VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
on

Analysis and Design of Algorithms

Submitted by

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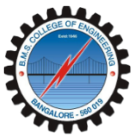
in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING



B.M.S. COLLEGE OF ENGINEERING
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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 **LOKESH R(1BM20CS078),** 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

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

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.

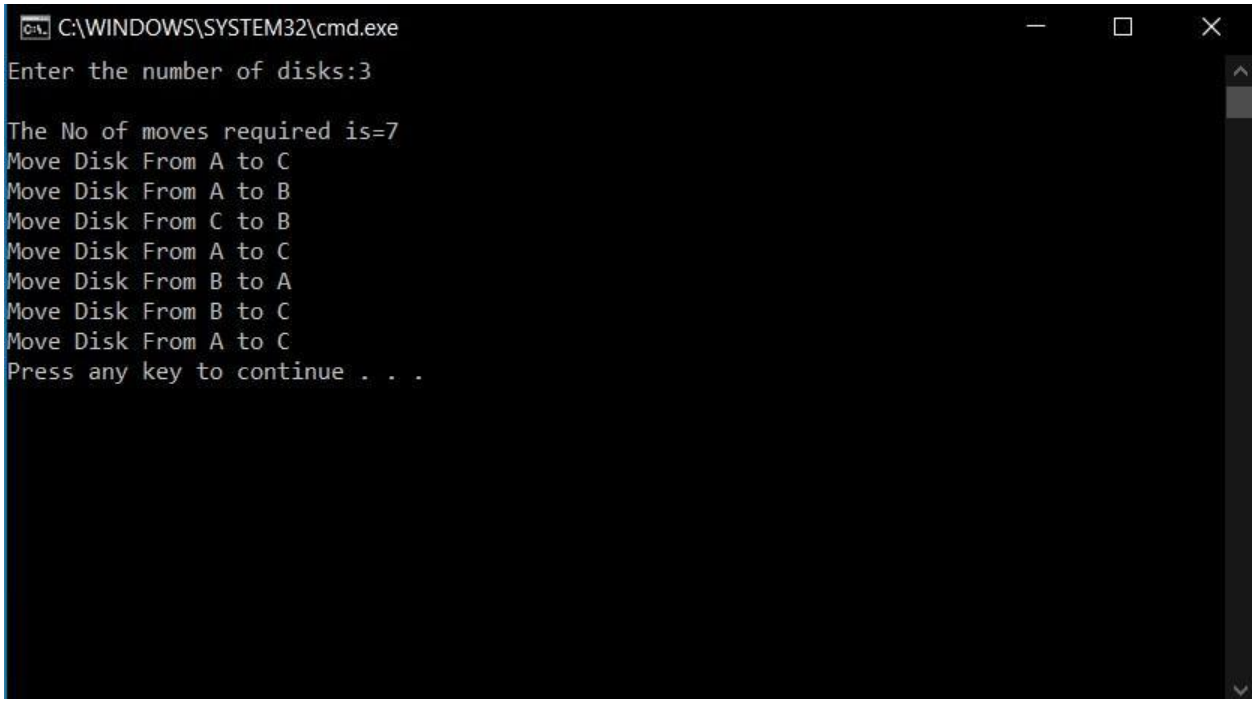
1 .Write a recursive program to

a. Solve Towers-of-Hanoi problem

```
a)  #include<stdio.h>
    #include<conio.h>
    #include<math.h>
void hanoi(int x, char from, char to, char aux)
{
if(x==1)
printf("Move Disk From %c to %c\n",from,to);
else
{
hanoi(x-1,from,aux,to);
printf("Move Disk From %c to %c\n",from,to);
hanoi(x-1,aux,to,from);
} }
int main()
{
int disk;
int moves;
printf("Enter the number of disks:");
scanf("%d",&disk);
moves=pow(2,disk)-1;
```

```
printf("\nThe No of moves required is=%d \n",moves);
hanoi(disk,'A','C','B');
return 0; }
```

OUTPUT-

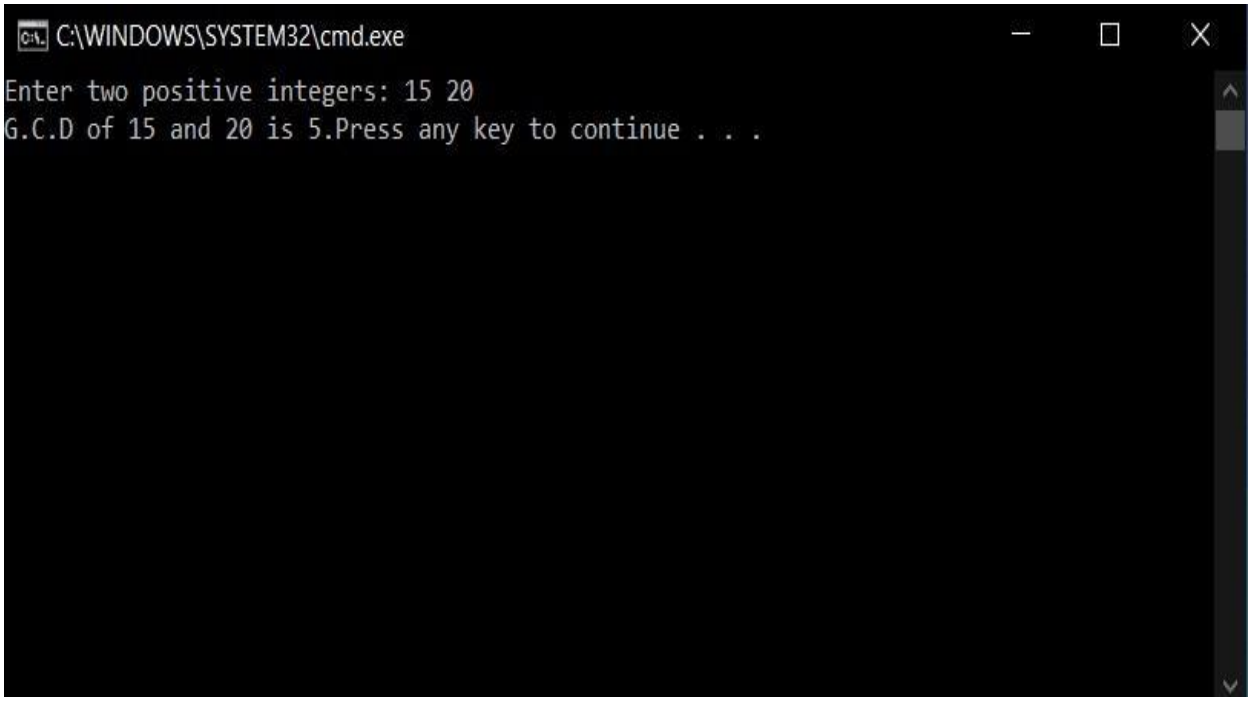


b)To find GCD

```
#include <stdio.h>
   int hcf(int x, int y);
   int main()
{
  int x;
  int y;
```

```
  printf("Enter two positive integers: ");
  scanf("%d %d", &x, &y);
  printf("G.C.D of %d and %d is %d.", x, y, hcf(x,y));
  return 0;
}

 int hcf(int x, int y)
{
        if (y != 0)
        return hcf(y,x%y);
        else
        return x;
}
```

OUTPUT -



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.

```
#include<stdio.h>

#include<time.h>

#include<stdlib.h> /* To recognise exit function when compiling with gcc*/

int bin_srch(int [],int,int,int);

int lin_srch(int [],int,int,int);

int n,a[10000];

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)
```

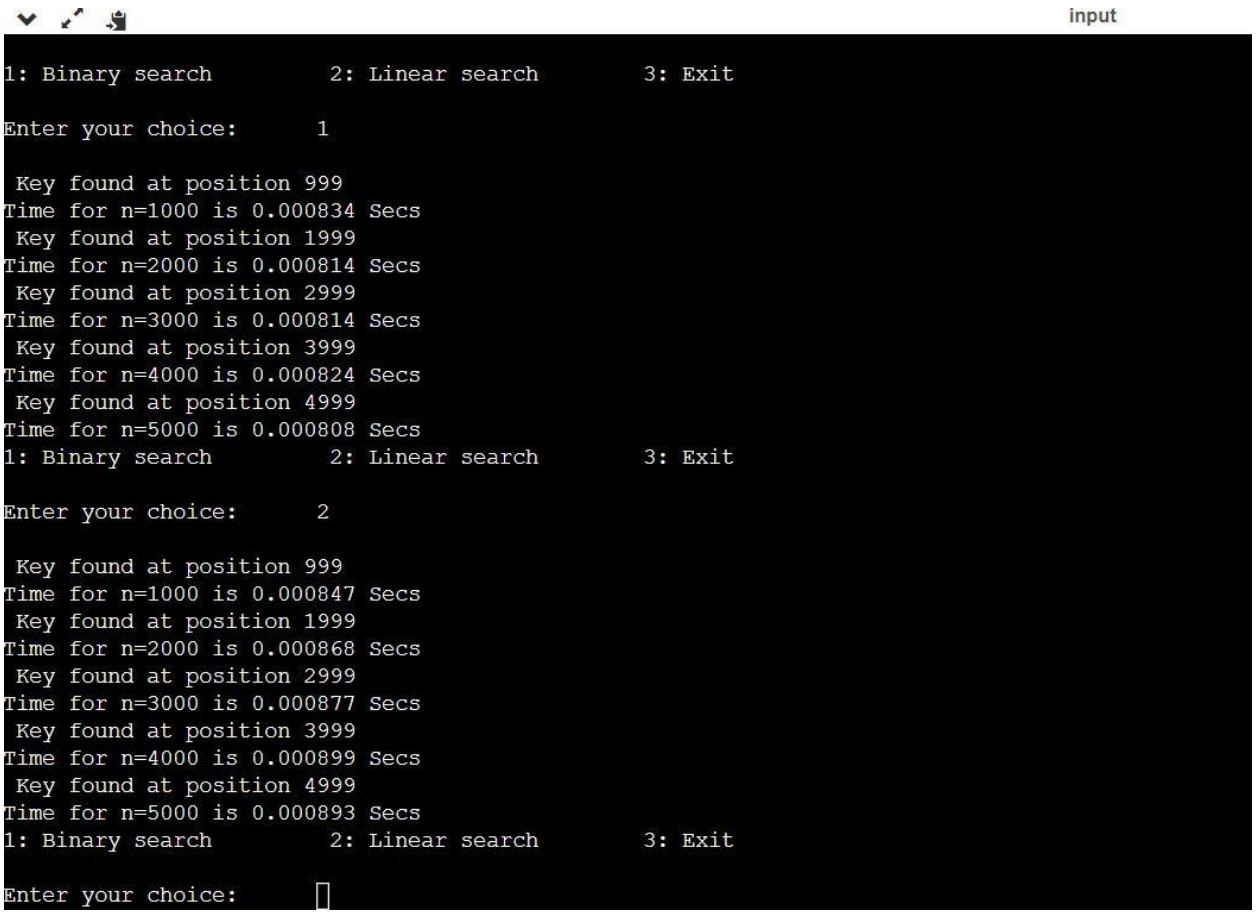
```
{
 case 1:
    n=1000;
while(n<=5000)
{
 for(i=0;i<n;i++)
 {
 //a[i]=random(1000);
 a[i]=i;  //Inserting numbers in Ascending order
 }
 key=a[n-1]; //Last element of the array
 start=clock();
          search_status=bin_srch(a,0,n-1,key);
 if(search_status==-1)
          printf("\nKey Not Found");
        else
          printf("\n Key found at position %d",search_status);
        //Dummy loop to create delay
 for(j=0;j<500000;j++){ temp=38/600;}

 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<=5000)
{
        for(i=0;i<n;i++)
 {
  //a[i]=random(10000);
  a[i]=i;
 }
 key=a[n-1]; //Last element of the aray
 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);
        //Dummy loop to create delay
for(j=0;j<500000;j++){ temp=38/600;}
 end=clock();
```

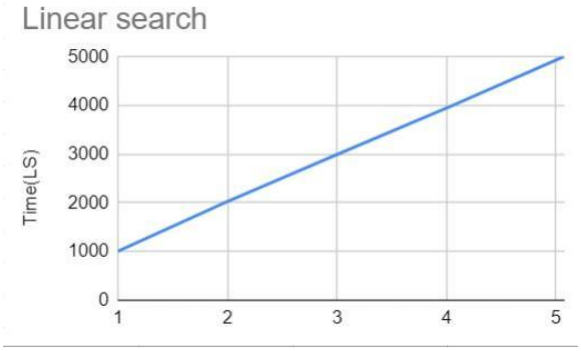
```
   printf("\nTime for n=%d is %f
Secs",n,(((double)(end-start))/CLOCKS_PER_SEC));
   n=n+1000;
  }
  break;
   default:
         exit(0);
  }
  getchar();
 }
}
int bin_srch(int a[],int low,int high,int key) {
 int mid;
 if(low>high)
  return -1;
 mid=(low+high)/2;
 if(key==a[mid])
  return mid;
 if(key<a[mid])
  return bin_srch(a,low,mid-1,key);
 else
  return bin_srch(a,mid+1,high,key);
}
```

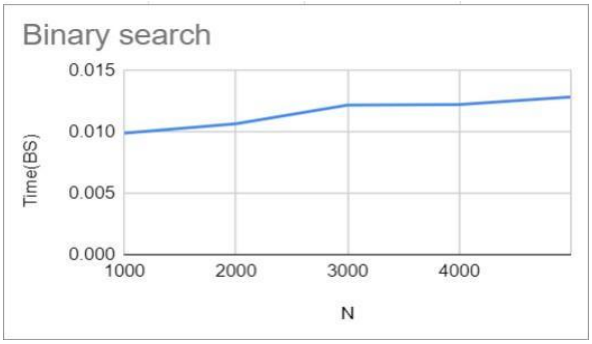
```
int lin_srch(int a[],int i,int high,int key) {
 if(i>high)
  return -1;
 if(key==a[i])
  return i;
 else
  return lin_srch(a,i+1,high,key);  }
```

OUTPUT -



Time(LS)	N	Time(BS)
0.9987	1000	0.009863
1.9786	2000	0.010633
3.011	3000	0.012154
4.061	4000	0.012196
5.077	5000	0.012823





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.

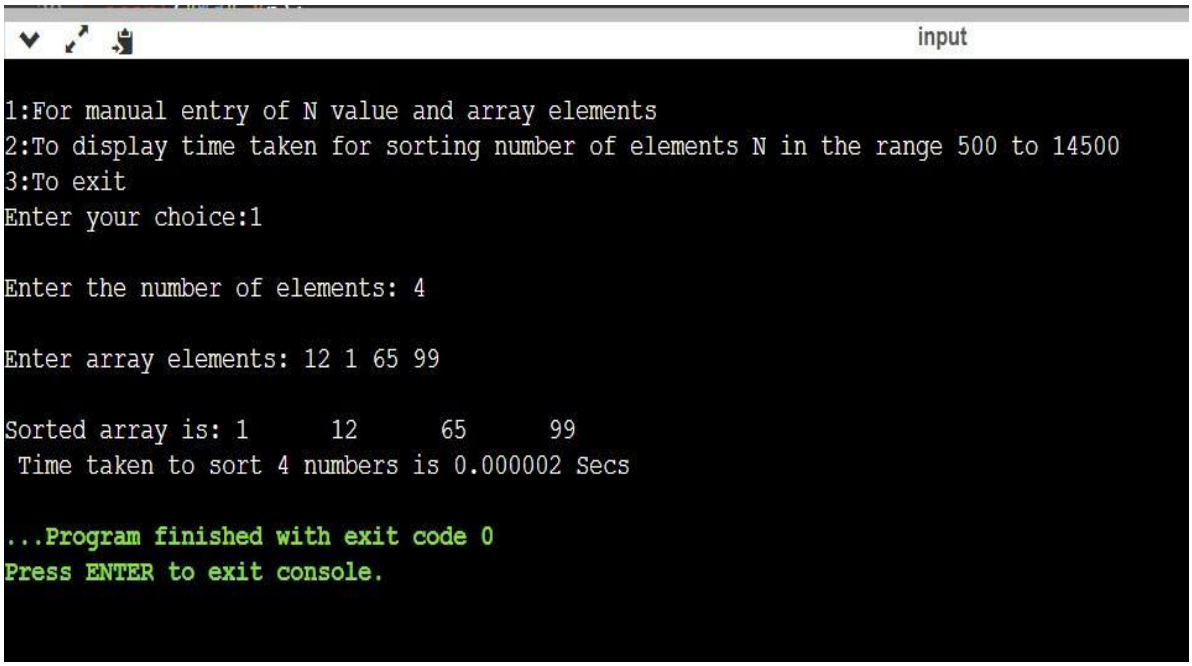
```
#include<stdio.h>
#include<time.h>
#include<stdlib.h>
 /* To recognise exit function when compiling with gcc*/
void selsort(int n,int a[]);
int main()
{
  int a[15000],n,i,j,ch,temp;
  clock_t start,end;
  while(1)
  {
 printf("\n1:For manual entry of N value and array elements");
 printf("\n2:To display time taken for sorting number of elements N in the range 500 to 14500");
 printf("\n3:To exit");
 printf("\nEnter your choice:");
 scanf("%d", &ch);
 switch(ch)
   {
 case 1:  printf("\nEnter the number of elements: ");
```

```
 scanf("%d",&n);
 printf("\nEnter array elements: ");
 for(i=0;i<n;i++)
 {
  scanf("%d",&a[i]);
 }
start=clock();
selsort(n,a);
end=clock();
printf("\nSorted array is: ");
for(i=0;i<n;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<=14500) {
        for(i=0;i<n;i++)
        {
        //a[i]=random(1000);
         a[i]=n-i;
                }
```

```
 start=clock();
 selsort(n,a);
  //Dummy loop to create delay
 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 3: exit(0);
   }
   return 0;
    }
}
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++)
```

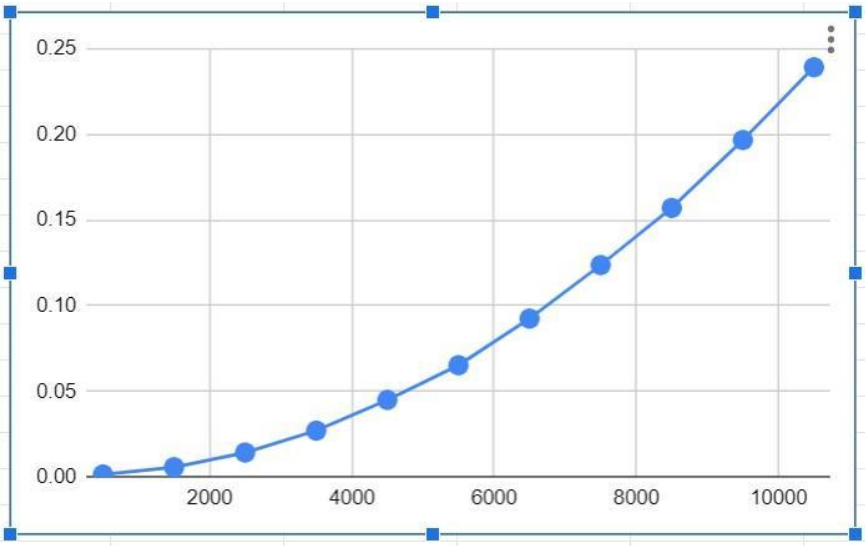
```
{  if(a[j]<small)
 { small=a[j];
   pos=j;  } }
  t=a[i];
  a[i]=a[pos];
  a[pos]=t;   } }
```

OUTPUT-



```
input

1:For manual entry of N value and array elements
2:To display time taken for sorting number of elements N in the range 500 to 14500
3:To exit
Enter your choice:2

 Time taken to sort 500 numbers is 0.001610 Secs
 Time taken to sort 1500 numbers is 0.005862 Secs
 Time taken to sort 2500 numbers is 0.014398 Secs
 Time taken to sort 3500 numbers is 0.027170 Secs
 Time taken to sort 4500 numbers is 0.045081 Secs
 Time taken to sort 5500 numbers is 0.065311 Secs
 Time taken to sort 6500 numbers is 0.092552 Secs
 Time taken to sort 7500 numbers is 0.123708 Secs
 Time taken to sort 8500 numbers is 0.157582 Secs
 Time taken to sort 9500 numbers is 0.196691 Secs
 Time taken to sort 10500 numbers is 0.239021 Secs
 Time taken to sort 11500 numbers is 0.291980 Secs
 Time taken to sort 12500 numbers is 0.340763 Secs
 Time taken to sort 13500 numbers is 0.403541 Secs
 Time taken to sort 14500 numbers is 0.468520 Secs

...Program finished with exit code 0
Press ENTER to exit console.
```

N	T
500	0.0016
1500	0.005862
2500	0.014398
3500	0.02717
4500	0.045081
5500	0.0653
6500	0.0925
7500	0.1237
8500	0.157
9500	0.1966
10500	0.239



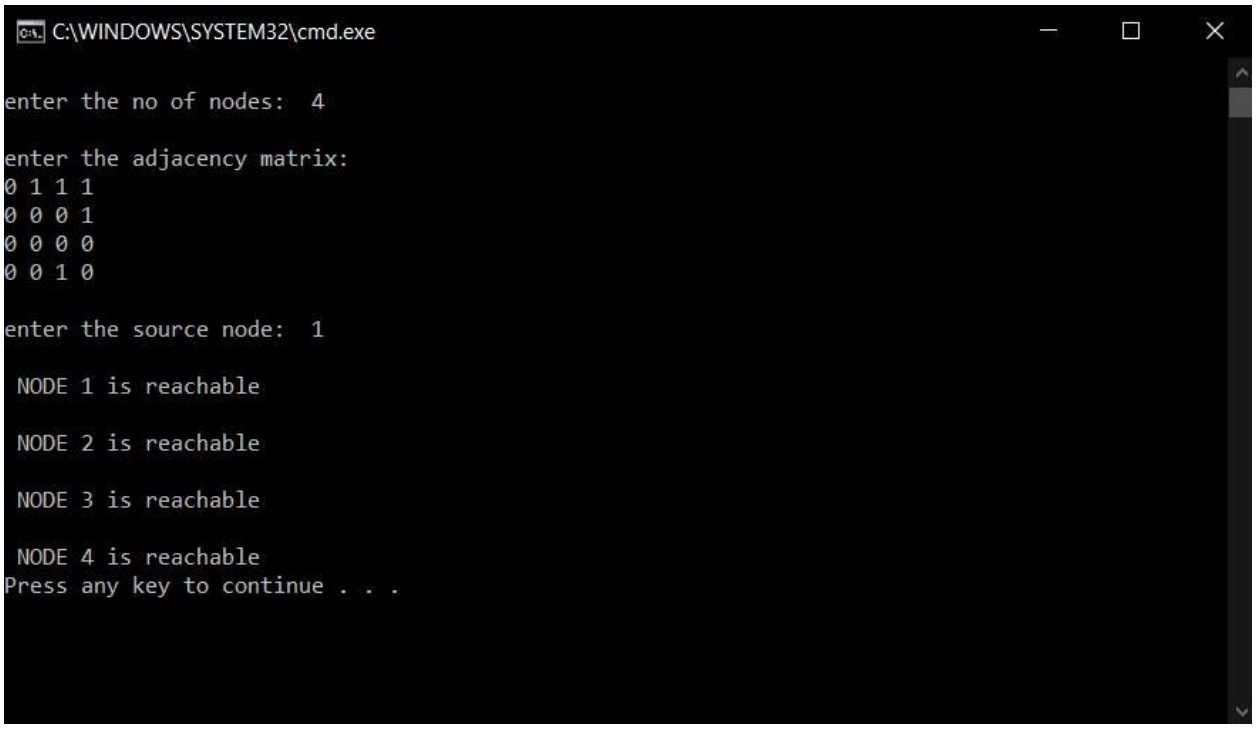
4.Write program to do the following: a) Print all the nodes reachable from a given starting node in a digraph using BFS method.

```
#include<stdio.h>
#include<conio.h>
int a[10][10],n;
void bfs(int);
int 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);
return 0;
}
```

```
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("\n NODE %d is not reachable\n",j);
```

```
  else
  { printf("\n NODE %d is reachable\n",j);
  } } }
```

OUTPUT -



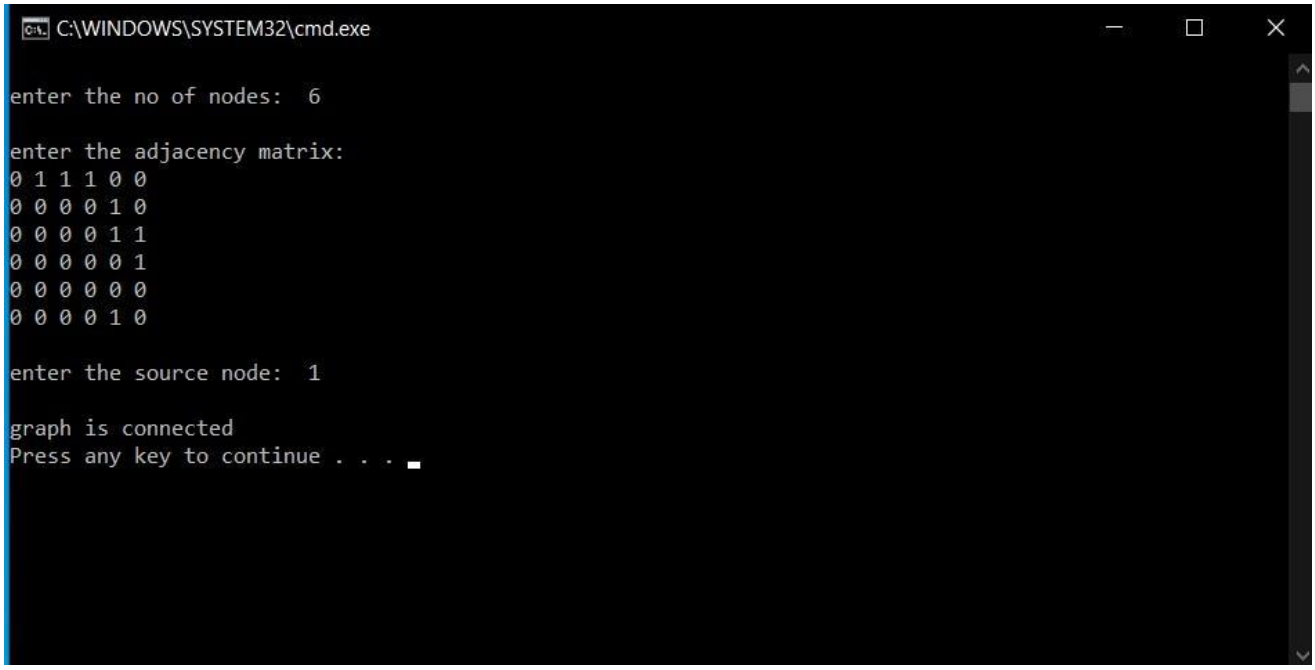
b. Check whether a given graph is connected or not using DFS method.

```
#include<stdio.h>
#include<conio.h>
int a[10][10],n,vis[10];
int dfs(int);
int 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"); }
```

```
return 0;
}
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:\WINDOWS\SYSTEM32\cmd.exe
enter the no 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
enter the source node: 1
graph is connected
Press any key to continue . . .

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

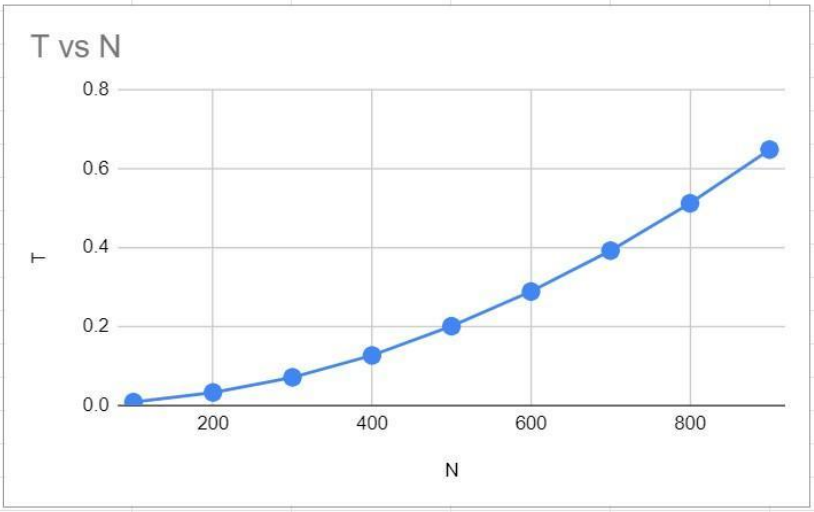
```
#include <math.h>
#include <stdio.h>
#include <time.h>
void delay(){
 long n;
 for(n=0;n<1000;n++){
 int a = 10/10;
 }
}
void insertionSort(int arr[], int n)
{
int i, val, j;
for (i = 1; i < n; i++) {
val = arr[i];
j = i - 1;
while (j >= 0 && arr[j] > val) {
arr[j + 1] = arr[j];
j --;
delay();
}
arr[j + 1] = val;
```

```
}
}
int main()
{ int arr[1500],n=100,i;
 double start,end;
 while(n<=1200){
 for(i=0;i<n;i++){
 arr[i]=i;
 }
 start = clock();
 insertionSort(arr, n);
 end=clock();
 printf("n=%d time= %f \n",n,(end-start)/CLOCKS_PER_SEC);
 n=n+100;
 }
return 0;
}
```

OUTPUT-

```
input
to sort out element using insertion sort
enter size of array
12
enter array elements
array elements are
7 10 9 7 5 7 10 0 9 1 2 7 sorted array is
 0  1  2  5  7  7  7  7  9  9  10  10 time taken is 0.001569

...Program finished with exit code 0
Press ENTER to exit console.
```

N	T
100	0.007591
200	0.032031
300	0.070505
400	0.125896
500	0.200085
600	0.287917
700	0.391542
800	0.511558
900	0.647698



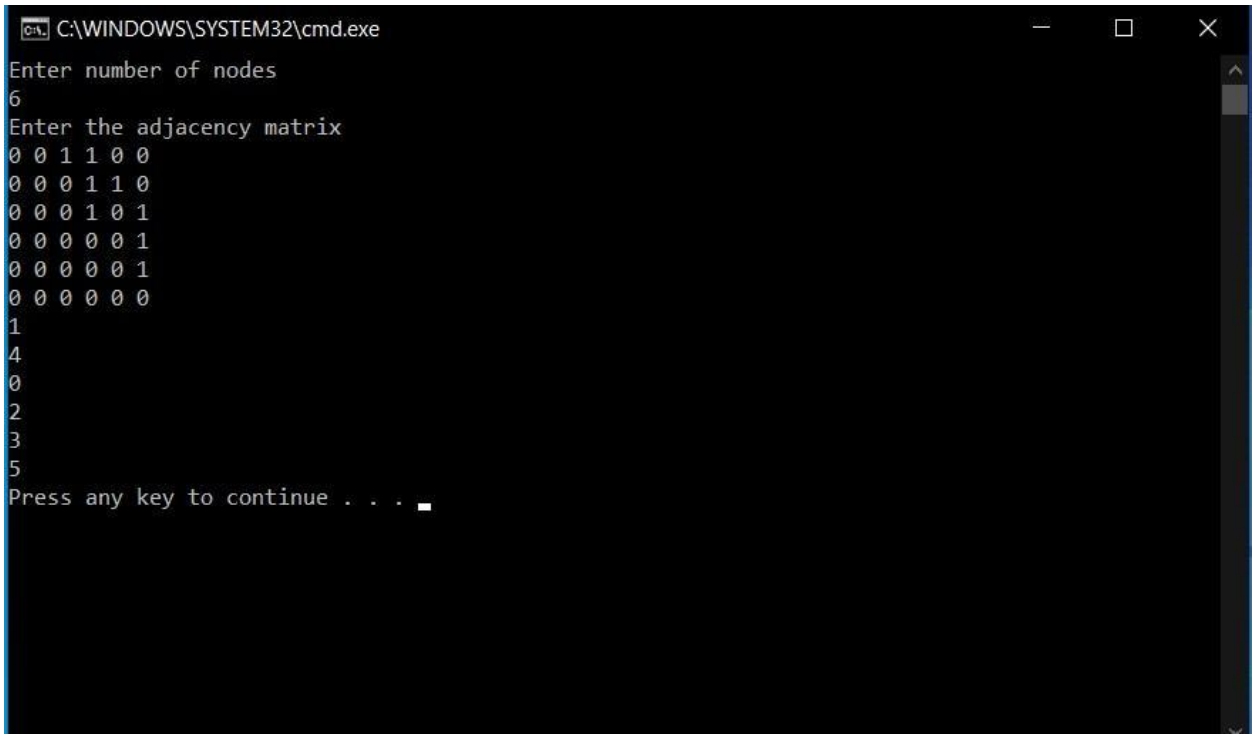
6.Write program to obtain the Topological ordering of vertices in a given digraph.

```
#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;
}
}
}
for(i=0;i<n;i++)
{
printf("%d\n", t[i]);
}
}
int 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);
return 0;
}
```

OUTPUT-



7.Implement Johnson Trotter algorithm to generate permutations

```
#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++ ;    }
```

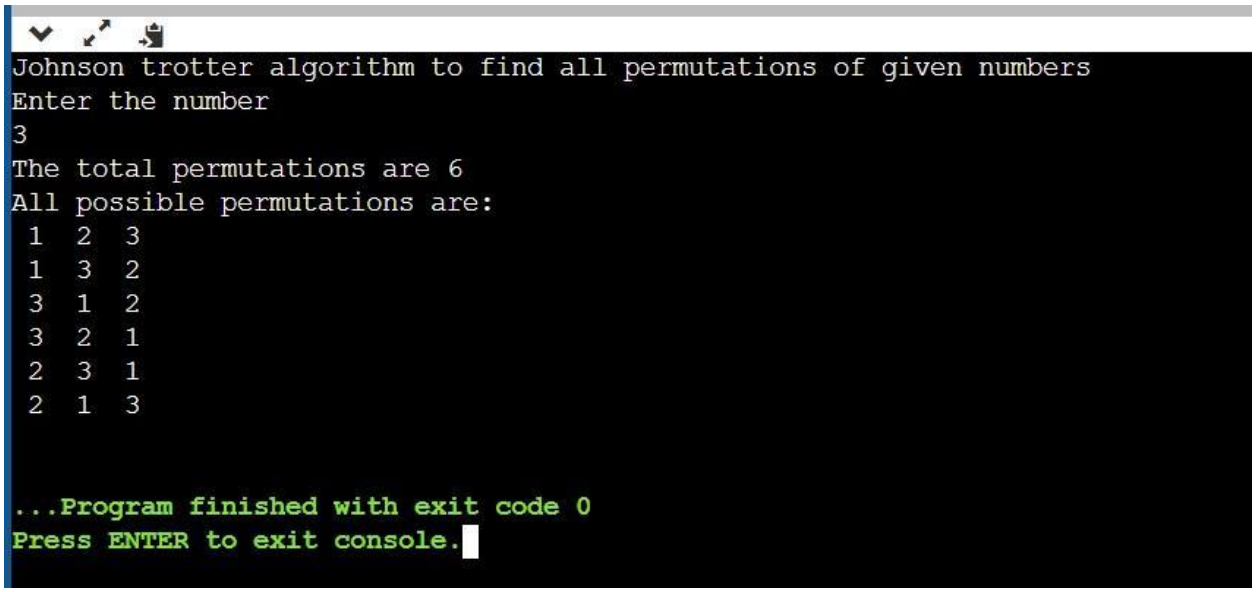
```
    }
    else if((d[arr[i]-1] == 1) & i != num-1)
    {
        if(arr[i]>arr[i+1] && arr[i]>mobile_p)
        {
            mobile = arr[i];
            mobile_p = mobile;
        }
        else
        {
            flag++;
        }
    }
    else
        {
            flag++;
        }
}
if((mobile_p == 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("The total permutations are %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 -


Johnson trotter algorithm to find all permutations of given numbers
Enter the number
3
The total permutations are 6
All possible permutations are:
1 2 3
1 3 2
3 1 2
3 2 1
2 3 1
2 1 3
...Program finished with exit code 0
Press ENTER to exit console.

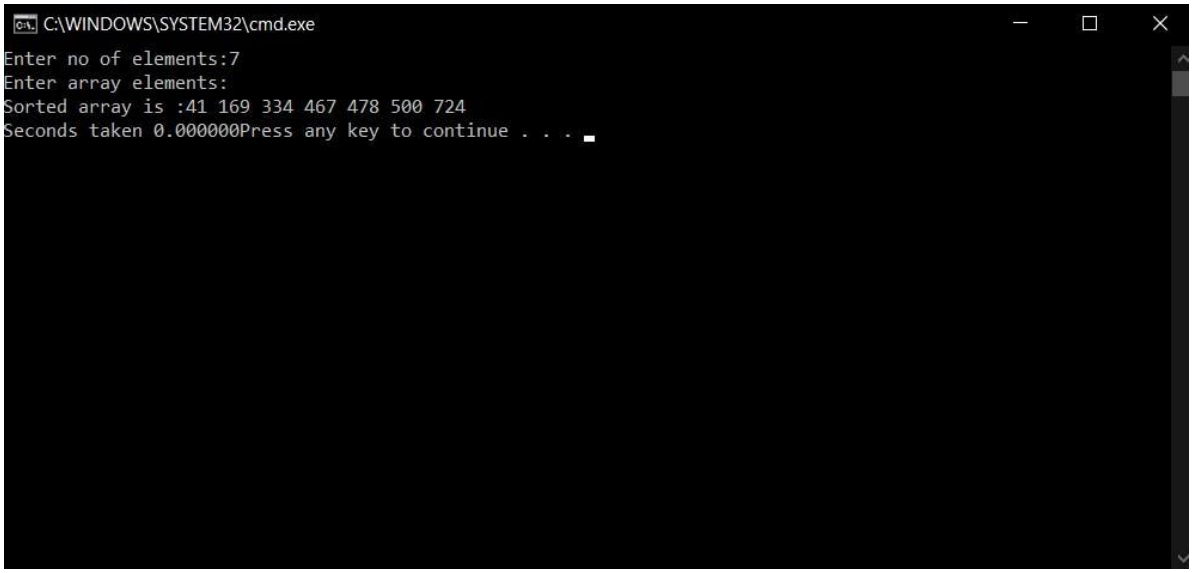
8.Sort a given set of N integer elements using Merge Sort technique and compute its time taken. Run the program for different values of N and record the time taken to sort.

```
#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[3000],n,i;
printf("Enter no of elements:");
scanf("%d",&n);
printf("Enter array elements:");
for(i=0;i<n;i++)
   a[i] = rand()%1000;
start = clock();
mergesort(a,0,n-1);
end = clock();
printf("\nSorted array is :");
for(i=0;i<n;i++)
printf("%d ",a[i]);
```

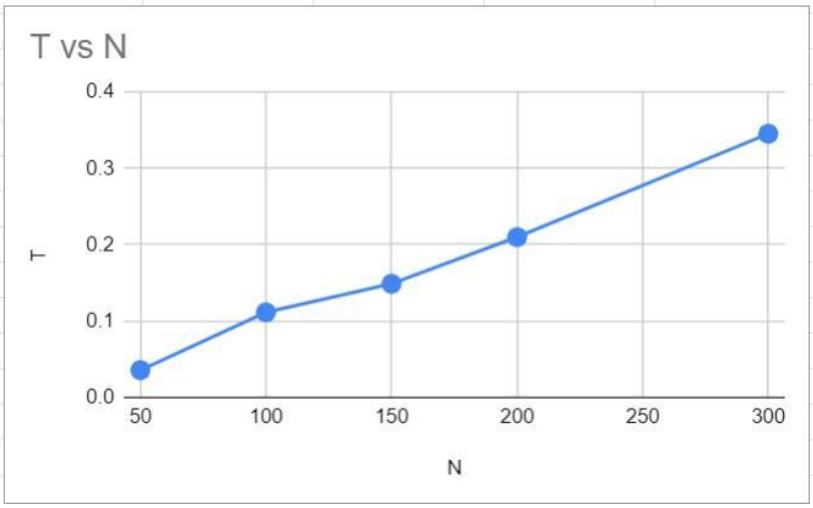
```
printf("\nSeconds taken %lf",(double)(end-start)/CLOCKS_PER_SEC);
return 0;
}
void mergesort(int a[],int i,int j)
{
int mid;
if(i<j)
{
mid=(i+j)/2;
mergesort(a,i,mid);
mergesort(a,mid+1,j);
merge(a,i,mid,mid+1,j);
}
}
void merge(int a[],int i1,int j1,int i2,int j2)
{
int temp[3000];
int i,j,k;
i=i1;
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-



N	T
50	0.0355
100	0.111199
150	0.148658
200	0.209777
300	0.345228



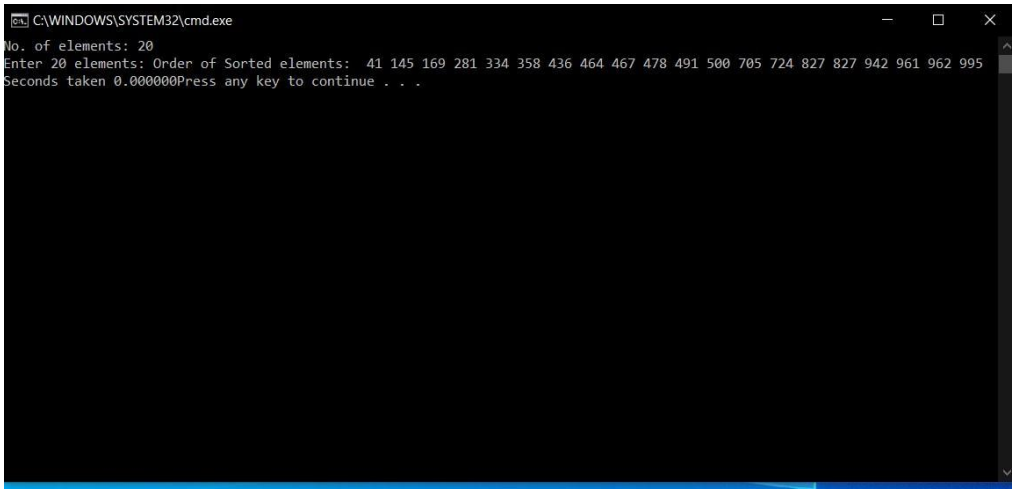
9.Sort a given set of N integer elements using Quick Sort technique and compute its time taken

```
#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<100000;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;
      }
```

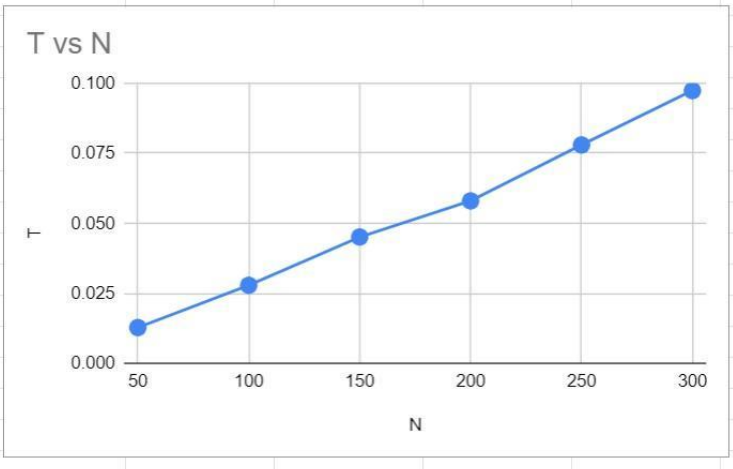
```
    }
    temp=number[pivot];
    number[pivot]=number[j];
    number[j]=temp;
    quicksort(number,first,j-1);
    quicksort(number,j+1,last);
  }
}
int main(){
  clock_t start,end;
  int i, count, number[5000];
  printf("No. of elements: ");
  scanf("%d",&count);
  printf("Enter %d elements: ", count);
  for(i=0;i<count;i++)
      number[i] = rand()%1000;
  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-



N	T
50	0.01287
100	0.027947
150	0.045167
200	0.058032
250	0.077984
300	0.097361



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

```
#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, temp;
   clock_t start, end;
   while (1)
   {
      printf("\n1:FOR MANUAL ENTRY");
      printf("\n2:DISPLAY TIME TAKEN TO SORT ELEMENTS FROM
RANGE 500 TO 15000");
      printf("\n3:EXIT");
      printf("\nENTER YOUR CHOICE:");
      scanf("%d", &ch);
      switch (ch)
      {
```

```
        case 1:
            printf("\nENTER NUMBER OF ARRAY ELEMENTS: ");
            scanf("%d", &n);
            printf("\nENTER 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 <= 14500)
            {
                for (i = 0; i < n; i++)
                {
```

```
            //a[i]=rand()%n;
            a[i] = n - i;
        }
        start = clock();
        heapSort(a, n);
        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 3:
      exit(0);
    }
    getchar();
  }
}

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

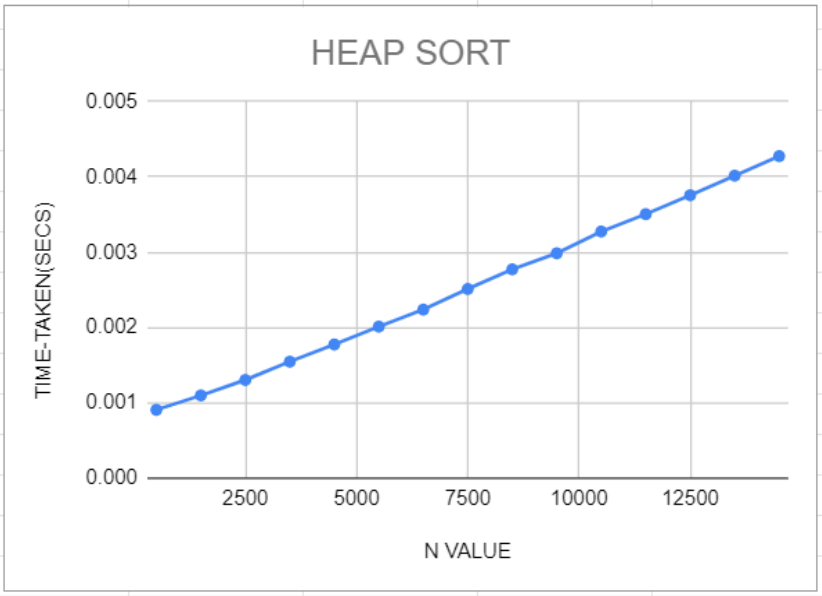
```
{
   int temp = *a;
   *a = *b;
   *b = temp;
}
void heapify(int arr[], int n, int i)
{
   int largest = i;
   int left = 2 * i + 1;
   int right = 2 * i + 2;
   if (left < n && arr[left] > arr[largest])
      largest = left;
   if (right < n && arr[right] > arr[largest])
      largest = right;
   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 15000
3:EXIT
ENTER YOUR CHOICE:1

ENTER NUMBER OF ARRAY ELEMENTS: 5

ENTER ARRAY ELEMENTS: 5 4 3 2 1

SORTED ARRAY IS: 1      2       3       4       5
 TIME TAKEN TO SORT 5 NUMBERS IS 0.000003 SECS
1:FOR MANUAL ENTRY
2:DISPLAY TIME TAKEN TO SORT ELEMENTS FROM RANGE 500 TO 15000
3:EXIT
ENTER YOUR CHOICE:2

 TIME TAKEN TO SORT 500 NUMBERS IS 0.000904 SECS
 TIME TAKEN TO SORT 1500 NUMBERS IS 0.001096 SECS
 TIME TAKEN TO SORT 2500 NUMBERS IS 0.001301 SECS
 TIME TAKEN TO SORT 3500 NUMBERS IS 0.001544 SECS
 TIME TAKEN TO SORT 4500 NUMBERS IS 0.001772 SECS
 TIME TAKEN TO SORT 5500 NUMBERS IS 0.002010 SECS
 TIME TAKEN TO SORT 6500 NUMBERS IS 0.002236 SECS
 TIME TAKEN TO SORT 7500 NUMBERS IS 0.002510 SECS
 TIME TAKEN TO SORT 8500 NUMBERS IS 0.002771 SECS
 TIME TAKEN TO SORT 9500 NUMBERS IS 0.002984 SECS
 TIME TAKEN TO SORT 10500 NUMBERS IS 0.003273 SECS
 TIME TAKEN TO SORT 11500 NUMBERS IS 0.003504 SECS
 TIME TAKEN TO SORT 12500 NUMBERS IS 0.003755 SECS
 TIME TAKEN TO SORT 13500 NUMBERS IS 0.004015 SECS
 TIME TAKEN TO SORT 14500 NUMBERS IS 0.004275 SECS
1:FOR MANUAL ENTRY
2:DISPLAY TIME TAKEN TO SORT ELEMENTS FROM RANGE 500 TO 15000
3:EXIT
ENTER YOUR CHOICE:3


...Program finished with exit code 0
Press ENTER to exit console.
```

N VALUE	TIME-TAKEN(SECS)
500	0.000904
1500	0.001096
2500	0.001301
3500	0.001544
4500	0.001772
5500	0.00201
6500	0.002236
7500	0.00251
8500	0.002771
9500	0.002984
10500	0.003273
11500	0.003504
12500	0.003755
13500	0.004015
14500	0.004275



11) Implement Warshall's algorithm using dynamic programming.

```
#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-

```
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 finished with exit code 0
Press ENTER to exit console.
```

12) 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-

```
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:  5

the output is:
0       0       0       0       0       0

0       0       12      12      12      12

0       10      12      22      22      22

0       10      12      22      30      32

0       10      15      25      30      37


the optimal solution is 37
the solution vector is:
1       1       0       1

...Program finished with exit code 255
Press ENTER to exit console.
```

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

```
#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;
}
```

```
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 finished with exit code 0
Press ENTER to exit console.
```

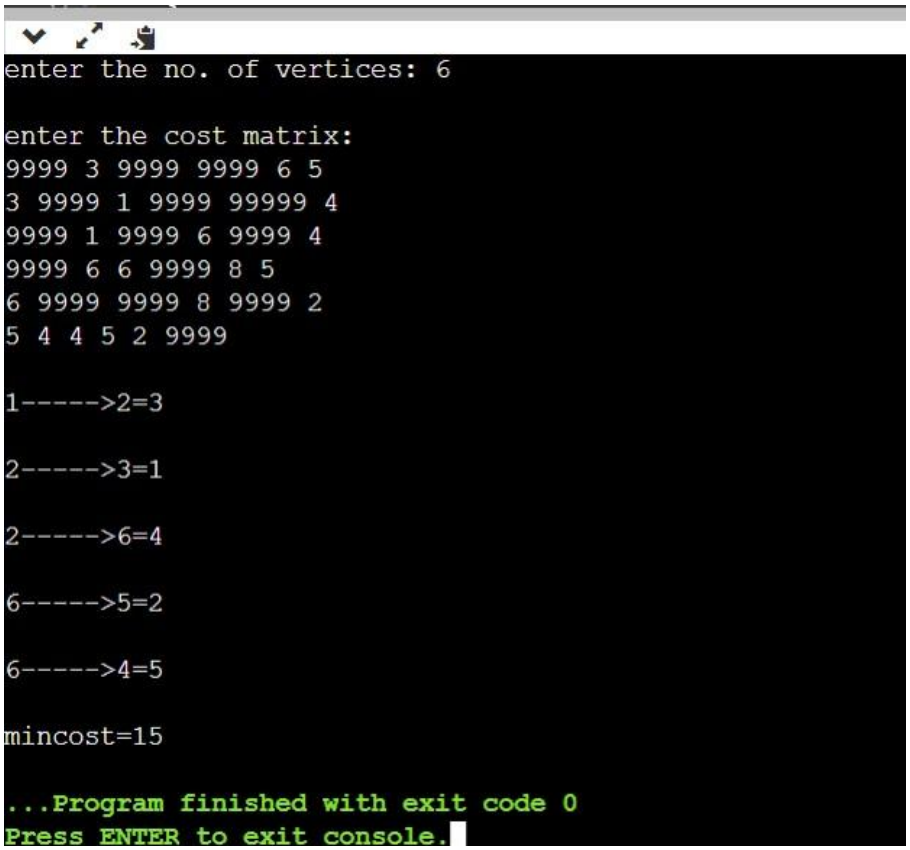
14) Find Minimum Cost Spanning Tree of a given undirected graph using Prim's algorithm.

```
#include<stdio.h>
void prims();
int c[10][10],n;
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]);
  }
 }
 prims();
}
void prims()
{
```

```
int i,j,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=9999;
 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]!=1) {
   printf("\n%d----->%d=%d\n",u,v,min);
   elec[v]=1;
   ne=ne+1;
   mincost=mincost+min; }
  c[u][v]=c[v][u]=9999;
 }
 printf("\nmincost=%d",mincost);
}
```

OUTPUT-



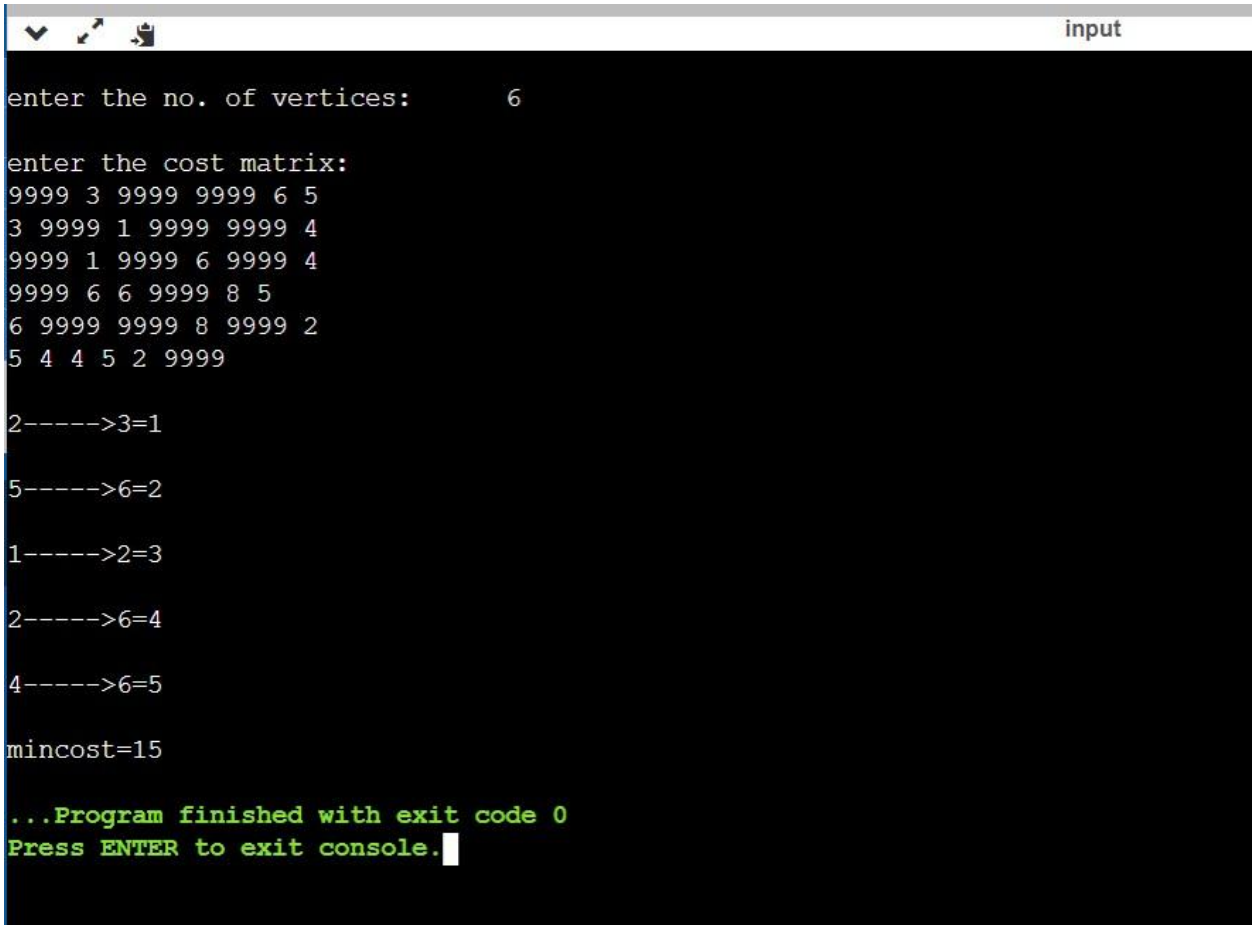
15) Find Minimum Cost Spanning Tree of an undirected graph using Kruskals algorithm

```
#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]);
  }
 }
 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 -


input
enter the no. of vertices: 6
enter the cost matrix:
9999 3 9999 9999 6 5
3 9999 1 9999 9999 4
9999 1 9999 6 9999 4
9999 6 6 9999 8 5
6 9999 9999 8 9999 2
5 4 4 5 2 9999
2----->3=1
5----->6=2
1----->2=3
2----->6=4
4----->6=5
mincost=15
...Program finished with exit code 0
Press ENTER to exit console.

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

```
#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]);
  }
 }
 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 -

```
enter the no of vertices: 5

enter the cost matrix:
99 3 99 7 99
3 99 4 2 99
99 4 99 5 6
7 2 5 99 4
99 99 6 4 99

enter the source node: 1

the shortest distance is:

1----->1=0
1----->2=3
1----->3=7
1----->4=5
1----->5=9

...Program finished with exit code 0
Press ENTER to exit console.
```

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.

```
#include <stdio.h>
#include <conio.h>
int count, w[10], d, x[10];
void subset(int cs, int k, int r)
{
   int i;
   x[k] = 1;
   if (cs + w[k] == d)
   {
      printf("\nSubset solution = %d\n", ++count);
      for (i = 0; i <= k; i++)
      {
         if (x[i] == 1)
            printf("%d ", w[i]);
      }
   }
   else if (cs + w[k] + w[k + 1] <= d)
      subset(cs + w[k], k + 1, r - w[k]);
```

```
    if ((cs + r - w[k] >= d) && (cs + w[k + 1]) <= d)
    {
        x[k] = 0;
        subset(cs, k + 1, r - w[k]);
    }
}

void main()
{
    int sum = 0, i, n;
    printf("Enter the number of elements\n");
    scanf("%d", &n);
    printf("Enter the elements in ascending order\n");
    for (i = 0; i < n; i++)
        scanf("%d", &w[i]);

    printf("Enter the required sum\n");
    scanf("%d", &d);
    for (i = 0; i < n; i++)
        sum += w[i];
    if (sum < d)
    {
        printf("No solution exists\n");
```

```
        return;
    }
    printf("The solution is\n");
    count = 0;
    subset(0, 0, sum);
    getch();
}
```

OUTPUT -

```
Enter the number of elements
5
Enter the elements in ascending order
1
2
5
6
8
Enter the required sum
9
The solution is

Subset solution = 1
1 2 6
Subset solution = 2
1 8

...Program finished with exit code 0
Press ENTER to exit console.
```

18)Implement N-Queens problem using backtracking

```
#include<stdio.h>
#include<conio.h>
void nqueens(int n)
{
	int k,x[20],count=0;
	k=1;
	x[k]=0;
	while(k!=0)
	{
		x[k]++;
		while(place(x,k)!=1 && x[k]<=n)
			x[k]++;
		if(x[k]<=n)
		{
			if(k==n)
			{
				printf("\nSolution is %d\n", ++count);
				printf("Queen\t\tPosition\n");
				for(k=1;k<=n;k++)
					printf("%d\t\t%d\n", k,x[k]);
			}
			else
```

```
                {
                        k++;
                        x[k]=0;
                }
        }
        else
                k--;
    }
}
int place(int x[], int k)
{
    int i;
    for(i=1;i<=k-1;i++)
    {
        if(i+x[i]==k+x[k]||i-x[i]==k-x[k]||x[i]==x[k])
            return 0;
    }
    return 1;
}
void main()
{
    int n;
    printf("Enter the number of Queens\n");
```

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

OUTPUT-