VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

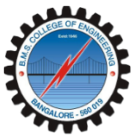
LAB REPORT
on

Analysis and Design of Algorithms

Submitted by

GAMANA YELURI R (1BM21CS065)

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



B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019
June-2023 to September-2023

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 **GAMANA YELURI R (1BM21CS065),** 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 academic semester June-2023 to September-2023. The Lab report has been approved as it satisfies the academic requirements in respect of a **Analysis and Design of Algorithms (22CS4PCADA)** work prescribed for the said degree.

Name of the Lab-In charge:	Dr. Jyothi S Nayak
Designation	Professor and Head
Department of CSE	Department of CSE
BMSCE, Bengaluru	BMSCE, Bengaluru

Index Sheet

Course Outcome

CO1	Analyze time complexity of Recursive and Non-recursive algorithms using asymptotic notations.
CO2	Apply various design techniques for the given problem.
CO3	Apply the knowledge of complexity classes P, NP, and NP-Complete and prove certain problems are NP-Complete
CO4	Design efficient algorithms and conduct practical experiments to solve problems.

WEEK 1

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 the DFS method.

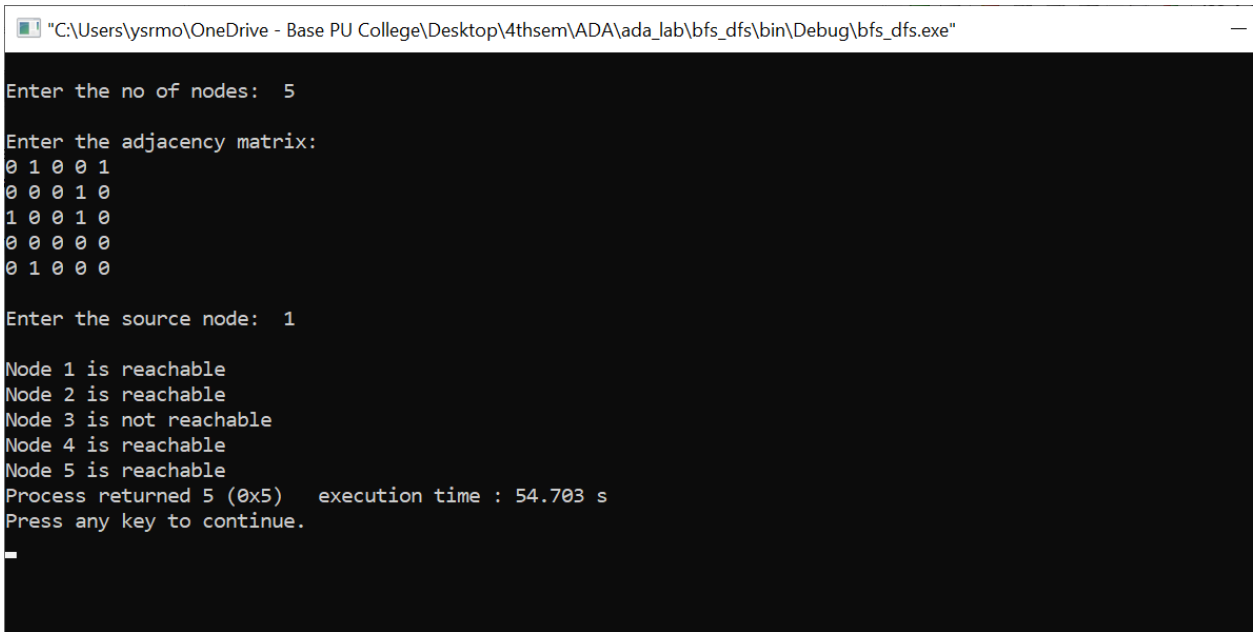
a)BFS
Code:

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

int a[15][15],n;
void bfs(int);

void main()  {
 int i,j,src;

 printf("\nEnter the no of nodes:\t");

 scanf("%d",&n);

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

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

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

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

 printf("\nEnter the source node:\t");

 scanf("%d",&src);

