VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT
on

Analysis and Design of Algorithms

Submitted by

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in partial fulfilment 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 **NIKHIL SRIKANTH (1BM20CS096),** 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 2022. The Lab report has been approved as it satisfies the academic requirements in respect of an **Analysis and Design of Algorithms - (19CS4PCADA)** work prescribed for the said degree.

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Index Sheet

Course Outcome

CO1	Ability to **analyze** time complexity of Recursive and Non-Recursive algorithms using asymptotic notations.
CO2	Ability to **design** efficient algorithms using various design techniques.
CO3	Ability to **apply** the knowledge of complexity classes P, NP, and NP-Complete and prove certain problems are NP-Complete
CO4	Ability to **conduct** practical experiments to solve problems using an appropriate designing method and find time efficiency.

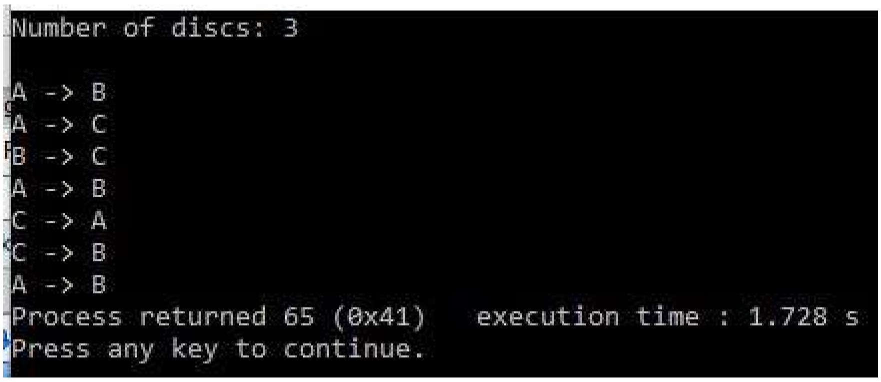
Experiment 1

Write a recursive program to Solve
A: *Towers-of-Hanoi problem*

Program:

```
#include<stdio.h>

void TOH(int,char,char,char);

void main()

{        int n;

         printf("Number of discs: ");

         scanf("%d",&n);

         TOH(n,'A','B','C');

}


void TOH(int n,char x,char y,char z)

{  if(n>0)

   {

         TOH(n-1,x,z,y);

         printf("\n%c -> %c",x,y);

         TOH(n-1,z,y,x);

   }

}
```

Output:



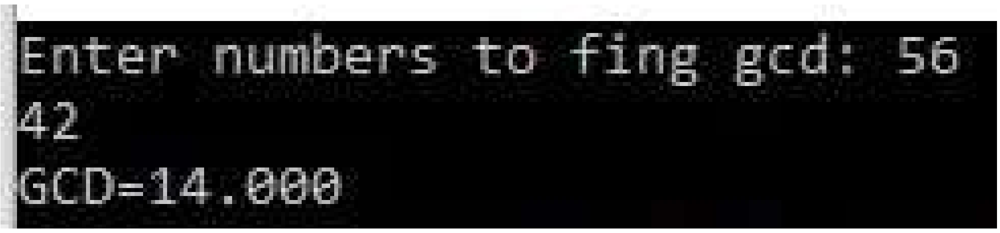
```
Number of discs: 3

A -> B
A -> C
B -> C
A -> B
C -> A
C -> B
A -> B
Process returned 65 (0x41)   execution time : 1.728 s
Press any key to continue.
```

B: *To find GCD*

Program:

```
#include<stdio.h>
int main()
{   double HCF;
    int n1,n2;
    printf("Enter numbers to fing gcd: ");
    scanf("%d %d", &n1,&n2);
    HCF=hcf(n1,n2);
    printf("GCD=%.3f", HCF);
}

hcf(int m,int n)
{
    if(n==0)
        return m;
    else
        return(hcf(n,m%n));
}
```

Output:



```
Enter numbers to fing gcd: 56
42
GCD=14.000
```

Experiment 2

Implement Recursive *Binary search* and *Linear search* and determine the time required to search an element. Repeat the experiment for different values of N and plot a graph of the time taken versus N.

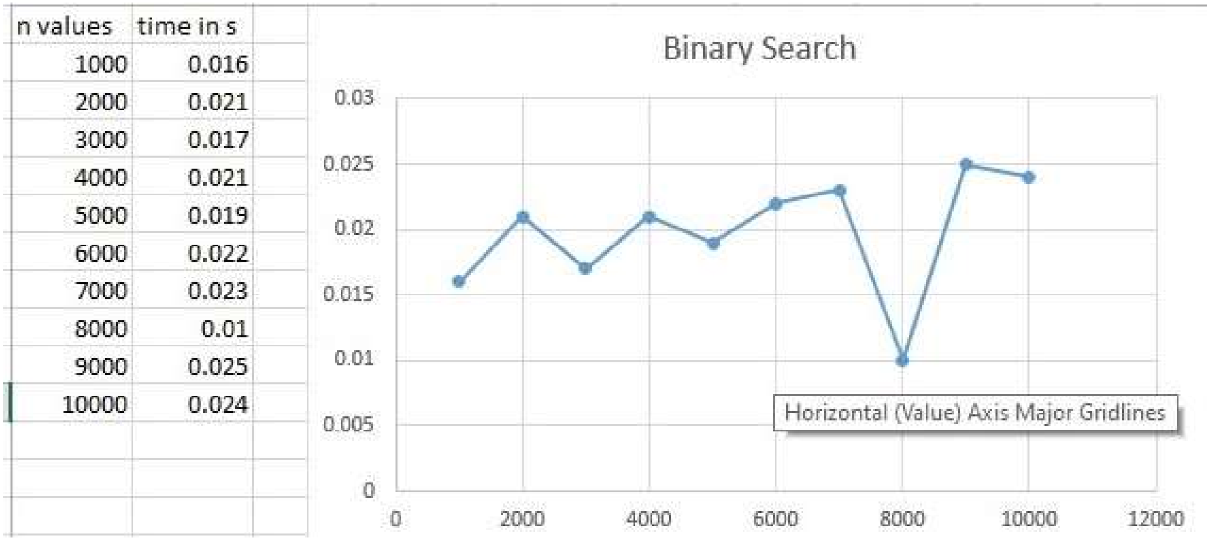
Binary Search:

Program:

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

void delay()
{
   int i,j,temp;
   for(i=0;i<500000;i++)
      temp=30/333;
   return;
}
int binary(int l,int h,int arr[],int key)
{
   int m;
   delay();
   m=(l+h)/2;
   if(l>h)
      return -1;
   if(arr[m]==key)
      return (m+1);
   else if(key>arr[m])
```

```
        return (binary(m+1,h,arr,key));
    else
        return (binary(l,m-1,arr,key));
}

int main()
{
    clock_t start,end;
    int m,l,h,flag;
    int n, arr[10000],key,i;
    printf("Enter the value of n: ");
    scanf("%d",&n);
    for(i=0;i<n;i++)
        arr[i]=i;
    key=arr[n-1];
    l=0;
    h=n-1;
    i=0;
    start=clock();
    flag=binary(l,h,arr,key);
    if(flag==-1)
        printf("\nKey not found!");
    else
        printf("\nKey found at %d position",flag);
    end=clock();
    printf("\nTime taken: %f",(double)(end-start)/CLOCKS_PER_SEC);
}
```

Output:



n values	time in s
1000	0.016
2000	0.021
3000	0.017
4000	0.021
5000	0.019
6000	0.022
7000	0.023
8000	0.01
9000	0.025
10000	0.024

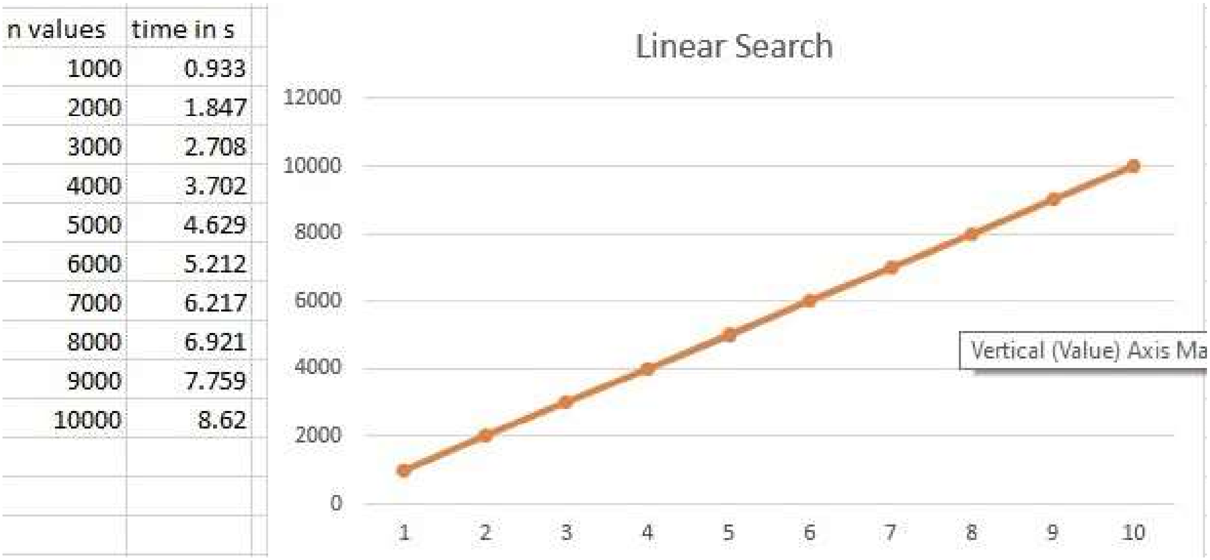
Linear Search:

Program:

```
#include<stdio.h>

#include<stdlib.h>

#include<time.h>


void delay()

{

   int i,j,temp;

   for(i=0;i<500000;i++)

      temp=30/333;

   return;

}


int linear(int arr[],int i,int key,int n)

