VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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

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This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by **PRAJWAL K K(1BM22CS199)**, 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

Sl. No.	Experiment Title	Page No.
1	Stack Implementation	4
2	Infix to Postfix expression	6
3	Queue & Circular Queue Implementation	9
4	Singly Linked List & Leetcode-min stack	14
5	Singly Linked List(Deletion) & Leetcode- Reverse list	21
6	Linked List Operations,Stack & Queue implementation Using Linked List	28
7	Doubly Linked List & Leetcode – split linked list	43
8	Binary Search Tree & Leetcode- Rotate List	52
9	Traverse Graph using BFS method	59
10	Hashing Program	63

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.

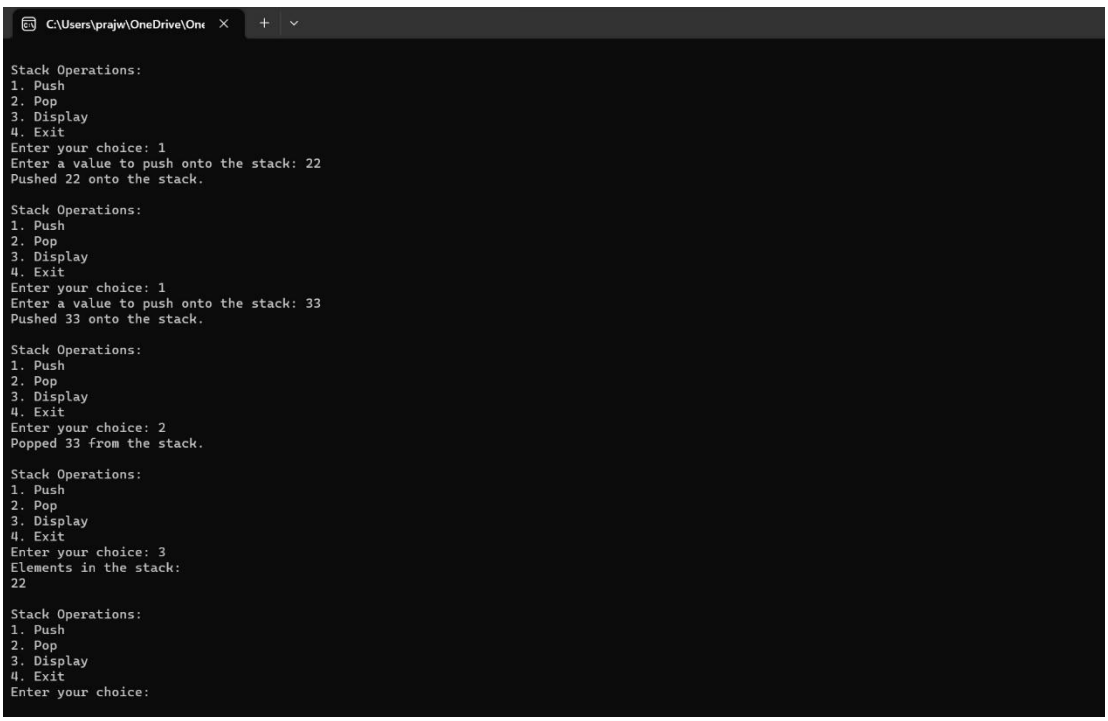
Lab program 1:

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:



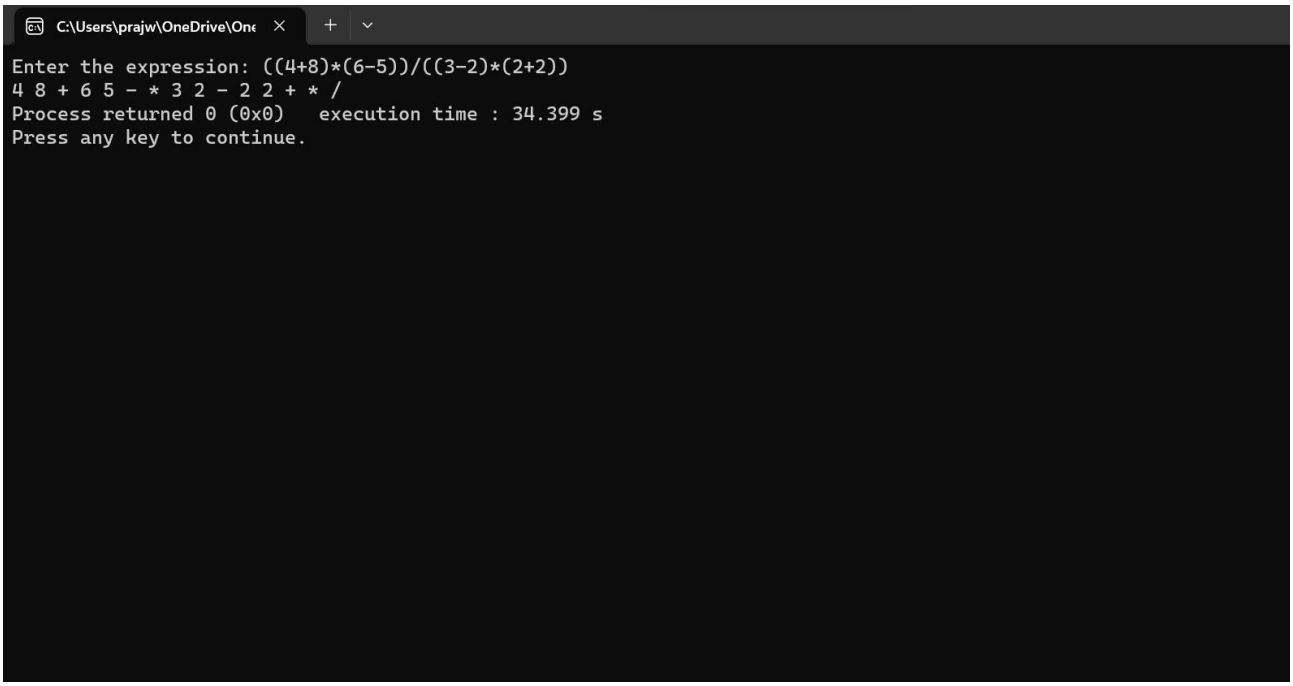
Lab Program 2:

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:



Lab Program 3:

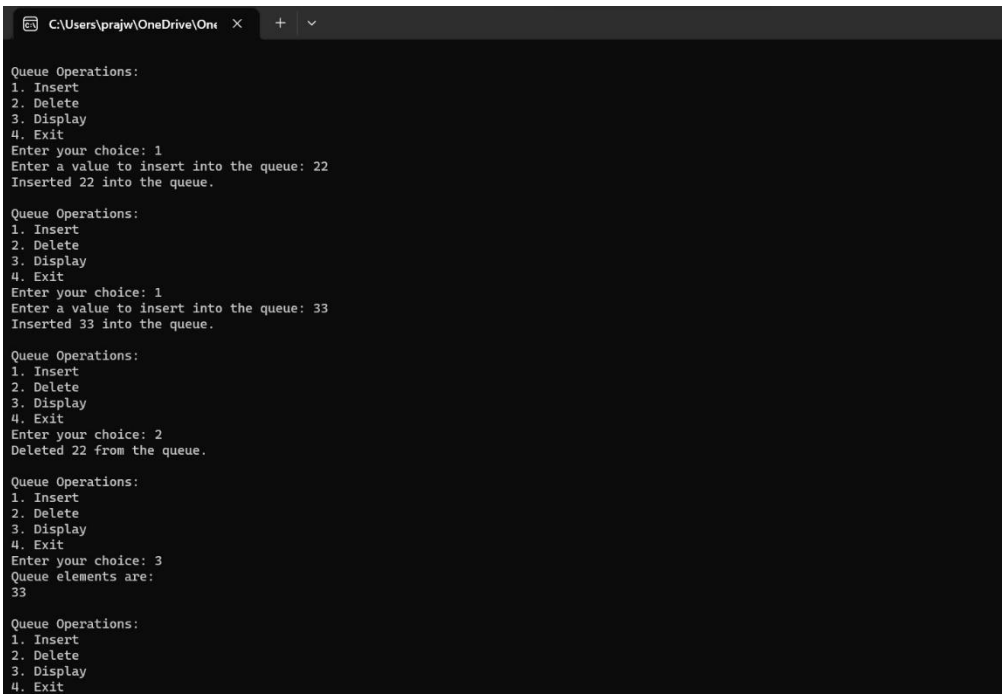
3a) WAP to simulate the working of a queue of integers using an array. Provide the following operations: Insert, Delete, Display
The program should print appropriate messages for queue empty and queue overflow conditions

```
#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:



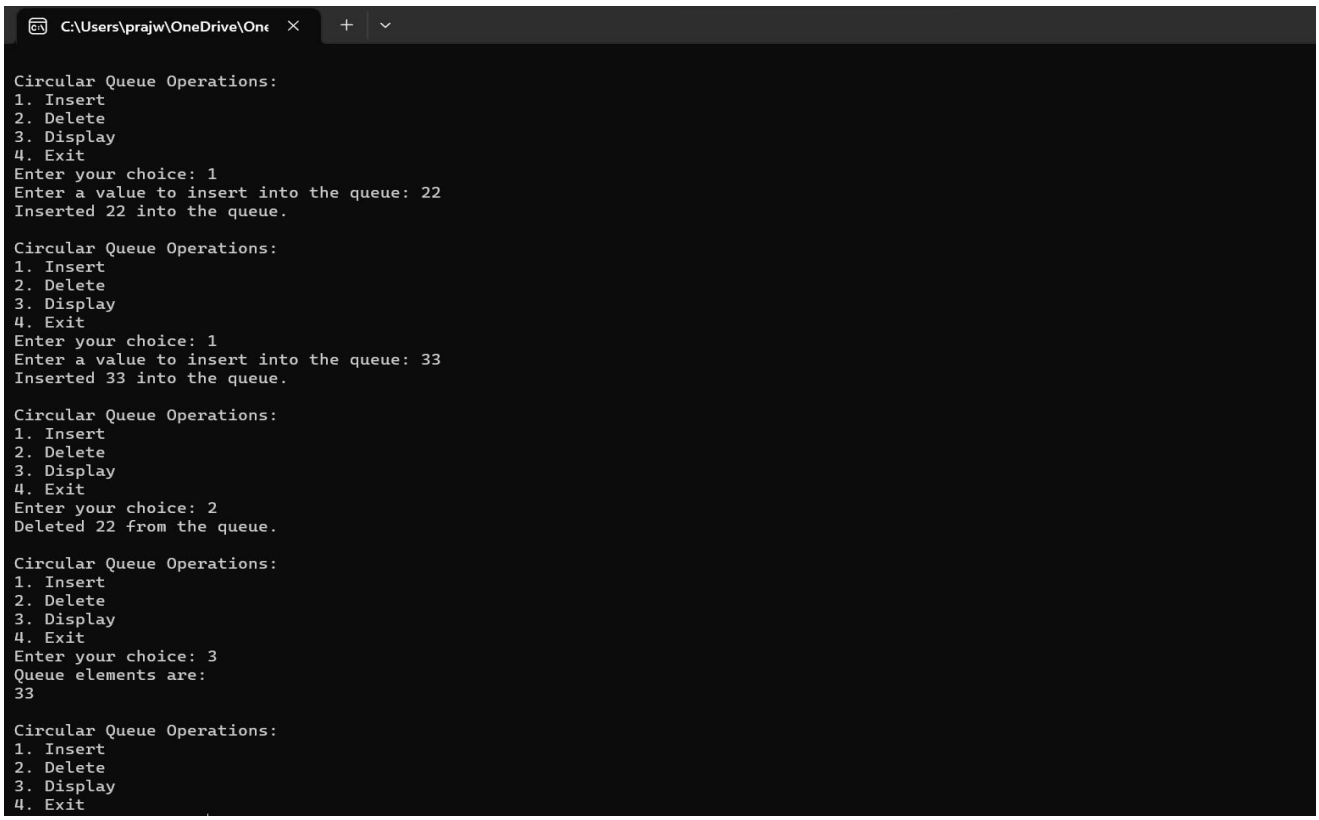
3b) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete & Display The program should print appropriate messages for queue empty and queue overflow conditions

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

