VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
on

Analysis and Design of Algorithms

Submitted by

Amshu G M(1BM21CS019)

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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B. M. S. College of Engineering,

Bull Temple Road, Bangalore 560019

(Affiliated To Visvesvaraya Technological University, Belgaum)

Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "**Analysis and Design of Algorithms**" carried out by **Amshu G M (1BM21CS019),** who is Bonafede 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 academic semester May-2023 to July-2023. The Lab report has been approved as it satisfies the academic requirements in respect of **Analysis and Design of Algorithms (22CS4PCADA)** work prescribed for the said degree.

Name of the Lab-In charge: Sunayana S
Assistant Professor
Department of CSE
BMSCE, Bengaluru

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

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Course Outcome

CO1	Analyze time complexity of Recursive and Non-recursive algorithms using asymptotic notations.
CO2	Apply various design techniques for the given problem.
CO3	Apply the knowledge of complexity classes P, NP, and NP-Complete and prove certain problems are NP-Complete
CO4	Design efficient algorithms and conduct practical experiments to solve problems.

1. a) Breadth First Search

Aim: To print all the reachable nodes from a given root node in a digraph using BFS method

Code:

```
#include<stdio.h>
#include<conio.h>
void insert_rear(int q[],int *r, int item, int size)
{
    if(*r==size)
    printf("Queue overflow!\n");
    else
    {
        *r=*r+1;
        q[*r]=item;
    }
}
int delete_front(int q[],int *r, int *f)
{
    int del_item=-1;
    *f=*f+1;
    del_item=q[*f];


    return del_item;
}
int isEmpty(int q[], int *r, int *f)
{
    if(*r==-1 || *r==*f)
    return 1;
    else
    return 0;
}
void main()
{
    int n,i,j,r=-1,f=-1;
    printf("Enter the number of vertices:\n");
    scanf("%d",&n);
    printf("Enter the adjacency matrix representing the graph:\n");
    int graph[n][n];
    int vis[n],q[n];
    for(int i=0;i<n;i++)
    {    for(int j=0;j<n;j++)
```

```
        {
            scanf("%d",&graph[i][j]);
        }
    }
      for(int i=0;i<n;i++)
    {
        vis[i]=0;
    }
    int k=0;
    printf("Starting vertex:%d\n",k);
    printf("Breadth First Search of the graph\n");
    printf("%d ",k);
    vis[k]=1;
    insert_rear(q,&r,k,n);
    while(isEmpty(q,&r,&f)==0)
    {
        int node=delete_front(q,&r,&f);
        for(j=0;j<n;j++)
        {
            if(graph[node][j]==1 && vis[j]==0)
            {
                printf("%d ",j);
                vis[j]=1;
                insert_rear(q,&r,j,n);
            }
        }
    }
}
```

Output:

```
D:\Codes\c\ADA_LAB>.\a.exe
Enter the number of vertices:
6
Enter the adjacency matrix representing the graph:
0 1 1 0 1 1
1 0 0 1 0 0
1 1 0 0 0 1
0 0 1 0 1 1
1 0 0 0 0 1

1 0 1 1 0 0
Starting vertex:0
Breadth First Search of the graph
0 1 2 4 5 3
D:\Codes\c\ADA_LAB>
```

1. b) Depth First Search

Aim: To check whether a given graph is connected or not using DFS method

Code:

```
int graph[20][20];
void DFS(int i,int vis[],int n)
{
    int j;
    printf("%d ",i);
    vis[i]=1;
    for(j=0;j<n;j++)
    {
        if(graph[i][j]==1 && vis[j]==0)
        {
            DFS(j,vis,n);
        }
    }
}
void main()
{
    int n,i,j,top=-1,start;
    printf("Enter the number of vertices:\n");
    scanf("%d",&n);
    printf("Enter the adjacency matrix representing the graph:\n");
    int vis[n],st[n];
    for(int i=0;i<n;i++)
    {
        for(int j=0;j<n;j++)
        {
            scanf("%d",&graph[i][j]);
        }
    }
    for(int i=0;i<n;i++)
    {
        vis[i]=0;
    }
    printf("Enter the starting vertex:");
    scanf("%d",&start);
    printf("Depth First Search of the graph is\n");
    DFS(start,vis,n);
}
```

