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ODD SEMESTER

B.Tech

END TERM EXAMINATION *Dec-2025*

COURSE CODE-CS205

COURSE TITLE- Design & Analysis of Algorithms

Time: 03:00 Hours *Max. Marks: 50*

Note :1. Q.no. 1 is **Compulsory**. Answer ***any Four*** Questions from the rest.
2. Assume suitable missing data, if any.
3. Where an algorithm is asked, provide pseudocode (including brief explanatory comment lines). Do not express the answer in paragraph form.

Q.1 (a) A priority queue is implemented using a min-heap. Consider the following sequence of operations performed on the min-heap, initially heap is empty: Insert(15), Insert(8), Insert(12), DeleteMin, Insert(5), Insert(20), and DeleteMin. Trace these operations step-by-step and show the resulting heap configuration after each operation is performed. [2M][CO2][BT3]

(b) Define optimal substructure. Why is it essential for dynamic programming? [2M][CO4][BT3]

(c) Does prims algorithm for finding minimum spanning tree will work if there are negative edge weights, give reasons. [2M][CO3][BT3]

(d) Give an example of directed weighted graph with negative-edge weight for which Dijkstra shortest path algorithm produces incorrect results. [2M][CO3][BT4]

(e) Solve the following recurrence relation using suitable method
$T(n) = 2T(n^{1/2}) + \log n$ [2M][CO1][BT4]

Q2 (a) Tower of Hanoi is a mathematical puzzle where we have three rods - S (source), D (destination) and T (temporary) and n disks. Initially, all the disks are stacked in decreasing value of diameter i.e., the smallest disk is placed on the top and they are on rod S. The objective is to move the entire stack to another rod (here considered D), obeying the following simple rules:

- Only one disk can be moved at a time.
- Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e. a disk can only be moved if it is the uppermost disk on a stack.
- No disk may be placed on top of a smaller disk.

Answer the following questions:

i) Write a recursive code to move all n disks from S (source) to D (destination).

ii) Write the recurrence relation for the recursive code and solve it. Discuss the time complexity for Tower of Hanoi.

iii) How many moves are required to move n disks from S (source) to D (destination). [6M][CO2][BTL3]

(b) Given a list of activities along with the starting ad finishing time:

Activity	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Start	1	2	3	4	7	8	9	9	11	12
Finish	3	5	4	7	10	9	11	13	12	14

Compute a schedule using greedy strategy where the largest number of activities takes place. The next activity can only be selected when previous chosen activity has completed and at a time only one activity can be executed. [4M][CO3][BTL3]

Q3. (a) Consider the following instance of 0/1 knapsack problem using DP: n=5, with capacity C=15, you are given the following items along with profits and weight.

Item	1	2	3	4	5
Profit	12	10	20	22	25
Weight	3	4	7	8	9

Build the complete DP table and find the maximum achievable value along with the set of items included. [7M][CO4][BTL4]

(b) Consider a complete weighted graph with 100 vertices, vertices are denoted as V_0, V_1, V_2,.....V_{99}. Cost of an edge between vertex V_i and V_j is $|V_i - V_j|$. Find the cost of **maximum spanning tree** possible from the graph. [3M][CO3][BTL4]

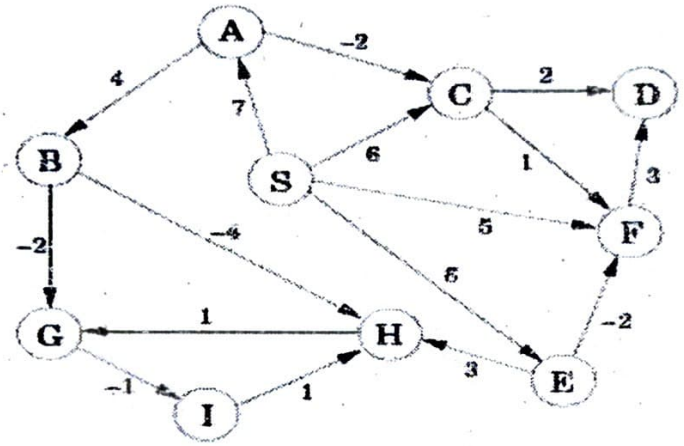
Q4. (a) Given two sequences X= "AABCDAB" and Y = "BABCAAB". Find the length of longest common subsequence using Dynamic Programming and print the elements. Construct the complete DP table and show all steps involved.

[7M][CO3][BTL4]

(b) Using divide and conquer approach, write a recursive function to find the maximum and minimum elements of a set containing 2^n elements. Also write the recurrence relation for the same.

[3M][CO4][BTL4]

Q5 (a) Perform Bellman Ford Shortest Path Algorithm on the following graph assuming S as the source vertex. Draw a table showing the intermediate distance values of all the nodes at each iteration of the algorithm and show the final shortest-path tree. [8M][CO3][BTL4]



(b) Consider a max heap of size n. Provide an efficient algorithm to find the kth largest element in the heap where k is a constant. What is the time complexity of suggested algorithm? [2M] [CO2][BTL4]

Q6 (a) Write the backtracking algorithm for solving the Subset Sum problem, which finds all subsets of a given set whose sum equals a specified target value. Given a set of integers $S = \{5,7,10,12,15,18,20\}$ and a target sum $M = 35$, apply the backtracking technique to determine all possible subsets of S whose elements add up exactly to the target value. The task involves systematically exploring all combinations of the given numbers, using backtracking to prune infeasible paths and identify only those subsets whose total sum equals 35. Present all valid subsets that satisfy this condition and describe how backtracking is used to reach the solution. [3+5=8M][CO5][BTL4]

(b) Given six symbols A, B, C, D, E, and F with probabilities 0.30, 0.25, 0.20, 0.10, 0.10, and 0.05 respectively. Using the Huffman coding technique, construct the corresponding Huffman tree and assign binary codes to each symbol. [2M][CO3][BT2]