{

   delay();
```

```
    if(i==n)
        return -1;
    else if(arr[i]==key)
        return (i+1);
    else
        return (linear(arr,(i+1),key,n));
}

int main()
{
    clock_t start,end;
    int flag;
    int n, arr[10000],key,i;
    printf("Enter the value of n: ");
    scanf("%d",&n);
    for(i=0;i<n;i++)
        arr[i]=i;
    key=arr[n-1];
    i=0;
    start=clock();
    flag=linear(arr,i,key,n);
    if(flag==-1)
        printf("\nKey not found!");
    else
        printf("\nKey found at %d position",flag);
    end=clock();
    printf("\nTime taken: %f",(double)(end-start)/CLOCKS_PER_SEC);   }
```

Output:



n values	time in s
1000	0.933
2000	1.847
3000	2.708
4000	3.702
5000	4.629
6000	5.212
7000	6.217
8000	6.921
9000	7.759
10000	8.62

Experiment 3

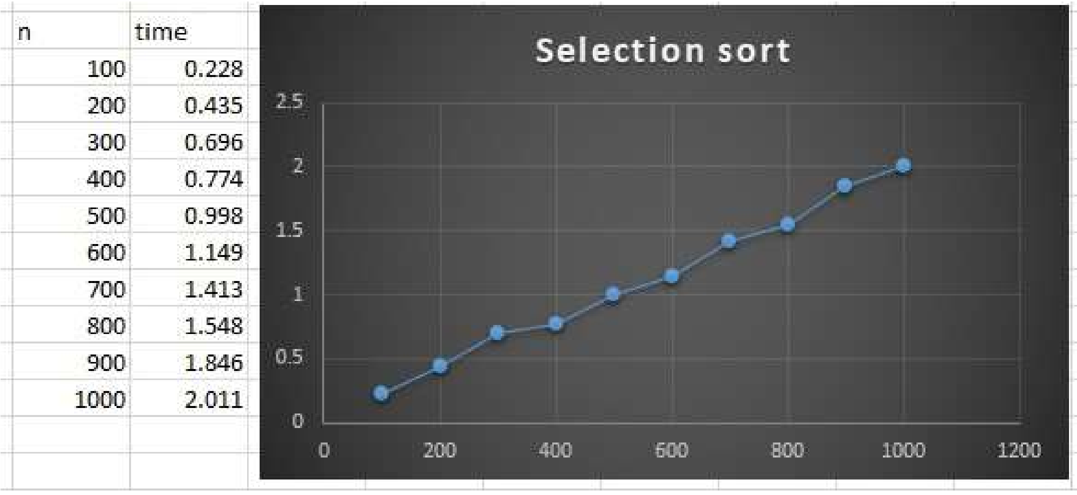
Sort a given set of N integer elements using ***Selection Sort*** technique and compute its time taken. Run the program for different values of N and record the time taken to sort.

Program:

```
#include <stdio.h>

#include<time.h>

#define MAX 20000

void delay()

{

   int i,temp;

   for(i=0;i<1000000;i++)

      temp=32/33233;

   return;

}

int main()

{

         int a[MAX], k, n, i, j, position, swap;

         printf("Enter number of elements:");

         scanf("%d", &n);

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

           {  a[i]= rand(); }

         clock_t start=clock();

         for(i = 0; i < n - 1; i++)

         {delay();

         position=i;

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

         {
```

```
    if(a[position] > a[j])
        position=j;
    }
    if(position != i)
    {
    swap=a[i];
    a[i]=a[position];
    a[position]=swap;
    }
    }
    clock_t end=clock();
    printf("Sorted Array: ");
    for(i = 0; i < n; i++)
    printf("%d ", a[i]);
    printf("\nExecution time: %f",(double)(end-start)/CLOCKS_PER_SEC);
    return 0;
}
```

Output:



n	time
100	0.228
200	0.435
300	0.696
400	0.774
500	0.998
600	1.149
700	1.413
800	1.548
900	1.846
1000	2.011

Experiment 4

Write program to do the following:

a) Print all the nodes reachable from a given starting node in a digraph using *BFS method*.
b) Check whether a given graph is connected or not using *DFS method*.

a)

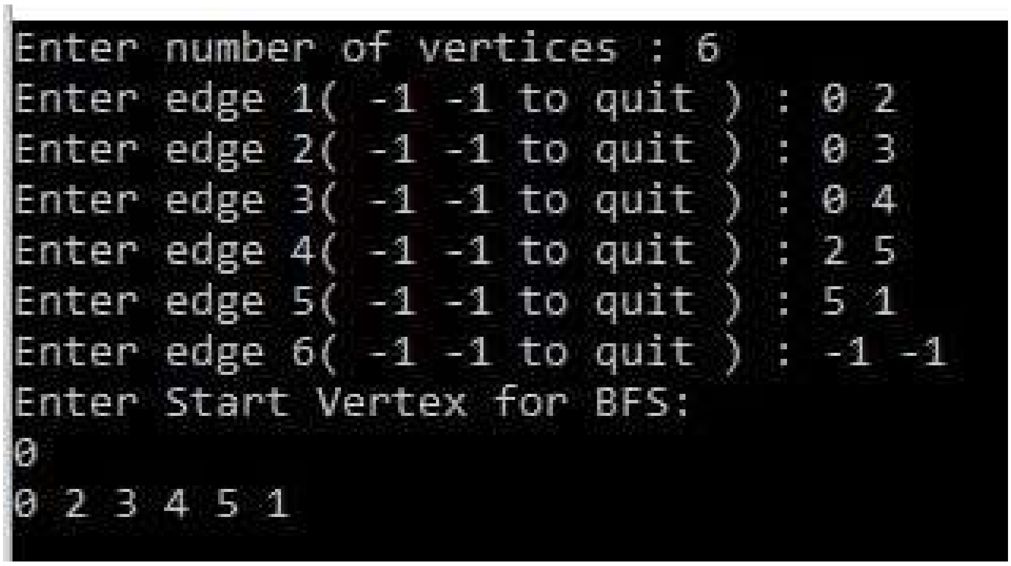
Program:

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

#define MAX 100

#define initial 1
#define waiting 2
#define visited 3

int n;
int adj[MAX][MAX];
int state[MAX];
void create_graph();
void BF_Traversal();
void BFS(int v);

int queue[MAX], front = -1,rear = -1;
void insert_queue(int vertex);
int delete_queue();
int isEmpty_queue();
int main()
{
create_graph();
BF_Traversal();
return 0;
}

void BF_Traversal()
{
int v;
for(v=0; v<n; v++)
state[v] = initial;
printf("Enter Start Vertex for BFS: \n");
scanf("%d", &v);
BFS(v);
}

void BFS(int v)
{
int i;
insert_queue(v);
state[v] = waiting;
while(!isEmpty_queue())
{
v = delete_queue( );
printf("%d ",v);
state[v] = visited;
for(i=0; i<n; i++)
{
if(adj[v][i] == 1 && state[i] == initial)
{
insert_queue(i);
state[i] = waiting;
}
}
}
printf("\n");
}

void insert_queue(int vertex)
{
if(rear == MAX-1)
printf("Queue Overflow\n");
else
{
if(front == -1)
front = 0;
rear = rear+1;
queue[rear] = vertex ;
}
}

int isEmpty_queue()
{
if(front == -1 || front > rear)
```

```c
return 1;
else
return 0;
}

int delete_queue()
{
int delete_item;
if(front == -1 || front > rear)
{
printf("Queue Underflow\n");
exit(1);
}
delete_item = queue[front];
front = front+1;
return delete_item;
}

void create_graph()
{
int count,max_edge,origin,destin;

printf("Enter number of vertices : ");
scanf("%d",&n);
max_edge = n*(n-1);

for(count=1; count<=max_edge; count++)
{
```

```
printf("Enter edge %d( -1 -1 to quit ) : ",count);
scanf("%d %d",&origin,&destin);

if((origin == -1) && (destin == -1))
break;

if(origin>=n || destin>=n || origin<0 || destin<0)
{
printf("Invalid edge!\n");
count--;
}
else
{
adj[origin][destin] = 1;
} } }
```

Output:



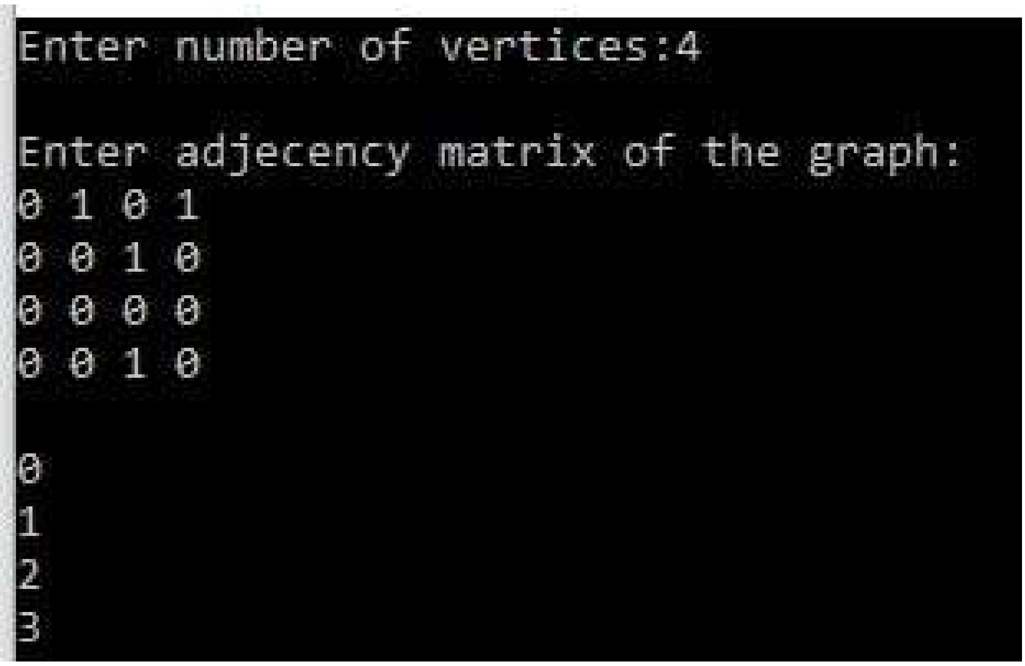
```
Enter number of vertices : 6
Enter edge 1( -1 -1 to quit ) : 0 2
Enter edge 2( -1 -1 to quit ) : 0 3
Enter edge 3( -1 -1 to quit ) : 0 4
Enter edge 4( -1 -1 to quit ) : 2 5
Enter edge 5( -1 -1 to quit ) : 5 1
Enter edge 6( -1 -1 to quit ) : -1 -1
Enter Start Vertex for BFS:
0
0 2 3 4 5 1
```

b)

