P. V. P. SIDDHARTHA INSTITUTE OF TECHNOLOGY	
BRANCH: CSE/AI&ML/DS	**REGULATION: PVP23**
COURSE: B. TECH	**SUBJECT: Advanced Data Structures & Algorithm Analysis**
SUBJECT CODE: 23CS3301/23AM3301/23DS3301	**YEAR AND SEMESTER: II B. TECH SEMESTER I**
QUESTION BANK	

UNIT – I

PART - A
Short Answer Questions (2 Marks Each)

Q. No.	QUESTION	CO	BL	Marks
1	What is an algorithm? Why is the need of studying algorithms?	CO1	L2	2
2	What are the fundamental steps involved in algorithmic problem solving? And also explain what is order of growth?	CO1	L2	2
3	What is the height of an AVL tree with n nodes in the worst case?	CO1	L2	2
4	What property ensures the balanced nature of an AVL tree?	CO1	L2	2
5	Why do AVL trees require rotations	CO1	L2	2
6	Why are B-Trees used in databases and file systems?	CO1	L2	2
7	What is the minimum degree t of a B-Tree?	CO1	L2	2
8	What is the height of a B-Tree with n keys and minimum degree t in the worst case?	CO1	L2	2
9	What is the primary advantage of B-Trees over binary search trees in terms of disk access?	CO1	L2	2
10	What does it mean if an algorithm has a time complexity of O(n^2)?	CO1	L2	2

PART- B
Long Answer Questions (10 Marks Each)

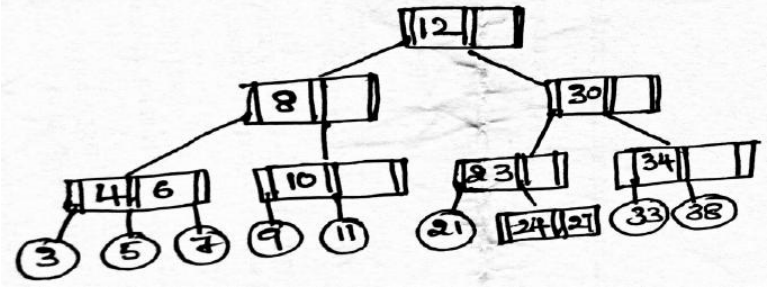
Q. No.	QUESTION	CO	BL	Marks
1	**a)Discuss** the various notations used for computing the complexity of an algorithm? **Express** the Time complexities for the following control statements with an example: a) conditional statements b) iterative statements c) recursive statements	CO1, CO3	L2	5

	b)Calculate the time complexities of the following code:				

	a)
	x=y+z;
	for(i=1;i<=n;i++)
	x=y+z;
		b)
		x=y+z;
		for(i=1;i<=n;i++)
		{
		for(j=1;j<=n/2;j++)
		x=y+z;
		}
			CO1, CO3	L3	5

	c)
	x=y+z;
	for(i=1;i<=n;i++)
	{ for(j=1;j<=i;j++)
	{
	for(k=1;k<=133;k++)
	x=y+z;
	}
	}
		d)
		while(n>1)
		{
		n=n/2;
		x=y+z;
		}			

2	Evaluate the following equalities are correct: i)5n2 -6n=Θ(n^2) ii)n!=O(n^n) iii)n3 +106 n 2 =Θ(n^3) iv)2n2 2 n +n logn=Θ(n^2 2 ^{n})		CO3	L3	10
3	a) Explain the concept of time complexity and its importance in algorithm analysis		CO3	L3	5
	b)Describe the difference between worst-case, best-case, and average-case time complexity, providing examples for each.		CO3	L3	5
4	a)Construct an AVL Tree using the following data entered as a sequence set. Show the balance factors in the resulting tree: 13, 22, 6, 9, 32, 55, 79, 65, 70		CO3	L3	5
	b) Insert 42, 43, 46 and 49 in the above constructed AVL tree and show a balanced AVL Tree.		CO3	L3	5
5	a)Apply the steps in insertion operation in B tree with an example?		CO3	L3	5
	b)Construct 2-3 tree by using the following sequence of numbers 6, 7, 9, 22, 13, 31, 35, 28, 24, 5, 34, 8, 25, 10, 11, 12, 14 and 39.		CO3	L3	5
6	a)Construct an AVL Tree using the following data entered as a sequence set. Show the balance factors in the resulting tree: 13, 22, 6, 9, 32, 55, 79, 65, 70		CO3	L3	5
	b))Illustrate the deletion algorithm in AVL tree with example?.		CO3	L3	5
7	a)Discuss the significance of time complexity in the context of large-scale data processing and real-time systems.		CO1	L2	5
	b)Explain the concept of space complexity and its significance in algorithm analysis.		CO1	L2	5

