

JK Lakshmipat University Jaipur

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination, December 2025

B.Tech. Semester III

Roll No.....

CS1131: Data Structures and Algorithm

Time: 2 hour 30 Minutes

Max. Marks: 30

Instructions to students:

1. Non-programmable Scientific calculator is allowed.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q1A. Determine the Time and Space complexity of the following C functions or codes or algorithm.

04 Marks
CO3,
CO6

```
1) int countNodes(struct Node* root) {  
    if (root == NULL)  
        return 0;  
    return 1 + countNodes(root->left) + countNodes(root->right); }
```

```
2)  
int fib(int n) {  
    if (n <= 1)  
        return n;  
    return fib(n - 1) + fib(n - 2); }
```

```
3)  
int arr[n][n];  
for (int i = 0; i < n; i++) {  
    for (int j = 0; j < n; j++) {  
        arr[i][j] = i + j;  
    }  
}
```

```
4) struct Node* merge(struct Node* list1, struct Node* list2) {  
    if (list1 == NULL) return list2;  
    if (list2 == NULL) return list1;  
    if (list1->data < list2->data) {  
        list1->next = merge(list1->next, list2);  
        return list1;  
    } else {  
        list2->next = merge(list1, list2->next);  
        return list2;  
    }  
}
```

Q1B. A logistics company processes thousands of online delivery orders every day. Each order includes a unique Order ID and an estimated delivery time (in minutes).

04 Marks
CO1,
CO3

To ensure faster and organized dispatching, the company needs to arrange all delivery times in ascending order before assigning routes to drivers.

The company chooses a divide-and-conquer-based strategy that:

- Works efficiently for large datasets,
- Maintains balanced and efficient performance in all cases, and
- Avoids performance degradation seen in simpler sorting methods like

bubble or insertion sorts.

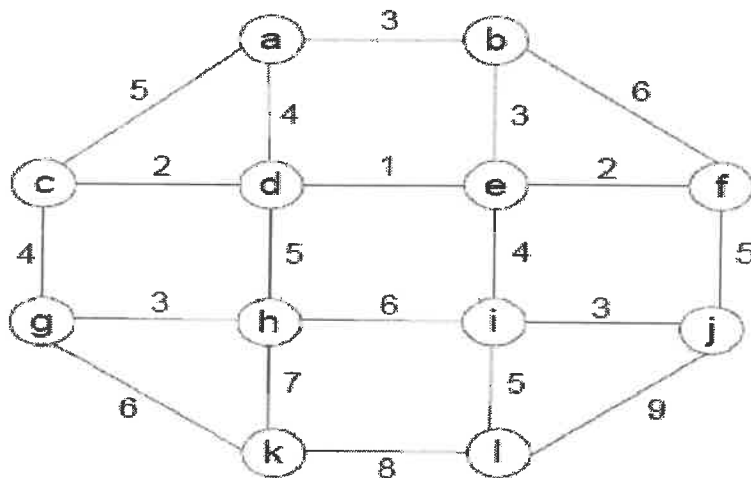
Write C functions/program to:

1. Accept an array of delivery times for multiple customer orders.
2. Implement a **divide-and-conquer-based approach** to arrange delivery times in ascending order.
3. Display the sorted list of delivery times.

Q.2A A telecommunications company, **ConnectLink Pvt. Ltd.**, is planning to lay **fiber-optic cables** to connect 12 cities across a region. Each possible cable route between two cities has a **construction cost** (in lakhs of rupees), which depends on the distance and terrain difficulty. **05 Marks**
CO5

The company wants to ensure **all cities are connected with the least total cost**, while avoiding any redundant routes (no cycles). The network must remain **fully connected** even if not all possible routes are used.

To achieve this, the company decides to use an **optimization approach** to design a network layout that connects all cities with the **minimum total connection cost** and without forming any redundant links.



Design a cost-effective network

- Connected Approach** - ensuring that all cities remain directly or indirectly connected in a single network. **(show each step)**
- Isolated (Disconnected) Approach** - identifying cases where the network may consist of separate connected components (sub-networks) due to missing or costly routes. **(show each step)**

connecting all the given cities using the available routes and their construction costs. Ensure that every city is connected with the **minimum total cost** and **no redundant connections** are included.

