VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

PAWAN A (1BM22CS191)

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

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019
Dec 2023- March 2024

B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
(Affiliated To Visvesvaraya Technological University, Belgaum)

Department of Computer Science and Engineering

This is to certify that the Lab work entitled **“DATA STRUCTURES”** carried out by PAWAN A **(1BM22CS191)** 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.

Prof. Lakshmi Neelima
Assistant Professor
Department of CSE
BMSCE, Bengaluru

Dr. Jyothi S Nayak
Professor and Head
Department of CSE
BMSCE, Bengaluru

Index Sheet

Course outcomes:

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

Lab program 1:

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

```
#include<stdio.h>
#include<stdlib.h>
#define n 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)
```

```c
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--];
}
```

```c
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.

```
#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:

```
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.
```

```
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: 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: 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);
        }

        }
    }
```

```
#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:

```
C:\Users\vigne\OneDrive\Des
1
Enter a value:20

1.insert 2.delete 3.DISPLAY 4.EXIT:
1
Enter a value:30

1.insert 2.delete 3.DISPLAY 4.EXIT:
1
Enter a value:40

1.insert 2.delete 3.DISPLAY 4.EXIT:
2
20 deleted
1.insert 2.delete 3.DISPLAY 4.EXIT:
2
30 deleted
1.insert 2.delete 3.DISPLAY 4.EXIT:
1
Enter a value:30

1.insert 2.delete 3.DISPLAY 4.EXIT:
3
40      30
1.insert 2.delete 3.DISPLAY 4.EXIT:
4

--------------------------------
Process exited after 51.07 seconds with return value 0
Press any key to continue . . .
```

Lab program 4:

WAP to Implement Singly Linked List with following operations

a) Create a linked list.

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

c) Display the contents of the linked list.

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

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

struct node * 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;
```

```
};
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.

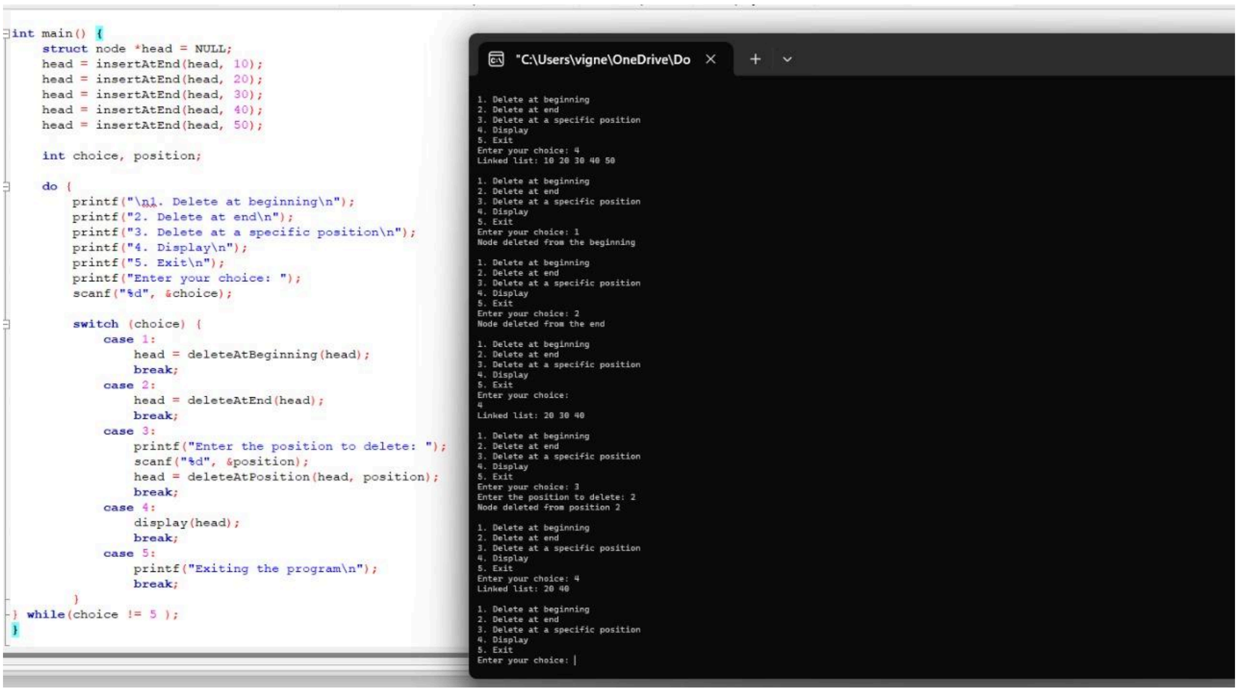
c) Display the contents of the linked list.

```
#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;
}
```

```c
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");
}
```



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;
}
```

```c
    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);
```

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

1. Insert at Beginning
2. Insert at End
3. Sort List
4. Reverse
5. Concatenate
6. Display
7. Exit
Enter your choice: 1
Enter data: 45
Enter your choice: 1
Enter data: 80
Enter your choice: 2
Enter data: 60
Enter your choice: 2
Enter data: 12
Enter your choice: 6
80 -> 45 -> 60 -> 12 -> NULL
Enter your choice: 4
Enter your choice: 6
12 -> 60 -> 45 -> 80 -> NULL
Enter your choice: 3
Enter your choice: 6
12 -> 45 -> 60 -> 80 -> NULL
Enter your choice: 5
Enter the first linked list: 12 -> 45 -> 60 -> 80 -> NULL
Enter the second linked list: 50 60 12 13 -1
After concatenating the two lists, the concatenated list is: 50 -> 60 -> 12 -> 13 -> NULL
Enter your choice: 7
Exiting the program...

Process returned 0 (0x0)   execution time : 61.745 s
Press any key to continue.
```

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;
  }
```

```c
  }

  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:

```
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter the value to be inserted: 10

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter the value to be inserted: 20

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
10 -> 20 -> NULL

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Deleted value: 10

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter the value to be inserted: 40

1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
20 -> 40 -> NULL

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

Lab program 7:

WAP to Implement doubly link list with primitive operations

a) Create a doubly linked list.

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

c) Delete the node based on a specific value

d) Display the contents of the list

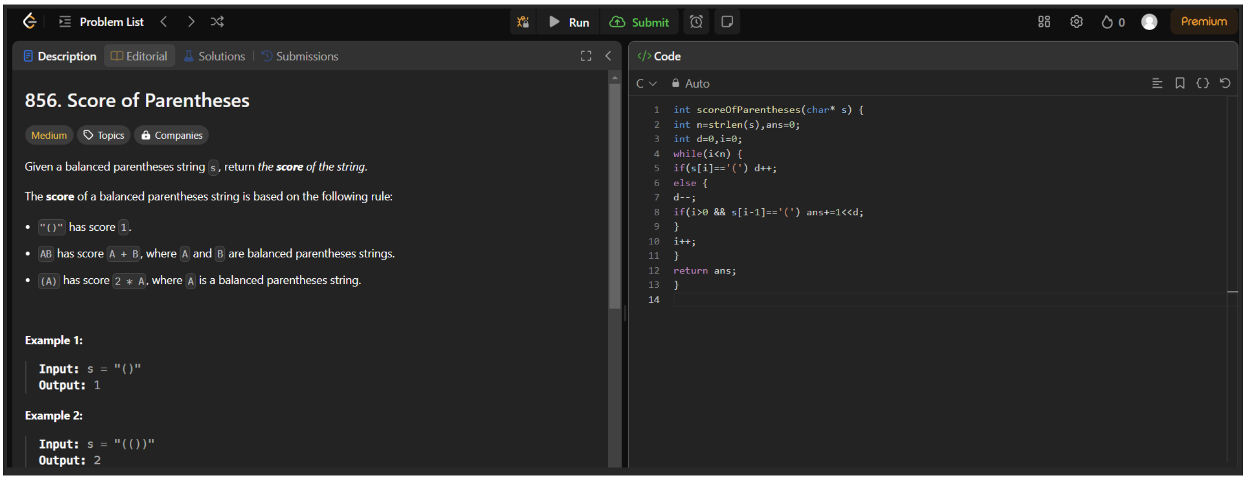
```
#include <stdio.h>
#include <stdlib.h>

struct Node {
    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;
}
```

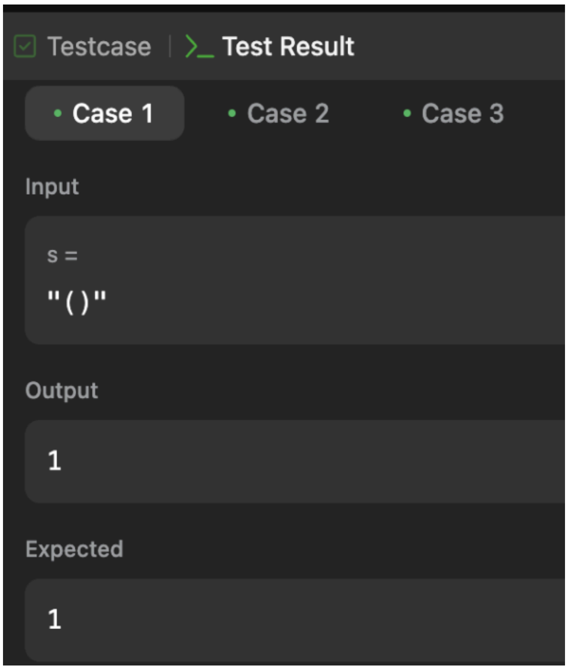
```
/tmp/oIoPCUSYwa.o
1. Insert at beginning
2. Delete node based on specific value
3. Display
4. Exit
Enter your choice: 1
Enter the data to be inserted: 40
Enter your choice: 1
Enter the data to be inserted: 50
Enter your choice: 1
Enter the data to be inserted: 30
Enter your choice: 2
Enter the value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

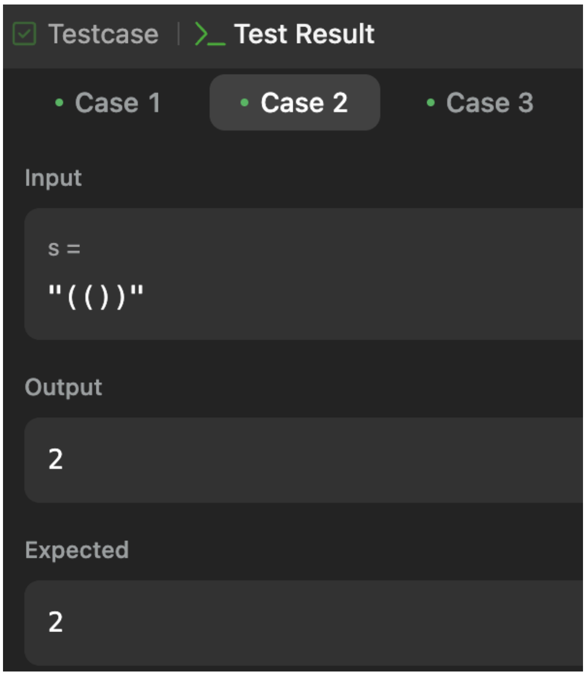
LeetCode Problem:

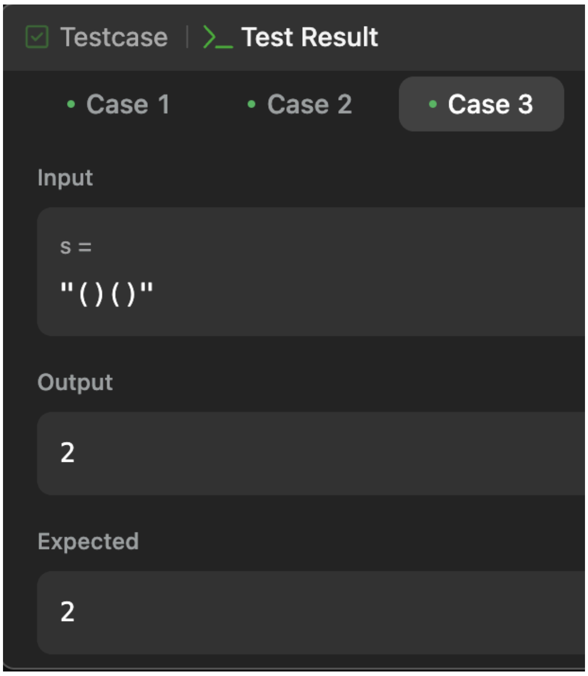
ScoreOfParentheses:



Output:


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


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


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;
}
```

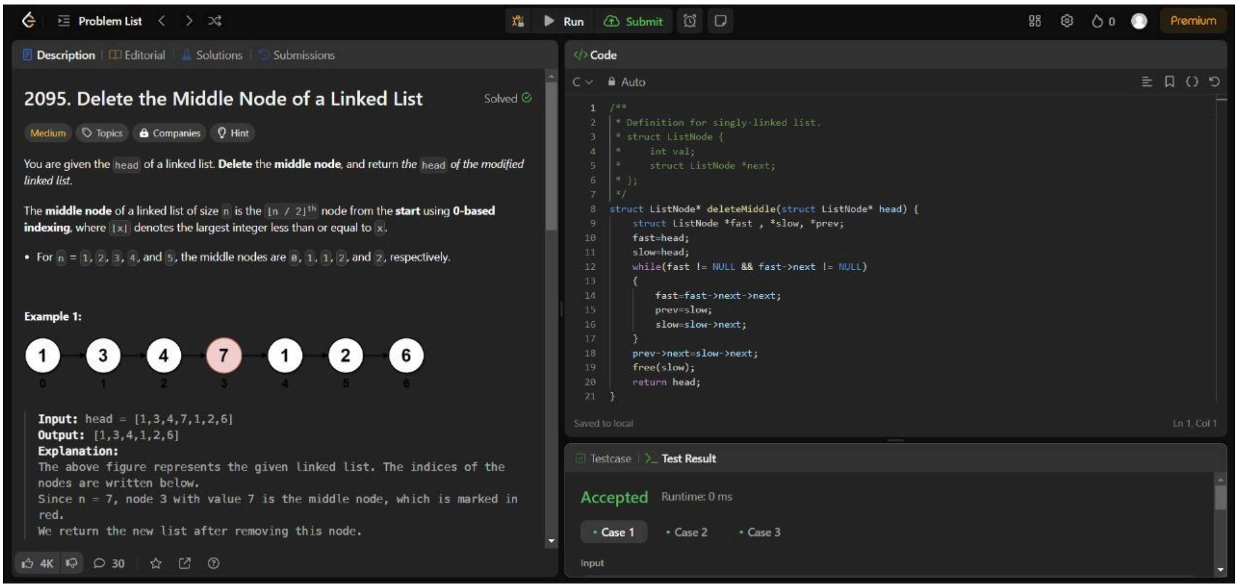
Output:

```
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
```

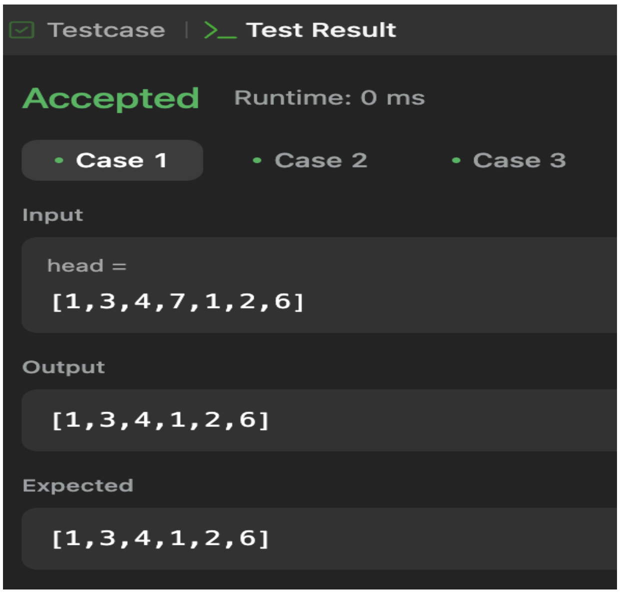
```
1. Insert
2. Inorder Traversal
3. Preorder Traversal
4. Postorder Traversal
5. Display Tree
6. Exit
Enter your choice: 2
Inorder Traversal: 3 4 5 6 7

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...
```

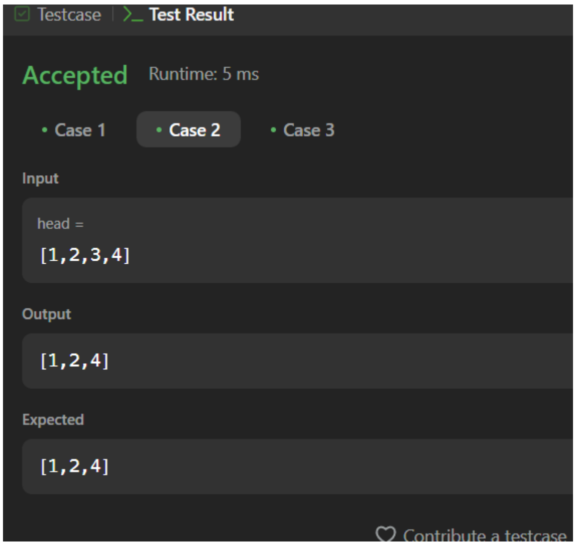
Leet Code Problem:

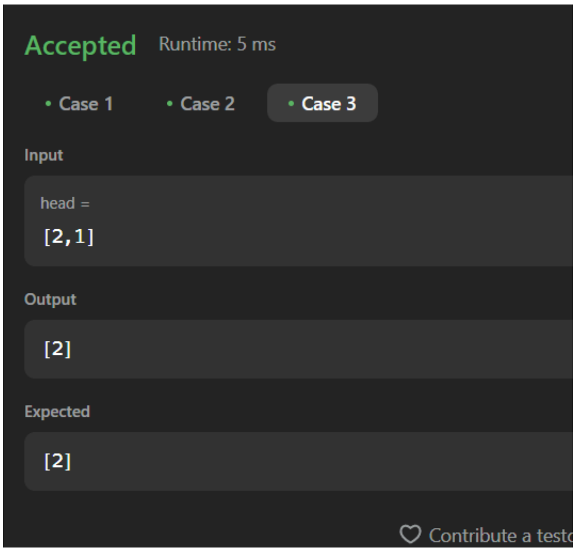
Delete the Middle Node Of a Linked List:



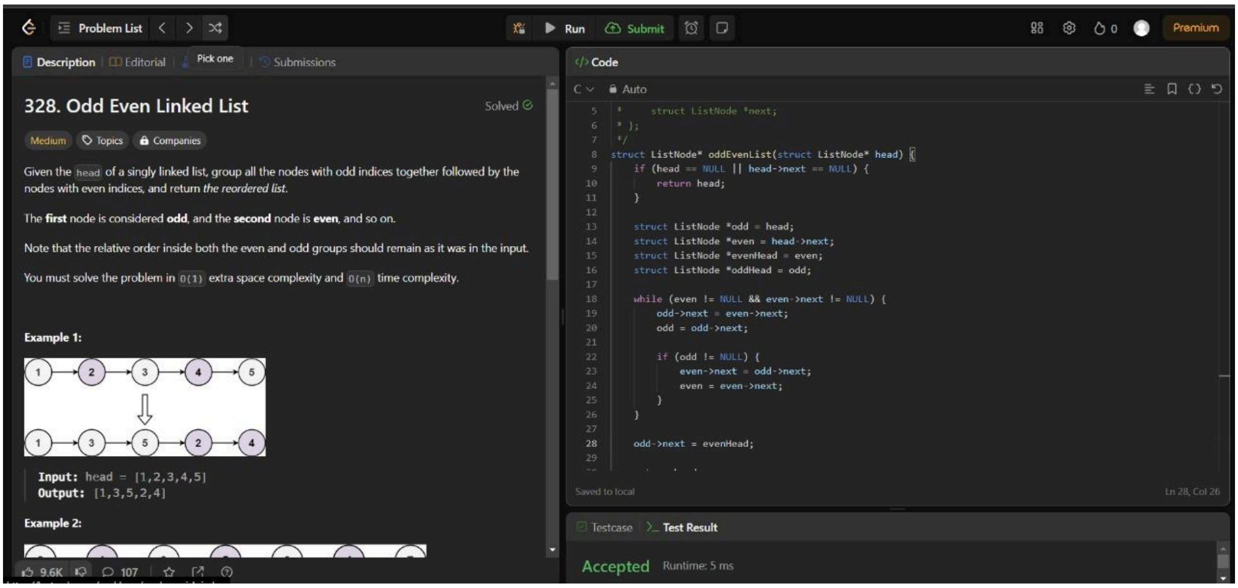
Output:


Testcase
Test Result
Accepted
Runtime: 0 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]

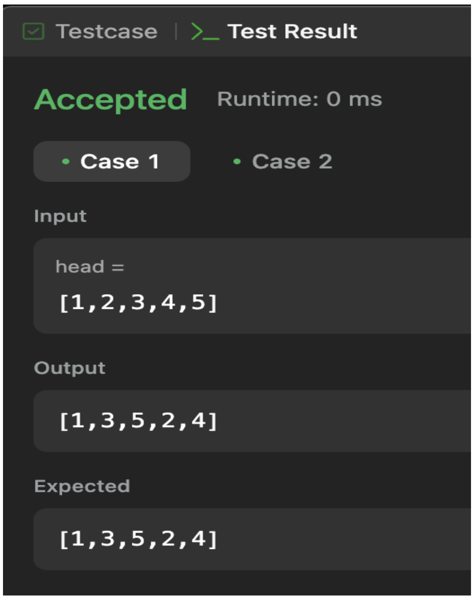

Testcase
Test Result
Accepted
Runtime: 5 ms
Case 1
Case 2
Case 3
Input
head =
[1,2,3,4]
Output
[1,2,4]
Expected
[1,2,4]
Contribute a testcase

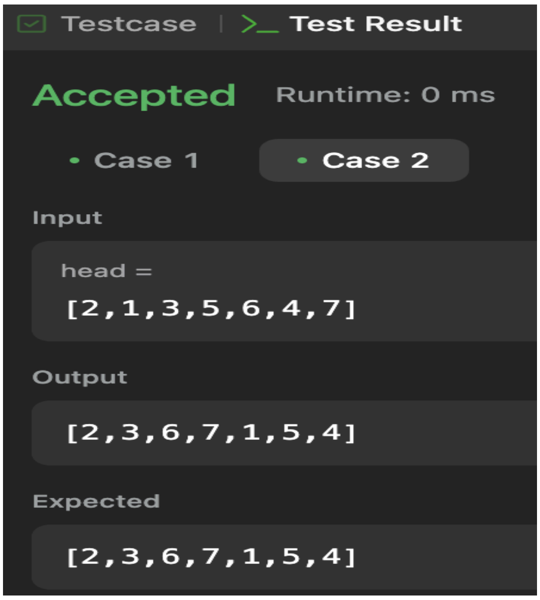


Odd Even Linked List



Output:


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]


Testcase | >_ Test Result
Accepted Runtime: 0 ms
• Case 1 • Case 2
Input
head =
[2,1,3,5,6,4,7]
Output
[2,3,6,7,1,5,4]
Expected
[2,3,6,7,1,5,4]

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]);
}
}

for (source = 0; source < n; source++) {
```

```
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
```

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

```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++;
}
```

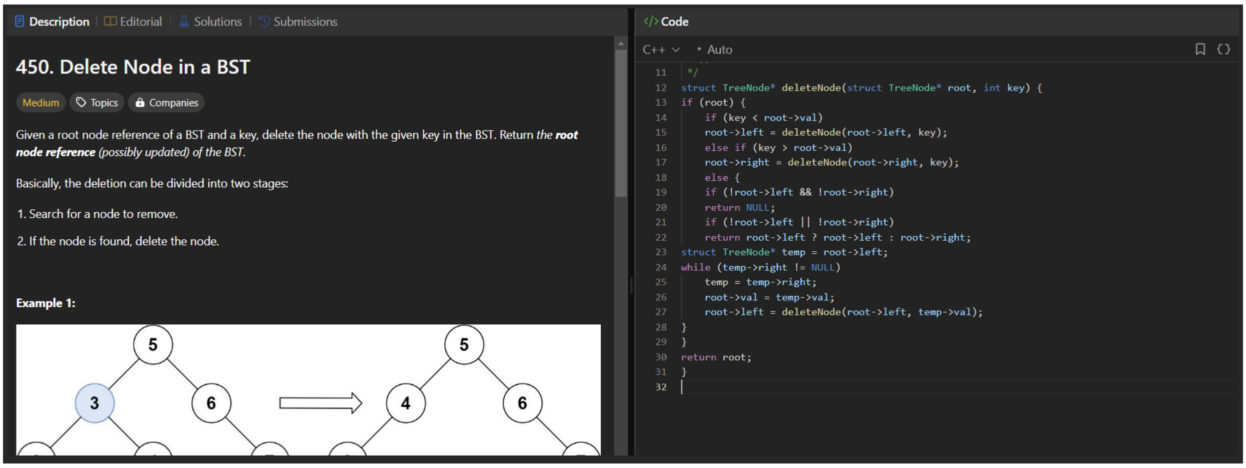
```
if (a[v][i] && !s[i]) {
dfs(i);
}
}
}

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
```

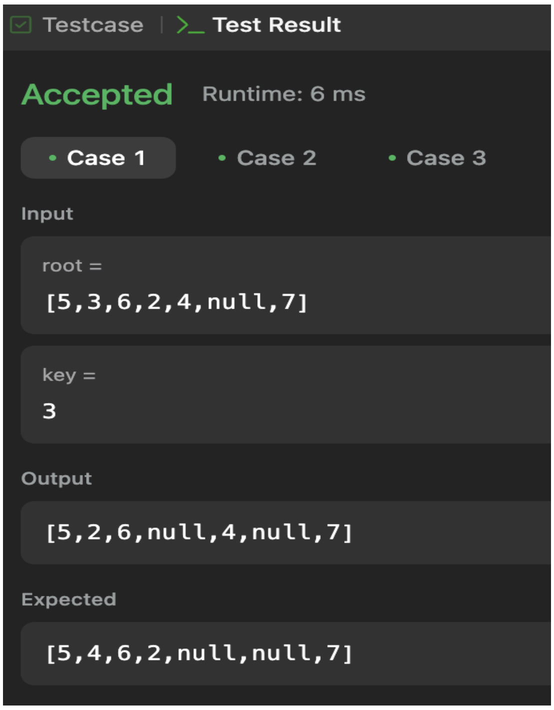
LeetCode Problem:

a)Delete Node In BST

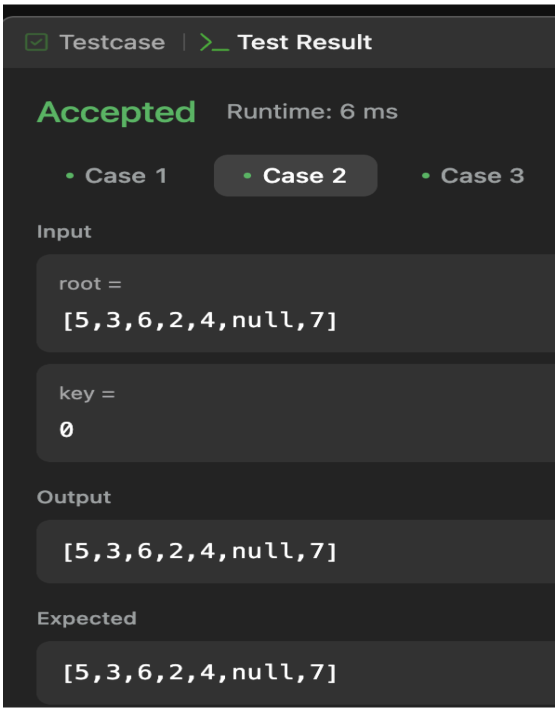


Description | Editorial | Solutions | Submissions
450. Delete Node in a BST
Medium
Topics
Companies
Given a root node reference of a BST and a key, delete the node with the given key in the BST. Return the root node reference (possibly updated) of the BST.
Basically, the deletion can be divided into two stages:
1. Search for a node to remove.
2. If the node is found, delete the node.
Example 1:
5
3
6
4
5
6
Code
C++
Auto
*/
struct TreeNode* deleteNode(struct TreeNode* root, int key) {
if (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 && !root->right)
return NULL;
if (!root->left || !root->right)
return root->left ? root->left : root->right;
struct TreeNode* temp = root->left;
while (temp->right != NULL)
temp = temp->right;
root->val = temp->val;
root->left = deleteNode(root->left, temp->val);
}
}
return root;
}

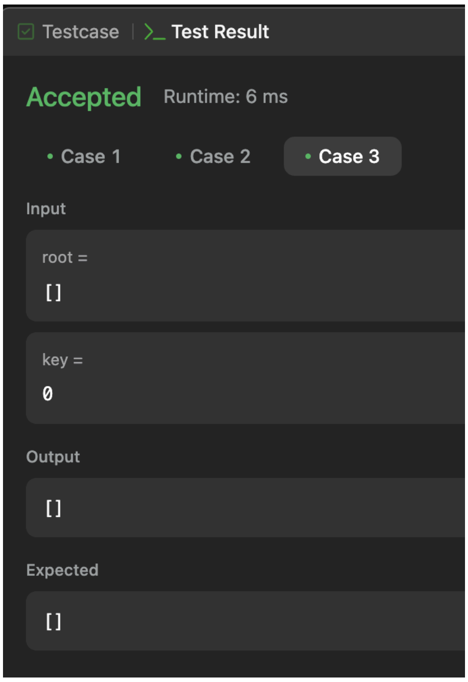
Output:



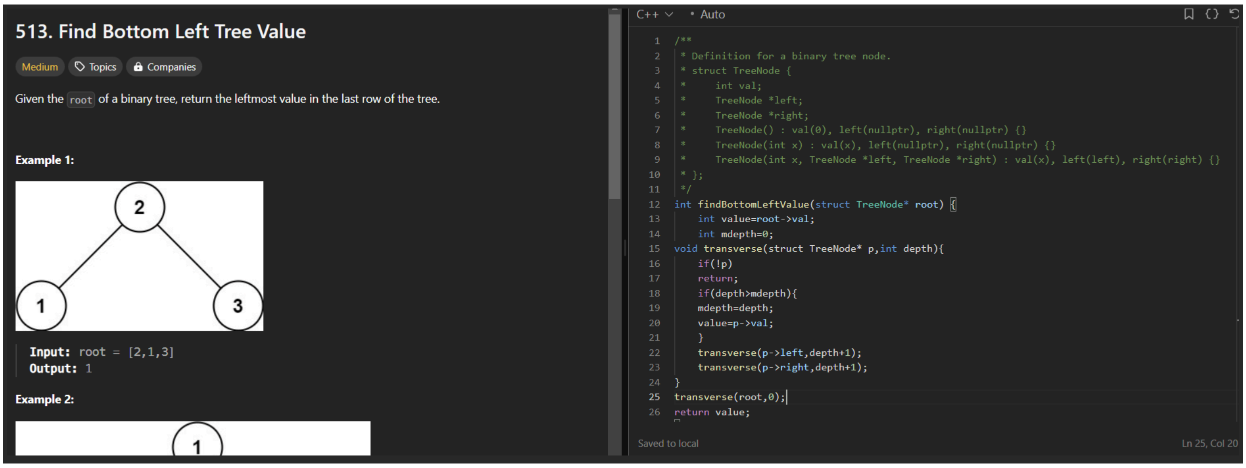
Testcase | Test Result
Accepted Runtime: 6 ms
Case 1 Case 2 Case 3
Input
root =
[5,3,6,2,4,null,7]
key =
3
Output
[5,2,6,null,4,null,7]
Expected
[5,4,6,2,null,null,7]



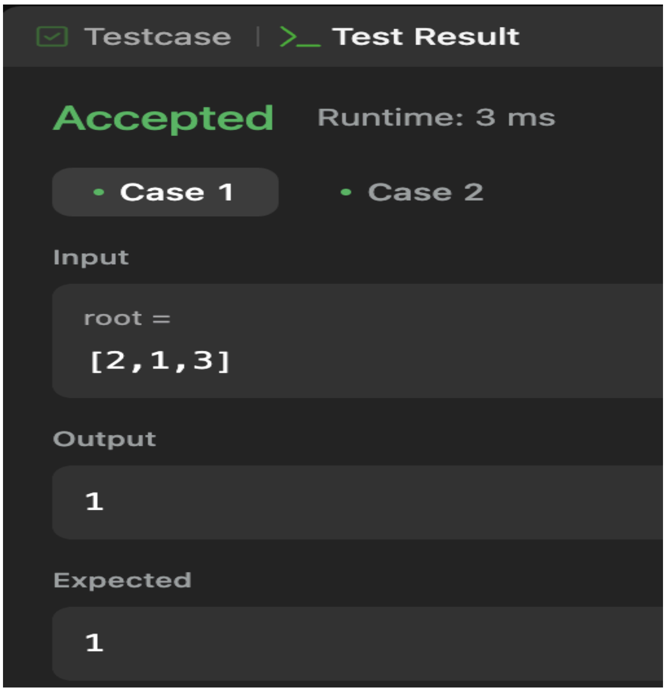
Testcase | Test Result
Accepted Runtime: 6 ms
Case 1 Case 2 Case 3
Input
root =
[5,3,6,2,4,null,7]
key =
0
Output
[5,3,6,2,4,null,7]
Expected
[5,3,6,2,4,null,7]

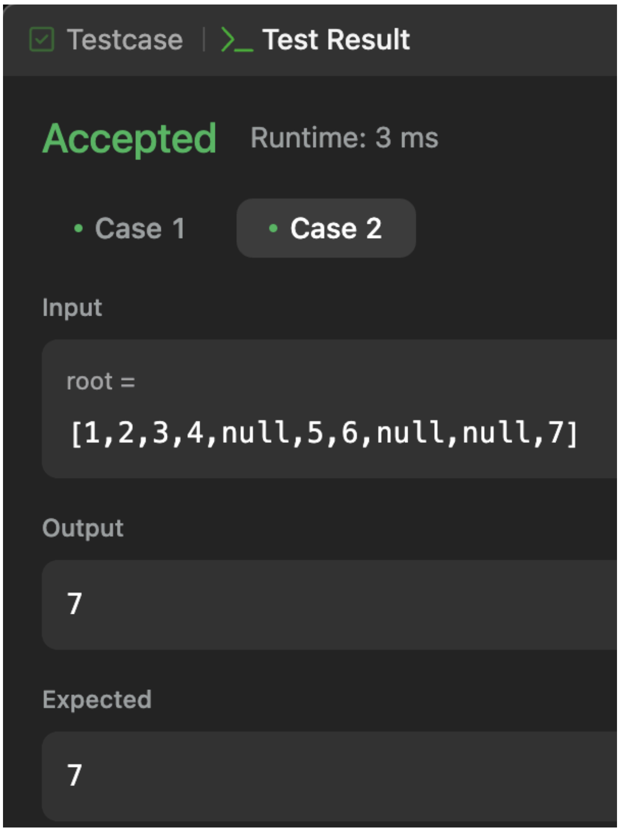


b)Find Bottom Left Tree Value



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

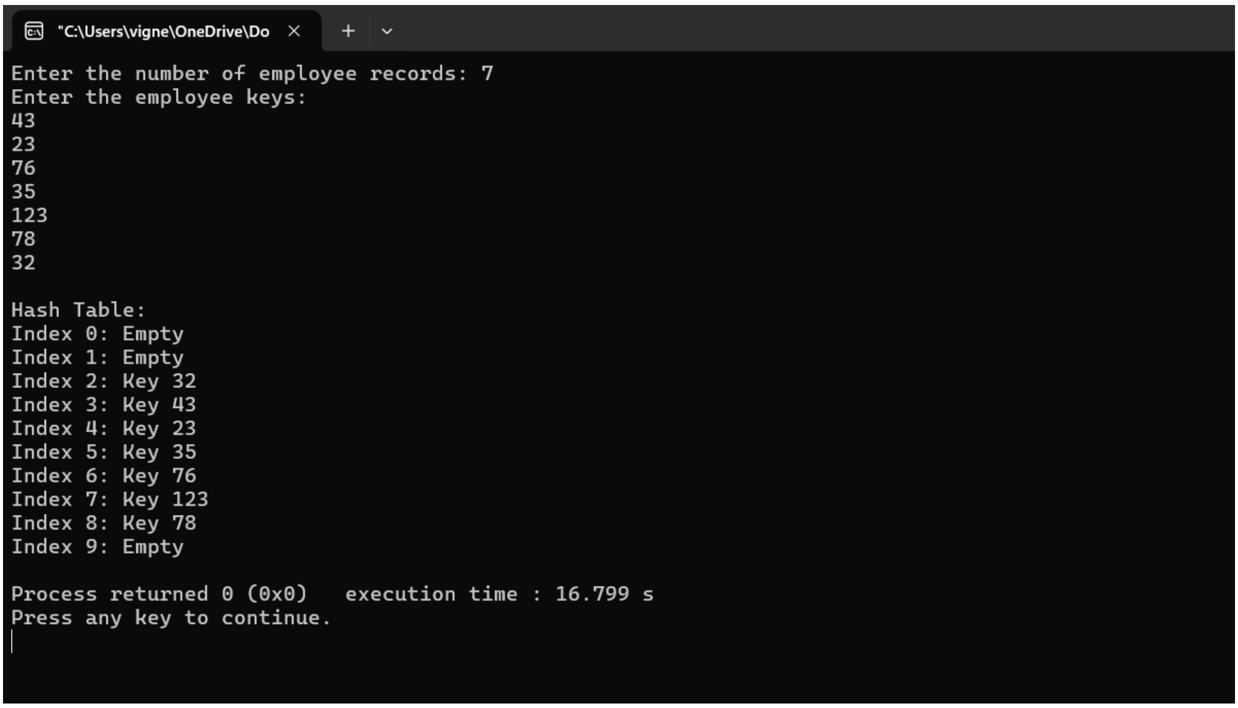
Lab Program 10:

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);
}
```

```c
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.
```