8	a) Apply deletion of 38, 5 and 8 from the following B- trees and show the resulting B- tree after every deletion operation.  	CO3	L3	5
	b)Explain the process of insertion by using the properties of B- trees with an example.	CO1	L2	5
10	a)Explain the structure and properties of a B-Tree. Why are B-Trees used in databases and file systems?	CO2	L3	5
	b)How does deletion work in a B-Tree? Describe the different cases and the strategies used to maintain the B-Tree properties.	CO2	L3	5

UNIT – II

PART - A

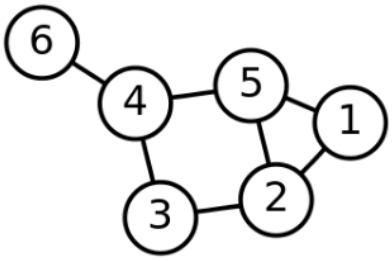
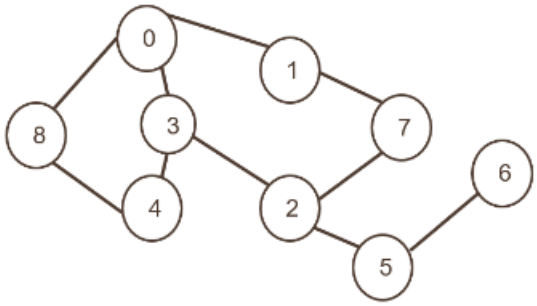
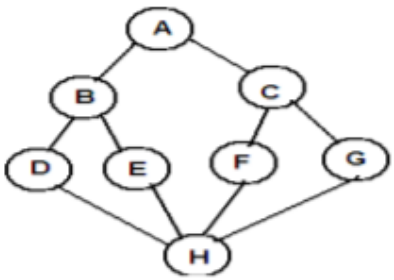
Short Answer Questions (2 Marks Each)

Q. No.	QUESTION	CO	BL	Marks
1	How does a binary heap differ from a binary search tree (BST)?	**CO1**	**L2**	**2**
2	**How do you insert an element into a binary heap?**	**CO1**	**L2**	**2**
3	How can a binary heap be represented in an array? And what is the heapify operation.	**CO1**	**L2**	**2**
4	What are some applications of binary heaps?	**CO1**	**L2**	**2**
5	Differentiate between directed and undirected graphs.	**CO1**	**L2**	**2**
6	What data structure is typically used to implement DFS and BFS	**CO1**	**L2**	**2**
7	**Differentiate adjacency matrix and incidence matrix**	**CO1**	**L2**	**2**
8	What is the difference between a tree and a forest in graph theory?	**CO1**	**L2**	**2**
9	What is a disjoint set? What is the role of the "parent" array in the union-find data structure?	**CO1**	**L2**	**2**
10	What are the two main operations of the union-find data structure?	**CO1**	**L2**	**2**

PART- B

Long Answer Questions (10 Marks Each)

Q. No.	QUESTION	CO	BL	Marks
1	a) Explain the Binary Heap Structure property with an example?	CO1	L2	3
	b) Apply the following operations of priority queues (i) Construct the min and ~~max~~ heap with the following elements 20, 10, 5, 18, 6, 12, 14, 4, and 22. (ii) Insert 2 and 28 in the min heap (iii) Perform two successive deletion operations on max heap	CO3	L3	7
2	a) Explain the following 1. Priority Queue 2. Min Heap 3. Max Heap	CO1	L2	4
	b) Build insertion and deletion algorithms of max priority heap.	CO3	L3	6
3	a) Apply the sequence of steps in deleting the elements in a successive order from the following heap 18, 12, 14, 8, 7, 10, 9.	CO3	L3	5
	b) Develop code to implement insertion and deletion algorithms of min priority heap?	CO3	L3	5
4	a) Apply the following operations of heap tress (i) Construct the max heap tree with the following elements 11, 10, 5, 69, 6, 12, 14, 4, and 2. (ii) Insert 1 and 99 in the heap tree (iii) Perform two successive deletion operations on heap tree	CO3	L3	6
	b)Develop the code to implement deletion in both min and max heap.	CO3	L3	4
5	a)Discuss the difference between Depth-First Search (DFS) and Breadth-First Search (BFS) algorithms.	CO3	L3	4
	b. Illustrate BFS and DFS procedure with an example graph	CO1, CO3, CO4	L3	6
6	Explain the Heap Sort algorithm, including its steps and time complexity.	CO1, CO3	L2, L3	10
7	**a)Illustrate** the various ways of representing a Graph? Show the various mechanisms of representation for the following Graph:	CO1, CO3, CO4	L2	5

