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LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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in partial fulfillment for the award of the degree of
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in
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This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by RANJAN DEVI **(1BM22CS219)**, 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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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 STACK_SIZE 5
void push(int st[],int *top)
{
	int item;
	if(*top==STACK_SIZE-1)
		printf("Stack overflow\n");
	else
	{
		printf("\nEnter an item :");
		scanf("%d",&item);
		(*top)++;
		st[*top]=item;
	}
}
void pop(int st[],int *top)
{
	if(*top==-1)
		printf("Stack underflow\n");
	else
	{
		printf("\n%d item was deleted",st[(*top)--]);
	}
}
void display(int st[],int *top)
{
	int i;
	if(*top==-1)
		printf("Stack is empty\n");
	for(i=0;i<=*top;i++)
		printf("%d\t",st[i]);
}
void main()
{
	int st[10],top=-1, c,val_del;
	while(1)
	{
		printf("\n1. Push\n2. Pop\n3. Display\n");
		printf("\nEnter your choice :");
		scanf("%d",&c);
		switch(c)
		{
```

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

Output:

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL

PS D:\jyothika\DST> cd "d:\jyothika\DST\" ; if ($?) { gcc 1.c -o 1 } ; if ($?) { .\1 }

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :12

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :65

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :45

1. Push
2. Pop
3. Display

Enter your choice :1
Stack overflow
```

```
1. Push
2. Pop
3. Display

Enter your choice :2

45 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :2

65 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :3
12
1. Push
2. Pop
3. Display

Enter your choice :2

12 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :2
Stack underflow

1. Push
2. Pop
3. Display

Enter your choice :4

Invalid choice!!!
```

Lab program 2:

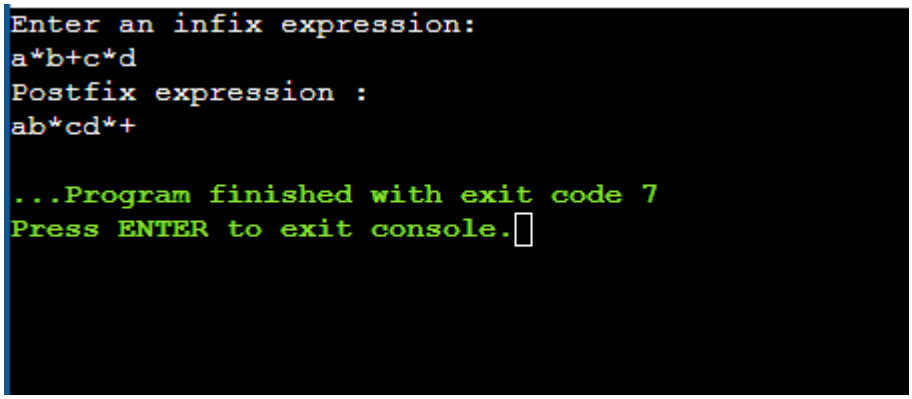
WAP to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and the binary operators + (plus), - (minus), * (multiply) and /(divide)

```
#include <stdio.h>
#include <string.h>
int i,j=0,n,top=-1;
char val,temp,c;
char stack[100];
char infix[100],postfix[100];
void push(char );
char pop();
int precedence( char);
void main()
{
	printf("Enter an infix expression:\n");
	scanf("%s",infix);
	n=strlen(infix);
	for(i=0;i<=n;i++)
	{
		if(infix[i]=='(')
			push(infix[i]);
		else if(infix[i]>='a' && infix[i]<='z' || infix[i]>='A' && infix[i]<='Z' || infix[i]>='0'
		&& infix[i]<='9')
		{
			postfix[j]=infix[i];
			j++;
		}
		else if(infix[i]==')')
		{
			while(stack[top]!='(')
			{	postfix[j]=pop();
				j++;
			}
			temp=pop();
		}
		else
		{
			while(precedence(infix[i])<=precedence(stack[top]) && top>=0)
			{
				postfix[j]=pop();
				j++;
			}
```

```
                        push(infix[i]);
                }
        }
        while(stack[top]!='\0')
        {
                postfix[j]=pop();
                j++;
        }
        postfix[j]='\0';
        printf("Postfix expression :\n");
        printf("%s",postfix);
}
void push(char val)
{
        if(top==n-1)
                printf("Stack is full");
        else
        {
                top+=1;
                stack[top]=val;
        }
}
char pop()
{
        if(top==-1)
                printf("Stack is empty ");
        else
        {
                val=stack[top];
                top-=1;
                return val;
        }
}
int precedence(char c)
{
        if(c=='^')
                return 5;
        else if(c=='/')
                return 4;
        else if(c=='*')
                return 3;
        else if(c=='+')
                return 2;
        else if(c=='-')
```

```
            return 1;
        else
            return -1;
}
```

OUTPUT:



Lab program 3:

3a) WAP to simulate the working of a queue of integers using an array.Provide the following operations: Insert, Delete, Display. The program should print appropriate messages for queue empty and queue overflow conditions.

```
#include <stdio.h>
int q[50],rear=-1,front=-1,max=50;
void enqueue();
void dequeue();
void display();
void main()
{
	int ch;
	printf("Press-1.insert, 2.delete, 3.Display and 4.Exit\n");
	while(ch!=4)
	{
		printf("Enter choice:");
		scanf("%d",&ch);
		switch(ch){
			case 1:
				enqueue();
				break;
			case 2:
				dequeue();
				break;
			case 3:
				display();
				break;
		}
	}
	printf("Exited");
}

void enqueue()
{
	int item;
	if(rear==max-1)
		printf("Queue overflow\n");
	else
	{	if(front==-1)
			front=0;
		printf("Insert an element:");
		scanf("%d",&item);
```

```
                rear+=1;
                q[rear]=item;
        }
}
void dequeue()
{
        if(front==-1||front>rear)
                printf("Queue underflow\n");
        else
        {
                printf("Deleted element is:%d\n",q[front]);
                front+=1;
        }
}
void display()
{
        int i;
        if(front==-1)
                printf("Queue is empty");
        else
        {
                printf("Queue is:\n");
                for(i=front;i<=rear;i++)
                        printf("%d\t",q[i]);
                printf("\n");
        }
}
```

OUTPUT:

```
Press-1.insert, 2.delete, 3.Display and 4.Exit
Enter choice:2
Queue underflow
Enter choice:1
Insert an element:6
Enter choice:1
Insert an element:8
Enter choice:1
Insert an element:5
Enter choice:2
Deleted element is:6
Enter choice:3
Queue is:
8       5
Enter choice:4
Exited
```

3b) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete and Display The program should print appropriate messages for queue empty and queue overflow conditions.

```
#include <stdio.h>
int q[50],front=-1,rear=-1,size;
void display();
void enqueue();
void dequeue();
void main()
{
	int ch;
	printf("Enter no. of elements:");
	scanf("%d",&size);
	while(ch!=4)
	{
		printf("1.Insert  2.Delete  3.Display  4.Exit\n");
		printf("Enter your choice:");
		scanf("%d",&ch);
		switch (ch)
		{
			case 1:
				enqueue();
				break;
			case 2:
				dequeue();
				break;
			case 3:
				display();
				break;
		}
	}
	printf("Exited");
}
void enqueue()
{
	int item;
	if((front == rear+1)||(front==0 && rear==size-1))
		printf("Queue is full\n");
	else
	{
		if(front == -1)
			front=0;
```

```
                printf("Enter element:");
                scanf("%d",&item);
                rear=(rear + 1)%size;
                q[rear] = item;
        }
}
void dequeue()
{
        int ele;
        if(front==-1)
                printf("Queue is empty\n");
        else
        {
                ele = q[front];
                if(front==rear)
                {
                        front = -1;
                        rear = -1;
                }
                else
                        front = (front+1) % size;
                printf("Deleted element = %d\n",ele);
        }
}
void display()
{
        int i;
        if(front == -1)
                printf("Queue is empty");
        else
        {
                printf("Front = %d\t",front);
                printf("Rear = %d\n",rear);
                printf("Queue:");
                for(i=front;i!=rear;i=(i+1)%size)
                        printf("%d",q[i]);
                printf("%d\n",q[i]);
        }
}
```

OUTPUT:

```
Enter no. of elements:4
1.Insert  2.Delete  3.Display  4.Exit
Enter your choice:1
Enter element:1
1.Insert  2.Delete  3.Display  4.Exit
Enter your choice:1
Enter element:2
1.Insert  2.Delete  3.Display  4.Exit
Enter your choice:1
Enter element:3
1.Insert  2.Delete  3.Display  4.Exit
Enter your choice:1
Enter element:4
1.Insert  2.Delete  3.Display  4.Exit
Enter your choice:1
Queue is full
1.Insert  2.Delete  3.Display  4.Exit
Enter your choice:2
Deleted element = 1
1.Insert  2.Delete  3.Display  4.Exit
Enter your choice:1
Enter element:5
1.Insert  2.Delete  3.Display  4.Exit
Enter your choice:3
Front = 1       Rear = 0
Queue:2345
1.Insert  2.Delete  3.Display  4.Exit
Enter your choice:4
Exited
```

Lab program 4:

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

```
#include <stdlib.h>
#include <stdio.h>
void push();
void append();
void display();
void insert_at_pos();
struct node
{
        int data;
        struct node *next;
};
struct node *head=NULL;
void main()
{
        printf("1.Insert from beginning\n2.Insert at end\n3.Insert at  particular position \n 4.
        Display \n5.Exit\n");
        int ch;
        while(ch!=6)
        {
                printf("Enter choice:");
                scanf("%d",&ch);
                switch(ch)
                {
                        case 1:
                                push();
                                break;
                        case 2:
                                append();
                                break;
                        case 3:
                                insert_at_pos();
                                break;
                        case 4:
                                display();
                                break;
                        case 5:exit(0);
                        default: printf("Invalid choise");
                                break;
```

```
                }
        }
}
void push()
{
        int data;
        struct node *new_node;
        new_node=(struct node*)malloc(sizeof(struct node));
        printf("Enter the data to be inserted\n");
        scanf("%d",&data);
        new_node->data=data;
        new_node->next=head;
        head = new_node;
}
void append()
{
        int data;
        struct node *last=head;
        struct node *new_node;
        new_node=(struct node*)malloc(sizeof(struct node));
        printf("Enter the data\n");
        scanf("%d",&data);
        new_node -> data =data;
        new_node->next=NULL;
        if(head==NULL)
        {
                head=new_node;
                return;
        }
        while(last->next!=NULL)
        {
                last=last->next;
        }
        last-> next =new_node;
}
void insert_at_pos()
{
        int data;
        int pos;
        struct node *temp=head;
        struct node *new_node;
        new_node = (struct node*) malloc(sizeof(struct node));
        printf("Enter the data to be inserted\n");
        scanf("%d",&data);
```

```
        new_node->data=data;
        printf("enter the position\n");
        scanf("%d",&pos);
        new_node -> next = NULL;
        if(pos==0)
        {
                new_node->next=head;
                head = new_node;
        }
        else
        {
                for(int i=1 ; i<pos-1 ; i++)
                {
                        temp=temp->next;
                }
                struct node *temp1=temp->next;
                new_node->next= temp1;
                temp->next = new_node;
        }
}
void display()
{
        struct node *p= head;
        printf("List:\n");
        while(p != NULL)
        {
                printf("%d ->",p->data);
                p=p->next;
        }
        printf("NULL\n");
}
```

OUTPUT:

```
1.Insert from beginning
2.Insert at end
3.Insert at particular position
4.Display
5.Exit
Enter choice:1
Enter the data to be inserted
1
Enter choice:2
Enter the data
9
Enter choice:1
Enter the data to be inserted
2
Enter choice:2
Enter the data
8
Enter choice:3
Enter the data to be inserted
5
enter the position
3
Enter choice:4
List:
2 ->1 ->5 ->9 ->8 ->NULL
Enter choice:5
```

LEETCODE 1: MINSTACK

```
typedef struct {
    int size;
    int top;
    int *s;
    int *minstack;
} MinStack;

MinStack* minStackCreate() {
    MinStack *st=(MinStack*) malloc(sizeof(MinStack));
    if(st==NULL)
    {
        exit(0);
    }
    st->size=1000;
    st->top=-1;
    st->s=(int*) malloc (st->size*sizeof(int));
    st->minstack = (int*) malloc (st->size * sizeof(int));
    if(st->s==NULL)
    {
        printf("memory allocation failed");
        free(st->s);
        free(st->minstack);
```

```
        exit(0);
    }
    return st;
}

void minStackPush(MinStack* obj, int val) {
    if(obj->top==obj->size-1)
        printf("stack is overflow");
    else{
        obj->top++;
        obj->s[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) {
    int value;
    if(obj->top==-1)
        printf("underflow");
    else
    {
        value=obj->s[obj->top];
        obj->top--;
    }
}

int minStackTop(MinStack* obj) {
    int value=-1;
    if(obj->top==-1)
    {
        exit(0);
    }
    else
    {
        value=obj->s[obj->top];
        return value;
    }
}

int minStackGetMin(MinStack* obj) {
    if(obj->top==-1)
    {
        exit(0);
    }
    else
    {
```

```
        return obj->minstack[obj->top];
    }
}

void minStackFree(MinStack* obj) {
    free(obj->s);
    free(obj->minstack);
    free(obj);
}
/**
 * Your MinStack struct will be instantiated and called as such:
 * MinStack* obj = minStackCreate();
 * minStackPush(obj, val);
 * minStackPop(obj);
 * int param_3 = minStackTop(obj);

 * int param_4 = minStackGetMin(obj);
 * minStackFree(obj);
*/
```

OUTPUT:

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>
void pop();
void end_delete();
void delete_at_pos();
void display();
void append();
struct node
{
        int data;
        struct node *next;
};
struct node *head = NULL;
void main()
{
        printf("Insert the elements in list\n");
        append();
        printf("1.Delete from beginning\n2.Delete at end\n3.Delete at particular
position\n4.Display\n5.Exit\n");
        int ch;
        while(ch!=5)
        {
                printf("Enter choice:");
                scanf("%d",&ch);
                switch(ch)
                {
                        case 1:
                                pop();
                                break;
                        case 2:
                                end_delete();
                                break;
                        case 3:
                                delete_at_pos();
                                break;
                        case 4:
                                display();
                                break;
```

```
                default: printf("Invalid choice");
                        break;
                }
        }
}
void append()
{
        int data,n;
        printf("Enter no. of nodes:");
         scanf("%d",&n);
        for(int i=0;i<n;i++)
        {
                struct node *last=head;
                struct node *new_node;
                new_node=(struct node*)malloc(sizeof(struct node));
                printf("Enter the data:");
                scanf("%d",&data);
                new_node -> data=data;
                new_node -> next =NULL;
                if(head==NULL)
                        head = new_node;
                else
                {
                        while(last->next!=NULL)
                        {
                                last=last->next;
                        last-> next =new_node;
                        }
                }
        }
}
void pop()
{
        struct node *ptr;
        if(head == NULL)
                printf("List is empty\n");
        else
        {
                ptr=head;
                head = ptr->next;
                free(ptr);
                printf("Node deleted from beginning\n");
        }
}
```

```
void end_delete()
{
	struct node *ptr;
	struct node *ptr1;
	if(head == NULL)
		printf("List is empty\n");
	else if(head -> next ==NULL)
	{
		free(head);
		head = NULL;
	}
	else
	{
		ptr = head;
		ptr1 = head;
		while(ptr -> next !=NULL)
		{
			ptr1 = ptr;
			ptr = ptr->next;
		}
		ptr1 -> next =NULL;
		free(ptr);
		printf("Node deleted from end\n");
	}
}
void delete_at_pos()
{
	struct node *ptr;
	struct node *ptr1;
	int pos;
	printf("Enter the position of deletion:\n");
	scanf("%d",&pos);
	ptr = head;
	for(int i=0;i<pos-1;i++)
	{
		ptr1 = ptr;
		ptr = ptr->next;
		if(ptr == NULL)
		{
			printf("There are less elements in the list\n");
			return;
		}
	}
	ptr1->next = ptr->next;
```

```
        free(ptr);
        printf("Node deleted from position %d\n",pos);
}
void display()
{
        struct node *p= head;
        printf("List:\n");
        while(p != NULL)
        {
                printf("%d ->",p->data);
                p=p->next;
        }
        printf("NULL\n");
}
```

OUTPUT:

```
Insert the elements in list
Enter no. of nodes:5
Enter the data:1
Enter the data:2
Enter the data:3
Enter the data:4
Enter the data:5
1.Delete from beginning
2.Delete at end
3.Delete at particular position
4.Display
5.Exit
Enter choice:1
Node deleted from beginning
Enter choice:2
Node deleted from end
Enter choice:4
List:
2 ->3 ->4 ->NULL
Enter choice:3
Enter the position of deleteion:
3
Node deleted from position 3
Enter choice:4
List:
2 ->3 ->NULL
Enter choice:5
Invalid choice
```

LEETCODE 2: Reverse Linked List

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
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* preLeft = dummy;
    for (int i = 1; i < left; i++) {
        preLeft = preLeft->next;
    }
    struct ListNode* current = preLeft->next;
    struct ListNode* prev = NULL;
    struct ListNode* next = NULL;
    for (int i = 0; i <= right - left; i++) {
        next = current->next;
        current->next = prev;
        prev = current;
        current = next;
    }
    preLeft->next->next = current;
    preLeft->next = prev;
    if (left == 1) {
        head = dummy->next;
    }
    free(dummy);
    return head;
}
```

OUTPUT:

Testcase | Test Result

Accepted Runtime: 0 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]
```

Lab program 6:

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

```
#include <stdio.h>
#include <stdlib.h>
struct node
{
	int data;
	struct node *next;
};
struct node *head1=NULL;
struct node *head2=NULL;
void insert1()
{
	int n,i,data;
	printf("Enter the no of nodes:");
	scanf("%d",&n);
	printf("Enter the data:\n");
	for(i=0;i<n;i++)
	{
		struct node *last1=head1;
		struct node *new_node1;
		new_node1=(struct node*)malloc(sizeof(struct node));
		scanf("%d",&data);
		new_node1->data=data;
		new_node1->next=NULL;
		if(head1==NULL)
		{
			head1=new_node1;
		}
		else
		{
			while(last1->next!=NULL)
			{
				last1=last1->next;
			}
			last1->next=new_node1;
		}
	}
}
void insert2()
{
```

```
	int n,i,data;
	printf("Enter the number of nodes:");
	scanf("%d",&n);
	printf("Enter the data:\n");
	for(i=0;i<n;i++)
	{
		struct node *last2=head2;
		struct node *new_node2;
		new_node2=(struct node*)malloc(sizeof(struct node));
		scanf("%d",&data);
		new_node2->data=data;
		new_node2->next=NULL;
		if(head2==NULL)
		{
			head2=new_node2;
		}
		else
		{
			while(last2->next!=NULL)
			{
				last2=last2->next;
			}
			last2->next=new_node2;
		}
	}
}
void sort()
{
	struct node *curr = head1;
	struct node *ptr = NULL;
	int temp;
	while(curr != NULL)
	{
		ptr = curr->next;
		while(ptr !=NULL)
		{
			if(curr->data > ptr->data)
			{
				temp = curr->data;
				curr->data=ptr->data;
				ptr->data=temp;
			}
			ptr = ptr->next;
		}
```

```
                curr = curr->next;
        }
        display();
}
void reverse()
{
        struct node* prev=NULL;
        struct node* ptr=NULL;
        while(head1!=NULL)
        {
                ptr=head1->next;
                head1->next=prev;
                prev=head1;
                head1=ptr;
        }
        head1=prev;
        display();
}
void concate()
{
        struct node*temp=head1;
        if(head1==NULL)
        {
                struct node *node=head2;
                while(node!=NULL)
                {
                        printf("%d->",node->data);
                        node=node->next;
                }
                printf("\n");
        }
        else
        {
                while(temp->next!=NULL)
                {
                        temp=temp->next;
                }
                temp->next=head2;
        }
        display();
}
void display()
{
        struct node *node=head1;
```

```
        if(head1==NULL)
        {
                printf("List is empty\n");
        }
        else
        {
                while(node!=NULL)
                {
                        printf("%d -> ",node->data);
                        node=node->next;
                }
                printf("NULL\n");
        }
}
void main()
{
        printf("Insert elemnts in first list:\n");
        insert1();
        printf("Sorted list:\n");
        sort();
        printf("Reversed list:\n");
        reverse();
        printf("Insert the elements in second list:\n");
        insert2();
        printf("Concatenated list:\n");
        concate();
}
```

OUTPUT:

```
Insert elemnts in first list:
Enter the no of nodes:5
Enter the data:
4 6 1 2 7
Sorted list:
1 -> 2 -> 4 -> 6 -> 7 -> NULL
Reversed list:
7 -> 6 -> 4 -> 2 -> 1 -> NULL
Insert the elements in second list:
Enter the number of nodes:3
Enter the data:
3 2 1
Concatenated list:
7 -> 6 -> 4 -> 2 -> 1 -> 3 -> 2 -> 1 -> NULL
```

6b) WAP to Implement Single Link List to simulate Stack and Queue operations.

STACK implementation

```
#include <stdio.h>
struct node
{
	int data;
	struct node *next;
};
struct node *head=NULL;
void push()
{
	int i,data;
	printf("Enter the data :");
	struct node *last=head;
	struct node *new_node;
	new_node=(struct node*)malloc(sizeof(struct node));
	scanf("%d",&data);
	new_node->data=data;
	new_node->next=NULL;
	if(head==NULL)
	{
		head=new_node;
	}
	else
	{
		while(last->next!=NULL)
		{
			last=last->next;
		}
		last->next=new_node;
	}
	printf("Element pushed successfully\n");
}
void pop()
{
	struct node*ptr;
	struct node*ptr1;
	if(head==NULL)
		printf("List is empty\n");
	else if(head->next==NULL)
		free(head);
	else
	{
```

```
                ptr=head;
                while(ptr->next!=NULL)
                {
                        ptr1=ptr;
                        ptr=ptr->next;
                }
                free(ptr);
                ptr1->next=NULL;
                printf("Element popped successfully\n");
        }
}
void display()
{
        struct node *node=head;
        if(head==NULL)
                printf("List is empty\n");
        else
        {
                printf("Stack :\n");
                while(node!=NULL)
                {
                        printf("%d -> ",node->data);
                        node=node->next;
                }
                printf("NULL\n");
        }
}
void main()
{
        int ch;
        printf("Enter 1:pop \n 2:push \n 3:display \n 4:exit\n");
        while(ch!=4)
        {
                printf("Enter the choice:");
                scanf("%d",&ch);
                switch(ch)
                {
                        case 1: pop();
                                break;
                        case 2:push();
                                break;
                        case 3:display();
                                break;
                }
```

```
        }
}
```

OUTPUT:

```
Enter 1:pop
 2:push
 3:display
 4:exit
Enter the choice:2
Enter the data :1
Element pushed successfully
Enter the choice:2
Enter the data :2
Element pushed successfully
Enter the choice:2
Enter the data :3
Element pushed successfully
Enter the choice:3
Stack :
1 -> 2 -> 3 -> NULL
Enter the choice:2
Enter the data :4
Element pushed successfully
Enter the choice:1
Element popped successfully
Enter the choice:3
Stack :
1 -> 2 -> 3 -> NULL
Enter the choice:4
```

Queue Implementation

```
#include <stdio.h>
struct node
{
        int data;
        struct node *next;
};
struct node *head=NULL;
void enqueue()
{
        int i,data;
        printf("Enter the data :");
        struct node *last=head;
        struct node *new_node;
        new_node=(struct node*)malloc(sizeof(struct node));
        scanf("%d",&data);
        new_node->data=data;
        new_node->next=NULL;
```

```
        if(head==NULL)
        {
                head=new_node;
        }
        else
        {
                while(last->next!=NULL)
                {
                        last=last->next;
                }
                last->next=new_node;
        }
}
void dequeue()
{
        struct node *ptr;
        if(head == NULL)
                printf("List is empty\n");
        else
        {
                ptr=head;
                head = ptr->next;
                free(ptr);
                printf("Node deleted from beginning\n");
        }
}
void display()
{
        struct node *node=head;
        if(head==NULL)
                printf("List is empty\n");
        else
        {
                printf("Queue:\n");
                while(node!=NULL)
                {
                        printf("%d -> ",node->data);
                        node=node->next;
                }
                printf("NULL\n");
        }
}
void main()
{
```

```
        int ch;
        printf("Enter 1:Enqueue \n 2:Dequeue \n 3:Display \n 4:exit\n");
        while(ch!=4)
        {
                printf("Enter the choice:");
                scanf("%d",&ch);
                switch(ch)
                {
                        case 1:enqueue();
                                break;
                        case 2:dequeue();
                                break;
                        case 3:display();
                                break;
                }
        }
}
```

OUTPUT:

```
Enter 1:Enqueue
 2:Dequeue
 3:Display
 4:exit
Enter the choice:1
Enter the data :1
Enter the choice:1
Enter the data :2
Enter the choice:1
Enter the data :3
Enter the choice:1
Enter the data :4
Enter the choice:3
Queue:
1 -> 2 -> 3 -> 4 -> NULL
Enter the choice:2
Node deleted from beginning
Enter the choice:3
Queue:
2 -> 3 -> 4 -> NULL
Enter the 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 *prev;
        struct node *next;
};
struct node *head = NULL;
void insert();
void delete();
void display();
void main()
{
        int ch;
        printf("Press - 1.Insert\n 2.Delete\n 3.Display\n");
        while(ch!=4)
        {
                printf("Enter choice:");
                scanf("%d",&ch);
                switch(ch)
                {
                        case1:insert();
                                break;
                        case 2:delete();
                                break;
                        case 3:display();
                                break;
                }
        }
}
void insert()
{
        int pos,i=1;
        struct node *new = (struct node*)malloc(sizeof(struct node));
        struct node *ptr=head;
        printf("Enter data:");
        scanf("%d",&new->data);
```

```
        if(head == NULL)
        {
                new -> prev = NULL;
                new -> next = NULL;
                head = new;
                printf("Node inserted\n");
                return;
        }
        printf("Enter the position:");
        scanf("%d",&pos);
        if(pos==1)
        {
                new -> prev =NULL;
                new->next = head;
                head -> prev =new;
                head=new;
                printf("Node inserted\n");
        }
        else{
                for(i=0;i<pos-1;i++)
                {
                        ptr = ptr->next;
                }
                new->prev = ptr->prev;
                new->next = ptr;
                ptr->prev->next=new;
                ptr->prev = new;
                printf("Node inserted\n");
        }
}
void delete()
{
        int val;
        printf("Enter the value:");
        scanf("%d",&val);
        struct node *ptr=head;
        if(head->data == val)
        {
                head = ptr->next;
                free(ptr);
                printf("Node deleted\n");
                return;
        }
        while(ptr->data != val)
```

```
        {
                ptr = ptr->next;
                if(ptr->next == NULL)
                {
                        ptr->prev->next = NULL;
                        free(ptr);
                        printf("Node deleted\n");
                        return;
                }
        }
        ptr->prev->next = ptr->next;
        ptr->next->prev = ptr->prev;
        free(ptr);
        printf("Node deleted\n");
}
void display()
{
        struct node *p=head;
        while(p != NULL)
        {
                printf("%d -> ",p->data);
                p=p->next;
        }
        printf("NULL\n");
}
```

OUTPUT:

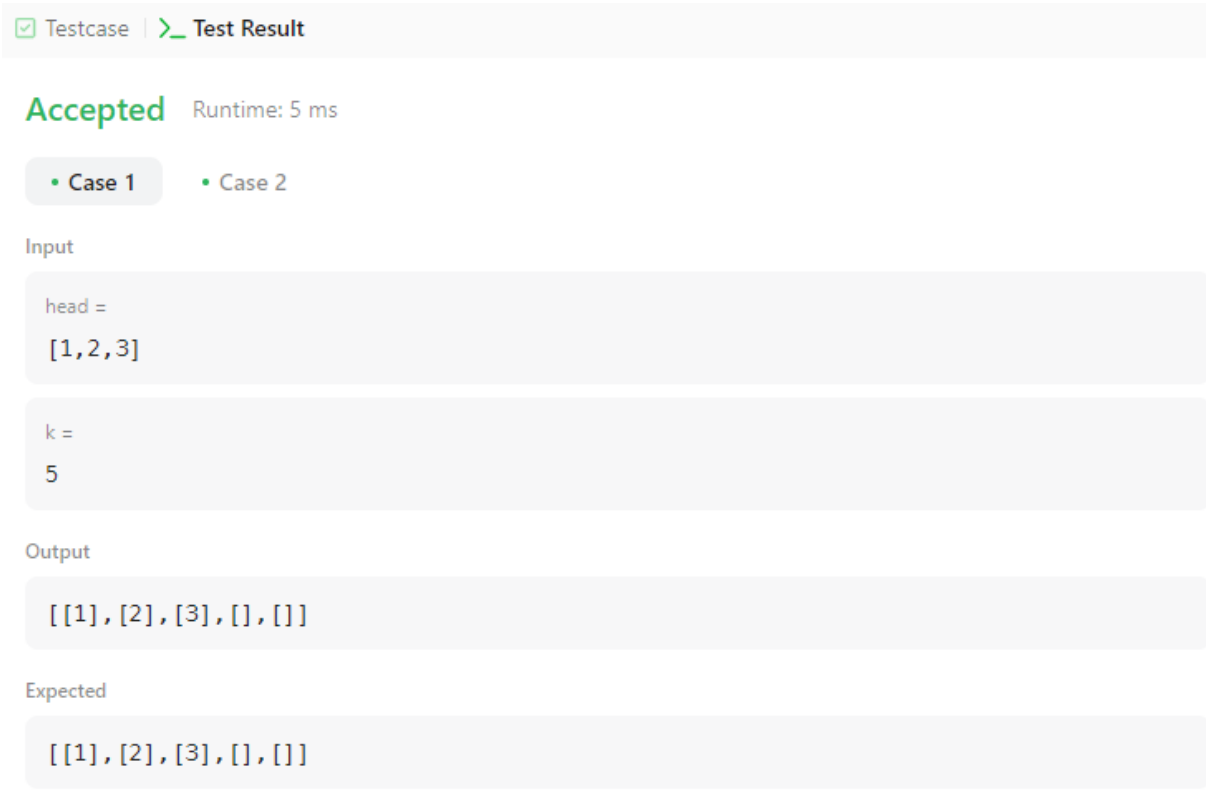
```
Press - 1.Insert
 2.Delete
 3.Display
Enter choice:1
Enter data:4
Node inserted
Enter choice:1
Enter data:5
Enter the position:1
Node inserted
Enter choice:3
5 -> 4 -> NULL
Enter choice:1
Enter data:6
Enter the position:2
Node inserted
Enter choice:3
5 -> 6 -> 4 -> NULL
Enter choice:2
Enter the value:5
Node deleted
Enter choice:3
6 -> 4 -> NULL
Enter choice:4
```

LEETCODE 3: Split list into parts

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
int findLength(struct ListNode *head) {
    int length = 0;
    while (head != NULL) {
        length++;
        head = head->next;
    }
    return length;
}
struct ListNode** splitListToParts(struct ListNode* head, int k, int* returnSize) {
    int length = findLength(head);
    int partSize = length / k;
    int extraNodes = length % k;
    struct ListNode **result = (struct ListNode **)malloc(k * sizeof(struct ListNode *));
    for (int i = 0; i < k; i++) {
        result[i] = head;
        int currentPartSize = partSize + (extraNodes-- > 0 ? 1 : 0);
        for (int j = 0; j < currentPartSize - 1; j++) {
            if (head != NULL) {
                head = head->next;
            }
        }
```

```
        if (head != NULL) {
            struct ListNode *temp = head;
            head = head->next;
            temp->next = NULL;
        }
    }
    *returnSize = k;
    return result;
}
```

OUTPUT:



Lab program 8:
Write a program
a) To construct a binary Search tree.
b) To traverse the tree using all the methods i.e., in-order, preorder and post order
c) To display the elements in the tree.

```
# include <stdio.h>
# include<stdlib.h>
struct node
{
        int data;
        struct node*left;
        struct node*right;
};
struct node*root=NULL;
void create()
{
        struct node*new_node = (struct node*)malloc(sizeof(struct node));
        int val;
        printf("Enter data:");
        scanf("%d",&val);
        new_node->data=val;
        new_node->left=NULL;
        new_node->right=NULL;
        if (root==NULL)
        {
                root=new_node;
        }
        else
        {
                struct node*ptr=root;
                struct node*ptr1=NULL;
                while(ptr!=NULL)
                {
                        ptr1=ptr;
                        if(val<ptr->data)
                        {
                                ptr=ptr->left;
                        }
                        else
                        {
                                ptr=ptr->right;
                        }
                }
```

```
                if(val<ptr1->data)
                        ptr1->left=new_node;
                else
                        ptr1->right=new_node;
        }
}
void postorder(struct node* ptr)
{
        if(ptr!=NULL)
        {
                postorder(ptr->left);
                postorder(ptr->right);
                printf("%d ",ptr->data);
        }
}
void preorder(struct node* ptr)
{
        if(ptr!=NULL)
        {
                printf("%d ",ptr->data);
                preorder(ptr->left);
                preorder(ptr->right);
        }
}
void inorder(struct node* ptr)
{
        if(ptr!=NULL)
        {
                inorder(ptr->left);
                printf("%d ",ptr->data);
                inorder(ptr->right);
        }
}
void main()
{
        int n;
        printf("Enter no of nodes to be inserted:");
        scanf("%d",&n);
        for(int i=0;i<n;i++)
        {
                create();
        }
        printf("\nInorder:\n");
        inorder(root);
```

```
        printf("\nPreorder:\n");
        preorder(root);
        printf("\nPostorder:\n");
        postorder(root);
}
```

OUTPUT:

```
Enter no of nodes to be inserted:5
Enter data:5
Enter data:7
Enter data:1
Enter data:3
Enter data:9

Inorder:
1 3 5 7 9
Preorder:
5 1 3 7 9
Postorder:
3 1 9 7 5
```

LEETCODE 4: Rotate list

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* rotateRight(struct ListNode* head, int k) {
   struct ListNode *ptr=head;
    int count=1;
    if(head == NULL || head->next==NULL ||k==0)
        return head;
    else
    {
        while(ptr->next!=NULL)
        {
            ptr=ptr->next;
            count++;
        }
        if(k%count==0)
            return head;
        ptr->next=head;
        for(int i=k%count ; i<count ; i++)
        {
            ptr=ptr->next;
        }
        head=ptr->next;
        ptr->next=NULL;
```

```
        return head;
    }
}
```

OUTPUT:

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

```
#include <stdio.h>
int a[20][20],q[20],visited[20],n,i,j,f=0,r=-1;
void bfs(int v)
{
	for(i=1; i<=n; i++)
	{
		if(a[v][i] && !visited[i])
			q[++r]=i;
	}
	if(f<=r)
	{
		visited[q[f]]=1;
		bfs(q[f++]);
	}
}
int main()
{
	int v;
	printf("\n Enter the number of vertices:");
	scanf("%d", &n);
	for(i=1; i<=n; i++)
	{
		q[i]=0;
		visited[i]=0;
	}
	printf("Enter graph data in matrix form:\n");
	for(i=1; i<=n; i++)
	{	for(j=1; j<=n; j++)
		{
			scanf("%d", &a[i][j]);
		}
	}
	printf("\n Enter the starting vertex:");
	scanf("%d", &v);
	bfs(v);
	printf("The nodes which are reachable are:\n");
	for(i=1; i<=n; i++)
	{
		if(visited[i])
		printf("%d\t", i);
	}
	return 0;
}
```

OUTPUT:

```
 Enter the number of vertices:4
Enter graph data in matrix form:
0 1 0 1
1 0 0 1
0 0 0 0
1 1 0 0

 Enter the starting vertex:1
The nodes which are reachable are:
1   2   4
```

9b) Write a program to check whether given graph is connected or not using DFS method.

```
#include <stdio.h>
int a[20][20], s[20], n;
void dfs(int v)
{
        int i;
        s[v]=1;
        for(i=1; i<=n; i++)
        {
                if(a[v][i] && !s[i])
                {
                        printf("\n %d->%d",v,i);
                        dfs(i);
                }
        }
}
int main()
{
        int i, j, count=0;
        printf("\n Enter 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);
        printf("\n");
        for(i=1; i<=n; i++)
        {
                if(s[i])
                        count++;
        }
        if(count==n)
                printf("Graph is connected");
        else
                printf("Graph is not connected");
        return 0;
}
```

OUTPUT:

```
 Enter number of vertices:4
Enter the adjacency matrix:
0 1 0 1
1 0 0 1
0 0 0 0
1 1 0 0

 1->2
 2->4
Graph is not connected
```

HACKER RANK: Swap nodes

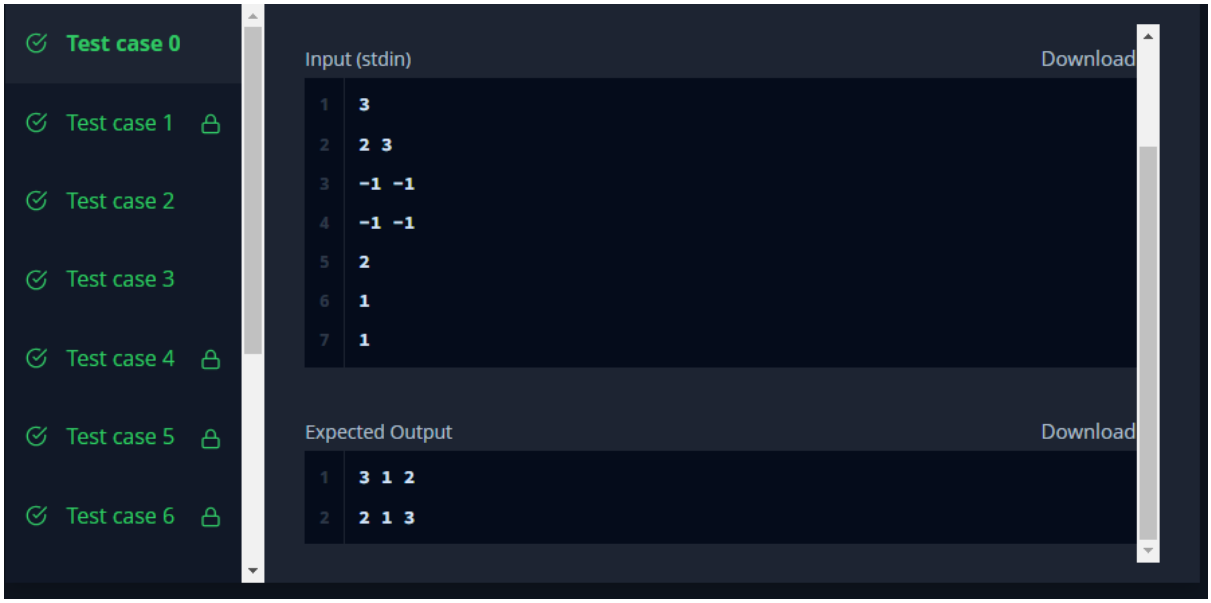
```
typedef struct TreeNode {
        int data;
        struct TreeNode* left;
        struct TreeNode* right;
} TreeNode;
void inOrderTraversal(TreeNode* root, int* result, int* index) {
        if (root == NULL)
                return;
        inOrderTraversal(root->left, result, index);
        result[(*index)++] = root->data;
        inOrderTraversal(root->right, result, index);
}
void swapSubtrees(TreeNode* root, int k, int depth) {
        if (root == NULL)
                return;
        if (depth % k == 0) {
                TreeNode* temp = root->left;
```

```
            root->left = root->right;
            root->right = temp;
        }
        swapSubtrees(root->left, k, depth + 1);
        swapSubtrees(root->right, k, depth + 1);
}
TreeNode* buildTree(int indexes_rows, int indexes_columns, int** indexes)
{
        TreeNode* root = (TreeNode*)malloc(sizeof(TreeNode));
        root->data = 1;
        root->left = NULL;
        root->right = NULL;
        TreeNode* nodes[indexes_rows + 1];
        nodes[1] = root;
        for (int i = 0; i < indexes_rows; i++)
        {
                TreeNode* curr = nodes[i + 1];
                if (indexes[i][0] != -1)
                {
                        curr->left = (TreeNode*)malloc(sizeof(TreeNode));
                        curr->left->data = indexes[i][0];
                        curr->left->left = NULL;
                        curr->left->right = NULL;
                        nodes[indexes[i][0]] = curr->left;
                }
                if (indexes[i][1] != -1)
                {
                        curr->right = (TreeNode*)malloc(sizeof(TreeNode));
                        curr->right->data = indexes[i][1];
                        curr->right->left = NULL;
                        curr->right->right = NULL;
                        nodes[indexes[i][1]] = curr->right;
                }
        }
        return root;
}

int** swapNodes(int indexes_rows, int indexes_columns, int** indexes, int queries_count,
int* queries, int* result_rows, int* result_columns)
{
        int** result = (int**)malloc(queries_count * sizeof(int*));
        *result_rows = queries_count;
        *result_columns = indexes_rows;
        TreeNode* root = buildTree(indexes_rows, indexes_columns, indexes);
        for (int i = 0; i < queries_count; i++)
        {
                int k = queries[i];
                swapSubtrees(root, k, 1);
                int* traversal = (int*)malloc(indexes_rows * sizeof(int));
                int index = 0;
```

```
            inOrderTraversal(root, traversal, &index);
            result[i] = traversal;
        }
        return result;
}
```

OUTPUT:



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.

```
#include <stdio.h>
#include <stdlib.h>
#define MAX_MEMORY_LOCATIONS 10
int hashTable[MAX_MEMORY_LOCATIONS] = {0};
int status[MAX_MEMORY_LOCATIONS] = {0};
void initializeHashTable(int size)
{
	for (int i=0; i < size; i++) {
		status[i]=0;
	}
}
int hashFunction(int key, int size) {
	return key%size;
}
int linearProbe(int hashValue, int attempt, int size)
{
	return ((hashValue + attempt)%size);
}
void insertEmployee(int size, int key)
{
	int hashValue = hashFunction (key, size);
	int index = hashValue;
	int attempt=1;
	while (status[index] == 1)
	{
		index = linearProbe(hashValue, attempt ,size);
		attempt ++;
	}
	hashTable[index] = key;
	status[index] = 1;
}
void displayHashTable(int size)
{
	printf("\n Hash Table: \n");
	printf("Index\tKey\n");
	for(int i=0;i<size;i++)
	{
		printf("%d\t",i);
		if(status[i]==1)
			printf("%d\n",hashTable[i]);
```

```
                else
                        printf("Empty\n");
        }
}
int main()
{
        int m=MAX_MEMORY_LOCATIONS;
        initializeHashTable(m);
        int n;
        printf("Enter the number of employees:");
        scanf("%d",&n);
        int key[n];
        printf("Enter the employee keys:\n");
        for(int i=0;i<n;i++)
        {
                printf("Employee %d: ",i+1);
                scanf("%d",&key[i]);
        }
        for(int i=0;i<n;i++)
        {
                insertEmployee(m,key[i]);
        }
        displayHashTable(m);
        return 0;
}
```

OUTPUT:

```
Enter the number of employees:6
Enter the employee keys:
Employee 1: 85
Employee 2: 56
Employee 3: 23
Employee 4: 35
Employee 5: 43
Employee 6: 11

 Hash Table:
Index   Key
0   Empty
1   11
2   Empty
3   23
4   43
5   85
6   56
7   35
8   Empty
9   Empty
```