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|  **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)**

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| **Q. No.** | **QUESTION** | **CO** | **LEVEL** | **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)**

|  |  |  |  |  |
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| **Q. No.** | **QUESTION** | **CO** | **LEVEL** | **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 statementsb) iterative statementsc) 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(n2 ) ii)n!=O(nn )  iii)n3 +106 n 2 =ϴ(n3 ) iv)2n2 2 n +n logn=ϴ(n2 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 | 1. 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)**

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| **Q. No.** | **QUESTION** | **CO** | **LEVEL** | **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)**

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| **Q. No.** | **QUESTION** | **CO** | **LEVEL** | **MARKS** |
| 1 | 1. Explain the Binary Heap Structure property with an example?
 | CO1 | L2 | 3 |
| 1. 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 | 1. Explain the following
2. Priority Queue
3. Min Heap
4. Max Heap
 | CO1 | L2 | 4 |
| 1. Build insertion and deletion algorithms of max priority heap.
 | CO3 | L3 | 6 |
| 3 | 1. 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 |
| 1. Develop code to implement insertion and deletion algorithms of min priority heap?
 | CO3 | L3 | 5 |
| 4 | 1. 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 graphb) Tree v/s Graphc) 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)**

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| **Q. NO.** | **QUESTIONS** | **CO** | **Bloom’s Level** | **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)**

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| **UNIT- III** |
| S.No. | Question | CO | BTL | 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, 55Analyze 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, 45Analyze the time complexity. | CO2,CO3 | 4 | 10 |
| 5 | Apply Strassen’s matrix multiplication on following matrices**4 5 2 10**  **5 9 1 6** | 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 problemN=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 graphNew Picture (2) | CO2 | 3 | 10 |

**UNIT IV**

**Short Answer Questions (2 Marks Each)**

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| **Q. NO.** | **QUESTIONS** | **CO** | **Bloom’s Level** | **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 Algorithmb)Travelling Salesman Problem | CO1 | L2 | 2M |
| 10 | What is Travelling Salesman Problem? | CO1 | L2 | 2M |

**Long Answer Questions (10 Marks Each)**

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| **UNIT- 4** |
| S.No. | Question | CO | BTL | Marks |
| 1 | 1. Differentiate greedy method and dynamic programming.
 | CO4 | 4 | 5 |
| 1. 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 $\infty $ 0] | CO3 | 3 | 5 |
| 2 | Implement OBST algorithm to find optimal binary search tree for the identifier set (a1, a2, a3, a4) = (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(a1, a2, a3, a4) = (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 | 1. 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 |
| 1. 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 graphFloyd-Warshall Algorithm (+ Java Example) - HappyCoders.eufor computing shortest paths between every pairof 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 a1< a2 < a3 < a4 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)**

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| **Q. NO.** | **QUESTIONS** | **CO** | **Bloom’s Level** | **MARKS** |
| 1 | How does backtracking differ from brute force? | CO1 | L2 | 2M |
| 2 | Identify the P and NP problems in the followinga) merge sort b) single-source shortest pathsc) 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?

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 | 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)**

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| **UNIT- V** |
| **S.No.** | **Question** | **CO** | **Bloom’s Level** | **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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