# VISVESVARAYA TECHNOLOGICAL UNIVERSITY

**"JnanaSangama", Belgaum -590014, Karnataka.**

# DATA STRUCTURE LAB RECORD

***Submitted by***


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***Under the Guidance of***

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


**B.M.S. COLLEGE OF ENGINEERING**
**(Autonomous Institution under VTU)**
**BENGALURU-560019**

**Sep-2020 to Jan-2021**

# B. M. S. College of Engineering,

**Bull Temple Road, Bangalore 560019**

(Affiliated To Visvesvaraya Technological University, Belgaum)

## Department of Computer Science and Engineering

## CERTIFICATE

This is to certify that the LAB RECORD carried out by **SHREEHARI KULKARNI (1BM19CS153)** who is the bonafide students 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 Visveswaraiah Technological University, Belgaum during the year 2020-2021. The lab report has been approved as it satisfies the academic requirements in respect of **DATA STRUCTURE LAB RECORD (19CS3PCDST)** work prescribed for the said degree.

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1._____ _____

2. _____ _____

# INDEX

## 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

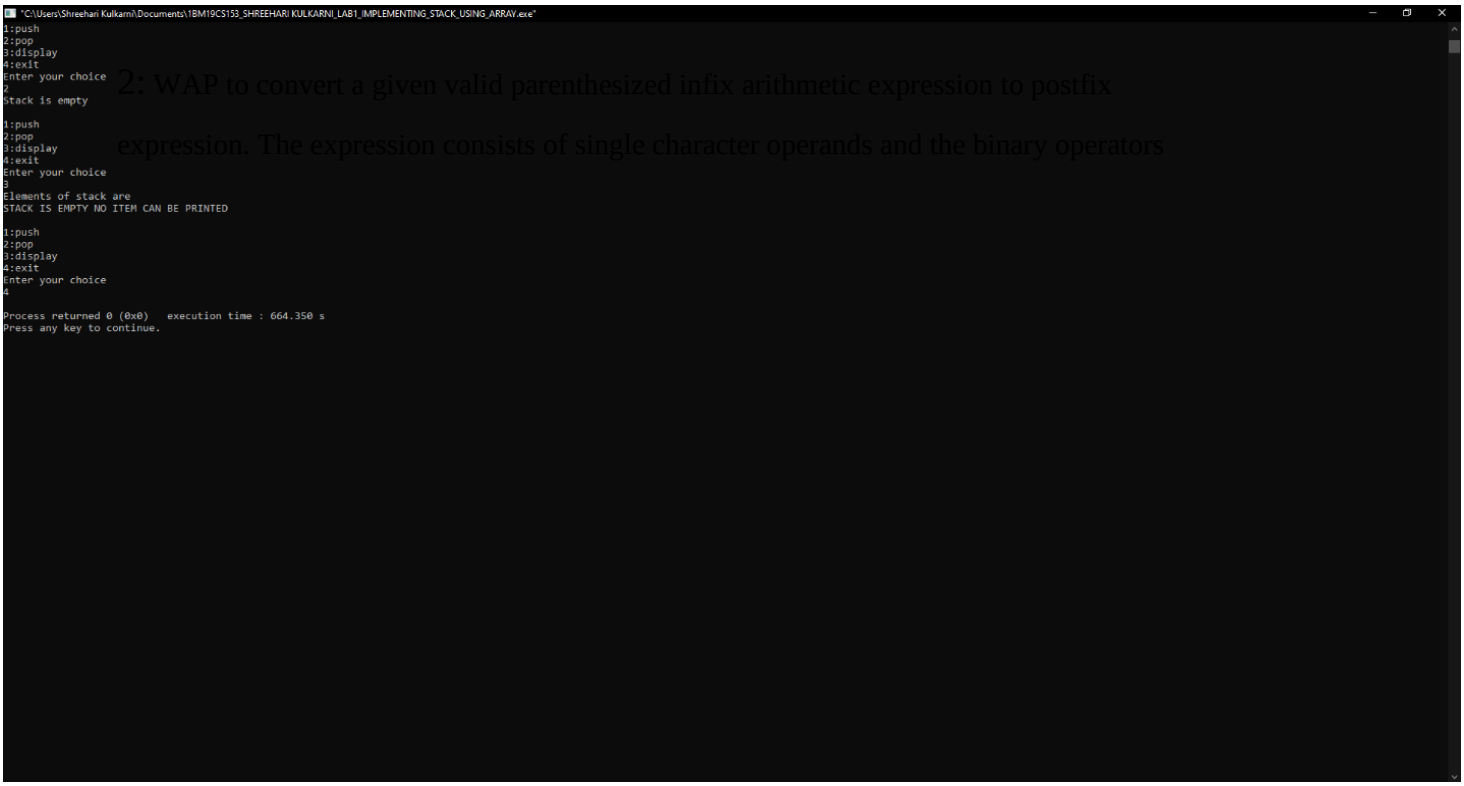
```
#include<stdio.h>
#include<stdlib.h>
#define STACK_SIZE 5
int top=-1;
int s[10];
int item;
void push()
{
   if(top==STACK_SIZE-1)
   {

      printf("STACK OVERFLOW ELEMENT CANNOT BE ADDED\n");
      return;
   }
   top+=1;
   s[top]=item;
}

int pop()
```

```
{
   if(top==-1)
   {
      return -1;
   }
   return s[top--];
}
 void display()
 {

    if(top==-1)
    {
       printf("STACK IS EMPTY NO ITEM CAN BE PRINTED\n");
       return;
    }
    else
    {
       for(int i=top;i>=0;i--)
       {
          printf("%d\n",s[i]);
       }
    }

 }
 int main()
 {
```

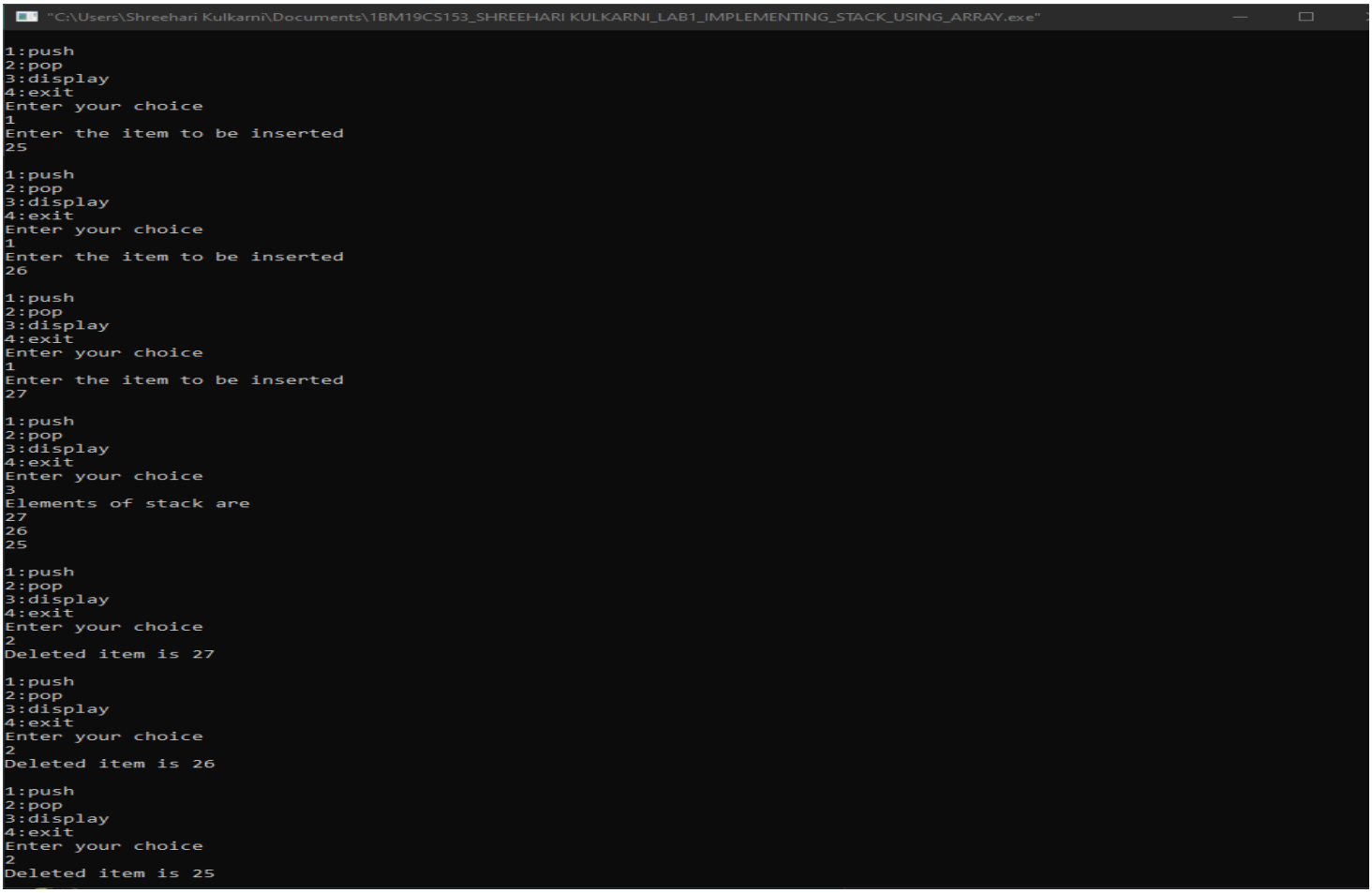
```
int item_deleted;
int choice;
for(;;)
{
   printf("\n1:push\n2:pop\n3:display\n4:exit\n");
   printf("Enter your choice\n");
   scanf("%d",&choice);
   switch(choice)
   {

   case 1:
      printf("Enter the item to be inserted\n");
      scanf("%d",&item);
      push();
      break;

   case 2:
      item_deleted=pop();
      if(item_deleted==-1)
         printf("Stack is empty\n");
      else{
         printf("Deleted item is %d\n",item_deleted);
      }
      break;

   case 3:
```

```
            printf("Elements of stack are \n");
            display();
            break;


        default:
            exit(0);
        }
    }

}
```

# 1:OUTPUT:




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



## 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<string.h>
#include<stdlib.h>
char stack[100];
int top1=-1;
/*code to check validity of Expression*/
int check(char a[])
{
   for (int i = 0; a[i] != '\0';i++)
        {
                if (a[i] == '(')
                {
                        push(a[i]);
                }
                else if (a[i] == ')')
                {
                        pop();
```

```
            }
        }
        return(find_top());

}
void push(char a)
{
        stack[++top1] = a;
}
void pop()
{
        if (top1 == -1)
        {
                printf("expression is invalid\n");
                exit(0);
        }
        else
        {
                top1--;
        }
}
int find_top()
{
        if (top1 == -1)
                return 1;
        else
```

```
        return 0;
}

/*END OF CHECK FOR INVALID EXPRESSION*/
int F(char symbol)
{
   switch(symbol)
   {

   case '+':
   case '-':
      return 2;



   case '*':
   case '/':
      return 4;



   case '^':
   case '$':
      return 5;

   case '(':
      return 0;
```

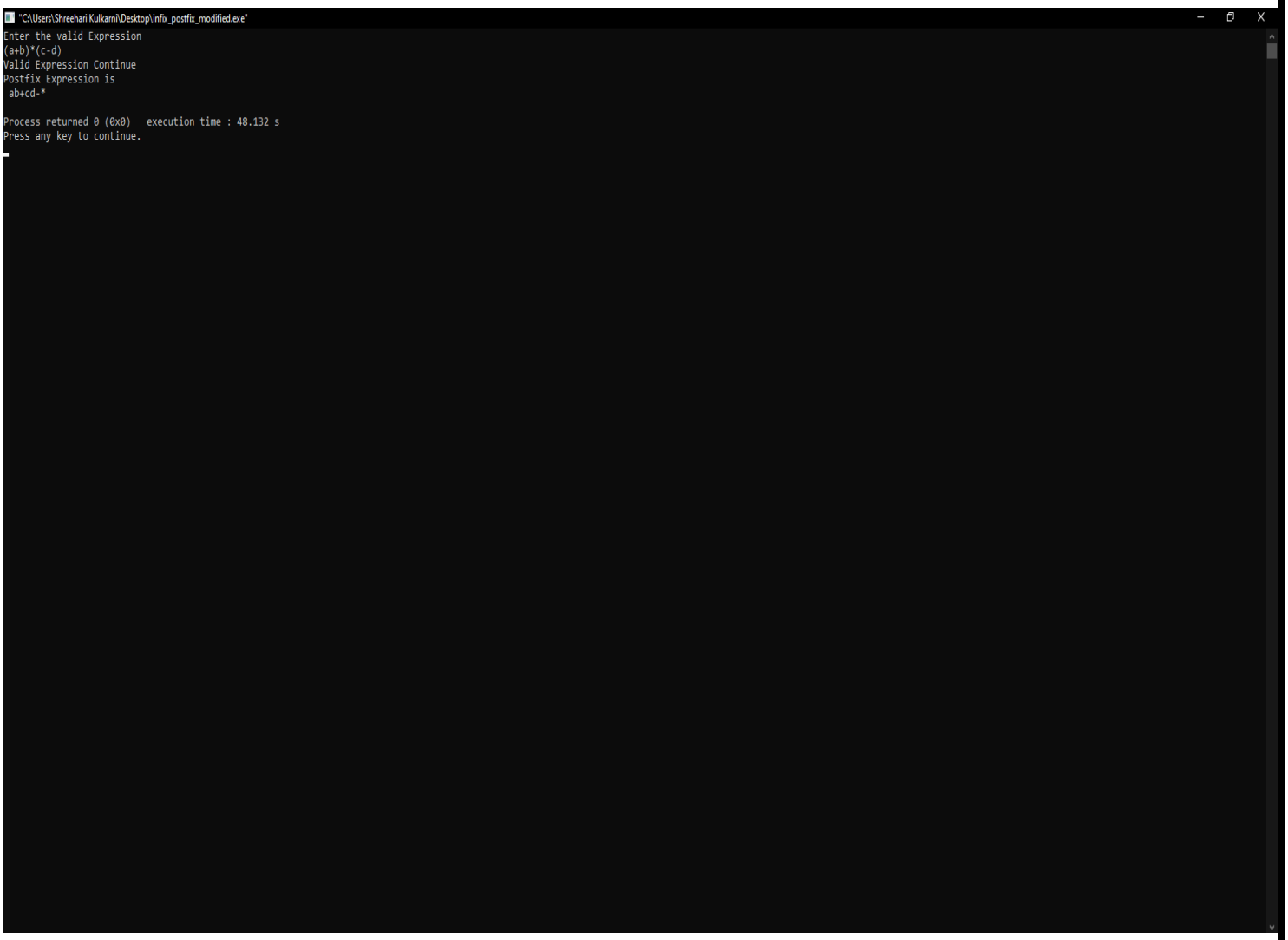
```
    case '#':
        return -1;


    default:
        return 8;

    }
}

int G(char symbol)
{

    switch(symbol)
    {

    case '+':
    case '-':
        return 1;


    case '*':
    case '/':
        return 3;
```

```
    case '^':
    case '$':
        return 6;

    case '(':
        return 9;

    case ')':
        return 0;

    default:
        return 7;
    }
}

void  infix_postfix(char infix[],char postfix[])
{

    int top,i,j;
    char s[30],symbol;
    top=-1;
    s[++top]='#';
    j=0;
     if(check(infix))
     {
```

```
    printf("Valid Expression Continue\n");
 }
 else
 {
    printf("Invalid Expression\n");
    exit(0);
 }
for(i=0;i<strlen(infix);i++)
{
   symbol=infix[i];
   while(F(s[top])>G(symbol))
   {
      postfix[j]=s[top--];
      j++;
   }

   if(F(s[top])!=G(symbol))
   {
      s[++top]=symbol;
   }
   else
   {
      top--;
   }
}
```

```
    while(s[top]!='#')
    {
        postfix[j++]=s[top--];
    }
    postfix[j]='\0';
}

int main()
{

    char infix[20];
    char postfix[20];
    printf("Enter the valid Expression\n");
    scanf(" %s",infix);
    infix_postfix(infix,postfix);
    fflush(stdin);
    printf("Postfix Expression is\n");
    printf(" %s\n",postfix);

    return 0;

}
```

# 2: OUTPUT


"C:\Users\Shreehari Kulkarni\Desktop\infix_postfix_modified.exe"
Enter the valid Expression
(a+b)*(c-d)
Valid Expression Continue
Postfix Expression is
ab+cd-*
Process returned 0 (0x0) execution time : 48.132 s
Press any key to continue.

3: WAP to simulate the working of a queue of integers using an array. Provide the following

operations

a) Insert b) Delete c) Display

The program should print appropriate messages for queue empty and queue overflow

Conditions

```
#include<stdio.h>
#include<math.h>
#include<stdlib.h>
#define max 5
int q[max];
int front=-1,rear=-1;
void insert();
int delete();
void display();
int main()
{

   int option,val;
   do
   {
```

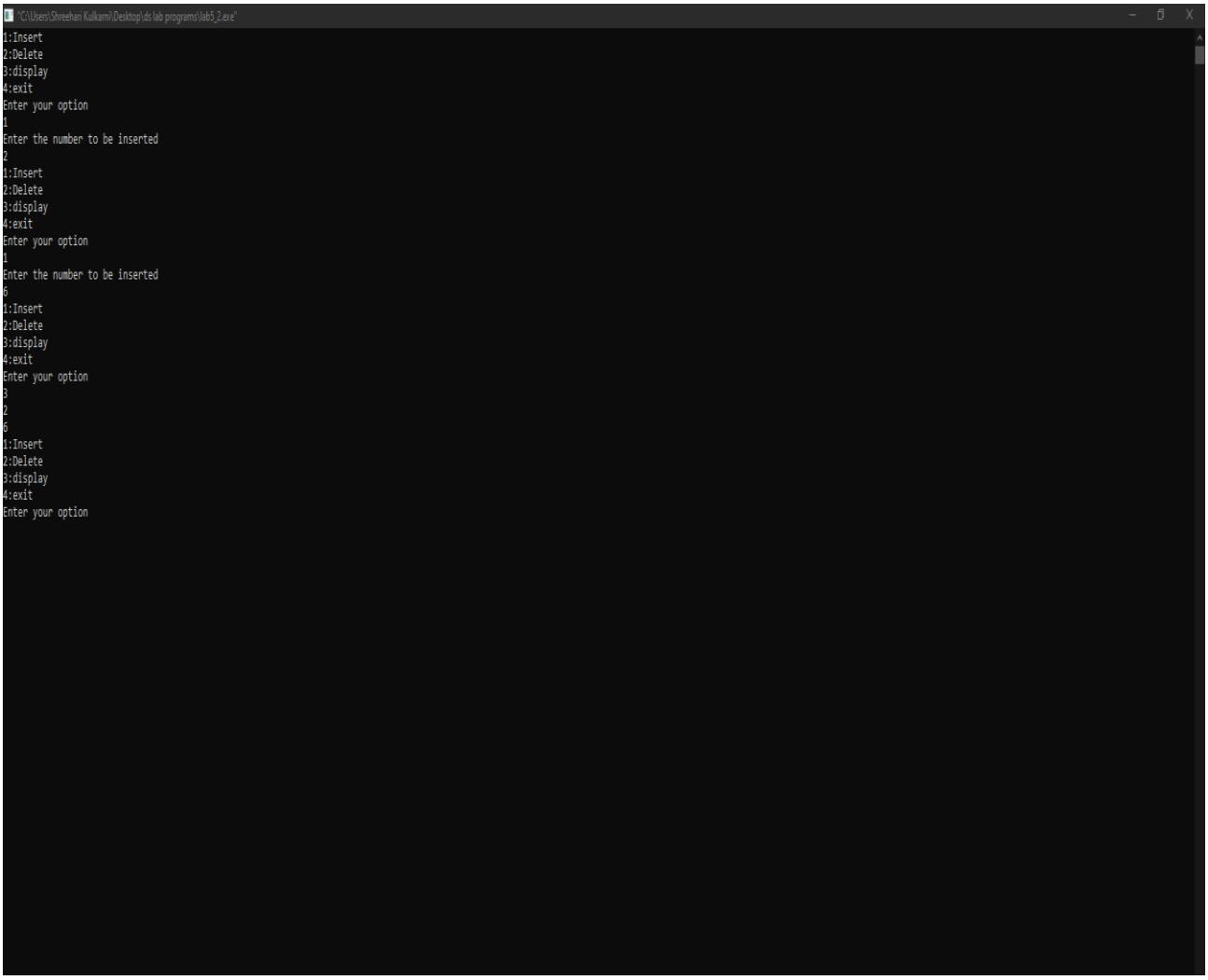
```
printf("**********MAIN MENU**********\n");
printf("1:INSERT\n");
printf("2:DELETE\n");
printf("3:DISPLAY\n");
printf("4:EXIT\n");
printf("Enter the option\n");
scanf("%d",&option);
switch(option)
{

case 1:
   insert();
   break;
case 2:
   val=delete();
   if(val!=-1)
   {
      printf("Item deleted is %d\n",val);
   }
   break;
case 3:
   display();
   break;

case 4:
   exit(0);
```

```
        }
    }while(option!=5);
    return 0;
}

void insert()
{
    int num;
    printf("Enter the number to be inserted\n");
    scanf("%d",&num);
    if(rear==max-1)
    {
        printf("OVERFLOW\n");
    }
    if(front==-1&&rear==-1)
    {
        front=0;
        rear=0;
        q[rear]=num;
    }
    else
    {
        rear++;
        q[rear]=num;
    }
}
```

```
int delete()
{
   int val;
   if(front==-1||front>rear)
   {
      printf("UNDERFLOW\n");
      return -1;
   }
   else
   {
      val=q[front];
      front++;
      if(front>rear)
      {
         front=-1;
         rear=-1;
      }

      return val;
   }
}
void display()
{
   if(front==-1||front>rear)
   {
      printf("Queue Is Empty\n");
```

```
    }
    else
    {
       for(int i=front;i<=rear;i++)
       {
           printf("%d\n",q[i]);
       }
    }

}
```

# 3: OUTPUT



4: WAP to simulate the working of a circular queue of integers using an array. Provide the

following operations.

a) Insert b) Delete c) Display

The program should print appropriate messages for queue empty and queue overflow

Conditions

```
#include<stdio.h>
#include<math.h>
#include<stdlib.h>
#define max 5
int q[max];
int front=-1;
int rear=-1;
void insert();
int del();
void display();
int main()
{
   int option,val;
   do
   {
      printf("1:Insert\n");
      printf("2:Delete\n");
```

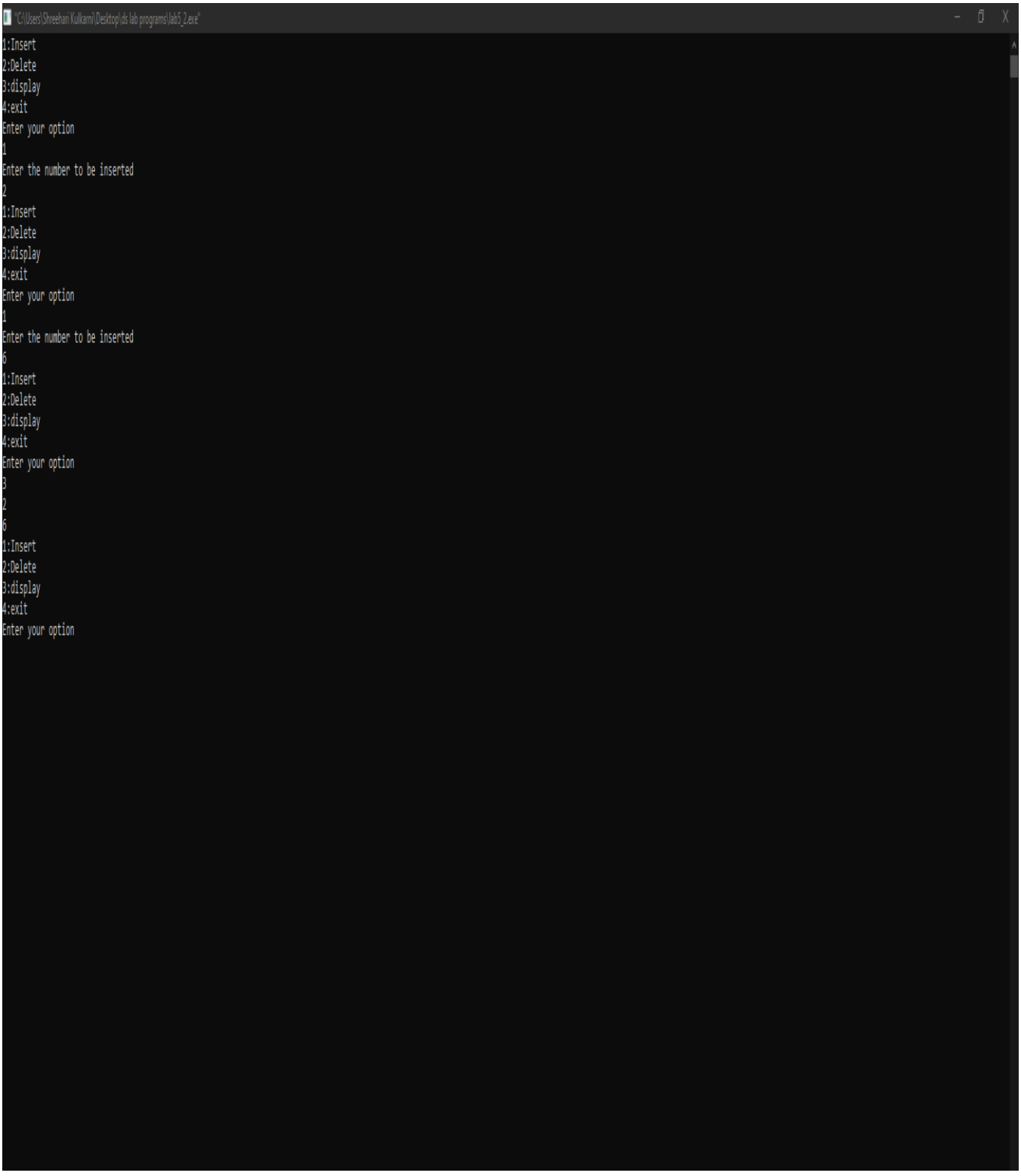
```
        printf("3:display\n");
        printf("4:exit\n");
        printf("Enter your option\n");
        scanf("%d",&option);
        switch(option)
        {
        case 1:
            insert();
            break;
        case 2:
            val=del();
            if(val!=-1)
                printf("Item Deleted is %d\n",val);
            break;
        case 3:
            display();
            break;
        case 4:
            exit(0);
        }

    }while(option!=4);
    return 0;
}
void insert()
{
```

```
int num;
printf("Enter the number to be inserted\n");
scanf("%d",&num);
if(front==0&&rear==max-1)
   printf("Overflow\n");
else if(front==-1&&rear==-1)
{
   front=0;
   rear=0;
   q[rear]=num;
}
else if(rear==max-1&&front!=0)
{
   rear=0;
   q[rear]=num;
}
else if(rear==max-1&&front!=0)
{
   rear=0;
   q[rear]=num;
}
else
{
   rear++;
   q[rear]=num;
}
```

```
}

int del()
{
   int val;
   if(front==-1&&rear==-1)
   {
      printf("UNDERFLOW\n");
      return -1;
   }
   val=q[front];
   if(front==rear)
   {
      front=-1;
      rear=-1;
   }
   else
   {
      if(front==max-1)
         front=0;
      else
         front++;
   }
   return val;
}
```

```
void display()
{
   if(front==-1&&rear==-1)
      printf("QUEUQ UNDERFLOW\n");
   else
   {
      if(front<rear)
      {
         for(int i=front;i<=rear;i++)
         {
            printf("%d\n",q[i]);
         }
      }
      else
      {
         for(int i=front;i<max;i++)
            printf("%d\n",q[i]);
         for(int i=0;i<=rear;i++)
            printf("%d\n",q[i]);
      }
   }
}
```

# 4: OUTPUT


"C:\Users\Shreehari Kulkarni\Desktop\ds lab programs\lab5_2.exe"
1:Insert
2:Delete
3:display
4:exit
Enter your option
1
Enter the number to be inserted
2
1:Insert
2:Delete
3:display
4:exit
Enter your option
1
Enter the number to be inserted
6
1:Insert
2:Delete
3:display
4:exit
Enter your option
3
2
6
1:Insert
2:Delete
3:display
4:exit
Enter your option

5: 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. c) Display the contents of the linked list.

6: 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.

7: WAP Implement Single Link List with following operations

a) Sort the linked list. b) Reverse the linked list. c) Concatenation of two linked lists

```
#include<stdio.h>
#include<string.h>
#include<math.h>
#include<malloc.h>
#include<stdlib.h>
struct node
{
   int item;
   struct node *next;
};
typedef struct node *Node;
Node getNode()
```

```
{
   Node x;
   x=(Node)malloc(sizeof(struct node));
   return x;
}
Node insert_front(Node first,int data)
{
   Node new_node;
   new_node=getNode();
   new_node->item=data;
   new_node->next=NULL;
   if(first==NULL)
   {
      return new_node;
   }
      new_node->next=first;
      first=new_node;
      return first;

}
Node insert_end(Node first,int data)
{
   Node last;
   Node new_node;
   new_node=getNode();
   new_node->item=data;
```

```
    new_node->next=NULL;
    if(first==NULL)
    {
       return new_node;
    }
    last=first;
    while(last->next!=NULL)
    {
      last=last->next;
    }
    last->next=new_node;
    return first;
}
Node insert_pos(Node first,int data,int pos)
{
    Node last;
    Node new_node;
    new_node=getNode();
    new_node->item=data;
    if(first==NULL&&pos==1)
    {
       new_node->next=NULL;
       return new_node;
    }
    else if(pos<1)
    {
```

```
        printf("Invalid Position\n");
        return first;
    }
    else if(pos==1)
    {
        new_node->next=first;
        first=new_node;
        return first;
    }
    else
    {
        last=first;
        for(int i=1;i<pos-1;i++)
        {
            last=last->next;
        }
        new_node->next=last->next;
        last->next=new_node;
        return first;
    }

}
Node delete_front(Node first)
{
    Node temp;
    if(first==NULL)
```

```
    {
        printf("List Is Empty Cannot be deleted\n");
        return first;
    }
    temp=first;
    temp=temp->next;
    free(first);
    return temp;
}
Node delete_end(Node first)
{
    Node prev,cur;
    if(first==NULL)
    {
        printf("List Is Empty And Cannot be deleted\n");
        return first;
    }
    cur=first;
    while(cur->next!=NULL)
    {
        prev=cur;
        cur=cur->next;
    }
    prev->next=NULL;
    free(cur);
    return first;
```

```
}
Node delete_pos(Node first,int pos)
{
   Node prev,cur;
   if(first==NULL)
   {
      printf("List is empty and cannot be deleted\n");
      return first;
   }
   if(pos==1)
   {
      cur=first;
      first=first->next;
      free(cur);
      return first;
   }
   cur=first;
   for(int i=1;i<pos;i++)
   {
      prev=cur;
      cur=cur->next;
   }
   prev->next=cur->next;
   free(cur);
   return first;
}
```

```
void display(Node first)
{

   Node temp;
   if(first==NULL)
   {
      printf("List Is Empty\n");
   }
   for(temp=first;temp!=NULL;temp=temp->next)
   {
      printf("%d\n",temp->item);
   }
}
Node reverse(Node first)
{
   Node cur,prev,temp;
   if(first==NULL)
   {
      printf("List Is Empty\n");
      return first;
   }
   cur=NULL;
   while(first!=NULL)
   {
     temp=first;
     first=first->next;
```

```
      temp->next=cur;
      cur=temp;
    }
    return cur;
}
Node delete_specific(Node first,int key)
{
    Node cur,prev;
    if(first->item==key)
    {
        Node temp=first;
        temp=temp->next;
        free(first);
        return temp;
    }
    cur=first;
    while(cur->item!=key)
    {
        prev=cur;
        cur=cur->next;
    }
    prev->next=cur->next;
    free(cur);
    return first;
}
void sort(Node first)
```

```
{
   int t;
   Node temp;
   if(first==NULL)
   {
      printf("List Is Empty\n");
      return;
   }
   for(Node i=first;i!=NULL;i=i->next)
   {
      for(Node j=i->next;j!=NULL;j=j->next)
      {
         if((i->item)>(j->item))
         {
            t=i->item;
            i->item=j->item;
            j->item=t;
         }
         if((i->item)==(j->item))
         {
            first=delete_specific(first,j->item);
            break;
         }

      }
   }
```

```
}
Node concat(Node first,Node second)
{
   Node cur;
   if(first==NULL)
   {
      first=second;
      return first;
   }
   if(second==NULL)
   {
      return first;
   }

      cur=first;
      while(cur->next!=NULL)
      {
         cur=cur->next;
      }
      cur->next=second;
      printf("Final Concatinated List is \n");
      return first;
}
Node merged_sort(Node a,Node b)
{
   Node result;
```

```
    if(a==NULL)
    {
       return b;
    }
    else if(b==NULL)
    {
       return b;
    }
    if(a->item<=b->item)
    {
       result=a;
       result->next=merged_sort(a->next,b);
    }
    else
    {
       result=b;
       result->next=merged_sort(a,b->next);
    }
    return result;
}
Node order_list(Node first,int data)
{
    Node new_node;
    Node prev,cur;
    new_node=getNode();
    new_node->item=data;
```

```
    if(data<first->item)
    {
       new_node->next=first;
       first=new_node;
       return first;
    }
    cur=first;
    prev=NULL;
    while(cur!=NULL&&cur->item<data)
    {
       prev=cur;
       cur=cur->next;
    }
    prev->next=new_node;
    new_node->next=cur;
    return first;
}

int main()
{
    Node first=NULL;
    Node a= NULL;
    Node b=NULL;
    Node ans=NULL;
    int choice,val,pos,n;
    do
```

```
{
   printf("1:Insert at Front\n");
   printf("2:Insert at End\n");
   printf("3:Insert at Specified Position\n");
   printf("4:Delete Front\n");
   printf("5:Delete End\n");
   printf("6:Delete At Specified Position\n");
   printf("7:Display\n");
   printf("8:Reverse the list\n");
   printf("9:Sort the List\n");
   printf("10:Concat\n");
   printf("11: Ordered List\n");
   printf("12: Merged Sort\n");
   printf("13: Exit\n");*/
   printf("Enter your choice\n");
   scanf("%d",&choice);
   switch(choice)
   {
   case 1:
      printf("Enter the Value To Be Inserted\n");
      scanf("%d",&val);
      first=insert_front(first,val);
      break;
   case 2:
      printf("Enter the Value\n");
      scanf("%d",&val);
```

```
        first=insert_end(first,val);
        break;
    case 3:
        printf("Enter the Value\n");
        scanf("%d",&val);
        printf("Enter the position to be inserted\n");
        scanf("%d",&pos);
        first=insert_pos(first,val,pos);
        break;
    case 4:
        first=delete_front(first);
        break;
    case 5:
        first=delete_end(first);
        break;
    case 6:
        printf("Enter the position from which element has to be deleted\n");
        scanf("%d",&pos);
        first=delete_pos(first,pos);
        break;
    case 7:
        display(first);
        break;
    case 8:
        first=reverse(first);
        break;
```

```
case 9:
    sort(first);
    break;
case 10:
    printf("Enter the Number of nodes In List 1\n");
    scanf("%d",&n);
    for(int i=0;i<n;i++)
    {
        printf("Enter the Item To Be Inserted\n");
        scanf("%d",&val);
        a=insert_end(a,val);
    }
    printf("Enter the Number of nodes In List 2\n");
    scanf("%d",&n);
    for(int i=0;i<n;i++)
    {
        printf("Enter the Item To Be Inserted\n");
        scanf("%d",&val);
        b=insert_end(b,val);
    }
    a=concat(a,b);
    display(a);
    break;
case 11:
    printf("Enter the Value\n");
    scanf("%d",&val);
```

```
        first=order_list(first,val);
        break;

    case 12:
        printf("Enter the Number of Nodes in  The List \n");
        scanf("%d",&n);
        printf("Enter the Items In Ascending order for list 1\n");
        for(int i=0;i<n;i++)
        {
            printf("Enter the item %d to be inserted at List 1 \n",(i+1));
            scanf("%d",&val);
            a=insert_end(a,val);
        }
        printf("Enter the item in ascending order for list 2\n");
        for(int i=0;i<n;i++)
        {
            printf("Enter the item %d to be inserted at List 1 \n",(i+1));
            scanf("%d",&val);
            b=insert_end(b,val);
        }
        ans=merged_sort(a,b);
        display(ans);
        break;

    }
}while(choice!=13);
```

}

# OUTPUT:


"C:\Users\Shreehari Kulkarni\OneDrive\Desktop\LAB SUBJECT\DS LAB\final_linked_list.exe"
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
Enter your choice
1
Enter the Value To Be Inserted
15
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
Enter your choice
1
Enter the Value To Be Inserted
25
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
Enter your choice
2
Enter the Value
35
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
Enter your choice
2
Enter the Value
59
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
Enter your choice
7
25
15
35
59
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position


"C:\Users\Shreehari Kulkarni\OneDrive\Desktop\LAB SUBJECT\DS LAB\final_linked_list.exe"
7:Display
Enter your choice
4
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
Enter your choice
7
15
15
59
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
Enter your choice
5
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
Enter your choice
7
15
35
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
Enter your choice


"C:\Users\Shreehari Kulkarni\OneDrive\Desktop\LAB SUBJECT\DS LAB\final_linked_list.exe"
Enter your choice
7
45
15
10
4
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
8:Reverse the list
9:Sort the List
10:Concat
11: Ordered List
12: Merged Sort
13: Exit
Enter your choice
9
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
8:Reverse the list
9:Sort the List
10:Concat
11: Ordered List
12: Merged Sort
13: Exit
Enter your choice
7
4
15
25
30
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
8:Reverse the list
9:Sort the List
10:Concat
11: Ordered List
12: Merged Sort
13: Exit
Enter your choice
8
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
8:Reverse the list


"C:\Users\Shreeharı Kulkarnı\OneDrive\Desktop\LAB SUBJECT\DS LAB\final_linked_list.exe"
6:Delete At Specified Position
7:Display
8:Reverse the list
9:Sort the List
10:Concat
11: Ordered List
12: Merged Sort
13: Exit
Enter your choice
1
10
25
15
4
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
8:Reverse the list
9:Sort the List
10:Concat
11: Ordered List
12: Merged Sort
13: Exit
Enter your choice
12
Enter the Number of Nodes in The List
2
Enter the Items In Ascending order for list 1
Enter the item 1 to be inserted at List 1
5
Enter the item 2 to be inserted at List 1
10
Enter the item in ascending order for list 2
Enter the item 1 to be inserted at List 1
2
Enter the item 2 to be inserted at List 1
7
2
5
7
1:Insert at Front
2:Insert at End
3:Insert at Specified Position
4:Delete Front
5:Delete End
6:Delete At Specified Position
7:Display
8:Reverse the list
9:Sort the List
10:Concat
11: Ordered List
12: Merged Sort
13: Exit
Enter your choice
7
10
25
15
4

## 8: WAP to implement Stack & Queues using Linked Representation

```
#include<stdio.h>
#include<math.h>
#include<stdlib.h>
#include<string.h>
struct node
{
   int item;
   struct node *next;
};
typedef struct node *Node;
Node getNode()
{
   Node x;
   x=(Node)malloc(sizeof(struct node));
   return x;
}
Node insert_front(Node first,int data)
{
   Node new_node;
   new_node=getNode();
   new_node->item=data;
   new_node->next=NULL;
```

```
    if(first==NULL)
    {
       return new_node;
    }
       new_node->next=first;
       first=new_node;
       return first;

}
Node insert_end(Node first,int data)
{
    Node last;
    Node new_node;
    new_node=getNode();
    new_node->item=data;
    new_node->next=NULL;
    if(first==NULL)
    {
       return new_node;
    }
    last=first;
    while(last->next!=NULL)
    {
      last=last->next;
    }
    last->next=new_node;
```

```
    return first;
}
Node delete_front(Node first)
{
    Node temp;
    if(first==NULL)
    {
        printf("List Is Empty Cannot be deleted\n");
        return first;
    }
    temp=first;
    temp=temp->next;
    free(first);
    return temp;
}
Node delete_end(Node first)
{
    Node prev,cur;
    if(first==NULL)
    {
        printf("List Is Empty And Cannot be deleted\n");
        return first;
    }
    cur=first;
    while(cur->next!=NULL)
    {
```

```
        prev=cur;
        cur=cur->next;
    }
    prev->next=NULL;
    free(cur);
    return first;
}
void display(Node first)
{

    Node temp;
    if(first==NULL)
    {
        printf("List Is Empty\n");
    }
    for(temp=first;temp!=NULL;temp=temp->next)
    {
        printf("%d\n",temp->item);
    }
}
void stack()
{
    int choice,data;
    Node head=NULL;
    printf("STACK IS IMPLEMENTED INSERT REARE AND DELETE
REAR\n");
```

```
    do{
    printf("1:INSERT REAR\n");
    printf("2:DELETE REAR\n");
    printf("3:DISPLAY\n");
    printf("4:EXIT\n");
    printf("Enter Your Choice\n");
    scanf("%d",&choice);
    switch(choice)
    {

    case 1:
       printf("Enter The Data To Be Inserted\n");
       scanf("%d",&data);
       head=insert_end(head,data);
       break;
    case 2:
       head=delete_end(head);
       break;
    case 3:
       display(head);
       break;
    }

    }while(choice!=4);

}
```

```
void q()
{
   int choice,data;
   Node head=NULL;
   printf("QUEUE IS IMPLEMENTED INSERT FRONT AND DELETE
FRONT\n");
   do{
   printf("1:INSERT FRONT\n");
   printf("2:DELETE FRONT\n");
   printf("3:DISPLAY\n");
   printf("4:EXIT\n");
   printf("Enter Your Choice\n");
   scanf("%d",&choice);
   switch(choice)
   {

   case 1:
      printf("Enter The Data To Be Inserted\n");
      scanf("%d",&data);
      head=insert_front(head,data);
      break;
   case 2:
      head=delete_front(head);
      break;
   case 3:
      display(head);
```

```
        break;
    }

    }while(choice!=4);

}
int main()
{

    int option;
    printf("1:STACK\n");
    printf("2:QUEUE\n");
    printf("3:EXIT\n");
    printf("Enter Your Choice\n");
    scanf("%d",&option);
    switch(option)
    {
    case 1:
        stack();
        break;
    case 2:
        q();
        break;
    case 3:
        exit(0);
        break;
```

```
    }
}
```

# OUTPUT:

# STACK-OUTPUT:

# QUEUE-OUTPUT:

## 9: WAP 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. c) Display the contents of the list

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
#include<ctype.h>
struct node
{
   int info;
   struct node *prev;
   struct node *next;
};
typedef struct node *NODE;
NODE getnode()
{

   NODE x=(NODE)malloc(sizeof(struct node));
   return x;
}
NODE insert_front(NODE head,int item)
```

```
{
   NODE new_node,cur;
   new_node=getnode();
   new_node->info=item;
   cur=head->next;
   head->next=new_node;
   new_node->prev=head;
   new_node->next=cur;
   cur->prev=new_node;
   return head;
}
NODE insert_rear(NODE head,int item)
{
   NODE new_node,cur;
   new_node=getnode();
   new_node->info=item;
   cur=head->prev;
   cur->next=new_node;
   new_node->prev=cur;
   new_node->next=head;
   head->prev=new_node;
   return head;
}
NODE insert_leftpos(NODE head,int key,int item)
{
   int flag=1;
```

```
NODE new_node,cur;
new_node=getnode();
new_node->info=item;
cur=head->next;
if(cur->info==key)
{
   new_node->next=cur;
   head->next=new_node;
   new_node->prev=head;
   cur->prev=new_node;
   return head;
   flag=0;
}
else
{
  while(cur->info!=key&&cur!=head)
  {

     cur=cur->next;
      if(cur->info==key)
      {
         flag=0;
      }
  }
  if(flag==0)
  {
```

```
        (cur->prev)->next=new_node;
        new_node->prev=cur->prev;
        new_node->next=cur;
        cur->prev=new_node;
        return head;
       }
       else
       {
          printf("Invalid Key\n");
          return head;
       }

    }
}
NODE insert_rightpos(NODE head,int key,int item)
{
    int flag=1;
    NODE new_node;
    new_node=getnode();
    new_node->info=item;
    NODE cur;
    cur=head->next;
    if(cur->info==key)
    {
        new_node->next=cur->next;
        (cur->next)->prev=new_node;
```

```
    new_node->prev=cur;
    cur->next=new_node;
    flag=0;
    return head;

}
if((cur->info==key)&&(cur->next==head))
{
    cur->next=new_node;
    new_node->prev=cur;
    new_node->next=head;
    head->prev=new_node;
    flag=0;
    return head;
}
while(cur->info!=key)
{
    cur=cur->next;
    if(cur->info==key)
    {
        flag=0;
    }
}
if(flag==0)
{
    new_node->next=cur->next;
```

```
        cur->next=new_node;
        (cur->next)->prev=new_node;
        new_node->prev=cur;
        return head;
    }
    else
    {
        printf("KEY NOT FOUNF\n");
        return head;
    }

}
NODE delete_front(NODE head)
{
    if(head->next==head)
    {
        printf("List Is Empty\n");
        return head;
    }
    NODE temp;
    temp=head->next;
    head->next=temp->next;
    (temp->next)->prev=head;
    free(temp);
    return head;
}
```

```
NODE delete_rear(NODE head)
{
   if(head->next==head)
   {
      printf("List Is Empty\n");
      return head;
   }
   NODE cur;
   cur=head->prev;
   (cur->prev)->next=head;
   head->prev=cur->prev;
   free(cur);
   return head;
}
NODE delete_all(NODE head)
{
   NODE temp;
   for(NODE i=head->next;i!=head;i=i->next)
   {
      for(NODE j=i->next;j!=head;j=j->next)
      {
         if(i->info==j->info)
         {
            temp=j;
            (j->prev)->next=j->next;
            if(j->next!=head)
```

```
            {
               j->next->prev=j->prev;
            }
            temp=NULL;
           // temp=NULL;
         }
      }
   }
}
void display(NODE head)
{
   if(head->next==head)
   {
      printf("List Is Empty\n");
      return;
   }
   NODE cur=head->next;
   while(cur!=head)
   {
      printf("%d\n",cur->info);
      cur=cur->next;
   }
}
void search(NODE head,int key)
{
   NODE cur;
```

```
int i=1;
int flag=0;
if((head->next)->info==key)
{
   flag=1;
   printf("Element Found At Position %d\n " + i);
   return;
}
cur=head->next;
while(cur->info!=key&&cur->next!=head)
{
   cur=cur->next;
   i++;
   if(cur->info==key)
   {
      flag=1;
      break;
   }
}
if(flag==1)
{
   printf("Element Found At %d\n",i);
}
else
{
   printf("Element Not Found\n");
```

```
    }

}
int main()
{
    NODE head=getnode();
    head->next=head;
    head->prev=head;
    int option,item,key;
    do{
    printf("1:Insert At Front\n");
    printf("2:Insert At End\n");
    printf("3:Delete Front\n");
    printf("4:Delete Rear\n");
    printf("5:Display\n");
    printf("6:Insert left\n");
    printf("7:Insert Right\n");
    printf("8:Delete Duplicates\n");
    printf("9:Search For Element\n");
    printf("Enter Your Choice\n");
    scanf("%d",&option);
    switch(option)
    {
    case 1:
       printf("Enter the item\n");
       scanf("%d",&item);
```

```
    head=insert_front(head,item);
    break;
case 2:
    printf("Enter the item\n");
    scanf("%d",&item);
    head=insert_rear(head,item);
    break;
case 3:
    head=delete_front(head);
    break;
case 4:
    head=delete_rear(head);
    break;
case 5:
    display(head);
    break;
case 6:
    printf("Enter the key Element\n");
    scanf("%d",&key);
    printf("Enter the Item\n");
    scanf("%d",&item);
    head=insert_leftpos(head,key,item);
    break;
case 7:
    printf("Enter the key Element\n");
    scanf("%d",&key);
```

```
        printf("Enter the item\n");
        scanf("%d",&item);
        head=insert_rightpos(head,key,item);
        break;
    case 8:
        head=delete_all(head);
        break;
    case 9:
        printf("Enter the Element To Be Searched\n");
        scanf("%d",&key);
        search(head,key);
        break;
    }
    }while(option!=10);
}
```

# OUTPUT


"C:\Users\Shreehari Kulkarni\OneDrive\Desktop\LAB SUBJECT\DS LAB\doublylinkedlist.exe"
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice
1
enter the item at front end
25
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice
1
enter the item at front end
50
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice
1
enter the item at front end
75
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice
1
enter the item at front end
100
1:insert front
2:insert rear


"C:\Users\Shreehari Kulkarni\OneDrive\Desktop\LAB SUBJECT\DS LAB\doublylinkedlist.exe"
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice
1
enter the item at front end
125
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice
5
contents of dq
125
100
75
50
25
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice
8
enter the key item
100
enter towards left of 100-5
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice
5
contents of dq
125


"C:\Users\Shreehari Kulkarni\OneDrive\Desktop\LAB SUBJECT\DS LAB\doublylinkedlist.exe"
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice
9
enter the key item
100
enter towards right of 100=10
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice
5
contents of dq
125
5
100
10
75
50
25
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice
8
Enter item which you want to search?
100
item found at location 3
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates


"C:\Users\Shreehari Kulkarni\OneDrive\Desktop\LAB SUBJECT\DS LAB\doublylinkedlist.exe"
Enter item which you want to search?
100
item found at location 3
1:insert front
2:insert rear
3:delete front
4:delete rear
5:display
6:Insert Left
7: remove duplicates
8: Search
9:Insert Right
10:Exit
enter the choice

## 10: 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<math.h>
#include<string.h>
#include<stdlib.h>
struct node
{
   int data;
   struct node *left;
   struct node *right;
};
typedef struct node *NODE;

NODE getnode(int data)
{
   NODE x=(NODE)malloc(sizeof(struct node));
   x->data=data;
   x->right=NULL;
   x->left=NULL;
   return x;
```

```
}
NODE insert(NODE root,int info)
{

   if(root==NULL)
   {
      root=getnode(info);
      return root;
   }
   else if(info<=root->data)
   {
      root->left=insert(root->left,info);
   }
   else
   {
      root->right=insert(root->right,info);
   }
   return root;
}
void preorder(NODE root)
{
   if(root==NULL)
      return;
   printf("%d\t",root->data);
   preorder(root->left);
   preorder(root->right);
```

```
}
void inorder(NODE root)
{
   if(root==NULL)
      return;
   inorder(root->left);
   printf("%d\t",root->data);
   inorder(root->right);
}
void postorder(NODE root)
{
   if(root==NULL)
      return;
   postorder(root->left);
   postorder(root->right);
   printf("%d\t",root->data);
}
NODE findmin(NODE root)
{
   if(root==NULL)
   {
      return NULL;
   }
   else if(root->left==NULL)
   {
      return root;
```

```
    }
    return findmin(root->left);
}
NODE findmax(NODE root)
{
    if(root==NULL)
        return NULL;
    else if(root->right==NULL)
        return root;
    return findmax(root->right);
}
NODE delete_node(NODE root,int info)
{
    if(root==NULL)
    {
        return root;
    }
    else if(info<root->data)
    {
        root->left=delete_node(root->left,info);
    }
    else if(info>root->data)
    {
        root->right=delete_node(root->right,info);
    }
    else
```

```
{
   if(root->left==NULL&&root->right==NULL)
   {
     free(root);
     root=NULL;
     return root;
   }
   else if(root->left==NULL)
   {
      NODE temp=root;
      root=root->left;
      free(temp);
      return root;
   }
   else if(root->right==NULL)
   {
      NODE temp=root;
      root=root->right;
      free(temp);
      return root;
  }
  else
  {
      NODE temp=findmin(root->right);
      root->data=temp->data;
      root->right=delete_node(root->right,temp->data);
```

```
            return root;
        }
    }
}
void display(NODE root,int i)
{
    if(root==NULL)
        return;
    display(root->right,i+1);
    for(int j=1;j<=i;j++)
        printf(" ");
    printf("%d\n",root->data);
    display(root->left,i+1);
}
int getleafcount(NODE root)
{
    NODE current=root;
    if(current==NULL)
        return 0;
    else if(current->right==NULL&&current->left==NULL)
        return 1;
    else
        return (getleafcount(current->left)+getleafcount(current->right));
}
int height(NODE root)
{
```

```
    if(root==NULL)
        return -1;
    int left_height=height(root->left);
    int right_height=height(root->right);
    if(left_height>right_height)
        return left_height+1;
    else
        return right_height+1;
}
NODE search(NODE root,int key)
{
    if(root==NULL)
        return NULL;
    if(root->data==key)
        return root;
    else if(key<root->data)
        search(root->left,key);
    else if(key>root->data)
        search(root->right,key);
    else
        printf("Search UnSuccessfull\n");
}
NODE inorder_successor(NODE root,int data)
{
    if(root==NULL)
    {
```

```
    printf("Tree Empty\n");
    return root;
}
NODE current=search(root,data);
//NODE current=root;
if(current==NULL)
   return NULL;
if(current->right!=NULL)
{
    NODE temp=findmin(current->right);
}
else
{
    NODE successor=NULL;
    NODE ancestor=root;
    while(current!=ancestor)
    {
        if(current->data<ancestor->data)
        {
            successor=ancestor;
            ancestor=ancestor->left;
        }
        else
        {
            ancestor=ancestor->right;
        }
```

```
        }
        return successor;
    }
}
int main()
{
    NODE root=NULL;
    NODE value=NULL;
    int data,option,ans;
    do{
    printf("1:Insert\n");
    printf("2:Delete\n");
    printf("3:Preorder\n");
    printf("4:PostOrder\n");
    printf("5:Inorder\n");
    printf("6:Display\n");
    printf("7:Height Of Tree\n");
    printf("8:Find Maximum\n");
    printf("9:Search\n");
    printf("10:In Order Successor\n");
    printf("11:Exit\n");
    printf("Enter Your Choice\n");
    scanf("%d",&option);
    switch(option)
    {
    case 1:
```

```
    printf("Enter The Data To Be Inserted\n");
    scanf("%d",&data);
    root=insert(root,data);
    break;
case 2:
    printf("Enter the Data To Be Deleted\n");
    scanf("%d",&data);
    root=delete_node(root,data);
    break;
case 3:
    preorder(root);
    printf("\n");
    break;
case 4:
    postorder(root);
    printf("\n");
    break;
case 5:
    inorder(root);
    printf("\n");
    break;
case 6:
    display(root,1);
    break;
case 7:
    ans=height(root);
```

```
        printf("Height Of Tree Is %d\n",ans);
        break;
    case 8:
        value=findmax(root);
        printf("Maximum Value is%d\n",value->data);
        break;
    case 9:
        printf("Enter the Key Value To Be Searched\n");
        scanf("%d",&data);
        value=search(root,data);
        if(root!=NULL)
            printf("Search SuccessFull\n");
        else
            printf("Search Unsuccesfull\n");
        break;
    case 10:
        printf("Enter the key value whose successor you want to find\n");
        scanf("%d",&data);
        root=inorder_successor(root,data);
        printf("Successor is %d\n",root->data);

    }
    }while(option!=11);
}
```

# OUTPUT:


"C:\Users\Shreehari Kulkarni\OneDrive\Desktop\LAB SUBJECT\DS LAB\binarysearchtree.exe"
1:Insert
2:Delete
3:Preorder
4:PostOrder
5:Inorder
6:Display
7:Height Of Tree
8:Find Maximum
9:Search
10:In Order Successor
11:Exit
Enter Your Choice
1
Enter The Data To Be Inserted
15
1:Insert
2:Delete
3:Preorder
4:PostOrder
5:Inorder
6:Display
7:Height Of Tree
8:Find Maximum
9:Search
10:In Order Successor
11:Exit
Enter Your Choice
1
Enter The Data To Be Inserted
10
1:Insert
2:Delete
3:Preorder
4:PostOrder
5:Inorder
6:Display
7:Height Of Tree
8:Find Maximum
9:Search
10:In Order Successor
11:Exit
Enter Your Choice
1
Enter The Data To Be Inserted
25
1:Insert
2:Delete
3:Preorder
4:PostOrder
5:Inorder
6:Display
7:Height Of Tree
8:Find Maximum
9:Search
10:In Order Successor
11:Exit
Enter Your Choice
1
Enter The Data To Be Inserted
35
1:Insert
2:Delete
3:Preorder


"C:\Users\Shreehari Kulkarni\OneDrive\Desktop\LAB SUBJECT\DS LAB\binarysearchtree.exe"
1:Insert
2:Delete
3:Preorder
4:PostOrder
5:Inorder
6:Display
7:Height Of Tree
8:Find Maximum
9:Search
10:In Order Successor
11:Exit
Enter Your Choice
6
35
25
15
10
1:Insert
2:Delete
3:Preorder
4:PostOrder
5:Inorder
6:Display
7:Height Of Tree
8:Find Maximum
9:Search
10:In Order Successor
11:Exit
Enter Your Choice
3
15 10 25 35
1:Insert
2:Delete
3:Preorder
4:PostOrder
5:Inorder
6:Display
7:Height Of Tree
8:Find Maximum
9:Search
10:In Order Successor
11:Exit
Enter Your Choice
4
10 35 25 15
1:Insert
2:Delete
3:Preorder
4:PostOrder
5:Inorder
6:Display
7:Height Of Tree
8:Find Maximum
9:Search
10:In Order Successor
11:Exit
Enter Your Choice
5
10 15 25 35
1:Insert
2:Delete
3:Preorder
4:PostOrder