				
	b)Compare the following: a) Directed v/s Undirected graph b) Tree v/s Graph c) DFS v/s BFS	CO1, CO3, CO4	L3	5
8	**a)Explain** the Depth First Search graph traversal technique. Write an algorithm using stack to perform DFS.	CO1, CO3, CO4	L3	5
	b)Trace the algorithm for the following Graph stating from node 0: 	CO1, CO3, CO4	L3	5
9	a)Design a simple find algorithm in a disjoin sets. Explain with an example.	CO2	L3	5
	b)Design a simple union algorithm in a disjoin sets. Explain with an example.	CO2	L3	5
10	a)Explain the Breadth First Search graph traversal technique. **Write** an algorithm using stack to perform BFS.	CO1, CO3, CO4	L3	5
	b) Trace the algorithm for the following Graph starting from Node A: 	CO1, CO3, CO4	L3	5

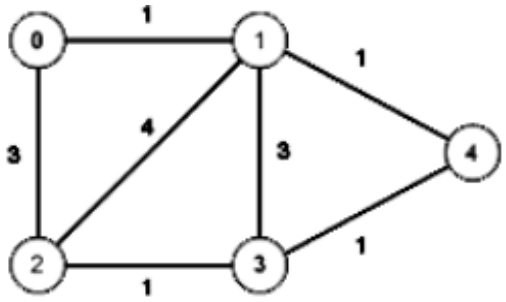
UNIT III

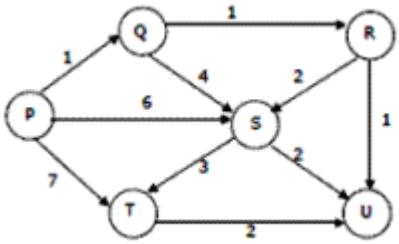
Short Answer Questions (2 Marks Each)

Q. NO.	QUESTIONS	CO	BL	Marks
1	What is the Divide and Conquer strategy?	CO1	L2	2M
2	What are the three main steps in the Divide and Conquer approach?	CO1	L2	2M
3	Give an example of an algorithm that uses Divide and Conquer.	CO1	L2	2M
4	What is the time complexity of Merge Sort.	CO1	L2	2M
5	How does the Divide and Conquer approach improve efficiency?	CO1	L2	2M
6	What is a Greedy Algorithm?	CO1	L2	2M
7	Can Greedy Algorithms guarantee an optimal solution?	CO1	L2	2M
8	What is a Minimum Spanning Tree (MST)?	CO1	L2	2M
9	Name two algorithms used to find the Minimum Spanning Tree.	CO1	L2	2M
10	What is the Single Source Shortest Path problem?	CO1	L2	2M

Long Answer Questions (10 Marks Each)

UNIT- III				
S.No.	Question	CO	BL	Marks
1	How do we analyze the time complexity of the algorithm that are based on divide and conquer techniques?	CO2	2	10
2	Explain divide and conquer technique. Construct a recursive algorithm for finding the maximum and minimum element from a list.	CO2	3	10

