VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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

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

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by **RUTH MARY PAUL (1BM22CS360)**, 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 n 5
int top=-1; stack[n];

void push(int a)
{
    if(top==n-1)
    {
     printf("Stack is full");
    }
    else{
            top++;
     stack[top] = a;
    }

}
int pop()
{
    int a;
    if(top==-1)
    {
        printf("underflow");

    }
    else{
        a=stack[top];
        printf("%d is popped",a);
        top--;
    }

}

void display()
{

    if(top==-1)
```

```
void display()
{

    if(top==-1)
    {
        printf("no elements");
    }
    else{
        while(top!=-1)
        {
            printf("%d \n",stack[top]);
            top--;
        }
    }
}
void main()
{
    int a,choice;
    printf("Enter 1 Push, 2 Pop, 3 Display 4 Exit \n");
    while(1)
    {
        printf("Enter choice \t");
        scanf("%d",&choice);
        switch(choice)
        {
            case 1: printf("Enter number to be inserted \t");
                    scanf("%d",&a);
                    push(a);
            break;
            case 2: pop();
                    break;
            case 3: display();
                    break;
            case 4: exit(0);
        }

        }
    }
```

Output:

```
Enter 1 Push, 2 Pop, 3 Display 4 Exit
Enter choice    1

 Enter number to be inserted    20
Enter choice    1

 Enter number to be inserted    50
Enter choice    1

 Enter number to be inserted    80
Enter choice    2
80 is poppedEnter choice    1

 Enter number to be inserted    67
Enter choice    3
Stack elements:
67
50
20
```

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 <stdlib.h>
#include <ctype.h>

#define MAX_SIZE 100

int precedence(char symbol);
void push(char item);
char pop();
void infixToPostfix(char infix[], char postfix[]);

char stack[MAX_SIZE];
int top = -1;

int main() {
    char infix[MAX_SIZE], postfix[MAX_SIZE];

    printf("Enter infix expression: ");
    scanf("%s", infix);

    infixToPostfix(infix, postfix);

    printf("Postfix expression: %s\n", postfix);

    return 0;
}

int precedence(char symbol) {
    switch(symbol) {
        case '^':
            return 3;
```

```c
int precedence(char symbol) {
    switch(symbol) {
        case '^':
            return 3;
        case '*':
        case '/':
            return 2;
        case '+':
        case '-':
            return 1;
        default:
            return 0;
    }
}

void push(char item) {
    if (top == MAX_SIZE - 1) {
        printf("Stack Overflow\n");
        exit(EXIT_FAILURE);
    }
    stack[++top] = item;
}

char pop() {
    if (top == -1) {
        printf("Stack Underflow\n");
        exit(EXIT_FAILURE);
    }
    return stack[top--];
}
```

```
void infixToPostfix(char infix[], char postfix[]) {
    int i = 0, j = 0;
    char symbol, x;

    push('(');

    while ((symbol = infix[i++]) != '\0') {
        if (symbol == '(') {
            push(symbol);
        } else if (isalnum(symbol)) {
            postfix[j++] = symbol;
        } else if (symbol == ')') {
            while (stack[top] != '(') {
                postfix[j++] = pop();
            }
            x = pop();
        } else {
            while (precedence(stack[top]) >= precedence(symbol)) {
                postfix[j++] = pop();
            }
            push(symbol);
        }
    }

    while (stack[top] != '(') {
        postfix[j++] = pop();
    }
    x = pop();

    postfix[j] = '\0';
}
```

Output:

```
Enter the expression : 4+(3//7)-(6*8)+2/8-4

4 3 / 7 / + 6 8 * - 2 8 / + 4 -
--------------------------------
Process exited after 12.95 seconds with return value 0
Press any key to continue . . .
```

Lab program 3a:

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

a) Insert

b) Delete

c) Display

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

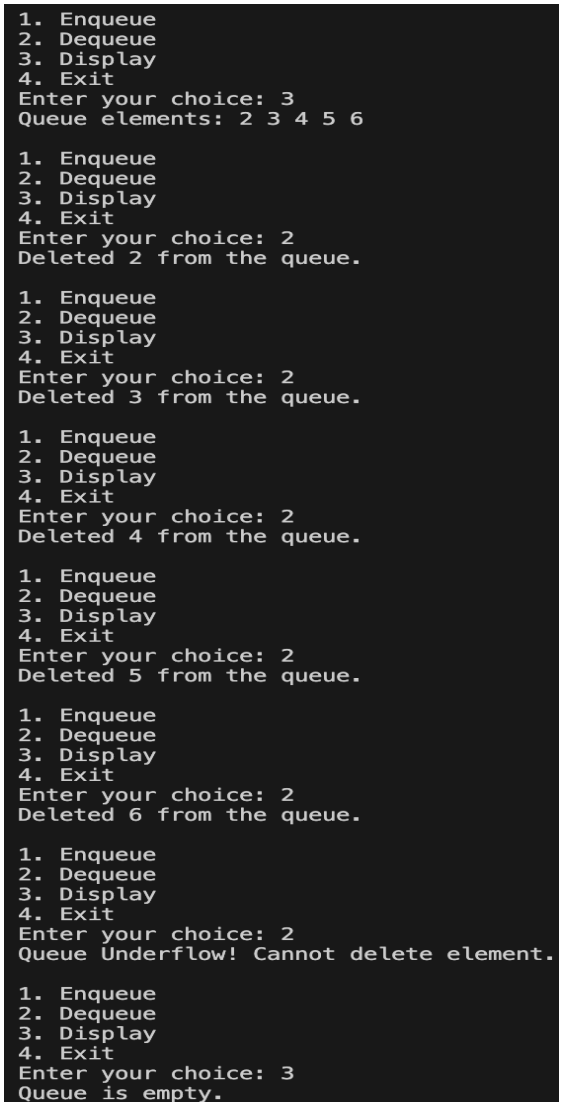
```c
#include <stdio.h>
#define size 5
int queue[size],front=-1,rear=-1;
void enqueue(int a){
  if(rear==size-1){
    printf("Queue is full/overflow\n");
    return;
  }
  else if(front==-1 && rear==-1){
    front=0;
    rear=0;
  }
  else{
    rear=rear+1;
  }
  queue[rear]=a;
}
int dequeue(){
  int a;
  if((front==-1 && rear==-1)||front>rear){
    printf("Queue is empty/underflow\n");
  }
  else{
    a=queue[front];
    front++;
  }
  return a;
}
void display(){
  if((front==-1 && rear==-1)||front>rear){
    printf("Queue is empty/underflow\n");
  }
  else{
    for(int i=front;i<=rear;i++){
      printf("%d\t",queue[i]);
    }
  }
```

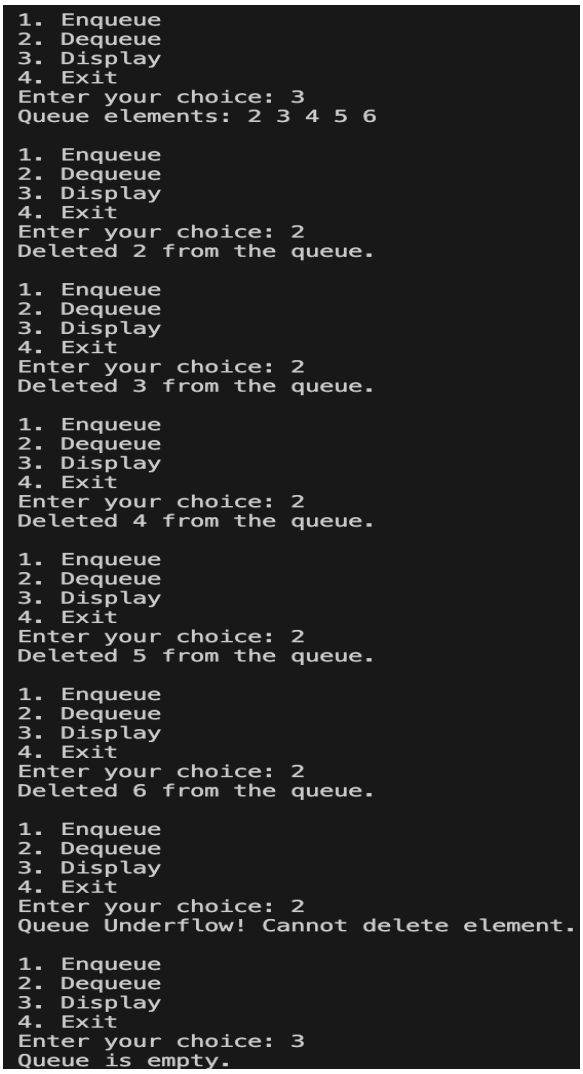
```
    front++;
  }
  return a;
}
void display(){
  if((front==-1 && rear==-1)||front>rear){
    printf("Queue is empty/underflow\n");
  }
  else{
    for(int i=front;i<=rear;i++){
      printf("%d\t",queue[i]);
    }
  }
}
void main(){
  int op,n;
  while(1){
    printf("\nEnter 1.Enqueue\n2.Dequeue\n3.Display\n4.-1 to stop exicution\n");
    scanf("%d",&op);
    if(op==-1){
      break;
    }
    switch(op){
      case 1:printf("Enter no\n");
             scanf("%d",&n);
             enqueue(n);
             break;
      case 2:n=dequeue();
             printf("%d is Dequeued\n",n);
             break;
      case 3:display();
             break;
      default:printf("Invalid choice\n");
    }
  }
}
```

