VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

PRAJWAL C(1BM22CS198)

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 **PRAJWAL C(1BM22CS198)**, 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.

Prof. Sneha S Bagalkot	**Dr. Jyothi S Nayak**
Assistant Professor	Professor and Head
Department of CSE	Department of CSE
BMSCE, Bengaluru	BMSCE, Bengaluru

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.

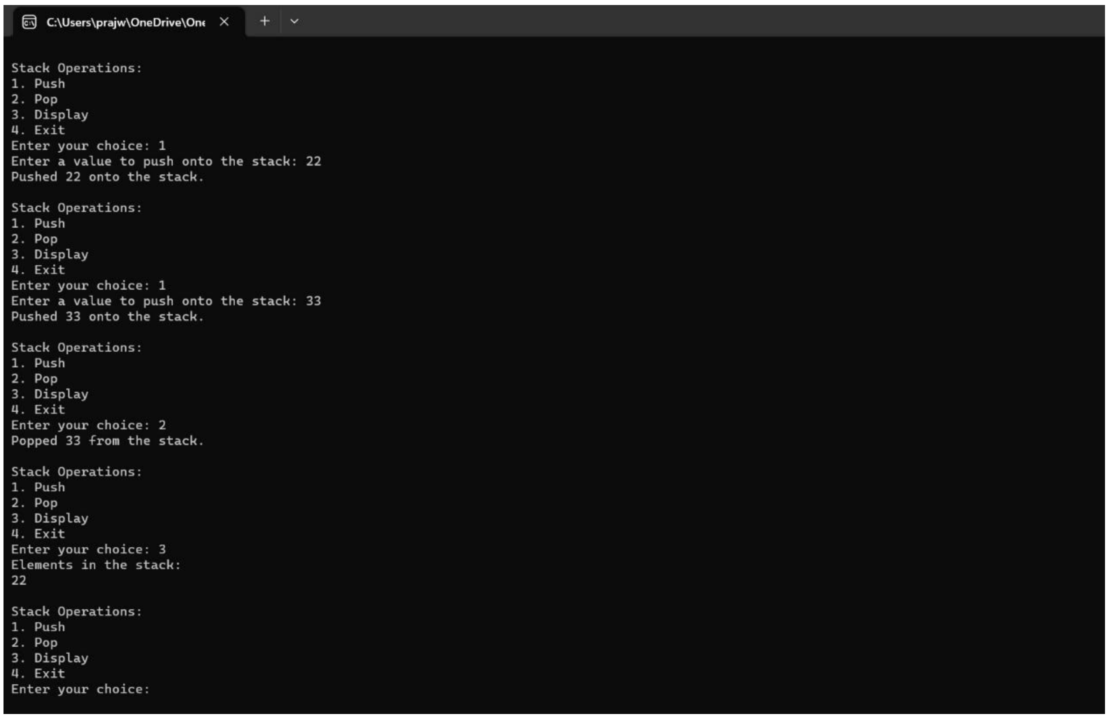
Lab program 1

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 MAX_SIZE 100

int stack[MAX_SIZE];
int top = -1;

void push(int value) {
    if (top == MAX_SIZE - 1) {
        printf("Stack overflow! Cannot push more elements.\n");
    } else {
        top++;
        stack[top] = value;
        printf("Pushed %d onto the stack.\n", value);
    }
}

int pop() {
    if (top == -1) {
        printf("Stack underflow! Cannot pop from an empty stack.\n");
        return -1; // Return a sentinel value to indicate underflow
    } else {
        int poppedValue = stack[top];
        top--;
        printf("Popped %d from the stack.\n", poppedValue);
        return poppedValue;
    }
}

void display() {
    if (top == -1) {
        printf("Stack is empty.\n");
    } else {
        printf("Elements in the stack:\n");
        for (int i = top; i >= 0; i--) {
            printf("%d\n", stack[i]);
        }
    }
}

int main() {
```

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

    switch (choice) {
        case 1:
            printf("Enter a value to push onto the stack: ");
            scanf("%d", &value);
            push(value);
            break;
        case 2:
            pop();
            break;
        case 3:
            display();
            break;
        case 4:
            printf("Exiting the program.\n");
            exit(0);
        default:
            printf("Invalid choice! Please enter a valid option.\n");
    }
}
return 0;
```

Output:



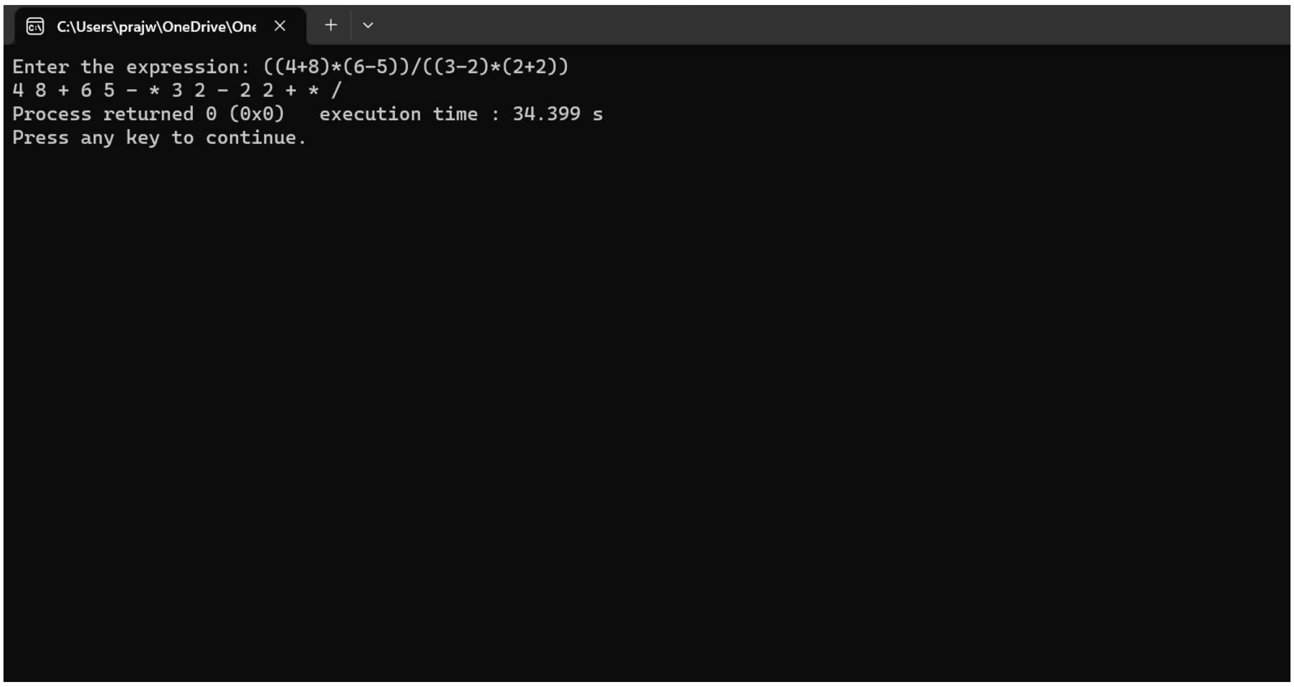
```
C:\Users\prajw\OneDrive\On

Stack Operations:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter a value to push onto the stack: 22
Pushed 22 onto the stack.

Stack Operations:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter a value to push onto the stack: 33
Pushed 33 onto the stack.

Stack Operations:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2
Popped 33 from the stack.

Stack Operations:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 3
Elements in the stack:
22

Stack Operations:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice:
```

Lab Program 2:

WAP 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 <ctype.h>

char stack[100];
int top = -1;

void push(char x) {
    stack[++top] = x;
}

char pop() {
    if (top == -1)
        return -1;
    else
        return stack[top--];
}

int priority(char x) {
    if (x == '(')
        return 0;
    if (x == '+' || x == '-')
        return 1;
    if (x == '*' || x == '/')
        return 2;
    return 0;
}

int main() {
    char exp[100];
    char *e, x;

    printf("Enter the expression: ");
    scanf("%s", exp);

    e = exp;
    while (*e != '\0') {
        if (isalnum(*e))
            printf("%c ", *e);
        else if (*e == '(')
            push(*e);
        else if (*e == ')') {
            while ((x = pop()) != '(')
                printf("%c ", x);
        } else {
            while (priority(stack[top]) >= priority(*e))
                printf("%c ", pop());
        push(*e);
      }
      e++;
    }

    while (top != -1)
      printf("%c ", pop());

    return 0;
}
```

Output:



```
Enter the expression: ((4+8)*(6-5))/((3-2)*(2+2))
4 8 + 6 5 - * 3 2 - 2 2 + * /
Process returned 0 (0x0)   execution time : 34.399 s
Press any key to continue.
```

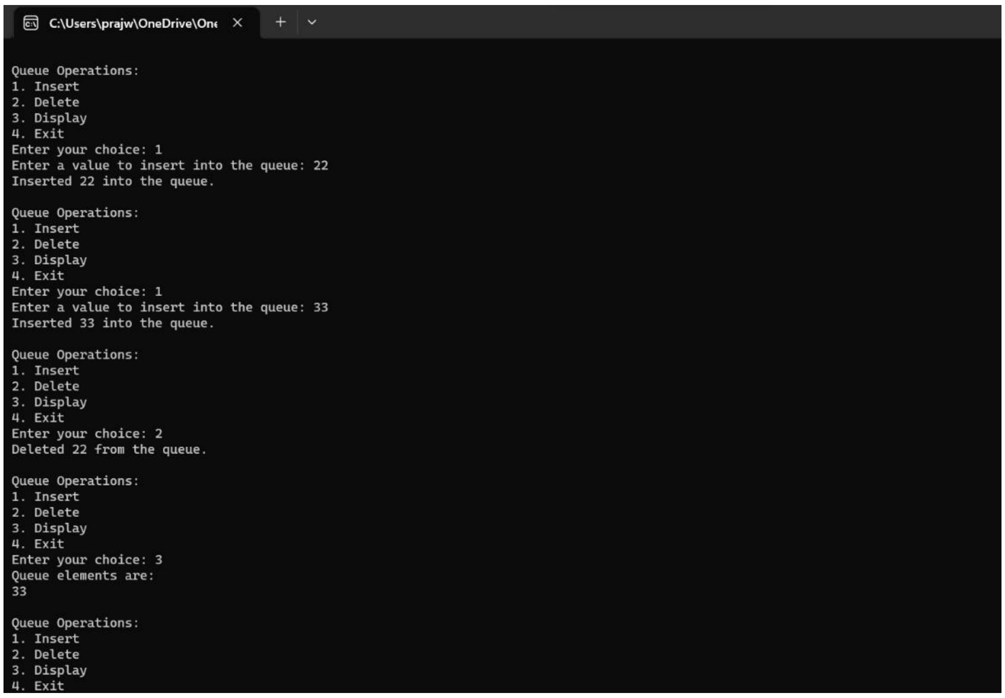
Lab Program 3:

3a) WAP 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 <stdlib.h>

#define MAX_SIZE 5
```

```
int queue[MAX_SIZE];
int front = -1;
int rear = -1;

void insert(int value) {
    if (rear == MAX_SIZE - 1) {
        printf("Queue overflow! Cannot insert more elements.\n");
    } else {
        if (front == -1) {
            front = 0; // Initialize front if it's the first element
        }
        rear++;
        queue[rear] = value;
        printf("Inserted %d into the queue.\n", value);
    }
}

int delete() {
    if (front == -1 || front > rear) {
        printf("Queue underflow! Cannot delete from an empty queue.\n");
        return -1; // Return a sentinel value to indicate underflow
    } else {
        int deletedValue = queue[front];
        front++;
        printf("Deleted %d from the queue.\n", deletedValue);
        return deletedValue;
    }
}

void display() {
    if (front == -1 || front > rear) {
        printf("Queue is empty.\n");
    } else {
        printf("Queue elements are:\n");
        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 a value to insert into the queue: ");
                scanf("%d", &value);
                insert(value);
                break;
            case 2:
                delete();
                break;
            case 3:
                display();
                break;
            case 4:
                printf("Exiting the program.\n");
                exit(0);
            default:
                printf("Invalid choice! Please enter a valid option.\n");
        }
    }

    return 0;
}
```

OUTPUT:



