Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. / B. Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, APR/MAY 2025

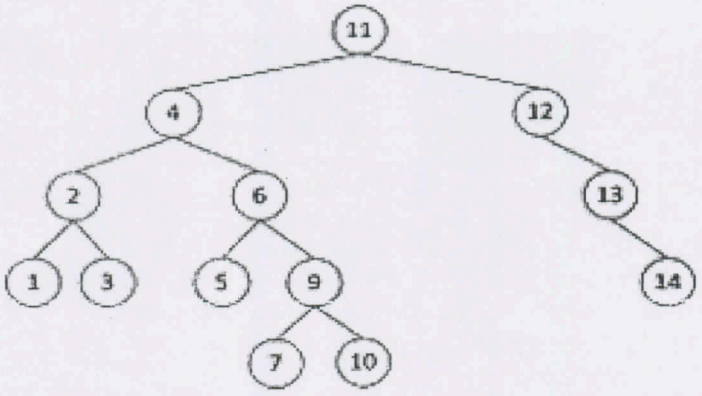
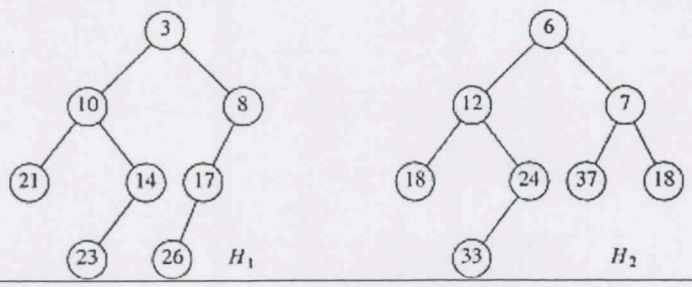
INFORMATION TECHNOLOGY
Fourth Semester (IV)
IT23401 & Advanced Data Structures
(Regulation 2023)

Time: 3hrs Max.Marks: 100

CO 1	Understand the usage of Amortized analysis and Skip list for real world problem solving.
CO 2	Implement Balanced Trees through ADT's.
CO 3	Understand and use Heap algorithms using Amortized analysis.
CO 4	Apply Disjoint Sets for suitable applications.
CO 5	Analyze and apply the graph data structures for a given problem.

BL – Bloom's Taxonomy Levels
(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analyzing, L5 - Evaluating, L6 - Creating)

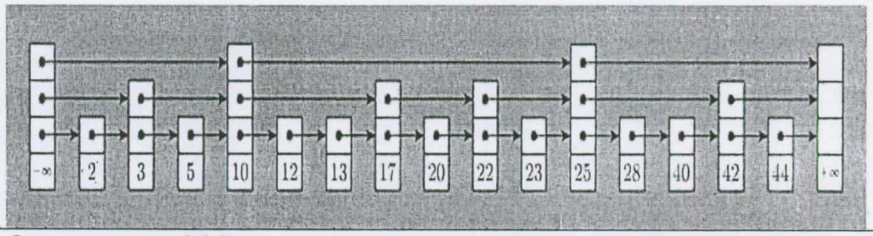
PART- A (10 x 2 = 20 Marks)
(Answer all Questions)

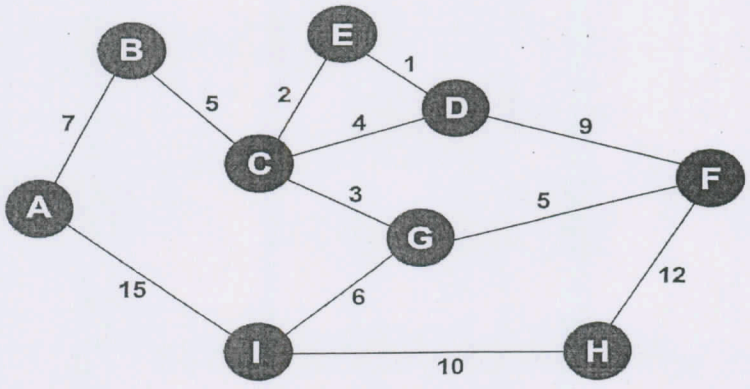
Q. No	Questions	Marks	CO	BL
1	Prove that multi pop operation costs O(1) amortized time.	2	CO1	L2
2	Do amortized cost and Average case analysis are same? Justify your answer with a clear example.	2	CO1	L5
3	Write down the properties of Red Black Tree with a neat example depicting each property.	2	CO2	L2
4	Search the key 8 in the following splay tree and simulate the results step by step: 	2	CO2	L2
5	Analyze the Complexity of Binomial heap, Fibonacci heap and Leftist heap with respect to Merge, Insert and Deletemin operations.	2	CO3	L2
6	Merge the following two heaps and draw the resultant leftist heap. 	2	CO3	L3