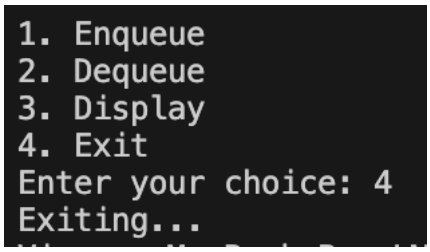
Output:

```
Vismays-MacBook-Pro:LNM code notes
/vismaypawar/Desktop/All notes/dsa

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

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

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

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

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

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Queue Overflow. Cannot enqueue.
```


```
Vismays-MacBook-Pro:LNM code notes
/vismaypawar/Desktop/All notes/dsa

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

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

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

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

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

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Queue Overflow. Cannot enqueue.
```


1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue elements: 2 3 4 5 6
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 2 from the queue.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 3 from the queue.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 4 from the queue.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 5 from the queue.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 6 from the queue.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Queue Underflow! Cannot delete element.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue is empty.


1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue elements: 2 3 4 5 6
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 2 from the queue.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 3 from the queue.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 4 from the queue.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 5 from the queue.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted 6 from the queue.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Queue Underflow! Cannot delete element.
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue is empty.


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

Lab program 3b:

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

a) Insert

b) Delete

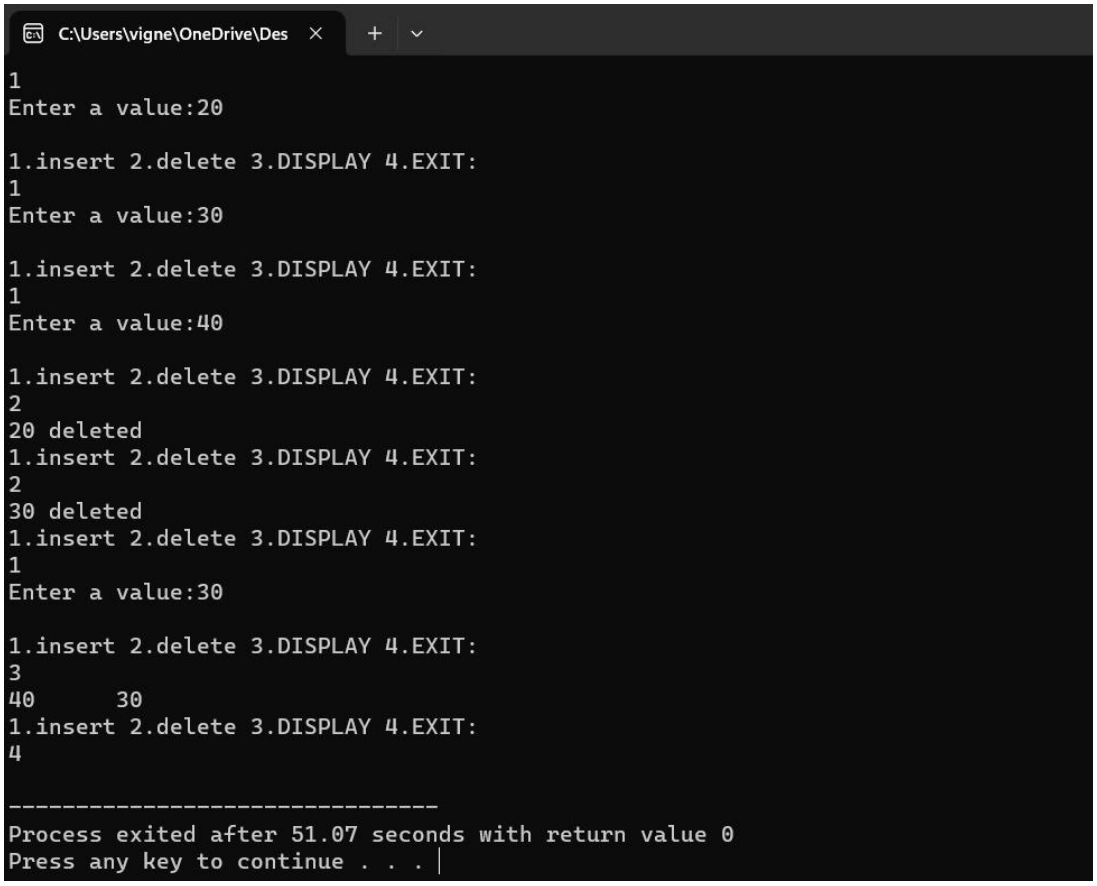
c) Display

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

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

}

void display()
{
    int i=front;
    if(front==-1)
    {
        printf("no elements \t");
    }
    else{
     while(i!=rear)
        {
            printf("%d \n",queue[i]);
             i=(i+1)%n;
        }
        break;

    }
}
void main()
{
    int a,choice;
    printf("Enter 1 enqueue, 2 dequeue ;, 3 Display 4 Exit \n");
    while(1)
    {
        printf("Enter choice \t");
        scanf("%d",&choice);
        switch(choice)
        {
            case 1: printf("Enter number to be inserted \n");
                    scanf("%d",&a);
                    enqueue(a);
            break;
            case 2: dequeue();
                    break;
            case 3: display();
                    break;
            case 4: exit(0);
        }

        }
    }
```

```c
#include<stdio.h>
#include<stdlib.h>
#define n 3
int front=-1, rear=-1, queue[n];

void enqueue(int a)
{
    if(rear==-1 && front== -1)
    {
     rear=front=0;
     queue[rear]=a;
    }
    else if((rear+1)%n==front)
    {
       printf("Queue is full \n");

    }
    else{
            rear=(rear+1)%n;
            queue[rear] = a;
    }

}
void dequeue()
{
    int a;
    if(front==-1 && rear == -1)
    {
        printf("underflow \n");

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

}

void display()
{
    int i=front;
    if(front==-1)
    {
        printf("no elements \t");
    }
    else{
     while(i!=rear)
        {
            printf("%d \n",queue[i]);
             i=(i+1)%n;
        }
        break;
```

Output:



Lab program 4:

WAP to Implement Singly Linked List with following operations

a) Create a linked list.

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

c) Display the contents of the linked list.

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

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

struct node * create (int a)
{
    struct node* newnode = (struct node*) malloc (sizeof(struct node));
    newnode->data=a;
    newnode->next=0;
    return newnode;
};
struct node * insertatbeg(int a, struct node* head)
{
    struct node * newnode =create(a);
    newnode->next=head;
    head=newnode;
    return head;
};
struct node * insertatpos(int a, struct node *head, int pos )
{
    struct node*temp=head;
    int i=1;
    while(i>pos-1)
    {
        temp=temp->next;
    }
    struct node* newnode = create(a);
    newnode->next=temp->next;
    temp->next=newnode;

};
struct node * insertatend(int a, struct node* head)
{
    struct node*temp=head;
    while(temp->next!=NULL)
    {
        temp=temp->next;
    }
    struct node* newnode = create(a);
    temp->next=newnode;
```

```c
struct node * insertatend(int a, struct node* head)
{
    struct node*temp=head;
    while(temp->next!=NULL)
    {
        temp=temp->next;
    }
    struct node* newnode = create(a);
    temp->next=newnode;
};
void display( struct node*head)
{
    struct node* temp= head;
    while(temp->next!=NULL)
    {
        printf("%d \t -> \t",temp->data);
        temp=temp->next;
    }
    printf("%d",temp->data);
}

void main()
{
    int choice, pos,value;
    struct node*head=NULL;
    printf("enter 1.beg 2.end, 3.pos  4.display 5.exit");
    do{
```

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

void main()
{
    int choice, pos,value;
    struct node*head=NULL;
    printf("enter 1.beg 2.end, 3.pos  4.display 5.exit");
    do{

        printf("\n Enter choice \t");
        scanf("%d", &choice);
        switch(choice)
        {
            case 1:printf("\n Enter the element to be inserted at beginning \t");
                    scanf("%d",&value);
                    head=insertatbeg(value,head);
                    break;
            case 2: printf("\n Enter the element to be inserted at end \t");
                    scanf("%d",&value);
                    insertatend(value,head);
                    break;
            case 3:printf("\n Enter the element to be inserted at position \t");
                    scanf("%d",&value);
                   printf("\n Enter pos");
                    scanf("%d",&pos);
                    insertatpos(value,head,pos);
                    break;
            case 4: display(head);
                    break;
            case 5: exit(0);

        }
    }while(choice != 6);

}
```

Output:

```
"C:\Users\vigne\OneDrive\Do
enter 1.beg 2.end, 3.pos  4.display 5.exit
 Enter choice   1

 Enter the element to be inserted at beginning  20

 Enter choice   1

 Enter the element to be inserted at beginning  30

 Enter choice   2

 Enter the element to be inserted at end        45

 Enter choice   2

 Enter the element to be inserted at end        60

 Enter choice   3

 Enter the element to be inserted at position   3

 Enter pos3

 Enter choice   4
30       ->     3       ->     20       ->     45       ->     60
 Enter choice   5

Process returned 0 (0x0)   execution time : 27.893 s
Press any key to continue.
```

Lab program 5:

WAP to Implement Singly Linked List with following operations

a) Create a linked list.

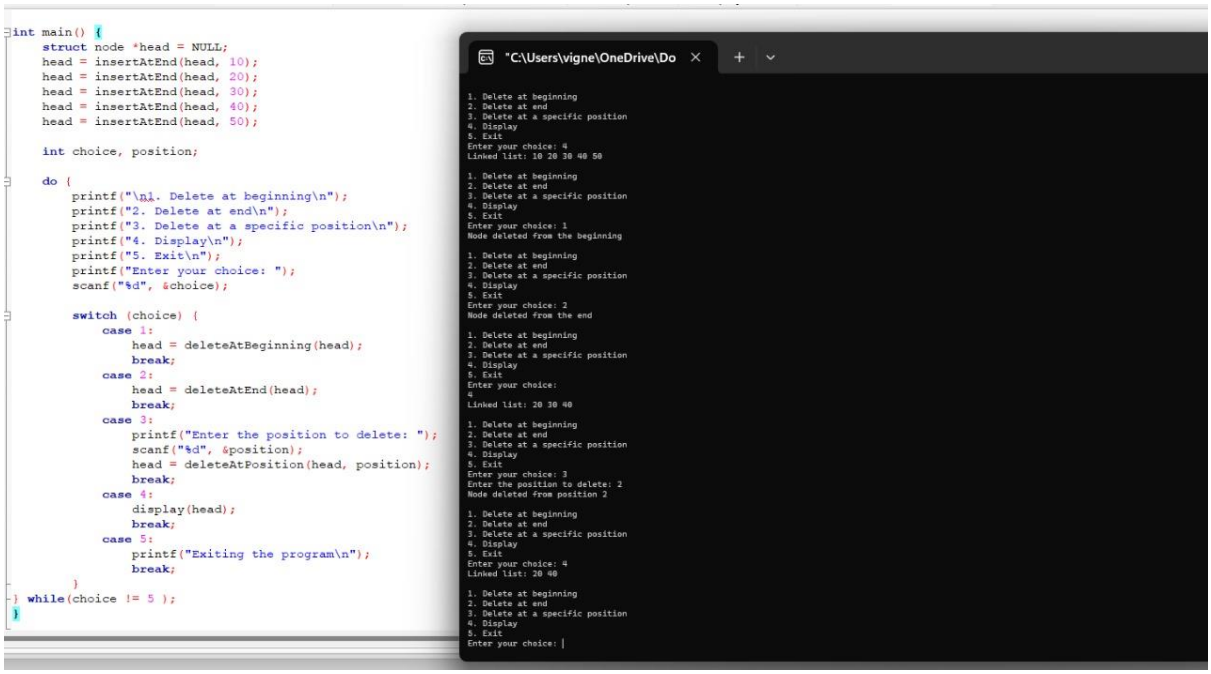
b) Deletion of first element, specified element and last element in the list.

c) Display the contents of the linked list.

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

struct node *createNode(int data) {
    struct node *newNode = (struct node *)malloc(sizeof(struct node));
    if (newNode == NULL) {
        printf("Memory allocation failed\n");
        exit(1);
    }
    newNode->data = data;
    newNode->next = NULL;
    return newNode;
}

struct node *insertAtBeginning(struct node *head, int data) {
    struct node *newNode = createNode(data);
    if (head == NULL) {
        head = newNode;
    } else {
        newNode->next = head;
        head = newNode;
    }
    return head;
}
```

```c
struct node *deleteAtBeginning(struct node *head) {
    if (head == NULL) {
        printf("List is empty\n");
    } else {
        struct node *temp = head;
        head = head->next;
        free(temp);
        printf("Node deleted from the beginning\n");
    }
    return head;
}


struct node *deleteAtEnd(struct node *head) {
    if (head == NULL) {
        printf("List is empty\n");
    } else if (head->next == NULL) {
        free(head);
        head = NULL;
        printf("Node deleted from the end\n");
    } else {
        struct node *temp = head;
        struct node *prev = NULL;
        while (temp->next != NULL) {
            prev = temp;
            temp = temp->next;
        }
        prev->next = NULL;
        free(temp);
        printf("Node deleted from the end\n");
    }
    return head;
}
```

```c
struct node *deleteAtPosition(struct node *head, int position) {
    if (head == NULL) {
        printf("List is empty\n");
    } else if (position == 1) {
        head = deleteAtBeginning(head);
    } else {
        struct node *temp = head;
        struct node *prev = NULL;
        int count = 1;
        while (temp != NULL && count < position) {
            prev = temp;
            temp = temp->next;
            count++;
        }
        if (temp == NULL) {
            printf("Invalid position\n");
        } else {
            prev->next = temp->next;
            free(temp);
            printf("Node deleted from position %d\n", position);
        }
    }
    return head;
}


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



```c
int main() {
    struct node *head = NULL;
    head = insertAtEnd(head, 10);
    head = insertAtEnd(head, 20);
    head = insertAtEnd(head, 30);
    head = insertAtEnd(head, 40);
    head = insertAtEnd(head, 50);

    int choice, position;

    do {
        printf("\n1. Delete at beginning\n");
        printf("2. Delete at end\n");
        printf("3. Delete at a specific position\n");
        printf("4. Display\n");
        printf("5. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                head = deleteAtBeginning(head);
                break;
            case 2:
                head = deleteAtEnd(head);
                break;
            case 3:
                printf("Enter the position to delete: ");
                scanf("%d", &position);
                head = deleteAtPosition(head, position);
                break;
            case 4:
                display(head);
                break;
            case 5:
                printf("Exiting the program\n");
                break;
        }
    } while(choice != 5 );
}
```

```
"C:\Users\vigne\OneDrive\Do

1. Delete at beginning
2. Delete at end
3. Delete at a specific position
4. Display
5. Exit
Enter your choice: 4
Linked list: 10 20 30 40 50

1. Delete at beginning
2. Delete at end
3. Delete at a specific position
4. Display
5. Exit
Enter your choice: 1
Node deleted from the beginning

1. Delete at beginning
2. Delete at end
3. Delete at a specific position
4. Display
5. Exit
Enter your choice: 2
Node deleted from the end

1. Delete at beginning
2. Delete at end
3. Delete at a specific position
4. Display
5. Exit
Enter your choice:
4
Linked list: 20 30 40

1. Delete at beginning
2. Delete at end
3. Delete at a specific position
4. Display
5. Exit
Enter your choice: 3
Enter the position to delete: 2
Node deleted from position 2

1. Delete at beginning
2. Delete at end
3. Delete at a specific position
4. Display
5. Exit
Enter your choice: 4
Linked list: 20 40

1. Delete at beginning
2. Delete at end
3. Delete at a specific position
4. Display
5. Exit
Enter your choice:
```

Lab program 6a:

WAP to Implement Single Link List with following operations

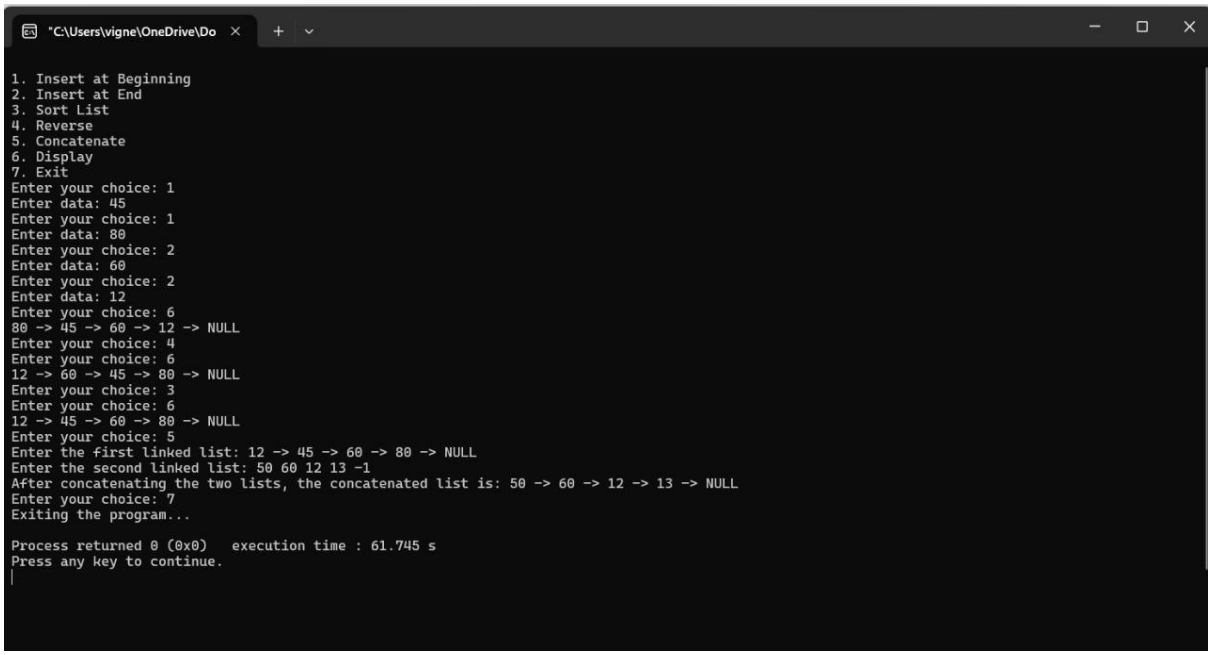
a) Sort the linked list.

b) Reverse the linked list.

c) Concatenation of two linked lists

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

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

struct Node *head = NULL;
struct Node *newnode = NULL;
struct Node *p = NULL;
struct Node *q = NULL;
struct Node *prevnode = NULL;
struct Node *currentnode = NULL;
struct Node *temp = NULL;
struct Node *i = NULL;
struct Node *j = NULL;

void insertatbeg(int data) {
    newnode = (struct Node*)malloc(sizeof(struct Node));
    newnode->data = data;
    newnode->next = head;
    head = newnode;
}

void insertatend(int data) {
    newnode = (struct Node*)malloc(sizeof(struct Node));
    newnode->data = data;
    newnode->next = NULL;

    if (head == NULL) {
        head = newnode;
        return;
    }

    struct Node *current = head;
    while (current->next != NULL) {
        current = current->next;
    }

    current->next = newnode;
    current->next = newnode;
}

void concatenate(struct Node *p, struct Node *q) {
    if (head == NULL) {
        head = p;
    } else {
        struct Node *current = head;
        while (current->next != NULL) {
            current = current->next;
        }

        current->next = p;
    }

    while (q != NULL) {
        insertatend(q->data);
        q = q->next;
    }
}

void reverse() {
    prevnode = NULL;
    currentnode = head;
    newnode = NULL;

    while (currentnode != NULL) {
        newnode = currentnode->next;
        currentnode->next = prevnode;
        prevnode = currentnode;
        currentnode = newnode;
    }

    head = prevnode;
}
```

```c
void sortlist() {
    i = head;
    while (i != NULL) {
        j = head;
        while (j->next != NULL) {
            if (j->data > j->next->data) {
                int temp = j->data;
                j->data = j->next->data;
                j->next->data = temp;
            }
            j = j->next;
        }
        i = i->next;
    }
}

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

int main() {
    int choice;
    int data;
        printf("\n1. Insert at Beginning\n2. Insert at End\n3. Sort List\n4. Reverse\n5. Concatenate\n6. Display\n7. Exit\n");

    while (1) {

        printf("Enter your choice: ");
        scanf("%d", &choice);
```



Lab program 6b:

WAP to implement Stack & Queues using Linked Representation a)Stack

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

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

void display(struct Node *top) {
  if (top != NULL) {
    printf("Stack elements are:\t");
    while (top != NULL) {
      printf("%d\t", top->data);
      top = top->link;
    }
    printf("\n");
  } else {
    printf("Stack is empty\n");
  }
}

struct Node *push(struct Node *top, int x) {
  struct Node *newNode = (struct Node *)malloc(sizeof(struct Node));
  if (newNode == NULL) {
    printf("Stack Overflow\n");
    return top;
  }

  newNode->data = x;
  newNode->link = top;
  top = newNode;

  return top;
}

struct Node *pop(struct Node *top, int *poppedElement) {
  if (top == NULL) {
    printf("Stack Underflow\n");
    *poppedElement = -1;
    return NULL;
  }

  struct Node *temp = top;
  *poppedElement = temp->data;
  top = top->link;
  free(temp);

  return top;
}

int main() {
  int choice, n, poppedElement;
  struct Node *top = NULL;
  printf("Enter 1. Push\n2. Pop\n3. -1 to stop\n");
  while (1) {
    printf("Enter choice:\n");
    scanf("%d", &choice);

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

    switch (choice) {
    case 1:
      printf("Enter the element to push\n");
      scanf("%d", &n);
      top = push(top, n);
      break;
    case 2:
      top = pop(top, &poppedElement);
      if (poppedElement != -1) {
        printf("Popped Element: %d\n", poppedElement);
      }
    }
    display(top);
  }

  return 0;
}
```

```
"C:\Users\vigne\OneDrive\Do

Enter 1. Push
2. Pop
3. -1 to stop
Enter choice:
1
Enter the element to push
45
Stack elements are:     45
Enter choice:
2
Popped Element: 45
Stack is empty
Enter choice:
1
Enter the element to push
56
Stack elements are:     56
Enter choice:
1
Enter the element to push
80
Stack elements are:     80      56
Enter choice:
1
Enter the element to push
70
Stack elements are:     70      80      56
Enter choice:
2
Popped Element: 70
Stack elements are:     80      56
Enter choice:
-1
Execution stopped

Process returned 0 (0x0)   execution time : 53.949 s
Press any key to continue.
```

b)Queue

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

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

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

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

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

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

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

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

    rear->next = newNode;
    rear = newNode;
}

int dequeue(struct Node* front, struct Node* rear) {
    if (front == NULL) {
        printf("Queue Underflow\n");
        return -1;
    }

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

    front = front->next;

    if (front == NULL) {
        rear = NULL;
    }

    free(temp);
    return dequeuedData;
}

int main() {
    int choice, n, dequeuedElement;
    struct Node* front = NULL;
    struct Node* rear = NULL;
    printf("Enter 1. Enqueue\n2. Dequeue\n3. Display\n4. Exit\n");
    while (1) {
        printf("Enter choice\n");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the element to enqueue\n");
                scanf("%d", &n);
                enqueue(front, rear, n);
                break;
```

```c
int main() {
    int choice, value;

    while (1) {
        printf("\n1. Enqueue\n2. Dequeue\n3. Display\n4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the value to be inserted: ");
                scanf("%d", &value);
                enqueue(value);
                break;
            case 2:
                value = dequeue();
                if (value != -1) {
                    printf("Deleted value: %d\n", value);
                }
                break;
            case 3:
                display();
                break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice\n");
        }
    }

    return 0;
}
```

Output:

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

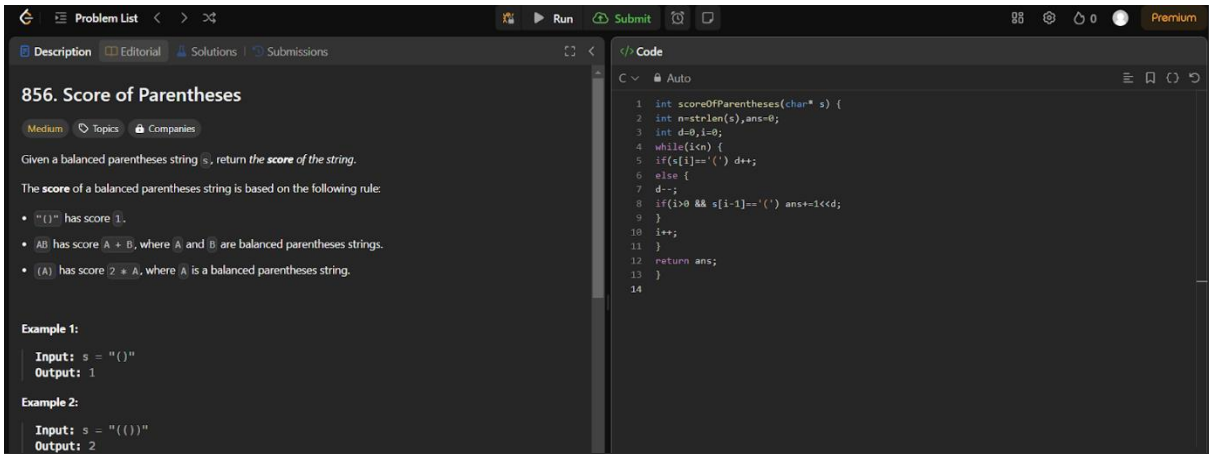
```c
#include <stdio.h>
#include <stdlib.h>

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

struct Node* create(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if (newNode == NULL) {
        printf("Memory allocation failed\n");
        exit(EXIT_FAILURE);
    }
    newNode->data = data;
    newNode->next = NULL;
    newNode->prev = NULL;
    return newNode;
}

void insertAtBeginning(struct Node** head, int data) {
    struct Node* newNode = create(data);
    if (*head == NULL) {
        *head = newNode;
    } else {
        newNode->next = *head;
        (*head)->prev = newNode;
        *head = newNode;
    }
}

void deleteNode(struct Node** head, int value) {
    if (*head == NULL) {
        printf("List is empty\n");
        return;
    }
    struct Node* temp = *head;
    while (temp != NULL && temp->data != value) {
        temp = temp->next;
    }
    if (temp == NULL) {
        printf("Value not found in the list\n");
        return;
    }
```

```
    }
    if (temp == NULL) {
        printf("Value not found in the list\n");
        return;
    }
    if (temp->prev == NULL) {
        *head = temp->next;
        if (temp->next != NULL) {
            temp->next->prev = NULL;
        }
    } else {
        temp->prev->next = temp->next;
        if (temp->next != NULL) {
            temp->next->prev = temp->prev;
        }
    }
    free(temp);
}

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

int main() {
    struct Node* head = NULL;
    int choice, data;
    printf("1. Insert at beginning\n");
    printf("2. Delete node based on specific value\n");
    printf("3. Display\n");
    printf("4. Exit\n");
    while (1) {
        printf("Enter your choice: ");
        scanf("%d", &choice);
        switch (choice) {
            case 1:
                printf("Enter the data to be inserted: ");
                scanf("%d", &data);
                insertAtBeginning(&head, data);
                break;
            case 2:
                printf("Enter the value to be deleted: ");
                scanf("%d", &data);
                deleteNode(&head, data);
                break;
            case 3:
                display(head);
                break;
            case 4:
                printf("Exiting...\n");
                exit(EXIT_SUCCESS);
            default:
                printf("Invalid choice\n");
        }
    }
    return 0;
}
```

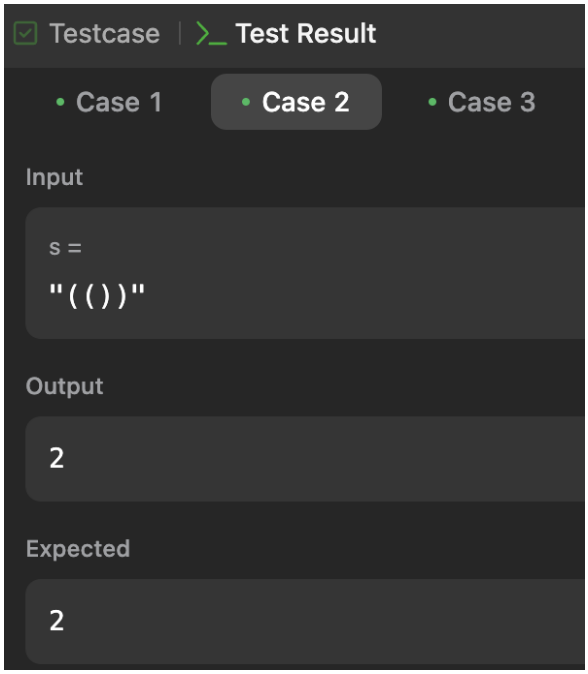
```
/tmp/oIoPCUSYwa.o
1. Insert at beginning
2. Delete node based on specific value
3. Display
4. Exit
Enter your choice: 1
Enter the data to be inserted: 40
Enter your choice: 1
Enter the data to be inserted: 50
Enter your choice: 1
Enter the data to be inserted: 30
Enter your choice: 2
Enter the value to be deleted: 50
Enter your choice: 3
List elements: 30 40
Enter your choice: 4
Exiting...
```

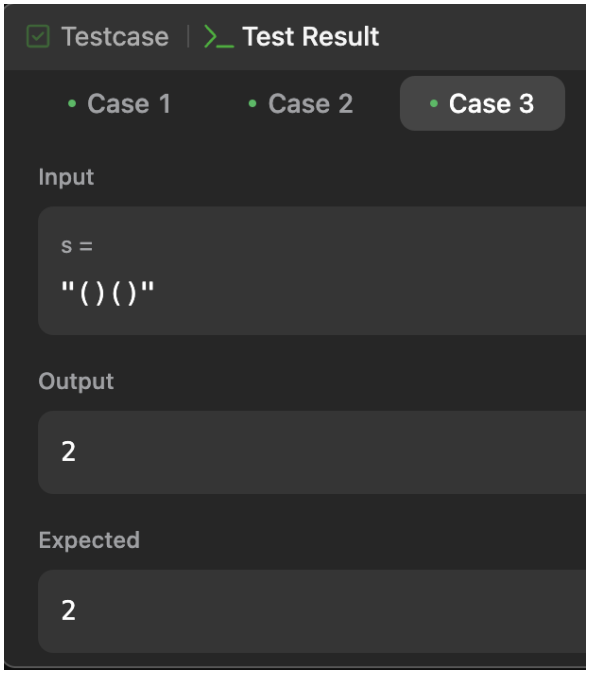
LeetCode Problem:

ScoreOfParentheses:



Output:




Testcase
Test Result
Case 1
Case 2
Case 3
Input
s =
"()()"
Output
2
Expected
2

Lab program 8:

Write a program

a) To construct a binary Search tree.

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

c) To display the elements in the tree.

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


typedef struct TreeNode {
int data;
struct TreeNode* left;
struct TreeNode* right;
} TreeNode;

TreeNode* createNode(int data) {
TreeNode* newNode = (TreeNode*)malloc(sizeof(TreeNode));
if (newNode == NULL) {
printf("Memory allocation failed!\n");
exit(1);
}
newNode->data = data;
newNode->left = NULL;
newNode->right = NULL;
return newNode;
}

TreeNode* insertNode(TreeNode* root, int data) {
if (root == NULL) {
return createNode(data);
}
if (data < root->data) {
root->left = insertNode(root->left, data);
} else if (data > root->data) {
root->right = insertNode(root->right, data);
}
return root;
}
```

```c
void inorderTraversal(TreeNode* root) {
if (root != NULL) {
inorderTraversal(root->left);
printf("%d ", root->data);
inorderTraversal(root->right);
}
}

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

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

void displayTree(TreeNode* root) {
printf("Elements in the tree (inorder traversal): ");
inorderTraversal(root);
printf("\n");
}
```

```c
int main() {
TreeNode* root = NULL;
int choice, data;
printf("\n1. Insert\n2. Inorder Traversal\n3. Preorder Traversal\n4. Postorder Traversal\n5. Display Tree\n6. Exit\n");
do {

printf("Enter your choice: ");
scanf("%d", &choice);
switch (choice) {
case 1:
printf("Enter data to insert into the tree: ");
scanf("%d", &data);
root = insertNode(root, data);
break;
case 2:
printf("Inorder Traversal: ");
inorderTraversal(root);
printf("\n");
break;
case 3:
printf("Preorder Traversal: ");
preorderTraversal(root);
printf("\n");
break;
case 4:
printf("Postorder Traversal: ");
postorderTraversal(root);
printf("\n");
break;
case 5:
displayTree(root);
break;
case 6:
printf("Exiting...\n");
break;
default:
printf("Invalid choice! Please enter a valid option.\n");
}
} while (choice != 6);
return 0;
}
```

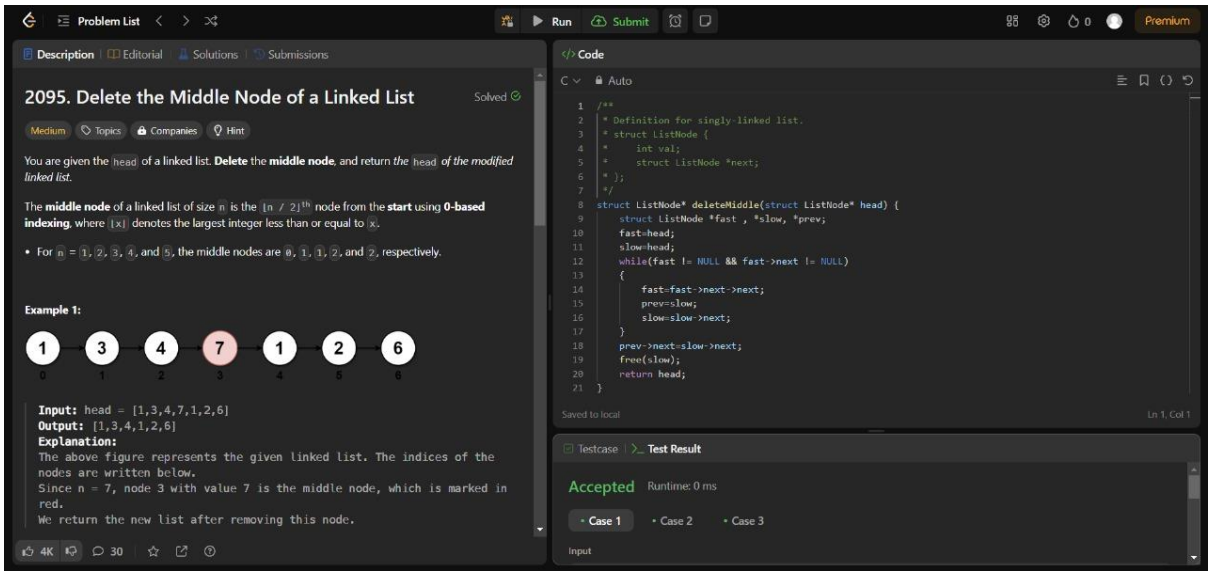
Output:

```
1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 1
Enter data to insert into the tree: 5

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 1
Enter data to insert into the tree: 6

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 1
Enter data to insert into the tree: 4

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 1
Enter data to insert into the tree: 7

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 1
Enter data to insert into the tree: 3

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 5
Elements in the tree (inorder traversal): 3 4 5 6 7
```

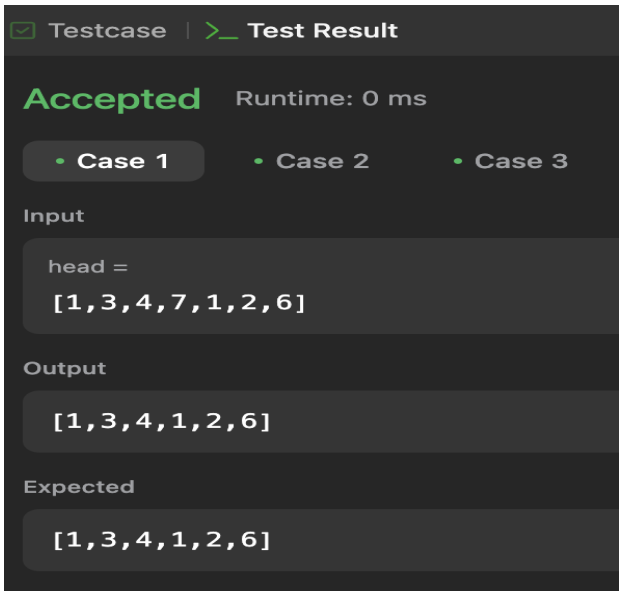
```
1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 2
Inorder Traversal: 3 4 5 6 7

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 3
Preorder Traversal: 5 4 3 6 7

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 4
Postorder Traversal: 3 4 7 6 5

1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 6
Exiting...
Vismays-MacBook-Pro:LNM code no
```

Leet Code Problem:

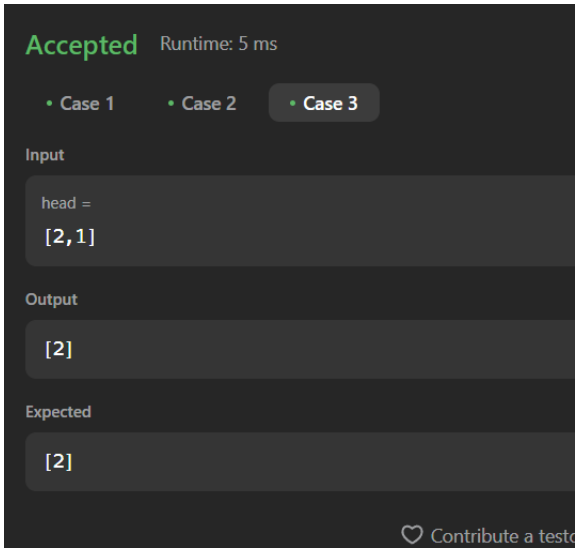
Delete the Middle Node Of a Linked List:



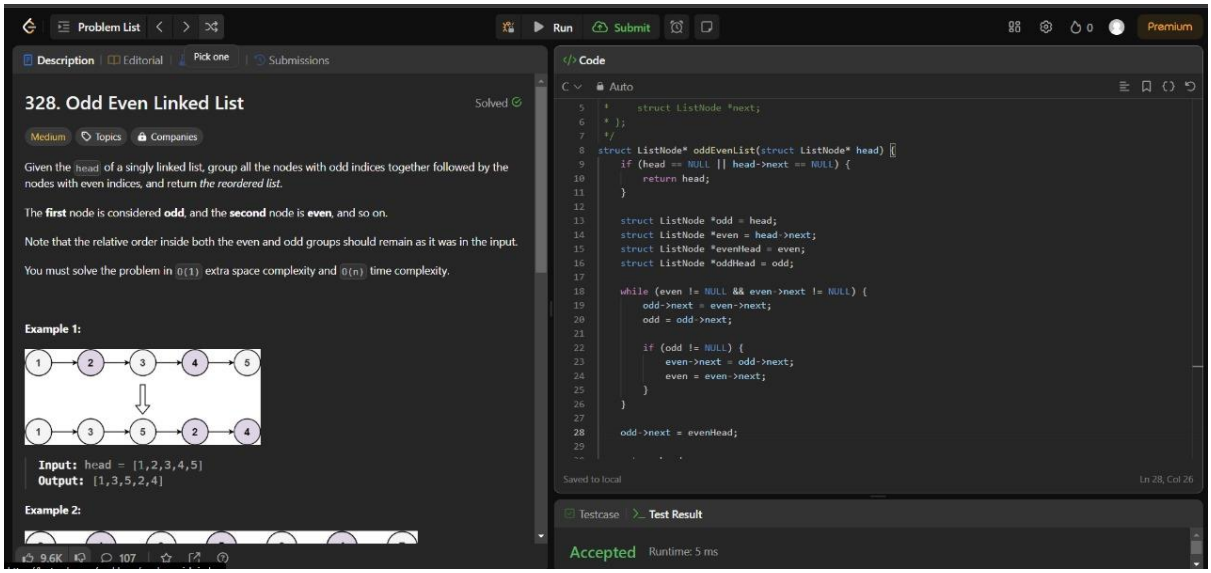
Output:



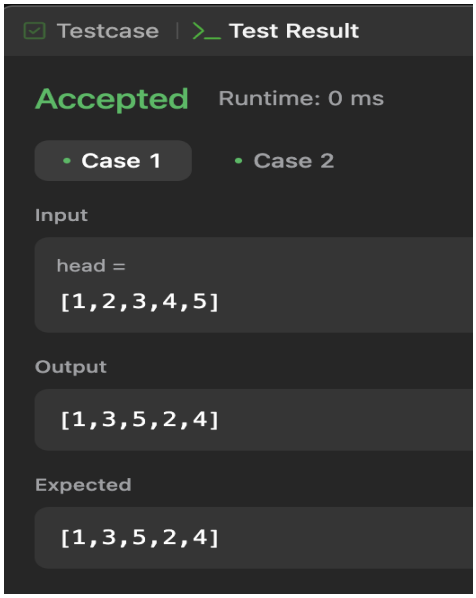

Testcase
Test Result
Accepted
Runtime: 5 ms
Case 1
Case 2
Case 3
Input
head =
[1,2,3,4]
Output
[1,2,4]
Expected
[1,2,4]
Contribute a testcase

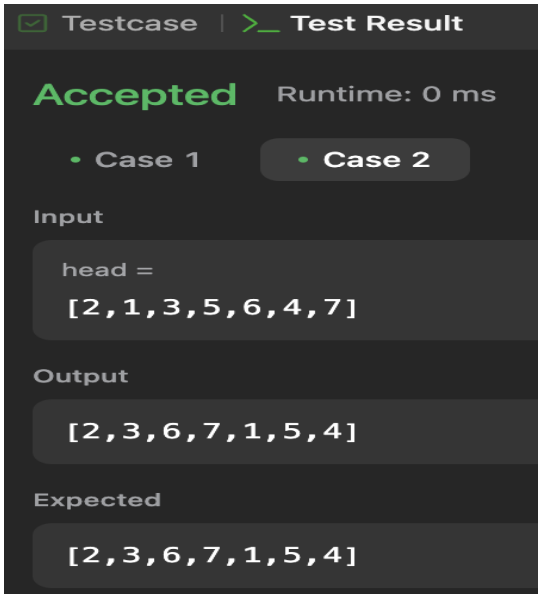

Accepted
Runtime: 5 ms
Case 1
Case 2
Case 3
Input
head =
[2,1]
Output
[2]
Expected
[2]
Contribute a testc

Odd Even Linked List



Output:



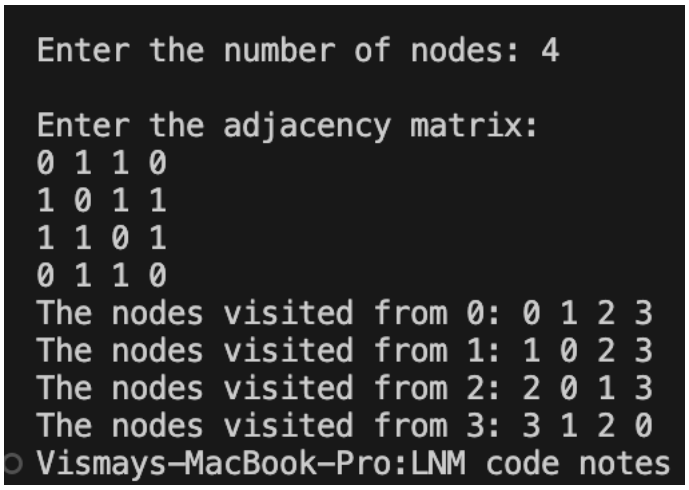


Lab program 9: Write a Program to traverse a graph using BFS method.

```c
#include <stdio.h>


void bfs(int a[10][10], int n, int u) {
int f = 0, r = -1, q[10] = {0}, v, s[10] = {0};
printf("The nodes visited from %d: ", u);

q[++r] = u;
s[u] = 1;
printf("%d ", u);

while (f <= r) {
u = q[f++];

for (v = 0; v < n; v++) {
if (a[u][v] == 1 && s[v] == 0) {
printf("%d ", v);
s[v] = 1;
q[++r] = v;
}
}
}
printf("\n");
}

int main() {
int n, a[10][10], source, i, j;
printf("\nEnter the number of nodes: ");
scanf("%d", &n);
printf("\nEnter the adjacency matrix:\n");

for (i = 0; i < n; i++) {
for (j = 0; j < n; j++) {
scanf("%d", &a[i][j]);
}
}
```

```c
q[++r] = u;
s[u] = 1;
printf("%d ", u);

while (f <= r) {
u = q[f++];

for (v = 0; v < n; v++) {
if (a[u][v] == 1 && s[v] == 0) {
printf("%d ", v);
s[v] = 1;
q[++r] = v;
}
}
}
printf("\n");
}

int main() {
int n, a[10][10], source, i, j;
printf("\nEnter the number of nodes: ");
scanf("%d", &n);
printf("\nEnter the adjacency matrix:\n");

for (i = 0; i < n; i++) {
for (j = 0; j < n; j++) {
scanf("%d", &a[i][j]);
}
}

for (source = 0; source < n; source++) {
bfs(a, n, source);
}
return 0;
}
```

Output:


Enter the number of nodes: 4
Enter the adjacency matrix:
0 1 1 0
1 0 1 1
1 1 0 1
0 1 1 0
The nodes visited from 0: 0 1 2 3
The nodes visited from 1: 1 0 2 3
The nodes visited from 2: 2 0 1 3
The nodes visited from 3: 3 1 2 0
Vismays-MacBook-Pro:LNM code notes

```c
#define MAX_SIZE 100

int n;
int a[MAX_SIZE][MAX_SIZE];
int s[MAX_SIZE];

void dfs(int v) {
 s[v] = 1;
for (int i = 1; i <= n; i++) {
if (a[v][i] && !s[i]) {
 dfs(i);
}
}
 }

int main() {
 int i, j, count = 0;

 printf("\nEnter number of vertices: ");
 scanf("%d", &n);
for (i = 1; i <= n; i++) {
 s[i] = 0;
for (j = 1; j <= n; j++) {
 a[i][j] = 0;
}
}
 printf("Enter the adjacency matrix:\n");
for (i = 1; i <= n; i++) {
for (j = 1; j <= n; j++) {
 scanf("%d", &a[i][j]);
}
}
 dfs(1);
for (i = 1; i <= n; i++) {
if (s[i]) {
 count++;
}
```

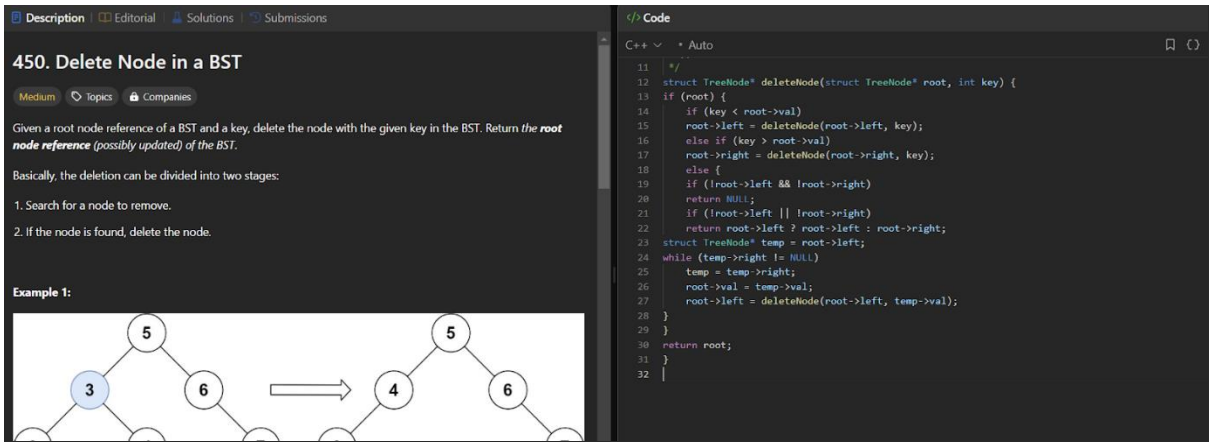
```
if (a[v][i] && !s[i]) {
 dfs(i);
}
}
}

int main() {
 int i, j, count = 0;

 printf("\nEnter number of vertices: ");
 scanf("%d", &n);
for (i = 1; i <= n; i++) {
 s[i] = 0;
for (j = 1; j <= n; j++) {
 a[i][j] = 0;
}
}
 printf("Enter the adjacency matrix:\n");
for (i = 1; i <= n; i++) {
for (j = 1; j <= n; j++) {
 scanf("%d", &a[i][j]);
}
}
 dfs(1);
for (i = 1; i <= n; i++) {
if (s[i]) {
 count++;
}
}
if (count == n) {
 printf("Graph is connected\n");
 } else {
 printf("Graph is not connected\n");
}
 return 0;
 }
```

Output:

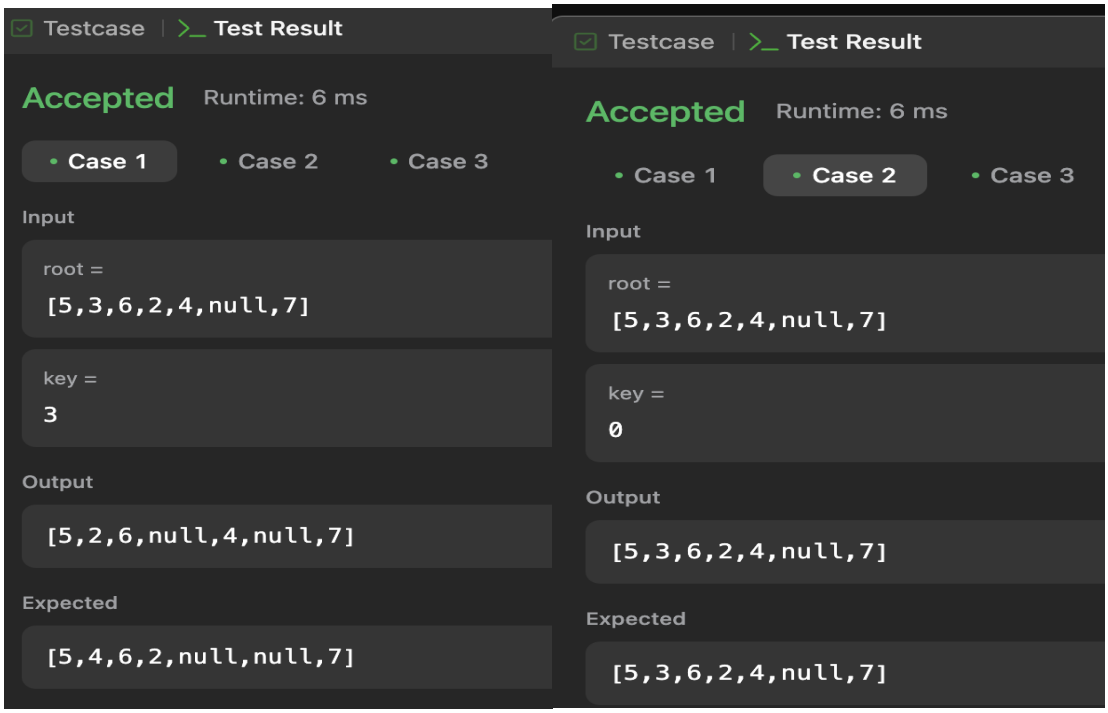
```
Enter number of vertices: 4
Enter the adjacency matrix:
0 1 1 0
1 0 0 1
1 0 0 1
0 1 1 0
Graph is connected
Vismays-MacBook-Pro:LNM code r
```

LeetCode Problem:

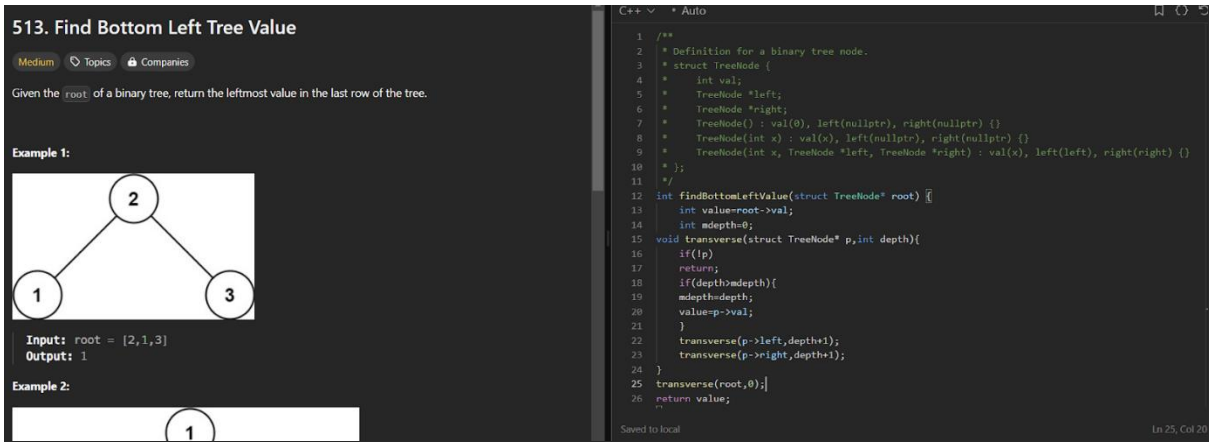
a)Delete Node In BST



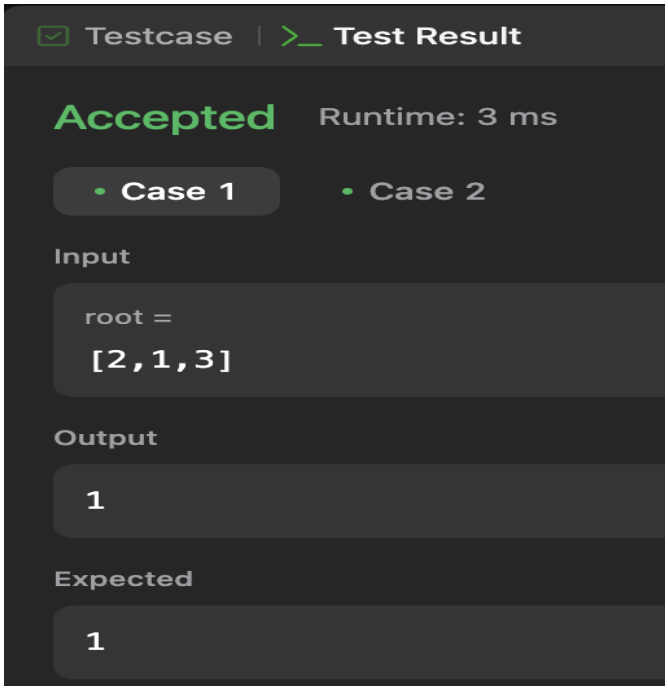
Output:

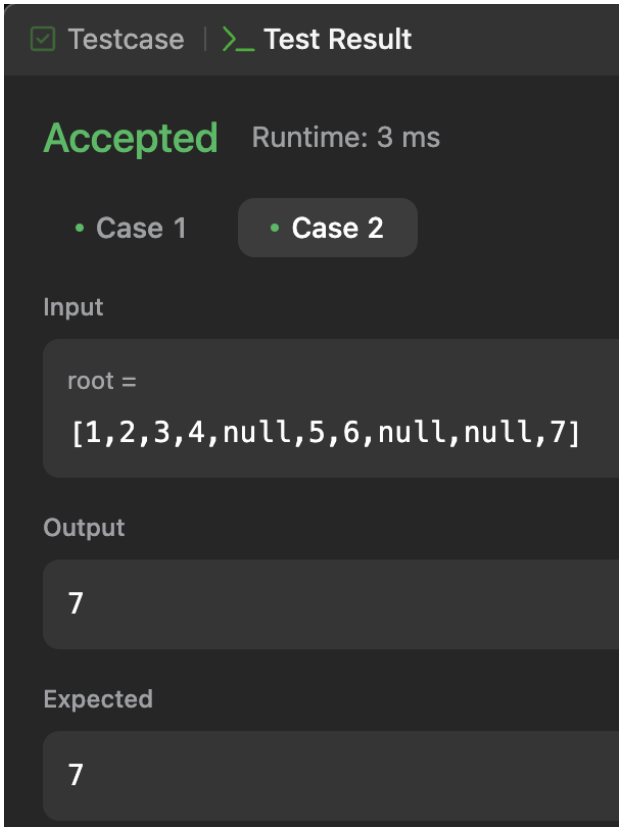


b)Find Bottom Left Tree Value



Output:


Testcase
Test Result
Accepted
Runtime: 3 ms
Case 1
Case 2
Input
root =
[2,1,3]
Output
1
Expected
1


Testcase
Test Result
Accepted
Runtime: 3 ms
Case 1
Case 2
Input
root =
[1,2,3,4,null,5,6,null,null,7]
Output
7
Expected
7

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 MAX_EMPLOYEES 100
#define HT_SIZE 10

typedef struct {
int key;
} Employee;

typedef struct {
Employee* entries[HT_SIZE];
} HashTable;

int hash(int key) {
return key % HT_SIZE;
}

void initHashTable(HashTable* ht) {
for (int i = 0; i < HT_SIZE; i++) {
ht->entries[i] = NULL;
}
}

void insertEmployee(HashTable* ht, Employee* emp) {
int index = hash(emp->key);
while (ht->entries[index] != NULL) {
index = (index + 1) % HT_SIZE;
}

ht->entries[index] = emp;
}

void displayHashTable(HashTable* ht) {
printf("\nHash Table:\n");
for (int i = 0; i < HT_SIZE; i++) {
if (ht->entries[i] != NULL) {
printf("Index %d: Key %d\n", i, ht->entries[i]->key);
} else {
printf("Index %d: Empty\n", i);
}
```

```
while (ht->entries[index] != NULL) {
index = (index + 1) % HT_SIZE;
}

ht->entries[index] = emp;
}

void displayHashTable(HashTable* ht) {
printf("\nHash Table:\n");
for (int i = 0; i < HT_SIZE; i++) {
if (ht->entries[i] != NULL) {
printf("Index %d: Key %d\n", i, ht->entries[i]->key);
} else {
printf("Index %d: Empty\n", i);
}
}
}

int main() {
HashTable ht;
initHashTable(&ht);

int n;
printf("Enter the number of employee records: ");
scanf("%d", &n);

printf("Enter the employee keys:\n");
for (int i = 0; i < n; i++) {
Employee* emp = (Employee*)malloc(sizeof(Employee));
if (emp == NULL) {
printf("Memory allocation failed!\n");
exit(1);
}
scanf("%d", &emp->key);
insertEmployee(&ht, emp);
}
displayHashTable(&ht);
return 0;
}
```

Output:

```
"C:\Users\vigne\OneDrive\Do
Enter the number of employee records: 7
Enter the employee keys:
43
23
76
35
123
78
32

Hash Table:
Index 0: Empty
Index 1: Empty
Index 2: Key 32
Index 3: Key 43
Index 4: Key 23
Index 5: Key 35
Index 6: Key 76
Index 7: Key 123
Index 8: Key 78
Index 9: Empty

Process returned 0 (0x0)   execution time : 16.799 s
Press any key to continue.
```