WORKSHEET 4

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Question 1.1

1. STL Container Practice: Write a program using STL containers that:
    1. Uses vector<string> to store names
    2. Uses map<string, int> to store age against each name
    3. Implements functions to:
        1. Add new name-age pair
        2. Find all people above certain age
        3. Sort and display names alphabetically

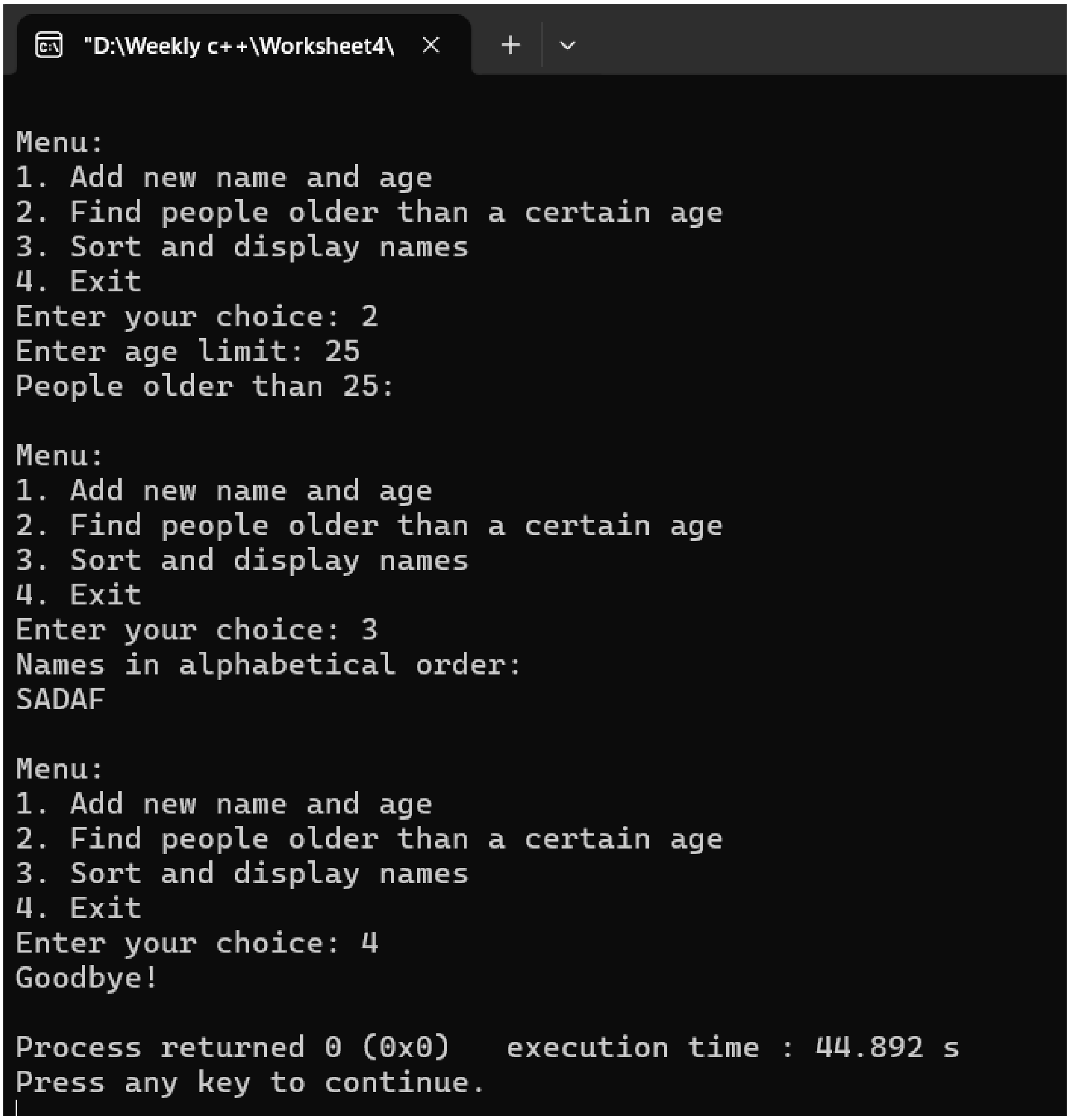
CODE:

```
#include <iostream>
#include <vector>
#include <string>
#include <map>
#include <algorithm>
using namespace std;

// Function to add a new name and age
void addNameAgePair(vector<string>& names, map<string, int>& ageMap, const string& name, int age) {
    names.push_back(name);      // Add name to list
    ageMap[name] = age;         // Add name and age to map
}
```

```
// Function to find people older than a given age
void findPeopleAboveAge(const map<string, int>& ageMap, int
threshold) {
    cout << "People older than " << threshold << ":\n";
    for (const auto& person : ageMap) {
        if (person.second > threshold) {
            cout << person.first << " (" << person.second << " years old)"
<< endl;
        }
    }
}

// Function to sort and show names in order
void sortAndDisplayNames(vector<string>& names) {
    vector<string> sortedNames = names; // Copy names
    sort(sortedNames.begin(), sortedNames.end()); // Sort names

    cout << "Names in alphabetical order:\n";
    for (const auto& name : sortedNames) {
        cout << name << endl;
    }
}
```

```
int main() {
    vector<string> names;    // List to store names
    map<string, int> ageMap; // Map to store name and age

    int choice;
    do {
        // Show menu
        cout << "\nMenu:\n";
        cout << "1. Add new name and age\n";
        cout << "2. Find people older than a certain age\n";
        cout << "3. Sort and display names\n";
        cout << "4. Exit\n";
        cout << "Enter your choice: ";
        cin >> choice;

        if (choice == 1) {
            string name;
            int age;
            cout << "Enter name: ";
            cin >> name;
            cout << "Enter age: ";
            cin >> age;
            addNameAgePair(names, ageMap, name, age);
            cout << "Added successfully.\n";
        }
        else if (choice == 2) {
            int threshold;
            cout << "Enter age limit: ";
            cin >> threshold;
            findPeopleAboveAge(ageMap, threshold);
        }
        else if (choice == 3) {
            sortAndDisplayNames(names);
        }
        else if (choice == 4) {
            cout << "Goodbye!\n";
        }
        else {
            cout << "Invalid option. Try again.\n";
        }

    } while (choice != 4); // Keep running until user chooses to exit
    return 0;
}
```