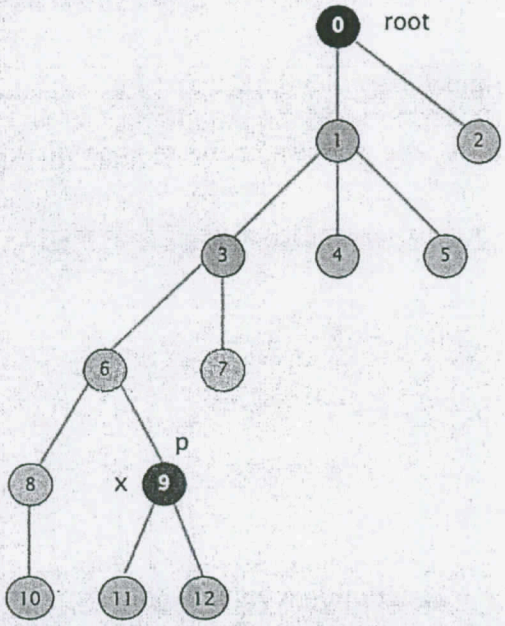
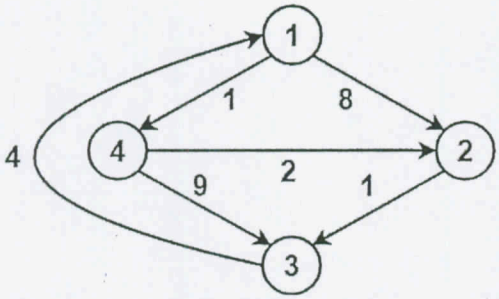
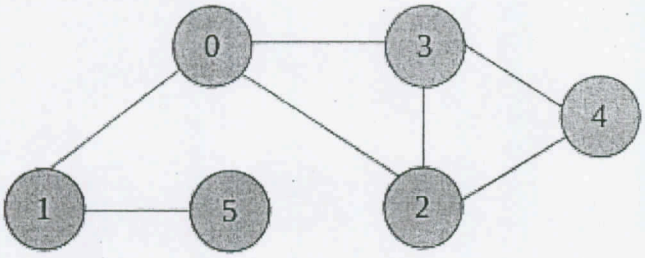
7	When a relation would become an Equivalence Relation? Write down its properties with suitable examples.	2	CO4	L2
8	Derive the complexity if Union by Rank and Path compression has been performed together in a Disjoint Set.	2	CO4	L3
9	Write a recursive code to perform Depth First Search in a given graph.	2	CO5	L3
10	Write down the Max flow – Min Cut Theorem. Mention the significance of this theorem.	2	CO5	L2

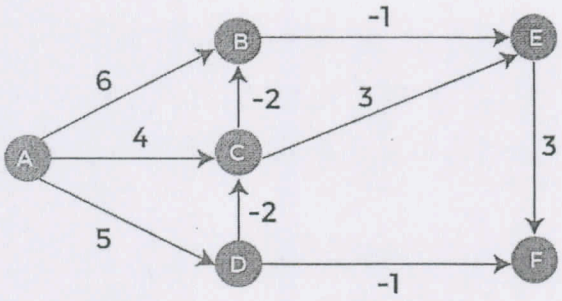
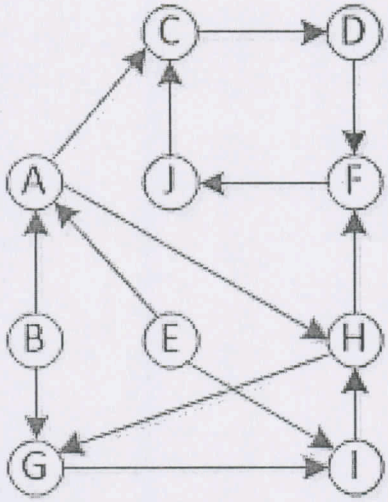
PART- B (5 x 13 = 65 Marks)

(Restrict to a maximum of 2 subdivisions)

Q. No	Questions	Marks	CO	BL
11 (a)(i)	Draw a digital circuit of k bit Binary counter (8-bit) and implement the same using a suitable algorithm. Record the number of flips after every increment in a sequence of n increments in a worst case scenario.	7	CO1	L3
(ii)	Derive the amortized cost of Binary Counter implemented in the above problem using Aggregate method and Potential Method.	6	CO1	L3
	OR			
11 (b) (i)	Derive the amortized cost per operation for Dynamic Table implementation using Aggregate analysis and Potential Method with a neat illustration. (Simulate the insertions in Dynamic Table to prove the amortized cost using aggregate analysis)	7	CO1	L3
(ii)	Write down the properties of Skip list. In the following skip list, simulate the process of inserting the elements 15, 24 and deleting the elements 12 and 22.  	6	CO1	L3
12 (a) (i)	Construct an AVL tree with values 23,22,21,24,25,26,27,36,45,44 into an initially empty tree. Delete 24, 36 from the tree. Simulate the tree that results after each insertion and deletion. Perform post order traversal of the resultant tree. Write suitable routines to delete a given node from an AVL tree with necessary rotations (Deletion algorithm)	9	CO2	L3
(ii)	Construct a B- Tree of order 4 for the following elements: "MM", "AC", "GG", "PQ", "PS", "MN", "LL", "LK", "LT", "NN". Further delete the elements AC, PQ, LL.	4	CO2	L3
	OR			
12 (b) (i)	Simulate the step by step process of inserting the following numbers one by one in the Red-Black tree: 85 15 17 20 70 80 100 65 90 45 55 30 Draw the figures depicting your tree immediately after each insertion and identify the rebalancing rotation or color change (if any). Further delete the following elements from the constructed tree: 20 70 17 45	9	CO2	L3

