

# **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  
(Autonomous Institution under VTU)**

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Department of Computer Science and Engineering**



This is to certify that the Lab work entitled “**DATA STRUCTURES**” carried out by **Arnav Dinesh (1BM23CS052)**, 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 2024-25. 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:

```

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:

**Program to convert a given valid parenthesized infix arithmetic expression to postfix expression.**

```
#include <stdio.h>
#define STACK_SIZE 15

void push(char s[], int *top, char item) {
    (*top)++;
    s[*top] = item;
}

char pop(char s[], int *top) {
    return s[(--)*top];
}

int pr(char op) {
    switch(op) {
        case '#': return 0;
        case '(': return 1;
        case '+': return 2;
        case '-': return 2;
        case '*': return 3;
        case '/': return 3;
        default: return 0;
    }
}

int main() {
    char s[STACK_SIZE];
    int top = -1;
    char str[30], postfix[30];
    int i = 0, j = 0;

    push(s, &top, '#');
    printf("Enter infix expression: ");
    scanf("%s", str);

    while (str[i] != '\0') {
        if (str[i] != '+' && str[i] != '-' && str[i] != '*' && str[i] != '/' && str[i] != '(' && str[i] != ')') {
            postfix[j++] = str[i];
        } else if (str[i] == '(') {
            push(s, &top, str[i]);
        } else if (str[i] == ')') {
            while (s[top] != '(') {
                postfix[j++] = s[top--];
            }
            s[top--] = '\0';
        }
        i++;
    }
    postfix[j] = '\0';
    printf("Postfix expression: %s\n", postfix);
}
```

```

        postfix[j++] = pop(s, &top);
    }
    pop(s, &top);
} else {
    while (pr(str[i]) <= pr(s[top])) {
        postfix[j++] = pop(s, &top);
    }
    push(s, &top, str[i]);
}
i++;
}

while (top > 0) {
    postfix[j++] = pop(s, &top);
}

postfix[j] = '\0';
printf("Postfix expression: %s\n", postfix);
return 0;
}

```

Output:

```

enter infix expression:A*B+C*D-E
the postfix expression is: AB*CD*+E-

```



### Lab program 3:

#### Program to simulate the working of a queue

```
#include <stdio.h>
#define QUEUE_SIZE 5

void insert(int q[], int item, int *rear) {
    if (*rear == QUEUE_SIZE - 1) {
        printf("Queue overflow.\n");
        return;
    }
    (*rear)++;
    q[*rear] = item;
}

int delete(int q[], int *front, int rear) {
    if (*front > rear) {
        printf("Queue is empty.\n");
        return -1;
    }
    int del = q[*front];
    (*front)++;
    return del;
}

void display(int q[], int front, int rear) {
    if (front > rear) {
        printf("Queue is empty.\n");
        return;
    }
    printf("Queue elements: ");
    for (int i = front; i <= rear; i++) {
        printf("%d ", q[i]);
    }
    printf("\n");
}

void main() {
    int q[QUEUE_SIZE];
```

```

int front = 0, rear = -1, item, del, choice;

while (1) {
    printf("\nEnter choice: 1) insert 2) delete 3) display 4) exit: ");
    scanf("%d", &choice);
    switch (choice) {
        case 1: {
            printf("Enter item to be inserted: ");
            scanf("%d", &item);
            insert(q, item, &rear);
            break;
        }
        case 2: {
            del = delete(q, &front, rear);
            if (del != -1) {
                printf("Item deleted: %d\n", del);
            }
            break;
        }
        case 3: {
            display(q, front, rear);
            break;
        }
        case 4: {
            return;
        }
        default: {
            printf("Invalid choice.\n");
            break;
        }
    }
}
}

```

```

Enter choice: 1) insert 2) delete 3) display 4) exit: 1
Enter item to be inserted: 1

Enter choice: 1) insert 2) delete 3) display 4) exit: 1
Enter item to be inserted: 2

Enter choice: 1) insert 2) delete 3) display 4) exit: 1
Enter item to be inserted: 3

