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Question Paper Code : 90485

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025.

Third Semester

Computer and Communication Engineering

CD 3291 – DATA STRUCTURES AND ALGORITHMS

(Common to : Computer Science and Engineering (Artificial Intelligence and Machine Learning)/Computer Science and Engineering (Cyber security)/Information Technology))

(Regulations 2021)

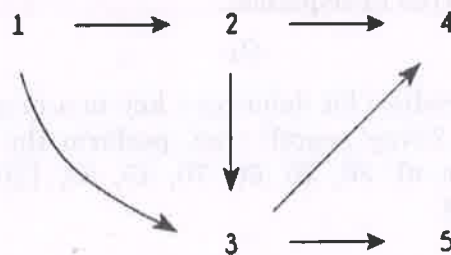
Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Find the upper bound of $f(n) = 4n^2 + 3$.
2. Define Abstract data type. Give an example.
3. List the operations in a Queue ADT.
4. Can linked list be used to implement binary search? Give reasons.
5. What is the time complexity of selection sort in the best and worst case?
6. What is the worst case time complexity of sequential search on a sorted array?
7. What is the disadvantage of a binary search tree? How is it overcome?
8. Construct a max heap with the following elements: 1,2,4,8,3.
9. Find the topological ordering of the following graph.



10. When does a decision problem belong to class P?

PART B — (5 × 13 = 65 marks)

11. (a) What is operator overloading? List any two operators that cannot be overloaded. Write a program to overload '*' operator to multiply two fractions.

Or

- (b) Find the time complexity of the recurrence:

$$T(n) = \begin{cases} 2T(n-1) - 1 & \text{if } n > 0 \\ 1 & \text{otherwise} \end{cases}$$

12. (a) What are the advantages of using a linked list over array? Give the structure of a doubly linked list. Write procedures to insert, search and delete a node in a doubly linked list.

Or

- (b) Define stack ADT. Write procedures for PUSH and POP operations in a stack. Apply them to convert the infix expression $A + B * C + D$ to postfix expression. Evaluate the obtained postfix expression with $A = 1, B = -1, C = 3$ and $D = 2$ using a stack.

13. (a) Give input $\{43, 13, 61, 41, 53, 79, 89\}$ and a hash function $h(x) = x \bmod 10$, show the results of :

- (i) separate chaining hash table (3)
- (ii) hash table using linear probing (5)
- (iii) hash table using quadratic probing (5)

Or

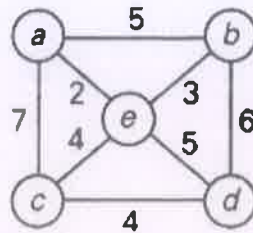
- (b) Write an algorithm to sort elements using merge sort and analyze its time complexity in the worst case. Trace the algorithm for the following input. 16, 3, 2, 4, 1, 77, 88.

14. (a) Write procedures for single and double rotations during insertion in an AVL tree. Construct an AVL search tree using the following data in the order given: 91, 10, 22, 45, 12, 7, 34, 60, 55, 100. Delete 100, 55, 60 from the constructed tree in sequence.

Or

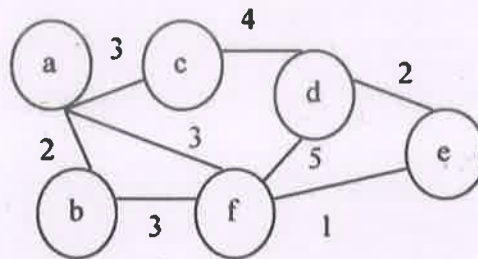
- (b) Explain the procedure for deleting a key in a m-way search tree. Starting with an empty 3-way search tree, perform the following operations in sequence: Insert 40, 80, 20, 60, 70, 45, 88, 120, 37, 21, 22 and Delete 45, 60, 22, 40, 88.

15. (a) List the properties of greedy approach. Explain Dijkstra's algorithm to find the shortest path from a source vertex and analyse the time complexity of the approach. Apply the same on the graph given below to find the shortest path from vertex 'a'.



Or

- (b) Define minimum spanning tree. Write the pseudocode to find the minimum spanning tree using kruskal's algorithm and analyze its time complexity. Trace the algorithm on the graph given below.

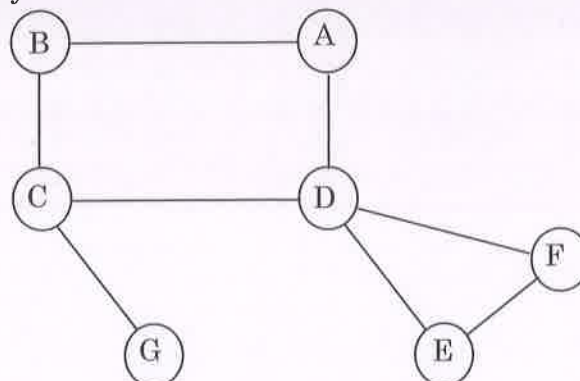


PART C — (1 × 15 = 15 marks)

16. (a) Write an algorithm to sort elements using Quick sort and analyze its time complexity. Sort the following elements using Quick sort 16, 3, 2, 4, 1, 77, 88 and discuss the result of considering 4 as the pivot element in the first pass. How does the time complexity of the algorithm increase when the elements are in sorted order?

Or

- (b) Write recursive procedures for inorder, preorder and postorder traversals and analyze their time complexity. Apply them to obtain depth and breadth first order of the following graph from vertex 'A'. Break ties alphabetically.



14. Let G be a graph with 10 vertices and 15 edges. Suppose that G is a simple graph. Find the maximum possible degree of a vertex in G .



Figure 1

15. Let G be a graph with 10 vertices and 15 edges. Suppose that G is a simple graph. Find the maximum possible degree of a vertex in G .



Figure 2

16. Let G be a graph with 10 vertices and 15 edges. Suppose that G is a simple graph. Find the maximum possible degree of a vertex in G .

Figure 3

17. Let G be a graph with 10 vertices and 15 edges. Suppose that G is a simple graph. Find the maximum possible degree of a vertex in G .