Output:

```
D:\Codes\c\ADA_LAB>.\a.exe
Enter the number of vertices:
5
Enter the adjacency matrix representing the graph:
0 1 1 1 1
1 0 0 0 0
1 0 0 0 0
1 0 0 0 0
1 0 0 0 0
Enter the starting vertex:2
Depth First Search of the graph is
2 0 1 3 4
D:\Codes\c\ADA_LAB>
```

2. Topological Sorting

Aim: To obtain the Topological ordering of vertices in a given digraph

Code:

```c
#include <stdio.h>

int main()
{
    int n;
    printf("Enter the no of vertices: ");
    scanf("%d", &n);
    int a[n][n], indeg[n], flag[n];

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

    for (i = 0; i < n; i++)
    {
        indeg[i] = 0;
        flag[i] = 0;
    }

    for (i = 0; i < n; i++)
        for (j = 0; j < n; j++)
            indeg[i] = indeg[i] + a[j][i];

    printf("\nThe topological order is: ");

    while (count < n)
    {
        for (k = 0; k < n; k++)
        {
            if ((indeg[k] == 0) && (flag[k] == 0))
            {
                printf("%d ", (k + 1));
                flag[k] = 1;
```

```
            }

            for (i = 0; i < n; i++)
            {
                if (a[i][k] == 1)
                    indeg[k]--;
            }
        }
        count++;
    }

    return 0;
}
```

Output:

```
D:\Codes\c\ADA_LAB>gcc Topological_Sort.c

D:\Codes\c\ADA_LAB>.\a.exe
Enter the no of vertices: 4
Enter the adjacency matrix:
0 1 1 0
0 0 0 1
1 0 0 0
1 1 1 0

The topological order is: 1 2 3 4
```

3. Johnson Trotter algorithm

Aim: To generate permutations of n numbers using Johnson Trotter algorithm

Code:

```c
#include <stdio.h>

#define MAXN 10

int p[MAXN];
int dir[MAXN];


void printPermutation(int n) {
    for (int i = 0; i < n; i++) {
        printf("%d ", p[i]);
    }
    printf("\n");
}


void swap(int* a, int* b) {
    int temp = *a;
    *a = *b;
    *b = temp;
}


void generatePermutations(int n) {

    printPermutation(n);

    int mobile, mobileIndex;
    while (1) {
        mobile = 0;
        mobileIndex = -1;


        for (int i = 0; i < n; i++) {
            if ((dir[i] == -1 && i > 0 && p[i] > p[i - 1]) ||
                (dir[i] == 1 && i < n - 1 && p[i] > p[i + 1])) {
                if (p[i] > mobile) {
                    mobile = p[i];
```

```
                    mobileIndex = i;
                }
            }
        }


        if (mobileIndex == -1) {
            break;
        }


        if (dir[mobileIndex] == -1) {
            swap(&p[mobileIndex], &p[mobileIndex - 1]);
            swap(&dir[mobileIndex], &dir[mobileIndex - 1]);
            mobileIndex--;
        }
        else if (dir[mobileIndex] == 1) {
            swap(&p[mobileIndex], &p[mobileIndex + 1]);
            swap(&dir[mobileIndex], &dir[mobileIndex + 1]);
            mobileIndex++;
        }

        for (int i = 0; i < n; i++) {
            if (p[i] > mobile) {
                dir[i] = -dir[i];
            }
        }


        printPermutation(n);
    }
}

int main() {
    int n;

    printf("Enter the value of n (maximum %d): ", MAXN);
    scanf("%d", &n);

    if (n <= 0 || n > MAXN) {
        printf("Invalid value of n!\n");
        return 0;
    }
```

```
    for (int i = 0; i < n; i++) {
        p[i] = i + 1;
        dir[i] = -1;
    }


    generatePermutations(n);

    return 0;
}
```