```
#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:



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:

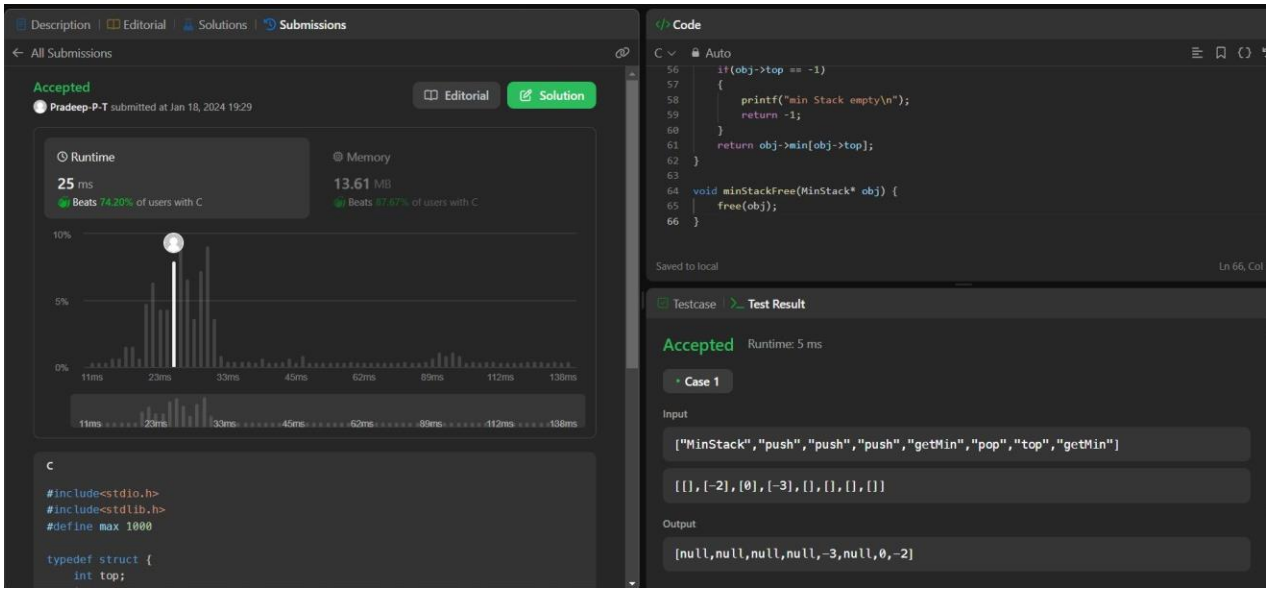
```
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 1
Enter data in the new node: 18
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 2
Enter data in the new node: 78
1. Insert at beginning
2. Insert at end
3. 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:


Description | Editorial | Solutions | Submissions
All Submissions
Accepted
Pradeep-P-T submitted at Jan 18, 2024 19:29
Editorial
Solution
Runtime
25 ms
Beats 74.20% of users with C
Memory
13.61 MB
Beats 87.67% of users with C
10%
5%
0%
11ms
23ms
33ms
45ms
62ms
89ms
112ms
138ms
c
#include<stdio.h>
#include<stdlib.h>
#define max 1000
typedef struct {
int top;
Code
C
Auto
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
Testcase
Test Result
Accepted
Runtime: 5 ms
Case 1
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)
      {
```