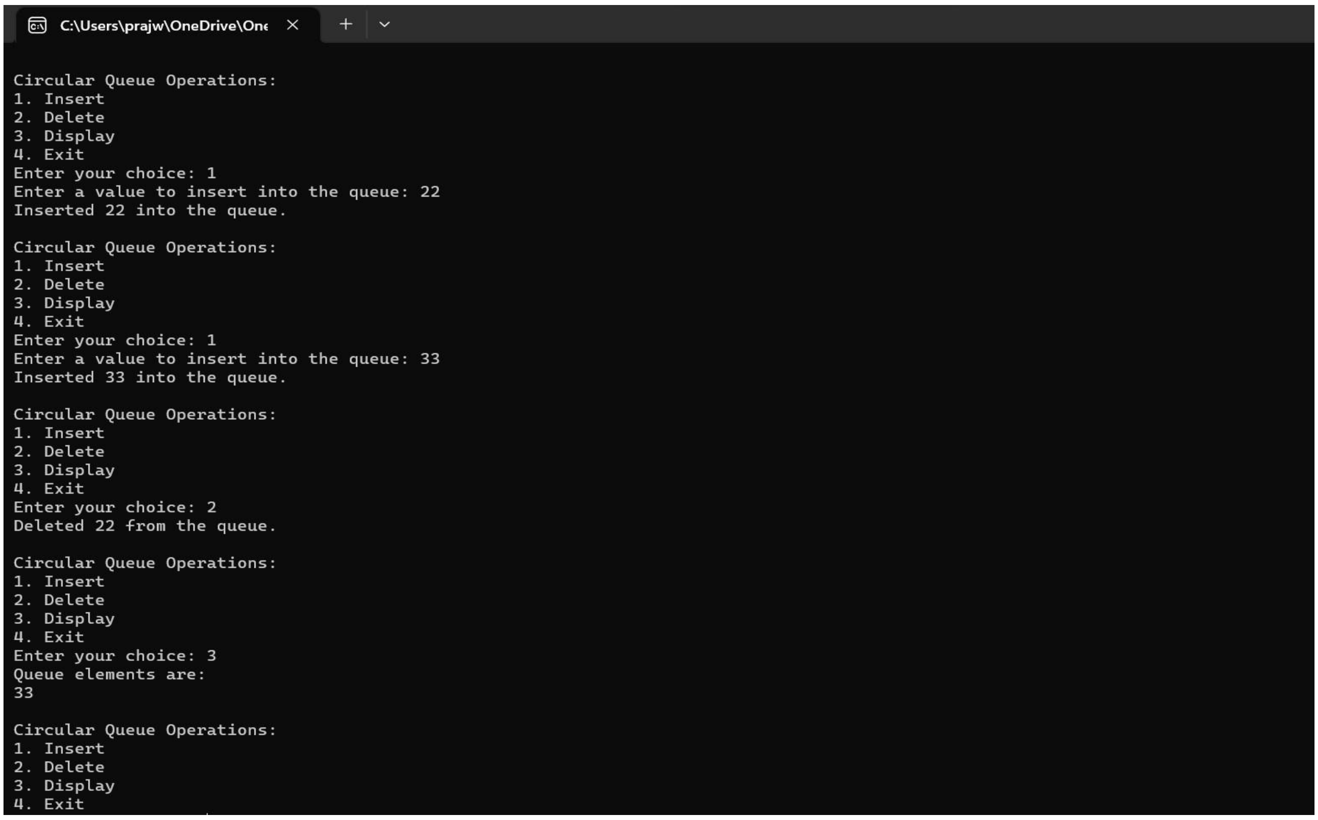
```
Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter a value to insert into the queue: 22
Inserted 22 into the queue.

Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter a value to insert into the queue: 33
Inserted 33 into the queue.

Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 22 from the queue.

Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue elements are:
33

Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
```

3b) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete &amp; Display The program should print appropriate messages for queue empty and queue overflow conditions

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

```
#include <stdlib.h>

#define MAX_SIZE 5

int queue[MAX_SIZE];
int front = -1;
int rear = -1;

void insert(int value) {
    if ((front == 0 && rear == MAX_SIZE - 1) || (front == rear + 1)) {
        printf("Queue overflow! Cannot insert more elements.\n");
    } else {
        if (front == -1) {
            front = 0; // Initialize front if it's the first element
        }
        rear = (rear + 1) % MAX_SIZE; // Circular increment
        queue[rear] = value;
        printf("Inserted %d into the queue.\n", value);
    }
}

int delete() {
    if (front == -1) {
        printf("Queue underflow! Cannot delete from an empty queue.\n");
        return -1; // Return a sentinel value to indicate underflow
    } else {
        int deletedValue = queue[front];
        if (front == rear) {
            front = -1; // Reset front and rear when last element is removed
            rear = -1;
        } else {
            front = (front + 1) % MAX_SIZE; // Circular increment
        }
        printf("Deleted %d from the queue.\n", deletedValue);
        return deletedValue;
    }
}

void display() {
    if (front == -1) {
        printf("Queue is empty.\n");
    } else {
        printf("Queue elements are:\n");
        int i = front;
        while (i != rear) {
            printf("%d ", queue[i]);
            i = (i + 1) % MAX_SIZE; // Circular increment
        }
        printf("%d\n", queue[rear]);
    }
}

int main() {
    int choice, value;
    while (1) {
        printf("\nCircular 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 a value to insert into the queue: ");
                scanf("%d", &value);
                insert(value);
                break;
            case 2:
                delete();
                break;
            case 3:
                display();
                break;
            case 4:
                printf("Exiting the program.\n");
                exit(0);
            default:
                printf("Invalid choice! Please enter a valid option.\n");
        }
    }

    return 0;
}
```

Output:



```
Circular Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter a value to insert into the queue: 22
Inserted 22 into the queue.

Circular Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter a value to insert into the queue: 33
Inserted 33 into the queue.

Circular Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 22 from the queue.

Circular Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue elements are:
33

Circular Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
```

Lab Program 4:

WAP to Implement Singly Linked List with following operations

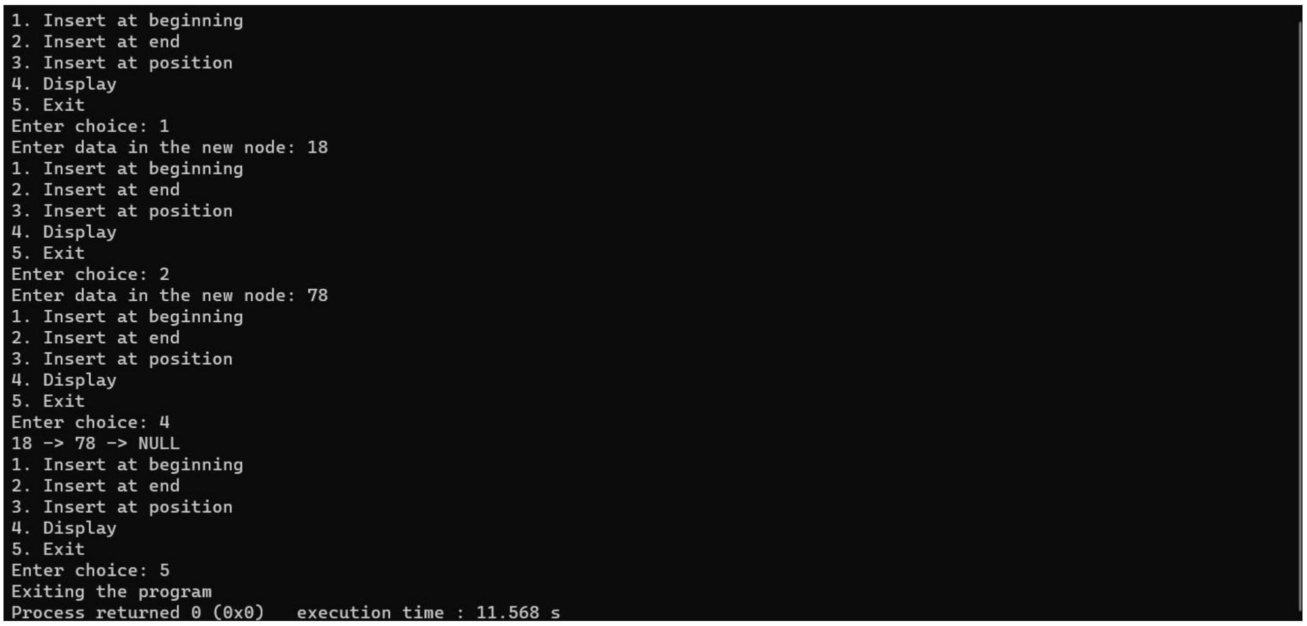
a) Create a linked list.
b) Insertion of a node at first position, at any position and at end of list.

Display the contents of the linked list.

```
#include<stdio.h>

#include<stdlib.h>

struct node

{

   int data;

   struct node *next;

};

struct node *start=NULL;

void insert_begin();

void insert_end();

void insert_pos();

void display();

int main()

{

   int option;

   do{

      printf("\n***MAIN MENU***\n1.Insert at beginning\n2.Insert at end\n3.Insert at any
position\n4.Display\n5.Exit\n");

      printf("\nEnter an option to perform the following operations: ");

      scanf("%d",&option);

      switch(option)

      {

         case 1:insert_begin();

              printf("\nElement inserted successfully\n");
```

```
                break;
            case 2:insert_end();
                printf("\nElement inserted successfully\n");
                break;
            case 3:insert_pos();
                printf("\nElement inserted successfully\n");
                break;
            case 4:printf("\nElements in the linked list:\n");
                display();
                break;
        }
    }while(option!=5);
    return 0;
}
void insert_begin()
{
    struct node *new_node;
    int num;
    printf("Enter the data\n");
    scanf("%d",&num);
    new_node=(struct node*)malloc(sizeof(struct node));
    new_node->data=num;
    new_node->next=start;
    start=new_node;
}
void insert_end()
{
    struct node *new_node,*ptr;
    int num;
    printf("Enter the data\n");
    scanf("%d",&num);
    new_node=(struct node*)malloc(sizeof(struct node));
    new_node->data=num;
    new_node->next=NULL;
    ptr=start;
    while(ptr->next!=NULL)
    ptr=ptr->next;
    ptr->next=new_node;
}
void insert_pos()
{
    struct node *new_node,*ptr,*prev;
    int num,pos,count=1;
    printf("Enter the data\n");
    scanf("%d",&num);
    printf("Enter the position to be inserted\n");
    scanf("%d",&pos);
    new_node=(struct node*)malloc(sizeof(struct node));
    new_node->data=num;
    if(pos==1)
    {
    new_node->next=start;
    start=new_node;
    }
    else
    {
        ptr=start;
        while(count<pos&&ptr!=NULL)
        {
         prev=ptr;
         ptr=ptr->next;
         count++;
        }
        if(count==pos)
        {
         prev->next=new_node;
         new_node->next=ptr;
        }
    }
}
void display()
{
    struct node *ptr;
    ptr=start;
    while(ptr!=NULL)
    {
        printf("\t%d",ptr->data);
        ptr=ptr->next;
    }
    printf("\n");
}
```

Output:



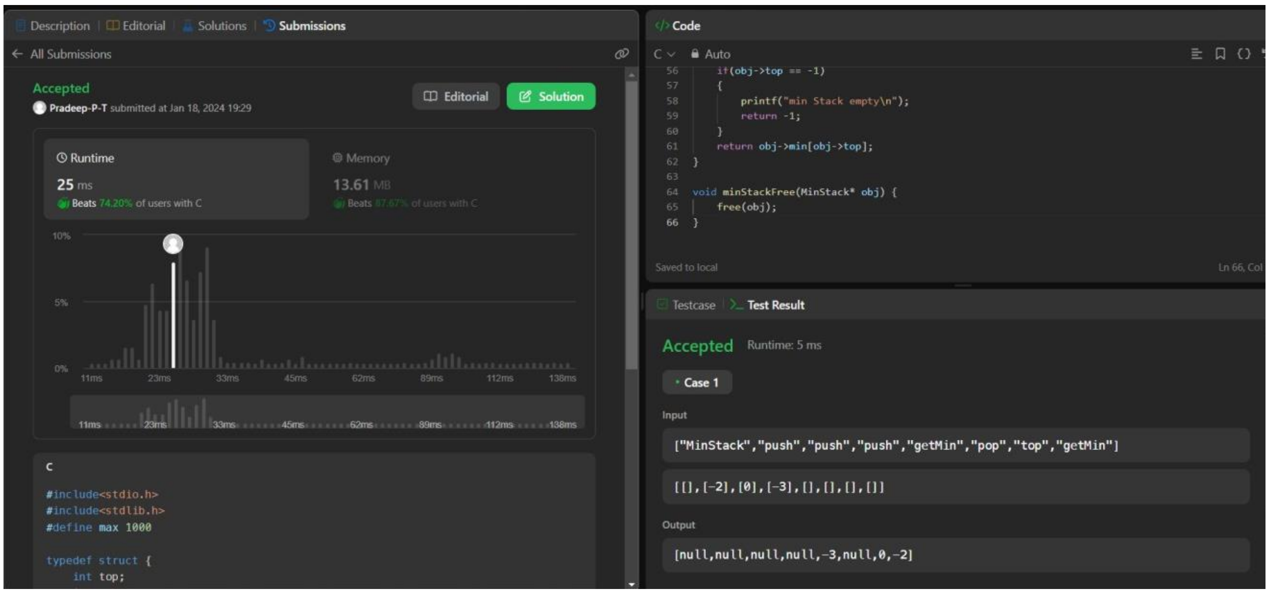
```
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 1
Enter data in the new node: 18
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 2
Enter data in the new node: 78
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 4
18 -> 78 -> NULL
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 5
Exiting the program
Process returned 0 (0x0)   execution time : 11.568 s
```