Output:

```
D:\Codes\c\ADA_LAB>gcc johnson_trott.c

D:\Codes\c\ADA_LAB>.\a.exe
Enter the value of n (maximum 10): 4
1 2 3 4
1 2 4 3
1 4 2 3
4 1 2 3
4 1 3 2
1 4 3 2
1 3 4 2
1 3 2 4
3 1 2 4
3 1 4 2
3 4 1 2
4 3 1 2
4 3 2 1
3 4 2 1
3 2 4 1
3 2 1 4
2 3 1 4
2 3 4 1
2 4 3 1
4 2 3 1
4 2 1 3
2 4 1 3
2 1 4 3
2 1 3 4
```

4. Merge Sort

Aim: To sort a given set of N integer elements using Merge Sort technique, compute its time taken for different values of N and record the time taken to sort

Code:

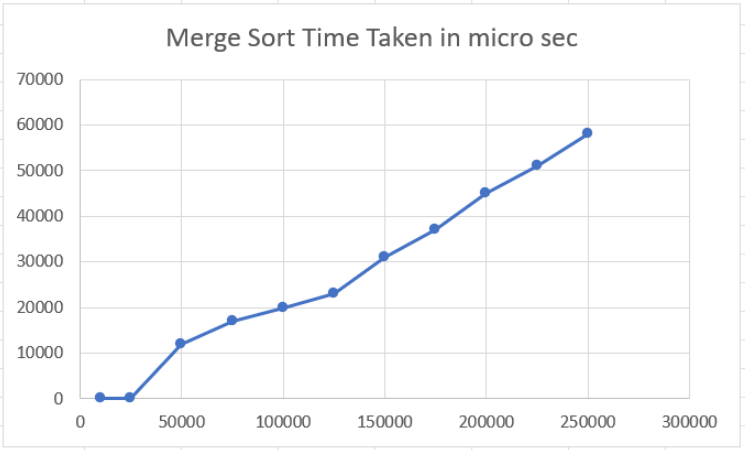
```
#include<stdio.h>
#include<time.h>
#include<stdlib.h>

void merge(int arr[],int l,int m,int h){
    int i,j,k;
    int n1=m-l+1;
    int n2=h-m;
    int temp1[n1];
    int temp2[n2];
    for(int i=0;i<n1;i++){
        temp1[i]=arr[l+i];
    }
    for(int i=0;i<n2;i++){
        temp2[i]=arr[m+i+1];
    }
    i=0;
    j=0;
    k=l;
    while(i<n1&&j<n2){
        if(temp1[i]<temp2[j]){
            arr[k]=temp1[i];
            i++;
        }
        else{
            arr[k]=temp2[j];
            j++;
        }
        k++;
    }
    while(i<n1){
        arr[k]=temp1[i];
        i++;
        k++;
    }
    while(j<n2){
```

```
        arr[k]=temp2[j];
        j++;
        k++;
    }

}

void mergesort(int arr[],int l, int h){
    if(l<h){
        int m=(l+h-1)/2;
        mergesort(arr,l,m);
        mergesort(arr,m+1,h);
        merge(arr,l,m,h);
    }
}

int main(){
    clock_t start,end;
    int arr[100000],n,low,high;
    printf("Enter size of array: ");
    scanf("%d",&n);
    for(int i=0;i<n;i++){
        arr[i]=rand()%1000;
    }
    low=0;
    high=n-1;
    printf("The Elements before sorting:\n ");
   for(int i=0;i<n;i++){
        printf("%d ",arr[i]);
    }
    start=clock();
    mergesort(arr,low,high);
    end=clock();
    double time=(double)(end-start)/CLOCKS_PER_SEC;
    printf("\nThe Elements after sorting:\n ");
    for(int i=0;i<n;i++){
        printf("%d ",arr[i]);
    }
    printf("\nTime taken:%lf in microseconds\n",time*1000000);
    return 0;
}
```

