VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT
on

Analysis and Design of Algorithms

Submitted by

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in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING
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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 **MANOJKIRAN R(1BM21CS403),** 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 a **Analysis and Design of Algorithms - (19CS4PCADA)** work prescribed for the said degree.

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Index Sheet

	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.	
18	Implement "N-Queens Problem" using Backtracking.	**56-58**

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.

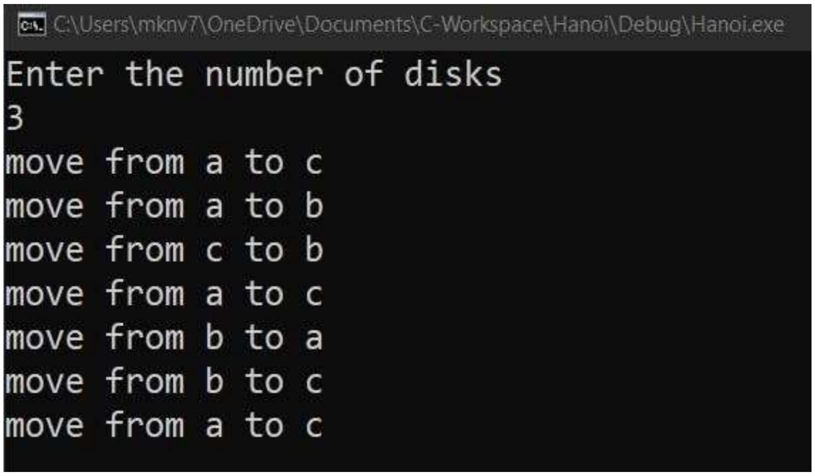
1. Write a recursive program to Solve
a) Towers-of-Hanoi problem   b) To find GCD

CODE:

a) TOWER OF HANOI

```
#include <stdio.h>
void hanoi(int n, char a,char b,char c) {
  if(n==1)
    printf("move from %c to %c\n",a,c);
  else {
    hanoi(n-1,a,c,b);
    printf("move from %c to %c\n",a,c);
    hanoi(n-1,b,a,c); }
}
void main() {
  int n;
  int moves;
  printf("Enter the number of disks\n");
  scanf("%d",&n);
  hanoi(n,'a','b','c'); }
```

OUTPUT:



C:\Users\mknv7\OneDrive\Documents\C-Workspace\Hanoi\Debug\Hanoi.exe

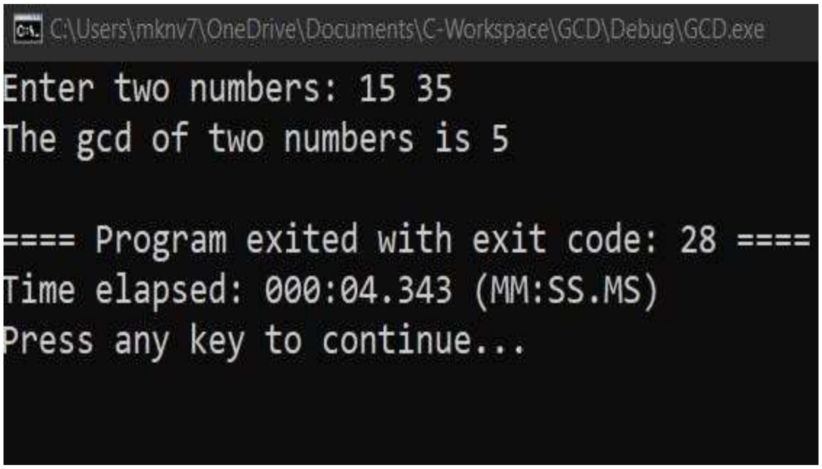
```
Enter the number of disks
3
move from a to c
move from a to b
move from c to b
move from a to c
move from b to a
move from b to c
move from a to c
```

b) GREATEST COMMON DIVISOR

CODE:

```
#include <stdio.h>

int gcd(int a,int b) {
        if(b!=0)
          return gcd(b,a%b);
        else
          return a;
}
void main()
{
   int a,b,c;
   printf("Enter two numbers: ");
   scanf("%d%d",&a,&b);
   c=gcd(a,b);
   printf("The gcd of two numbers is %d\n",c);
}
```

OUTPUT:



C:\Users\mknv7\OneDrive\Documents\C-Workspace\GCD\Debug\GCD.exe

```
Enter two numbers: 15 35
The gcd of two numbers is 5

==== Program exited with exit code: 28 ====
Time elapsed: 000:04.343 (MM:SS.MS)
Press any key to continue...
```

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.

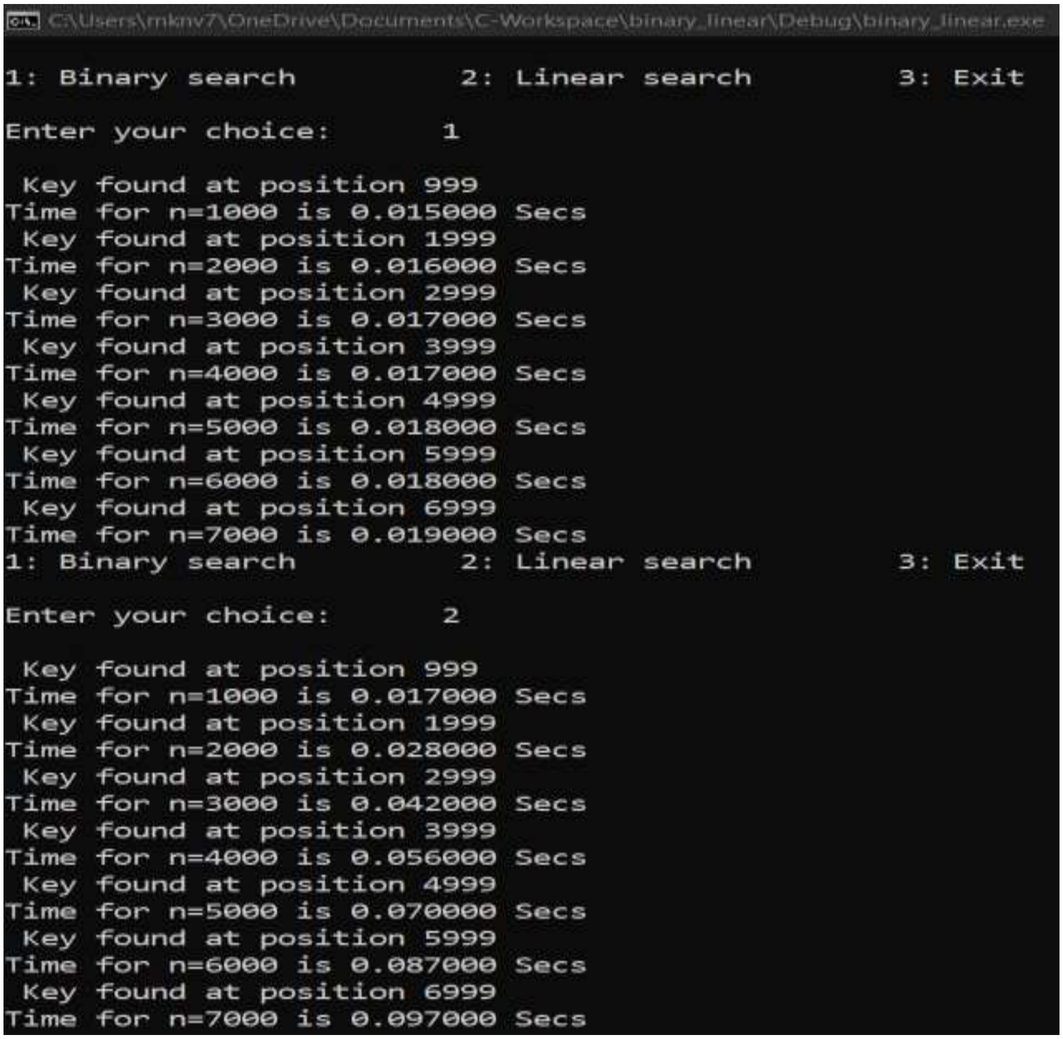
CODE:

```
#include<stdio.h>
#include<time.h>
#include<stdlib.h>
int bin_srch(int [],int,int,int);
int  lin_srch(int  [],int,int,int);
int n,a[1000000];

int main() {
 int ch,key,search_status,temp;
 clock_t end,start;
unsigned long int i, j;
 while(1) {
    printf("\n1: Binary search\t 2: Linear search\t 3: Exit\n");
    printf("\nEnter your choice:\t");
    scanf("%d",&ch);
    switch(ch) {
   case 1:
       n=1000;
        while(n<=7000)
               for(i=0;i<n;i++)
                    a[i]=i;
   key=a[n-1];
   start=clock();
   search_status=bin_srch(a,0,n-1,key);
   if(search_status==-1)
```

```
              printf("\nKey Not Found");
           else
              printf("\n Key found at position %d",search_status);
   end=clock();
   printf("\nTime for n=%d is %f Secs",n,(double)(end-
start)/CLOCKS_PER_SEC);
   n=n+1000;
  }
  break;
   case        2:
          n=1000;
  while(n<=7000) {
        for(i=0;i<n;i++)
            a[i]=i;
   key=a[n-1];
   start=clock();
   search_status=lin_srch(a,0,n-1,key);
   if(search_status==-1)
              printf("\nKey Not Found");
           else
              printf("\n Key found at position %d",search_status);
   end=clock();
   printf("\nTime for n=%d is %f Secs",n,(double)(end-
start)/CLOCKS_PER_SEC);
   n=n+1000;
  }
  break;
   default:
          exit(0);
  }
  getchar();
```

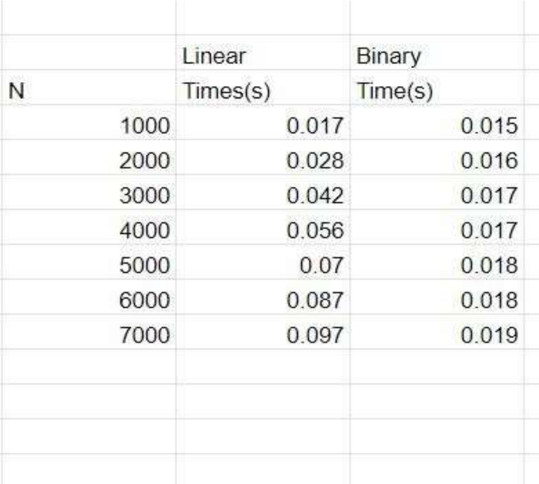
```
 }
}
int bin_srch(int a[],int low,int high,int key) {
 for(int j=0;j<1000000;j++){ int temp=38/600;}
 int mid;
 if(low>high)
 return -1;
 mid=(low+high)/2;
 if(key==a[mid])
 return mid;
 if(key<a[mid])
  return bin_srch(a,low,mid-1,key);
 else
  return bin_srch(a,mid+1,high,key);
}
int lin_srch(int a[],int i,int high,int key) {
    for(int j=0;j<10000;j++){ int temp=38/600;}
 if(i>high)
 return -1;
 if(key==a[i])
 return i;
 else
  return lin_srch(a,i+1,high,key);
}
```

OUTPUT:

