VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT

On

DATA STRUCTURES (23CS3PCDST)

Submitted by

TEJAS S(1BM22CS308)

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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(Affiliated To Visvesvaraya Technological University, Belgaum)
Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried outby **TEJAS S (1BM22CS308)**, who is a 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 2023-24. 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.

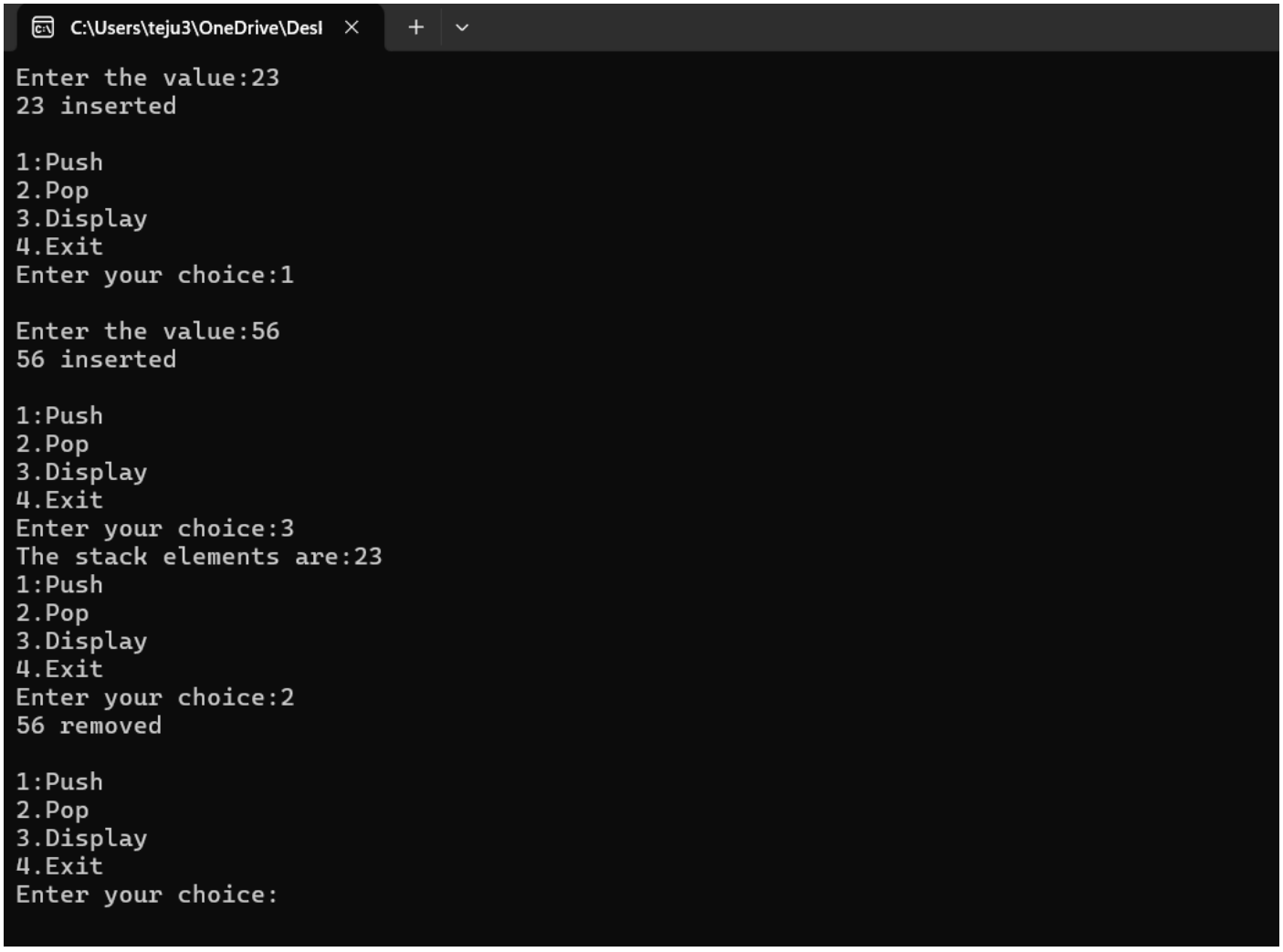
Lab program 1:

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 i,stack[SIZE],top=-1;
void main(){
   int value,choice;
   while(1){
      printf("\n1:Push\n2.Pop\n3.Display\n4.Exit\n");
      printf("Enter your choice:");
      scanf("%d",&choice);
      switch(choice)
      {
         case 1:printf("\nEnter the value:");
               scanf("%d",&value);
               push(value);
               break;
         case 2:pop();
         break;
         case 3:display();
         break;
         case 4:exit(0);
         default:printf("Invalid input\n");
      }
   }
}
void push(int value){
   if(top==SIZE-1)
      printf("Overflow\n");
   else{
      top=top+1;
   stack[top]=value;
   printf("%d inserted\n",value);}
}

void pop(){
   int value;
   if(top==-1)
        printf("Underflow\n");
   else{
      value=stack[top];
      top=top-1;
      printf("%d removed\n",value); }
```

```
}
void display()
{
   int i;
   if(top==-1)
     printf("Stack is empty");
   else{printf("The stack elements are:");
       for(i=0;i>=0;i--)
          printf("%d",stack[i]); }
}
```

OUTPUT:



LAB PROGRAM 2:

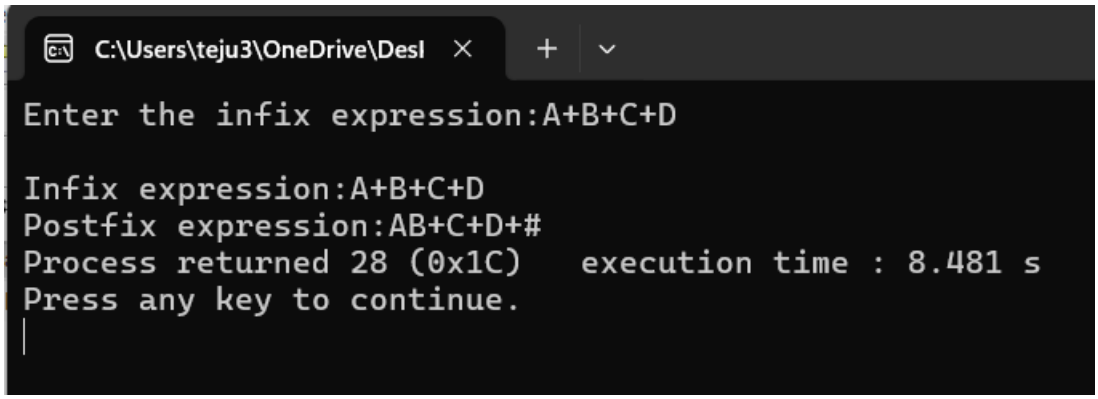
Write a program to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and the binary operators + (plus), - (minus), * (multiply) and / (divide).

```
#include<stdio.h>
#include<string.h>
int ind=0,top=-1,pos=0,length;
char symbol,temp,infix[20],postfix[20],stack[20];
void infix to postfix();
void push(char symbol);
char pop();
int pred(char symbol);
void main(){
   printf("Enter the infix expression:");
   scanf("%s",infix);
   infixtopostfix();
   printf("\nInfix expression:%s",infix);
   printf("\nPostfix expression:%s",postfix);
}
void infixtopostfix(){
length=strlen(infix);
 push('#');
 while(ind<length){
    symbol=infix[ind];
    switch(symbol){
       case '(':push (symbol);
       break;
       case ')':temp=pop();
              while (temp !='('){
                 postfix[pos]=temp;
                 pos++;
                 temp=pop(); }
```

```
            break;
        case '+':
        case '-':
        case '*':
        case '/':
          while(pred(stack[top])>=pred(symbol)){
             temp=pop();
             postfix[pos++]=temp;  }
          push(symbol);
          break;
       default:postfix[pos++]=symbol;  }
    ind++;}
 while(top >0) {
    temp=pop();
    postfix[pos++]=temp; }}
void push(char symbol){
   top=top+1;
   stack[top]=symbol;}
char pop(){
   char symbol;
   symbol=stack[top];
   top=top-1;
   return (symbol);}
int pred(char symbol){
   int p;


 switch(symbol){
       case '*':
       case'/':p=2;
       break;
       case '+':
```

