VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019
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B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
(Affiliated To Visvesvaraya Technological University, Belgaum)
Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by Pranay Kommuri (1BM23CS242), who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2024-25. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab - **(23CS3PCDST)**work prescribed for the said degree.

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Index Sheet

Course outcomes:

CO1	Apply the concept of linear and nonlinear data structures.
CO2	Analyze data structure operations for a given problem
CO3	Design and develop solutions using the operations of linear and nonlinear data structure for a given specification.
CO4	Conduct practical experiments for demonstrating the operations of different data structures.

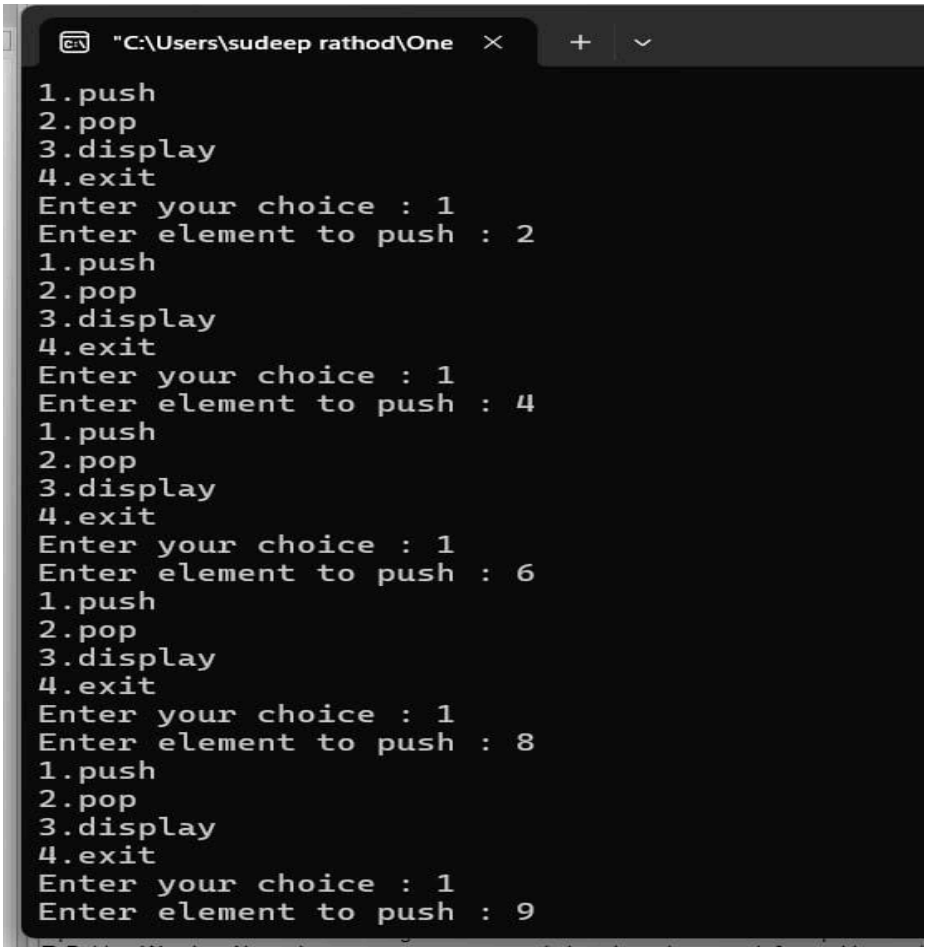
Lab program 1:

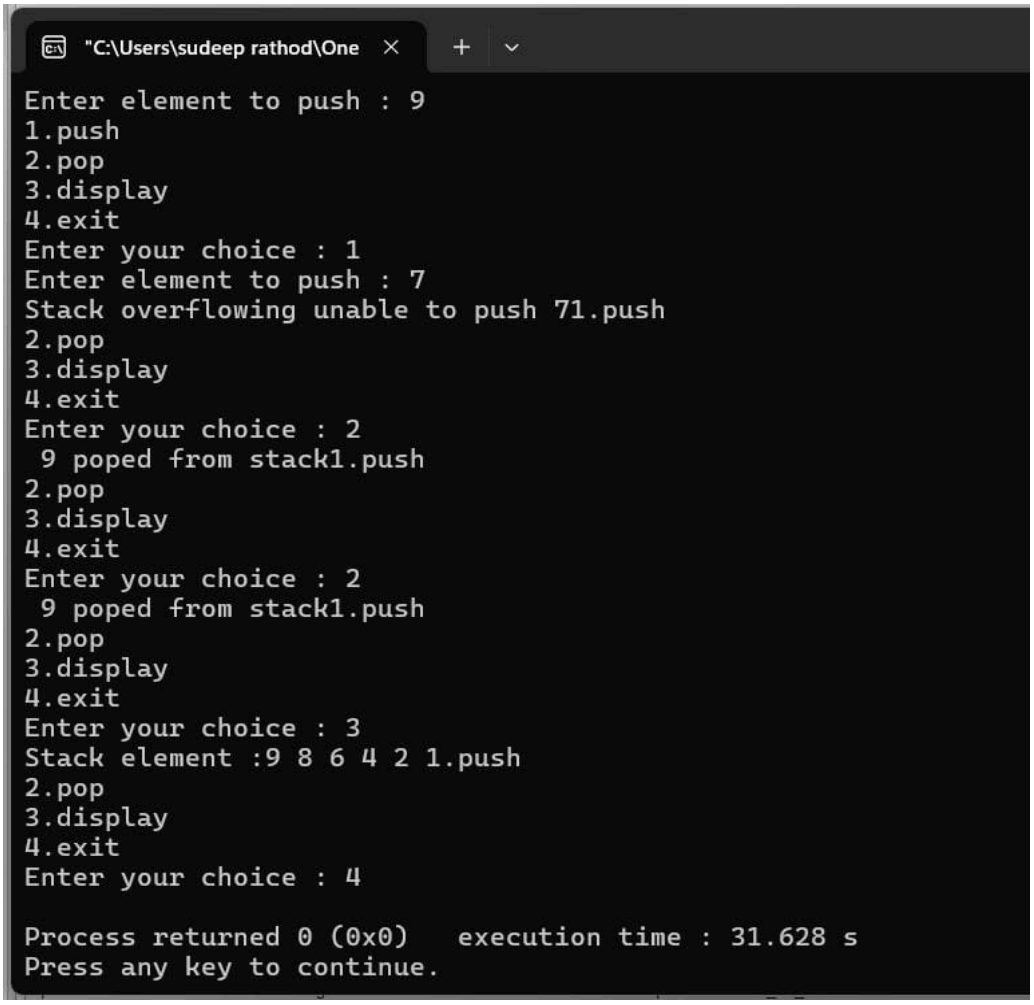
Write a program to simulate the working of stack using an array with the following:
a) Push
b) Pop
c) Display
The program should print appropriate messages for stack overflow, stack underflow.

```
#include<stdio.h>
#include<stdlib.h>
#define SIZE 5

int stack[SIZE],top=-1;

void push (int element){
   if(top == SIZE-1){
      printf("Stack overflowing unable to push %d",element);
   }else{
      top++;
      stack[top]= element;
   }
}
void pop(){
   if (top == -1){
      printf("stack underflow no element to pop");
   }else{
      printf(" %d poped from stack",stack[top]);
   }
}
void display(){
   if (top == -1){
      printf("Stack is Empty");
   }else{
      printf("Stack element :");
      for(int i=top ; i>=0 ; i--){
         printf("%d ",stack[i]);
   }
   }
}
int main(){
   int choice,element;
   while(1){
      printf("1.push\n2.pop\n3.display\n4.exit\n");
      printf("Enter your choice : ");
      scanf("%d",&choice);

      switch(choice){
         case 1:
         printf("Enter element to push : ");
```

```
            scanf("%d",&element);
            push(element);
            break;

            case 2:
            pop();
            break;

            case 3:
            display();
            break;

            case 4:
            exit (0);

            default:
            printf("Invalid choice, please try again");
        }
}
        return (0);
}
```

OUTPUT:





Lab Program 2:

Write a program to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and the binary operators + (plus), - (minus), * (multiply) and / (divide)

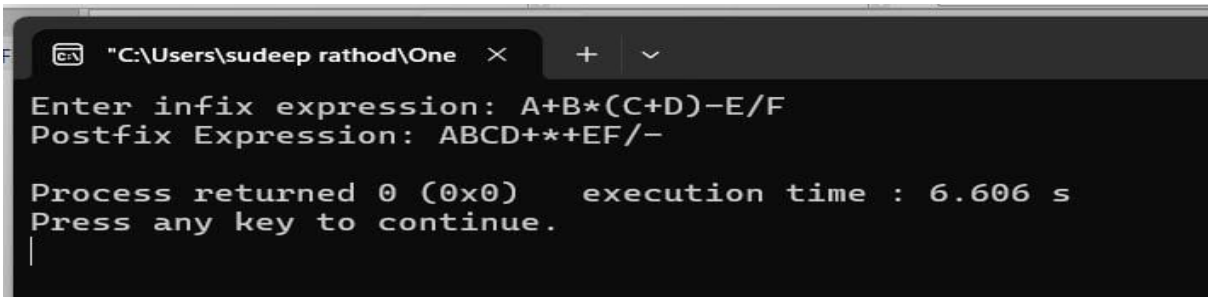
```
#include <stdio.h>

#define MAX 100


char stack[MAX];

int top = -1;


void push(char x) {

   if (top == MAX - 1) {
```

```
        printf("Stack Overflow\n");
    } else {
        stack[++top] = x;
    }
}
char pop() {
    if (top == -1) {
        printf("Stack Underflow\n");
        return -1;
    } else {
        return stack[top--];
    }
}
int precedence(char x) {
    if (x == '^') {
        return 3;
    } else if (x == '*' || x == '/') {
        return 2;
    } else if (x == '+' || x == '-') {
        return 1;
    } else {
        return 0;
    }
}
int isOperand(char ch) {
    if ((ch >= 'A' && ch <= 'Z') || (ch >= 'a' && ch <= 'z') || (ch >= '0' && ch <= '9')) {
        return 1;
    }
    return 0;
```

```
}
void infixToPostfix(char* exp) {
    char postfix[MAX];
    int i, j = 0;
    for (i = 0; exp[i] != '\0'; i++) {
        char ch = exp[i];
        if (isOperand(ch)) {
            postfix[j++] = ch;
        }
        else if (ch == '(') {
            push(ch);
        }
        else if (ch == ')') {
            while (top != -1 && stack[top] != '(') {
                postfix[j++] = pop();
            }
            pop();
        }
        else {
            while (top != -1 && precedence(stack[top]) >= precedence(ch)) {
                postfix[j++] = pop();
            }
            push(ch);
        }
    }
    while (top != -1) {
        postfix[j++] = pop();
    }
    postfix[j] = '\0';
```

```
    printf("Postfix Expression: %s\n", postfix);
}


int main() {
    char infix[MAX];
    printf("Enter infix expression: ");
    scanf("%s", infix);
    infixToPostfix(infix);


    return 0;
}
```

OUTPUT:



Lab Program 3:

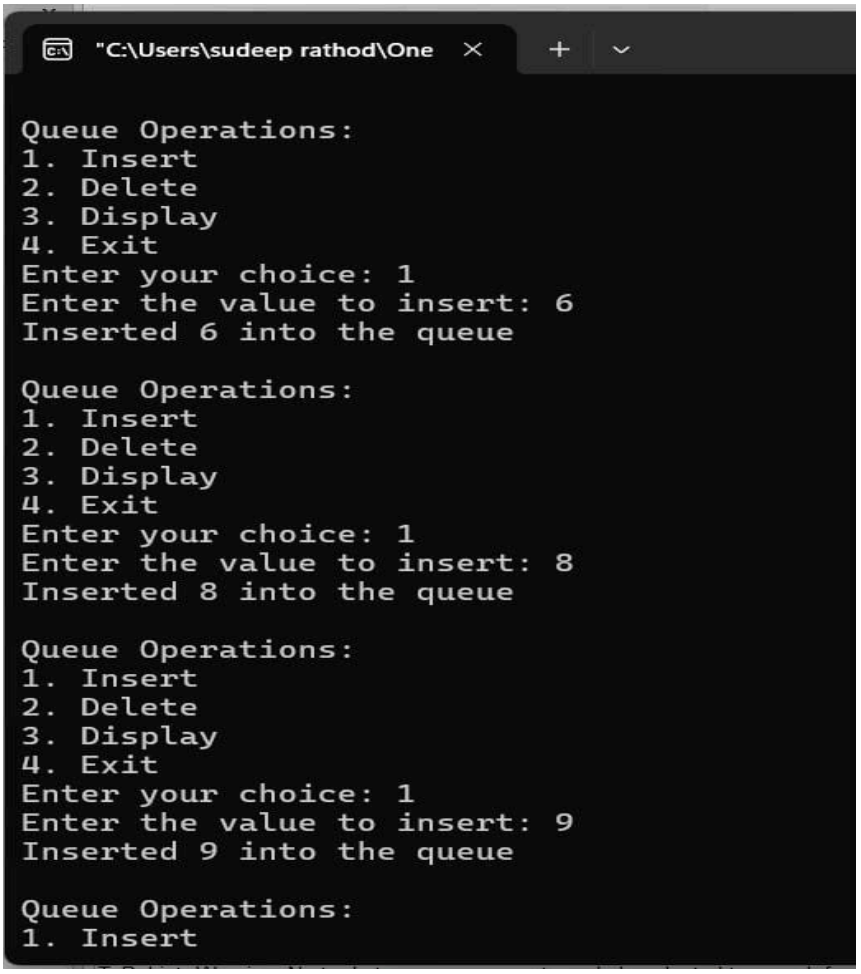
Write a program to simulate the working of a queue of integers using an array. Provide the following operations: Insert, Delete, Display The program should print appropriate messages for queue empty and queue overflow conditions.

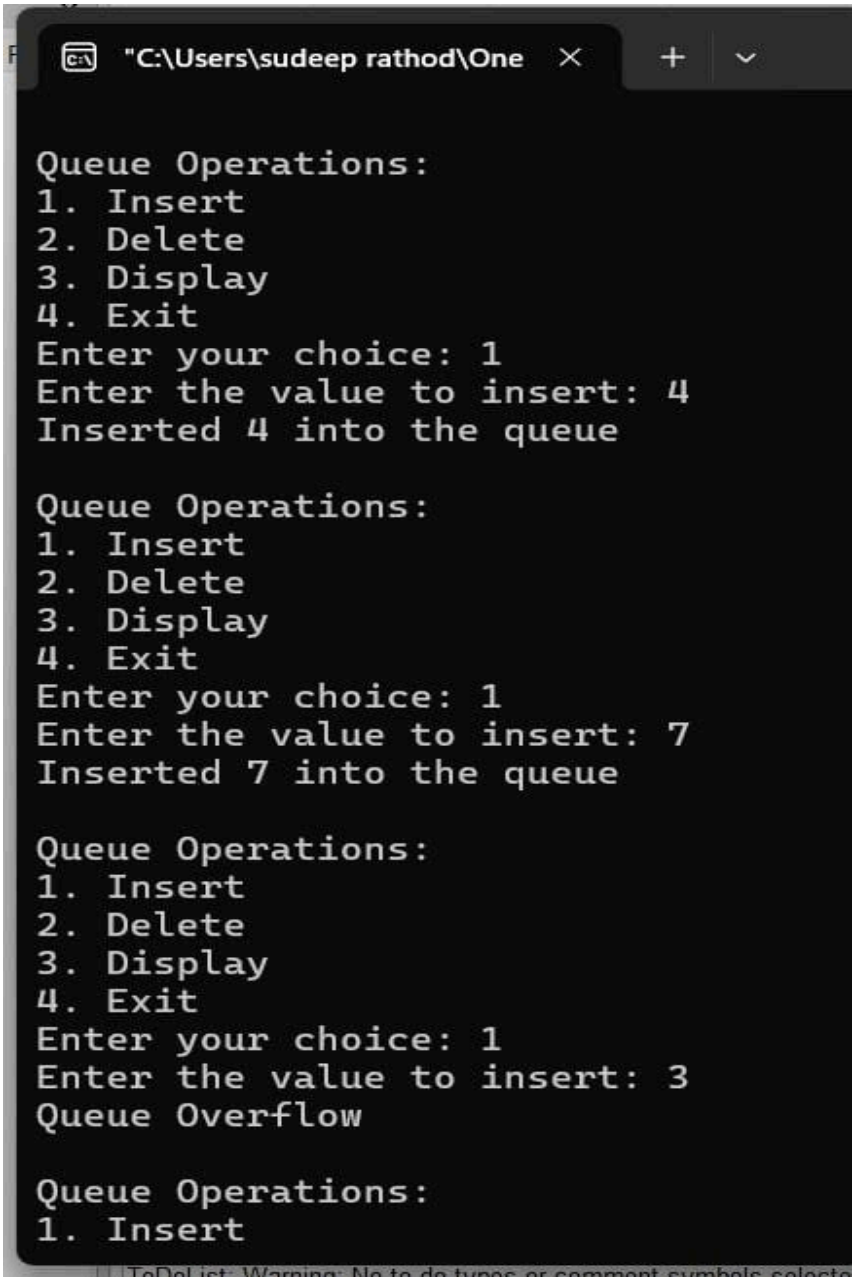
```
#include <stdio.h>
#define MAX 5

int queue[MAX];
int front = -1, rear = -1;

int isEmpty() {
    return (front == -1 || front > rear);
}

int isFull() {
    return (rear == MAX - 1);
}
```

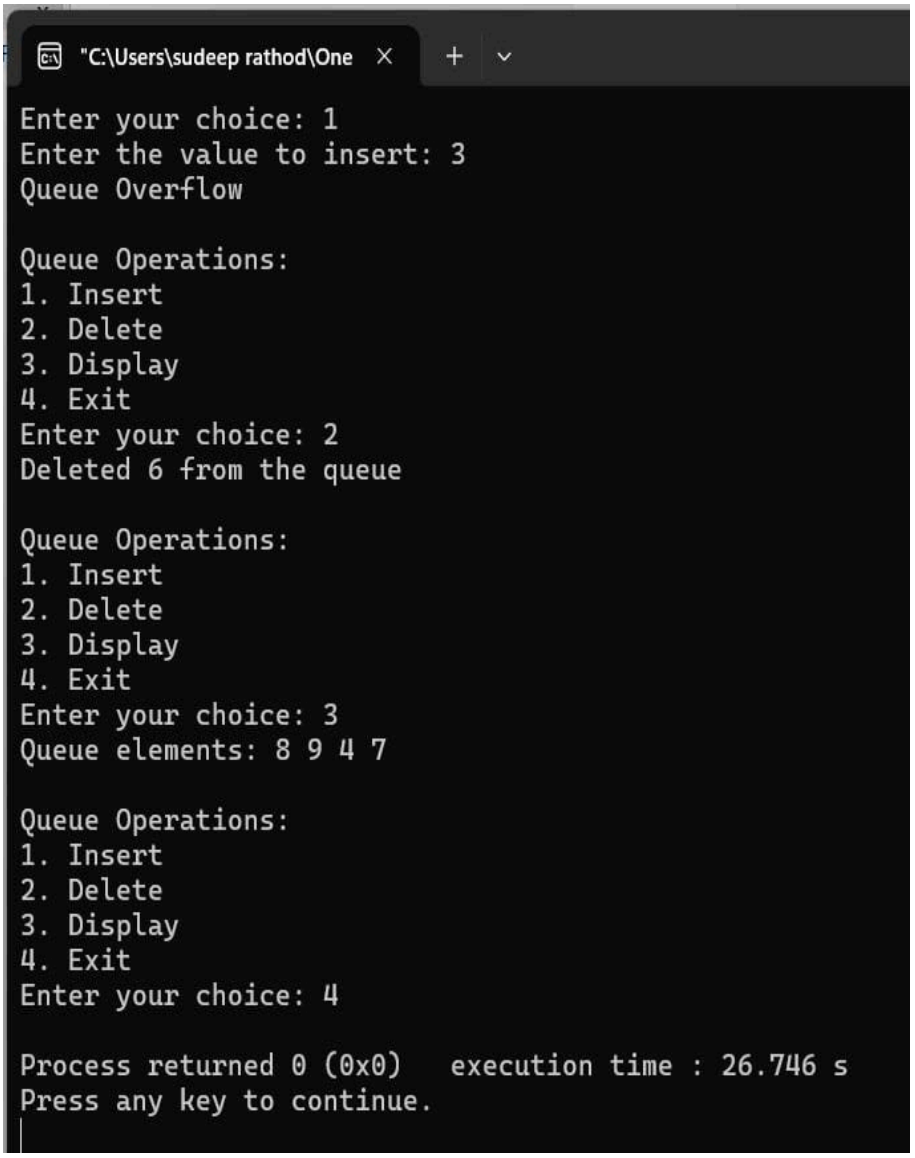
```
void insert(int value) {
   if (isFull()) {
      printf("Queue Overflow\n");
   } else {
      if (front == -1) {
         front = 0;
      }
      queue[++rear] = value;
      printf("Inserted %d into the queue\n", value);
   }
}

void delete() {
   if (isEmpty()) {
      printf("Queue Underflow\n");
   } else {
      printf("Deleted %d from the queue\n", queue[front]);
      front++;
      if (front > rear) {
         front = rear = -1;
      }
   }
}

void display() {
   if (isEmpty()) {
      printf("Queue is empty\n");
   } else {
      printf("Queue elements: ");
      for (int i = front; i <= rear; i++) {
         printf("%d ", queue[i]);
      }
      printf("\n");
   }
}

int main() {
   int choice, value;
   while (1) {
      printf("\nQueue Operations:\n");
      printf("1. Insert\n");
      printf("2. Delete\n");
      printf("3. Display\n");
      printf("4. Exit\n");
      printf("Enter your choice: ");
      scanf("%d", &choice);
```

```
        switch (choice) {
            case 1:
                printf("Enter the value to insert: ");
                scanf("%d", &value);
                insert(value);
                break;
            case 2:
                delete();
                break;
            case 3:
                display();
                break;
            case 4:
                return 0;
            default:
                printf("Invalid choice! Please try again.\n");
        }
    }
}
```

OUTPUT :




"C:\Users\sudeep rathod\One
Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 4
Inserted 4 into the queue
Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 7
Inserted 7 into the queue
Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 3
Queue Overflow
Queue Operations:
1. Insert



Lab Program 4:

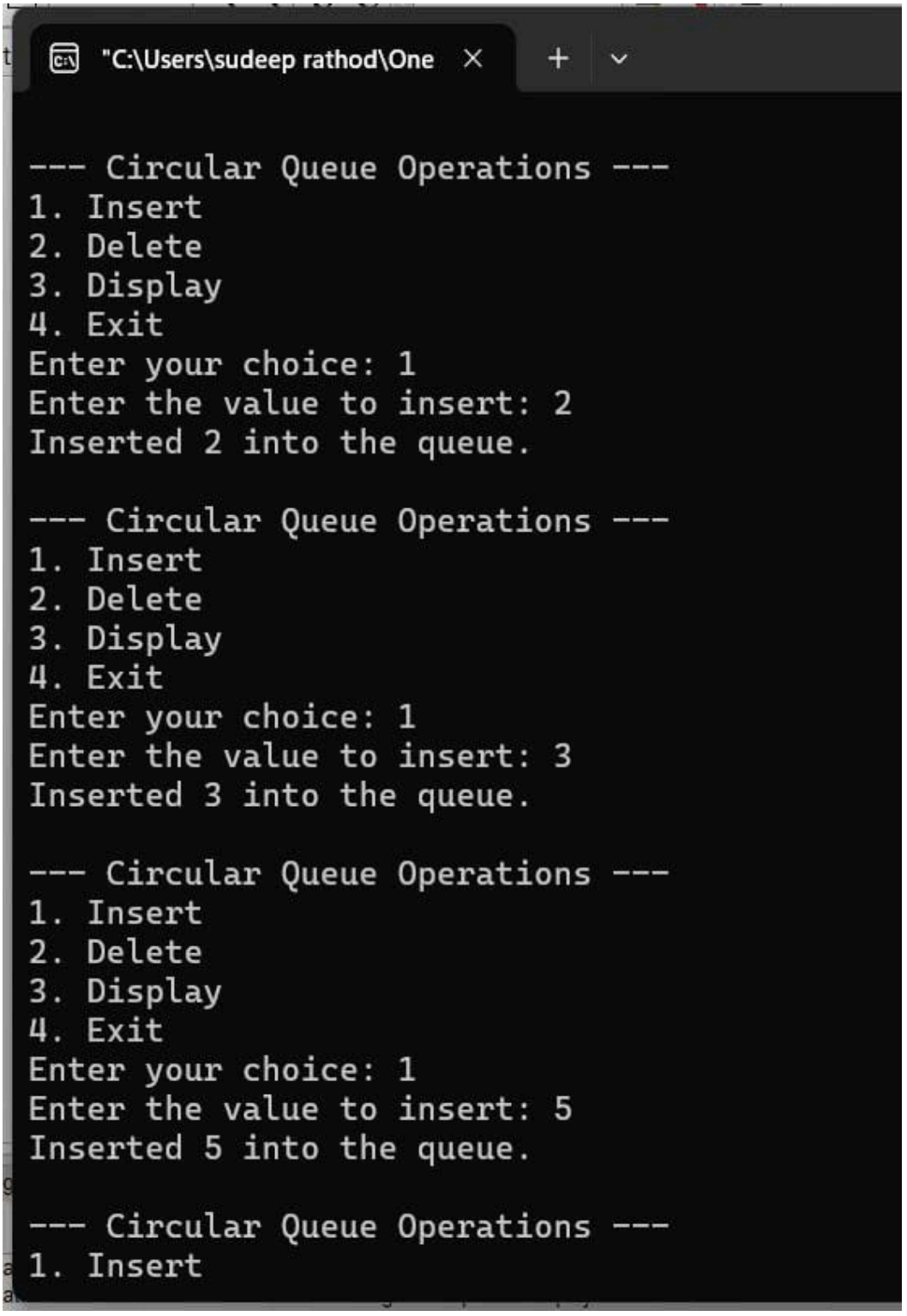
WAP to simulate the working of a circular queue of integers using an array. Provide the following operations:
Insert, Delete & Display The program should print appropriate messages for queue empty and queue overflow conditions.

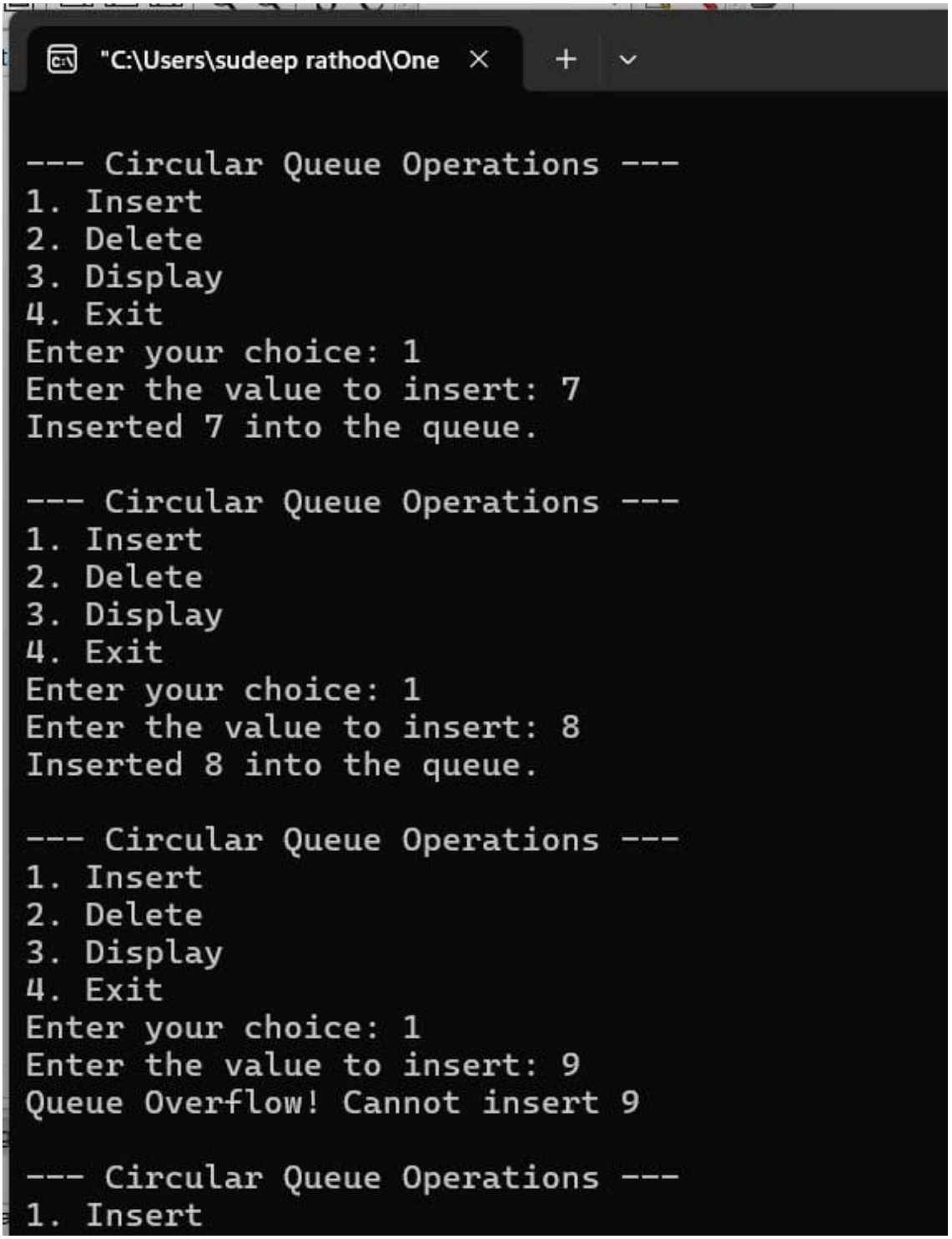
```
#include <stdio.h>
#define SIZE 5

int queue[SIZE];
int front = -1, rear = -1;

int isFull() {
   return (front == (rear + 1) % SIZE);
}
```

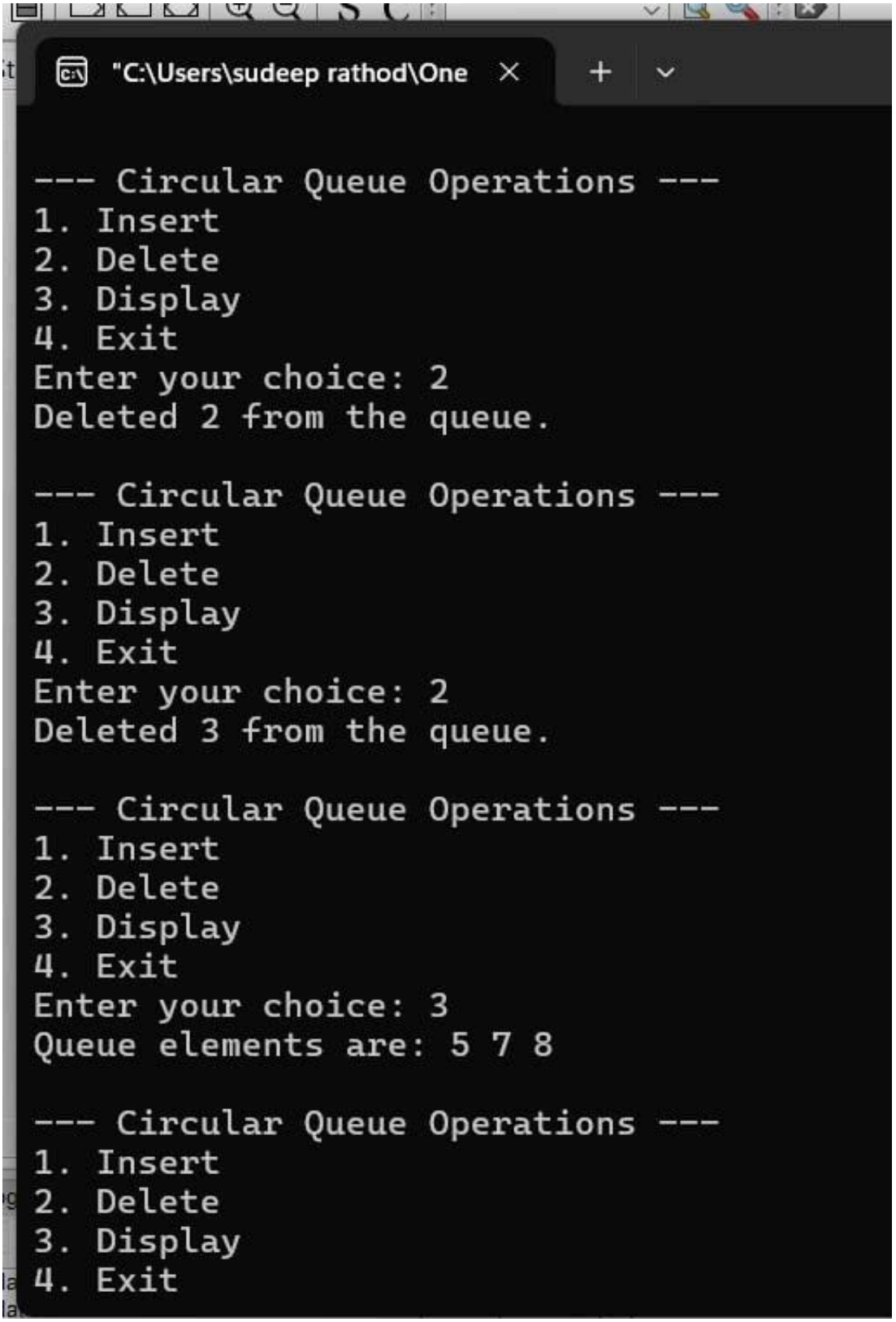
```
int isEmpty() {
   return (front == -1);
}

void insert(int value) {
   if (isFull()) {
      printf("Queue Overflow! Cannot insert %d\n", value);
      return;
   }

   if (isEmpty()) {
      front = rear = 0;
   } else {
      rear = (rear + 1) % SIZE;
   }

   queue[rear] = value;
   printf("Inserted %d into the queue.\n", value);
}

void delete() {
   if (isEmpty()) {
      printf("Queue Underflow! Cannot delete.\n");
      return;
   }

   printf("Deleted %d from the queue.\n", queue[front]);

   if (front == rear) {
      front = rear = -1;
   } else {
      front = (front + 1) % SIZE;
   }
}

void display() {
   if (isEmpty()) {
      printf("Queue is empty.\n");
      return;
   }

   printf("Queue elements are: ");
   int i = front;
   do {
      printf("%d ", queue[i]);
      i = (i + 1) % SIZE;
   } while (i != (rear + 1) % SIZE);
   printf("\n");
```

```
}

int main() {
    int choice, value;

    while (1) {
        printf("\n--- Circular Queue Operations ---\n");
        printf("1. Insert\n");
        printf("2. Delete\n");
        printf("3. Display\n");
        printf("4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the value to insert: ");
                scanf("%d", &value);
                insert(value);
                break;
            case 2:
                delete();
                break;
            case 3:
                display();
                break;
            case 4:
                printf("Exiting...\n");
                return 0;
            default:
                printf("Invalid choice! Please try again.\n");
        }
    }
}
```

OUTPUT :


"C:\Users\sudeep rathod\One
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 2
Inserted 2 into the queue.
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 3
Inserted 3 into the queue.
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 5
Inserted 5 into the queue.
--- Circular Queue Operations ---
1. Insert


"C:\Users\sudeep rathod\One
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 7
Inserted 7 into the queue.
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 8
Inserted 8 into the queue.
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 9
Queue Overflow! Cannot insert 9
--- Circular Queue Operations ---
1. Insert


"C:\Users\sudeep rathod\One
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 2 from the queue.
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 3 from the queue.
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue elements are: 5 7 8
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit

Lab Program 5:

Write a program for Insertion and Deletion of Single Linked List.

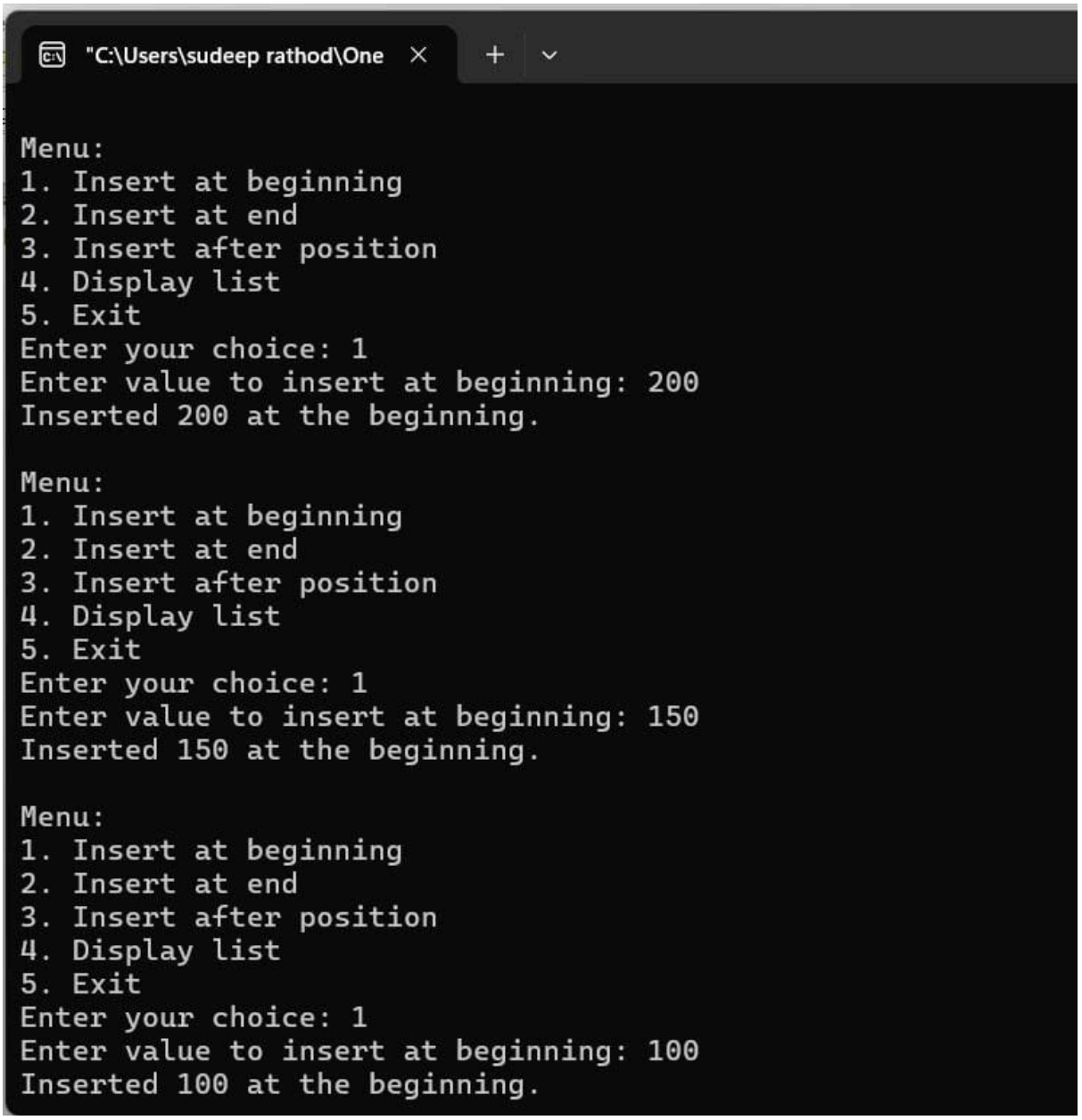
Insertion program:

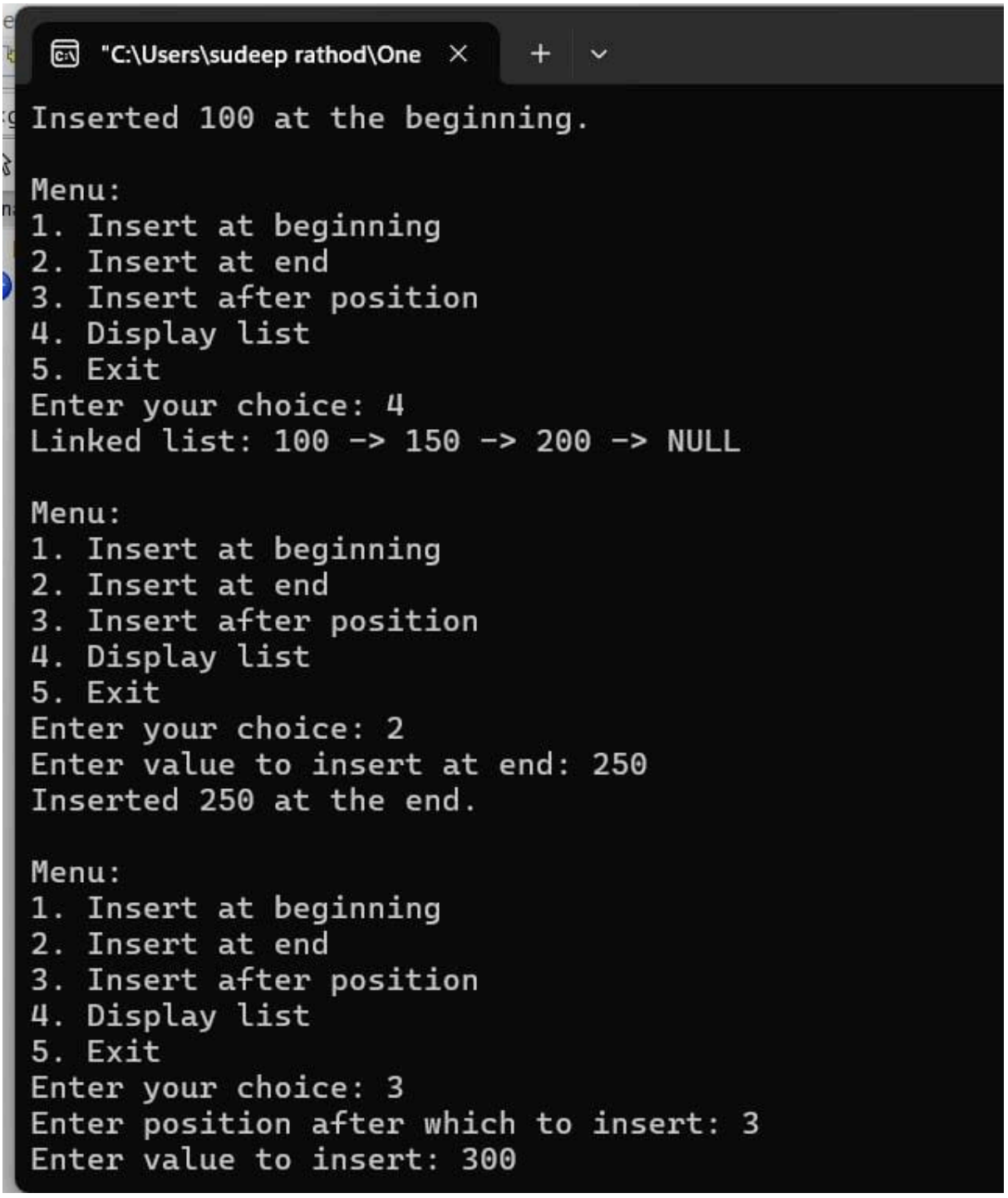
```
#include <stdio.h>
#include <stdlib.h>

struct Node {
   int data;
   struct Node *next;
};
struct Node *top = NULL;
struct Node* createNode(int value) {
   struct Node *newNode = (struct Node*)malloc(sizeof(struct Node));
   if (!newNode) {
      printf("Memory allocation failed.\n");
      exit(1);
   }
   newNode->data = value;
   newNode->next = NULL;
   return newNode;
}
void insertAtBeginning(int value) {
   struct Node *newNode = createNode(value);
   newNode->next = top;
   top = newNode;
   printf("Inserted %d at the beginning.\n", value);
}
void insertAtEnd(int value) {
   struct Node *newNode = createNode(value);
   if (top == NULL) {
      top = newNode;
      printf("Inserted %d at the end.\n", value);
      return;
   }
   struct Node *ptr = top;
   while (ptr->next != NULL) {
      ptr = ptr->next;
   }
   ptr->next = newNode;
   printf("Inserted %d at the end.\n", value);
}
void insertAfterPosition(int position, int value) {
   struct Node *newNode = createNode(value);
   struct Node *ptr = top;
   for (int i = 0; i < position; i++) {
```

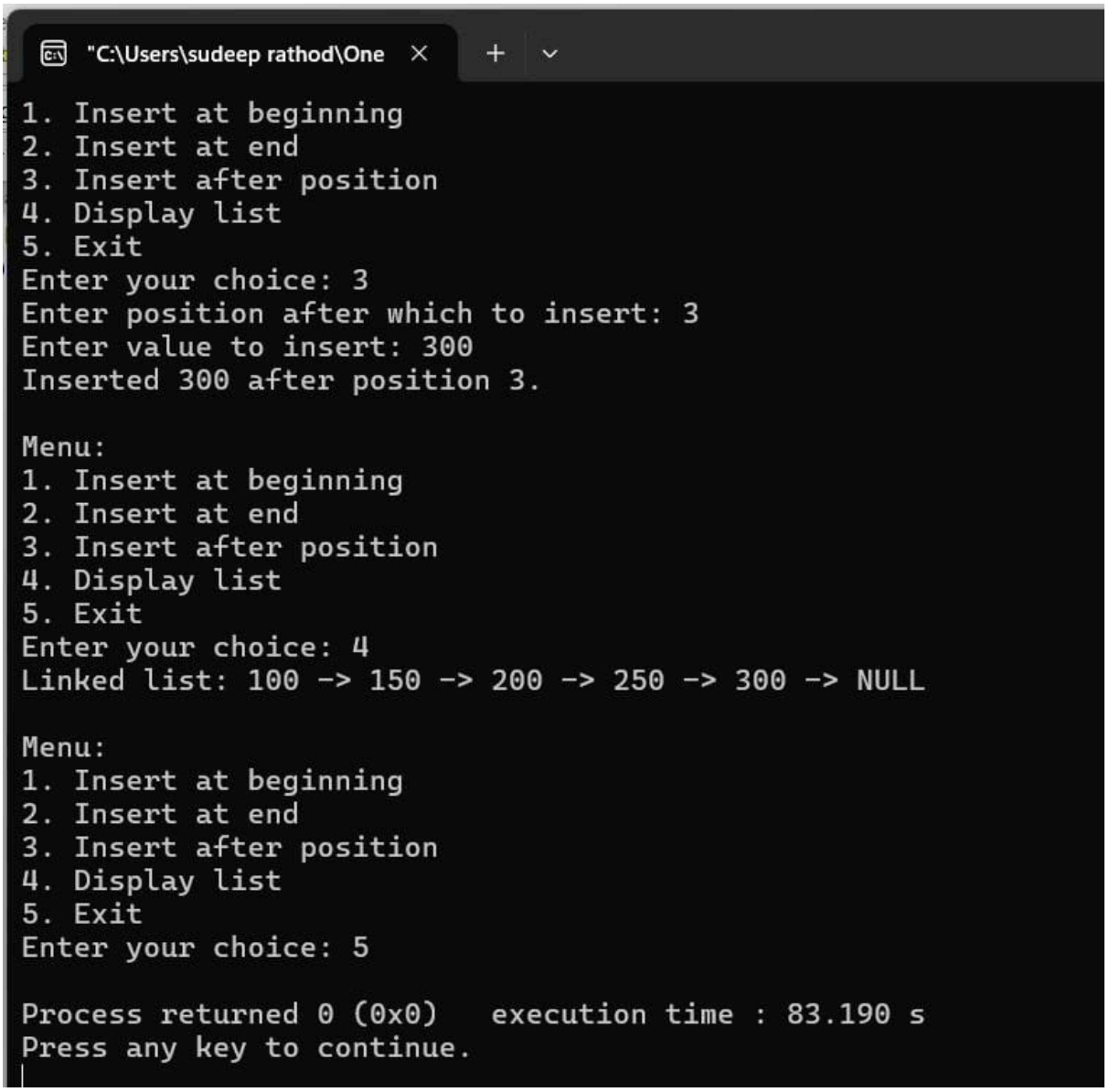
```
        if (ptr == NULL) {
            printf("Position %d is out of bounds.\n", position);
            free(newNode);
            return;
        }
        ptr = ptr->next;
    }
    newNode->next = ptr->next;
    ptr->next = newNode;
    printf("Inserted %d after position %d.\n", value, position);
}
void displayList() {
    if (top == NULL) {
        printf("The list is empty.\n");
        return;
    }
    struct Node *ptr = top;
    printf("Linked list: ");
    while (ptr != NULL) {
        printf("%d -> ", ptr->data);
        ptr = ptr->next;
    }
    printf("NULL\n");
}

int main() {
    int choice, value, position;
    while (1) {
        printf("\nMenu:\n1. Insert at beginning\n2. Insert at end\n3. Insert after position\n4.
Display list\n5. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to insert at beginning: ");
                scanf("%d", &value);
                insertAtBeginning(value);
                break;
            case 2:
                printf("Enter value to insert at end: ");
                scanf("%d", &value);
                insertAtEnd(value);
                break;
            case 3:
                printf("Enter position after which to insert: ");
                scanf("%d", &position);
                printf("Enter value to insert: ");
                scanf("%d", &value);
                insertAfterPosition(position, value);
```

```
            break;
        case 4:
            displayList();
            break;
        case 5:
            exit(0);
        default:
            printf("Invalid choice. Please try again.\n");
      }
   }
   return 0;
}
```

OUTPUT:




"C:\Users\sudeep rathod\One
Inserted 100 at the beginning.
Menu:
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 4
Linked list: 100 -> 150 -> 200 -> NULL
Menu:
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 2
Enter value to insert at end: 250
Inserted 250 at the end.
Menu:
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 3
Enter position after which to insert: 3
Enter value to insert: 300



Deletion Program:

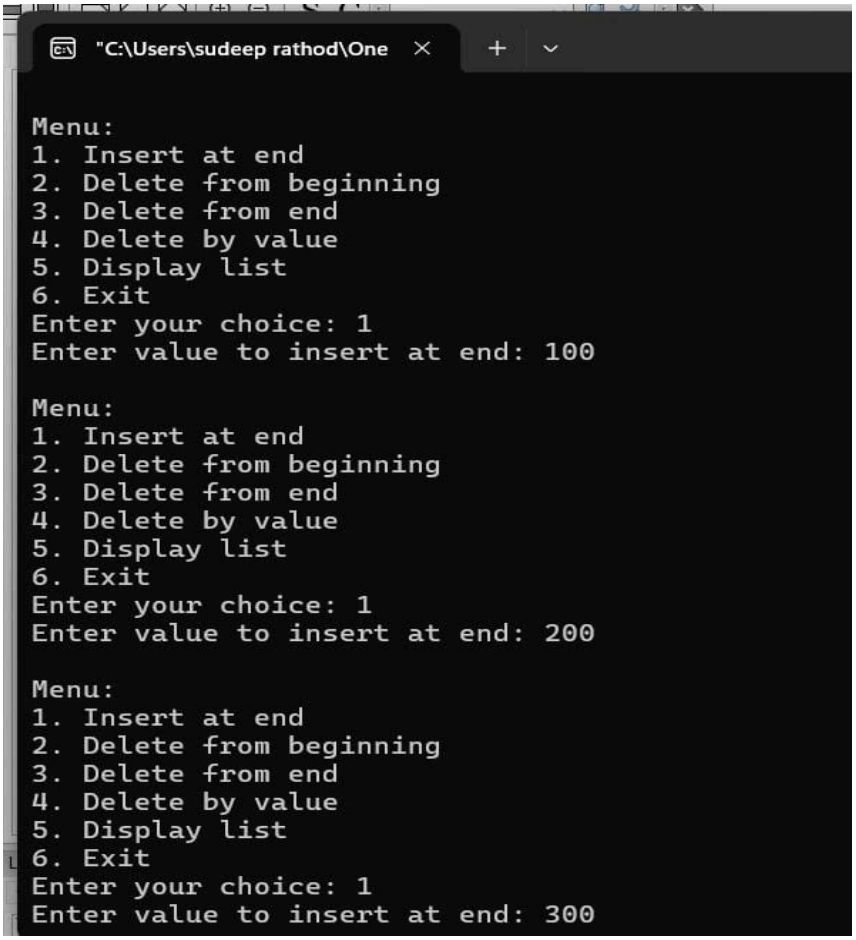
```
#include <stdio.h>
#include <stdlib.h>

struct Node {
   int data;
   struct Node *next;
};
struct Node *top = NULL;
struct Node* createNode(int value) {
   struct Node *newNode = (struct Node*)malloc(sizeof(struct Node));
   if (!newNode) {
      printf("Memory allocation failed.\n");
      exit(1);
   }
```

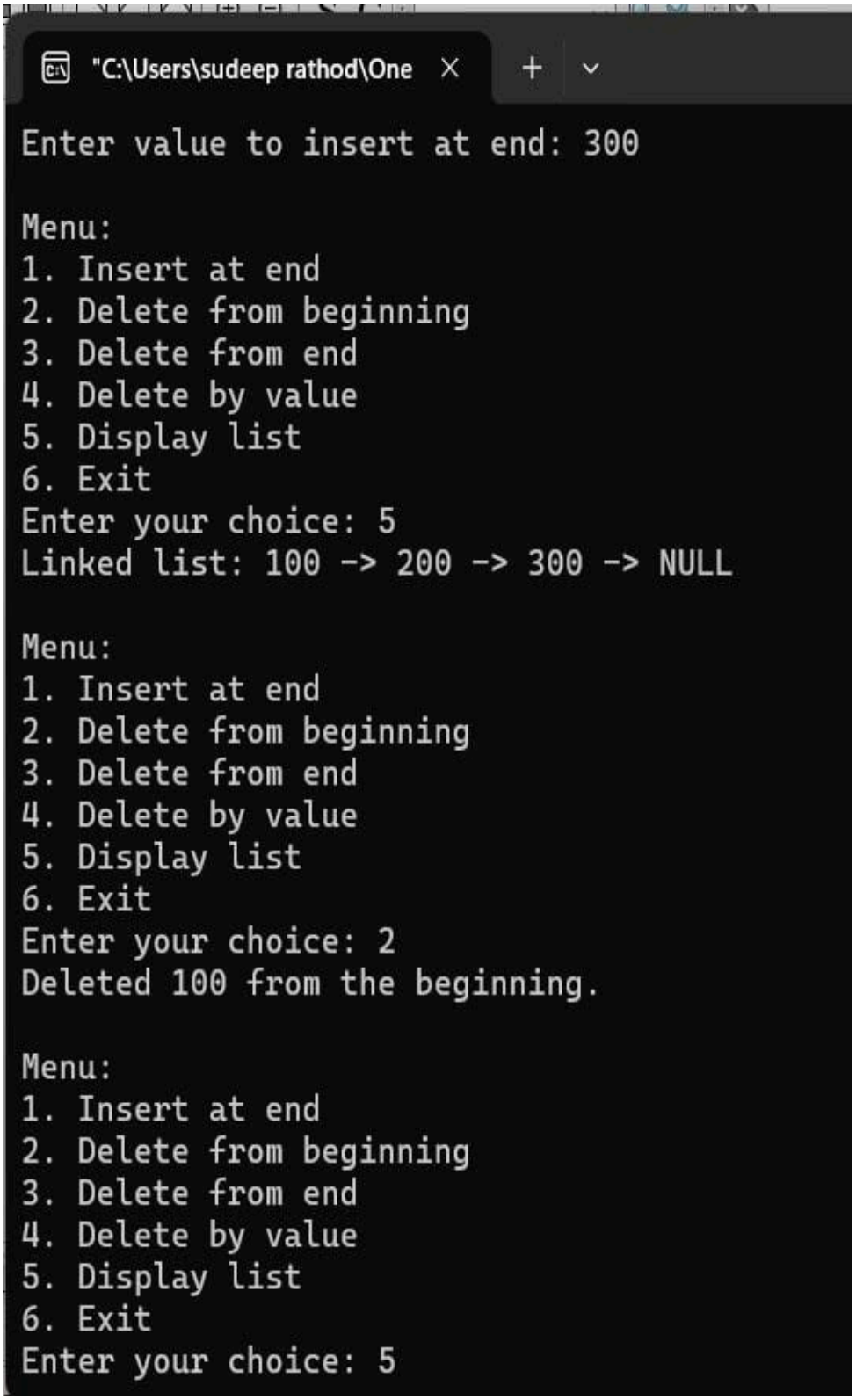
```
    newNode->data = value;
    newNode->next = NULL;
    return newNode;
}
void insertAtEnd(int value) {
    struct Node *newNode = createNode(value);
    if (top == NULL) {
        top = newNode;
        return;
    }
    struct Node *ptr = top;
    while (ptr->next != NULL) {
        ptr = ptr->next;
    }
    ptr->next = newNode;
}
void deleteFromBeginning() {
    if (top == NULL) {
        printf("The list is empty. Nothing to delete.\n");
        return;
    }
    struct Node *temp = top;
    top = top->next;
    printf("Deleted %d from the beginning.\n", temp->data);
    free(temp);
}
void deleteFromEnd() {
    if (top == NULL) {
        printf("The list is empty. Nothing to delete.\n");
        return;
    }
    struct Node *ptr = top;
    if (ptr->next == NULL) {
        printf("Deleted %d from the end.\n", ptr->data);
        free(ptr);
        top = NULL;
        return;
    }
    while (ptr->next->next != NULL) {
        ptr = ptr->next;
    }
    struct Node *temp = ptr->next;
    printf("Deleted %d from the end.\n", temp->data);
    ptr->next = NULL;
    free(temp);
}
void deleteByValue(int value) {
    if (top == NULL) {
        printf("The list is empty. Nothing to delete.\n");
        return;
```

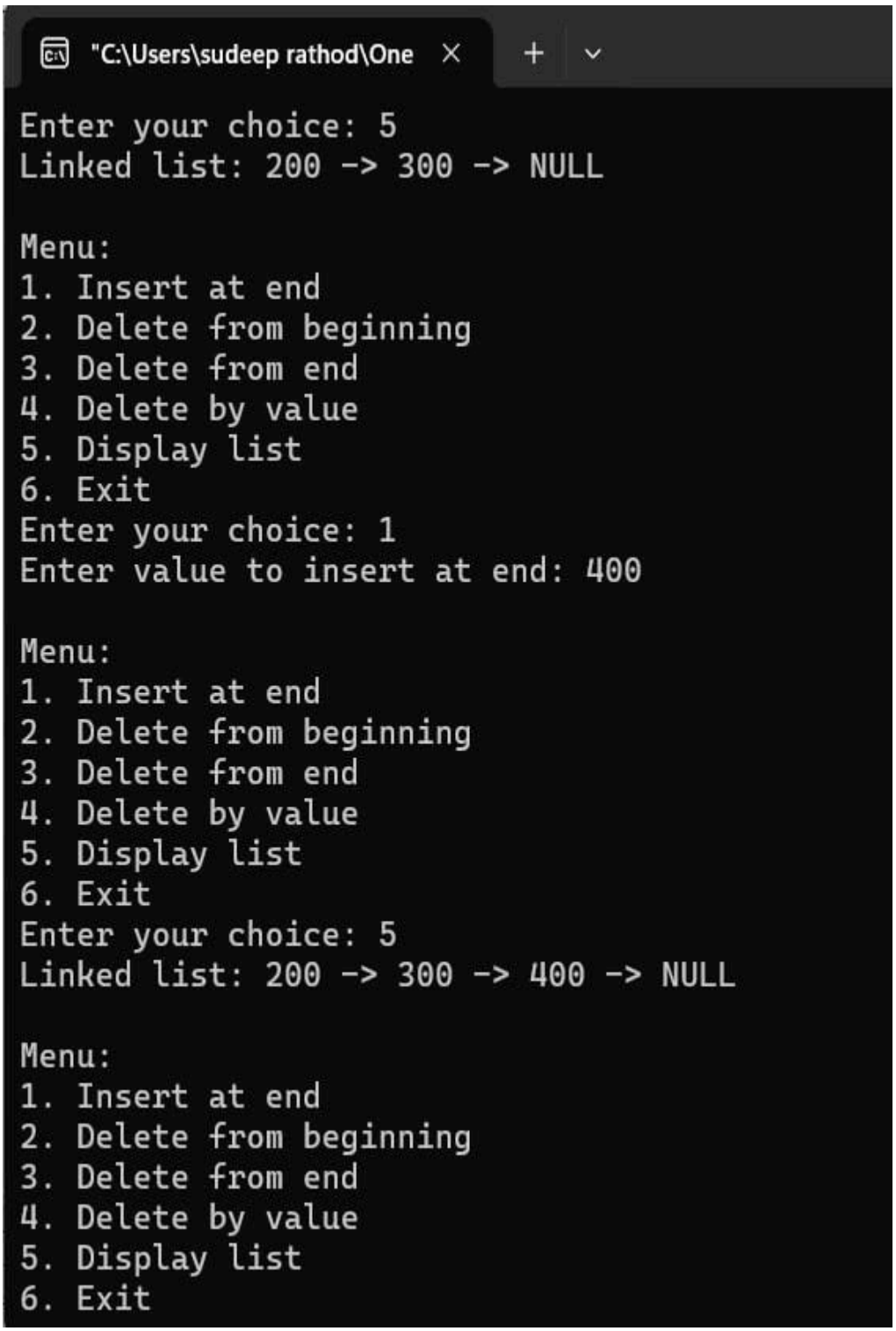
```
    }
    struct Node *ptr = top, *prev = NULL;
    if (ptr != NULL && ptr->data == value) {
        top = ptr->next;
        printf("Deleted %d from the list.\n", ptr->data);
        free(ptr);
        return;
    }
    while (ptr != NULL && ptr->data != value) {
        prev = ptr;
        ptr = ptr->next;
    }
    if (ptr == NULL) {
        printf("Value %d not found in the list.\n", value);
        return;
    }
    prev->next = ptr->next;
    printf("Deleted %d from the list.\n", ptr->data);
    free(ptr);
}
void displayList() {
    if (top == NULL) {
        printf("The list is empty.\n");
        return;
    }
    struct Node *ptr = top;
    printf("Linked list: ");
    while (ptr != NULL) {
        printf("%d -> ", ptr->data);
        ptr = ptr->next;
    }
    printf("NULL\n");
}

int main() {
    int choice, value;
    while (1) {
        printf("\nMenu:\n1. Insert at end\n2. Delete from beginning\n3. Delete from end\n4.
Delete by value\n5. Display list\n6. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to insert at end: ");
                scanf("%d", &value);
                insertAtEnd(value);
                break;
            case 2:
                deleteFromBeginning();
```

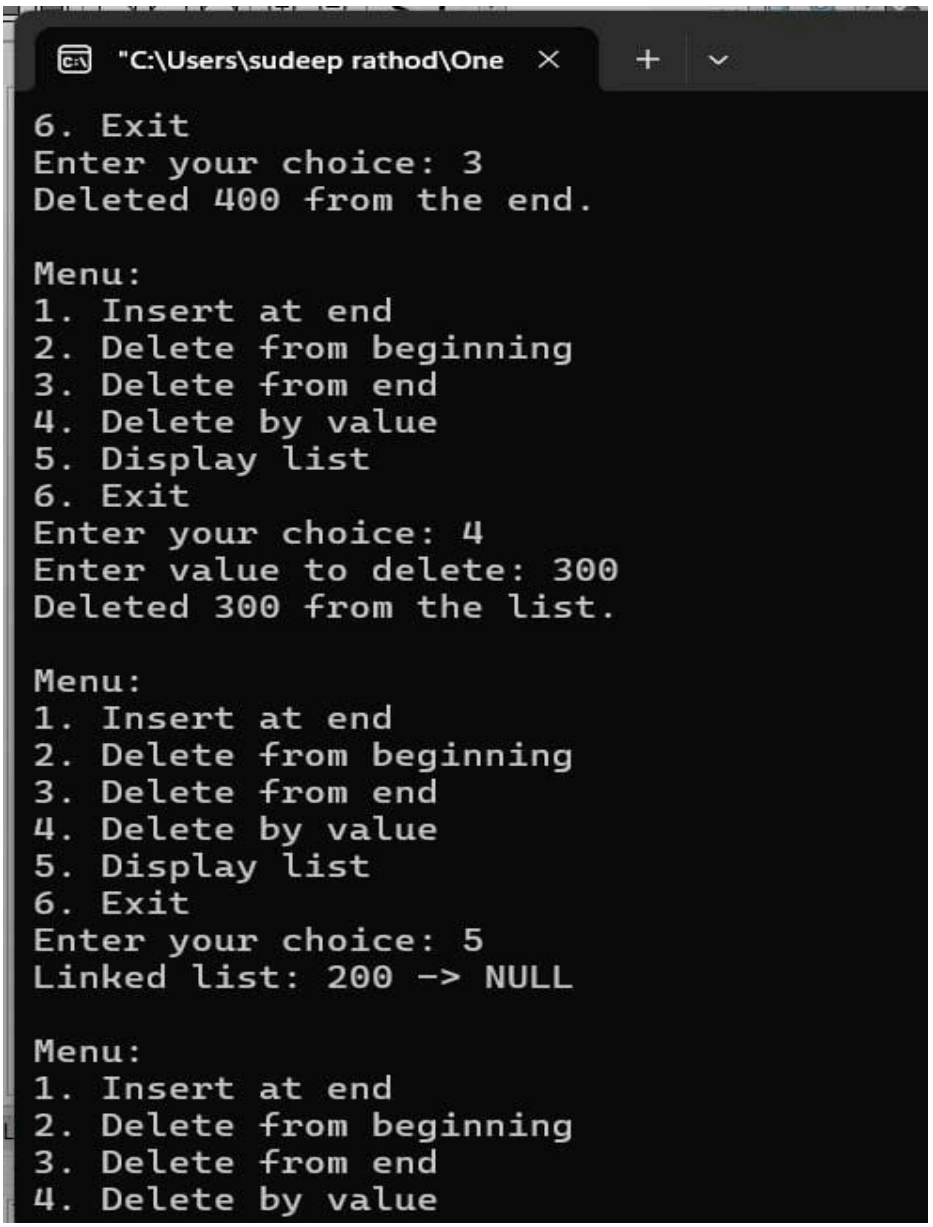
```
            break;
        case 3:
            deleteFromEnd();
            break;
        case 4:
            printf("Enter value to delete: ");
            scanf("%d", &value);
            deleteByValue(value);
            break;
        case 5:
            displayList();
            break;
        case 6:
            exit(0);
        default:
            printf("Invalid choice. Please try again.\n");
      }
   }
   return 0;
}
```

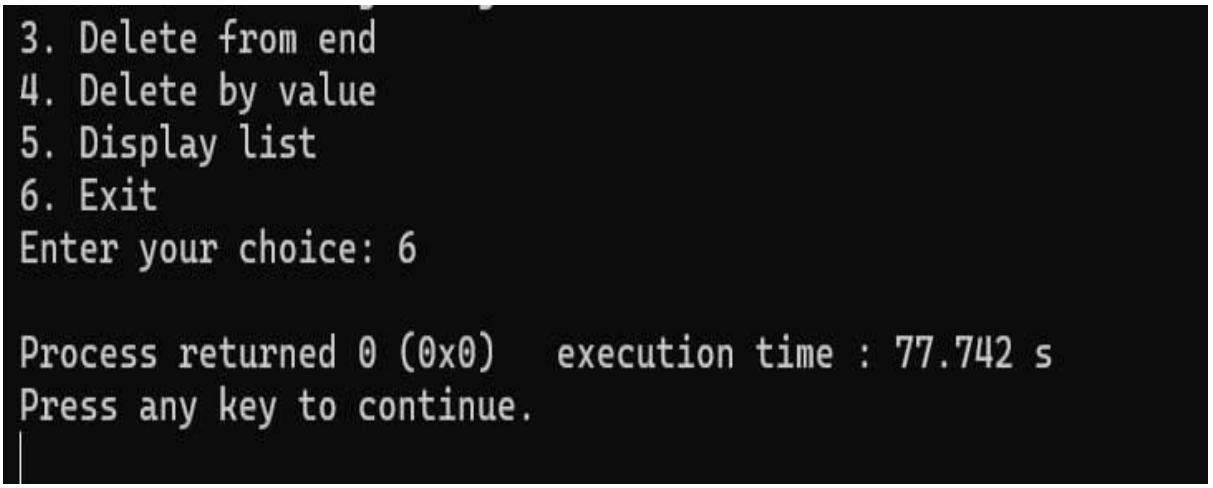
OUTPUT:




"C:\Users\sudeep rathod\One
Enter value to insert at end: 300
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 5
Linked list: 100 -> 200 -> 300 -> NULL
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 2
Deleted 100 from the beginning.
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 5


"C:\Users\sudeep rathod\One
Enter your choice: 5
Linked list: 200 -> 300 -> NULL
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 1
Enter value to insert at end: 400
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 5
Linked list: 200 -> 300 -> 400 -> NULL
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit


"C:\Users\sudeep rathod\One
6. Exit
Enter your choice: 3
Deleted 400 from the end.
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 4
Enter value to delete: 300
Deleted 300 from the list.
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 5
Linked list: 200 -> NULL
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value


3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 6
Process returned 0 (0x0) execution time : 77.742 s
Press any key to continue.

Lab Program 6:

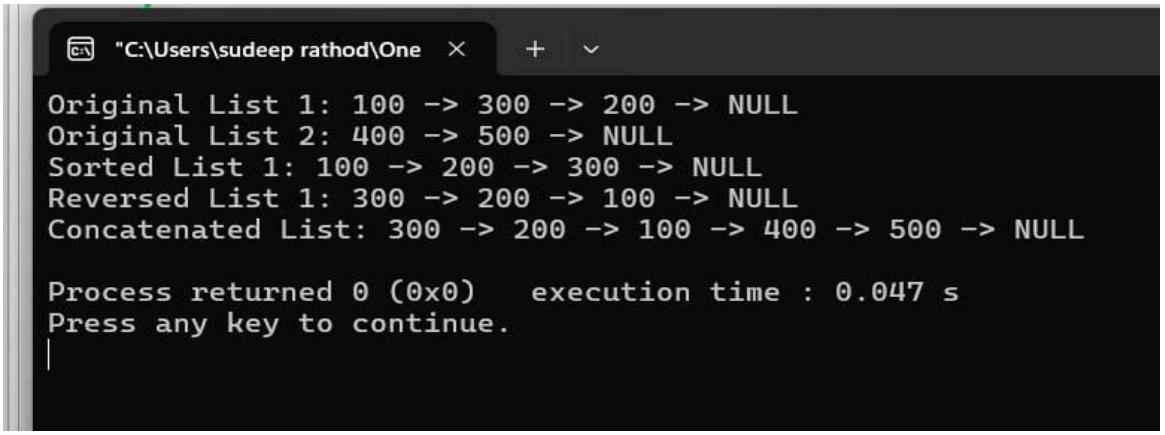
Write a program to Implement Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists.

```
#include<stdio.h>
#include<stdlib.h>
#include<stddef.h>

struct Node {
   int data;
   struct Node *next;
};
struct Node *top1 = NULL, *top2 = NULL;

void sortLinkedList(struct Node *top) {
   struct Node *ptr, *pre_ptr;
   int temp;

   if (top == NULL || top->next == NULL) {
      return;
   }
   for (ptr = top; ptr != NULL; ptr = ptr->next) {
      for (pre_ptr = top; pre_ptr->next != NULL; pre_ptr = pre_ptr->next) {
         if (pre_ptr->data > pre_ptr->next->data) {
            temp = pre_ptr->data;
            pre_ptr->data = pre_ptr->next->data;
            pre_ptr->next->data = temp;
         }
      }
   }
}

struct Node* reverseLinkedList(struct Node *top) {
   struct Node *ptr = top, *pre_ptr = NULL, *next_ptr = NULL;

   while (ptr != NULL) {
      next_ptr = ptr->next;
      ptr->next = pre_ptr;
      pre_ptr = ptr;
      ptr = next_ptr;
   }
   return pre_ptr;
}

struct Node* concatenateLinkedLists(struct Node *top1, struct Node *top2) {
   struct Node *ptr = top1;
```

```
   if (top1 == NULL) return top2;
   if (top2 == NULL) return top1;

   while (ptr->next != NULL) {
      ptr = ptr->next;
   }

   ptr->next = top2;
   return top1;
}

struct Node* createNode(int data) {
   struct Node *newNode = (struct Node*) malloc(sizeof(struct Node));
   newNode->data = data;
   newNode->next = NULL;
   return newNode;
}

void displayList(struct Node *top) {
   struct Node *ptr = top;
   while (ptr != NULL) {
      printf("%d -> ", ptr->data);
      ptr = ptr->next;
   }
   printf("NULL\n");
}

void main() {
   top1 = createNode(100);
   top1->next = createNode(300);
   top1->next->next = createNode(200);

   top2 = createNode(400);
   top2->next = createNode(500);

   printf("Original List 1: ");
   displayList(top1);

   printf("Original List 2: ");
   displayList(top2);

   sortLinkedList(top1);
   printf("Sorted List 1: ");
   displayList(top1);

   top1 = reverseLinkedList(top1);
   printf("Reversed List 1: ");
   displayList(top1);
```

```
    struct Node *mergedList = concatenateLinkedLists(top1, top2);
    printf("Concatenated List: ");
    displayList(mergedList);
}
```

OUTPUT:



Lab Program 7:

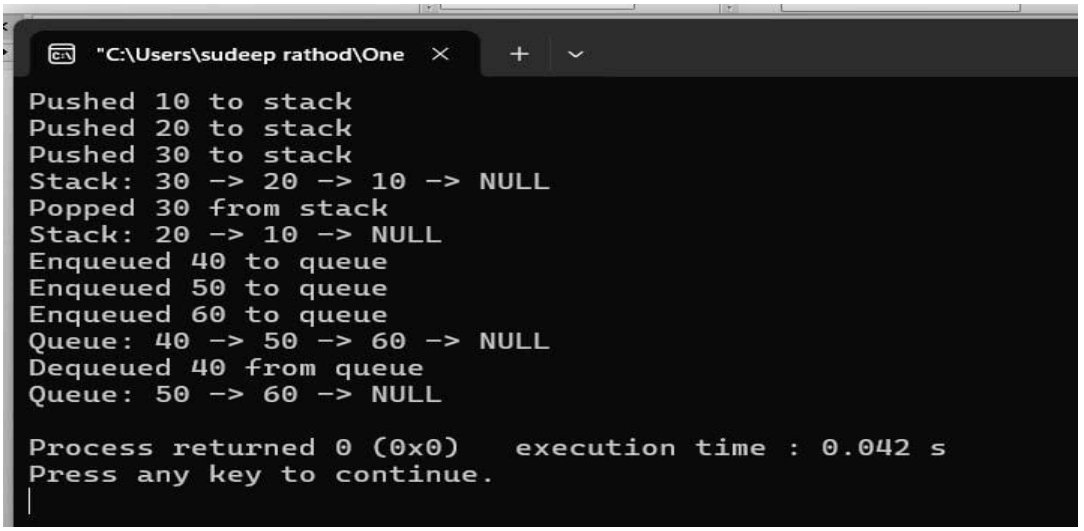
Write a program to Implement Single Link List to simulate Stack & Queue Operations.

```
#include <stdio.h>
#include <stdlib.h>

struct Node {
    int data;
    struct Node* next;
};

struct Node* top = NULL;
struct Node* front = NULL;
struct Node* rear = NULL;

struct Node* createNode(int value) {
    struct Node* ptr = (struct Node*)malloc(sizeof(struct Node));
    ptr->data = value;
    ptr->next = NULL;
    return ptr;
}

void push(int value) {
    struct Node* ptr = createNode(value);
    ptr->next = top;
```

```
    top = ptr;
    printf("Pushed %d to stack\n", value);
}

void pop() {
    if (top == NULL) {
        printf("Stack Underflow\n");
        return;
    }
    struct Node* ptr = top;
    printf("Popped %d from stack\n", top->data);
    top = top->next;
    free(ptr);
}

void enqueue(int value) {
    struct Node* ptr = createNode(value);
    if (rear == NULL) {
        front = rear = ptr;
    } else {
        rear->next = ptr;
        rear = ptr;
    }
    printf("Enqueued %d to queue\n", value);
}

void dequeue() {
    if (front == NULL) {
        printf("Queue Underflow\n");
        return;
    }
    struct Node* ptr = front;
    printf("Dequeued %d from queue\n", front->data);
    front = front->next;
    if (front == NULL) {
        rear = NULL;
    }
    free(ptr);
}

void displayStack() {
    struct Node* ptr = top;
    if (ptr == NULL) {
        printf("Stack is Empty\n");
        return;
    }
    printf("Stack: ");
    while (ptr != NULL) {
        printf("%d -> ", ptr->data);
        ptr = ptr->next;
```

```
    }
    printf("NULL\n");
}

void displayQueue() {
    struct Node* ptr = front;
    if (ptr == NULL) {
        printf("Queue is Empty\n");
        return;
    }
    printf("Queue: ");
    while (ptr != NULL) {
        printf("%d -> ", ptr->data);
        ptr = ptr->next;
    }
    printf("NULL\n");
}

int main() {
    push(10);
    push(20);
    push(30);
    displayStack();
    pop();
    displayStack();

    enqueue(40);
    enqueue(50);
    enqueue(60);
    displayQueue();
    dequeue();
    displayQueue();

    return 0;
}
```

OUTPUT:



Lab Program 8:

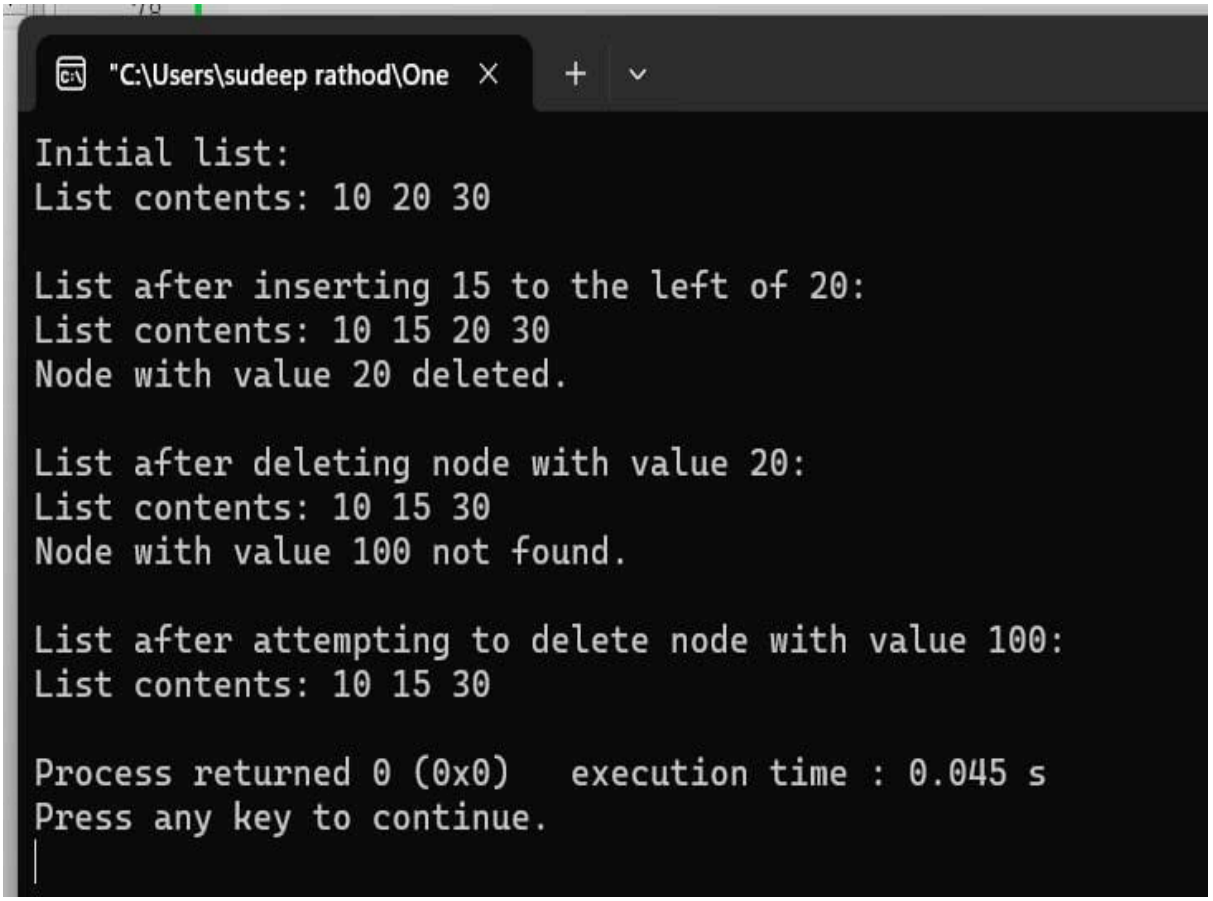
WAP to Implement doubly link list with primitive operations Create a doubly linked list.Insert a new node to the left of the node.Delete the node based on a specific valueDisplay the contents of the list.

```
#include <stdio.h>
#include <stdlib.h>

struct Node {
   int data;
   struct Node* prev;
   struct Node* next;
};

struct Node* createNode(int data) {
   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
   if (!newNode) {
      printf("Memory allocation failed!\n");
      exit(1);
   }
   newNode->data = data;
   newNode->prev = newNode->next = NULL;
   return newNode;
}

void insertLeft(struct Node** head, struct Node* targetNode, int data) {
   if (targetNode == NULL) {
      printf("Target node is NULL. Insertion failed.\n");
      return;
   }

   struct Node* newNode = createNode(data);

   newNode->next = targetNode;
   newNode->prev = targetNode->prev;

   if (targetNode->prev != NULL) {
      targetNode->prev->next = newNode;
   } else {
      *head = newNode;
   }

   targetNode->prev = newNode;
}

void deleteNode(struct Node** head, int value) {
   struct Node* temp = *head;
```

```
    while (temp != NULL && temp->data != value) {
        temp = temp->next;
    }

    if (temp == NULL) {
        printf("Node with value %d not found.\n", value);
        return;
    }
    if (*head == temp) {
        *head = temp->next;
    }
    if (temp->prev != NULL) {
        temp->prev->next = temp->next;
    }
    if (temp->next != NULL) {
        temp->next->prev = temp->prev;
    }

    free(temp);
    printf("Node with value %d deleted.\n", value);
}

void displayList(struct Node* head) {
    struct Node* temp = head;
    if (temp == NULL) {
        printf("The list is empty.\n");
        return;
    }
    printf("List contents: ");
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}

int main() {
    struct Node* head = NULL;
    head = createNode(10);
    struct Node* second = createNode(20);
    struct Node* third = createNode(30);

    head->next = second;
    second->prev = head;
    second->next = third;
    third->prev = second;
    printf("Initial list:\n");
    displayList(head);
```

```
    insertLeft(&head, second, 15);
    printf("\nList after inserting 15 to the left of 20:\n");
    displayList(head);

    deleteNode(&head, 20);
    printf("\nList after deleting node with value 20:\n");
    displayList(head);

    deleteNode(&head, 100);
    printf("\nList after attempting to delete node with value 100:\n");
    displayList(head);

    return 0;
}
```

OUTPUT:



Lab Program 9:

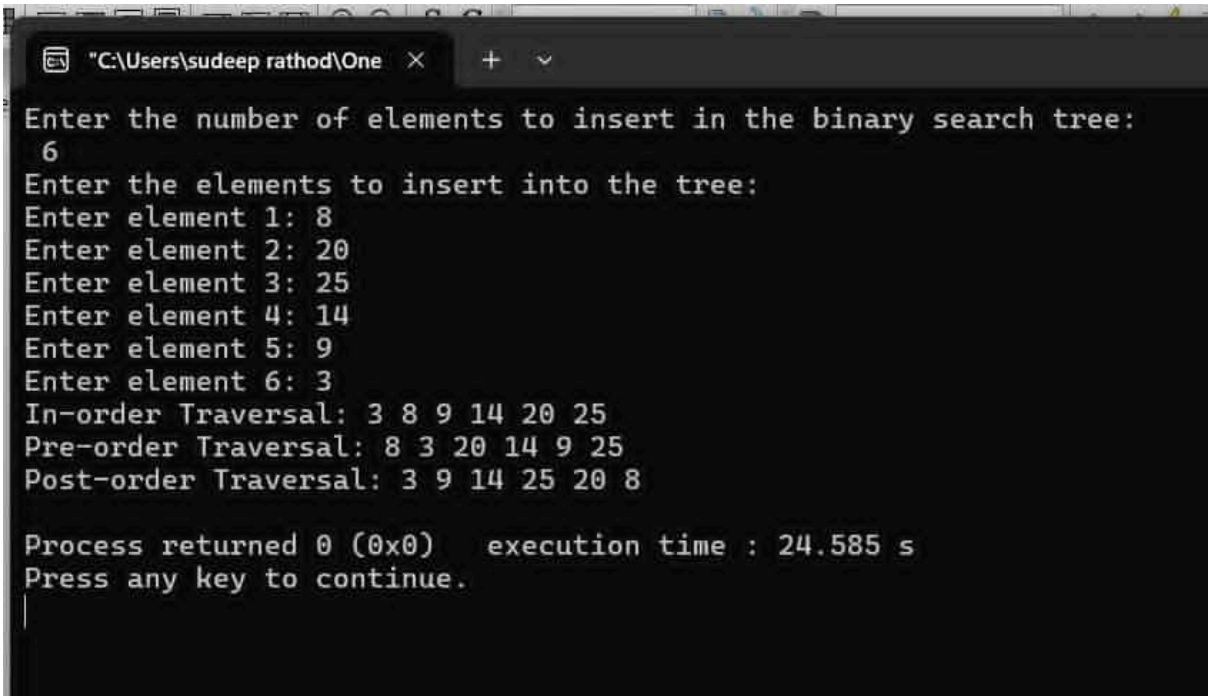
Write a program

- **To construct a binary Search tree.**
- **To traverse the tree using all the methods i.e., in-order, preorder and post order**
- **To display the elements in the tree.**

```
#include <stdio.h>
#include <stdlib.h>

struct Node {
   int data;
   struct Node* left;
   struct Node* right;
};

struct Node* createNode(int data) {
   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
   newNode->data = data;
   newNode->left = newNode->right = NULL;
   return newNode;
}

struct Node* insert(struct Node* root, int data) {
   if (root == NULL) {
      return createNode(data);
   }

   if (data < root->data) {
      root->left = insert(root->left, data);
   } else {
      root->right = insert(root->right, data);
   }

   return root;
}

void inOrderTraversal(struct Node* root) {
   if (root != NULL) {
      inOrderTraversal(root->left);
      printf("%d ", root->data);
      inOrderTraversal(root->right);
   }
}

void preOrderTraversal(struct Node* root) {
   if (root != NULL) {
```

```
        printf("%d ", root->data);
        preOrderTraversal(root->left);
        preOrderTraversal(root->right);
    }
}

void postOrderTraversal(struct Node* root) {
    if (root != NULL) {
        postOrderTraversal(root->left);
        postOrderTraversal(root->right);
        printf("%d ", root->data);
    }
}

void displayTree(struct Node* root) {
    printf("In-order Traversal: ");
    inOrderTraversal(root);
    printf("\n");

    printf("Pre-order Traversal: ");
    preOrderTraversal(root);
    printf("\n");

    printf("Post-order Traversal: ");
    postOrderTraversal(root);
    printf("\n");
}

int main() {
    struct Node* root = NULL;
    int n, data;
    printf("Enter the number of elements to insert in the binary search tree:\n ");
    scanf("%d", &n);
    printf("Enter the elements to insert into the tree:\n");
    for (int i = 0; i < n; i++) {
        printf("Enter element %d: ", i + 1);
        scanf("%d", &data);
        root = insert(root, data);
    }
    displayTree(root);

    return 0;
}
```

OUTPUT:



Lab Program 10:

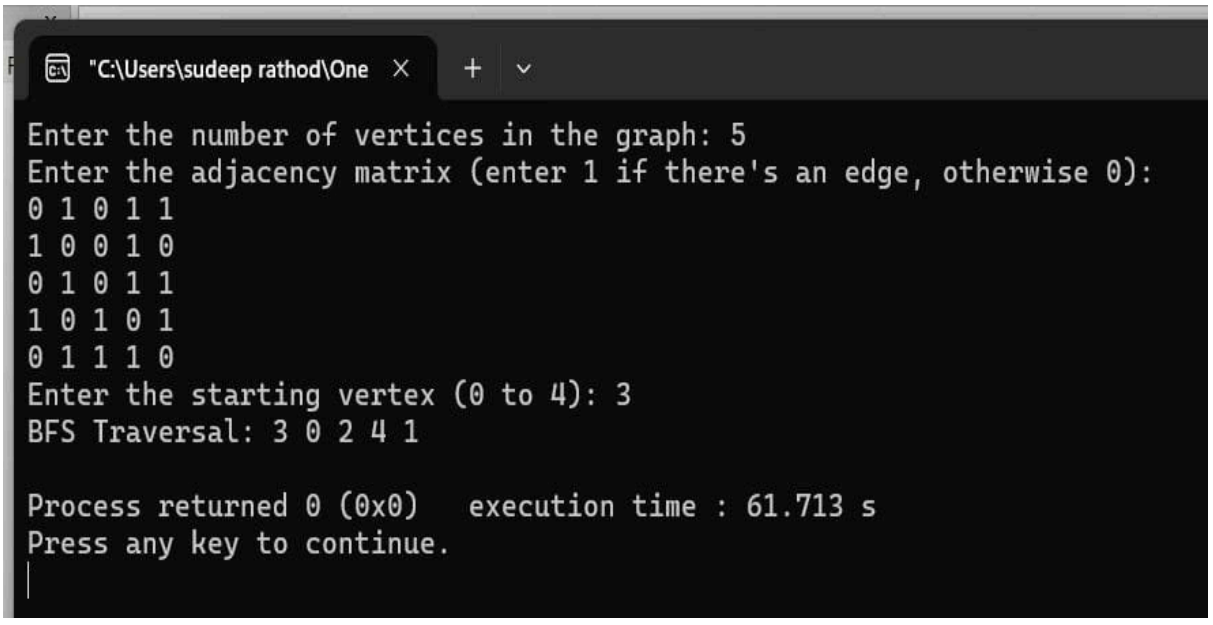
Write a program to traverse a graph using BFS method.

```
#include <stdio.h>
#include <stdlib.h>

#define MAX 100

typedef struct {
    int items[MAX];
    int front;
    int rear;
} Queue;

void initializeQueue(Queue* q) {
    q->front = -1;
    q->rear = -1;
}

int isEmpty(Queue* q) {
    return q->front == -1;
}

void enqueue(Queue* q, int value) {
    if (q->rear == MAX - 1) {
```

```
        printf("Queue overflow!\n");
        return;
    }
    if (isEmpty(q)) {
        q->front = 0;
    }
    q->rear++;
    q->items[q->rear] = value;
}

int dequeue(Queue* q) {
    if (isEmpty(q)) {
        printf("Queue underflow!\n");
        return -1;
    }
    int item = q->items[q->front];
    if (q->front >= q->rear) {
        q->front = -1;
        q->rear = -1;
    } else {
        q->front++;
    }
    return item;
}

void BFS(int graph[MAX][MAX], int visited[MAX], int start, int n) {
    Queue q;
    initializeQueue(&q);
    visited[start] = 1;
    enqueue(&q, start);

    printf("BFS Traversal: ");
    while (!isEmpty(&q)) {
        int current = dequeue(&q);
        printf("%d ", current);
        for (int i = 0; i < n; i++) {
            if (graph[current][i] == 1 && !visited[i]) {
                visited[i] = 1;
                enqueue(&q, i);
            }
        }
    }
    printf("\n");
}

int main() {
    int n, start;
    int graph[MAX][MAX], visited[MAX];
```

```
    printf("Enter the number of vertices in the graph: ");
    scanf("%d", &n);

    printf("Enter the adjacency matrix (enter 1 if there's an edge, otherwise 0):\n");
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            scanf("%d", &graph[i][j]);
        }
    }
    for (int i = 0; i < n; i++) {
        visited[i] = 0;
    }

    printf("Enter the starting vertex (0 to %d): ", n - 1);
    scanf("%d", &start);

    if (start < 0 || start >= n) {
        printf("Invalid starting vertex!\n");
        return 1;
    }

    BFS(graph, visited, start, n);

    return 0;
}
```

OUTPUT:



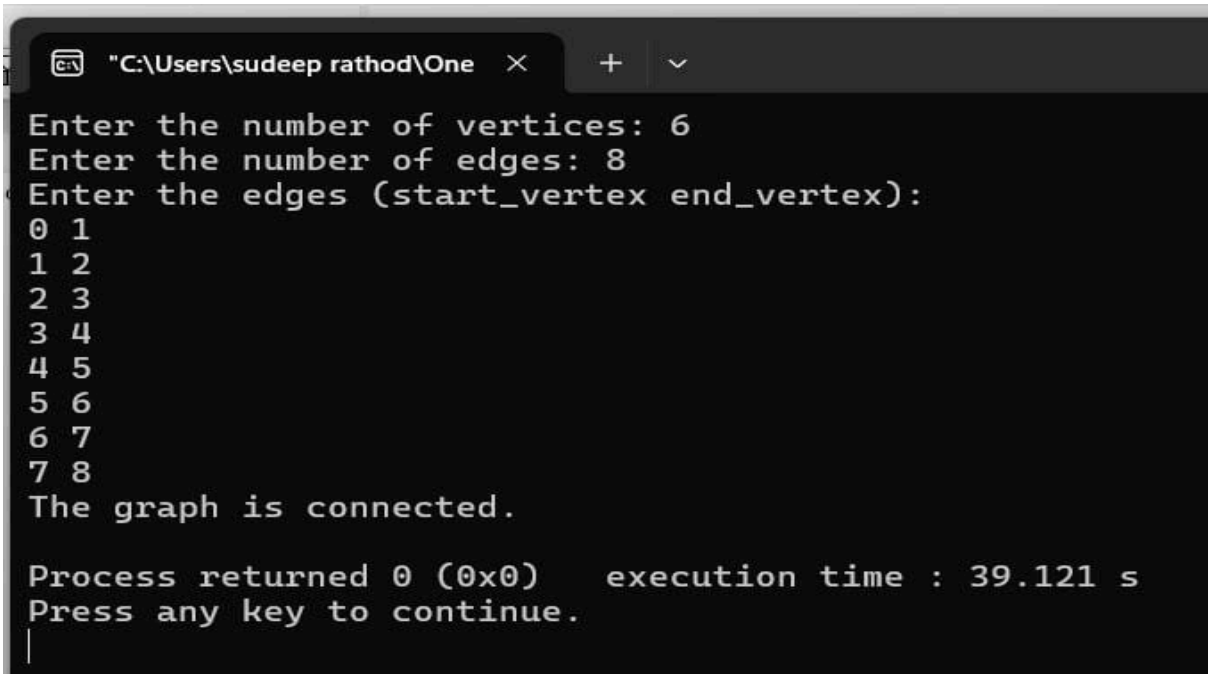
Lab Program 11:

DFS Method Program.

```
#include <stdio.h>
#include <stdbool.h>

#define MAX 100

int adjMatrix[MAX][MAX];
bool visited[MAX];
int stack[MAX];
int top = -1;

void push(int vertex) {
   if (top == MAX - 1) {
      printf("Stack Overflow\n");
      return;
   }
   stack[++top] = vertex;
}

int pop() {
   if (top == -1) {
      printf("Stack Underflow\n");
      return -1;
   }
   return stack[top--];
}

void dfsUsingStack(int startVertex, int numVertices) {
   push(startVertex);
   visited[startVertex] = true;

   while (top != -1) {
      int currentVertex = pop();

      for (int i = 0; i < numVertices; i++) {
         if (adjMatrix[currentVertex][i] == 1 && !visited[i]) {
            push(i);
            visited[i] = true;
         }
      }
   }
}

bool isConnected(int numVertices) {
   for (int i = 0; i < numVertices; i++) {
```

```
        visited[i] = false;
    }

    dfsUsingStack(0, numVertices);

    for (int i = 0; i < numVertices; i++) {
        if (!visited[i]) {
            return false;
        }
    }
    return true;
}

int main() {
    int numVertices, numEdges;
    printf("Enter the number of vertices: ");
    scanf("%d", &numVertices);

    printf("Enter the number of edges: ");
    scanf("%d", &numEdges);

    for (int i = 0; i < numVertices; i++) {
        for (int j = 0; j < numVertices; j++) {
            adjMatrix[i][j] = 0;
        }
    }

    printf("Enter the edges (start_vertex end_vertex):\n");
    for (int i = 0; i < numEdges; i++) {
        int u, v;
        scanf("%d %d", &u, &v);
        adjMatrix[u][v] = 1;
        adjMatrix[v][u] = 1;
    }

    if (isConnected(numVertices)) {
        printf("The graph is connected.\n");
    } else {
        printf("The graph is not connected.\n");
    }

    return 0;
}
```

OUTPUT:



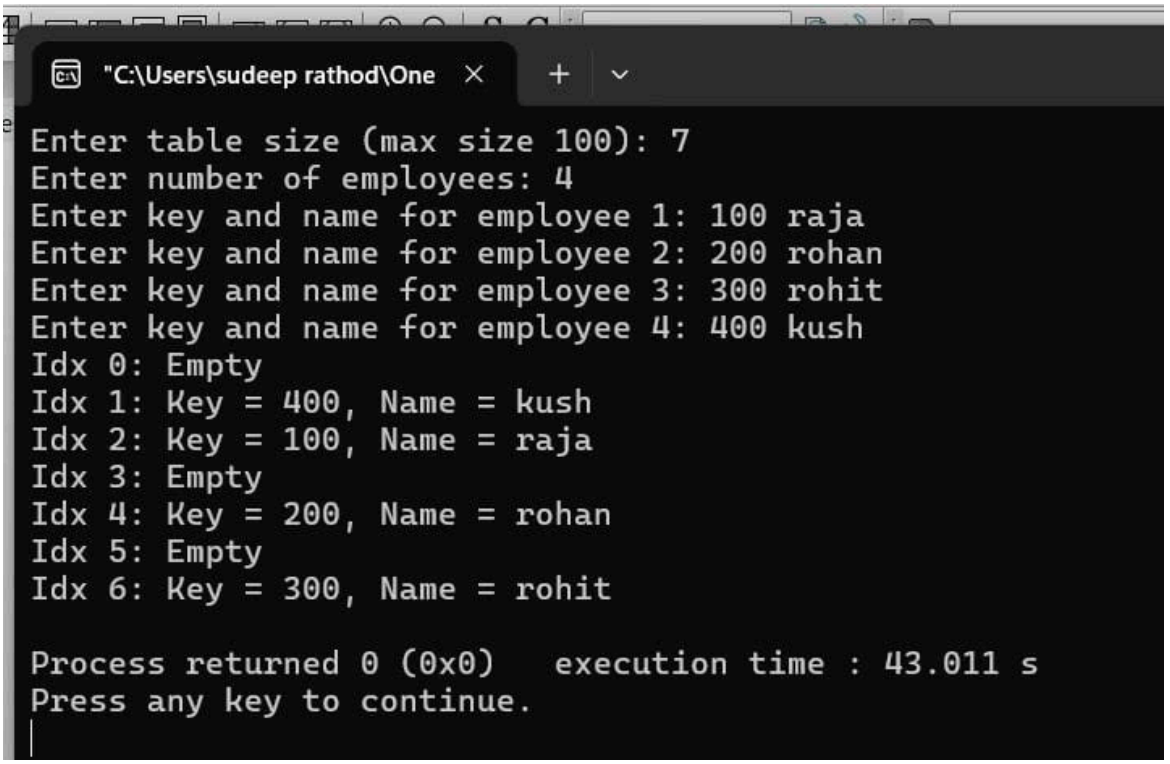
Lab Program 12:

Hashing Program.

```
#include <stdio.h>
#define MAX 100

struct Employee {
   int k;
   char n[50];
};

struct Employee ht[MAX];
int ts;

void init() {
   for (int i = 0; i < MAX; i++) ht[i].k = -1;
}

int hash(int k) {
   return k % ts;
}

void insert(int k, char n[]) {
   int idx = hash(k);
   while (ht[idx].k != -1) {
      idx = (idx + 1) % ts;
```

```
    }
    ht[idx].k = k;
    for (int i = 0; n[i] != '\0' && i < 49; i++) {
        ht[idx].n[i] = n[i];
    }
    ht[idx].n[49] = '\0';
}

void display() {
    for (int i = 0; i < ts; i++) {
        if (ht[i].k != -1)
            printf("Idx %d: Key = %d, Name = %s\n", i, ht[i].k, ht[i].n);
        else
            printf("Idx %d: Empty\n", i);
    }
}

int main() {
    int n;
    printf("Enter table size (max size %d): ", MAX);
    scanf("%d", &ts);

    if (ts > MAX) ts = MAX;

    init();

    printf("Enter number of employees: ");
    scanf("%d", &n);
    getchar();

    for (int i = 0; i < n; i++) {
        int k;
        char name[50];
        printf("Enter key and name for employee %d: ", i + 1);
        scanf("%d", &k);
        getchar();
        gets(name);
        insert(k, name);
    }

    display();

    return 0;
}
```

OUTPUT:

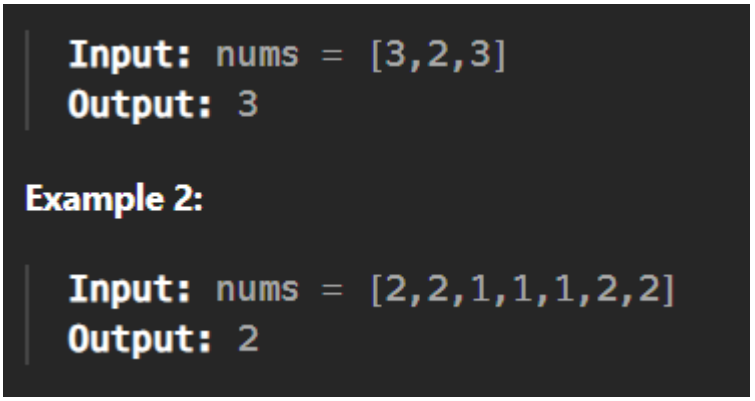


Leetcode 169 [Majority Elements]:

Given an array nums of size n, return the majority elements. The majority element is the element that appears more than [n/2] times. you may assume that the majority element always exists in the array.

```
#include <stdio.h>

int majorityElement(int* nums, int numsSize) {
    int candidate = nums[0];
    int count = 1;
    for (int i = 1; i < numsSize; i++) {
        if (count == 0) {
            candidate = nums[i];
            count = 1;
        } else if (nums[i] == candidate) {
            count++;
        } else {
            count--;
        }
    }

    return candidate;
}
```

OUTPUT:

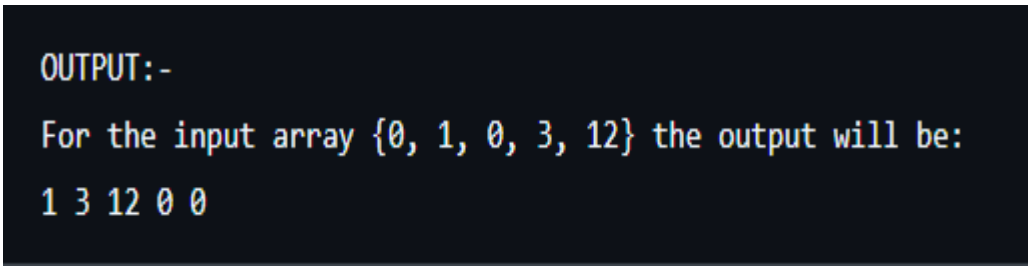


Leetcode 283 [Move Zeroes]:

Given an integer array nums, move all zeroes to the end of it while maintaining the relative order of the non-zero elements.

```
#include <stdio.h>

void moveZeroes(int *nums, int numsSize){
    int L=0, r=numsSize-1;
    for (int i = 0; i < r; i++) {
        if (nums[i] == 0) {
            for(int j = 1; j<r; j++){
            nums[j] = nums[j+1];
        }
        nums[r] = 0;
        r--;
    }
}
```

OUTPUT:

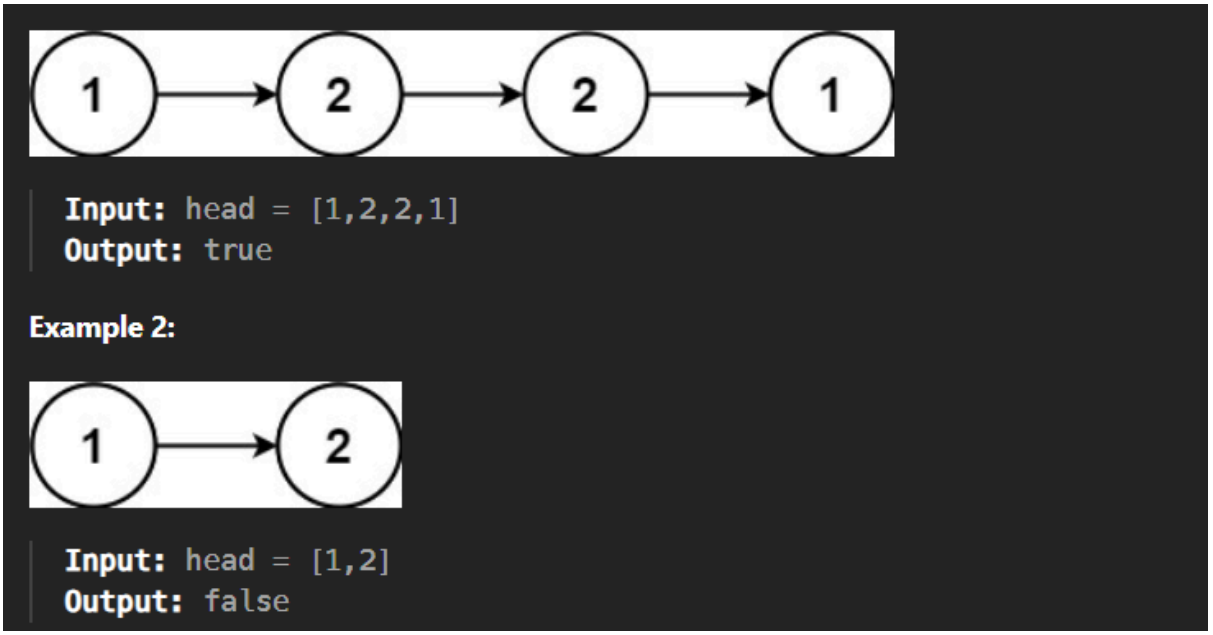


Leetcode 234 [Palindrome Linked List]:

Given the head of a singly linked list, return true if it is a palindrome OR false otherwise.

```
struct ListNode {
    int val;
    struct ListNode* next;
};

bool isPalindrome(struct ListNode* head) {
    if (!head || !head->next) return true;

    struct ListNode* slow = head;
    struct ListNode* fast = head;

    while (fast && fast->next) {
        slow = slow->next;
        fast = fast->next->next;
    }

    struct ListNode* prev = NULL;
    while (slow) {
        struct ListNode* nextTemp = slow->next;
        slow->next = prev;
        prev = slow;
        slow = nextTemp;
    }

    struct ListNode* firstHalf = head;
    struct ListNode* secondHalf = prev;
    while (secondHalf) {
        if (firstHalf->val != secondHalf->val) return false;
        firstHalf = firstHalf->next;
        secondHalf = secondHalf->next;
    }
    return true;
}
```

OUTPUT:



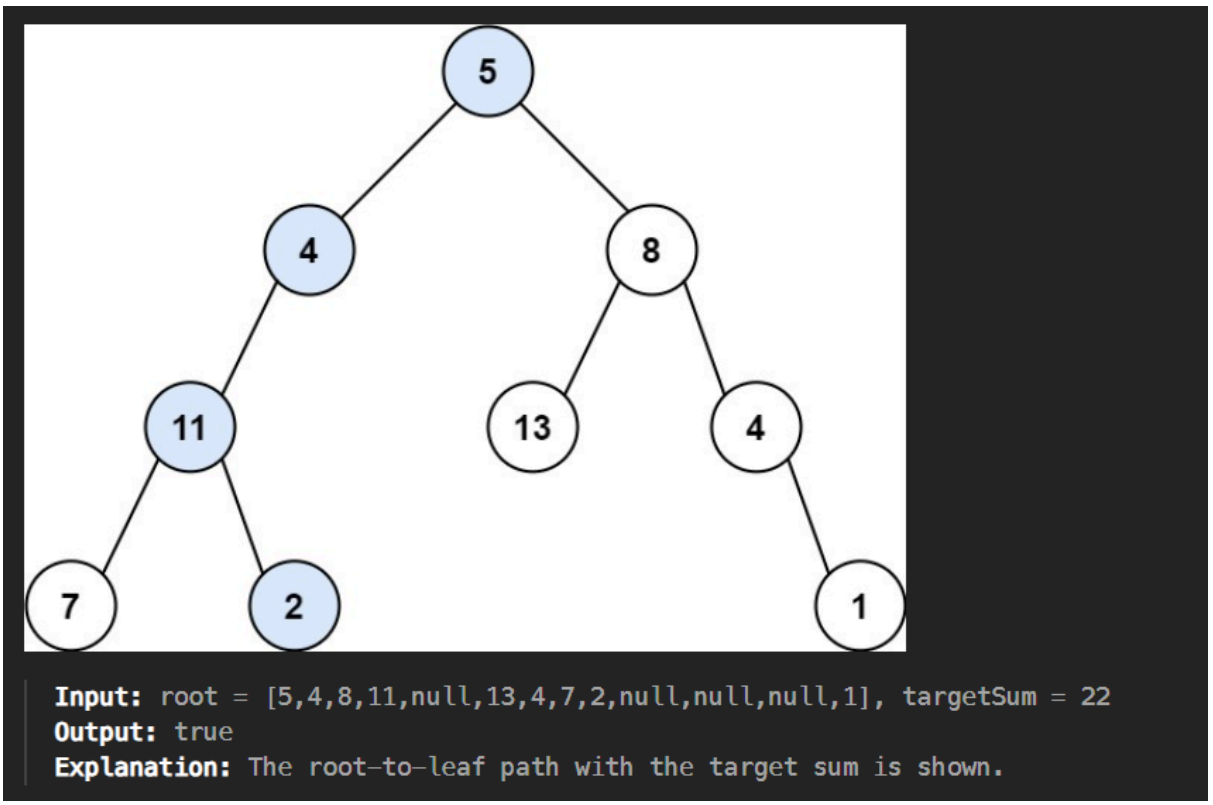
Leetcode 112 [Path Sum]:

Given the root of a binary tree and an integer targetSum, return true if the tree has a root-to-leaf path such that adding up all the values along the path equals. targetSum, A leaf is a node with no children.

```
struct TreeNode {
    int val;
    struct TreeNode* left;
    struct TreeNode* right;
};

bool hasPathSum(struct TreeNode* root, int targetSum) {
    if (root == NULL) {
        return false;
    }

    if (root->left == NULL && root->right == NULL) {
        return root->val == targetSum;
    }

    targetSum -= root->val;
    return hasPathSum(root->left, targetSum) || hasPathSum(root->right, targetSum);
}

struct TreeNode* createNode(int val) {
    struct TreeNode* newNode = (struct TreeNode*)malloc(sizeof(struct TreeNode));
    newNode->val = val;
    newNode->left = NULL;
```

```
    newNode->right = NULL;
    return newNode;
}
```

OUTPUT:



Input: root = [5,4,8,11,null,13,4,7,2,null,null,null,1], targetSum = 22
Output: true
Explanation: The root-to-leaf path with the target sum is shown.