V/D/TZ

Reg. No:

Final Assessment Test - April 2026

VIT
Vellore Institute of Technology

Course: **BCSE204L - Design and Analysis of Algorithms**

Class NBR(s): **3560/3584/3586** Slot: **A2+TA2**

Time: **Three Hours** Max. Marks: **100**

- **KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE**
- **DON'T WRITE ANYTHING ON THE QUESTION PAPER**

COs	CO Statements
CO1	Apply the mathematical tools to analyze and derive the running time of the algorithms.
CO2	Demonstrate the major algorithm design paradigms.
CO3	Explain major graph algorithms, string matching and geometric algorithms along with their analysis.
CO4	Articulating Randomized Algorithms.
CO5	Explain the hardness of real-world problems with respect to algorithmic efficiency and learning to cope with it.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions

(10 X 10 = 100 Marks)

1. a) Design a Huffman Code for the following set of frequencies: **[5] CO1 BL3**

a:20, b:12, c:8, d:30, e:5, f:7

Show the step-by-step construction of the Huffman Tree. What is the total cost (total number of bits) required to encode the string "abcdef" using your generated codes?

Design the pseudocode for the Huffman Code algorithm and describe its significance of being a "prefix code"?

b) Solve the following recurrence relations and find the time complexity for the following using master method. **[5]**

i) T(n) = 3T(n/3) + O (n^ {1/2})

ii) T(n) = 4T(n/2) + n^2

2. Using the Karatsuba algorithm for fast integer multiplication, compute the product: **CO1 BL4**

$$1234 \times 4321$$

Show the recursive decomposition step-by-step (splitting the numbers into high and low parts). Write the pseudocode of the algorithm and demonstrate how it reduces the number of multiplications compared to the traditional method.

3. A treasure hunter discovers 6 valuable items in an ancient tomb. He has a backpack with maximum capacity of W = 18 kg. The items have the following properties: CO2 BL3

Item	1	2	3	4	5	6
Profit (in ₹1000)	25	30	15	40	20	35
Weight (in kg)	5	8	3	10	6	7

Using the Dynamic Programming (DP) approach for 0/1 Knapsack, construct the complete DP table and determine the optimal solution.

4. Find the optimal parenthesization and minimum number of scalar multiplications for multiplying the following chain of matrices: CO2 BL4

Matrix	A_1	A_2	A_3	A_4	A_5
Dimensions	5×4	4×6	6×2	2×7	7×3

Let the dimensions be represented as: p = [5, 4, 6, 2, 7, 3] where matrix A_i has dimensions $p_{i-1} \times p_i$. Construct the cost table (m[i][j]) showing minimum multiplications for each subsequence. Construct the split table (s[i][j]) showing the optimal split point k for each subsequence. Write the optimal parenthesization using the split table. Project the minimum number of scalar multiplications required. Compare the Time Complexity with Brute Force approach.

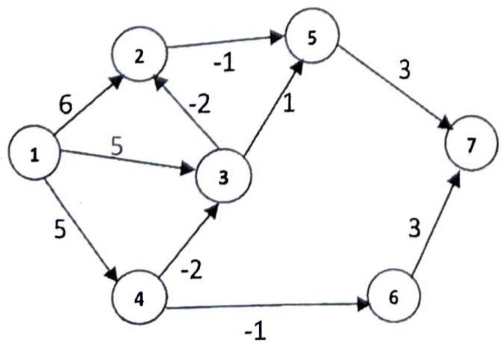
5. Given: Pattern P="ABABACABA" CO3 BL3

Text: T="ABABABACABABACABA"

Construct the LPS (Longest Prefix Suffix) array step by step. Show how Knuth-Morris-Pratt (KMP) avoids redundant comparisons during mismatch. Trace the complete matching process.

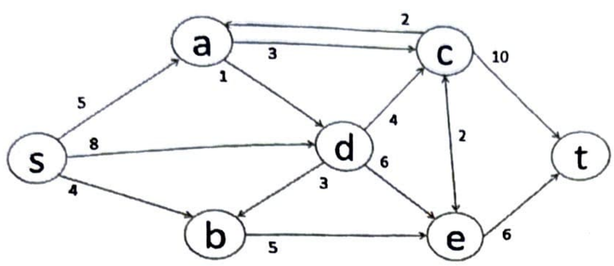
Express the number of comparisons with the naïve method for this example and prove that KMP runs in O(n+m) time.

6. Given Vertices: {1, 2, 3, 4, 5, 6, 7}. Edges with weights: CO3 BL3



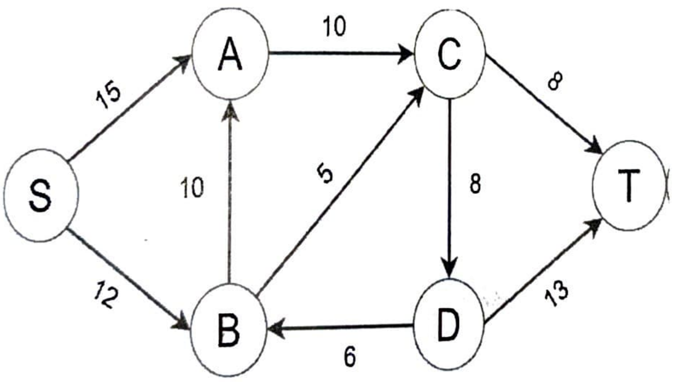
Apply Bellman–Ford (BF) starting from source vertex 1. Show all the relaxation steps (iteration-wise table). Illustrate the tracing of the algorithm on the given directed graph. Explain how Bellman–Ford works correctly even in the presence of negative edges whereas Dijkstra's algorithm fails and give the time complexity of the Bellman–Ford (BF).

7.(a) Deduce the maximum flow for the network given below by using an approach which allows an intermediate node to store the excess flow locally. The flow starts from the source, s, ends in the sink, t, and the values on the edges represent the corresponding edge capacities. Illustrate the tracing of the algorithm with time complexity. **CO3 BL3**



OR

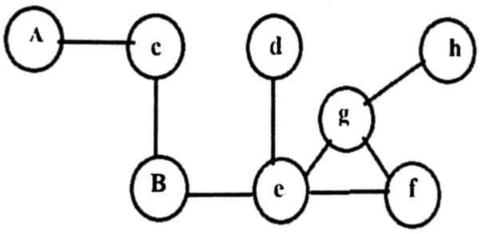
7.(b) Use the Edmonds – Karp algorithm to determine the maximum flow possible in the given flow network. Illustrate the tracing of the algorithm with suitable diagram, and compare with Ford Fulkerson algorithm in terms of time complexity. **CO3 BL3**



8. In the field of robotics, path planning algorithms are crucial for robots to navigate their environment efficiently. Imagine a robot vacuum cleaner that needs to clean the edges of a room. How can the Graham Scan algorithm be used to determine the most efficient cleaning path along the room's perimeter. The coordinates given for this problem are: **CO3 BL4**

{(-3 -4), (2 -3), (4 3), (-4 2), (0 5), (2 -3), (-1 4)}.

9.a)	Consider the undirected, unweighted graph G = (V, E). Use Karger's Algorithm to find a Global Minimum Cut. Graph Details: V = {1, 2, 3, 4} E = {(1,2), (2,3), (3,4), (4,1), (2,4)} Define the operation of Edge Contraction. Show a step-by-step trace of the algorithm by randomly picking edges until only two nodes remain. Identify the resulting cut and state the success probability for this specific graph.	CO4	BL5
	OR		
9.b)	Write the pseudo code for solving hiring problem. Consider the cost to interview as ci per candidate and the cost to hire the candidate is 'ch'. Analyse the performance and prove that when the 'n' candidates are presented in random order, then algorithm Hire-Assistant has a hiring cost of O(ch In n).	CO4	BL5
10.	Provide a summarized explanation of the Vertex Cover Problem, its computational complexity, and its significance in real-world applications. Discuss why it is classified as NP-complete and demonstrate the proof that Vertex Cover has a 2-approximation algorithm, outlining the key steps involved in the approximation technique. Obtain a vertex cover for the following graph.	CO5	BL2



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