Enter choice: 1) insert 2) delete 3) display 4) exit: 2
Item deleted: 1

Enter choice: 1) insert 2) delete 3) display 4) exit: 2
Item deleted: 2

Enter choice: 1) insert 2) delete 3) display 4) exit: 3
Queue elements: 3

Enter choice: 1) insert 2) delete 3) display 4) exit: █

```

Leet code -1  
Clear digits problem

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <ctype.h>
#include <stdbool.h>
#define size 100
char arr[size],top=-1,item,ch;
```

```
void push(char item){
    if(top==size-1){

        return;
    }
    top+=1;
    arr[top]=item;
}
```

```
char pop(){
    if(top==-1){

        return '\0';
    }
    item=arr[top];
    top--;
    return item;
}
```

```
void topelement(){
    if(top==-1){

        return;
    }
}
```

```
bool isempty(){
    if(top==-1){

        return true;
    }
    return false;
}
```

```
void isfull(){
    if(top==size-1){
```

```

        return;
    }

}

char* clearDigits(char* s) {
    char output[50];
    int sizeofthestring=0;
    int i=0;
    while(s[i]!='\0'){
        sizeofthestring++;
        i++;
    }
    for(int i=0;i<sizeofthestring;i++){
        char data=s[i];
        if (isalpha(data)){
            push(data);
        }
        else{
            pop();
        }
    }
    i=0;
    while(!isempty()){
        output[i]=pop();
        i++;
    }
    output[i]='\0';
    char* new = (char*)malloc((i + 1) * sizeof(char));
    int len=strlen(output);

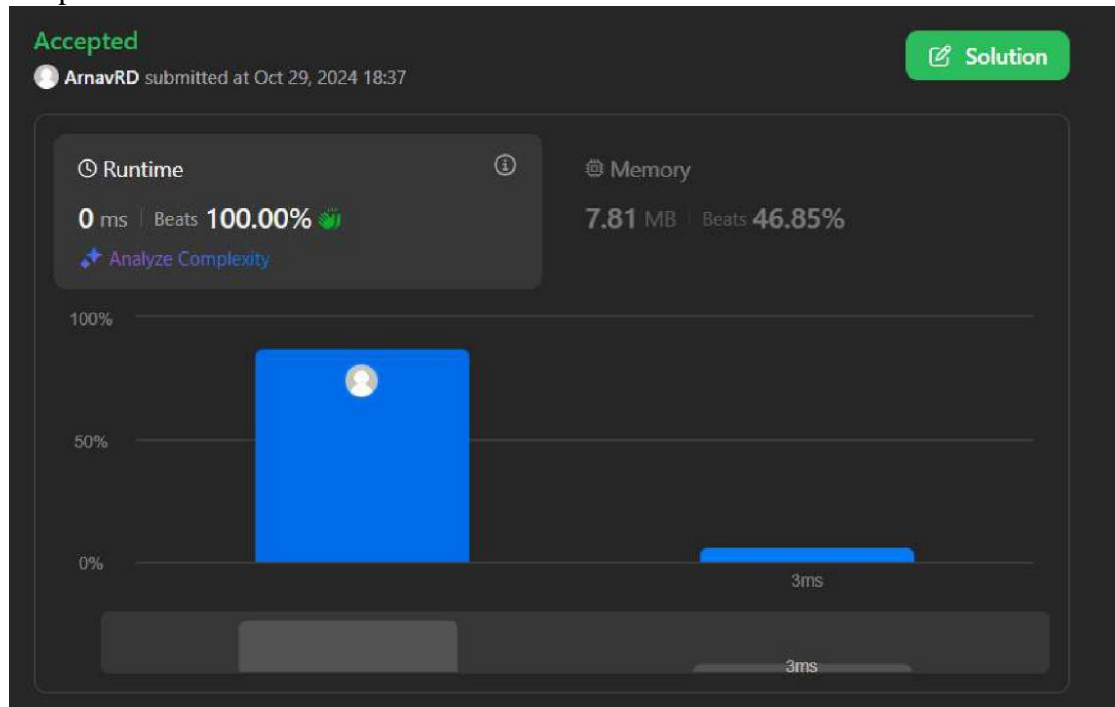
    i=0;

    while(i<len){
        new[i]=output[len-i-1];
        i++;
    }

    new[i]='\0';
    printf("%s",new);
    return new;
}

```

## Output



Program to simulate the working of a circular queue

```
#include <stdio.h>
#include <stdlib.h>
#define N 5
int front=-1,rear=-1,item,i;
int queue[N];

void insert()
{
    if(front == -1 && rear == -1)
    {
        front = 0;
        rear = 0;
        printf("Enter the element:");
        scanf("%d",&item);
        queue[rear] = item;
    }
    else if((rear+1)%N == front)
    {
        printf("Queue is full\n");
    }
    else
    {
        rear = (rear+1)%N;
        printf("Enter the element:");
        scanf("%d",&item);
        queue[rear] = item;
    }
}
```

```

void delete()
{
    if(front == -1 && rear == -1)
    {
        printf("Queue is empty\n");
    }
    else if(front == rear)
    {
        front = -1;
        rear = -1;
    }
    else
    {
        front = (front+1)%N;
    }
}

void display()
{
    if(front == -1 && rear == -1)
    {
        printf("Queue is empty\n");
    }
    while(i!=rear)
    {
        printf("%d\n",queue[i]);
        i=(i+1)%N;
    }
    printf("%d\n",queue[i]);
}

void main()
{
    int ch;
    while(1)
    {
        printf("1 Insert\n 2 Delete\n 3 Display\n 4 Exit\n");
        printf("Enter the choice:\n");
        scanf("%d",&ch);

        switch(ch)
        {
            case 1:insert();break;
            case 2:delete();break;
            case 3:display();break;
            case 4:exit(0);break;
        }
    }
}

```

## Output

```
Enter choice:
1) Insert 2) Delete 3) Display 4) Exit
1
Enter item to insert: 1
Enter choice:
1) Insert 2) Delete 3) Display 4) Exit
3
1
Enter choice:
1) Insert 2) Delete 3) Display 4) Exit
1
Enter item to insert: 4
Enter choice:
1) Insert 2) Delete 3) Display 4) Exit
1
Enter item to insert: 5
Enter choice:
1) Insert 2) Delete 3) Display 4) Exit
3
1 4 5
Enter choice:
1) Insert 2) Delete 3) Display 4) Exit
2
Item deleted: 1
Enter choice:
1) Insert 2) Delete 3) Display 4) Exit
2
Item deleted: 4
Enter choice:
1) Insert 2) Delete 3) Display 4) Exit
2
Item deleted: 5
Enter choice:
1) Insert 2) Delete 3) Display 4) Exit
1
Enter item to insert: 7
Enter choice:
1) Insert 2) Delete 3) Display 4) Exit
4
PS C:\dslab> █
```

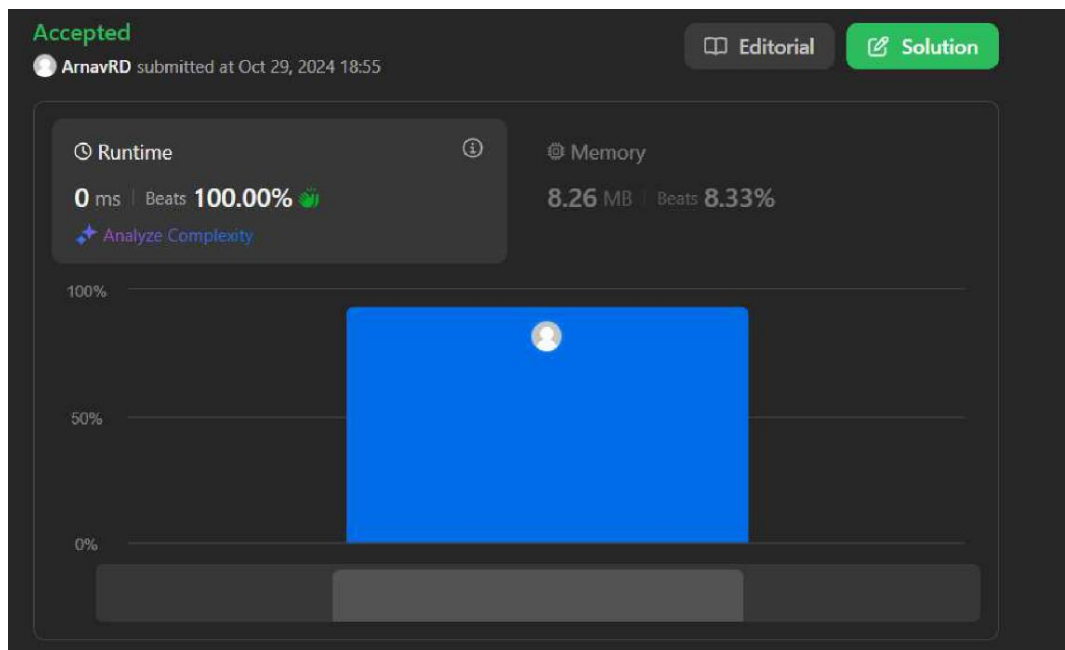
## Leetcode – 2

Time required to buy tickets problem

```
int timeRequiredToBuy(int* tickets, int N, int k) {
    int res = 0;

    for(int i = 0; i < N; i++){
        if(i < k){
            if(tickets[k] > tickets[i])
                res += tickets[i];
            else
                res += tickets[k];
        }
        else if (i > k){
            if(tickets[k] > tickets[i])
                res += tickets[i];
            else
                res += tickets[k] - 1;
        }
        else
            res += tickets[k];
    }

    return res;
}
```

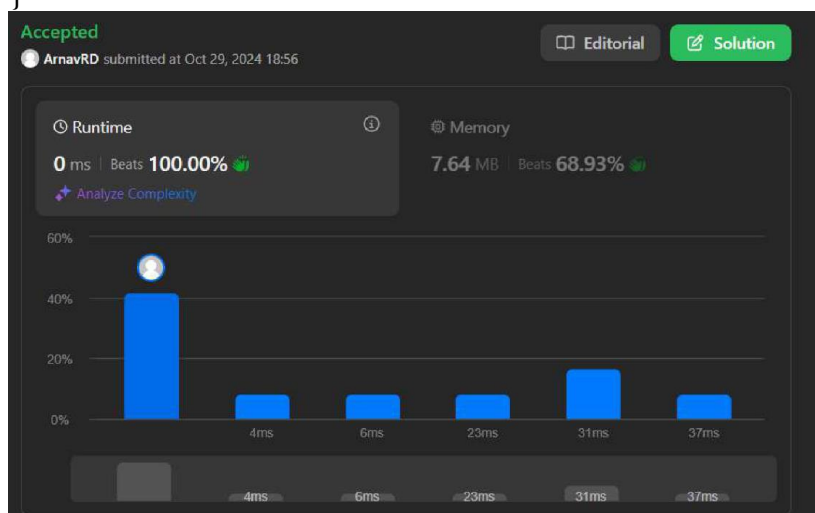


### Leetcode – 3

Find the winner problem

```
int findTheWinner(int numFriends, int k) {
    int winpos = 0;

    for (int currentFriends = 2; currentFriends <= numFriends; currentFriends++) {
        winpos = (winpos + k) % currentFriends;
    }
    return winpos + 1;
}
```





#### **Lab program 4:**

**Program to Implement Singly Linked List (Insertion at first position, at any position and at end of list). Display the contents of the linked list.**

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

struct node {
    int value;
    struct node *next;
};
typedef struct node *NODE;

NODE get_node() {
    NODE ptr = (NODE)malloc(sizeof(struct node));
    if (ptr == NULL) {
        printf("Memory not allocated\n");
    }
    return ptr;
}

NODE insert_beginning(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = first;
    return new_node;
}

NODE insert_end(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = NULL;
    if (first == NULL) {
        return new_node;
    }
    NODE temp = first;
    while (temp->next != NULL) {
        temp = temp->next;
    }
    temp->next = new_node;
    return first;
}
```

```

NODE insert_pos(NODE first, int item, int pos) {
    NODE new_node = get_node();
    new_node->value = item;
    if (pos == 1) {
        new_node->next = first;
        return new_node;
    }
    int count = 1;
    NODE prev = NULL, current = first;
    while (count < pos && current != NULL) {
        prev = current;
        current = current->next;
        count++;
    }
    if (prev != NULL) {
        prev->next = new_node;
        new_node->next = current;
    } else {
        printf("Invalid position\n");
    }
    return first;
}

```

```

void display(NODE first) {
    NODE temp = first;
    if (first == NULL) {
        printf("Empty\n");
        return;
    }
    while (temp != NULL) {
        printf("%d ", temp->value);
        temp = temp->next;
    }
    printf("\n");
}

```

```

int main() {
    int item, pos, choice;
    NODE first = NULL;

    while (1) {
        printf("Choose an operation:\n");
        printf("1. Insert at beginning\n");
        printf("2. Insert at end\n");
    }
}

```

```

printf("3. Insert at position\n");
printf("4. Display list\n");
printf("5. Exit\n");
scanf("%d", &choice);

switch (choice) {
    case 1:
        printf("Enter item to insert at beginning: ");
        scanf("%d", &item);
        first = insert_beginning(first, item);
        break;
    case 2:
        printf("Enter item to insert at end: ");
        scanf("%d", &item);
        first = insert_end(first, item);
        break;
    case 3:
        printf("Enter item to insert and position: ");
        scanf("%d %d", &item, &pos);
        first = insert_pos(first, item, pos);
        break;
    case 4:
        printf("List: ");
        display(first);
        break;
    case 5:
        exit(0);
    default:
        printf("Invalid choice. Please try again.\n");
}
}

return 0;
}

```

Output:

```

Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
1
Enter item to insert at beginning: 1
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
1
Enter item to insert at beginning: 2
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
1
Enter item to insert at beginning: 3
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
4
List: 3 2 1
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
2
Enter item to insert at end: 4
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
4
List: 3 2 1 4
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit

```

```

5. Exit
1
Enter item to insert at beginning: 3
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
4
List: 3 2 1
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
2
Enter item to insert at end: 4
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
4
List: 3 2 1 4
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
3
Enter item to insert and position: 5
2
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
4
List: 3 5 2 1 4
Choose an operation:
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
5

```

### **Lab Program 5:**

#### **Program to Implement Singly Linked List (Delete first element,Delete last element, Delete,Display)**

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

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

```
struct node {  
    int value;  
    struct node *next;  
};  
typedef struct node *NODE;
```

```
NODE get_node() {  
    NODE ptr = (NODE)malloc(sizeof(struct node));  
    if (ptr == NULL) {  
        printf("Memory not allocated\n");  
    }  
    return ptr;  
}
```

```
NODE delete_first(NODE first){  
    NODE temp=first;  
    if (first == NULL) {  
        printf("Empty\n");  
        return NULL;  
    }  
    first=first->next;  
    free(temp);  
    return first;  
}
```

```
NODE delete_end(NODE first){  
    if (first == NULL) {  
        printf("Empty\n");  
        return NULL;  
    }  
    NODE prev,last;  
    prev=NULL;  
    last=first;  
    while(last->next!=NULL){  
        prev=last;  
        last=last->next;  
    }  
    prev->next=NULL;
```

```

    free(last);
    return first;
}

NODE delete_value(NODE first,int value){
    if (first == NULL) {
        printf("Empty\n");
        return NULL;
    }
    NODE prev,current;
    prev=NULL;
    current=first;
    while(value!=current->value || current->next!=NULL){
        prev=current;
        current=current->next;
    }
    if(current==NULL){
        printf("Value notfound");
        return first;
    }
    prev->next=current->next;
    free(current);
    return first;
}

NODE insert_beginning(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = first;
    return new_node;
}

void display(NODE first) {
    NODE temp = first;
    if (first == NULL) {
        printf("Empty\n");
        return;
    }
    while (temp != NULL) {
        printf("%d ", temp->value);
        temp = temp->next;
    }
    printf("\n");
}

```

```

int main() {
    int item, choice;
    NODE first = NULL;

    first = insert_beginning(first, 6);
    first = insert_beginning(first, 5);
    first = insert_beginning(first, 4);
    first = insert_beginning(first, 3);
    first = insert_beginning(first, 2);
    first = insert_beginning(first, 1);

    printf("List before deleting:\n");
    display(first);

    while (1) {
        printf("Choose an operation to delete:\n");
        printf("1. Delete at beginning\n");
        printf("2. Delete at end\n");
        printf("3. Delete specific value\n");
        printf("4. Display list\n");
        printf("5. Exit\n");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Deleting at first.\n");
                first = delete_first(first);
                display(first);
                break;
            case 2:
                printf("Deleting at the end.\n");
                first = delete_end(first);
                display(first);
                break;
            case 3:
                printf("Enter value to delete: ");
                scanf("%d", &item);
                first = delete_value(first, item);
                display(first);
                break;
            case 4:
                printf("List: ");
                display(first);

```

```

        break;
    case 5:
        exit(0);
    default:
        printf("Invalid choice. Please try again.\n");
    }
}

return 0;
}

```

Output:

```

1 2 3 4 5 6
Choose an operation to delete:
1. Delete at beginning
2. Delete at end
3. Delete specific value
4. Display list
5. Exit
1
Deleting at first.
2 3 4 5 6
Choose an operation to delete:
1. Delete at beginning
2. Delete at end
3. Delete specific value
4. Display list
5. Exit
2
Deleting at the end.
2 3 4 5
Choose an operation to delete:
1. Delete at beginning
2. Delete at end
3. Delete specific value
4. Display list
5. Exit
4
List: 2 3 4 5
Choose an operation to delete:
1. Delete at beginning
2. Delete at end
3. Delete specific value
4. Display list
5. Exit
3
Enter value to delete: 4

```



### Lab Program 6:

- a) **Linked list operations (Sort, Reverse, Concatenate)**
- b) **Implementation of Queue and Stack using Linked List**

a)

```
#include <stdio.h>
#include <stdlib.h>
struct node {
    int value;
    struct node *next;
};
typedef struct node *NODE;
NODE get_node() {
    NODE ptr = (NODE)malloc(sizeof(struct node));
    if (ptr == NULL) {
        printf("Memory not allocated\n");
    }
    return ptr;
}
NODE insert_beginning(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = first;
    return new_node;
}
NODE insert_end(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = NULL;
    if (first == NULL) {
        return new_node;
    }
    NODE temp = first;
    while (temp->next != NULL) {
        temp = temp->next;
    }
    temp->next = new_node;
    return first;
}
NODE delete_first(NODE first){
    NODE temp=first;
    if (first == NULL) {
        printf("Empty\n");
        return NULL;
    }
```

```

    }
    first=first->next;
    free(temp);
    return first;
}
NODE delete_end(NODE first){
    if (first == NULL) {
        printf("Empty\n");
        return NULL;
    }
    NODE prev,last;
    prev=NULL;
    last=first;
    while(last->next!=NULL){
        prev=last;
        last=last->next;
    }
    prev->next=NULL;
    free(last);
    return first;
}
void display(NODE first) {
    NODE temp = first;
    if (first == NULL) {
        printf("Empty\n");
        return;
    }
    while (temp != NULL) {
        printf("%d ", temp->value);
        temp = temp->next;
    }
    printf("\n");
}

NODE concatenate(NODE first1, NODE first2){
    if(first1 == NULL && first2==NULL){ return NULL;}
    if(first1==NULL){ return first2; }
    if(first2==NULL){ return first1; }
    NODE temp=first1;
    while(temp->next!= NULL){
        temp=temp->next;
    }
    temp->next=first2;
    return first1;
}

```

```

}

NODE reverse(NODE first){
    if(first==NULL){
        return NULL;
    }
    NODE curr=NULL,temp;
    while(first!=NULL){
        temp=first;
        first=first->next;
        temp->next=curr;
        curr=temp;
    }
    return curr;
}

void sort(NODE first){
    NODE temp1=first,temp2=first->next;
    while((temp1->next)!=NULL){
        while(temp2!=NULL){
            if(temp1->value >= temp2->value){
                int x=temp1->value;
                temp1->value=temp2->value;
                temp2->value=x;
            }
            temp2=temp2->next;
        }
        temp1=temp1->next;
    }
}

int main() {
    int choice, item;
    NODE first1 = NULL, first2 = NULL, mergedList = NULL;
    NODE ConcatenatedList;

    // Menu to choose operations
    while (1) {
        printf("\nChoose an operation:\n");
        printf("1. Insert item into first list\n");
        printf("2. Insert item into second list\n");
        printf("3. Display first list\n");
        printf("4. Display second list\n");
        printf("5. Concatenate lists\n");
    }
}

```

```

printf("6. Reverse the first list\n");
printf("7. Sort the first list\n");
printf("8. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);

switch (choice) {
    case 1:
        printf("Enter item to insert into first list: ");
        scanf("%d", &item);
        first1 = insert_beginning(first1, item);
        break;
    case 2:
        printf("Enter item to insert into second list: ");
        scanf("%d", &item);
        first2 = insert_beginning(first2, item);
        break;
    case 3:
        printf("First list: ");
        display(first1);
        break;
    case 4:
        printf("Second list: ");
        display(first2);
        break;
    case 5:
        ConcatenatedList = concatenate(first1, first2);
        printf(" Concatenated List: ");
        display( ConcatenatedList);
        break;
    case 6:
        first1 = reverse(first1);
        printf("First list after reversal: ");
        display(first1);
        break;
    case 7:
        sort(first1);
        printf("First list after sorting: ");
        display(first1);
        break;
    case 8:
        exit(0);
    default:
        printf("Invalid choice..\n");
}

```

```

    }
}

return 0;
}

```

Output:

```

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 1
Enter item to insert into first list: 2

```

```

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 1
Enter item to insert into first list: 3

```

```

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 1
Enter item to insert into first list: 4

```

```

Choose an operation:
1. Insert item into first list

```

```

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 2
Enter item to insert into second list: 6

```

```

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 2
Enter item to insert into second list: 8

```

```

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 2
Enter item to insert into second list: 1

```

```

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list

```

```

7. Sort the first list
8. Exit
Enter your choice: 3
First list: 4 3 2

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 4
Second list: 1 8 6

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 6
First list after reversal: 2 3 4

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 7
First list after sorting: 2 3 4

```

```

6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 7
First list after sorting: 2 3 4

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 5
Concatenated list: 2 3 4 1 8 6

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 7
First list after sorting: 1 3 4 2 8 6

Choose an operation:
1. Insert item into first list
2. Insert item into second list
3. Display first list
4. Display second list
5. Concatenate lists
6. Reverse the first list
7. Sort the first list
8. Exit
Enter your choice: 8

```

**b)**

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

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

```

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

```

```
typedef struct node *NODE;
```

```

NODE get_node() {
    NODE ptr = (NODE)malloc(sizeof(struct node));

```

```

    if (ptr == NULL) {
        printf("Memory not allocated\n");
    }
    return ptr;
}

NODE delete_first(NODE first){
    NODE temp=first;
    if (first == NULL) {
        printf("Empty\n");
        return NULL;
    }
    first=first->next;
    free(temp);
    return first;
}

NODE insert_beginning(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = first;
    return new_node;
}

NODE insert_end(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = NULL;
    if (first == NULL) {
        return new_node;
    }
    NODE temp = first;
    while (temp->next != NULL) {
        temp = temp->next;
    }
    temp->next = new_node;
    return first;
}

void display(NODE first) {
    NODE temp = first;
    if (first == NULL) {
        printf("Empty\n");
        return;
    }

```

```

    }
    while (temp != NULL) {
        printf("%d ", temp->value);
        temp = temp->next;
    }
    printf("\n");
}

int main() {
    int item, choice, deleted_item;
    NODE first = NULL;

    printf("Choose:\n");
    printf("1. Stack\n");
    printf("2. Queue\n");
    printf("Enter choice (1/2): ");
    scanf("%d", &choice);

    if (choice == 1) {
        while (1) {
            printf("\nStack Operations:\n");
            printf("1. Push\n");
            printf("2. Pop\n");
            printf("3. Display stack\n");
            printf("4. Exit\n");
            printf("Enter choice: ");
            scanf("%d", &choice);

            switch (choice) {
                case 1:
                    printf("Enter item to push: ");
                    scanf("%d", &item);
                    first = insert_beginning(first, item);
                    break;
                case 2:
                    if (first != NULL) {
                        deleted_item = first->value;
                        first = delete_first(first);
                        printf("Deleted item from stack: %d\n", deleted_item);
                    } else {
                        printf("Stack is empty\n");
                    }
                    break;
                case 3:

```



```

        printf("Stack: ");
        display(first);
        break;
    case 4:
        exit(0);
    default:
        printf("Invalid choice.\n");
    }
}
}
else if (choice == 2) {
    while (1) {
        printf("\nQueue Operations:\n");
        printf("1. Insert\n");
        printf("2. Delete\n");
        printf("3. Display queue\n");
        printf("4. Exit\n");
        printf("Enter choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter item to insert: ");
                scanf("%d", &item);
                first = insert_end(first, item);
                break;
            case 2:
                if (first != NULL) {
                    deleted_item = first->value;
                    first = delete_first(first);
                    printf("Deleted item from queue: %d\n", deleted_item);
                } else {
                    printf("Queue is empty!\n");
                }
                break;
            case 3:
                printf("Queue: ");
                display(first);
                break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice.\n");
        }
    }
}

```

```

    }
}
else {
    printf("Invalid operation.\n");
}

return 0;
}

```

Output:

```

Choose:
1. Stack
2. Queue
Enter choice (1/2): 1

Stack Operations:
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: 1
Enter item to push: 3

Stack Operations:
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: 1
Enter item to push: 5

Stack Operations:
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: 3
Stack: 5 3

Stack Operations:
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: 2
Deleted item from stack: 5

Stack Operations:
1. Push

```

```

Choose:
1. Stack
2. Queue
Enter choice (1/2): 2

Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 1
Enter item to insert: 4

Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 1
Enter item to insert: 5

Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 3
Queue: 4 5

Queue Operations:
1. Insert
2. Delete

```

```
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 1
Enter item to Insert: 5
```

```
Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 3
Queue: 4 5
```

```
Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 2
Deleted item from queue: 4
```

```
Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 4
```

**Lab Program 7:**  
**Program to Implement doubly link list**

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

struct Node {
    int value;
    struct Node* prev;
    struct Node* next;
};
typedef struct Node* NODE;

NODE get_node() {
    NODE ptr = (NODE)malloc(sizeof(struct Node));
    if (ptr == NULL) {
        printf("Memory not allocated\n");
    }
    return ptr;
}

NODE insert_beginning(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = first;
    new_node->prev = NULL;
    if (first != NULL) {
        first->prev = new_node;
    }
    return new_node;
}

NODE insert_left_value(NODE first, int item, int key) {
    NODE curr = first;
    NODE new_node = get_node();
    new_node->value = item;

    if (curr == NULL) {
        printf("value not found.\n");
        return first;
    }
```

```

while (curr != NULL && curr->value != key) {
    curr = curr->next;
}

new_node->next = curr;
new_node->prev = curr->prev;
(curr->prev)->next = new_node;
curr->prev = new_node;
}

NODE deleteNode(NODE first, int value) {
    NODE curr = first;
    if (curr == NULL) {
        printf("Value %d not found.\n", value);
        return first;
    }

    while (curr != NULL && curr->value != value) {
        curr = curr->next;
    }
    (curr->prev)->next = curr->next;
    (curr->next)->prev = curr->prev;
    free(curr);
    return first;
}

void displayList(NODE first) {
    if (first == NULL) {
        printf("List is empty.\n");
        return;
    }

    NODE curr = first;
    while (curr != NULL) {
        printf("%d ", curr->value);
        curr = curr->next;
    }
    printf("\n");
}

int main() {
    NODE first = NULL;
    int choice, value, key;

```

```

do {
    printf("Operations:\n");
    printf("1. Insert at beginning\n");
    printf("2. Insert to the left \n");
    printf("3. Delete a node by value\n");
    printf("4. Display list\n");
    printf("5. Exit\n");
    printf("Enter choice: ");
    scanf("%d", &choice);

    switch (choice) {
        case 1:
            printf("Enter the value to insert at beginning: ");
            scanf("%d", &value);
            first = insert_beginning(first, value);
            break;

        case 2:
            printf("Enter the value to insert: ");
            scanf("%d", &value);
            printf("Enter the key value: ");
            scanf("%d", &key);
            insert_left_value(first, value, key);
            break;

        case 3:
            printf("Enter the value to delete: ");
            scanf("%d", &value);
            first = deleteNode(first, value);
            break;

        case 4:
            printf("List : ");
            displayList(first);
            break;

        case 5:
            break;

        default:
            printf("Invalid choice\n");
    }
} while (choice != 5);

```

```
    return 0;
}
```

## Output:

```
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 1
Enter the value to insert at beginning: 3
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 1
Enter the value to insert at beginning: 5
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 1
Enter the value to insert at beginning: 2
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 4
List : 2 5 3
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 2
Enter the value to insert: 7
Enter the key value: 5
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 4
List : 2 7 5 3
```

```
List : 2 7 5 3
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 3
Enter the value to delete: 5
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 4
List : 2 7 3
Operations:
1. Insert at beginning
2. Insert to the left
3. Delete a node by value
4. Display list
5. Exit
Enter choice: 5
```

**Lab Program 8:**  
**Program to Implement Binary Search Tree**

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

struct Node {
    int value;
    struct Node *left, *right;
};
typedef struct Node *NODE;

NODE newNode(int key) {
    NODE node = (NODE)malloc(sizeof(struct Node));
    node->value = key;
    node->left = node->right = NULL;
    return node;
}

NODE insert(NODE root, int key) {
    if (root == NULL) {
        return newNode(key);
    }

    if (key < root->value) {
        root->left = insert(root->left, key);
    } else if (key > root->value) {
        root->right = insert(root->right, key);
    }

    return root;
}

void inorder(NODE root) {
    if (root != NULL) {
        inorder(root->left);
        printf("%d ", root->value);
        inorder(root->right);
    }
}

void preorder(NODE root) {
```



```

    if (root != NULL) {
        printf("%d ", root->value);
        preorder(root->left);
        preorder(root->right);
    }
}

void postorder(NODE root) {
    if (root != NULL) {
        postorder(root->left);
        postorder(root->right);
        printf("%d ", root->value);
    }
}

int main() {
    NODE root = NULL;
    int choice, value;

    do {
        printf("\nBST Operations\n");
        printf("1. Insert a node\n");
        printf("2. Display: In-order\n");
        printf("3. Display: Pre-order\n");
        printf("4. Display: Post-order\n");
        printf("5. Exit\n");

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

        switch(choice) {
            case 1:
                printf("Enter the value to insert: ");
                scanf("%d", &value);
                root = insert(root, value);
                printf("Value inserted:%d\n",value);
                break;
            case 2:
                if (root == NULL) {
                    printf("The tree is empty!\n");
                } else {
                    inorder(root);
                }
                break;

```

```

    case 3:
        if (root == NULL) {
            printf("The tree is empty!\n");
        } else {
            preorder(root);
        }
        break;
    case 4:
        if (root == NULL) {
            printf("The tree is empty!\n");
        } else {
            postorder(root);
        }
        break;
    case 5:
        break;
    default:
        printf("Invalid choice\n");
    }
} while (choice != 5);

return 0;
}

```

Output:

```

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 6
Value inserted:6

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 8
Value inserted:8

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 5
Value inserted:5

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 7
Value inserted:7

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 9
Value inserted:9

```

```

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 7
Value inserted:7

```

```

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 1
Enter the value to insert: 9
Value inserted:9

```

```

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 2
5 6 7 8 9

```

```

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 3
6 5 8 7 9

```

```

BST Operations
1. Insert a node
2. Display: In-order
3. Display: Pre-order
4. Display: Post-order
5. Exit
Enter your choice: 4
5 7 9 8 6

```

### Lab Program 9:

- a) BFS traversal
- b) DFS traversal and other functions

a)

```
#include<stdio.h>
void bfs(int);
int a[10][10],vis[10],n;

void main()
{
    int i,j,src;

    printf("enter the number of vertices\n");
    scanf("%d",&n);
    printf("enter the adjacency matrix\n");
    for(i=1;i<=n;i++)
    {
        for(j=1;j<=n;j++)
        {
            scanf("%d",&a[i][j]);

        }

        vis[i]=0;
    }

    printf("enter the src vertex\n");
    scanf("%d",&src);
    printf("nodes reachable from src vertex\n");
    bfs(src);

}

void bfs(int v)
{
    int q[10],f=1,r=1,u,i;
    q[r]=v;
    vis[v]=1;
    while(f<=r)
    {
        u=q[f];
        printf("%d",u);
        for(i=1;i<=n;i++)
```

```

    {
    if(a[v][i]==1 && vis[i]==0)
    {
        vis[i]=1;
        r=r+1;
        q[r]=i;
    }
    }
    f=f+1;
}
}

```

Output:

```

enter the number of vertices
5
enter the adjacency matrix
0 1 1 1 0
1 0 1 1 0
1 1 0 0 1
1 1 0 0 1
0 0 1 1 0
enter the src vertex
1
nodes reachable from src vertex
1234

```

**b)**

```
#include <stdio.h>

void dfs(int);
int n, i, j, a[10][10], vis[10];

int main() {
    printf("Enter the number of vertices: ");
    scanf("%d", &n);

    printf("Enter the adjacency matrix:\n");
    for(i = 0; i < n; i++) {
        for(j = 0; j < n; j++) {
            scanf("%d", &a[i][j]);
        }
        vis[i] = 0;
    }

    printf("DFS Traversal:\n");
    for(i = 0; i < n; i++) {
        if(vis[i] == 0)
            dfs(i);
    }

    return 0;
}

void dfs(int v) {
    vis[v] = 1;
    printf("%d ", v + 1);

    for(j = 0; j < n; j++) {
        if(a[v][j] == 1 && vis[j] == 0) {
            dfs(j);
        }
    }
}
```

Output:

```
Enter the number of vertices: 5
Enter the adjacency matrix:
0 1 1 1 0
1 0 1 1 0
1 1 0 0 1
1 1 0 0 1
0 0 1 1 0
DFS Traversal:
1 2 3 5 4
```

**Lab Program 10:**

**Design and develop a Program in C that uses Hash function  $H: K \rightarrow L$  as  $H(K) = K \bmod m$  (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_RECORDS 100
void displayHashTable(int HT[], int m) {
    printf("\nHash Table:\n");
    for (int i = 0; i < m; i++) {
        if (HT[i] != -1) {
            printf("Index %d: %d\n", i, HT[i]);
        } else {
            printf("Index %d: Empty\n", i);
        }
    }
}
int hashFunction(int key, int m) {
    return key % m;
}
void insert(int HT[], int key, int m) {
    int hash = hashFunction(key, m);
    int i = 0;
    while (HT[(hash + i) % m] != -1) {
        i++;
    }
    if (i == m) {
        printf("Hash table is full. Unable to insert key %d\n", key);
        return;
    }
    HT[(hash + i) % m] = key;
    printf("Inserted key %d at index %d\n", key, (hash + i) % m);
}
int main() {
    int m, n;
    int HT[MAX_RECORDS];
    for (int i = 0; i < MAX_RECORDS; i++) {
        HT[i] = -1;
    }

    printf("Enter the number of memory locations in the hash table (m): ");
    scanf("%d", &m);
```



```
printf("Enter the number of employee records: ");
scanf("%d", &n);
for (int i = 0; i < n; i++) {
    int key;
    printf("Enter the 4-digit key for employee record %d: ", i + 1);
    scanf("%d", &key);
    if (key < 1000 || key > 9999) {
        printf("Invalid key! Please enter a 4-digit number.\n");
        i--;
    } else {
        insert(HT, key, m);
    }
}
displayHashTable(HT, m);
return 0;
}
```

Output:

```
Enter the number of memory locations in the hash table (m): 3
Enter the number of employee records: 2
Enter the 4-digit key for employee record 1: 1111
Inserted key 1111 at index 1
Enter the 4-digit key for employee record 2: 2222
Inserted key 2222 at index 2

Hash Table:
Index 0: Empty
Index 1: 1111
Index 2: 2222
```