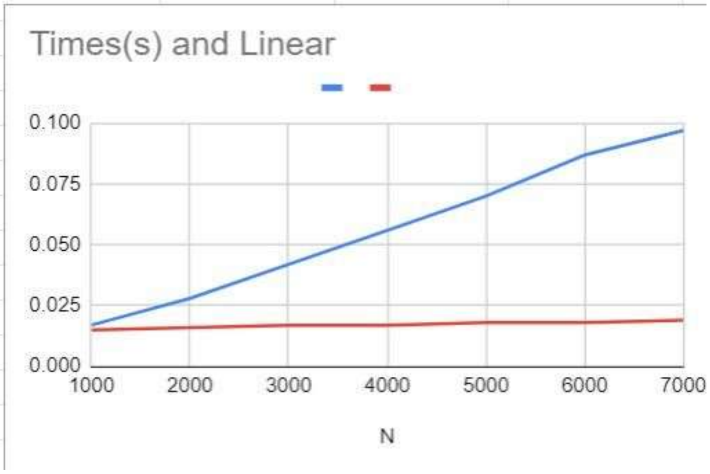

C:\Users\mknv7\OneDrive\Documents\C-Workspace\binary_linear\Debug\binary_linear.exe

```
1: Binary search         2: Linear search        3: Exit

Enter your choice:       1

 Key found at position 999
Time for n=1000 is 0.015000 Secs
 Key found at position 1999
Time for n=2000 is 0.016000 Secs
 Key found at position 2999
Time for n=3000 is 0.017000 Secs
 Key found at position 3999
Time for n=4000 is 0.017000 Secs
 Key found at position 4999
Time for n=5000 is 0.018000 Secs
 Key found at position 5999
Time for n=6000 is 0.018000 Secs
 Key found at position 6999
Time for n=7000 is 0.019000 Secs
1: Binary search         2: Linear search        3: Exit

Enter your choice:       2

 Key found at position 999
Time for n=1000 is 0.017000 Secs
 Key found at position 1999
Time for n=2000 is 0.028000 Secs
 Key found at position 2999
Time for n=3000 is 0.042000 Secs
 Key found at position 3999
Time for n=4000 is 0.056000 Secs
 Key found at position 4999
Time for n=5000 is 0.070000 Secs
 Key found at position 5999
Time for n=6000 is 0.087000 Secs
 Key found at position 6999
Time for n=7000 is 0.097000 Secs
```

GRAPH:



	Linear	Binary
N	Times(s)	Time(s)
1000	0.017	0.015
2000	0.028	0.016
3000	0.042	0.017
4000	0.056	0.017
5000	0.07	0.018
6000	0.087	0.018
7000	0.097	0.019

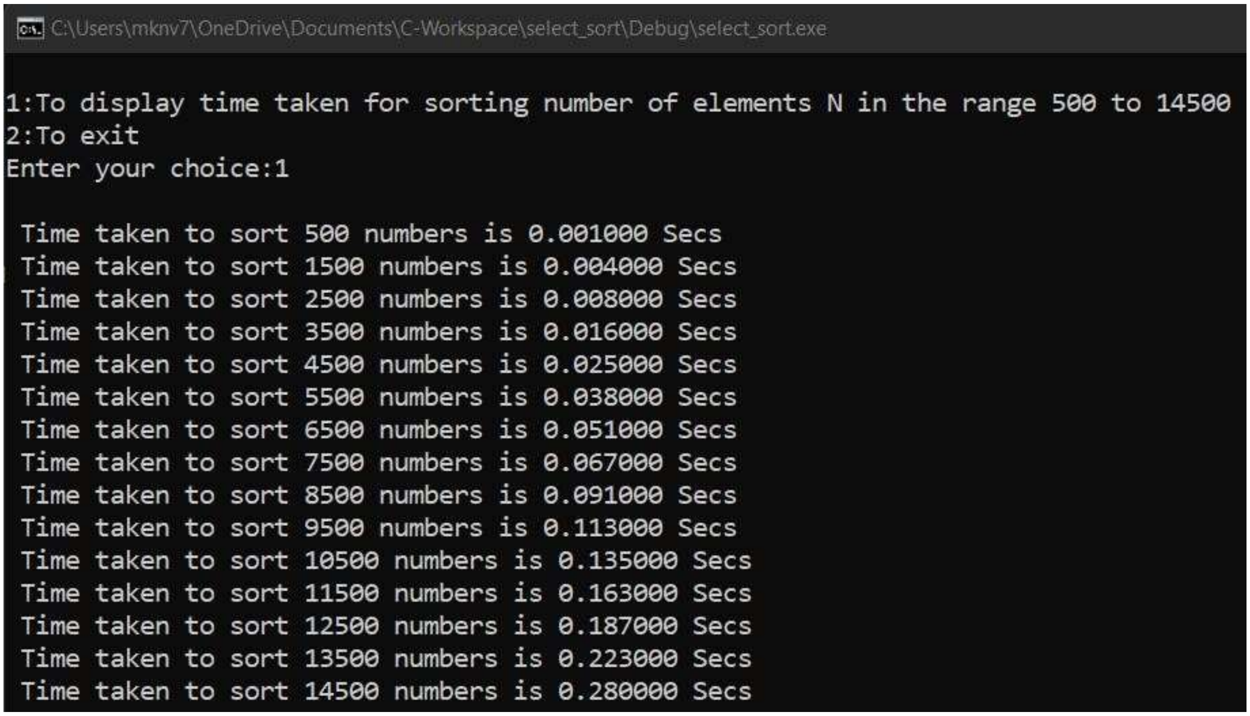


3.Sort a given set of N integer elements using Selection Sort technique and compute its time taken. Run the program for different values of N and record the time taken to sort.

CODE:

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

void selsort(int n,int a[])
{
    int i,j,t,small,pos;
    for(i=0;i<n-1;i++)
     {
      pos=i;
      small=a[i];
      for(j=i+1;j<n;j++)
      {
           if(a[j]<small)
           {
             small=a[j];
             pos=j;
           }
      }
      t=a[i];
      a[i]=a[pos];
      a[pos]=t;
   }
}
void main()
{
   int a[15000],n,i,j,ch,temp;
   clock_t start,end;
   while(1) {
    printf("\n1:To display time taken for sorting number of elements N
in the range 500 to 14500");
    printf("\n2:To exit");
    printf("\nEnter your choice:");
    scanf("%d", &ch);
    switch(ch)
    {
    case 1:
                n=500;
                while(n<=14500) {
                for(i=0;i<n;i++)
                       a[i]=n-i;
                start=clock();
                selsort(n,a);
            for(j=0;j<500000;j++){ temp=38/600;}
             end=clock();
printf("\n Time taken to sort %d numbers is %f Secs",n,
(((double)(end-start))/CLOCKS_PER_SEC));
                       n=n+1000;
                      }
                break;
   case 2: exit(0);
   }
   getchar();
   }
}
```

OUTPUT:

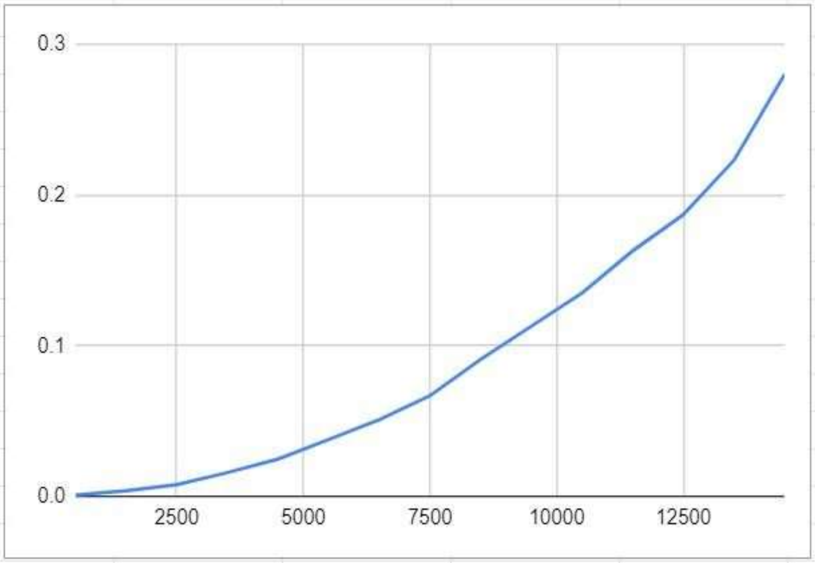


C:\Users\mknv7\OneDrive\Documents\C-Workspace\select_sort\Debug\select_sort.exe

```
1:To display time taken for sorting number of elements N in the range 500 to 14500
2:To exit
Enter your choice:1

 Time taken to sort 500 numbers is 0.001000 Secs
 Time taken to sort 1500 numbers is 0.004000 Secs
 Time taken to sort 2500 numbers is 0.008000 Secs
 Time taken to sort 3500 numbers is 0.016000 Secs
 Time taken to sort 4500 numbers is 0.025000 Secs
 Time taken to sort 5500 numbers is 0.038000 Secs
 Time taken to sort 6500 numbers is 0.051000 Secs
 Time taken to sort 7500 numbers is 0.067000 Secs
 Time taken to sort 8500 numbers is 0.091000 Secs
 Time taken to sort 9500 numbers is 0.113000 Secs
 Time taken to sort 10500 numbers is 0.135000 Secs
 Time taken to sort 11500 numbers is 0.163000 Secs
 Time taken to sort 12500 numbers is 0.187000 Secs
 Time taken to sort 13500 numbers is 0.223000 Secs
 Time taken to sort 14500 numbers is 0.280000 Secs
```

GRAPH:

N Inputs	Time in sec
500	0.001
1500	0.004
2500	0.008
3500	0.016
4500	0.025
5500	0.038
6500	0.051
7500	0.067
8500	0.091
9500	0.113
10500	0.135
11500	0.163
12500	0.187
13500	0.223
14500	0.28



4. Write program to do the following:

a) Print all the nodes reachable from a given starting node in a digraph using BFS method.

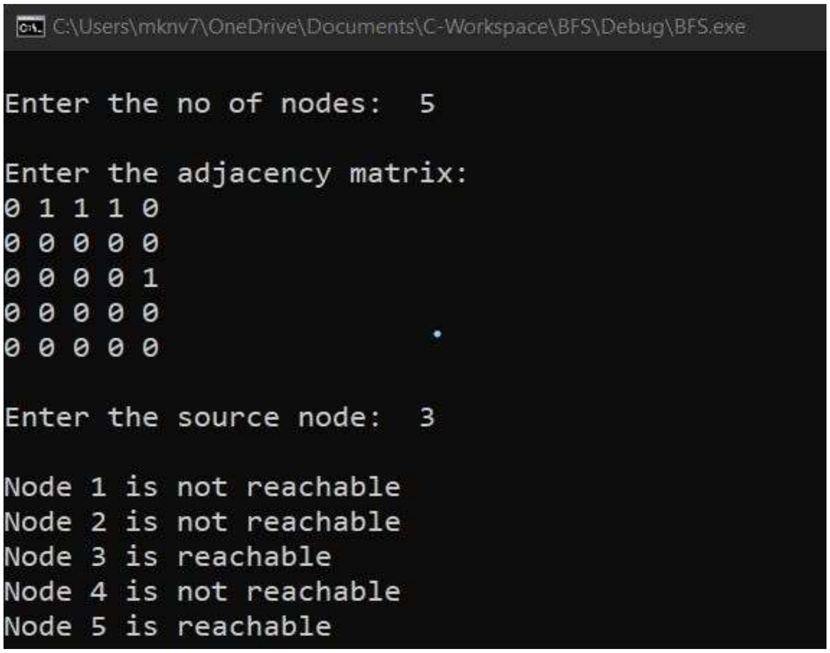
b) Check whether a given graph is connected or not using DFS method.

a) BREADTH FIRST SEARCH

CODE:

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

void main() {
 int i,j,src;
 printf("\nEnter the no of nodes:\t");
 scanf("%d",&n);
 printf("\nEnter the adjacency matrix:\n");
 for(i=1;i<=n;i++)
    for(j=1;j<=n;j++)
     scanf("%d",&a[i][j]);
 printf("\nEnter the source node:\t");
 scanf("%d",&src);
 bfs(src);
}
void bfs(int src) {
 int q[10],f=0,r=-1,vis[10],i,j;
 for(j=1;j<=n;j++)
    vis[j]=0;
 vis[src]=1;
 r=r+1;
 q[r]=src;
 while(f<=r) {
  i=q[f];
  f=f+1;
  for(j=1;j<=n;j++)
  {
   if(a[i][j]==1&&vis[j]!=1) {
    vis[j]=1;
    r=r+1;
    q[r]=j;
   }
  }
 }
 for(j=1;j<=n;j++)  {
  if(vis[j]!=1)
   printf("\nNode %d is not reachable",j);
  else
   printf("\nNode %d is reachable",j);
 }
}
```

