VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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

B.M.S. COLLEGE OF ENGINEERING
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Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by **SWAPNIL SAHIL (1BM22CS300)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2023-24. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab - **(23CS3PCDST)**work prescribed for the said degree.

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Index Sheet

Course outcomes:

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

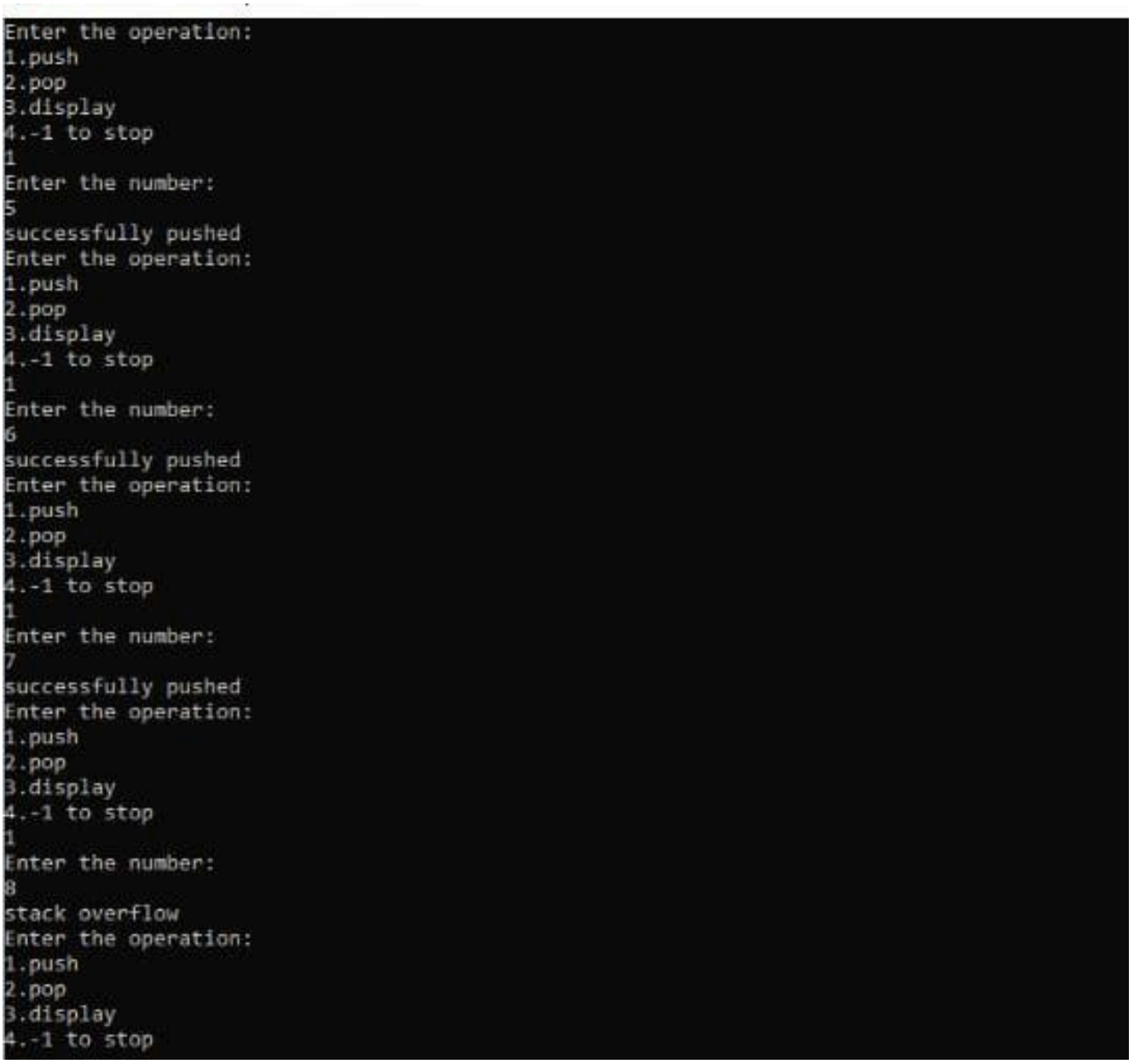
Lab program 1:

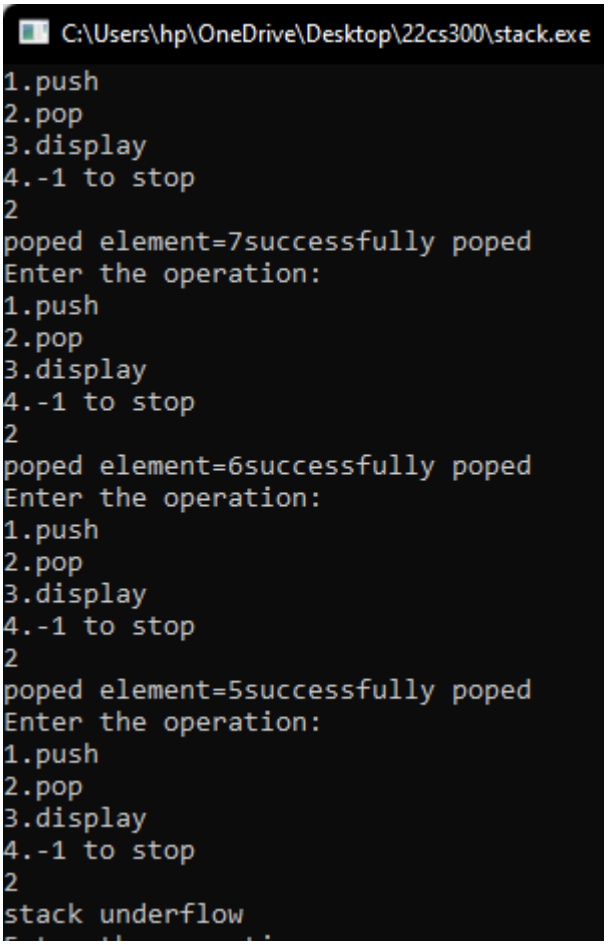
Write a program to simulate the working of stack using an array with the following:
a) Push
b) Pop
c) Display
The program should print appropriate messages for stack overflow, stack underflow.

```
#include<stdio.h>
#include<stdlib.h>
#define N 10

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

void push(int var);
void pop();
void display();

void main()
{
   int choice,num;

   while(1){
         printf("Enter the operation:\n1.push\n2.pop\n3.display\n4.-1 to stop\n");
         scanf("%d",&choice);
      if(choice==-1){
         printf("operation completed.\n");
         break;
      }
      else{
         switch(choice)
         {
            case 1:printf("Enter the number:\n");
```

```
                scanf("%d",&num);
                push(num);
                break;
            case 2:pop();
                break;
            case 3:display();
                break;

            default:printf("invalid input");

        }
    }
  }
}

void push(int var)
{
  if(top==N-1)
  {
    printf("stack overflow\n");
  }
  else{
    top++;
    stack[top]=var;
    printf("successfully pushed\n");
  }
}

void pop()
{
  if(top==-1)
  {
    printf("stack underflow\n");
  }
  else{
    printf("poped element=%d",stack[top]);
    printf("successfully poped\n");
    top--;
  }
}

void display()
{
  int i;
  for(i=top;i>=0;i--)
  {
    printf("%d",stack[i]);
  }
}
```

Output:


Enter the operation:
1.push
2.pop
3.display
4.-1 to stop
1
Enter the number:
5
successfully pushed
Enter the operation:
1.push
2.pop
3.display
4.-1 to stop
1
Enter the number:
6
successfully pushed
Enter the operation:
1.push
2.pop
3.display
4.-1 to stop
1
Enter the number:
7
successfully pushed
Enter the operation:
1.push
2.pop
3.display
4.-1 to stop
1
Enter the number:
8
stack overflow
Enter the operation:
1.push
2.pop
3.display
4.-1 to stop


C:\Users\hp\OneDrive\Desktop\22cs300\stack.exe
1.push
2.pop
3.display
4.-1 to stop
2
poped element=7successfully poped
Enter the operation:
1.push
2.pop
3.display
4.-1 to stop
2
poped element=6successfully poped
Enter the operation:
1.push
2.pop
3.display
4.-1 to stop
2
poped element=5successfully poped
Enter the operation:
1.push
2.pop
3.display
4.-1 to stop
2
stack underflow

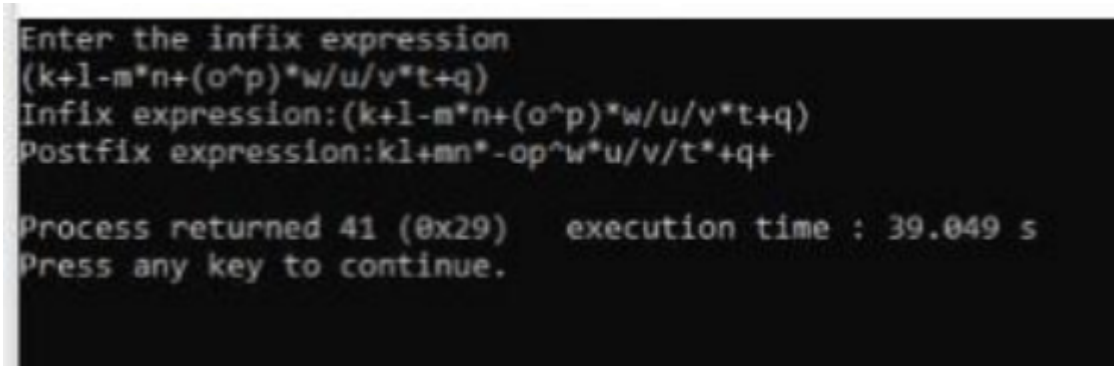
Lab program 2:

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<string.h>
int index1=0,pos=0,top=-1,length;
char symbol,temp,infix[50],postfix[50],stack[50];
void infixtopostfix();
void push(char symbol);
char pop();
int pred(char symb);
void main(){
  printf("Enter the infix expression\n");
  scanf("%s",infix);
  infixtopostfix();
  printf("Infix expression:%s\n",infix);
  printf("Postfix expression:%s\n",postfix);
}
void infixtopostfix(){
  length=strlen(infix);
  push('#');
  while(index1<length){
    symbol=infix[index1];
    switch(symbol){
      case '(':push(symbol);
               break;
      case ')':temp=pop();
               while(temp!='('){
                 postfix[pos]=temp;
                 pos++;
                 temp=pop();
               }
               break;
      case '+':
      case '-':
      case '*':
      case '/':
      case '^':while(pred(stack[top])>=pred(symbol)){
        temp=pop();
        postfix[pos++]=temp;
      }
      push(symbol);
      break;
      default:postfix[pos++]=symbol;
    }
    index1++;
  }
```