Output with input size vs time graph:

```
D:\Codes\c\ADA_LAB>gcc merge_sort.c

D:\Codes\c\ADA_LAB>.\a.exe
Enter size of array: 5
The Elements before sorting:
 41 467 334 500 169
The Elements after sorting:
 41 169 334 467 500
Time taken:0.000000 in microseconds
```

Merge Sort	
Input Size	Time Taken in micro sec
10000	0
25000	0
50000	12000
75000	17000
100000	20000
125000	23000
150000	31000
175000	37000
200000	45000
225000	51000
250000	58000



5. Quick Sort

Aim: To sort a given set of N integer elements using Quick Sort technique and compute its time taken

Code:

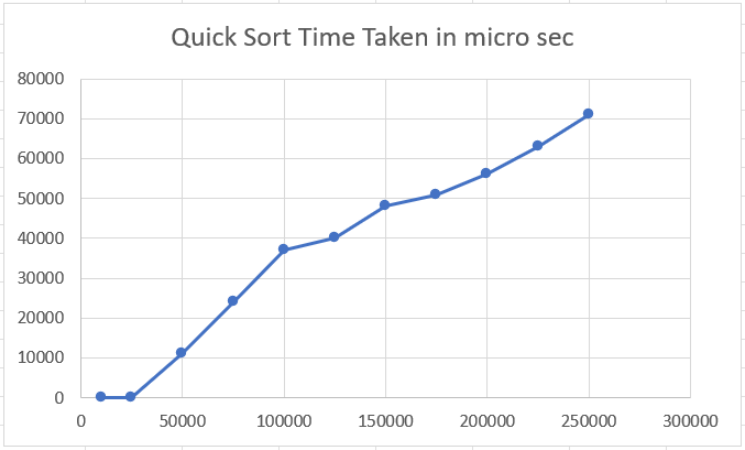
```
#include<stdio.h>
#include<time.h>
#include<stdlib.h>

void merge(int arr[],int l,int m,int h){
    int i,j,k;
    int n1=m-l+1;
    int n2=h-m;
    int temp1[n1];
    int temp2[n2];
    for(int i=0;i<n1;i++){
        temp1[i]=arr[l+i];
    }
    for(int i=0;i<n2;i++){
        temp2[i]=arr[m+i+1];
    }
    i=0;
    j=0;
    k=l;
    while(i<n1&&j<n2){
        if(temp1[i]<temp2[j]){
            arr[k]=temp1[i];
            i++;
        }
        else{
            arr[k]=temp2[j];
            j++;
        }
        k++;
    }
    while(i<n1){
        arr[k]=temp1[i];
        i++;
        k++;
    }
    while(j<n2){
        arr[k]=temp2[j];
        j++;
```

```
        k++;
    }

}

void mergesort(int arr[],int l, int h){
    if(l<h){
        int m=(l+h-1)/2;
        mergesort(arr,l,m);
        mergesort(arr,m+1,h);
        merge(arr,l,m,h);
    }
}

int main(){
    clock_t start,end;
    int arr[100000],n,low,high;
    printf("Enter size of array: ");
    scanf("%d",&n);
    for(int i=0;i<n;i++){
        arr[i]=rand()%1000;
    }
    low=0;
    high=n-1;
    printf("The Elements before sorting:\n ");
   for(int i=0;i<n;i++){
        printf("%d ",arr[i]);
    }
    start=clock();
    mergesort(arr,low,high);
    end=clock();
    double time=(double)(end-start)/CLOCKS_PER_SEC;
    printf("\nThe Elements after sorting:\n ");
    for(int i=0;i<n;i++){
        printf("%d ",arr[i]);
    }
    printf("\nTime taken:%lf in microseconds\n",time*1000000);
    return 0;
}
```

Output with input size vs time graph:

```
D:\Codes\c\ADA_LAB>gcc quick_sort.c

D:\Codes\c\ADA_LAB>.\a.exe
Enter size of array: 5
The Elements before sorting:
 41 467 334 500 169
The Elements after sorting:
 41 169 334 467 500
Time taken:0.000000 in microseconds
```