(ii)	Write down the algorithms involved in the process of inserting a new element in a Top down splay tree using Templates.	**4**	CO2	L3
13 (a) i)	Create a Fibonacci Heap with the following numbers: 25, 20, 16, 30, 19, 21, 55, 71, 18, 32, 24, 36, 42 i) After Creation, perform DeleteMin operation twice. ii) Further decrease the keys 30 to 21 and 20 to 1 in the Fibonacci Heap.	**8**	CO3	L3
ii)	Write down the DeleteMin and DecreaseKey algorithms of Fibonacci Heap and derive its amortized cost using aggregate analysis.	**5**	CO3	L3
	OR			
13 (b) (i)	Write suitable algorithms to perform Insert, DeleteMin and Merge operations in a Binomial heap.	**8**	CO3	L3
(ii)	If a set of key priority pairs (k,p) has been followed while creating Treaps, Construct a Treap with the following randomly generated (key, priority) pairs : (10, 35), (20, 10) , (80, 65), (90, 15), (50, 25), (60, 17), (95,32) (30, 56). Delete the pairs (80, 65) and (30, 56)	**5**	CO3	L3
14 (a) (i)	If singleton sets of the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 ,13,14 are available, Show the result of the following sequence of instructions when performed: union(1,2), union(3,4), union(3,5), union(1,7), union(3,6), union(8,9), union(1,8), union(3,10), union (3,11), union(3,12), union(3,13), union(14,15), union(16,0), union(14,16), union (1,3), union(1, 14) a. union arbitrarily b. union by size c. union by height	**9**	CO4	L3
(ii)	Write about the Dynamic Equivalence Problem. Write down the pseudocode to find the representative element of the Set.	**4**	CO4	L2
	OR			
14 (b) (i)	Construct a Minimum Cost Spanning Tree for the following graph using Disjoint Sets. Consider each of the vertices as a singleton set during the construction of spanning tree. Write down the algorithm involved behind this process.  	**9**	CO4	L3

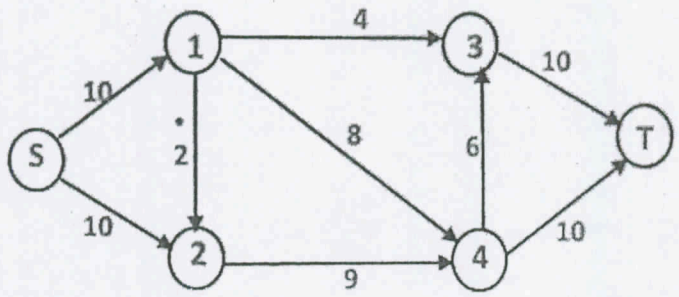
(ii)	Perform Path compression for the following Disjoint Set if **Find(9)** has been performed. Simulate the process step by step with a suitable algorithm: 	**4**	CO4	L3
15 (a) (i)	Consider the following directed weighted graph- Using Floyd-Warshall Algorithm, find the shortest path distance between every pair of vertices in a step by step manner. Also write down its algorithm. 	**9**	CO5	L3
ii)	Draw a depth first spanning tree for the following graph starting at the node 0 and identify the articulation points of the graph in a step by step manner: 	**4**	CO5	L3
	OR			
15 (b) (i)	Find out the shortest path from the source vertex (A) to all other vertices in the following graph using Bellman ford algorithm. Also, Write down the algorithm used to compute the shortest path	**9**	CO5	L3

				
(ii)	Nodes of the following network are connected with each other with a strong relation. Strongly connected nodes form a group. Spot out the connected components which are strong in the following network by simulating the results in a step by step manner. 	**4**	CO5	L3

PART- C (1 x 15 = 15 Marks)

(Q.No.16 is compulsory)

Q. No	Questions	Marks	CO	BL
16. (i)	Develop an application to design an **INDEX CHAIN** which attempts to store the strings in the following manner: C CA CAR CARS CAB CABLE CABLES etc. Write appropriate functions to perform the following operations: a) Adding of a new word in INDEX b) Checking the presence of word using its prefix. c) Auto complete the word during the search, if the string "CA" is given.	**8**	CO2 CO3	L6
(ii)	Assume a networking company with the structure shown below wants to provide a real time streaming of data with better performance by optimizing maximum flow of information between	**7**	CO5	L4

	the sender and receiver. Amount of data received by the intermediary nodes should be disbursed immediately.  a) Provide a step by step solution to this problem by optimizing the maximum flow of information between sender and receiver. b) Write down the equations which depicts the flow of network (Residual flow and Augmented path).			