Program:

```
#include<stdio.h>
#include<stdlib.h>
void DFS(int);
int G[10][10],visited[10],n;

void DFS(int i)
{
    int j;
    printf("\n%d",i);
    visited[i]=1;
    for(j=0;j<n;j++)
       {if(!visited[j]&&G[i][j]==1)
            {DFS(j); }
       }  }
void main()
{
    int i,j;
    printf("Enter number of vertices:");
    scanf("%d",&n);
    printf("\nEnter adjecency matrix of the graph:");
    for(i=0;i<n;i++)
       for(j=0;j<n;j++)
        scanf("%d",&G[i][j]);
    for(i=0;i<n;i++)
        visited[i]=0;
    DFS(0);   }
```

Output:



```
Enter number of vertices:4

Enter adjecency matrix of the graph:
0 1 0 1
0 0 1 0
0 0 0 0
0 0 1 0

0
1
2
3
```

Experiment 5

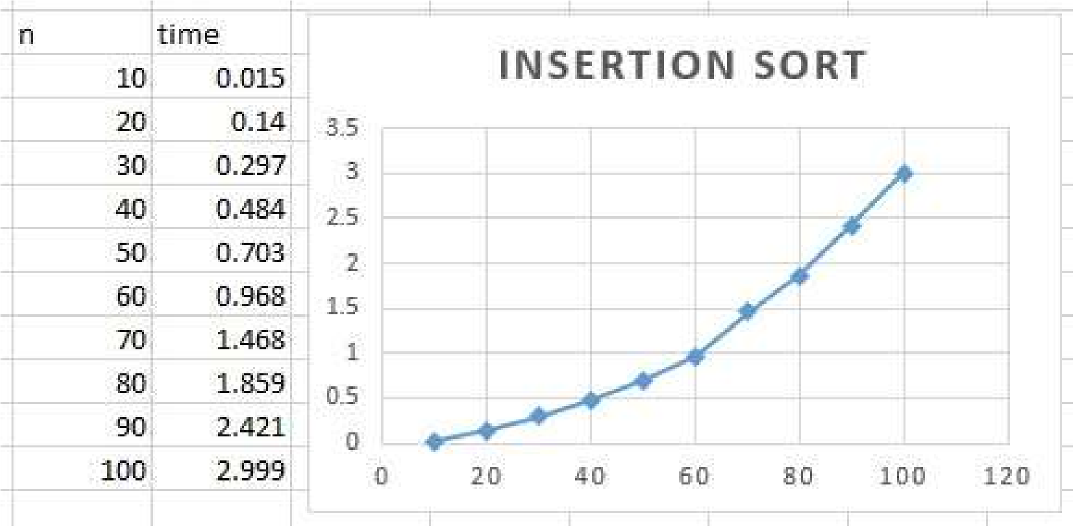
Sort a given set of N integer elements using *Insertion Sort* technique and compute its time taken.

Program:

```
#include <stdio.h>

#include<time.h>

#define MAX 200000

void delay()

{

   int i,j,temp;

   for(i=0;i<1000000;i++)

      temp=32/33233;

   return;

}

void insert(int a[], int n)

{

   int i, j, temp;

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

      temp = a[i];

      j = i - 1;

      while(j>=0 && temp <= a[j])

      {   delay();

         a[j+1] = a[j];

         j = j-1;

      }

      a[j+1] = temp;

   } }
```

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

int main()
{  clock_t start,end;
     int a[MAX],n,i;
    printf("Enter the number of elements: ");
    scanf("%d",&n);
    for(i=0;i<n;i++)
        {   a[i]= rand(); }
    start=clock();
    insert(a, n);
    end=clock();
    printf("\nAfter sorting array elements are - ");
    print(a, n);
    printf("\nTime taken: %f", (double)(end-start)/CLOCKS_PER_SEC );
    printf("\n");
    return 0;
}
```

Output:



n	time
10	0.015
20	0.14
30	0.297
40	0.484
50	0.703
60	0.968
70	1.468
80	1.859
90	2.421
100	2.999

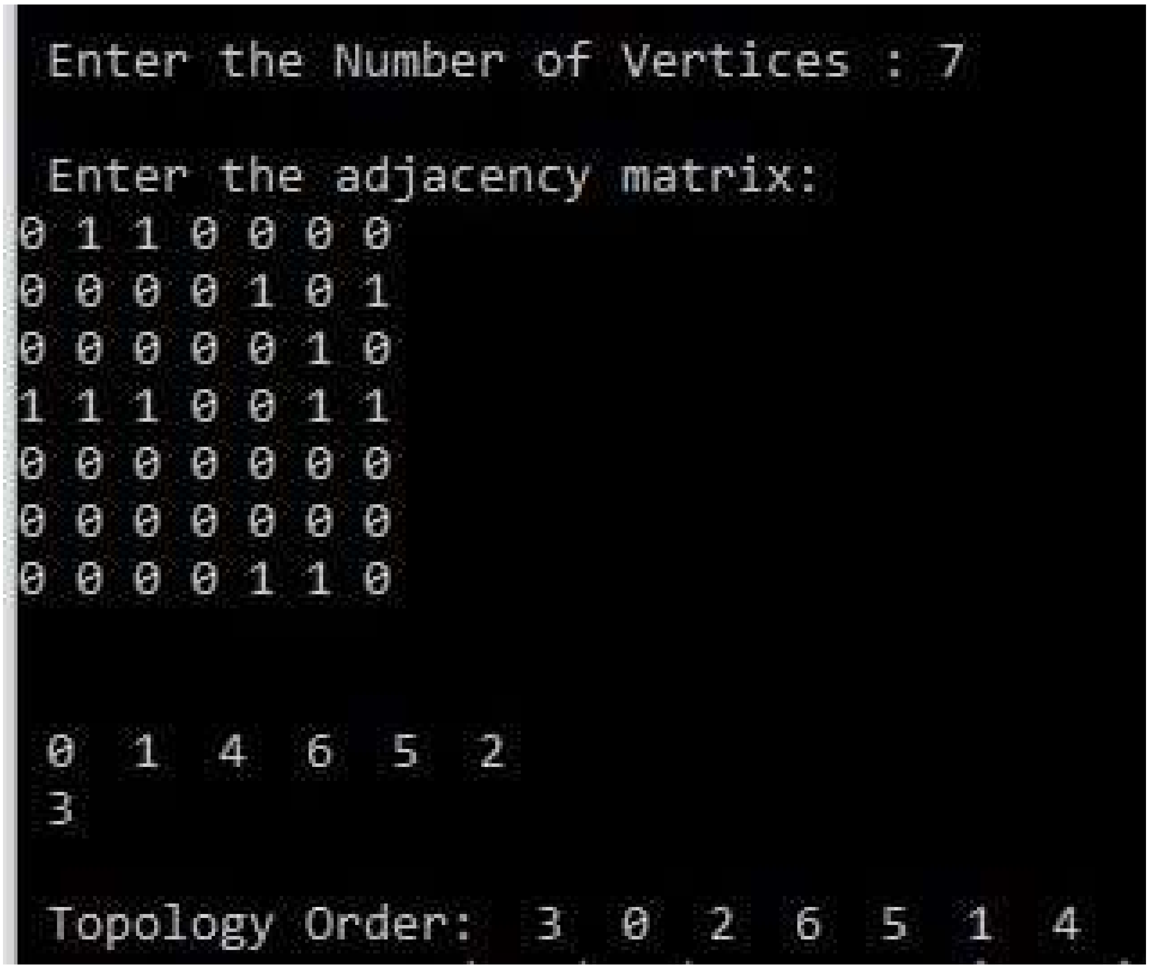
Experiment 6

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

Program:

```
#include<stdio.h>


 void topo(int,int);
 int g[10][10],visited[10],deadend[10],d=-1,n;
 int sortedOrder[10],o,count=0;


 int main()
 {
    printf("\n Enter the Number of Vertices : ");
    scanf("%d",&n);
    o=n;
    printf("\n Enter the adjacency matrix:\n");
       for(int i=0;i<n;i++)
       { for(int j=0;j<n;j++)
                   scanf("%d",&g[i][j]);
       visited[i]=0;
       }
       printf("\n");
       for(int i=0;i<n;i++)
    {
      topo(i,0);
    }
    printf("\n\n Topology Order: ");
    for(int i=0;i<n;i++)
    {
        printf(" %d ",sortedOrder[i]);
    }
    return 0;
}

void topo(int k,int flag)
{
    if(flag==0 && visited[k]==0)
    {
        printf("\n %d ",k);
        sortedOrder[--o]=k;
    }
    else if(flag==0 && visited[k]!=0)
    printf("");
    else
    {
        printf(" %d ",k);
        deadend[++d]=k;
    }
    visited[k]=1;
    for(int j=0;j<n;j++)
        if(visited[j]==0 && g[k][j]==1)
        {
            topo(j,1);
        }
    if(d>=0){
    int temp=sortedOrder[o++];
    for(int k=d;k>=0;k--,--d)
    {
       sortedOrder[--o]=deadend[k];
    }
    sortedOrder[--o]=temp;
    }
 }
```

Output:



```
 Enter the Number of Vertices : 7

 Enter the adjacency matrix:
0 1 1 0 0 0 0
0 0 0 0 1 0 1
0 0 0 0 0 1 0
1 1 1 0 0 1 1
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 1 1 0


 0  1  4  6  5  2
 3

 Topology Order:  3  0  2  6  5  1  4
```

Experiment 7

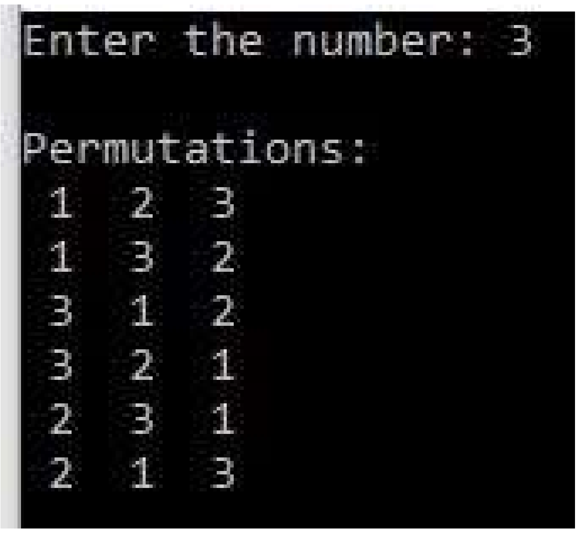
Implement *Johnson Trotter algorithm* to generate permutations.

Program:

```
#include <stdio.h>
#include <stdlib.h>
int flag = 0;
int swap(int *a,int *b)
{
     int t = *a;
    *a = *b;
    *b = t;
}

int search(int arr[],int num,int mobile)
{
    int g;
    for(g=0;g<num;g++)
    {
        if(arr[g] == mobile)
        {
             return g+1;
        }
        else
        {
         flag++;
        }
    }
    return -1;
}
int find_Moblie(int arr[],int d[],int num)
{
    int mobile = 0;
    int mobile_p = 0;
    int i;
    for(i=0;i<num;i++)
    {
        if((d[arr[i]-1] == 0) && i != 0)
        {
            if(arr[i]>arr[i-1] && arr[i]>mobile_p)
            {
                mobile = arr[i];
                mobile_p = mobile;
            }
            else
            {
                flag++ ;    }
        }
        else if((d[arr[i]-1] == 1) & i != num-1)
        {
            if(arr[i]>arr[i+1] && arr[i]>mobile_p)
            {
                mobile = arr[i];
                mobile_p = mobile;
            }
            else
            {
                flag++;
            }
        }
        else
            {
                flag++;
            }
    }
    if((mobile_p == 0) && (mobile == 0))
        return 0;
    else
        return mobile;
}
void permutations(int arr[],int d[],int num)
{
    int i;
    int mobile = find_Moblie(arr,d,num);
    int pos = search(arr,num,mobile);
    if(d[arr[pos-1]-1]==0)
        swap(&arr[pos-1],&arr[pos-2]);
    else
        swap(&arr[pos-1],&arr[pos]);
    for(int i=0;i<num;i++)
    {
        if(arr[i] > mobile)
        {
            if(d[arr[i]-1]==0)
            d[arr[i]-1] = 1;
         else
            d[arr[i]-1] = 0;
      }
   }
   for(i=0;i<num;i++)
   {
      printf(" %d ",arr[i]);
   }
}

int factorial(int k)
{
   int f = 1;
   int i = 0;
   for(i=1;i<k+1;i++)
   {
      f = f*i;
   }
   return f;
}
int main()
{
   int num = 0;
   int i,j,z=0;
   printf("Enter the number: ");
   scanf("%d",&num);
   int arr[num],d[num];
```

```
    z = factorial(num);
    printf("\nPermutations: \n");
    for(i=0;i<num;i++)
    {
        d[i] = 0;
        arr[i] = i+1;
        printf(" %d ",arr[i]);
    }
    printf("\n");
    for(j=1;j<z;j++)
    {
        permutations(arr,d,num);
        printf("\n");
    }
    return 0;
}
```

Output:



```
Enter the number: 3

Permutations:
 1  2  3
 1  3  2
 3  1  2
 3  2  1
 2  3  1
 2  1  3
```

Experiment 8

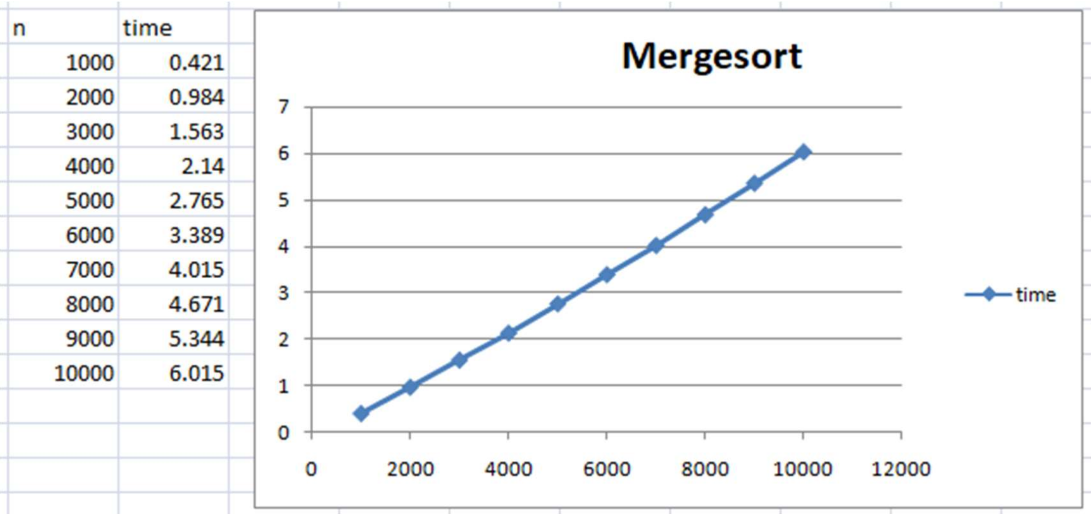
Sort a given set of N integer elements using *Merge Sort* technique and compute its time taken. Run the program for different values of N and record the time taken to sort.

Program:

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

void mergesort(int a[],int i,int j);
void merge(int a[],int i1,int j1,int i2,int j2);
void delay();
int main()
{
   int n,i;
   printf("Enter no of elements:");
   scanf("%d",&n);
   int a[n];
   for(i=0;i<n;i++)
      a[i] = rand();

   clock_t start = clock();
   mergesort(a,0,n-1);
   clock_t end = clock();

   printf("\nSorted array is :");
   for(i=0;i<n;i++)
      printf("%d ",a[i]);
```

```
    printf("\n\nThe total time taken is : %f",(double)(end-start)/CLOCKS_PER_SEC);
    return 0;
}

void mergesort(int a[],int i,int j)
{
int mid;
if(i<j)
{
mid=(i+j)/2;
mergesort(a,i,mid);
mergesort(a,mid+1,j);
merge(a,i,mid,mid+1,j);
}
}

void merge(int a[],int i1,int j1,int i2,int j2)
{
    int temp[10000];
    int i,j,k;
    i=i1;
    j=i2;
    k=0;
    while(i<=j1 && j<=j2)
    {   delay();
        if(a[i]<a[j])
        temp[k++]=a[i++];
        else
        temp[k++]=a[j++];
    }
    while(i<=j1)
        temp[k++]=a[i++];
    while(j<=j2)
        temp[k++]=a[j++];

    for(i=i1,j=0;i<=j2;i++,j++)
        a[i]=temp[j];
}

void delay()
{
    int  i, k;
    for(i=0;i<40000;i++)
        k= 33/333;
}
```

Output:



n	time
1000	0.421
2000	0.984
3000	1.563
4000	2.14
5000	2.765
6000	3.389
7000	4.015
8000	4.671
9000	5.344
10000	6.015

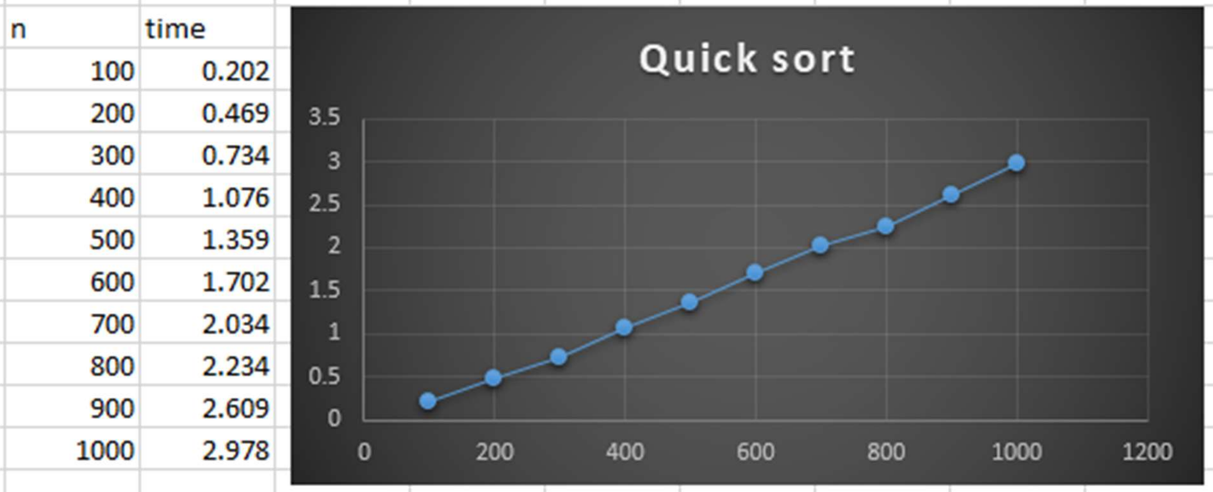
Experiment 9

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

Program:

```
#include<stdio.h>

#include<time.h>

#define MAX 15000


void delay()

{

   int i,temp;

   for(i=0;i<1000000;i++)

      temp=32/33233;

}


void quicksort(int number[MAX],int first,int last){

  int i, j, pivot, temp;

  if(first<last){

    pivot=first;

    i=first;

    j=last;

    while(i<j){

      delay();

      while(number[i]<=number[pivot]&&i<last)

      i++;

      while(number[j]>number[pivot])

      j--;
      if(i<j){
        temp=number[i];
        number[i]=number[j];
        number[j]=temp;
      }
    }
    temp=number[pivot];
    number[pivot]=number[j];
    number[j]=temp;
    quicksort(number,first,j-1);
    quicksort(number,j+1,last);
  }
}
int main(){
   clock_t start,end;
  int i, count, a[MAX];
  printf("No. of elements: ");
  scanf("%d",&count);

  for(i=0;i<count;i++)
   {
      a[i]=rand();
   }

  start=clock();
  quicksort(a,0,count-1);
  end=clock();
  printf("Order of Sorted elements: ");
  for(i=0;i<count;i++)
  printf(" %d",a[i]);
  printf("\nExecution time: %f",(double)(end-start)/CLOCKS_PER_SEC);
  return 0;
}
```

Output:



n	time
100	0.202
200	0.469
300	0.734
400	1.076
500	1.359
600	1.702
700	2.034
800	2.234
900	2.609
1000	2.978