3	Discuss how Quick sort algorithm works to sort an array and trace the following dataset. 25, 91, 46, 35, 11, 82, 14, 55 Analyze the best case complexity of Quick sort algorithm.	CO2, CO3	4	10
4	Develop an algorithm for sorting elements using simple merge. Apply the same for sorting list of elements given below:67, 90, 12, 56, 23, 34, 45 Analyze the time complexity.	CO2, CO3	4	10
5	Apply Strassen's matrix multiplication on following matrices $\begin{bmatrix} 4 & 5 \\ 5 & 9 \end{bmatrix} \quad \begin{bmatrix} 2 & 10 \\ 1 & 6 \end{bmatrix}$	CO3	3	10
6	How fractional knapsack problem can be solved using Greedy method? Discuss with an example. Also analyze its time complexity	CO2, CO3	3	10
7	Compute an optimal solution using greedy method to the following instance of job sequencing with deadlines and profit problem N=7, [P1:P7]=(3,5,20,18,1,6,30), [D1:D7]=(1,3,4,3,2,1,2)	CO2	3	10
8	Interpret Kruskal's algorithm for minimum spanning tree with a suitable example. Also analyze it's time complexity.	CO2, CO3	4	10
9	Construct minimum cost spanning tree using Prim's algorithm  	CO2	3	10

10	Apply single source shortest path problem for the following graph 	CO2	3	10

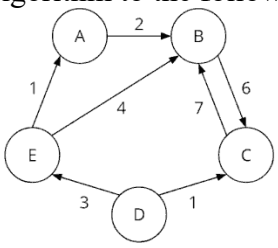
UNIT IV

Short Answer Questions (2 Marks Each)

Q. NO.	QUESTIONS	CO	BL	Marks
1	State the principle of optimality	CO1	L2	2M
2	List any two applications of Dynamic Programming	CO1	L2	2M
3	State the Merge Rule in 0/1 Knapsack Problem using Dynamic Programming.	CO1	L2	2M
4	State the Purge Rule in 0/1 Knapsack Problem using Dynamic Programming.	CO1	L2	2M
5	State Longest Common Subsequence Problem	CO1	L2	2M
6	What is String Editing Problem?	CO1	L2	2M
7	Define Optimal Binary Search Tree	CO1	L2	2M
8	Name algorithms used to compute shortest path	CO1	L2	2M
9	What is the time complexity of a)OBST Algorithm b)Travelling Salesman Problem	CO1	L2	2M
10	What is Travelling Salesman Problem?	CO1	L2	2M

Long Answer Questions (10 Marks Each)

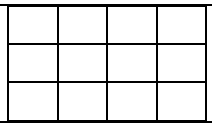
UNIT- 4				
S.No.	Question	CO	BL	Marks
1	a. Differentiate greedy method and dynamic programming.	CO4	4	5
	b. Apply Floyd's algorithm to compute lengths of shortest paths between all pairs of nodes for the given 3X3 adjacency matrix [0 6 13, 8 0 4, 5 ∞ 0]	CO3	3	5
2	Implement OBST algorithm to find optimal binary search tree for the identifier set (a_1, a_2, a_3, a_4) = (for, else, if, while) with p(1)= 1/20, p(2) =1/5, p(3)=1/10, p(4) =1/20 and q(0) = 1/5, q(1) =1/10, q(2) = 1/5, q(3) = 1/20 and q(4) =1/20	CO3	3	10
3	Apply dynamic programming to construct OBST for the following (a_1, a_2, a_3, a_4) = (do, if, int, while), P(1:4)= (3,3,1,1), q(0:4) = (2,3,1,1,1)	CO3	3	10
4	Solve the following 0/1 knapsack problem using dynamic programming n=3, m=6 profits (p1,p2,p3) = (1,2,5) weights (w1,w2,w3) = (2,3,4) and provide an optimal solution.	CO3	3	10
5	a.Compare divide and conquer and dynamic programming design techniques	CO4	4	5
	b.What is principle of optimality? What are merging and purging rules to get the solution of 0/1 knapsack problem by dynamic programming?	CO1	2	5
6	a. Apply dynamic progamming to find the shortest tour of Travelling Salesman Problem for the following 4X4 cost matrix [0 10 15 20, 5 0 9 10, 6 13 0 12, 8 8 9 0]	CO3	3	5
	b.Apply dynamic Programming to find a minimum cost edit sequence that transforms X into Y. X= a, a, b, a, b and Y= b, a, b, b	CO3	3	5
7	a.Given two sequences X = <A, B, C, B, D, A, B> and Y = <B, D, C, A, B, A>. Find the LCS of X and Y using Dynamic Programming	CO3	3	5
	b.Draw all possible binary search trees for the identifier set { do, if, stop}	CO1	2	5
8	a.Analyze the time complexity of Floyd's All pairs shortest path algorithm	CO4	4	5
	b.Explain the methodology of Dynamic Programming. Mention applications of Dynamic Programming.	CO1	2	5