Quick Sort	
Input Size	Time Taken in micro sec
10000	0
25000	0
50000	11000
75000	24000
100000	37000
125000	40000
150000	48000
175000	51000
200000	56000
225000	63000
250000	71000



6. Heap Sort

Aim: To sort a given set of N integer elements using Heap Sort technique and compute its time taken

Code:

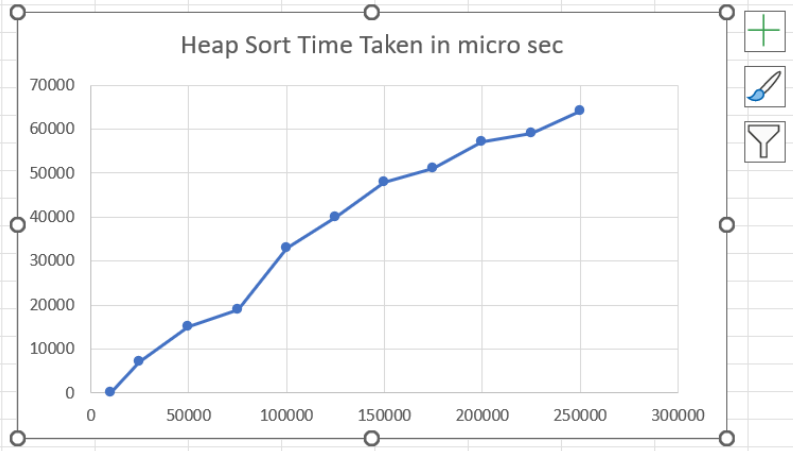
```
#include <stdio.h>
#include<time.h>
#include<stdlib.h>

void swap(int *a, int *b)
{
    int temp = *a;
    *a = *b;
    *b = temp;
}

void heapify(int arr[], int N, int i)
{
    int largest = i;
    int left = 2 * i + 1;
    int right = 2 * i + 2;

    if (left < N && arr[left] > arr[largest])
    {
        largest = left;
    }

    if (right < N && arr[right] > arr[largest])
    {
        largest = right;
    }

    if (largest != i)
    {
        swap(&arr[i], &arr[largest]);
        heapify(arr, N, largest);
    }
}

void heapSort(int arr[], int N)
{
    for (int i = N / 2 - 1; i >= 0; i--)
```

```
    {
        heapify(arr, N, i);
    }

    for (int i = N - 1; i >= 0; i--)
    {
        swap(&arr[0], &arr[i]);
        heapify(arr, i, 0);
    }
}

int main(void)
{
    int n;
    srand(time(0));
    clock_t start, end;
    printf("Enter the size of array: ");
    scanf("%d", &n);
    int arr[n];
    for (int i = 0; i < n; i++)
    {
        // scanf("%d", &arr[i]);
        arr[i]=rand()%1000;
    }
     printf("The Elements before sorting:\n ");
     for (int i = 0; i < n; i++)
    {
        printf("%d ", arr[i]);

    }
    start=clock();
    heapSort(arr, n);
    end=clock();
    double time=(double)(end-start)/CLOCKS_PER_SEC;
     printf("\nThe Elements after sorting:\n ");
    for (int i = 0; i < n; i++)
    {
        printf("%d ", arr[i]);

    }
   printf("\nTime taken:%lf in microseconds\n",time*1000000);
}
```

Output with input size vs time graph:

```
D:\Codes\c\ADA_LAB>gcc heapsort.c

D:\Codes\c\ADA_LAB>.\a.exe
Enter the size of array: 5
The Elements before sorting:
 85 748 575 194 98
The Elements after sorting:
 85 98 194 575 748
Time taken:0.000000 in microseconds
```

	Heap Sort
Input Size	Time Taken in micro sec
10000	0
25000	7000
50000	15000
75000	19000
100000	33000
125000	40000
150000	48000
175000	51000
200000	57000
225000	59000
250000	64000



7. 0/1 Knapsack Problem

Aim: To optimize(maximize) the items in the knapsack for our requirement using 0/1 Knapsack algorithm

