**VISVESVARAYA TECHNOLOGICAL UNIVERSITY**

**“JnanaSangama”, Belgaum -590014, Karnataka.**

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**LAB REPORT**

**on**

**Analysis and Design of Algorithms**

***Submitted by***

**MALATESH SANGAMESH MANTUR(1BM20CS081)**

***in partial fulfillment for the award of the degree of***

**BACHELOR OF ENGINEERING**

***in***

**COMPUTER SCIENCE AND ENGINEERING**

**B. M. S. College of Engineering,**

**Bull Temple Road, Bangalore 560019**

(Affiliated To Visvesvaraya Technological University, Belgaum)

**Department of Computer Science and Engineering**



**CERTIFICATE**

This is to certify that the Lab work entitled “**Analysis and Design of Algorithms**” carried out by **MALATESH SANGAMESH MANTUR(1BM20CS081),**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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**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. |

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

**Tower of Hanoi**

#include <stdio.h>

#include<time.h>

void towerOfHanoi(int n, char from\_rod, char to\_rod, char aux\_rod)

{

if (n == 1)

{

printf("\n Move disk 1 from %c to %c", from\_rod, to\_rod);

return;

}

towerOfHanoi(n-1, from\_rod, aux\_rod, to\_rod);

printf("\n Move disk %d from %c to %c", n, from\_rod, to\_rod);

towerOfHanoi(n-1, aux\_rod, to\_rod, from\_rod);

}

void main()

{

int n;

time\_t start,end;

printf("Enter the number of discs");

scanf("%d",&n);

start=time(NULL);

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

end=time(NULL);

printf("\n Time is %fs",difftime(end,start)); }

**OUTPUT:**

![Text

Description automatically generated with medium confidence](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAkACQAAD/4RDoRXhpZgAATU0AKgAAAAgABAE7AAIAAAAKAAAISodpAAQAAAABAAAIVJydAAEAAAAUAAAQzOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAHlhc2Fzd2luaQAABZADAAIAAAAUAAAQopAEAAIAAAAUAAAQtpKRAAIAAAADMDQAAJKSAAIAAAADMDQAAOocAAcAAAgMAAAIlgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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**GCD**

#include<stdio.h>

#include<time.h>

void delay()

{

int i;

for(i=8000;i>0;i--);

}

int gcd(int a,int b)

{

if(b!=0)

return gcd(b,a%b);

else return a;

}

void main()

{

int m,n,ans;

time\_t start,end;

start=time(NULL);

printf("enter two numbers");

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

delay();

ans=gcd(m,n);

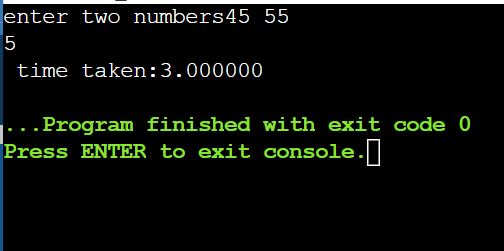
printf("%d",ans);

end=time(NULL);

printf("\n time taken:%f", difftime(end,start));

}

OUTPUT:



**PROGRAM-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.

**LINEAR SEARCH:**

#include <stdio.h>

#include <time.h>

#include <stdlib.h>

int RecursiveLS(int arr[], int value, int index, int n)

{

int pos = 0;

if(index >= n)

{

return 0;

}

else if (arr[index] == value)

{

pos = index + 1;

return pos;

}

else

{

return RecursiveLS(arr, value, index+1, n);

}

return pos;

}

int main()

{

int n, value, pos, m = 0, arr[1000000],i;

time\_t start,end;

printf("Enter the total elements in the array ");

scanf("%d", &n);

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

{

arr[i]=rand();

}

start=time(NULL);

printf("Array elements are\n");

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

{

printf("%d ",arr[i]);

}

printf("Enter the element to search ");

scanf("%d", &value);

pos = RecursiveLS(arr, value, 0, n);

if (pos != 0)

{

printf("Element found at pos %d ", pos);

}

else

{

printf("Element not found");

}

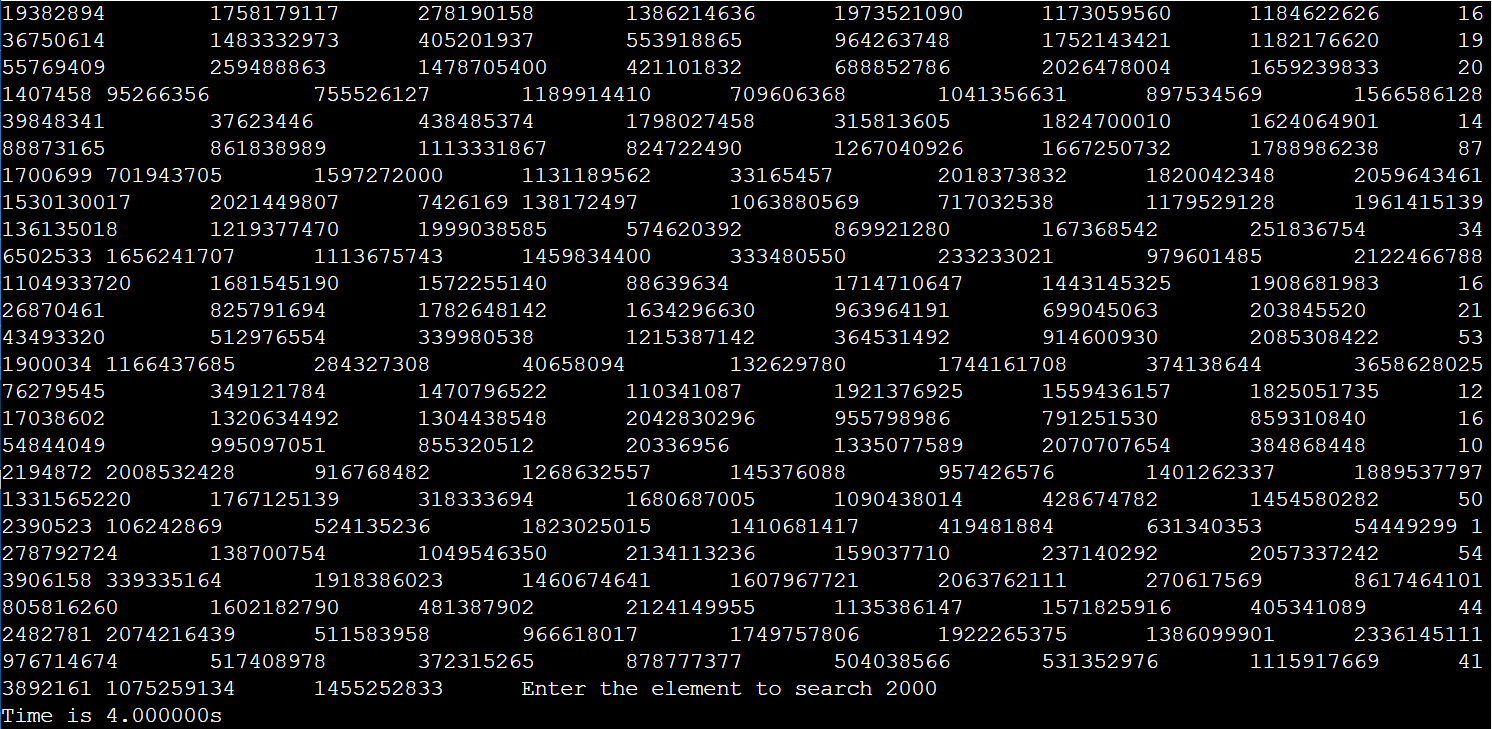
end=time(NULL);

printf("Time is %f",difftime(end,start));

return 0;

}

**OUTPUT:**



**BINARY SEARCH:**

#include <stdio.h>

#include <time.h>

void delay()

{

int u;

for(u=8000;u>0;u--); }

int recursiveBinarySearch(int array[], int start\_index, int end\_index, int element){

if (end\_index >= start\_index){

int middle = start\_index + (end\_index - start\_index )/2;

if (array[middle] == element)

return middle;

if (array[middle] > element)

return recursiveBinarySearch(array, start\_index, middle-1, element);

return recursiveBinarySearch(array, middle+1, end\_index, element);

} return -1; }

void main{

int array[10],n,element,i;

time\_t start,end;

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

scanf("%d",&n);

start=time(NULL);

delay();

printf("Enter %d elements\n",n);

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

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

int found\_index = recursiveBinarySearch(array, 0, n-1, element);

if(found\_index == -1 ) {

printf("Element not found in the array ");

}

else {

printf("Element found at index : %d",found\_index);

}

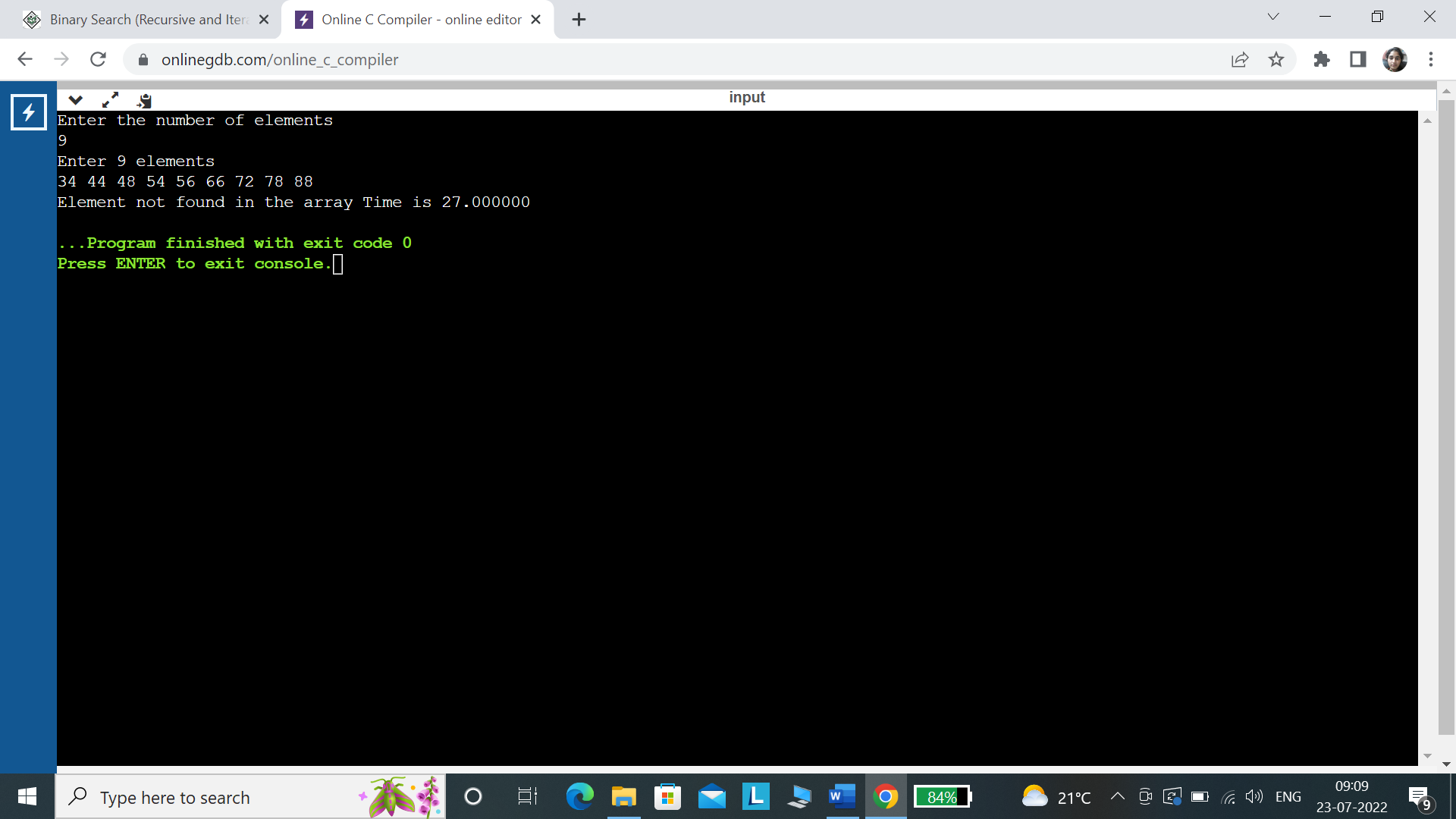
end=time(NULL);

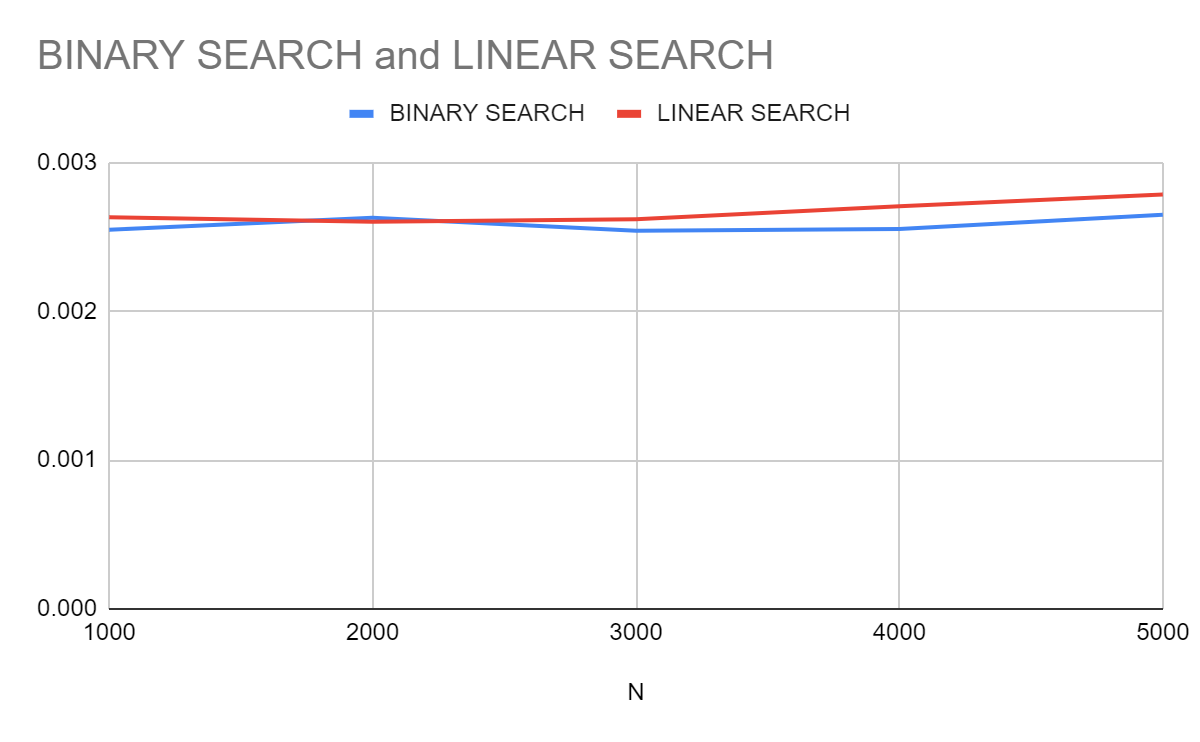
printf("Time is %f",difftime(end,start));

return 0;

}

**OUTPUT:**



**PROGRAM 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>

void main()

{

int a[100], n, i, j, position, swap;

time\_t start,end;

printf("Enter number of elements");

scanf("%d", &n);

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

a[i]=rand(); }

start=time(NULL);

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

{

position=i;

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

{

if(a[position] > a[j])

position=j;

}

if(position != i)

{

swap=a[i];

a[i]=a[position];

a[position]=swap; } }

end=time(NULL);

printf("Sorted Array:");

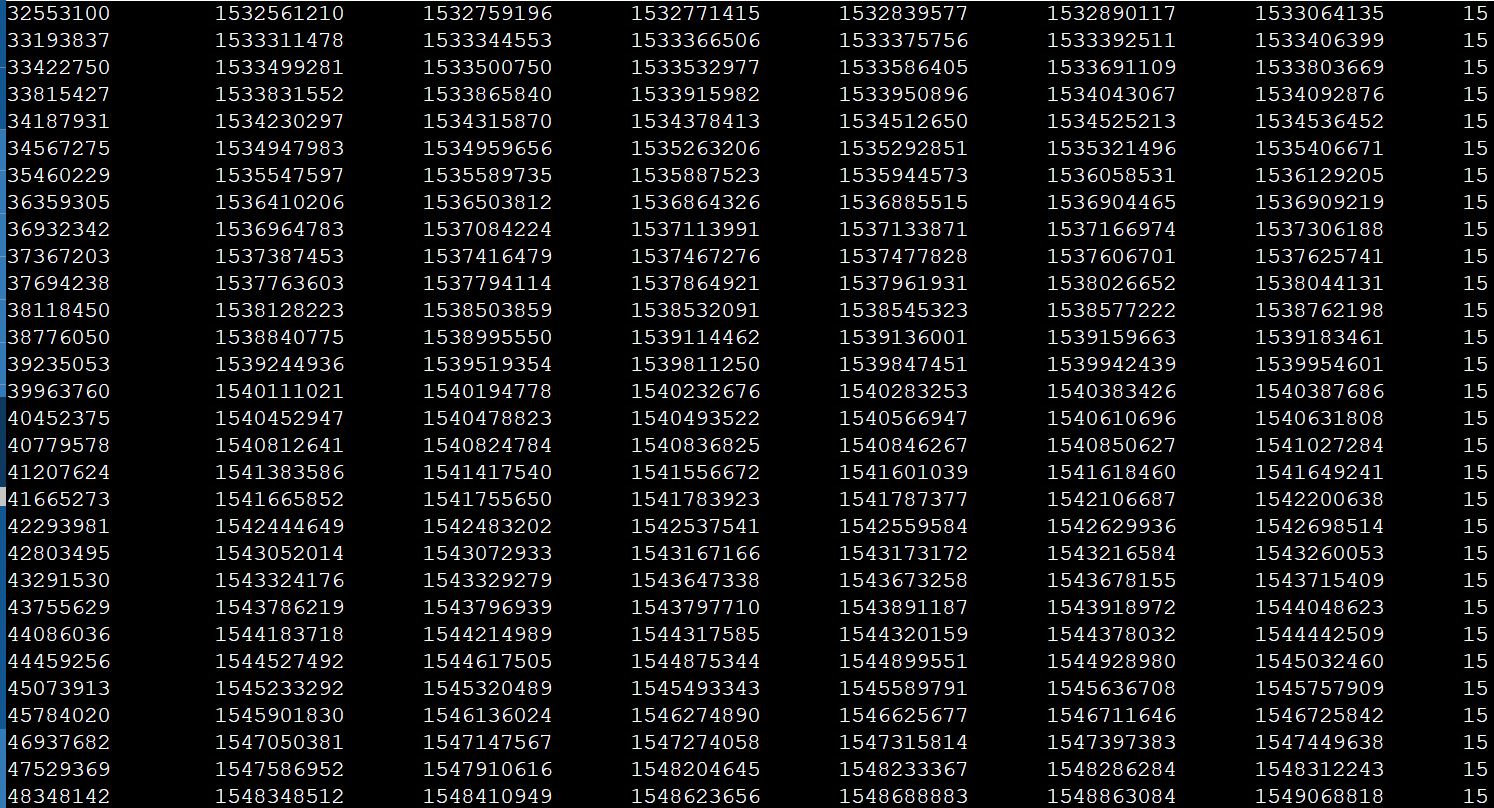
for(i = 0; i < n; i++)

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

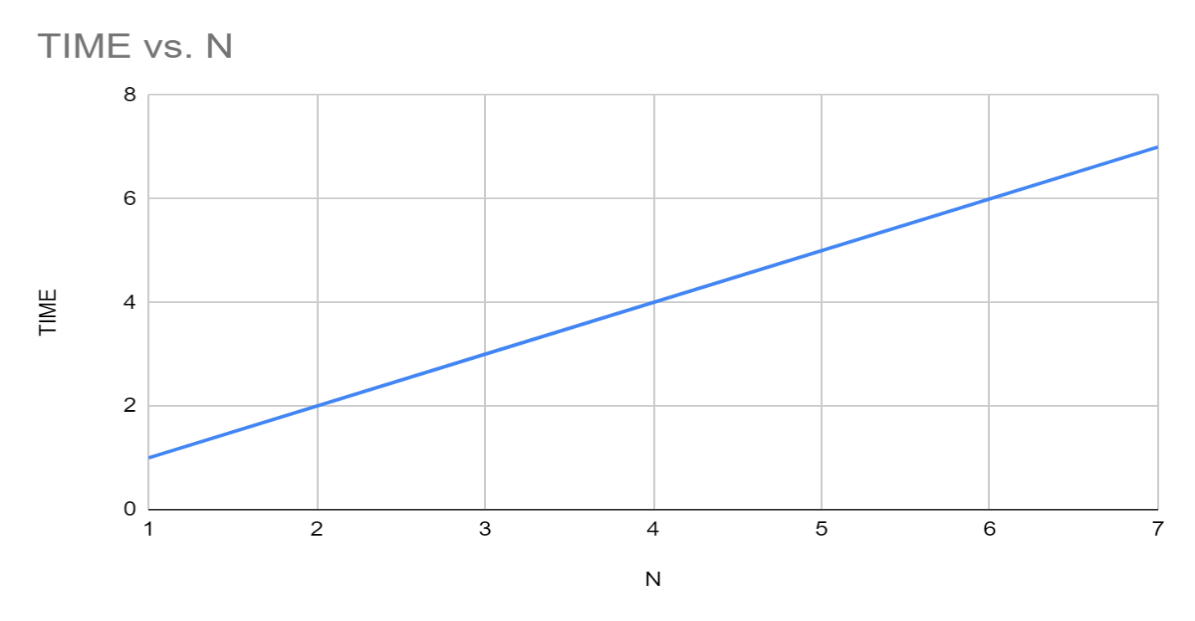
printf("Time is %fs",difftime(end,start));

}

**OUTPUT**



**GRAPH**



**PROGRAM 4 :** Write program to do the following:

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

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

**A:** #include<stdio.h>

#include<conio.h>

int a[20][20],q[20],visited[20],n,i,j,f=0,r=-1;

void bfs(int v)

{

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

if(a[v][i] && !visited[i])

q[++r]=i;

if(f<=r)

{

visited[q[f]]=1;

bfs(q[f++]);

}

}

void main()

{

int v;

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

scanf("%d",&n);

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

{

q[i]=0;

visited[i]=0;

}

printf("\n Enter graph data in matrix form:\n");

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

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

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

printf("\n Enter the starting vertex:");

scanf("%d",&v);

bfs(v);

printf("\n The node which are reachable are:\n");

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

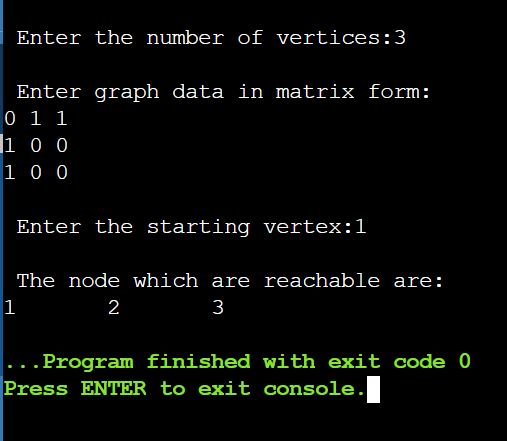
if(visited[i])

printf("%d\t",i);

getch();

}

**OUTPUT**



**B.** #include<stdio.h>

#include<stdlib.h>

#include<conio.h>

#include<time.h>

int a[20][20],reach[20],n;

time\_t start,end;

void dfs(int v) {

int i;

reach[v]=1;

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

if(a[v][i] && !reach[i]) {

printf("\n %d->%d",v,i);

dfs(i); } }

void main() {

int i,j,count=0;

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

scanf("%d",&n);

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

reach[i]=0;

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

a[i][j]=0;

}

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

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

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

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

start=time(NULL);

dfs(1);

end=time(NULL);

printf("\n");

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

{

if(reach[i])

count++;

}

if(count==n)

printf("\n Graph is connected");

else

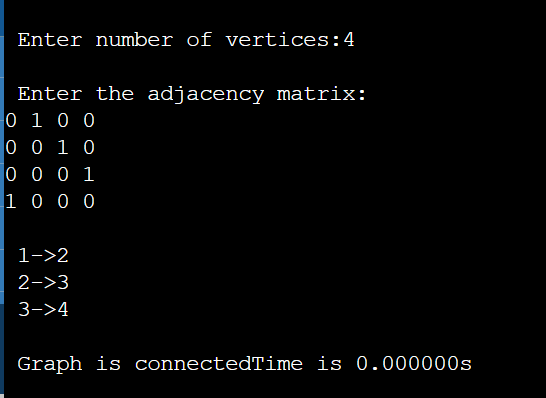
printf("\n Graph is not connected");

printf("Time is %fs",difftime(end,start));

getch();

}

**OUTPUT**



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

#include <stdio.h>

#include<time.h>

void main()

{

int n, i, j, temp;

int arr[64];

time\_t start,end;

printf("Enter number of elements\n");

scanf("%d", &n);

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

arr[i]=rand(); }

start=time(NULL);

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

{ j = i;

while ( j > 0 && arr[j-1] > arr[j])

{

temp = arr[j];

arr[j] = arr[j-1];

arr[j-1] = temp;

j--;

}

}

end=time(NULL);

printf("Sorted list in ascending order:\n");

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

{

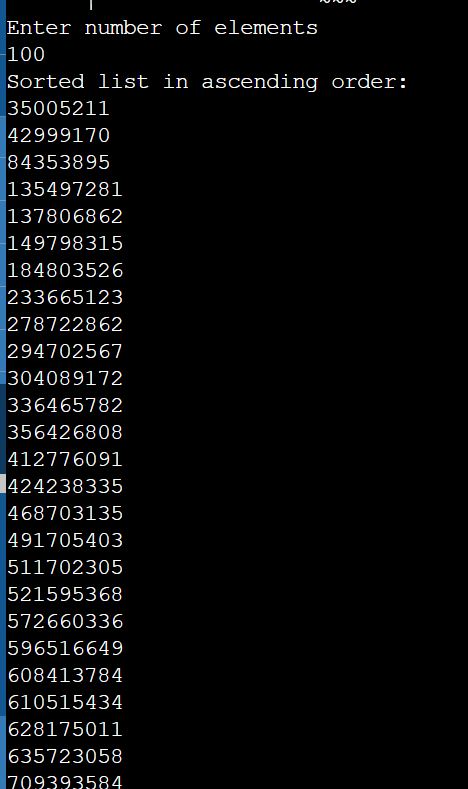
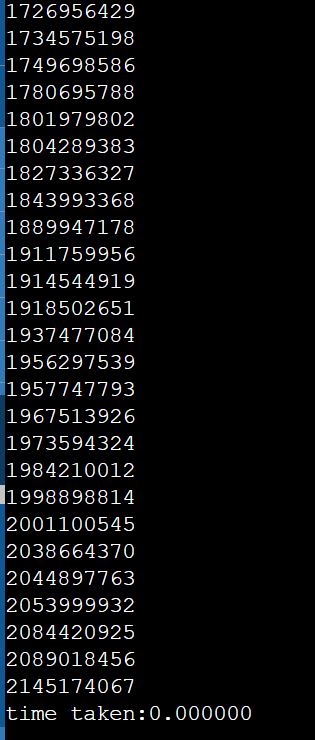
printf("%d\n", arr[i]);

}

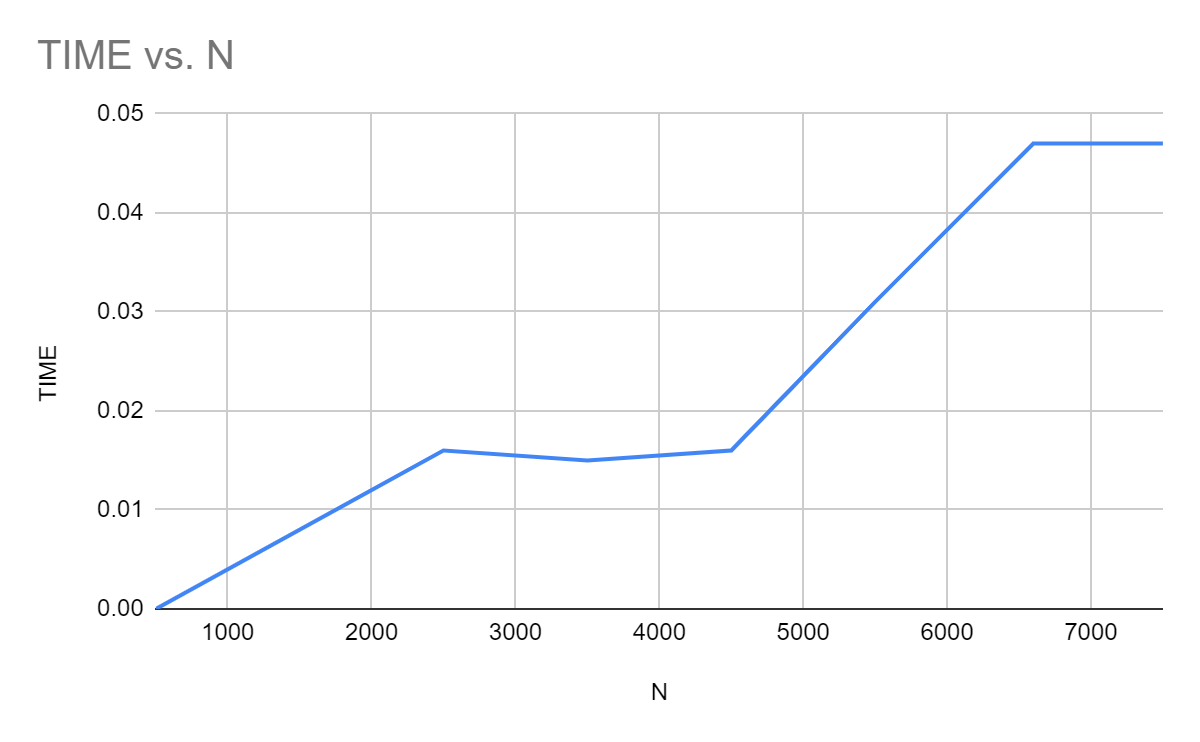
printf("time taken:%f",difftime(end,start));

}

**OUTPUT**

**GRAPH**

****

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

#include<stdio.h>

#include<conio.h>

void main()

{

int i,j,k,n,a[10][10],indeg[10],flag[10],count=0;

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

scanf("%d",&n);

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

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

{

printf("Enter row %d\n",i+1);

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

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

}

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

{

indeg[i]=0;

flag[i]=0; }

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

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

indeg[i]=indeg[i]+a[j][i];

printf("\nThe topological order is:");

while(count<n)

{

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

if((indeg[k]==0) && (flag[k]==0)){

printf("%d ",(k+1));

flag [k]=1;

}

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

{

if(a[i][k]==1)

indeg[k]--;

}

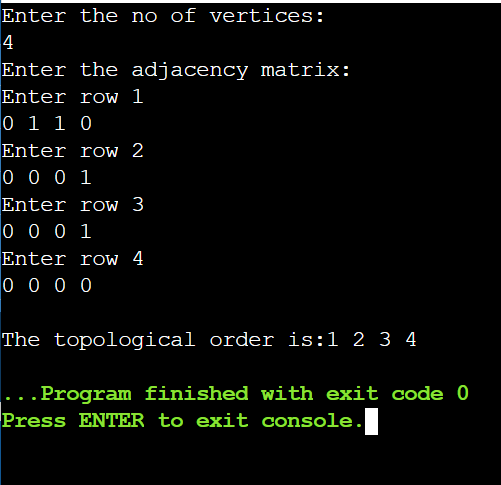
}

count++;

}

}

**OUTPUT**



**PROGRAM 7:** Implement Johnson Trotter algorithm to generate permutations.

#include <stdio.h>

int fact(int n) {

int f=1;

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

f=f\*i; }

return f; }

int search(int a[],int mobile,int n) {

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

if(a[i]==mobile) {

return i; } }

return -1; }

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

{ int mobile=0;

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

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

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

mobile=a[i]; } }

else if(dir[a[i]-1]==1 && i!=n-1) {

if(a[i]>a[i+1] && a[i]>mobile) {

mobile=a[i]; } } }

return mobile;

}

void Permutations(int a[],int dir[],int n) {

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

int pos=search(a,mobile,n);

if(dir[a[pos]-1]==0 ) {

int temp=a[pos];

a[pos]=a[pos-1];

a[pos-1]=temp; }

else if(dir[a[pos]-1]==1 ) {

int 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]==0) {

dir[a[i]-1]=1; }

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

dir[a[i]-1]=0; } }

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

printf("%d\t",a[i]); }

printf("\n"); }

int main()

{

int n=4; int a[]={1,2,3,4};

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

{

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

}

printf("\n");

int dir[]={0,0,0,0};

int total=fact(n);

int count=1;

// printf("%d",total);

for(int i=1;i<total;i++)

{

Permutations(a,dir,n);

count++;

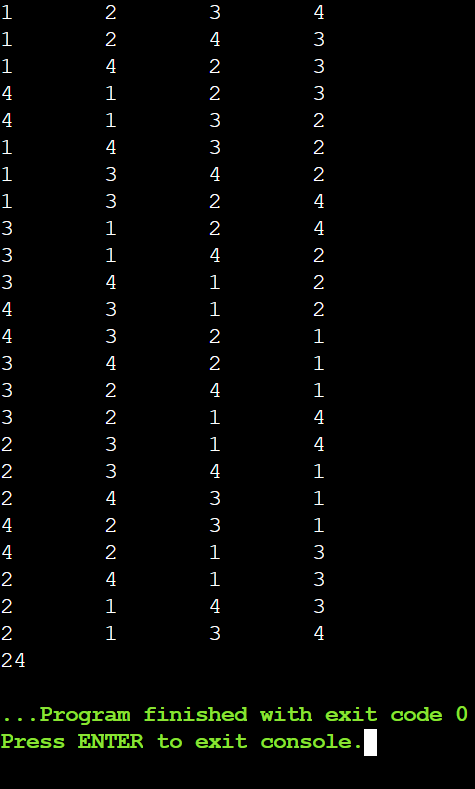
}

printf("%d",count);

return 0;

}

**OUTPUT**



**PROGRAM 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 merge(int arr[], int l, int m, int r)

{

    int i, j, k;

    int n1 = m - l + 1;

    int n2 = r - m;

    int L[n1], R[n2];

    for (i = 0; i < n1; i++)

        L[i] = arr[l + i];

    for (j = 0; j < n2; j++)

        R[j] = arr[m + 1 + j];

    i = 0;

    j = 0;

    k = l;

    while (i < n1 && j < n2) {

        if (L[i] <= R[j]) {

            arr[k] = L[i];

            i++; }

        else {

            arr[k] = R[j];

            j++; }

        k++; }

    while (i < n1) {

        arr[k] = L[i];

        i++;

        k++; }

    while (j < n2) {

        arr[k] = R[j];

        j++;

        k++; } }

void mergeSort(int arr[], int l, int r)

{

    if (l < r) {

int m = l + (r - l) / 2;

        mergeSort(arr, l, m);

        mergeSort(arr, m + 1, r);

  merge(arr, l, m, r);   } }

int main()

{

    int i,n;

    int arr[1000];

      time\_t start, end;

    printf("enter the number of elements");

    scanf("%d",&n);

    for(i=0;i<=n;i++)

    {

        arr[i]=rand();

    }

    start=time(NULL);

    int arr\_size = sizeof(arr) / sizeof(arr[0]);

    printf("Given array is \n");

    for (i = 0; i < n ;i++)

        printf("%d ", arr[i]);

    printf("\n");

    mergeSort(arr, 0, arr\_size - 1);

    for (i = 0; i < n; i++)

        printf("%d ", arr [i]);

    printf("\n");

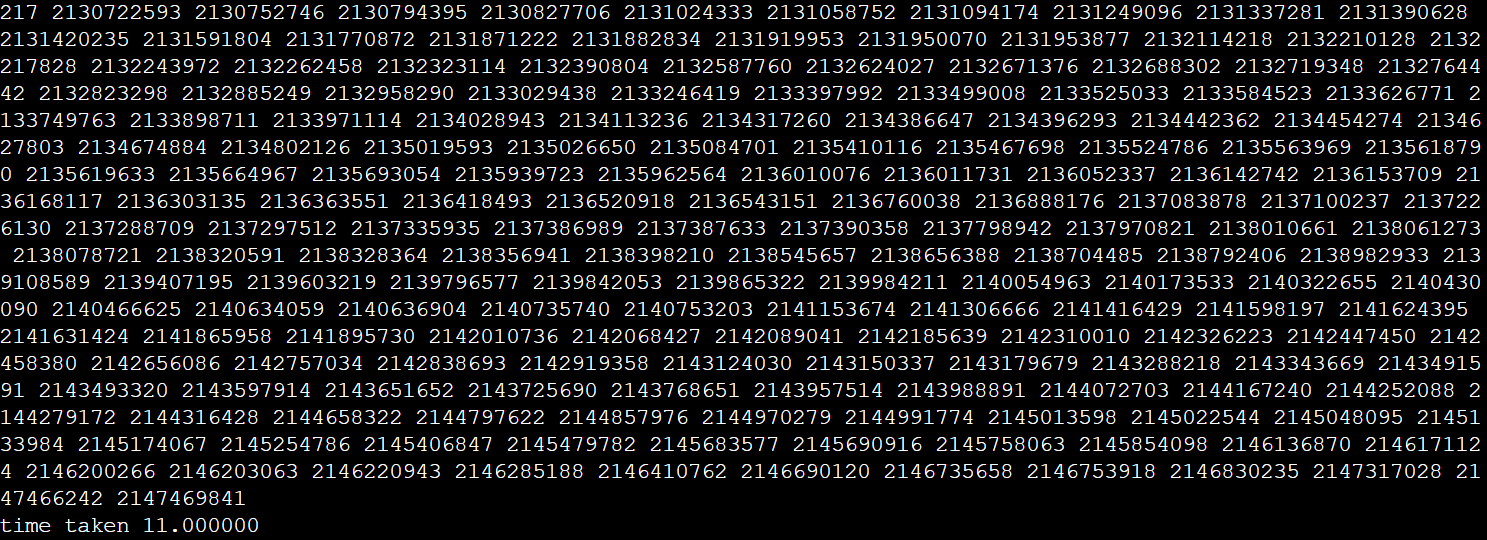
    end=time(NULL);

    printf("time taken %f", difftime(end,start));

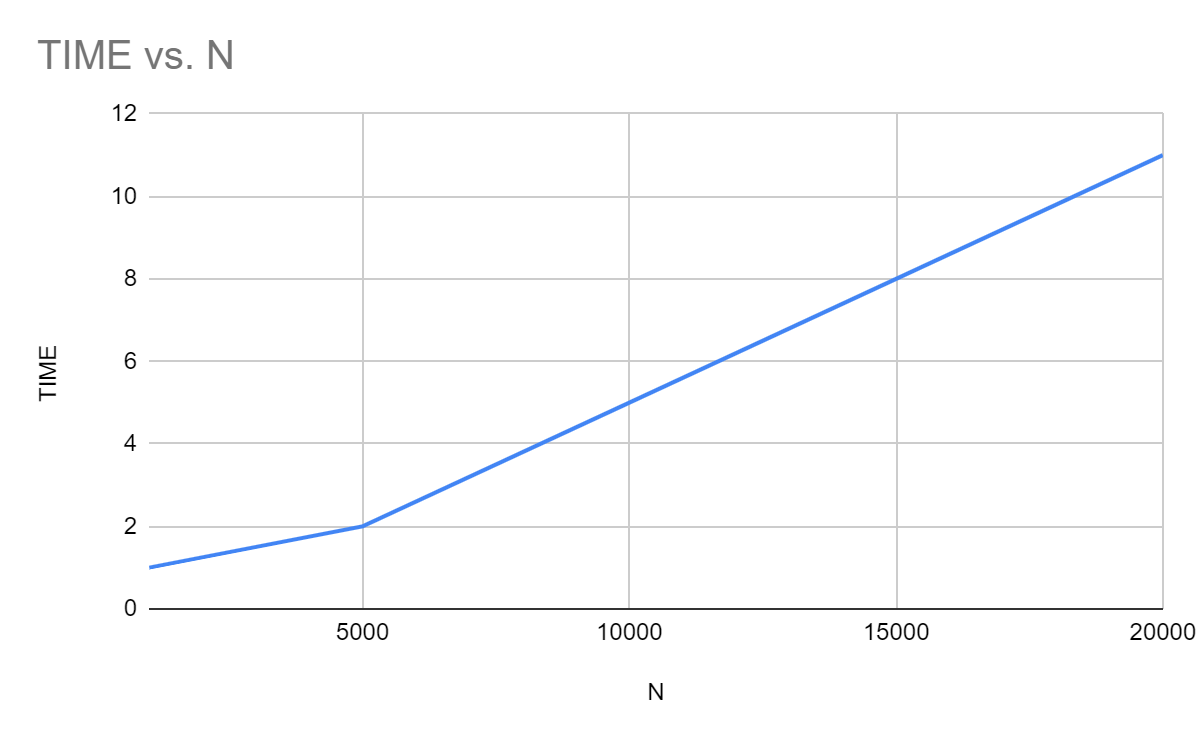
    return 0;

}

**OUTPUT:**



**GRAPH:**

****

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

#include<stdio.h>

#include <stdlib.h>

 #include<time.h>

void quicksort(int number[25],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--;

         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(){

    time\_t start, end;

   int i, count, number[10000];

   printf("How many elements are u going to enter?: ");

   scanf("%d",&count);

   for(i=0;i<count;i++)

   {

       number[i]=rand();

   }

   start=time(NULL);

   quicksort(number,0,count-1);

   end=time(NULL);

   printf("Order of Sorted elements: ");

   for(i=0;i<count;i++)

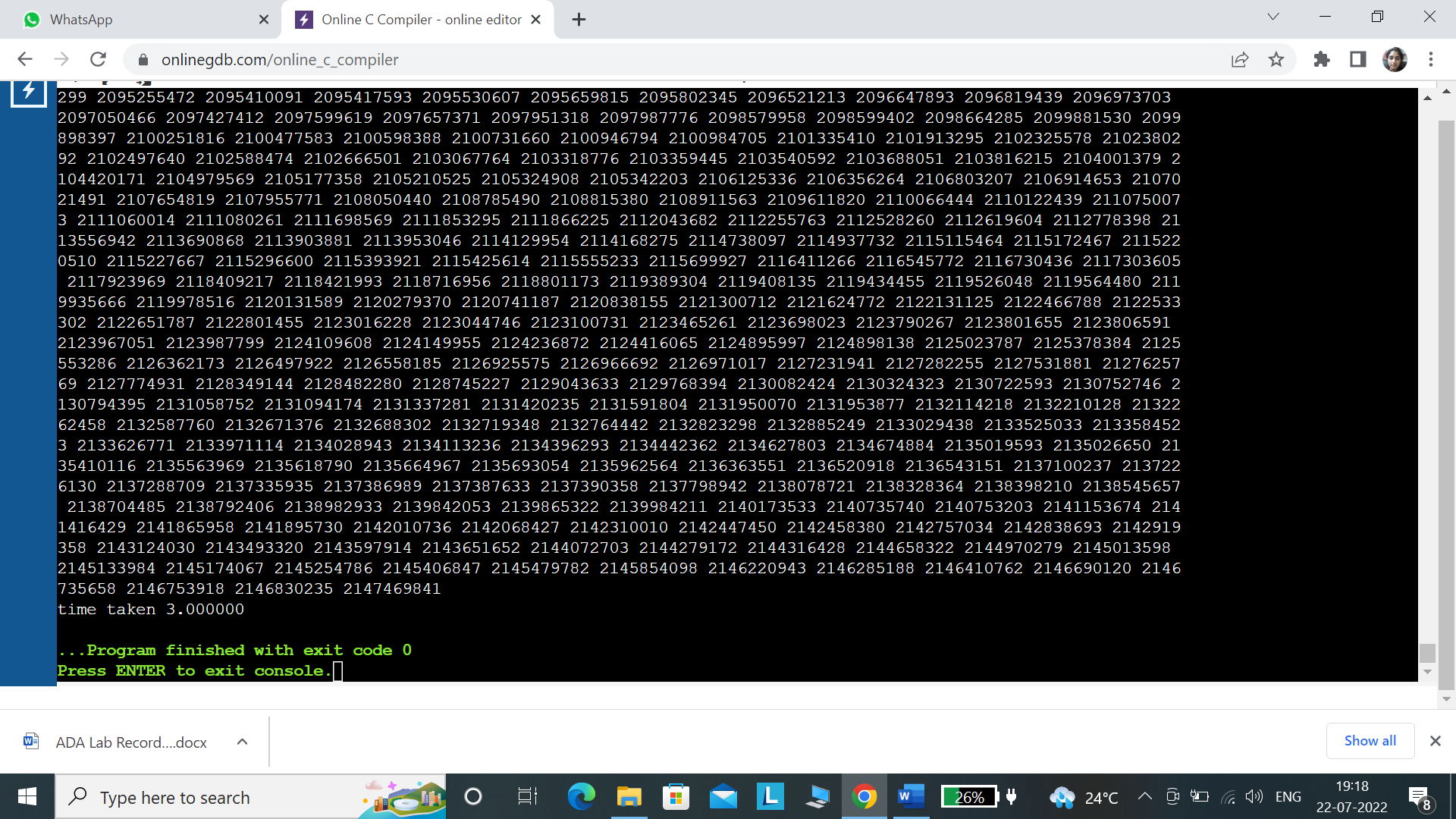
   printf(" %d",number[i]);

   printf("\ntime taken %f", difftime(end,start));

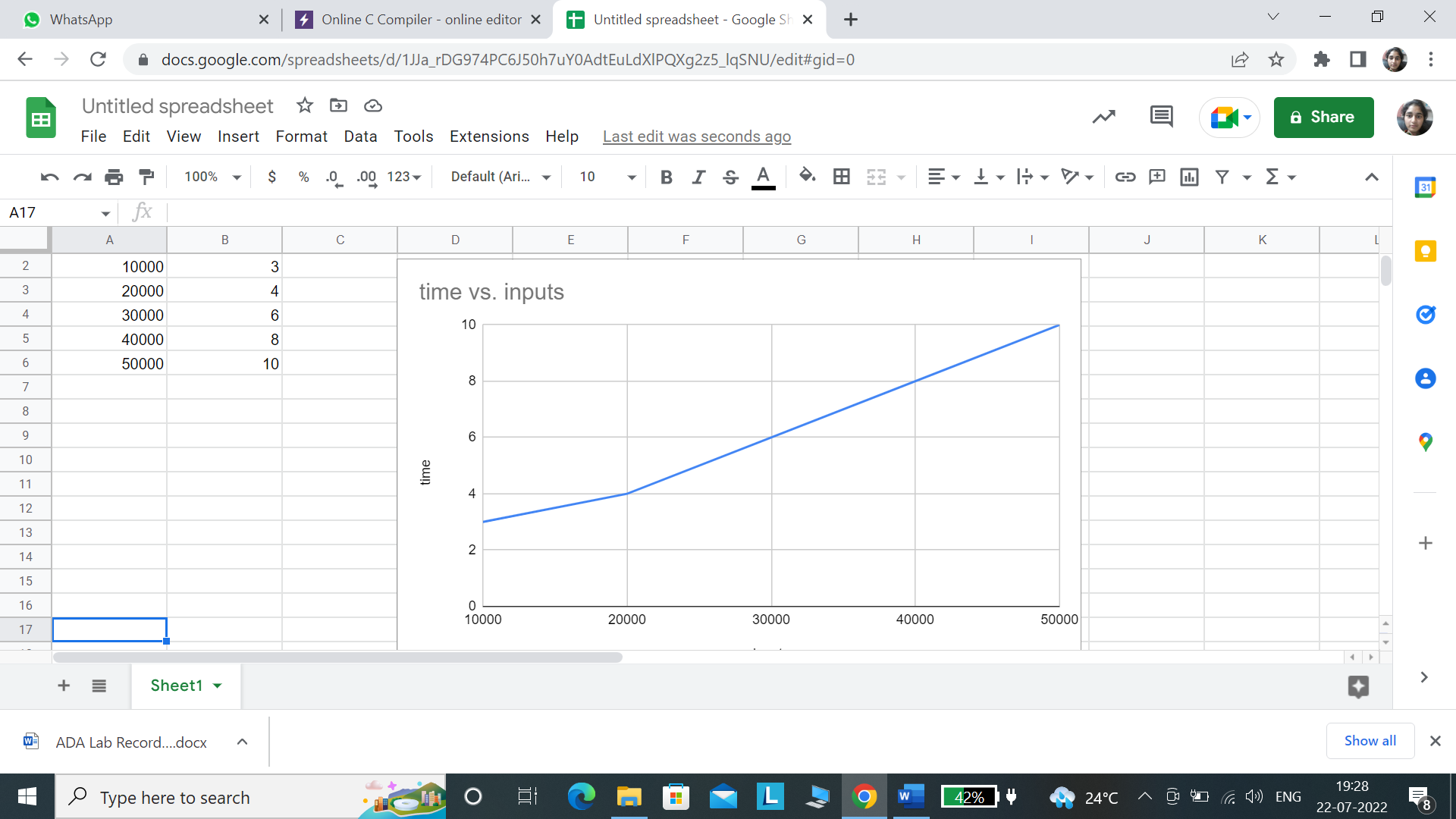
   return 0;

}

**OUTPUT:**



**GRAPH:**



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

#include <stdio.h>

#include <stdlib.h>

#include<conio.h>

#include<time.h>

void heapify(int a[], int n, int i)

{

int largest = i;

int left = 2 \* i + 1;

int right = 2 \* i + 2;

if (left < n && a[left] > a[largest])

largest = left;

if (right < n && a[right] > a[largest])

largest = right;

if (largest != i) {

int temp = a[i];

a[i] = a[largest];

a[largest] = temp;

heapify(a, n, largest);

}

}

void heapSort(int a[], int n)

{ int i, temp;

for ( i = n / 2 - 1; i >= 0; i--)

heapify(a, n, i);

for ( i = n - 1; i >= 0; i--)

{

temp = a[0];

a[0] = a[i];

a[i] = temp;

heapify(a, i, 0);

}

}

void printArr(int arr[], int n)

{ int i;

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

{

printf("%d", arr[i]);

printf(" ");

}

}

int main()

{

int i,n;

int a[100000];

time\_t start,end;

printf("enter the no.of elements");

scanf("%d",&n);

start=time(NULL);

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

{

a[i]=rand();

}

heapSort(a, n);

printf("\nAfter sorting array elements are - \n");

printArr(a, n);

end=time(NULL);

printf("\nThe time taken is %f",difftime(end,start));

return 0;

}

**OUTPUT:**

Graphical user interface, text

Description automatically generated

**GRAPH:**

Graphical user interface, chart

Description automatically generated

**PROGRAM 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:**

A screenshot of a computer

Description automatically generated

**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("\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();

}

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 selected are\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++)

{

if(x[i]==1)

printf("%d\t",i);

}

}

int max(int x,int y)

{

if(x>y)

{

return x;

}

else

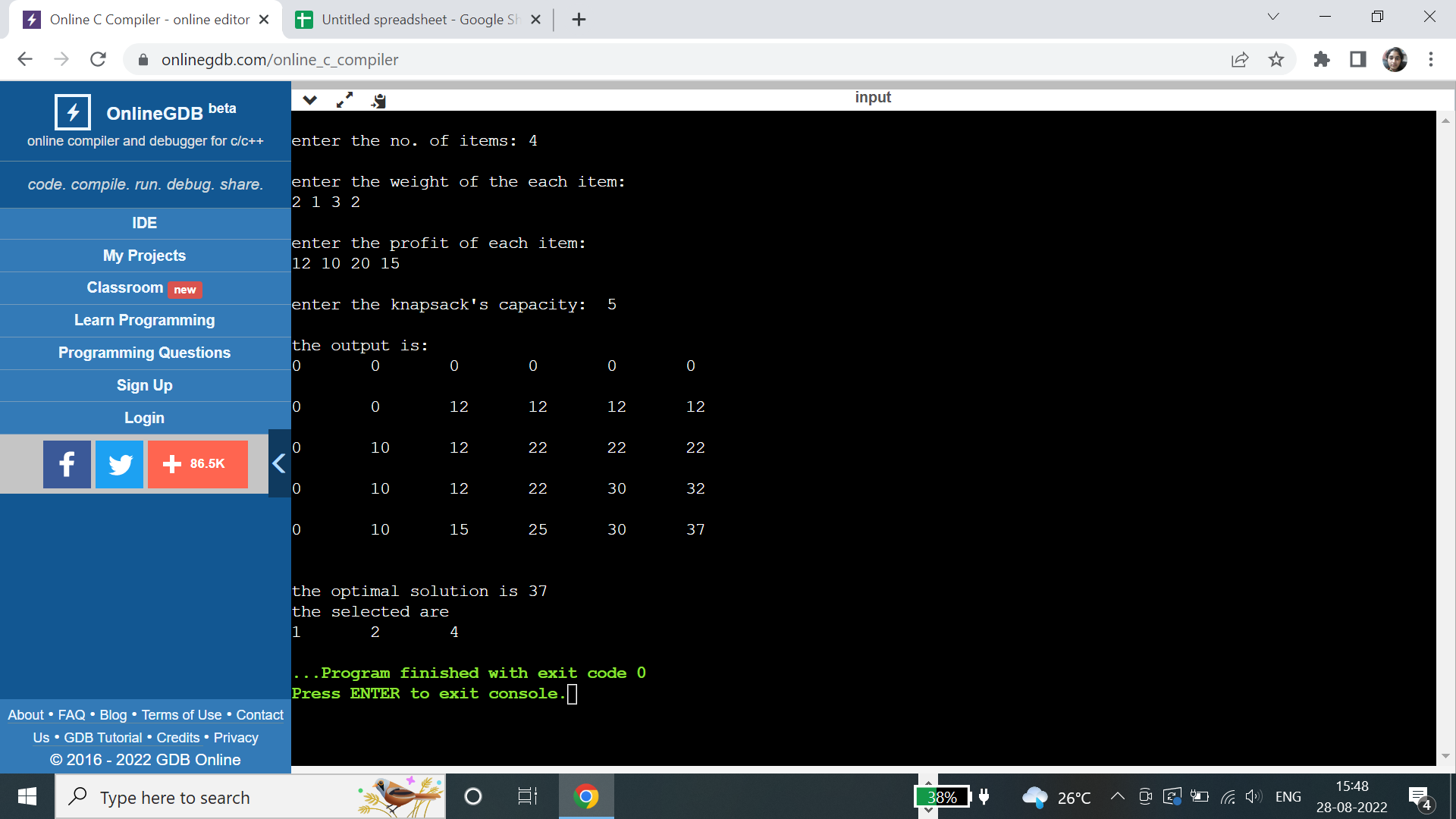
{

return y;

}

}

**OUTPUT:**



**PROGRAM 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]);

}

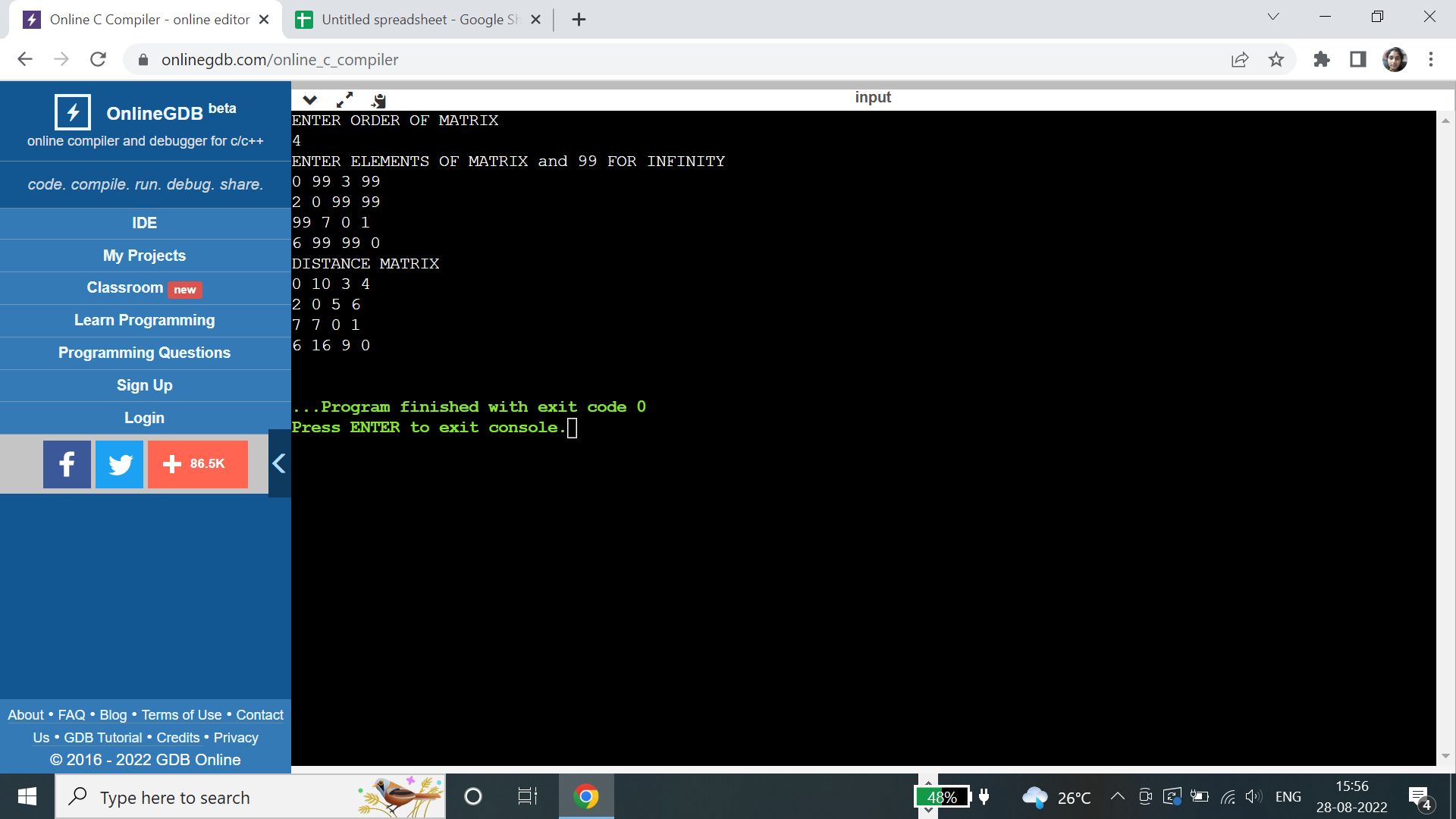
}

floyd(graph);

return 0;

}

**OUTPUT:**



**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;

}

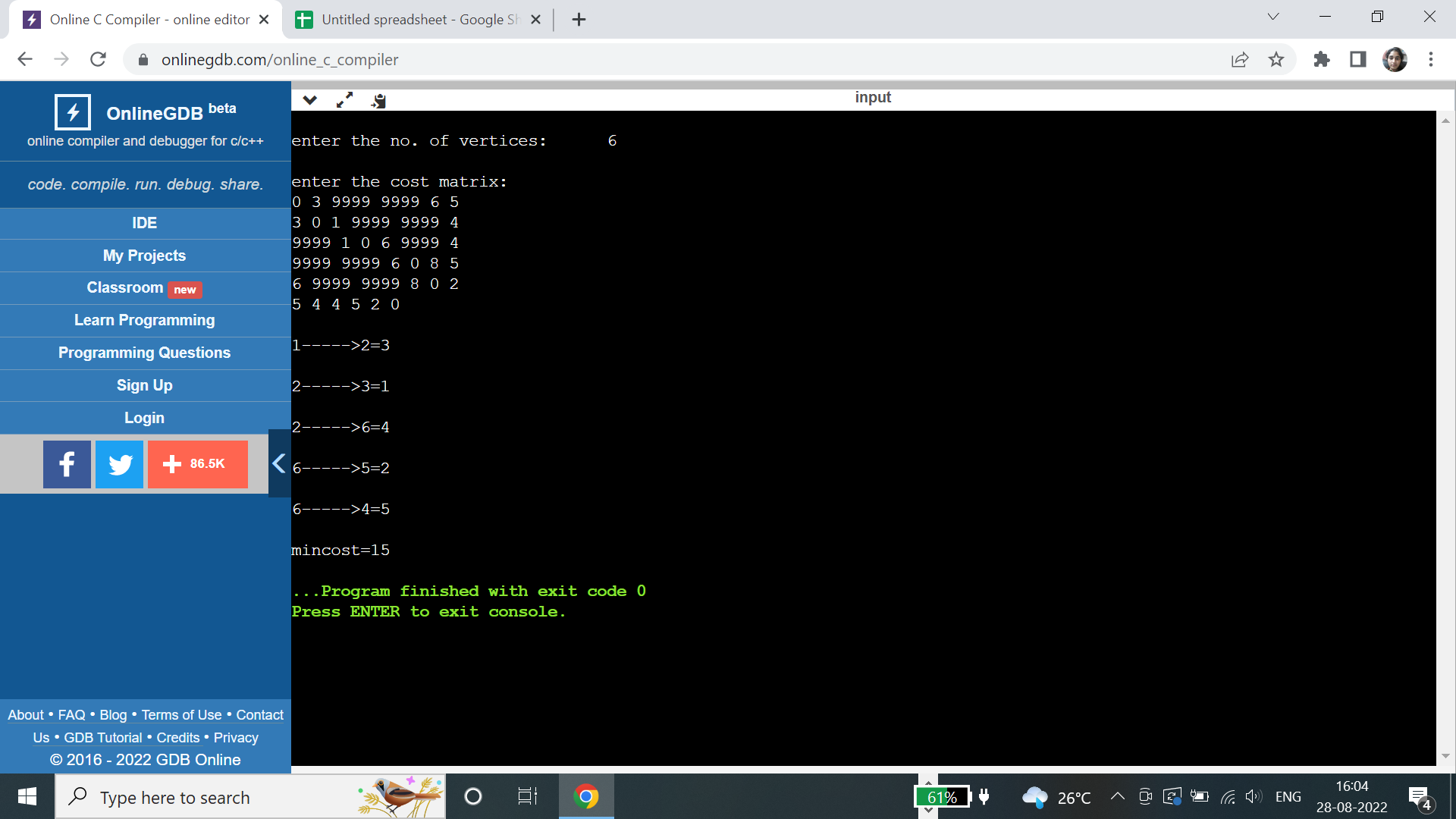
c[u][v]=c[v][u]=9999;

}

printf("\nmincost=%d",mincost);

}

**OUTPUT:**



**PROGRAM 15:** Find Minimum Cost Spanning Tree of a given undirected graph using Kruskals 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;

}

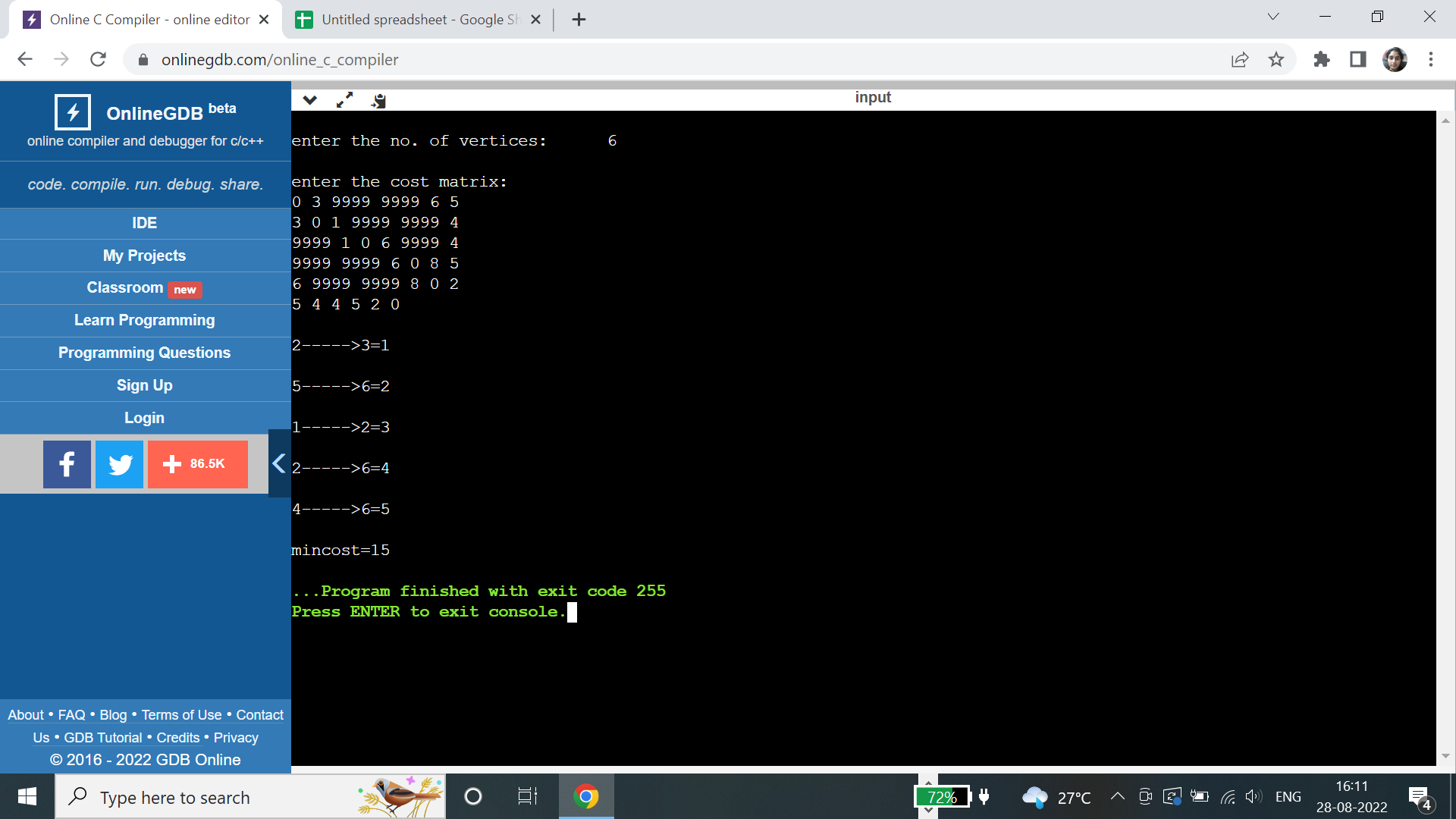
c[a][b]=c[b][a]=9999;

}

printf("\nmincost=%d",mincost);

}

**OUTPUT:**



**PROGRAM 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++)

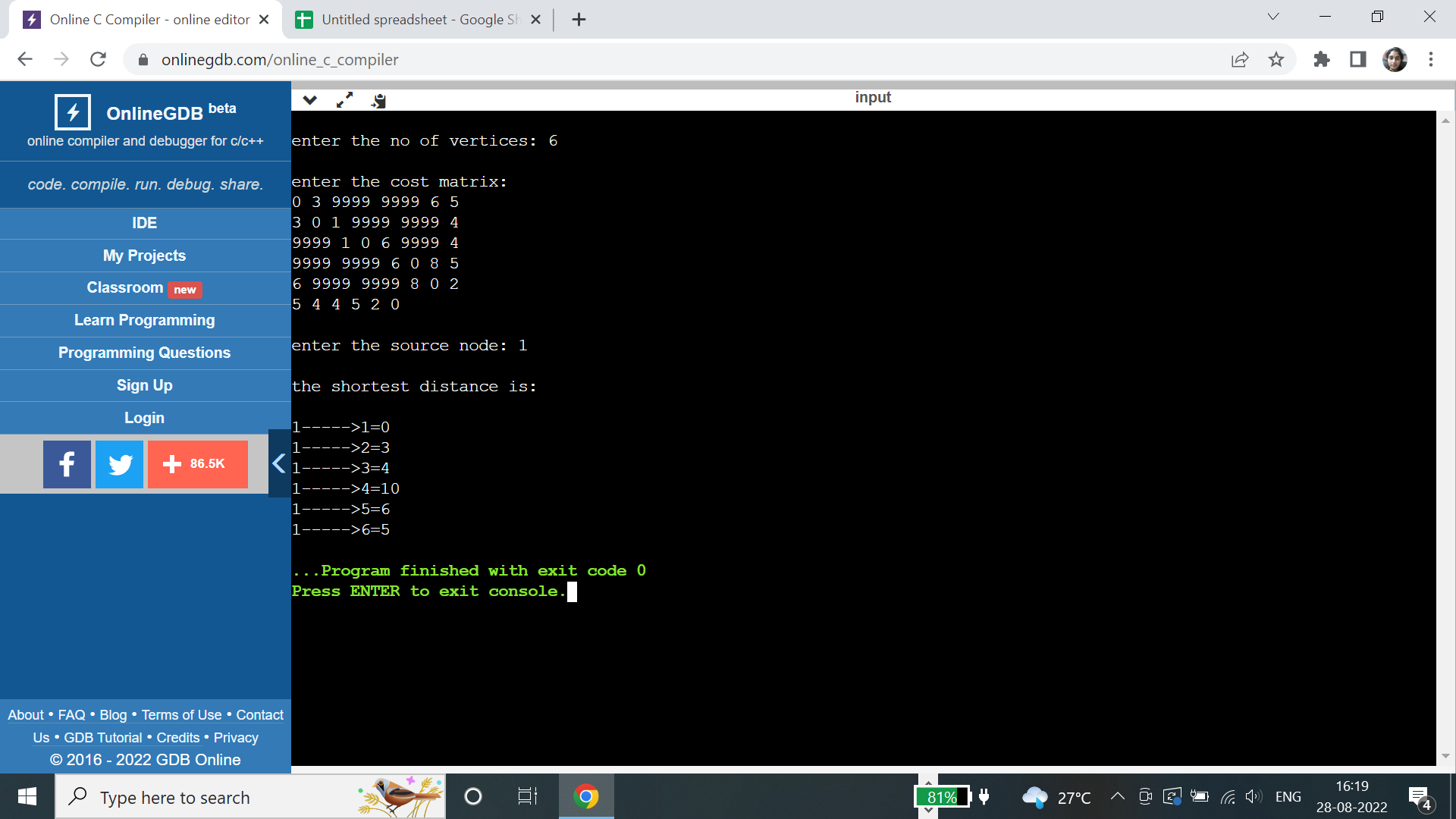
{

printf("\n%d----->%d=%d",src,j,dist[j]);

}

}

**OUTPUT:**



**PROGRAM 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 s[10] , x[10],d ;

void sumofsub ( int , int , int ) ;

void main ()

{

int n , sum = 0 ;

int i ;

printf ( " \n Enter the size of the set : " ) ;

scanf ( "%d" , &n ) ;

printf ( " \n Enter the set in increasing order:\n" ) ;

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

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

printf ( " \n Enter the value of d : \n " ) ;

scanf ( "%d" , &d ) ;

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

sum = sum + s[i] ;

if ( sum < d || s[1] > d )

printf ( " \n No subset possible : " ) ;

else

sumofsub ( 0 , 1 , sum ) ;

getch () ;

}

void sumofsub ( int m , int k , int r )

{

int i=1 ;

x[k] = 1 ;

if ( ( m + s[k] ) == d )

{

printf("Subset:");

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

if ( x[i] == 1 )

printf ( "\t%d" , s[i] ) ;

printf ( "\n" ) ;

}

else

if ( m + s[k] + s[k+1] <= d )

sumofsub ( m + s[k] , k + 1 , r - s[k] ) ;

if ( ( m + r - s[k] >= d ) && ( m + s[k+1] <=d ) )

{

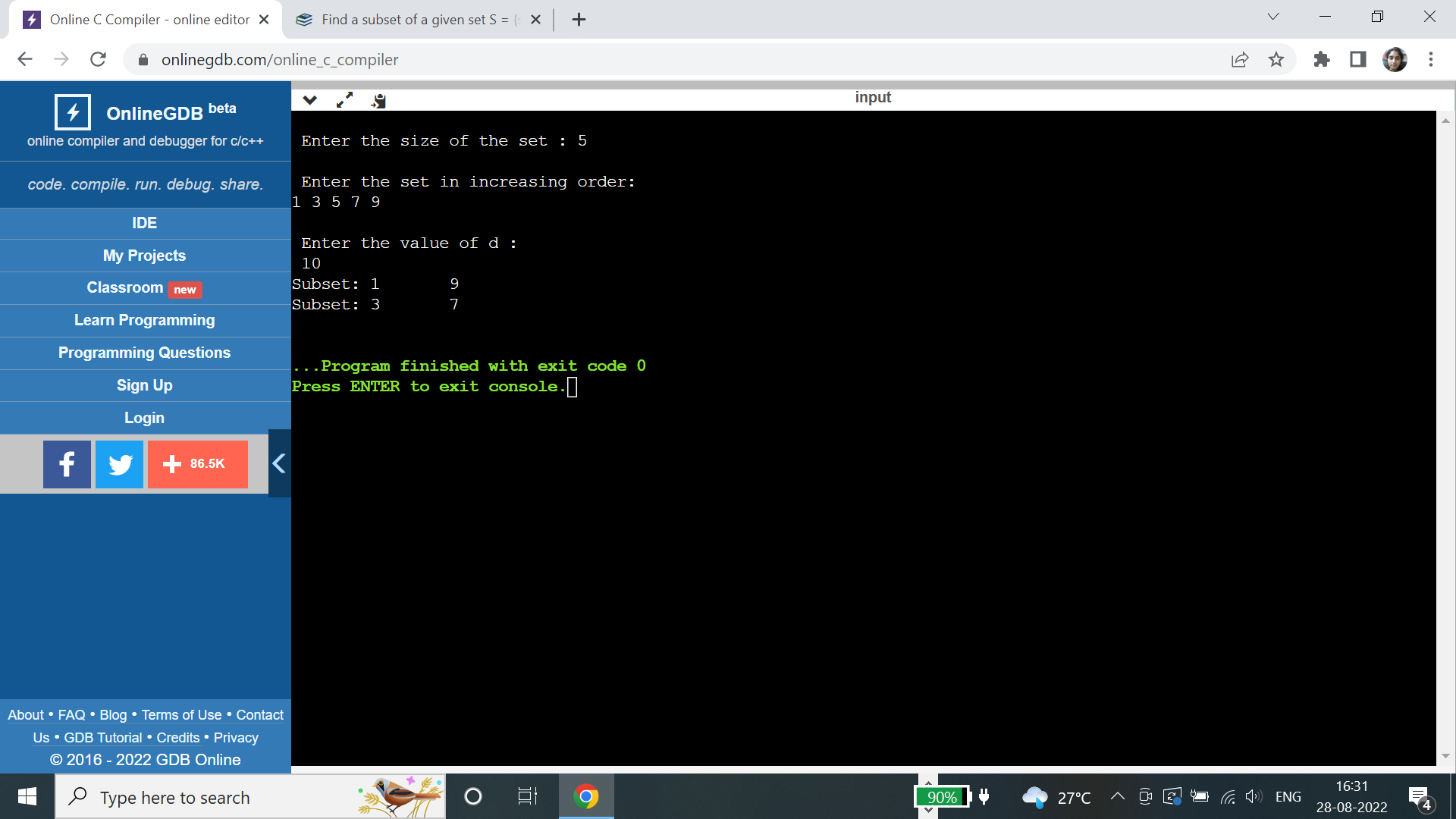
x[k] = 0;

sumofsub ( m , k + 1 , r - s[k] ) ;

}

}

**OUTPUT:**



**PROGRAM 18:** Implement “N-Queens Problem” using Backtracking.

#include<stdio.h>

#include<math.h>

int board[20],count;

int main()

{

int n,i,j;

void queen(int row,int n);

printf("\n\nEnter number of Queens:");

scanf("%d",&n);

queen(1,n);

return 0;

}

void print(int n)

{

int i,j;

printf("\n\nSolution %d:\n\n",++count);

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

printf("\t%d",i);

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

{

printf("\n\n%d",i);

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

{

if(board[i]==j)

printf("\tQ");

else

printf("\t-");

}

}

}

int place(int row,int column)

{

int i;

for(i=1;i<=row-1;++i)

{

if(board[i]==column)

return 0;

else

if(abs(board[i]-column)==abs(i-row))

return 0;

}

return 1;

}

void queen(int row,int n)

{

int column;

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

{

if(place(row,column))

{

board[row]=column;

if(row==n)

print(n);

else

queen(row+1,n);

}

}

}

**OUTPUT:**