OUTPUT:



```
Menu:
1. Add new name and age
2. Find people older than a certain age
3. Sort and display names
4. Exit
Enter your choice: 2
Enter age limit: 25
People older than 25:

Menu:
1. Add new name and age
2. Find people older than a certain age
3. Sort and display names
4. Exit
Enter your choice: 3
Names in alphabetical order:
SADAF

Menu:
1. Add new name and age
2. Find people older than a certain age
3. Sort and display names
4. Exit
Enter your choice: 4
Goodbye!

Process returned 0 (0x0)   execution time : 44.892 s
Press any key to continue.
```

Question 1.2

1. Stack Problem: Implement a stack using arrays (not STL) that:
    1. Has basic push and pop operations
    2. Has a function to find middle element
    3. Has a function to reverse only bottom half of stack

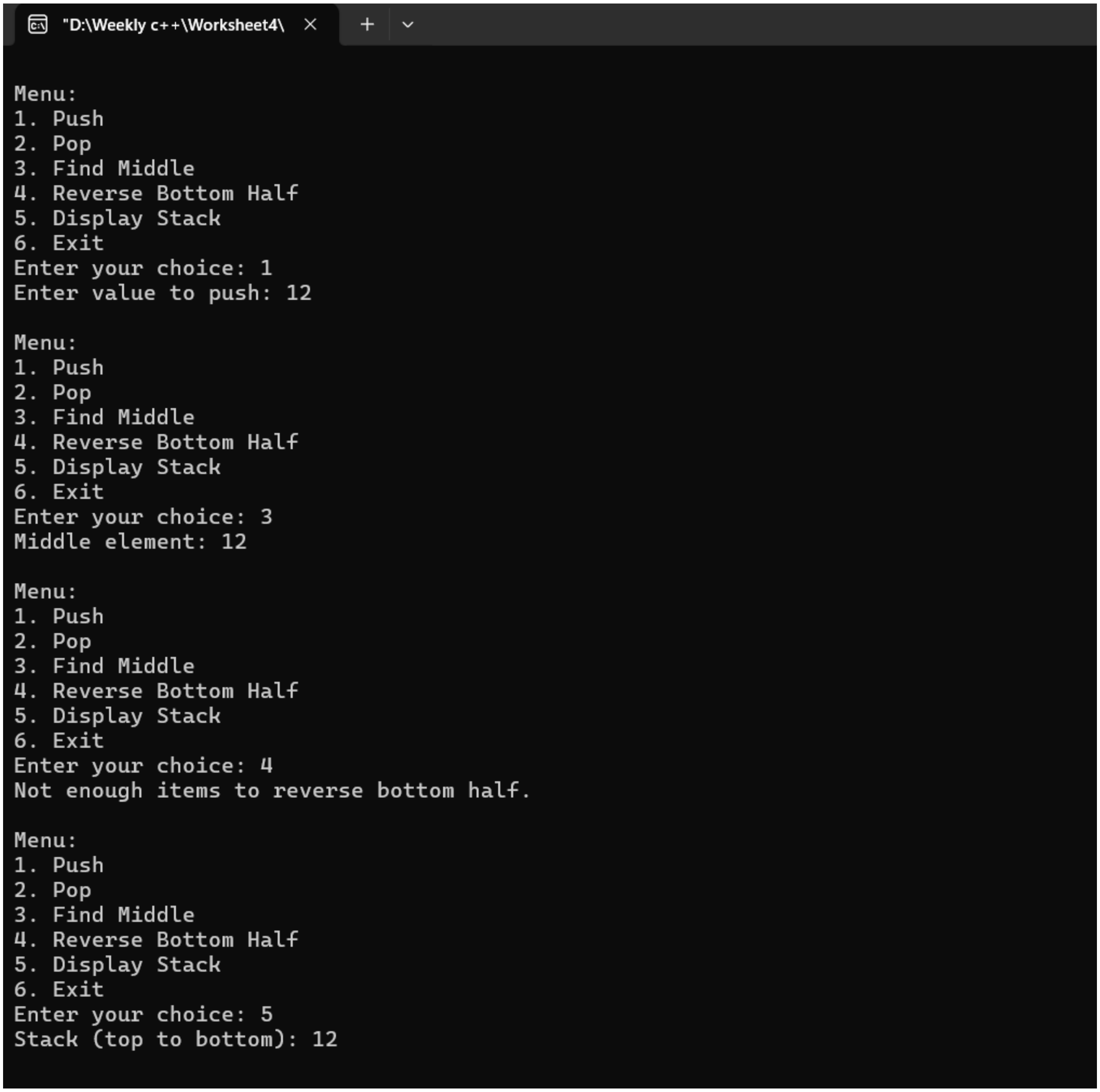
4. Maintain stack size of 10

CODE:

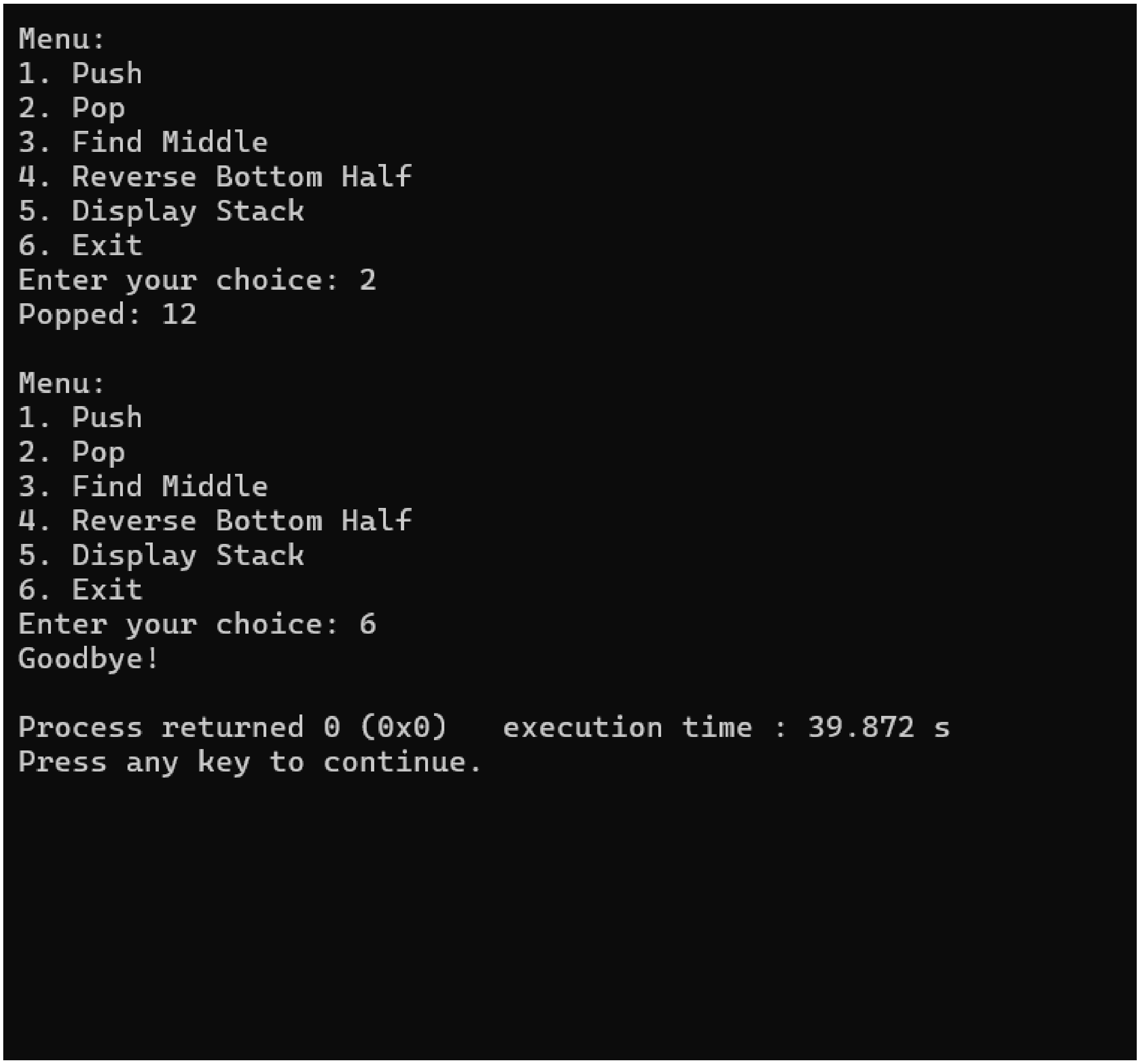
```
#include <iostream>
using namespace std;

#define MAX_SIZE 10 // Max size of stack

class Stack {
private:
    int arr[MAX_SIZE]; // Array to store stack items
    int top;           // Top index of stack
public:
    Stack() {
        top = -1; // Stack starts empty
    }

    // Add value to stack
    void push(int value) {
        if (top >= MAX_SIZE - 1) {
            cout << "Stack full! Cannot push " << value << endl;
            return;
        }
        arr[++top] = value;
    }

    // Remove value from top of stack
    int pop() {
        if (top < 0) {
            cout << "Stack empty! Cannot pop.\n";
            return -1;
        }
        return arr[top--];
    }

    // Show middle value of stack
    void findMiddle() {
        if (top < 0) {
            cout << "Stack is empty!\n";
            return;
        }
        int middleIndex = top / 2;
        cout << "Middle element: " << arr[middleIndex] << endl;
    }
```

```
// Reverse only the bottom half of the stack
void reverseBottomHalf() {
    if (top < 1) {
        cout << "Not enough items to reverse bottom half.\n";
        return;
    }
    int halfSize = (top + 1) / 2;
    for (int i = 0; i < halfSize / 2; i++) {
        swap(arr[i], arr[halfSize - 1 - i]);
    }
    cout << "Bottom half reversed.\n";
}

// Show all elements of stack
void display() {
    if (top < 0) {
        cout << "Stack is empty.\n";
        return;
    }
    cout << "Stack (top to bottom): ";
    for (int i = top; i >= 0; i--) {
        cout << arr[i] << " ";
        }
        cout << endl;
    }
};

int main() {
    Stack stack;
    int choice, value;
    do {
        cout << "\nMenu:\n";
        cout << "1. Push\n2. Pop\n3. Find Middle\n4. Reverse Bottom Half\n5. Display Stack\n6. Exit\n";
        cout << "Enter your choice: ";
        cin >> choice;
        switch (choice) {
            case 1:
                cout << "Enter value to push: ";
                cin >> value;
                stack.push(value);
                break;
            case 2:
                value = stack.pop();
                if (value != -1)
                    cout << "Popped: " << value << endl;
                break;
            case 3:
                stack.findMiddle();
                break;
            case 4:
                stack.reverseBottomHalf();
                break;
            case 5:
                stack.display();
                break;
            case 6:
                cout << "Goodbye!\n";
                break;
            default:
                cout << "Wrong option. Try again.\n";
        }
    } while (choice != 6);
    return 0;
}
```