Code:

```c
#include <stdio.h>

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

    printf("Enter the price of each item: ");
    int price[n];
    int i;
    for (i = 0; i < n; i++)
    {
        scanf("%d", &price[i]);
    }

    printf("Enter the weight of each item: ");
    int weight[n];
    for (i = 0; i < n; i++)
    {
        scanf("%d", &weight[i]);
    }

    printf("Enter the max weight: ");
    int W;
    scanf("%d", &W);

    printf("\nThe dp table is:\n");
    int dp[n + 1][W + 1];
    for (i = 0; i <= n; i++)
    {
        for (int j = 0; j <= W; j++)
        {
            if (i == 0 || j == 0)
            {
                dp[i][j] = 0;
```

```
            }
            else if (weight[i - 1] <= j)
            {
                dp[i][j] = (price[i - 1] + dp[i - 1][j - weight[i - 1]]) > dp[i -
1][j] ? (price[i - 1] + dp[i - 1][j - weight[i - 1]]) : dp[i - 1][j];
            }
            else
            {
                dp[i][j] = dp[i - 1][j];
            }
            printf("%d  ", dp[i][j]);
        }
        printf("\n");
    }

    printf("\nThe maximum value we can get is: %d", dp[n][W]);

    return 0;
}
```

Output:

```
D:\Codes\c\ADA_LAB>.\a.exe
Enter the number of items: 4
Enter the price of each item: 2 3 4 1
Enter the weight of each item: 4 5 2 8
Enter the max weight: 12

The dp table is:
0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  2  2  2  2  2  2  2  2  2
0  0  0  0  2  3  3  3  3  5  5  5  5
0  0  4  4  4  4  6  7  7  7  7  9  9
0  0  4  4  4  4  6  7  7  7  7  9  9

The maximum value we can get is: 9
```

8. Floyd's Algorithm

Aim: To find out the shortest path between all pairs of vertices

Code:

```c
#include <stdio.h>
#define INF 999
int V;
void printSolution(int dist[][V]);

void floydWarshall(int dist[][V])
{
    int i, j, k;
    for (k = 0; k < V; k++)
    {

        for (i = 0; i < V; i++)
        {
            for (j = 0; j < V; j++)
            {
                if (dist[i][k] + dist[k][j] < dist[i][j])
                    dist[i][j] = dist[i][k] + dist[k][j];
            }
        }
    }

    printSolution(dist);
}

void printSolution(int dist[][V])
{
    printf(
        "The following matrix shows the shortest distances"
        " between every pair of vertices \n");
    for (int i = 0; i < V; i++)
    {
        for (int j = 0; j < V; j++)
        {
                printf("%7d", dist[i][j]);
        }
        printf("\n");
    }
```

```c
}

// driver's code
int main()
{
    printf("Enter the number of vertices\n");
    scanf("%d", &V);
    int graph[V][V];
    printf("Enter the weighted Adjacency matrix (give 999 for infinty)\n");
    for (int i = 0; i < V; i++)
    {
        for (int j = 0; j < V; j++)
        {
            scanf("%d", &graph[i][j]);
        }
    }

    // Function call
    floydWarshall(graph);
    return 0;
}
```

Output:

```
D:\Codes\c\ADA_LAB>.\a.exe
Enter the number of vertices
5
give 999 for infinty
^C
D:\Codes\c\ADA_LAB>gcc Floyds.c

D:\Codes\c\ADA_LAB>.\a.exe
Enter the number of vertices
4
Enter the weighted Adjacency matrix (give 999 for infinty)
0 4 6 999
9 0 12 999
999 2 0 12
12 10 999 0
The following matrix shows the shortest distances between every pair of vertices
      0      4      6     18
      9      0     12     24
     11      2      0     12
     12     10     18      0
```

9. Prim's and Kruskal's algorithm

Aim: To find minimal spanning tree of a graph using Prim's and Kruskal's algorithms