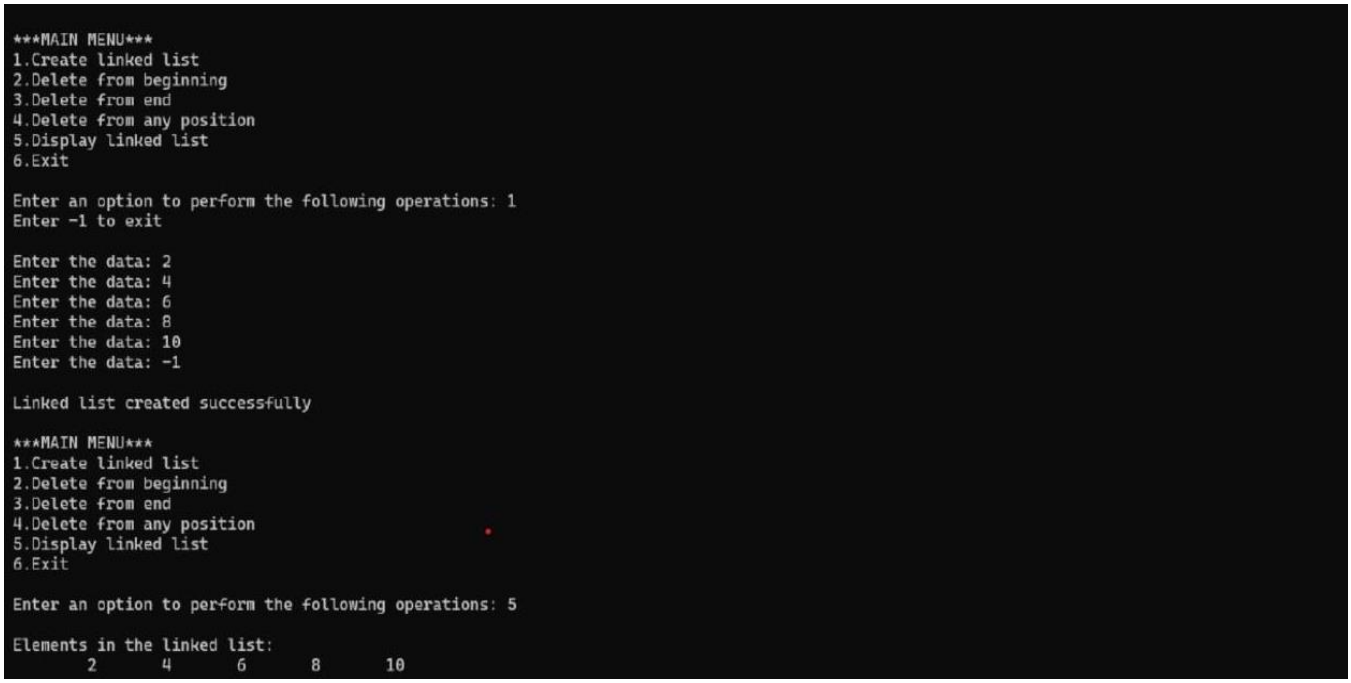
```
            case 1:create();
                printf("\nLinked list created successfully\n");
                break;
            case 2:delete_begin();
                printf("Element deleted successfully\n");
                break;
            case 3:delete_end();
                printf("Element 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:

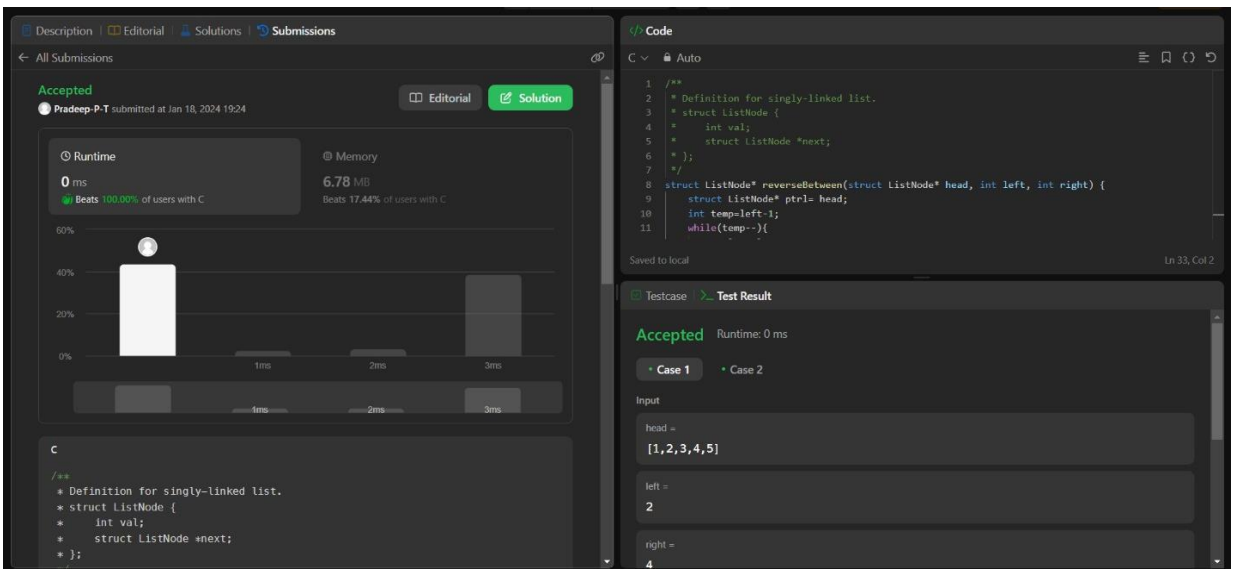


Leetcode Program: Reverse Linked List

