VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT on

Analysis and Design of Algorithms

Submitted by

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in partial fulfilment for the award of the degree of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING

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Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "**Analysis and Design of Algorithms**" carried out by **LESTYN CALIX MORAS (1BM20CS206), who is bonafide student of B. M. S. College of Engineering.** It is in partial fulfilment 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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16	From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.	**58-59**
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.	**60-61**
18	Implement "N-Queens Problem" using Backtracking.	**62-63**

Course Outcome

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

1. Write a recursive program to Solve

a) Towers-of-Hanoi problem b) To find GCD Program:

a)

```
#include<stdio.h>
void TOH(int n,char S,char T,char D){
   if(n==1)
      printf("move disk 1 from %c to %c \n",S,D);
else{
      TOH(n-1,S,D,T);
      printf("move disk %d from %c to %c\n",n,S,D);
      TOH(n-1,T,S,D);
   }
}
int main(){
   int n;
   printf("Enter no of disks:");
scanf("%d",&n);
   TOH(n,'S','T','D');
}
```

Result:

```
Enter no of disks:3
move disk 1 from S to D
move disk 2 from S to T
move disk 1 from D to T
move disk 3 from S to D
move disk 1 from T to S
move disk 2 from T to D
move disk 1 from S to D


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

b)

```
#include<stdio.h> int
gcd(int a, int b)
{     if(b!=0)         return
gcd(b, a%b);      else
return a;
}

int main()
{     int n1, n2, result;      printf("Enter two
numbers: ");      scanf("%d %d",&n1,&n2);
result = gcd(n1,n2);      printf("GCD of %d and %d
= %d",n1,n2,result);      return 0;
}
```

Result:

```
Enter two numbers: 36 48
GCD of 36 and 48 = 12

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

2. Implement Recursive Binary search and Linear search and determine the time required to search an element. Repeat the experiment for different values of N and plot a graph of the time taken versus N.

```
#include<stdio.h>
#include<time.h>
#include<stdlib.h>
int bin_srch(int[] , int , int, int);
int lin_srch(int [], int, int, int);
int n , a[10000];
int main()
{
   int ch , key , search_status ,temp;
   clock_t end, start;
   unsigned long int i , j;
   while(1)
   {
      printf("\n1:Binary Search\t 2: Linear Search\t 3: Exit\n");
      scanf("%d", &ch);
      switch(ch)
      {
         case 1:
               n = 1000;
               while(n<=5000)
               {
                  for(i=0; i<n ; i++)
```

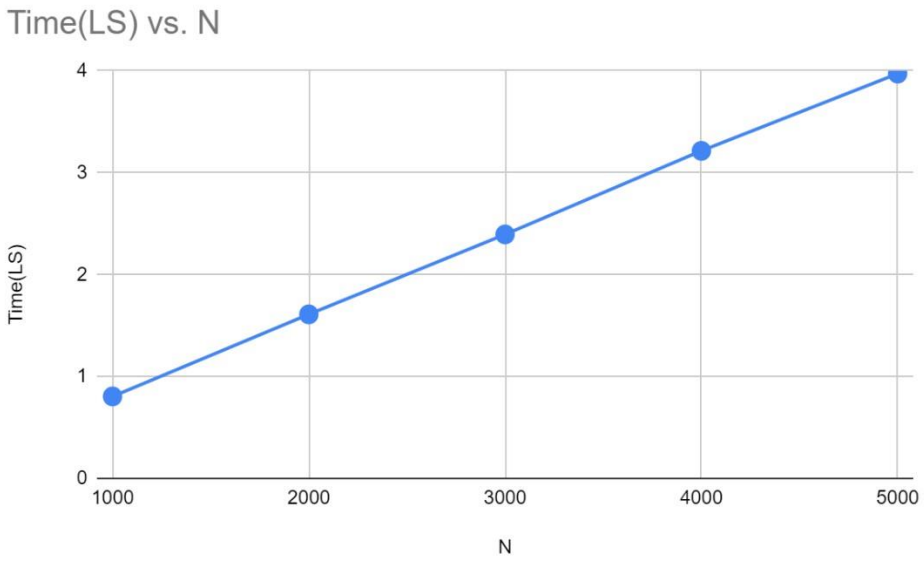
```
                a[i] = i;
            key = a[n-1];
            start = clock();
            search_status = bin_srch(a , 0 , n-1 , key);
            if(search_status == -1)
               printf("\nKey not found");
            else
               printf("key found at position %d", search_status);
            for(j = 0; j<500000000 ; 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] = i;
                  key = a[n-1];
                  start = clock();
                  search_status = lin_srch(a, 0, n-1, key);
```

```
                    if(search_status == -1)
                       printf("\nKey Not Found");
                    else
                   printf("\nKey found at position %d", search_status);
                    for(j = 0 ; j<500000000 ; 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);
          }
     }
}
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])
```

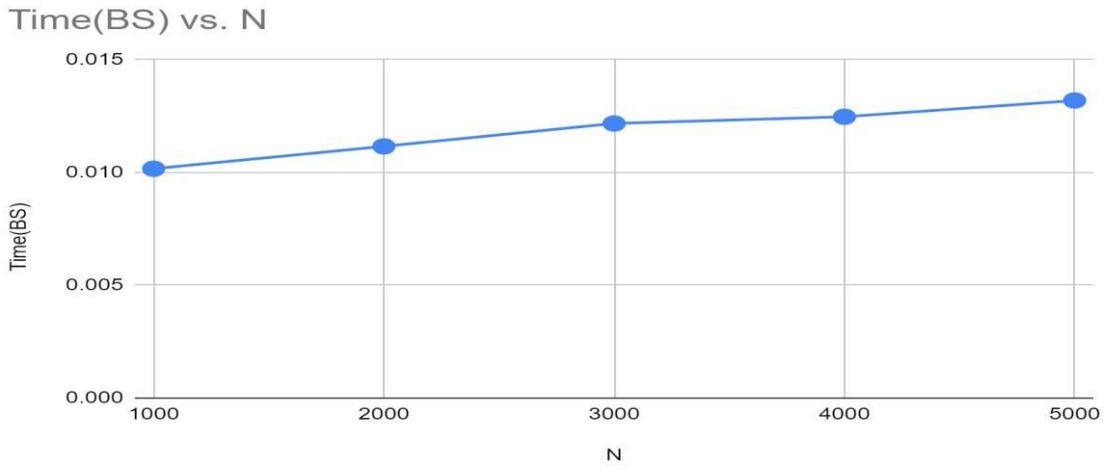
```
        return bin_srch(a , low , mid-1 , key);
    else
        return bin_srch(a , mid+1 , high ,  key);
}
int lin_srch(int a[] , int i , int high , int key)
{
    if(i > high)
        return -1;
    if(key == a[i])
        return i;
    else
        return lin_srch(a, i+1 , high ,key);
}
```

Result:

```
enter the choice: 1.linear search 2.binary search1

search element is found
time for n=1000 is 0.804261 secs
search element is found
time for n=2000 is 1.609531 secs
search element is found
time for n=3000 is 2.393621 secs
search element is found
time for n=4000 is 3.213841 secs
search element is found
time for n=5000 is 3.972152 secs

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




```
enter the choice: 1.linear search 2.binary search2

search element is found
time for n=1000 is 0.010167 secs
search element is found
time for n=2000 is 0.011159 secs
search element is found
time for n=3000 is 0.012174 secs
search element is found
time for n=4000 is 0.012470 secs
search element is found
time for n=5000 is 0.013195 secs

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



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.

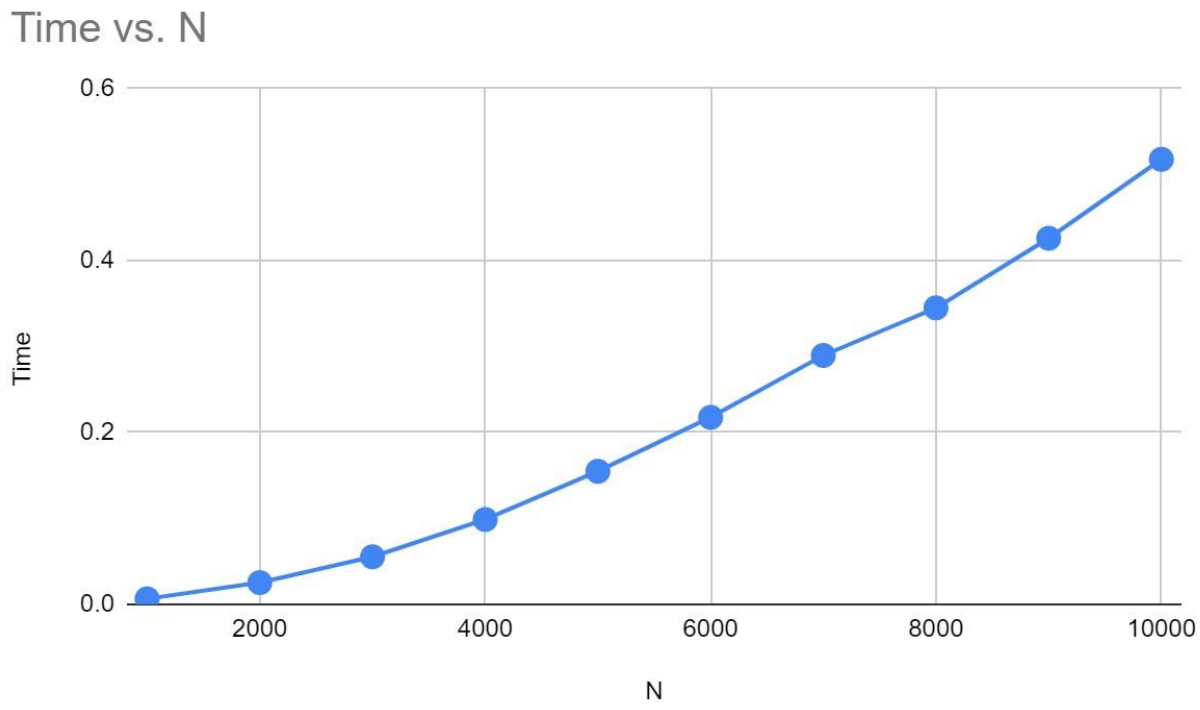
```
#include<stdio.h>
#include<stdlib.h>
#include<time.h>

void selsort(int n, int a[]);
void main()
{
   int a[15000],n,i,j,ch,temp;
   clock_t start,end;
   while(1)
{
   printf("\n 1:For manual entry of N value and array elements ");
   printf("\n 2:To display time taken for sorting elements in the range");
   printf("\n 3:To exit ");
   printf("\n Enter your choice:");
   scanf("%d", &ch);

switch(ch)
{
   case 1: printf("\nEnter the number of elements: ");
   scanf("%d",&n);
   printf("\nEnter array elements: ");
   for(i=0;i<n;i++)
   {
   scanf("%d",&a[i]);
   }
```

```
   start=clock();
   selsort(n,a);
   end=clock();

   printf("\nSorted array is: ");
   for(i=0;i<n;i++)
   printf("%d\t",a[i]);

   printf("\n Time taken to sort %d numbers is %f Secs",n,
(((double)(end-start))/CLOCKS_PER_SEC));
   break;

   case 2:
      n=500;
      while(n<=14500)
       {
         for(i=0;i<n;i++)
{
a[i]=n-i;
}
start=clock();
selsort(n,a);

//Dummy loop to create delay
for(j=0;j<500000;j++)
   { temp=38/600;}
end=clock();

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

```
n=n+1000;
}
break;

case 3: exit(0);
}
}
}

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;
}
}
```

Result:

```
n=1000  time= 0.006374
n=2000  time= 0.025264
n=3000  time= 0.055312
n=4000  time= 0.098661
n=5000  time= 0.154757
n=6000  time= 0.217534
n=7000  time= 0.289528
n=8000  time= 0.344848
n=9000  time= 0.425852
n=10000  time= 0.517693


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



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>
int a[10][10], n;
void bfs(int);
void main() {
 int i, j, src;
 printf("\n Enter the no of nodes: ");
 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);
 getch();
```

```
}
void bfs(int src) {
 int q[10], f=0, r=-1, vis[10], i, j;
 for(j = 1; j <= n; j++) {
  vis[j]=0;
 }
 vis[src] = 1;
 r = r + 1;
 q[r] = src;
 while(f <= r) {
  i = q[f];
  f = f + 1;
  for(j = 1; j <= n; j++) {
   if(a[i][j] == 1 && vis[j] != 1) {
    vis[j] = 1;
    r = r + 1;
    q[r] = j;
   }
  }
 }

 for(j = 1; j <= n; j++) {
  if(vis[j] != 1) {
   printf("\n Node %d is not reachable\n", j);
  }
```

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

```
}
```

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;
}
```

Result:

```
enter the no of nodes:  4

enter the adjacency matrix:
0 1 1 1
0 0 0 1
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


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

```
enter the no of nodes:  4

enter the adjacency matrix:
0 1 1 1
0 0 0 1
0 0 0 0
0 0 1 0

enter the source node:  1

graph is connected


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

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

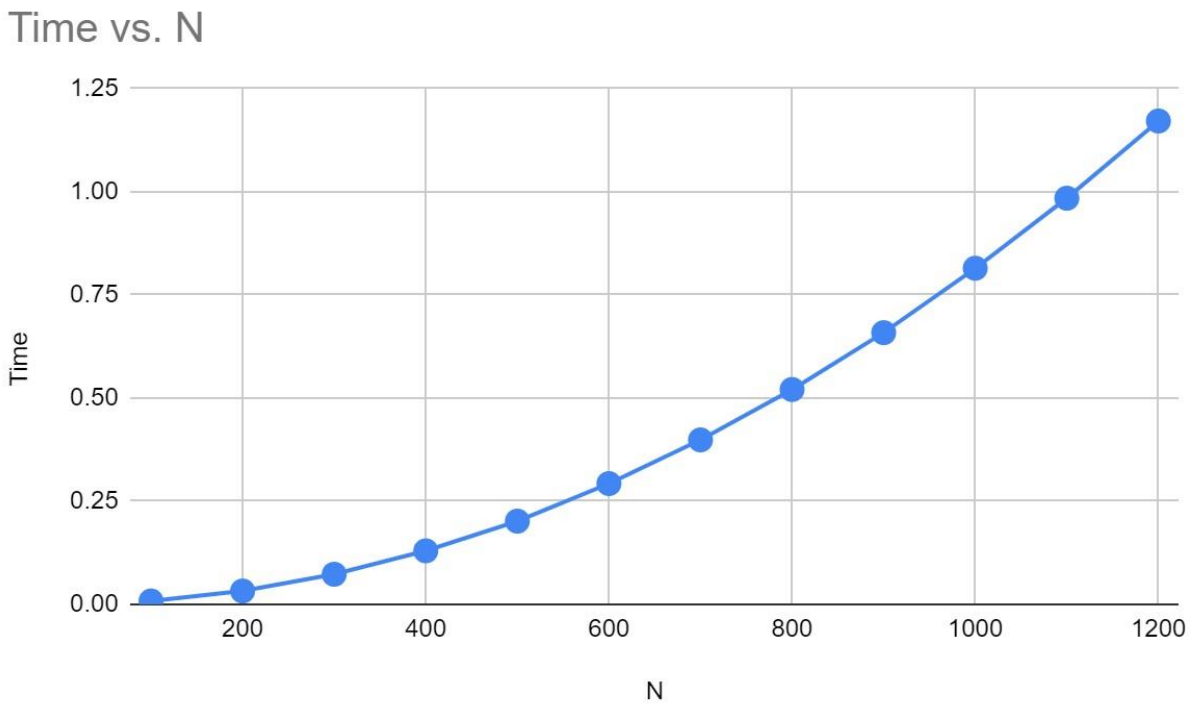
```
#include<stdio.h>
#include<time.h>
#include<stdlib.h>
void insertionSort(int n, int a[]);
void main()
{
   int a[15000],n,i,j,ch,temp;
   clock_t start,end;
   while(1)
   {
      printf("\n 1. For manual entry of N value and array elements ");
      printf("\n 2. To display time taken for sorting number elements N “);
      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 the array elements : ");
              for(i=0;i<n;i++)
```

```
            scanf("%d",&a[i]);
        start = clock();
        insertionSort(n,a);
         for(j=0;j<50000000;j++)
           temp = 38/600;
        end=clock();
          printf("\n Sorted array is : ");
        for(i=0;i<n;i++)
            printf("%d \t",a[i]);

        printf("\n Time taken to sort %d elements is %1.10f seconds.
\n",n , (((double)(end - start))/CLOCKS_PER_SEC));
        break;

    case 2 :  n = 500;
        while(n <= 14500)
        {
          for(i=0;i<n;i++)
            a[i] = rand()%1000;

          start = clock();
          insertionSort(n,a);
          for(j=0;j<500000;j++)
            temp = 38/600;
```

```
                end = clock();
                printf("\n Time taken to sort %d elements is %f seconds. \n",n ,
(((double)(end - start))/CLOCKS_PER_SEC));
                n = n + 1000;
               }
               break;
       case 3 : exit(0);
       }
    }
}
void insertionSort(int n, int a[])
{
  for(int step = 1; step < n; step++)
   {
    int key = a[step];
    int j = step - 1;
    while (key < a[j] && j >= 0)
    {
      a[j + 1] = a[j];
      --j;
    }
    a[j + 1] = key;
  }
}
```

Result:

```
n=100  time= 0.008087
n=200  time= 0.032288
n=300  time= 0.072864
n=400  time= 0.129651
n=500  time= 0.201637
n=600  time= 0.292635
n=700  time= 0.398545
n=800  time= 0.520654
n=900  time= 0.658422
n=1000  time= 0.814551
n=1100  time= 0.984286
n=1200  time= 1.171455


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



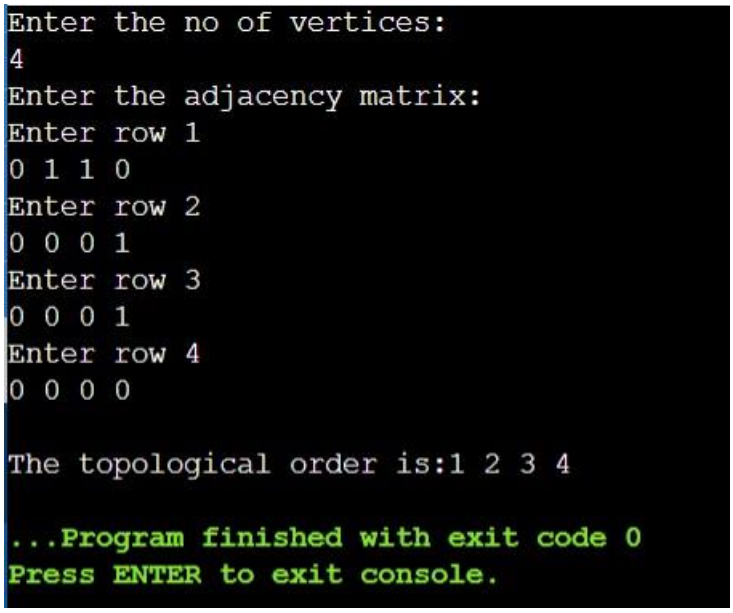
6.Write program to obtain the Topological ordering of vertices in a given digraph.

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

```
    for(v = 0; v < n; v++) {
      if(a[u][v] == 1) {
        indeg[v] = indeg[v] - 1;
        if(indeg[v] == 0)
        s[++top] = v;
      }
    }
  }
  for(i = 0;i < n; i++) {
    printf("%d\n", t[i]);
  }
}
void main() {
  int i, j, a[10][10], n;
  printf("Enter number of nodes\n");
  scanf("%d", &n);
  printf("Enter the adjacency matrix\n");
  for(i = 0; i < n; i++) {
    for(j = 0; j < n; j++) {
      scanf("%d", &a[i][j]);
    }
  }
```

```
  source_removal(n,a);
}
```

Output:



7.Implement Johnson Trotter algorithm to generate permutations.

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

int flag = 0; int
swap(int *a,int *b)
{
    int t = *a;
*a = *b;
   *b = t;
}
int search(int arr[],int num,int mobile)
{    int
g;
   for(g=0;g<num;g++)
   {
      if(arr[g] == mobile)
          return g+1;
else       {          flag++;
      }
   }
   return -1;
```

```
}
int find_Moblie(int arr[],int d[],int num)
{    int mobile = 0;
int mobile_p = 0;
   int i;
   for(i=0;i<num;i++)
   {
      if((d[arr[i]-1] == 0) && i != 0)
      {
         if(arr[i]>arr[i-1] && arr[i]>mobile_p)
         {
            mobile = arr[i];
mobile_p = mobile;
         }
else          {
flag++;
         }
      }
      else if((d[arr[i]-1] == 1) & i != num-1)
      {
         if(arr[i]>arr[i+1] && arr[i]>mobile_p)
         {
```

```
            mobile = arr[i];
mobile_p = mobile;
        }
else        {
flag++;
        }
}
else
        {
flag++;
        }
   }
   if((mobile_p == 0) && (mobile == 0))       return 0;    else       return
mobile;
}

void permutations(int arr[],int d[],int num)
{    int
i;
   int mobile = find_Moblie(arr,d,num);
int pos = search(arr,num,mobile);
```

```
if(d[arr[pos-1]-1]==0)
swap(&arr[pos-1],&arr[pos-2]);    else
      swap(&arr[pos-1],&arr[pos]);
for(int i=0;i<num;i++)
   {
      if(arr[i] > mobile)
      {
         if(d[arr[i]-1]==0)
d[arr[i]-1] = 1;
else              d[arr[i]-1]
= 0;       }

   }
   for(i=0;i<num;i++)
   {
      printf(" %d ",arr[i]);
   }
}

int factorial(int k)
{    int f = 1;    int i
= 0;
for(i=1;i<k+1;i++)
```

```
   {       f =
f*i;
   }
   return f;
}
int main()
{    int num =
0;
   int i;
   int j;
int z = 0;
   printf("Johnson trotter algorithm to find all permutations of given
numbers \n");
   printf("Enter the number\n");
scanf("%d",&num);    int
arr[num],d[num];    z =
factorial(num);
   printf("total permutations = %d",z);
printf("\nAll possible permutations are: \n");
for(i=0;i<num;i++)
```

```
   {       d[i] = 0;
arr[i] = i+1;        printf("
%d ",arr[i]);
   }
   printf("\n");
for(j=1;j<z;j++)
   {
      permutations(arr,d,num);
printf("\n");
   } return 0;
}
```

Output:

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


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

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

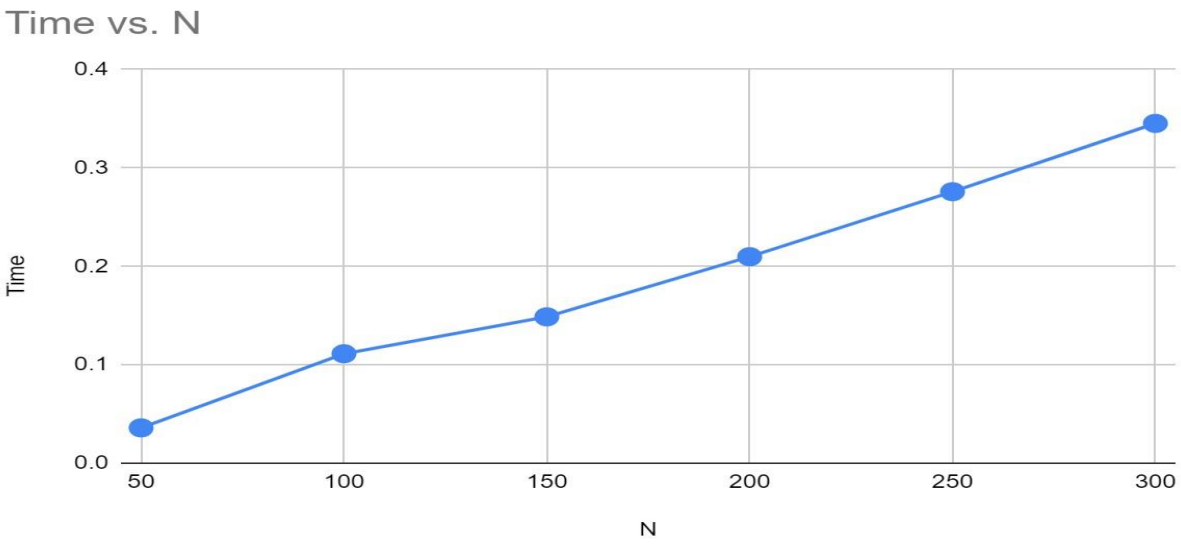
```
#include<stdio.h>
#include<stdlib.h> #include<time.h>
void mergesort(int a[],int i,int j); void
merge(int a[],int i1,int j1,int i2,int j2); int
main()
{
clock_t start,end; int
a[3000],n,i;
printf("Enter no of elements:"); scanf("%d",&n);
printf("Enter array elements:");
for(i=0;i<n;i++) a[i] =
rand()%1000; start = clock();
mergesort(a,0,n-1); end =
clock();
printf("\nSorted array is :");
for(i=0;i<n;i++) printf("%d
",a[i]); printf("\nSeconds
taken %lf",(double)(end-
start)/CLOCKS_PER_SEC);
return 0;
```

```
}
void mergesort(int a[],int i,int j)
{
int mid;
if(i<j)
{
mid=(i+j)/2; mergesort(a,i,mid);
mergesort(a,mid+1,j);
merge(a,i,mid,mid+1,j);
}
}
void merge(int a[],int i1,int j1,int i2,int j2)
{
int temp[3000];
int i,j,k; i=i1;
j=i2; k=0;
while(i<=j1 && j<=j2)
{for(int j=0;j<100000;j++); if(a[i]<a[j])
temp[k++]=a[i++]; else
temp[k++]=a[j++];
}
```

```
while(i<=j1) temp[k++]=a[i++];
while(j<=j2) temp[k++]=a[j++];
for(i=i1,j=0;i<=j2;i++,j++)
a[i]=temp[j];
}
```

Output:

```
Enter no of elements:50
Enter array elements:
Sorted array is :11 22 27 42 58 59 67 69 123 135 167 172 198 211 229 315 324 335 362 368 370 373 383 386 393 421 421 426 429 456 492 530
 537 540 567 649 690 736 763 777 782 784 793 802 862 886 915 919 926 929
Seconds taken 0.035865

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

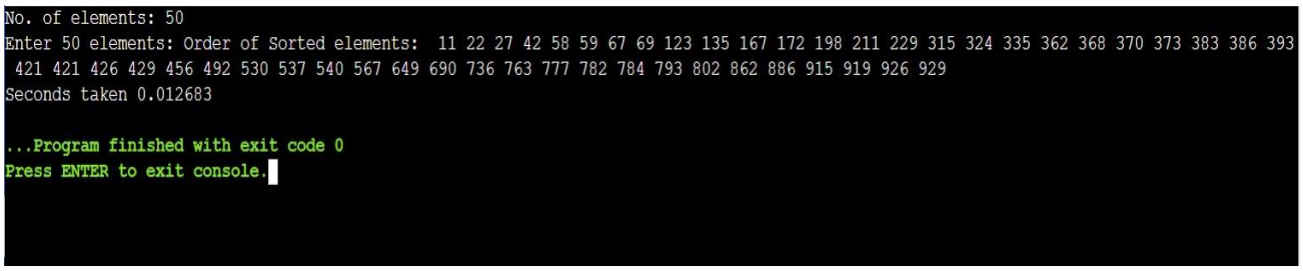


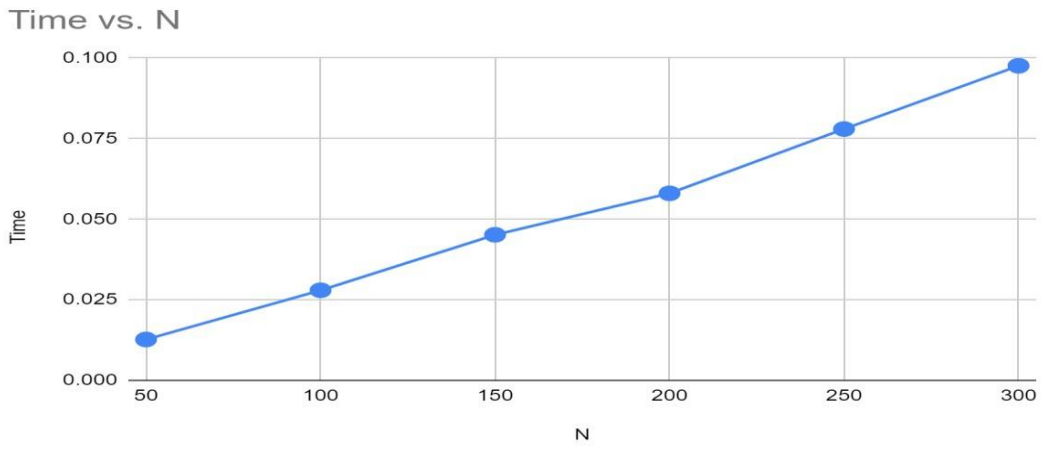
9.Sort a given set of N integer elements using Quick sort technique and compute its time taken.

```
#include<stdio.h>
#include<time.h> #include<stdlib.h>
void quicksort(int number[5000],int first,int last){
int i, j, pivot, temp; if(first<last){ pivot=first; i=first;
j=last; while(i<j){
for(int x=0;x<100000;x++);
while(number[i]<=number[pivot]&&i<last) i++;
while(number[j]>number[pivot])
j--; if(i<j){
temp=number[i]; number[i]=number[j];
number[j]=temp;
}
}
temp=number[pivot];
number[pivot]=number[j]; number[j]=temp;
quicksort(number,first,j-1);
quicksort(number,j+1,last);
}
}
```

```
int main(){ clock_t
start,end; int i, count,
number[5000]; printf("No.
of elements: ");
scanf("%d",&count);
printf("Enter %d elements: ", count);
for(i=0;i<count;i++) number[i] =
rand()%1000; start = clock();
quicksort(number,0,count-1); end
= clock();
printf("Order of Sorted elements: ");
for(i=0;i<count;i++) printf("
%d",number[i]);
printf("\nSeconds taken %lf",(double)(end-start)/CLOCKS_PER_SEC); return
0;
}
```

Output:




Time vs. N
0.100
0.075
0.050
0.025
0.000
Time
50
100
150
200
250
300
N

10. Heap Sort

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

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);
        }
```

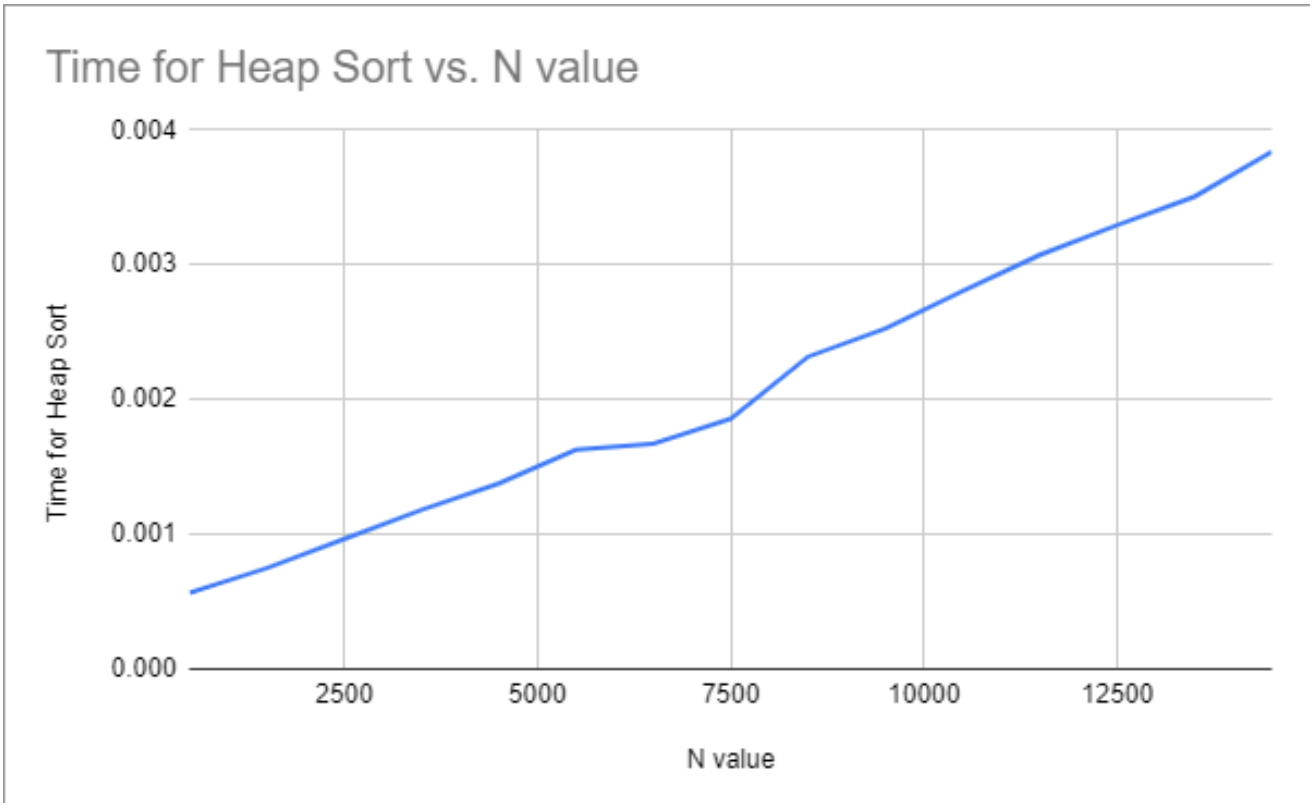
```
}

int main() {
        int arr[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", &arr[i]);
      }
      start = clock();
      heapSort(arr, n);
      end = clock();
      printf("\nSorted array is: ");

      for(i = 0; i < n; i++)
         printf("%d\t", arr[i]);
        printf("\n Time taken to sort %d numbers is %f Secs", n,
(((double)(end - start))/CLOCKS_PER_SEC));
      break;

      case 2:
         n = 500;
```

```
        while(n <= 14500) {
        for(i = 0; i < n; i++) {
        //a[i]=random(1000);
           arr[i] = n - i;
        }
        start = clock();
        heapSort(arr, n);

        //Dummy loop to create delay
        for(j = 0; j < 500000; j++) {
           temp = 38/600;
        }
        end = clock();
        printf("\n Time taken to sort %d numbers is %f Secs", n,
(((double)(end-start))/CLOCKS_PER_SEC));
        n = n + 1000;
        }
      break;
      case 3: exit(0);
   }
getchar();
}
}
```

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:2

 Time taken to sort 500 numbers is 0.000864 Secs
 Time taken to sort 1500 numbers is 0.001097 Secs
 Time taken to sort 2500 numbers is 0.001231 Secs
 Time taken to sort 3500 numbers is 0.001507 Secs
 Time taken to sort 4500 numbers is 0.001735 Secs
 Time taken to sort 5500 numbers is 0.001819 Secs
 Time taken to sort 6500 numbers is 0.001954 Secs
 Time taken to sort 7500 numbers is 0.002155 Secs
 Time taken to sort 8500 numbers is 0.002310 Secs
 Time taken to sort 9500 numbers is 0.002530 Secs
 Time taken to sort 10500 numbers is 0.002828 Secs
 Time taken to sort 11500 numbers is 0.002885 Secs
 Time taken to sort 12500 numbers is 0.003093 Secs
 Time taken to sort 13500 numbers is 0.003298 Secs
 Time taken to sort 14500 numbers is 0.003681 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:3
```

Graph :



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("%dt",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("%dt",p[i][j]);
  printf("n");
 }
 getch();
}
```

Output :

```
Enter the number of vertices4
Enter the adjecency matrix
0 1 0 1
1 0 0 1
0 1 0 0
0 0 1 0
Transitive closure
1111
1111
1111
1111
```

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() {
  clrscr();
  printf("\nEnter the num of items: \t");
  scanf("%d", &n);
  printf("\nEnter the weight of the each item: \n");
  for(i = 1; i <= n; i++) {
  scanf("%d", &w[i]);
  }

  printf("\nEnter the profit of each item: \n");
  for(i = 1; i <= n; i++) {
    scanf("%d", &p[i]);
  }

  printf("\nEnter the knapsack&'s capacity: \t");
  scanf("%d", &m);
  knapsack();
  getch();
}

void knapsack() {
  int x[10];
```

```
for(i = 0; i <= n; i++) {
  for(j = 0; j <= m; j++) {
    if(i == 0 || j == 0) {
      v[i][j] = 0;
    }
    else if(j - w[i] < 0) {
      v[i][j] = v[i - 1][j];
    }
    else {
      v[i][j] = max(v[i - 1][j], v[i - 1][j - w[i]] + p[i]);
    }
  }
}

printf("\nThe output is: \n");
for(i = 0; i <= n; i++) {
  for(j = 0; j <= m; j++) {
    printf("%d\t", v[i][j]);
  }
  printf("\n\n");
}
printf("\nThe optimal solution is %d", v[n][m]);
printf("\nThe solution vector is: \n");
for(i = n; i >= 1; i--) {
  if(v[i][m] != v[i - 1][m]) {
    x[i] = 1;
    m = m - w[i];
  }
  else {
    x[i] = 0;
```

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

int max(int x, int y) {
  if(x > y) {
    return x;
  }
  else {
    return y;
  }
}
```

Output :

```
Enter the num 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       _
```

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

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

int a[10][10], n;
void floyds();
int min(int,int);

void main() {
  int i, j;
  clrscr();
  printf("\nEnter the num 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 :

```
Enter the num of vertices:      4

Enter the cost matrix:
9999 9999 3 9999
2 9999 9999 9999
9999 7 9999 1
6 9999 9999 9999

All pair shortest path matrix is:
10      10      3       4

2       12      5       6

7       7       10      1

6       16      9       10
```

14. Minimal spanning tree using Kruskal's algorithm

```
#include<stdio.h>
void kruskals();
int c[10][10], n;
void main() {
   int i, j;
   printf("\nEnter the num of vertices: \t");
   scanf("%d", &n);
   printf("\nEnter the cost matrix: \n");
   for(i = 1; i <= n; i++) {
   for(j = 1; j <= n; j++) {
      scanf("%d", &c[i][j]);
   } }
   kruskals();
}
void kruskals() {
   int i, j, u, v, a, b, min;
   int ne = 0, mincost = 0;
   int parent[10];
   for(i = 1; i <= n; i++)
      parent[i] = 0;
   while(ne != n - 1) {
      min = 9999;
      for(i = 1; i <= n; i++) {
      for(j = 1; j <= n; j++) {
         if(c[i][j] < min) {
            min = c[i][j];
            u = a = i;
            v = b = j;
         }}}
      while(parent[u] != 0)
         u = parent[u];
      while(parent[v] != 0)
         v = parent[v];
      if(u != v) {
         printf("\n%d----->%d = %d\n", a, b, min);
         parent[v] = u;
         ne = ne + 1;
         mincost = mincost + min;
      }
      c[a][b] = c[b][a] = 9999;
   }
   printf("\nmincost = %d", mincost);
}
```

Output :

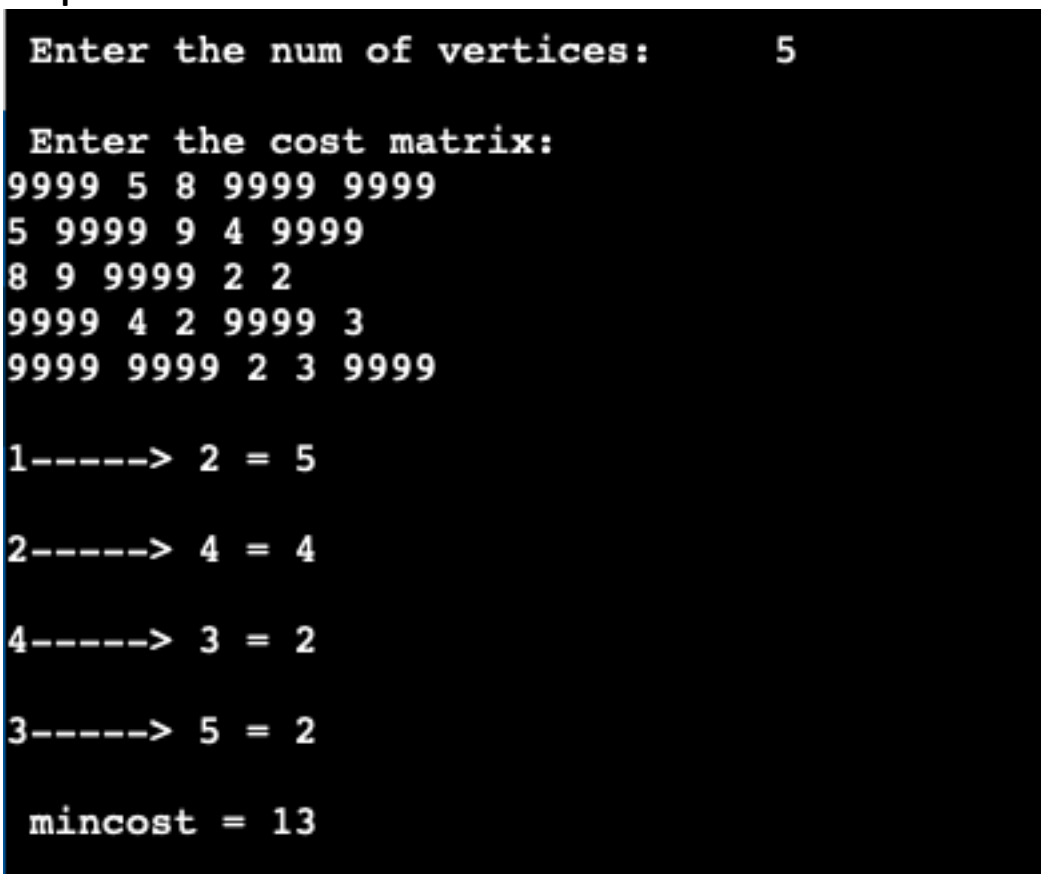
```
Enter the num of vertices:      5

Enter the cost matrix:
9999 5 8 9999 9999
5 9999 9 9999 4 9999
8 9 9999 2 2
9999 4 2 9999 3
9999 9999 2 3 9999

3----->5 = 2

4----->1 = 2

5----->4 = 2

2----->5 = 4

mincost = 10
```

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

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

void prims();
int c[10][10], n;

void main() {
   int i, j;
   printf("\n Enter the num 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]);
      }
   }
   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("\n mincost = %d", mincost);
}
```

Output :



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 num 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();

}

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 num of vertices:      3

Enter the cost matrix:
1 2 9
5 7 9
4 5 9

Enter the source node:  2

The shortest distance is:

2----->1 = 5
2----->2 = 0
2----->3 = 9
```

17. Implement “Sum of Subsets” using Backtracking. “Sum of Subsets” problem: Find a subset of a given set S = {s1,s2,……,sn} of n positive integers whose sum is equal to a given positive integer d. For example, if S = {1,2,5,6,8} and d = 9 there are two solutions {1,2,6} and {1,8}. A suitable message is to be displayed if the given problem instance doesn’t have a solution.

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

int count, w[10], d, x[10];

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

void main() {
  int sum = 0,i,n;
  printf("Enter the number of elements: \n");
```

```
  scanf("%d", &n);
  printf("Enter the elements in ascending order: \n");
  for(i = 0; i < n ; i++)
    scanf("%d", &w[i]);
  printf("Enter the required sum: \n");
    scanf("%d", &d);
  for(i = 0; i < n; i++)
    sum += w[i];
  if(sum < d) {
    printf("No solution exists\n");
    return;
  }
printf("The solution is: \n");
count = 0;
subset(0, 0, sum);
getch();
}
```

Output :

```
Enter the number of elements:
5
Enter the elements in ascending order:
1 3 4 5 7
Enter the required sum:
12
The solution is:

Subset solution = 1
147
Subset solution = 2
345
Subset solution = 3
57
```

18. N-Queens problem using backtracking

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

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

int place(int x[], int k) {
  int i;
  for(i = 1; i <= k - 1; i++) {
    if(i + x[i] == k + x[k]||i - x[i] == k - x[k]||x[i] == x[k])
    return 0;
  }
```

```
  return 1;
}

void main() {
  int n;
  clrscr();
  printf("Enter the number of Queens: \n");
  scanf("%d", &n);
  nqueens(n);
  getch();
}
```

Output :