2	4	1	0

(b) Find an optimal parenthesization of a matrix-chain product whose sequence of dimensions is {20, 10, 30, 35, 25}.

4 + 8 = 12

7.(a) Using greedy method write an algorithm of fractional Knapsack problem to find out three feasible solutions (with respect to minimum weight, maximum profit, maximum profit per unit weight).

(b) Explain with an example how negative edge cycle can be detected by Bellman-Ford algorithm. Deduce its time complexity.

6 + (4 + 2) = 12

Group – E

8. (a) What is the difference between deterministic and non deterministic algorithm?

(b) Write a non deterministic algorithm to search an element X on A[1:n] where n>=1.

(c) Show that 2SAT is in P but 3SAT is NP-complete.

3 + 4 + 5= 12

9. (a) Describe circuit satisfiability problem.

(b) Prove that clique decision problem is NP-complete.

(c) Write a short note on approximation schemes.

3 + 5 + 4 = 12

B.TECH/IT/4TH SEM/INFO 2202/2019
DESIGN & ANALYSIS OF ALGORITHM
(INFO 2202)

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) The complexity of adding two matrices of order m*n is _____.
(a) mn (b) m + n (c) max(m , n) (d) min(m , n).

(ii) Given an array arr = {45,77,89,90,94,99,100} and key = 100; using Binary Search, what are the mid values(corresponding array elements) generated in the first and second iterations?
(a) 90 and 99
(b) 90 and 100
(c) 89 and 94
(d) 94 and 99.

(iii) The time factor, when determining the efficiency of an algorithm, is measured by
(a) counting microseconds
(b) counting the number of key operations
(c) counting the number of statements
(d) counting the kilobytes of algorithm.

(iv) For merging two sorted lists of sizes m and n into a sorted list of size m + n, requires _____ number of comparisons.
(a) O(m) (b) O(n) (c) O(m+n) (d) O(log m + log n).

(v) The time complexity for Strassen's matrix multiplication is _____.
(a) $O(n^2)$ (b)$O(n^3)$ (c) $O(n^{2.31})$ (d)$O(n^{2.81})$.

(vi) f(n)=Θ(g(n)) if and only if g(n)=Θ(f(n)) denotes_____ property.
(a) transitivity (b) symmetry
(c) transpose symmetry (d) reflexivity.