OUTPUT:


C:\Users\mknv7\OneDrive\Documents\C-Workspace\BFS\Debug\BFS.exe

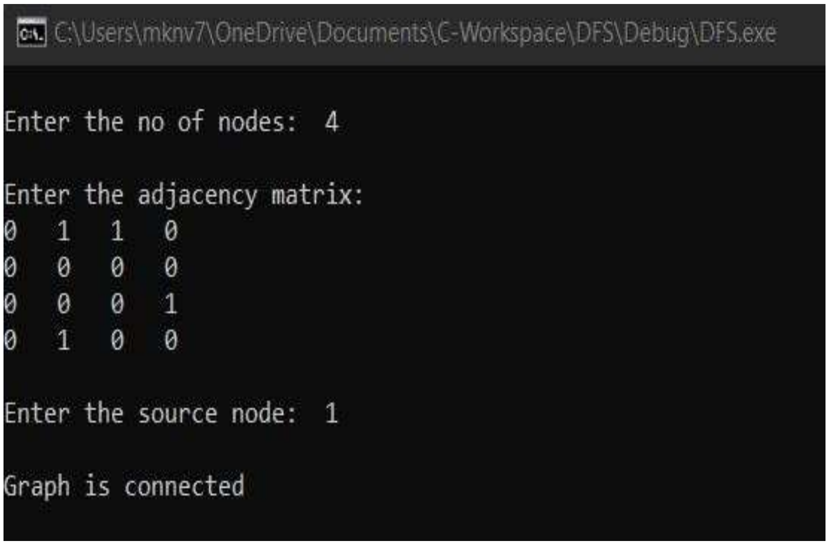
```

Enter the no of nodes:  5

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

Enter the source node:  3

Node 1 is not reachable
Node 2 is not reachable
Node 3 is reachable
Node 4 is not reachable
Node 5 is reachable
```

b)DEPTH FIRST SEARCH

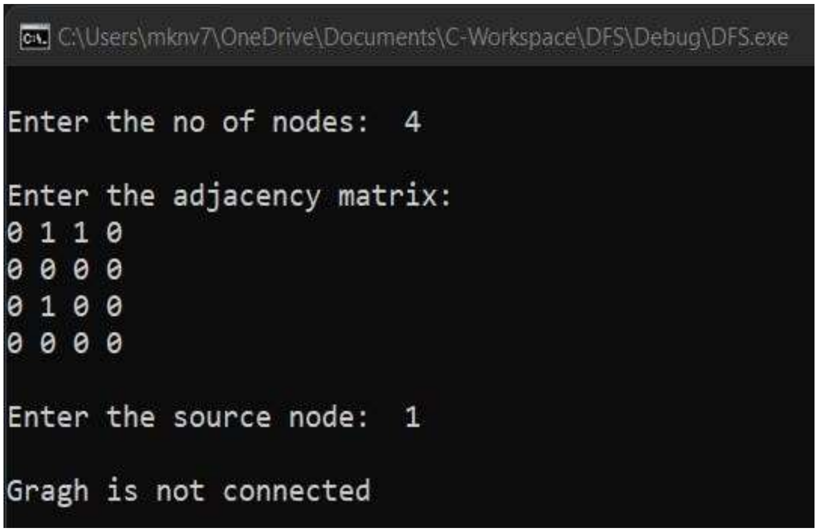
CODE:

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

int a[10][10],n,vis[10];
int dfs(int);
void main()
{
 int i,j,src,ans;
 for(j=1;j<=n;j++)
 vis[j]=0;
 printf("\nEnter the no of nodes:\t");
 scanf("%d",&n);
 printf("\nEnter the adjacency matrix:\n");
 for(i=1;i<=n;i++)
  for(j=1;j<=n;j++)
   scanf("%d",&a[i][j]);
 printf("\nEnter the source node:\t");
 scanf("%d",&src);
 ans=dfs(src);
 if(ans==1)
  printf("\nGraph is connected\n");
 else
  printf("\nGragh is not connected\n");
 getch();
}
int dfs(int src)
{
 int j;
 vis[src]=1;
 for(j=1;j<=n;j++)
 if(a[src][j]==1&&vis[j]!=1)
  dfs(j);
for(j=1;j<=n;j++) {
 if(vis[j]!=1)
 return 0;
}
return 1;
}
```

OUTPUT:


C:\Users\mknv7\OneDrive\Documents\C-Workspace\DFS\Debug\DFS.exe

```
Enter the no of nodes:  4

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

Enter the source node:  1

Graph is connected
```


C:\Users\mknv7\OneDrive\Documents\C-Workspace\DFS\Debug\DFS.exe

```
Enter the no of nodes:  4

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

Enter the source node:  1

Gragh is not connected
```

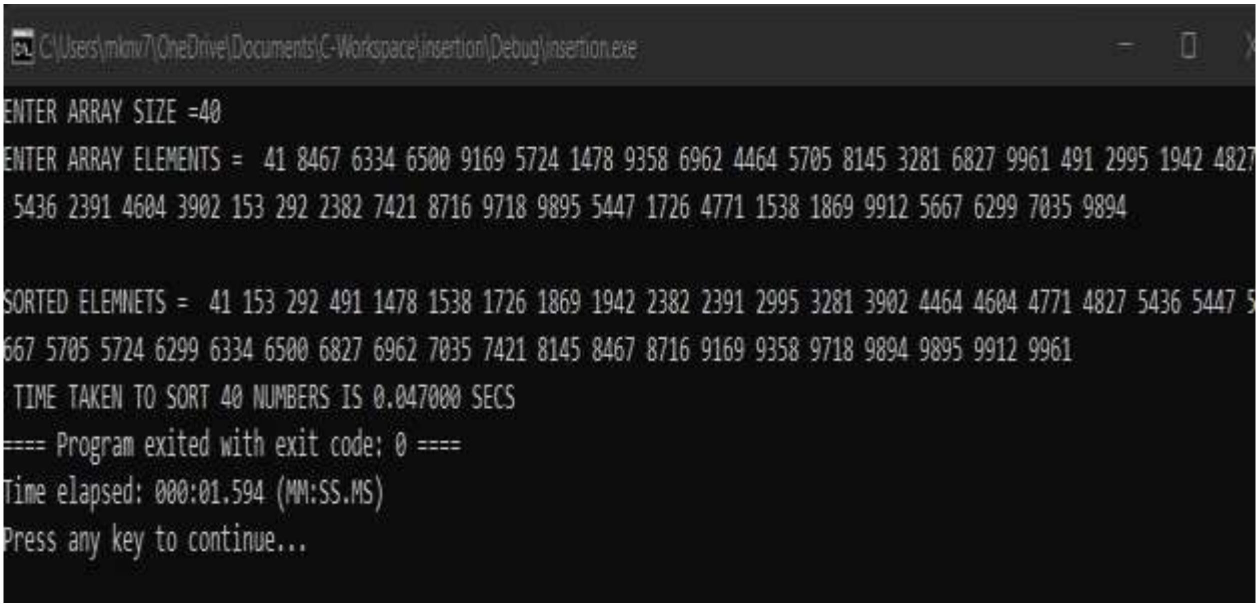
5.Sort a given set of N integer elements using Insertion Sort technique and compute its time taken.

CODE:

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

void insertionSort(int arr[], int n)
{
        int i, key, j;
        for (i = 1; i < n; i++)
        {
                key = arr[i];
                j = i - 1;
                while (j >= 0 && arr[j] > key)
                {
                        for(int k=0;k<100000;k++);
                        arr[j + 1] = arr[j];
                        j = j - 1;
                }
                arr[j + 1] = key;
        }
}
int main()
{
    int i, n;
   clock_t start, end;
   printf("ENTER ARRAY SIZE =");
   scanf("%d", &n);
   int arr[150000];
   printf("ENTER ARRAY ELEMENTS = ");
```

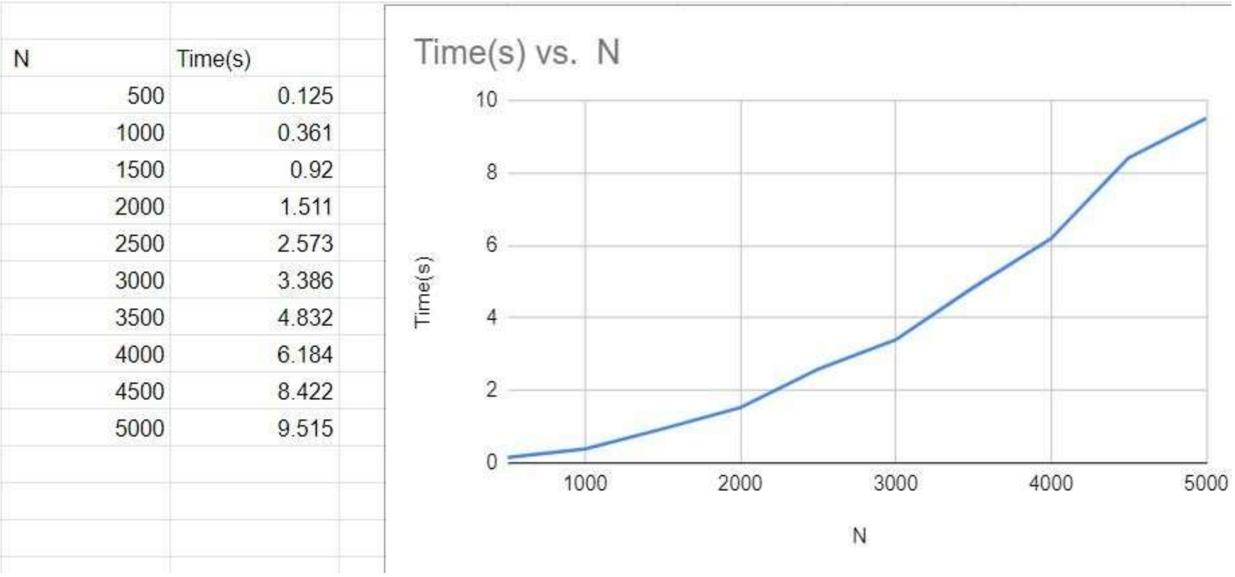
```
    for (int j = 0; j < n; j++)
    {
        arr[j] = rand()%10000;
    }
    for (i = 0; i < n; i++)
    {
        printf(" %d", arr[i]);
     }
    printf("\n");
    start = clock();
    insertionSort(arr, n);
    end = clock();
    printf("\nSORTED ELEMNETS = ");
    for (i = 0; i < n; i++) {
        printf(" %d", arr[i]);
     }
    printf("\n TIME TAKEN TO SORT %d NUMBERS IS %f SECS", n,
(((double)(end - start)) / CLOCKS_PER_SEC));
    return 0;
}
```

OUTPUT:


C:\Users\mlonv7\OneDrive\Documents\C-Workspace\insertion\Debug\insertion.exe

```
ENTER ARRAY SIZE =40
ENTER ARRAY ELEMENTS =  41 8467 6334 6500 9169 5724 1478 9358 6962 4464 5705 8145 3281 6827 9961 491 2995 1942 4827
 5436 2391 4604 3902 153 292 2382 7421 8716 9718 9895 5447 1726 4771 1538 1869 9912 5667 6299 7035 9894

SORTED ELEMNETS =  41 153 292 491 1478 1538 1726 1869 1942 2382 2391 2995 3281 3902 4464 4604 4771 4827 5436 5447 5
667 5705 5724 6299 6334 6500 6827 6962 7035 7421 8145 8467 8716 9169 9358 9718 9894 9895 9912 9961
 TIME TAKEN TO SORT 40 NUMBERS IS 0.047000 SECS
==== Program exited with exit code: 0 ====
Time elapsed: 000:01.594 (MM:SS.MS)
Press any key to continue...
```

GRAPH:



N	Time(s)
500	0.125
1000	0.361
1500	0.92
2000	1.511
2500	2.573
3000	3.386
3500	4.832
4000	6.184
4500	8.422
5000	9.515

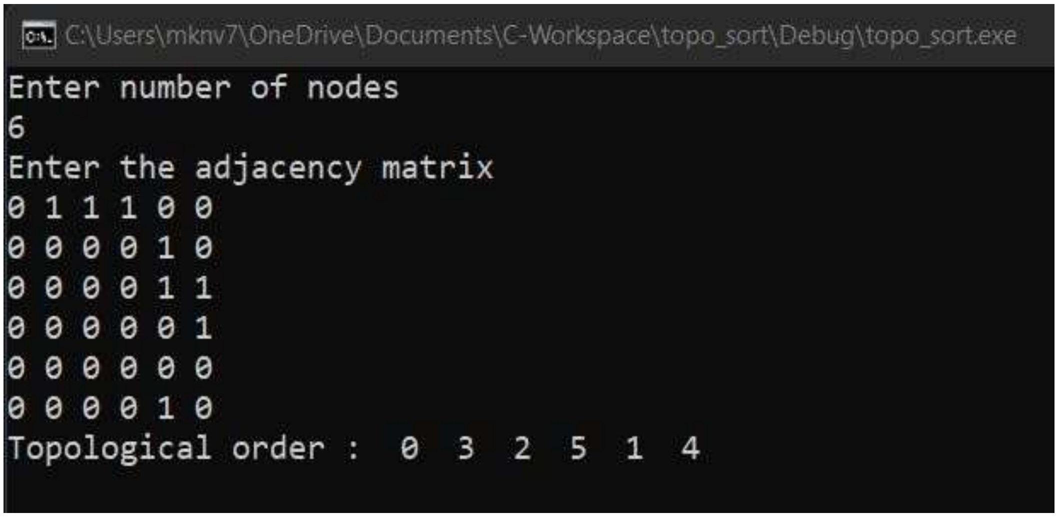
6. Write program to obtain the Topological ordering of vertices in a given digraph.

CODE:

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

void source_removal(int n, int a[10][10]) {
   int i,j,k,u,v,top,s[10],t[10],indeg[10],sum;
   for(i=0;i<n;i++) {
      sum=0;
      for(j=0;j<n;j++)
         sum+=a[j][i];
      indeg[i]=sum;
   }
   top=-1;
   for(i=0;i<n;i++) {
      if(indeg[i]==0)
         s[++top]=i;
   }
   k=0;
   while(top!=-1) {
      u=s[top--];
      t[k++]=u;
      for(v=0;v<n;v++) {
         if(a[u][v]==1) {
            indeg[v]=indeg[v]-1;
            if(indeg[v]==0)
               s[++top]=v;
         }
      }
   }
```

```
    printf("Topological order :");
    for(i=0;i<n;i++)
        printf("  %d", t[i]);
}

void main() {
int i,j,a[10][10],n;
printf("Enter 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]);
source_removal(n,a);
getch();
}
```

OUTPUT:


C:\Users\mknv7\OneDrive\Documents\C-Workspace\topo_sort\Debug\topo_sort.exe

```
Enter number of nodes
6
Enter the adjacency matrix
0 1 1 1 0 0
0 0 0 0 1 0
0 0 0 0 1 1
0 0 0 0 0 1
0 0 0 0 0 0
0 0 0 0 1 0
Topological order :  0  3  2  5  1  4
```

7. Implement Johnson Trotter algorithm to generate permutations.

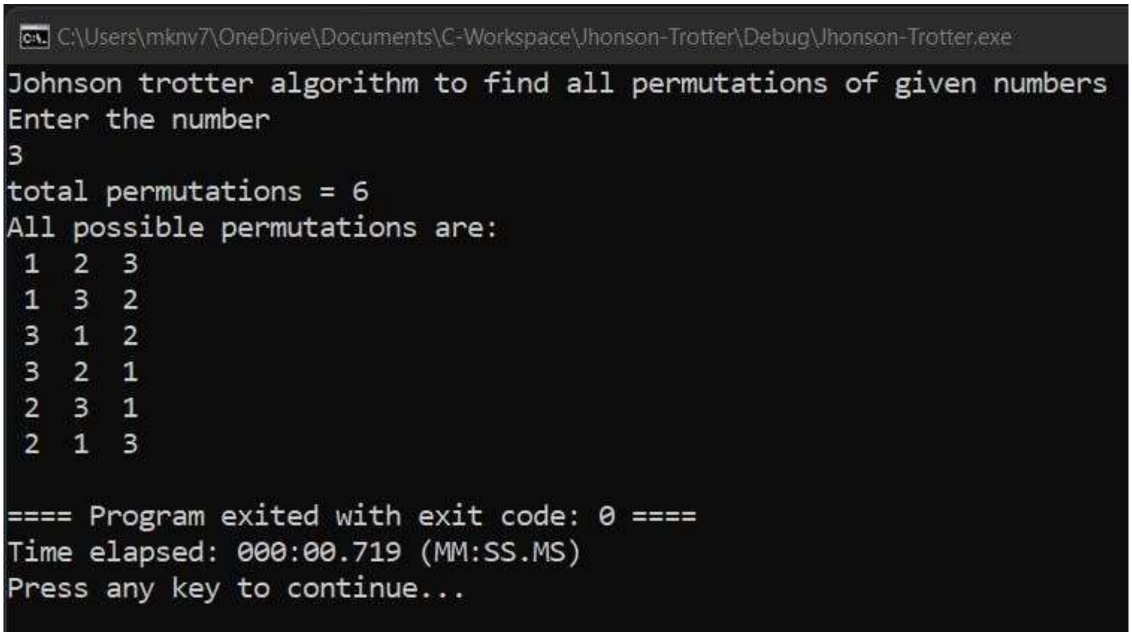
CODE:

```
#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;
 int j;
 int z = 0;
 printf("Johnson trotter algorithm to find all permutations of given
numbers \n");
 printf("Enter the number\n");
 scanf("%d",&num);
```

```
int arr[num],d[num];
z = factorial(num);
printf("total permutations = %d",z);
printf("\nAll possible permutations are: \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:


C:\Users\mknv7\OneDrive\Documents\C-Workspace\Jhonson-Trotter\Debug\Jhonson-Trotter.exe

```
Johnson trotter algorithm to find all permutations of given numbers
Enter the number
3
total permutations = 6
All possible permutations are:
 1  2  3
 1  3  2
 3  1  2
 3  2  1
 2  3  1
 2  1  3

==== Program exited with exit code: 0 ====
Time elapsed: 000:00.719 (MM:SS.MS)
Press any key to continue...
```

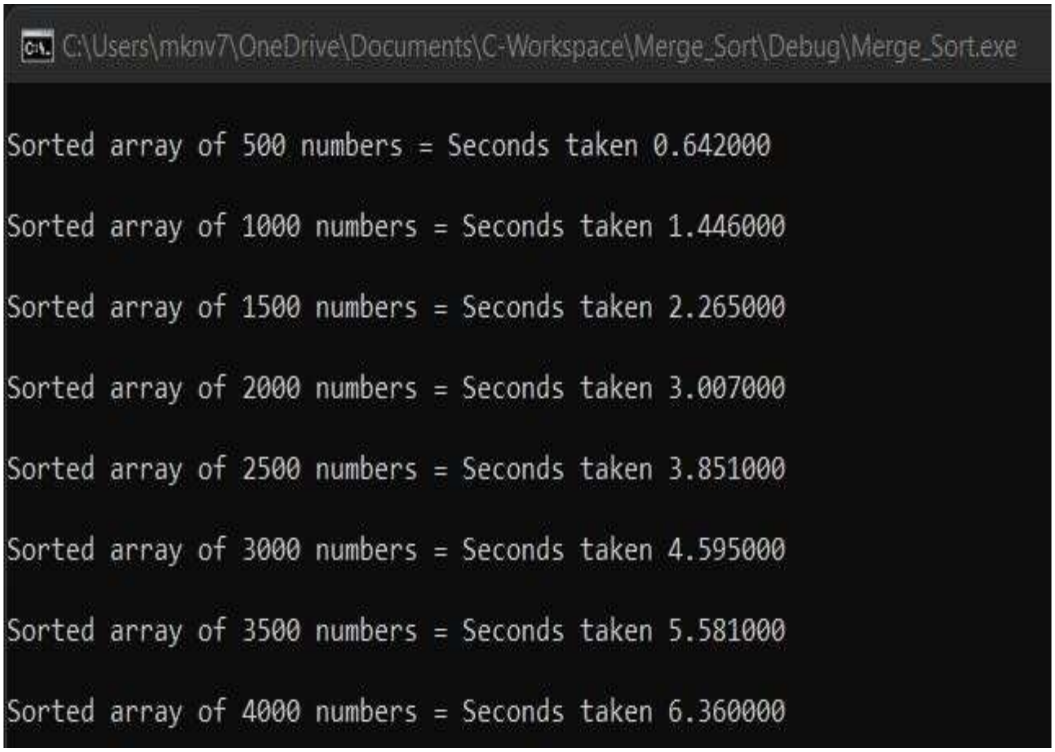
8. Sort a given set of N integer elements using Merge Sort technique and compute its time taken. Run the program for different values of N and record the time taken to sort.

