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LAB REPORT on

Analysis and Design of Algorithms

Submitted by

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in partial fulfillment for the award of the degree of
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in
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CERTIFICATE

This is to certify that the Lab work entitled “**Analysis and Design of Algorithms**” carried out by **AVANI KAMATH(1BM21CS036)**, 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 academic semester June-2023 to September-2023. The Lab report has been approved as it satisfies the academic requirements in respect of a **Analysis and Design of Algorithms (22CS4PCADA)** work prescribed for the said degree.

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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).Write program to print all the nodes reachable from a given starting node in a digraph using BFS method.

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

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

```
int a[10][20], q[10], visited[10], n, i, j, f = 0, r = -1;
```

```
void bfs(int k) {
```

```
    for(i = 0; i < n; i++){
```

```
        if(a[k][i] && visited[i]==0){
```

```
            q[++r] = i;
```

```
        }
```

```
    }
```

```
    if(f <= r){
```

```
        visited[q[f]] = 1;
```

```
        bfs(q[f++]);
```

```
    }
```

```
}
```

```
int main() {
```

```
    int v;
```

```
    printf("\nEnter the number of vertices:");
```

```
    scanf("%d", &n);
```

```
    for(i=1; i <= n; i++) {
```

```

    q[i] = 0;
    visited[i] = 0;
}

printf("\nEnter graph data in matrix form:\n");
for(i=0; i<n; i++) {
    for(j=0; j<n; j++) {
        scanf("%d", &a[i][j]);
    }
}

printf("\nEnter the starting vertex:");
scanf("%d", &v);
bfs(v);
printf("\nThe node which are reachable are:\n");

for(i=0; i < n; i++) {
    if(visited[i])
        printf("%d\t", i);
    else {
        printf("\nBfs is not possible. Not all nodes are reachable!\n");
        break;
    }
}
return 0;
}

```

OUTPUT

CASE1:

```
Enter the number of vertices:9

Enter graph data in matrix form:
0 1 1 1 0 0 0 0 0
1 0 0 0 1 1 0 0 0
1 0 0 0 0 0 1 0 0
1 0 0 0 0 0 0 1 0
1 0 0 0 0 0 0 1 0
0 1 0 0 0 0 0 0 1
0 1 0 0 0 0 0 0 1
0 0 1 0 0 0 0 0 1
0 0 0 1 0 0 0 0 1
0 0 0 0 1 1 1 1 0

Enter the starting vertex:1

The node which are reachable are:
0      1      2      3      4      5      6      7      8
Process returned 0 (0x0)   execution time : 146.258 s
Press any key to continue.
```

CASE 2:

```
Enter the number of vertices:5

Enter graph data in matrix form:
0 1 0 0 0
1 0 1 0 0
0 1 0 1 1
0 0 1 0 0
0 0 1 0 0

Enter the starting vertex:1

The node which are reachable are:
0      1      2      3      4
```

1(b).Write program to do the following check whether a given graph is connected or not using DFS method.

```
#include<stdio.h>

int graph[20][20], vis[10];

void DFS(int i,int n){
    int j;
    printf("Visited:%d\n",i);
    vis[i]=1;
    for(j=0;j<n;j++){
        if(graph[i][j]==1 && vis[j]==0){
            DFS(j,n);
        }
    }
}

void main(){

    int n,i,j,top=-1;
    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;
    }
```



```
    DFS(0,n);  
}
```

OUTPUT

CASE1:

```
Enter the number of vertices:  
9  
Enter the adjacency matrix representing the graph:  
0 1 1 1 0 0 0 0 0  
1 0 0 0 1 1 0 0 0  
1 0 0 0 0 0 1 1 0  
1 0 0 0 0 0 0 1 0  
0 1 0 0 0 0 0 0 1  
0 1 0 0 0 0 0 0 1  
0 0 1 0 0 0 0 0 1  
0 0 0 1 0 0 0 0 1  
0 0 0 0 1 1 1 1 0  
Visited:0  
Visited:1  
Visited:4  
Visited:8  
Visited:5  
Visited:6  
Visited:2  
Visited:7  
Visited:3
```

CASE2:

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

2. Write program to obtain the Topological ordering of vertices in a given digraph

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

int visited[50],graph[10][10],n,stack[10],top=-1;

void topological_sort(int node){
    visited[node]=1;

    for(int j=0;j<n;j++){
        if(graph[node][j]==1 && visited[j]!=1){
            topological_sort(j);
        }
    }

    stack[++top]=node;
}

int main(){
    printf("Enter Number of nodes\n");
    scanf("%d",&n);
    printf("Enter the matrix\n");
    for(int i=0;i<n;i++){
        for(int j=0;j<n;j++){
            int key;
            scanf("%d",&key);
            graph[i][j]=key;
        }
    }
    for(int i=0;i<n;i++){
        topological_sort(i);
    }
}
```

```
printf("\nTOPOLOGICAL SORT\n");
while(top!=-1){
    printf("%d ",stack[top--]);
}

return 0;
}
```

OUTPUT

CASE1:

```
C:\Users\Avani\Desktop\Tbm2Tcs036\w\bin\
Enter Number of nodes
4
Enter the matrix
0 0 0 0
1 0 0 0
1 0 0 0
0 1 1 0

TOPOLOGICAL SORT
3 2 1 0
```

CASE 2:

```
Enter Number of nodes
5
Enter the matrix
0 1 1 0 0
0 0 0 1 1
0 0 0 1 0
0 0 0 0 1
0 0 0 0 0

TOPOLOGICAL SORT
4 3 2 1 0 2 1 3 4
0 0 0 0 0 (0-0)
```

3. Implement Johnson Trotter algorithm to generate permutations.

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

```
#include <conio.h>
```

```
int NN, i, count=0;
```

```
int p[100], pi[100];
```

```
int dir[100];
```

```
void PrintPerm()
```

```
{
```

```
    int i;
```

```
    for (i=1; i <= NN; ++i)
```

```
        printf( "%d", p[i] );
```

```
    printf("\n");
```

```
}
```

```
void Move( int x, int d )
```

```
{
```

```
    int z;
```

```
    z = p[pi[x]+d];
```

```
    p[pi[x]] = z;
```

```
    p[pi[x]+d] = x;
```

```
    pi[z] = pi[x];
```

```

    pi[x] = pi[x]+d;
}

void Perm ( int n )
{
    int i;
    if (n > NN)
        PrintPerm();
    else
    {
        Perm( n+1 );
        for (i=1; i<=n-1; ++i)
        {
            Move( n, dir[n] );
            Perm( n+1 );
        }
        dir[n] = -dir[n];
    }
}

void main ()
{
    printf( "Enter n: " );
    scanf( "%d", &NN );

```

```
printf( "\n" );  
for (i=1; i<=NN; ++i)  
{  
    dir[i] = -1; p[i] = i;  
    pi[i] = i;  
}  
Perm ( 1 );  
printf( "\n" );  
}
```

OUTPUT

CASE1:

```
Enter n: 4
1234
1243
1423
4123
4132
1432
1342
1324
3124
3142
3412
4312
4321
3421
3241
3214
2314
2341
2431
4231
4213
2413
2143
2134
```

CASE2:

```
Enter n: 3
123
132
312
321
231
213
```


4. Sort a given set of N integer elements using Merge Sort technique and compute its time taken. Run the program for different values of N and record the time taken to sort.

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

int res[10], n;
void SortedMerge(int arr[], int l, int m, int h) {
    int i=l, j=m+1, k=0;

    while (i<=m && j<=h){
        if (arr[i]<arr[j]){
            res[k]=arr[i];
            i++;
        }
        else{
            res[k]=arr[j];
            j++;
        }
        k++;
    }
    while (i<=m){
        res[k++]=arr[i++];
    }
    while (j<=h){
        res[k]=arr[j];
        k++;
        j++;
    }
    for (int i=0; i<(h-l)+1; i++) {
        arr[l+i]=res[i];
    }
}

void Merge(int arr[], int l, int h){
    if (l<h){
```

```

        int m = (l+h)/2;
        Merge(arr, l, m);
        Merge(arr, m+1, h);
        SortedMerge(arr, l, m , h);
    }
}

int main(){
    int a[10],i;
    printf ("Enter size of array:\n");
    scanf("%d",&n);
    printf ("Enter elements:\n");
    for (i=0; i<n; i++){
        scanf("%d",&a[i]);
    }
    Merge(a,0,n-1);

    for (i=0; i<n; i++){
        printf ("%d ",a[i]);
    }
    return 0;
}

```

OUTPUT

CASE1:

```
Enter size of array:  
5  
Enter elements:  
14 87 98 2 0  
0 2 14 87 98
```

CASE2:

```
Enter size of array:  
6  
Enter elements:  
99 76 54 2 3 1  
1 2 3 54 76 99
```

5.Sort a given set of N integer elements using Quick Sort technique and compute its time taken.

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

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

```
int partition(int arr[], int low, int high) {  
    int i=low, j=high+1;  
    int pivot=arr[low];  
  
    while (i<j){  
        while (pivot >= arr[i]) i++;  
        while (pivot < arr[j]) j--;  
  
        if (i<j) swap(&arr[i], &arr[j]);  
    }  
    swap (&arr[low], &arr[j]);  
    return j;  
}
```

```
void quickSort(int arr[], int low, int high) {  
    if (low < high) {  
        int j = partition(arr, low, high);  
  
        quickSort(arr, low, j-1);  
        quickSort(arr, j+1, high);  
    }  
}
```

```
int main() {  
    int arr[10], n, i;
```

```
printf("Enter no. of elemetns:\n");
scanf ("%d", &n);

printf ("Enter elements:\n");
for (i=0; i<n; i++){
    scanf ("%d",&arr[i]);
}
quickSort(arr, 0, n-1);

printf("Sorted array: ");
for (i=0; i<n; i++){
    printf ("%d ", arr[i]);
}

return 0;
}
```

OUTPUT

CASE1:

```
Enter no. of elemetns:  
5  
Enter elements:  
20 30 40 50 60  
Sorted array: 0 20 30 40 60
```

CASE2:

```
Enter no. of elemetns:  
7  
Enter elements:  
10 20 30 40 70 675 1  
Sorted array: 0 1 10 20 30 40 675
```

6. Sort a given set of N integer elements using Heap Sort technique and compute its time taken.

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

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

```
void swap (int *x, int *y){
```

```
    int temp = *x;
```

```
    *x = *y;
```

```
    *y = temp;
```

```
}
```

```
void heapify (int arr[], int n, int i){
```

```
    int largest = i, left = 2*i+1, 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 (){
```

```
    int n;
```

```
    printf ("Enter number of elements: ");
```

```
    scanf ("%d", &n);
```

```
    int arr[n];
```

```
    printf ("Enter the elements: ");
```

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

```
        scanf ("%d", &arr[i]);
```

```
    }
```

```
    heapsort (arr, n);
```



```
printf ("Sorted elements: ");  
for (int i=0; i<n; i++){  
    printf ("%d ", arr[i]);  
}  
printf ("\n");  
return 0;  
}
```

OUTPUT

CASE1:

```
Enter number of elements: 7
Enter the elements: 11 23 66 8 45 9 54
Sorted elements: 8 9 11 23 45 54 66
```

CASE2:

```
Enter number of elements: 4
Enter the elements: 12 87 65 9
Sorted elements: 9 12 65 87
```

7.Implement 0/1 Knapsack problem using dynamic programming.

```
#include<stdio.h>

#include<conio.h>

void knapsack();

int max(int,int);

int i,j,n,m,p[10],w[10],v[10][10];

void main()

{

    printf("\nenter the no. of items:\t");

    scanf("%d",&n);

    printf("\nenter the weight of the each item:\n");

    for(i=1;i<=n;i++)

    {

        scanf("%d",&w[i]);

    }

    printf("\nenter the profit of each item:\n");

    for(i=1;i<=n;i++)

    {

        scanf("%d",&p[i]);

    }

    printf("\nenter the knapsack's capacity:\t");

    scanf("%d",&m);

    knapsack();

    getch();

}
```

```

}

void knapsack()
{
    int x[10];
    for(i=0;i<=n;i++)
    {
        for(j=0;j<=m;j++)
        {
            if(i==0 || j==0)
            {
                v[i][j]=0;
            }
            else if(j-w[i]<0)
            {
                v[i][j]=v[i-1][j];
            }
            else
            {
                v[i][j]=max(v[i-1][j],v[i-1][j-w[i]]+p[i]);
            }
        }
    }
}

printf("\nthe output is:\n");
for(i=0;i<=n;i++)

```

```

{
    for(j=0;j<=m;j++)
    {
        printf("%d\t",v[i][j]);
    }
    printf("\n\n");
}

printf("\nthe optimal solution is %d",v[n][m]);

printf("\nthe solution vector is:\n");

for(i=n;i>=1;i--)
{
    if(v[i][m]!=v[i-1][m])
    {
        x[i]=1;
        m=m-w[i];
    }
    else
    {
        x[i]=0;
    }
}

for(i=1;i<=n;i++)
{
    printf("%d\t",x[i]);
}

```

```
}  
  
}  
  
int max(int x,int y)  
{  
    if(x>y)  
    {  
        return x;  
    }  
    else  
    {  
        return y;  
    }  
}
```

OUTPUT

CASE1:

```
enter the no. of items: 4
enter the weight of the each item:
1 2 3 4
enter the profit of each item:
13 14 15 16
enter the knapsack's capacity: 5
the output is:
0      0      0      0      0      0
0      13     13     13     13     13
0      13     14     27     27     27
0      13     14     27     28     29
0      13     14     27     28     29
```

CASE 2:

```
enter the no. of items: 3
enter the weight of the each item:
2 3 4
enter the profit of each item:
56 14 34
enter the knapsack's capacity: 6
the output is:
0      0      0      0      0      0      0
0      0      56     56     56     56     56
0      0      56     56     56     70     70
0      0      56     56     56     70     90
```

8.Implement All Pair Shortest paths problem using Floyd's algorithm.

```
#include <stdio.h>

#include <stdlib.h>

#include <limits.h>

int min (int a, int b) {

    return a < b ? a : b;

}

int main(){

    int n, graph[10][10], i, j, k;

    printf("Enter the number of vertices:\n");

    scanf("%d",&n);

    printf("Enter the weighs of graph in the form of an adjacency matrix:\n");

    for (int i=0; i<n; i++){

        for (int j=0; j<n; j++) {

            scanf ("%d", &graph[i][j]);

            if (i==j) graph[i][j]=0;

            else if (graph[i][j]==0) graph[i][j] = INT_MAX/3;

        }

    }

    for (k=0; k<n; k++) {
```



```

    for (i=0; i<n; i++){
        for (j=0; j<n; j++){
            graph[i][j] = min(graph[i][j], graph[i][k]+graph[k][j]);
        }
    }
}

for (i=0; i<n; i++){
    printf ("\n");
    for (j=0; j<n; j++) {
        printf ("%d ", graph[i][j]);
    }
}

return 0;
}

```

OUTPUT

CASE 1:

```
Enter the number of vertices:
4
Enter the weighs of graph in the form of an adjecency matrix:
0 1 999 4
999 0 999 999
8 2 0 999
999 6 5 0

0 1 9 4
999 0 999 999
8 2 0 12
13 6 5 0
```

CASE 2:

```
Enter the number of vertices:
3
Enter the weighs of graph in the form of an adjecency matrix:
0 999 1
0 999 999
2 8 0

0 9 1
1001 0 999
2 8 0
```

9. Find Minimum Cost Spanning Tree of a given undirected graph using Prim's and Kruskal's algorithm.

PRIMS ALGORITHM

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

```
int cost[10][10],vt[10],et[10][10],vis[10],j,n;
```

```
int sum=0;
```

```
int x=1;
```

```
int e=0;
```

```
void prims();
```

```
int main()
```

```
{
```

```
    int i;
```

```
    printf("enter the number of vertices\n");
```

```
    scanf("%d",&n);
```

```
    printf("enter the cost adjacency matrix\n");
```

```
    for(i=1;i<=n;i++)
```

```
    {
```

```
        for(j=1;j<=n;j++)
```

```
        {
```

```
            scanf("%d",&cost[i][j]);
```

```
        }
```

```

        vis[i]=0;
    }
    prims();
    printf("edges of spanning tree\n");
    for(i=1;i<=e;i++)
    {
        printf("%d,%d\t",et[i][0],et[i][1]);
    }
    printf("weight=%d\n",sum);
    return 0;
}

```

```

void prims()
{
    int s,min,m,k,u,v;

    vt[x]=1;
    vis[x]=1;
    for(s=1;s<n;s++)
    {
        j=x;
        min=999;
        while(j>0)
        {
            k=vt[j];

```

```

        for(m=2;m<=n;m++)
        {
            if(vis[m]==0)
            {
                if(cost[k][m]<min)
                {
                    min=cost[k][m];
                    u=k;
                    v=m;
                }
            }
        }
        j--;
    }
    vt[++x]=v;
    et[s][0]=u;
    et[s][1]=v;
    e++;
    vis[v]=1;
    sum=sum+min;
}
}

```

OUTPUT

CASE1:

```
enter the number of vertices
6
enter the cost adjacency matrix
0 3 999 999 6 5
3 0 1 999 999 4
999 1 0 6 999 4
999 999 6 0 8 5
6 999 999 8 0 5
6 999 999 8 0 2
edges of spanning tree
1,2    2,3    3,6    6,5    3,4    weight=14
```

CASE 2:

```
enter the number of vertices
4
enter the cost adjacency matrix
999 1 3 999
0 3 999 999
999 5 6 7
8 2 1 0
edges of spanning tree
1,2    1,3    3,4    weight=11
```

KRUSHKALS ALGORITHM

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

```
int find(int v, int parent[10])
{
    while (parent[v] != v)
    {
        v = parent[v];
    }
    return v;
}
```

```
void union1(int i, int j, int parent[10])
{
    if (i < j)
        parent[j] = i;
    else
        parent[i] = j;
}
```

```
void kruskal(int n, int a[10][10])
{
    int count, k, min, sum, i, j, t[10][10], u, v, parent[10];
    count = 0;
    k = 0;
    sum = 0;
    for (i = 0; i < n; i++)
        parent[i] = i;
    while (count != n - 1)
    {
        min = 999;
        for (i = 0; i < n; i++)
        {
            for (j = 0; j < n; j++)
            {
                if (a[i][j] < min && a[i][j] != 0)
```

```

        {
            min = a[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 + a[u][v];
}
a[u][v] = a[v][u] = 999;
}
if (count == n - 1)
{
    printf("spanning tree\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("spanning tree does not exist\n");
}

int main()
{
    int n, i, j, a[10][10];
    printf("enter the number of nodes\n");
    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]);  
}  
kruskal(n, a);  
return 0;  
}
```

OUTPUT

CASE 1:

```
enter the number of nodes
5
enter the adjacency matrix
0 5 999 6 999
5 0 1 3 999
0 1 0 4 6
6 3 4 0 2
0 0 6 2 0
spanning tree
1 2
3 4
1 3
0 1
cost of spanning tree=11
```

CASE 2:

```
enter the number of nodes
4
enter the adjacency matrix
999 1 3 4
5 6 7 8
999 999 3 4
9 8 7 5
spanning tree
0 1
0 2
0 3
cost of spanning tree=8
```

10.From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.

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

void dijkstras();
int c[10][10], n, src;
void printPath(int parent[], int node);

void main()
{
    int i, j;
    printf("\nEnter the no of vertices:\t");
    scanf("%d", &n);
    printf("\nEnter the cost matrix:\n");
    for (i = 1; i <= n; i++)
    {
        for (j = 1; j <= n; j++)
        {
            scanf("%d", &c[i][j]);
        }
    }
    printf("\nEnter the source node:\t");
    scanf("%d", &src);
    dijkstras();
    getch();
}

void dijkstras()
{
    int vis[10], dist[10], parent[10], u, j, count, min;
    for (j = 1; j <= n; j++)
    {
        dist[j] = c[src][j];
        parent[j] = src;
    }
    for (j = 1; j <= n; j++)
```

```

{
    vis[j] = 0;
}
dist[src] = 0;
vis[src] = 1;
count = 1;
while (count != n)
{
    min = 9999;
    for (j = 1; j <= n; j++)
    {
        if (dist[j] < min && vis[j] != 1)
        {
            min = dist[j];
            u = j;
        }
    }
    vis[u] = 1;
    count++;
    for (j = 1; j <= n; j++)
    {
        if (min + c[u][j] < dist[j] && vis[j] != 1)
        {
            dist[j] = min + c[u][j];
            parent[j] = u;
        }
    }
}
printf("\nThe shortest distance is:\n");
for (j = 1; j <= n; j++)
{
    printf("\n%d-->%d=%d (Path: %d", src, j, dist[j], src);
    printPath(parent, j);
    printf(")");
}
}

```

```

void printPath(int parent[], int node)

```

```
{  
    if (parent[node] == src)  
    {  
        printf("->%d", node);  
        return;  
    }  
    printPath(parent, parent[node]);  
    printf("->%d", node);  
}
```

OUTPUT

CASE 1:

```
Enter the no of vertices:      6

Enter the cost matrix:
0 25 35 999 100 999
999 0 27 14 999 999
999 999 0 29 999 999
999 999 999 0 999 21
999 999 50 999 0 999
999 999 999 999 48 0

Enter the source node:  1

The shortest distance is:

1-->1=0 (Path: 1->1)
1-->2=25 (Path: 1->2)
1-->3=35 (Path: 1->3)
1-->4=39 (Path: 1->2->4)
1-->5=100 (Path: 1->5)
1-->6=60 (Path: 1->2->4->6)

```

CASE 2:

```
Enter the no of vertices:      5

Enter the cost matrix:
999 5 4 3 999
12 3 4 999 999
6 0 8 4 3
8 9 999 999 999
999 999 12 34 5

Enter the source node:  1

The shortest distance is:

1-->1=0 (Path: 1->1)
1-->2=4 (Path: 1->3->2)
1-->3=4 (Path: 1->3)
1-->4=3 (Path: 1->4)
1-->5=7 (Path: 1->3->5)

```

11. Implement "N-Queens Problem" using Backtracking.

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

int board[20],count;

int main()
{
    int n,i,j;
    void queen(int row,int n);

    printf(" - N Queens Problem Using Backtracking -");
    printf("\n\nEnter number of Queens:");
    scanf("%d",&n);
    queen(1,n);
    return 0;
}

void print(int n)
{
    int i,j;
    printf("\n\nSolution %d:\n\n",++count);

    for(i=1;i<=n;++i)
        printf("\t%d",i);

    for(i=1;i<=n;++i)
    {
        printf("\n\n%d",i);
        for(j=1;j<=n;++j)
        {
            if(board[i]==j)
                printf("\tQ");
            else
                printf("\t-");
        }
    }
}
```

```
}
```

```
int place(int row,int column)
```

```
{
```

```
int i;
```

```
for(i=1;i<=row-1;++i)
```

```
{
```

```
    if(board[i]==column)
```

```
        return 0;
```

```
    else
```

```
        if(abs(board[i]-column)==abs(i-row))
```

```
            return 0;
```

```
}
```

```
return 1;
```

```
}
```

```
void queen(int row,int n)
```

```
{
```

```
int column;
```

```
for(column=1;column<=n;++column)
```

```
{
```

```
    if(place(row,column))
```

```
    {
```

```
        board[row]=column;
```

```
        if(row==n)
```

```
            print(n);
```

```
        else
```

```
            queen(row+1,n);
```

```
    }
```

```
}
```

```
}
```


OUTPUT

CASE 1:

```
Enter number of Queens:4

Solution 1:

   1   2   3   4
1   -   Q   -   -
2   -   -   -   Q
3   Q   -   -   -
4   -   -   Q   -

Solution 2:

   1   2   3   4
1   -   -   Q   -
2   Q   -   -   -
3   -   -   -   Q
4   -   Q   -   -
```

CASE 2:

```
Enter number of Queens:6

Solution 1:

   1   2   3   4   5   6
1   -   Q   -   -   -   -
2   -   -   -   Q   -   -
3   -   -   -   -   -   Q
4   Q   -   -   -   -   -
5   -   -   Q   -   -   -
6   -   -   -   -   Q   -

Solution 2:

   1   2   3   4   5   6
1   -   -   Q   -   -   -
2   -   -   -   -   -   Q
3   -   Q   -   -   -   -
4   -   -   -   -   Q   -
5   Q   -   -   -   -   -
6   -   -   -   Q   -   -

Solution 3:

   1   2   3   4   5   6
1   -   -   -   Q   -   -
2   Q   -   -   -   -   -
3   -   -   -   -   Q   -
4   -   Q   -   -   -   -
```

```
Solution 4:

   1   2   3   4   5   6
1   -   -   -   -   Q   -
2   -   -   Q   -   -   -
3   Q   -   -   -   -   -
4   -   -   -   -   -   Q
5   -   -   -   Q   -   -
6   -   Q   -   -   -   -
```

