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,

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(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 UTSAV BOSE **(1BM20CS219),** who is a 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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Index Sheet

Course Outcome

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

LAB PROGRAM-01

Write a recursive program to

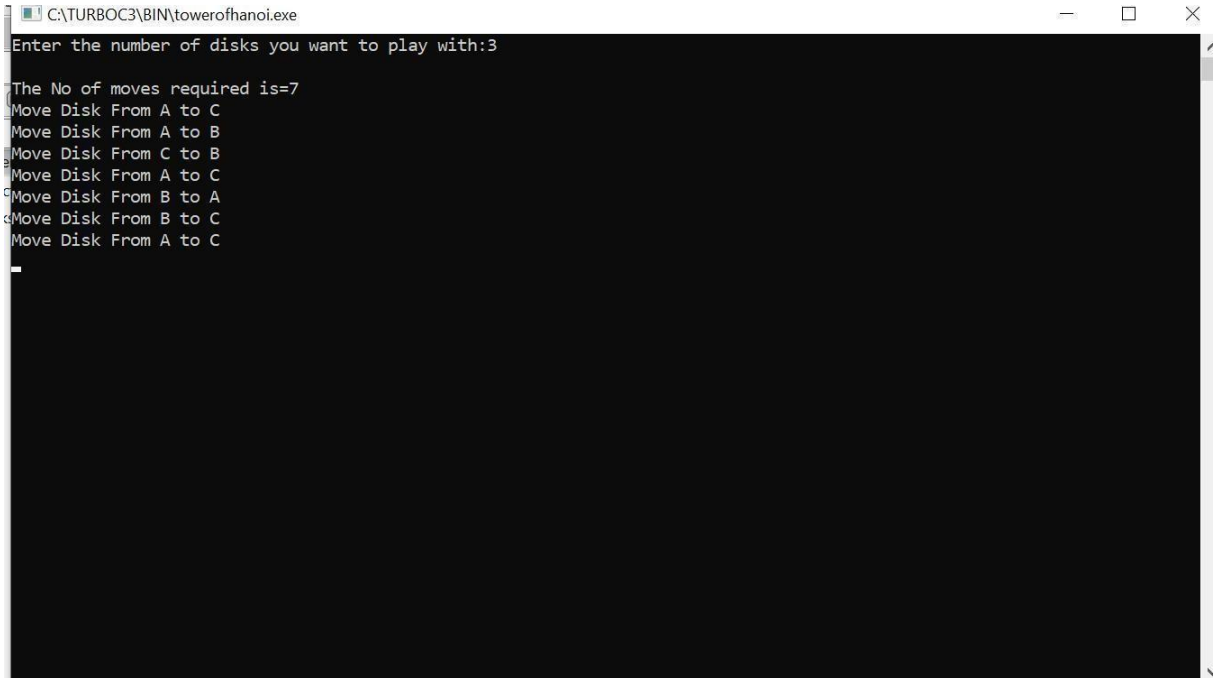
a. **Solve Towers-of-Hanoi problem**

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( );
}
```

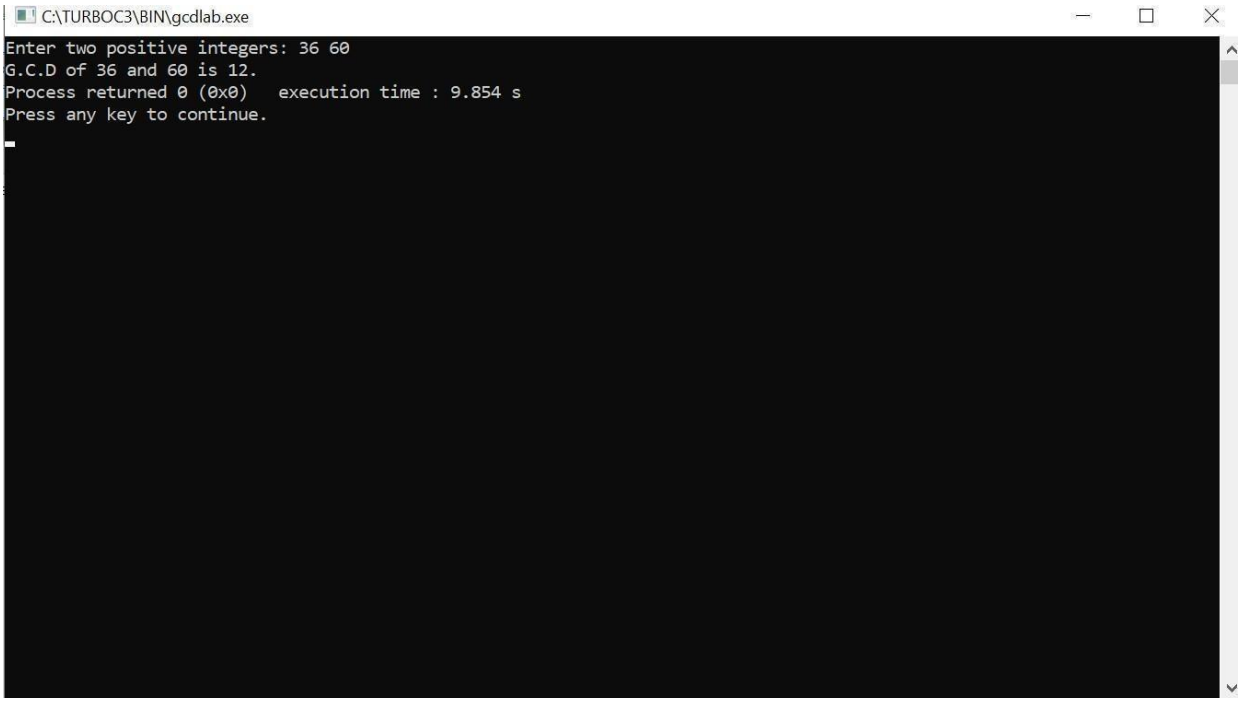
OUTPUT:

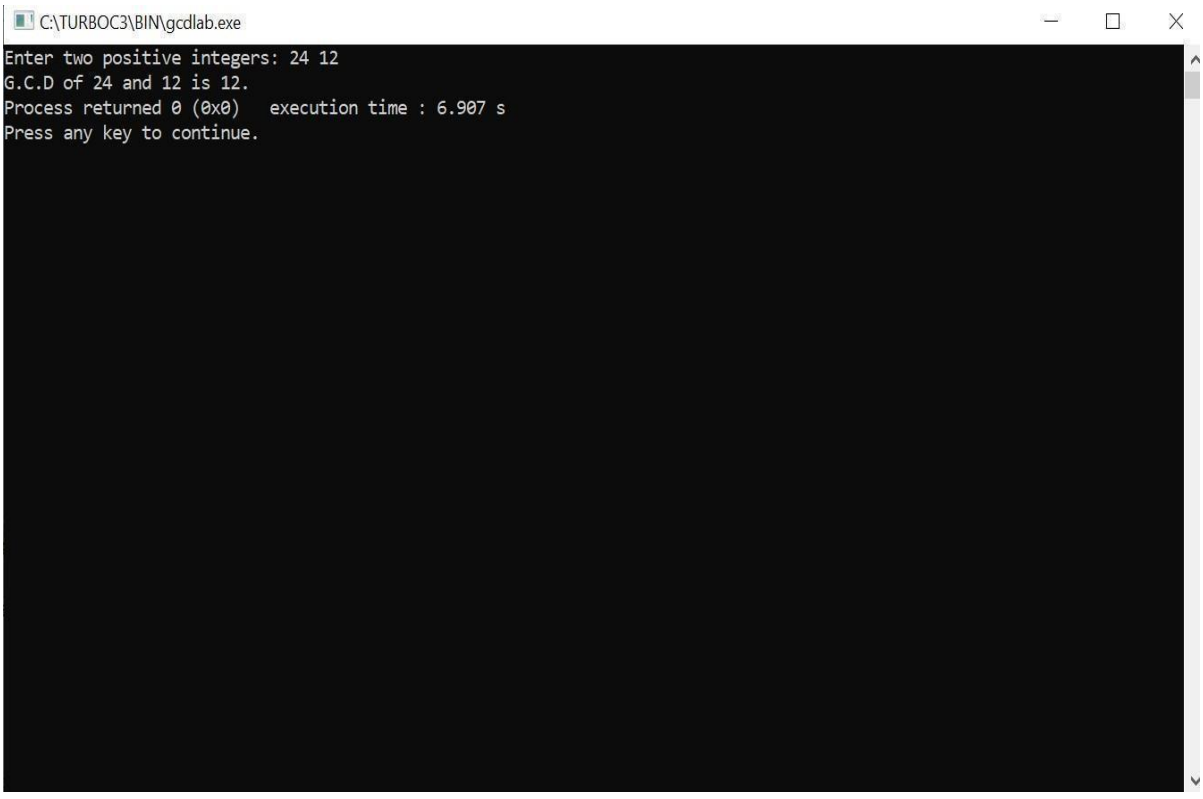


b.

```
#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:





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(1
```

```
000);
a[i]=i; //Insering numbers in Ascending order
} key=a[n-1]; //Last element of the
aray
start=clock();
//bub_sort(a,n); //Sorting numbers in Ascending
order using Bubble sort 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();
 }
} void bub_sort(int a[],int
n)
{ int i,j,temp;
 for(i=0;i<=n-
 2;i++)
 { for(j=0;j<=n-2i;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
)
{
```

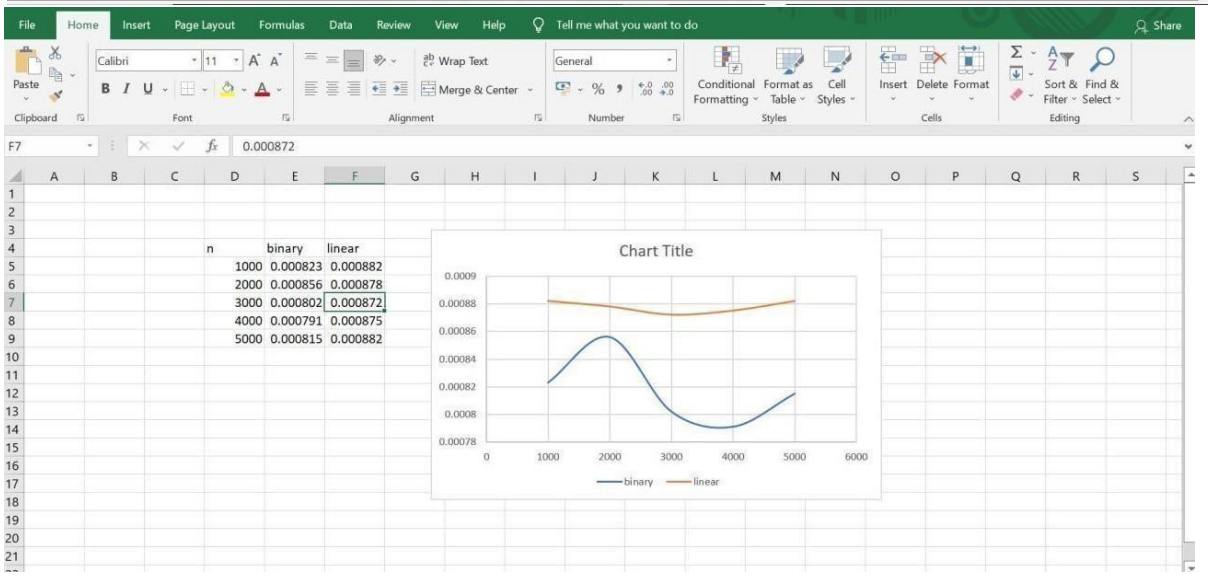
```
 return -1;
}
mid=(low+high)
/2;
if(key==a[mid]
) { return mid;
}
if(key<a[mid])
{
 return bin_srch(a,low,mid-1,key);
} else
{
 return bin_srch(a,mid+1,high,key);
} }

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

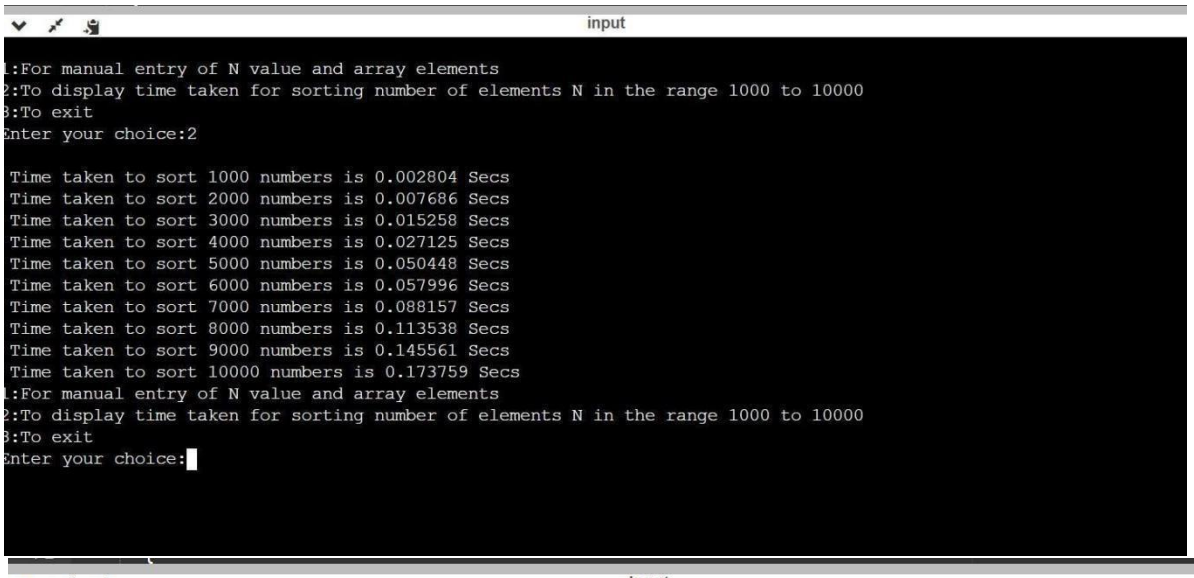
Sort a given set of N integer elements using Selection Sort technique and compute its time taken. Run the program for different values of N and record the time taken to sort.

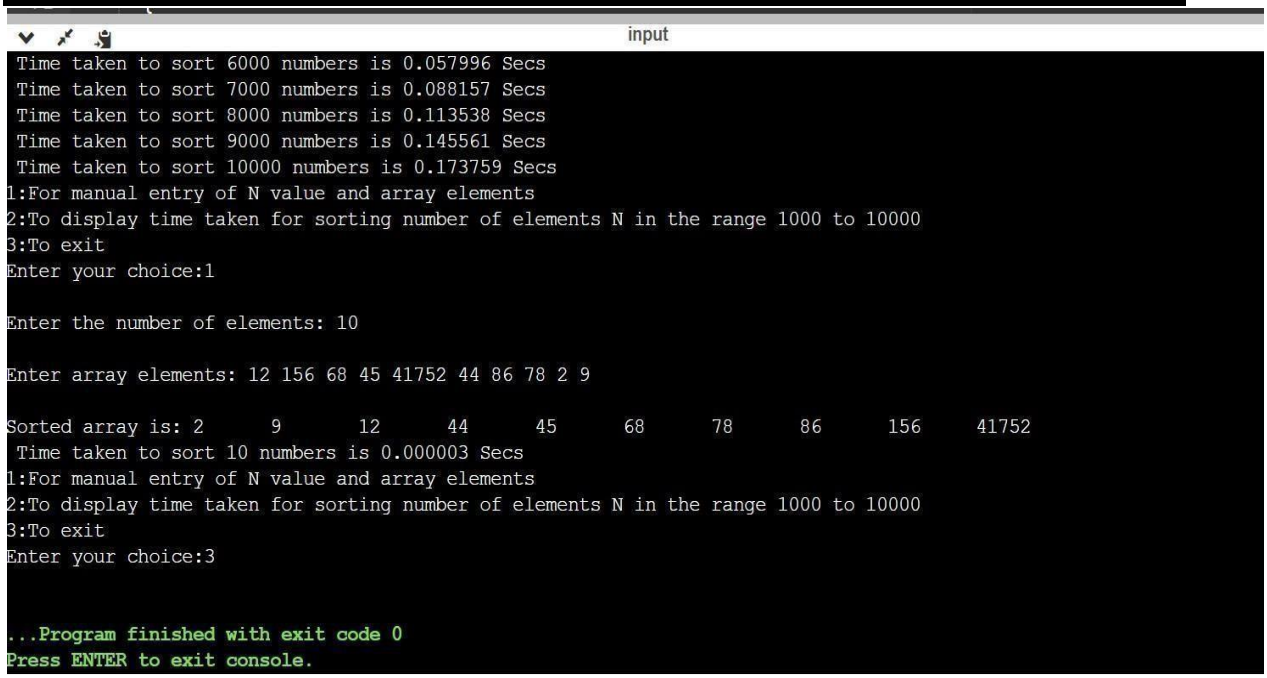
```
#include<stdio.h>
#include<time.h>
#include<stdlib.h
> void selsort(int
n,int
a[]); int main()
{ int a[15000],n,i,j,ch,temp;
  clock_t start,end; while(1)
  {
printf("\n1:For manual entry of N value and array elements");
printf("\n2:To display time taken for sorting number of elements N in
the range 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]);
```

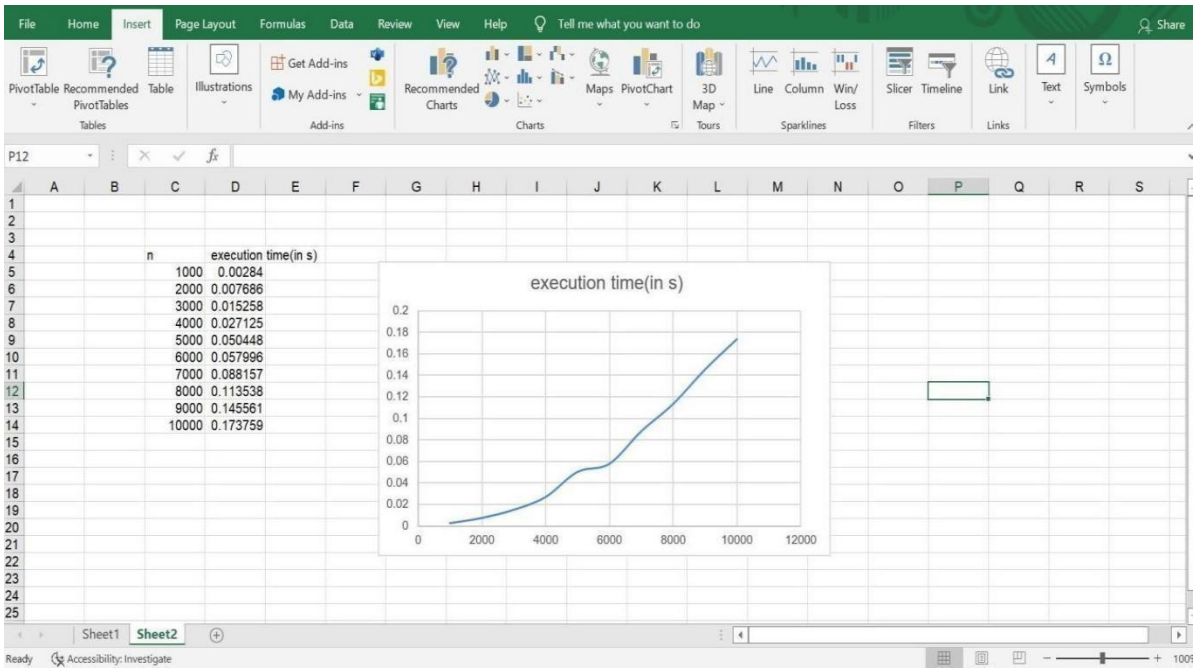
```
                } start=clock();
                selsort(n,a);
                end=clock();
                printf("\nSorted array
                is: "); for(i=0;i<n;i++)
                printf("%d\t",a[i]);
printf("\n Time taken to sort %d numbers is %f Secs",n,
(((double)(endstart))/CLOCKS_PER_SEC));
                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<50000
            0;j++){
            temp=38/600;}
           end=clock();
printf("\n Time taken to sort %d numbers is %f Secs",n,
(((double)(endstart))/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;
    }
}
```

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("\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("\nnode %d is not
 reachable\n",j);
 }
 else
 { printf("\nnode %d is
 reachable\n",j);
 }
}
}
```

OUTPUT:

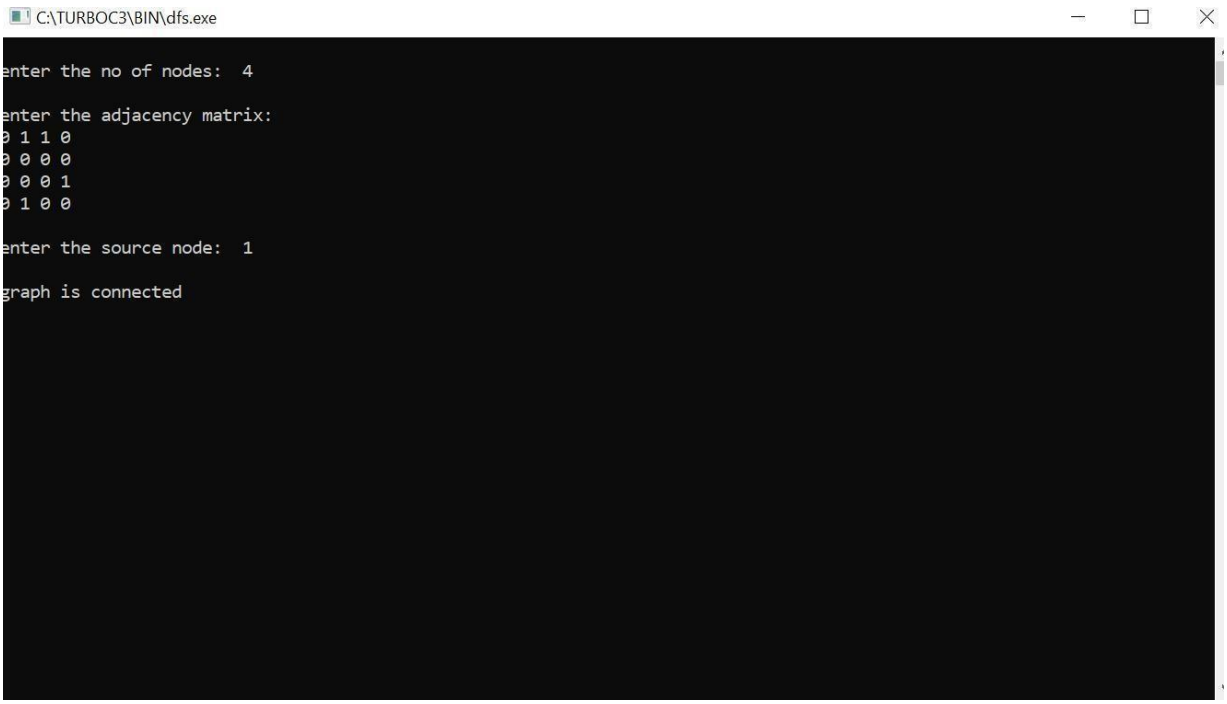
b.

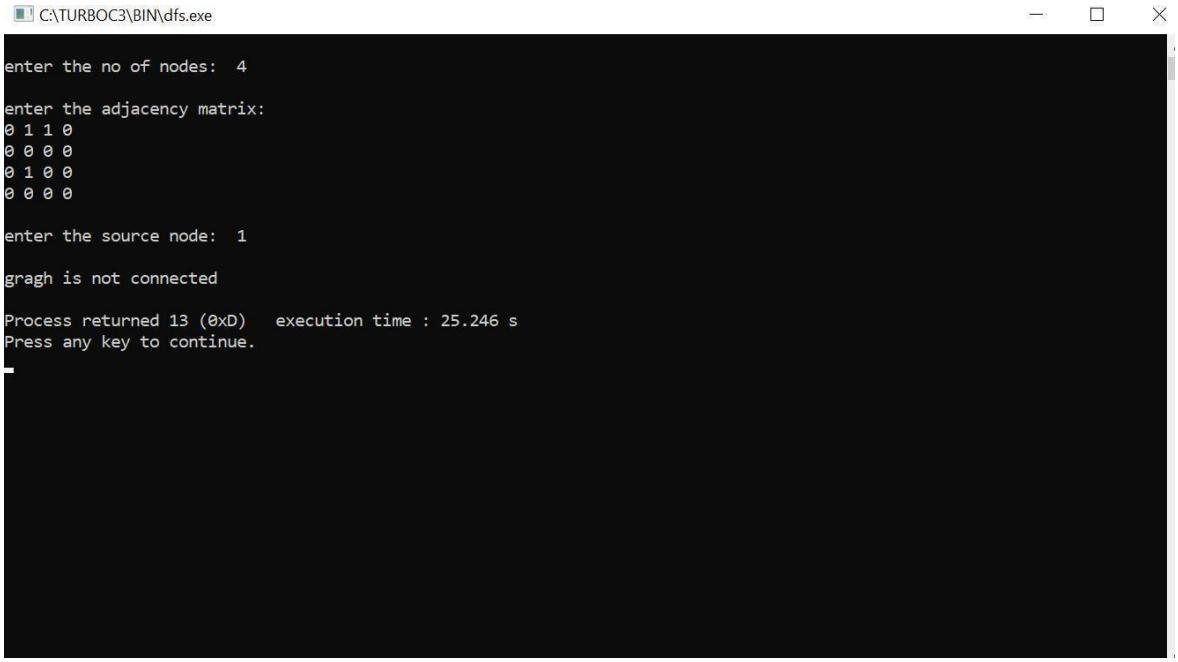
```
#include<stdio.h>
#include<conio.h
>
int
a[10][10],n,vis[10];
int dfs(int); void
main()
{ int i,j,src,ans;
   for(j=1;j<=n;j++)
   { vis[j]=0;
   }
  printf("\nenter the no of nodes:\t");
 scanf("%d",&n); printf("\nenter the
 adjacency matrix:\n"); for(i=1;i<=n;i++)
 { for(j=1;j<=n;j++)
    {
```

```
            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("\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:\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
gragh 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.

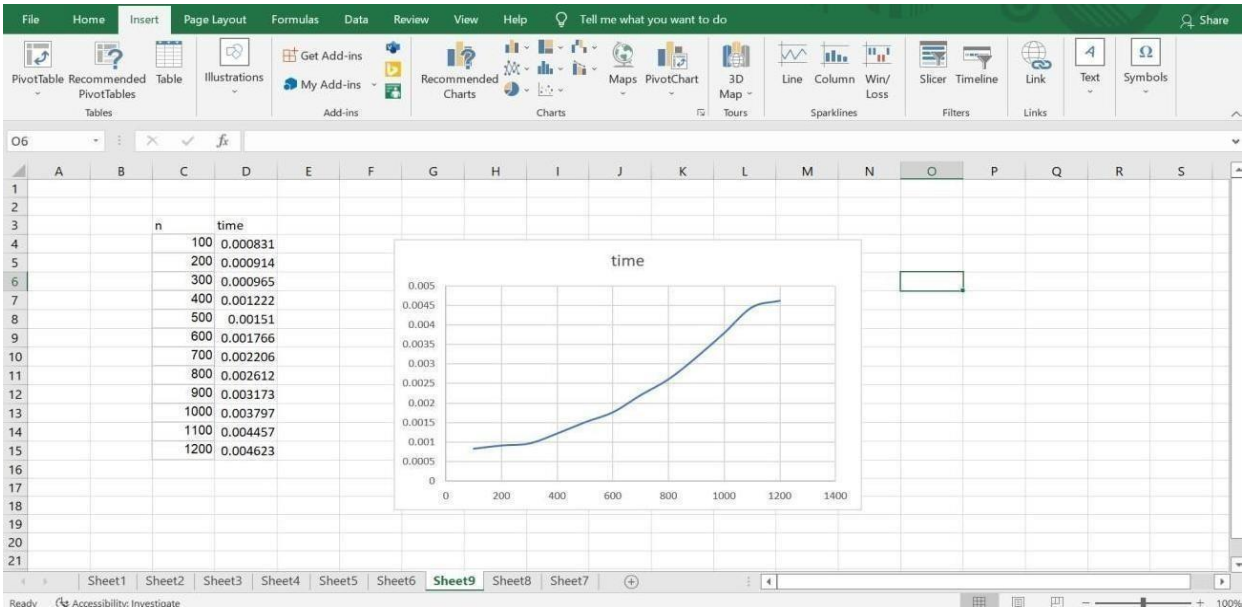
```
#include<stdio.h>
#include<conio.h
>
#include<time.h> void
insertionsort(int n,int a[])
{ int i,j,val,temp;
   for(i=1; i<n;
   i++)
   { val=a[i]; j=i-1;
   while(j>=0 && a[j]>val)
   {
      temp=a[j+1];
      a[j+1]=a[j];
      a[j]=temp;
      j--;
   }
   a[j+1]=val;
   }
}
```

```
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

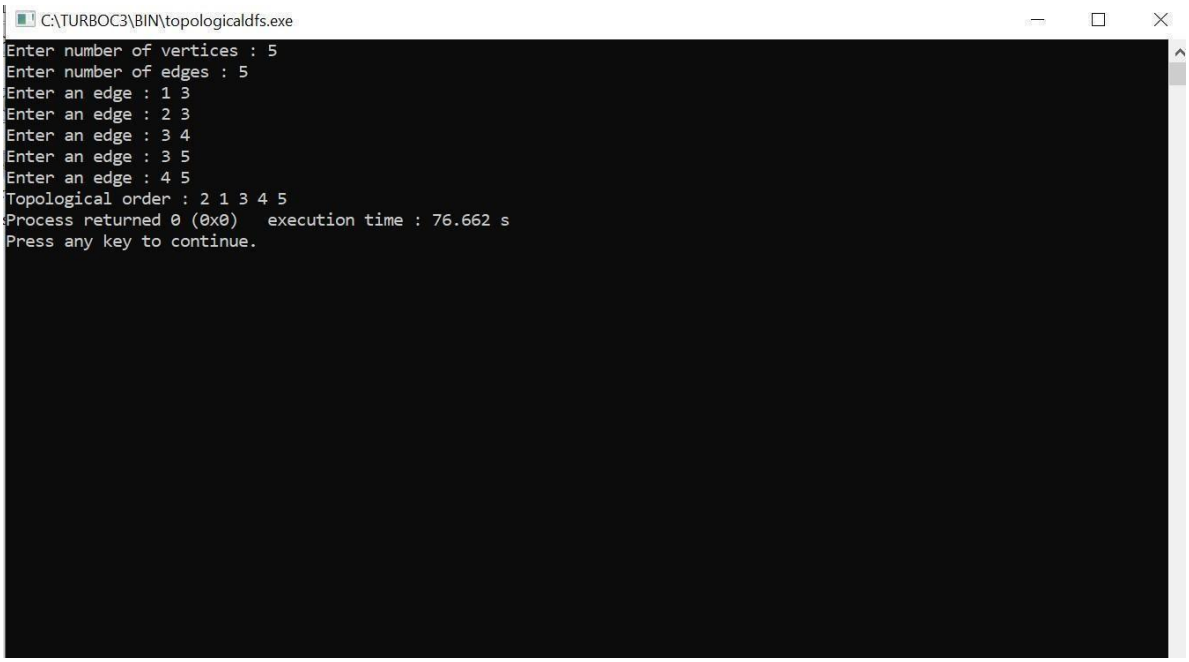
Write program to obtain the Topological ordering of vertices in a given digraph.

```
#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:



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)
```

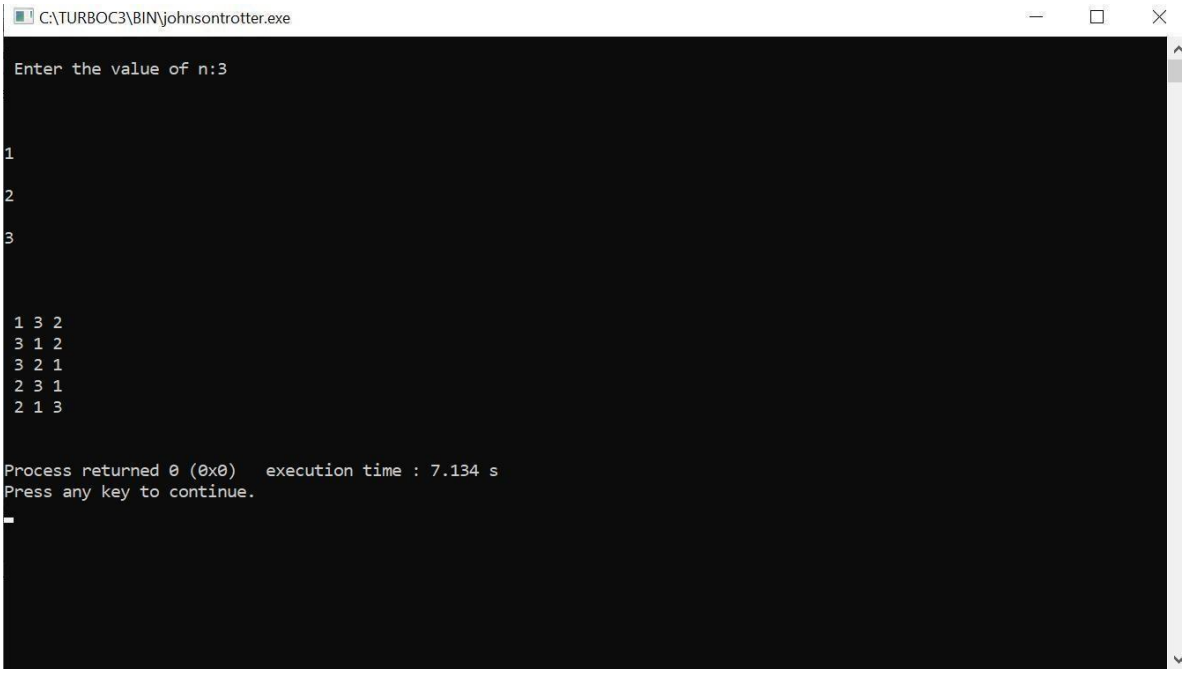
```
{ mobile =
a[i];
mobile_prev
= mobile;
}
}
}

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:



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]);
}
```

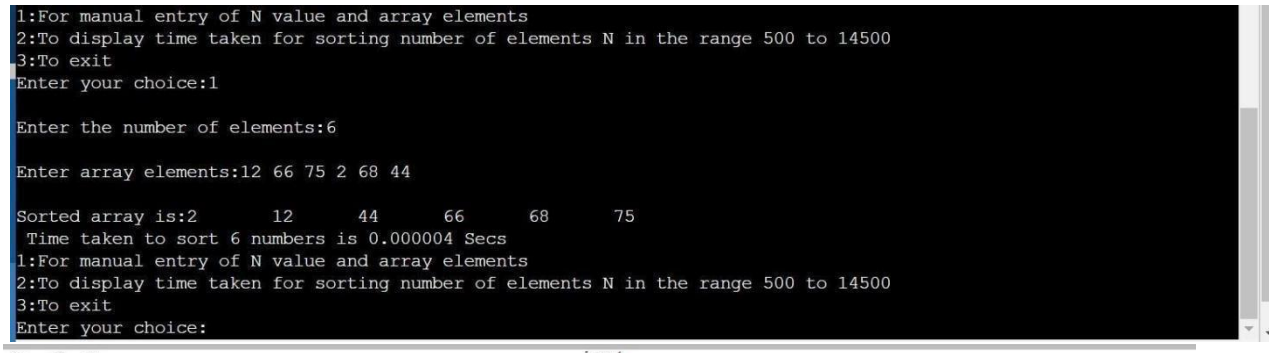
```
start=clock(); split(a,0,n-
1)
;
end=clock();
printf("\nSorted array
is:"); for(i=0;i<n;i++)
printf("%d\t",a[i]);

printf("\n Time taken to sort %d numbers is %f Secs",n,
(((double)(endstart))/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)
;
```

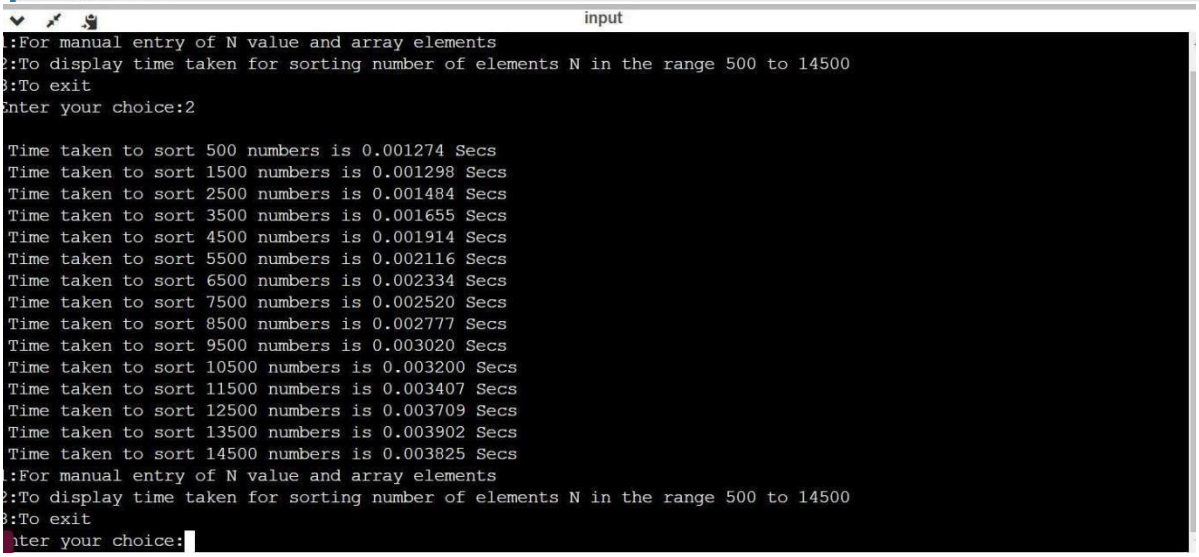
```
for(j=0;j<500000;j++){ temp=38/600;} end=clock(); printf("\n Time
taken to sort %d numbers is %f Secs",n,
(((double)(endstart))/CLOCKS_PER_SEC));


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)
```

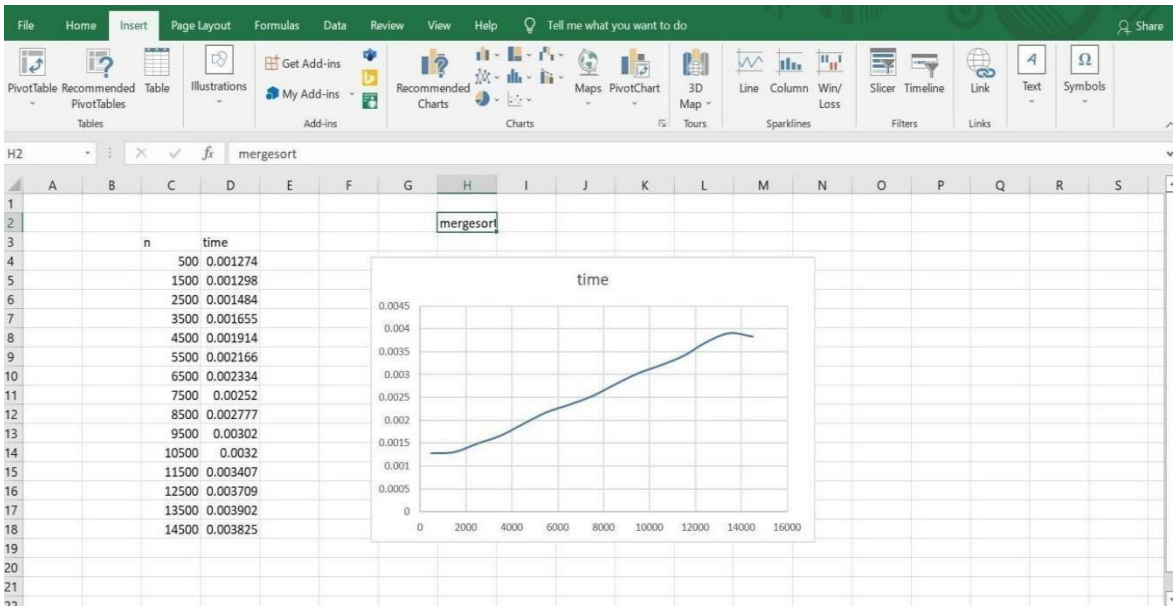
```
{
if(a[i]<a[j])
{ c[k]=a[i];
++k;
++i;
}
else
{
c[k]=a[j];
++k;
++j;
}
}
if(i>mid)
{
while(j<=high)
{
c[k]=a[j];
++k;
++j;
} }
if(j>high)
{
while(i<=mid)
```

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

Output:






File
Home
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Page Layout
Formulas
Data
Review
View
Help
Tell me what you want to do
Share
PivotTable
Recommended PivotTables
Table
Illustrations
Get Add-ins
My Add-ins
Recommended Charts
Maps
PivotChart
3D Map
Line
Column
Win/ Loss
Slicer
Timeline
Link
Text
Symbols
Tables
Add-ins
Charts
Tours
Sparklines
Filters
Links
H2
mergesort
mergesort
n
time
500 0.001274
1500 0.001298
2500 0.001484
3500 0.001655
4500 0.001914
5500 0.002166
6500 0.002334
7500 0.00252
8500 0.002777
9500 0.00302
10500 0.0032
11500 0.003407
12500 0.003709
13500 0.003902
14500 0.003825
time
0.0045
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
0
2000
4000
6000
8000
10000
12000
14000
16000

LAB PROGRAM-09

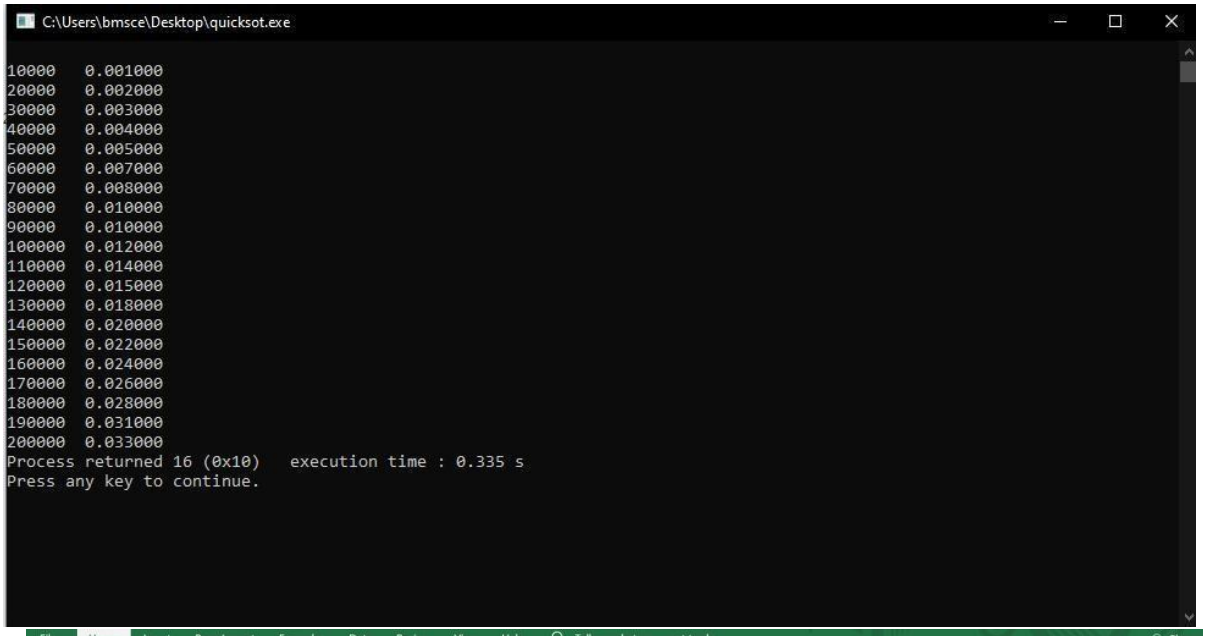
Sort a given set of N integer elements using Quick Sort technique and compute its time taken.

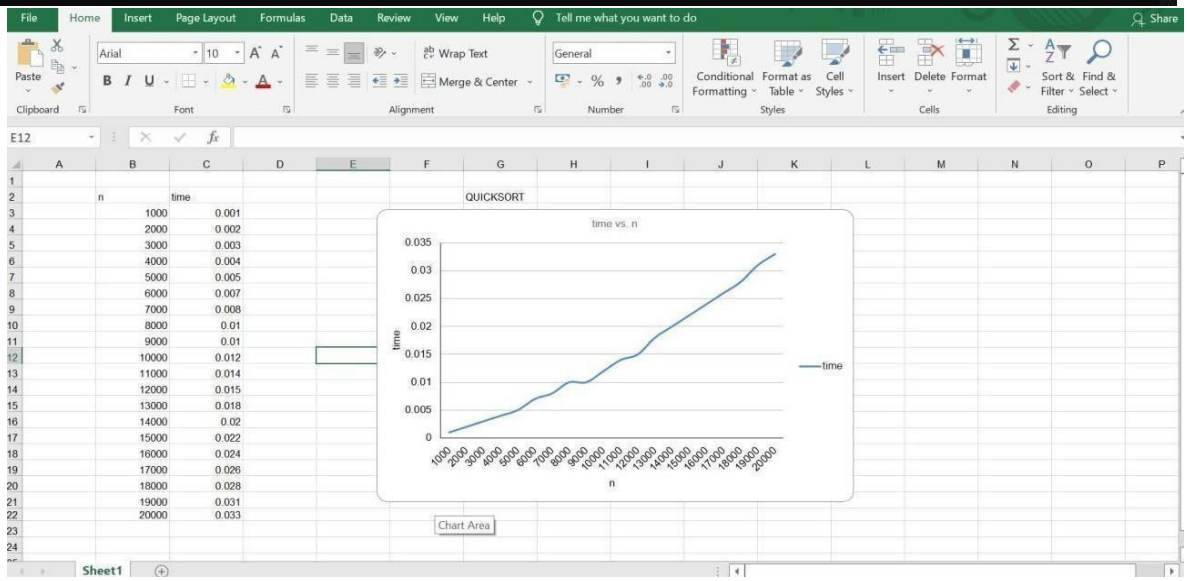
```
#include<stdio.h>
#include<time.h>
#include<stdlib.h>
#define MAXINT
2000 void delay(int n)
{ int
i;
for(i=0;i<n;i++)
{
}
} void quickSort(int
number[],int first,int last){int
i,j,pivot,temp; if(first<last){
   pivot=first;
   i=first; j=last;
while(i<j){ while(number[i]<=number[pivot]&
   &i<last){i++;
   }
   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<=n1;i++){
    a[i]=rand()%MAXI NT;
```

```
    } 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:





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:

```
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:20 31 10 46 78
 Sorted array is:78 46  31  20  10
 Time taken to sort 5 numbers is 0.000003 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 0.105851 secs
Time taken to sort 1500 numbers is 0.103846 secs
Time taken to sort 2500 numbers is 0.103909 secs
Time taken to sort 3500 numbers is 0.105498 secs
Time taken to sort 4500 numbers is 0.104747 secs
Time taken to sort 5500 numbers is 0.106133 secs
Time taken to sort 6500 numbers is 0.105619 secs
Time taken to sort 7500 numbers is 0.105099 secs
Time taken to sort 8500 numbers is 0.105469 secs
Time taken to sort 9500 numbers is 0.105425 secs
Time taken to sort 10500 numbers is 0.106843 secs
```

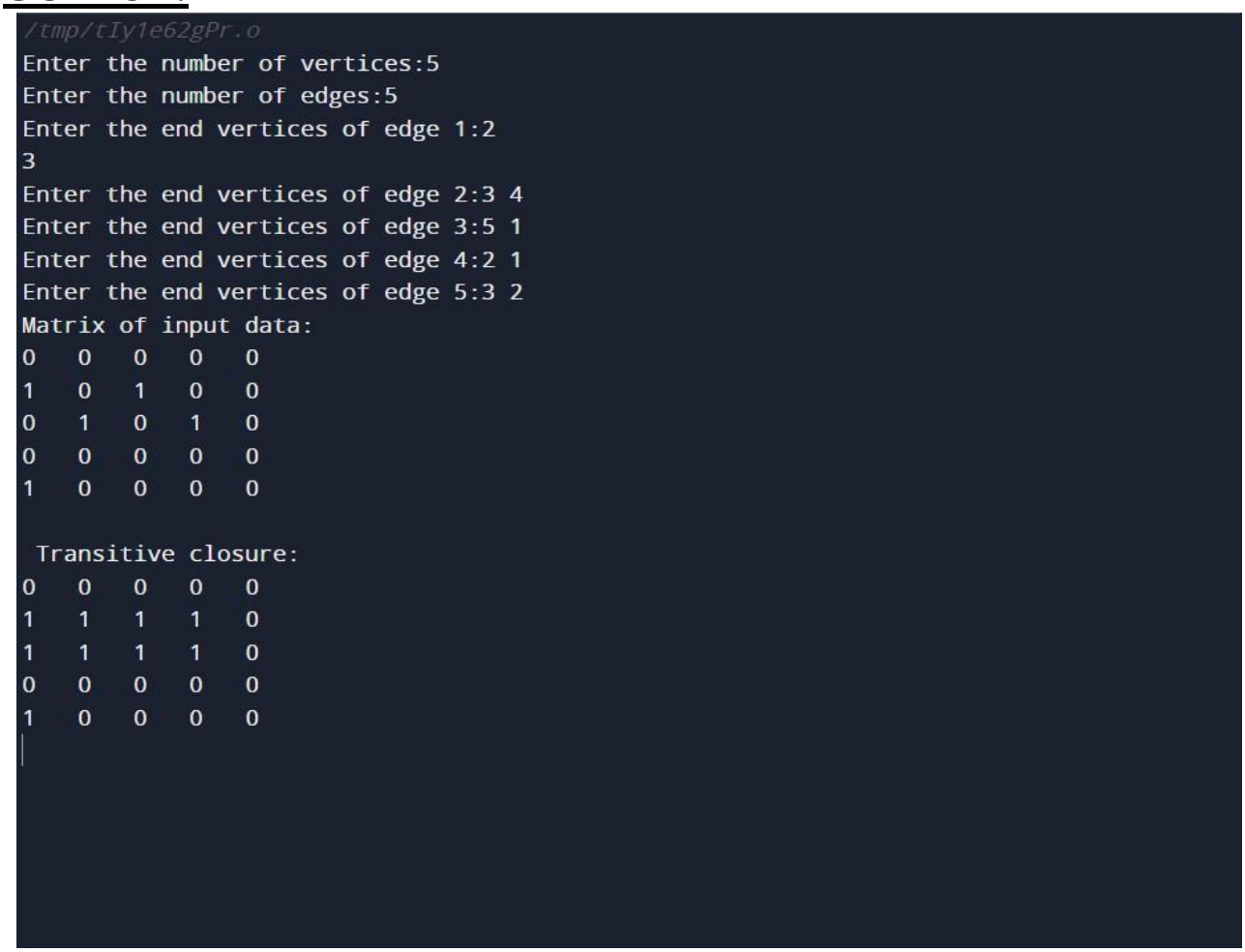
LAB PROGRAM-11

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");
    }
    getch();
}
```

OUTPUT:



LAB PROGRAM-12

Implement 0/1 Knapsack problem using dynamic programming.

```
#include<stdio.h>
void knapsack(); int
max(int,int);
int i,j,n,m,p[10],w[10],v[10][10]; void
main()
{
```

```
printf("\n enter the no. of items:\t");
scanf("%d",&n);
printf("\n enter the weight of the each item:\n ");
for(i=1;i<=n;i++)
{
scanf("%d",&w[i]);
}
printf("\n enter the profit of each item:\n ");
for(i=1;i<=n;i++)
{
scanf("%d",&p[i]);
}
printf("\n enter the knapsack's capacity:\t ");
scanf("%d",&m); knapsack();

}
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("\n the 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:
 10 20 30 40
 enter the profit of each item:
 20 30 55 33
 enter the knapsack's capacity:  60
 the output is:
0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   33

0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   33  33  33  33  33  33  33  33  33  33  33

0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   33
    33  33  33  33  33  33  33  33  33  33  33  33  33  33  33  33  33  33  33  4
```

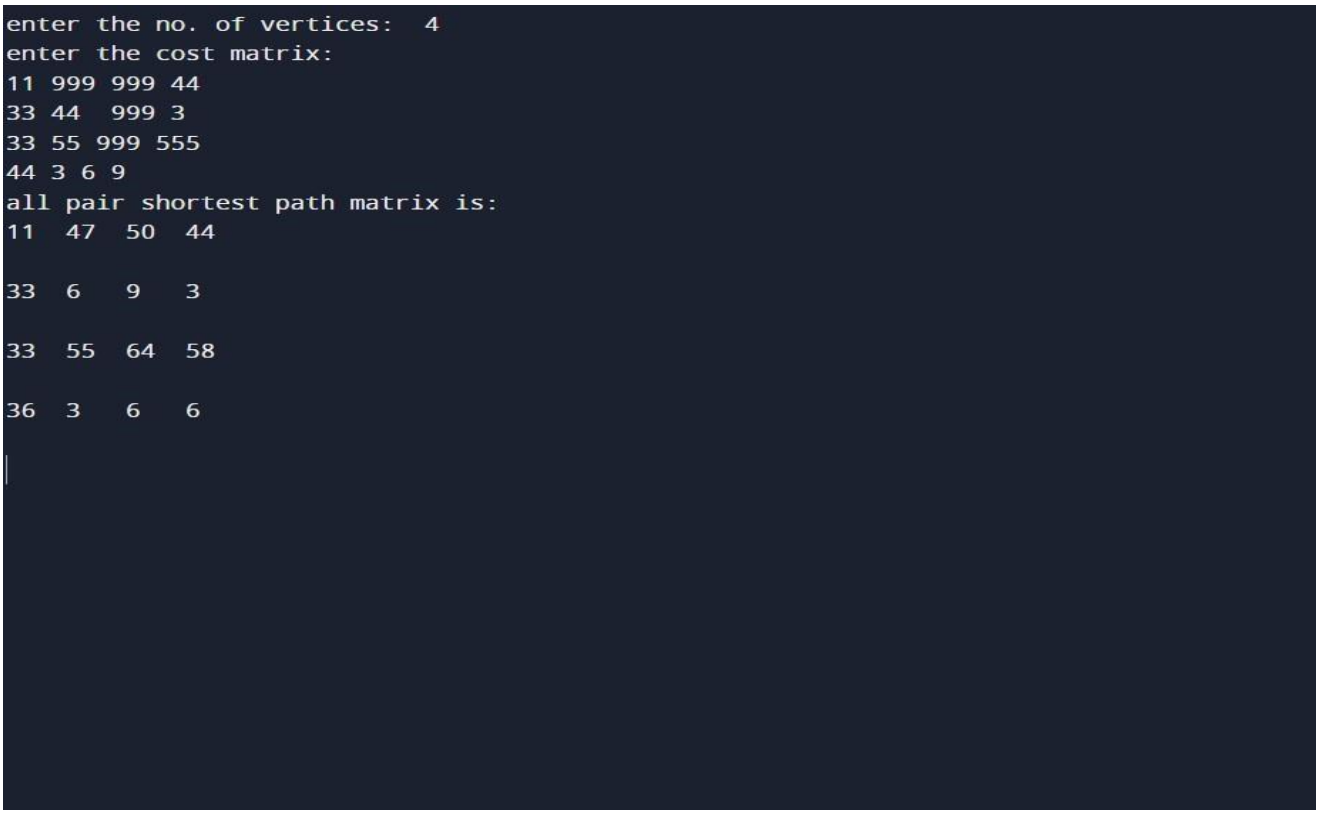
LAB PROGRAM-13

Implement All Pair Shortest paths problem using Floyd's algorithm

```
#include<stdio.h>

int a[10][10],n;
void floyds(); int
min(int,int);
void main()
{ int
i,j;

printf("\n enter the no. of vertices:\t");
scanf("%d",&n);
printf("\n enter the cost matrix:\n");
for(i=1;i<=n;i++)
{
for(j=1;j<=n;j++)
{
scanf("%d",&a[i][j]);
```

```
}
} floyds();

} 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("\n all 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:



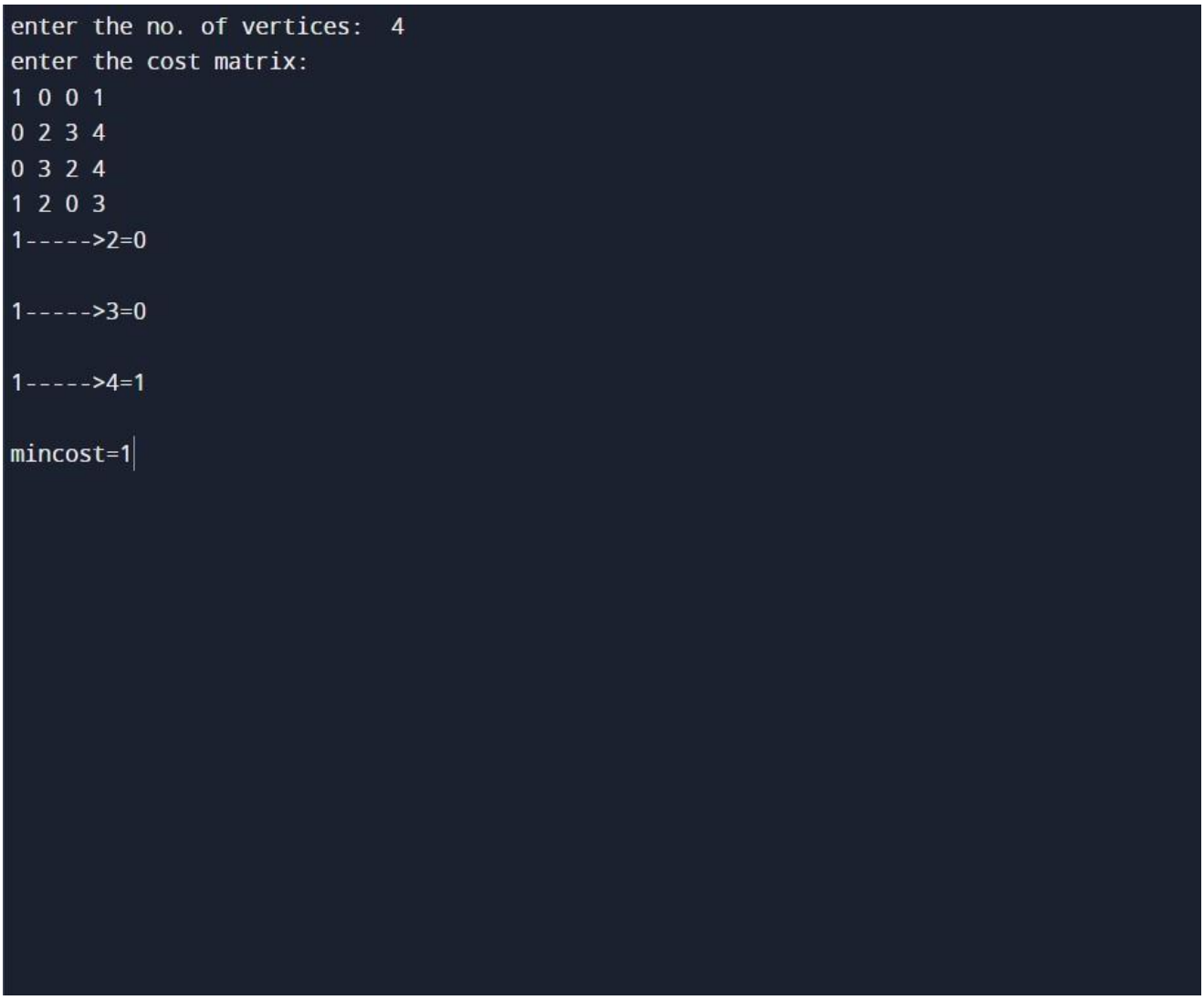
LAB PROGRAM-14

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:\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();
```

```
} 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:



LAB PROGRAM-15

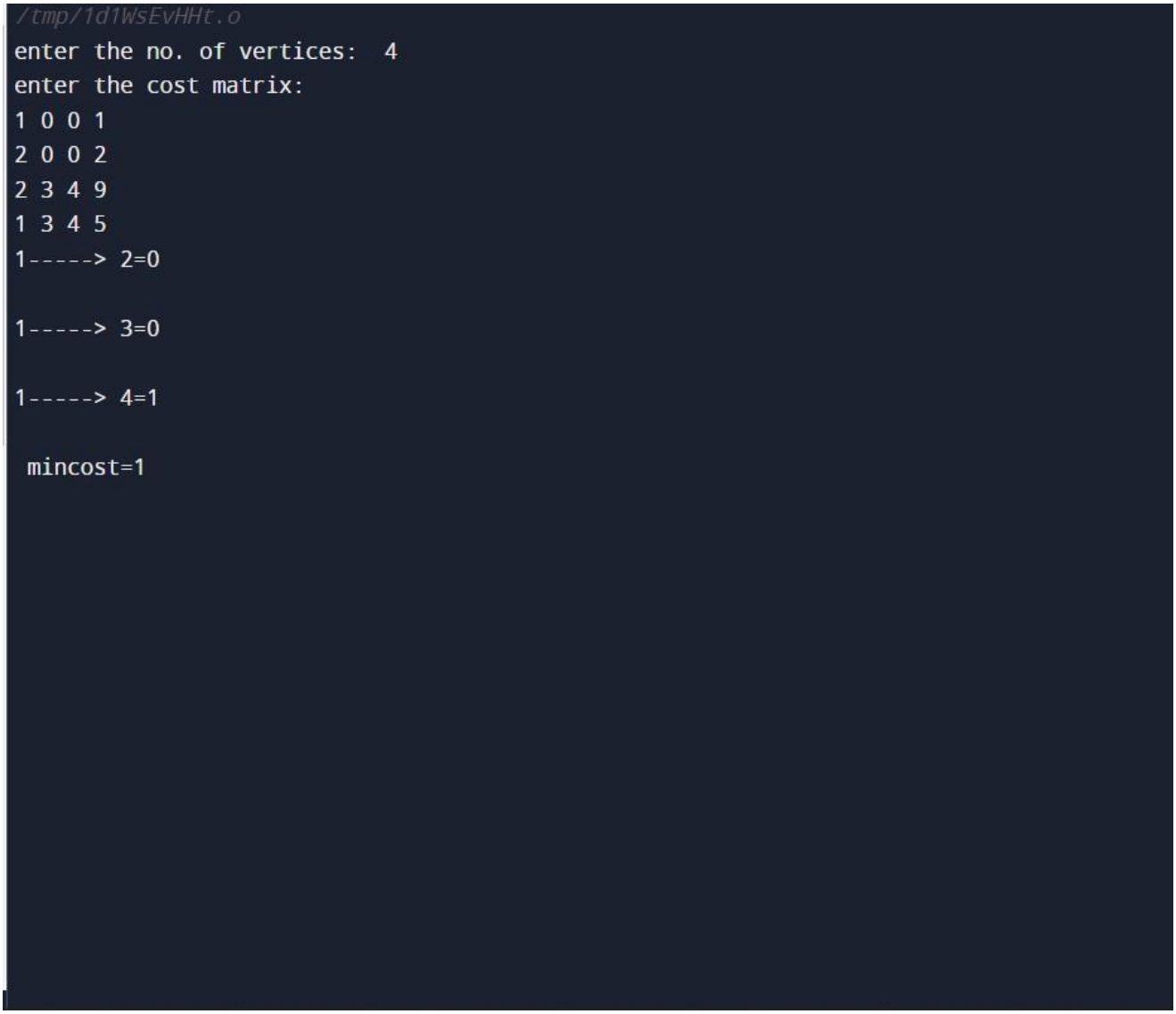
Find Minimum Cost Spanning Tree of a given undirected graph using Kruskals algorithm #include<stdio.h>

```
void kruskals();
int c[10][10],n;

void main()
{ int
i,j;

printf("\n enter the no. of vertices:\t");
scanf("%d",&n);
```

```
printf("\n enter 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("\n mincost=%d",mincost);
}
```

OUTPUT:



LAB PROGRAM-16

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

```
#include<stdio.h> #define infinity 999 void
dij(int n,int v,int cost[10][10],int dist[100])
{ int
i,u,count,w,flag[10],min;
for(i=1;i<=n;i++)
flag[i]=0,dist[i]=cost[v][i];
```

```
count=2;
while(count<=n)
{ min=99; for(w=1;w<=n;w++)
if(dist[w])
min=dist[w],u=w; flag[u]=1;
count++;
for(w=1;w<=n;w++) if(dist[u]+cost[u][w])
dist[w]=dist[u]+cost[u][w];
}
}
void main()
{ int
n,v,i,j,cost[10][10],dist[10];

printf("\n Enter the number of nodes:");
scanf("%d",&n); printf("\n Enter the
cost matrix:\n"); for(i=1;i<=n;i++)
for(j=1;j<=n;j++)
{ scanf("%d",&cost[i][j]);
if(cost[i][j]==0)
cost[i][j]=infinity;
}
printf("\n Enter the source matrix:");
scanf("%d",&v); dij(n,v,cost,dist); printf("\n
Shortest path:\n"); for(i=1;i<=n;i++)
if(i!=v) printf("%d-
>%d,cost=%d\n",v,i,dist[i]);
}
```

OUTPUT:

```
/tmp/RHJFW6kRtE.o
Enter the number of nodes:5
Enter the cost matrix:
2 3 4 999 999
999 4 5 999 999
3 45 999 2 5
999 5 6 7 999
5 6 8 999 999
Enter the source matrix:1
Shortest path:
1->2,cost=4002
1->3,cost=4004
1->4,cost=4995
1->5,cost=4995
```