```
  while(top>0){
    temp=pop();
    postfix[pos++]=temp;
  }
}
void push(char symbol){
  top++;
  stack[top]=symbol;
}
char pop(){
  char symb;
  symb=stack[top];
  top--;
  return(symb);
}
int pred(char symbol){
  int p;
  switch(symbol){
    case '^':p=3;
      break;
    case '*':
    case '/':p=2;
     break;
    case '+':
    case '-':p=1;
     break;
    case '(':p=0;
     break;
    case '#':p=-1;
     break;
  }
  return(p);
}
```

OUTPUT:



Lab program 3a:

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

a) Insert

b) Delete

c) Display

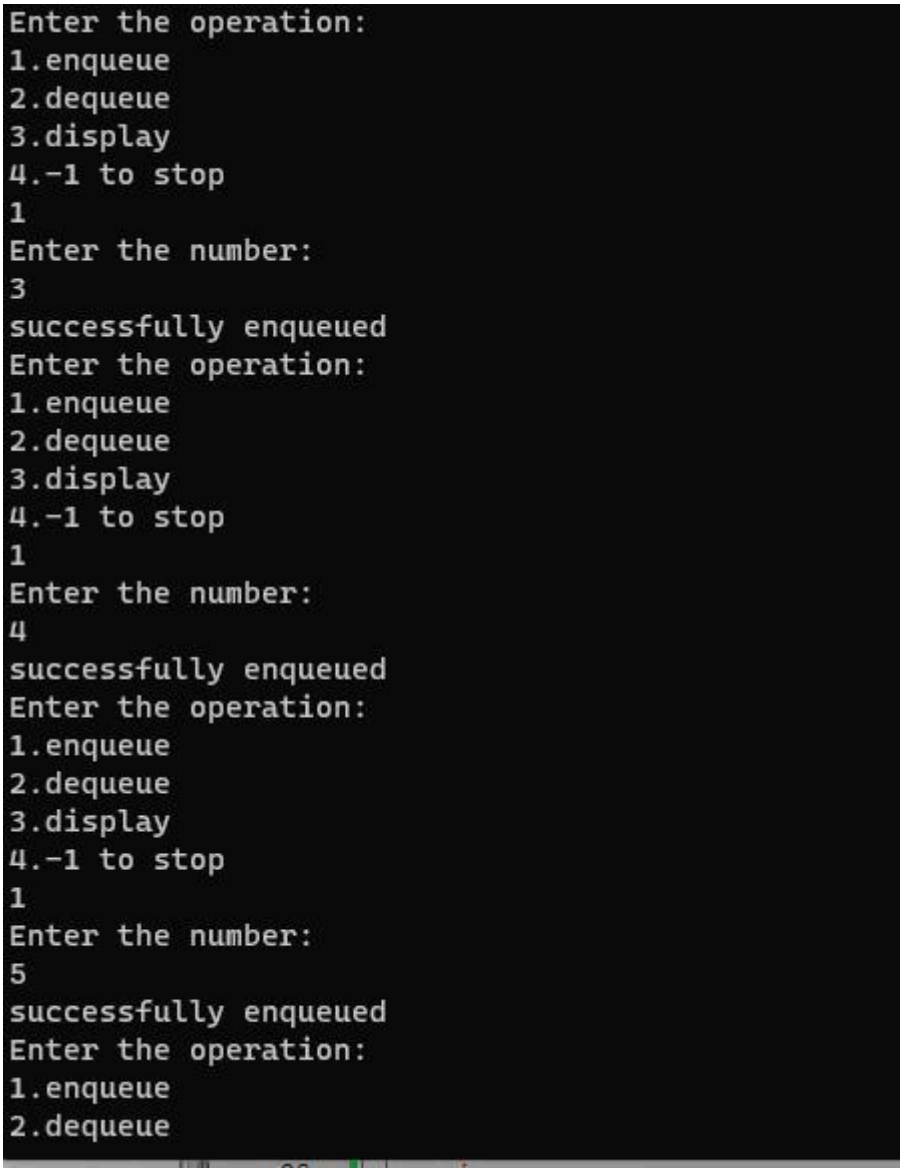
The program should print appropriate messages for queue empty and queue overflow conditions.

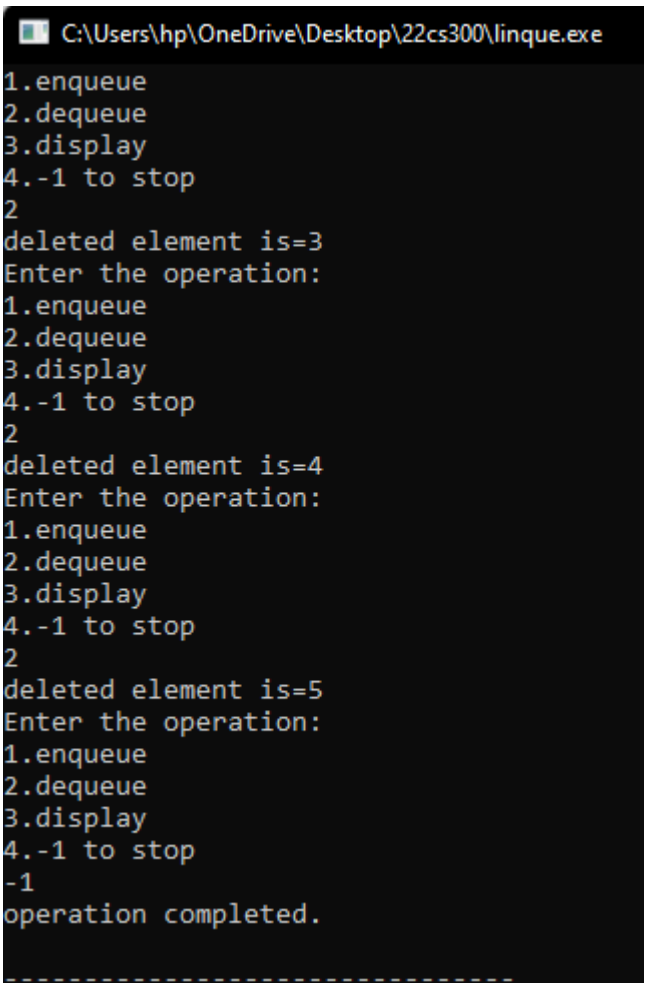
```
#include<stdio.h>
#define N 3

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

void enqueue(int x)
{
	if(rear==N-1)
	{
		printf("queue overflow\n");
	}
	else if(front==-1 && rear==-1)
	{
		front=rear=0;
		queue[rear]=x;
		printf("successfully enqueued\n");
	}
	else
	{
		rear++;
		queue[rear]=x;
		printf("successfully enqueued\n");
	}
}

void dequeue()
{
	if(front==-1)
	{
		printf("queue underflow\n");
	}
	else if(front==rear)
	{
		printf("deleted element is=%d\n",queue[front]);
		front=rear=-1;
	}
```

```
        else
        {
                printf("deleted element is=%d\n",queue[front]);
                front++;
        }

}
void display()
{
        if(front==-1)
        {
                printf("queue is empty\n");
        }
        else
        {
                int i;
                printf("Elements are:\n");
                for(i=front;i<=rear;i++)
                {
                        printf("%d\n",queue[i]);
                }
        }

}

void main()
{
   int choice,num;

   while(1){
        printf("Enter the operation:\n1.enqueue\n2.dequeue\n3.display\n4.-1 to stop\n");
        scanf("%d",&choice);
      if(choice==-1){
        printf("operation completed.\n");
        break;
      }
      else{
        switch(choice)
        {
          case 1:printf("Enter the number:\n");
                scanf("%d",&num);
                enqueue(num);
                break;
          case 2:dequeue();
                break;
          case 3:display();
                break;

          default:printf("invalid input");
```

```
        }
      }
    }
}
```

OUTPUT:


Enter the operation:
1.enqueue
2.dequeue
3.display
4.-1 to stop
1
Enter the number:
3
successfully enqueued
Enter the operation:
1.enqueue
2.dequeue
3.display
4.-1 to stop
1
Enter the number:
4
successfully enqueued
Enter the operation:
1.enqueue
2.dequeue
3.display
4.-1 to stop
1
Enter the number:
5
successfully enqueued
Enter the operation:
1.enqueue
2.dequeue



Lab program 3b:

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<stdlib.h>

#define N 3
```

```
int queue[N],front=-1,rear=-1;

void enqueue(int x)
{
	if((rear+1)%N==front)
	{
		printf("queue overflow\n");
	}
	else if(front==-1 && rear==-1)
	{
		front=rear=0;
		queue[rear]=x;
		printf("successfully enqueued\n");
	}
	else
	{
		rear=(rear+1)%N;
		queue[rear]=x;
		printf("successfully enqueued\n");
	}
}

void dequeue()
{
	if(front==-1)
	{
		printf("queue underflow\n");
```

```
        }
        else if(front==rear)
        {
                printf("deleted element is=%d\n",queue[front]);
                front=rear=-1;
        }
        else
        {
                printf("deleted element is=%d\n",queue[front]);
                front=(front+1)%N;
        }

}
void display()
{
        if(front==-1)
        {
                printf("queue is empty\n");
        }
        else
        {
                int i;
                printf("Elements are:\n");
                for(i=front;i!=rear;i=(i+1)%N)
                {
                        printf("%d\n",queue[i]);
                }
```

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

}

void main()
{
   int choice,num;

   while(1){
        printf("Enter the operation:\n1.enqueue\n2.dequeue\n3.display\n4.-1 to stop\n");
        scanf("%d",&choice);
      if(choice==-1){
        printf("operation completed.\n");
        break;
      }
      else{
        switch(choice)
        {
          case 1:printf("Enter the number:\n");
                scanf("%d",&num);
                enqueue(num);
                break;
          case 2:dequeue();
                break;
          case 3:display();
                break;
```

```
        default:printf("invalid input");


            }
        }
    }
}
```

OUTPUT:

```
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 2
Inserted 2 into the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 3
Inserted 3 into the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 4
Inserted 4 into the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 5
Inserted 5 into the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 6
Inserted 6 into the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter element to enqueue: 7
Queue Overflow! Cannot insert element.
```

```
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue elements: 2 3 4 5 6

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 2 from the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 3 from the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 4 from the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 5 from the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 6 from the queue.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Queue Underflow! Cannot delete element.

