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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This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by **PRADEEP P T (1BM22CS197)**, 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.

```c
#include <stdio.h>
#include<stdlib.h>
#define STACK_SIZE 5
void push(int st[],int *top)
{
        int item;
        if(*top==STACK_SIZE-1)
                printf("Stack overflow\n");
        else
        {
                printf("\nEnter an item :");
                scanf("%d",&item);
                (*top)++;
                st[*top]=item;
        }
}
void pop(int st[],int *top)
{
        if(*top==-1)
                printf("Stack underflow\n");
        else
        {
                printf("\n%d item was deleted",st[(*top)--]);
        }
}
void display(int st[],int *top)
{
        int i;
        if(*top==-1)
                printf("Stack is empty\n");
        for(i=0;i<=*top;i++)
                printf("%d\t",st[i]);
}
void main()
{
        int st[10],top=-1, c,val_del;
        while(1)
        {
                printf("\n1. Push\n2. Pop\n3. Display\n");
                printf("\nEnter your choice :");
                scanf("%d",&c);
```

```c
switch(c)
{
        case 1: push(st,&top);
                break;
        case 2: pop(st,&top);
                break;
        case 3: display(st,&top);
                break;
        default: printf("\nInvalid choice!!!");
                exit(0);
}
    }
}
```

Output:

```
Enter the option for the following operations:
1.Push
2.Pop
3.Display
4.Exit
1
Enter the element to be added
25
Enter the option for the following operations:
1.Push
2.Pop
3.Display
4.Exit
2
Popped element is 25
Enter the option for the following operations:
1.Push
2.Pop
3.Display
4.Exit
3
Stack is empty
Enter the option for the following operations:
1.Push
2.Pop
3.Display
4.Exit
4

Process returned 0 (0x0)    execution time : 14.555 s
```

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)

```c
#include<stdio.h>
#include<ctype.h>
#define max 20
void push(char a);
char pop();
char stack[max],top =-1;
int pre(char a);

void main(){
   char infix[max],a;
   char post[max];
   printf("Enter infix expression: ");
   scanf("%s",infix);
   int j=0;
   push('(');
   for(int i=0;i<strlen(infix);i++){
     if(isalnum(infix[i])){
        post[j]=infix[i];
        j+=1;
     }
    else if((infix[i]=='+' || infix[i]=='-' || infix[i]=='/' || infix[i]=='*')){
          if(pre(infix[i])>pre(stack[top])){
            push(infix[i]);
          }
          else if(pre(infix[i])<=pre(stack[top])){

            while(1){
            a=pop();
            if(a=='('){
               push(a);
               break;
            }
            post[j]=a;
            j+=1;
          }
          push(infix[i]);
       }


   }
}
while(top!=-1){
   char y=pop();
   if(y=='('){
```
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```c
            break;
        }
    post[j]=y;
    j+=1;



}
post[j]='\0';
printf("%s",post);

}

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

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

    }
}

int pre(char a){
        if(a=='^'){
            return 3;
        }
        else if( a=='*' || a=='/'){
            return 2;
        }
        else if(a=='+' || a=='-'){
            return 1;
        }
        else{
            return 0;
        }
}
```
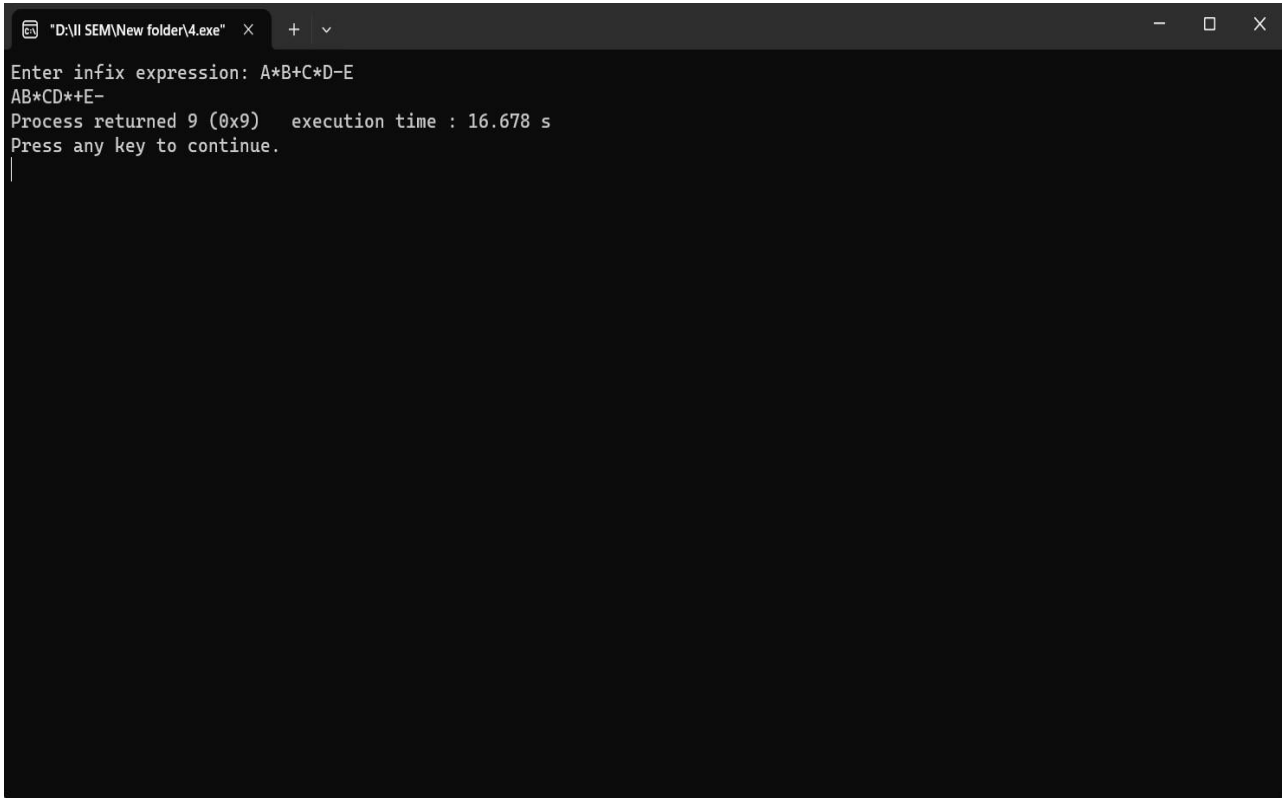
Output:

```
Enter infix expression: A*B+C*D-E
AB*CD*+E-
Process returned 9 (0x9)   execution time : 16.678 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

```c
#include<stdio.h>
#include<string.h>
#define MAX 100
int rear=-1,front=-1;
int queue[MAX];
void enqueue();
int dequeue();
void display();
int main()
{
   int option,val;
   do
   {
     printf("\nEnter an option to perform following
operations\n1.Insert\n2.Delete\n3.Display\n4.Exit\n");
     scanf("%d",&option);
     switch(option)
     {
       case 1: enqueue();
       break;
       case 2: val=dequeue();
            printf("Element deleted from queue is: %d",val);
       break;
       case 3: display();
       break;
     }
   }while(option!=4);
    return 0;
}
void enqueue()
{
   int x;
   printf("Enter the number to be inserted in the queue\n");
   scanf("%d",&x);
   if(rear==MAX-1)
   printf("Overflow");
   else if(front==-1&&rear==-1)
   front=rear=0;
   else
   rear=rear+1;
   queue[rear]=x;
}
int dequeue()
{
```

```c
    int y;
    if(front==-1||front>rear)
    printf("Underflow");
    else
    {
      y=queue[front];
      front=front+1;
    }
    return y;
}
void display()
{
    int i;
    printf("Elements in the queue:\n");
    if(front==-1||front>rear)
    printf("Underflow");
    for(i=front;i<=rear;i++)
    printf("\t%d",queue[i]);
}
```

Output:

```
Enter an option to perform following operations
1.Insert
2.Delete
3.Display
4.Exit
1
Enter the number to be inserted in the queue
18

Enter an option to perform following operations
1.Insert
2.Delete
3.Display
4.Exit
2
Element deleted from queue is: 18
Enter an option to perform following operations
1.Insert
2.Delete
3.Display
4.Exit
3
Elements in the queue:
Underflow
Enter an option to perform following operations
1.Insert
2.Delete
3.Display
4.Exit
4

Process returned 0 (0x0)   execution time : 7.040 s
Press any key to continue.
```

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

```c
#include <stdio.h>
#define MAX 5
int rear = -1, front = -1;
int queue[MAX];

void enqueue();
int dequeue();
void display();

int main() {
    int option, value;
    do {
        printf("\nEnter an option to perform the following operations:\n1. Insert\n2. Delete\n3. Display\n4. Exit\n");
        scanf("%d", &option);

        switch (option) {
            case 1:
                enqueue();
                break;
            case 2:
                value = dequeue();
                printf("Element deleted from queue: %d\n", value);
                break;
            case 3:
                display();
                break;
        }
    } while (option != 4);

    return 0;
}

void enqueue() {
    int x;
    printf("Enter the element to be inserted: ");
    scanf("%d", &x);

    if ((rear + 1) % MAX == front) {
        printf("Overflow. Queue is full.\n");
    } else if (front == -1 && rear == -1) {
        front = rear = 0;
        queue[rear] = x;
    } else if (front != 0 && rear == MAX - 1) {
        rear = 0;
```

```c
            queue[rear] = x;
        } else {
            rear = (rear + 1) % MAX;
            queue[rear] = x;
        }
    }

    int dequeue() {
        int y;
        if (front == -1 && rear == -1) {
            printf("Underflow. Queue is empty.\n");
            return -1;
        }

        y = queue[front];
        if (front == rear) {
            front = rear = -1;
        } else {
            if (front == MAX - 1) {
                front = 0;
            } else {
                front = (front + 1) % MAX;
            }
        }

        return y;
    }

    void display() {
        int i;
        printf("Elements in the Queue:\n");

        if (front == -1 && rear == -1) {
            printf("Underflow. Queue is empty.\n");
        } else {
            if (front <= rear) {
                for (i = front; i<=rear; i++) {
                    printf("\t%d", queue[i]);
                }
            } else {
                for (i = front; i < MAX; i++) {
                    printf("\t%d", queue[i]);
                }
                for (i = 0; i <= rear; i++) {
                    printf("\t%d", queue[i]);
                }
            }
            printf("\n");
        }
    }
```

Lab Program 4:

WAP to Implement Singly Linked List with following operations

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

Display the contents of the linked list.

```c
#include<stdio.h>

#include<stdlib.h>

struct node

{

    int data;

    struct node *next;

};

struct node *start=NULL;

void insert_begin();

void insert_end();

void insert_pos();

void display();

int main()

{

    int option;

    do{

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

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

        scanf("%d",&option);

        switch(option)

        {

            case 1:insert_begin();

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

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

    scanf("%d",&num);

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

    new_node->data=num;

    new_node->next=NULL;

    ptr=start;

    while(ptr->next!=NULL)

    ptr=ptr->next;

    ptr->next=new_node;

}

void insert_pos()

{

    struct node *new_node,*ptr,*prev;

    int num,pos,count=1;

    printf("Enter the data\n");

    scanf("%d",&num);

    printf("Enter the position to be inserted\n");

    scanf("%d",&pos);

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

    new_node->data=num;

    if(pos==1)

    {

    new_node->next=start;

    start=new_node;

    }

    else

    {

        ptr=start;

        while(count<pos&&ptr!=NULL)
```

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

Output:


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

Leetcode Program: Min Stack

```c
#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)
```

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```c
         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);
}
```
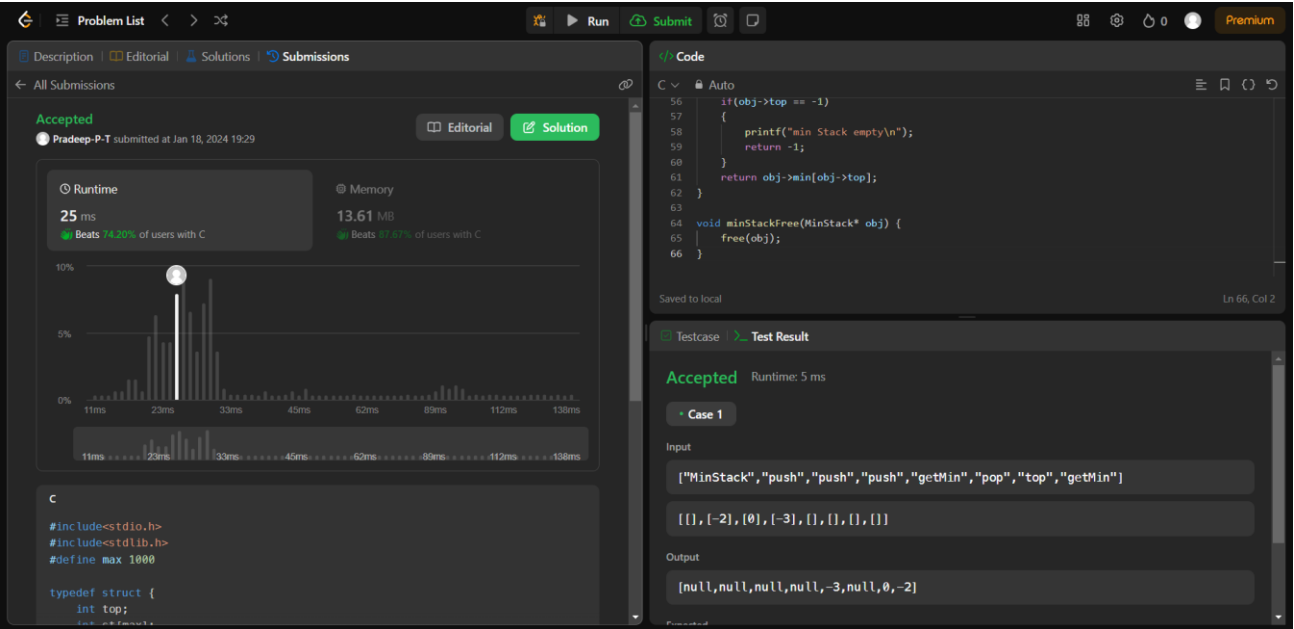
Lab Program 5:

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.

```c
#include<stdio.h>
#include<stdlib.h>
struct node
{
    int data;
    struct node *next;
};
struct node *start=NULL;
void create();
void delete_begin();
void delete_end();
void delete_pos();
void display();
int main()
{
    int option;
    do{
        printf("\n***MAIN MENU***\n1.Create linked list\n2.Delete from beginning\n3.Delete
from end\n4.Delete from any position\n5.Display linked list\n6.Exit\n");
        printf("\nEnter an option to perform the following operations: ");
        scanf("%d",&option);
        switch(option)
        {
```

```c
        case 1:create();
            printf("\nLinked list created successfully\n");
            break;
        case 2:delete_begin();
            printf("Element deleted successfully\n");
            break;
        case 3:delete_end();
            printf("Element deleted successfully\n");
            break;
        case 4:delete_pos();
            printf("Element deleted successfully\n");
            break;
        case 5:printf("\nElements in the linked list:\n");
            display();
            break;
    }
    }while(option!=6);
    return 0;
}
void create()
{
    struct node *ptr,*new_node;
    int num;
    printf("Enter -1 to exit\n");
    printf("\nEnter the data\n");
    scanf("%d",&num);
    while(num!=-1)
    {
        new_node=(struct node*)malloc(sizeof(struct node));
```
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```c
        new_node->data=num;
        if(start==NULL)
        {
            start=new_node;
            new_node->next=NULL;
        }
        else
        {
            ptr=start;
            while(ptr->next!=NULL)
            ptr=ptr->next;
            ptr->next=new_node;
            new_node->next=NULL;
        }
        printf("Enter the data\n");
        scanf("%d",&num);
    }
}
void delete_begin()
{
    struct node *ptr;
    ptr=start;
    start=start->next;
    free(ptr);
}
void delete_end()
{
    struct node *ptr,*preptr;
    ptr=start;
```

```c
    while(ptr->next!=NULL)
    {
    preptr=ptr;
    ptr=ptr->next;
    }
    preptr->next=NULL;
    free(ptr);
}
void delete_pos()
{
    struct node *ptr,*preptr,*postptr;
    int pos,count=1;
    printf("Enter the position: ");
    scanf("%d",&pos);
    ptr=start;
    if(pos==1)
    {
        start=start->next;
        free(ptr);
    }
    else
    {
        while(count<pos&&ptr!=NULL)
        {
            preptr=ptr;
            ptr=ptr->next;
            postptr=ptr->next;
            count++;
        }
```

```c
        if(pos==count)
        {
            preptr->next=postptr;

            free(ptr);
        }


    }
}
void display()
{
    struct node *ptr;

    ptr=start;

    while(ptr!=NULL)
    {
        printf("\t%d",ptr->data);

        ptr=ptr->next;
    }
    printf("\n");
}
```

Output:

Leetcode Program: Reverse Linked List

```
struct ListNode* reverseBetween(struct ListNode* head, int left, int right) {

    struct ListNode* ptrl= head;

    int temp=left-1;

    while(temp--){

        ptrl=ptrl->next;

    }

    int count=right-left+1;

    int* a = (int*)malloc(count * sizeof(int));

    for(int i=0;i<count;i++){

        a[i]=ptrl->val;

        ptrl=ptrl->next;

    }

    struct ListNode* ptr= head;

    left--;

    while(left--){
```

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```c
        printf("%d",ptr->val);

        ptr=ptr->next;

    }


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


        ptr->val=a[i];

        ptr=ptr->next;

    }

    return head;

}
```

Output:

Lab Program 6:

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

```c
#include<stdio.h>
#include<stdlib.h>
struct node
{
    int data;
    struct node *next;
};
struct node *s1=NULL;
struct node *s2=NULL;
struct node *start=NULL;
struct node *create(struct node*);
void sort();
struct node *concatenate(struct node*,struct node*);
void reverse();
void display(struct node*);

int main()
{
    int option;
    struct node *a=NULL;
    do{
        printf("\n*****MAIN MENU*****\n\n1.Create a linked list\n2.Create two linked lists for concatenation\n3.Sort\n4.Concatenate\n5.Reverse\n6.Display linked list\n7.Display Concatenated linked list\n8.Exit\n");

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

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

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

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

```c
        return 0;
}


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

```
        }
        return start;
    }


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


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

```c
    }
ptr->next=t2;
return t1;
}


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


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

```
  printf("\n");

}
```

Output:

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

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

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

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

Linked list created successfully

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

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

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

Enter an option to perform the following operations: 6

Elements in the linked list
        10       8       6       4       2

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

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

Enter an option to perform the following operations: 3

Linked list sorted

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

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

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

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

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

Linked list 2:
Enter -1 to exit

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

Linked lists created successfully

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

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

Enter an option to perform the following operations: 7

Elements in the linked list after concatenation:


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

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

```
Linked lists concatenated successfully

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

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

Enter an option to perform the following operations: 7

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

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

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

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

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

```c
//Stack Implementation
#include<stdio.h>
#include<stdlib.h>
struct node
{
 int data;
 struct node *next;
};
struct node *start=NULL;
void push();
void pop();
void display();
int main()
{
  int val,option;
   do
   {
     printf("\nEnter the number to perform following
operations\n1.Push\n2.Pop\n3.Display\n4.Exit\n");
     scanf("%d",&option);
     switch(option)
     {
       case 1:push();
       break;
       case 2:pop();
       break;
       case 3:display();
       break;
```

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

        free(ptr);

    }



}

void display()

{


    struct node *ptr;

    ptr=start;

    while(ptr!=NULL)

    {

        printf("\t%d",ptr->data);

        ptr=ptr->next;

    }

    printf("\n");

}
```

Output:

```c
//Queue Implementation

#include<stdio.h>
#include<stdlib.h>
struct node
{
 int data;
 struct node *next;
};
struct node *start=NULL;
void enqueue();
void dequeue();
void display();
int main()
{
  int val,option;
   do
   {
     printf("\nEnter the number to perform following
operations\n1.Enqueue\n2.Dequeue\n3.Display\n4.Exit\n");
     scanf("%d",&option);
     switch(option)
     {
       case 1:enqueue();
       break;
       case 2:dequeue();
       break;
       case 3:display();
       break;
     }
```

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

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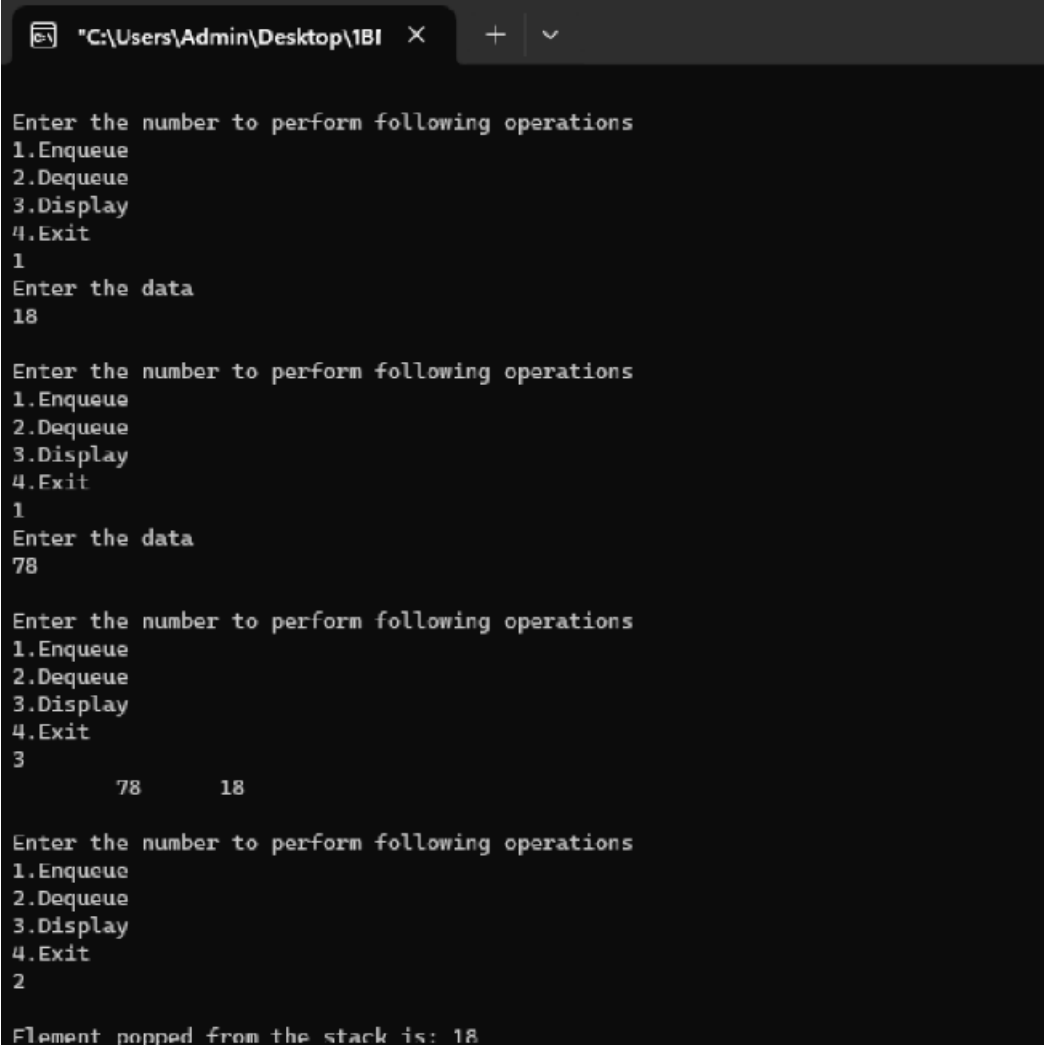
```c
    }
    else
    {
     while(ptr->next!=NULL)
     {
     preptr=ptr;
     ptr=ptr->next;
     }
     preptr->next=NULL;
     printf("\nElement popped from the stack is: %d\n",ptr->data);
     free(ptr);
    }
}
void display()
{

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

Output:

```
"C:\Users\Admin\Desktop\1BI  ×    +   ∨

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

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

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

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

Element popped from the stack is: 18
```

Lab Program 7:

WAP to Implement doubly link list with primitive operations

a) Create a doubly linked list.

b) Insert a new node to the left of the node.

c) Delete the node based on a specific value

d) Display the contents of the list

//Doubly Linked List

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

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

struct node *start=NULL;
void create();
void insert();
void delete();
void display();

void main()
{
int option;
do
{
```

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

scanf("%d",&option);

switch(option)

{

case 1: create();

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

    break;

case 2: insert();

    printf("\nNode inserted\n");

    break;

case 3: delete();

    printf("\nNode deleted\n");

    break;

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

    display();

    break;

}

}while(option!=5);

}


void create()

{

struct node *new_node, *ptr;

int num;

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

printf("\nEnter the data : ");

scanf("%d",&num);

while(num!=-1)

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


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

```c
printf("\nEnter the data : ");

scanf("%d", &val);

printf("\nEnter the position before which the data has to be inserted:");

scanf("%d", &pos);


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

new_node->data = val;

ptr = start;

while (count < pos - 1 && ptr != NULL)

{

   ptr = ptr->next;

   count++;

}

if (count == pos - 1 && ptr != NULL)

{

   new_node->next = ptr;


   if (ptr->prev != NULL)

   {

      new_node->prev = ptr->prev;

      ptr->prev->next = new_node;

   }

   else

   {

      start = new_node;

      new_node->prev = NULL;

   }


   ptr->prev = new_node;
```

```c
        }

    else

    {

        printf("Invalid position. Insertion failed.\n");

        free(new_node);

    }

}


void delete()

{

struct node *ptr;

int num;

printf("Enter the data to be deleted\n");

scanf("%d", &num);

ptr = start;

while (ptr != NULL && ptr->data == num)

{

start = ptr->next;

if (start != NULL)

start->prev = NULL;

free(ptr);

ptr = start;

}

while (ptr != NULL && ptr->data != num)

ptr = ptr->next;

if (ptr == NULL)

{

printf("Data not found. Deletion failed.\n");

}
```

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


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

Output:

```
***MAIN MENU***

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

Enter an option: 1

Enter -1 to end
Enter the data : 2

Enter the data : 4

Enter the data : 6

Enter the data : -1

Doubly linked list created

***MAIN MENU***

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

Enter an option: 2

Enter the data : 8

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

Node inserted
```

```
***MAIN MENU***

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

Enter an option: 4

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

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

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

Node deleted

***MAIN MENU***

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

Enter an option: 4

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

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

Leetcode Program: Split Linked List

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


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


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


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


    ptr=head;
    for(int i=0;i<k;i++){
        L[i] = ptr;
```

```c
        int segmentSize = nums + (a-- > 0 ? 1 : 0);

        for (int j = 1; j < segmentSize; j++) {

            ptr = ptr->next;

        }


        if (ptr != NULL) {

            struct ListNode* next = ptr->next;

            ptr->next = NULL;

            ptr = next;

        }

    }

    return L;

}
```
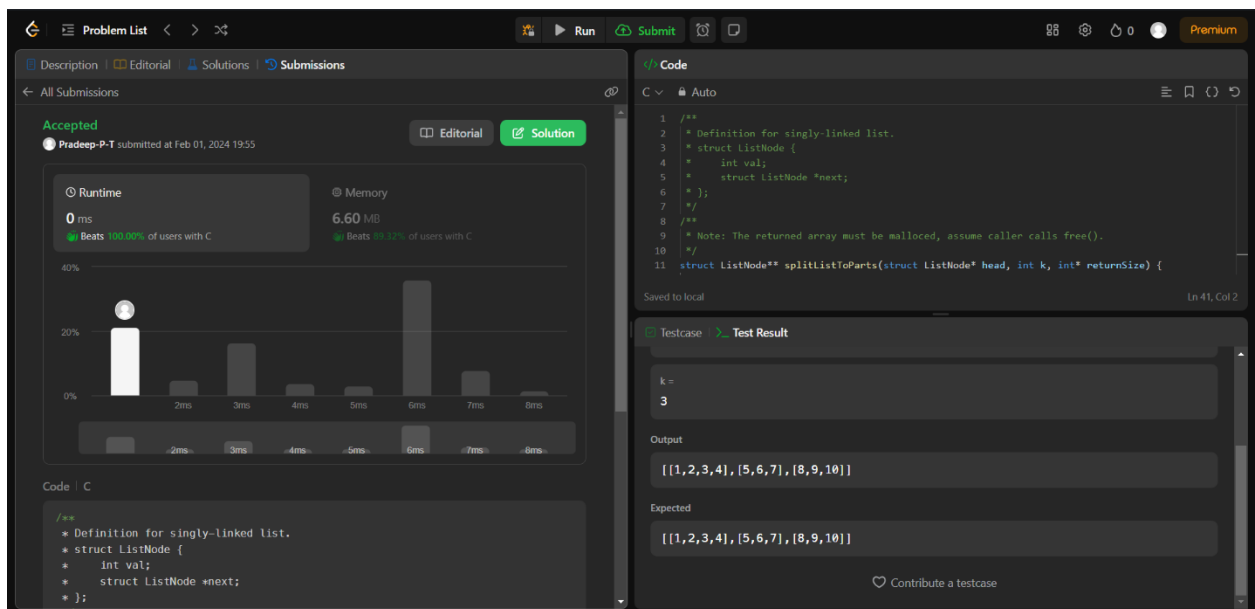
Output:

Lab Program 8:

Write a program

a) To construct a binary Search tree.

b) To traverse the tree using all the methods i.e., in-order,

preorder and post order

c) To display the elements in the tree.

```c
#include<stdio.h>

#include<stdlib.h>


struct node

{

 struct node *left;

 struct node *right;

 int data;

};

struct node *tree=NULL;


void create();

void pre(struct node *);

void post(struct node *);

void in(struct node *);


void main()

{

 int option;

 do

 {

  printf("\n\n***MAIN MENU***\n\n1.Create a binary search tree\n2.Preorder
traversal\n3.Postorder traversal\n4.Inorder traversal\n5.Exit\n\nEnter an option: ");

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

```c
    switch(option)
    {
    case 1: create();
         printf("Binary search tree created\n\n");
         break;
    case 2: printf("\nThe elements in the tree are\n");
         pre(tree);
         break;
    case 3: printf("\nThe elements in the tree are\n");
         post(tree);
         break;
    case 4: printf("\nThe elements in the tree are\n");
         in(tree);
         break;
    }
    }while(option!=5);
}

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

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

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


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


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

Output:

```
***MAIN MENU***

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

Enter an option: 1

Enter -1 to end
Enter the element : 8

Enter the element : 1

Enter the element : 5

Enter the element : 3

Enter the element : 9

Enter the element : 4

Enter the element : 6

Enter the element : 7

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

```
***MAIN MENU***

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

Enter an option: 2

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

***MAIN MENU***

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

```
Enter an option: 3

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

***MAIN MENU***

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

Enter an option: 4

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

***MAIN MENU***

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

Enter an option: 5

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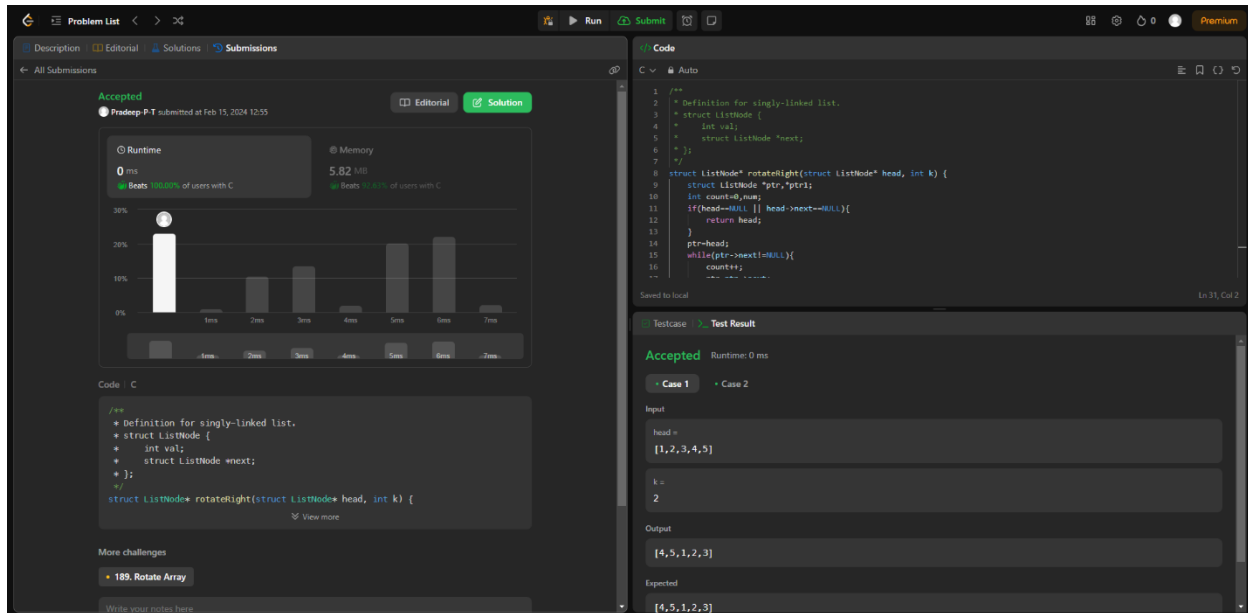
Leetcode Program: Rotate List

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

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```
    ptr=head;
    while(ptr->next!=NULL){
        count++;
        ptr=ptr->next;
    }
    num=k%(count+1);
    while(num--){
        ptr=head;
        while(ptr->next!=NULL){
        ptr1=ptr;
        ptr=ptr->next;
        }
        ptr->next=head;
        ptr1->next=NULL;
        head=ptr;
    }
    return head;
}
```

Output:

Lab Program 9:

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

9b) Write a program to check whether given graph is connected or not

using DFS method.

```c
#include<stdio.h>

#define MAX_VERTICES 50

typedef struct Graph_t {

    int V;

    int adj[MAX_VERTICES][MAX_VERTICES];

} Graph;

int DFS_V[50];

Graph* Graph_create(int V)

{

    Graph* g = malloc(sizeof(Graph));

    g->V = V;
```

```c
    for (int i = 0; i <=V; i++) {

      for (int j = 0; j <=V; j++) {

        g->adj[i][j] = 0;

      }

    }


    return g;

}

void Graph_addEdge(Graph* g, int v, int w)

{

  g->adj[v][w] = 1;

  g->adj[w][v] = 1;

}

void BFS(Graph* g, int root){

  int visited[g->V+1];

  for(int i=0;i<=g->V;i++)

      visited[i]=0;


  int queue[g->V+1];

  int front=0,rear=0;

  visited[root]=1;


  queue[rear++]=root;

  while(front!=rear){

      root=queue[front++];

    printf("%d ",root);

    for(int i=0;i<=g->V;i++){

      if(g->adj[root][i]==1 && visited[i]!=1){

        visited[i]=1;
```

```c
        queue[rear++]=i;
      }
    }
  }


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


  Graph* g = Graph_create(4);
  Graph_addEdge(g, 0, 1);
  Graph_addEdge(g, 0, 4);
  Graph_addEdge(g, 1, 3);
  Graph_addEdge(g, 1, 2);
```
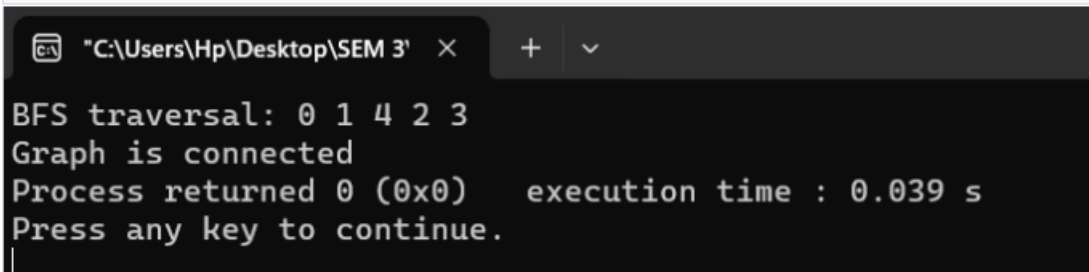
```
Graph_addEdge(g, 2, 3);

Graph_addEdge(g, 4, 3);

printf("BFS traversal: ");

BFS(g,0);

int count=DFS(g,0);

if(count==g->V+1){

   printf("\nGraph is connected");

}

else{

   printf("\nGraph is disconnected");

}

}
```

Output:

```
"C:\Users\Hp\Desktop\SEM 3'   ×    +   ˅

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

Lab Program 10:

Given a File of N employee records with a set K of Keys(4-digit) which

uniquely determine the records in file F.

Assume that file F is maintained in memory by a Hash Table (HT) of m

memory locations with L as the set of memory addresses (2-digit) of

locations in HT.

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

Design and develop a Program in C that uses Hash function H: K -> L

as H(K)=K mod m (remainder method), and implement hashing

technique to map a given key K to the address space L.

Resolve the collision (if any) using linear probing.

```c
#include <stdio.h>

#include <stdlib.h>

#define TABLE_SIZE 10

struct EmployeeRecord {

    int key;

    // Other fields of the employee record can be added here

};

struct EmployeeRecord *hashTable[TABLE_SIZE];

int hashFunction(int key) {

    return key % TABLE_SIZE;

}

void insert(struct EmployeeRecord *record) {

    int key = record->key;

    int index = hashFunction(key);

    int i = 0;


    while (i < TABLE_SIZE) {

        if (hashTable[index] == NULL) {
```

```c
            hashTable[index] = record;

            printf("Inserted record with key %d at index %d\n", key, index);

            return;

        }

        i++;

        index = (hashFunction(key) + i) % TABLE_SIZE;

    }


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

}


struct EmployeeRecord* search(int key) {

    int index = hashFunction(key);

    int i = 0;


    while (i < TABLE_SIZE) {

        if (hashTable[index] != NULL && hashTable[index]->key == key) {

            printf("Record with key %d found at index %d\n", key, index);

            return hashTable[index];

        }

        i++;

        index = (hashFunction(key) + i) % TABLE_SIZE;

    }

    printf("Record with key %d not found in the HashTable\n", key);

    return NULL;

}

int main() {

    // Initialize hashTable with NULL pointers

    for (int i = 0; i < TABLE_SIZE; i++) {
```
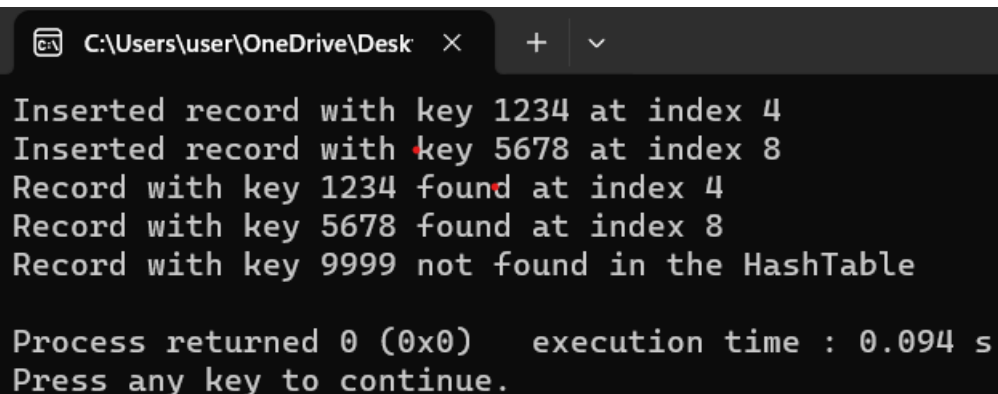
```
    hashTable[i] = NULL;

  }

  struct EmployeeRecord record1 = {1234}; // Example record with key 1234

  struct EmployeeRecord record2 = {5678}; // Example record with key 5678


  insert(&record1);

  insert(&record2);


  search(1234);

  search(5678);

  search(9999);

 return 0;

}
```

Output:


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

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