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
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This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by **Vyom Gupta (1BM22CS333)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2023-24. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab - **(23CS3PCDST)**work prescribed for the said degree.

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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
int stack[SIZE],top=-1;
```

```
void push(int value)
{
   if(top==SIZE-1)
      printf("Overflow\n");
   else{
      top=top+1;
   stack[top]=value;
   printf("%d inserted\n",value);
         }
}

void pop()
{
   int value;
   if(top==-1)
       printf("Underflow\n");
   else{
      value=stack[top];
      printf("Popped element: %d\n",value);
      top=top-1;
         }
}
void display()
{
   int i;
   if(top==-1)
     printf("Stack is empty");
   else{
         printf("The elements in the stack are:\n");
         for(i=0;i<=top;i++)
         printf("%d     ",stack[i]);
         }
}

void main()
{
   int value,choice;
   while(1){
      printf("\n1:Push\n2.Pop\n3.Display\n4.Exit\n");
      printf("Enter your choice:");
      scanf("%d",&choice);
      switch(choice)
      {
         case 1: printf("\nEnter the value: ");
```

```
                scanf("%d",&value);
                push(value);
                break;
        case 2: pop();
                break;
        case 3: display();
                break;
        case 4: exit(0);
                break;
        default: printf("Invalid input\n");
      }
   }
}
```

OUTPUT:

```
1:Push
2.Pop
3.Display
4.Exit
Enter your choice: 1

Enter the value: 23
23 inserted

1:Push
2.Pop
3.Display
4.Exit
Enter your choice: 1

Enter the value: 45
45 inserted

1:Push
2.Pop
3.Display
4.Exit
Enter your choice: 1

Enter the value: 78
78 inserted
```

```
1:Push
2.Pop
3.Display
4.Exit
Enter your choice: 2
Popped element: 78

1:Push
2.Pop
3.Display
4.Exit
Enter your choice: 3
The stack elements are:
23   45
1:Push
2.Pop
3.Display
4.Exit
Enter your choice: 4
```

LAB PROGRAM 2:

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

```
#include<stdio.h>

#include<string.h>

int index1=0,top=-1,pos=0,length;

char symbol,temp,infix[20],postfix[20],stack[20];

void infixtopostfix();

void push(char symbol);

char pop();

int precedence(char symbol);

void main()

{

   printf("Enter the infix expression:");

   scanf("%s",infix);
```

```
    infixtopostfix();
    printf("\nInfix expression:%s",infix);
    printf("\nPostfix expression:%s",postfix);
}
void infixtopostfix(){
length=strlen(infix);
 push('#');
 while(index1<length){
     symbol=infix[index1];
     switch(symbol)
   {
         case '(':   push (symbol);
                     break;
         case ')':   temp=pop();
                     while (temp !='(')
                     {
                             postfix[pos]=temp;
                             pos++;
                             temp=pop();
                     }
                     break;
         case '+':
         case '-':
         case '*':
         case '/':
            while(precedence(stack[top])>=precedence(symbol))
            {
               temp=pop();
               postfix[pos++]=temp;
```

```
            }
            push(symbol);
            break;
        default:postfix[pos++]=symbol;
            }
     Index1++;
}
 while(top >0) {
     temp=pop();
     postfix[pos++]=temp; }
}
void push(char symbol)
{
    top=top+1;
    stack[top]=symbol;
}
char pop()
{
    char symbol;
    symbol=stack[top];
    top=top-1;
    return (symbol);
}
int precedence(char symbol)
{
    int p;
 switch(symbol){
        case '*':
        case'/':     p=2;
```

```
                    break;
        case '+':
        case '-':   p=1;
                    break;
        case '(':   p=0;
                    break;
        case '#':   p=-1;
                    break;
          }
   return(p);
}
```

OUTPUT:

```
Enter the infix expression:a+b+c+d-e

Infix expression:a+b+c+d-e
Postfix expression:ab+c+d+e-
```

LAB PROGRAM 3:

a) Write a program 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 10

int queue[MAX];

int front = -1, rear = -1;

void insert()

{
```

```
	int item;
	if(rear == MAX-1)
		printf("\n OVERFLOW");
	else
	{
		if(front==-1)
			front=0;
		printf("\n Enter the element to be inserted in the queue : ");
		scanf("%d", &item);
		rear=rear+1;
		queue[rear] = item;
		printf("%d inserted successfully",item);
	}
}
void delete()
{
	int val;
	if(front == -1 || front>rear)
	{
		printf("\n QUEUE UNDERFLOW");
	}
	else
	{
		val = queue[front];
		printf("\n The number deleted is : %d", val);
		front=front+1;
		if(front > rear)
			front = rear = -1;
	}
```

```
}
void display()
{
    int i;
    printf("\n");
    if(front == -1 || front > rear)
        printf("\n QUEUE IS EMPTY");
    else
    {
        for(i = front;i <= rear;i++)
            printf("%d      ", queue[i]);
    }
}
void main()
{
    int choice;
    while(1)
    {
        printf("\nMENU");
        printf("\n 1. Insert an element");
        printf("\n 2. Delete an element");
        printf("\n 3. Display the queue");
        printf("\n 4. EXIT");
        printf("\n Enter your option :");
        scanf("%d", &choice);
        switch(choice)
        {
            case 1: insert();
                break;
```

```
                        case 2: delete();
                                break;
                        case 3: display();
                                break;
                        case 4: exit(0);
                                break;
                        default: printf("Invalid input");
                }
        }
}
```

OUTPUT:

```
MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted in the queue : 68
68 inserted successfully

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted in the queue : 83
83 inserted successfully

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted in the queue : 90
90 inserted successfully
```

```
MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :2

The number deleted is : 68

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :3

83      90
MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :4
```

b) 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 SIZE 10

int queue[SIZE];

int front = -1, rear = -1;

void insert()

{

        int item;

        if((front==rear+1)||(front==0 && rear==SIZE-1))

                printf("\n QUEUE OVERFLOW");

        else
```

```
	{
		if(front==-1)
			front=0;
		printf("\n Enter the element to be inserted : ");
		scanf("%d", &item);
		rear=(rear+1)%SIZE;
		queue[rear] = item;
		printf("%d inserted successfully",item);
	}
}
void delete()
{
	int val;
	if(front == -1)
	{
		printf("\n QUEUE UNDERFLOW");
	}
	else
	{
		val = queue[front];
		if(front==rear)
		{
			front=-1;
			rear=-1;
		}
		else
		{
			front=(front+1)%SIZE;
		}
```

```
            printf("\n The number deleted is : %d", val);
        }
}
void display()
{
        int i;
        printf(" \n");
        if(front == -1)
            printf("\n QUEUE IS EMPTY");
        else
        {
            for(i = front;i !=rear;i=(i+1)%SIZE)
                printf("%d      ", queue[i]);
        }
        printf("%d",queue[i]);
}
void main()
{
        int choice;
        while(1)
        {
            printf("\nMENU");
            printf("\n 1. Insert an element");
            printf("\n 2. Delete an element");
            printf("\n 3. Display the queue");
            printf("\n 4. EXIT");
            printf("\n Enter your option :");
            scanf("%d", &choice);
            switch(choice)
```

```
                {
                        case 1: insert();
                                break;
                        case 2: delete();
                                break;
                        case 3: display();
                                break;
                        case 4: exit(0);
                                break;
                        default: printf("Invalid input");
                }
        }
}
```

OUTPUT:

```
MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted : 37
37 inserted successfully

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted : 43
43 inserted successfully

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted : 74
74 inserted successfully
```

```
MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :2

The number deleted is : 37
MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :3

43      74
MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :4
```

LAB PROGRAM 4:

1)

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.

c) Display the contents of the linked list.

```
#include<stdio.h>

#include<stdlib.h>

struct node

{

   int data;

   struct node * next;

};
```

```
struct node *head=NULL,*newnode,*temp;

void create()
{
   int i,n;
   printf(" Enter the number of elements:");
   scanf("%d",&n);

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

      if(head==NULL)
      {
         temp=head=newnode;
      }
      else{
         temp->next=newnode;
         temp=newnode;
      }
   }
}
void display()
{
   temp=head;
   printf(" The elements are:\n");
```

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

void insert_beg()
{
    newnode=(struct node *)malloc(sizeof(struct node));
    printf(" Enter the new element:\n");
    scanf("%d",&newnode->data);
    newnode->next=head;
    head=newnode;
}

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

```
void insert_pos()
{
    int pos,i=1;
    newnode=(struct node *)malloc(sizeof(struct node));
    printf(" Enter the position:");
    scanf("%d",&pos);

    if(pos<0)
    {
        printf("Invalid position\n");
    }
    else
    {
        temp=head;
        while(i<pos-1)
        {
            temp=temp->next;
            i++;
        }
        printf(" Enter the new element:");
        scanf("%d",&newnode->data);
        newnode->next=temp->next;
        temp->next=newnode;
    }
}

void main()
{
```

```
    int choice;
    printf(" MENU\n 1.Create\n 2.Insert at beginnning\n 3.Insert at end\n 4.Insert at position\n
5.Display \n 6.Exit\n");
    while(1)
    {
        printf("\n Enter operation:");
        scanf("%d",&choice);
         switch(choice)
         {
                    case 1:create();
                            break;
                    case 2: insert_beg();
                            break;
                    case 3: insert_end();
                            break;
                    case 4:insert_pos();
                            break;
                    case 5: display();
                            break;
                    case 6: exit(0);
                            break;
                    default: printf(" invalid output\n");
           }
        }
}
```

OUTPUT:

```
MENU
1.Create
2.Insert at beginnning
3.Insert at end
4.Insert at position
5.Display
6.Exit

Enter operation:1
Enter the number of elements: 3
Enter the element 1: 2
Enter the element 2: 4
Enter the element 3: 6

Enter operation:2
Enter the new element: 10

Enter operation:3
Enter the new element: 5

Enter operation:4
Enter the position: 2
Enter the new element: 34

Enter operation:5
The elements are:
10      34      2       4       6       5
Enter operation:6
```

2)

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>

#include<stdlib.h>
```

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

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

void create()
{
    int i,n;
    printf(" Enter the number of elements:");
    scanf("%d",&n);

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

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

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

void delete_beg()
{
    temp=head;
    if(head==NULL)
    {
        printf("List is empty\n");
    }
    else
    {
         head=temp->next;
         free(temp);
    }
printf(" Element successfully deleted\n");
}

void delete_end()
```

```
{
    temp=head;
    struct node *prenode;
    while(temp->next!=NULL)
    {
        prenode=temp;
        temp=temp->next;
    }
    if(temp==head)
    {
        head=NULL;
    }
    else
    {
        prenode->next=NULL;

    }
    free(temp);
     printf(" Element successfully deleted\n");
}

void delete_pos()
{
    struct node *nextnode;
    int pos,i=1;
    printf(" Enter the position:\n");
    scanf("%d",&pos);
    temp=head;
    while(i<pos-1)
```

```
    {
        temp=temp->next;
        i++;
    }
    nextnode=temp->next;
    temp->next=nextnode->next;
    free(nextnode);
    printf(" Element successfully deleted\n");
}
void main()
{
    int choice;
    printf(" MENU\n 1.Create\n 2.Insert at beginnning\n 3.Insert at end\n 4.Insert at position\n
5.Display \n 6.Exit\n");
    while(1)
    {
        printf("\n Enter operation:");
        scanf("%d",&choice);
         switch(choice)
         {
                case 1:create();
                        break;
                case 2: delete_beg();
                        break;
                case 3: delete_end();
                        break;
                case 4:delete_pos();
                        break;
                case 5: display();
                        break;
```

```
                case 6: exit(0);
                        break;
                default: printf(" Invalid output\n");
        }
    }
}
```

OUTPUT:

```
MENU
1.Create
2.Insert at beginnning
3.Insert at end
4.Insert at position
5.Display
6.Exit

Enter operation:1
Enter the number of elements:5
Enter the element 1: 2
Enter the element 2: 4
Enter the element 3: 6
Enter the element 4: 8
Enter the element 5: 10

Enter operation:2
Element successfully deleted

Enter operation:3
Element successfully deleted

Enter operation:4
Enter the position: 1
Element successfully deleted

Enter operation:5
The elements are:
4       8
Enter operation:6
```

LAB PROGRAM 5:

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

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

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



void insertAtBeginning(struct Node** head, int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = *head;
    *head = newNode;
}

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

void sortList(struct Node** head) {
    struct Node *current, *nextNode;
    int temp;
    current = *head;

    while (current != NULL) {
```

```
        nextNode = current->next;
        while (nextNode != NULL) {
            if (current->data > nextNode->data) {
                temp = current->data;
                current->data = nextNode->data;
                nextNode->data = temp;
            }
            nextNode = nextNode->next;
        }
        current = current->next;
    }
}

void reverseList(struct Node** head) {
    struct Node *prev, *current, *nextNode;
    prev = NULL;
    current = *head;

    while (current != NULL) {
        nextNode = current->next;
        current->next = prev;
        prev = current;
        current = nextNode;
    }
    *head = prev;
}

void concatenateLists(struct Node** list1, struct Node* list2) {
    if (*list1 == NULL) {
        *list1 = list2;
        return;
    }
    struct Node* temp = *list1;
    while (temp->next != NULL) {
```

```
        temp = temp->next;
    }
    temp->next = list2;
}

void main() {
    struct Node* list1 = NULL;
    struct Node* list2 = NULL;
    int choice;
    int data;

    while(1)
    {
        printf("\n1. Insert into List 1\n");
        printf("2. Insert into List 2\n");
        printf("3. Sort List 1\n");
        printf("4. Reverse List 1\n");
        printf("5. Concatenate Lists\n");
        printf("6. Print Lists\n");
        printf("7. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter data to insert into List 1: ");
                scanf("%d", &data);
                insertAtBeginning(&list1, data);
                break;
            case 2:
                printf("Enter data to insert into List 2: ");
                scanf("%d", &data);
                insertAtBeginning(&list2, data);
                break;
```

```
            case 3:
                sortList(&list1);
                printf("List 1 sorted.\n");
                break;
            case 4:
                reverseList(&list1);
                printf("List 1 reversed.\n");
                break;
            case 5:
                concatenateLists(&list1, list2);
                printf("Lists concatenated.\n");
                break;
            case 6:
                printf("List 1: ");
                printList(list1);
                printf("List 2: ");
                printList(list2);
                break;
            case 7:
                exit(0);
                break;
            default:
                printf("Invalid choice\n");
        }
    }
}
```

OUTPUT:

```
1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 1
Enter data to insert into List 1: 5

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 1
Enter data to insert into List 1: 3

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 1
Enter data to insert into List 1: 9
```

```
1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 2
Enter data to insert into List 2: 4

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 3
List 1 sorted.

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 4
List 1 reversed.

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 6
```

```
List 1: 9 5 3
List 2: 4

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 5
Lists concatenated.

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 6
List 1: 9 5 3 4
List 2: 4

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 7
```

LAB PROGRAM 6:

Write a program to Implement Single Link List to simulate Stack & Queue Operations.

```
#include <stdio.h>

#include <stdlib.h>

struct node {

    int info;

    struct node *ptr;

}*top,*top1,*temp;



int count = 0;

void push(int data)
```

```
{
     if (top == NULL)
    {
        top =(struct node *)malloc(1*sizeof(struct node));
        top->ptr = NULL;
        top->info = data;
    }
    else
    {
        temp =(struct node *)malloc(1*sizeof(struct node));
        temp->ptr = top;
        temp->info = data;
        top = temp;
    }
    count++;
    printf("Node is Inserted\n\n");
}

int pop()
{
     top1 = top;
    if (top1 == NULL)
    {
        printf("\nStack Underflow\n");
        return -1;
```

```
    }
    else
        top1 = top1->ptr;
    int popped = top->info;
    free(top);
    top = top1;
    count--;
    return popped;
}

void display() {
    top1 = top;
    if (top1 == NULL)
    {
        printf("\nStack Underflow\n");
        return;
    }

    printf("The stack is \n");
    while (top1 != NULL)
    {
        printf("%d--->", top1->info);
        top1 = top1->ptr;
    }
    printf("NULL\n\n");
```

```
}
void main() {
    int choice, value;
    printf("\nImplementation of Stack using Linked List\n");
    while (1) {
        printf("\nMENU\n1. Push\n2. Pop\n3. Display\n4. Exit\n");
        printf("Enter your choice : ");
        scanf("%d", &choice);
        switch (choice) {
        case 1:
            printf("\nEnter the value to insert: ");
            scanf("%d", &value);
            push(value);
            break;
        case 2:
            printf("Popped element is :%d\n", pop());
            break;
        case 3:
            display();
            break;
        case 4:
            exit(0);
            break;
        default:
            printf("\Invalid Choice\n");
```

```
      }
    }
}
```

OUTPUT:

```
Implementation of Stack using Linked List

MENU
1. Push
2. Pop
3. Display
4. Exit
Enter your choice : 1

Enter the value to insert: 4
Node is Inserted


MENU
1. Push
2. Pop
3. Display
4. Exit
Enter your choice : 1

Enter the value to insert: 6
Node is Inserted


MENU
1. Push
2. Pop
3. Display
4. Exit
Enter your choice : 1

Enter the value to insert: 5
Node is Inserted
```

```
MENU
1. Push
2. Pop
3. Display
4. Exit
Enter your choice : 2
Popped element is :5
MENU
1. Push
2. Pop
3. Display
4. Exit
Enter your choice : 3
The stack is
6--->4--->NULL


MENU
1. Push
2. Pop
3. Display
4. Exit
Enter your choice : 4
```

QUEUE IMPLEMENTATION:

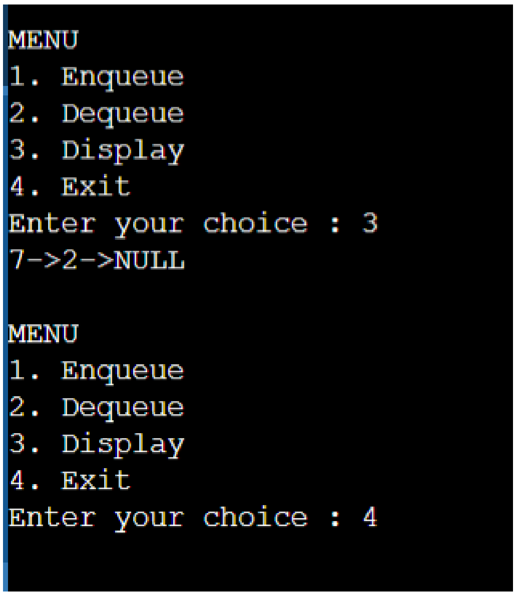
```
#include<stdio.h>
#include<stdlib.h>
struct node
{
   int data;
   struct node *next;
};

struct node *front = NULL, *rear = NULL;

void enqueue(int val)
{
   struct node *newNode = malloc(sizeof(struct node));
   newNode->data = val;
   newNode->next = NULL;
   if(front == NULL && rear == NULL)
      front = rear = newNode;
   else
   {
      //add newnode in rear->next
      rear->next = newNode;
      rear = newNode;
   }
}
int dequeue()
{
   if(front == NULL)
```

```
    {
         printf("\nUNDERFLOW\n");
         return-1;
    }
    else
    {
        struct node *temp = front;
        int temp_data=front->data;
        front = front->next;
        free(temp);
        return temp_data;
    }
}
void display()
{
    struct node *temp = front;
    while(temp)
    {
        printf("%d->",temp->data);
        temp = temp->next;
    }
    printf("NULL\n");
}
void main()
{
    int choice, value;
    printf("\nImplementation of Queue using Linked List\n");
    while (1) {
        printf("\nMENU\n1. Enqueue\n2. Dequeue\n3. Display\n4. Exit\n");
```

```
        printf("Enter your choice : ");
        scanf("%d", &choice);
        switch (choice)
{
                case 1:
                        printf("\nEnter the value to insert: ");
                        scanf("%d", &value);
                        enqueue(value);
                        break;
                case 2:
                        printf("The element removed is :%d\n", dequeue());
                         break;
                case 3:
                         display();
                        break;
                case 4:
                        exit(0);
                        break;
                 default:
                         printf("\nInvalid Choice\n");
                }
            }
}
```

OUTPUT:

```
Implementation of Queue using Linked List

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

Enter the value to insert: 5

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

Enter the value to insert: 7

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

Enter the value to insert: 2

MENU
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice : 2
The element removed is :5
```



```
MENU
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice : 3
7->2->NULL

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

LAB PROGRAM 7:

Write a program 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 {
    int data;
    struct Node* prev;
    struct Node* next;
};

struct Node* head = NULL;

void createlist() {
    int i, n;
    struct Node* newNode;
    struct Node* temp;
```

```
    printf("Enter the number of elements:");
    scanf("%d", &n);
    for (i = 0; i < n; i++) {
        newNode = (struct Node*)malloc(sizeof(struct Node));
        printf("Enter the element: ");
        scanf("%d", &newNode->data);
        if (head == NULL) {
            head = temp = newNode;
            head->prev = NULL;
            temp->next = NULL;
        } else {
            temp->next = newNode;
            newNode->prev = temp;
            temp = newNode;
            temp->next = NULL;
        }
    }
    printf("List created successfully.\n");
}

void insertLeft(struct Node* temp, int data) {
    struct Node* newNode;
    if (temp == NULL) {
        printf("Target node doesn't exist!\n");
        return;
    }
    newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = temp;
    newNode->prev = temp->prev;
    if (temp->prev != NULL) {
        temp->prev->next = newNode;
    }
    temp->prev = newNode;
    if (head == temp) {
        head = newNode;
    }
    printf("Node inserted successfully.\n");
}

void deleteNode(int key) {
    struct Node* current = head;
    while (current != NULL) {
        if (current->data == key) {
```

```
            if (current->prev != NULL) {
                current->prev->next = current->next;
            }
            if (current->next != NULL) {
                current->next->prev = current->prev;
            }
            if (current == head) {
                head = current->next;
            }
            free(current);
            printf("Node deleted successfully.\n");
            return;
        }
        current = current->next;
    }
    printf("Node with value %d not found!\n", key);
}


void printList() {
    struct Node* temp = head;
    if (temp == NULL) {
        printf("List is empty!\n");
        return;
    }
    printf("Doubly linked list: ");
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}

void main()
{
    int choice, data, targetValue, deleteValue;

    while(1)
   {
            printf("\nMENU:\n");
            printf("1. Create linked list\n");
            printf("2. Insert left of node\n");
            printf("3. Delete node by value\n");
             printf("4. Print the list\n");
```

```
        printf("5. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                createlist();
                break;
            case 2:
                printf("Enter the value of the node to insert left of: ");
                scanf("%d", &targetValue);
                printf("Enter the element to insert left of the node: ");
                scanf("%d", &data);
                struct Node* temp = head;
                while (temp != NULL) {
                    if (temp->data == targetValue) {
                        insertLeft(temp, data);
                        break;
                    }
                    temp = temp->next;
                }
                break;
            case 3:
                printf("Enter the value of the node to delete: ");
                scanf("%d", &deleteValue);
                deleteNode(deleteValue);
                break;
            case 4:
                printList();
                break;
            case 5:
                exit(0);
                break;
            default:
                printf("Invalid choice.\n");
        }
    }

}
```

OUTPUT:

```
MENU:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 1
Enter the number of elements:3
Enter the element: 2
Enter the element: 4
Enter the element: 6
List created successfully.

MENU:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 2
Enter the value of the node to insert left of: 4
Enter the element to insert left of the node: 3
Node inserted successfully.
```

```
MENU:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 3
Enter the value of the node to delete: 6
Node deleted successfully.

MENU:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 4
Doubly linked list: 2 3 4

MENU:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 5
```

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 TreeNode {
    int val;
    struct TreeNode *left;
    struct TreeNode *right;
};


struct TreeNode* createNode(int value) {
    struct TreeNode* newNode = (struct TreeNode*)malloc(sizeof(struct TreeNode));
    newNode->val = value;
    newNode->left = NULL;
    newNode->right = NULL;
    return newNode;
}


struct TreeNode* insert(struct TreeNode* node, int value) {
    if (node == NULL) {
        return createNode(value);
    }
    if (value < node->val) {
        node->left = insert(node->left, value);
    } else if (value > node->val) {
        node->right = insert(node->right, value);
    }
    return node;
}

void inorderTraversal(struct TreeNode* node) {
    if (node != NULL) {
```

```
        inorderTraversal(node->left);
        printf("%d ", node->val);
        inorderTraversal(node->right);
    }
}

void postorderTraversal(struct TreeNode* node) {
    if (node != NULL) {
        postorderTraversal(node->left);
        postorderTraversal(node->right);
        printf("%d ", node->val);
    }
}

void preorderTraversal(struct TreeNode* node) {
    if (node != NULL) {
        printf("%d ", node->val);
        preorderTraversal(node->left);
        preorderTraversal(node->right);
    }
}


void main()
{
    struct TreeNode* root = NULL;
    int n, value,choice;

   printf("\nMENU:\n");
   printf("1. Create tree\n");
   printf("2. Preorder\n");
   printf("3. Inorder\n");
   printf("4. Postorder\n");
   printf("5. Exit\n");
   printf("Enter your choice: ");
   scanf("%d", &choice);
   while(1)
  {
          switch(choice)
          {
                    case 1:
                              printf("Enter the number of nodes: ");
                              scanf("%d", &n);
```

```
                 printf("Enter the values of the nodes: ");
                for (int i = 0; i < n; ++i)
                {
                        scanf("%d", &value);
                        root = insert(root, value);
                }
                break;

        case 2:
           printf("Inorder traversal: ");
           inorderTraversal(root);
           printf("\n");

        case 3:
                printf("Inorder traversal: ");
                 inorderTraversal(root);
                printf("\n");
                break;
        case 4:
                printf("Postorder traversal: ");
                postorderTraversal(root);
                printf("\n");
                break;

        case 5:
                exit(0);
                break;
        default:
                printf("Invalid chouce ");

        }
    }
}
```

OUTPUT:

```
MENU:
1. Create tree
2. Preorder
3. Inorder
4. Postorder
5. Exit

Enter your choice: 1
Enter the number of nodes: 6
Enter the values of the nodes: 2 5 7 8 6 9

Enter your choice: 2

Inorder traversal: 2 5 6 7 8 9

Enter your choice: 3

Inorder traversal: 2 5 6 7 8 9

Enter your choice: 4

Postorder traversal: 6 9 8 7 5 2

Enter your choice: 5
```

LAB PROGRAM 9:

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

```
#include <stdio.h>

#include <stdlib.h>

#define SIZE 40



struct queue {

  int items[SIZE];

  int front;

  int rear;
```

```
};

struct queue* createQueue();
void enqueue(struct queue* q, int);
int dequeue(struct queue* q);
void display(struct queue* q);
int isEmpty(struct queue* q);
void printQueue(struct queue* q);

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

struct node* createNode(int);

struct Graph {
  int numVertices;
  struct node** adjLists;
  int* visited;
};

void bfs(struct Graph* graph, int startVertex) {
  struct queue* q = createQueue();
```

```
  graph->visited[startVertex] = 1;
  enqueue(q, startVertex);

  while (!isEmpty(q)) {
    int currentVertex = dequeue(q);
    printf("Visited %d\n", currentVertex);

    struct node* temp = graph->adjLists[currentVertex];

    while (temp) {
      int adjVertex = temp->vertex;

      if (graph->visited[adjVertex] == 0) {
        graph->visited[adjVertex] = 1;
        enqueue(q, adjVertex);
      }
      temp = temp->next;
    }
  }
}

struct node* createNode(int v) {
  struct node* newNode = malloc(sizeof(struct node));
  newNode->vertex = v;
  newNode->next = NULL;
```

```
  return newNode;
}

struct Graph* createGraph(int vertices) {
  struct Graph* graph = malloc(sizeof(struct Graph));
  graph->numVertices = vertices;

  graph->adjLists = malloc(vertices * sizeof(struct node*));
  graph->visited = malloc(vertices * sizeof(int));

  int i;
  for (i = 0; i < vertices; i++) {
    graph->adjLists[i] = NULL;
    graph->visited[i] = 0;
  }

  return graph;
}

void addEdge(struct Graph* graph, int src, int dest) {
  struct node* newNode = createNode(dest);
  newNode->next = graph->adjLists[src];
  graph->adjLists[src] = newNode;

  newNode = createNode(src);
```

```
  newNode->next = graph->adjLists[dest];

  graph->adjLists[dest] = newNode;

}


struct queue* createQueue() {

  struct queue* q = malloc(sizeof(struct queue));

  q->front = -1;

  q->rear = -1;

  return q;

}


int isEmpty(struct queue* q) {

  if (q->rear == -1)

    return 1;

  else

    return 0;

}


void enqueue(struct queue* q, int value) {

  if (q->rear == SIZE - 1)

    printf("\nQueue is Full!!");

  else {

    if (q->front == -1)

      q->front = 0;

    q->rear++;
```

```
    q->items[q->rear] = value;
  }
}

int dequeue(struct queue* q) {
  int item;
  if (isEmpty(q)) {
    printf("Queue is empty");
    item = -1;
  } else {
    item = q->items[q->front];
    q->front++;
    if (q->front > q->rear) {
      printf("Resetting queue ");
      q->front = q->rear = -1;
    }
  }
  return item;
}

void printQueue(struct queue* q) {
  int i = q->front;

  if (isEmpty(q)) {
    printf("Queue is empty");
```

```
  } else {
    printf("\nQueue contains \n");
    for (i = q->front; i < q->rear + 1; i++) {
      printf("%d ", q->items[i]);
    }
  }
}

void main() {
  int vertices, edges, src, dest;
  printf("Enter the number of vertices: ");
  scanf("%d", &vertices);
  printf("Enter the number of edges: ");
  scanf("%d", &edges);

  struct Graph* graph = createGraph(vertices);
  printf("Enter edges (source destination):\n");
  for (int i = 0; i < edges; ++i)
{
		scanf("%d%d", &src, &dest);
		addEdge(graph, src, dest);
  }
  bfs(graph, 0);
}
```

OUTPUT:

```
Enter the number of vertices: 5
Enter the number of edges: 4
Enter edges (source destination):
0 1
0 2
1 3
2 4
Resetting queue Visited 0
Visited 2
Visited 1
Visited 4
Resetting queue Visited 3
```

b) Write a program to traverse a graph using DFS method.

```
#include <stdio.h>

#include <stdlib.h>


struct node {

  int vertex;

  struct node* next;

};


struct node* createNode(int v);


struct Graph {

  int numVertices;

  int* visited;


  struct node** adjLists;
```

```
};

void DFS(struct Graph* graph, int vertex) {
  struct node* adjList = graph->adjLists[vertex];
  struct node* temp = adjList;

  graph->visited[vertex] = 1;
  printf("Visited %d \n", vertex);

  while (temp != NULL) {
    int connectedVertex = temp->vertex;

    if (graph->visited[connectedVertex] == 0) {
      DFS(graph, connectedVertex);
    }
    temp = temp->next;
  }
}

struct node* createNode(int v) {
  struct node* newNode = malloc(sizeof(struct node));
  newNode->vertex = v;
  newNode->next = NULL;
  return newNode;
}
```

```
struct Graph* createGraph(int vertices) {
  struct Graph* graph = malloc(sizeof(struct Graph));
  graph->numVertices = vertices;

  graph->adjLists = malloc(vertices * sizeof(struct node*));

  graph->visited = malloc(vertices * sizeof(int));

  int i;
  for (i = 0; i < vertices; i++) {
    graph->adjLists[i] = NULL;
    graph->visited[i] = 0;
  }
  return graph;
}

void addEdge(struct Graph* graph, int src, int dest) {
  struct node* newNode = createNode(dest);
  newNode->next = graph->adjLists[src];
  graph->adjLists[src] = newNode;

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

```
  graph->adjLists[dest] = newNode;
}

void printGraph(struct Graph* graph) {
  int v;
  for (v = 0; v < graph->numVertices; v++) {
    struct node* temp = graph->adjLists[v];
    printf("\n Adjacency list of vertex %d\n ", v);
    while (temp) {
      printf("%d -> ", temp->vertex);
      temp = temp->next;
    }
    printf("\n");
  }
}

void main()
{
	int vertices, edges, src, dest;
	printf("Enter the number of vertices: ");
	scanf("%d", &vertices);
	printf("Enter the number of edges: ");
	scanf("%d", &edges);

	 struct Graph* graph = createGraph(vertices);
```

```
        printf("Enter edges (source destination):\n");

        for (int i = 0; i < edges; ++i)

        {

                scanf("%d%d", &src, &dest);

                addEdge(graph, src, dest);

        }

        printGraph(graph);

        DFS(graph, 2);

}
```

OUTPUT:

```
Enter the number of vertices: 4
Enter the number of edges: 4
Enter edges (source destination):
0 1
0 2
1 2
2 3

 Adjacency list of vertex 0
 2 -> 1 ->

 Adjacency list of vertex 1
 2 -> 0 ->

 Adjacency list of vertex 2
 3 -> 1 -> 0 ->

 Adjacency list of vertex 3
 2 ->
Visited 2
Visited 3
Visited 1
Visited 0
```

LeetCode Programs:

1.Score of Parentheses(LP:856)

Given a balanced parentheses string s, return *the **score** of the string*.

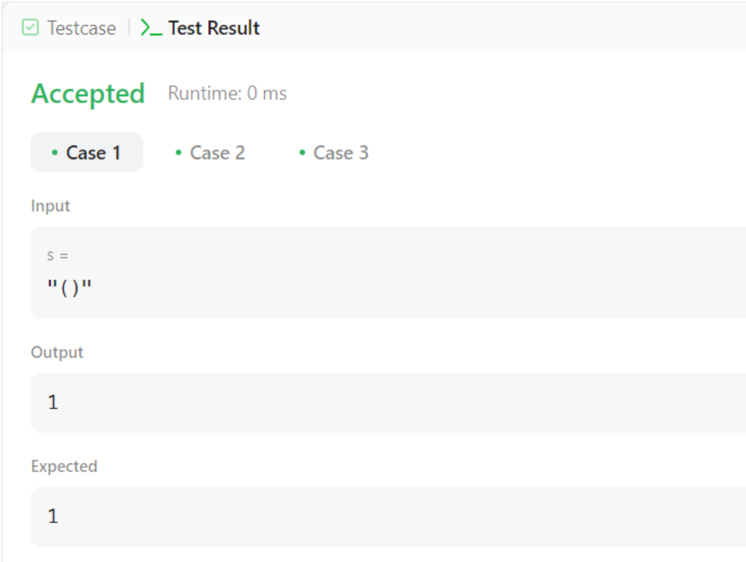
The **score** of a balanced parentheses string is based on the following rule:

- "()" has score 1.
- AB has score A + B, where A and B are balanced parentheses strings.
- (A) has score 2 * A, where A is a balanced parentheses string.

</> Code

C Auto

```c
int scoreOfParentheses(char* s)
{
    int stack[50];
    int top = -1;
    int score = 0;

    for(int i = 0; s[i] != '\0'; i++) {
        if(s[i] == '(') {
            stack[++top] = score;
            score = 0;
        } else {
            score = stack[top--] + (score == 0 ? 1 : (score * 2));
        }
    }
    return score;
}
```



2.Odd Even Linked List(LP:328)

Given the head of a singly linked list, group all the nodes with odd indices together followed by the nodes with even indices, and return *the reordered list*.

The **first** node is considered **odd**, and the **second** node is **even**, and so on.

Code

C Auto

```c
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* oddEvenList(struct ListNode* head) {
    if (head == NULL || head->next == NULL || head->next->next == NULL)
        return head;

    struct ListNode *oddHead = head;
    struct ListNode *evenHead = head->next;
    struct ListNode *oddCurrent = oddHead;
    struct ListNode *evenCurrent = evenHead;

    while (evenCurrent != NULL && evenCurrent->next != NULL) {
        oddCurrent->next = evenCurrent->next;
        oddCurrent = oddCurrent->next;
        evenCurrent->next = oddCurrent->next;
        evenCurrent = evenCurrent->next;
    }
     oddCurrent->next = evenHead;

    return oddHead;
}
```

Testcase | Test Result

Accepted Runtime: 0 ms

• Case 1 • Case 2

Input

head =

[1,2,3,4,5]

Output

[1,3,5,2,4]

Expected

[1,3,5,2,4]

3.Delete middle node of linked list.(LP:2095)

You are given the head of a linked list. **Delete** the **middle node**, and return *the* head *of the modified linked list*.

The **middle node** of a linked list of size n is the $\lfloor n / 2 \rfloor^{th}$ node from the **start** using **0-based indexing**, where $\lfloor x \rfloor$ denotes the largest integer less than or equal to x.

- For n = 1, 2, 3, 4, and 5, the middle nodes are 0, 1, 1, 2, and 2, respectively.

</> Code

C ⌄ 🔒 Auto

```c
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
int countOfNodes(struct ListNode* head)
{
    int count = 0;
    while (head != NULL) {
        head = head->next;
        count++;
    }
    return count;
}
struct ListNode* deleteMiddle(struct ListNode* head)
{
    if (head == NULL)
        return NULL;
    if (head->next == NULL) {
        free(head);
        return NULL;
    }
    struct ListNode* copyHead = head;
    int count = countOfNodes(head);
    int mid = count / 2;
    while(mid-->1)
    head = head->next;
    head->next = head->next->next;
    return copyHead;
}
```

Testcase | Test Result

Accepted Runtime: 2 ms

• Case 1 • Case 2 • Case 3

Input

head =

```
[1,3,4,7,1,2,6]
```

Output

```
[1,3,4,1,2,6]
```

Expected

```
[1,3,4,1,2,6]
```

4.Delete a node in BST.(LP:450)

Given a root node reference of a BST and a key, delete the node with the given key in the BST. Return *the **root node reference** (possibly updated) of the BST*.

Basically, the deletion can be divided into two stages:

1. Search for a node to remove.
2. If the node is found, delete the node.

</> Code

C ∨ Auto

```c
/**
 * Definition for a binary tree node.
 * struct TreeNode {
 *     int val;
 *     struct TreeNode *left;
 *     struct TreeNode *right;
 * };
 */
struct TreeNode* minValueNode(struct TreeNode* node) {
    struct TreeNode* current = node;
    while (current && current->left != NULL)
        current = current->left;
    return current;
}

struct TreeNode* deleteNode(struct TreeNode* root, int key) {
    if (root == NULL) return root;

    if (key < root->val)
        root->left = deleteNode(root->left, key);
    else if (key > root->val)
        root->right = deleteNode(root->right, key);
    else {
        if (root->left == NULL) {
            struct TreeNode* temp = root->right;
            free(root);
            return temp;
        } else if (root->right == NULL) {
            struct TreeNode* temp = root->left;
            free(root);
            return temp;
        }

        struct TreeNode* temp = minValueNode(root->right);
        root->val = temp->val;
        root->right = deleteNode(root->right, temp->val);
    }
    return root;
}
```

Testcase | >_ Test Result

Accepted Runtime: 2 ms

• Case 1 • Case 2 • Case 3

Input

root =
[5,3,6,2,4,null,7]

key =
3

Output

[5,4,6,2,null,null,7]

Expected

[5,4,6,2,null,null,7]

5.Bottom Left Tree Value.(LP:513)

Given the root of a binary tree, return the leftmost value in the last row of the tree.

</> Code

C Auto

```c
/**
 * Definition for a binary tree node.
 * struct TreeNode {
 *     int val;
 *     struct TreeNode *left;
 *     struct TreeNode *right;
 * };
 */
int findBottomLeftValue(struct TreeNode* root) {
    struct TreeNode* queue[10000]; // Assuming maximum 10000 nodes
    int front = 0, rear = 0;
    queue[rear++] = root;
    int leftmostValue = root->val;

    while (front < rear) {
        int levelSize = rear - front;
        for (int i = 0; i < levelSize; i++) {
            struct TreeNode* current = queue[front++];
            if (i == 0) // first node at the current level
                leftmostValue = current->val;
            if (current->left != NULL)
                queue[rear++] = current->left;
            if (current->right != NULL)
                queue[rear++] = current->right;
        }
    }

    return leftmostValue;
}
```

Testcase | >_ Test Result

Accepted   Runtime: 5 ms

• Case 1   • Case 2

Input

root =

```
[1,2,3,4,null,5,6,null,null,7]
```

Output

```
7
```

Expected

```
7
```

Testcase | >_ Test Result

Accepted Runtime: 5 ms

• Case 1 • Case 2

Input

root =

[1,2,3,4,null,5,6,null,null,7]

Output

7

Expected

7

Testcase | >_ Test Result

Accepted Runtime: 5 ms

• Case 1 • Case 2

Input

root =

[2,1,3]

Output

1

Expected

1