 bfs(src);
```

```
}
void bfs(int src) {
 int q[15],f=0,r=-1,vis[15],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",j);
  else
   printf("\nNode %d is reachable",j);
 }
}
```

Output:



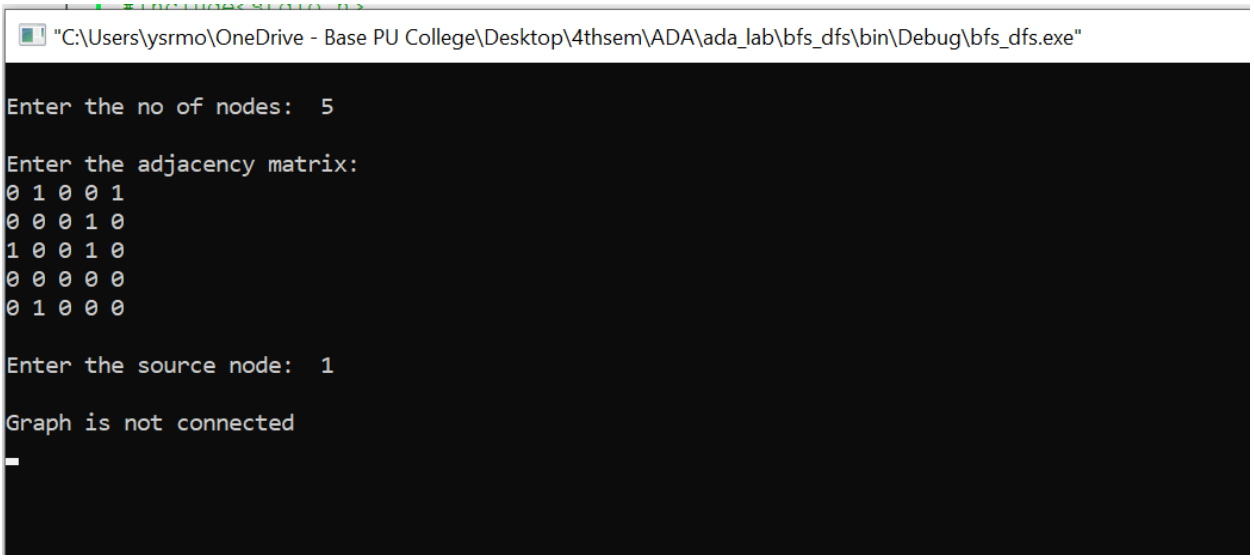
b)DFS

Code:

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

int a[10][10],n,vis[10];
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;
}
void main()
{
 int i,j,src,ans;
 for(j=1;j<=n;j++)
  vis[j]=0;
 printf("\nEnter the no of nodes:\t");
 scanf("%d",&n);
 printf("\nEnter the adjacency matrix:\n");
 for(i=1;i<=n;i++)
  for(j=1;j<=n;j++)
   scanf("%d",&a[i][j]);
 printf("\nEnter the source node:\t");
 scanf("%d",&src);
 ans=dfs(src);
```

```
 if(ans==1)
  printf("\nGraph is connected\n");
 else
  printf("\nGraph is not connected\n");
 getch();
}
```

Output:



WEEK 2

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

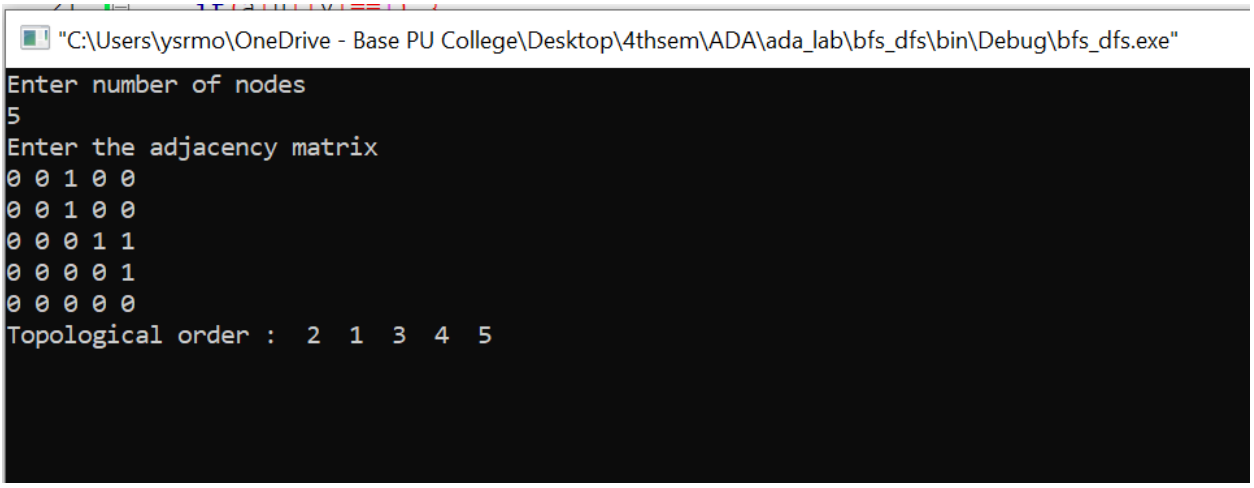
Code:

```
#include<stdio.h>
#include<conio.h>
 void dfs(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;
        }
        }
        }
        printf("Topological order :");
        for(i=0;i<n;i++)
        printf("  %d", 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]);
dfs(n,a);
```

```
getch();
}
```

Output:



WEEK 3

Implement Johnson Trotter algorithm to generate permutations.

CODE:

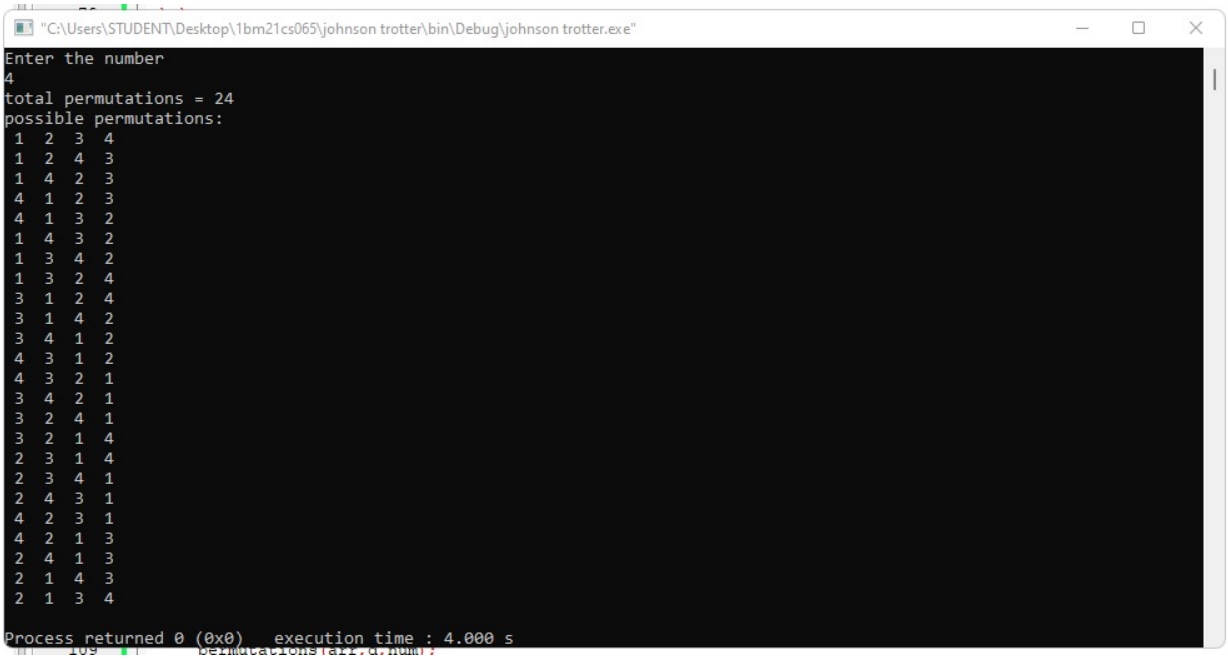
```
#include <stdio.h>
#include <stdlib.h>
int flag = 0;

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("Enter the number\n");
 scanf("%d",&num);
 int arr[num],d[num];
```

```
 z = factorial(num);
 printf("total permutations = %d",z);
 printf("\npossible permutations: \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:



WEEK 4

Sort a given set of N integer elements using Merge Sort technique.

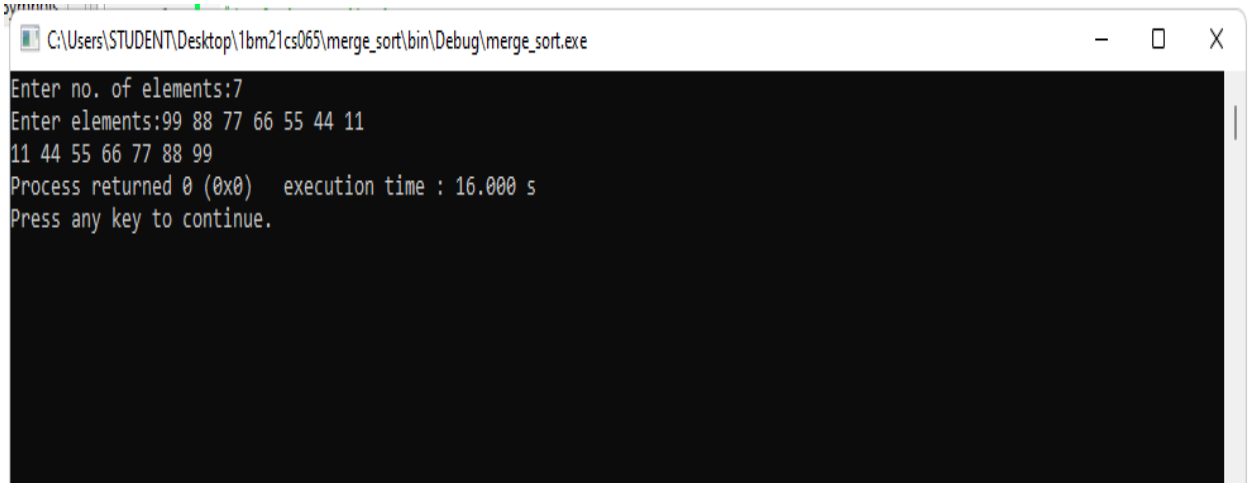
CODE:

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


void merge(int low,int mid,int high,int array[20],int mer[20])
{
   int i = low;
   int j = mid+1;
   int k = 0;

   while(i<=mid && j<=high)
   {
      if(array[i]<array[j])
      {
         mer[k] = array[i];
         i++;
         k++;
      }
      else
      {
         mer[k] = array[j];
         j++;
         k++;
      }
   }

   while (i <= mid)
   {
      mer[k] = array[i];
```

```
        i++;
        k++;
    }

    while (j <= high)
    {
        mer[k] = array[j];
        j++;
        k++;
    }

    for(int i=0;i<k;i++)
    {
        array[low+i] = mer[i];
    }
}

void merge_sort(int low,int high,int array[20],int merged[20])
{
    if(low<high)
    {
        int mid = (low+high)/2;
        merge_sort(low,mid,array,merged);
        merge_sort(mid+1,high,array,merged);
        merge(low,mid,high,array,merged);
    }
}


int main()
{
    int n,array[30];
    printf("Enter no. of elements:");
    scanf("%d",&n);
```

```
    printf("Enter elements:");
    for(int i=0;i<n;i++)
    {
        scanf("%d",&array[i]);
    }

    int merged[30];

    merge_sort(0,n-1,array,merged);

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

OUTPUT:



WEEK 5

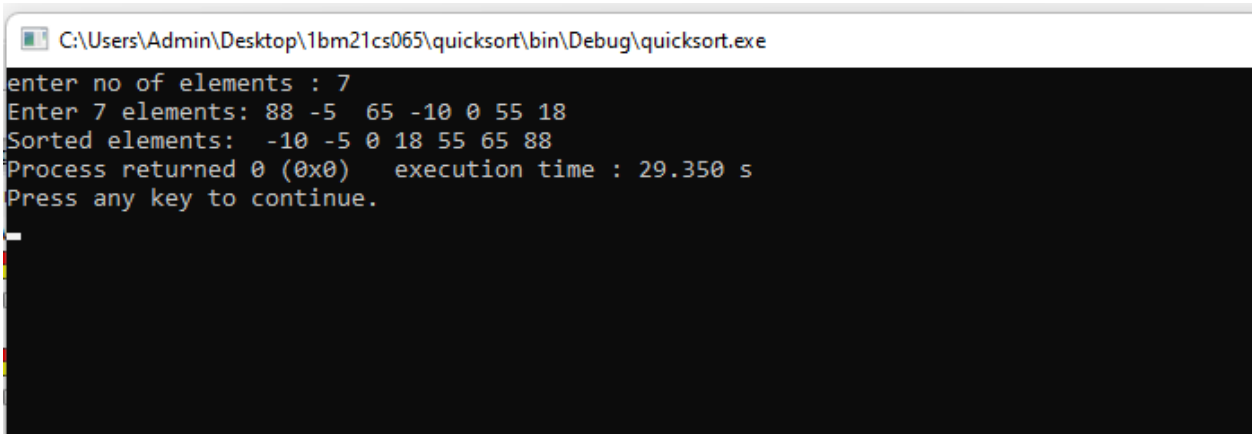
Sort a given set of N integer elements using Quick Sort technique.

CODE:

```
#include<stdio.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()
{
   int i, count, number[25];
   printf("enter no of elements : ");
   scanf("%d",&count);
   printf("Enter %d elements: ", count);
   for(i=0;i<count;i++)
   scanf("%d",&number[i]);
   quicksort(number,0,count-1);
   printf("Sorted elements: ");
   for(i=0;i<count;i++)
   printf(" %d",number[i]);
   return 0;
}
```

OUTPUT:



WEEK 6

Implement 0/1 Knapsack problem using dynamic programming.

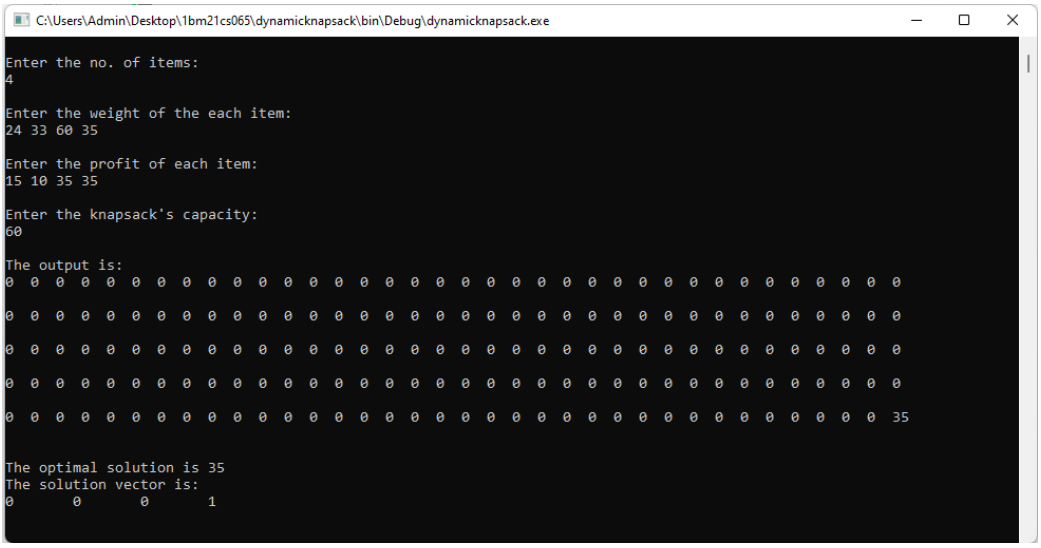
CODE:

```
#include <stdio.h>
#include <conio.h>
void knapsack();
int max(int, int);
int i, j, n, m, p[10], w[10], v[10][10];
void main()
{
   printf("\nEnter the no. of items:\n");
   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:\n");
   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  ", 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:



WEEK 7

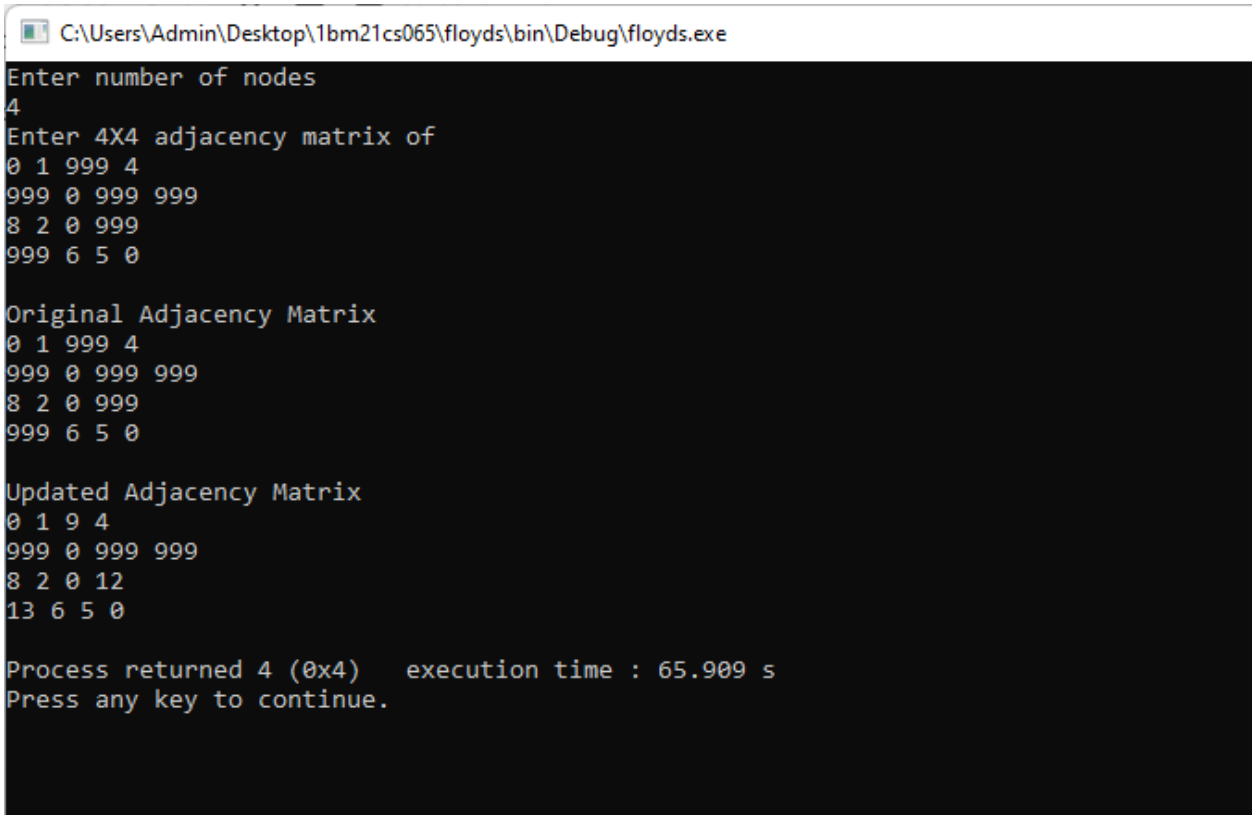
Implement All Pair Shortest paths problem using Floyd's algorithm.

CODE:

```
#include<stdio.h>

void main()
{
   int i,j,k,n,p[10][10],o[10][10];

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

   printf("Enter %dX%d adjacency matrix of \n",n,n);
   for(i=0;i<n;i++)
   {
      for(j=0;j<n;j++)
      scanf("%d",&p[i][j]);
   }

   for(i=0;i<n;i++)
   for(j=0;j<n;j++)
   o[i][j]=p[i][j];

   for(k=0;k<n;k++)
   for(i=0;i<n;i++)
   for(j=0;j<n;j++)
   if(p[i][j] > p[k][j]+p[i][k])
   p[i][j]=p[k][j]+p[i][k];

   printf("\nOriginal Adjacency Matrix \n");
   for(i=0;i<n;i++)
   {
```

```
        for(j=0;j<n;j++)
        printf("%d ",o[i][j]);
        printf("\n");
    }

    printf("\nUpdated Adjacency Matrix \n");
    for(i=0;i<n;i++)
    {
        for(j=0;j<n;j++)
        printf("%d ",p[i][j]);
        printf("\n");
    }
}
```

OUTPUT:



WEEK 8

Find the minimum cost spanning tree of a given undirected graph using prims and Kruskal's algorithm.

PRIMS:

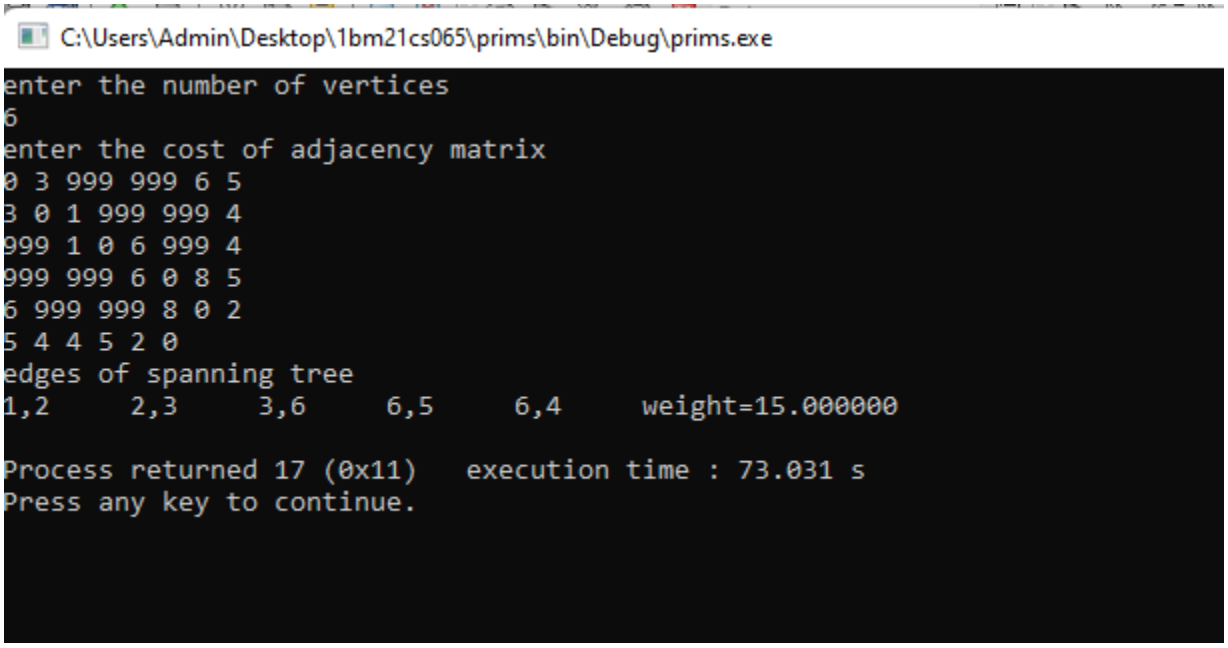
CODE:

```
#include<stdio.h>


float cost[10][10];
int vt[10],et[10][10],vis[10],j,n;
float sum=0;
int x=1;
int e=0;
void prims();

void main()
{
  int i;

  printf("enter the number of vertices\n");
  scanf("%d",&n);
  printf("enter the cost of adjacency matrix\n");
  for(i=1;i<=n;i++)
  {
     for(j=1;j<=n;j++)
     {
         scanf("%f",&cost[i][j]);
     }
     vis[i]=0;
   }
   prims();
```

```
    printf("edges of spanning tree\n");
    for(i=1;i<=e;i++)
    {
         printf("%d,%d\t",et[i][0],et[i][1]);
    }
    printf("weight=%f\n",sum);

}

void prims()
{
   int s,m,k,u,v;
   float min;
   vt[x]=1;
   vis[x]=1;
   for(s=1;s<n;s++)
   {
      j=x;
      min=999;
      while(j>0)
      {
           k=vt[j];
           for(m=2;m<=n;m++)
           {
            if(vis[m]==0)
            {
                 if(cost[k][m]<min)
                 {
                   min=cost[k][m];
                   u=k;
                   v=m;
                 }
            }
          }
```

```
        j--;
    }
    vt[++x]=v;
    et[s][0]=u;
    et[s][1]=v;
    e++;
    vis[v]=1;
    sum=sum+min;
 }
}
```

OUTPUT:



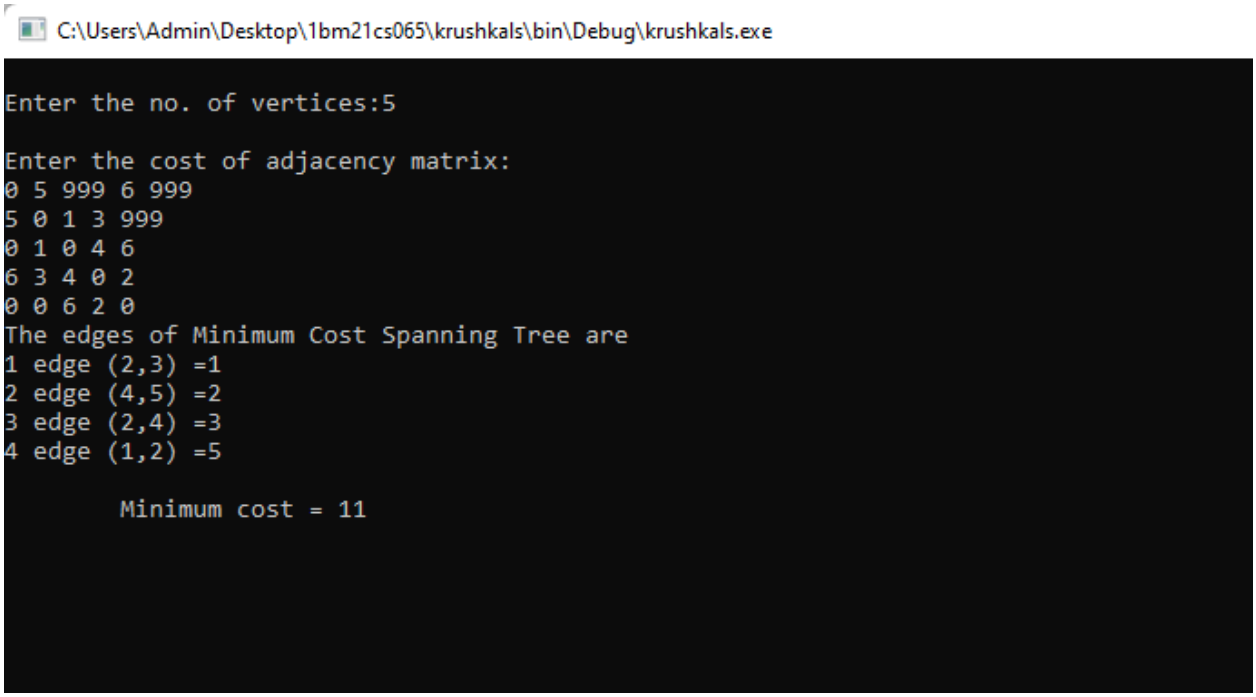
KRUSHKAL'S:

CODE:

```
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>
int i,j,k,a,b,u,v,n,ne=1;
int min,mincost=0,cost[9][9],parent[9];
int find(int);
int uni(int,int);
void main()
{
   printf("\nEnter the no. of vertices:");
   scanf("%d",&n);
   printf("\nEnter the cost of adjacency 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]=999;
     }
   }
   printf("The edges of Minimum Cost Spanning Tree are\n");
   while(ne < n)
   {
    for(i=1,min=999;i<=n;i++)
    {
      for(j=1;j <= n;j++)
      {
        if(cost[i][j] < min)
```

```
        {
         min=cost[i][j];
         a=u=i;
         b=v=j;
        }
       }
      }
      u=find(u);
      v=find(v);
      if(uni(u,v))
      {
       printf("%d edge (%d,%d) =%d\n",ne++,a,b,min);
       mincost +=min;
      }
      cost[a][b]=cost[b][a]=999;
    }
    printf("\nMinimum cost = %d\n",mincost);
    getch();
}
int find(int i)
{
   while(parent[i])
   i=parent[i];
   return i;
}
int uni(int i,int j)
{
  if(i!=j)
  {
   parent[j]=i;
   return 1;
  }
  return 0;
}
```

OUTPUT:


C:\Users\Admin\Desktop\1bm21cs065\krushkals\bin\Debug\krushkals.exe
Enter the no. of vertices:5
Enter the cost of adjacency matrix:
0 5 999 6 999
5 0 1 3 999
0 1 0 4 6
6 3 4 0 2
0 0 6 2 0
The edges of Minimum Cost Spanning Tree are
1 edge (2,3) =1
2 edge (4,5) =2
3 edge (2,4) =3
4 edge (1,2) =5
Minimum cost = 11

WEEK 9

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

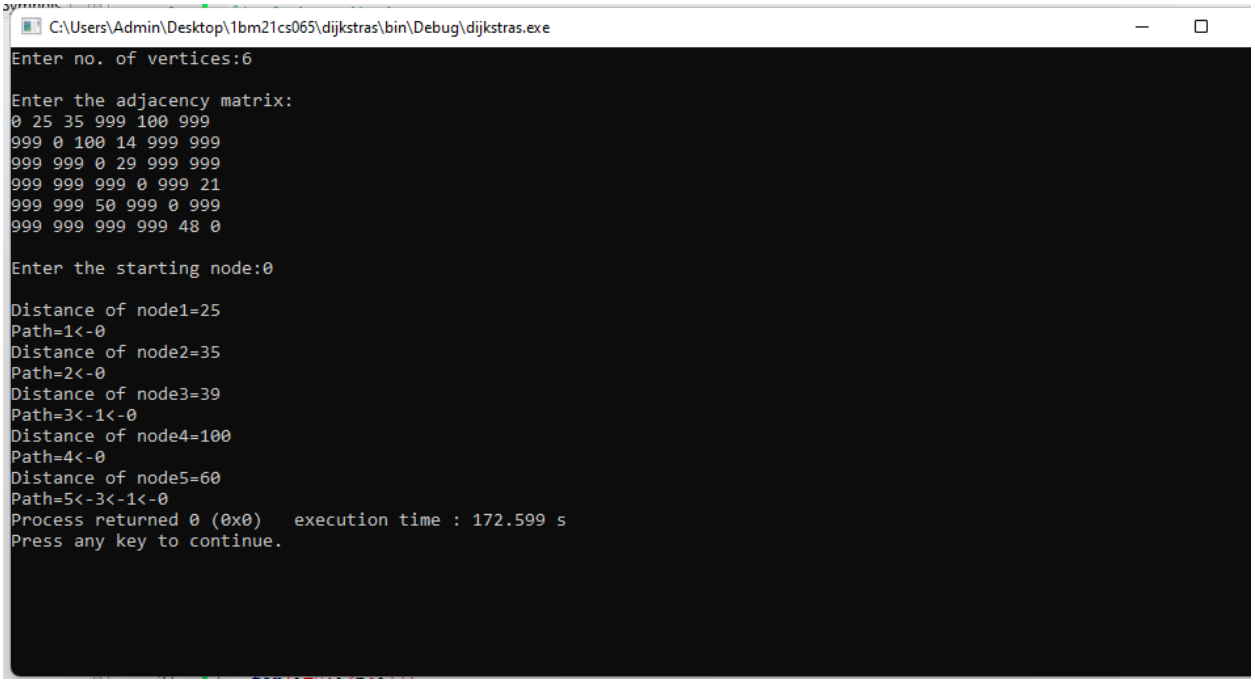
CODE:

```
#include<stdio.h>
#include<conio.h>
#define INFINITY 999
#define MAX 10

void dijkstra(int G[MAX][MAX],int n,int startnode);
int main()
{
  int G[MAX][MAX],i,j,n,u;
  printf("Enter no. of vertices:");
  scanf("%d",&n);
  printf("\nEnter the adjacency matrix:\n");
  for(i=0;i<n;i++)
  for(j=0;j<n;j++)
  scanf("%d",&G[i][j]);
  printf("\nEnter the starting node:");
  scanf("%d",&u);
  dijkstra(G,n,u);
  return 0;
}
void dijkstra(int G[MAX][MAX],int n,int startnode)
{
  int cost[MAX][MAX],distance[MAX],pred[MAX];
  int visited[MAX],count,mindistance,nextnode,i,j;
  for(i=0;i<n;i++)
  for(j=0;j<n;j++)
  if(G[i][j]==0)
  cost[i][j]=INFINITY;
```

```
  else
  cost[i][j]=G[i][j];
  for(i=0;i<n;i++)
  {
   distance[i]=cost[startnode][i];
   pred[i]=startnode;
   visited[i]=0;
  }
  distance[startnode]=0;
  visited[startnode]=1;
  count=1;
  while(count<n-1)
  {
   mindistance=INFINITY;
   for(i=0;i<n;i++)
   if(distance[i]<mindistance&&!visited[i])
   {
    mindistance=distance[i];
    nextnode=i;
   }
   visited[nextnode]=1;
   for(i=0;i<n;i++)
   if(!visited[i])
   if(mindistance+cost[nextnode][i]<distance[i])
   {
    distance[i]=mindistance+cost[nextnode][i];
    pred[i]=nextnode;
   }
   count++;
}

for(i=0;i<n;i++)
if(i!=startnode)
{
```

```
 printf("\nDistance of node%d=%d",i,distance[i]);
 printf("\nPath=%d",i);
 j=i;
 do
 {
  j=pred[j];
  printf("<-%d",j);
 }
 while(j!=startnode);
}
}
```

OUTPUT:



WEEK 10

Implement “N-Queens Problem” using Backtracking.