```
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:



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 & 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:

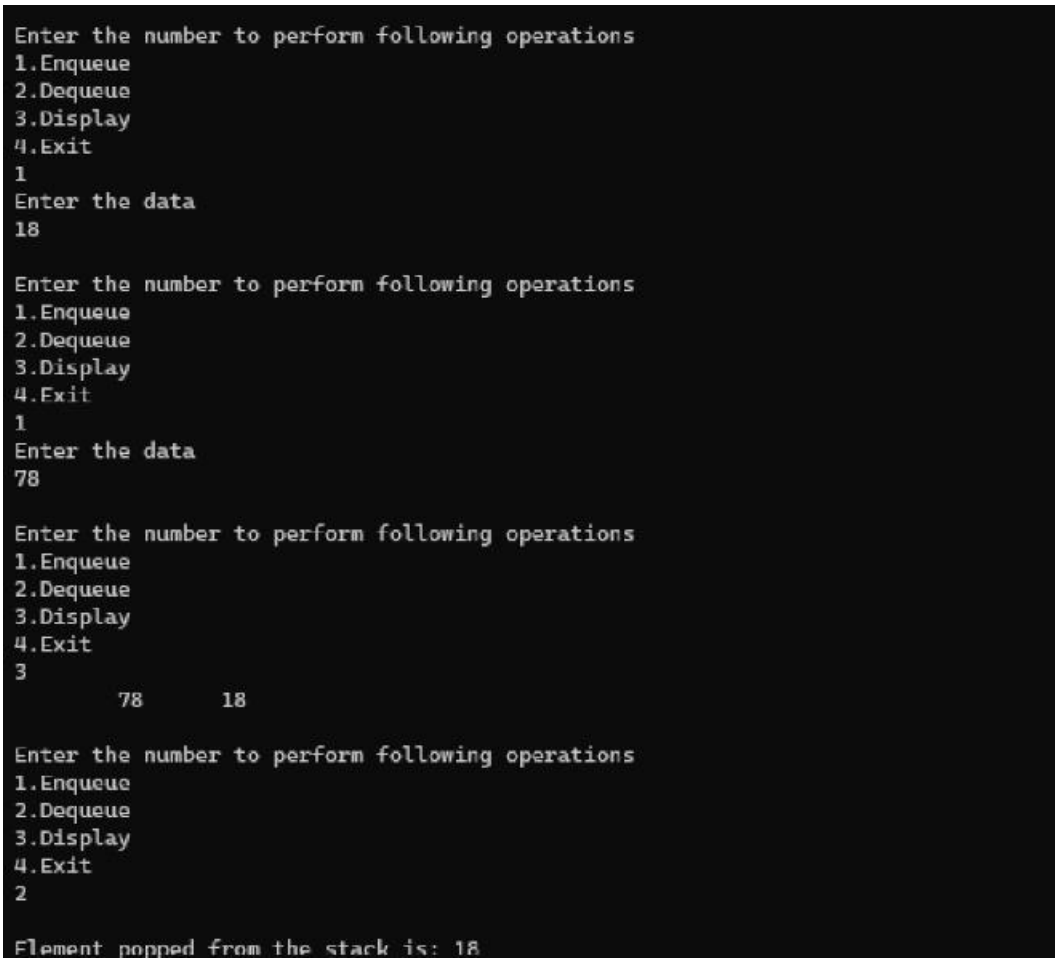
```
Enter the number to perform following operations
1.Push
2.Pop
3.Display
4.Exit
1
Enter the data
2

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
```

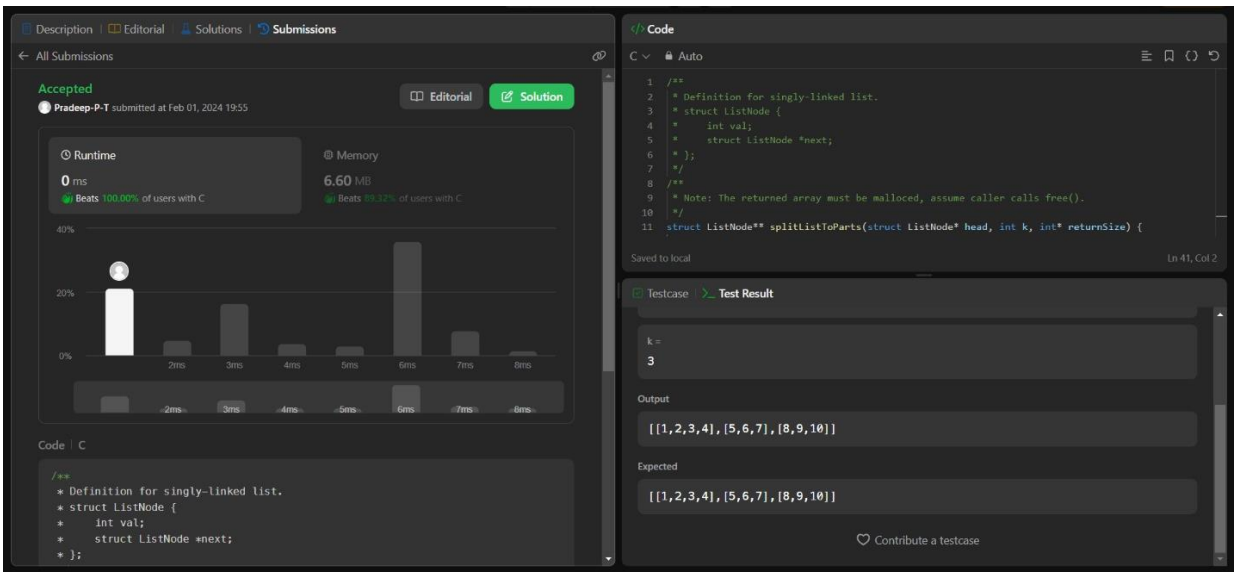
```
***MAIN MENU***

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:



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.

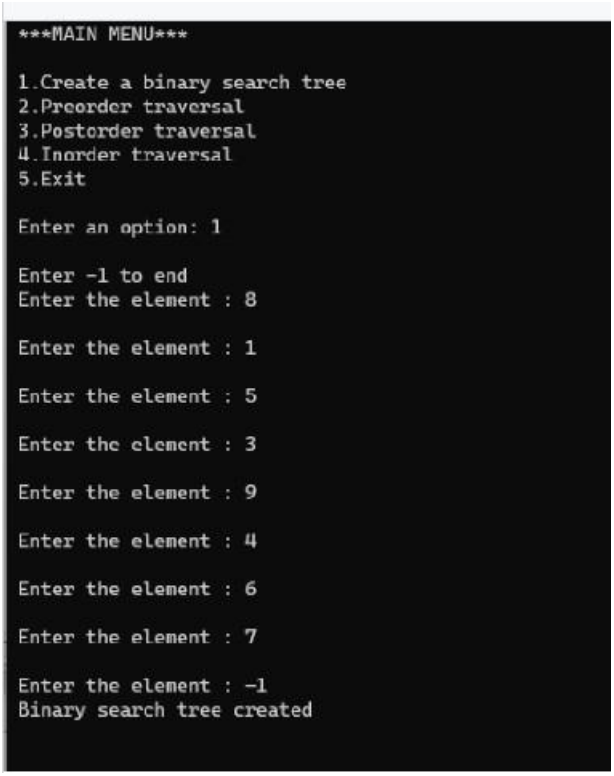
```
#include<stdio.h>
#include<stdlib.h>

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);
```

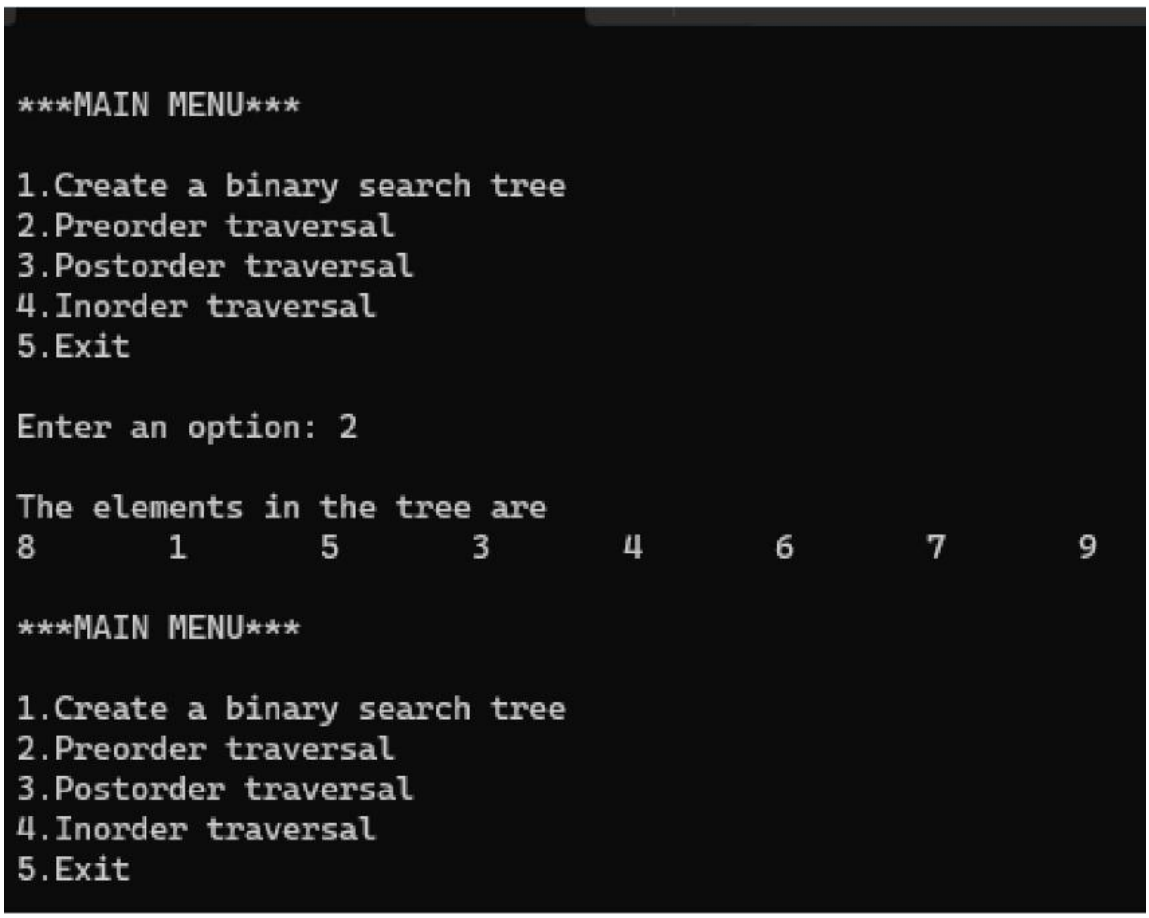
```
 switch(option)
 {
  case 1: create();
          printf("Binary search tree created\n\n");
          break;
  case 2: printf("\nThe elements in the tree are\n");
          pre(tree);
          break;
  case 3: printf("\nThe elements in the tree are\n");
          post(tree);
          break;
  case 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;
```

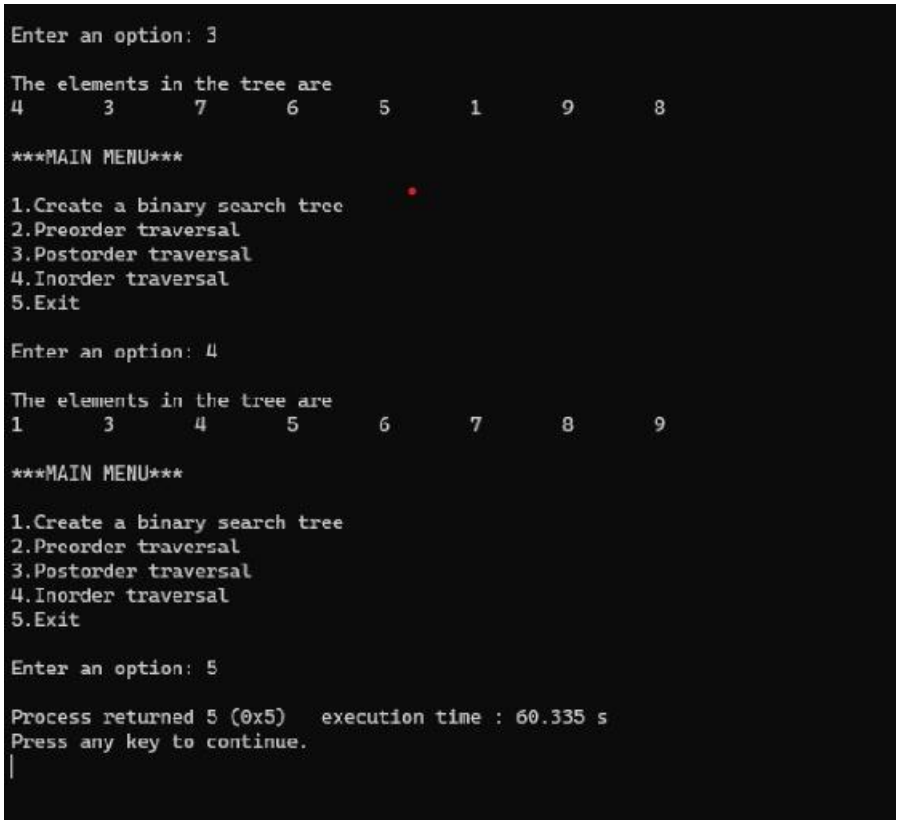
```
ptr->left = NULL;
ptr->right = NULL;
if(tree==NULL)
{
 tree=ptr;
 tree->left=NULL;
 tree->right=NULL;
}
else
{
 parentptr=NULL;
 nodeptr=tree;
 while(nodeptr!=NULL)
 {
  parentptr=nodeptr;
  if(val<nodeptr->data)
  nodeptr=nodeptr->left;
  else
   nodeptr = nodeptr->right;
 }
 if(val<parentptr->data)
 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

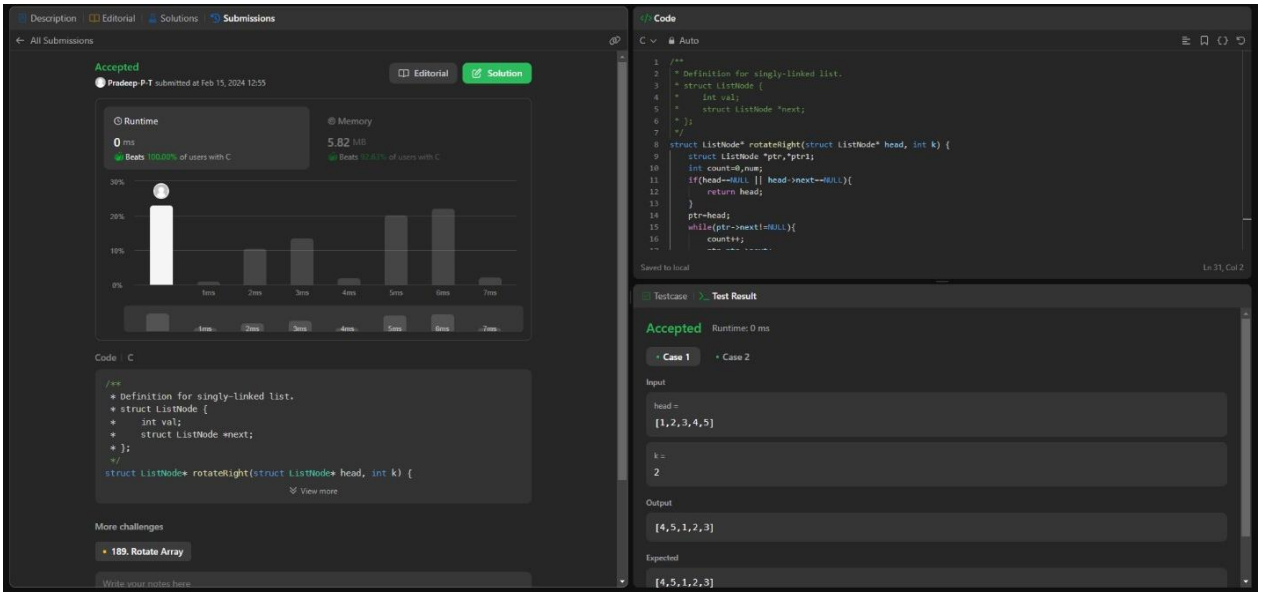


Leetcode Program: Rotate List

```
/**
 * 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:



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 -> 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: