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 **ROHIT RAMCHANDRA GANDHI (1BM23CS417)**, 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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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 MAX_SIZE 5

// Structure to represent the stack
struct Stack {
   int arr[MAX_SIZE];
   int top;
};
struct Stack stack={{0,0,0,0,0},-1};
// Function to initialize the stack



// Function to check if the stack is empty
int isEmpty() {
   if(stack.top ==-1){
      return 1;
   }
   else{
      return 0;
   }
}

// Function to check if the stack is full
int isFull() {
   return stack.top == MAX_SIZE - 1;
}

// Function to push an element onto the stack
void push(int value) {
   if (isFull(stack)) {
      printf("Stack Overflow! Cannot push %d.\n", value);
   } else {
      stack.arr[++(stack.top)] = value;
      printf("Pushed %d onto the stack.\n", value);
   }

}

// Function to pop an element from the stack
```

```
void pop() {
    if (isEmpty(stack)) {
        printf("Stack Underflow! Cannot pop from an empty stack.\n");
    } else {
        printf("Popped %d from the stack.\n", stack.arr[stack.top--]);
    }

}

// Function to display the elements of the
stack void display() {
    if (isEmpty(stack)) {
        printf("Stack is empty.\n");
    } else {
        printf("Stack elements: ");
        for (int i = 0; i <= stack.top; i++) {
            printf("%d ", stack.arr[i]);
        }
        printf("\n");
    }
}

int main() {
    struct Stack stack;

    int choice,
    value; do {
        printf("\n1. Push\n");
        printf("2. Pop\n");
        printf("3. Display\n");
        printf("4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the value to push: ");
                scanf("%d", &value);
               push(value)
                ; break;
            case 2:
                pop();
                break;
            case 3:
                display();
                break;
            case 4:
                printf("Exiting the program.\n");
```

```
                break
            ;
            default:
                printf("Invalid choice. Please enter a valid option.\n");
        }
    } while (choice != 4);
    getchar();
    return 0;
}
```

Output:

```
PS C:\PLC\DATA STRUCTURES> cd "c:\PLC\DATA STRUCTURES\" ; if ($?) { gcc LAB_1.c -o LAB_1 } ; if ($?)
 { .\LAB_1 }

1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter the value to push: 1
Pushed 1 onto the stack.

1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter the value to push: 4
Pushed 4 onto the stack.

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

1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2
Popped 4 from the stack.

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

Lab Program 2:

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

```
#include<stdio.h>
#include<ctype.h
> #define SIZE
50 char
stack[SIZE]; int
top=-1;
void push(char x){
   top++;
   stack[top]=x;
}
char
   pop(){
   char x;
   return(stack[top--]);
}
      int pr(char
       symbol){
  if(symbol=='^'){
      return (3);
   }
   else if(symbol=='*' || symbol=='/'){
      return(2);
   }
   else if(symbol=='+' || symbol=='-'){
      return(1);
   }
   else{
      return(0);
   }
}
void main(){
   char infix[50],postfix[50],ch,elem;
   int i=0,k=0;
   printf("Enter infix expression:");
   scanf("%s",infix);
   push('#');
   while((ch=infix[i++])!='\0')
   {
      if(ch=='(')
      push (ch);
      else
      if(isalnum(ch))
      postfix[k++]=ch
      ; else
      if(ch==')')
      {
```

```
while(stack[top]!='('){
    postfix[k++]=pop()
    ;
```

```
            elem=pop();
        }
        else{
            while(pr(stack[top])>=pr(ch))
                { postfix[k++]=pop();
            }
            push(ch);
        }
    }
    while(stack[top]!='#')
        {
        postfix[k++]=pop()
        ;
    }
    postfix[k]='\0';
    printf("\n Postfix Expression =%s \n",postfix);

}
```

Output:

```
PS C:\PLC\DATA STRUCTURES> cd "c:\PLC\DATA STRUCTURES\" ; if ($?) { gcc InfixPostfi
x.c -o InfixPostfix } ; if ($?) { .\InfixPostfix }
Enter infix expression:A+(B*C-(D/E^F)*G)*H

 Postfix Expression =ABC*DEF^/G*-H*+
PS C:\PLC\DATA STRUCTURES>
```

Lab Progarm 3:

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>
#include<stdlib.h
> #define SIZE 5
void enqueue();
void dequeue();
void show();
struct queue{
    int arr[SIZE];
    int top;
    int rear;
};
struct queue q={{0,0,0,0,0},-1,-1};
void enqueue(){
    int item;
    if(q.rear == SIZE-1){
        printf("OverFlow \n");
    }
    else{
        if(q.top ==-1 || q.top>=0){
            q.top=0;
            printf("Enter the element to insert:");
            scanf("%d",&item);
            printf("\n");
            q.rear+=1;
            q.arr[q.rear]=item
            ;
        }
    }
}
void dequeue(){
    if(q.top==-1 || q.top>q.rear){
        printf("UnderFlow \n");
        return;
    }
    else{
        printf("Element deleted:%d \n",q.arr[q.top]);
        q.top=q.top+1;
    }
}
void show(){
    if(q.top == -1){
```

```
        printf("Empty Queue \n");
    }
    else{
        printf("Queue: \n");
        for(int i=q.top;i<=q.rear;i++){
            printf("%d ",q.arr[i]);
        }
        printf("\n");
    }
}
int main(){
    int ch;
    while(1)
    {
        printf("1 for Enqueue \n");
        printf("2 for Dequeue \n");
        printf("3 for Display \n");
        printf("4 Exit \n");
        printf("Enter your choice \n");
        scanf("%d",&ch);
        printf("\n");
        switch(ch){
            case 1:
            enqueue()
            ; break;
            case 2:
            dequeue()
            ; break;
            case 3:
            show();
            break;
            case 4:
            exit(0);
            default:
            printf("Wrong Choice \n");
            break;
        }
    }
}
```

Output:

```
Enter the element to insert:2

1 for Enqueue
2 for Dequeue
3 for Display
4 Exit
Enter your choice
1

Enter the element to insert:3

1 for Enqueue
2 for Dequeue
3 for Display
4 Exit
Enter your choice
3

Queue:
2 3
1 for Enqueue
2 for Dequeue
3 for Display
4 Exit
Enter your choice
2

Element deleted:2
1 for Enqueue
2 for Dequeue
3 for Display
4 Exit
Enter your choice
2

Element deleted:3
1 for Enqueue
2 for Dequeue
3 for Display
4 Exit
Enter your choice
2

UnderFlow
1 for Enqueue
2 for Dequeue
3 for Display
4 Exit
Enter your choice
4

PS C:\PLC\DATA STRUCTURES>
```

Lab Program 4:

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.

```
#include <stdio.h>

#define MAX_SIZE 5

// Circular Queue variables
int items[MAX_SIZE];
int front = -1, rear = -1;

// Function to check if the queue is
empty int isEmpty() {
    return (front == -1 && rear == -1);
}

// Function to check if the queue is full
int isFull() {
    return ((rear + 1) % MAX_SIZE == front);
}

// Function to enqueue an element into the circular queue
void enqueue(int value) {
    if (isFull()) {
        printf("Queue is full. Cannot enqueue %d.\n", value);
        return;
    }

    if (isEmpty()) {
        front = 0;
        rear = 0;
    } else {
        rear = (rear + 1) % MAX_SIZE;
    }

    items[rear] = value;
    printf("%d enqueued to the queue.\n", value);
}

// Function to dequeue an element from the circular queue
int dequeue() {
    int dequeuedItem;

    if (isEmpty()) {
```

```
printf("Queue is empty. Cannot dequeue.\n");
        return -1;
    }
    dequeuedItem = items[front];
    if (front == rear) {
        // If there was only one element in the queue
        front = -1;
        rear = -1;
    } else {
        front = (front + 1) % MAX_SIZE;
    }

    printf("%d dequeued from the queue.\n", dequeuedItem);
    return dequeuedItem;
}

// Function to display the elements of the circular queue
void display() {
    if (isEmpty()) {
        printf("Queue is empty.\n");
        return;
    }

    printf("Queue elements: ");
    int i = front;
    do {
        printf("%d ", items[i]);
        i = (i + 1) % MAX_SIZE;
    } while (i != (rear + 1) % MAX_SIZE);
    printf("\n");
}

int main() {
    int choice, value;

    do {
        printf("\nCircular Queue Operations:\n");
        printf("1. Enqueue\n");
        printf("2. Dequeue\n");
        printf("3. Display\n");
        printf("4. Exit\n");

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

        switch (choice) {
            case 1:
                printf("Enter the value to enqueue: ");
                scanf("%d", &value);
                enqueue(value);
```

```
            break;

        case 2:
            dequeue();
            break;

        case 3:
            display();
            break;

        case 4:
            printf("Exiting the program.\n");
            break;

        default:
            printf("Invalid choice. Please enter a valid option.\n");
        }

    } while (choice != 4);

    return 0;
}
```

Output:

```
PROBLEMS   OUTPUT   DEBUG CONSOLE   TERMINAL   PORTS

PS C:\PLC\DATA STRUCTURES> cd "c:\PLC\DATA STRUCTURES\" ; if ($?) { gcc Circular_Queue.c -o Circular_Queue } ; if ($?) { .\Circular_Queue }

Circular Queue Operations:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter the value to enqueue: 1
1 enqueued to the queue.

Circular Queue Operations:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter the value to enqueue: 2
2 enqueued to the queue.

Circular Queue Operations:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter the value to enqueue: 3
3 enqueued to the queue.

Circular Queue Operations:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue elements: 1 2 3

Circular Queue Operations:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
1 dequeued from the queue.

Circular Queue Operations:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
2 dequeued from the queue.

Circular Queue Operations:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
3 dequeued from the queue.

Circular Queue Operations:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Queue is empty. Cannot dequeue.

Circular Queue Operations:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 4
Exiting the program.
PS C:\PLC\DATA STRUCTURES>
```

Lab Program 5:

WAP to Implement Singly Linked List with following operations
a) Create a linked list.
b) Insertion of a node at first position, and at end of list.
c) Delete a node at front and at the end of the list.
d) Display the contents of the linked list.

```
#include<stdio.h>
#include<stdlib.h
> struct Node{
    int data;
    struct Node *next;
};
//Create Linked List
struct Node* createLL(struct Node* head){
    int num;

    printf("Enter -1 to stop.\n");
    printf("Enter Number:");
    scanf("%d",&num);
    while(num!=-1){
        struct Node* newNode=(struct Node*)malloc(sizeof(struct Node));
        struct Node* p;
        p=head;
        if(head==NULL)
        {
            newNode->data=num;
            newNode->next=NULL
            ; head=newNode;
        }
        else{

            while(p->next!=NULL)
                { p=p->next;
            }
            newNode->data=num
            ; p->next=newNode;
            newNode->next=NULL;
        }
    printf("Enter Number:");
    scanf("%d",&num);
    }
    return head;
}
//Display Linked List
struct Node* displayLL(struct Node* head){
    struct Node*p;
    p=head;
    printf("Linked List Elements:");
    while(p !=NULL){
```

```
 printf("%d ",p->data);
        p=p->next;
    }
    printf("\n");
    return head;
}
//Insert a node at First Position
struct Node* insertAtBeg(struct Node* head){
    int num;
    printf("Enter Number:");
    scanf("%d",&num);
    struct Node* newNode=(struct Node*)malloc(sizeof(struct
    Node)); newNode->data=num;
    newNode->next=head
    ; head=newNode;
    return head;
}
//Insert a node at End Position
struct Node* insertAtEnd(struct Node* head){
    int num;
    struct Node
    *p; p=head;
    printf("Enter Number:");
    scanf("%d",&num);
    struct Node* newNode=(struct Node*)malloc(sizeof(struct
    Node)); while(p->next!=NULL){
        p=p->next;
    }
    newNode->data=num
    ; p->next=newNode;
    newNode->next=NULL
    ; return head;
}
//Insert a node at any Position
struct Node* insertAtPos(struct Node* head,int pos){
    int num,i=0;
    struct Node
    *p; p=head;
    printf("Enter Number:");
    scanf("%d",&num);
    struct Node* newNode=(struct Node*)malloc(sizeof(struct
    Node)); while(i!=pos-1){
        p=p->next
        ; i++;
    }
    newNode->data=num;
    newNode->next=p->next
    ; p->next=newNode;
    return head;
}
//Delete a node at front
```

```
struct Node* delAtFront(struct Node* head){
    if(head==NULL){
        printf("Linked List alredy empty.\n");
        return head;
    }
    else{
    struct Node*
    p;
    p=head->next;
    free(head);
    head=p;
    return head;
    }
}
//Delete a node at end
struct Node* delAtEnd(struct Node* head){
    struct Node *p,*preNode;
    p=head;
    while(p->next!=NULL)
        { preNode=p;
        p=p->next;
    }
    preNode->next=NULL
    ; free(p);
    return head;
}
//Delete a node at any position
struct Node* delAtPos(struct Node* head, int pos){
    struct Node*p,*preNode;
    int i=0;
    p=head;
    if(pos==0){
        head=delAtFront(head)
        ; return head;
    }
    while(i!=pos)
        {
        preNode=p;
        p=p->next;
        i++;
    }
    preNode->next=p->next
    ; free(p);
    return head;
}
int main(){
    struct Node* head=NULL;
    head=createLL(head);
    head=displayLL(head);

    head=insertAtBeg(head);
    printf("Linked list after insertion at begining.\n");
```

```
    head=insertAtEnd(head);
    printf("Linked list after insertion at end.\n");
    head=displayLL(head);

    head=insertAtPos(head,2);
    printf("Linked list after insertion at position.\n");
    head=displayLL(head);

    head=delAtFront(head);
    printf("Linked list after deletion at front.\n");
    head=displayLL(head);

    head=delAtEnd(head);
    printf("Linked list after deletion at end.\n");
    head=displayLL(head);

    head=delAtPos(head,0);
    printf("Linked list after deletion from pos.\n");
    head=displayLL(head);
}
```

Output:

```
PS C:\PLC\DATA STRUCTURES> cd "c:\PLC\DATA STRUCTURES\" ; if ($?) { gcc Singl
yLinkedList.c -o SinglyLinkedList } ; if ($?) { .\SinglyLinkedList }
Enter -1 to stop.
Enter Number:1
Enter Number:2
Enter Number:3
Enter Number:4
Enter Number:-1
Linked List Elements:1 2 3 4
Enter Number:7
Linked list after insertion at begining.
Linked List Elements:7 1 2 3 4
Enter Number:9
Linked list after insertion at end.
Linked List Elements:7 1 2 3 4 9
Enter Number:5
Linked list after insertion at position.
Linked List Elements:7 1 5 2 3 4 9
Linked list after deletion at front.
Linked List Elements:1 5 2 3 4 9
Linked list after deletion at end.
Linked List Elements:1 5 2 3 4
Linked list after deletion from pos.
Linked List Elements:5 2 3 4
PS C:\PLC\DATA STRUCTURES>
```

Lab Program 6:

WAP to Implement Circular Singly Linked List with following operations
a) Create a linked list.
b) Insertion of a node at first position, and at end of list and at any position
c) Delete a node at front and at the end of the list and at any position
d) Display the contents of the linked list.

```
#include<stdio.h>
#include<stdlib.h
> struct Node{
   int data;
   struct Node *next;
};
//Create Circular Linked List
struct Node* createCircularLL(struct Node* head){
   int data;
   struct Node*p;
   printf("Enter -1 to stop.\n");
   printf("Enter Number:");
   scanf("%d",&data);
   while(data!=-1){

      struct Node *newNode=(struct Node*)malloc(sizeof(struct Node));
      newNode->data=data;
      if(head==NULL){
         newNode->next=newNode;
         head=newNode;
      }
      else{
         p=head;
         while(p->next!=head)
            { p=p->next;
         }
         p->next=newNode;
         newNode->next=head
         ;

      }
   printf("Enter Number:");
   scanf("%d",&data);
   }
   return head;
}
//Display Circular Linked List
struct Node* displayCircularLL(struct Node* head){
   struct Node* p;
   p=head;
   printf("Circular List Elements:");
   while(p->next !=head){
      printf("%d ",p->data);
      p=p->next;
   }
```

```
printf("%d ",p->data);
    printf("\n");
    return head;
}
//Insert At Begining
struct Node* insertFirst(struct Node* head){
    int num;
    struct Node
    *p; p=head;
    printf("Enter Number:");
    scanf("%d",&num);
    struct Node *newNode=(struct Node*)malloc(sizeof(struct
    Node)); newNode->data=num;
    while(p->next!=head)
        { p=p->next;
    }
    p->next=newNode;
    newNode->next=head
    ; head=newNode;
    return head;
}
//Insert At End
struct Node* insertEnd(struct Node* head){
    int num;
    struct Node
    *p; p=head;
    printf("Enter Number:");
    scanf("%d",&num);
    struct Node *newNode=(struct Node*)malloc(sizeof(struct
    Node)); newNode->data=num;
    while(p->next!=head)
        { p=p->next;
    }
    p->next=newNode;
    newNode->next=head
    ; return head;
}
//Insert At Any Position
struct Node* insertPosition(struct Node* head, int pos){
    int num,i=0;
    struct Node
    *p; p=head;
    printf("Enter Number:");
    scanf("%d",&num);
    struct Node *newNode=(struct Node*)malloc(sizeof(struct
    Node)); newNode->data=num;
    if(pos==0){
        head=insertFirst(head);
        return head;
    }
    else{
```

```
 while(i!=pos-1){
           p=p->next
           ; i++;
       }
    newNode->next=p->next
    ; p->next=newNode;
    return head;
    }

}
//Delete From Front
struct Node* DelFromFront(struct Node* head){
    struct Node *p;
    p=head;
    while(p->next!=head)
        { p=p->next;
    }
    p->next=head->next
    ; free(head);
    head=p->next;
}
//Delete From End
struct Node* DelFromEnd(struct Node* head){
    struct Node *p,*preNode;
    p=head;
    while(p->next!=head){
        preNode=p;
        p=p->next;
    }
    preNode->next=p->next
    ; free(p);
    return head;
}
//Delete From Any Position
struct Node* DelFromPos(struct Node* head,int
    pos){ int i=0;
    struct Node* p,*preNode;
    p=head;
    if(pos==0){
        head=DelFromFront(head)
        ; return head;
    }
    else{
        while(i!=pos)
            {
            preNode=p;
            p=p->next;
            i++;
        }
    preNode->next=p->next
    ; free(p);
    return head;
```

```
}
}
int main(){
    struct Node* head=NULL;
    head=createCircularLL(head);
    printf("Linked List Created. \n");
    head=displayCircularLL(head);

    head=insertFirst(head);
    printf("Linked List after insertion at begining.\n");
    head=displayCircularLL(head);

    head=insertEnd(head);
    printf("Linked List after insertion at end.\n");
    head=displayCircularLL(head);

    head=insertPosition(head, 3);
    printf("Linked List after insertion at pos.\n");
    head=displayCircularLL(head);

    head=DelFromFront(head);
    printf("Linked List after deletion from
    front\n"); head=displayCircularLL(head);

    head=DelFromEnd(head);
    printf("Linked List after Deletion form end.\n");
    head=displayCircularLL(head);

    head=DelFromPos(head,2);
    printf("Linked List after Deletion form pos.\n");
    head=displayCircularLL(head);
}
```

Output:

```
PS C:\PLC\DATA STRUCTURES> cd "c:\PLC\DATA STRUCTURES\" ; if ($?) { gcc Circ
ular_LL.c -o Circular_LL } ; if ($?) { .\Circular_LL }
Enter -1 to stop.
Enter Number:1
Enter Number:2
Enter Number:3
Enter Number:-1
Linked List Created.
Circular List Elements:1 2 3
Enter Number:10
Linked List after insertion at begining.
Circular List Elements:10 1 2 3
Enter Number:7
Linked List after insertion at end.
Circular List Elements:10 1 2 3 7
Enter Number:5
Linked List after insertion at pos.
Circular List Elements:10 1 2 5 3 7
Linked List after deletion from front
Circular List Elements:1 2 5 3 7
Linked List after Deletion form end.
Circular List Elements:1 2 5 3
Linked List after Deletion form pos.
Circular List Elements:1 2 3
PS C:\PLC\DATA STRUCTURES>
```

Lab Program 7:

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

```
#include<stdio.h>
#include<stdlib.h
> struct Node{
   int data;
   struct Node *next;
};
//Create Linked List
struct Node* createLL(struct Node* head){
   int num;

   printf("Enter -1 to stop.\n");
   printf("Enter Number:");
   scanf("%d",&num);
   while(num!=-1){
      struct Node* newNode=(struct Node*)malloc(sizeof(struct Node));
      struct Node* p;
      p=head;
      if(head==NULL)
      {
         newNode->data=num;
         newNode->next=NULL
         ; head=newNode;
      }
      else{

         while(p->next!=NULL)
            { p=p->next;
         }
         newNode->data=num
         ; p->next=newNode;
         newNode->next=NULL;
      }
   printf("Enter Number:");
   scanf("%d",&num);
   }
   return head;
}
//Display Linked List
struct Node* displayLL(struct Node* head){
   struct Node*p;
   p=head;
   printf("Linked List Elements:");
   while(p !=NULL){
      printf("%d ",p->data);
      p=p->next;

}
```

```
 printf("\n");
    return head;
}
//Sort Linked List
struct Node* sortLL(struct Node* head){
    struct Node* ptr,*trav;
    int temp;
    ptr=head;
    while(ptr->next != NULL){
        trav=ptr->next;
        while(trav!=NULL){
            if(ptr->data > trav->data){
                temp=ptr->data;
                ptr->data=trav->data
                ; trav->data=temp;
            }
            trav=trav->next;
        }
        ptr=ptr->next;
    }
    return head;
}
struct Node* LLRev(struct Node* head){
    struct Node* temp;
    struct Node*
    prev=NULL; struct
    Node* cur=head;
    while(cur!=NULL){
        temp=cur->next
        ;
        cur->next=prev;
        prev=cur;
        cur=temp;
    }
    head=prev;
    return head;
}
struct Node* ConcatLL(struct Node* head1,struct Node*
    head2){ struct Node*ptr;
    ptr=head1;
    while(ptr->next!=NULL)
        { ptr= ptr->next;
    }
    ptr->next=head2
    ; return head1;

}
int main(){
    struct Node* head=NULL;
    struct Node*
    head1=NULL; struct
    Node* head2=NULL;
```

```
head=displayLL(head);
    printf("After Sorting \n");
    head=sortLL(head);
    head=displayLL(head);
    printf("After Reversal \n");
    head=LLRev(head);
    head=displayLL(head);
    printf("Enter 1st Linked List : \n");
    head1=createLL(head1);
    printf("Enter 2nd Linked List : \n");
    head2=createLL(head2);
    printf("After Concatenation \n");
    head1=ConcatLL(head1,head2);
    head1=displayLL(head1);
}
```

Output:

```
PS C:\PLC\DATA STRUCTURES> cd "c:\PLC\DATA STRUCTURES\" ; if ($?) { gcc Sort
_Reverse_Concatenate_LL.c -o Sort_Reverse_Concatenate_LL } ; if ($?) { .\Sor
t_Reverse_Concatenate_LL }
Enter -1 to stop.
Enter Number:4
Enter Number:3
Enter Number:5
Enter Number:-1
Linked List Elements:4 3 5
After Sorting
Linked List Elements:3 4 5
After Reversal
Linked List Elements:5 4 3
Enter 1st Linked List :
Enter -1 to stop.
Enter Number:1
Enter Number:2
Enter Number:3
Enter Number:-1
Enter 2nd Linked List :
Enter -1 to stop.
Enter Number:4
Enter Number:5
Enter Number:6
Enter Number:-1
After Concatenation
Linked List Elements:1 2 3 4 5 6
PS C:\PLC\DATA STRUCTURES>
```

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

Stack Implementation :-

```
#include<stdio.h>
#include<stdlib.h
> struct Node{
    int data;
    struct Node* next;
};
int isEmpty(struct Node* top){
    if(top == NULL){
        return 1;
    }
    return 0;
}
struct Node* displayLL(struct Node* top){
    if(isEmpty(top)){
        printf("No elements to print.\n");
        return top;
    }
    printf("Linked list elements:");
    struct Node* p =top;
    while(p!=NULL){
        printf("%d ",p->data);
        p=p->next;
    }
    printf("\n")
    ; return top;
}
struct Node* push(struct Node* top,int data){
    struct Node* newNode=(struct Node*)malloc(sizeof(struct Node));
    if(top==NULL){
        newNode->data=data;
        top=newNode;
        newNode->next=NULL
        ; return top;
    }
    else{
        newNode->data=data
        ;
        newNode->next=top;
        top=newNode;
        return top;
    }
}
struct Node* pop(struct Node* top){
    if(isEmpty(top)){
        printf("Stack is empty.\n");
    }
    else{
        struct Node* p =top;
```

```
top=p->next;
        free(p);
        return top;
    }
}
int peek(struct Node* top){
    struct Node* p =top;
    return p->data;
}
int main(){
    struct Node* top=NULL;
    top=push(top,5);
    top=push(top,7);
    top=push(top,9);
    printf("Linked list after push operation \n");
    top=displayLL(top);
    printf("Linked list after pop operation \n");
    top=pop(top);
    top=displayLL(top)
    ; int x=peek(top);
    printf("Top Element: %d \n",x);
    top=push(top,10);
    printf("Linked list after push operation \n");
    top=displayLL(top);
}
```

Output:

```
PS C:\PLC\DATA STRUCTURES> cd "c:\PLC\DATA STRUCTURES\" ; if ($?) { gcc StackUsingLL.c -o StackUsingLL } ; if ($?) { .\StackUsingLL }
Linked list after push operation
Linked list elements:9 7 5
Linked list after pop operation
Linked list elements:7 5
Top Element: 7
Linked list after push operation
Linked list elements:10 7 5
PS C:\PLC\DATA STRUCTURES>
```

Lab Program 8:

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* prev;
    struct Node* next;
};
//Create a DLL
struct Node* createDLL(struct Node* head){
    int num;
    printf("Enter -1 to stop.\n");
    printf("Enter Number:");
    scanf("%d",&num);
    while(num!=-1)
    { struct Node*
    ptr;
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if(head==NULL){
        newNode->data=num;
        newNode->prev=NULL
        ;
        newNode->next=NULL
        ; head=newNode;
    }
    else{
        ptr=head;
        while(ptr->next!=NULL)
            { ptr=ptr->next;
        }
        newNode->data=num
        ;
        newNode->prev=ptr;
        ptr->next=newNode;
        newNode->next=NULL;
    }
    printf("Enter Number:");
    scanf("%d",&num);
    }
    return head;

}
//Display Linked List
struct Node* displayLL(struct Node* head){
    struct Node*p;
```

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

//Insert a new node to the left of the node
struct Node* insertLeft(struct Node*
head){
    struct Node*ptr;
    struct Node* newNode=(struct Node*)malloc(sizeof(struct Node));
    int n,val;
    printf("Enter Number:");
    scanf("%d",&n);
    printf("Enter the value before which number is to be inserted:");
    scanf("%d",&val);
    ptr=head;
    while(ptr->data!=val)
        { ptr=ptr->next;
    }
    newNode->data=n;
    newNode->next=ptr;
    newNode->prev=ptr->prev
    ;
    ptr->prev->next=newNode
    ; ptr->prev=newNode;
    return head;

}
//Delete the node based on a specific value
struct Node* deleteNode(struct Node* head){
    int val;
    struct Node* ptr;
    printf("Enter the value for which node is to be deleted:");
    scanf("%d",&val);
    ptr=head;
    while(ptr->data!=val)
        { ptr=ptr->next;
    }
    ptr->prev->next=ptr->next
    ;
    ptr->next->prev=ptr->prev
    ; return head;
}
int main(){
    struct Node* head=NULL;
    head=createDLL(head);
    head=displayLL(head);
    head=insertLeft(head);
    head=displayLL(head);
```

```
    head=deleteNode(head);
    head=displayLL(head);
}
```

Output:

```
PS C:\PLC\DATA STRUCTURES> cd "c:\PLC\DATA STRUCTURES\" ; if ($?) { gcc Doub
ly_Linked_List.c -o Doubly_Linked_List } ; if ($?) { .\Doubly_Linked_List }
Enter -1 to stop.
Enter Number:1
Enter Number:2
Enter Number:3
Enter Number:4
Enter Number:-1
Linked List Elements:1 2 3 4
Enter Number:7
Enter the value before which number is to be inserted:2
Linked List Elements:1 7 2 3 4
Enter the value for which node is to be deleted:3
Linked List Elements:1 7 2 4
PS C:\PLC\DATA STRUCTURES>
```

Lab Program 9:

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.

Also perform finding the immediate predecessor and immediate successor in inorder traversal using BST.

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

struct node {
    struct node* left;
    int data;
    struct node* right;
};

struct node* CreateNode(int ele) {
    struct node* nn = (struct node*)malloc(sizeof(struct node));
    if (nn == NULL) {
        printf("Memory Can't be allocated");
    }
    else {
        nn->data = ele;
        nn->left = NULL;
        nn->right = NULL;
        return nn;
    }
}


struct node* insert(struct node* root, int data) {
    if (root == NULL) {
        root = CreateNode(data);
    }
    else if (data >= root->data) {
        root->right = insert(root->right, data);
    }
    else if (data < root->data) {
        root->left = insert(root->left, data);
    }
    return root;
}
void inordertrav(struct node* root) {
    if (root == NULL) {
        return;
    }
    inordertrav(root->left);
```

```
    printf("%d ", root->data);
    inordertrav(root->right);
}

void postordertrav(struct node* root) {
    if (root == NULL) {
        return;
    }
    postordertrav(root->left);
    postordertrav(root->right)
    ; printf("%d ",
    root->data);
}
void preordertrav(struct node* root) {
    if (root == NULL) {
        return;
    }
    printf("%d ", root->data);
    preordertrav(root->left);
    preordertrav(root->right)
    ;
}
struct node* findImmediatePredecessor(struct node* root, int key) {
    struct node* pre = NULL;
    while (root) {
        if (root->data < key) {
            pre = root;
            root = root->right;
        }
        else if (root->data >= key) {
            root = root->left;
        }
    }
    return pre;
}
struct node* findImmediateSuccessor(struct node* root, int key) {
    struct node* suc = NULL;
    while (root) {
        if (root->data > key) {
            suc = root;
            root = root->left;
        }
        else if (root->data <= key) {
            root = root->right;
        }
    }
    return suc;
}

int main() {
```

```
    root = insert(root, 14);
    root = insert(root, 5);
    root = insert(root, 44);
    root = insert(root, 3);
    root = insert(root, 7);
    root = insert(root, 100);
    root = insert(root, 46);
    root = insert(root, 8);
    root = insert(root, 10);
    root = insert(root, 11);
    root = insert(root, 17);
    root = insert(root, 25);
    root = insert(root, 23);
    root = insert(root, 34);
    root = insert(root, 16);
    root = insert(root, 50);
    root = insert(root, 1);
    root = insert(root, 6);
    root = insert(root, 2);

    printf("In Order Traversal: ");
    inordertrav(root);
    printf("\n");

    printf("Post Order Traversal: ");
    postordertrav(root);
    printf("\n");

    printf("Pre Order Traversal: ");
    preordertrav(root);
    printf("\n");

    printf("Enter Key to search:");
    scanf("%d",&key);
    struct node* pre = findImmediatePredecessor(root, key);
    struct node* suc = findImmediateSuccessor(root, key);

    if (pre)
        printf("Immediate Predecessor of %d is %d\n", key, pre->data);
    else
        printf("No Immediate Predecessor of %d\n", key);

    if (suc)
        printf("Immediate Successor of %d is %d\n", key, suc->data);
    else
        printf("No Immediate Successor of %d\n", key);

    return 0;
}
```

Output:

```
PS C:\PLC\DATA STRUCTURES> cd "c:\PLC\DATA STRUCTURES\" ; if ($?) { gcc BinarySearchTree.c -o BinarySearchTree } ; if ($?) { .\BinarySearchTree }
In Order Traversal: 1 2 3 5 6 7 8 10 11 14 16 17 23 25 34 44 46 50 100
Post Order Traversal: 2 1 3 6 11 10 8 7 5 16 23 34 25 17 50 46 100 44 14
Pre Order Traversal: 14 5 3 1 2 7 6 8 10 11 44 17 16 25 23 34 100 46 50
Enter Key to search:17
Immediate Predecessor of 17 is 16
Immediate Successor of 17 is 23
PS C:\PLC\DATA STRUCTURES>
```

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
i. linear probing
ii. Quadratic Probing
iii. Double Hashing

```
#include<stdio.h>
#include<stdlib.h>
#define MAX_SIZE 100
int L[MAX_SIZE];
int count = 0;
int hash_lprobe(int key) {
    int i = 0;
    while (L[(key + i) % MAX_SIZE] != 0) {
        i++;
        if (count == MAX_SIZE) {
            printf("Array is full\n");
            return -1;
        }
    }
    count++;
    return (key + i) % MAX_SIZE;
}
int hash_qprobe(int key) {
    int i = 0;
    while (L[(key + i * i) % MAX_SIZE] != 0)
        { i++;
        if (i == MAX_SIZE)
            return -1;
        if (count == MAX_SIZE) {
            printf("Array is full\n");
            return -1;
        }
    }
    count++;
    return (key + i * i) % MAX_SIZE;
}
int double_hash(int key) {
    int i = 0;
```

```
    while (L[(key % MAX_SIZE + 97 - key % 97) % MAX_SIZE] != 0) {
        i++;
        if (count == MAX_SIZE) {
            printf("Array is full\n");
            return -1;
        }
    }
    count++;
    return (key % MAX_SIZE + 97 - key % 97) % MAX_SIZE;
}
int search_lp(int key) {
    int i = 0;
    while (L[(key + i) % MAX_SIZE] != key) {
        if (i == MAX_SIZE) {
            printf("Value doesn't exist\n");
            return -1;
        }
        i++;
    }
    return (key + i) % MAX_SIZE;
}
int search_qp(int key) {
    int i = 0;
    while (L[(key + i * i) % MAX_SIZE] != key)
        { if (i == MAX_SIZE) {
            printf("Value doesn't exist\n");
            return -1;
        }
        i++;
    }
    return (key + i * i) % MAX_SIZE;
}

int search_db(int key) {
    int i = 0;
    while (L[(key % MAX_SIZE + 97 - key % 97) % MAX_SIZE] != key) {
        if (i == MAX_SIZE) {
            printf("Value doesn't exist\n");
            return -1;
        }
        i++;
    }
    return (key % MAX_SIZE + 97 - key % 97) % MAX_SIZE;
}

int main() {
    printf("1)Insert\n2)Search\n3)Exit\n")
    ;

    while (1) {
```

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

    switch (choice) {
        case 1:
            printf("Enter the key:");
            scanf("%d", &key);
            printf("1)Linear\n2)Quadratic\n3)Double Hash\n");
            scanf("%d", &subChoice);

            if (subChoice == 1)
                key = hash_lprobe(key);
            else if (subChoice == 2)
                key = hash_qprobe(key);
            else
                key = double_hash(key);

            L[key] =
            key; if (key
            != -1)
                printf("Value %d inserted\n", key);
            break;

        case 2:
            printf("Enter the key:");
            scanf("%d", &key);
            printf("1)Linear\n2)Quadratic\n3)Double Hash\n");
            scanf("%d", &subChoice);

            if (subChoice == 1)
                                            key =
                 search_lp(key); else if
              (subChoice == 2) key =
                       search_qp(key);
            else
                key = search_db(key);

            if (key != -1)
                printf("Value %d found at %d\n", L[key], key);
            break;

        case 3:
            exit(0);

        default:
            printf("Invalid choice\n");
            break;
    }
}
```

```c
    return 0;
}
```

Output

```
PS C:\PLC\DATA STRUCTURES> cd "c:\PLC\DATA STRUCTURES\" ; if ($?) { gcc Hashing.c -o Hashing } ; if ($?) { .\Hashing }
1)Insert
2)Search
3)Exit
Enter choice:1
Enter the key:42
1)Linear
2)Quadratic
3)Double Hash
1
Value 42 inserted
Enter choice:2
Enter the key:42
1)Linear
2)Quadratic
3)Double Hash
1
Value 42 found at 42
Enter choice:1
Enter the key:55
1)Linear
2)Quadratic
3)Double Hash
1
Value 55 inserted
Enter choice:1
Enter the key:68
1)Linear
2)Quadratic
3)Double Hash
1
Value 68 inserted
Enter choice:2
Enter the key:68
1)Linear
2)Quadratic
3)Double Hash
1
Value 68 found at 68
Enter choice:3
PS C:\PLC\DATA STRUCTURES>
```

LEETCODE 1:

Demonstration of stack program

```
typedef struct {
int *stack;
int *minStack;
int top
} MinStack;


MinStack* minStackCreate() {
MinStack* stack = (MinStack*)malloc(sizeof(MinStack));
stack->stack = (int*)malloc(sizeof(int) * 10000);
stack->minStack = (int*)malloc(sizeof(int) * 10000);
stack->top = -1;
return stack;
}

void minStackPush(MinStack* obj, int val) {
obj->top++;
obj->stack[obj->top] = val;
if (obj->top == 0 || val <= obj->minStack[obj->top - 1]) {
obj->minStack[obj->top] = val;
} else {
obj->minStack[obj->top] = obj->minStack[obj->top - 1];
}
}

void minStackPop(MinStack* obj) {
obj->top--;
}

int minStackTop(MinStack* obj) {
return obj->stack[obj->top];
}

int minStackGetMin(MinStack* obj) {
return obj->minStack[obj->top];
}

void minStackFree(MinStack* obj) {
free(obj->stack);
free(obj->minStack);
free(obj);
```

Testcase | Test Result

Accepted Runtime: 0 ms

• Case 1

Input

```
["MinStack","push","push","push","getMin","pop","top","getMin"]
```

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

Output

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

Expected

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

LEETCODE 2:

Demonstration of LeetCode program on Singly linked list

```
struct ListNode* reverseBetween(struct ListNode* head, int left, int
right) {
    if (head == NULL|| left == right)
    {
        return head;
    }
    struct ListNode *dummy = (struct ListNode*)malloc(sizeof(struct
ListNode));
    dummy->next=head;
    struct ListNode *prev=dummy;
    for(int i=1; i<left; i++)
    {
        prev=prev->next;
    }
    struct ListNode* current=prev->next;
    struct ListNode* next=NULL;
    struct ListNode* tail=current;
    for(int i=left; i<=right; i++){
        struct ListNode* temp=current->next;
        current->next=next;
        next=current;
        current=temp;
    }
    prev->next=next;
    tail->next=current;
    struct ListNode* result=dummy->next;
    free(dummy);
    return result;
}
```

Testcase | >_ Test Result

Accepted Runtime: 6 ms

• Case 1 • Case 2

Input

head =

[1,2,3,4,5]

left =

2

right =

4

Output

[1,4,3,2,5]

Expected

[1,4,3,2,5]

LEETCODE 3:

Demonstration of LeetCode program on Singly linked list

```
struct ListNode** splitListToParts(struct ListNode* head, int k, int* returnSize)
{
    // Calculate the length of the linked list int
    length = 0;
    struct ListNode* current = head;
    while (current != NULL) {
        length++;
        current = current->next;
    }

    // Calculate the size of each part and the number of nodes that will have
an extra node
    int partSize = length / k; int
    extraNodes = length % k;

    // Initialize the array to store the heads of the parts
    struct ListNode** result = (struct ListNode**)malloc(k * sizeof(struct
ListNode*));

    // Split the linked list into parts
    current = head;
    for (int i = 0; i < k; i++) {
   // Determine the size of the current part
   int currentPartSize = partSize + (i < extraNodes ? 1 : 0);

   // Store the head of the current part in the result array result[i]
   = current;

   // Move to the end of the current part
   for (int j = 0; j < currentPartSize - 1 && current != NULL; j++) { current =
   current->next;
   }

   // If there are more nodes, break the link between parts if
   (current != NULL) {
   struct ListNode* nextNode = current->next;
   current->next = NULL;
   current = nextNode;
   }
```

Testcase | >_ Test Result

Accepted Runtime: 6 ms

• Case 1 • Case 2

Input

head =

[1,2,3,4,5]

left =

2

right =

4

Output

[1,4,3,2,5]

Expected

[1,4,3,2,5]

LEETCODE 4 :

```
struct ListNode* rotateRight(struct ListNode* head, int k) {
    if (head == NULL || head->next == NULL || k == 0) // If the list
is empty or has only one node or k is zero, no need to rotate
        return head;

    int length = 1;
    struct ListNode *tail = head;

    while (tail->next != NULL) { // Finding the length of the list
and the tail node
        length++;
        tail = tail->next;
    }

    k = k % length; // Adjusting k if it's greater than the length
of the list
    if (k == 0) // If k becomes 0 after adjustment, no rotation is
needed
        return head;

    struct ListNode *new_tail = head;
    for (int i = 0; i < length - k - 1; i++) { // Finding the new
tail node after rotation
        new_tail = new_tail->next;
    }

    struct ListNode *new_head = new_tail->next; // New head after
rotation
    new_tail->next = NULL; // Breaking the link between the new tail
and the next node to form a new list

    tail->next = head; // Connecting the original tail to the
original head to form a circular list
    return new_head;
}
```

Testcase | >_ Test Result

Accepted Runtime: 5 ms

• Case 1 • Case 2

Input

head =

```
[1,2,3,4,5]
```

k =

```
2
```

Output

```
[4,5,1,2,3]
```

Expected

```
[4,5,1,2,3]
```

Hacker Rank 1:

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

struct node
{
    int id;
    int depth;
    struct node *left, *right;
};

void
inorder(struct node* tree)
{
    if(tree == NULL)
        return;

    inorder(tree->left);
    printf("%d ",tree->id);
    inorder((tree->right));

}


int
main(void)
{
    int no_of_nodes, i = 0;
    int l,r, max_depth,k;
    struct node* temp = NULL;
    scanf("%d",&no_of_nodes);
    struct node* tree = (struct node *) calloc(no_of_nodes , sizeof(struct
node));
    tree[0].depth = 1;
    while(i <  no_of_nodes )
    {
        tree[i].id = i+1;
        scanf("%d %d",&l,&r);
        if(l ==  -1)
            tree[i].left = NULL;
        else
             {
                 tree[i].left = &tree[l-1];
                 tree[i].left->depth = tree[i].depth + 1;
                 max_depth = tree[i].left->depth;
             }
```

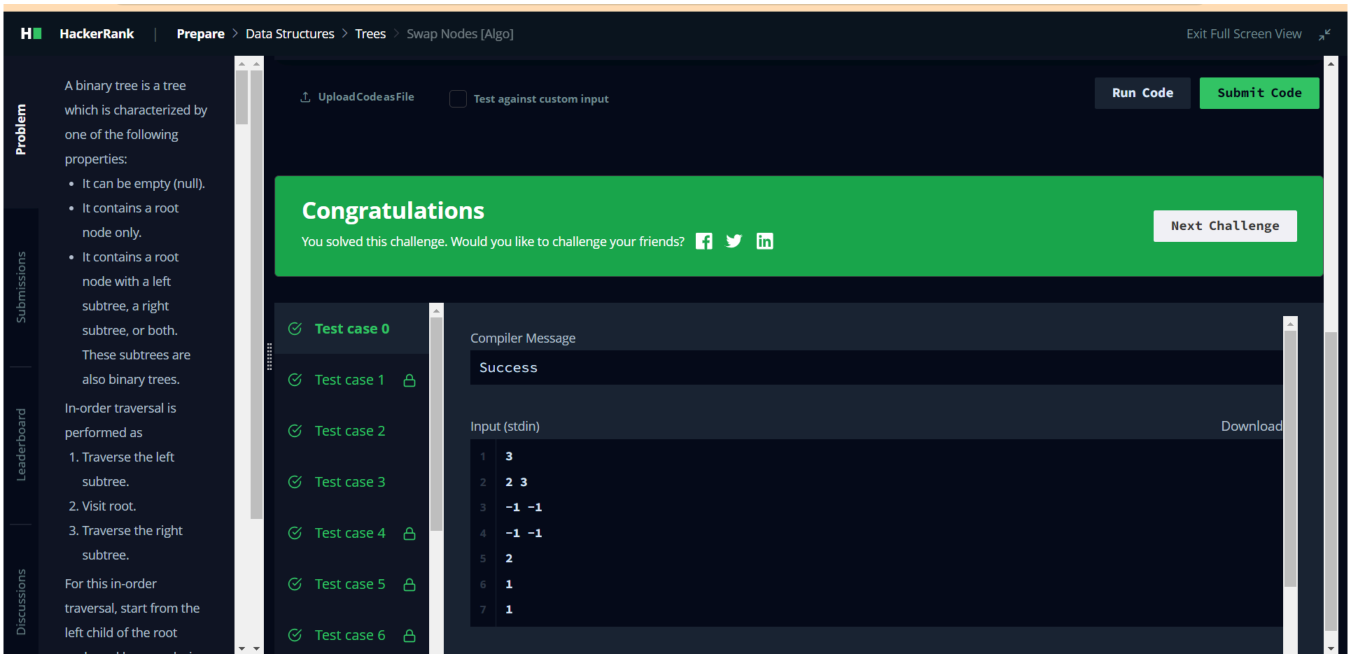
```
            if(r ==  -1)
                tree[i].right = NULL;
            else
                 {
                     tree[i].right = &tree[r-1];
                     tree[i].right->depth = tree[i].depth + 1;
                     max_depth = tree[i].right->depth+2;
                 }

        i++;
        }

        scanf("%d", &i);
        while(i--)
        {
            scanf("%d",&l);
            r = l;
            while(l <= max_depth)
            {
                for(k = 0;k < no_of_nodes; ++k)
                {
                    if(tree[k].depth == l)
                    {
                        temp = tree[k].left;
                        tree[k].left = tree[k].right;
                        tree[k].right = temp;
                    }
                }
                l = l + r;
            }
            inorder(tree);
            printf("\n");
        }



        return 0;
    }
```


HackerRank
Prepare > Data Structures > Trees > Swap Nodes [Algo]
Exit Full Screen View
Problem
Submissions
Leaderboard
Discussions
A binary tree is a tree which is characterized by one of the following properties:
• It can be empty (null).
• It contains a root node only.
• It contains a root node with a left subtree, a right subtree, or both. These subtrees are also binary trees.
In-order traversal is performed as
1. Traverse the left subtree.
2. Visit root.
3. Traverse the right subtree.
For this in-order traversal, start from the left child of the root
Upload Code as File
Test against custom input
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You solved this challenge. Would you like to challenge your friends?
Next Challenge
Test case 0
Test case 1
Test case 2
Test case 3
Test case 4
Test case 5
Test case 6
Compiler Message
Success
Input (stdin)
Download
3
2 3
-1 -1
-1 -1
2
1
1