OUTPUT:



```
Menu:
1. Push
2. Pop
3. Find Middle
4. Reverse Bottom Half
5. Display Stack
6. Exit
Enter your choice: 1
Enter value to push: 12

Menu:
1. Push
2. Pop
3. Find Middle
4. Reverse Bottom Half
5. Display Stack
6. Exit
Enter your choice: 3
Middle element: 12

Menu:
1. Push
2. Pop
3. Find Middle
4. Reverse Bottom Half
5. Display Stack
6. Exit
Enter your choice: 4
Not enough items to reverse bottom half.

Menu:
1. Push
2. Pop
3. Find Middle
4. Reverse Bottom Half
5. Display Stack
6. Exit
Enter your choice: 5
Stack (top to bottom): 12
```



```
Menu:
1. Push
2. Pop
3. Find Middle
4. Reverse Bottom Half
5. Display Stack
6. Exit
Enter your choice: 2
Popped: 12

Menu:
1. Push
2. Pop
3. Find Middle
4. Reverse Bottom Half
5. Display Stack
6. Exit
Enter your choice: 6
Goodbye!

Process returned 0 (0x0)   execution time : 39.872 s
Press any key to continue.
```

Question 1.3

1. Queue Problem: Implement a queue using arrays (not STL) that:
    1. Has basic enqueue and dequeue operations
    2. Has a function to reverse first K elements
    3. Has a function to interleave first half with second half
    4. Handle queue overflow/underflow

CODE:

```
#include <iostream>
using namespace std;

#define MAX_SIZE 10 // Maximum size of queue

class Queue {
private:
    int arr[MAX_SIZE];  // Array to hold queue elements
    int front, rear, size;  // Front, rear indices and size of queue

public:
    // Constructor to initialize queue
    Queue() {
        front = 0;
        rear = -1;
        size = 0;
    }

    // Check if queue is empty
    bool isEmpty() {
        return size == 0;
```