Leetcode Program: Min Stack

```
#include<stdio.h>
#include<stdlib.h>
#define max 1000

typedef struct {
   int top;
   int st[max];
   int min[max];
} MinStack;

MinStack* minStackCreate() {
   MinStack* stack = (MinStack*)malloc(sizeof(MinStack));
   stack->top = -1;
   return stack;
}

void minStackPush(MinStack* obj, int val) {
   if(obj->top == max-1){
      printf("Stack Full\n");
      return;
   }
   obj->st[++obj->top] = val;

   if(obj->top > 0)
   {
      if(obj->min[obj->top - 1] < val)
```

```
            obj->min[obj->top] = obj->min[obj->top - 1];
        else
            obj->min[obj->top] = val;
    }
    else
        obj->min[obj->top] = val;
}

void minStackPop(MinStack* obj) {
    if(obj->top == -1)
    {
        printf("Stack empty\n");
        return;
    }
    else {
        obj->top -= 1;
    }
}

int minStackTop(MinStack* obj) {
    if(obj->top == -1)
    {
        printf("Stack empty\n");
        return -1;
    }
    return obj->st[obj->top];
}

int minStackGetMin(MinStack* obj) {
    if(obj->top == -1)
    {
        printf("min Stack empty\n");
        return -1;
    }
    return obj->min[obj->top];
}

void minStackFree(MinStack* obj) {
    free(obj);
}
```

Output:



Accepted
Pradeep-P-T submitted at Jan 18, 2024 19:29

Runtime
25 ms
Beats 74.20% of users with C

Memory
13.61 MB
Beats 87.67% of users with C

C

```
#include<stdio.h>
#include<stdlib.h>
#define max 1000

typedef struct {
    int top;
```

```
    if(obj->top == -1)
    {
        printf("min Stack empty\n");
        return -1;
    }
    return obj->min[obj->top];
}

void minStackFree(MinStack* obj) {
    free(obj);
}
```

Saved to local
Ln 66, Col

Accepted Runtime: 5 ms

Input

```
["MinStack","push","push","push","getMin","pop","top","getMin"]
```

```
[[],[-2],[0],[-3],[],[],[],[]]
```

Output

```
[null,null,null,null,-3,null,0,-2]
```

Lab Program 5:

WAP to Implement Singly Linked List with following operations

a) Create a linked list.

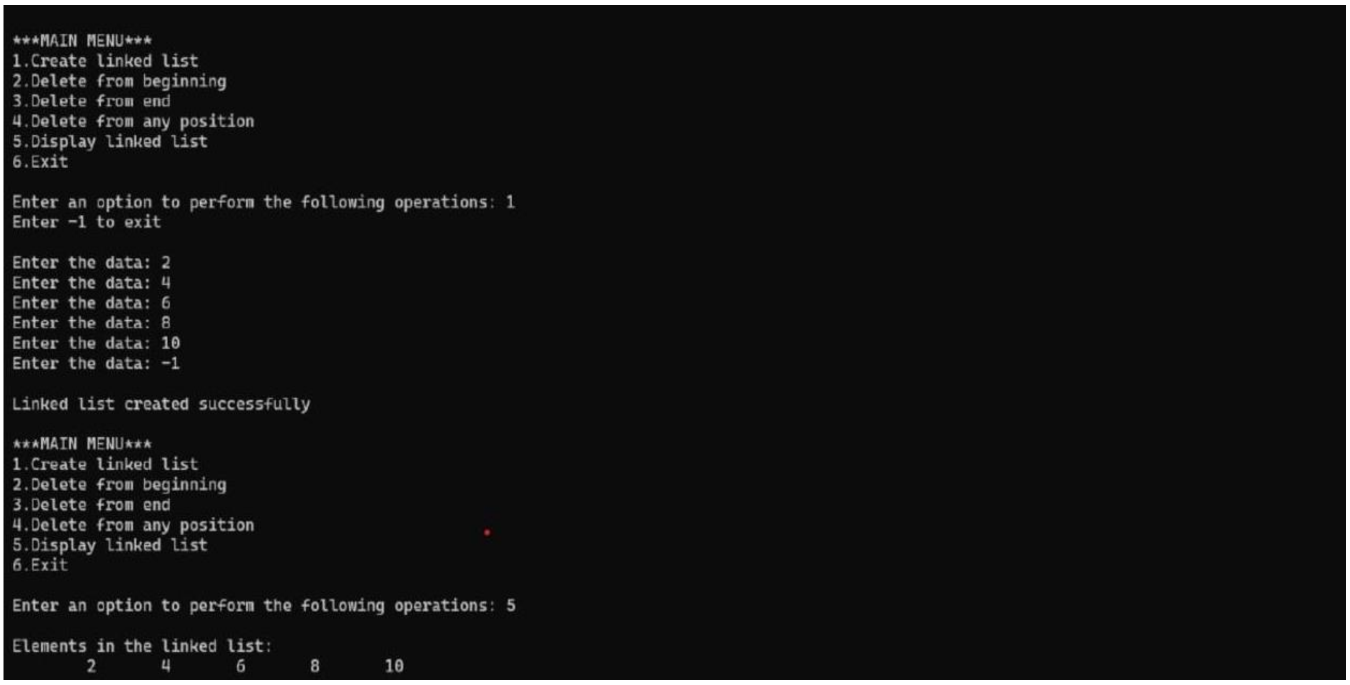
b) Deletion of first element, specified element and last

element in the list.

c) Display the contents of the linked list.

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
   int data;
   struct node *next;
};
struct node *start=NULL;
void create();
void delete_begin();
void delete_end();
void delete_pos();
void display();
int main()
{
   int option;
   do{
      printf("\n***MAIN MENU***\n1.Create linked list\n2.Delete from beginning\n3.Delete
from end\n4.Delete from any position\n5.Display linked list\n6.Exit\n");
      printf("\nEnter an option to perform the following operations: ");
      scanf("%d",&option);
      switch(option)
      {
            case 1:create();
                   printf("\nLinked list created successfully\n");
                   break;
            case 2:delete_begin();
                   printf("Element deleted successfully\n");
                   break;
            case 3:delete_end();
                   printf("Element deleted successfully\n");
                   break;
            case 4:delete_pos();
                   printf("Element deleted successfully\n");
                   break;
            case 5:printf("\nElements in the linked list:\n");
                   display();
                   break;
        }
    }while(option!=6);
    return 0;
}
void create()
{
    struct node *ptr,*new_node;
    int num;
    printf("Enter -1 to exit\n");
    printf("\nEnter the data\n");
    scanf("%d",&num);
    while(num!=-1)
    {
        new_node=(struct node*)malloc(sizeof(struct node));
        new_node->data=num;
        if(start==NULL)
        {
           start=new_node;
           new_node->next=NULL;
        }
        else
        {
           ptr=start;
           while(ptr->next!=NULL)
           ptr=ptr->next;
           ptr->next=new_node;
           new_node->next=NULL;
        }
        printf("Enter the data\n");
        scanf("%d",&num);
    }
}
void delete_begin()
{
    struct node *ptr;
    ptr=start;
    start=start->next;
    free(ptr);
}
void delete_end()
{
    struct node *ptr,*preptr;
    ptr=start;
    while(ptr->next!=NULL)
    {
    preptr=ptr;
    ptr=ptr->next;
    }
    preptr->next=NULL;
    free(ptr);
}
void delete_pos()
{
    struct node *ptr,*preptr,*postptr;
    int pos,count=1;
    printf("Enter the position: ");
    scanf("%d",&pos);
    ptr=start;
    if(pos==1)
    {
        start=start->next;
        free(ptr);
    }
    else
    {
        while(count<pos&&ptr!=NULL)
        {
            preptr=ptr;
            ptr=ptr->next;
            postptr=ptr->next;
            count++;
        }
        if(pos==count)
        {
            preptr->next=postptr;
            free(ptr);
        }

    }
}
void display()
{
    struct node *ptr;
    ptr=start;
    while(ptr!=NULL)
    {
        printf("\t%d",ptr->data);
        ptr=ptr->next;
    }
    printf("\n");
}
```

Output:

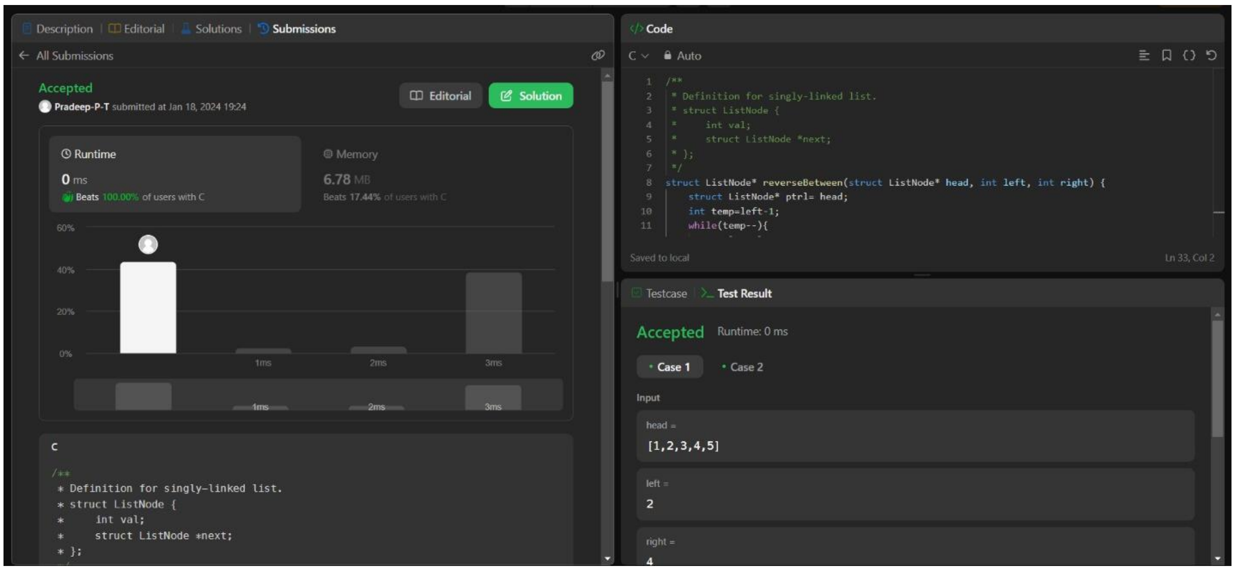


```
***MAIN MENU***
1.Create linked list
2.Delete from beginning
3.Delete from end
4.Delete from any position
5.Display linked list
6.Exit

Enter an option to perform the following operations: 1
Enter -1 to exit

Enter the data: 2
Enter the data: 4
Enter the data: 6
Enter the data: 8
Enter the data: 10
Enter the data: -1

Linked list created successfully

***MAIN MENU***
1.Create linked list
2.Delete from beginning
3.Delete from end
4.Delete from any position
5.Display linked list
6.Exit

Enter an option to perform the following operations: 5

Elements in the linked list:
        2       4       6       8       10
```

Leetcode Program: Reverse Linked List

