

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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LAB REPORT

on

ANALYSIS AND DESIGN OF ALGORITHMS

Submitted by

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in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING

in

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CERTIFICATE

This is to certify that the Lab work entitled “**ANALYSIS AND DESIGN OF ALGORITHMS**” carried out by **Vaddi Durga Varaprasad (1BM20CS223)**, 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 - (19CS34PCADA)** work prescribed for the said degree.

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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.

LAB PROGRAM-01

Write a recursive program to

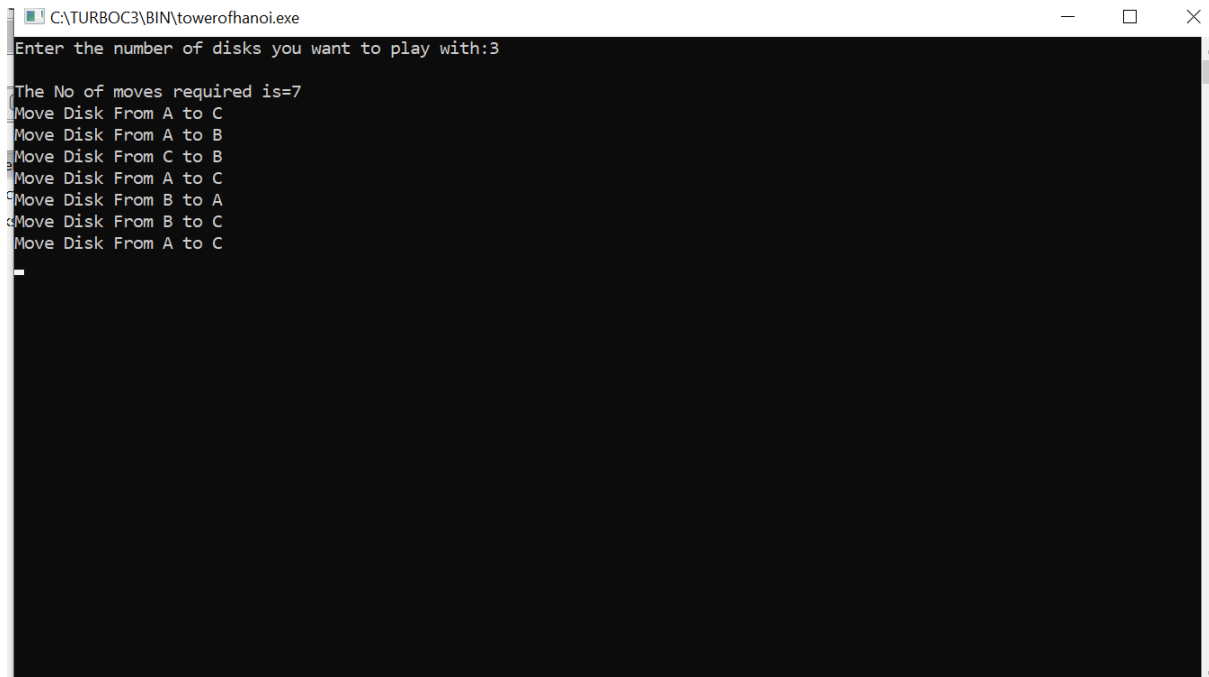
a. Solve Towers-of-Hanoi problem

b. To find GCD

```
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);
          }
      }
      void main( )
      {
          int disk;
          int moves;
          clrscr();
          printf("Enter the number of disks you want to play with:");
          scanf("%d",&disk);
          moves=pow(2,disk)-1;
          printf("\nThe No of moves required is=%d \n",moves);
          hanoi(disk,'A','C','B');
          getch( );
      }
```

}

OUTPUT:



```
C:\TURBOC3\BIN\towerofhanoi.exe
Enter the number of disks you want to play with:3

The No of moves required is=7
Move Disk From A to C
Move Disk From A to B
Move Disk From C to B
Move Disk From A to C
Move Disk From B to A
Move Disk From B to C
Move Disk From A to C
```

b. `#include <stdio.h>`

```
int hcf(int n1, int n2);
int main()
{
    int n1, n2;

    printf("Enter two positive integers: ");
    scanf("%d %d", &n1, &n2);
    printf("G.C.D of %d and %d is %d.", n1, n2, hcf(n1,n2));
    return 0;
}

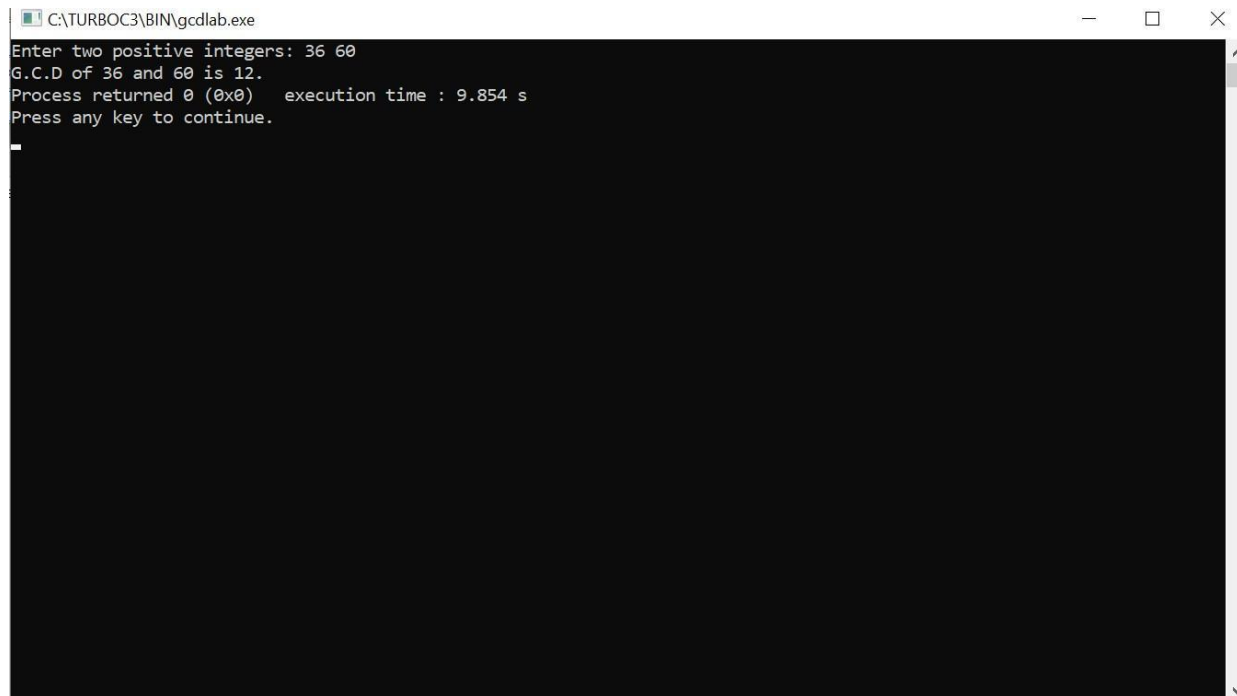
int hcf(int n1, int n2)
{
```



```
if (n2 != 0)
```

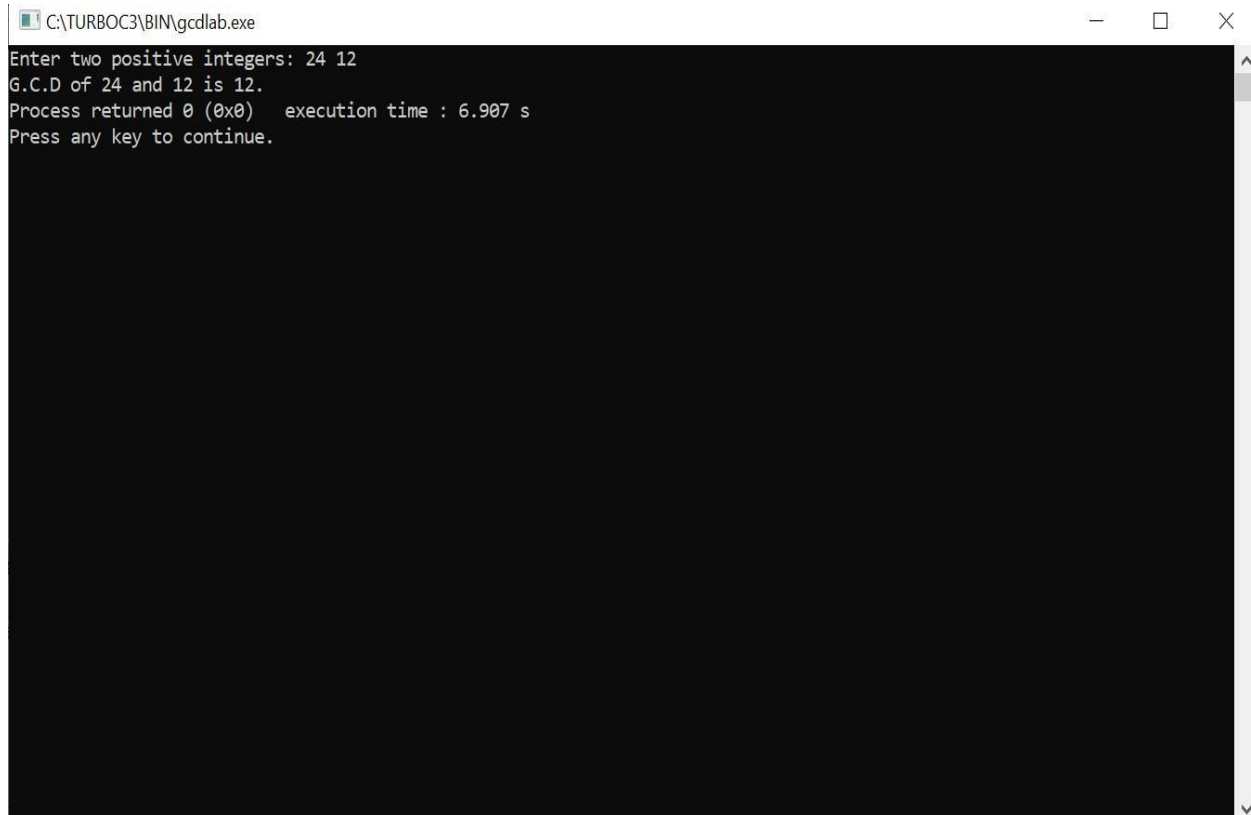
```
    return hcf(n2, n1%n2);  
else  
    return n1;  
}
```

OUTPUT:



The screenshot shows a Turbo C++ console window titled "C:\TURBOC3\BIN\gcdlab.exe". The program prompts the user to "Enter two positive integers: 36 60". It then displays the output "G.C.D of 36 and 60 is 12.". Below this, it shows "Process returned 0 (0x0) execution time : 9.854 s" and "Press any key to continue.". The console window has a black background and white text. The title bar includes standard Windows window controls (minimize, maximize, close).

```
C:\TURBOC3\BIN\gcdlab.exe  
Enter two positive integers: 36 60  
G.C.D of 36 and 60 is 12.  
Process returned 0 (0x0) execution time : 9.854 s  
Press any key to continue.  
-
```

A screenshot of a Turbo C++ console window. The title bar shows the file path 'C:\TURBOC3\BIN\gcdlab.exe'. The console output is as follows:
Enter two positive integers: 24 12
G.C.D of 24 and 12 is 12.
Process returned 0 (0x0) execution time : 6.907 s
Press any key to continue.
The rest of the console area is black, indicating the program has finished execution and is waiting for a key press.

LAB PROGRAM-02

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);
void bub_sort(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; //Insering numbers in Ascending order
}
key=a[n-1]; //Last element of the array
start=clock();
//bub_sort(a,n); //Sorting numbers in Ascending order using Bubble
sort                                sea
                                  rch
                                   _st
                                   atu
                                   s=
                                   bin
                                   _sr
                                   ch(
                                   a,0
                                   ,n-

```

```
1,k  
ey)  
;  
if(  
sea  
rch  
_st  
atu  
s=  
=-  
1)  
p  
r  
i  
n  
t  
f  
(  
"  
\n  
K  
e  
y  
N  
o  
t  
F  
o  
u  
n  
d  
"  
)  
;
```

```
e  
l  
s  
e  
    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 array
        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();

```

```

}
void bub_sort(int a[],int n)
{
    int i,j,temp;
    for(i=0;i<=n-2;i++)
    {
        for(j=0;j<=n-2-i;j++)
        {
            if(a[j]>a[j+1])
            {
                temp=a[j];
                a[j]=a[j+1];
                a[j+1]=temp;
            }
        }
    }
}
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:


```
input

1: Binary search      2: Linear search      3: Exit

Enter your choice:    1

Key found at position 999
Time for n=1000 is 0.000823 Secs
Key found at position 1999
Time for n=2000 is 0.000856 Secs
Key found at position 2999
Time for n=3000 is 0.000802 Secs
Key found at position 3999
Time for n=4000 is 0.000791 Secs
Key found at position 4999
Time for n=5000 is 0.000815 Secs
1: Binary search      2: Linear search      3: Exit

Enter your choice:    
```

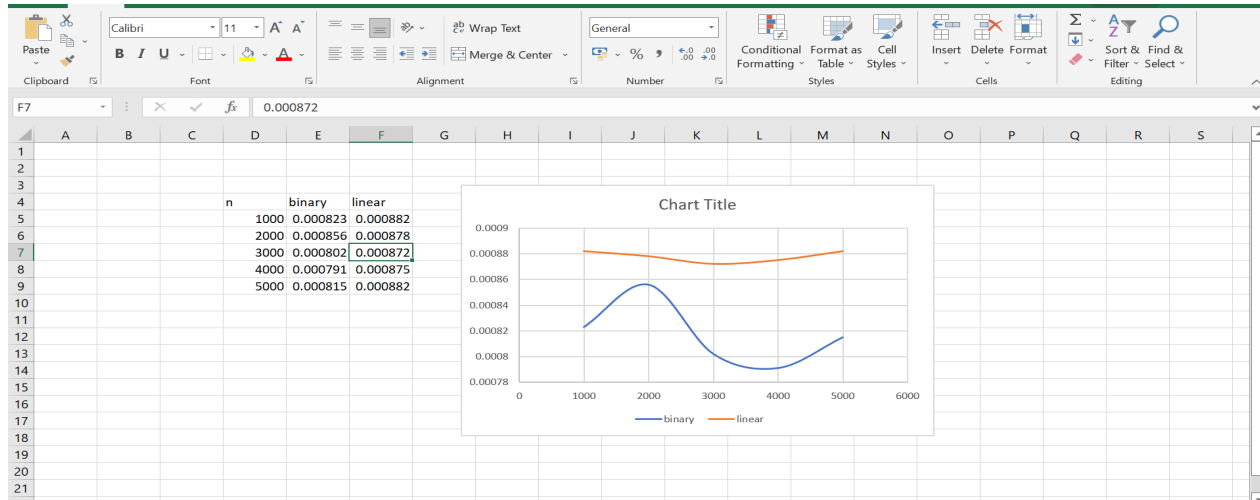
```
input

Time for n=2000 is 0.000856 Secs
Key found at position 2999
Time for n=3000 is 0.000802 Secs
Key found at position 3999
Time for n=4000 is 0.000791 Secs
Key found at position 4999
Time for n=5000 is 0.000815 Secs
1: Binary search      2: Linear search      3: Exit

Enter your choice:    2

Key found at position 999
Time for n=1000 is 0.000882 Secs
Key found at position 1999
Time for n=2000 is 0.000878 Secs
Key found at position 2999
Time for n=3000 is 0.000872 Secs
Key found at position 3999
Time for n=4000 is 0.000875 Secs
Key found at position 4999
Time for n=5000 is 0.000882 Secs
1: Binary search      2: Linear search      3: Exit

Enter your choice:
```



LAB PROGRAM-03

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>
```

```
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 1000 to 10000");
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=1000;
    while(n<=10000) {
        for(i=0;i<n;i++)
        {
            //a[i]=random(1000);
            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 3: exit(0);

```
    getchar();  
    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;  
    }  
}
```

```
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 1000 to 10000
3:To exit
Enter your choice:2

Time taken to sort 1000 numbers is 0.002804 Secs
Time taken to sort 2000 numbers is 0.007686 Secs
Time taken to sort 3000 numbers is 0.015258 Secs
Time taken to sort 4000 numbers is 0.027125 Secs
Time taken to sort 5000 numbers is 0.050448 Secs
Time taken to sort 6000 numbers is 0.057996 Secs
Time taken to sort 7000 numbers is 0.088157 Secs
Time taken to sort 8000 numbers is 0.113538 Secs
Time taken to sort 9000 numbers is 0.145561 Secs
Time taken to sort 10000 numbers is 0.173759 Secs
1:For manual entry of N value and array elements
2:To display time taken for sorting number of elements N in the range 1000 to 10000
3:To exit
Enter your choice:█
```

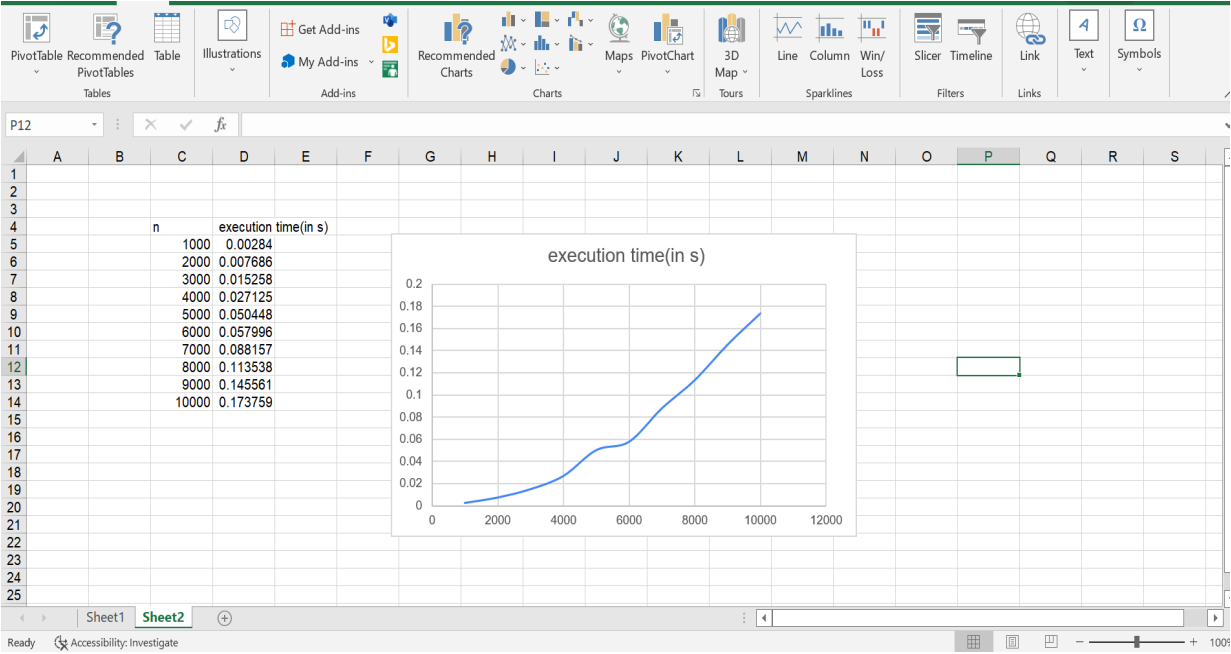
```
input
Time taken to sort 6000 numbers is 0.057996 Secs
Time taken to sort 7000 numbers is 0.088157 Secs
Time taken to sort 8000 numbers is 0.113538 Secs
Time taken to sort 9000 numbers is 0.145561 Secs
Time taken to sort 10000 numbers is 0.173759 Secs
1:For manual entry of N value and array elements
2:To display time taken for sorting number of elements N in the range 1000 to 10000
3:To exit
Enter your choice:1

Enter the number of elements: 10

Enter array elements: 12 156 68 45 41752 44 86 78 2 9

Sorted array is: 2      9      12      44      45      68      78      86      156      41752
Time taken to sort 10 numbers is 0.000003 Secs
1:For manual entry of N value and array elements
2:To display time taken for sorting number of elements N in the range 1000 to 10000
3:To exit
Enter your choice:3

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



LAB PROGRAM-04

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. #include<stdio.h>
#include<conio.h>
int a[10][10],n;
void bfs(int);
int main()
{
    int i,j,src;

    printf("\n enter the no of nodes:\t");
    scanf("%d",&n);
    printf("\n enter the adjacency matrix:\n");
    for(i=1;i<=n;i++)
    {
        for(j=1;j<=n;j++)
        {
            scanf("%d",&a[i][j]);
        }
    }
    printf("\n enter 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("\nnode %d is not reachable\n",j);
    }
    else
    {
        printf("\nnode %d is reachable\n",j);
    }
}
}

```

OUTPUT:

```
C:\TURBOC3\BIN\BFSS.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
node 1 is reachable
node 2 is reachable
node 3 is reachable
node 4 is reachable
node 5 is reachable
node 6 is reachable

Process returned 0 (0x0)   execution time : 32.448 s
Press any key to continue.
```

b. `#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("\ngraph 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:\TURBOC3\BIN\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:\TURBOC3\BIN\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
graph is not connected
Process returned 13 (0xD)   execution time : 25.246 s
Press any key to continue.
```

LAB PROGRAM-05

Sort a given set of N integer elements using Insertion Sort technique and compute its time taken. Run the program for different values of N and record the time taken to sort. Plot a graph of the time taken versus N using MS Excel. The program should allow both manual entry of the array elements and also reading of array elements using random number generator.

```
#include<stdio.h>
#include<conio.h>
#include<time.h>
void insertionsort(int n,int a[])
{
    int i,j,val,temp;
    for(i=1; i<n; i++)
    {
        val=a[i];
        j=i-1;
        while(j>=0 && a[j]>val)
        {
            temp=a[j+1];
            a[j+1]=a[j];
            a[j]=temp;
```

j--;

```
}  
    a[j+1]=val;  
}  
}  
void main()  
{  
    clock_t start,end;  
    int a[15500],i,j,temp;  
    int n=100;  
    while(n<1300)  
    {  
        for(i=0; i<n; i++)  
        {  
            a[i]=n-i;  
        }  
        start=clock();  
        insertionsort(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+100;

    }

}

```

Output:

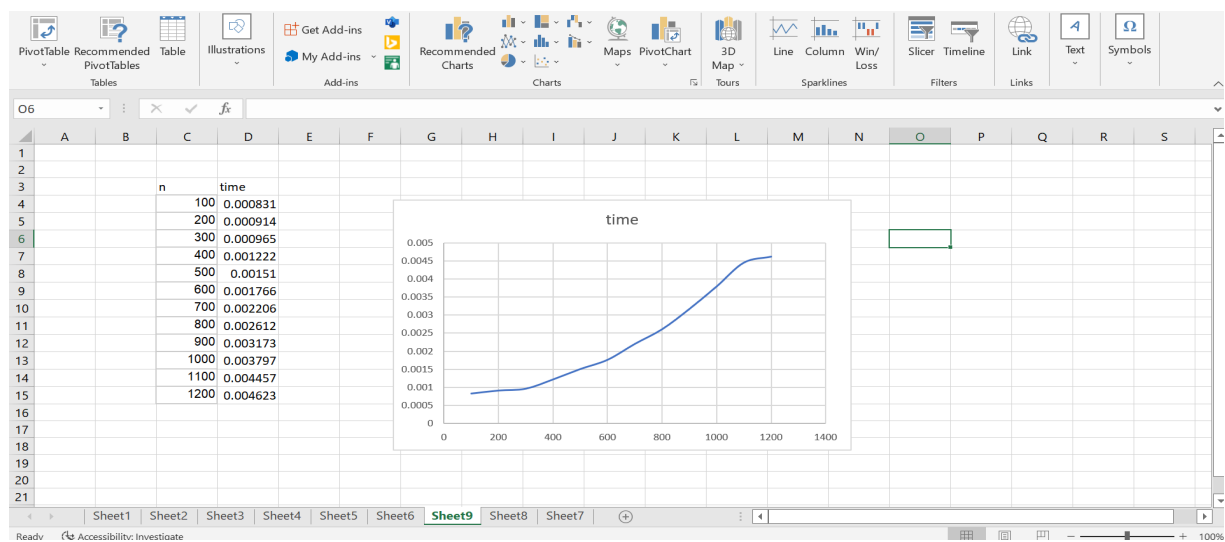
```

input

Time taken to sort 100 numbers is 0.000831 Secs
Time taken to sort 200 numbers is 0.000914 Secs
Time taken to sort 300 numbers is 0.000965 Secs
Time taken to sort 400 numbers is 0.001222 Secs
Time taken to sort 500 numbers is 0.001510 Secs
Time taken to sort 600 numbers is 0.001766 Secs
Time taken to sort 700 numbers is 0.002206 Secs
Time taken to sort 800 numbers is 0.002612 Secs
Time taken to sort 900 numbers is 0.003173 Secs
Time taken to sort 1000 numbers is 0.003797 Secs
Time taken to sort 1100 numbers is 0.004457 Secs
Time taken to sort 1200 numbers is 0.004623 Secs

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

```



LAB PROGRAM-06

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

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

```
void dfs(int);
```

```
int a[10][10],n,e[10],vis[10],j=0;
```

```
int main()
```

```
{
```

```
    int m, u, v, i;
```

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

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

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

```
    {
```

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

```
        {
```

```
            a[i][j] = 0;
```

```
        }
```

```
    }
```

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

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

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

```
    {
```

```
        printf("Enter an edge : ");
```

```
        scanf("%d%d",&u,&v);
```

```
        a[u][v] = 1;
```

```
    }
```

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

```
        vis[i] = 0;
```

```
    j=0;
```



```

    for(i=1;i<=n;i++)
    {
        if(vis[i] == 0)
            dfs(i);
    }
    printf("Topological order : ");
    for(i=n-1; i>=0;i--)
        printf("%d ", e[i]);

    return 0;
}

void dfs(int v)
{
    int i;
    vis[v] = 1;

    for(i=1;i<=n;i++)
    {
        if(a[v][i] == 1 && vis[i] == 0)
            dfs(i);
    }
    e[j++] = v;
}

```

Output:

```
C:\TURBOC3\BIN\topologicaldfs.exe
Enter number of vertices : 5
Enter number of edges : 5
Enter an edge : 1 3
Enter an edge : 2 3
Enter an edge : 3 4
Enter an edge : 3 5
Enter an edge : 4 5
Topological order : 2 1 3 4 5
Process returned 0 (0x0)   execution time : 76.662 s
Press any key to continue.
```

LAB PROGRAM-07

Implement Johnson Trotter algorithm to generate permutations.

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

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

```
int LEFT_TO_RIGHT = 1;
```

```
int RIGHT_TO_LEFT = 0;
```

```
int searchArr(int a[], int n, int mobile) {
```

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

```
        if (a[i] == mobile)
```

```
            return i + 1;
```

```
}
```

```
int getMobile(int a[], int dir[], int n) {
```

```
    int mobile_prev = 0, mobile = 0;
```

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

```
        if (dir[a[i]-1] == RIGHT_TO_LEFT && i!=0) {
```

```
if (a[i] > a[i-1] && a[i] > mobile_prev) {
```

```

        mobile = a[i];
        mobile_prev =
        mobile;
    }

}

if (dir[a[i]-1] == LEFT_TO_RIGHT && i!=n-1) {
if (a[i] > a[i+1] && a[i] > mobile_prev)
{

mobile = a[i];
mobile_prev = mobile;
}

}

}

if (mobile == 0 && mobile_prev == 0)
return 0;
else

return mobile;
}

int printOnePerm(int a[], int dir[], int n)
{

```

```
int mobile = getMobile(a, dir, n);
```

```
int pos = searchArr(a, n, mobile);
```

```
if (dir[a[pos - 1] - 1] == RIGHT_TO_LEFT)
{
    printf("\n");
    int temp;
    temp = a[pos-1] ;
    a[pos-1] = a[pos-2];
    a[pos-2]= temp;
}
```

```
else if (dir[a[pos - 1] - 1] == LEFT_TO_RIGHT)
{
    printf("\n");
    int temp;
    temp = a[pos] ;
    a[pos] = a[pos-1];
    a[pos-1]= temp;
}
```

```
for (int i = 0; i < n; i++)
{
    if (a[i] > mobile)
    {
        if (dir[a[i] - 1] == LEFT_TO_RIGHT)
            dir[a[i] - 1] = RIGHT_TO_LEFT;
```

```
else if (dir[a[i] - 1] == RIGHT_TO_LEFT)
```

```
dir[a[i] - 1] = LEFT_TO_RIGHT;
```

```
}
```

```
}
```

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

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

```
}
```

```
int fact(int n)
```

```
{
```

```
int res = 1;
```

```
int i;
```

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

```
res = res * i;
```

```
return res;
```

```
}
```

```
void printPermutation(int n)
```

```
{
```

```
int a[n];
```

```
int dir[n];
```

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



```
printf("\n");  
for (int i = 0; i < n; i++)  
{  
    a[i] = i + 1;  
    printf("%d \n", a[i]);  
    printf("\n");  
}
```

```
printf("\n");  
for (int i = 0; i < n; i++)  
    dir[i] = RIGHT_TO_LEFT;  
for (int i = 1; i < fact(n); i++)
```

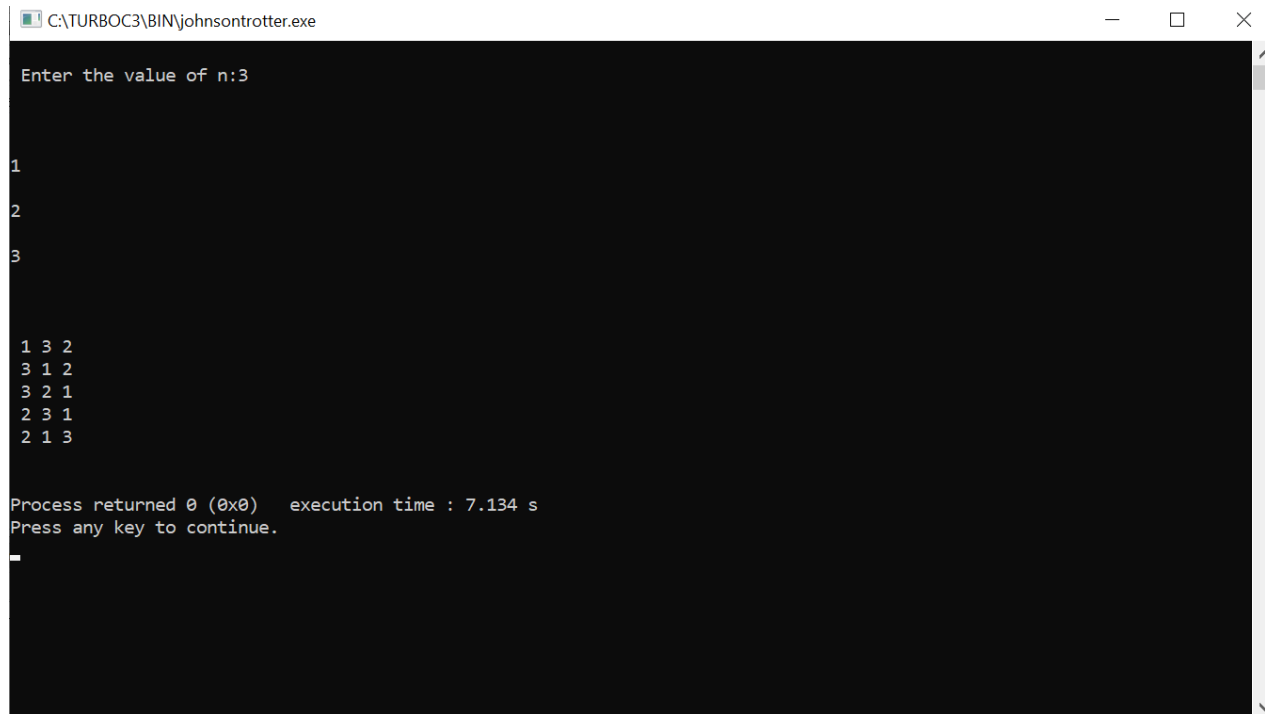
```
printOnePerm(a, dir,  
n); printf("\n");  
}
```

```
int main()  
{  
    int n;  
    printf("\n Enter the value of n:N");  
    scanf("%d",&n);  
    printf("\n");
```

```
printPermutation(n);
```

```
printf("\n");  
return 0;  
}
```

Output:



```
C:\TURBOC3\BIN\johnsontrotter.exe  
Enter the value of n:3  
  
1  
2  
3  
  
1 3 2  
3 1 2  
3 2 1  
2 3 1  
2 1 3  
  
Process returned 0 (0x0) execution time : 7.134 s  
Press any key to continue.
```

LAB PROGRAM-08

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<time.h>  
#include<stdlib.h>  
void split(int[],int,int);
```

```
void combine(int[],int,int,int);
void 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();
split(a,0,n-1)
;
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]=n-i;
    }
    start=clock();
    split(a,0,n-1)
    ;
    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 split(int a[],int low,int high)
{

```

```
int mid;
```



```

if(low<high)
{

mid=(low+high)/2;
split(a,low,mid);
split(a,mid+1,high);
combine(a,low,mid,high);
}

}
void combine(int a[],int low,int mid,int high)
{
int c[15000],i,j,k;
i=k=low;
j=mid+1;
while(i<=mid &&j<=high)

{
if(a[i]<a[j])
{
c[k]=a[i];
++k;
++i;
}

```

else

```
{  
c[k]=a[j];  
++k;  
++j;  
}  
}  
if(i>mid)  
{  
while(j<=high)  
{  
c[k]=a[j];  
++k;  
++j;  
}  
}  
if(j>high)  
{  
while(i<=mid)  
{  
c[k]=a[i];  
++k;  
++i;  
}
```

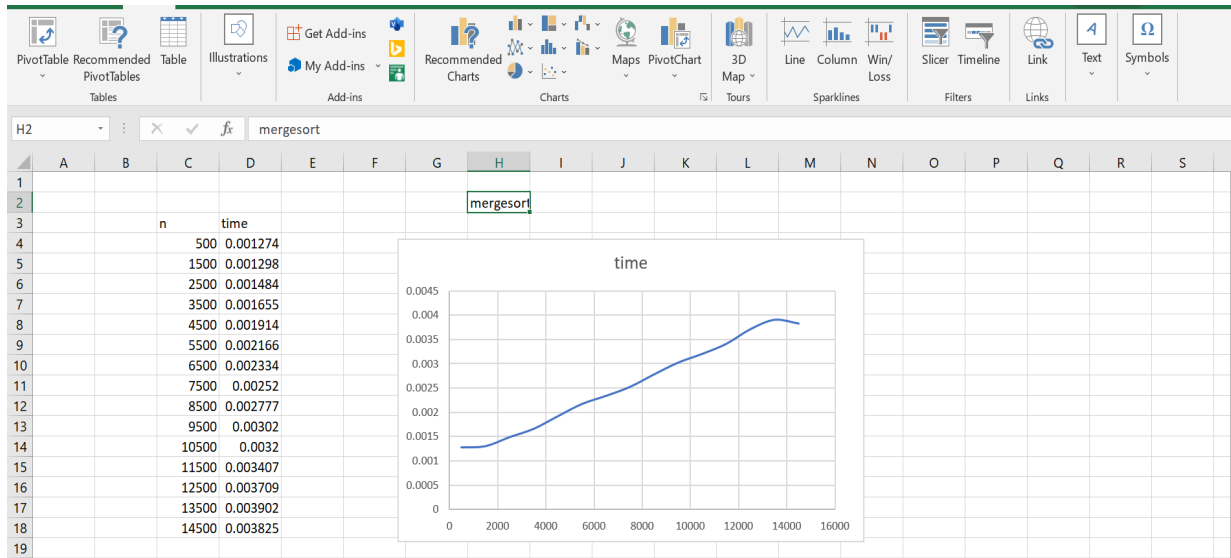
```
}  
for(i=low;i<=high;i++)  
{  
a[i]=c[i];  
}  
}
```

Output:

```
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:1  
  
Enter the number of elements:6  
  
Enter array elements:12 66 75 2 68 44  
  
Sorted array is:2      12      44      66      68      75  
Time taken to sort 6 numbers is 0.000004 Secs  
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:
```

```
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 0.001274 Secs
Time taken to sort 1500 numbers is 0.001298 Secs
Time taken to sort 2500 numbers is 0.001484 Secs
Time taken to sort 3500 numbers is 0.001655 Secs
Time taken to sort 4500 numbers is 0.001914 Secs
Time taken to sort 5500 numbers is 0.002116 Secs
Time taken to sort 6500 numbers is 0.002334 Secs
Time taken to sort 7500 numbers is 0.002520 Secs
Time taken to sort 8500 numbers is 0.002777 Secs
Time taken to sort 9500 numbers is 0.003020 Secs
Time taken to sort 10500 numbers is 0.003200 Secs
Time taken to sort 11500 numbers is 0.003407 Secs
Time taken to sort 12500 numbers is 0.003709 Secs
Time taken to sort 13500 numbers is 0.003902 Secs
Time taken to sort 14500 numbers is 0.003825 Secs
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:
```



LAB PROGRAM-09

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>
#define MAXINT
2000 void delay(int n)
{
int i;
for(i=0;i<n;i++)
{
}
}
void quickSort(int number[],int first,int last){
int i,j,pivot,temp;
if(first<last){
    pivot=first;
    i=first;
    j=last;
while(i<j){
    while(number[i]<=number[pivot]&&i<last){
        i++;
```

}

```

    while(number[j]>number[pivot]&& j>first){
        j--;

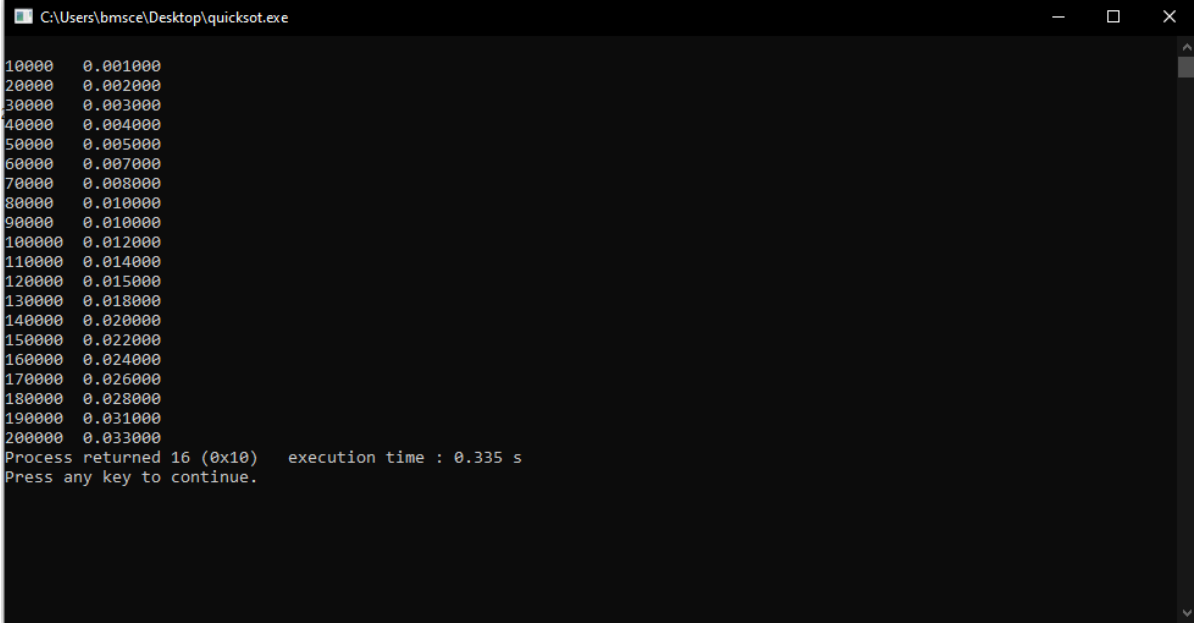
    }
    if(i<j){
        temp=number[i];
        number[i]=number[j];
        number[j]=temp;
    }
}
temp=number[pivot];
number[pivot]=number[j];
number[j]=temp;
quickSort(number,first,j-1);
quickSort(number,j+1,last);
}
}
void main()
{
    clock_t start,end;
    int i,datasize=1;
    long int n=10000;
    int *a;

```

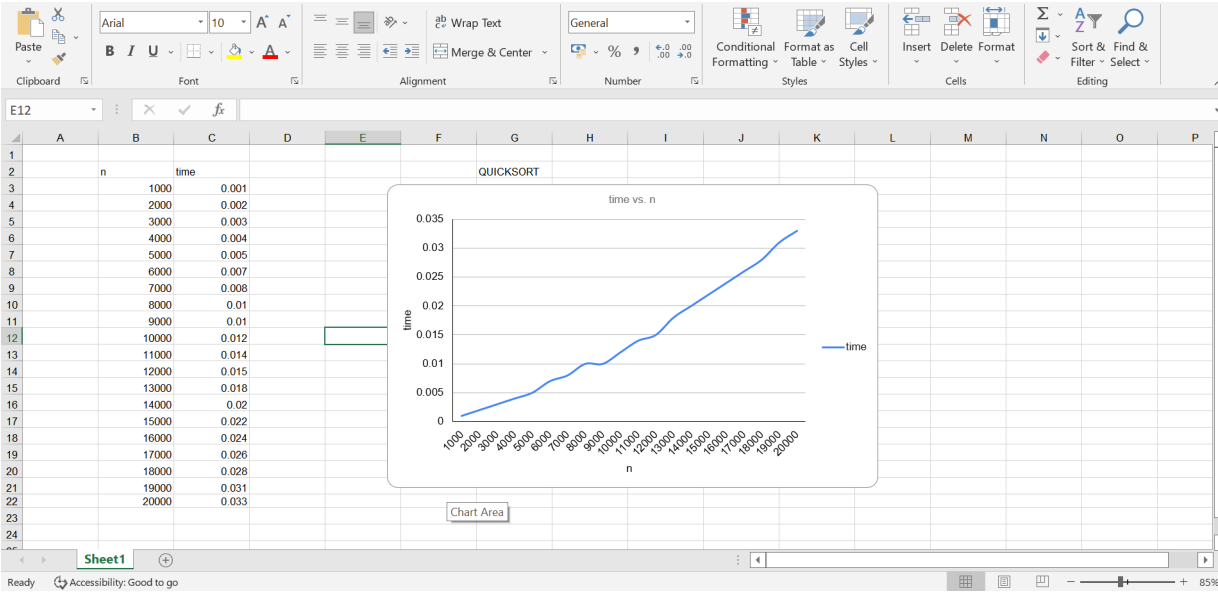


```
while(datasize<=20){
    a=(int *)calloc(n,sizeof(int));
    if(a==NULL){
        printf("Insufficiant Memory");
        exit(0);
    }
    for(i=0;i<=n-1;i++){
        a[i]=rand()%MAXINT;
    }
    start=clock();
    quickSort(a,0,n-1);
    end=clock();
    free(a);
    if((end-start)!=0){
        printf("\n%d\t%f",n,(double)(end-start)/CLK_TCK);
        datasize++;
    }
    n+=10000;
}
return;
}
```

Output:



```
C:\Users\bmsce\Desktop\quicksot.exe
10000 0.001000
20000 0.002000
30000 0.003000
40000 0.004000
50000 0.005000
60000 0.007000
70000 0.008000
80000 0.010000
90000 0.010000
100000 0.012000
110000 0.014000
120000 0.015000
130000 0.018000
140000 0.020000
150000 0.022000
160000 0.024000
170000 0.026000
180000 0.028000
190000 0.031000
200000 0.033000
Process returned 16 (0x10)   execution time : 0.335 s
Press any key to continue.
```



LAB PROGRAM-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("\n 1: For manual entry of N values and array elements:");
        printf("\n 2: To display time taken for sorting number of elements N in
the range 500 to 14500:");
        printf("\n 3: To exit");
        printf("\n Enter your
choice:"); scanf("%d",&ch);
        switch(ch)
        {
            case 1: printf("\n Enter the number of elements:");
                scanf("%d",&n);
                printf("\n Enter array elements:");
                for(i=0;i<n;i++)
                {
                    scanf("%d",&a[i]);
                }
            }
```

```
start=clock();
```

```

        heapSort(a, n);
        end=clock();
        printf("\n Sorted 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]=n-i;

                }
                start=clock();
                heapSort(a, n);
                for(j=0;j<50000000;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);
    }

```

```

    }
}
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:

```
input
1: For manual entry of N values 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:1

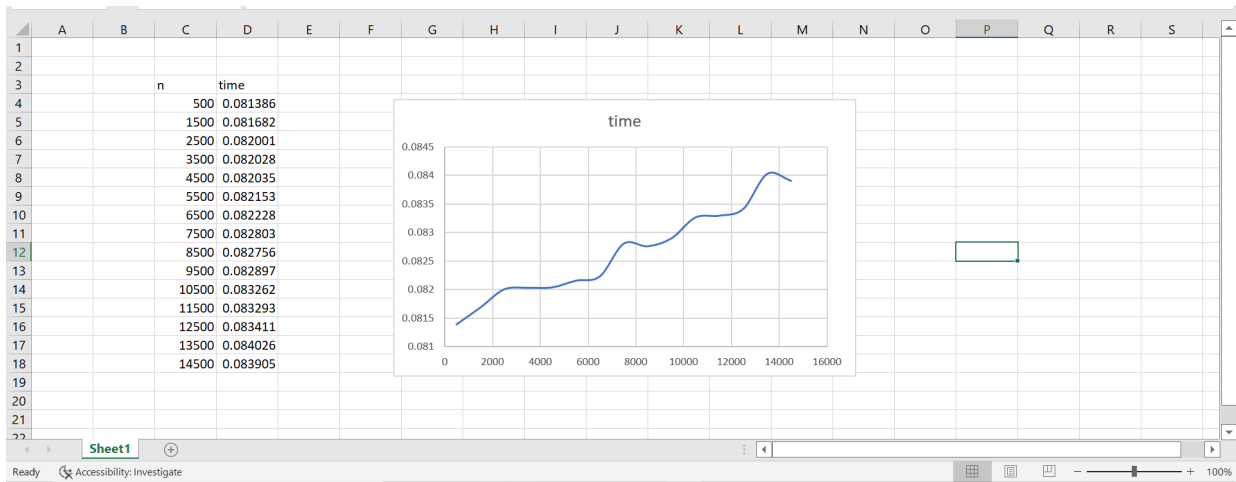
Enter the number of elements:5

Enter array elements:14 4456 3 1 45

Sorted array is:4456 45 14 3 1
Time taken to sort 5 numbers is 0.000001 secs
1: For manual entry of N values 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 0.081386 secs
Time taken to sort 1500 numbers is 0.081682 secs
Time taken to sort 2500 numbers is 0.082001 secs
Time taken to sort 3500 numbers is 0.082028 secs
Time taken to sort 4500 numbers is 0.081910 secs
Time taken to sort 5500 numbers is 0.082153 secs
Time taken to sort 6500 numbers is 0.082228 secs
```

```
Time taken to sort 7500 numbers is 0.082803 secs
Time taken to sort 8500 numbers is 0.082756 secs
Time taken to sort 9500 numbers is 0.082897 secs
Time taken to sort 10500 numbers is 0.083262 secs
Time taken to sort 11500 numbers is 0.083293 secs
Time taken to sort 12500 numbers is 0.083411 secs
Time taken to sort 13500 numbers is 0.084026 secs
Time taken to sort 14500 numbers is 0.083905 secs
1: For manual entry of N values 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:
```



LAB PROGRAM-11

Implement Warshall's algorithm using dynamic programming.

```
#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");
}
}

```

Output:

 "C:\Users\HP\Desktop\ADA Programs\Warshall.exe"

```

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

Process returned 4 (0x4)   execution time : 71.101 s
Press any key to continue.

```

LAB PROGRAM-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:

"C:\Users\HP\Desktop\ADA Programs\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: 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 ■

LAB PROGRAM-13

Implement All Pair Shortest paths problem using Flyod's algorithm.

```
#include<stdio.h>
#include<conio.h>
> int a[10][10],n;
void floyds();
int min(int,int);
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",&a[i][j]);
        }
    }
}
```

```
floyds();  
getch();  
}
```

```
void floyds()  
{  
    int i,j,k;  
    for(k=1;k<=n;k++)  
    {  
        for(i=1;i<=n;i++)  
        {  
            for(j=1;j<=n;j++)  
            {  
                a[i][j]=min(a[i][j],a[i][k]+a[k][j]);  
            }  
        }  
    }  
    printf("\nall pair shortest path matrix is:\n");  
    for(i=1;i<=n;i++)  
    {  
        for(j=1;j<=n;j++)  
        {  
            printf("%d\t",a[i][j]);  
        }  
    }  
}
```

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

```
int min(int x,int y)  
{  
    if(x<y)  
    {  
        return x;  
    }  
    else  
    {  
        return y;  
    }  
}
```

Output:

"C:\Users\HP\Desktop\ADA Programs\Floyds.exe"

enter the no. of vertices: 4

enter the cost matrix:

0 9999 3 9999

2 0 9999 9999

9999 7 0 1

6 9999 9999 0

all pair shortest path matrix is:

0	10	3	4
---	----	---	---

2	0	5	6
---	---	---	---

7	7	0	1
---	---	---	---

6	16	9	0
---	----	---	---

LAB PROGRAM-14

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

```
#include<stdio.h>
#include<conio.h>
#include<process.h>
void prims();
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]);
        }
    }
    prims();
    getch();
}
```

```
}
```

```
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:

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

1----->2=3

2----->3=1

2----->6=4

6----->5=2

6----->4=5

mincost=15

LAB PROGRAM-15

Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's Algorithm.

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

```
#include<conio.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();  
  
getch();  
  
}
```

```
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:
```

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

LAB PROGRAM-16

Find Minimum Cost Spanning Tree of a given undirected graph using Dijkstra's Algorithm.

```
#include<stdio.h>
#include<conio.h>
void dijkstras();
int c[10][10],n,src;
void main()
{
    int i,j;
    printf("\nEnter the no of vertices:\t");
    scanf("%d",&n);
    printf("\nEnter the cost matrix:\n");
    for(i=1;i<=n;i++)
    {
        for(j=1;j<=n;j++)
        {
            scanf("%d",&c[i][j]);
        }
    }
    printf("\nEnter the source node:\t");
    scanf("%d",&src);
    dijkstras();
}
```

```
getch();  
}
```

```
void dijkstras()  
{  
    int vis[10],dist[10],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:

9999	3	9999	7	9999
3	9999	4	2	9999
9999	4	9999	5	6
7	2	5	9999	4
9999	9999	6	4	9999

enter the source node: 1

the shortest distance is:

1----->1=0

1----->2=3

1----->3=7

1----->4=5

1----->5=9

LAB PROGRAM -17

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;

    }

}

els

e

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;

clrscr(

);

printf("Enter the number of
Queens\n"); scanf("%d", &n);

nqueens(n

);

getch();

}

```

output

Enter the number of Queens

4

Solution is 1

Queen Position

1 2

2 4

3 1

4 3

LAB PROGRAM-18

Write program to find the Binomial Co-efficient using Dynamic Programming.

```
#include<stdio.h>

#include<conio.h>

int bin(int n, int k)
{
    int i, j, c[10][10];
    for (i=0; i<=n; i++)
    {
        for (j=0; j<=k; j++)
        {
            if (j==0 || i==j)
                c[i][j]=1;
            else
                c[i][j]=c[i-1][j-1]+c[i-1][j];
        }
    }
    return c[n][k];
}

void main()
{
    int n, k;
    printf("Enter n and k: ");
    scanf("%d %d", &n, &k);
    printf("Binomial Coefficient is: %d", bin(n, k));
}
```

```

int n,k;

printf("Enter the value of n & k such that
n>k\n"); scanf("%d%d",&n,&k);
printf("C(%d,%d)=%d\n",&n,&k,bin(n,k));
getch();
}

```

Output:

Enter the value of n & k such that n>k

3

2

C(3,2)=3

Enter the value of n & k such that n>k

5

3

C(5,3)=10