CODE:

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

void mergesort(int a[],int i,int j);

void merge(int a[],int i1,int j1,int i2,int j2);

int main()
{
clock_t start,end;
int a[30000],n=500,i;
while(n<=5000){
for(i=0;i<n;i++)
{
   a[i] = rand()%1000;
}
start = clock();
mergesort(a,0,n-1);
end = clock();
printf("\nSorted array of %d numbers =  ",n);
printf("Seconds taken %lf",(double)(end-start)/CLOCKS_PER_SEC);
printf("\n");
n+=500;
}
}
```

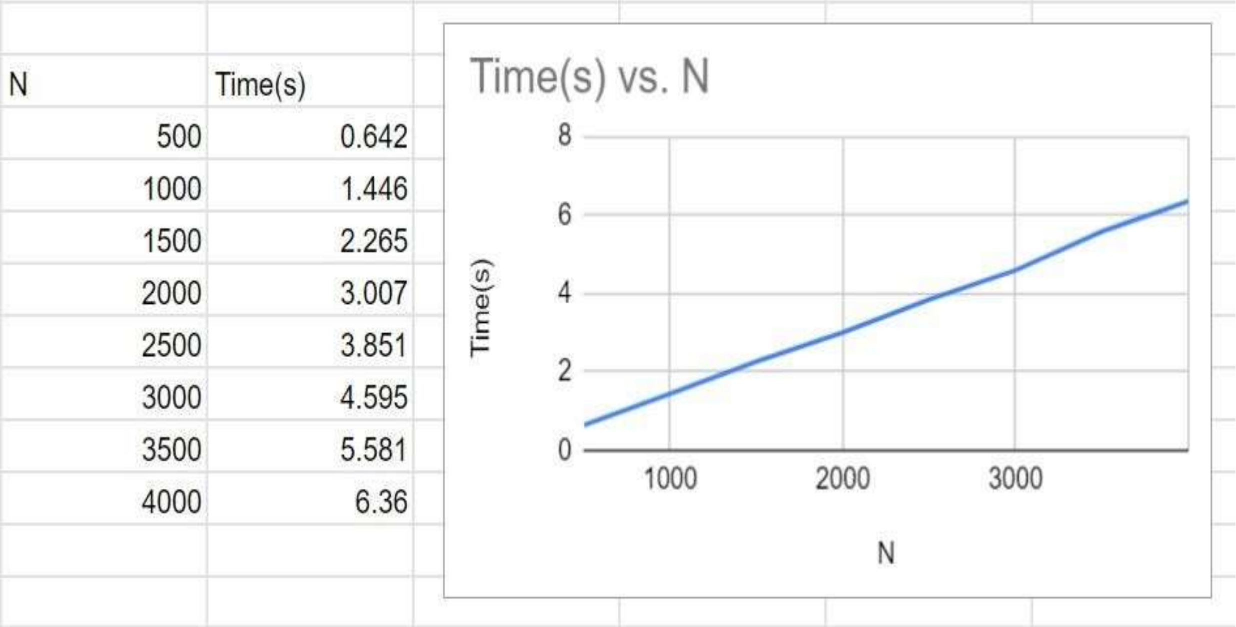
```
void mergesort(int a[],int i,int j)
{
int mid;
if(i<j)
{
mid=(i+j)/2;
mergesort(a,i,mid);
mergesort(a,mid+1,j);
merge(a,i,mid,mid+1,j);
}
}

void merge(int a[],int i1,int j1,int i2,int j2)
{
int temp[30000];
int i,j,k;
i=i1;
j=i2;
k=0;
while(i<=j1 && j<=j2)
{
   for(int j=0;j<100000;j++);
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]; }
```

OUTPUT:


C:\Users\mknv7\OneDrive\Documents\C-Workspace\Merge_Sort\Debug\Merge_Sort.exe

```
Sorted array of 500 numbers = Seconds taken 0.642000

Sorted array of 1000 numbers = Seconds taken 1.446000

Sorted array of 1500 numbers = Seconds taken 2.265000

Sorted array of 2000 numbers = Seconds taken 3.007000

Sorted array of 2500 numbers = Seconds taken 3.851000

Sorted array of 3000 numbers = Seconds taken 4.595000

Sorted array of 3500 numbers = Seconds taken 5.581000

Sorted array of 4000 numbers = Seconds taken 6.360000
```

GRAPH:



N	Time(s)
500	0.642
1000	1.446
1500	2.265
2000	3.007
2500	3.851
3000	4.595
3500	5.581
4000	6.36

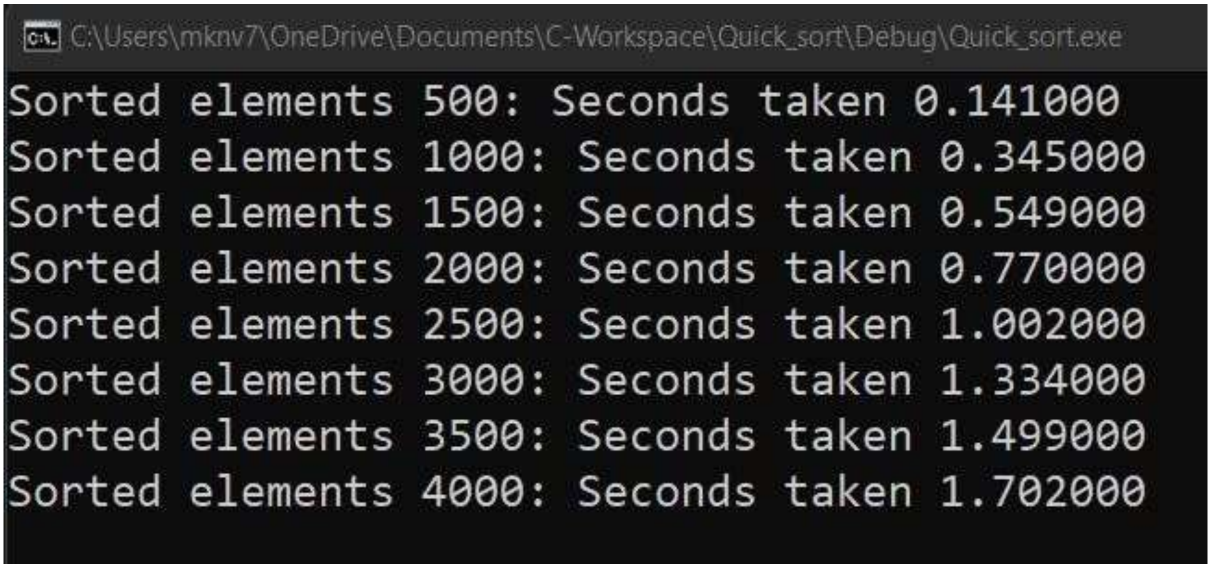
9. Sort a given set of N integer elements using Quick Sort technique and compute its time taken.

CODE:

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

void quicksort(int number[5000],int first,int last)
{
  int i, j, pivot, temp;
  if(first<last)
 {
    pivot=first;
    i=first;
    j=last;
    while(i<j)
     {
      for(int x=0;x<10000000;x++);
             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, number[5000];
    printf("No. of elements: ");
    scanf("%d",&count);
    printf("Enter %d elements: ", count);
    for(i=0;i<count;i++)\
   {
        scanf("%d",&number[i]);
    }
    start = clock();
    quicksort(number,0,count-1);
    end = clock();
    printf("Order of Sorted elements: ");
    for(i=0;i<count;i++)
   {
        printf(" %d",number[i]);
   }
    printf("\nSeconds taken %lf",(double)(end-start)/CLOCKS_PER_SEC);
    return 0;
  }
```

OUTPUT:

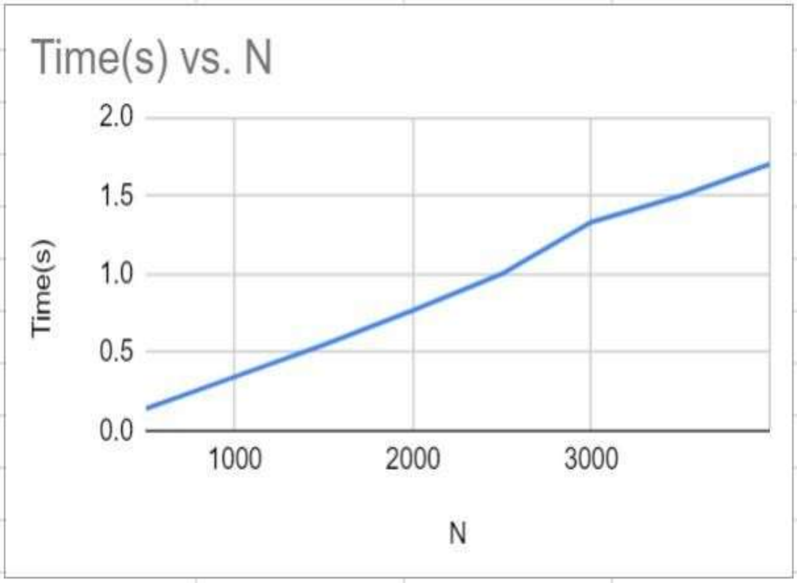


C:\Users\mknv7\OneDrive\Documents\C-Workspace\Quick_sort\Debug\Quick_sort.exe

```
Sorted elements 500: Seconds taken 0.141000
Sorted elements 1000: Seconds taken 0.345000
Sorted elements 1500: Seconds taken 0.549000
Sorted elements 2000: Seconds taken 0.770000
Sorted elements 2500: Seconds taken 1.002000
Sorted elements 3000: Seconds taken 1.334000
Sorted elements 3500: Seconds taken 1.499000
Sorted elements 4000: Seconds taken 1.702000
```

GRAPH:

N	Time(s)
500	0.141
1000	0.345
1500	0.549
2000	0.77
2500	1.002
3000	1.334
3500	1.499
4000	1.702



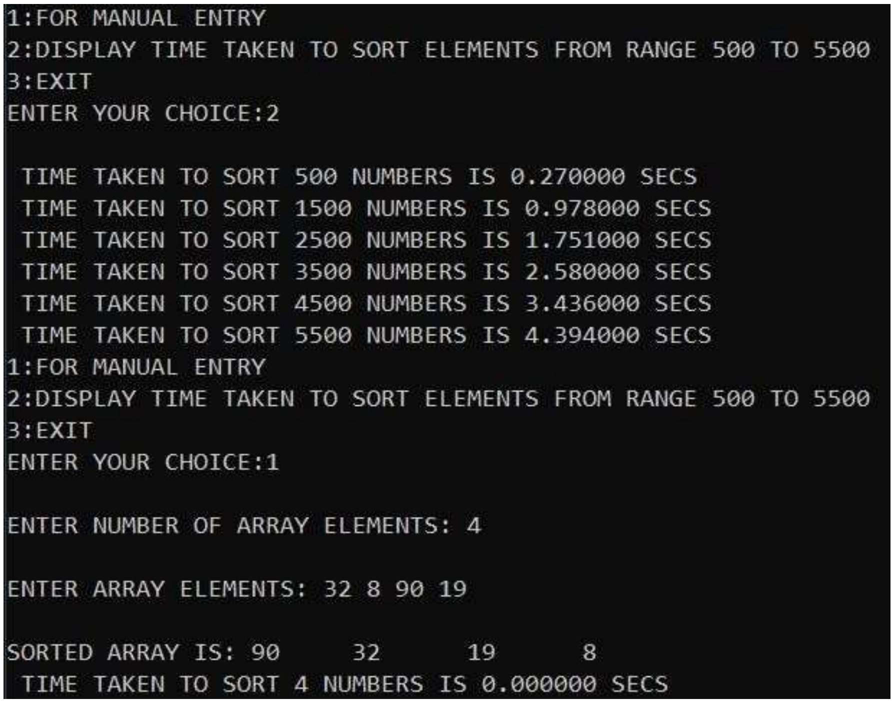
10. Sort a given set of N integer elements using Heap Sort technique and compute its time taken.

CODE:

```
#include <stdio.h>
#include <time.h>
#include <stdlib.h>
#include <math.h>
void swap(int *,int *);
void heapify(int [],int,int);
void heapSort(int[], int);
int main()
{
   int a[15000], n, i, j, ch;
   clock_t start, end;
   while (1)
   {
      printf("\n1:FOR MANUAL ENTRY");
      printf("\n2:DISPLAY TIME TAKEN TO SORT ELEMENTS FROM
RANGE 500 TO 5500");
      printf("\n3:EXIT");
      printf("\nENTER YOUR CHOICE:");
      scanf("%d", &ch);
      switch (ch)
      {
      case 1:
         printf("\nENTER NUMBER OF ARRAY ELEMENTS: ");
         scanf("%d", &n);
         printf("ENTER ARRAY ELEMENTS: ");
         for (i = 0; i < n; i++)
         {
            scanf("%d", &a[i]);
         }
         start = clock();
         heapSort(a, n);
         end = clock();
         printf("\nSORTED ARRAY IS: ");
         for (i = n-1; i >= 0; i--)
            printf("%d\t", a[i]);
         printf("\n TIME TAKEN TO SORT %d NUMBERS IS %f SECS", n,
(((double)(end - start)) / CLOCKS_PER_SEC));
         break;
      case 2:
         n = 500;
         while (n <= 5500)
         {
            for (i = 0; i < n; i++)
            {
                 //a[i]=rand()%n;
                a[i] = n - i;
            }
            start = clock();
            heapSort(a, n);
            end = clock();
            printf("\n TIME TAKEN TO SORT %d NUMBERS IS %f SECS", n,
(((double)(end - start)) / CLOCKS_PER_SEC));
            n = n + 1000;
         }
         break;
      case 3:
         exit(0);
      }
      getchar();
   }
}
```

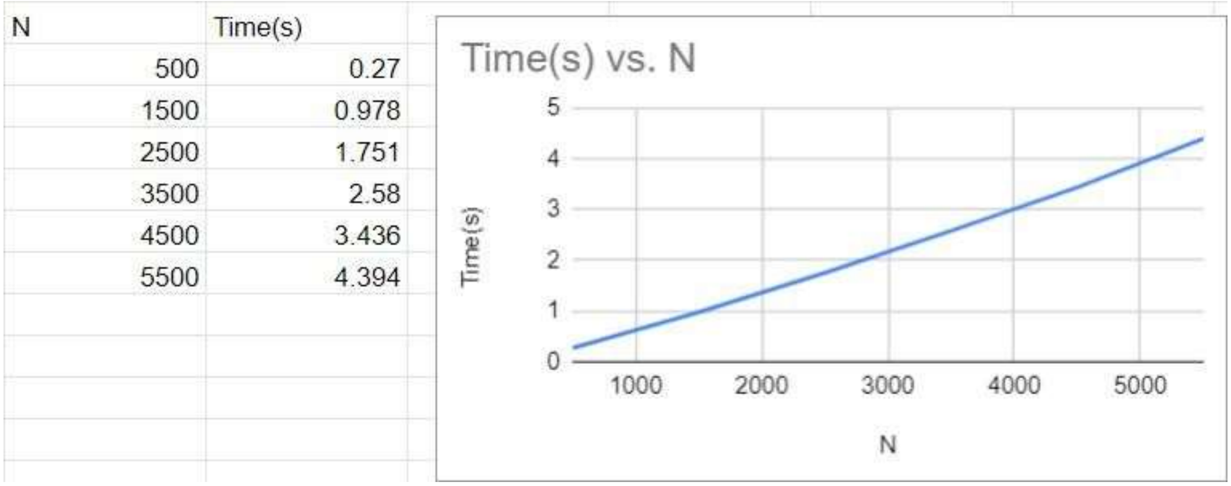
```
void swap(int *a, int *b)
{
   int temp = *a;
   *a = *b;
   *b = temp;
}
void heapify(int arr[], int n, int i)
{
   int temp;
   for (int j = 0; j < 50000; j++)
      temp = 38 / 600;
   int largest = i;
   int left = 2 * i + 1;
   int right = 2 * i + 2;
   if (left < n && arr[left] > arr[largest])
      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); } }
```

OUTPUT:



```
1:FOR MANUAL ENTRY
2:DISPLAY TIME TAKEN TO SORT ELEMENTS FROM RANGE 500 TO 5500
3:EXIT
ENTER YOUR CHOICE:2

 TIME TAKEN TO SORT 500 NUMBERS IS 0.270000 SECS
 TIME TAKEN TO SORT 1500 NUMBERS IS 0.978000 SECS
 TIME TAKEN TO SORT 2500 NUMBERS IS 1.751000 SECS
 TIME TAKEN TO SORT 3500 NUMBERS IS 2.580000 SECS
 TIME TAKEN TO SORT 4500 NUMBERS IS 3.436000 SECS
 TIME TAKEN TO SORT 5500 NUMBERS IS 4.394000 SECS
1:FOR MANUAL ENTRY
2:DISPLAY TIME TAKEN TO SORT ELEMENTS FROM RANGE 500 TO 5500
3:EXIT
ENTER YOUR CHOICE:1

ENTER NUMBER OF ARRAY ELEMENTS: 4

ENTER ARRAY ELEMENTS: 32 8 90 19

SORTED ARRAY IS: 90      32      19      8
 TIME TAKEN TO SORT 4 NUMBERS IS 0.000000 SECS
```

GRAPH:



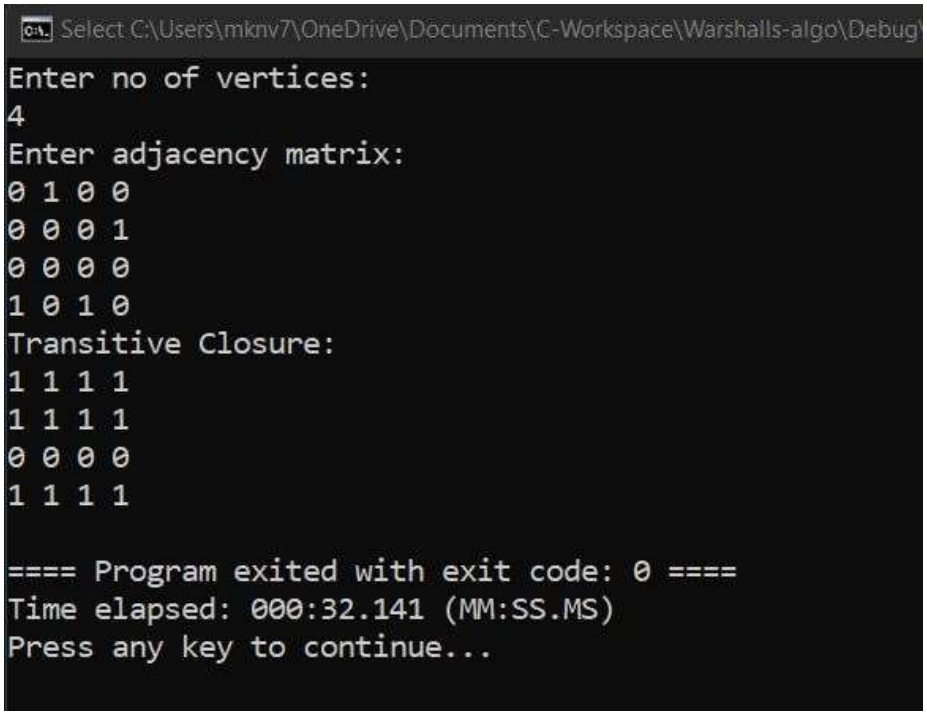
N	Time(s)
500	0.27
1500	0.978
2500	1.751
3500	2.58
4500	3.436
5500	4.394

11. Implement Warshall’s algorithm using dynamic programming

CODE:

```
#include<stdio.h>
int a[30][30];

void warshall(int n){
    for(int k=1;k<=n;k++)
        for(int i=1;i<=n;i++)
            for(int j=1;j<=n;j++)
                a[i][j]=a[i][j]|| (a[i][k] && a[k][j]);
}

int main(){
    int n;
    printf("Enter no of vertices: \n");
    scanf("%d",&n);

    printf("Enter adjacency matrix: \n");
    for(int i=1;i<=n;i++)
        for(int j=1;j<=n;j++)
            scanf("%d",&a[i][j]);
    warshall(n);
    printf("Transitive Closure: \n");
    for(int i=1;i<=n;i++){
        for(int j=1;j<=n;j++)
            printf("%d ",a[i][j]);
        printf("\n");
    }
}
```

OUTPUT:



Select C:\Users\mknv7\OneDrive\Documents\C-Workspace\Warshalls-algo\Debug\

```
Enter no of vertices:
4
Enter adjacency matrix:
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

==== Program exited with exit code: 0 ====
Time elapsed: 000:32.141 (MM:SS.MS)
Press any key to continue...
```

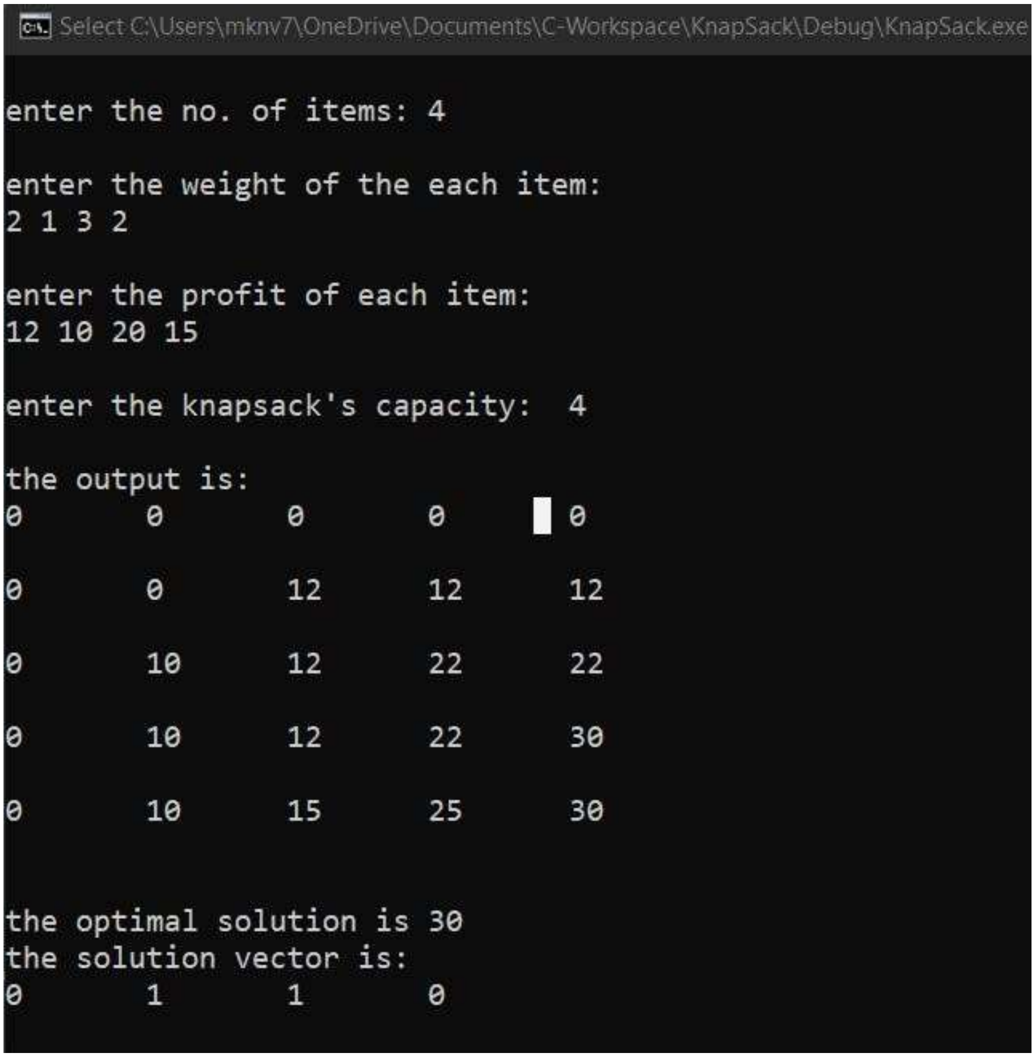
12. Implement 0/1 Knapsack problem using dynamic programming.

CODE:

```
#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()
{
 clrscr();
 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:


Select C:\Users\mknv7\OneDrive\Documents\C-Workspace\KnapSack\Debug\KnapSack.exe

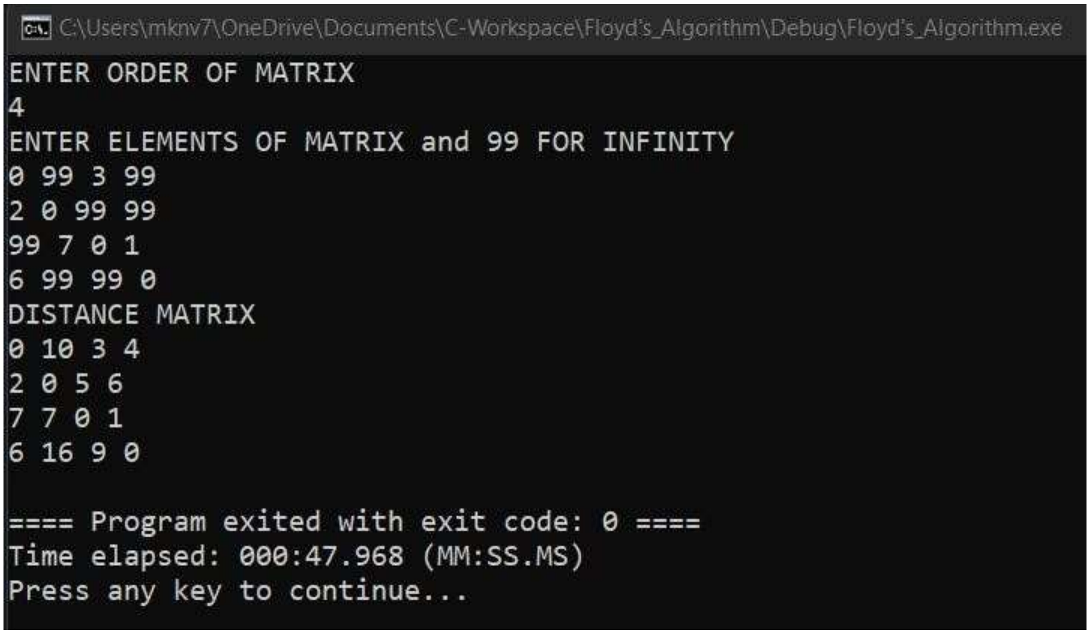
```
enter the no. of items: 4

enter the weight of the each item:
2 1 3 2

enter the profit of each item:
12 10 20 15

enter the knapsack's capacity:  4

the output is:
0       0       0       0       0

0       0       12      12      12

0       10      12      22      22

0       10      12      22      30

0       10      15      25      30


the optimal solution is 30
the solution vector is:
0       1       1       0
```

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

CODE:

```
#include<stdio.h>
int n;
void display(int dist[][n]);
void floyd (int graph[][n])
{
        int dist[n][n], i, j, k;

        for (i = 0; i < n; i++)
                for (j = 0; j < n; j++)
                        dist[i][j] = graph[i][j];

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

void display(int dist[][n]) {
        printf ("DISTANCE MATRIX \n");
        for (int i = 0; i < n; i++)
        {
                for (int j = 0; j < n; j++)
                {
                        if (dist[i][j] == 99)
                                printf("99 ");
                        else
                                printf ("%d ", dist[i][j]);
                }
                printf("\n");
        }
}

int main()
{
   printf("ENTER ORDER OF MATRIX \n");
   scanf("%d",&n);
   int graph[n][n];
   printf("ENTER ELEMENTS OF MATRIX and 99 FOR INFINITY\n");
   for(int i = 0;i < n;i++)
        for(int j = 0;j < n; j++)
                scanf("%d",&graph[i][j]);
        floyd(graph);
        return 0;
}
```

OUTPUT:


C:\Users\mknv7\OneDrive\Documents\C-Workspace\Floyd's_Algorithm\Debug\Floyd's_Algorithm.exe

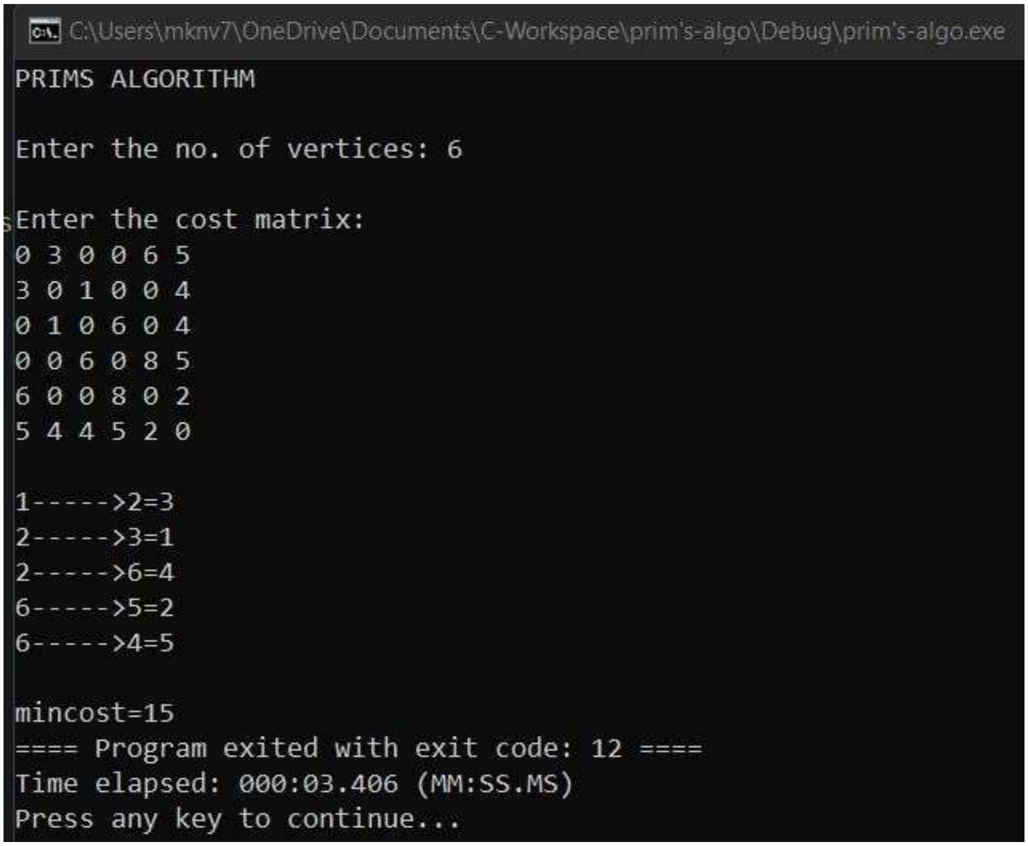
```
ENTER ORDER OF MATRIX
4
ENTER ELEMENTS OF MATRIX and 99 FOR INFINITY
0 99 3 99
2 0 99 99
99 7 0 1
6 99 99 0
DISTANCE MATRIX
0 10 3 4
2 0 5 6
7 7 0 1
6 16 9 0

==== Program exited with exit code: 0 ====
Time elapsed: 000:47.968 (MM:SS.MS)
Press any key to continue...
```

14. Find Minimum Cost Spanning Tree of a given undirected graph using Prim’s algorithm.

CODE:

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

void main()
{
 int i,j;
 int c[10][10],n;
 printf("\nenter the no. of vertices: ");
 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]);
   if(c[i][j]==0)
       c[i][j]=1000;
  }
 }
 int u,v,min;
 int ne=0,mincost=0;
 int elec[10];
 for(i=1;i<=n;i++)
 {
  elec[i]=0;
 }
 elec[1]=1;
 while(ne!=n-1)
 {
  min=1000;
  for(i=1;i<=n;i++)
  {
   for(j=1;j<=n;j++)
   {
       if(elec[i]==1){
     if(c[i][j]<min)
     {
      min=c[i][j];
      u=i;
      v=j;
     }
   }}
  }
  if(elec[v]==0)
  {
   printf("\n%d---->%d=%d\n",u,v,min);
   ne=ne+1;
   mincost=mincost+min;
  }
  elec[v]=1;
  c[u][v]=c[v][u]=1000;
 }
 printf("\nmincost=%d",mincost);
}
```

OUTPUT:



C:\Users\mknv7\OneDrive\Documents\C-Workspace\prim's-algo\Debug\prim's-algo.exe

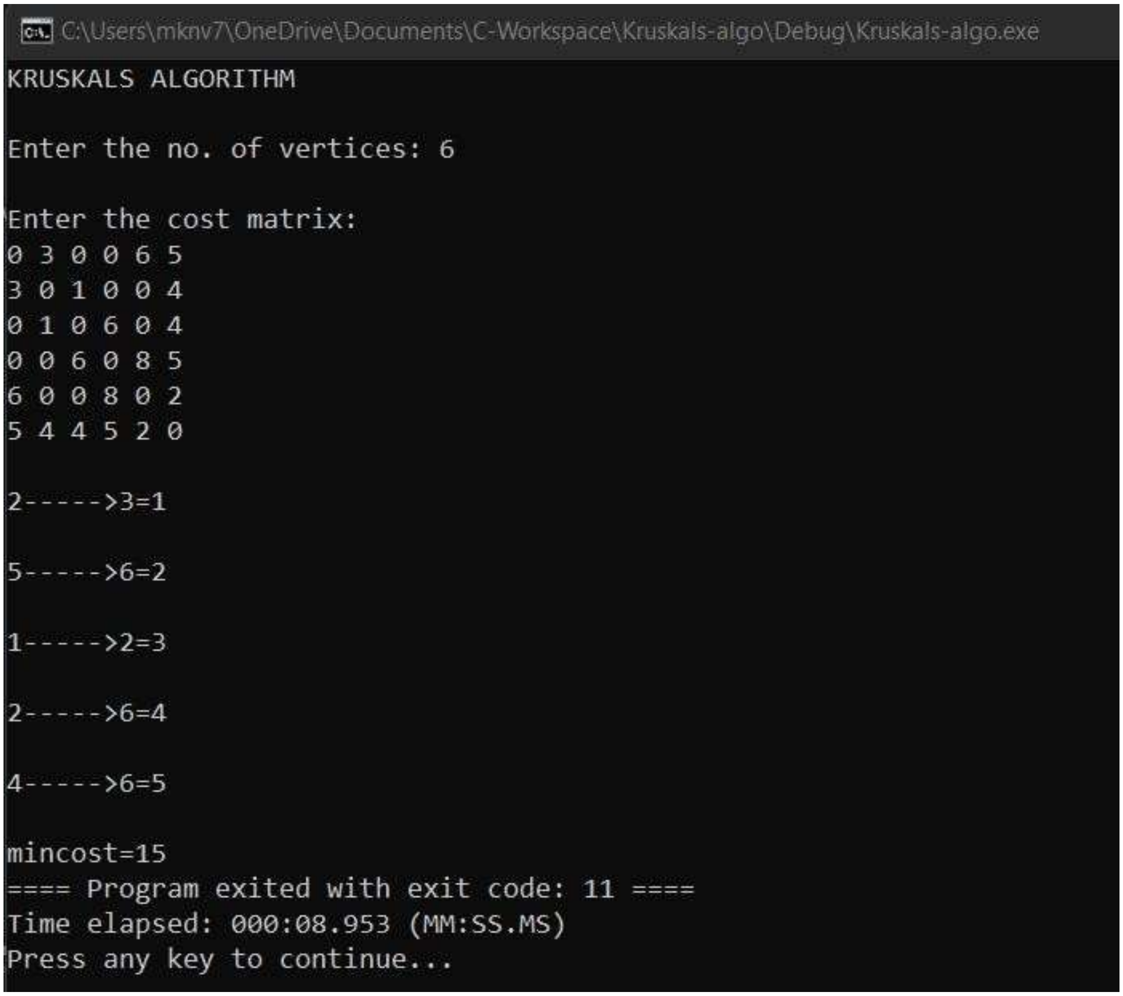
```
PRIMS ALGORITHM

Enter the no. of vertices: 6

Enter the cost 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----->2=3
2----->3=1
2----->6=4
6----->5=2
6----->4=5

mincost=15
==== Program exited with exit code: 12 ====
Time elapsed: 000:03.406 (MM:SS.MS)
Press any key to continue...
```

15. Find Minimum Cost Spanning Tree of a given undirected graph using Kruskals algorithm.

CODE:

```
#include<stdio.h>
void kruskals();
int c[10][10],n;
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]);
  if(c[i][j]==0)
          c[i][j]=9999;
  }
 }
 kruskals();
}

void kruskals()
{
 int i,j,u,v,a,b,min;
 int ne=0,mincost=0;
 int parent[10];
 for(i=1;i<=n;i++)
 {
  parent[i]=0;
 }
 while(ne!=n-1)
 {
  min=9999;
  for(i=1;i<=n;i++)
  {
   for(j=1;j<=n;j++)
   {
     if(c[i][j]<min)
     {
      min=c[i][j];
      u=a=i;
      v=b=j;
     }
   }
  }
  while(parent[u]!=0)
           u=parent[u];
  while(parent[v]!=0)
          v=parent[v];
  if(u!=v)
  {
   printf("\n%d---->%d=%d\n",a,b,min);
   parent[v]=u;
   ne=ne+1;
   mincost=mincost+min;
  }
  c[a][b]=c[b][a]=9999;
 }
 printf("\nmincost=%d",mincost);
}
```

OUTPUT:



C:\Users\mknv7\OneDrive\Documents\C-Workspace\Kruskals-algo\Debug\Kruskals-algo.exe

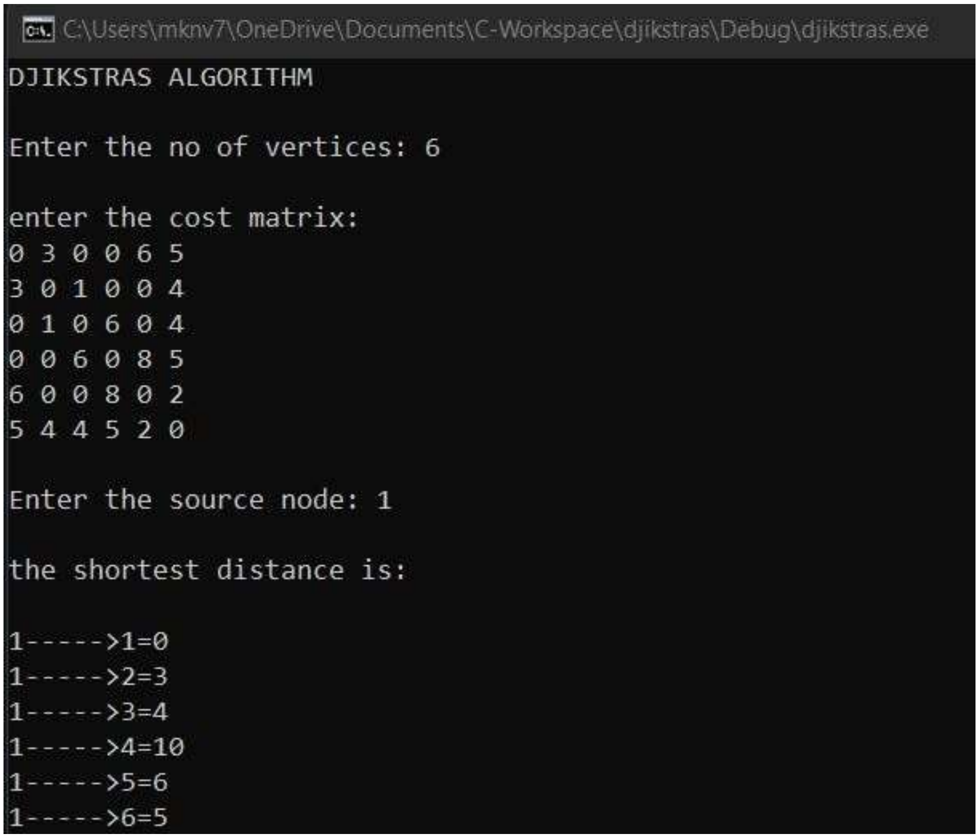
```
KRUSKALS ALGORITHM

Enter the no. of vertices: 6

Enter the cost 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

2----->3=1

5----->6=2

1----->2=3

2----->6=4

4----->6=5

mincost=15
==== Program exited with exit code: 11 ====
Time elapsed: 000:08.953 (MM:SS.MS)
Press any key to continue...
```

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

CODE:

```
#include <stdio.h>
void dijkstras();
int c[10][10], n, src;
void main()
{
  int i, j;
  printf("\nenter the no of vertices: ");
  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]);
     if(c[i][j]==0)
          c[i][j]=9999;
    }
  }
  printf("\nenter the source node: ");
  scanf("%d", &src);
  dijkstras();
}
void dijkstras()
{
  int vis[10], dist[10], u, j, count, min;
  for (j = 1; j <= n; j++)
  {
    dist[j] = c[src][j];
  }
  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];
      }
    }
  }
  printf("\nthe shortest distance is:\n");
  for (j = 1; j <= n; j++)
              printf("\n%d --- >%d=%d", src, j, dist[j]);
}
```

OUTPUT:



C:\Users\mknv7\OneDrive\Documents\C-Workspace\djikstras\Debug\djikstras.exe

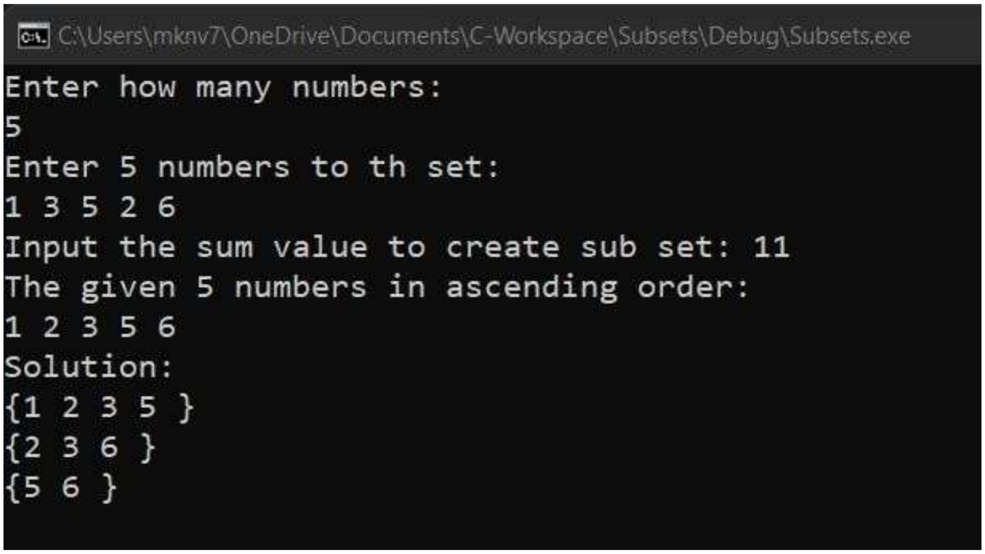
```
DJIKSTRAS ALGORITHM

Enter the no of vertices: 6

enter the cost 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

Enter the source node: 1

the shortest distance is:

1----->1=0
1----->2=3
1----->3=4
1----->4=10
1----->5=6
1----->6=5
```

17. Implement “Sum of Subsets” using Backtracking. “Sum of Subsets” 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.

CODE:

```
#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:


C:\Users\mknv7\OneDrive\Documents\C-Workspace\Subsets\Debug\Subsets.exe

```
Enter how many numbers:
5
Enter 5 numbers to th set:
1 3 5 2 6
Input the sum value to create sub set: 11
The given 5 numbers in ascending order:
1 2 3 5 6
Solution:
{1 2 3 5 }
{2 3 6 }
{5 6 }
```

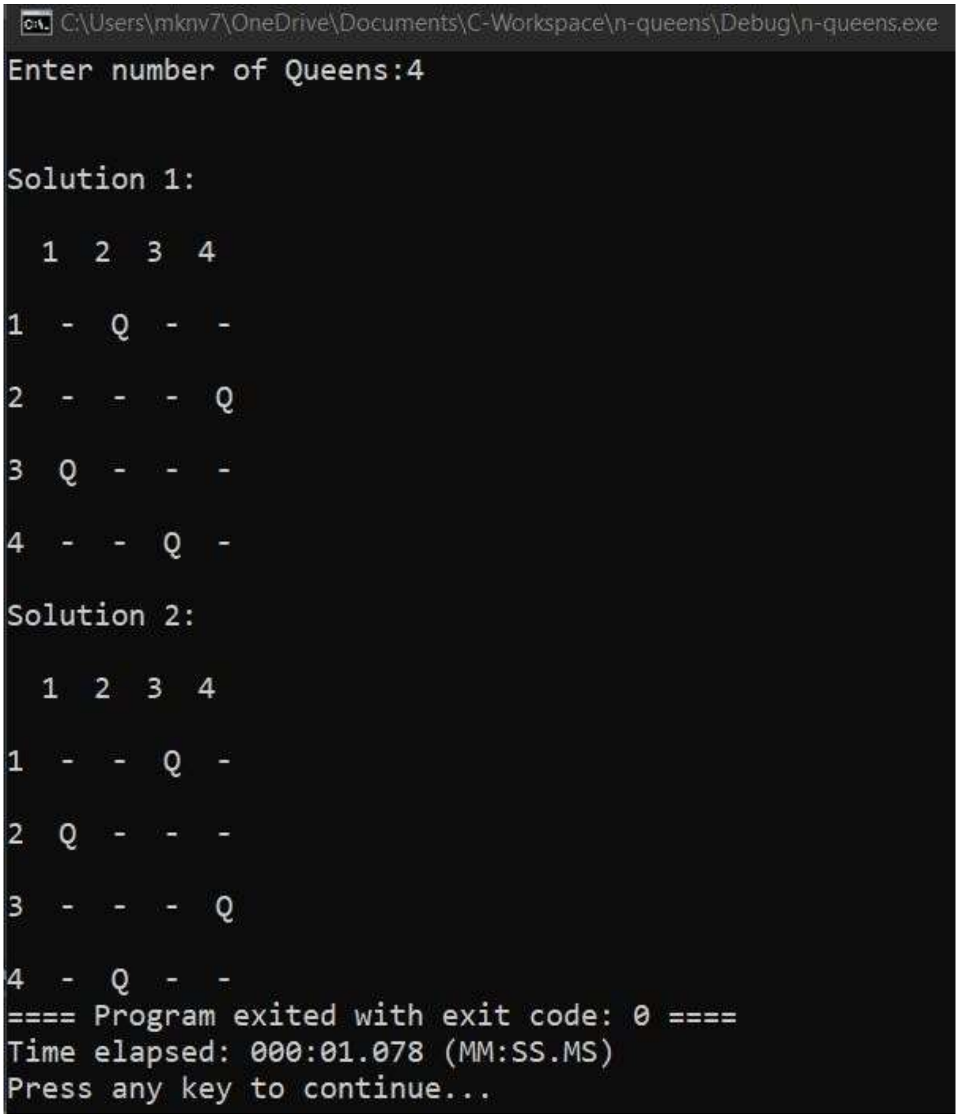
18. Implement “N-Queens Problem” using Backtracking.

CODE:

```
#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:


C:\Users\mknv7\OneDrive\Documents\C-Workspace\n-queens\Debug\n-queens.exe

```
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  -  -
==== Program exited with exit code: 0 ====
Time elapsed: 000:01.078 (MM:SS.MS)
Press any key to continue...
```