Ex/IT/PC/B/T/321/2025

B.E. INFORMATION TECHNOLOGY THIRD YEAR SECOND SEMESTER EXAM 2025

DESIGN & ANALYSIS OF ALGORITHM

Time: Three Hours **Full Marks: 100**

1. CO1 (12): a. Given a min heap of n elements. Write an efficient algorithm to find the number of leaf nodes of the heap. Compute complexity of your algorithm. (4+2)

b. Compute time complexity of the given recurrence relations. (3+3)

a) $T(n) = 3T(n/2) + n^2$

b) $T(n) = 8T(n/2) + n\log_2 n$

2. CO2 (10): a. Explain a case with an example when Best case and Worst case time complexities of an algorithm are the same. (5)

b. What do you understand by amortized analysis? Explain with an example. (5)

3. CO3 (38):

a. Write an efficient algorithm to find the 16^{th} largest number from a set of 60 numbers. Compute complexity of your algorithms. (8+2)

OR

Write and Explain a Dynamic Programming for creating Fibonacci Series. (10)

b. Let L be a string aabbaabbababa. Check if there is a substring baba in L. Compute Complexity (8+2)

OR

Write an efficient algorithm to find the maximum difference between any two elements of a given array of n numbers (not necessarily distinct) in O(n) time. (10)

[Turn over

c. Write the Huffman's Algorithm. Construct the Huffman's tree for the following data and obtain its Huffman's Code. (3+5+2)

Character	A	B	C	D	E	-
probability	0.5	0.35	0.5	0.1	0.4	0.2

OR

Let us consider that the capacity of the knapsack (bag) W = 60 and the list of items are shown in the following table – Give the optimal Knapsack with computed profit. (10)

Item	A	B	C	D
Profit	281	101	121	121
Weight	40	10	20	24

d. Give solutions to 5 -queen problem. (8)

OR

What is the significance of path compression in the Union Find Problem? Explain with an example. (8)

4. CO4 (20): a. Illustrate a stable sort on the array 45, 33, 24, 45, 12, 12 ,24, 12}. How many comparisons are performed by the algorithm? (4+2)

OR

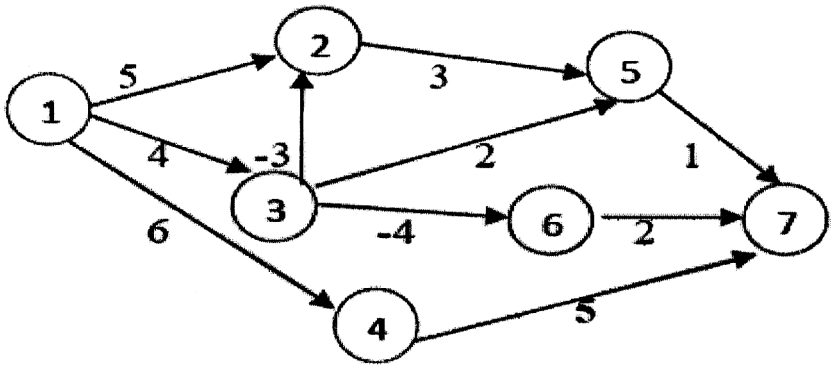
Write and justify a divide and conquer method to find a minimum and maximum numbers from a set of n elements. Compute Complexity. (6)

b. Let A[1..60] = 11, 12,..., 70. How many comparisons are performed by algorithm binary search when searching for the following values of x?

(i) 33. (ii) 71. (2+2)

c. Given L1 (List of k1 numbers in ascending order), L2 (List of k2 numbers in descending order), L3 (List of k3 numbers in ascending order), L4 (List of k4 numbers in descending order). Write an efficient algorithm to create a list of all these numbers arranged in descending order. Compute complexity of your algorithm. (10)

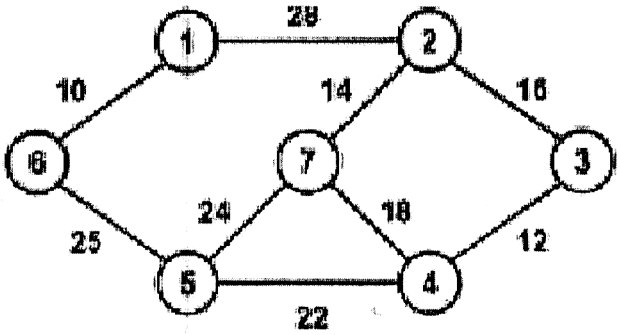
5. CO5 (10): a. Can you apply Dijkstra's Algorithm to the following Graph ? Justify your answer. (5)



b. How do you determine whether a given graph has a negative cycle? (5)

OR

a. Draw the minimum spanning tree (MST) of the following graph using Kruskal's and Prim's (5+5)



6. CO6 (10): Given a graph G(V, E) and an integer K = 3, the task is to determine if the graph can be colored using at most 3 colors such that no two adjacent vertices are given the same colour. Prove that this coloring problem is NP Complete.

OR

Prove that 3-SAT problem is a NP-Complete problem. (10)

END