Prim's Algorithm Code:

```c
#include <stdio.h>

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

    printf("Enter the adjacency matrix(use 999 as infinity):\n");
    int adj[n][n];
    int i, j, k;
    for (i = 0; i < n; i++)
    {
        for (int j = 0; j < n; j++)
        {
            scanf("%d", &adj[i][j]);
        }
    }

    int visited[n];
    for (i = 0; i < n; i++)
    {
        visited[i] = 0;
    }

    printf("Enter the starting vertex: ");
    int start;
    scanf("%d", &start);
    visited[start] = 1;

    printf("\nThe minimal spanning tree is:\nEdge : Weight\n");
    for (k = 0; k < n - 1; k++)
    {
        int min = 999;
        int u = 0;
        int v = 0;
        for (i = 0; i < n; i++)
```

```
        {
            if (visited[i])
            {
                for (j = 0; j < n; j++)
                {
                    if (!visited[j] && adj[i][j])
                    {
                        if (min > adj[i][j])
                        {
                            min = adj[i][j];
                            u = i;
                            v = j;
                        }
                    }
                }
            }
        }
        printf("%d - %d : %d\n", u, v, adj[u][v]);
        visited[v] = 1;
    }
}
```

Output:

```
D:\Codes\c\ADA_LAB>gcc prims.c

D:\Codes\c\ADA_LAB>.\a.exe
Enter the number of vertices: 4
Enter the adjacency matrix(use 999 as infinity):
0 8 12 999
999 0 7 3
2 6 0 999
13 999 7 0
Enter the starting vertex: 2

The minimal spanning tree is:
Edge : Weight
2 - 0 : 2
2 - 1 : 6
1 - 3 : 3
```

Kruskal's Algorithm Code:

```c
#include <stdio.h>

int find(int v, int *parent)
{
    while (parent[v] != v)
    {
        v = parent[v];
    }
    return v;
}

void union1(int i, int j, int *parent)
{
    if (i < j)
        parent[j] = i;
    else
        parent[i] = j;
}

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

    printf("Enter the adjacency matrix(use 999 as infinity):\n");
    int adj[n][n];
    int i;
    for (i = 0; i < n; i++)
    {
        for (int j = 0; j < n; j++)
        {
            scanf("%d", &adj[i][j]);
        }
    }
    int parent[n];
    for (i = 0; i < n; i++)
    {
        parent[i] = i;
    }

    int count = 0, k = 0, min, sum = 0, j, t[n][n], u, v;
```

```
    while (count != n - 1)
    {
        min = 999;
        for (i = 0; i < n; i++)
        {
            for (j = 0; j < n; j++)
            {
                if (adj[i][j] < min && adj[i][j] != 0)
                {
                    min = adj[i][j];
                    u = i;
                    v = j;
                }
            }
        }
        i = find(u, parent);
        j = find(v, parent);

        if (i != j)
        {
            union1(i, j, parent);
            t[k][0] = u;
            t[k][1] = v;
            k++;
            count++;
            sum = sum + adj[u][v];
        }
        adj[u][v] = adj[v][u] = 999;
    }
    if (count == n - 1)
    {
        printf("The minimal spanning tree is as:\n");
        for (i = 0; i < n - 1; i++)
        {
            printf("%d -> %d\n", t[i][0], t[i][1]);
        }
        printf("Cost of spanning tree = %d\n", sum);
    }
    else
    {
        printf("\nSpanning tree does not exist!");
    }
}
```

Output:

```
D:\Codes\c\ADA_LAB>gcc kruskal.c

D:\Codes\c\ADA_LAB>.\a.exe
Enter the number of vertices: 4
Enter the adjacency matrix(use 999 as infinity):
0 999 999 2
3 0 999 8
1 4 0 12
999 999 6 0
The minimal spanning tree is as:
2 -> 0
0 -> 3
1 -> 0
Cost of spanning tree = 6
```

10. Dijkstra's Algorithm

Aim: To find shortest paths to other vertices from a given vertex in a weighted connected graph using Dijkstra's algorithm

Code:

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

int V;

int minDistance(int dist[], bool sptSet[])
{
    int min = INT_MAX, min_index;

    for (int v = 0; v < V; v++)
        if (sptSet[v] == false && dist[v] <= min)
        {
            min = dist[v], min_index = v;
        }

    return min_index;
}

void printSolution(int dist[])
{
    printf("Vertex \t\t Distance from Source\n");
    for (int i = 0; i < V; i++)
    {
        printf("%d \t\t\t\t %d\n", i+1, dist[i]);
    }
}

void dijkstra(int graph[V][V], int src)
{
    int dist[V];

    bool sptSet[V];

    for (int i = 0; i < V; i++)
    {
```

```
        dist[i] = INT_MAX, sptSet[i] = false;
    }

    dist[src] = 0;

    for (int count = 0; count < V - 1; count++)
    {
        int u = minDistance(dist, sptSet);
        sptSet[u] = true;

        for (int v = 0; v < V; v++)
            if (!sptSet[v] && graph[u][v] && dist[u] != INT_MAX && dist[u] +
graph[u][v] < dist[v])
            {
                dist[v] = dist[u] + graph[u][v];
            }
    }

    printSolution(dist);
}

int main()
{
    printf("Enter the number of vertices: ");
    scanf("%d", &V);
    int graph[V][V],source;

    printf("Enter cost matrix(use 999 for infinity):\n");
    for (int i = 0; i < V; i++)
    {
        printf("Enter the row %d: ", i + 1);
        for (int j = 0; j < V; j++)
        {
            scanf("%d", &graph[i][j]);
        }
    }
    printf("Enter the Source vertex named from 1 to %d:",V);
    scanf("%d",&source);

    dijkstra(graph, source-1);

    return 0;
}
```

Output:

```
D:\Codes\c\ADA_LAB>gcc dijkstras.c

D:\Codes\c\ADA_LAB>.\a.exe
Enter the number of vertices: 4
Enter cost matrix(use 999 for infinity):
Enter the row 1: 0 8 13 999
Enter the row 2: 12 0 999 999
Enter the row 3: 7 5 0 999
Enter the row 4: 999 999 9 0
Enter the Source vertex named from 1 to 4:2
Vertex          Distance from Source
1                               12
2                               0
3                               25
4                               999
```

11. N – Queen's Problem

Aim: To calculate a solution to place N queens in an N x N chess board such that no two queens cancel each other

Code:

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

int n;

bool isSafe(int **arr, int x, int y)
{
  int row, col;

  for (row = 0; row < x; row++)
  {
    if (arr[row][y] == 1)
    {
      return false;
    }
  }

  for (row = x, col = y; row >= 0 && col >= 0; row--, col--)
  {
    if (arr[row][col] == 1)
    {
      return false;
    }
  }
  for (row = x, col = y; row >= 0 && col < n; row--, col++)
  {
    if (arr[row][col] == 1)
    {
      return false;
    }
  }

  return true;
}
```

```c
bool nQueen(int **arr, int x)
{
  if (x >= n)
  {
    return true;
  }

  for (int col = 0; col < n; col++)
  {
    if (isSafe(arr, x, col))
    {
      arr[x][col] = 1;

      if (nQueen(arr, x + 1))
      {
        return true;
      }

      arr[x][col] = 0;
    }
  }

  return false;
}

int main(void)
{
  printf("Enter the size of board: ");
  scanf("%d", &n);
  int **arr = (int **)malloc(n * sizeof(int *));

  int i, j;
  for (i = 0; i < n; i++)
  {
    arr[i] = (int *)malloc(n * sizeof(int));
    for (j = 0; j < n; j++)
    {
      arr[i][j] = 0;
    }
  }

  if (nQueen(arr, 0))
  {
    for (i = 0; i < n; i++)
```

```
    {
      for (j = 0; j < n; j++)
      {
        printf("%d ", arr[i][j]);
      }
      printf("\n");
    }
  }
  else
  {
    printf("\nSolution does not exist!");
  }
}
```

Output:

```
D:\Codes\c\ADA_LAB>.\a.exe
Enter the size of board: 5
1 0 0 0 0
0 0 1 0 0
0 0 0 0 1
0 1 0 0 0
0 0 0 1 0
```