Experiment 10

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

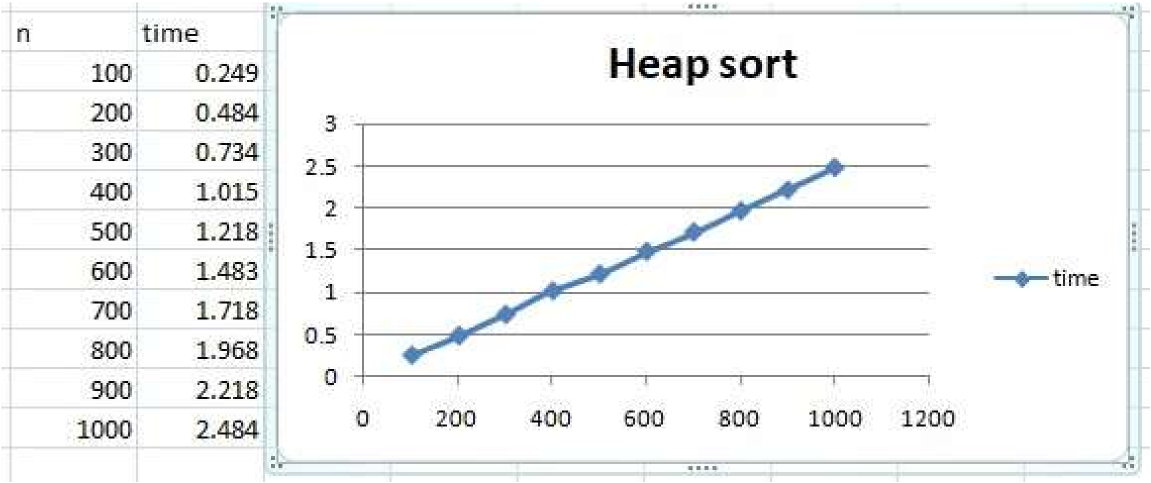
Program:

```
#include <stdio.h>

#include<time.h>

#define max 10000


void swap(int *a, int *b) {

  int temp = *a;

  *a = *b;

  *b = temp;

}


void delay()

{   int i,j,temp;

    for(i=0;i<2000000;i++)

        temp=32/33233;  }


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]);
    delay();
    heapify(arr, i, 0);
  }
}
void printArray(int arr[], int n)
{
  for (int i = 0; i < n; i++)
    printf("%d ", arr[i]);
  printf("\n");
}

int main()
{
  int arr[max],m,i;
  clock_t start,end;
  printf("Enter the number of elements: ");
```

```
 scanf("%d",&m);
 for(i=0;i<m;i++)
 {
    arr[i]=rand();
 }
 start=clock();
 heapSort(arr, m);
 end=clock();

 printf("\n\nSorted array is given in the following way \n");
 printArray(arr, m);
 printf("\nExecution time: %f",(double)(end-start)/CLOCKS_PER_SEC);

}
```

Output:



n	time
100	0.249
200	0.484
300	0.734
400	1.015
500	1.218
600	1.483
700	1.718
800	1.968
900	2.218
1000	2.484

Experiment 11

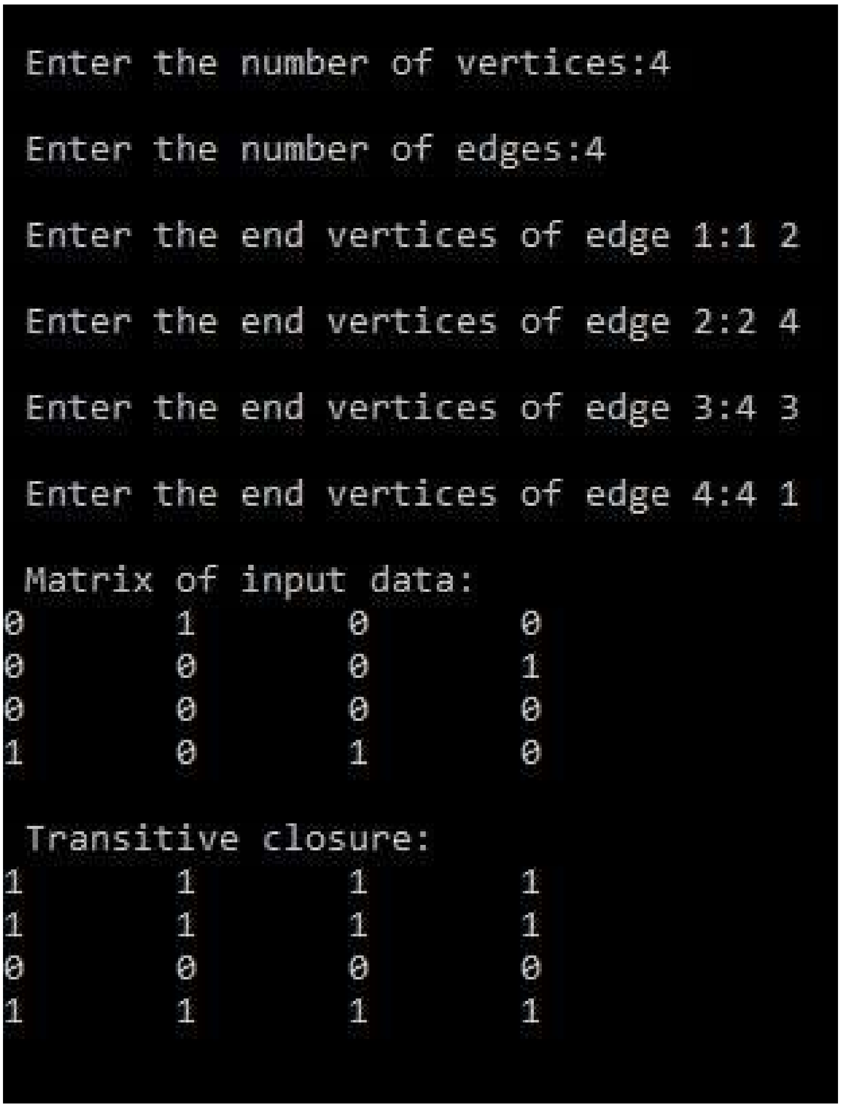
Implement *Warshall's algorithm* using dynamic programming

Program:

```
#include<stdio.h>

#include<conio.h>

#include<math.h>


int max(int,int);


void warshal(int p[10][10],int n) {

        int i,j,k;

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

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

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

            p[i][j]=max(p[i][j],p[i][k]&&p[k][j]);

}


int max(int a,int b) {

        if(a>b)

         return(a); else

         return(b);

}


void main() {

        int p[10][10]= {0},n,e,u,v,i,j;

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

        scanf("%d",&n);

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

```
    scanf("%d",&e);
    for (i=1;i<=e;i++) {
        printf("\n Enter the end vertices of edge %d:",i);
        scanf("%d%d",&u,&v);
        p[u][v]=1;
    }
    printf("\n Matrix of input data: \n");
    for (i=1;i<=n;i++) {
        for (j=1;j<=n;j++)
          printf("%d\t",p[i][j]);
        printf("\n");
    }

    warshal(p,n);
    printf("\n Transitive closure: \n");
    for (i=1;i<=n;i++) {
        for (j=1;j<=n;j++)
          printf("%d\t",p[i][j]);
        printf("\n");
    }
    getch();
}
```

Output:



```
 Enter the number of vertices:4

 Enter the number of edges:4

 Enter the end vertices of edge 1:1 2

 Enter the end vertices of edge 2:2 4

 Enter the end vertices of edge 3:4 3

 Enter the end vertices of edge 4:4 1

 Matrix of input data:
0       1       0       0
0       0       0       1
0       0       0       0
1       0       1       0

 Transitive closure:
1       1       1       1
1       1       1       1
0       0       0       0
1       1       1       1
```

Experiment 12

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

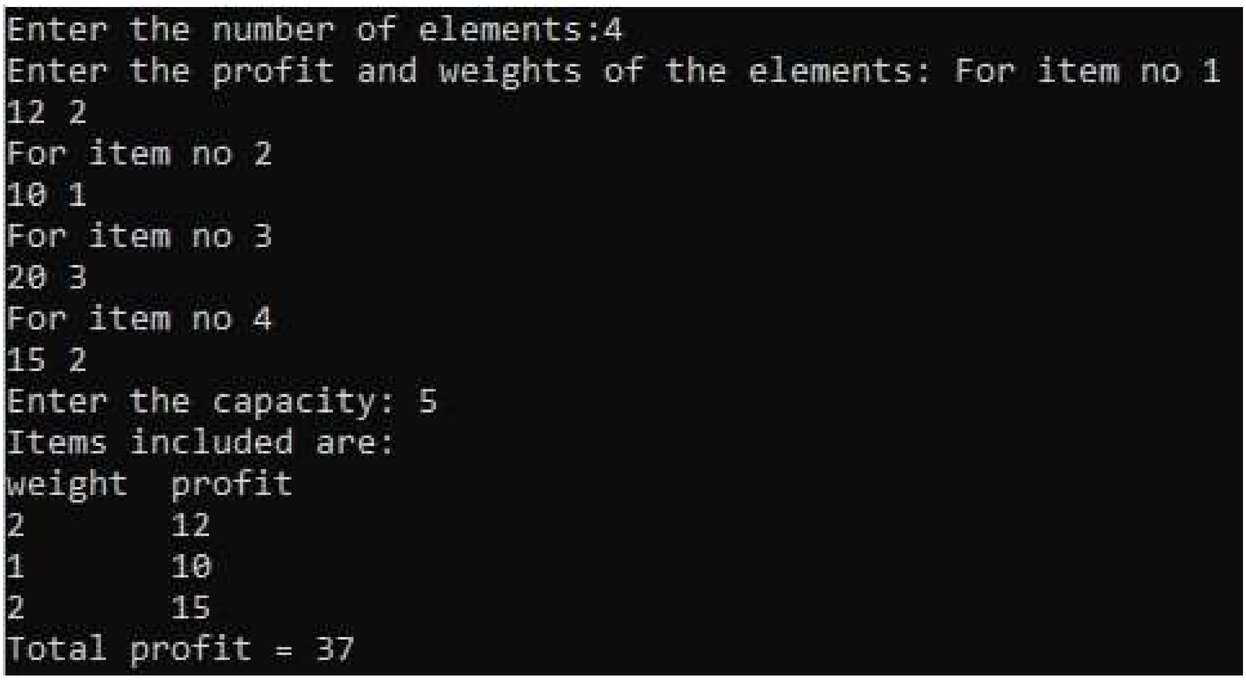
Program:

```
#include<stdio.h>

#include<conio.h>


int w[10],p[10],v[10][10],n,i,j,cap,x[10]= {0};


int max(int i,int j) {

    return ((i>j)?i:j);

}


int knap(int i,int j) {

    int value;

    if(v[i][j]<0) {

        if(j<w[i])

          value=knap(i-1,j); else

          value=max(knap(i-1,j),p[i]+knap(i-1,j-w[i]));

        v[i][j]=value;

    }

    return(v[i][j]);

}


void main() {

    int profit,count=0;

    printf("\nEnter the number of elements\n");

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

```
printf("Enter the profit and weights of the elements\n");
for (i=1;i<=n;i++) {
        printf("For item no %d\n",i);
        scanf("%d%d",&p[i],&w[i]);
}
printf("\nEnter the capacity \n");
scanf("%d",&cap);
for (i=0;i<=n;i++)
  for (j=0;j<=cap;j++)
   if((i==0)||(j==0))
    v[i][j]=0; else
    v[i][j]=-1;
profit=knap(n,cap);
i=n;
j=cap;
while(j!=0&&i!=0) {
        if(v[i][j]!=v[i-1][j]) {
                x[i]=1;
                j=j-w[i];
                i--;
        } else
           i--;
}
printf("Items included are\n");
printf("Sl.no\tweight\tprofit\n");
for (i=1;i<=n;i++)
  if(x[i])
   printf("%d\t%d\t%d\n",++count,w[i],p[i]);
```

```
        printf("Count:%d",count);

        printf("\nTotal profit = %d\n",profit);

        getch();

}
```

Output:



```
Enter the number of elements:4
Enter the profit and weights of the elements: For item no 1
12 2
For item no 2
10 1
For item no 3
20 3
For item no 4
15 2
Enter the capacity: 5
Items included are:
weight   profit
2        12
1        10
2        15
Total profit = 37
```

Experiment 13

Implement All Pair Shortest paths problem using *Floyd’s algorithm*.

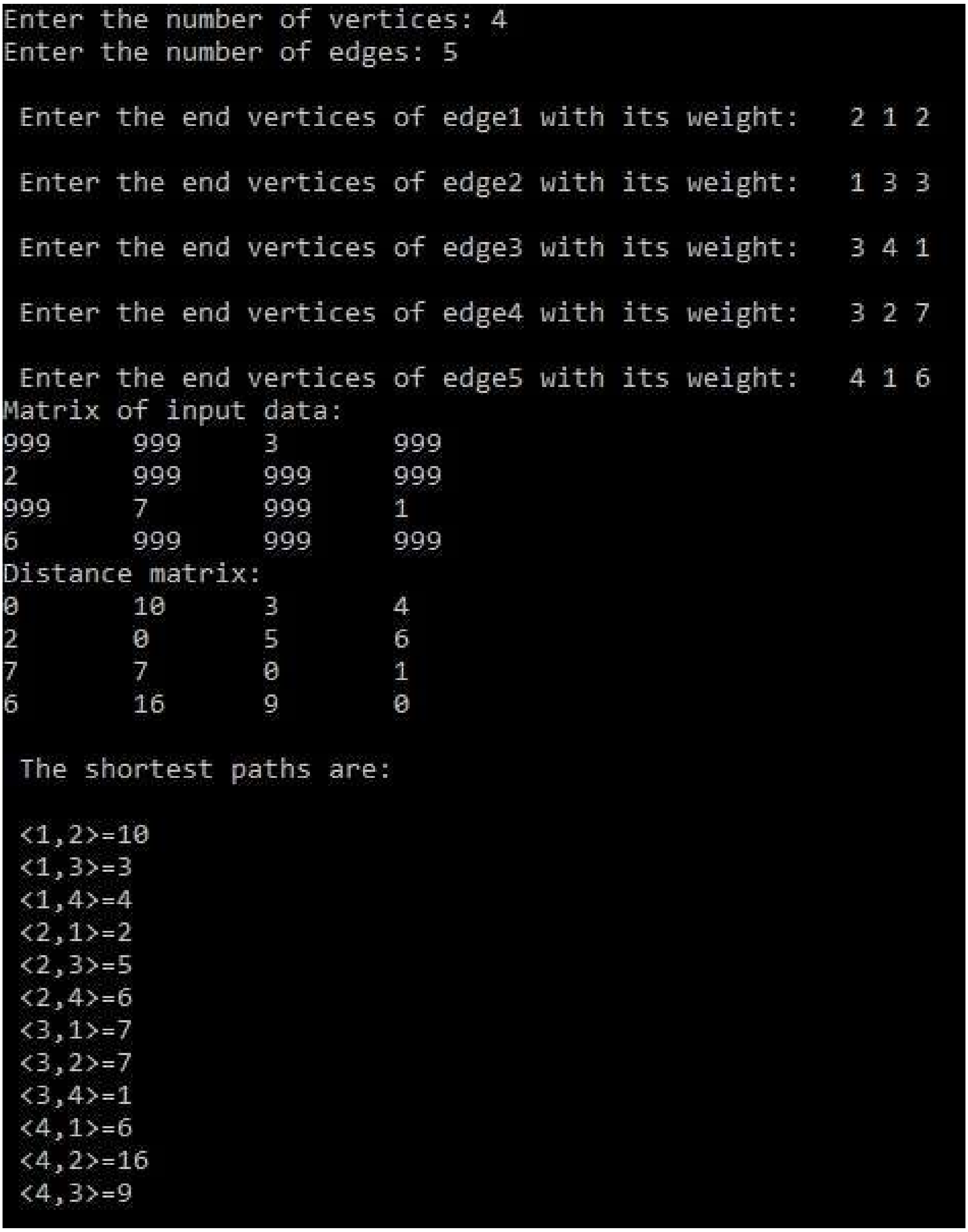
Program:

```
#include<stdio.h>

#include<conio.h>

int min(int,int);


void floyds(int p[10][10],int n) {

            int i,j,k;

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

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

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

                if(i==j)

                 p[i][j]=0; else

                 p[i][j]=min(p[i][j],p[i][k]+p[k][j]);

}


int min(int a,int b) {

            if(a<b)

              return(a); else

              return(b);

}


void main() {

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

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

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

```
printf("\n Enter the number of edges:\n");
scanf("%d",&e);
for (i=1;i<=n;i++) {
        for (j=1;j<=n;j++)
          p[i][j]=999;
}
for (i=1;i<=e;i++) {
        printf("\n Enter the end vertices of edge%d with its weight \n",i);
        scanf("%d%d%d",&u,&v,&w);
        p[u][v]=w;
}
printf("\n Matrix of input data:\n");
for (i=1;i<=n;i++) {
        for (j=1;j<=n;j++)
          printf("%d \t",p[i][j]);
        printf("\n");
}
floyds(p,n);
printf("\n Distance matrix:\n");
for (i=1;i<=n;i++) {
        for (j=1;j<=n;j++)
          printf("%d \t",p[i][j]);
        printf("\n");
}
printf("\n The shortest paths are:\n");
for (i=1;i<=n;i++)
  for (j=1;j<=n;j++) {
        if(i!=j)
```

```
                printf("\n <%d,%d>=%d",i,j,p[i][j]);
        }
        getch();
}
```

Output:



```
Enter the number of vertices: 4
Enter the number of edges: 5

 Enter the end vertices of edge1 with its weight:   2 1 2

 Enter the end vertices of edge2 with its weight:   1 3 3

 Enter the end vertices of edge3 with its weight:   3 4 1

 Enter the end vertices of edge4 with its weight:   3 2 7

 Enter the end vertices of edge5 with its weight:   4 1 6
Matrix of input data:
999     999     3       999
2       999     999     999
999     7       999     1
6       999     999     999
Distance matrix:
0       10      3       4
2       0       5       6
7       7       0       1
6       16      9       0

 The shortest paths are:

 <1,2>=10
 <1,3>=3
 <1,4>=4
 <2,1>=2
 <2,3>=5
 <2,4>=6
 <3,1>=7
 <3,2>=7
 <3,4>=1
 <4,1>=6
 <4,2>=16
 <4,3>=9
```

Experiment 14

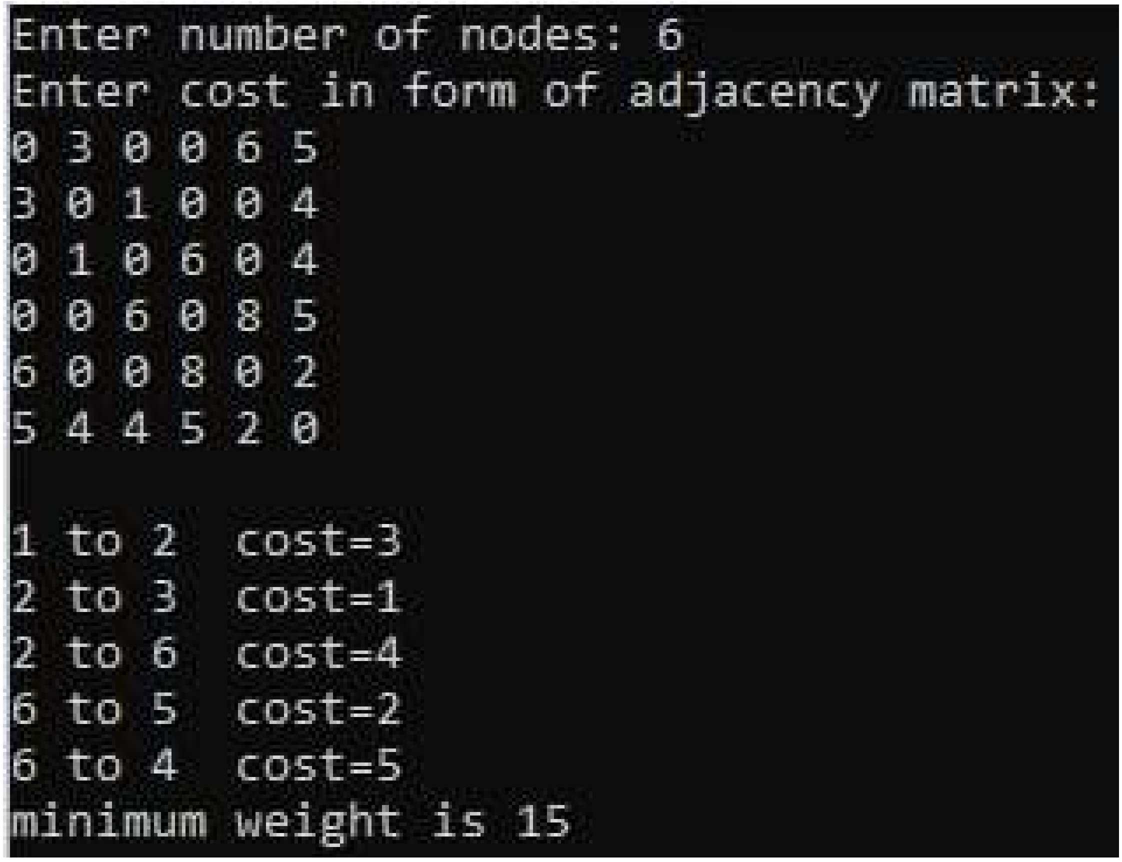
Find Minimum Cost Spanning Tree of a given undirected graph using *Prim's algorithm*.

Program:

```
#include<stdio.h>

int main()
{
  int cost[10][10],visited[10]={0},i,j,n,no_e=1,min,a,b,min_cost=0;
  printf("Enter number of nodes ");
  scanf("%d",&n);
  printf("Enter cost in form of adjacency matrix\n");
  for(i=1;i<=n;i++)
  {
    for(j=1;j<=n;j++)
    {
      scanf("%d",&cost[i][j]);
      if(cost[i][j]==0)
       cost[i][j]=1000;
    }
  }

 visited[1]=1; // visited first node
  while(no_e<n)
  {
    min=1000;
    for(i=1;i<=n;i++)
```

```
        {
            for(j=1;j<=n;j++)
            {
                if(cost[i][j]<min)
                {
                    if(visited[i]!=0)
                    {
                        min=cost[i][j];
                        a=i;
                        b=j;
                    }
                }
            }
        }
        if(visited[b]==0)
        {
            printf("\n%d to %d  cost=%d",a,b,min);
            min_cost=min_cost+min;
            no_e++;
        }
        visited[b]=1;
        cost[a][b]=cost[b][a]=1000;
    }
    printf("\nminimum weight is %d",min_cost);
    return 0;
}
```

Output:



```
Enter number of nodes: 6
Enter cost in form of adjacency matrix:
0 3 0 0 6 5
3 0 1 0 0 4
0 1 0 6 0 4
0 0 6 0 8 5
6 0 0 8 0 2
5 4 4 5 2 0

1 to 2  cost=3
2 to 3  cost=1
2 to 6  cost=4
6 to 5  cost=2
6 to 4  cost=5
minimum weight is 15
```

Experiment 15

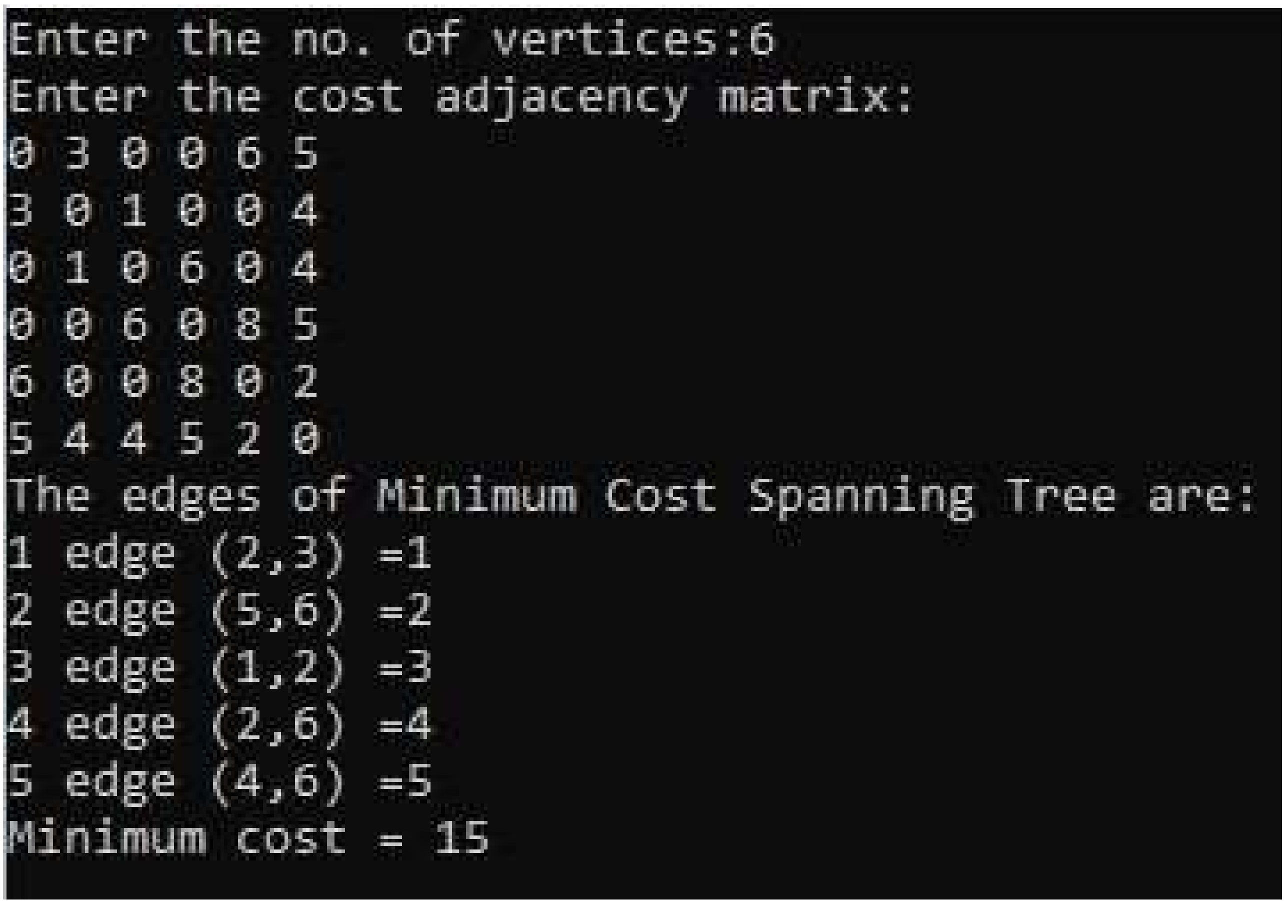
Find Minimum Cost Spanning Tree of a given undirected graph using *Kruskal’s algorithm*.

Program:

```
#include <stdio.h>

#include <conio.h>

#include <stdlib.h>


int i, j, k, a, b, u, v, n, ne = 1;

int min, mincost = 0, cost[9][9], parent[9];


int find(int);

int uni(int, int);


void main()

{

  printf("Enter the no. of vertices:\n");

  scanf("%d", &n);

  printf("\nEnter the cost adjacency matrix:\n");

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

  {

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

    {

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

      if (cost[i][j] == 0)

        cost[i][j] = 999;

    }
}
printf("The edges of Minimum Cost Spanning Tree are\n");
while (ne < n)
{
 for (i = 1, min = 999; i <= n; i++)
 {
  for (j = 1; j <= n; j++)
  {
   if (cost[i][j] < min)
   {
    min = cost[i][j];
    a = u = i;
    b = v = j;
   }
  }
 }

 u = find(u);
 v = find(v);

 if (uni(u, v))
 {
  printf("%d edge (%d,%d) =%d\n", ne++, a, b, min);
  mincost += min;
 }

 cost[a][b] = cost[b][a] = 999;
}
```

```
  printf("\nMinimum cost = %d\n", mincost);
  getch();
}

int find(int i)
{
  while (parent[i])
    i = parent[i];
  return i;
}

int uni(int i, int j)
{
  if (i != j)
  {
    parent[j] = i;
    return 1;
  }

  return 0;
}
```

Output:



```
Enter the no. of vertices:6
Enter the cost adjacency matrix:
0 3 0 0 6 5
3 0 1 0 0 4
0 1 0 6 0 4
0 0 6 0 8 5
6 0 0 8 0 2
5 4 4 5 2 0
The edges of Minimum Cost Spanning Tree are:
1 edge (2,3) =1
2 edge (5,6) =2
3 edge (1,2) =3
4 edge (2,6) =4
5 edge (4,6) =5
Minimum cost = 15
```

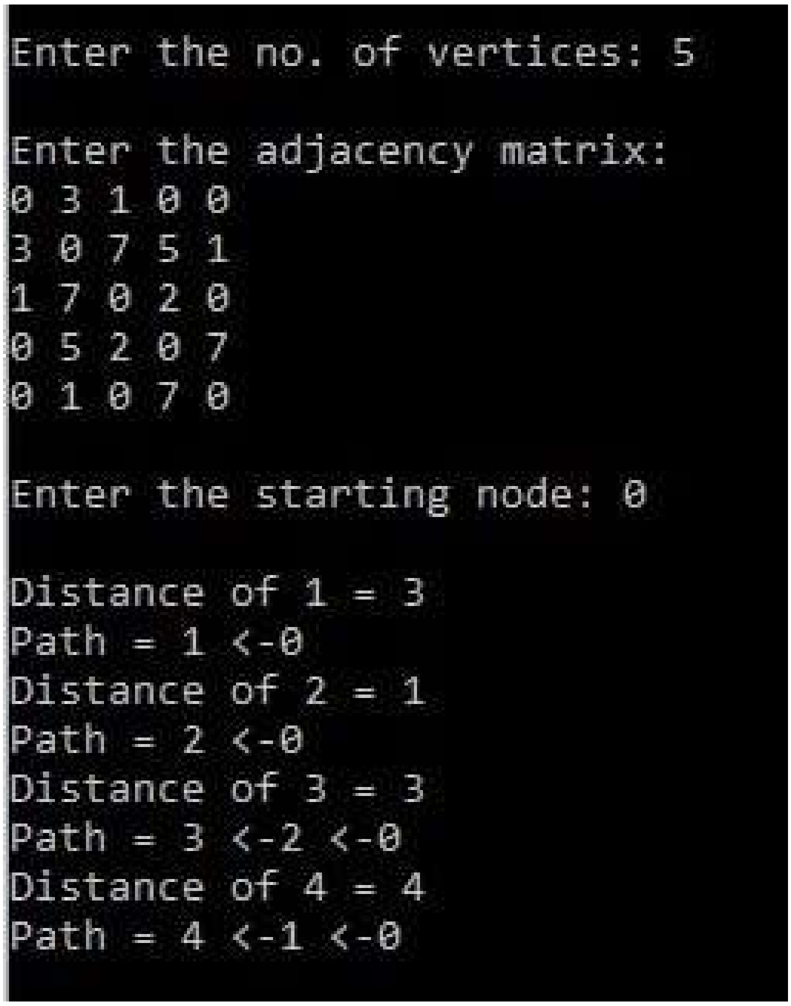
Experiment 16

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

Program:

```
#include<stdio.h>

#include<conio.h>

#define INFINITY 9999

#define MAX 10

void dijkstra(int G[MAX][MAX], int n, int startnode);


void main(){

        int G[MAX][MAX], i, j, n, u;

        printf("\nEnter the no. of vertices: ");

        scanf("%d", &n);

        printf("\nEnter the adjacency matrix:\n");