9	a.Analyze the time complexity of Travelling Salesman Problem using Dynamic Programming.	CO4	4	5
	b. Apply dynamic progamming to find the shortest tour of Travelling Salesman Problem for the following 4X4 cost matrix [0 10 9 3, 5 0 6 2, 9 6 0 7, 7 3 5 0]	CO3	3	5
10	Apply Floyd' s algorithm to the following graph  for computing shortest paths between every pair of vertices	CO3	3	10
11	Solve the following instance of 0/1 knapsack problem using dynamic programming n=3, m=4, profits (p1,p2,p3) = (3,7,12) weights (w1,w2,w3) = (3,5,7) and provide an optimal solution.	CO3	3	10
12	Consider 4 elements $a_1 < a_2 < a_3 < a_4$ with q(0) = 1/8, q(1) = 1/16, q(2) = 1/16, q(3) = 1/16, q(4)= 1/16 and p(1) = 1/4, p(2) = 1/8, p(3) = 1/16, p(4) = 1/16. Construct the table of values of W(i,j),R(i,j) and C(i,j) computed by the algorithm to compute the roots of optimal sub trees.	CO3	3	10

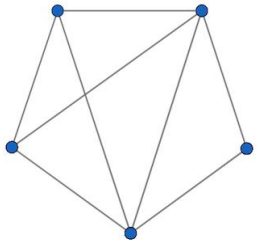
UNIT V

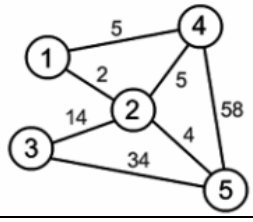
Short Answer Questions (2 Marks Each)

Q. NO.	QUESTIONS	CO	BL	Marks
1	How does backtracking differ from brute force?	CO1	L2	2M
2	Identify the P and NP problems in the following a) merge sort b) single-source shortest paths c) 0/1 knapsack problem d) Travelling salesperson problem. e) Searching f) Graph coloring	CO1	L2	2M
3	Write a solution for 4-Queens problem by placing a queen in respective cell?	CO1	L2	2M

				
4	Define State space tree in backtracking	CO1	L2	2M
5	Define Explicit and Implicit constraints in backtracking.	CO1	L2	2M
6	What is the difference between FIFO Branch and Bound and LIFO Branch and Bound?	CO1	L2	2M
7	How does Branch and Bound differ from Backtracking?	CO1	L2	2M
8	What is the class P in computational complexity?	CO1	L2	2M
9	What is the class NP in computational complexity?	CO1	L2	2M
10	Define NP-complete ? Mention any two NP-complete problems?	CO1	L2	2M

Long Answer Questions (10 Marks Each)

UNIT- V				
S.No.	**Question**	**CO**	**BL**	**Marks**
1	Apply back-tracking technique to solve the below instance of the sum-of-subset problem. Generate a possible feasible solution, S= {1,3,4,6} d=7	CO2	L3	10
2	Apply the backtracking algorithm to solve the following instance of the sum of subsets problem S={5,10,12,13,15,18} and d=30	CO2	L3	10
3	Elaborate how backtracking technique can be used to solve the n-queens problem. Construct an optimal solution for n=4Queens.	CO4	L3	10
4	Draw the state space tree generated by backtracking approach for the following graph and mention the possible solutions. 	CO2	L3	10
5	Write a backtracking algorithm for the sum of subsets problem using the state space tree corresponding to the variable tuple size formulation.	CO2	L3	10
6	What do you understand by branch and bound techniques? Explain LC branch and bound and FIFO branch and bound.	CO1	L2	10

7	Draw the state space tree generated by LCBB for the following knapsack instances: (a) n = 5, (p1,p2,p3,p4,p5)= (10,15,6, 8, 4), (w1,w2,w3,w4,w5) = (4,6,3,4,2) and m = 12 (4, 6, 3, 4, 2), and m = 12.	CO2	L3	10
8	Solve the following instance of travelling sales person problem using Least Cost Branch Bound 	CO2	L3	10
9	What are the different complexity classes? Explain each with an example.	CO1	L2	10
10	Explain P, NP and NP complete problems.	CO1	L2	10

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