```
struct ListNode* reverseBetween(struct ListNode* head, int left, int right) {
    struct ListNode* ptrl= head;
    int temp=left-1;
    while(temp--){
        ptrl=ptrl->next;
    }
    int count=right-left+1;
    int* a = (int*)malloc(count * sizeof(int));
    for(int i=0;i<count;i++){
        a[i]=ptrl->val;
        ptrl=ptrl->next;
    }
    struct ListNode* ptr= head;
    left--;
    while(left--){
        printf("%d",ptr->val);
        ptr=ptr->next;
    }

    for(int i=count-1;i>-1;i--){

        ptr->val=a[i];
        ptr=ptr->next;
    }
    return head;
}
```

Output:



Accepted
Pradeep-P-T submitted at Jan 18, 2024 19:24

Runtime
0 ms
Beats 100.00% of users with C

Memory
6.78 MB
Beats 17.44% of users with C

C

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
```

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* reverseBetween(struct ListNode* head, int left, int right) {
    struct ListNode* ptrl= head;
    int temp=left-1;
    while(temp--){
```

Saved to local
Ln 33, Col 2

Accepted Runtime: 0 ms

Case 1 Case 2

Input

head =
[1,2,3,4,5]

left =
2

right =
4

Lab Program 6:

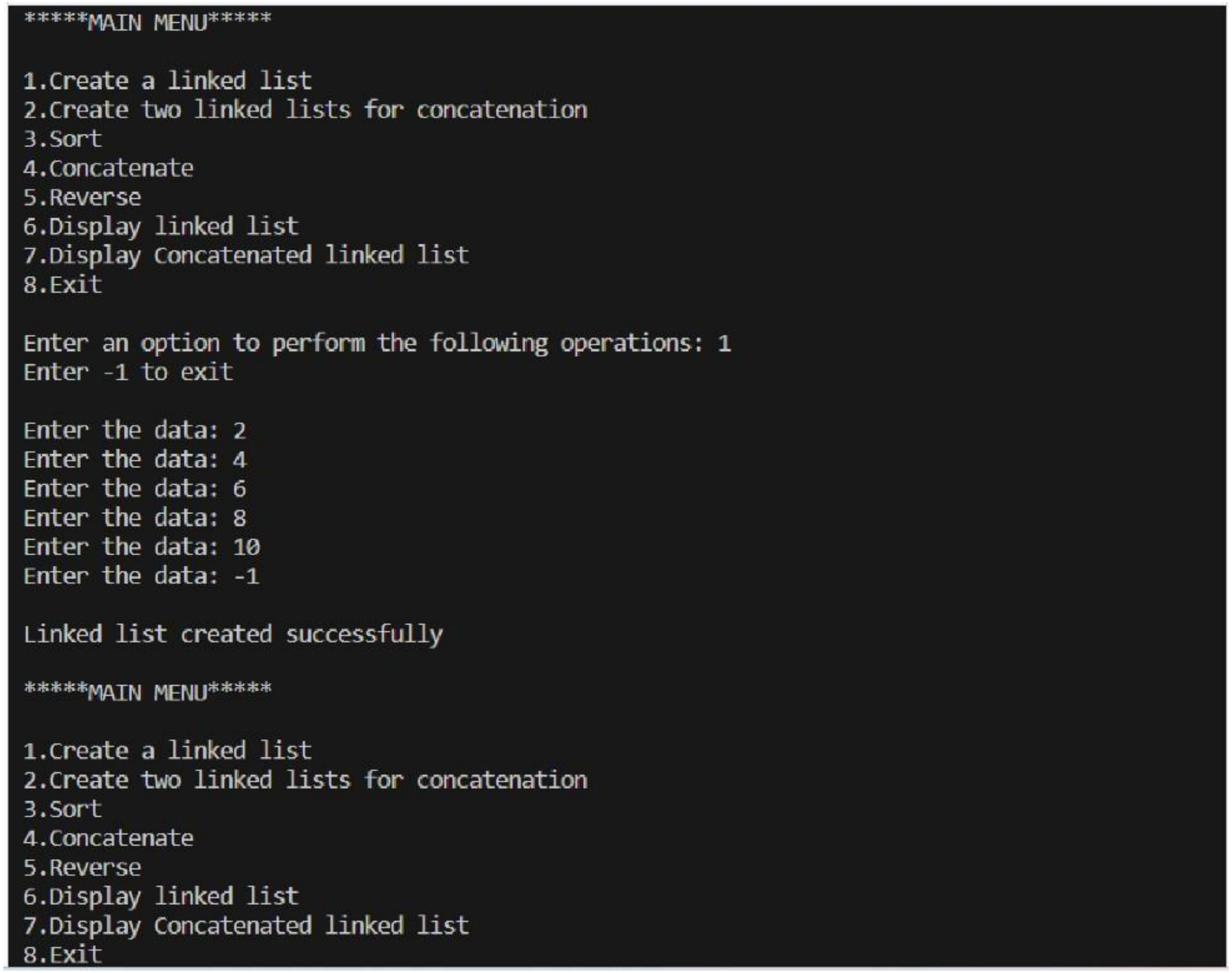
6a) WAP to Implement Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists.

```
#include<stdio.h>

#include<stdlib.h>

struct node

{

   int data;

   struct node *next;

};

struct node *s1=NULL;

struct node *s2=NULL;

struct node *start=NULL;

struct node *create(struct node*);

void sort();

struct node *concatenate(struct node*,struct node*);

void reverse();

void display(struct node*);


int main()

{

   int option;

   struct node *a=NULL;

   do{

      printf("\n*****MAIN MENU*****\n\n1.Create a linked list\n2.Create two linked lists for
concatenation\n3.Sort\n4.Concatenate\n5.Reverse\n6.Display linked list\n7.Display
Concatenated linked list\n8.Exit\n");

      printf("\nEnter an option to perform the following operations: ");

      scanf("%d",&option);
```

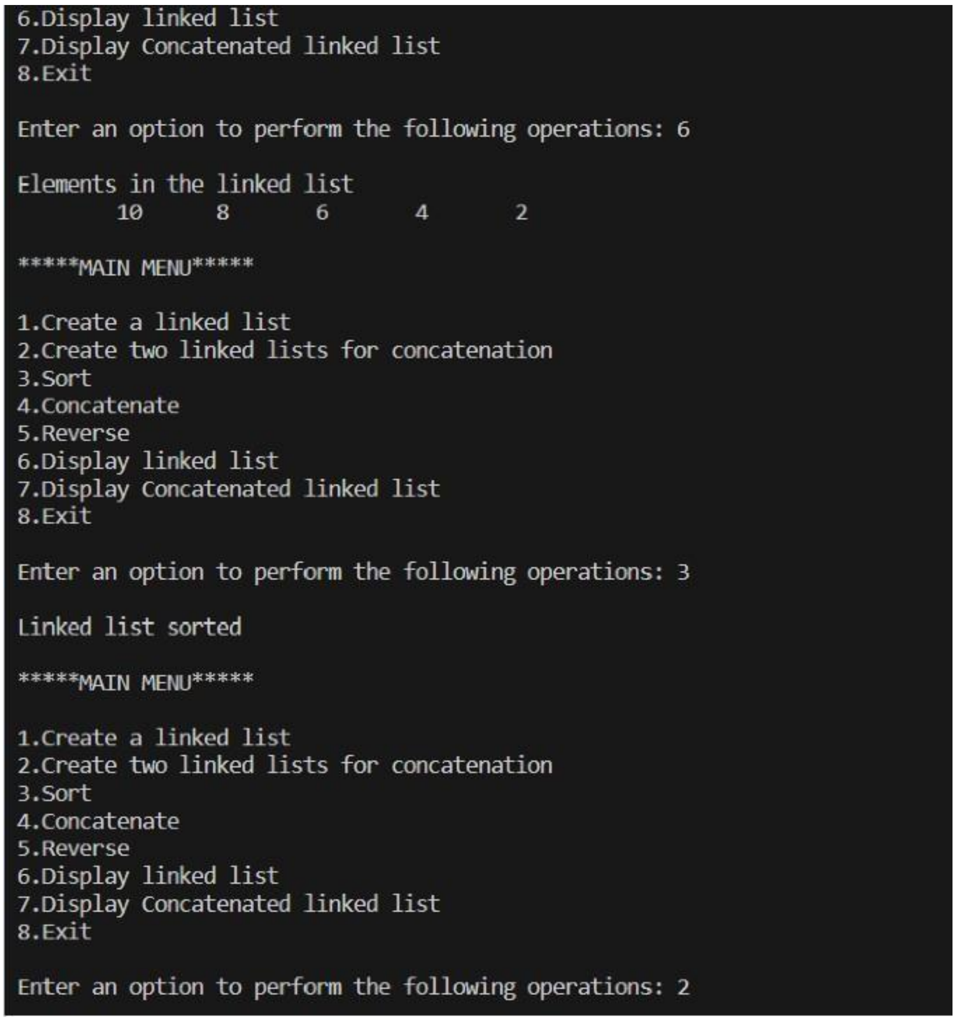
```
    switch(option)
    {
       case 1:start=create(start);
              printf("\nLinked list created successfully\n");
              break;
       case 2:printf("\nLinked list 1:\n");
              s1=create(s1);
              printf("\nLinked list 2:\n");
              s2=create(s2);
              printf("\nLinked lists created successfully\n");
              break;
       case 3:sort();
              printf("\nLinked list sorted\n");
              break;
       case 4:a=concatenate(s1,s2);
              printf("\nLinked lists concatenated successfully\n");
              break;
       case 5:reverse();
              printf("\nLinked list reversed\n");
              break;
       case 6:printf("\nElements in the linked list\n");
              display(start);
              break;
       case 7:printf("\nElements in the linked list after concatenation:\n");
              display(a);
              break;


    }
}while(option!=8);
```

```
    return 0;
}

struct node * create(struct node *start)
{
    struct node *ptr,*new_node;
    int num;
    printf("Enter -1 to exit\n");
    printf("\nEnter the data: ");
    scanf("%d",&num);
    while(num!=-1)
    {
        new_node=(struct node*)malloc(sizeof(struct node));
        new_node->data=num;
        if(start==NULL)
        {
            start=new_node;
            new_node->next=NULL;
        }
        else
        {
            ptr=start;
            while(ptr->next!=NULL)
            ptr=ptr->next;
            ptr->next=new_node;
            new_node->next=NULL;
        }
        printf("Enter the data: ");
        scanf("%d",&num);
    }
    return start;
}

void sort()
{
    struct node *i,*j;
    int temp;
    for(i=start;i->next!=NULL;i=i->next)
    {
        for(j=i->next;j!=NULL;j=j->next)
        {
          if(i->data>j->data)
          {
            temp=i->data;
            i->data=j->data;
            j->data=temp;
          }
        }
    }
}

struct node *concatenate(struct node *t1,struct node *t2)
{
    struct node *ptr;
    ptr=t1;
    while(ptr->next!=NULL)
    {
     ptr=ptr->next;
    }
ptr->next=t2;
return t1;
}

void reverse()
{
  struct node *prev=NULL;
  struct node *next=NULL;
  struct node *cur=start;
  while(cur!=NULL)
  {
    next=cur->next;
    cur->next=prev;
    prev=cur;
    cur=next;
  }
  start=prev;
}

void display(struct node *p)
{
    struct node *ptr;
    ptr=p;
    while(ptr!=NULL)
    {
        printf("\t%d",ptr->data);
        ptr=ptr->next;
    }
    printf("\n");
}
```

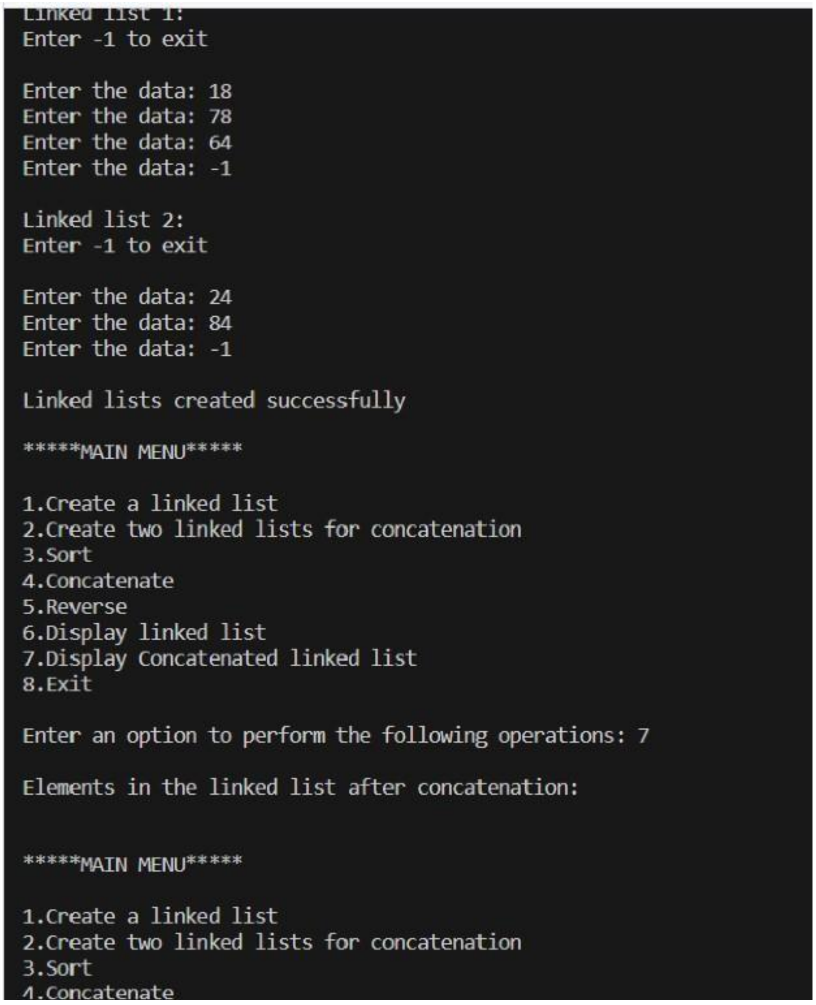
Output:



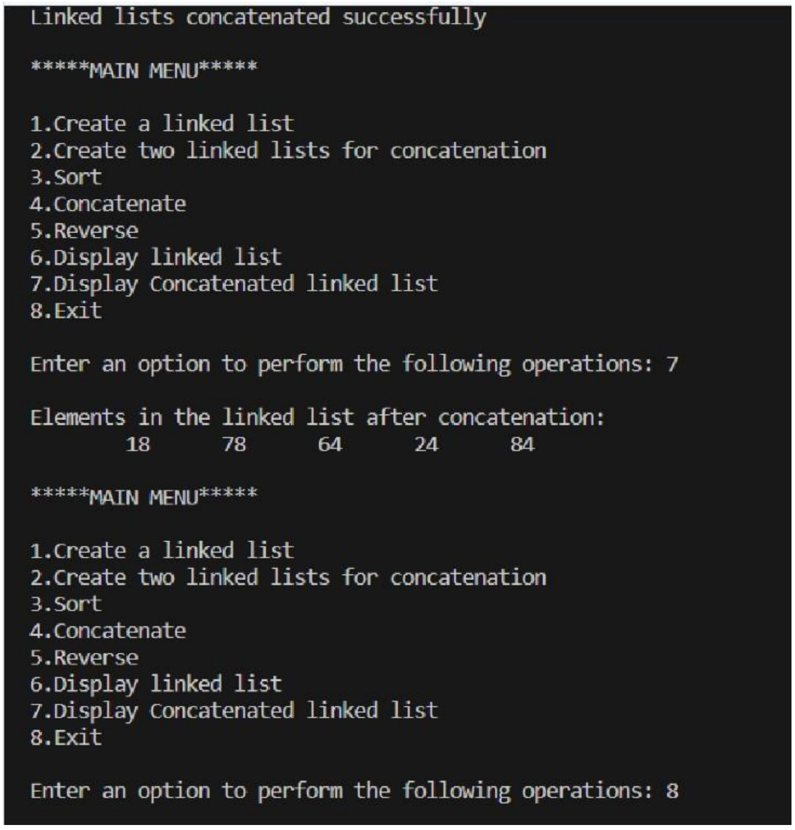
```
*****MAIN MENU*****

1.Create a linked list
2.Create two linked lists for concatenation
3.Sort
4.Concatenate
5.Reverse
6.Display linked list
7.Display Concatenated linked list
8.Exit

Enter an option to perform the following operations: 1
Enter -1 to exit

Enter the data: 2
Enter the data: 4
Enter the data: 6
Enter the data: 8
Enter the data: 10
Enter the data: -1

Linked list created successfully

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

1.Create a linked list
2.Create two linked lists for concatenation
3.Sort
4.Concatenate
5.Reverse
6.Display linked list
7.Display Concatenated linked list
8.Exit
```



```
6.Display linked list
7.Display Concatenated linked list
8.Exit

Enter an option to perform the following operations: 6

Elements in the linked list
        10      8       6       4       2

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

1.Create a linked list
2.Create two linked lists for concatenation
3.Sort
4.Concatenate
5.Reverse
6.Display linked list
7.Display Concatenated linked list
8.Exit

Enter an option to perform the following operations: 3

Linked list sorted

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

1.Create a linked list
2.Create two linked lists for concatenation
3.Sort
4.Concatenate
5.Reverse
6.Display linked list
7.Display Concatenated linked list
8.Exit

Enter an option to perform the following operations: 2
```



```
Linked list 1:
Enter -1 to exit

Enter the data: 18
Enter the data: 78
Enter the data: 64
Enter the data: -1

Linked list 2:
Enter -1 to exit

Enter the data: 24
Enter the data: 84
Enter the data: -1

Linked lists created successfully

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

1.Create a linked list
2.Create two linked lists for concatenation
3.Sort
4.Concatenate
5.Reverse
6.Display linked list
7.Display Concatenated linked list
8.Exit

Enter an option to perform the following operations: 7

Elements in the linked list after concatenation:


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

1.Create a linked list
2.Create two linked lists for concatenation
3.Sort
4.Concatenate
```

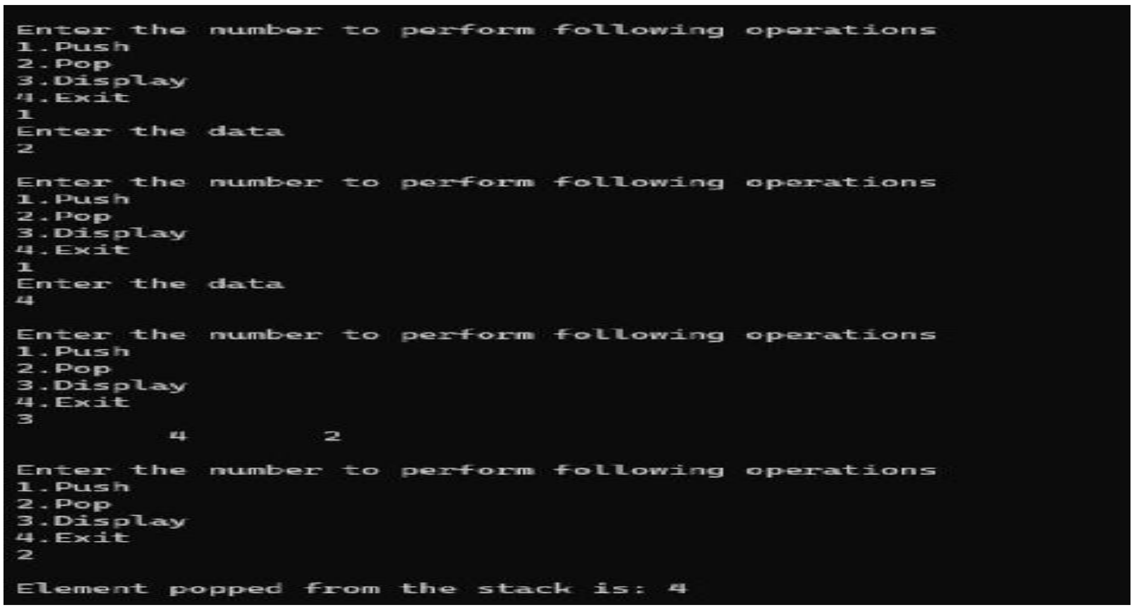


```
Linked lists concatenated successfully

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

1.Create a linked list
2.Create two linked lists for concatenation
3.Sort
4.Concatenate
5.Reverse
6.Display linked list
7.Display Concatenated linked list
8.Exit

Enter an option to perform the following operations: 7

Elements in the linked list after concatenation:
        18      78      64      24      84

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

1.Create a linked list
2.Create two linked lists for concatenation
3.Sort
4.Concatenate
5.Reverse
6.Display linked list
7.Display Concatenated linked list
8.Exit

Enter an option to perform the following operations: 8
```

6b) WAP to Implement Single Link List to simulate Stack &amp; Queue Operations.

```
//Stack Implementation
#include<stdio.h>
#include<stdlib.h>
struct node
{
  int data;
  struct node *next;
};
struct node *start=NULL;
void push();
void pop();
void display();
int main()
{
   int val,option;
    do
    {
        printf("\nEnter the number to perform following
operations\n1.Push\n2.Pop\n3.Display\n4.Exit\n");
        scanf("%d",&option);
        switch(option)
        {
            case 1:push();
            break;
            case 2:pop();
            break;
            case 3:display();
            break;
        }
    }
    while(option!=4);
    return 0;
}
void push()
{
    struct node *new_node;
    int num;
    printf("Enter the data\n");
    scanf("%d",&num);
    new_node=(struct node*)malloc(sizeof(struct node));
    new_node->data=num;
    new_node->next=start;
    start=new_node;
}
void pop()
{
  struct node *ptr;
  ptr=start;
  if(start==NULL)
  {
  printf("Stack is empty\n");
  exit(0);
  }
  else
  {
    ptr=start;
    start=ptr->next;
    printf("\nElement popped from the stack is: %d\n",ptr->data);
    free(ptr);
  }


}
void display()
{


    struct node *ptr;
    ptr=start;
    while(ptr!=NULL)
    {
        printf("\t%d",ptr->data);
        ptr=ptr->next;
    }
    printf("\n");
}
```

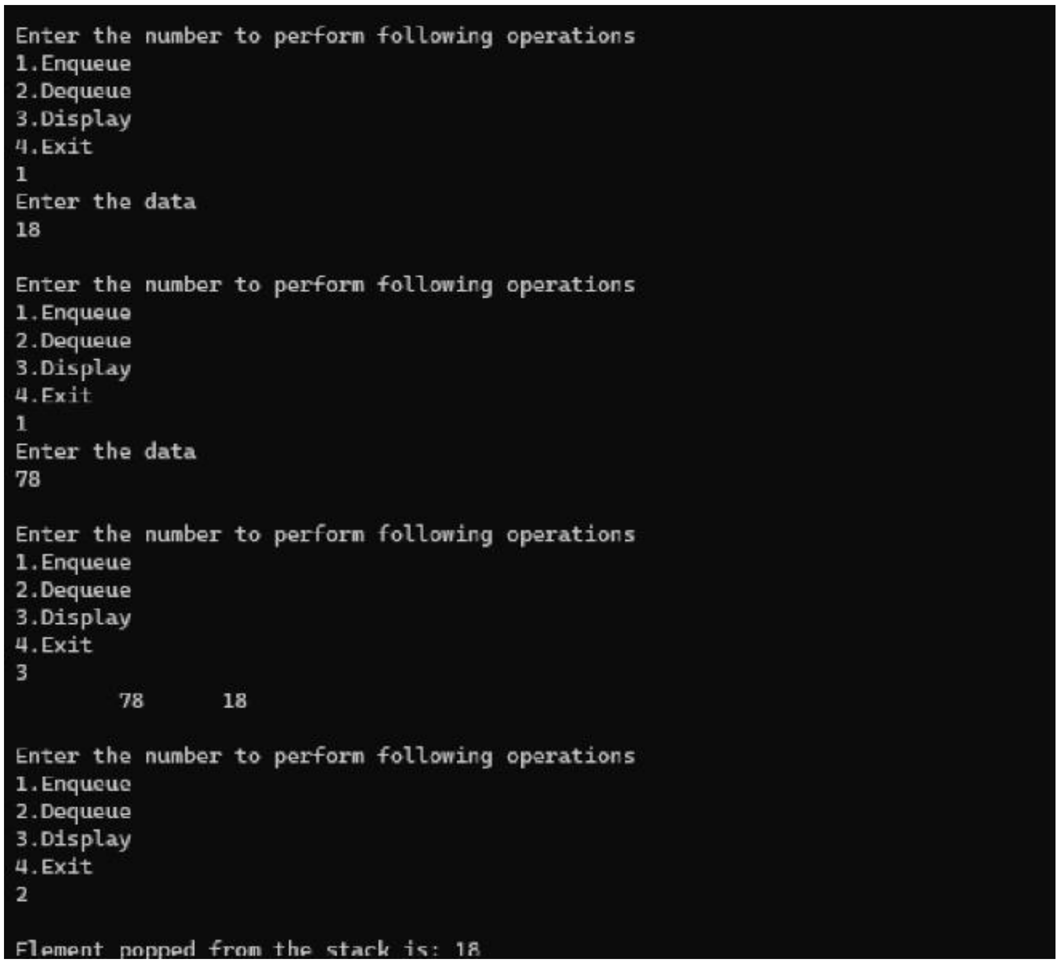
Output:



```
Enter the number to perform following operations
1.Push
2.Pop
3.Display
4.Exit
1
Enter the data
2

Enter the number to perform following operations
1.Push
2.Pop
3.Display
4.Exit
1
Enter the data
4

Enter the number to perform following operations
1.Push
2.Pop
3.Display
4.Exit
3
        4       2

Enter the number to perform following operations
1.Push
2.Pop
3.Display
4.Exit
2

Element popped from the stack is: 4
```

```
//Queue Implementation


#include<stdio.h>

#include<stdlib.h>

struct node

{

  int data;

  struct node *next;

};

struct node *start=NULL;

void enqueue();

void dequeue();

void display();

int main()

{

   int val,option;

    do

    {

        printf("\nEnter the number to perform following
operations\n1.Enqueue\n2.Dequeue\n3.Display\n4.Exit\n");

        scanf("%d",&option);

        switch(option)

        {

            case 1:enqueue();

            break;

            case 2:dequeue();

            break;

            case 3:display();

            break;

        }
    }
    while(option!=4);
    return 0;
}
void enqueue()
{
    struct node *new_node;
    int num;
    printf("Enter the data\n");
    scanf("%d",&num);
    new_node=(struct node*)malloc(sizeof(struct node));
    new_node->data=num;
    new_node->next=start;
    start=new_node;
}
void dequeue()
{
  struct node *ptr,*preptr;
  ptr=start;
  if(start==NULL)
  {
  printf("Stack is empty\n");
  exit(0);
  }
  else if(start->next==NULL)
  {
    start=start->next;
    printf("\nElement popped from the stack is: %d\n",ptr->data);
    free(ptr);
  }
  else
  {
    while(ptr->next!=NULL)
    {
    preptr=ptr;
    ptr=ptr->next;
    }
    preptr->next=NULL;
    printf("\nElement popped from the stack is: %d\n",ptr->data);
    free(ptr);
  }
}
void display()
{

    struct node *ptr;
    ptr=start;
    while(ptr!=NULL)
    {
        printf("\t%d",ptr->data);
        ptr=ptr->next;
    }
    printf("\n");
}
```

Output:



```
Enter the number to perform following operations
1.Enqueue
2.Dequeue
3.Display
4.Exit
1
Enter the data
18

Enter the number to perform following operations
1.Enqueue
2.Dequeue
3.Display
4.Exit
1
Enter the data
78

Enter the number to perform following operations
1.Enqueue
2.Dequeue
3.Display
4.Exit
3
        78      18

Enter the number to perform following operations
1.Enqueue
2.Dequeue
3.Display
4.Exit
2

Element popped from the stack is: 18
```

Lab Program 7:

WAP 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

```
//Doubly Linked List


#include<stdio.h>

#include<stdlib.h>


struct node

{

int data;

struct node *next;

struct node *prev;

};


struct node *start=NULL;

void create();

void   insert();

void   delete();

void display();


void main()

{

int option;

do

{
```

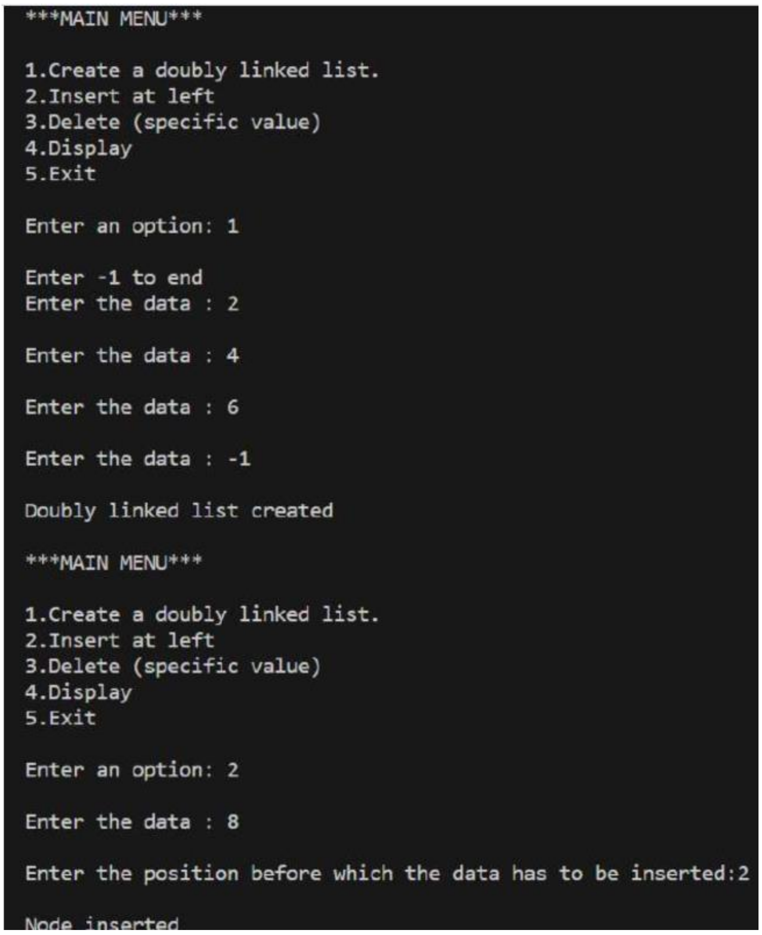
```
printf("\n***MAIN MENU***\n\n1.Create a doubly linked list.\n2.Insert at left\n3.Delete
(specific value)\n4.Display\n5.Exit\n\nEnter an option: ");

scanf("%d",&option);

switch(option)

{

case 1: create();

        printf("\nDoubly linked list created\n");

        break;

case 2: insert();

        printf("\nNode inserted\n");

        break;

case 3: delete();

        printf("\nNode deleted\n");

        break;

case 4: printf("\nElements in the doubly linked list\n");

        display();

        break;

}

}while(option!=5);

}


void create()

{

struct node *new_node, *ptr;

int num;

printf("\nEnter -1 to end");

printf("\nEnter the data : ");

scanf("%d",&num);

while(num!=-1)

{
```

```
if(start==NULL)
{
new_node=(struct node*)malloc(sizeof(struct node));
new_node->prev = NULL;
new_node->data = num;
new_node->next = NULL;
start=new_node;
}
else
{
ptr=start;
new_node=(struct node*)malloc(sizeof(struct node));
new_node->data=num;
while(ptr->next!=NULL)
ptr=ptr->next;
ptr->next=new_node;
new_node->prev=ptr;
new_node->next=NULL;
}
printf("\nEnter the data : ");
scanf("%d", &num);
}
}

void insert()
{
   struct node *new_node, *ptr;
   int pos, val, count = 0;
```

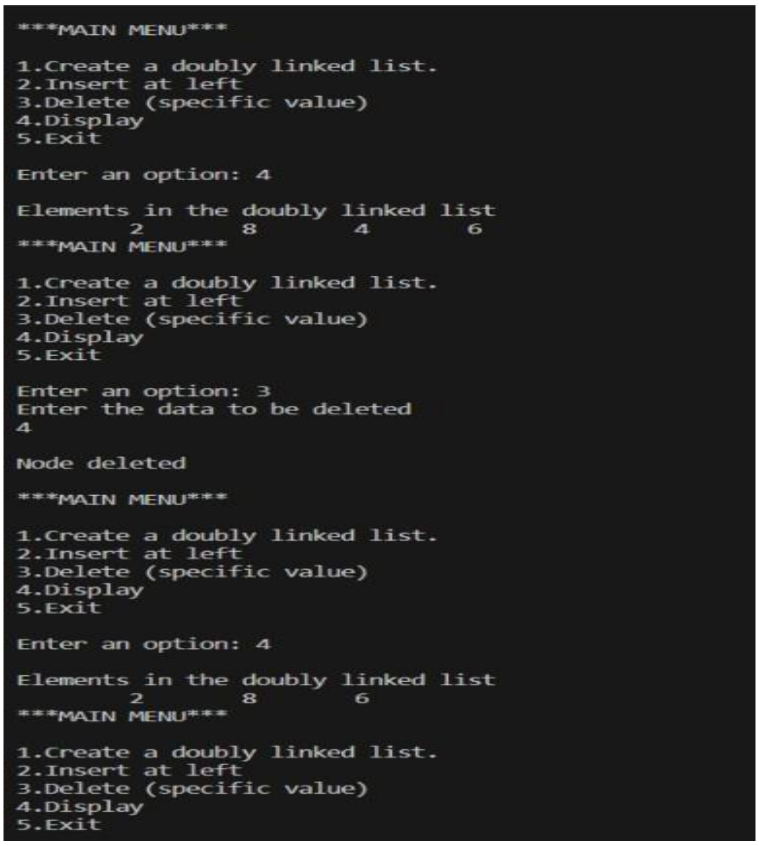
```
printf("\nEnter the data : ");
scanf("%d", &val);
printf("\nEnter the position before which the data has to be inserted:");
scanf("%d", &pos);

new_node = (struct node *)malloc(sizeof(struct node));
new_node->data = val;
ptr = start;
while (count < pos - 1 && ptr != NULL)
{
    ptr = ptr->next;
    count++;
}
if (count == pos - 1 && ptr != NULL)
{
    new_node->next = ptr;

    if (ptr->prev != NULL)
    {
        new_node->prev = ptr->prev;
        ptr->prev->next = new_node;
    }
    else
    {
        start = new_node;
        new_node->prev = NULL;
    }

    ptr->prev = new_node;
    }
    else
    {
        printf("Invalid position. Insertion failed.\n");
        free(new_node);
    }
}

void delete()
{
struct node *ptr;
int num;
printf("Enter the data to be deleted\n");
scanf("%d", &num);
ptr = start;
while (ptr != NULL && ptr->data == num)
{
start = ptr->next;
if (start != NULL)
start->prev = NULL;
free(ptr);
ptr = start;
}
while (ptr != NULL && ptr->data != num)
ptr = ptr->next;
if (ptr == NULL)
{
printf("Data not found. Deletion failed.\n");
}
```

```
else
{
if (ptr->prev != NULL)
ptr->prev->next = ptr->next;
if (ptr->next != NULL)
ptr->next->prev = ptr->prev;
free(ptr);
}
}

void display()
{
struct node *ptr;
ptr=start;
while(ptr!=NULL)
{
printf("\t%d",ptr->data);
ptr=ptr->next;
}
}
```

Output:



```
***MAIN MENU***

1.Create a doubly linked list.
2.Insert at left
3.Delete (specific value)
4.Display
5.Exit

Enter an option: 1

Enter -1 to end
Enter the data : 2

Enter the data : 4

Enter the data : 6

Enter the data : -1

Doubly linked list created

***MAIN MENU***

1.Create a doubly linked list.
2.Insert at left
3.Delete (specific value)
4.Display
5.Exit

Enter an option: 2

Enter the data : 8

Enter the position before which the data has to be inserted:2

Node inserted
```

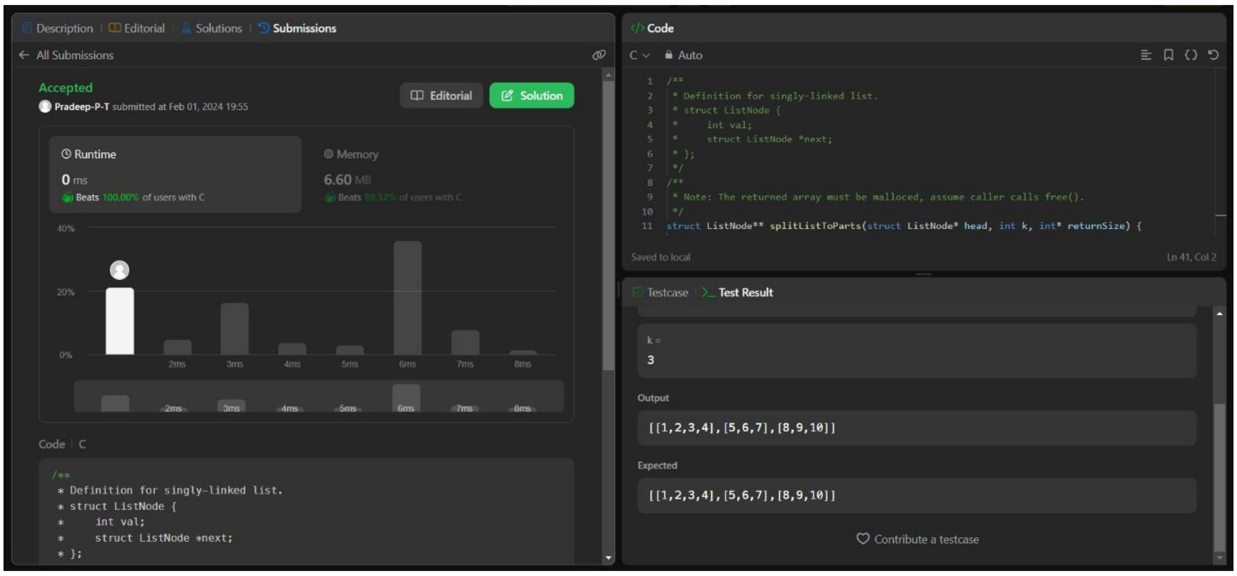


```
***MAIN MENU***

1.Create a doubly linked list.
2.Insert at left
3.Delete (specific value)
4.Display
5.Exit

Enter an option: 4

Elements in the doubly linked list
        2       8       4       6
***MAIN MENU***

1.Create a doubly linked list.
2.Insert at left
3.Delete (specific value)
4.Display
5.Exit

Enter an option: 3
Enter the data to be deleted
4

Node deleted

***MAIN MENU***

1.Create a doubly linked list.
2.Insert at left
3.Delete (specific value)
4.Display
5.Exit

Enter an option: 4

Elements in the doubly linked list
        2       8       6
***MAIN MENU***

1.Create a doubly linked list.
2.Insert at left
3.Delete (specific value)
4.Display
5.Exit
```

Leetcode Program: Split Linked List

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
/**
 * Note: The returned array must be malloced, assume caller calls free().
 */
struct ListNode** splitListToParts(struct ListNode* head, int k, int* returnSize) {
    struct ListNode* ptr=head;
    *returnSize=k;
    int count=0;

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

    int nums=count/k,a=count%k;

    struct ListNode **L=(struct ListNode**)calloc(k,sizeof(struct ListNode*));

    ptr=head;
    for(int i=0;i<k;i++){
        L[i] = ptr;
        int segmentSize = nums + (a-- > 0 ? 1 : 0);
        for (int j = 1; j < segmentSize; j++) {
            ptr = ptr->next;
        }

        if (ptr != NULL) {
            struct ListNode* next = ptr->next;
            ptr->next = NULL;
            ptr = next;
        }
    }
    return L;
}
```

Output:



Accepted
Pradeep-P-T submitted at Feb 01, 2024 19:55

Runtime
0 ms
Beats 100.00% of users with C

Memory
6.60 MB
Beats 89.32% of users with C

Code | C

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
```

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
/**
 * Note: The returned array must be malloced, assume caller calls free().
 */
struct ListNode** splitListToParts(struct ListNode* head, int k, int* returnSize) {
```

Saved to local
Ln 41, Col 2

k =
3

Output
```
[[1,2,3,4],[5,6,7],[8,9,10]]
```

Expected
```
[[1,2,3,4],[5,6,7],[8,9,10]]
```

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

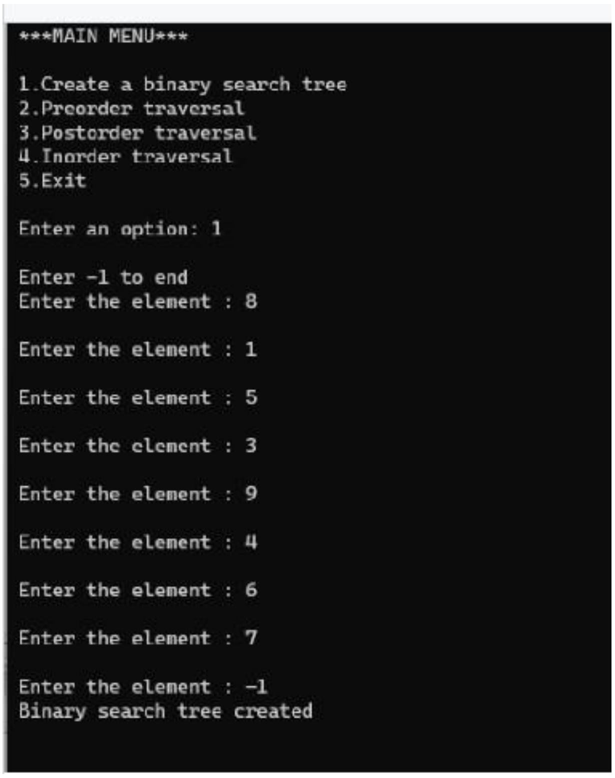
c) To display the elements in the tree.

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

struct node
{
 struct node *left;
 struct node *right;
 int data;
};
struct node *tree=NULL;

void create();
void pre(struct node *);
void post(struct node *);
void in(struct node *);

void main()
{
 int option;
 do
 {
  printf("\n\n***MAIN MENU***\n\n1.Create a binary search tree\n2.Preorder
traversal\n3.Postorder traversal\n4.Inorder traversal\n5.Exit\n\nEnter an option: ");
  scanf("%d",&option);
  switch(option)
  {
   case 1: create();
           printf("Binary search tree created\n\n");
           break;
   case 2: printf("\nThe elements in the tree are\n");
           pre(tree);
           break;
   case 3: printf("\nThe elements in the tree are\n");
           post(tree);
           break;
   case 4: printf("\nThe elements in the tree are\n");
           in(tree);
           break;
  }
 }while(option!=5);
}

void create()
{
 int val;
 printf("\nEnter -1 to end");
 printf("\nEnter the element : ");
 scanf("%d",&val);
 while(val!=-1)
 {
 struct node *ptr, *nodeptr, *parentptr;
 ptr = (struct node*)malloc(sizeof(struct node));
 ptr->data = val;
```

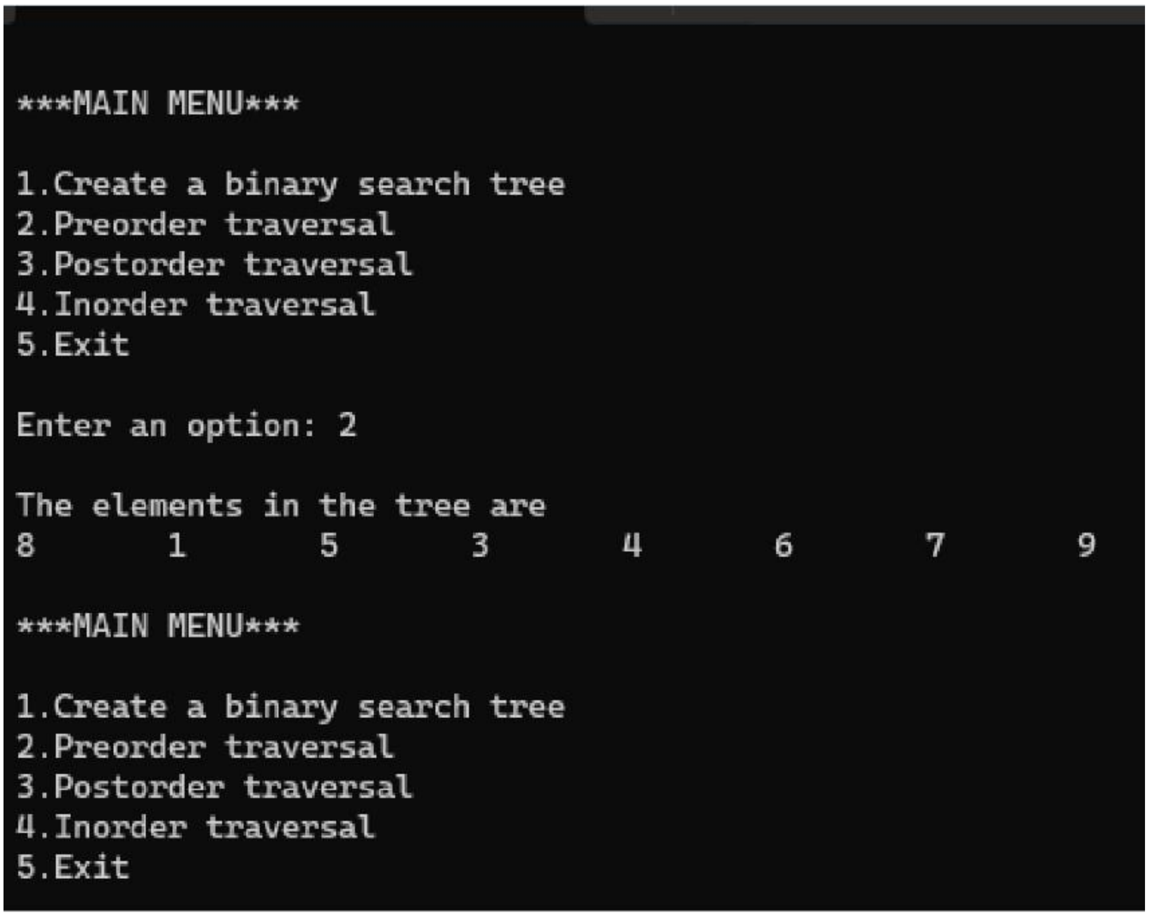
```
ptr->left = NULL;
ptr->right = NULL;
if(tree==NULL)
{
 tree=ptr;
 tree->left=NULL;
 tree->right=NULL;
}
else
{
 parentptr=NULL;
 nodeptr=tree;
 while(nodeptr!=NULL)
 {
  parentptr=nodeptr;
  if(val<nodeptr->data)
  nodeptr=nodeptr->left;
  else
   nodeptr = nodeptr->right;
 }
 if(val<parentptr->data)
 parentptr->left = ptr;
 else
  parentptr->right = ptr;
 }
 printf("\nEnter the element : ");
 scanf("%d",&val);
 }
}
```

```
void pre(struct node *tree)
{
if(tree!=NULL)
 {
 printf("%d\t", tree->data);
 pre(tree->left);
 pre(tree->right);
 }
}

void in(struct node *tree)
{
 if(tree != NULL)
 {
  in(tree->left);
  printf("%d\t", tree->data);
  in(tree->right);
 }
}

void post(struct node *tree)
{
 if(tree != NULL)
 {
  post(tree->left);
  post(tree->right);
  printf("%d\t", tree->data);
 }}
```

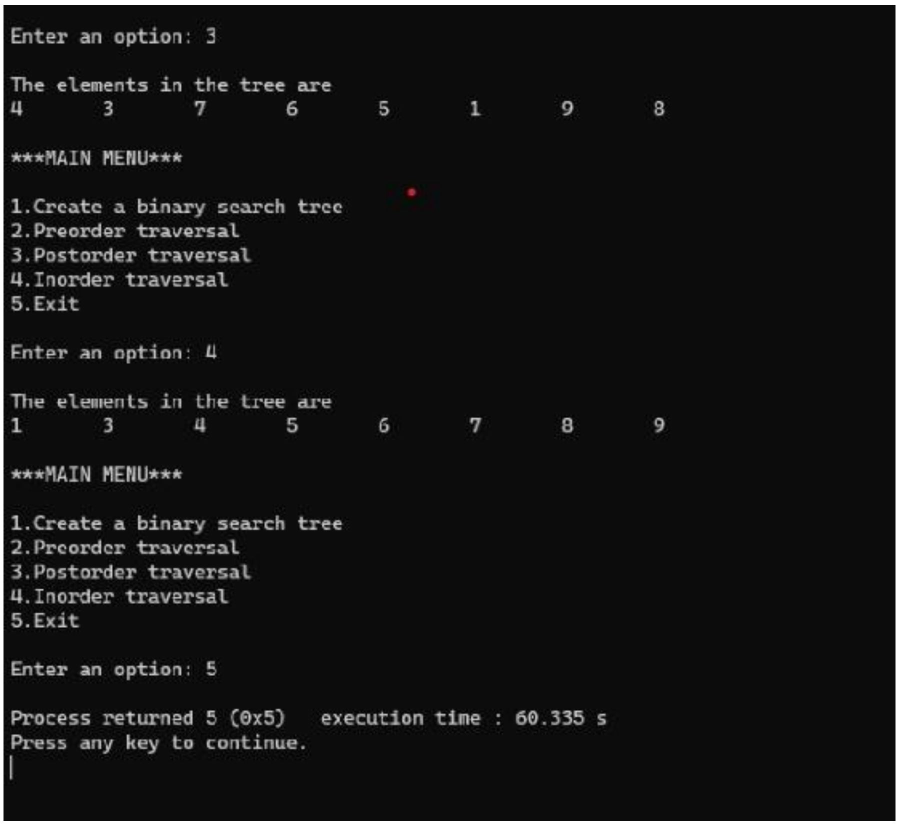
Output:



```
***MAIN MENU***

1.Create a binary search tree
2.Preorder traversal
3.Postorder traversal
4.Inorder traversal
5.Exit

Enter an option: 1

Enter -1 to end
Enter the element : 8

Enter the element : 1

Enter the element : 5

Enter the element : 3

Enter the element : 9

Enter the element : 4

Enter the element : 6

Enter the element : 7

Enter the element : -1
Binary search tree created
```



```
***MAIN MENU***

1.Create a binary search tree
2.Preorder traversal
3.Postorder traversal
4.Inorder traversal
5.Exit

Enter an option: 2

The elements in the tree are
8       1       5       3       4       6       7       9

***MAIN MENU***

1.Create a binary search tree
2.Preorder traversal
3.Postorder traversal
4.Inorder traversal
5.Exit
```

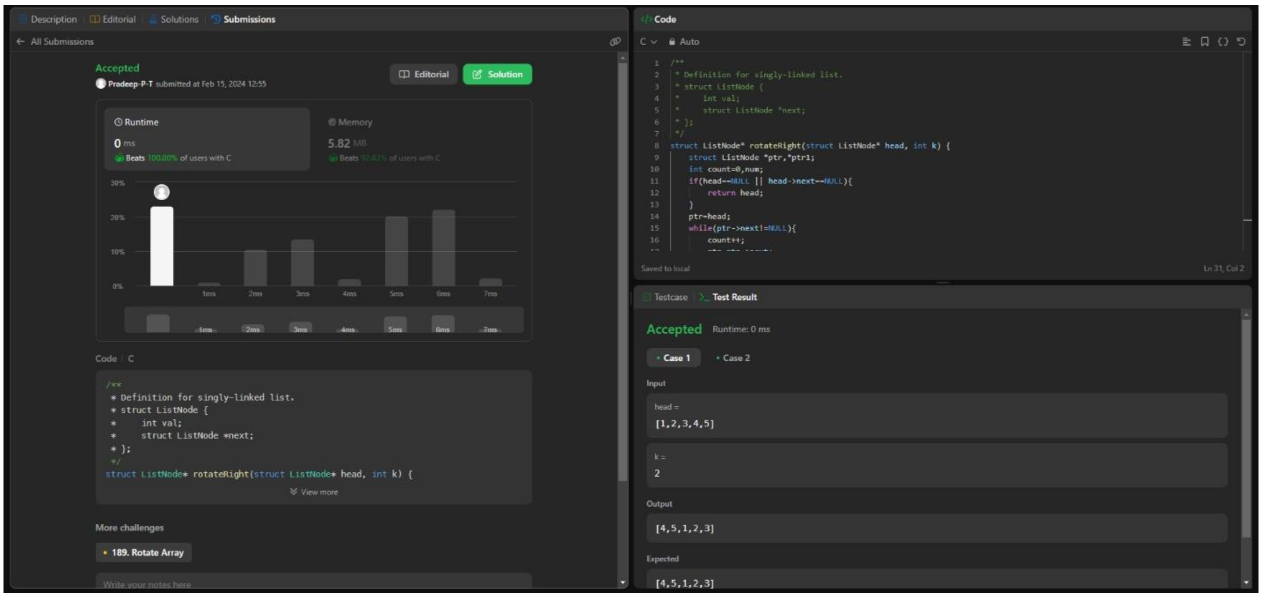


```
Enter an option: 3

The elements in the tree are
4       3       7       6       5       1       9       8

***MAIN MENU***

1.Create a binary search tree
2.Preorder traversal
3.Postorder traversal
4.Inorder traversal
5.Exit

Enter an option: 4

The elements in the tree are
1       3       4       5       6       7       8       9

***MAIN MENU***

1.Create a binary search tree
2.Preorder traversal
3.Postorder traversal
4.Inorder traversal
5.Exit

Enter an option: 5

Process returned 5 (0x5)   execution time : 60.335 s
Press any key to continue.
```

Leetcode Program: Rotate List

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* rotateRight(struct ListNode* head, int k) {
    struct ListNode *ptr,*ptr1;
    int count=0,num;
    if(head==NULL || head->next==NULL){
        return head;
    }
    ptr=head;
    while(ptr->next!=NULL){
        count++;
        ptr=ptr->next;
    }
    num=k%(count+1);
    while(num--){
        ptr=head;
        while(ptr->next!=NULL){
        ptr1=ptr;
        ptr=ptr->next;
        }
        ptr->next=head;
        ptr1->next=NULL;
        head=ptr;
    }
    return head;
}
```

Output:



Accepted
Pradeep-P-T submitted at Feb 15, 2024 12:55

Runtime
0 ms
Beats 100.00% of users with C

Memory
5.82 MB

Code | C

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* rotateRight(struct ListNode* head, int k) {
    struct ListNode *ptr,*ptr1;
    int count=0,num;
    if(head==NULL || head->next==NULL){
        return head;
    }
    ptr=head;
    while(ptr->next!=NULL){
        count++;
```

Accepted Runtime: 0 ms

Case 1 Case 2

Input

head =
[1,2,3,4,5]

k =
2

Output

[4,5,1,2,3]

Expected

[4,5,1,2,3]

Lab Program 9:

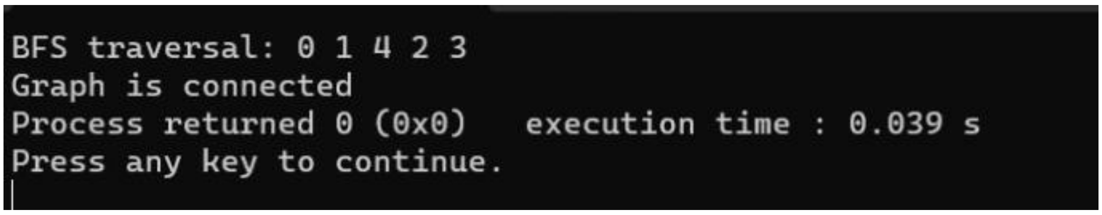
9a) Write a program to traverse a graph using BFS method.

9b) Write a program to check whether given graph is connected or not using DFS method.

```
#include<stdio.h>
#define MAX_VERTICES 50
typedef struct Graph_t {
  int V;
  int adj[MAX_VERTICES][MAX_VERTICES];
} Graph;
int DFS_V[50];
Graph* Graph_create(int V)
{
  Graph* g = malloc(sizeof(Graph));
  g->V = V;
```

```
    for (int i = 0; i <=V; i++) {
        for (int j = 0; j <=V; j++) {
            g->adj[i][j] = 0;
        }
    }

    return g;
}
void Graph_addEdge(Graph* g, int v, int w)
{
    g->adj[v][w] = 1;
    g->adj[w][v] = 1;
}
void BFS(Graph* g, int root){
    int visited[g->V+1];
    for(int i=0;i<=g->V;i++)
            visited[i]=0;

    int queue[g->V+1];
    int front=0,rear=0;
    visited[root]=1;

    queue[rear++]=root;
    while(front!=rear){
            root=queue[front++];
        printf("%d ",root);
        for(int i=0;i<=g->V;i++){
            if(g->adj[root][i]==1 && visited[i]!=1){
                visited[i]=1;
                queue[rear++]=i;
            }
        }
    }


}
int DFS(Graph *g,int root){
    for(int i=0;i<=g->V;i++){
        if(g->adj[root][i]==1 && DFS_V[i]!=1){
            DFS_V[i]=1;
            DFS(g,i);
        }
    }
    int count=0;
    for(int i=0;i<=g->V;i++){
        if(DFS_V[i]==1){
         count++;
        }
    }
    return count;
}
int main()
{

    Graph* g = Graph_create(4);
    Graph_addEdge(g, 0, 1);
    Graph_addEdge(g, 0, 4);
    Graph_addEdge(g, 1, 3);
    Graph_addEdge(g, 1, 2);
    Graph_addEdge(g, 2, 3);
    Graph_addEdge(g, 4, 3);
    printf("BFS traversal: ");
    BFS(g,0);
    int count=DFS(g,0);
    if(count==g->V+1){
        printf("\nGraph is connected");
    }
    else{
        printf("\nGraph is disconnected");
    }
}
```

Output:



```
BFS traversal: 0 1 4 2 3
Graph is connected
Process returned 0 (0x0)   execution time : 0.039 s
Press any key to continue.
```

Lab Program 10:

Given a File of N employee records with a set K of Keys(4-digit) which uniquely determine the records in file F.

Assume that file F is maintained in memory by a Hash Table (HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT.

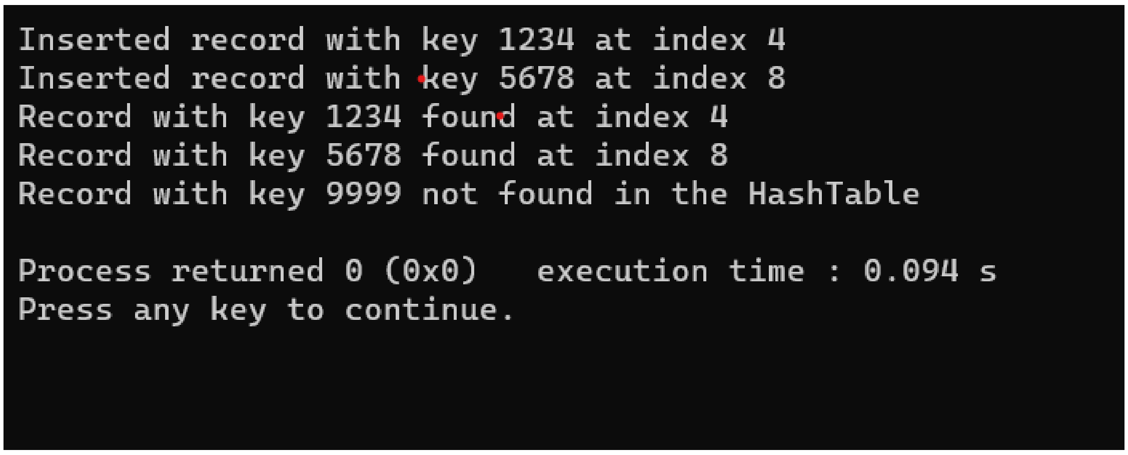
Let the keys in K and addresses in L are integers.

Design and develop a Program in C that uses Hash function H: K -&gt; L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L.

Resolve the collision (if any) using linear probing.

```
#include <stdio.h>
#include <stdlib.h>
#define TABLE_SIZE 10
struct EmployeeRecord {
    int key;
    // Other fields of the employee record can be added here
};
struct EmployeeRecord *hashTable[TABLE_SIZE];
int hashFunction(int key) {
    return key % TABLE_SIZE;
}
void insert(struct EmployeeRecord *record) {
    int key = record->key;
    int index = hashFunction(key);
    int i = 0;

    while (i < TABLE_SIZE) {
        if (hashTable[index] == NULL) {
            hashTable[index] = record;
            printf("Inserted record with key %d at index %d\n", key, index);
            return;
        }
        i++;
        index = (hashFunction(key) + i) % TABLE_SIZE;
    }

    printf("HashTable is full. Unable to insert record with key %d\n", key);
}

struct EmployeeRecord* search(int key) {
    int index = hashFunction(key);
    int i = 0;

    while (i < TABLE_SIZE) {
        if (hashTable[index] != NULL && hashTable[index]->key == key) {
            printf("Record with key %d found at index %d\n", key, index);
            return hashTable[index];
        }
        i++;
        index = (hashFunction(key) + i) % TABLE_SIZE;
    }
 printf("Record with key %d not found in the HashTable\n", key);
    return NULL;
}
int main() {
    // Initialize hashTable with NULL pointers
    for (int i = 0; i < TABLE_SIZE; i++) {
        hashTable[i] = NULL;
    }
    struct EmployeeRecord record1 = {1234}; // Example record with key 1234
    struct EmployeeRecord record2 = {5678}; // Example record with key 5678


    insert(&record1);
    insert(&record2);


    search(1234);
   search(5678);
   search(9999);
   return 0;
}
```

Output:



```
Inserted record with key 1234 at index 4
Inserted record with key 5678 at index 8
Record with key 1234 found at index 4
Record with key 5678 found at index 8
Record with key 9999 not found in the HashTable

Process returned 0 (0x0)   execution time : 0.094 s
Press any key to continue.
```