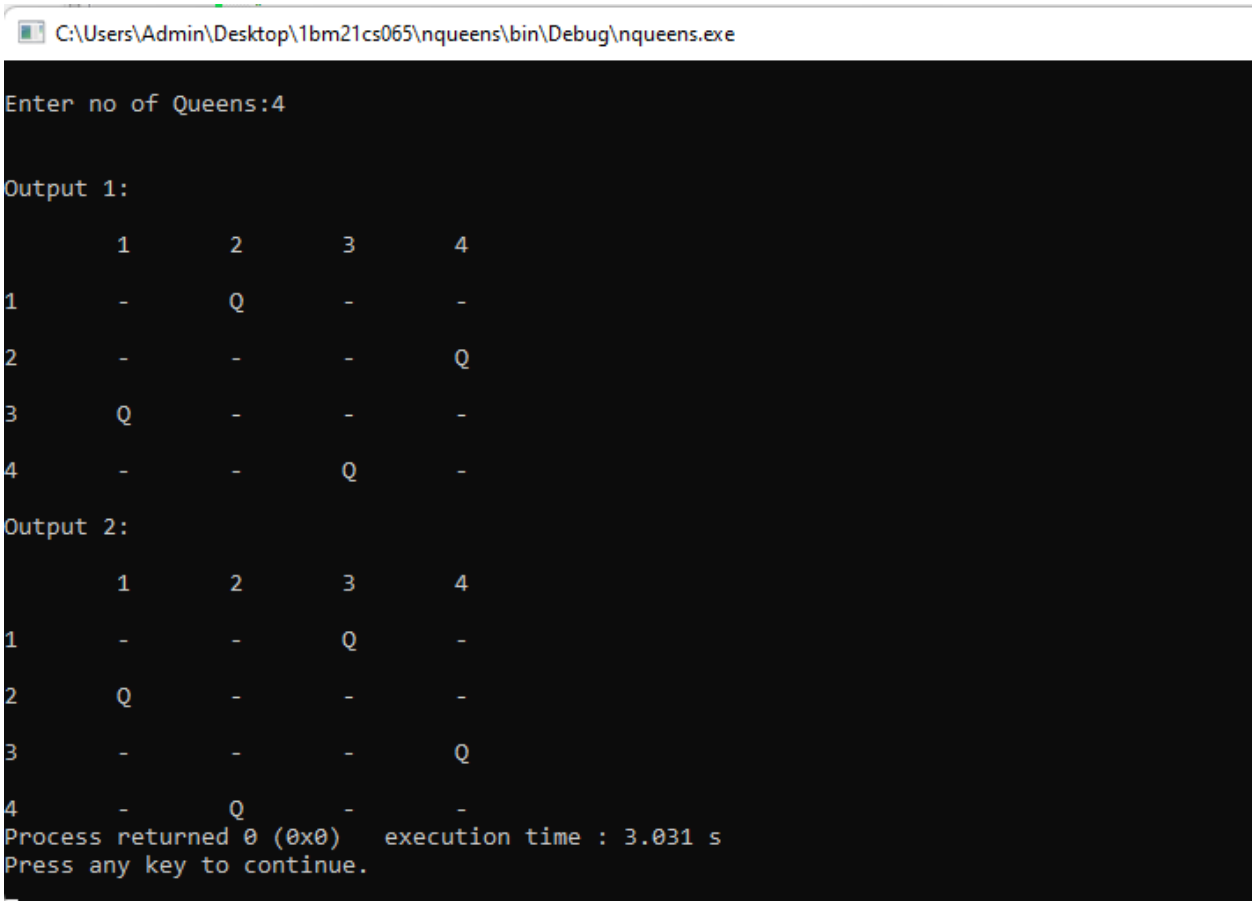
CODE:

```
#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 no of Queens:");
scanf("%d",&n);
queen(1,n);
return 0;
}

void print(int n)
{
int i,j;
printf("\n\nOutput %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:


C:\Users\Admin\Desktop\1bm21cs065\nqueens\bin\Debug\nqueens.exe
Enter no of Queens:4
Output 1:
1 2 3 4
1 - Q - -
2 - - - Q
3 Q - - -
4 - - Q -
Output 2:
1 2 3 4
1 - - Q -
2 Q - - -
3 - - - Q
4 - Q - -
Process returned 0 (0x0) execution time : 3.031 s
Press any key to continue.

WEEK 11

Sort a given set of N integer elements using Heap Sort technique.

CODE:

```
#include <stdio.h>

void heapify(int arr[], int n, int i) {
    int largest = i, left = 2 * i + 1, 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) {
        int temp = arr[i];
        arr[i] = arr[largest];
        arr[largest] = temp;
        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--) {
        int temp = arr[0];
        arr[0] = arr[i];
        arr[i] = temp;
        heapify(arr, i, 0);
    }
}

int main() {
    int arr[10], n, i;
```

```
    printf("Enter number of elements \n");
    scanf("%d", &n);
    printf("Enter %d elements \n", n);
    for (i = 0; i < n; i++)
        scanf("%d", &arr[i]);
    heapsort(arr, n);

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

    return 0;
}
```

OUTPUT: