

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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This is to certify that the Lab work entitled “**DATA STRUCTURES**” carried out by Varsha Prasanth(**1BM22CS321**), who is a bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2023-24. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab - (**23CS3PCDST**) work prescribed for the said degree.

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Index Sheet

Sl. No.	Experiment Title	Page No.
1	Stack Program	4-6
2	Infix Postfix Expression	7-10
3	Queue Program	11-15
4	Circular Queue	16-18
5	Singly Linked List	19-21
6	Deletion SLL	22-27
7	Sorting SLL,Reverse SLL,Concatenation SLL	28-32
8	Stack Implementation SLL	33-35
9	Queue Implementation SLL	36-39
10	Doubly Linked List	40-43
11	Binary Search Tree	44-46
12	BFS and DFS	47-49
13	Balanced Parentheses(LeetCode)	50
14	Deletion of Middle Node(LeetCode)	51-52
15	Odd Even Linked List(LeetCode)	53-54
16	Delete a node in BST(LeetCode)	55-56
17	Binary Left Tree Value(LeetCode)	57

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

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.

CODE

```
#include <stdio.h>
#include <stdlib.h>
#define size 5
void push(int);
void pop();
void display();
int stack[size], top=-1;
void main(){
    int op, n;
    printf("enter the operation\n 1.push\n 2.pop\n 3.display\n enter -1 to stop\n");
    while(1){
        scanf("%d", &op);
        if (op == -1){
            printf("stopping the operations\n");
            break;
        }
        else{
            switch(op){
                case 1: printf("enter the values\n");

                scanf("%d", &n);
                push(n);
                break;
                case 2: pop();
                break;
                case 3: display();
                break;
                default: printf("wrong choice\n");
            }
        }
    }
}

void push(int n){
    if(top == size-1){
        printf("stack overflow condition\n");
```

```

    }
    else{
        top++;
        stack[top]=n;
        printf("push operation is succesfull\n");
    }
}

void pop(){
    if(top==-1){
        printf("stack underflow condition\n");

    }
    else{
        printf("%d pop() operation successfull\n",stack[top]);
        top--;
    }
}

void display(){
    if(top==-1){
        printf("stack is empty");
    }
    else{
        for(int i=top;i>=0;i--){
            printf("%d\t", stack[i]);
        }
        printf("\n");
    }
}
}

```

OUTPUT

```
enter the operation
1.push
2.pop
3.display
enter -1 to stop
1
enter the values
10
push operation is succesfull
1
enter the values
20
push operation is succesfull
2
20 pop() operation successfull
3
10
-1
stopping the operations

Process returned 0 (0x0)    execution time : 23.158 s
Press any key to continue.
```

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)

CODE

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

char stack[100];
int top = -1,size;

void push(char item)
{
    if(top >= size-1)
    {
        printf("\nStack Overflow.");
    }
    else
    {
        top = top+1;
        stack[top] = item;
    }
}

char pop()
{
    char item ;
    if(top <0)
    {
        printf("\nStack Underflow\n");
    }
    else
    {
        item = stack[top];
        top = top-1;
        return(item);
    }
}

int is_operator(char symbol)
```

```

{
    if(symbol == '^' || symbol == '*' || symbol == '/' || symbol == '+' || symbol == '-')
    {
        return 1;
    }
    else
    {
        return 0;
    }
}
int precedence(char symbol)
{
    if(symbol == '^')
    {
        return(3);
    }
    else if(symbol == '*' || symbol == '/')
    {
        return(2);
    }
    else if(symbol == '+' || symbol == '-')
    {
        return(1);
    }
    else
    {
        return(0);
    }
}

```

```

void InfixToPostfix(char infix_exp[], char postfix_exp[])
{
    int i, j;
    char item;
    char x;

    push('(');
    strcat(infix_exp, "(");

    i=0;
    j=0;
    item=infix_exp[i];

```



```

while(item != '\0')
{
    if(item == '(')
    {
        push(item);
    }
    else if( isdigit(item) || isalpha(item))
    {
        postfix_exp[j] = item;
        j++;
    }
    else if(is_operator(item) == 1)
    {
        x=pop();
        while(is_operator(x) == 1 && precedence(x)>= precedence(item))
        {
            postfix_exp[j] = x;
            j++;
            x = pop();
        }
        push(x);

        push(item);
    }
    else if(item == ')')
    {
        x = pop();
        while(x != '(')
        {
            postfix_exp[j] = x;
            j++;
            x = pop();
        }
    }
    else
    {
        printf("\nInvalid infix Expression.\n");
        exit(1);
    }
    i++;
    item = infix_exp[i];
}
postfix_exp[j] = '\0';

```

```

}
main()
{
    char infix[100], postfix[100];
    printf("\nEnter size of stack");
    scanf("%d",&size);
    printf("Assume the infix expression contains single letter variables and single digit
constants only.\n");
    printf("\nEnter Infix expression : ");
    scanf(" %s",infix);
    InfixToPostfix(infix,postfix);
    printf("Postfix Expression: ");
    printf("%s",postfix);
}

```

OUTPUT

```

Enter size of stack 3
Assume the infix expression contains single letter variables and single digit constants only.

Enter Infix expression : 2a+6b+m*k-k
Postfix Expression: 2a6b+mk*+k-
Process returned 0 (0x0)   execution time : 41.382 s
Press any key to continue.

```

LAB PROGRAM 3

write a program to simulate the working of the queue of integers using an array. Provide the following operations: Insert, delete, display. The program should print appropriate message for overflow and underflow condition

CODE

```
#include<stdio.h>
#include<conio.h>
#define MAX 3
int queue[MAX];
int front=-1,rear=-1;
void insert(void);
int delete_element(void);
int peek(void);
void display(void);
int main()
{
    int option,val;
    do
    {
        printf("\n\n****MAIN MENU****");
        printf("\n 1.Insert an element");
        printf("\n 2.Delete an element");
        printf("\n 3.Peek");
        printf("\n 4.Display the queue");
        printf("\n 5.Exit");
        printf("\n Enter your option:");
        scanf("%d",&option);
        switch(option)
        {
            case 1:
                insert();
                break;
            case 2:
                val=delete_element();
                if(val!=-1)
                    printf("\n The number deleted is :%d",val);
                break;
```

```

        case 3:
            val=peek();
            if(val!=-1)
                printf("\n The first value in queue is:%d",val);
            break;
        case 4:
            display();
            break;
    }
}while(option!=5);
getch();
return 0;
}
void insert()
{
    int num;
    printf("\n Enter the number to be inserted in the queue:");
    scanf("%d",&num);
    if(rear==MAX-1)
        printf("\n OVERFLOW");
    else if(front==-1 &&rear==-1)
        front=rear=0;
    else
        rear++;
    queue[rear]=num;
}
int delete_element()
{
    int val;
    if(front==-1||front>rear)
    {
        printf("\n UNDERFLOW");
        return -1;
    }
    else
    {
        val=queue[front];
        front++;
        if(front>rear)
            front=rear=-1;
        return val;
    }
}
}

```

```

int peek()
{
    if(front==-1||front>rear)
    {
        printf("\n QUEUE IS EMPTY");
        return -1;
    }
    else
    {
        return queue[front];
    }
}

void display()
{
    int i;
    printf("\n");
    if(front==-1||front>rear)
        printf("\n QUEUE IS EMPTY");
    else
    {
        for(i=front;i<=rear;i++)
            printf("\t %d",queue[i]);
    }
}

```

OUTPUT

```
****MAIN MENU****
1.Insert an element
2.Delete an element
3.Peek
4.Display the queue
5.Exit
Enter your option:4

QUEUE IS EMPTY

****MAIN MENU****
1.Insert an element
2.Delete an element
3.Peek
4.Display the queue
5.Exit
Enter your option:2

UNDERFLOW

****MAIN MENU****
1.Insert an element
2.Delete an element
3.Peek
4.Display the queue
5.Exit
Enter your option:1

Enter the number to be inserted in the queue:10

****MAIN MENU****
1.Insert an element
2.Delete an element
3.Peek
4.Display the queue
5.Exit
Enter your option:1

Enter the number to be inserted in the queue:20

****MAIN MENU****
1.Insert an element
2.Delete an element
3.Peek
4.Display the queue
5.Exit
Enter your option:1

Enter the number to be inserted in the queue:30
```

Enter your option:1

Enter the number to be inserted in the queue:40

OVERFLOW

****MAIN MENU****

- 1.Insert an element
- 2.Delete an element
- 3.Peek
- 4.Display the queue
- 5.Exit

Enter your option:2

The number deleted is :10

****MAIN MENU****

- 1.Insert an element
- 2.Delete an element
- 3.Peek
- 4.Display the queue
- 5.Exit

Enter your option:2

The number deleted is :20

****MAIN MENU****

- 1.Insert an element
- 2.Delete an element
- 3.Peek
- 4.Display the queue
- 5.Exit

Enter your option:3

The first value in queue is:40

****MAIN MENU****

- 1.Insert an element
- 2.Delete an element
- 3.Peek
- 4.Display the queue
- 5.Exit

Enter your option:4

40

****MAIN MENU****

- 1.Insert an element
- 2.Delete an element
- 3.Peek
- 4.Display the queue
- 5.Exit

Enter your option:5

Process returned 0 (0x0) execution time : 79.289 s

Press any key to continue.

LAB PROGRAM 4

write a program to simulate the working of a circular queue using an array. Provide the following operations: insert, delete & display. The program should print appropriate message for queue empty and queue overflow conditions.

CODE

```
#include<stdio.h>
#include<conio.h>
#include<process.h>
#define QUE_SIZE 3
int item,front=0,rear=-1,q[QUE_SIZE],count=0; void insertrear()
{
if(count==QUE_SIZE)
{
printf("queue overflow\n");
return;
}
rear=(rear+1)%QUE_SIZE;
q[rear]=item;
count++;
}
int deletefront()
{
if(count==0) return -1; item=q[front]; front=(front+1)%QUE_SIZE; count=count-1;
return item;
}
void displayQ() {
int i,f;
if(count==0)
{
printf("queue is empty\n"); return;
}
f=front;
printf("Contents of queue \n"); for(i=1;i<=count;i++)
{
printf("%d\n",q[f]); f=(f+1)%QUE_SIZE;
```



```

}
}
void main()
{
int choice;
for(;;)
{ printf("\n1:insertrear\n2:deletefront\n3:display\n4:exit\n"); printf("enter the choice\n");
scanf("%d",&choice);
switch(choice)
{
case 1:printf("enter the item to be inserted\n");
scanf("%d",&item); insertrear();
break;
case 2:item=deletefront(); if(item== -1)
printf("queue is empty\n");
else
printf("item deleted =%d\n",item); break;
case 3:displayQ(); break;
default:exit(0); }
} getch();

}

```

OUTPUT

```
1:insertrear
2:deletefront
3:display
4:exit
enter the choice
1
enter the item to be inserted
10

1:insertrear
2:deletefront
3:display
4:exit
enter the choice
1
enter the item to be inserted
20

1:insertrear
2:deletefront
3:display
4:exit
enter the choice
1
enter the item to be inserted
30

1:insertrear
2:deletefront
3:display
4:exit
enter the choice
2
item deleted =10

1:insertrear
2:deletefront
3:display
4:exit
enter the choice
3
Contents of queue
20
30

1:insertrear
2:deletefront
3:display
4:exit
enter the choice
4

Process returned 0 (0x0)   execution time : 23.786 s
Press any key to continue.
```

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, at any position and at end of list.

Display the contents of the linked list.

CODE

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
int data;
struct node *next;
};
void printData(struct node *head)
{
if(head==NULL)
{
printf("The list is empty");
}else{
struct node *ptr=head;
while(ptr!=NULL)
{
printf("%d\n",ptr->data);
ptr=ptr->next;
}}
}
void insertBeg(struct node **head,int value)
{
struct node *temp=(struct node*)malloc(sizeof(struct node));
temp->data=value;
temp->next=*head;
*head=temp;
}
```

```

void insertEnd(struct node*head, int value)
{
    struct node *ptr=head;
    struct node *temp=(struct node*)malloc(sizeof(struct node));
    temp->data=value;
    temp->next=NULL;
    while(ptr->next!=NULL){
        ptr=ptr->next;
    }
    ptr->next=temp;
}

void insertAtPos(struct node *head,int value,int pos)
{
    struct node *ptr,*ptr2;
    struct node *temp=(struct node*)malloc(sizeof(struct node));
    temp->data=value;
    temp->next=NULL;
    int position=pos;
    ptr=head;
    while(pos!=1)
    {
        ptr2=ptr;
        ptr=ptr->next;
        pos--;
    }
    temp->next=ptr2->next;
    ptr2->next=temp;
    printf("value %d added succuessful at %d\n",value,position);
}

int main()
{
    struct node *head=NULL;
    insertBeg(&head,34);
    printData(head);
    printf("-----\n");
    insertEnd(head,75);
    insertEnd(head,56);
    insertEnd(head,87);
    printData(head);
    printf("-----\n");
    insertAtPos(head,89,3);
    printData(head);
}

```

OUTPUT

```
34
-----
34
75
56
87
-----
value 89 added succuessful at 3
34
75
89
56
87

Process returned 0 (0x0)   execution time : 0.068 s
Press any key to continue.
|
```

LAB PROGRAM 6

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.

CODE

```
#include<stdio.h>

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

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

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

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

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

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

```

}

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

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

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

```

```

    nextnode=temp->next;
    temp->next=nextnode->next;
    free(nextnode);
}

void main()
{
    int choice;

    while(1)
    {
        printf("Enter operation:\n1.create\n2.display\n3.delete at beginnning\n4.delete at
end\n5.delete at position\n6.-1 to end\n");
        scanf("%d",&choice);

        if(choice==--1)
        {
            printf("operation completed!\n");
            break;
        }
        else
        {
            switch(choice)
            {
                case 1:create();
                break;
                case 2:display();
                break;
                case 3:delete_beg();
                break;
                case 4:delete_end();
                break;
                case 5:delete_pos();
                break;
                default:printf("invalid output\n");
            }
        }
    }
}

```


OUTPUT

```
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end

1
enter the number of elements:
4
Enter the element 1:
10
Enter the element 2:
20
Enter the element 3:
30
Enter the element 4:
40
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end

2
The elements are:
10
20
30
40
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end

3
```

```
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end
2
The elements are:
20
30
40
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end

3
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end
2
The elements are:
30
40
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
```

```
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end
5
enter the position:
2
Enter operation:
1.create
2.display
3.delete at beginnning
4.delete at end
5.delete at position
6.-1 to end
-1
```

LAB PROGRAM 7

All-sort,reverse,concatenation.

CODE

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

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

void append(struct node **head, int new_data)
{
    struct node *new_node = (struct node *)malloc(sizeof(struct node));

    new_node->data = new_data;
    new_node->next = NULL;
    struct node *last = *head;

    if (*head == NULL)
        *head = new_node;
    else
    {
        while (last->next != NULL)
            last = last->next;

        last->next = new_node;
    }
}

void display(struct node *head)
{
    if (head == NULL)
    {
        printf("Linked List empty.\n");
        return;
    }
    printf("Linked List:");
    while (head != NULL)
    {
```

```

        printf("%d ", head->data);
        head = head->next;
    }
    printf("\n");
}

```

```

void bubble_sort(struct node *head)
{
    struct node *prev;
    struct node *cur;
    int nex;
    int flag = 1;
    int flag2 = 1;

    while (flag)
    {
        prev = head;
        while (prev != NULL && prev->next != NULL)
        {
            cur = prev->next;

            if (cur->data < prev->data)
            {
                nex = cur->data;
                cur->data = prev->data;
                prev->data = nex;
            }

            prev = prev->next;
        }

        int max = 0;
        prev = head;

        while (prev != NULL)
        {
            if (max > prev->data)
            {
                flag2 = 0;
                break;
            }
            max = prev->data;
        }
    }
}

```

```

        prev = prev->next;
    }

    if (flag2)
        flag = 0;
    else
        flag2 = 1;
    }
}

```

```

void reverse(struct node **head)
{
    struct node *prev = NULL;
    struct node *current = *head;
    struct node *next = NULL;

    while (current != NULL)
    {
        next = current->next;
        current->next = prev;

        prev = current;
        current = next;
    }

    *head = prev;
}

```

```

void concat(struct node *head1, struct node *head2){
    struct node *prev=head2;

    while(prev!=NULL){
        append(&head1,prev->data);
        prev=prev->next;
    }
}

```

```

int main()
{
    struct node *head=NULL;
    int choice;
    append(&head,5);
}

```

```

append(&head,2);
append(&head,3);
append(&head,4);
append(&head,1);
append(&head,6);
struct node *head2=NULL;

while (1)
{
    printf("-----\n");
    printf("1.Bubble Sort\n2.Reverse\n3.Concat\nChoice:");
    scanf("%d",&choice);
    printf("-----\n");
    switch (choice)
    {
        case 1:bubble_sort(head);
            display(head);

            break;
        case 2: reverse(&head);
            display(head);
            break;

        case 3:
            append(&head2,76);
            append(&head2,43);
            append(&head2,34);

            concat(head,head2);
            display(head);
            break;

    }
}
return 0;
}

```


OUTPUT

```
-----  
1.Bubble Sort  
2.Reverse  
3.Concat  
Choice:1  
-----  
Linked List:1 2 3 4 5 6  
-----  
1.Bubble Sort  
2.Reverse  
3.Concat  
Choice:2  
-----  
Linked List:6 5 4 3 2 1  
-----  
1.Bubble Sort  
2.Reverse  
3.Concat  
Choice:3  
-----  
Linked List:6 5 4 3 2 1 76 43 34  
-----  
1.Bubble Sort  
2.Reverse  
3.Concat  
Choice:|
```

LAB PROGRAM 8

Stack implementation using single linked list

CODE

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

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

void append(struct node** head, int new_data) {
    struct node* new_node = (struct node*)malloc(sizeof(struct node));

    new_node->data = new_data;
    new_node->next = NULL;
    struct node* last = *head;

    if (*head == NULL)
        *head = new_node;
    else {
        while (last->next != NULL)
            last = last->next;

        last->next = new_node;
    }
}

void display(struct node* head) {
    if (head == NULL) {
        printf("Linked List empty.\n");
        return;
    }
    printf("Stack:");
    while (head != NULL) {
        printf("%d ", head->data);
        head = head->next;
    }
    printf("\n");
}
```

```

void del_end(struct node *head){
    if(head==NULL){
        printf("List Empty\n");
        return;
    }
    struct node *last=head;

    struct node *prev;
    while(last->next!=NULL){
        prev=last;
        last=last->next;
    }
    free(last);
    prev->next=NULL;
}

int main() {
    struct node* head = NULL;

    int choice,a;

    while(choice<4){
        printf("1.Push\n2.Pop\n3.Display\nChoice:");
        scanf("%d",&choice);
        switch (choice)
        {
            case 1:
                printf("Enter value:");
                scanf("%d",&a);
                append(&head,a);
                display(head);
                break;
            case 2:
                del_end(head);
                display(head);
                break;
            case 3:
                display(head);

```

```
        default:
            break;
    }
}

return 0;
}
```

OUTPUT

```
1.Push
2.Pop
3.Display
Choice:1
Enter value:10
Stack:10
1.Push
2.Pop
3.Display
Choice:1
Enter value:20
Stack:10 20
1.Push
2.Pop
3.Display
Choice:2
Stack:10
1.Push
2.Pop
3.Display
Choice:3
Stack:10
1.Push
2.Pop
3.Display
Choice:|
```

LAB PROGRAM 8

Queue implementation using single linked list

CODE

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

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

struct Queue {
    struct Node* front;
    struct Node* rear;
};

struct Node* createNode(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;
    return newNode;
}

struct Queue* initializeQueue() {
    struct Queue* queue = (struct Queue*)malloc(sizeof(struct Queue));
    if (queue == NULL) {
        printf("Memory allocation failed.\n");
        exit(EXIT_FAILURE);
    }
    queue->front = queue->rear = NULL;
    return queue;
}

void enqueue(struct Queue* queue, int data) {
    struct Node* newNode = createNode(data);

    if (queue->rear == NULL) {
        queue->front = queue->rear = newNode;
        return;
    }

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

```

void dequeue(struct Queue* queue) {
    if (queue->front == NULL) {
        printf("Queue underflow. Cannot dequeue.\n");
        return;
    }

```

```

    struct Node* temp = queue->front;
    queue->front = queue->front->next;

```

```

    if (queue->front == NULL) {
        queue->rear = NULL;
    }

```

```

    free(temp);
}

```

```

void displayQueue(struct Queue* queue) {
    if (queue->front == NULL) {
        printf("Queue is empty.\n");
        return;
    }

```

```

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

```

```

void freeQueue(struct Queue* queue) {
    while (queue->front != NULL) {
        struct Node* temp = queue->front;
        queue->front = queue->front->next;
        free(temp);
    }
    free(queue);
}

```

```

int main() {
    struct Queue* queue = initializeQueue();
    int choice, data;

```

```

    do {
        printf("\nMenu:\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 data to enqueue: ");
scanf("%d", &data);
enqueue(queue, data);
break;

case 2:
dequeue(queue);
break;

case 3:
displayQueue(queue);
break;

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

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

} while (choice != 4);

freeQueue(queue);

return 0;
}

```

OUTPUT

```
Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter data to enqueue: 10
```

```
Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter data to enqueue: 20
```

```
Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter data to enqueue: 30
```

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

```
Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue: 20 30
```

```
Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 4
Exiting the program.
```

```
Process returned 0 (0x0)   execution time : 20.029 s
Press any key to continue.
```


LAB PROGRAM 9

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

CODE

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

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

node* head = NULL;
int count = 0;

void insert(int data, int position);
void delete(int element);
void display();

int main(){
    int data, choice, pos;
    printf("1. Insert\n2. Delete\n3. Exit\nChoice: ");
    scanf("%d", &choice);
    while(choice != 3){
        if (choice == 1){
            printf("Enter data and position: ");
            scanf("%d%d", &data, &pos);
            insert(data, pos);
            printf("Count: %d\n", count);
        } else if (choice == 2){
            printf("Enter element: ");
            scanf("%d", &pos);
            delete(pos);
            printf("Count: %d\n", count);
        }
        display();
        printf("Enter choice: ");
        scanf("%d", &choice);
    }

    return 0;
}

void insert(int data, int position){
```

```

if (position == 0){
    node* new_node = malloc(sizeof(node));
    new_node->data = data;
    new_node->next = head;
    new_node->prev = NULL;
    if (head != NULL) head->prev = new_node;
    head = new_node;
    count++;
    return;
} else if (position == count){
    node* new_node = malloc(sizeof(node));
    new_node->data = data;
    new_node->next = NULL;
    node* temp = head;
    while(temp->next != NULL)
        temp = temp->next;
    temp->next = new_node;
    new_node->prev = temp;
    count++;
    return;
} else if (position > count || position < 0){
    printf("Unable to insert at given position\n");
    return;
} else {
    node* temp = head;
    for(int i = 0; i < position-1; i++)
        temp = temp->next;
    node* new_node = malloc(sizeof(node));
    new_node->data = data;
    new_node->next = temp->next;
    new_node->prev = temp;
    temp->next->prev = new_node;
    temp->next = new_node;
    count++;
    return;
}
}

void delete(int element){
    int position = 0; node *temp = head;
    if (head == NULL){
        printf("List is empty, cannot delete"); return;
    }
    for(; position < count; temp=temp->next, position++)
        if (temp->data == element) break;
    if (temp == NULL){
        printf("Element does not exist in list"); return;
    }
    if (position == 0){
        node* temp = head;
        temp = temp->next;

```

```

    temp->prev = NULL;
    free(head);
    head = temp;
    count--;
    return;
} else if (position == count-1){
    node* temp = head;
    for(int i = 1; i < count-1; i++)
        temp = temp->next;
    node* temp1 = temp->next;
    temp->next = NULL;
    free(temp1);
    count--;
    return;
} else if (position > count || position < 0){
    printf("Unable to delete at position\n");
    return;
} else {
    node* temp = head;
    for(int i = 0; i < position; i++)
        temp = temp->next;
    temp->next->prev = temp->prev;
    temp->prev->next = temp->next;
    free(temp);
    count--;
    return;
}
}

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

```

OUTPUT

```
1. Insert
2. Delete
3. Exit
Choice: 1
Enter data and position: 10 0
Count: 1
Linked List: 10
Enter choice: 1
Enter data and position: 20 1
Count: 2
Linked List: 10 20
Enter choice: 2
Enter element: 10
Count: 1
Linked List: 20
Enter choice:
```

LAB PROGRAM 10

Tree Program(inorder, postorder, preorder)

CODE

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

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

node *root = NULL;

void insert(node **root, int data);
void preorder(node **root);
void postorder(node **root);
void inorder(node **root);

int main(){
    int choice, data;
    insert(&root, 8);
    insert(&root, 3);
    insert(&root, 1);
    insert(&root, 6);
    insert(&root, 4);
    insert(&root, 7);
    insert(&root, 10);
    insert(&root, 14);
    insert(&root, 13);
    printf("1. Preorder\n2. Inorder\n3. Postorder\n4. Exit\nChoice: ");
    scanf("%d", &choice);
    while (choice != 4){
        if (choice == 1){
            preorder(&root);
            printf("\n");
        } else if (choice == 2){
            inorder(&root);
            printf("\n");
        } else if (choice == 3){
```

```

        postorder(&root);
        printf("\n");
    }
    printf("Enter choice: ");
    scanf("%d", &choice);
}
}

```

```

void insert(node **root, int data){
    if (*root == NULL) {
        node *new_node = malloc(sizeof(node));
        new_node->data = data;
        new_node->right = NULL;
        new_node->left = NULL;
        *root = new_node;
        return;
    }
    if (data < (*root)->data){
        insert(&((*root)->left), data);
    } else if (data > (*root)->data){
        insert(&((*root)->right), data);
    }
    return;
}

```

```

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

```

```

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

```

```

void inorder(node **root){

```

```
if (*root != NULL) {  
    inorder(&(*root)->left);  
    printf("%d ", (*root)->data);  
    inorder(&(*root)->right);  
}  
}
```

OUTPUT

```
1. Preorder  
2. Inorder  
3. Postorder  
4. Exit  
Choice: 1  
8 3 1 6 4 7 10 14 13  
Enter choice: 2  
1 3 4 6 7 8 10 13 14  
Enter choice: 3  
1 4 7 6 3 13 14 10 8  
Enter choice: 4  
  
Process returned 0 (0x0)   execution time : 14.294 s  
Press any key to continue.  
|
```

LAB PROGRAM 11

BFS & DFS

CODE

```
#include <stdio.h>
#include <stdlib.h>
#define MAX_SIZE 100
struct Node {
    int data;
    struct Node* next;
};
struct Graph {
    int numVertices;
    struct Node** adjLists;
    int* visited;
};
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = NULL;
    return newNode;
}
struct Graph* createGraph(int numVertices) {
    struct Graph* graph = (struct Graph*)malloc(sizeof(struct Graph));
    graph->numVertices = numVertices;
    graph->adjLists = (struct Node**)malloc(numVertices * sizeof(struct Node));
    graph->visited = (int*)malloc(numVertices * sizeof(int));
    for (int i = 0; i < numVertices; i++) {
        graph->adjLists[i] = NULL;
        graph->visited[i] = 0;
    }
    return graph;
}
void addEdge(struct Graph* graph, int src, int dest) {
    struct Node* newNode = createNode(dest);
    newNode->next = graph->adjLists[src];
    graph->adjLists[src] = newNode;
    newNode = createNode(src);
    newNode->next = graph->adjLists[dest];
    graph->adjLists[dest] = newNode;
}
```



```

void BFS(struct Graph* graph, int startVertex) {
int queue[MAX_SIZE];
int front = -1, rear = -1;
graph->visited[startVertex] = 1;
queue[++rear] = startVertex;
while (front != rear) {
int currentVertex = queue[++front];
printf("%d ", currentVertex);
struct Node* temp = graph->adjLists[currentVertex];
while (temp) {
int adjVertex = temp->data;
if(graph->visited[adjVertex] == 0) {
graph->visited[adjVertex] = 1;
queue[++rear] = adjVertex;
}
temp = temp->next;
}
}
}

void DFS(struct Graph* graph, int vertex) {
graph->visited[vertex] = 1;
printf("%d ", vertex);
struct Node* temp = graph->adjLists[vertex];
while (temp) {
int adjVertex = temp->data;
if (graph->visited[adjVertex] == 0) {
DFS(graph, adjVertex);
}
temp = temp->next;
}
}

int main(){
struct Graph* graph = createGraph(4);
addEdge(graph, 0, 1);
addEdge(graph, 0, 2);
addEdge(graph, 1, 2);
addEdge(graph, 2, 3);
printf("BFS\n");
BFS(graph, 0);
for (int i = 0; i < graph->numVertices; i++){
graph->visited[i] = 0;
}
}

```

```
printf("\nDFS\n");  
DFS(graph, 0);  
return 0;  
}
```

OUTPUT

```
BFS  
0 2 1 3  
DFS  
0 2 3 1  
Process returned 0 (0x0)    execution time : 0.031 s  
Press any key to continue.
```

LAB PROGRAM 12

Balanced Parentheses(LeetCode)

CODE

```
#include <stdio.h>
#include <string.h>
int scoreOfParentheses(char *s)
{
    int stack[50];
    int top = -1;
    int score = 0;
    for (int i = 0; s[i] != '\0'; i++)
    {
        if (s[i] == '(')
        {
            stack[++top] = score;
            score = 0;
        }
        else
        {
            score = stack[top--] + (score == 0 ? 1 : 2 * score);
        }
    }
    return score;
}
```

OUTPUT

Accepted Runtime: 0 ms

• Case 1 • Case 2 • Case 3

Input

```
s =  
"()"
```

Output

```
1
```

Expected

```
1
```

LAB PROGRAM 13

Delete the Middle Node of a Linked List(LeetCode)

CODE

```
struct Node {  
    int data;  
    struct Node* next;  
};  
  
struct Node* deleteMiddle(struct Node* head) {  
    if (head == NULL)  
        return NULL;  
    if (head->next == NULL) {  
        free(head);  
        return NULL;  
    }  
  
    struct Node* slow_ptr = head;  
    struct Node* fast_ptr = head;  
    struct Node* prev;
```

```

while (fast_ptr != NULL && fast_ptr->next != NULL) {
    fast_ptr = fast_ptr->next->next;
    prev = slow_ptr;
    slow_ptr = slow_ptr->next;
}

prev->next = slow_ptr->next;
free(slow_ptr);

return head;
}

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

```

OUTPUT

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]

LAB PROGRAM 14

Odd Even Linked List

CODE

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

struct ListNode {
    int val;
    struct ListNode *next;
};

struct ListNode* oddEvenList(struct ListNode* head) {
    if (head == NULL || head->next == NULL || head->next->next == NULL)
        return head;

    struct ListNode *odd = head;
    struct ListNode *even = head->next;
    struct ListNode *evenHead = even;

    while (even != NULL && even->next != NULL) {
        odd->next = even->next;
        odd = odd->next;
        even->next = odd->next;
        even = even->next;
    }

    odd->next = evenHead;
    return head;
}
```

```
}  
struct ListNode* newNode(int val)  
{  
    struct ListNode* node = (struct ListNode*)malloc(sizeof(struct ListNode));  
    node->val = val;  
    node->next = NULL;  
    return node;  
}
```

OUTPUT

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]

LAB PROGRAM 15

Delete a node in BST .

CODE

```
struct TreeNode* minValueNode(struct TreeNode* node)
{
    struct TreeNode* current = node;
    while (current && current->left != NULL)
        current = current->left;
    return current;
}

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



```
root->val = temp->val;  
root->right = deleteNode(root->right, temp->val);  
}  
return root;  
}
```

OUTPUT

Accepted Runtime: 3 ms

- Case 1
- Case 2
- Case 3

Input

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

key =
3

Output

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

LAB PROGRAM 16

Bottom Left Tree Value.

CODE

```
void findBottomLeft(struct TreeNode* node, int depth, int* maxDepth, int* leftmostValue) {
    if (node == NULL)
        return;

    if (depth > *maxDepth) {
        *maxDepth = depth;
        *leftmostValue = node->val;
    }


    findBottomLeft(node->left, depth + 1, maxDepth, leftmostValue);
    findBottomLeft(node->right, depth + 1, maxDepth, leftmostValue);
}

int findBottomLeftValue(struct TreeNode* root) {
    int maxDepth = 0;
    int leftmostValue = root->val;

    findBottomLeft(root, 1, &maxDepth, &leftmostValue);

    return leftmostValue;
}
```

OUTPUT

Accepted Runtime: 3 ms 

• Case 1

• Case 2

Input

root =
[2,1,3]

Output

1

Expected

1