```
        case '-':p=1;
        break;
        case '(':p=0;
        break;
        case '#':p=-1;
        break; }
    return(p);}
```

OUTPUT:



LAB PROGRAM 3:

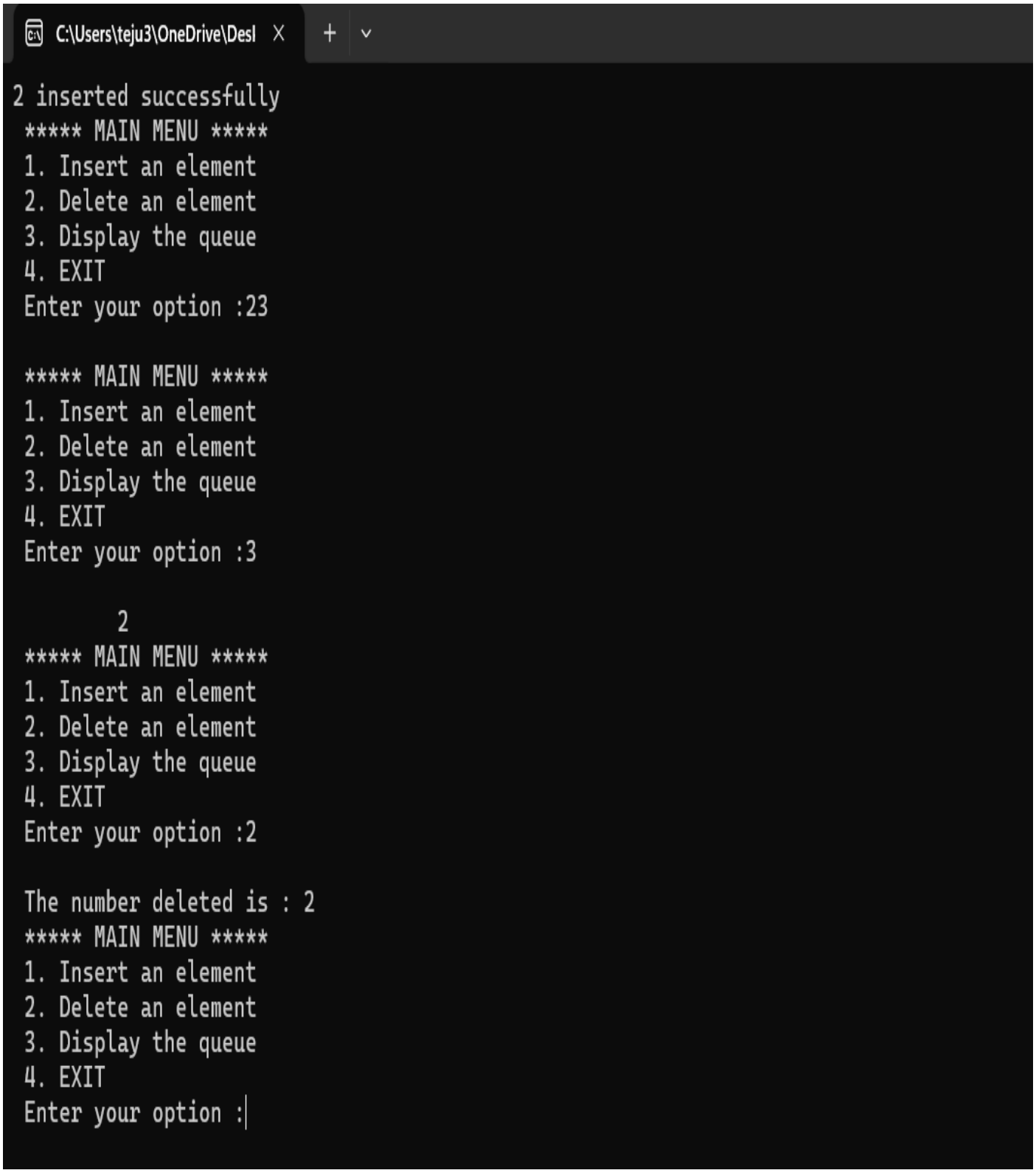
a) Write a program to simulate the working of a queue of integers using an array.Provide the following operations: Insert, Delete, Display.The program should print appropriate messages for queue empty and queue overflow conditions.

```
#include <stdio.h>
#include <conio.h>
#define MAX 10
int queue[MAX];
int front = -1, rear = -1;
void insert();
int delete_element();
void display();
int main(){
int option, val;
do{
printf("\n ***** MAIN MENU *****");
printf("\n 1. Insert an element");
printf("\n 2. Delete an element");
printf("\n 3. Display the queue");
printf("\n 4. EXIT");
printf("\n Enter your option :");
scanf("%d", &option);
switch(option) {
    case 1:insert();
           break;
    case 2:val = delete_element();
          if (val != -1)
           printf("\n The number deleted is : %d", val);
          break;
    case 3:display();
          break; }
}while(option != 4);
getch();
```

```
return 0;}
void insert(){
int num;
printf("\n Enter the number to be inserted in the queue : ");
scanf("%d", &num);
if(rear == MAX-1)
printf("\n OVERFLOW");
else if(front == -1 && rear == -1)
front = rear = 0;
else
rear++;
queue[rear] = num;
printf("%d inserted successfully",num);}
int delete_element(){
int val;
if(front == -1 || front>rear){
printf("\n UNDERFLOW");
return -1;}
else{
val = queue[front];
front++;
if(front > rear)
front = rear = -1;
return val;}
}
void display(){
int i;
printf("\n");
if(front == -1 || front > rear)
printf("\n QUEUE IS EMPTY");
else{
for(i = front;i <= rear;i++)
```

```
printf("\t %d", queue[i]);}
}
```

OUTPUT:



```
 4. EXIT
 Enter your option :3


 QUEUE IS EMPTY
 ***** MAIN MENU *****
 1. Insert an element
 2. Delete an element
 3. Display the queue
 4. EXIT
 Enter your option :2

 UNDERFLOW
 ***** MAIN MENU *****
 1. Insert an element
 2. Delete an element
 3. Display the queue
 4. EXIT
 Enter your option :1

 Enter the number to be inserted in the queue : 10
10 inserted successfully
 ***** MAIN MENU *****
 1. Insert an element
 2. Delete an element
 3. Display the queue
 4. EXIT
 Enter your option :3

         10
 ***** MAIN MENU *****
 1. Insert an element
 2. Delete an element
 3. Display the queue
 4. EXIT
 Enter your option :4

Process returned 0 (0x0)   execution time : 66.560 s
Press any key to continue.
```

b) Write a program 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>
#include <conio.h>
#define MAX 10
int queue[MAX],front=-1,rear=-1;
void insert();
int delete_element();
void display();
int main(){
int option, val;
do{
 printf("\n ***** MAIN MENU *****");
 printf("\n 1. Insert an element");
 printf("\n 2. Delete an element");
 printf("\n 3. Display the queue");
 printf("\n 4. EXIT");
 printf("\n Enter your option : ");
 scanf("%d", &option);
switch(option) {
 case 1:insert();
        break;
 case 2:val = delete_element();
        if(val!=-1)
           printf("\n The number deleted is : %d", val);
        break;
 case 3:display();
        break; }
}while(option!=4);
getch();
return 0;}
```

```
void insert(){
int num;
printf("\n Enter the number to be inserted in the queue : ");
scanf("%d", &num);
if(front==0 && rear==MAX-1)
 printf("\n OVERFLOW");
else if(front==-1 && rear==-1){
front=rear=0;
queue[rear]=num;
printf("Inserted successfully");}
else if(rear==MAX-1 && front!=0){
rear=0;
queue[rear]=num;
printf("Inserted successfully");}
else{
 rear++;
 queue[rear]=num;
 printf("Inserted successfully");}}
int delete_element(){
int val;
if(front==-1 && rear==-1) {
 printf("\n UNDERFLOW");
 return -1; }
val = queue[front];
if(front==rear)
 front=rear=-1;
else{
 if(front==MAX-1)
front=0;
 else
 front++;}
return val;
```

```
printf("Deleted successfully.");}
void display(){
int i;
printf("\n");
if (front ==-1 && rear ==-1)
 printf ("\n QUEUE IS EMPTY");
else{
 printf("The elements of the queue are:");
 for(i=front;i!=rear;i=(i+1)%MAX)
    printf("\t %d", queue[i]);
 printf("\t %d", queue[i]); }
}
```

OUTPUT:

```
 ***** MAIN MENU *****
 1. Insert an element
 2. Delete an element
 3. Display the queue
 4. EXIT
 Enter your option : 1

 Enter the number to be inserted in the queue : 10
Inserted successfully
 ***** MAIN MENU *****
 1. Insert an element
 2. Delete an element
 3. Display the queue
 4. EXIT
 Enter your option : 1

 Enter the number to be inserted in the queue : 20
Inserted successfully
 ***** MAIN MENU *****
 1. Insert an element
 2. Delete an element
 3. Display the queue
 4. EXIT
 Enter your option : 2

 The number deleted is : 10
 ***** MAIN MENU *****
 1. Insert an element
 2. Delete an element
 3. Display the queue
 4. EXIT
 Enter your option : 3

The elements of the queue are:   20
 ***** MAIN MENU *****
 1. Insert an element
 2. Delete an element
 3. Display the queue
 4. EXIT
```

LAB PROGRAM 4:

Write a program to Implement Singly Linked List with following operations

a) Create a linked list.

b) Insertion of a node at first position, at any position and at end of list.

c) Deletion of first element, specified element and last element in the list.

Display the contents of the linked list.

```
#include <stdio.h>
#include <stdlib.h>
struct node
{
   int data;
   struct node *next;
};
struct node *start = NULL;
struct node *insert_beg(struct node *);
struct node *insert_end(struct node *);
struct node *insert_at_pos(struct node *);
struct node *delete_beg(struct node *);
struct node *delete_end(struct node *);
struct node *delete_at_pos(struct node *);
struct node *display(struct node *);
int main(){
   int option;
   do    {
      printf("\n\n *****MAIN MENU *****");
      printf("\n 1: Add a node at the beginning");
      printf("\n 2: Add a node at the end");
      printf("\n 3: Add a node at a specific position");
      printf("\n 4: Delete a node from the beginning");
      printf("\n 5: Delete a node from the end");
      printf("\n 6: Delete a node from a specific position");
      printf("\n 7: Display the list");
```

```
        printf("\n 8: EXIT");
        printf("\n\n Enter your option :");
        scanf("%d", &option);
        switch (option) {
        case 1: start = insert_beg(start);
            break;
        case 2:  start = insert_end(start);
            break;
        case 3: start = insert_at_pos(start);
            break;
        case 4:start = delete_beg(start);
            break;
        case 5:   start = delete_end(start);
            break;
        case 6: start = delete_at_pos(start);
            break;
        case 7:start = display(start);
            break;    }
    } while (option != 8);
    struct node *temp;
    while (start != NULL){
        temp = start;
        start = start->next;
        free(temp);  }
    return 0;
}
struct node *insert_beg(struct node *start){
    struct node *new_node;
    int num;
    printf("Enter the data: ");
    scanf("%d", &num);
    new_node = (struct node *)malloc(sizeof(struct node));
```

```
    new_node->data = num;
    new_node->next = start;
    start = new_node;
    printf("Inserted at the beginning.\n");
    return start;}
struct node *insert_end(struct node *start){
    struct node *ptr, *new_node;
    int num;
    printf("Enter the data: ");
    scanf("%d", &num);
    new_node = (struct node *)malloc(sizeof(struct node));
    new_node->data = num;
    new_node->next = NULL;
    if (start == NULL)  {
       start = new_node;}
    else {
       ptr = start;
       while (ptr->next != NULL)    {
          ptr = ptr->next;     }
       ptr->next = new_node; }
    printf("Inserted at the end.\n");
    return start;}
struct node *insert_at_pos(struct node *start){
    struct node *new_node, *ptr, *preptr;
    int pos, num;
    printf("Enter the position to insert at: ");
    scanf("%d", &pos);
    printf("Enter the data: ");
    scanf("%d", &num);
    new_node = (struct node *)malloc(sizeof(struct node));
    new_node->data = num;
    new_node->next = NULL;
```

```
    if (pos == 1)   {
        new_node->next = start;
        start = new_node;
        printf("Inserted at position %d.\n", pos);
        return start;  }
    else  {
        int i;
        ptr = start;
        for (int i = 1; i < pos && ptr != NULL; i++) {
            preptr = ptr;
            ptr = ptr->next;   }
        if (ptr == NULL && pos > i   {
            printf("Invalid position. Node can't be inserted.\n");
            return start;  }
        preptr->next = new_node;
        new_node->next = ptr;
        printf("Inserted at position %d.\n", pos);
        return start'}}

struct node *delete_beg(struct node *start){
    struct node *ptr;
    ptr = start;
    if (ptr == NULL) {
        printf("Empty list. Can't be deleted.\n");
        return start;}
    else {
        start = start->next;
        free(ptr);
        printf("Deleted at the beginning.\n");
        return start; }
}
struct node *delete_end(struct node *start){
```

```
    struct node *ptr, *ptr1;
    ptr = start;
    if (ptr == NULL)   {
        printf("Empty list. Can't be deleted.\n");
        return start;  }
    else if (ptr->next == NULL){
        free(ptr);
        start = NULL;
        printf("Deleted at the end.\n");
       return start;}
else{
        while (ptr->next != NULL) {
            ptr1 = ptr;
            ptr = ptr->next;
        }
        ptr1->next = NULL;
        free(ptr);
        printf("Deleted at the end.\n");
        return start; }
}
struct node *delete_at_pos(struct node *start){
    struct node *ptr, *preptr;
    int pos;
    printf("Enter the position to delete: ");
    scanf("%d", &pos);
    if (start == NULL)  {
        printf("Empty list. Can't be deleted.\n");
        return start; }
    ptr = start;
    if (pos == 1)  {
        start = start->next;
        free(ptr);
```

```
        printf("Deleted at position %d.\n", pos);
        return start;  }
    else {
        for (int i = 1; i < pos && ptr != NULL; i++){
            preptr = ptr;
            ptr = ptr->next; }
        if (ptr == NULL) {
            printf("Invalid position. Node can't be deleted.\n");
            return start;}
        preptr->next = ptr->next;
        free(ptr);
        printf("Deleted at position %d.\n", pos);
        return start; }}
struct node *display(struct node *start){
    struct node *ptr;
    ptr = start;
    if (ptr == NULL){
        printf("Empty list.\n");
        return start;}
    else{
        printf("Linked list elements: ");
        while (ptr != NULL){
            printf("%d\t", ptr->data);
            ptr = ptr->next;}
        printf("\n");
        return start;}}
```

OUTPUT:

```
 *****MAIN MENU *****
 1: Add a node at the beginning
 2: Add a node at the end
 3: Add a node at a specific position
 4: Delete a node from the beginning
 5: Delete a node from the end
 6: Delete a node from a specific position
 7: Display the list
 8: EXIT

 Enter your option :1
Enter the data: 10
Inserted at the beginning.


 *****MAIN MENU *****
 1: Add a node at the beginning
 2: Add a node at the end
 3: Add a node at a specific position
 4: Delete a node from the beginning
 5: Delete a node from the end
 6: Delete a node from a specific position
 7: Display the list
 8: EXIT

 Enter your option :2
Enter the data: 30
Inserted at the end.


 *****MAIN MENU *****
 1: Add a node at the beginning
 2: Add a node at the end
 3: Add a node at a specific position
 4: Delete a node from the beginning
 5: Delete a node from the end
 6: Delete a node from a specific position
 7: Display the list
```

```
 7: Display the list
 8: EXIT

 Enter your option :3
Enter the position to insert at: 2
Enter the data: 20
Inserted at position 2.


 *****MAIN MENU *****
 1: Add a node at the beginning
 2: Add a node at the end
 3: Add a node at a specific position
 4: Delete a node from the beginning
 5: Delete a node from the end
 6: Delete a node from a specific position
 7: Display the list
 8: EXIT

 Enter your option :7
Linked list elements: 10        20      30


 *****MAIN MENU *****
 1: Add a node at the beginning
 2: Add a node at the end
 3: Add a node at a specific position
 4: Delete a node from the beginning
 5: Delete a node from the end
 6: Delete a node from a specific position
 7: Display the list
 8: EXIT

 Enter your option :4
Deleted at the beginning.


 *****MAIN MENU *****
 1: Add a node at the beginning
 2: Add a node at the end
```

```
 2: Add a node at the end
 3: Add a node at a specific position
 4: Delete a node from the beginning
 5: Delete a node from the end
 6: Delete a node from a specific position
 7: Display the list
 8: EXIT

 Enter your option :6
Enter the position to delete: 2
Deleted at position 2.


 *****MAIN MENU *****
 1: Add a node at the beginning
 2: Add a node at the end
 3: Add a node at a specific position
 4: Delete a node from the beginning
 5: Delete a node from the end
 6: Delete a node from a specific position
 7: Display the list
 8: EXIT

 Enter your option :7
Linked list elements: 20


 *****MAIN MENU *****
 1: Add a node at the beginning
 2: Add a node at the end
 3: Add a node at a specific position
 4: Delete a node from the beginning
 5: Delete a node from the end
 6: Delete a node from a specific position
 7: Display the list
 8: EXIT

 Enter your option :8

Process returned 0 (0x0)   execution time : 67.518 s
```

LAB PROGRAM 5:

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

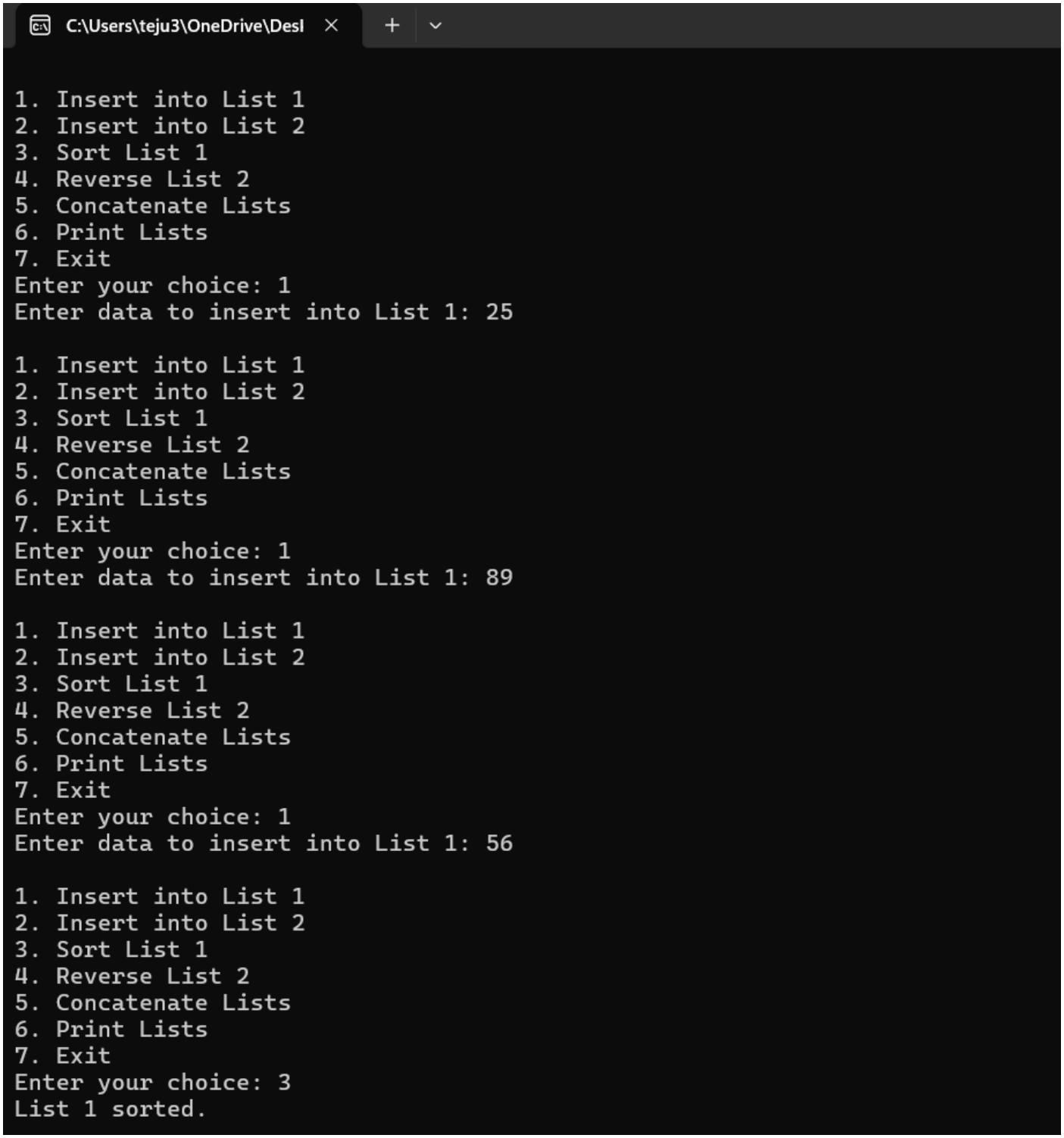
```
#include <stdio.h>
#include <stdlib.h>
struct Node {
    int data;
    struct Node* next;
};
void insertAtBeginning(struct Node** head, int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = *head;
    *head = newNode;
}
void printList(struct Node* head) {
    while (head != NULL) {
        printf("%d ", head->data);
        head = head->next; }
    printf("\n");}
void sortList(struct Node** head) {
    struct Node *current, *nextNode;
    int temp;
    current = *head;
    while (current != NULL) {
        nextNode = current->next;
        while (nextNode != NULL) {
            if (current->data > nextNode->data) {
                temp = current->data;
                current->data = nextNode->data;
                nextNode->data = temp; }
            nextNode = nextNode->next;}
```

```
        current = current->next;}
}
void reverseList(struct Node** head) {
    struct Node *prev, *current, *nextNode;
    prev = NULL;
    current = *head;
    while (current != NULL) {
        nextNode = current->next;
        current->next = prev;
        prev = current;
        current = nextNode; }
    *head = prev;}
void concatenateLists(struct Node** list1, struct Node* list2) {
    if (*list1 == NULL) {
        *list1 = list2;
       return; }
    struct Node* temp = *list1;
    while (temp->next != NULL) {
        temp = temp->next;   }
    temp->next = list2;}
void main() {
    struct Node* list1 = NULL;
    struct Node* list2 = NULL;
    int choice;
    int data;

    while(1) {
        printf("\n1. Insert into List 1\n");
        printf("2. Insert into List 2\n");
        printf("3. Sort List 1\n");
        printf("4. Reverse List 2\n");
        printf("5. Concatenate Lists\n");
```

```
printf("6. Print Lists\n");
printf("7. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);
switch (choice) {
    case 1: printf("Enter data to insert into List 1: ");
        scanf("%d", &data);
        insertAtBeginning(&list1, data);
        break;
    case 2:printf("Enter data to insert into List 2: ");
        scanf("%d", &data);
        insertAtBeginning(&list2, data);
        break;
    case 3:sortList(&list1);
        printf("List 1 sorted.\n");
        break;
    case 4:reverseList(&list1);
        printf("List 1 reversed.\n");
        break;
    case 5:concatenateLists(&list1, list2);
        printf("Lists concatenated.\n");
        break;

    case 6:
        printf("List 1: ");
        printList(list1);
        printf("List 2: ");
        printList(list2);
        break;
    case 7:
        exit(0);
        break;
```

```
        default:
            printf("Invalid choice\n");
      }
   }
}
```

OUTPUT:



```
1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 2
Enter data to insert into List 2: 56

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 6
List 1: 25 56 89
List 2: 56 45

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 6
List 1: 25 56 89
List 2: 56 45
```

```
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 2
Enter data to insert into List 2: 30

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 6
List 1: 12 10
List 2: 30

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 5
Lists concatenated.

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 6
List 1: 12 10 30
List 2: 30

1. Insert into List 1
2. Insert into List 2
```

```
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 5
Lists concatenated.

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 6
List 1: 12 10 30
List 2: 30

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 7

Process returned 0 (0x0)   execution time : 69.851 s
Press any key to continue.
```

LAB PROGRAM 6:

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

```
#include <stdio.h>
#include <stdlib.h>
struct stack
{
int data;
struct stack *next;
};
struct stack *top = NULL;
struct stack *push(struct stack *, int);
struct stack *display(struct stack *);
struct stack *pop(struct stack *);
void main(){
int val, option;
while(1){
 printf("\n *****MAIN MENU*****");
 printf("\n 1. PUSH");
 printf("\n 2. POP");
 printf("\n 3. DISPLAY");
 printf("\n 4. EXIT");
 printf("\n Enter your option: ");
 scanf("%d", &option);
 switch(option){
 case 1:
 printf("\n Enter the number to be pushed on stack: ");
 scanf("%d", &val);
 top = push(top, val);
 break;
 case 2:
 top = pop(top);
```

```
 break;
 case 3:
 top = display(top);
 break;
 case 4:exit(0);
 default:printf("Invalid input"); }}
}
struct stack *push(struct stack *top, int val){
struct stack *ptr;
ptr = (struct stack*)malloc(sizeof(struct stack));
ptr -> data = val;
if(top == NULL){
 ptr -> next = NULL;
 top = ptr;
 printf("The value %d is inserted",val);}
else{
 ptr -> next = top;
 top = ptr;
 printf("The value %d is inserted",val);}
return top;}
struct stack *display(struct stack *top){
struct stack *ptr;
ptr = top;
if(top == NULL)
printf("\n STACK IS EMPTY");
else{
 printf("The stack elements are:");
 while(ptr != NULL) {
 printf("\n %d", ptr -> data);
 ptr = ptr -> next; }}
return top;}
struct stack *pop(struct stack *top){
```

```
struct stack *ptr;
ptr = top;
if(top == NULL)
printf("\n STACK UNDERFLOW");
else{
 top = top -> next;
 printf("\n The value being deleted is: %d", ptr -> data);
 free(ptr);}
return top;}
```

OUTPUT:

```
 *****MAIN MENU*****
 1. PUSH
 2. POP
 3. DISPLAY
 4. EXIT
 Enter your option: 1

 Enter the number to be pushed on stack: 10
The value 10 is inserted
 *****MAIN MENU*****
 1. PUSH
 2. POP
 3. DISPLAY
 4. EXIT
 Enter your option: 1

 Enter the number to be pushed on stack: 20
The value 20 is inserted
 *****MAIN MENU*****
 1. PUSH
 2. POP
 3. DISPLAY
 4. EXIT
 Enter your option: 3
The stack elements are:
 20
 10
 *****MAIN MENU*****
 1. PUSH
 2. POP
 3. DISPLAY
 4. EXIT
 Enter your option: 2

 The value being deleted is: 20
 *****MAIN MENU*****
 1. PUSH
 2. POP
 3. DISPLAY
```

```
 Enter your option: 3
The stack elements are:
 20
 10
 *****MAIN MENU*****
 1. PUSH
 2. POP
 3. DISPLAY
 4. EXIT
 Enter your option: 2

 The value being deleted is: 20
 *****MAIN MENU*****
 1. PUSH
 2. POP
 3. DISPLAY
 4. EXIT
 Enter your option: 3
The stack elements are:
 10
 *****MAIN MENU*****
 1. PUSH
 2. POP
 3. DISPLAY
 4. EXIT
 Enter your option: 4

Process returned 0 (0x0)   execution time : 26.630 s
Press any key to continue.
```

Queue Implementation:

```
#include <stdio.h>

#include<stdlib.h>

struct node

{

int data;

struct node *next;

};

struct queue

{

struct node *front;
```

```
struct node *rear;
};
struct queue *createQueue(){
    struct queue* q = (struct queue*)malloc(sizeof(struct queue));
    q->front = q->rear = NULL;
    return q;}
struct queue *q;
struct queue *insert(struct queue *,int);
struct queue *delete_element(struct queue *);
struct queue *display(struct queue *);
void main(){
int val, option;
q=createQueue(q);
while(1){
 printf("\n *****MAIN MENU*****");
 printf("\n 1. INSERT");
 printf("\n 2. DELETE");
 printf("\n 3. DISPLAY");
 printf("\n 4. EXIT");
 printf("\n Enter your option : ");
 scanf("%d", &option);
 switch(option) {
 case 1:
 printf("\n Enter the number to insert in the queue:");
 scanf("%d", &val);
 q = insert(q,val);
 printf("\nThe value %d is inserted into the queue.\n",val);
 break;
 case 2:
 q = delete_element(q);
 break;
 case 3:
```

```
 q = display(q);
 break;
 case 4:exit(0);
 default:printf("Invalid input"); }}}
struct queue *insert(struct queue *q,int val){
struct node *ptr;
ptr = (struct node*)malloc(sizeof(struct node));
ptr -> data = val;
if(q -> front == NULL){
 q -> front = ptr;
 q -> rear = ptr;
 q -> front -> next = q -> rear -> next = NULL;}
else{
 q -> rear -> next = ptr;
 q -> rear = ptr;
 q -> rear -> next = NULL;}
return q;}
struct queue *display(struct queue *q){
struct node *ptr;
ptr = q -> front;
if(ptr == NULL)
 printf("\n QUEUE IS EMPTY\n");
else{
 printf("\n");
while(ptr!=q -> rear) {
 printf("%d\t", ptr -> data);
 ptr = ptr -> next; }
 printf("%d\t", ptr -> data);}
return q;}
struct queue *delete_element(struct queue *q){
struct node *ptr;
ptr = q -> front;
```

```
if(q -> front == NULL)
 printf("\n UNDERFLOW\n");
else{
 q -> front = q -> front -> next;
 printf("\n The value being deleted is : %d\n", ptr -> data);
 free(ptr);}
return q;
}
```

OUTPUT:

```
 *****MAIN MENU*****
 1. INSERT
 2. DELETE
 3. DISPLAY
 4. EXIT
 Enter your option : 1

 Enter the number to insert in the queue:10

The value 10 is inserted into the queue.

 *****MAIN MENU*****
 1. INSERT
 2. DELETE
 3. DISPLAY
 4. EXIT
 Enter your option : 1

 Enter the number to insert in the queue:20

The value 20 is inserted into the queue.

 *****MAIN MENU*****
 1. INSERT
 2. DELETE
 3. DISPLAY
 4. EXIT
 Enter your option : 3

10      20
 *****MAIN MENU*****
 1. INSERT
 2. DELETE
 3. DISPLAY
 4. EXIT
 Enter your option : 2

 The value being deleted is : 10
```

```
 Enter your option : 3

10      20
 *****MAIN MENU*****
 1. INSERT
 2. DELETE
 3. DISPLAY
 4. EXIT
 Enter your option : 2

 The value being deleted is : 10

 *****MAIN MENU*****
 1. INSERT
 2. DELETE
 3. DISPLAY
 4. EXIT
 Enter your option : 3

20
 *****MAIN MENU*****
 1. INSERT
 2. DELETE
 3. DISPLAY
 4. EXIT
 Enter your option : 4

Process returned 0 (0x0)   execution time : 28.655 s
Press any key to continue.
```

LAB PROGRAM 7:

Write a program to Implement doubly link list with primitive operations.

a) Create a doubly linked list.

b) Insert a new node to the left of the node.

c) Delete the node based on a specific value

d) Display the contents of the list

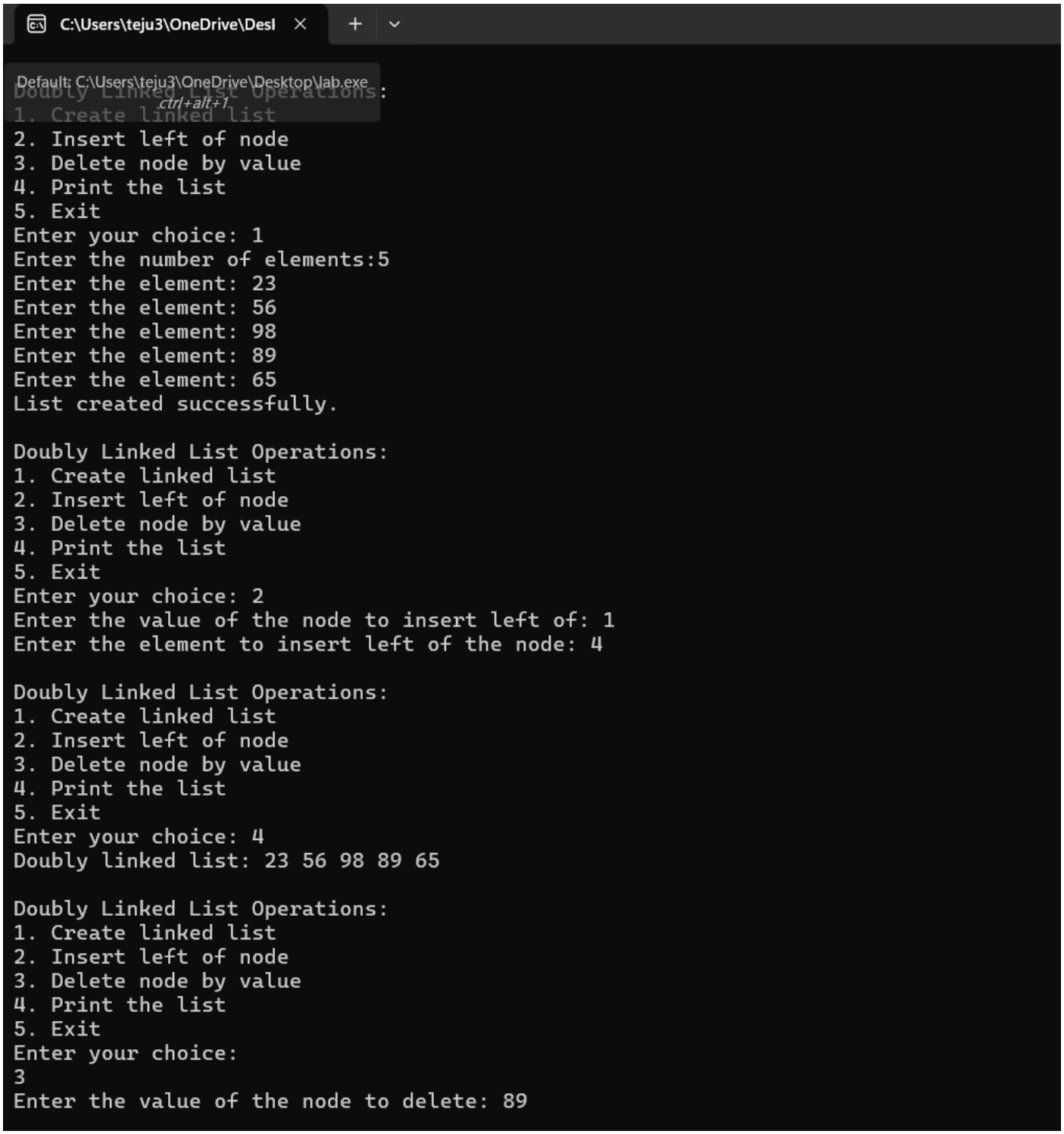
```
#include <stdio.h>
#include <stdlib.h>
struct Node {
    int data;
    struct Node* prev;
    struct Node* next;
};
struct Node* head = NULL;
void createlist() {
    int i, n;
    struct Node* newNode;
    struct Node* temp;
    printf("Enter the number of elements:");
    scanf("%d", &n);
    for (i = 0; i < n; i++) {
        newNode = (struct Node*)malloc(sizeof(struct Node));
        printf("Enter the element: ");
        scanf("%d", &newNode->data);
        if (head == NULL) {
            head = temp = newNode;
            head->prev = NULL;
            temp->next = NULL;
        } else {
            temp->next = newNode;
            newNode->prev = temp;
```

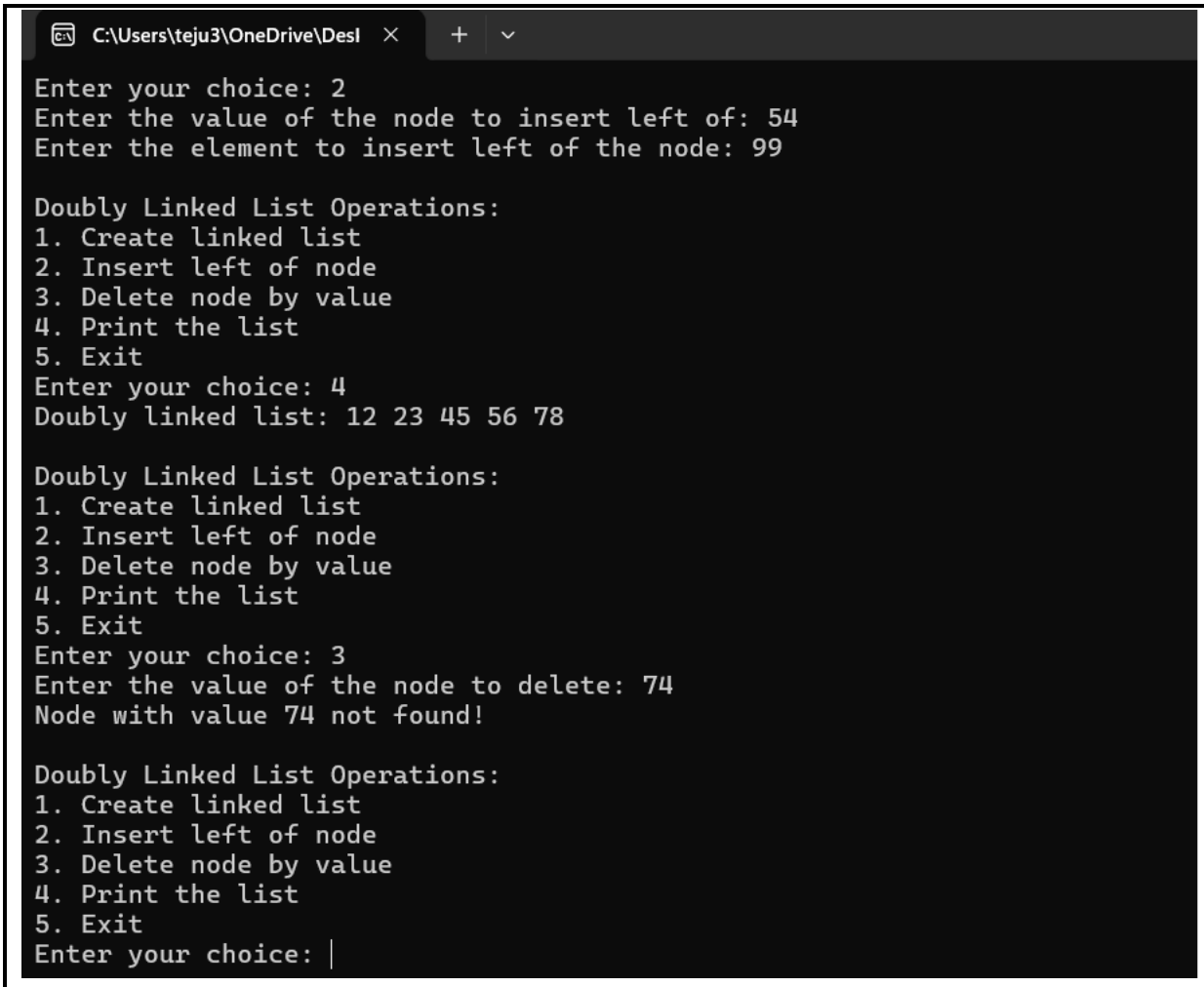
```
            temp = newNode;
            temp->next = NULL; } }
    printf("List created successfully.\n");}
void insertLeft(struct Node* temp, int data) {
    struct Node* newNode;
    if (temp == NULL) {
        printf("Target node doesn't exist!\n");
        return; }
    newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = temp;
    newNode->prev = temp->prev;
    if (temp->prev != NULL) {
        temp->prev->next = newNode; }
    temp->prev = newNode;
    if (head == temp) {
        head = newNode; }
    printf("Node inserted successfully.\n");}
void deleteNode(int key) {
    struct Node* current = head;
    while (current != NULL) {
        if (current->data == key) {
            if (current->prev != NULL) {
                current->prev->next = current->next;  }
            if (current->next != NULL) {
                current->next->prev = current->prev;
            }
            if (current == head) {
                head = current->next; }
            free(current);
            printf("Node deleted successfully.\n");
            return;   }
```

```
        current = current->next;}
    printf("Node with value %d not found!\n", key);}
void printList() {
    struct Node* temp = head;
    if (temp == NULL) {
        printf("List is empty!\n");
        return;   }
    printf("Doubly linked list: ");
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;}
    printf("\n");}
int main() {
    int choice, data, targetValue, deleteValue;
    while(1) {
        printf("\nDoubly Linked List Operations:\n");
        printf("1. Create linked list\n");
        printf("2. Insert left of node\n");
        printf("3. Delete node by value\n");
        printf("4. Print the list\n");
        printf("5. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1: createlist();
                break;
            case 2: printf("Enter the value of the node to insert left of: ");
                scanf("%d", &targetValue);
                printf("Enter the element to insert left of the node: ");
                scanf("%d", &data);
                struct Node* temp = head;
```

```
            while (temp != NULL) {
                if (temp->data == targetValue) {
                    insertLeft(temp, data);
                    break; }
                temp = temp->next; }
            break;
        case 3: printf("Enter the value of the node to delete: ");
            scanf("%d", &deleteValue);
            deleteNode(deleteValue);
            break;
        case 4:  printList();
            break;
        case 5:  exit(0);
            break;
        default:
            printf("Invalid choice!\n");
      }
   }
   return 0;
}
```

OUTPUT:


C:\Users\teju3\OneDrive\Desl
Default: C:\Users\teju3\OneDrive\Desktop\lab.exe
ctrl+alt+1
Doubly Linked List Operations:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 1
Enter the number of elements:5
Enter the element: 23
Enter the element: 56
Enter the element: 98
Enter the element: 89
Enter the element: 65
List created successfully.
Doubly Linked List Operations:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 2
Enter the value of the node to insert left of: 1
Enter the element to insert left of the node: 4
Doubly Linked List Operations:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 4
Doubly linked list: 23 56 98 89 65
Doubly Linked List Operations:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice:
3
Enter the value of the node to delete: 89


C:\Users\teju3\OneDrive\Desl
Enter your choice: 2
Enter the value of the node to insert left of: 54
Enter the element to insert left of the node: 99
Doubly Linked List Operations:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 4
Doubly linked list: 12 23 45 56 78
Doubly Linked List Operations:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 3
Enter the value of the node to delete: 74
Node with value 74 not found!
Doubly Linked List Operations:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice:

LAB PROGRAM 8:

Write a program

a) To construct a binary Search tree.

b) To traverse the tree using all the methods i.e., in-order, preorder and post order

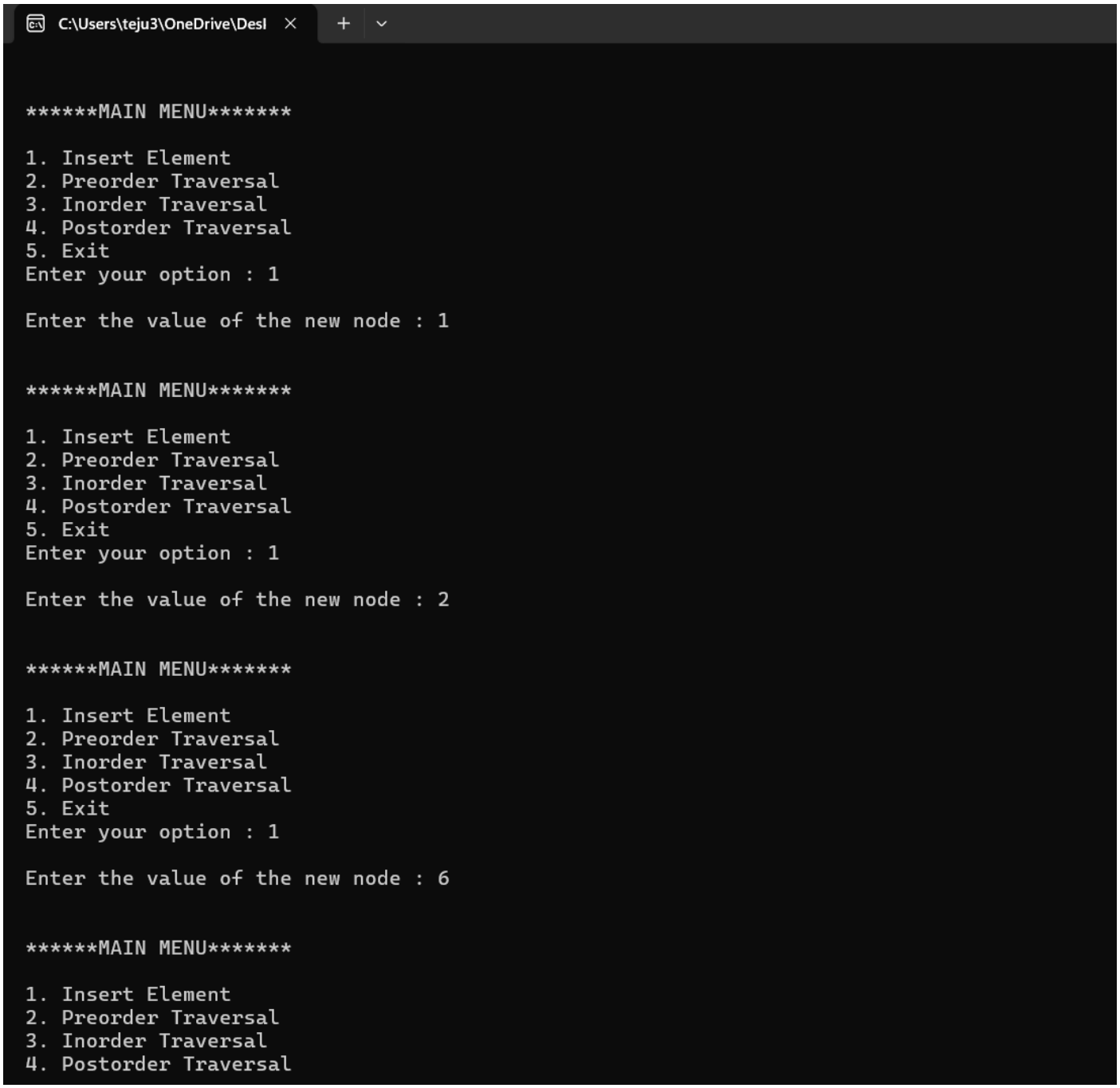
c) To display the elements in the tree.

```
#include <stdio.h>
#include <conio.h>
#include <malloc.h>

struct node{
int data;
struct node *left;
struct node *right;
};
struct node *tree=NULL;
struct node *insertElement(struct node *, int);
void preorderTraversal(struct node *);
void inorderTraversal(struct node *);
void postorderTraversal(struct node *);
void main(){
int option, val;
while(1){
printf("\n\n ******MAIN MENU******* \n");
printf("\n 1. Insert Element");
printf("\n 2. Preorder Traversal");
printf("\n 3. Inorder Traversal");
printf("\n 4. Postorder Traversal");
printf("\n 5. Exit");
printf("\n Enter your option : ");
scanf("%d", &option);
switch(option){
case 1:
```

```
printf("\n Enter the value of the new node : ");
scanf("%d", &val);
tree = insertElement(tree, val);
break;
case 2:
printf("\n The elements of the tree are : \n");
preorderTraversal(tree);
break;
case 3:
printf("\n The elements of the tree are : \n");
inorderTraversal(tree);
break;
case 4:
printf("\n The elements of the tree are : \n");
postorderTraversal(tree);
break;
case 5:exit(0);
default:printf("Invalid input");}}}
struct node *insertElement(struct node *tree, int val){
struct node *ptr, *nodeptr, *parentptr;
ptr = (struct node*)malloc(sizeof(struct node));
ptr->data = val;
ptr->left = NULL;
ptr->right = NULL;
if(tree==NULL){
tree=ptr;
tree->left=NULL;
tree->right=NULL;}
else{
parentptr=NULL;
nodeptr=tree;
while(nodeptr!=NULL) {
```

```
parentptr=nodeptr;
if(val<nodeptr->data)
nodeptr=nodeptr->left;
else
nodeptr = nodeptr->right; }
if(val<parentptr->data)
parentptr->left = ptr;
else
parentptr->right = ptr;}
return tree;}
void preorderTraversal(struct node *tree){
if(tree != NULL){
printf("%d\t", tree->data);
preorderTraversal(tree->left);
preorderTraversal(tree->right);}}
void inorderTraversal(struct node *tree){
if(tree != NULL){
inorderTraversal(tree->left);
printf("%d\t", tree->data);
inorderTraversal(tree->right);}}
void postorderTraversal(struct node *tree){
if(tree != NULL){
postorderTraversal(tree->left);
postorderTraversal(tree->right);
printf("%d\t", tree->data);}
}
```

OUTPUT:


C:\Users\teju3\OneDrive\Desl
******MAIN MENU*******
1. Insert Element
2. Preorder Traversal
3. Inorder Traversal
4. Postorder Traversal
5. Exit
Enter your option : 1
Enter the value of the new node : 1
******MAIN MENU*******
1. Insert Element
2. Preorder Traversal
3. Inorder Traversal
4. Postorder Traversal
5. Exit
Enter your option : 1
Enter the value of the new node : 2
******MAIN MENU*******
1. Insert Element
2. Preorder Traversal
3. Inorder Traversal
4. Postorder Traversal
5. Exit
Enter your option : 1
Enter the value of the new node : 6
******MAIN MENU*******
1. Insert Element
2. Preorder Traversal
3. Inorder Traversal
4. Postorder Traversal

```
******MAIN MENU*******

1. Insert Element
2. Preorder Traversal
3. Inorder Traversal
4. Postorder Traversal
5. Exit
Enter your option : 1

Enter the value of the new node : 8


******MAIN MENU*******

1. Insert Element
2. Preorder Traversal
3. Inorder Traversal
4. Postorder Traversal
5. Exit
Enter your option : 1

Enter the value of the new node : 3


******MAIN MENU*******

1. Insert Element
2. Preorder Traversal
3. Inorder Traversal
4. Postorder Traversal
5. Exit
Enter your option : 2

The elements of the tree are :
7       5       3       5       8
```

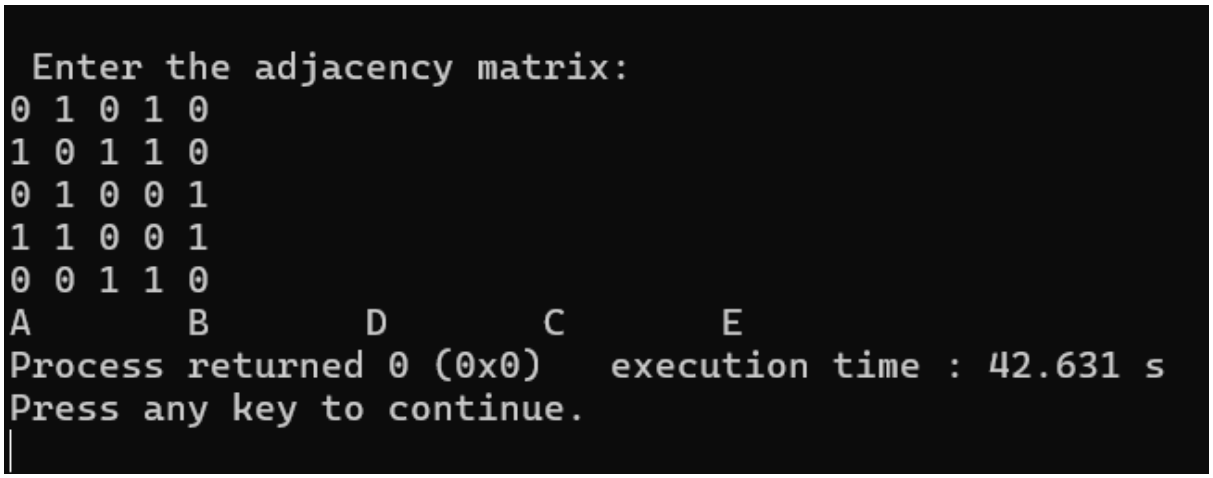
```
7       5       3       5       8

 ******MAIN MENU*******

 1. Insert Element
 2. Preorder Traversal
 3. Inorder Traversal
 4. Postorder Traversal
 5. Exit
 Enter your option : 3

 The elements of the tree are :
3       5       5       7       8

 ******MAIN MENU*******

 1. Insert Element
 2. Preorder Traversal
 3. Inorder Traversal
 4. Postorder Traversal
 5. Exit
 Enter your option : 4

 The elements of the tree are :
3       5       5       8       7

 ******MAIN MENU*******

 1. Insert Element
 2. Preorder Traversal
 3. Inorder Traversal
 4. Postorder Traversal
 5. Exit
 Enter your option : 5

Process returned 0 (0x0)   execution time : 54.695 s
Press any key to continue.
```

LAB PROGRAM 9:

a) Write a program to traverse a graph using BFS method.

```
#include <stdio.h>
#define MAX 5
void breadth_first_search(int adj[][MAX],int visited[],int start){
int queue[MAX],rear = -1,front = -1, i;
queue[++rear] = start;
visited[start] = 1;
while(rear != front){
 start = queue[++front];
 if(start == 4)
 printf("%c\t",start+65);
 else
 printf("%c \t",start + 65);
 for(i = 0; i < MAX; i++) {
    if(adj[start][i] == 1 && visited[i] == 0){
  queue[++rear] = i;
  visited[i] = 1; } }}
}
int main(){
int visited[MAX] = {0};
int adj[MAX][MAX], i, j;
printf("\n Enter the adjacency matrix: ");
for(i = 0; i < MAX; i++)
 for(j = 0; j < MAX; j++)
    scanf("%d", &adj[i][j]);
breadth_first_search(adj,visited,0);
    return 0;
}
```

OUTPUT:



b) Write a program to check whether a given graph is connected or not using the DFS method.

```
#include <stdbool.h>
#include <stdio.h>
#include <string.h>
#define N 50
int gr[N][N];
bool vis[N];
void Add_edge(int u, int v){
   gr[u][v] = 1;}
void dfs(int x){
   vis[x] = true;
   for (int i = 1; i <= N; i++)
      if (gr[x][i] && !vis[i])
         dfs(i);}

bool Is_Connected(int n){
   memset(vis, false, sizeof vis);
   dfs(1);
   for (int i = 1; i <= n; i++){
      if (!vis[i])
```

```
            return false; }
    return true;}
int main(){
    int n, u, v;
    printf("Enter the number of vertices: ");
    scanf("%d", &n);
    printf("Enter the number of edges: ");
    int m;
    scanf("%d", &m);
    printf("Enter the edges (u v):\n");
    for (int i = 0; i < m; ++i) {
        scanf("%d %d", &u, &v);
        Add_edge(u, v); }
    if (Is_Connected(n))
        printf("Connected\n");
    else
        printf("Not Connected\n");
    return 0;
}
```

OUTPUT:

```
Enter the number of vertices: 4
Enter the number of edges: 4
Enter the edges (u v):
1 2
1 3
2 3
3 4
Connected
```

```
Enter the number of vertices: 5
Enter the number of edges: 4
Enter the edges (u v):
1 2
4 3
4 5
2 3
Not Connected
```

LeetCode Programs:

1.Score of Parentheses(LP:856)

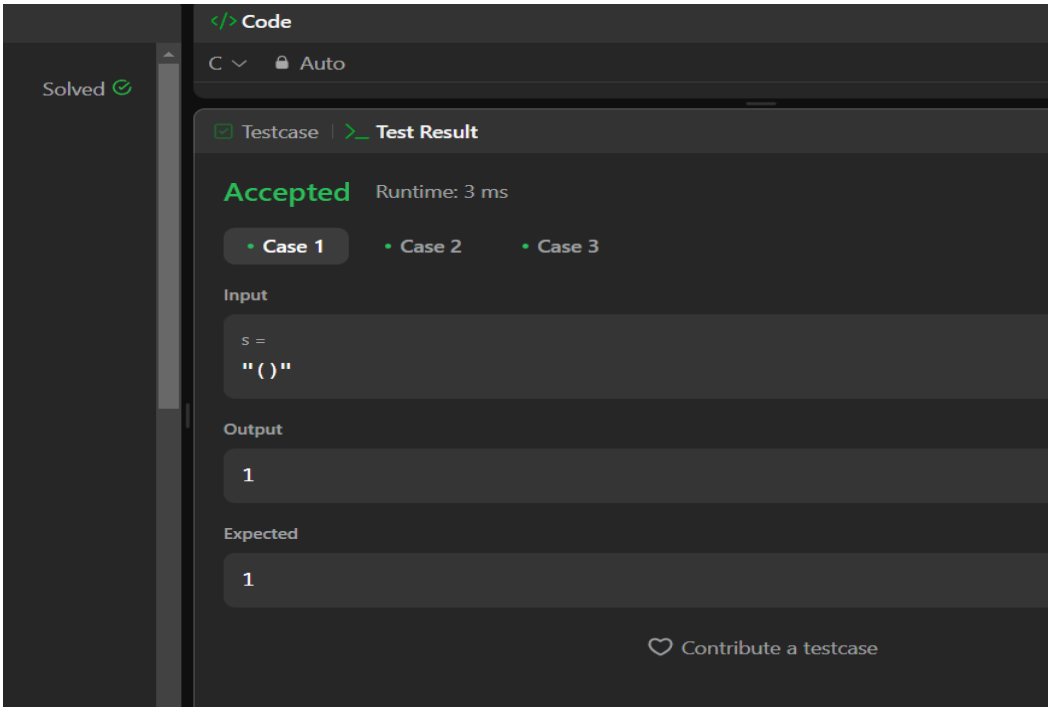
Submit

Code

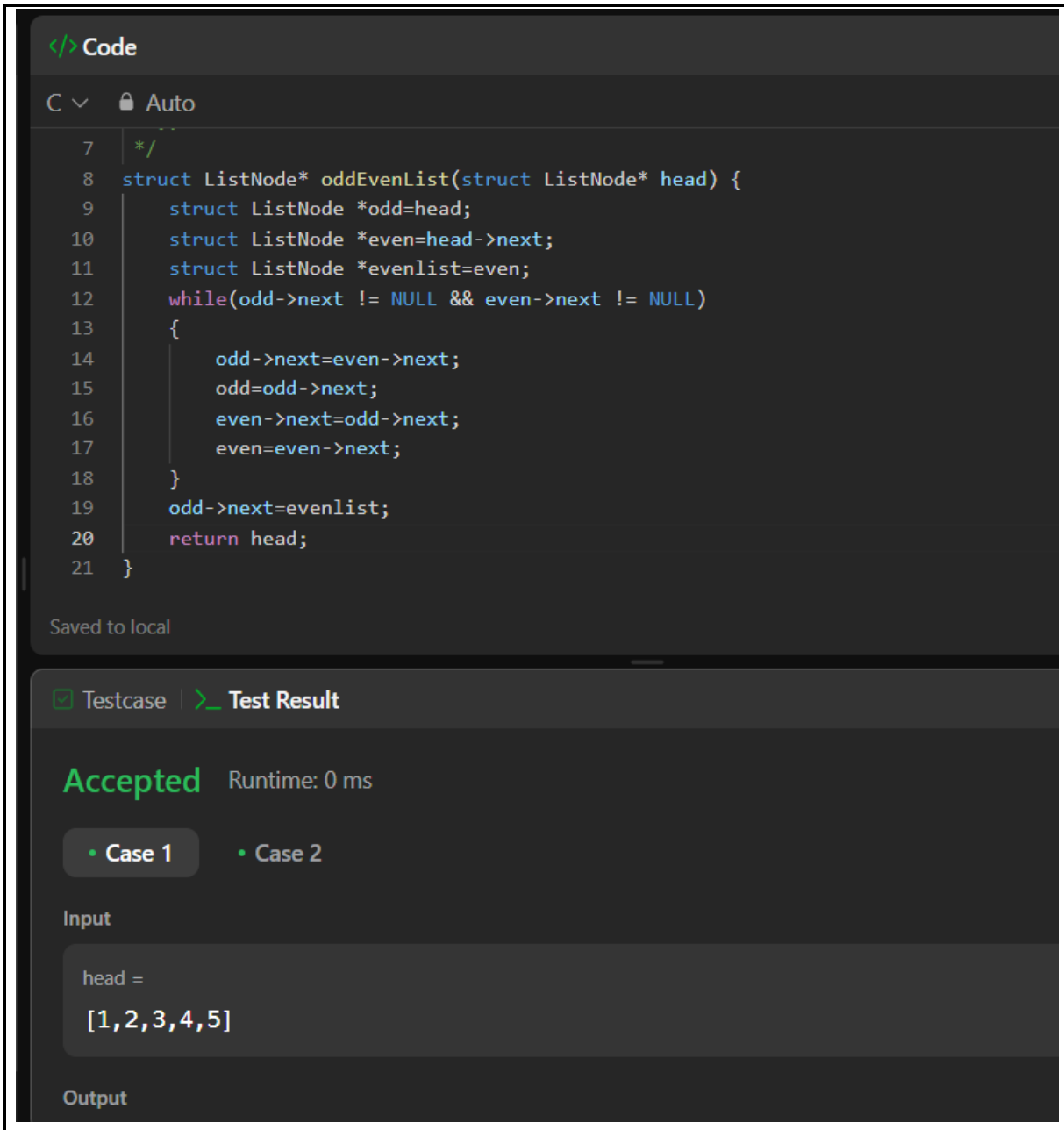
C Auto

```c
int scoreOfParentheses(char* s) {
    int *stack=(int*)malloc(sizeof(int));
   int size=0;
   int score=0;
   for(int i=0;s[i]!='\0';i++)
   {
       if(s[i]=='(')
       {
           stack=(int *)realloc(stack,(size+1)*sizeof(int));
           stack[size++]=score;
           score=0;
       }
       else{
           int previousScore=stack[--size];
           if(score>0)
           {
               score=previousScore+2*score;
           }
           else{
               score=previousScore+1;
           }
       }
   }free(stack);
   return score;
}
```

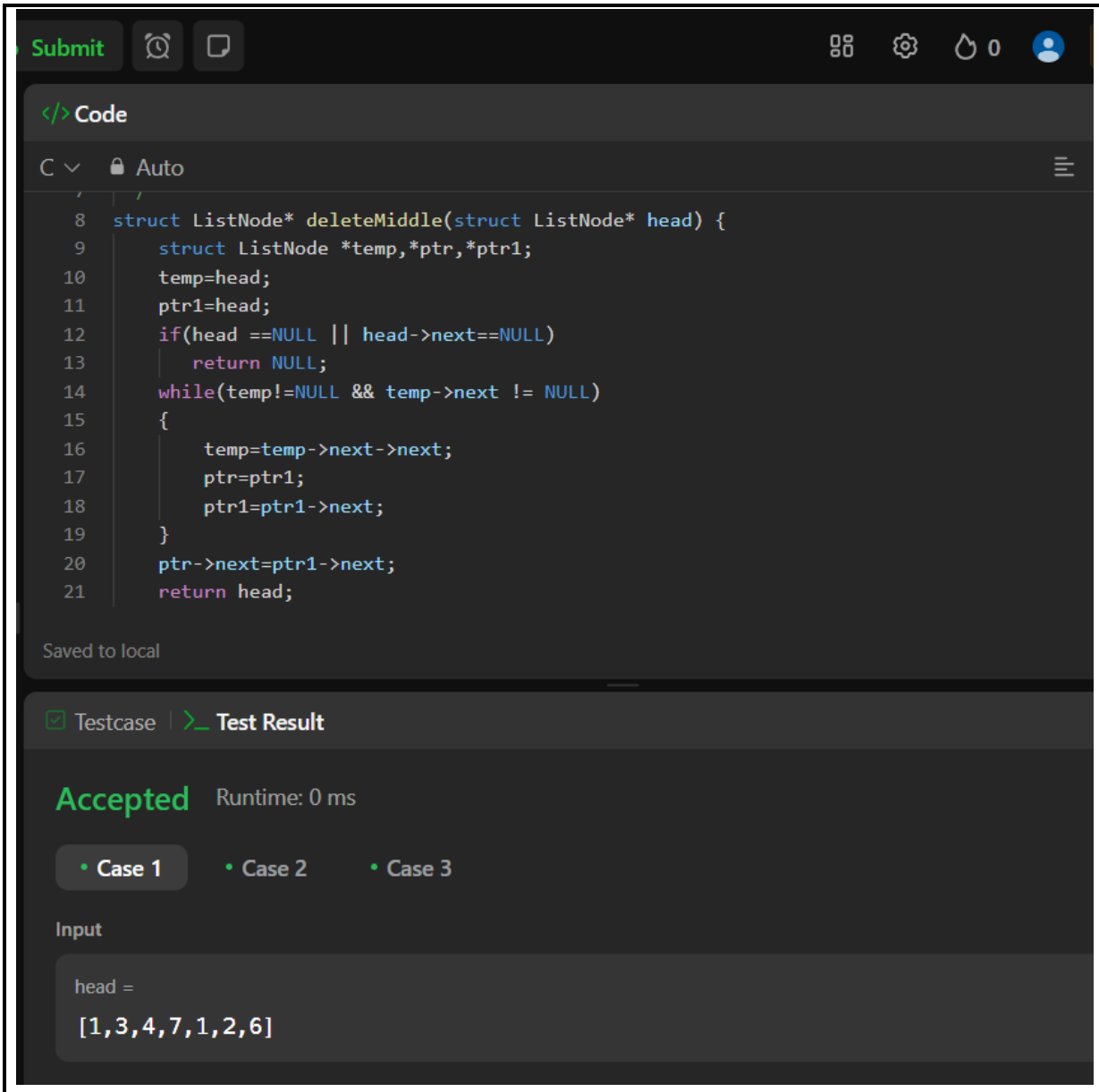
Saved to local



2.Odd Even Linked List(LP:328)



3.Delete middle node of linked list.(LP:2095)



4.Delete a node in BST.(LP:450)

```c
*/
struct TreeNode *smallest(struct TreeNode *root)
    {
        struct TreeNode *cur=root;
        while(cur->left != NULL)
          cur=cur->left;
        return cur;
    }

struct TreeNode* deleteNode(struct TreeNode* root, int key) {
    if(root == NULL)
      return root;

    if(key<root->val)
       root->left = deleteNode(root->left,key);
    else if(key > root->val)
       root->right = deleteNode(root->right,key);
    else
    {
        if(root->left == NULL)
        {
            struct TreeNode *temp =root->right;
            free(root);
            return temp;
        }
        else if(root->right == NULL)
        {
            struct TreeNode *temp=root->left;
```

Saved to local

```c
        else if(root->right == NULL)
        {
            struct TreeNode *temp=root->left;
            free(root);
            return temp;
        }
        struct TreeNode *temp= smallest(root->right);
        root->val=temp->val;
        root->right = deleteNode(root->right,root->val);
    }
    return root;
}
```

Saved to local

Testcase | Test Result

Accepted Runtime: 0 ms

• Case 1 • Case 2 • Case 3

Input

root =
[5,3,6,2,4,null,7]

key =
3

Output

5.Bottom Left Tree Value.(LP:513)

Code

C Auto

```c
*/
int findBottomLeftValue(struct TreeNode* root) {
    struct TreeNode *queue[100000];
    int front=0,rear=0;
    queue[rear++]=root;
    int leftmostValue=root->val;

while(front<rear)
{
    int levelSize = rear-front;
    for(int i=0;i<levelSize;i++)
    {
        struct TreeNode *current=queue[front++];
        if(i==0)
          leftmostValue=current->val;
        if(current->left != NULL)
           queue[rear++]=current->left;
        if(current->right != NULL)
           queue[rear++]=current ->right;
    }
}
return leftmostValue;
}
```