

[illegible]

Question Paper Code : 30037

**B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2026.**

## Second Semester

# Electrical and Electronics Engineering

CS25C04 — DATA STRUCTURES AND ALGORITHMS

(Regulations 2025)

Time : 3 hours

Maximum : 100 marks

## CO – Course Outcomes

|     |                                                                                                                               |
|-----|-------------------------------------------------------------------------------------------------------------------------------|
| CO1 | Explain fundamental concepts of data structures and Algorithms.                                                               |
| CO2 | Implement the data structures in different Applications.                                                                      |
| CO3 | Evaluate and compare different searching and sorting algorithms.                                                              |
| CO4 | Demonstrate in continuous learning in interdisciplinary projects involving AI, ML, Data Science, or other technology domains. |

## BL – Bloom's Taxonomy Levels

(L1-Remember, L2-Understand, L3-Apply, L4-Analyze, L5-Evaluate, L6-Create)

Answer ALL questions.

**PART - A (Total Marks = 40)**

**[Q. No. 1 to Q. No. 10 ;  $10 \times 1 = 10$  Marks (Multiple Choice Questions)]**

**Q. No. 11 to Q. No. 20;  $10 \times 3 = 30$  Marks]**

| Q.No. | Questions                                                                                                                                                                                                                      | Marks | CO | BL |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----|----|
| 1.    | <p>_____ is different components of a software system that does not reveal the internal details of their respective implementations.</p> <p>(A) Abstraction<br/>(B) Encapsulation<br/>(C) Inheritance<br/>(D) Polymorphism</p> | 1     | 1  | 1  |
| 2.    | <p>Among the following options, which of the following type of data structure is used in recursion?</p> <p>(A) Queues<br/>(B) Array<br/>(C) List<br/>(D) Stack</p>                                                             | 1     | 1  | 2  |

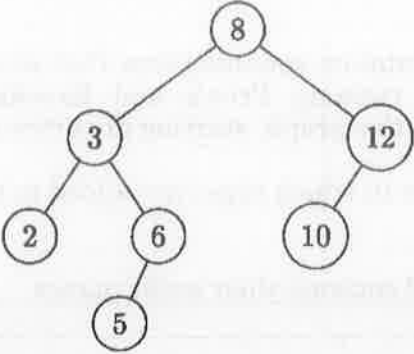
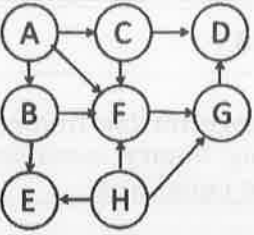
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|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|
| 3. | Suppose you want to delete the name that occurs before "Vivek" in an alphabetical listing. Which of the following data structures shall be most efficient for this operation?<br>(A) Circular linked list<br>(B) Doubly linked list<br>(C) Linked list<br>(D) Dequeue | 1 | 4 | 3 |
| 4. | Which traversal in a binary search tree visits the elements in sorted order?<br>(A) Pre-order<br>(B) Post-order<br>(C) In-order<br>(D) Level                                                                                                                          | 1 | 1 | 2 |
| 5. | Heap can be used as _____.<br>(A) Priority queue<br>(B) Stack<br>(C) A decreasing order array<br>(D) Normal Array                                                                                                                                                     | 1 | 1 | 2 |
| 6. | A _____ of a graph G is a subgraph of G that contains all the vertices of the graph G.<br>(A) Connected subgraph<br>(B) Directed acyclic graph<br>(C) Spanning subgraph<br>(D) Undirected subgraph                                                                    | 1 | 1 | 2 |
| 7. | Which notation is used to measure the upper bound on the growth rate of an algorithm's time complexity?<br>(A) Big O notation<br>(B) Omega notation<br>(C) Theta notation<br>(D) Amortized notation                                                                   | 1 | 1 | 2 |
| 8. | If an algorithm's time complexity is given by $O(1)$ , what does it signify?<br>(A) Polynomial complexity<br>(B) Constant complexity<br>(C) Exponential complexity<br>(D) Linear complexity                                                                           | 1 | 1 | 3 |

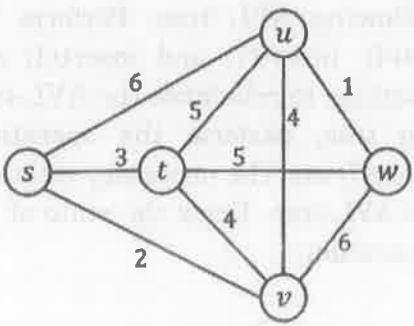
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|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|
| 9.  | <p>The space consumption of sorting algorithms is 'sometimes an important consideration. In particular, some sorting algorithms require the creation of additional temporary arrays to hold intermediate results. Which statement is correct?</p> <p>(A) Bubble sort requires no additional arrays, whereas selection sort, insertion sort, Merge sort and Quicksort all require additional arrays</p> <p>(B) Bubble sort and selection sort require no additional arrays, whereas insertion sort, Merge sort and Quicksort all require additional arrays.</p> <p>(C) Bubble sort and insertion sort require no additional arrays, whereas selection sort, Merge sort and Quicksort all require additional arrays.</p> <p>(D) Selection sort, bubble sort, and insertion sort require no additional arrays, whereas Merge sort and Quicksort require additional arrays.</p> | 1 | 3 | 3 |
| 10. | <p>Rehashing is typically triggered when which value exceeds a certain threshold?</p> <p>(A) Table size</p> <p>(B) Hash code</p> <p>(C) Load factor</p> <p>(D) Number of collisions</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1 | 3 | 2 |
| 11. | Differentiate Shallow and Deep Copying.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 3 | 1 | 2 |
| 12. | What is a namespace? Explain with an example                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 3 | 1 | 1 |
| 13. | Define the Stack Abstract Data Type and its fundamental operations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 3 | 2 | 2 |
| 14. | Give the pseudocode for inorder binary tree traversal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3 | 2 | 3 |
| 15. | Explain the data structures that can be used to store and manipulate a graph data.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 3 | 2 | 2 |
| 16. | <p>What do you mean by best and worst-case time complexities of an algorithm? What is the time complexity of the following code:</p> <pre> for (i = n/2; i &lt;= n; i++){     for (j = 2; j &lt;= n; j = j * 2){         k = k + n/2     } } </pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 3 | 2 | 4 |

|     |                                                                                                      |   |   |   |
|-----|------------------------------------------------------------------------------------------------------|---|---|---|
| 17. | Write a recursive function to compute the factorial of an integer. Analyze the time complexity.      | 3 | 2 | 3 |
| 18. | What are key differences between Greedy Algorithms and Dynamic Programming? Explain with an example. | 3 | 3 | 2 |
| 19. | Provide the pseudocode for Binary search algorithm.                                                  | 3 | 3 | 4 |
| 20. | What are the different graph traversals? Explain any one with example.                               | 3 | 3 | 2 |

**PART - B (5 × 12 = 60 marks)**

| Q.No. |     | Questions                                                                                                                                                                                                                                                                                                                                                                                                                                      | Marks | CO | BL |
|-------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----|----|
| 21.   | (a) | Design an abstract class Vehicle with methods calculate Fuel Efficiency( ) and maxSpeed( ). Derive classes such as Car, Truck, and Motorcycle that implement these methods. Further extend: <ul style="list-style-type: none"> <li>ElectricCar from Car</li> <li>HybridTruck from Truck</li> </ul> Implement a program to input vehicle details and display fuel efficiency and maximum speed. Assume the necessary attributes for each class. | 12    | 2  | 5  |
|       |     | <b>OR</b>                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |    |    |
|       | (b) | Given a sorted linked list, implement a function to remove duplicate elements such that each element appears only once. Give the time complexity of your algorithm.                                                                                                                                                                                                                                                                            | 12    | 2  | 5  |
| 22.   | (a) | Construct a Binary Search Tree by inserting the following elements in the given order:<br><br>10, 3, 15, 22, 6, 45, 65, 23, 78, 34, 5<br><br>Also design an algorithm to construct the Binary Search Tree.                                                                                                                                                                                                                                     | 12    | 2  | 4  |
|       |     | <b>OR</b>                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |    |    |

|     |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |   |   |
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|     | (b) | <p>Consider the following AVL tree, Perform the operations insert(4), insert(7) and insert(1) and the necessary rotations to rebalance the AVL-tree. In the resulting tree, perform the operations delete(5) and delete(7) and the necessary rotations to re-balance the AVL-tree. Draw the state of the tree after each operation.</p>                                                                                                  | 12 | 2 | 4 |
| 23. | (a) | <p>Given a DAG as follows,</p>  <p>The indegree of each vertex in the graph to the left is : A : 0, B : 1, C : 1, D : 2, E : 2, F : 4, G : 2 and H : 0.</p> <p>(i) Show the ordering of vertices by topological sort for the given DAG. Assume we start from node A.</p> <p>(ii) Give an implementation for the topological sorting algorithm.</p> <p>Discuss on its performance. What happens to this algorithm if it has cycles?</p> | 4  | 8 | 4 |
|     |     | OR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |    |   |   |

|     |       |                                                                                                                                                                                                                                                                                                                                               |    |   |   |
|-----|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---|---|
|     | (b)   |  <p>(i) Draw the minimum spanning tree that would result from running Prim's and Kruskal's algorithm on this graph, starting at vertex s.</p> <p>List the order in which edges are added to the tree.</p> <p>(ii) Compare and contrast their performance</p> | 10 | 2 | 4 |
| 24. | (a)   | A sequence S contains n-1 unique integers in the range [0, n-1]. There is one number from this range that is not in S. Design an O(n) time algorithm for finding that number. Discuss on the time and space complexity of your algorithm.                                                                                                     | 12 | 4 | 5 |
|     |       | OR                                                                                                                                                                                                                                                                                                                                            |    |   |   |
|     | (b)   | Design a recursive algorithm for finding the n <sup>th</sup> Fibonacci number using binary recursion. Draw the recursion trace for n equal to 4.                                                                                                                                                                                              | 12 | 4 | 5 |
| 25. | (a)   | Design an algorithm for merge sort. Check the working of the design for the following input, 15, 6, 3, 12, 9, 18, 1, 20.                                                                                                                                                                                                                      | 12 | 3 | 4 |
|     |       | OR                                                                                                                                                                                                                                                                                                                                            |    |   |   |
|     | (b)   | Consider inserting the keys 10, 22, 31, 4, 15, 28, 17, 88, 59 into a closed hash table of length m = 11 using the primary hashing function $h(K) = k \bmod m$ . Illustrate the result of inserting these Keys using                                                                                                                           |    | 3 | 4 |
|     | (i)   | Linear probing.                                                                                                                                                                                                                                                                                                                               | 5  |   |   |
|     | (ii)  | Quadratic probing with $h_i(k) = (h(k) + i + 3i^2) \bmod m$ .                                                                                                                                                                                                                                                                                 | 5  |   |   |
|     | (iii) | Give the efficiency of hash tables.                                                                                                                                                                                                                                                                                                           | 2  |   |   |