Q.2B A software company, **DataEase Solutions**, is developing a **customer management system** for a retail store. The system needs to store and search customer IDs efficiently to handle thousands of transactions per day. To optimize **search, insertion, and deletion** operations, the company decides to organize customer IDs using a **Binary Search Tree (BST)** data structure. **04 Marks**
CO2,
CO4

Given Data

The following customer IDs were registered in the order shown:

	45, 32, 60, 25, 40, 50, 70, 42, 12, 10, 4, 87, 16, 74, 15, 3, 14 Organize the given customer IDs in a structured form that allows efficient insertion, searching, and traversal, and display the data in inorder, preorder, and postorder sequences. Calculate and write all the operation complexity.	
Q.2C	A city transport department maintains a database of vehicle registration numbers to quickly verify ownership and track registration details. To reduce lookup time, they use a hash table, and handle collisions through chaining (linked lists). Each vehicle registration number is represented by a unique integer code. Given the following vehicle registration codes: 1012, 2543, 1875, 3299, 4156, 5021, 2788, 6630, 7235, 8902, 9120, 1005 and the hash function: $h(i) = (5i + 9) \bmod 12$ Task- 1. Construct the hash table (size = 12) using chaining to handle collisions. 2. Show the index positions and chained vehicle codes clearly. 3. Explain how this approach ensures quick registration verification for any given vehicle code.	04 Marks CO3
Q.2D	A banking application stores customer transactions in the order they occur during the day using a singly linked structure. At the end of the day, the bank manager needs to generate a report showing the latest transaction first, followed by earlier ones. To prepare this report, the system must rearrange the transaction records so that the most recent entry appears at the top. Criteria- You are not allowed to create a new list; instead, adjust the existing links between records. • Design an algorithm to reorganize the transaction list so that the order of transactions is from latest to earliest. • Determine the Time and Space complexity of your algorithm.	03 Marks CO2, CO3
Q.3A	A king has 1000 wine bottles, and exactly one of them is poisoned. The poison is so strong that even a single drop is lethal, and its effect appears exactly after one hour of consumption. The king wants to determine which one bottle is poisoned within one hour by using a set of laboratory rats for testing. Each rat can be given wine samples from any number of bottles, and after one hour, the rats will either die (if they drank poisoned wine) or survive (if they did not). The goal is to design a testing strategy that will identify the single poisoned bottle using the minimum possible number of rats within one hour. You are required to: 1. Determine the minimum number of rats required. 2. Describe a clear and systematic algorithm or approach to identify the poisoned bottle using those rats.	03 Marks CO2

3. Justify why your solution uses the minimum number of rats.

OR

Q.3B A company has **10,000 liters of oil** stored at a refinery located **1,000 km** away from its main plant.
A **tanker truck** can carry a maximum of **1,000 liters of oil at a time** and consumes **1 liter of oil per km** while traveling (including on return trips). To optimize the delivery, the company is allowed to **create intermediate storage stations** along the route where oil can be temporarily deposited and later picked up for further transport. The company must transport as much oil as possible to the plant using only this truck.

**03
Marks
CO2**

Task:

- Design an algorithm to determine the **maximum quantity of oil** that can reach the destination.
- Calculate the **time complexity** of your algorithm.

Q.3C A multinational company maintains a hierarchical record of its employees in a structured system. Due to a system crash, part of the hierarchy information was lost. However, two reports were recovered:

**03
Marks
CO3,
CO1**

1. The **first report** lists employees in the order they were **visited during a detailed managerial review**.
2. The **second report** lists employees in the order they **appear when grouped by their departmental alignment**.

Using this data, the company's IT team must **rebuild the complete reporting hierarchy**.

Given Data:

Managerial Review Sequence:

M, T, R, A, S, L, N, C, D, E, B, F

Departmental Sequence:

R, T, A, S, M, N, L, D, C, E, F, B

Your Tasks:

- 1) Reconstruct the **organizational hierarchy** (tree structure).
- 2) Identify the **top-most manager** in the structure.
- 3) Find the sequence of employees:
 - a) In the order of **completion of all subordinate reviews** (final visiting order).
 - b) In the order of **level-wise reporting from top to bottom**.

***** All The Best*****