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

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

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

        printf("\nEnter the starting node: ");

        scanf("%d", &u);

        dijkstra(G,n,u);

        getch();

}


void dijkstra(int G[MAX][MAX], int n, int startnode)

{

        int cost[MAX][MAX], distance[MAX], pred[MAX];
int visited[MAX], count, mindistance, nextnode, i,j;
for(i=0;i < n;i++)
        for(j=0;j < n;j++)
                if(G[i][j]==0)
                        cost[i][j]=INFINITY;
                else
                        cost[i][j]=G[i][j];

for(i=0;i< n;i++)
{
        distance[i]=cost[startnode][i];
        pred[i]=startnode;
        visited[i]=0;
}
distance[startnode]=0;
visited[startnode]=1;
count=1;
while(count < n-1){
        mindistance=INFINITY;
        for(i=0;i < n;i++)
                if(distance[i] < mindistance&&!visited[i])
                {
                        mindistance=distance[i];
                        nextnode=i;
                }
        visited[nextnode]=1;
        for(i=0;i < n;i++)
                if(!visited[i])
                if(mindistance+cost[nextnode][i] < distance[i])
                {
                    distance[i]=mindistance+cost[nextnode][i];
                    pred[i]=nextnode;
                }
            count++;
    }
    for(i=0;i < n;i++)
        if(i!=startnode)
        {
            printf("\n\nDistance of %d = %d", i, distance[i]);
            printf("\nPath = %d ", i);
            j=i;
            int countn=1;
            do
            {
                j=pred[j];
                printf("<-%d", j);
                countn++;
            }
            while(j!=startnode);
    printf("\nCount=%d",countn);
        }
}
```

Output:



```
Enter the no. of vertices: 5

Enter the adjacency matrix:
0 3 1 0 0
3 0 7 5 1
1 7 0 2 0
0 5 2 0 7
0 1 0 7 0

Enter the starting node: 0

Distance of 1 = 3
Path = 1 <-0
Distance of 2 = 1
Path = 2 <-0
Distance of 3 = 3
Path = 3 <-2 <-0
Distance of 4 = 4
Path = 4 <-1 <-0
```

Experiment 17

Implement *"Sum of Subsets"* using Backtracking. Problem:
Find a subset of a given set S = {s1,s2,……,sn} of n positive integers whose sum is equal to a given positive integer d. For example, if S = {1,2,5,6,8} and d = 9 there are two solutions {1,2,6} and {1,8}. A suitable message is to be displayed if the given problem instance doesn't have a solution.

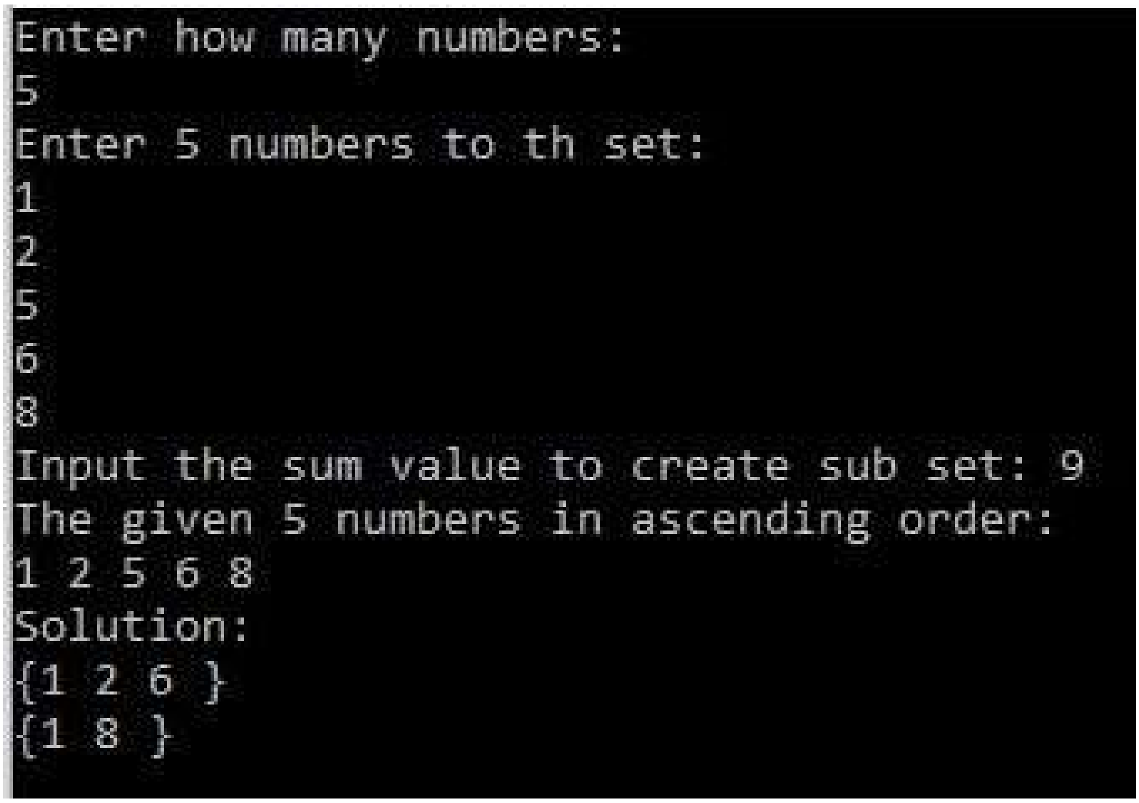
Program:

```
#include<stdio.h>

#include<conio.h>

#define TRUE 1

#define FALSE 0

int inc[50],w[50],sum,n;

int promising(int i,int wt,int total) {

        return(((wt+total)>=sum)&&((wt==sum)||(wt+w[i+1]<=sum)));

}


void main() {

        int i,j,n,temp,total=0;

        printf("Enter how many numbers:\n");

        scanf("%d",&n);

        printf("Enter %d numbers to th set:\n",n);

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

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

                total+=w[i];

        }

        printf("Input the sum value to create sub set: ");

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

```
    for (i=0;i<=n;i++)
      for (j=0;j<n-1;j++)
       if(w[j]>w[j+1]) {
        temp=w[j];
        w[j]=w[j+1];
        w[j+1]=temp;
    }
    printf("The given %d numbers in ascending order:\n",n);
    for (i=0;i<n;i++)
      printf("%d ",w[i]);
    if((total<sum))
      printf("\n Subset construction is not possible"); else {
        for (i=0;i<n;i++)
           inc[i]=0;
        printf("\nSolution:\n");
        sumset(-1,0,total);
    }
    getch();
}
void sumset(int i,int wt,int total) {
    int j;
    if(promising(i,wt,total)) {
        if(wt==sum) {
            printf("{");
            for (j=0;j<=i;j++)
                if(inc[j])
                 printf("%d ",w[j]);
            printf("}\n");
```

```
                } else {
                        inc[i+1]=TRUE;
                        sumset(i+1,wt+w[i+1],total-w[i+1]);
                        inc[i+1]=FALSE;
                        sumset(i+1,wt,total-w[i+1]);
                }
        }
}
```

Output:



```
Enter how many numbers:
5
Enter 5 numbers to th set:
1
2
5
6
8
Input the sum value to create sub set: 9
The given 5 numbers in ascending order:
1 2 5 6 8
Solution:
{1 2 6 }
{1 8 }
```

Experiment 18

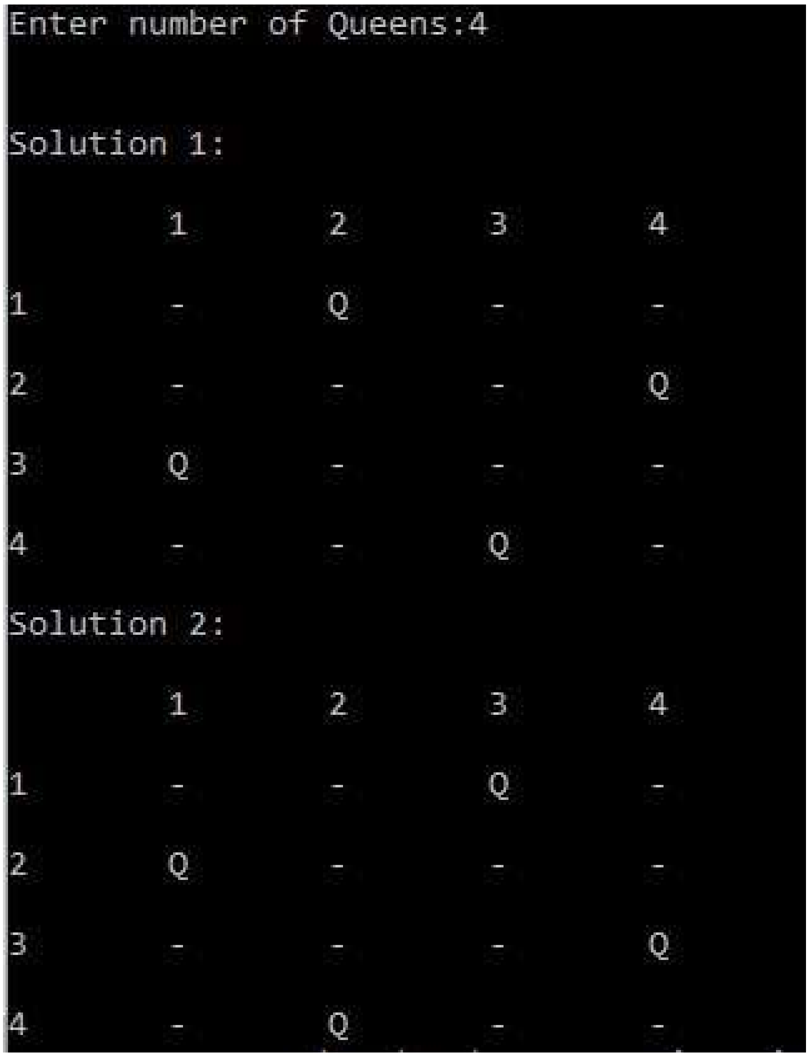
Implement *"N-Queens Problem"* using Backtracking.

Program:

```
#include<stdio.h>
#include<math.h>
int board[20],count;

int main()
{  int n,i,j;
void queen(int row,int n);
printf("Enter 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:



```
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       -       -
```