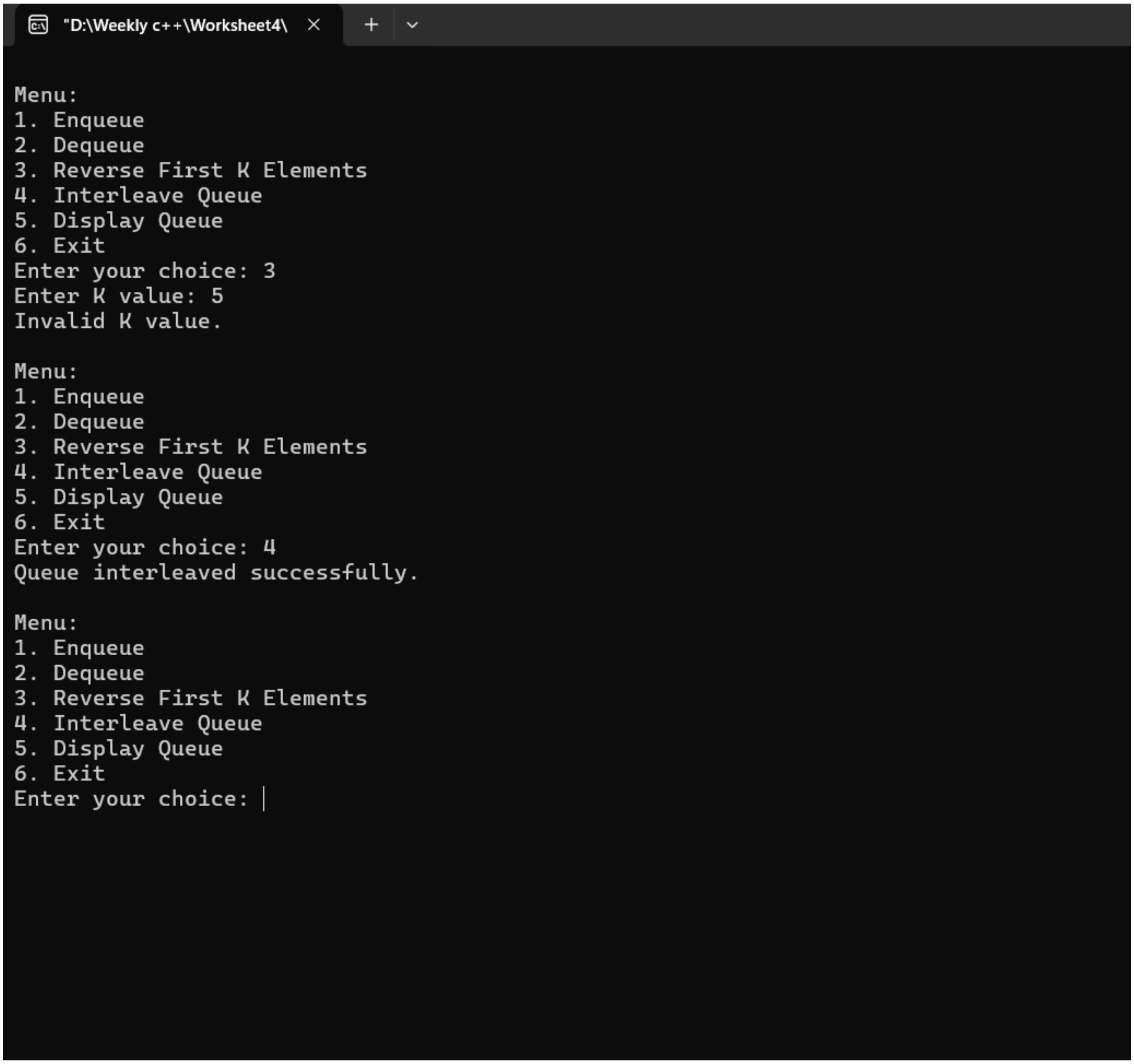
```
}

// Check if queue is full
bool isFull() {
   return size == MAX_SIZE;
}

// Add value to queue
void enqueue(int value) {
   if (isFull()) {
      cout << "Queue Overflow! Cannot add " << value << endl;
      return;
   }
   rear = (rear + 1) % MAX_SIZE;
   arr[rear] = value;
   size++;
}

// Remove value from queue
int dequeue() {
   if (isEmpty()) {
      cout << "Queue Underflow! No element to remove.\n";
```

```
            return -1;
        }
        int removedValue = arr[front];
        front = (front + 1) % MAX_SIZE;
        size--;
        return removedValue;
    }

    // Reverse the first K elements in the queue
    void reverseFirstK(int k) {
        if (k <= 0 || k > size) {
            cout << "Invalid K value.\n";
            return;
        }
        for (int i = 0; i < k / 2; i++) {
            swap(arr[(front + i) % MAX_SIZE], arr[(front + k - 1 - i) %
MAX_SIZE]);
        }
        cout << "First " << k << " elements reversed.\n";
    }

    // Interleave the first half with the second half of the queue
```

```
void interleaveQueue() {
    if (size % 2 != 0) {
        cout << "Queue size must be even to interleave.\n";
        return;
    }
    int halfSize = size / 2;
    int temp[MAX_SIZE];

    // Merge first half and second half into temp array
    for (int i = 0; i < halfSize; i++) {
        temp[i * 2] = arr[(front + i) % MAX_SIZE];
        temp[i * 2 + 1] = arr[(front + halfSize + i) % MAX_SIZE];
    }

    // Copy the interleaved result back to the queue
    for (int i = 0; i < size; i++) {
        arr[(front + i) % MAX_SIZE] = temp[i];
    }

    cout << "Queue interleaved successfully.\n";
}
```

```
    // Display all elements in the queue
    void display() {
        if (isEmpty()) {
            cout << "Queue is empty.\n";
            return;
        }
        cout << "Queue (front to rear): ";
        for (int i = 0; i < size; i++) {
            cout << arr[(front + i) % MAX_SIZE] << " ";
        }
        cout << endl;
    }
};

int main() {
    Queue queue;
    int choice, value, k;

    // Menu-driven interface for queue operations
    do {
        cout << "\nMenu:\n";
        cout << "1. Enqueue\n2. Dequeue\n3. Reverse First K Elements\n4. Interleave Queue\n5. Display Queue\n6. Exit\n";
        cout << "Enter your choice: ";
        cin >> choice;

        switch (choice) {
            case 1:
                cout << "Enter value to enqueue: ";
                cin >> value;
                queue.enqueue(value); // Add value to queue
                break;
            case 2:
                value = queue.dequeue(); // Remove value from queue
                if (value != -1) cout << "Dequeued: " << value << endl;
                break;
            case 3:
                cout << "Enter K value: ";
                cin >> k;
                queue.reverseFirstK(k); // Reverse first K elements
                break;
            case 4:
                queue.interleaveQueue(); // Interleave first half with second half
                break;
            case 5:
                queue.display(); // Display queue elements
                break;
            case 6:
                cout << "Exiting program.\n"; // Exit the program
                break;
            default:
                cout << "Invalid choice. Try again.\n"; // Handle invalid choice
        }
    } while (choice != 6); // Continue until user selects exit

    return 0;
}
```

OUTPUT:



```
Menu:
1. Enqueue
2. Dequeue
3. Reverse First K Elements
4. Interleave Queue
5. Display Queue
6. Exit
Enter your choice: 3
Enter K value: 5
Invalid K value.

Menu:
1. Enqueue
2. Dequeue
3. Reverse First K Elements
4. Interleave Queue
5. Display Queue
6. Exit
Enter your choice: 4
Queue interleaved successfully.

Menu:
1. Enqueue
2. Dequeue
3. Reverse First K Elements
4. Interleave Queue
5. Display Queue
6. Exit
Enter your choice: 
```

Question 1.4

1. Linked List Problem: Create a singly linked list (not STL) that:
    1. Has functions to insert at start/end/position
    2. Has a function to detect and remove loops
    3. Has a function to find nth node from end

4. Has a function to reverse list in groups of K nodes

CODE:

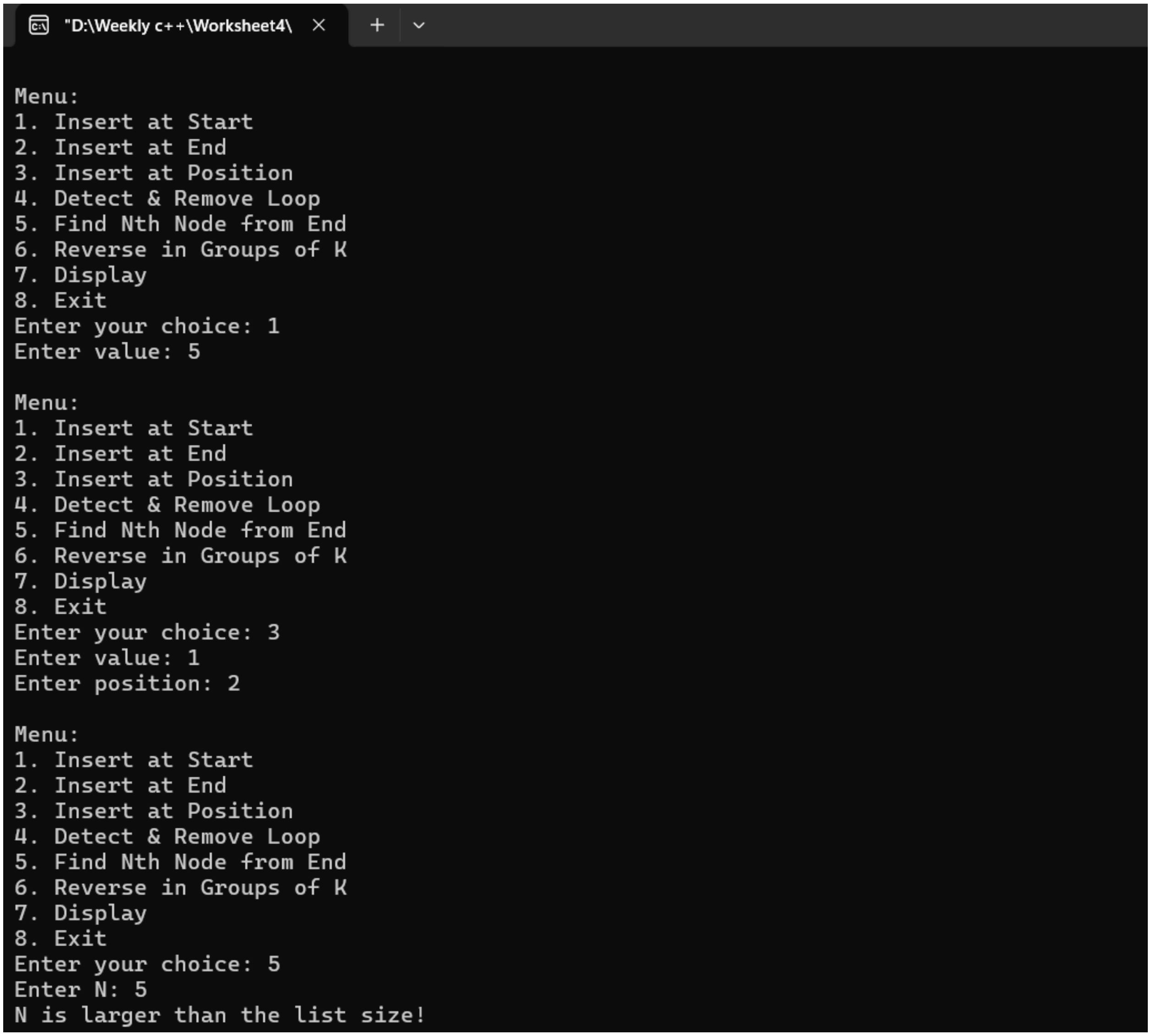
```
#include <iostream>
using namespace std;

class Node {
public:
    int data;
    Node* next;

    Node(int val) {
        data = val;
        next = nullptr;
    }
};

class LinkedList {
private:
    Node* head;

public:
    LinkedList() {
```

```
    head = nullptr;  // Initially, list is empty
}

// Insert a node at the beginning
void insertAtStart(int value) {
    Node* newNode = new Node(value);
    newNode->next = head;
    head = newNode;
}

// Insert a node at the end
void insertAtEnd(int value) {
    Node* newNode = new Node(value);
    if (!head) {
        head = newNode;  // If the list is empty, make new node the head
        return;
    }
    Node* temp = head;
    while (temp->next)  // Traverse to the last node
        temp = temp->next;
    temp->next = newNode;  // Add new node at the end
}
```

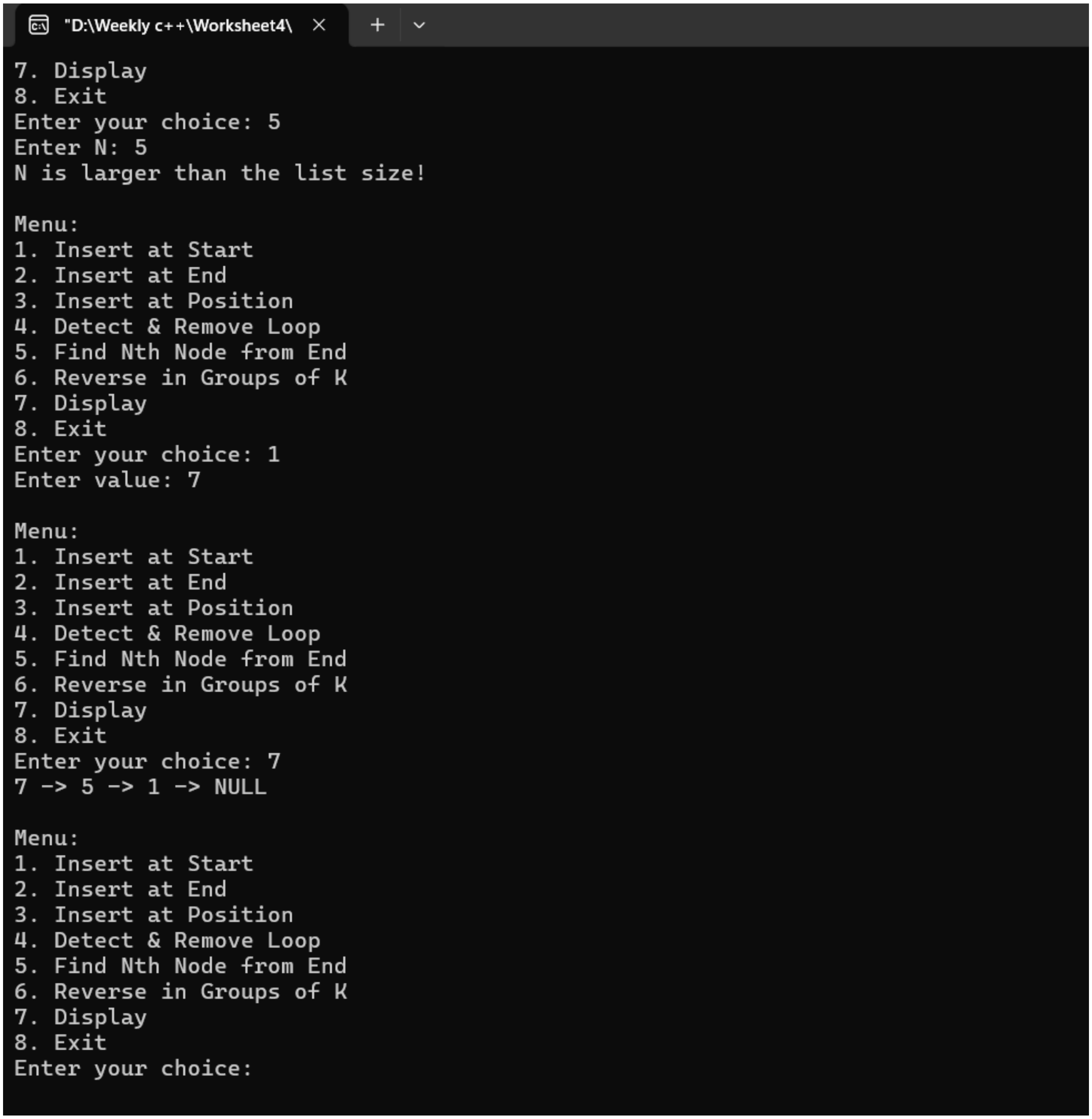
```
    // Insert a node at a specific position
    void insertAtPosition(int value, int position) {
        if (position <= 0) {
            cout << "Invalid position!\n";
            return;
        }
        if (position == 1) {
            insertAtStart(value);  // Insert at the beginning if position is 1
            return;
        }
        Node* newNode = new Node(value);
        Node* temp = head;
        for (int i = 1; i < position - 1 && temp; i++) {
            temp = temp->next;  // Traverse to the node just before the position
        }
        if (!temp) {
            cout << "Position out of bounds!\n";
            return;
        }
        newNode->next = temp->next;  // Insert new node at the specified position
        temp->next = newNode;
    }

    // Detect and remove loop in the list
    void detectAndRemoveLoop() {
        Node* slow = head, * fast = head;
        while (fast && fast->next) {
            slow = slow->next;
            fast = fast->next->next;  // Move fast pointer 2 steps, slow pointer 1 step
            if (slow == fast) {
                cout << "Loop detected! Removing...\n";
                removeLoop(slow);  // Remove loop if detected
                return;
            }
        }
        cout << "No loop detected.\n";
    }

    // Helper function to remove the loop
    void removeLoop(Node* loopNode) {
        Node* ptr1 = head;
        Node* ptr2 = loopNode;
        while (ptr1->next != ptr2->next) {
            ptr1 = ptr1->next;
            ptr2 = ptr2->next;  // Move both pointers until they meet at the loop entry point
        }
        ptr2->next = nullptr;  // Break the loop by setting the loop node's next to null
    }

    // Find the Nth node from the end of the list
    void findNthFromEnd(int n) {
        Node* first = head;
        Node* second = head;
        for (int i = 0; i < n; i++) {
            if (!first) {
                cout << "N is larger than the list size!\n";
                return;
            }
            first = first->next;  // Move first pointer N steps ahead
        }
        while (first) {
            first = first->next;
            second = second->next;  // Move both pointers one step at a time
until first reaches the end
        }
        cout << "The " << n << "th node from the end is: " << second-
>data << endl;
    }

    // Reverse the list in groups of K nodes
    Node* reverseInGroups(Node* head, int k) {
        if (!head || k <= 1) return head;  // If the list is empty or K is 1,
return as is

        Node* prev = nullptr;
        Node* current = head;
        Node* next = nullptr;
        int count = 0;
        Node* temp = head;
        for (int i = 0; i < k && temp; i++, temp = temp->next) count++;  //
Count if there are at least K nodes
        if (count < k) return head;  // If less than K nodes, no reversal

        // Reverse the first K nodes
        count = 0;
        while (current && count < k) {
            next = current->next;
            current->next = prev;
            prev = current;
            current = next;
            count++;
        }

        // Recursively reverse the rest of the list
        if (next) head->next = reverseInGroups(next, k);

        return prev;
    }

    // Reverse the list in groups of K nodes (public function)
    void reverseInGroupsK(int k) {
        head = reverseInGroups(head, k);
        cout << "List reversed in groups of " << k << endl;
    }

    // Display the list
    void display() {
        Node* temp = head;
        while (temp) {
            cout << temp->data << " -> ";  // Print each node's data
            temp = temp->next;
        }
        cout << "NULL\n";  // End of list
    }
};

int main() {
    LinkedList list;
    int choice, value, pos, k;
    do {
        cout << "\nMenu:\n";
        cout << "1. Insert at Start\n2. Insert at End\n3. Insert at Position\n4. Detect & Remove Loop\n5. Find Nth Node from End\n6. Reverse in Groups of K\n7. Display\n8. Exit\n";
        cout << "Enter your choice: ";
        cin >> choice;
        switch (choice) {
            case 1:
                cout << "Enter value: ";
                cin >> value;
    list.insertAtStart(value);
    break;
case 2:
    cout << "Enter value: ";
    cin >> value;
    list.insertAtEnd(value);
    break;
case 3:
    cout << "Enter value: ";
    cin >> value;
    cout << "Enter position: ";
    cin >> pos;
    list.insertAtPosition(value, pos);
    break;
case 4:
    list.detectAndRemoveLoop();
    break;
case 5:
    cout << "Enter N: ";
    cin >> pos;
    list.findNthFromEnd(pos);
    break;
```

```
            case 6:
                cout << "Enter K: ";
                cin >> k;
                list.reverseInGroupsK(k);
                break;
            case 7:
                list.display();
                break;
            case 8:
                cout << "Exiting program.\n";
                break;
            default:
                cout << "Invalid choice. Try again.\n";
        }
    } while (choice != 8);

    return 0;
}
```

OUTPUT:



```
Menu:
1. Insert at Start
2. Insert at End
3. Insert at Position
4. Detect & Remove Loop
5. Find Nth Node from End
6. Reverse in Groups of K
7. Display
8. Exit
Enter your choice: 1
Enter value: 5

Menu:
1. Insert at Start
2. Insert at End
3. Insert at Position
4. Detect & Remove Loop
5. Find Nth Node from End
6. Reverse in Groups of K
7. Display
8. Exit
Enter your choice: 3
Enter value: 1
Enter position: 2

Menu:
1. Insert at Start
2. Insert at End
3. Insert at Position
4. Detect & Remove Loop
5. Find Nth Node from End
6. Reverse in Groups of K
7. Display
8. Exit
Enter your choice: 5
Enter N: 5
N is larger than the list size!
```



```
7. Display
8. Exit
Enter your choice: 5
Enter N: 5
N is larger than the list size!

Menu:
1. Insert at Start
2. Insert at End
3. Insert at Position
4. Detect & Remove Loop
5. Find Nth Node from End
6. Reverse in Groups of K
7. Display
8. Exit
Enter your choice: 1
Enter value: 7

Menu:
1. Insert at Start
2. Insert at End
3. Insert at Position
4. Detect & Remove Loop
5. Find Nth Node from End
6. Reverse in Groups of K
7. Display
8. Exit
Enter your choice: 7
7 -> 5 -> 1 -> NULL

Menu:
1. Insert at Start
2. Insert at End
3. Insert at Position
4. Detect & Remove Loop
5. Find Nth Node from End
6. Reverse in Groups of K
7. Display
8. Exit
Enter your choice:
```