VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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(1BM22CS189)

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 **PANNAGA R BHAT (1BM22CS189)**, who is a bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2023-24. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab **- (23CS3PCDST) work** prescribed for the said degree.

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Index Sheet

Course outcomes:

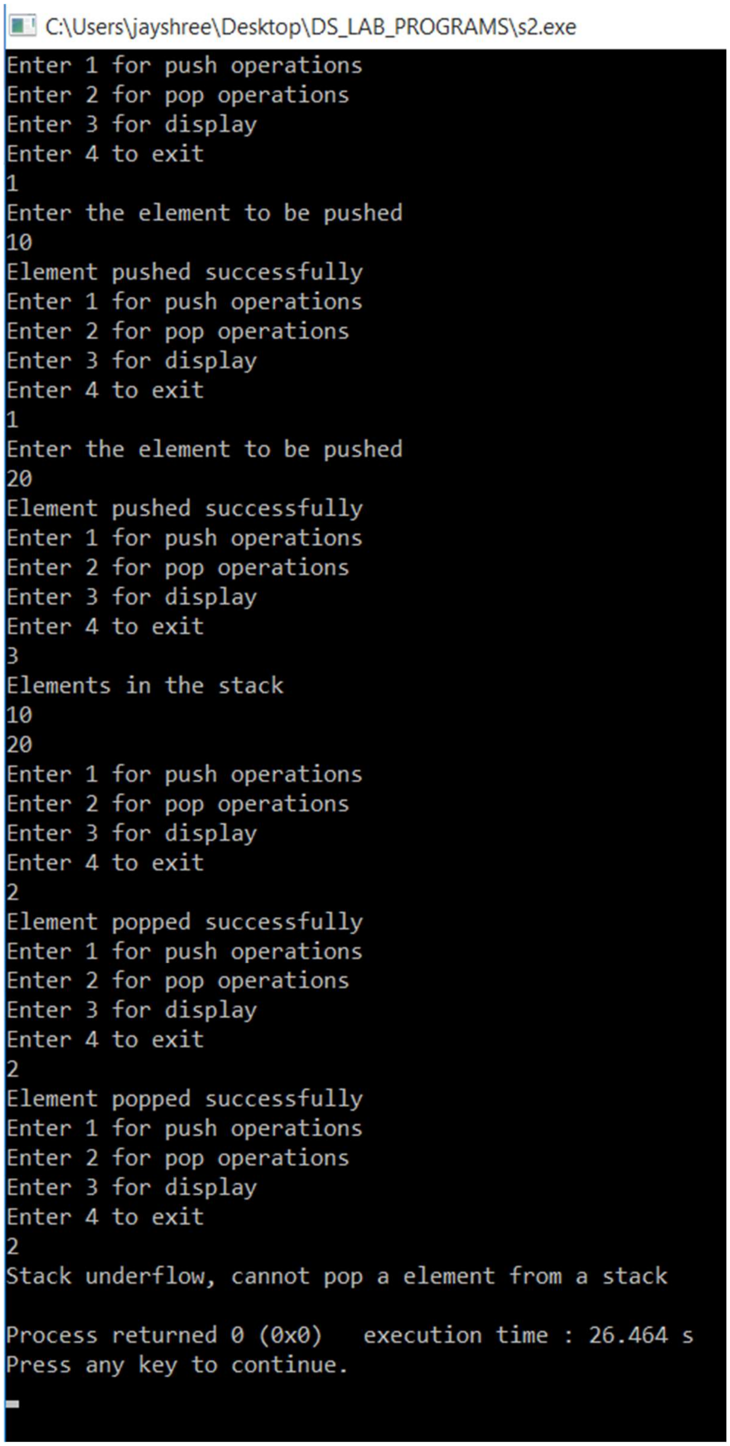
CO1	Apply the concept of linear and nonlinear data structures.
CO2	Analyze data structure operations for a given problem
CO3	Design and develop solutions using the operations of linear and nonlinear data structure for a given specification.
CO4	Conduct practical experiments for demonstrating the operations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

Lab program 1:

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

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

#define size 10

void push(int i, int a[]);
void pop();
void display(int a[]);

int top = -1;
int a[size],i;

void main(){
int choice;

while(1){
        printf("Enter 1 for push operations\n");
        printf("Enter 2 for pop operations\n");
        printf("Enter 3 for display\n");
        printf("Enter 4 to exit\n");

        scanf("%d",&choice);
        switch (choice){
        case 1:
           printf("Enter the element to be pushed\n");
           scanf("%d",&i);
           push(i,a);
           break;

        case 2:
           pop();
           break;
        case 3:
           display(a);
           break;
        case 4:
           printf("Programs ends successfully\n");
           exit(0);
        }
    }
}

void push(int i,int a[]){
    if(top == size-1){
        printf("Stack overflow, cannot insert a element into a stack\n");
        exit(0);
    }
    else{
    top = top+1;
    a[top] = i;
    printf("Element pushed successfully\n");
    return;
    }
}

void pop(){
    if(top == -1){
    printf("Stack underflow, cannot pop a element from a stack\n");
    exit(0);
    }
    else{
    top = top-1;
    printf("Element popped successfully\n");
    return;
    }
}

void display(int a[]){

    if(top == -1){
    printf("Stack Underflow");
    exit(0);
    }
    else{
        printf("Elements in the stack\n");
        for(int j=0;j<=top;j++)
        {
           printf("%d\n",a[j]);
        }
        return;
    }
}
```

Output:



C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\s2.exe

```
Enter 1 for push operations
Enter 2 for pop operations
Enter 3 for display
Enter 4 to exit
1
Enter the element to be pushed
10
Element pushed successfully
Enter 1 for push operations
Enter 2 for pop operations
Enter 3 for display
Enter 4 to exit
1
Enter the element to be pushed
20
Element pushed successfully
Enter 1 for push operations
Enter 2 for pop operations
Enter 3 for display
Enter 4 to exit
3
Elements in the stack
10
20
Enter 1 for push operations
Enter 2 for pop operations
Enter 3 for display
Enter 4 to exit
2
Element popped successfully
Enter 1 for push operations
Enter 2 for pop operations
Enter 3 for display
Enter 4 to exit
2
Element popped successfully
Enter 1 for push operations
Enter 2 for pop operations
Enter 3 for display
Enter 4 to exit
2
Stack underflow, cannot pop a element from a stack

Process returned 0 (0x0)   execution time : 26.464 s
Press any key to continue.
```

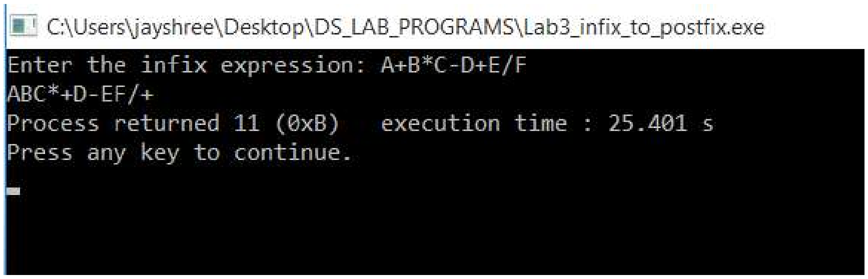
Lab Program 2:

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

```
#include<stdio.h>

#include<ctype.h>

#define max 15

void push(char a);

char pop();

int precedence(char b);


char stack[max];

int top = -1;

void main()

{

    char infix[max], p, postfix[max];

    printf("Enter the infix expression: ");

    scanf("%s",infix);

    int j = 0;

    push('(');

    for(int i=0;i<strlen(infix);i++)

    {

        if(isalnum(infix[i])){

            postfix[j] = infix[i];

            j+=1;

        }

        else if(infix[i]== '+' || infix[i]=='-' || infix[i]=='*' || infix[i]=='/' || infix[i]=='^'){

            if(precedence(infix[i]) > precedence(stack[top]))

                push(infix[i]);
            else if(precedence(infix[i]) <= precedence(stack[top])){
                while(1){
                    p = pop();
                    if (p =='('){
                        push(p);
                        break;
                    }

                    postfix[j] = p;
                    j+=1;
                }
                push(infix[i]);
            }
        }
    }
while(top!=-1){
    char y = pop();
    if (y == '(')
        break;
    postfix[j] = y;
    j+=1;
}
    postfix[j] = '\0';
    printf("%s",postfix);
}
```

```
void push(char a){
   if(top == max-1){
      printf("Stack overflow");
      exit(0);
   }
   else{
      stack[++top] = a;
   }
}

char pop(){
   if(top == -1){
      printf("Stack Underflow");
      exit(0);
   }
   else
      return stack[top--];
}

int precedence(char b){
   if(b == '^')
      return 3;
   else if(b == '/' || b == '*')
      return 2;
   else if(b == '+' || b == '-')
      return 1;
   else
      return 0;
}
```

Output:


C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\Lab3_infix_to_postfix.exe

```
Enter the infix expression: A+B*C-D+E/F
ABC*+D-EF/+
Process returned 11 (0xB)   execution time : 25.401 s
Press any key to continue.
```

Lab Program 3:

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

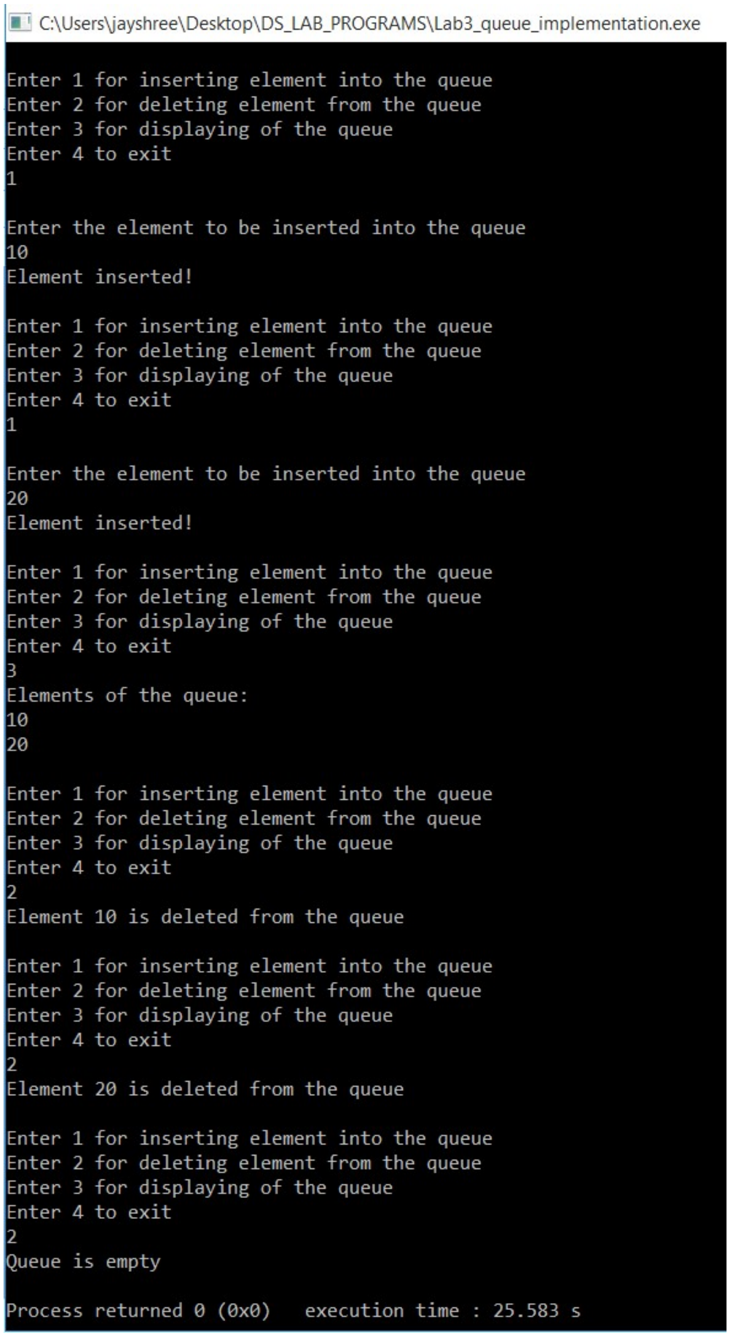
```
#include<stdio.h>

#include<stdlib.h>

#define max 6

void enqueue(int e);

int dequeue();

void display();

int q[max], front = -1, rear = -1, j = 0;


void main(){

   int choice, ele;

   while(1){

      printf("\nEnter 1 for inserting element into the queue\n");

      printf("Enter 2 for deleting element from the queue\n");
```

```
        printf("Enter 3 for displaying of the queue\n");
        printf("Enter 4 to exit\n");
        scanf("%d",&choice);
        switch(choice)
        {
            case 1:
                printf("\nEnter the element to be inserted into the queue\n");
                scanf("%d",&ele);
                enqueue(ele);
                break;
            case 2:
                printf("Element %d is deleted from the queue\n",dequeue());
                break;
            case 3:
                display();
                break;
            case 4:
                printf("Program ends successfully!!");
                exit(0);
                break;
            default:
                printf("Enter a valid choice.");
                continue;
        }
        continue;
    }
}

void enqueue(int e)
```

```
{
   if(rear == max-1){
       printf("Queue is full\n");
       exit(0);
   }



else
   {   if(rear == -1)
       {
       front=rear=0;
       q[rear] = e;
       }
       else
       {
           rear+=1;
           q[rear] = e;
       }
       printf("Element inserted!\n");
   return;
}
}





int dequeue()
{
   if(front > rear || front == -1){
       printf("Queue is empty\n");
```

```
        exit(0);
    }
    else{
        return q[front++];
    }
}

void display()
{
    if(front == -1 || front > rear){
        printf("Queue is empty\n");
        exit(0);
    }
    else{
        printf("Elements of the queue:\n");
        for(int i=front; i<=rear; i++)
            printf("%d\n",q[i]);
    }
}
```

Output:



C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\Lab3_queue_implementation.exe

```

Enter 1 for inserting element into the queue
Enter 2 for deleting element from the queue
Enter 3 for displaying of the queue
Enter 4 to exit
1

Enter the element to be inserted into the queue
10
Element inserted!

Enter 1 for inserting element into the queue
Enter 2 for deleting element from the queue
Enter 3 for displaying of the queue
Enter 4 to exit
1

Enter the element to be inserted into the queue
20
Element inserted!

Enter 1 for inserting element into the queue
Enter 2 for deleting element from the queue
Enter 3 for displaying of the queue
Enter 4 to exit
3
Elements of the queue:
10
20

Enter 1 for inserting element into the queue
Enter 2 for deleting element from the queue
Enter 3 for displaying of the queue
Enter 4 to exit
2
Element 10 is deleted from the queue

Enter 1 for inserting element into the queue
Enter 2 for deleting element from the queue
Enter 3 for displaying of the queue
Enter 4 to exit
2
Element 20 is deleted from the queue

Enter 1 for inserting element into the queue
Enter 2 for deleting element from the queue
Enter 3 for displaying of the queue
Enter 4 to exit
2
Queue is empty

Process returned 0 (0x0)   execution time : 25.583 s
```

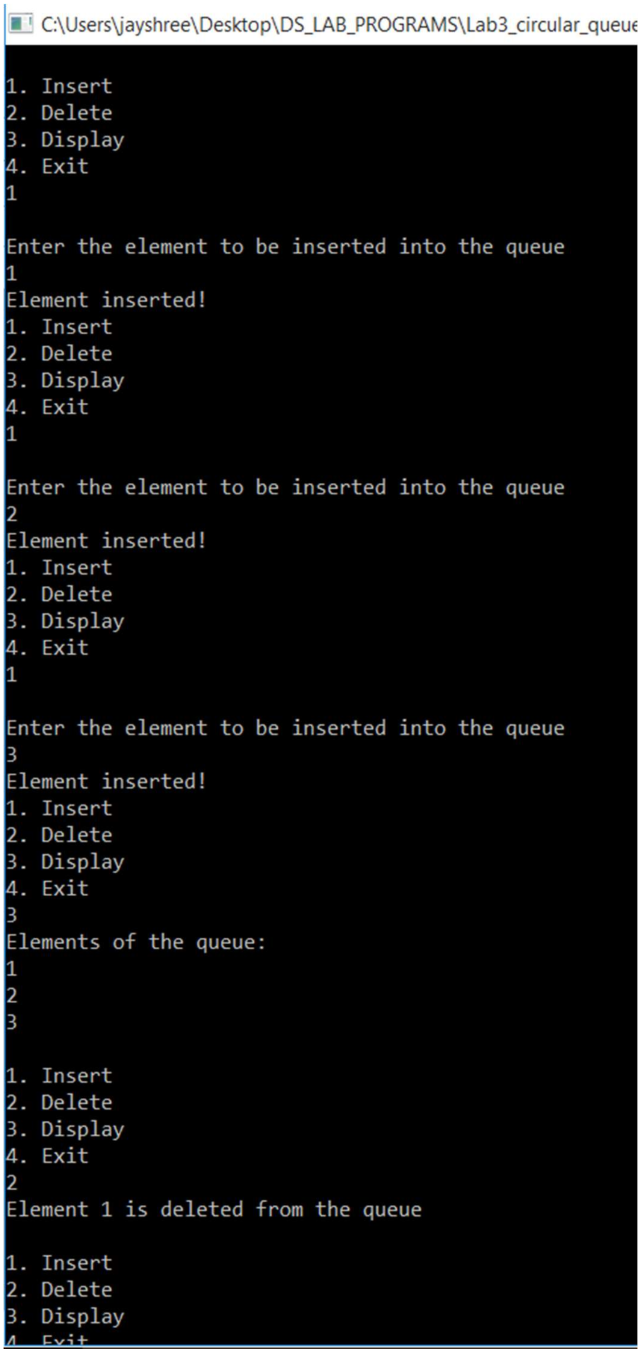
3b) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete & Display The program should print appropriate messages for queue empty and queue overflow conditions

```
#include<stdio.h>
#include<stdlib.h>
#define max 3
void enqueue(int e);
int dequeue();
void display();
int q[max], front = -1, rear = -1, j = 0;

void main(){
  int choice, ele;
  while(1){
    printf("\n1. Insert\n");
    printf("2. Delete\n");
    printf("3. Display\n");
    printf("4. Exit\n");
    scanf("%d",&choice);
    switch(choice)
    {
      case 1:
        printf("\nEnter the element to be inserted into the queue\n");
        scanf("%d",&ele);
        enqueue(ele);
        break;
      case 2:
        printf("Element %d is deleted from the queue\n",dequeue());
        break;
```

```
            case 3:
                display();
                break;
            case 4:
                printf("Program ends successfully!!");
                exit(0);
            default:
                printf("Enter a valid choice.");
                continue;
        }
    }
}
void enqueue(int e){
    if((rear-front) == max-1 || (front==(rear+1))){
        printf("Queue is full.");
        exit(0);
    }
   else{
        if(front == -1)
            rear = front = 0;
        else
            rear = (rear+1) % (max);
 }
    q[rear] = e;
    printf("Element inserted!");
}
int dequeue() {
    int item;
    if (front == -1) {
        printf("Queue is empty\n");
        exit(0);
    }
    item = q[front];
if (front == rear) {
        // Only one element in the queue
        front = rear = -1;
    } else {
        front = (front + 1) % max;
    }
    return item;
}
void display() {
    if (front == -1) {
        printf("Queue is empty\n");
        return;
    }
    if(rear>=front)
    {
        printf("Elements of the queue:\n");
        for(int i=front; i<=rear; i++)
            printf("%d\n", q[i]);
    }
    else{
        printf("Elements of the queue:\n");
       for(int i=front;i<=max-1;i++)
            printf("%d\n", q[i]);


        for(int i=0;i<=rear;i++)
```

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

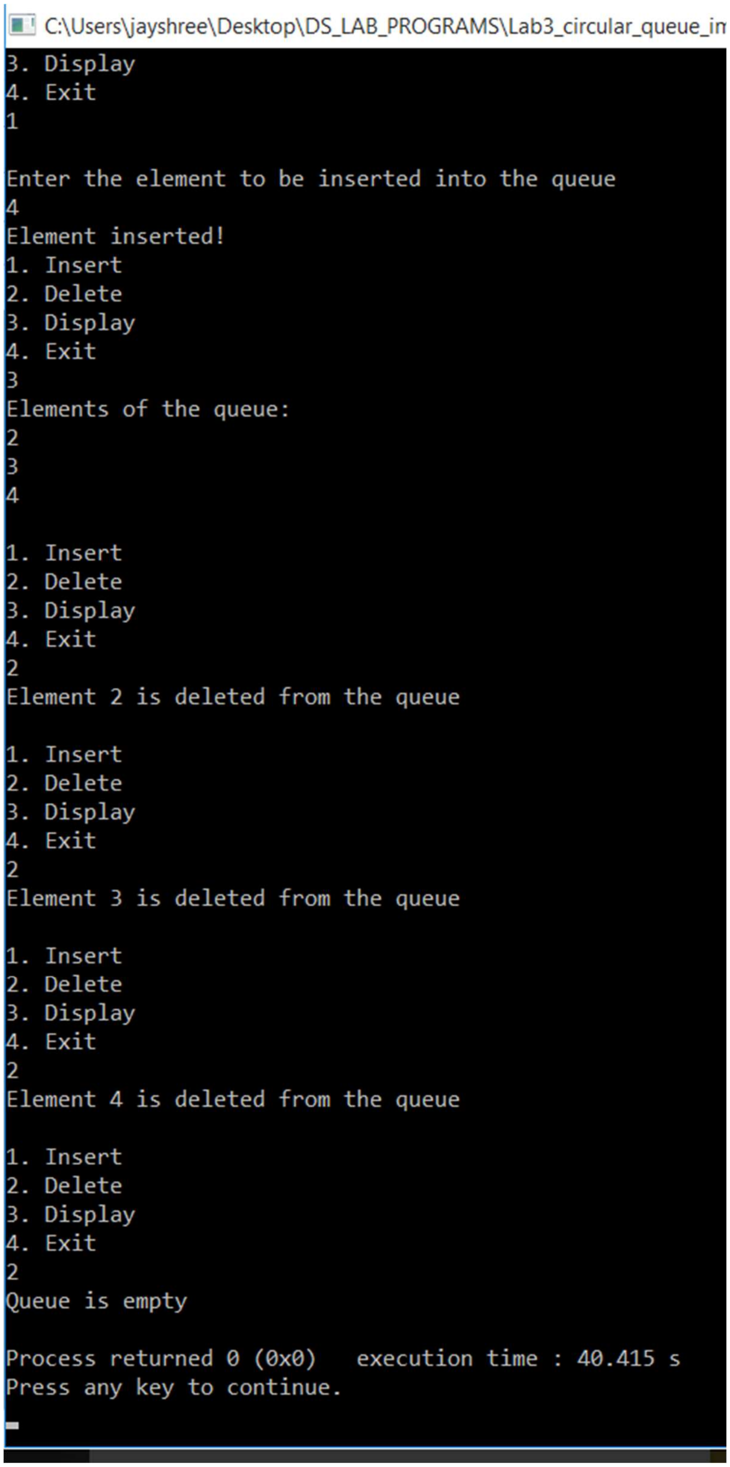
Output: 1)



C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\Lab3_circular_queue

```
1. Insert
2. Delete
3. Display
4. Exit
1

Enter the element to be inserted into the queue
1
Element inserted!
1. Insert
2. Delete
3. Display
4. Exit
1

Enter the element to be inserted into the queue
2
Element inserted!
1. Insert
2. Delete
3. Display
4. Exit
1

Enter the element to be inserted into the queue
3
Element inserted!
1. Insert
2. Delete
3. Display
4. Exit
3
Elements of the queue:
1
2
3


1. Insert
2. Delete
3. Display
4. Exit
2
Element 1 is deleted from the queue

1. Insert
2. Delete
3. Display
4. Exit
```

2)



C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\Lab3_circular_queue_im

```
3. Display
4. Exit
1

Enter the element to be inserted into the queue
4
Element inserted!
1. Insert
2. Delete
3. Display
4. Exit
3
Elements of the queue:
2
3
4

1. Insert
2. Delete
3. Display
4. Exit
2
Element 2 is deleted from the queue

1. Insert
2. Delete
3. Display
4. Exit
2
Element 3 is deleted from the queue

1. Insert
2. Delete
3. Display
4. Exit
2
Element 4 is deleted from the queue

1. Insert
2. Delete
3. Display
4. Exit
2
Queue is empty

Process returned 0 (0x0)   execution time : 40.415 s
Press any key to continue.
```

Lab Program 4:

Write a Program to Implement Singly Linked List with following operations a) Create a) linked list. b) Insertion of a node at first position, at any position and at end of list. Display the contents of the linked list.

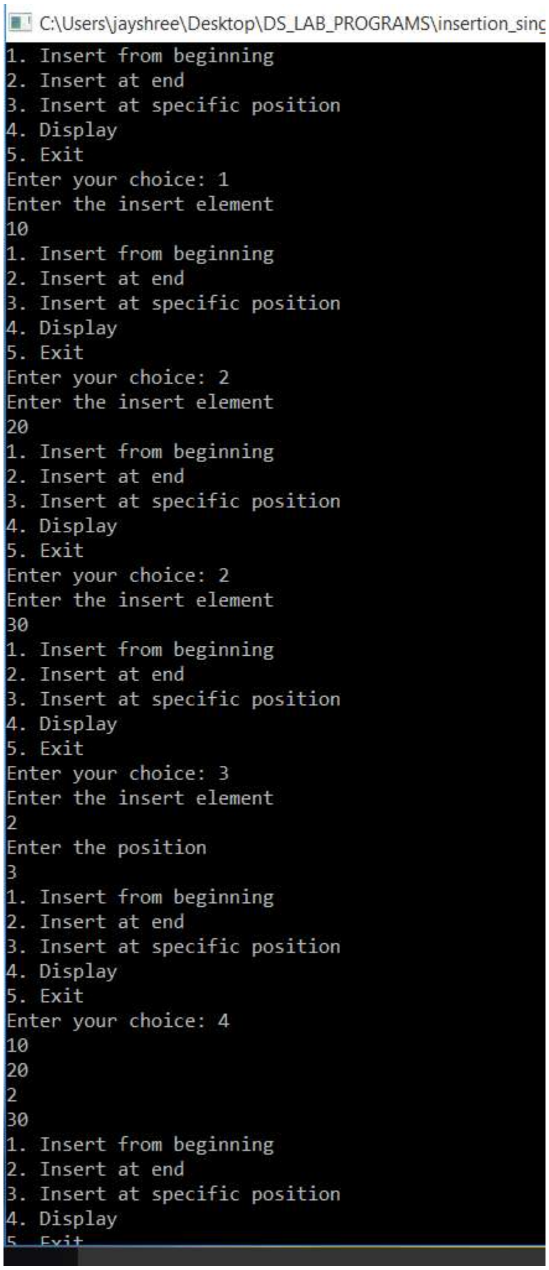
```
#include<stdio.h>

void push(int);

void append(int);

void insert_at_pos(int);

struct Node

{

   int data;

   struct Node *next;

};

struct Node *head = NULL;

int choice,pos,n;


void main()

{

   while(1){

   printf("1. Insert from beginning\n");

   printf("2. Insert at end\n");

   printf("3. Insert at specific position\n");

   printf("4. Display\n");

   printf("5. Exit\n");


   printf("Enter your choice: ");

   scanf("%d",&choice);


   switch(choice)
```

```
    {
    case 1:
        printf("Enter the insert element\n");
        scanf("%d",&n);
        push(n);
        break;
    case 2:
        printf("Enter the insert element\n");
        scanf("%d",&n);
        append(n);
        break;
    case 3:
        printf("Enter the insert element\n");
        scanf("%d",&n);
        insert_at_pos(n);
        break;
    case 4:
        display();
        break;
    case 5:
        exit(0);
    default:
        printf("Enter correct choice");
        break;
        }
        continue;
    }
}
void push(int n)
```

```
{
   struct Node* new_node = (struct Node*)malloc(sizeof(struct Node));
   new_node->data = n;
   new_node->next = head;
   head = new_node;
}


void append(int n)
{
   struct Node* new_node = (struct Node*)malloc(sizeof(struct Node));
   struct Node* last  = head;  // if head is linked to one or more nodes already, then point last
pointer to head.
   new_node->data = n;
   new_node->next = NULL;
   // if the list is empty.
   if(head == NULL)
   {
      head = new_node;
      return;
   }
   //traverse till the end
   else{
      while (last->next != NULL)
      {
         last = last->next;
      }
      last->next = new_node;
   }
}
```

```
void insert_at_pos(int n)
{
    int pos;
    printf("Enter the position\n");
    scanf("%d",&pos);
    struct Node* ptr =(struct Node*)malloc(sizeof(struct Node));
    struct Node* temp = head;
    ptr->data = n;

    if(pos==1){
        ptr->next = temp;
        head = ptr;
    }

    else{
        for(int i=1;i<pos-1 && temp!=NULL ;i++){
            temp = temp->next;
        }
        ptr->next = temp->next ;
        temp->next = ptr;
    }
}

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

Output:



C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\insertion_sinc

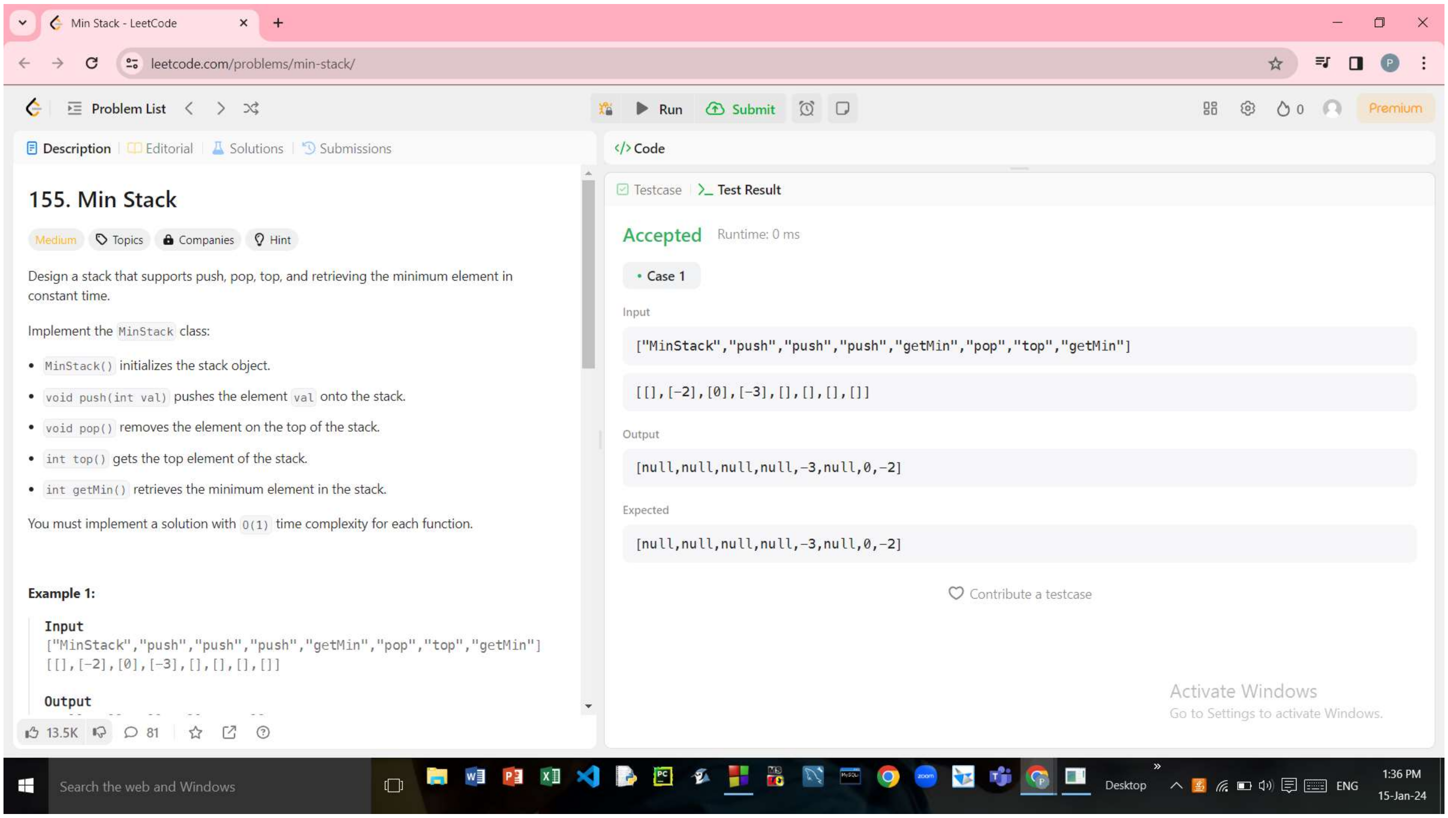
```
1. Insert from beginning
2. Insert at end
3. Insert at specific position
4. Display
5. Exit
Enter your choice: 1
Enter the insert element
10
1. Insert from beginning
2. Insert at end
3. Insert at specific position
4. Display
5. Exit
Enter your choice: 2
Enter the insert element
20
1. Insert from beginning
2. Insert at end
3. Insert at specific position
4. Display
5. Exit
Enter your choice: 2
Enter the insert element
30
1. Insert from beginning
2. Insert at end
3. Insert at specific position
4. Display
5. Exit
Enter your choice: 3
Enter the insert element
2
Enter the position
3
1. Insert from beginning
2. Insert at end
3. Insert at specific position
4. Display
5. Exit
Enter your choice: 4
10
20
2
30
1. Insert from beginning
2. Insert at end
3. Insert at specific position
4. Display
5. Exit
```

Program - Leetcode platform(Minimum 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);
}

int main() {
    MinStack* obj = minStackCreate();

    minStackPush(obj, 3);
    minStackPush(obj, 5);
    minStackPush(obj, 2);
    minStackPush(obj, 1);

    printf("Min: %d\n", minStackGetMin(obj));



    printf("Top: %d\n", minStackTop(obj));

    minStackPop(obj);
    printf("Min: %d\n", minStackGetMin(obj));
    minStackFree(obj);

    return 0;
}
```

Output:



155. Min Stack

Design a stack that supports push, pop, top, and retrieving the minimum element in constant time.

Implement the `MinStack` class:

- `MinStack()` initializes the stack object.
- `void push(int val)` pushes the element `val` onto the stack.
- `void pop()` removes the element on the top of the stack.
- `int top()` gets the top element of the stack.
- `int getMin()` retrieves the minimum element in the stack.

You must implement a solution with `O(1)` time complexity for each function.

Example 1:

```
Input
["MinStack","push","push","push","getMin","pop","top","getMin"]
[[],[-2],[0],[-3],[],[],[],[]]

Output
```

Accepted Runtime: 0 ms

Case 1

Input

```
["MinStack","push","push","push","getMin","pop","top","getMin"]
[[],[-2],[0],[-3],[],[],[],[]]
```

Output

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

Expected

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

Contribute a testcase

Activate Windows
Go to Settings to activate Windows.

Lab Program 5:

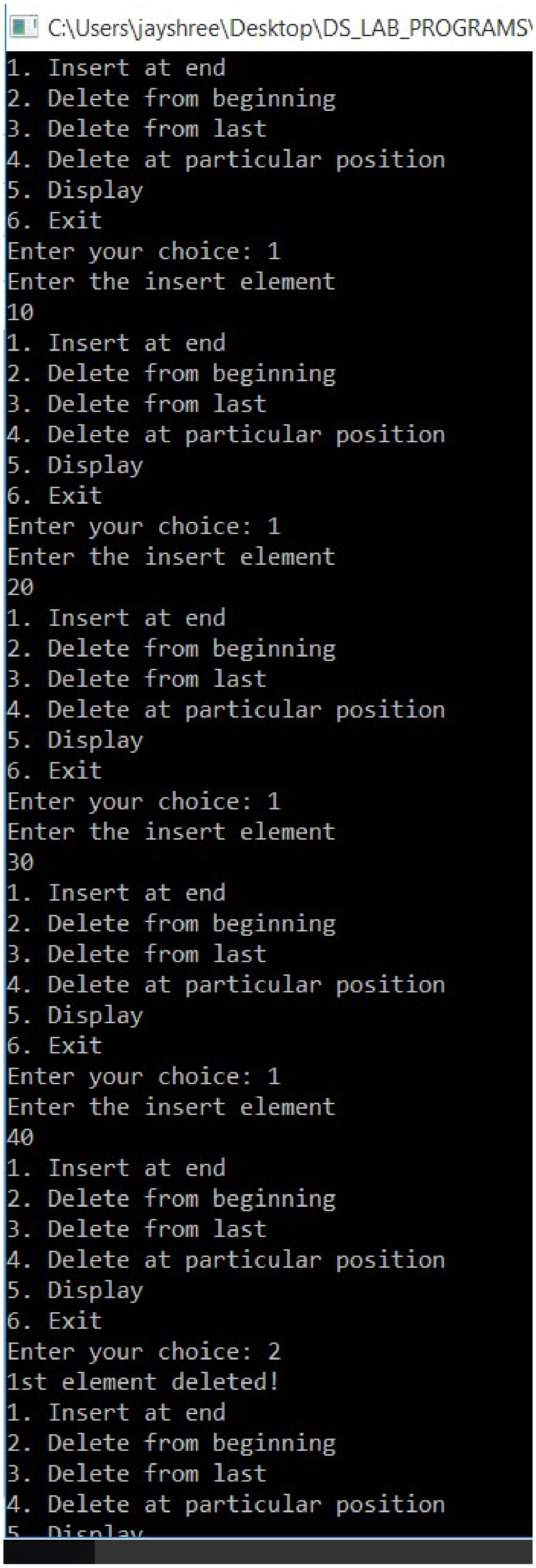
Write a Program to Implement Singly Linked List with following operations a) Create a linked list. b) Deletion of first element, specified element and last element in the list. c) Display the contents of the linked list.

```
#include<stdio.h>

void append(int);

void fpop();

void lpop();

void mpop();

struct Node

{

   int data;

   struct Node *next;

};


struct Node *head = NULL;

int choice,pos,n;


void main()

{

   while(1){

   printf("1. Insert at end\n");

   printf("2. Delete from beginning\n");

   printf("3. Delete from last\n");

   printf("4. Delete at particular position\n");

   printf("5. Display\n");

   printf("6. Exit\n");


   printf("Enter your choice: ");

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

```
    switch(choice)
    {
    case 1:
        printf("Enter the insert element\n");
        scanf("%d",&n);
        append(n);
        break;
    case 2:
        fpop();
        break;
    case 3:
        lpop();
        break;
    case 4:
        mpop();
        break;
    case 5:
        display();
        break;
    case 6:
        exit(0);
    default:
        printf("Enter correct choice\n");
        break;
        }
        continue;
    }
}
```

```
void append(int n)
{
    struct Node* new_node = (struct Node*)malloc(sizeof(struct Node));
    struct Node* last  = head;  // if head is linked to one or more nodes already, then point last pointer to head.
    new_node->data = n;
    new_node->next = NULL;
    // if the list is empty.
    if(head == NULL)
    {
        head = new_node;
        return;
    }
    //traverse till the end
    else{
        while (last->next != NULL)
        {
            last = last->next;
        }
        last->next = new_node;
    }
}


void fpop()
{
struct Node *ptr;
   if(head == NULL)
        printf("List is empty\n");
   else
   {
    ptr = head;
    head = head->next;
    free(ptr);
    printf("1st element deleted!\n");
   }
}

void lpop()
{
    struct Node *ptr,*p1;

    if(head == NULL)
        printf("List is empty\n");

    else
    {
        if(head->next == NULL)
        {
        free(head);
        head = NULL;
        }

        else
        {   ptr = head;
            while(ptr->next != NULL)
            {
                p1 = ptr;
                ptr = ptr->next;
            }
            p1->next = NULL;
            free(ptr);
        }
        printf("Last element deleted!\n");
    }

}




void mpop()
{
    int pos;
    printf("Enter the position to be deleted\n");
    scanf("%d",&pos);
    struct Node *ptr,*ptr1;
    if(pos == 1)
    {
        ptr = head;
        free(ptr);
        head = NULL;
    }
    else
    {
        ptr = head;
        while(pos-1 != 0)
        {
            ptr1 = ptr;
            ptr = ptr->next;
            pos--;
        }
        ptr1->next = ptr->next;
        free(ptr);
    }
    printf("element deleted!\n");
}
void display()
{
    struct Node* node = head;
    while(node != NULL)
        {
            printf("%d\n",node->data);
            node = node->next;
        }
}
```

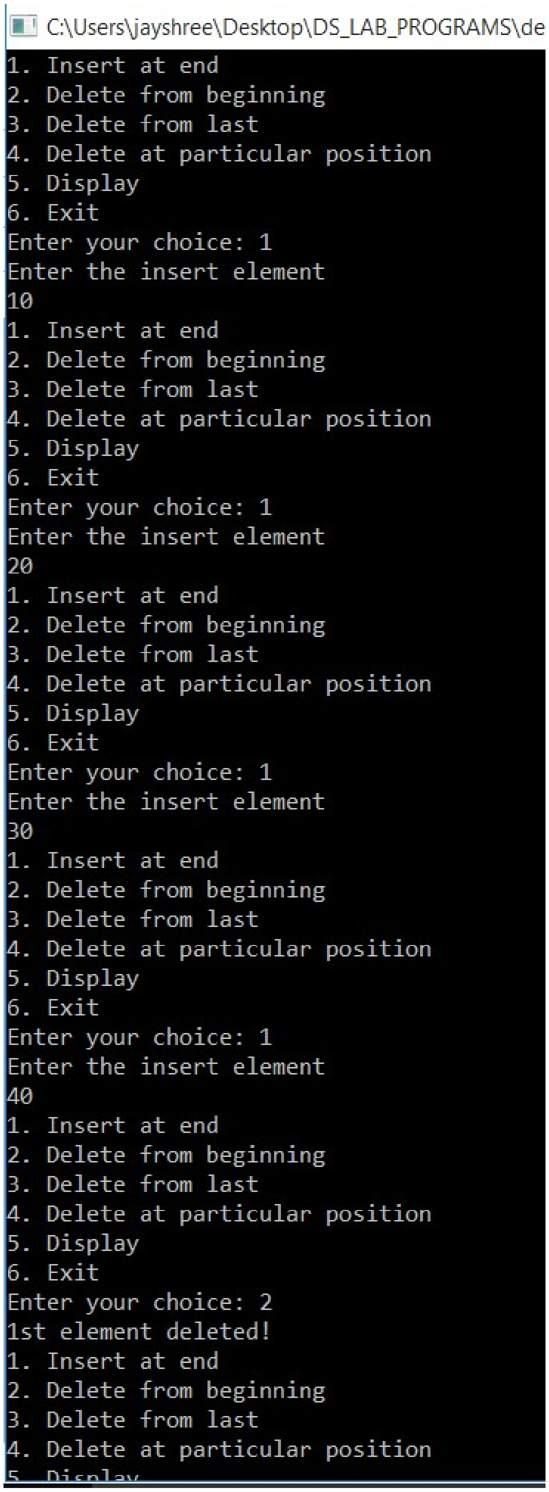
Output: 1)



C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\

```
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
6. Exit
Enter your choice: 1
Enter the insert element
10
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
6. Exit
Enter your choice: 1
Enter the insert element
20
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
6. Exit
Enter your choice: 1
Enter the insert element
30
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
6. Exit
Enter your choice: 1
Enter the insert element
40
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
6. Exit
Enter your choice: 2
1st element deleted!
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
```

2)



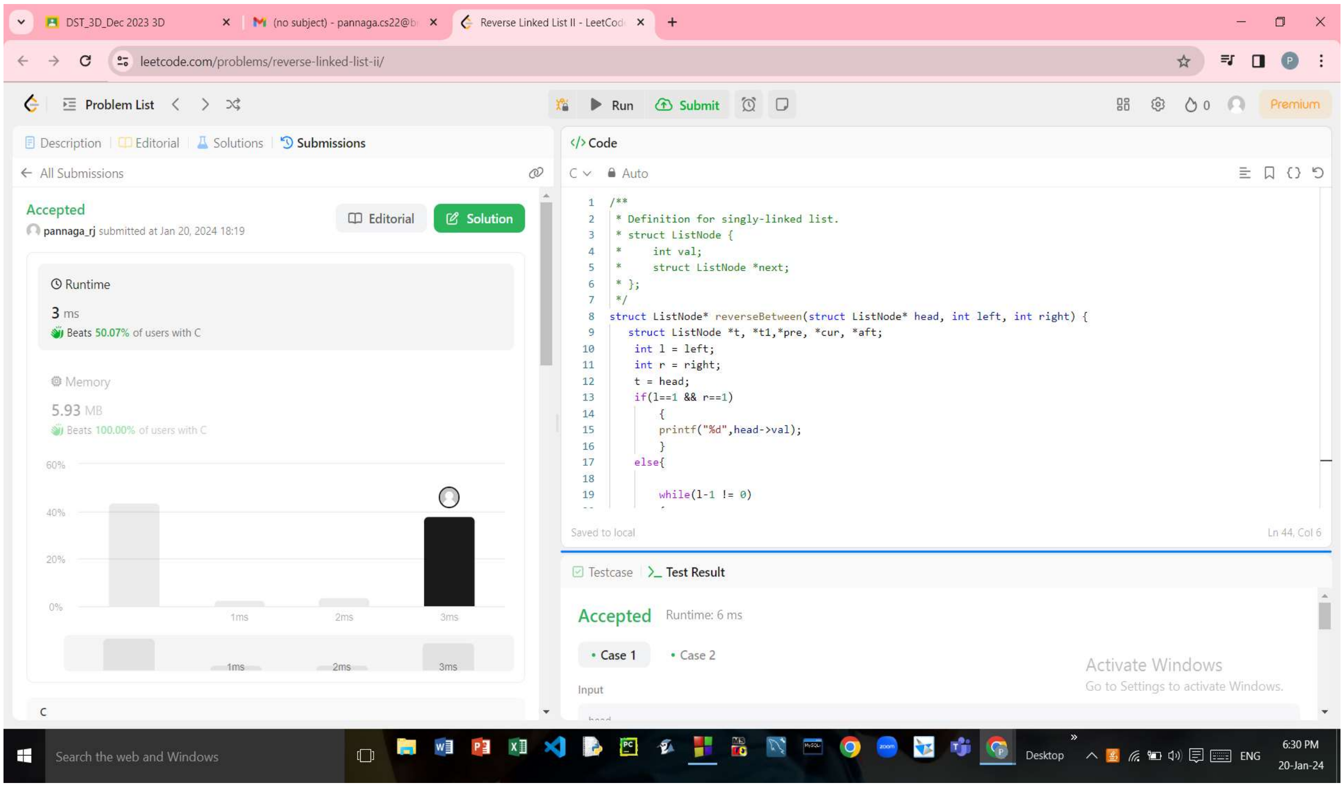
C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\de

```
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
6. Exit
Enter your choice: 1
Enter the insert element
10
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
6. Exit
Enter your choice: 1
Enter the insert element
20
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
6. Exit
Enter your choice: 1
Enter the insert element
30
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
6. Exit
Enter your choice: 1
Enter the insert element
40
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
6. Exit
Enter your choice: 2
1st element deleted!
1. Insert at end
2. Delete from beginning
3. Delete from last
4. Delete at particular position
5. Display
```

Program - Leetcode platform (Reverse Linked List II):

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* reverseBetween(struct ListNode* head, int left, int right) {
   struct ListNode *t, *t1,*pre, *cur, *aft;
    int l = left;
    int r = right;
    t = head;
    if(l==1 && r==1)
        {
        printf("%d",head->val);
        }
    else{
        while(l-1 != 0)
        {
            t1 = t;
            t = t->next;
            l--;
        }
        pre = NULL;
        cur = aft = t;
        for(int i=left;i<=right;i++)
        {
            aft = aft->next;
            cur->next = pre;
            pre = cur;
            cur = aft;
        }
        t1->next = pre;
        t->next = aft;
    }
        if (left > 1) {
        return head;
    } else {
        return pre;
    }
}
```

Output:



leetcode.com/problems/reverse-linked-list-ii/

Accepted

pannaga_rj submitted at Jan 20, 2024 18:19

Runtime

3 ms

Beats 50.07% of users with C

Memory

5.93 MB

Beats 100.00% of users with C

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* reverseBetween(struct ListNode* head, int left, int right) {
   struct ListNode *t, *t1,*pre, *cur, *aft;
    int l = left;
    int r = right;
    t = head;
    if(l==1 && r==1)
        {
        printf("%d",head->val);
        }
    else{

        while(l-1 != 0)
```

Saved to local

Ln 44, Col 6

Accepted Runtime: 6 ms

Case 1 Case 2

Input

Lab Program 6

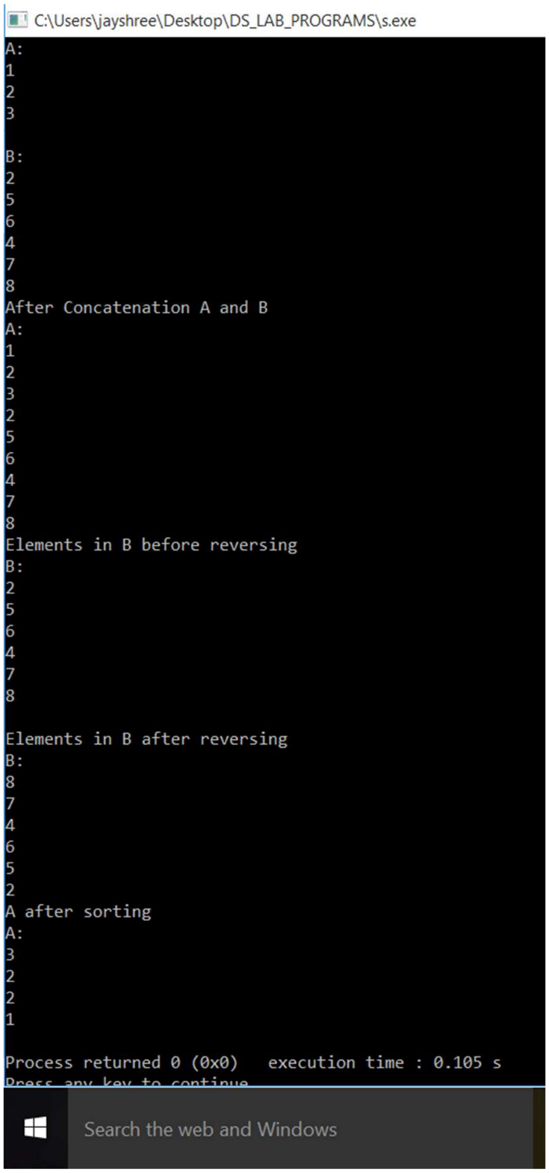
6a) Write a program to Implement Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists.

```
#include<stdio.h>


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


struct node *head, *head1, *head3;



void create()
{
    head = (struct node*)malloc(sizeof(struct node));
    head1 = (struct node*)malloc(sizeof(struct node));
   struct node *last, *last1;
   int a[] = {1,2,3,4};
   int b[] = {2,5,6,4,7,8};

   head->data = a[0];
   head->next = NULL;

   head1->data = b[0];
   head1->next = NULL;

   last = head;
   last1 = head1;
```

```
  for(int i=1;i<sizeof(a)/sizeof(a[0]);i++)
  {
     struct node *t;
     t = (struct node*)malloc(sizeof(struct node));
     t->data = a[i];
     t->next = NULL;
     last->next = t;
     last = t;
  }

  for(int i=1;i<sizeof(b)/sizeof(b[0]);i++)
  {
      struct node *t1;
      t1 = (struct node*)malloc(sizeof(struct node));
      t1->data = b[i];
      t1->next = NULL;
      last1->next = t1;
      last1 = t1;
   }

}



void display_a()
{
   struct node *n = head;

   printf("A:\n");
   while(n!=NULL)
```

```
    {
        printf("%d\n",n->data);
        n = n->next;
    }
    return;
}

void display_b()
{
    struct node *n1 = head1;

    printf("B:\n");
    while(n1!=NULL)
    {
        printf("%d\n",n1->data);
        n1 = n1->next;
    }
}

void reverse()
{
    struct node *t, *pre, *cur, *aft;
    printf("Elements in B before reversing\n");
    display_b();
    t = head1;
    pre = NULL;
    cur = aft = t;
    while(cur != NULL)
    {
        aft = aft->next;
        cur->next = pre;
        pre = cur;
        cur = aft;
    }
    head1 = pre;
    printf("\n");
    printf("Elements in B after reversing\n");
    display_b();
}

void concat()
{
    struct node *n, *n1;
    if(head == NULL || head1 == NULL)
    {
        if(head == NULL)
            display_b();
        else
            display_a();
    }
    else
    {
        n=head;
        while(n!=NULL)
        {
            n1 = n;
            n = n->next;
        }
        n1->next = head1;
        display_a();
    }

}

void sort()
{
    struct node *p, *p1;
    for(p = head; p!= NULL; p=p->next)
    {
        for(p1 = p->next;p1!=NULL; p1=p1->next)
        {
            if(p->data < p1->data)
            {
                int temp = p->data;
                p->data = p1->data;
                p1->data = temp;
            }
        }
    }
    printf("A after sorting\n");
    display_a();
}

void main()
{
    create();
    display_a();
    printf("\n");
    display_b();
    printf("After Concatenation A and B\n");
    concat();
    reverse();
    sort();
}
```

Output:


C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\s.exe
Search the web and Windows

```
A:
1
2
3

B:
2
5
6
4
7
8
After Concatenation A and B
A:
1
2
3
2
5
6
4
7
8
Elements in B before reversing
B:
2
5
6
4
7
8

Elements in B after reversing
B:
8
7
4
6
5
2
A after sorting
A:
3
2
2
1

Process returned 0 (0x0)   execution time : 0.105 s
Press any key to continue.
```

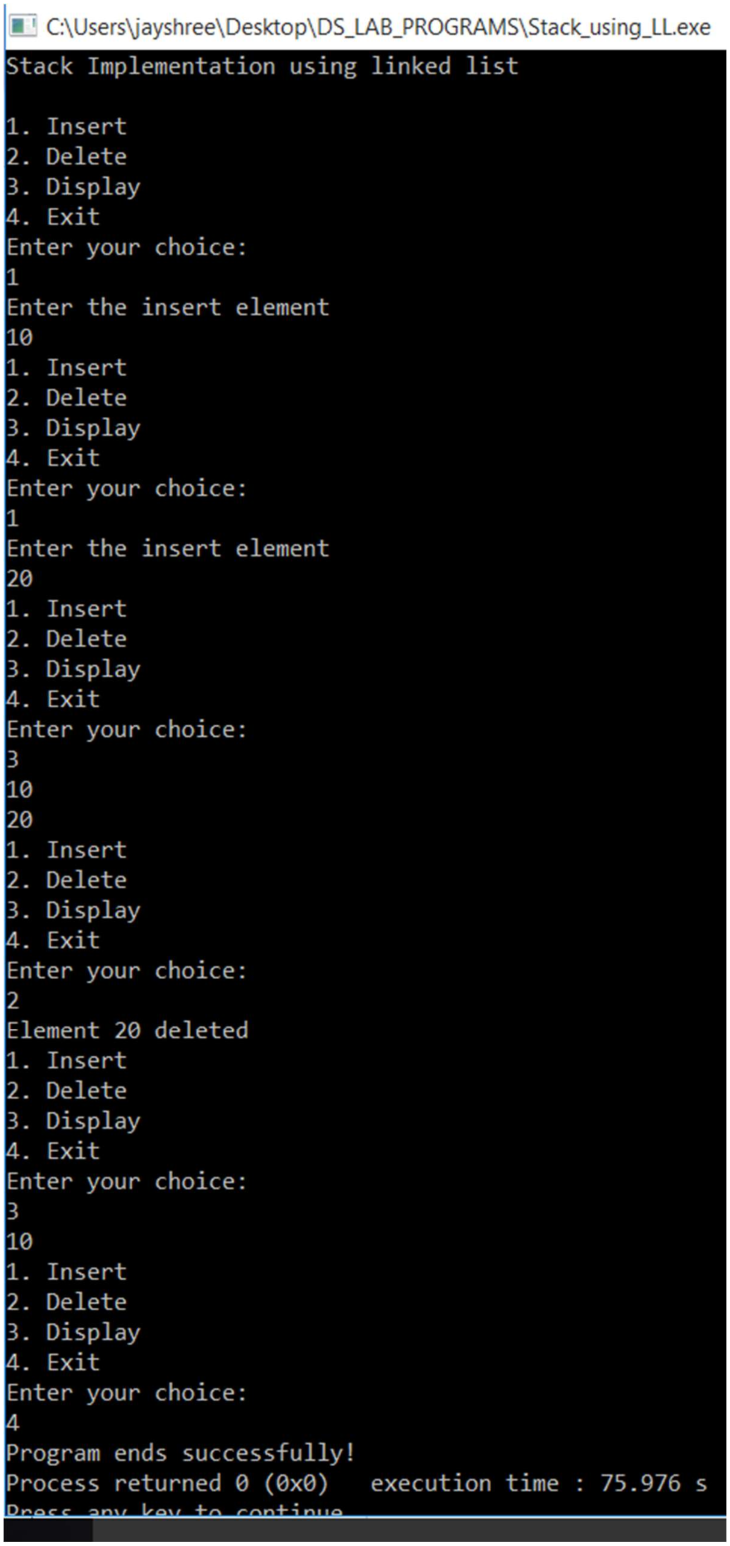
6b) WAP to Implement Single Link List to simulate Stack & Queue Operations.

Stack Implementation

```
#include<stdio.h>
#include<stdlib.h>
void push();
void pop();
void display();

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

struct node *head = NULL;
void main()
{
    int ch;
    printf("Stack Implementation using linked list\n\n");
    while(1){
        printf("1. Insert\n");
        printf("2. Delete\n");
        printf("3. Display\n");
        printf("4. Exit\n");
        printf("Enter your choice:\n");
        scanf("%d",&ch);
        switch(ch)
        {
            case 1:
                push();
                break;
            case 2:
                pop();
                break;
            case 3:
                display();
                break;
            case 4:
                printf("Program ends successfully!");
                exit(0);
            default:
                printf("Enter a valid number...\n");
        }
        continue;
    }
}

void push()
{
    int n;
    printf("Enter the insert element\n");
    scanf("%d",&n);

    struct node *new_node = (struct node*)malloc(sizeof(struct node));
    new_node -> data = n;
    new_node->next = NULL;

    if(head == NULL)
        head = new_node;
    else
    {   struct node *p;
        p = head;
        while(p->next != NULL)
        {
            p = p->next;
        }
        p->next = new_node;
    }
    return;
}

void pop()
{
    struct node *ptr,*p2;
    if(head == NULL)
    {
        printf("List is empty\n");
        exit(0);
    }
    else
    {   if(head->next == NULL)
        {
            printf("Element %d deleted\n",head->data);
            free(head);
            head = NULL;
        }
        else
        {
            ptr = head;
            while(ptr->next != NULL)
            {
                p2 = ptr;
                ptr = ptr->next;
            }
            printf("Element %d deleted\n",ptr->data);
            p2->next = NULL;
            free(ptr);
        }
        return;
    }
}
void display()
{
    struct node *n;
    if(head == NULL)
    {
        printf("List is empty");
        exit(0);
    }
    else{
    n = head;
    while(n != NULL)
        {
            printf("%d\n",n->data);
            n = n->next;
        }
    }
```

```
}
```

Output:


C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\Stack_using_LL.exe

```
Stack Implementation using linked list

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
1
Enter the insert element
10
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
1
Enter the insert element
20
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
3
10
20
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
2
Element 20 deleted
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
3
10
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
4
Program ends successfully!
Process returned 0 (0x0)   execution time : 75.976 s
Press any key to continue.
```

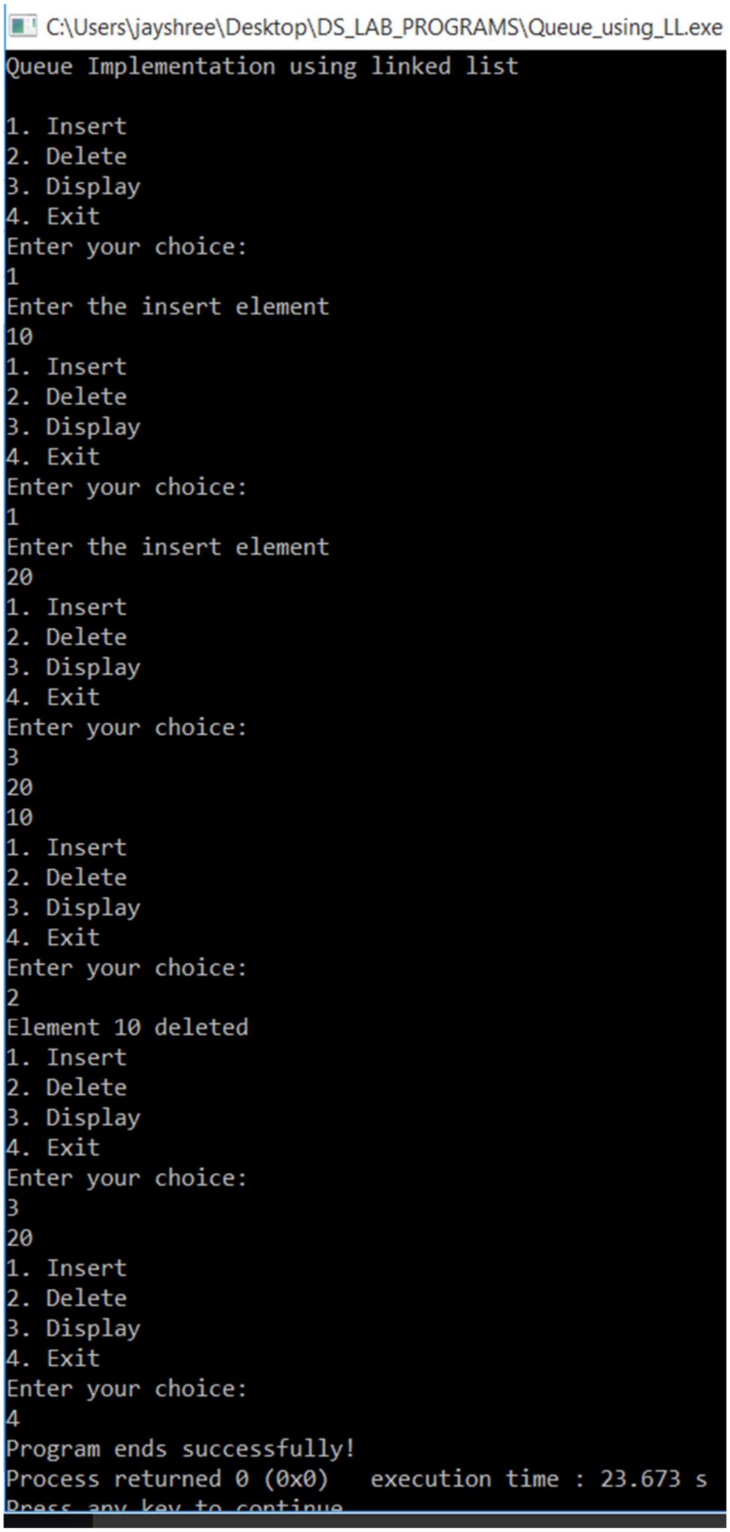
Queue Implementation

```
#include<stdio.h>

#include<stdlib.h>

void enqueue();

void dequeue();

void display();


struct node{

   int data;

   struct node *next;

};


struct node *head = NULL;

void main()

{

   int ch;

   printf("Queue Implementation using linked list\n\n");

   while(1){

      printf("1. Insert\n");

      printf("2. Delete\n");

      printf("3. Display\n");

      printf("4. Exit\n");

      printf("Enter your choice:\n");

      scanf("%d",&ch);

      switch(ch)

      {

         case 1:

            enqueue();

            break;
            case 2:
                dequeue();
                break;
            case 3:
                display();
                break;
            case 4:
                printf("Program ends successfully!");
                exit(0);
            default:
                printf("Enter a valid number...\n");
        }
        continue;
    }
}

void enqueue()
{
    int n;
    printf("Enter the insert element\n");
    scanf("%d",&n);

    struct node *new_node =(struct node*)malloc(sizeof(struct node));
    new_node->data = n;
    new_node->next = head;
    head = new_node;
}

void dequeue()
```

```
{
   if(head == NULL)
   {
      printf("List is empty");
      exit(0);
   }
   else
   {
      if(head->next == NULL)
      {
         printf("Element %d deleted\n",head->data);
         free(head);
         head = NULL;
      }
      else
      {
         struct node *p,*p1;
         p = head;
         while(p->next != NULL)
         {
            p1 = p;
            p = p->next;
         }
         p1->next = NULL;
         printf("Element %d deleted\n",p->data);
         free(p);
      }
   }
}
```

```
void display()
{
    struct node *n;
    if(head == NULL)
    {
        printf("List is empty");
        exit(0);
    }
    else{
    n = head;
    while(n != NULL)
        {
            printf("%d\n",n->data);
            n = n->next;
        }
    }
}
```

Output:


C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\Queue_using_LL.exe

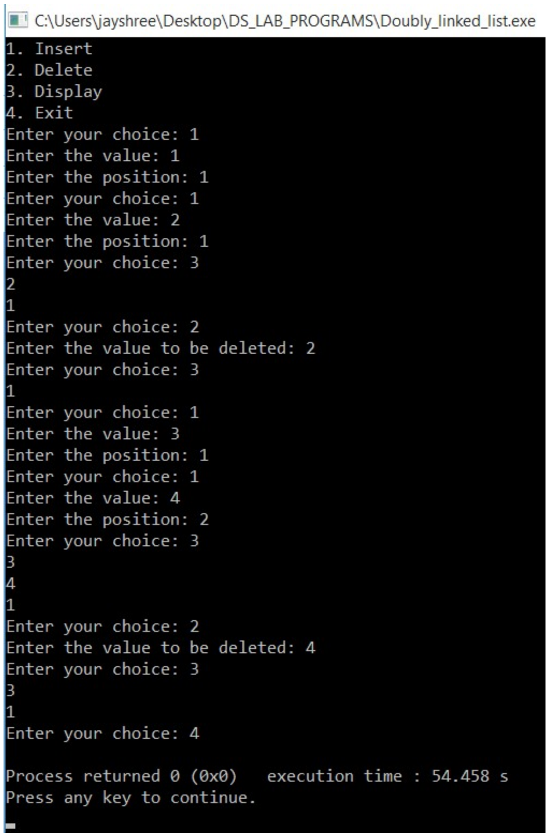
```
Queue Implementation using linked list

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
1
Enter the insert element
10
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
1
Enter the insert element
20
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
3
20
10
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
2
Element 10 deleted
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
3
20
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
4
Program ends successfully!
Process returned 0 (0x0)   execution time : 23.673 s
Press any key to continue
```

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>
#include <stdlib.h>

struct node
{
    struct node *pre;
    struct node *next;
    int data;
};
struct node *head = NULL;

void insert_left();
void delete_val();
void display();

int main()
{
    int ch;
    printf("1. Insert\n");
    printf("2. Delete\n");
    printf("3. Display\n");
    printf("4. Exit\n");

    while (1)
    {
        printf("Enter your choice: ");
        scanf("%d", &ch);
        switch (ch)
        {
        case 1:
            insert_left();
            break;
        case 2:
            delete_val();
            break;
        case 3:
            display();
            break;
        case 4:
            exit(0);
        default:
            printf("Enter correct choice:\n");
            break;
        }
    }
}

void insert_left()
{
    int val, pos;
    printf("Enter the value: ");
    scanf("%d", &val);
    printf("Enter the position: ");
    scanf("%d", &pos);
    struct node *new_node = (struct node*)malloc(sizeof(struct node));
    new_node->data = val;

    if (pos == 1)
    {
        new_node->pre = NULL;
        new_node->next = head;
        if (head != NULL)
        {
            head->pre = new_node;  // Set the "pre" pointer of the current head to the new node, if it has one node already.
        }
        head = new_node;
    }
    else
    {
        struct node *t;
        if(pos>1)
        {
            t = head;
            while(pos-1 != 0)
            {
                t = t->next;
                pos--;
            }
            new_node->pre = t->pre;
            new_node->next = t;
            t->pre->next = new_node;
            t->pre = new_node;
        }
    }
}

void delete_val()
{
    int d, c = 1;
    printf("Enter the value to be deleted: ");
    scanf("%d", &d);

    struct node *t = head;

    if (head == NULL)
    {
        printf("List is empty\n");
        return;
    }
    else
    {
        while(t != NULL)
        {
            if(t->data == d)
            {
                break;
            }
            t = t->next;
            c++;
        }
        if(t != NULL)
        {
            if(c==1)
            {
                head = t->next;

                if(head != NULL)
                    t->next->pre = NULL;

                free(t);
            }
            else
            {
            t->pre->next = t->next;

            if( t->next != NULL)
                t->next->pre = t->pre;

            free(t);
            }
        }
        else
        {
            printf("Element not found\n");
        }
    }
}
void display()
{
    struct node *t = head;
    if (head == NULL){
        printf("List is empty\n");
        return;
    }
    else{
        while (t != NULL)
        {
            printf("%d\n", t->data);
            t = t->next;
        }
    }
}
```

Output:

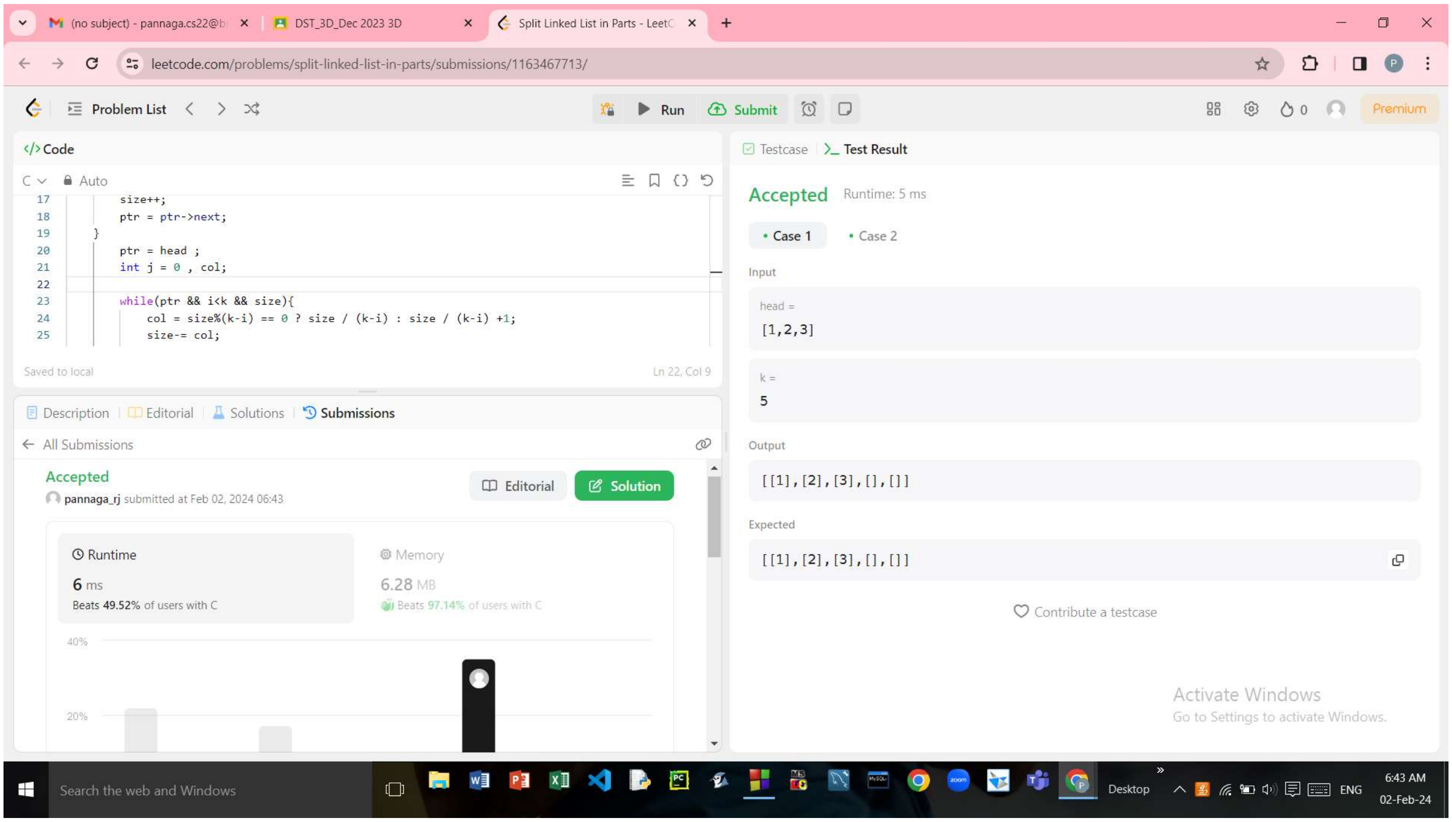

C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\Doubly_linked_list.exe

```
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value: 1
Enter the position: 1
Enter your choice: 1
Enter the value: 2
Enter the position: 1
Enter your choice: 3
2
1
Enter your choice: 2
Enter the value to be deleted: 2
Enter your choice: 3
1
Enter your choice: 1
Enter the value: 3
Enter the position: 1
Enter your choice: 1
Enter the value: 4
Enter the position: 2
Enter your choice: 3
3
4
1
Enter your choice: 2
Enter the value to be deleted: 4
Enter your choice: 3
3
1
Enter your choice: 4

Process returned 0 (0x0)   execution time : 54.458 s
Press any key to continue.
```

Program - Leetcode platform(Split Linked List into parts):

```
/**
 * 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 **arr = (struct ListNode*)calloc(k+1,sizeof(struct ListNode));
    int size = 0 ;
    struct ListNode *ptr = head , *next ;
    *returnSize = k; int i = 0;
    while(ptr){
        size++;
        ptr = ptr->next;
    }
        ptr = head ;
        int j = 0 , col;

        while(ptr && i<k && size){
            col = size%(k-i) == 0 ? size / (k-i) : size / (k-i) +1;
            size-= col;
            head = ptr;
            j = 0;
            while(ptr && j<col-1){
                ptr= ptr->next;
                j++;
            }
            next = ptr->next;
            arr[i++] = head , ptr->next = NULL;
            ptr = next;
        }
    return arr;
}
```

Output:



leetcode.com/problems/split-linked-list-in-parts/submissions/1163467713/

```
        size++;
        ptr = ptr->next;
    }

        ptr = head ;
        int j = 0 , col;

        while(ptr && i<k && size){
            col = size%(k-i) == 0 ? size / (k-i) : size / (k-i) +1;
            size-= col;
```

Accepted

pannaga_rj submitted at Feb 02, 2024 06:43

Runtime 6 ms Beats 49.52% of users with C

Memory 6.28 MB Beats 97.14% of users with C

Accepted Runtime: 5 ms

Case 1 Case 2

Input

head =
[1,2,3]

k =
5

Output

```
[[1],[2],[3],[],[]]
```

Expected

```
[[1],[2],[3],[],[]]
```

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

{

   int data;

   struct node *l;

   struct node *r;

};


struct node *root = NULL;


struct node *create(int d)

{

   struct node *t = (struct node*)malloc(sizeof(struct node));

   t->data = d;

   t->l = t->r = NULL;

   return t;

}

struct node *insert(struct node* t, int val)

{

   if(t == NULL)

   {

      return create(val);

   }

   if(val < t->data)
```

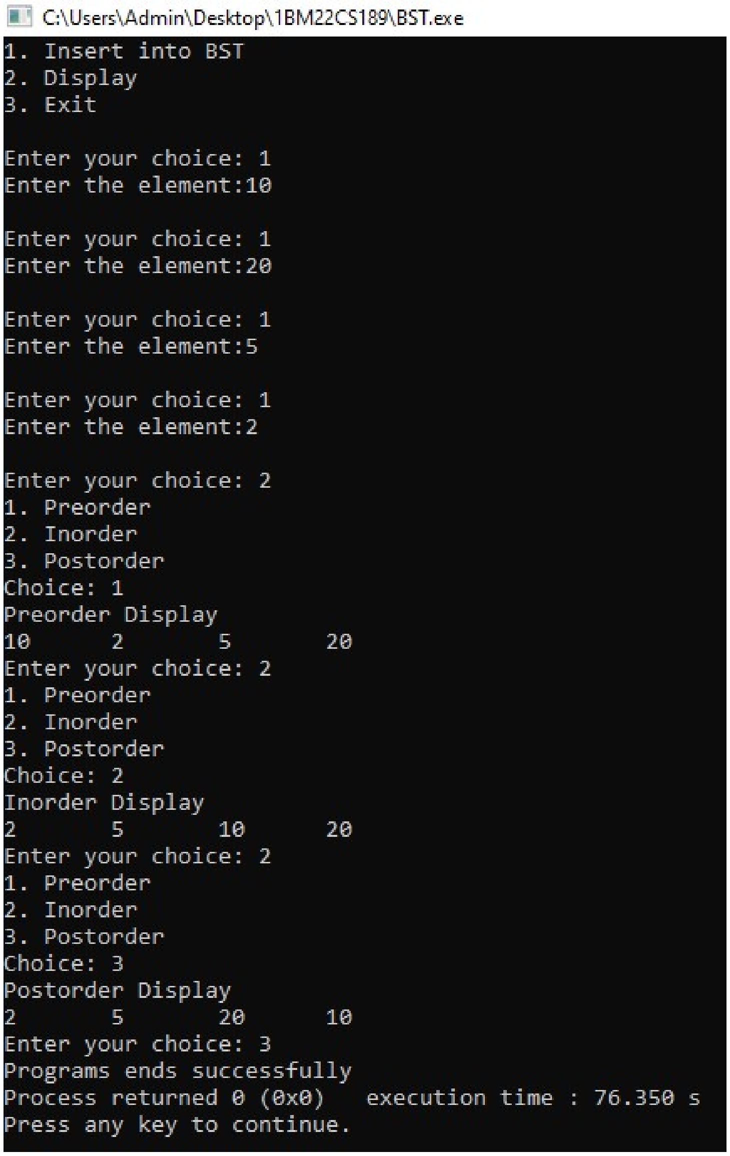
```
    {
        t->l = insert(t->l, val);
    }
    else if(val > t->data)
    {
        t->r = insert(t->r, val);
    }
    return t;
}

struct node* inorder(struct node* root)
{
    if(root != NULL)
    {
        inorder(root->l);
        printf("%d\t",(root->data));
        inorder(root->r);
    }
}

struct node* postorder(struct node* root)
{
    if(root != NULL)
    {
        postorder(root->l);
        postorder(root->r);
        printf("%d\t",root->data);
    }
}
```

```
struct node* preorder(struct node* root)
{
   if(root != NULL)
   {
      printf("%d\t",root->data);
      postorder(root->l);
      postorder(root->r);

   }
}

void main()
{
   int ch, d, d1;
   printf("1. Insert into BST\n");
   printf("2. Display\n");
   printf("3. Exit\n");
   while(1)
   {
      printf("\nEnter your choice: ");
      scanf("%d",&ch);
      switch(ch)
      {
      case 1:
         printf("Enter the element:");
         scanf("%d",&d);
         root = insert(root, d);
         break;
```

```
case 2:
   printf("1. Preorder\n");
   printf("2. Inorder\n");
   printf("3. Postorder\n");
   printf("Choice: ");
   scanf("%d",&d1);
   switch(d1)
   {
   case 1:
      printf("Preorder Display\n");
      preorder(root);
      break;
   case 2:
      printf("Inorder Display\n");
      inorder(root);
      break;
   case 3:
      printf("Postorder Display\n");
      postorder(root);
      break;
   default:
      printf("Enter correct choice.");
      break;
   }
   break;

case 3:
   printf("Programs ends successfully");
   exit(0);
```

```
        default:
            printf("Enter correct choice");
            break;
        }
    }
}
```

Output:



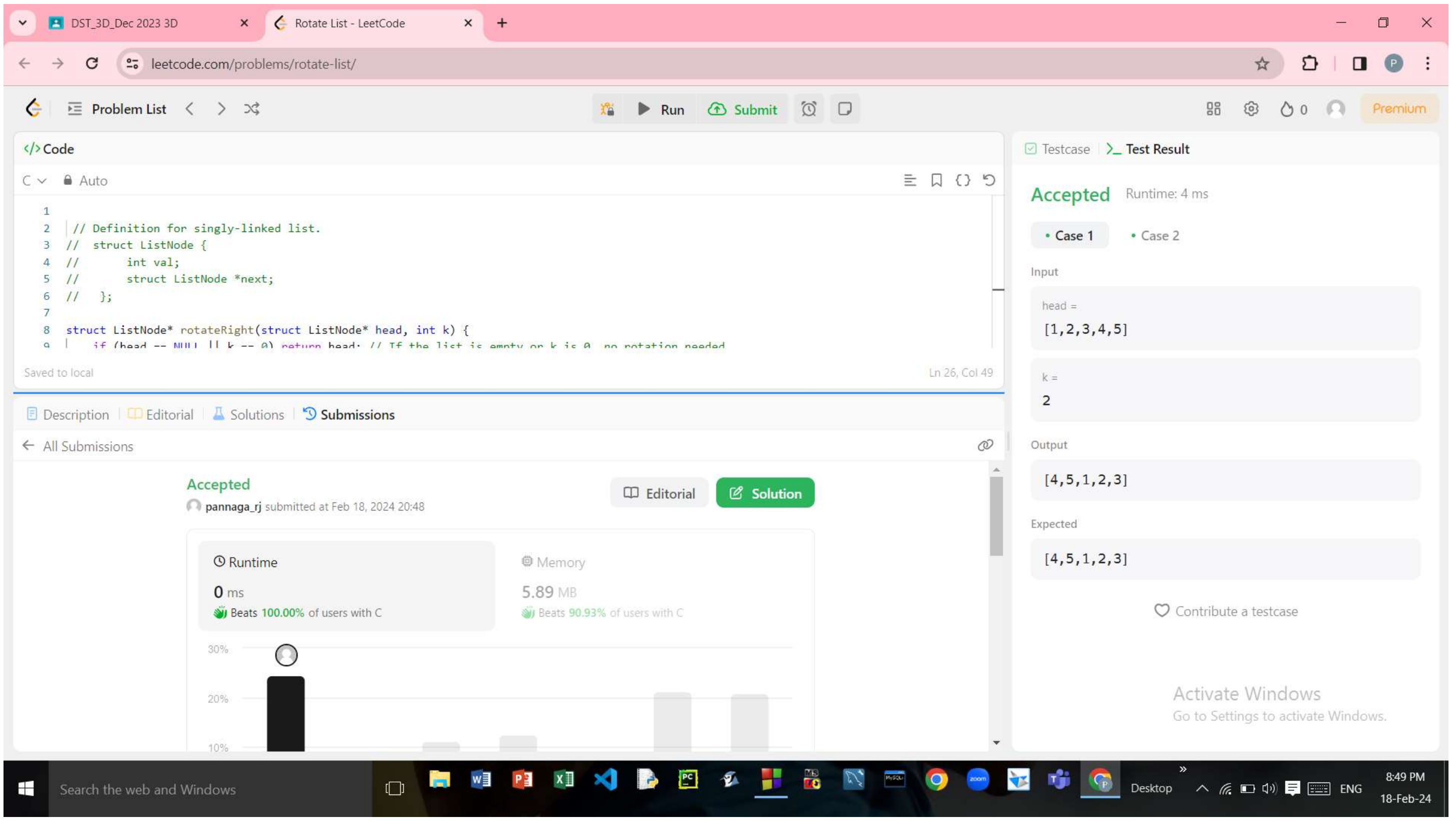
C:\Users\Admin\Desktop\1BM22CS189\BST.exe

```
1. Insert into BST
2. Display
3. Exit

Enter your choice: 1
Enter the element:10

Enter your choice: 1
Enter the element:20

Enter your choice: 1
Enter the element:5

Enter your choice: 1
Enter the element:2

Enter your choice: 2
1. Preorder
2. Inorder
3. Postorder
Choice: 1
Preorder Display
10      2       5       20
Enter your choice: 2
1. Preorder
2. Inorder
3. Postorder
Choice: 2
Inorder Display
2       5       10      20
Enter your choice: 2
1. Preorder
2. Inorder
3. Postorder
Choice: 3
Postorder Display
2       5       20      10
Enter your choice: 3
Programs ends successfully
Process returned 0 (0x0)   execution time : 76.350 s
Press any key to continue.
```

Program - Leetcode platform(Rotate Linked list):

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

struct ListNode* rotateRight(struct ListNode* head, int k) {
    if (head == NULL || k == 0) return head; // If the list is empty or k is 0, no rotation needed

    struct ListNode *t = head;
    int len = 1; // Length of the list

    // length of the list
    while (t->next != NULL) {
        t = t->next;
        len++;
    }

    // Adjust k if it's greater than the length of the list
    k = k % len;
    if (k == 0) return head; // no rotation needed

    t->next = head; // Connect last to first node (circular)

    // Traverse again to find the new last node
    t = head;
    for (int i = 0; i < len - k - 1; i++) {
        t = t->next;
    }
    // New head after rotation
    struct ListNode *newHead = t->next;
    t->next = NULL; // Break the circle
    return newHead;
}
```

Output:



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

struct ListNode* rotateRight(struct ListNode* head, int k) {
    if (head == NULL || k == 0) return head; // If the list is empty or k is 0, no rotation needed
```

Saved to local

Ln 26, Col 49

Accepted

pannaga_rj submitted at Feb 18, 2024 20:48

Runtime

0 ms

Beats 100.00% of users with C

Memory

5.89 MB

Beats 90.93% of users with C

Accepted Runtime: 4 ms

Input

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

k =
2

Output

[4,5,1,2,3]

Expected

[4,5,1,2,3]

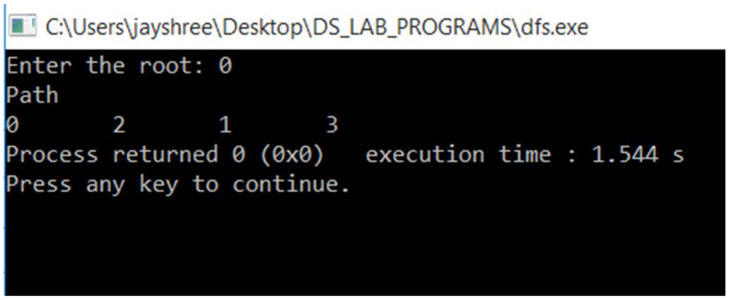
Lab Program 9:

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

```
#include <stdio.h>

#define r 4

int fr = 0;
int rear = 0;
int v[r];
int a[r][r] = {{1,0,1,0}, {0,0,1,1}, {0,1,0,1}, {1,1,1,1}};


int q[r];

void bfs(int n)
{
    int roo;
    while (fr < rear) {
        roo = q[fr++];
        printf("%d\t", roo);
        for (int j = 0; j < r; j++) {
            if (a[roo][j] && !v[j]) {
                v[j] = 1;
                q[rear++] = j;
            }
        }
    }
}
```

```
int main()
{
    int root;
    for (int i = 0; i < r; i++)
    {
        v[i] = 0;
    }
    printf("Enter the root: ");
    scanf("%d", &root);
    q[rear++] = root;
    v[root] = 1;
    bfs(root);

    return 0;
}
```

Output:

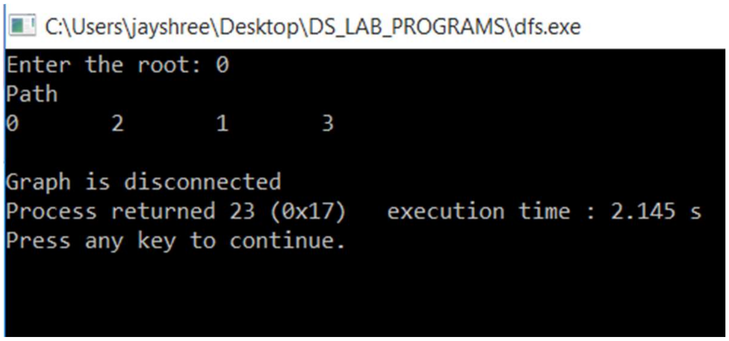


```
Enter the root: 0
Path
0       2       1       3
Process returned 0 (0x0)   execution time : 1.544 s
Press any key to continue.
```

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

```
// Depth wise Search
#include<stdio.h>

# define r 5

int a[r][r] = {{1,0,1,0}, {0,0,1,1}, {0,1,0,1}, {1,1,1,1}};
int v[r];

void dfs(int root)
{

    printf("%d\t",root);
    v[root] = 1;
    for(int i=0;i<r;i++)
    {
        if(a[root][i] && !v[i])
        {
            dfs(i);
        }
    }
}

void connected()
{
    int flag = 0;
    for(int i=0;i<r;i++)
    {
        if(v[i]==0)
            flag = 1;
    }

    if(flag==1)
        printf("\n\nGraph is disconnected");
    else
        printf("\n\nGraph is connected");

}
void main()
{
    int  root;
    for(int i=0;i<r;i++)
    {
        v[i] = 0;
    }

    printf("Enter the root: ");
    scanf("%d",&root);
    printf("Path\n");
    dfs(root);
    connected();
}
```

Output:



C:\Users\jayshree\Desktop\DS_LAB_PROGRAMS\dfs.exe

```
Enter the root: 0
Path
0       2       1       3

Graph is disconnected
Process returned 23 (0x17)   execution time : 2.145 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.

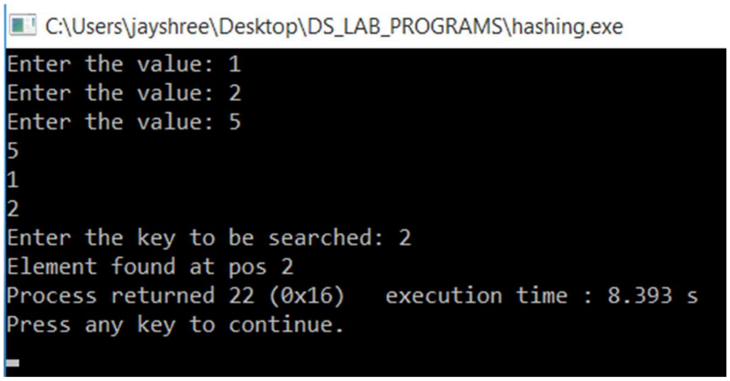
Let the keys in K and addresses in L are integers. Design and develop a Program in C that uses Hash function H: K -> L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L.

Resolve the collision (if any) using linear probing.

```
#include<stdio.h>

# define ts 3

int hash_array[ts];

void hashing(int key)
{
   int hkey, index;
   int i = 0;
```

```
    hkey = key % ts;
    while(i<ts)
    {
        index = (hkey+i) % ts;
        if(hash_array[index] == -1)
        {
            hash_array[index] = key;
            break;
        }
        i = i+1;
    }
}


void print()
{
    for(int i=0;i<ts;i++)
    {
        printf("%d\n",hash_array[i]);
    }
}

void search(int s)
{
    int hkey = s % ts;
    int i = 0, flag = 0;
    int index;
    while(i < ts)
    {
        index = (hkey+i) % ts;
        if(hash_array[index] == s)
        {
            flag = 1;
            printf("Element found at pos %d",index);
            break;
        }
        i+=1;
    }

    if(flag == 0)
        printf("Not found");

}

void main()
{
    int key, s;
    for(int j=0;j<ts;j++)
    {
        hash_array[j] = -1;
    }

    for(int c = 0;c<ts;c++)
    {
        printf("Enter the value: ");
        scanf("%d",&key);
        hashing(key);
    }
    printf("Enter the key to be searched: ");
    scanf("%d", &s);
    search(s);
}
```

Output:



```
Enter the value: 1
Enter the value: 2
Enter the value: 5
5
1
2
Enter the key to be searched: 2
Element found at pos 2
Process returned 22 (0x16)   execution time : 8.393 s
Press any key to continue.
```