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 4
Exiting...
```

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.

c) Display the contents of the linked list.

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

struct node{
        int data;
        struct node * next;
};
struct node *head=0,*newnode,*temp;
void create()
{
        int i,n;
        printf("Enter the no. of elements:\n");
        scanf("%d",&n);

        for(i=0;i<n;i++)
        {
                newnode=(struct node *)malloc(sizeof(struct node));
                printf("Enter the %d element :\n",i+1);
           scanf("%d",&newnode->data);
           newnode->next=0;

           if(head==0)
```

```
            {
                temp=head=newnode;
                }
                else
                {
                        temp->next=newnode;
                        temp=newnode;
                }
        }
}
void display()
{
   temp=head;
        printf("The elements are:\n");
        while(temp!=0)
        {
                printf("%d\n",temp->data);
                temp=temp->next;
                length++;
        }
}
void insert_beg()
{
        newnode=(struct node *)malloc(sizeof(struct node));
        printf("Enter the new element\n");
        scanf("%d",&newnode->data);
        newnode->next=head;
```

```
        head=newnode;


}
void insert_end()
{
        newnode=(struct node *)malloc(sizeof(struct node));
        printf("Enter the new element\n");
        scanf("%d",&newnode->data);
        newnode->next=0;
        temp=head;
        while(temp->next!=0)
        {
                temp=temp->next;
        }
        temp->next=newnode;
}
void insert_loc()
{
        int pos,i=0;
        newnode=(struct node *)malloc(sizeof(struct node));
        printf("Enter the position:\n");
        scanf("%d",&pos);


        if(pos<0)
        {
                printf("invalid position\n");
        }
```

```
        else
        {
                temp=head;
                while(i<pos)
                {
                        temp=temp->next;
                        i++;
                }
                printf("Enter the new element\n");
        scanf("%d",&newnode->data);
           newnode->next=temp->next;
           temp->next=newnode;


        }
}
void main()
{
        int choice;
        while(1)
        {
                printf("Enter operation:\n1.create\n2.display\n3.insert at beginning\n4.insert at
end\n5.insert after a location\n.-1 to end\n");
                scanf("%d",&choice);


                if(choice==-1)
                {
                        printf("operation completed!\n");
```

```
                break;
        }
        else
        {
                switch(choice)
                {
                        case 1:create();
                                break;
                   case 2:display();
                          break;
                   case 3:insert_beg();
                                break;
                        case 4:insert_end();
                                break;
                        case 5:insert_loc();
                                break;
                        default:printf("invalid input\n");
                }
        }
    }


}
```

OUTPUT:

```
Enter operation:
1.create
2.display
3.insert at beginnning
4.insert at end
5.insert at position
6.-1 to end
1
enter the number of elements:
2
Enter the element 1:
3
Enter the element 2:
4
Enter operation:
1.create
2.display
3.insert at beginnning
4.insert at end
5.insert at position
6.-1 to end
2
3
4
Enter operation:
1.create
2.display
3.insert at beginnning
4.insert at end
5.insert at position
6.-1 to end
3
Enter the new element:
5
Enter operation:
1.create
2.display
3.insert at beginnning
4.insert at end
5.insert at position
6.-1 to end
2
5
3
4
Enter operation:
1.create
2.display
3.insert at beginnning
4.insert at end
5.insert at position
```

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 *head=0,*newnode,*temp;
void create()
{
        int i,n;
        printf("Enter the no. of elements:\n");
        scanf("%d",&n);

        for(i=0;i<n;i++)
        {
                newnode=(struct node *)malloc(sizeof(struct node));
                printf("Enter the %d element :\n",i+1);
           scanf("%d",&newnode->data);
           newnode->next=0;

           if(head==0)
           {
                temp=head=newnode;
```

```
                }
                else
                {
                        temp->next=newnode;
                        temp=newnode;
                }
        }
}
void display()
{
   temp=head;
        printf("The elements are:\n");
        while(temp!=0)
        {
                printf("%d\n",temp->data);
                temp=temp->next;
                length++;
        }
}
void delete_beg()
{
        temp=head;
        if(head==0)
        {
                printf("empty");
        }
        else
        {
                head=temp->next;
```

```
                free(temp);
        }

}
void delete_end()
{
        temp=head;
        struct node *prenode;
        while(temp->next!=0)
        {
                prenode=temp;
                temp=temp->next;
        }
        if(temp=head)
        {
                head=0;
        }
        else
        {
                prenode->next=0;
        }
        free(temp);
}
void delete_pos()
{
        struct node *nextnode;
        int pos,i=1;
        temp=head;
        printf("enter position\n");
```

```
        scanf("%d",&pos);
        while(i<pos)
        {
                temp=temp->next;
                i++;
        }
        nextnode=temp->next;
        temp->next=nextnode->next;
        free(nextnode);
}

void main()
{
        int choice;
        while(1)
        {
                printf("Enter operation:\n1.create\n2.display\n3.delete at beginning\n4.delete at end\n5.delete at a location\n.-1 to end\n");
                scanf("%d",&choice);

                if(choice==-1)
                {
                        printf("operation completed!\n");
                        break;
                }
                else
                {
                        switch(choice)
                        {
                                case 1:create();
```

```
                    break;
                case 2:display();
                    break;
                case 3:delete_beg();
                    break;
                case 4:delete_end();
                    break;
                case 5:delete_loc();
                    break;
                default:printf("invalid input\n");
            }
        }
    }

}
```

OUTPUT:

```
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end
1
enter the number of elements:
4
Enter the element 1:
2
Enter the element 2:
3
Enter the element 3:
4
Enter the element 4:
5
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end
2
The elements are:
2
3
4
5
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end
3
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end
2
The elements are:
3
4
5
```

Lab program 6a:

WAP to 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>

struct node{
        int data;
        struct node * next;
};
struct node *head=0,*newnode,*temp;
int length=0;
void create()
{
        int i,n;
        printf("Enter the no. of elements:\n");
        scanf("%d",&n);

        for(i=0;i<n;i++)
        {
                newnode=(struct node *)malloc(sizeof(struct node));
                printf("Enter the %d element :\n",i+1);
           scanf("%d",&newnode->data);
           newnode->next=0;

           if(head==0)
           {
                temp=head=newnode;
```

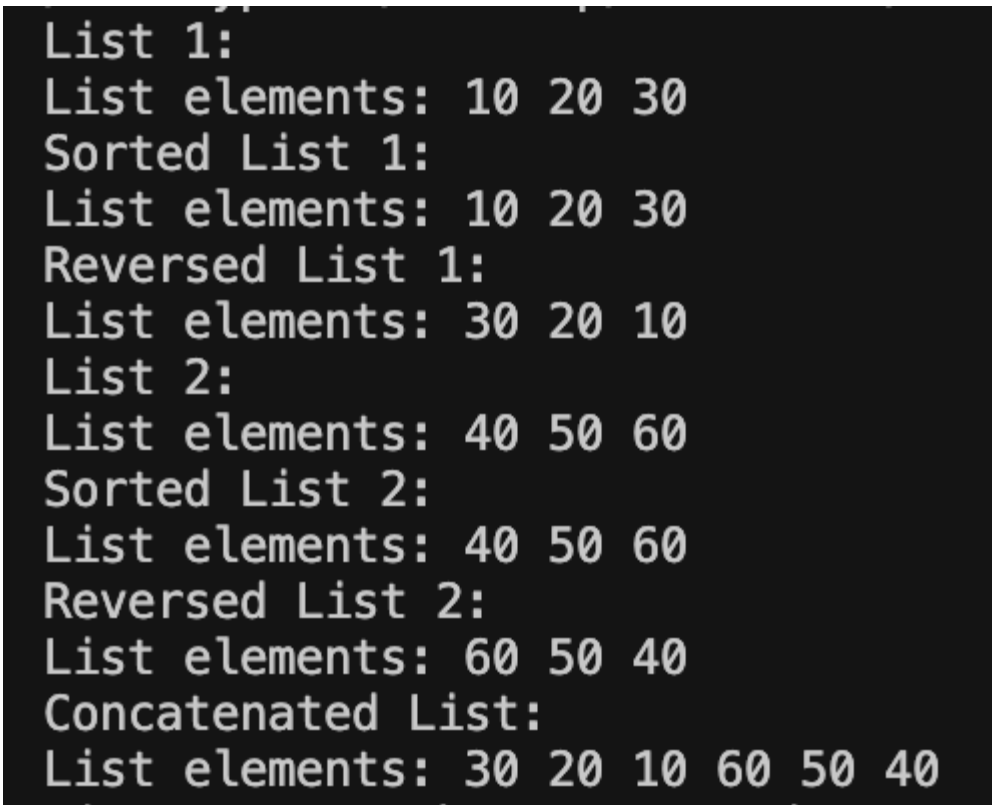
```
                }
                else
                {
                        temp->next=newnode;
                        temp=newnode;
                }
        }
}
void display()
{
   temp=head;
        printf("The elements are:\n");
        while(temp!=0)
        {
                printf("%d\n",temp->data);
                temp=temp->next;
                length++;
        }
}

void reverse()
{
        struct node *prenode=0,*curnode=head,*nextnode=head;

        while(nextnode != 0)
        {
                nextnode = nextnode->next;
                curnode->next=prenode;
                prenode=curnode;
```

```
                curnode=nextnode;
        }
        head=prenode;
}

void sort()
{
        int swapped=0;
        struct node *end=0;
        if (head == NULL || head->next == NULL) {
      printf("already sorted"); // Already sorted or empty list
   }
        do{
           swapped=0;
                temp=head;
                while(temp->next != end)
                {

                if(temp->data > temp->next->data)
                {
                        int t =temp->data;
                        temp->data=temp->next->data;
                        temp->next->data=t;
                        swapped=1;
                }
//              printf("%d\n",temp->data);
                temp=temp->next;
           }
           end=temp;
```

```
    } while(swapped);



}



void main()
{
        int choice;
        printf("Enter operation:\n1.create\n2.display\n3.reverse\n4.sort\n5.concat\n.-1 to
end\n");
        while(1)
        {
                printf("Enter operation:\n");
                scanf("%d",&choice);


                if(choice==-1)
                {
                        printf("operation completed!\n");
                        break;
                }
                else
                {
                        switch(choice)
                        {
                                case 1:create();
                                        break;
                           case 2:display();
                                    break;
```

```
                        case 3:reverse();
                                break;
                         case 4:sort();
                                break;
                        case 5:printf("Enter first list\n");
                              create();
                              printf("enter second list\n");
                              create();
                              break;
                               default:printf("invalid input\n");
                      }
                }
        }


}
```

OUTPUT:



Lab program 6b:

WAP to implement Stack & Queues using Linked Representation

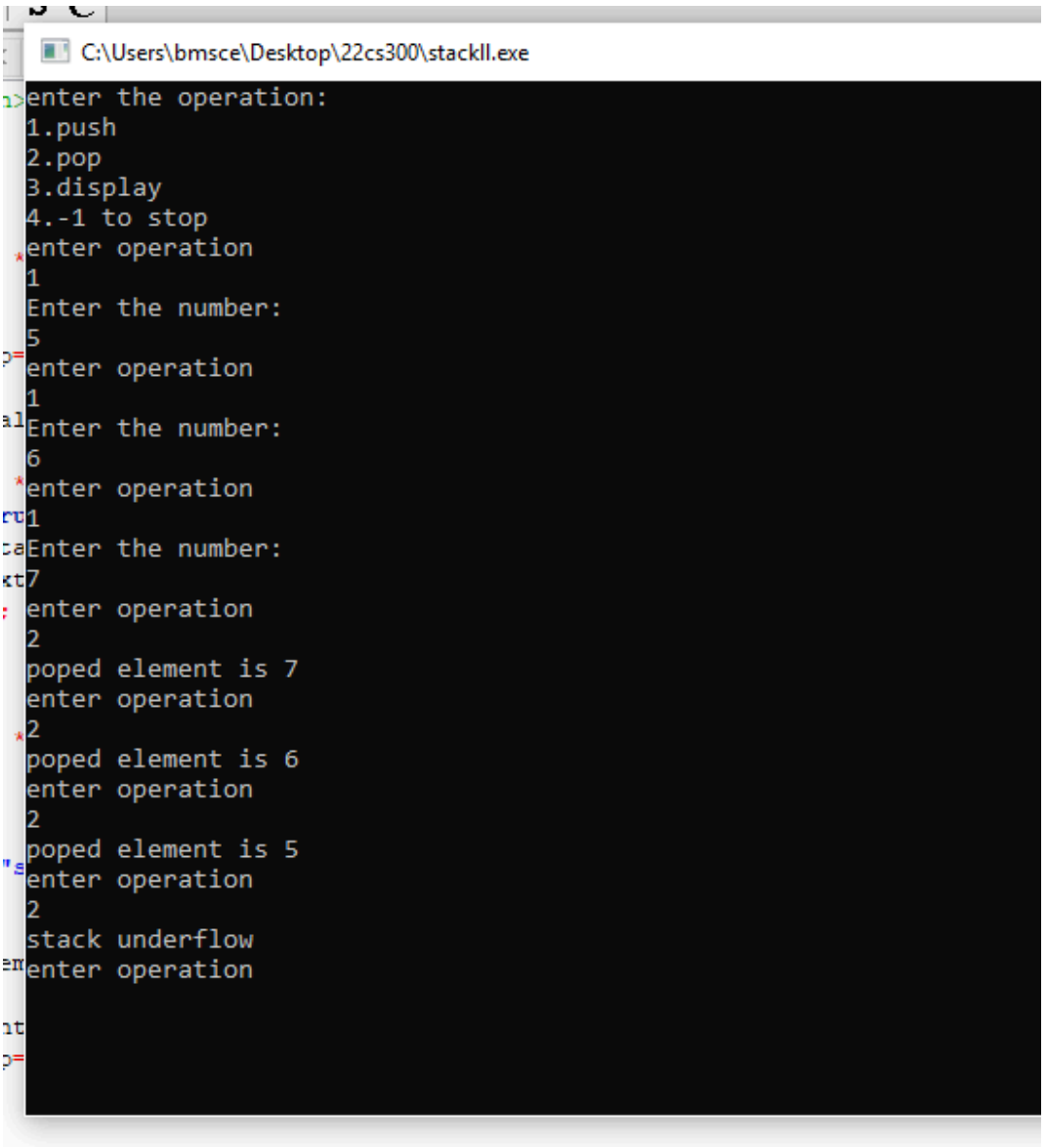
```
#include<stdio.h>
#include<stdlib.h>

struct node
{
        int data;
        struct node * link;

};

struct node *top=0;

void push(int val)
```

```
{
        struct node * newnode;
        newnode=(struct node *)malloc(sizeof(struct node));
        newnode->data=val;
        newnode->link=top;
        top=newnode;
}

void display()
{
        struct node *temp;
        temp=top;
        if(top==0)
        {
                printf("empty");
        }
        else
        {
                while(temp!=0)
                {
                        printf("%d\n",temp->data);
                        temp=temp->link;
                }
        }
}

void pop()
{
        struct node *temp;
```

```
        temp=top;
        if(top==0)
        {
                printf("empty");
        }
        else
        {
                printf("poped is %d",top->data);
                top=top->link;
                free(temp);
        }
}

void main()
{
         int choice,num;

   while(1){
        printf("Enter the operation:\n1.push\n2.pop\n3.display\n4.-1 to stop\n");
        scanf("%d",&choice);
      if(choice==-1){
        printf("operation completed.\n");
        break;
      }
      else{
        switch(choice)
        {
           case 1:printf("Enter the number:\n");
                scanf("%d",&num);
```

```
                push(num);
                break;
            case 2:pop();
                break;
            case 3:display();
                break;

            default:printf("invalid input");

        }
    }
  }
}
```

OUTPUT:



QUEUE:

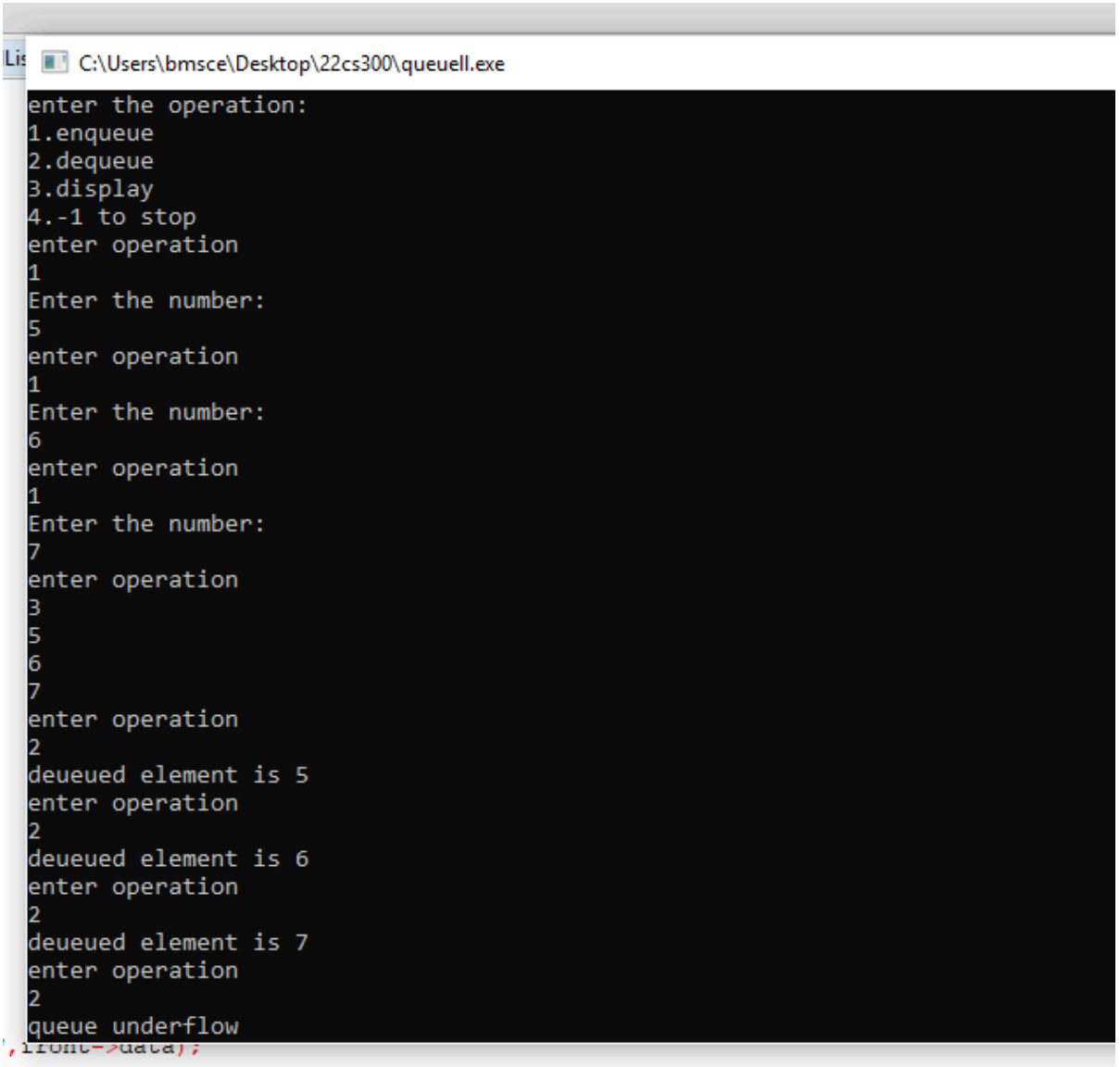
```
#include<stdio.h>
#include<stdlib.h>

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

```
void display(struct Node* front) {
    if (front == NULL) {
        printf("Queue is empty\n");
        return;
    }

    struct Node* temp = front;
    printf("Queue elements are:\t");
    while (temp != NULL) {
        printf("%d\t", temp->data);
        temp = temp->next;
    }
    printf("\n");
}

void enqueue(struct Node** front, struct Node** rear, int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if (newNode == NULL) {
        printf("Queue Overflow\n");
        return;
    }

    newNode->data = data;
    newNode->next = NULL;

    if (*rear == NULL) {
        *front = *rear = newNode;
        return;
```

```
    }

    (*rear)->next = newNode;
    *rear = newNode;
}

int dequeue(struct Node** front, struct Node** rear) {
    if (*front == NULL) {
        printf("Queue Underflow\n");
        return -1; // You can choose another value to indicate underflow
    }

    struct Node* temp = *front;
    int dequeuedData = temp->data;

    *front = (*front)->next;

    if (*front == NULL) {
        *rear = NULL; // If the last element is dequeued, update rear
    }

    free(temp);
    return dequeuedData;
}

int main() {
    int op, n, dequeuedElement;
    struct Node* front = NULL;
    struct Node* rear = NULL;
```

```
    printf("Enter 1. Enqueue\n2. Dequeue\n3. -1 to stop\n");
    while (1) {
        printf("Enter operation\n");
        scanf("%d", &op);

        if (op == -1) {
            printf("Execution stopped\n");
            break;
        }

        switch (op) {
            case 1:
                printf("Enter the element to enqueue\n");
                scanf("%d", &n);
                enqueue(&front, &rear, n);
                break;
            case 2:
                dequeuedElement = dequeue(&front, &rear);
                if (dequeuedElement != -1) {
                    printf("Dequeued Element: %d\n", dequeuedElement);
                }
                break;
        }
        display(front);
    }

    return 0;
}
```

OUTPUT:


C:\Users\bmsce\Desktop\22cs300\queuell.exe
enter the operation:
1.enqueue
2.dequeue
3.display
4.-1 to stop
enter operation
1
Enter the number:
5
enter operation
1
Enter the number:
6
enter operation
1
Enter the number:
7
enter operation
3
5
6
7
enter operation
2
deueued element is 5
enter operation
2
deueued element is 6
enter operation
2
deueued element is 7
enter operation
2
queue underflow

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

```
#include<stdio.h>

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

struct node *head=0,*newnode,*temp;

void create()
{
        int i,n;
        printf("Enter the no. of elements:\n");
        scanf("%d",&n);

        for(i=0;i<n;i++)
        {
                newnode=(struct node *)malloc(sizeof(struct node));
                printf("Enter the %d element :\n",i+1);
           scanf("%d",&newnode->data);
           newnode->prev=0;
           newnode->next=0;
```

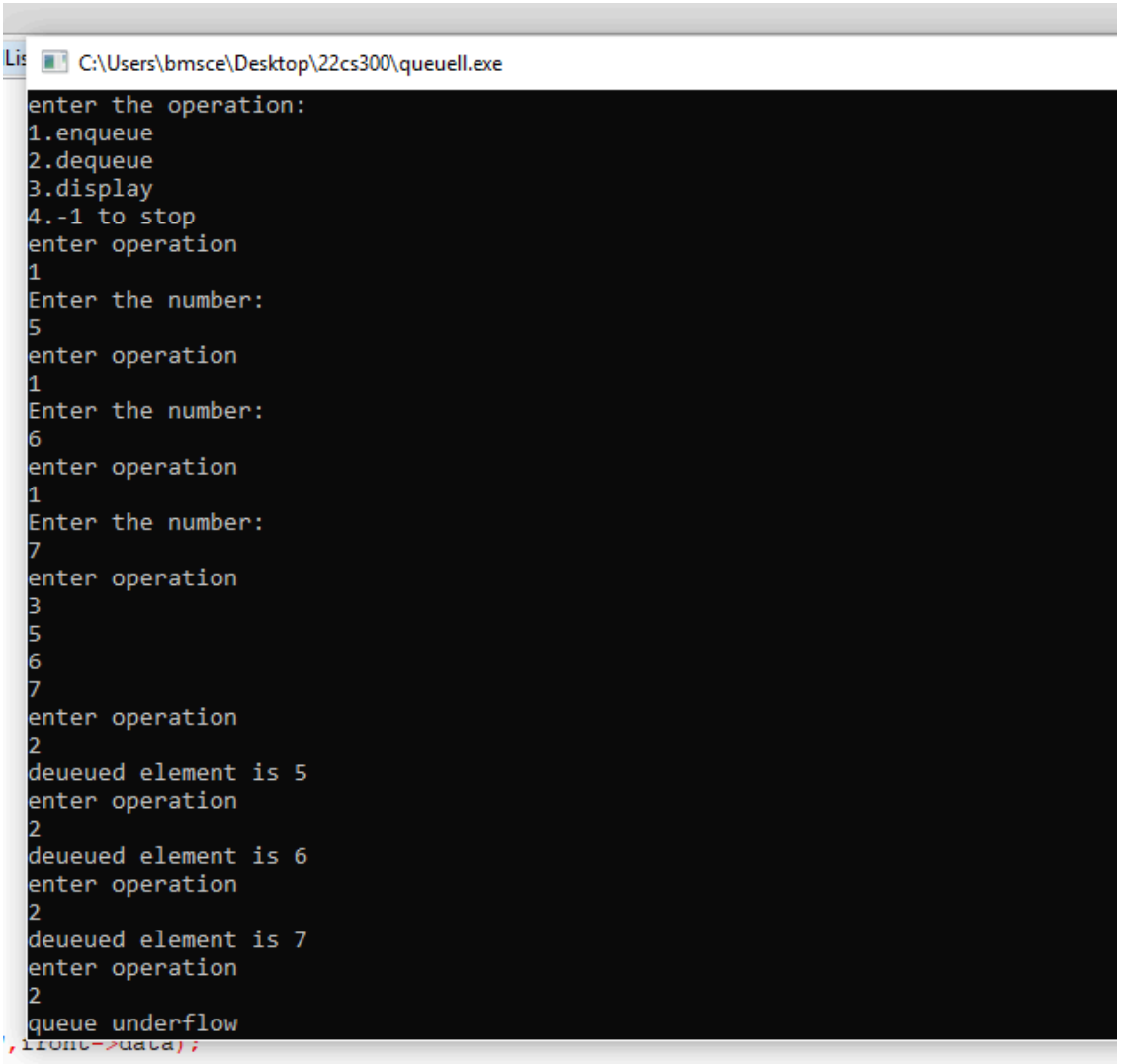
```
            if(head==0)
            {
                  temp=head=newnode;
                  }
                  else
                  {
                        temp->next=newnode;
                        newnode->prev=temp;
                        temp=newnode;
                  }
      }
}

void display()
{
      temp=head;
      while(temp!=0)
      {
            printf("%d\n",temp->data);
            temp=temp->next;
      }
}
void insert_left(){
int node,i=1;
printf("enter data\n");
scanf("%d",node);
temp=head;
if(node<1)
```

```
{
printf(“invalid position”);}
else if(node==1)
{
        newnode=(struct node *)malloc(sizeof(struct node));
        printf("enter data\n");
        scanf("%d",newnode->data);
        newnode->prev=0;
        head->prev=newnode;
        newnode->next=head;
        head=newnode;
}
else
{
newnode=(struct node *)malloc(sizeof(struct node));
printf("enter data\n");
scanf("%d",newnode->data);
while(i<node-1)
{
temp=temp->next;
i++;
}
newnode->prev=temp;
newnode->next=temp->next;
temp->next=newnode;
newnode->next->prev=newnode;
}
}
void delete_pos()
```

```
{
        int pos,i=1;
        temp=head;
        printf("enter position\n");
        scanf("%d",&pos);
        while(i<pos)
        {
                temp=temp->next;
                i++;
        }
        temp->prev->next=temp->next;
        temp->next->prev=temp->prev;
       free(temp);
}
void main()
{
        int choice;
        while(1)
        {
                printf("Enter operation:\n1.create\n2.display\n3.insert at beginning\n4.insert at
end\n5.insert after a location\n.-1 to end\n");
                scanf("%d",&choice);

                if(choice==-1)
                {
                        printf("operation completed!\n");
                        break;
                }
                else
                {
```

```
                    switch(choice)
                    {
                            case 1:create();
                                    break;
                       case 2:display();
                              break;
                       case 3:insert_left();
                                    break;
                              case 4:delete_pos();
                                    break;
                              default:printf("invalid input\n");
                    }
              }
        }


}
```

OUTPUT:

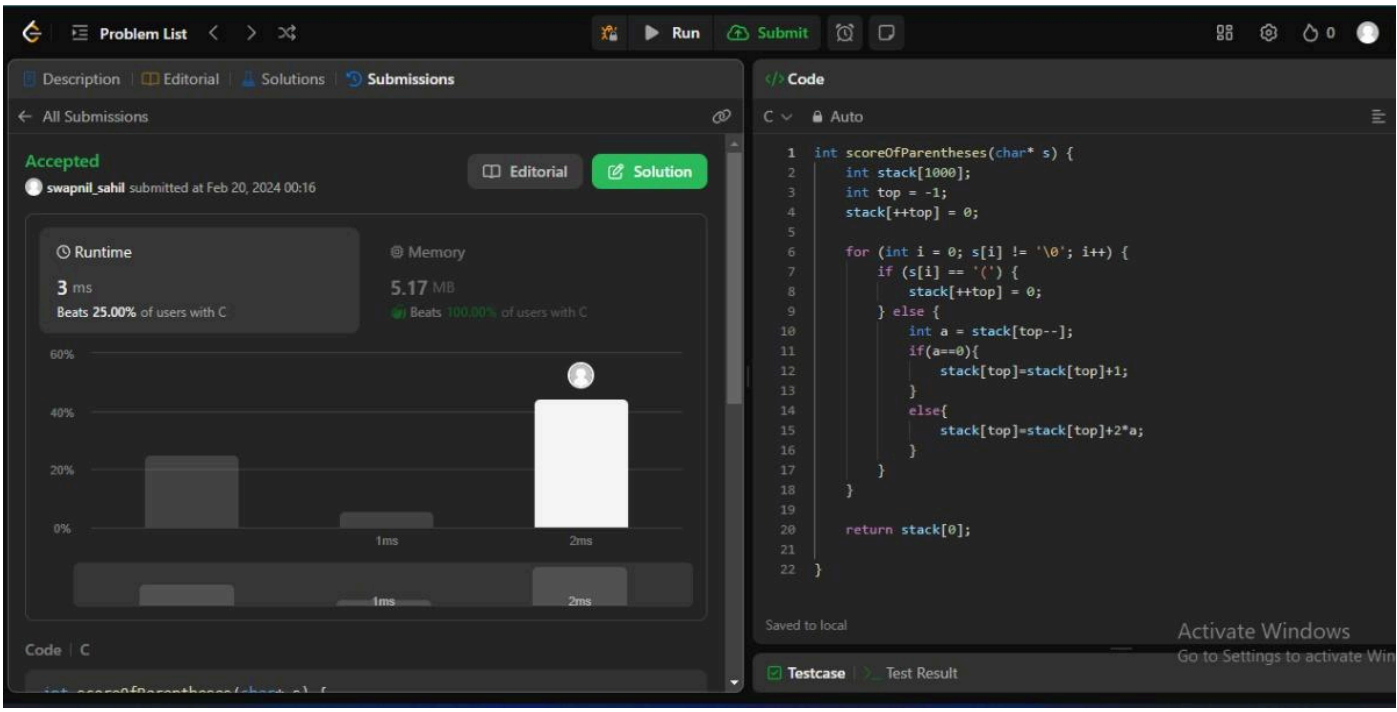


LeetCode Problem:

ScoreOfParentheses:

```
int scoreOfParentheses(char* s) {

    int stack[1000];

    int top = -1;

    stack[++top] = 0;



    for (int i = 0; s[i] != '\0'; i++) {

        if (s[i] == '(') {

            stack[++top] = 0;

        } else {
```

```
            int a = stack[top--];
            if(a==0){
                stack[top]=stack[top]+1;
            }
            else{
                stack[top]=stack[top]+2*a;
            }
        }
    }

    return stack[0];

}
```



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 andpost order

c) To display the elements in the tree.

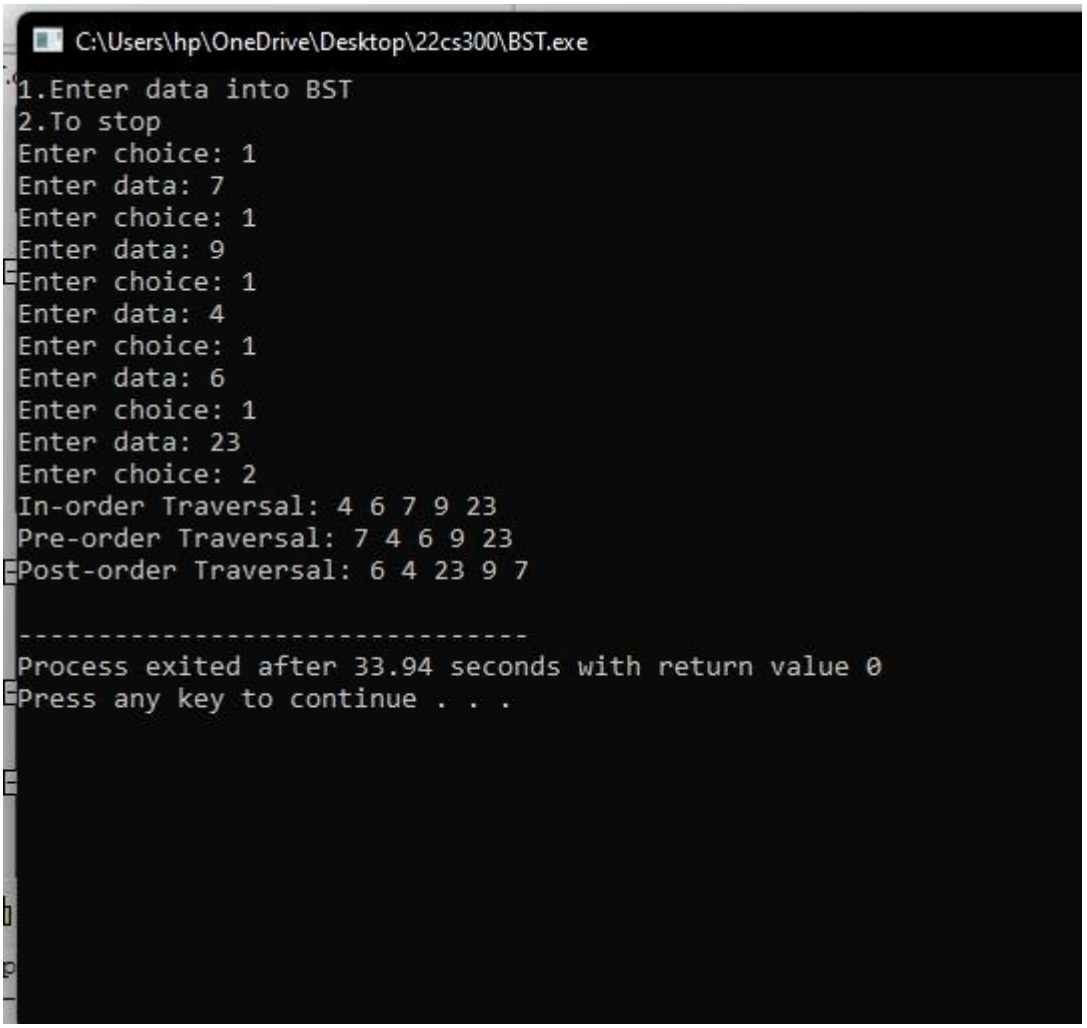
```
#include <stdio.h>
#include <stdlib.h>

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

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

struct Node* insert(struct Node* root, int data) {
    if (root == NULL) {
        return createNode(data);
    }
    if (data < root->data) {
        root->left = insert(root->left, data);
```

```
    } else if (data > root->data) {
        root->right = insert(root->right, data);
    }
    return root;
}

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

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

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

```
void display(struct Node* root) {
    printf("In-order Traversal: ");
    inOrder(root);
    printf("\nPre-order Traversal: ");
    preOrder(root);
    printf("\nPost-order Traversal: ");
    postOrder(root);
    printf("\n");
}

int main() {
    struct Node* root = NULL;
    int data,c;
    printf("1.Enter data into BST\n2.To stop\n");
    while(1){
      printf("Enter choice: ");
      scanf("%d",&c);
      switch(c){
        case 1:
        printf("Enter data: ");
        scanf("%d", &data);
        root = insert(root, data);
        break;
        case 2:
        display(root);
        exit(0);
      }
    }
```

```
    return 0;
}
```

OUTPUT:



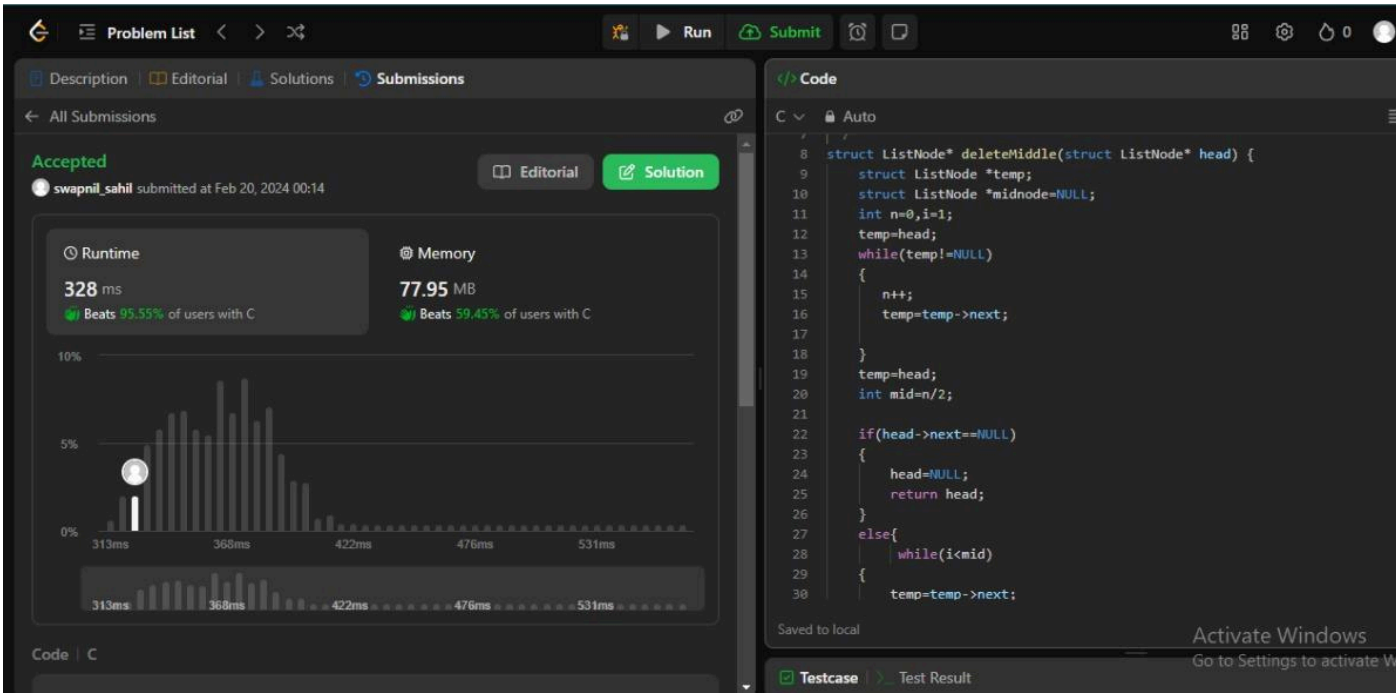
Leet Code Problem:

Delete the Middle Node Of a Linked List:

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

```
 * };
 */
struct ListNode* deleteMiddle(struct ListNode* head) {
    struct ListNode *temp;
    struct ListNode *midnode=NULL;
    int n=0,i=1;
    temp=head;
    while(temp!=NULL)
    {
       n++;
       temp=temp->next;

    }
    temp=head;
    int mid=n/2;

    if(head->next==NULL)
    {
        head=NULL;
        return head;
    }
    else{
         while(i<mid)
    {
        temp=temp->next;
        i++;
    }
    }
```

```
    midnode=temp->next;
    temp->next=midnode->next;
    free(midnode);

    return head;


}
```

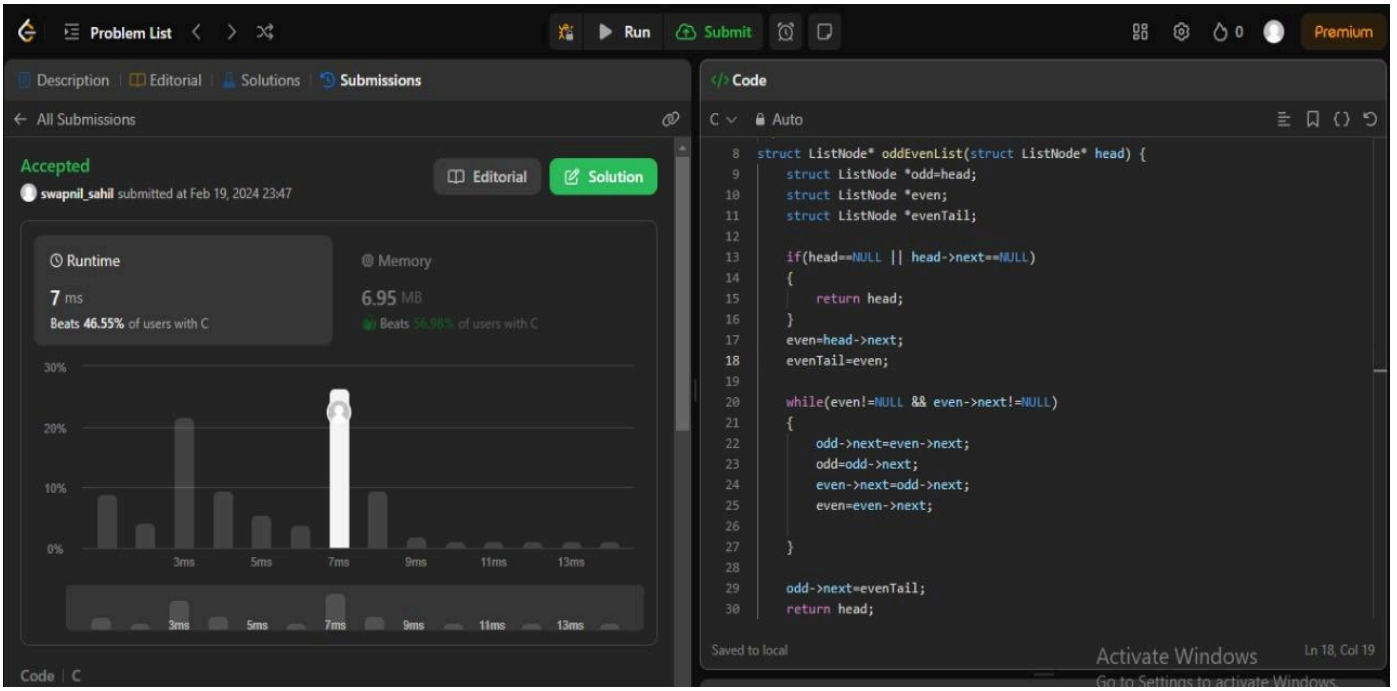


Leet Code Problem:

Odd Even Linked List:

```
struct ListNode* oddEvenList(struct ListNode* head) {

    struct ListNode *odd=head;

    struct ListNode *even;
```

```
    struct ListNode *evenTail;



    if(head==NULL || head->next==NULL)

    {

        return head;

    }

    even=head->next;

    evenTail=even;



    while(even!=NULL && even->next!=NULL)

    {

        odd->next=even->next;

        odd=odd->next;

        even->next=odd->next;

        even=even->next;



    }



    odd->next=evenTail;

    return head;

}
```


Problem List
Run
Submit
Premium
Description
Editorial
Solutions
Submissions
All Submissions
Accepted
swapnil_sahil submitted at Feb 19, 2024 23:47
Editorial
Solution
Runtime
7 ms
Beats 46.55% of users with C
Memory
6.95 MB
Beats 56.98% of users with C
30%
20%
10%
0%
3ms
5ms
7ms
9ms
11ms
13ms
Code | C
Code
C
Auto
struct ListNode* oddEvenList(struct ListNode* head) {
struct ListNode *odd=head;
struct ListNode *even;
struct ListNode *evenTail;
if(head==NULL || head->next==NULL)
{
return head;
}
even=head->next;
evenTail=even;
while(even!=NULL && even->next!=NULL)
{
odd->next=even->next;
odd=odd->next;
even->next=odd->next;
even=even->next;
}
odd->next=evenTail;
return head;
Saved to local
Ln 18, Col 19
Activate Windows

Lab program 9:

Write a Program to traverse a graph using BFS method.

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

#define MAX_NODES 100

// Define a structure for a node in the graph
struct Node {
    int data;
    struct Node* next;
};

// Define a structure for the graph
struct Graph {
    int numNodes;
    struct Node* adjLists[MAX_NODES];
    int visited[MAX_NODES];
};

// Function to create a new node
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = NULL;
    return newNode;
}
```

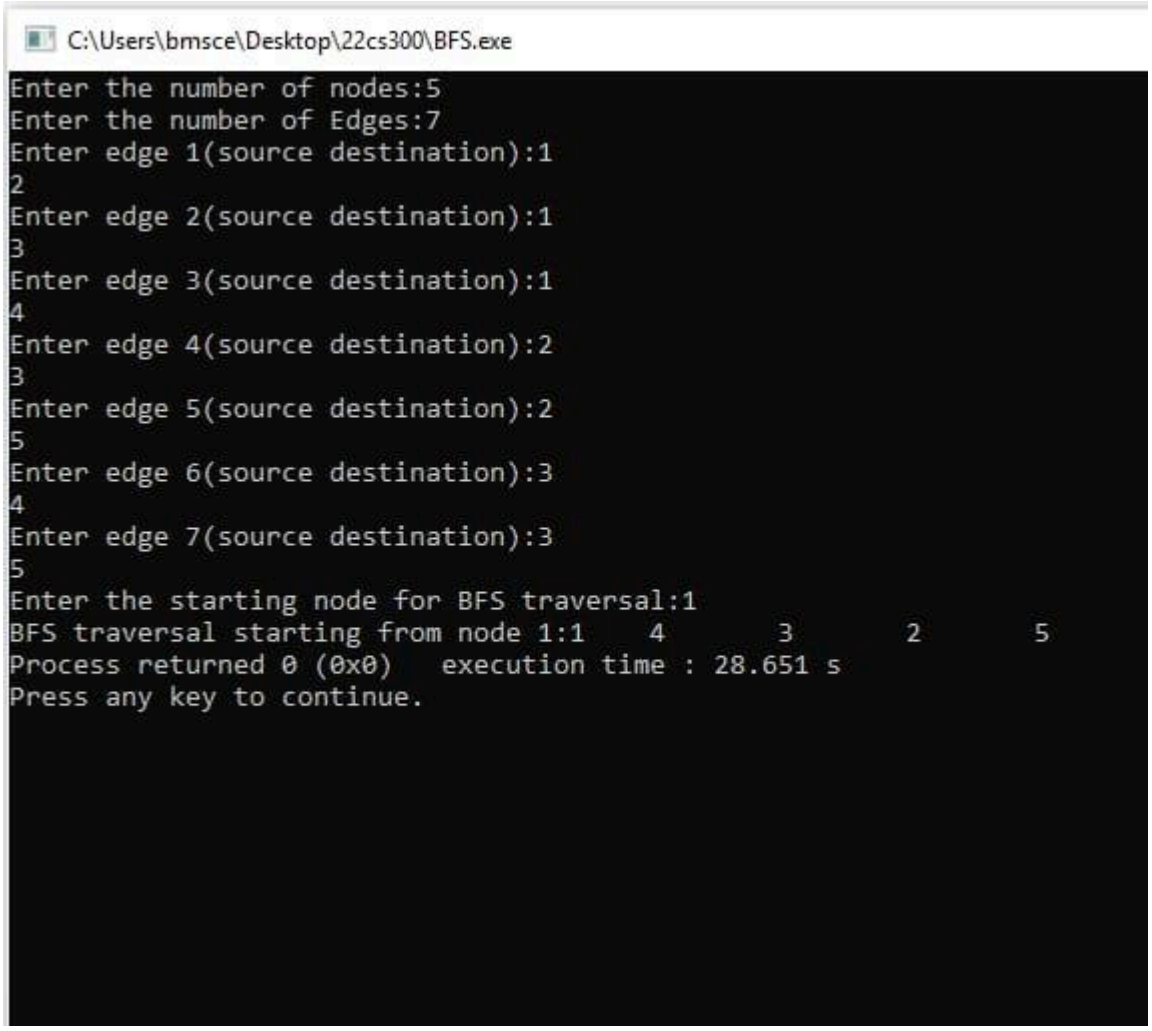
```
// Function to create a graph with n nodes
struct Graph* createGraph(int n) {
    struct Graph* graph = (struct Graph*)malloc(sizeof(struct Graph));
    graph->numNodes = n;
    for (int i = 0; i < n; i++) {
        graph->adjLists[i] = NULL;
        graph->visited[i] = 0;
    }
    return graph;
}

// Function to add an edge to the graph
void addEdge(struct Graph* graph, int src, int dest) {
    // Add edge from src to dest
    struct Node* newNode = createNode(dest);
    newNode->next = graph->adjLists[src];
    graph->adjLists[src] = newNode;

    // Add edge from dest to src
    newNode = createNode(src);
    newNode->next = graph->adjLists[dest];
    graph->adjLists[dest] = newNode;
}

// Function to perform Breadth First Search
void BFS(struct Graph* graph, int startNode) {
```

```
    // Create a queue for BFS
    int queue[MAX_NODES];
    int front = 0, rear = 0;

    // Mark the current node as visited and enqueue it
    graph->visited[startNode] = 1;
    queue[rear++] = startNode;

    while (front < rear) {
        // Dequeue a vertex from queue and print it
        int current = queue[front++];
        printf("%d ", current);

        // Get all adjacent vertices of the dequeued vertex current
        // If an adjacent has not been visited, then mark it visited and enqueue it
        struct Node* temp = graph->adjLists[current];
        while (temp) {
            int adjNode = temp->data;
            if (!graph->visited[adjNode]) {
                graph->visited[adjNode] = 1;
                queue[rear++] = adjNode;
            }
            temp = temp->next;
        }
    }
}
```

```
int main() {
    // Get the number of nodes from the user
    int numNodes;
    printf("Enter the number of nodes: ");
    scanf("%d", &numNodes);

    // Create a graph with the specified number of nodes
    struct Graph* graph = createGraph(numNodes);

    // Get the number of edges from the user
    int numEdges;
    printf("Enter the number of edges: ");
    scanf("%d", &numEdges);

    // Add edges
    for (int i = 0; i < numEdges; i++) {
        int src, dest;
        printf("Enter edge %d (source destination): ", i + 1);
        scanf("%d %d", &src, &dest);
        addEdge(graph, src, dest);
    }

    // Print BFS traversal
    int startNode;
    printf("Enter the starting node for BFS traversal: ");
    scanf("%d", &startNode);
    printf("BFS traversal starting from node %d: ", startNode);
```

```
    BFS(graph, startNode);

    return 0;
}
```

OUTPUT:



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

```
#include <stdio.h>

#include <stdlib.h>


#define MAX_NODES 100


// Define a structure for a node in the graph
```

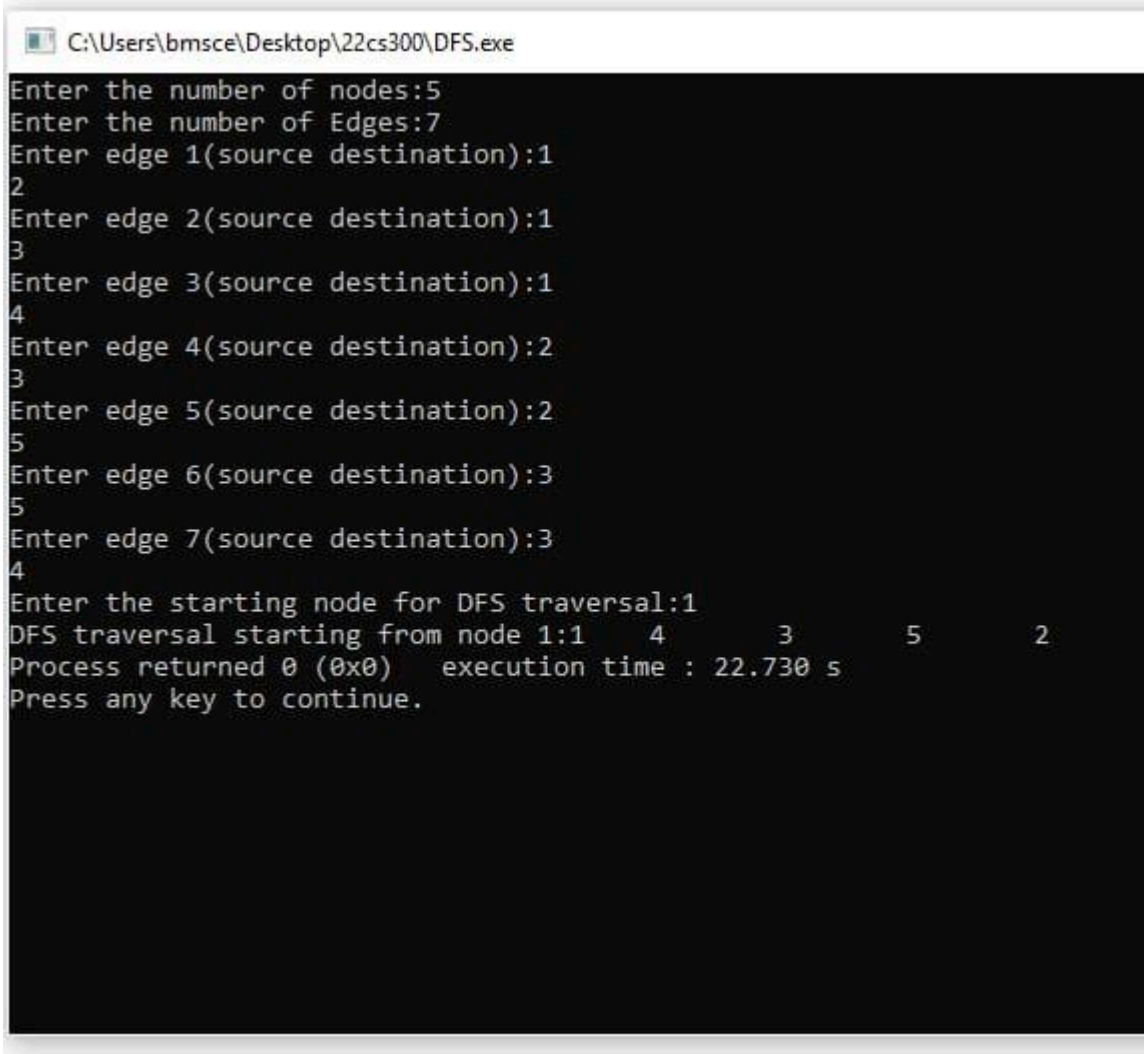
```
struct Node {
    int data;
    struct Node* next;
};

// Define a structure for the graph
struct Graph {
    int numNodes;
    struct Node* adjLists[MAX_NODES];
    int visited[MAX_NODES];
};

// Function to create a new node
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = NULL;
    return newNode;
}

// Function to create a graph with n nodes
struct Graph* createGraph(int n) {
    struct Graph* graph = (struct Graph*)malloc(sizeof(struct Graph));
    graph->numNodes = n;
    for (int i = 0; i < n; i++) {
        graph->adjLists[i] = NULL;
        graph->visited[i] = 0;
```

```
    }
    return graph;
}

// Function to add an edge to the graph
void addEdge(struct Graph* graph, int src, int dest) {
    // Add edge from src to dest
    struct Node* newNode = createNode(dest);
    newNode->next = graph->adjLists[src];
    graph->adjLists[src] = newNode;

    // Add edge from dest to src
    newNode = createNode(src);
    newNode->next = graph->adjLists[dest];
    graph->adjLists[dest] = newNode;
}

// Function to perform Depth First Search
void DFS(struct Graph* graph, int startNode) {
    // Mark the current node as visited
    graph->visited[startNode] = 1;
    printf("%d ", startNode);

    // Get all adjacent vertices of the current node
    struct Node* temp = graph->adjLists[startNode];
    while (temp) {
        int adjNode = temp->data;
```

```
        if (!graph->visited[adjNode]) {
            DFS(graph, adjNode);
        }
        temp = temp->next;
    }
}

int main() {
    // Get the number of nodes from the user
    int numNodes;
    printf("Enter the number of nodes: ");
    scanf("%d", &numNodes);

    // Create a graph with the specified number of nodes
    struct Graph* graph = createGraph(numNodes);

    // Get the number of edges from the user
    int numEdges;
    printf("Enter the number of edges: ");
    scanf("%d", &numEdges);

    // Add edges
    for (int i = 0; i < numEdges; i++) {
        int src, dest;
        printf("Enter edge %d (source destination): ", i + 1);
        scanf("%d %d", &src, &dest);
        addEdge(graph, src, dest);
```

```
    }

    // Print DFS traversal
    int startNode;
    printf("Enter the starting node for DFS traversal: ");
    scanf("%d", &startNode);
    printf("DFS traversal starting from node %d: ", startNode);
    DFS(graph, startNode);

    return 0;
}
```

OUTPUT

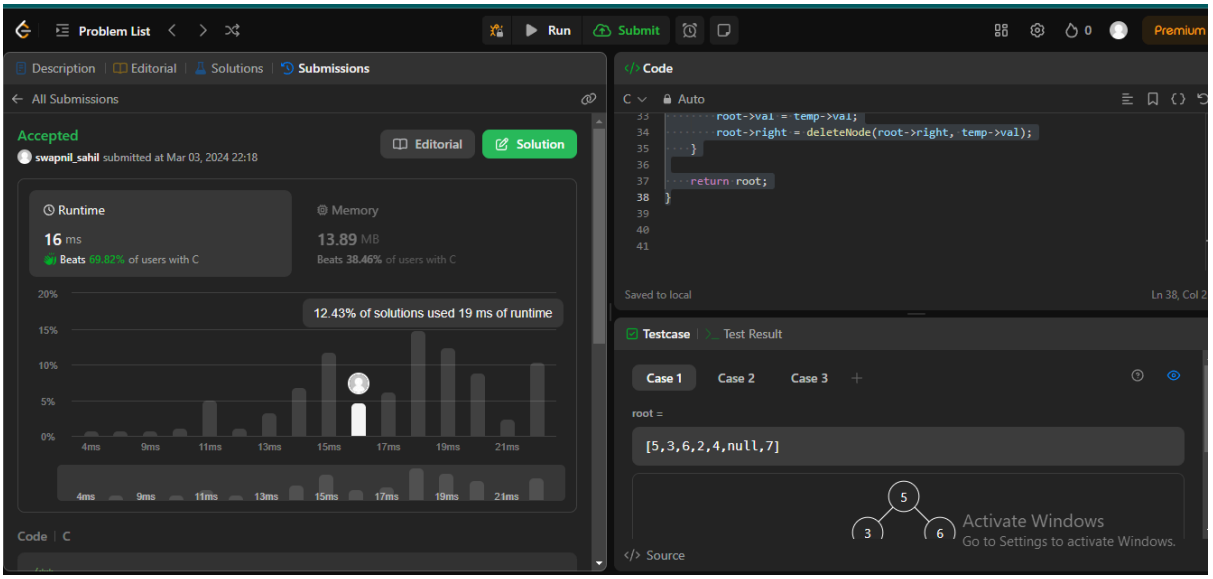


LeetCode Problem:

a)Delete Node In BST

```
struct TreeNode* deleteNode(struct TreeNode* root, int key) {

    if (root == NULL){

         return root;

    }



    if (key < root->val) {

        root->left = deleteNode(root->left, key);

    } else if (key > root->val) {

        root->right = deleteNode(root->right, key);
```

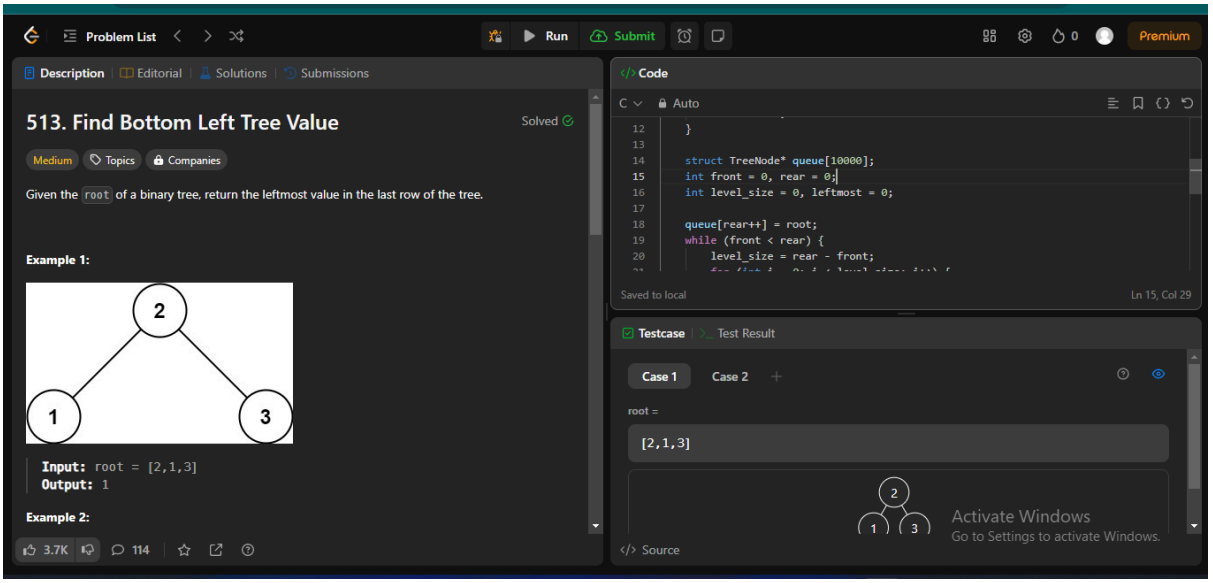
```
    } else {
        if (root->left == NULL) {
            struct TreeNode* temp = root->right;
            free(root);
            return temp;
        } else if (root->right == NULL) {
            struct TreeNode* temp = root->left;
            free(root);
            return temp;
        }

        struct TreeNode* temp = root->right;
        while (temp->left != NULL) {
            temp = temp->left;
        }
        root->val = temp->val;
        root->right = deleteNode(root->right, temp->val);
    }

    return root;
}
```



b)Find Bottom Left Tree Value

```c
int findBottomLeftValue(struct TreeNode* root) {
    if (root==NULL) {
        return root;
    }

    struct TreeNode* queue[10000];
    int front = 0, rear = 0;
    int level_size = 0, leftmost = 0;

    queue[rear++] = root;
    while (front < rear) {
        level_size = rear - front;
        for (int i = 0; i < level_size; i++) {
            struct TreeNode* node = queue[front++];
            if (i == 0) {
```

```
                leftmost = node->val;

            }

            if (node->left) {

                queue[rear++] = node->left;

            }

            if (node->right) {

                queue[rear++] = node->right;

            }

        }

    }


    return leftmost;

}
```



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 MAX_EMPLOYEES 100

#define HT_SIZE 10


typedef struct {

    int key;

    char name[50];

    // Add other employee details as needed

} Employee;


typedef struct {

    Employee *data;

    int key;

} HashTableEntry;


int hashFunction(int key, int m) {

    return key % m;

}
```

```
void insert(Employee employee, HashTableEntry *hashTable, int m) {
    int index = hashFunction(employee.key, m);
    int i = 1;
    while (hashTable[index].key != -1) {
        index = (index + i) % m;
        i++;
    }
    hashTable[index].key = employee.key;
    hashTable[index].data = &employee;
}

Employee* search(int key, HashTableEntry *hashTable, int m) {
    int index = hashFunction(key, m);
    int i = 1;
    while (hashTable[index].key != -1 && hashTable[index].key != key) {
        index = (index + i) % m;
        i++;
    }
    if (hashTable[index].key == key) {
        return hashTable[index].data;
    } else {
        return NULL;
    }
}

int main() {
    Employee employees[MAX_EMPLOYEES];
```

```
HashTableEntry hashTable[HT_SIZE];
for (int i = 0; i < HT_SIZE; i++) {
    hashTable[i].key = -1;
}

// Assume employees are read from a file and stored in the employees array

int n; // Number of employees
printf("Enter the number of employees: ");
scanf("%d", &n);

for (int i = 0; i < n; i++) {
    printf("Enter employee key and name (separated by a space): ");
    scanf("%d %s", &employees[i].key, employees[i].name);
    insert(employees[i], hashTable, HT_SIZE);
}

int searchKey;
printf("Enter the key to search: ");
scanf("%d", &searchKey);
Employee *result = search(searchKey, hashTable, HT_SIZE);
if (result != NULL) {
    printf("Employee found: %s\n", result->name);
} else {
    printf("Employee not found\n");
}
```

```
    return 0;
}
```

OUTPUT: