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,

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 **Aryan Rauniyar (1BM21CS034),** 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 academic semester May-2023 to July-2023. The Lab report has been approved as it satisfies the academic requirements in respect of an **Analysis and Design of Algorithms (22CS4PCADA)** work prescribed for the said degree.

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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.

1. Write program to do the following:

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

```
#include<stdio.h>
int n,i,j,visited[10],queue[10],front=0,rear=-1;
int adj[10][10];
void bfs(int v)
{
	for(i=1;i<=n;i++)
		if(adj[v][i] && !visited[i])
			queue[++rear]=i;
		if(front<=rear)
		{
			visited[queue[front]]=1;
			bfs(queue[front++]);
		}
}
int main()
{

	int v;
	printf("Enter the number of vertices\n");
	scanf("%d",&n);
	for(i=1;i<=n;i++)
	{
		queue[i]=0;
		visited[i]=0;
	}
	printf("Enter graph data in the form of adjacency matrix\n");
	for(i=1;i<=n;i++)
	{
		for(j=1;j<=n;j++)
		{
			scanf("%d",&adj[i][j]);
		}
	}
	printf("\nEnter the starting vertex\n");
	scanf("%d",&v);
```

```
        bfs(v);
        printf("The nodes which are reachable are:\n");
        for(i=1;i<=n;i++)
        {
                if(visited[i])
                {
                        printf("%d\t",i);
                }
                else
                {
                        printf("node not visited");
                }
        }

        return 1;
}
```

Output:

```
Enter the number of vertices
5
Enter graph data in the form of adjacency matrix
0 1 0 1 0
1 0 1 1 0
0 1 0 0 1
1 1 0 0 1
0 0 1 1 0

Enter the starting vertex
1
The nodes which are reachable are:
1       2       3       4       5
```

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

```
#include<stdio.h>
int a[20][20],visited[20],n;
void dfs(int v)
{
        int i;
        visited[v]=1;
        for(i=0;i<n;i++)
        {
```

```
			if(a[v][i] && !visited[i])
			{
				printf("\n%d->%d",v,i);
				dfs(i);
			}
		}
}
int main()
{
		int i,j,count=0;
		printf("Enter number of vertices ");
		scanf("%d",&n);
		for(i=0;i<n;i++)
		{
			for(j=0;j<n;j++)
			{
				visited[i]=0;
				a[i][j]=0;
			}
		}
		for(i=0;i<n;i++)
		{
			for(j=0;j<n;j++)
			{
				scanf("%d",&a[i][j]);
			}
		}
		dfs(0);
		for(i=0;i<n;i++)
		{
			if(visited[i])
				count++;
		}
		if(count==n)
		{
			printf("\nGraph is connected\n");
		}
		else
```

```
	{
		printf("Graph is disconnected");
	}
	return 1;
}
```

Output:

```
Enter number of vertices 5
0 1 0 1 0
1 0 1 1 0
0 1 0 0 1
1 1 0 0 1
0 0 1 1 0

0->1
1->2
2->4
4->3
Graph is connected
```

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

```
#include<stdio.h>
void dfs(int);
int a[10][10],vis[10],exp[10],n,j,m;

void main()
{

   int i,x,y;
   printf("enter the number of vertices\n");
   scanf("%d",&n);
   for(i=1;i<=n;i++)
   {
      for(j=1;j<=n;j++)
      {
         a[i][j]=0;
      }
      vis[j]=0;
   }
   printf("Enter the number of edges\n");
   scanf("%d",&m);
   for(i=1;i<=m;i++)
   {
      printf("Enter an edge\n");
      scanf("%d%d",&x,&y);
      a[x][y]=1;
   }
   j=0;
   for(i=1;i<=n;i++)
   {
      if(vis[i]==0)
         dfs(i);
   }
   printf("The topological sort\n");
   for(i=n-1;i>=0;i--)
   {
```

```
        printf("%d\t",exp[i]);
    }
}
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);
        }
    }
    exp[j++]=v;
}
```

Output:

```
enter the number of vertices
5
Enter the number of edges
6
Enter an edge
1 2
Enter an edge
2 4
Enter an edge
4 5
Enter an edge
5 3
Enter an edge
3 1
Enter an edge
1 2
The topological sort
1       2       4       5       3
```

3. Implement Johnson Trotter algorithm to generate permutations.

```
#include<stdio.h>

#define RIGHT_TO_LEFT 0

#define LEFT_TO_RIGHT 1

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

{

    int i;

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

    {


        if(a[i]==mobile)

            return i+1;

    }

    return -1;

}

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

{


    int i,mobile_prev=0,mobile=0;

    for(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;
            }
        }

             }
        return mobile;
}
void swap(int *a,int *b)
{
    int temp;
```

```
    temp=*a;

    *a=*b;

    *b=temp;

}

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

{

    int i;

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

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

    if(dir[a[pos-1]-1]==RIGHT_TO_LEFT)

        swap(&a[pos-1],&a[pos-2]);

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

        swap(&a[pos],&a[pos-1]);

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

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

    }
    printf(" ");
}
int fact(int n)
{

    int i, res=1;
    for(i=1;i<=n;i++)
        res*=i;
    return res;
}
void printPermutations(int n)
{
    int i, a[n];
    int dir[n];
    for(i=0;i<n;i++)
    {
        a[i]=i+1;
```

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

}
int  main()
{
    int n;
    printf("Enter the number of digits\n");
    scanf("%d",&n);
    printf("Permutations of the seqeuence :");
    printPermutations(n);return 0;
}
```

Output:

```
Enter the number of digits
4
Permutations of the seqeuence :1234
1243 1423 4123 4132 1432 1342 1324 3124 3142 3412 4312 4321 3421 3241 3214 2314 2341 2431 4231 4213 2413 2143 2134
```

4. 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 merge(int arr[],int l,int r,int m)
{
   int i,j,k;

   int n1=m-l+1;
   int n2=r-m;
   int left[n1], right[n2];
   for(i=0;i<n1;i++)
   {
      left[i]=arr[l+i];
   }
   for(j=0;j<n2;j++)
   {
      right[j]=arr[m+1+j];
   }
   i=0;
   j=0;
   k=l;
   while(i<n1 && j<n2)
   {
      if(left[i]<=right[j])
      {
         arr[k]=left[i];
         i++;
      }
      else
      {
         arr[k]=right[j];
         j++;
      }
      k++;
   }
```

```
    while(i<n1)
    {
        arr[k]=left[i];
        i++;
        k++;
    }
    while(j<n2)
    {
        arr[k]=right[j];
        j++;
        k++;
    }
}
void mergesort(int arr[], int l, int r)
{
    int mid;
    if(l<r)
    {
        mid=l+(r-l)/2;
        mergesort(arr,l,mid);
        mergesort(arr,mid+1,r);
        merge(arr,l,r,mid);
    }
}
void print(int arr[],int n)
{
    int i;
    for(i=0;i<n;i++)
    {
        printf("%d\t",arr[i]);
    }
}

void main()
{
    int arr[200000],n,i;
    clock_t st,et;
    float ts;
```

```
    printf("Enter the size of the array\n");
    scanf("%d",&n);
    for(i=0;i<n;i++)
    {
       arr[i]=rand();
    }
    if(n<=20)
    {
           printf("before sorting \n");
       print(arr,n);
           }

    st=clock();

    mergesort(arr,0,n-1);

    et=clock();
    ts=(float)(et-st)/CLOCKS_PER_SEC;
    if(n<=20)
    {
           printf("\nafter sorting using mergesort\n");
       print(arr,n);
           }

    //print(arr,n);
    printf("\nTime taken \t %f ",ts);


}
```

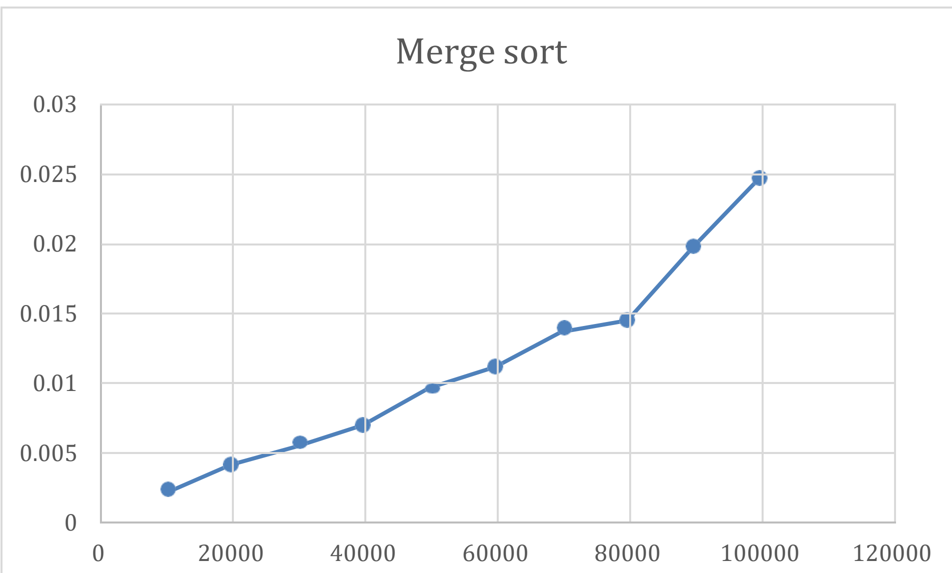
Output:

```
Enter the size of the array
6
before sorting
41      18467   6334    26500   19169   15724
after sorting using mergesort
41      6334    15724   18467   19169   26500   41      6334    15724   18467   19169   26500
```

Table of values:

Input size(n)	Time taken
10000	0.002114
20000	0.00418
30000	0.005486
40000	0.007019
50000	0.00969
60000	0.011191
70000	0.013704
80000	0.014539
90000	0.019828
100000	0.024749

Graph:



5. 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 swap(int *a,int *b)
{
   int temp;
   temp=*a;
   *a=*b;
   *b=temp;
}
int partition(int arr[],int l,int r)
{
   //ascending order
   int pivot=arr[r];
   int i=l-1,j;
   for(j=l;j<=r-1;j++)
   {
      if(arr[j]<pivot)
      {
         i++;
         swap(&arr[i],&arr[j]);
      }
   }
   swap(&arr[i+1],&arr[r]);
   return (i+1);

}
void quicksort(int arr[],int l,int r)
{
   int split;
   if(l<r)
   {
      split=partition(arr,l,r);
      quicksort(arr,l,split-1);
      quicksort(arr,split+1,r);
   }
```

```
}
void print(int arr[],int n)
{
   int i;
   for(i=0;i<n;i++)
   {
      printf("%d\t",arr[i]);
   }
}
void main()
{
   int arr[200000],n,i;
   clock_t st,et;
   float ts;
   printf("Enter the size of the array\n");
   scanf("%d",&n);
   for(i=0;i<n;i++)
   {
      arr[i]=rand();
   }
   if(n<=20)
   {
         printf("before sorting \n");
      print(arr,n);
         }
   st=clock();
   //print(arr,n);
   quicksort(arr,0,n-1);
   et=clock();
   ts=(float)(et-st)/CLOCKS_PER_SEC;
   if(n<=20)
   {
         printf("\nafter sorting using quicksort\n");
      print(arr,n);
         }

   printf("\nTime taken \t %f ",ts);
```

}

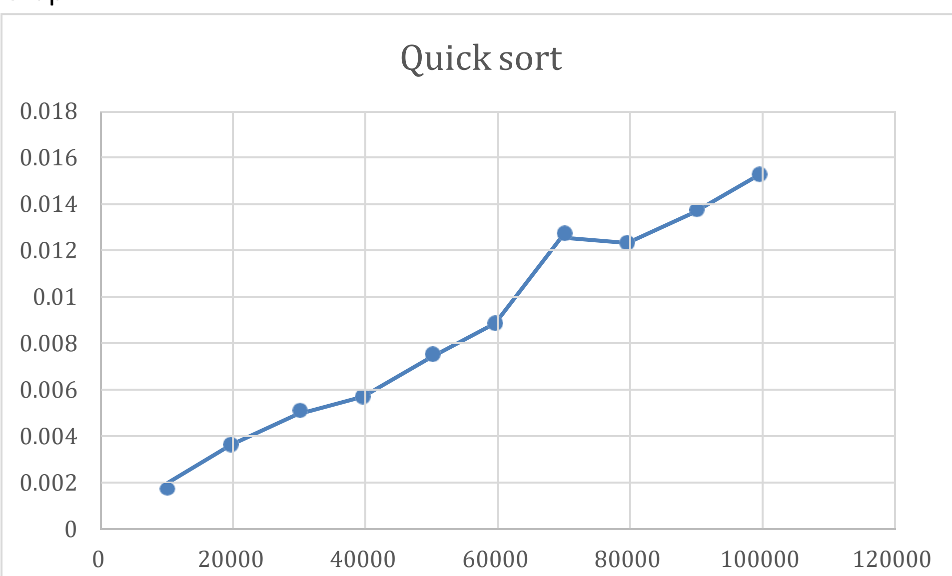
Output:

```
Enter the size of the array
5
before sorting
41      18467   6334    26500   19169
after sorting using quicksort
41      6334    18467   19169   26500
```

Table of values:

Input size(n)	Time taken
10000	0.001908
20000	0.003618
30000	0.004931
40000	0.005698
50000	0.00735
60000	0.008865
70000	0.012559
80000	0.012323
90000	0.013631
100000	0.015273

Graph:



6. 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>


void swap(int *a, int *b) {

    int temp = *a;

    *a = *b;

    *b = temp;

}


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

    int largest = i, l = 2 * i + 1, r = 2 * i + 2;

    while (l < n && a[l] > a[largest]) {

        largest = l;

    }

    while (r < n && a[r] > a[largest]) {

        largest = r;

    }

    if (largest != i) {

        swap(&a[i], &a[largest]);

        heapify(a, n, largest);

    }

}
```

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

void heapsort(int a[], int n) {
    int i;
    // Create max heap
    for (i = n / 2 - 1; i >= 0; i--) {
        heapify(a, n, i);
    }

    // Sort using deletion
    for (i = n - 1; i >= 0; i--) {
        swap(&a[0], &a[i]);
        heapify(a, i, 0);
    }
}

int main() {
```

```
int n, i;
clock_t st, et;
float ts;
printf("Enter the number of elements\n");
scanf("%d", &n);

// Dynamically allocate the array
int *a = (int *)malloc(n * sizeof(int));
if (a == NULL) {
   printf("Memory allocation failed.\n");
   return 1;
}

// Generate random values and place them in the array
for (i = 0; i < n; i++) {
   a[i] = rand();
}

st = clock();
heapsort(a, n);
et = clock();
ts = (float)(et - st) / CLOCKS_PER_SEC;

if (n <= 20) {
```

```c
        printf("\nAfter sorting elements are\n");
        print(a, n);
    }
    // Free dynamically allocated memory
    free(a);
    printf("\nTime taken: %f seconds\n", ts);
    return 0;
}
```

Output:

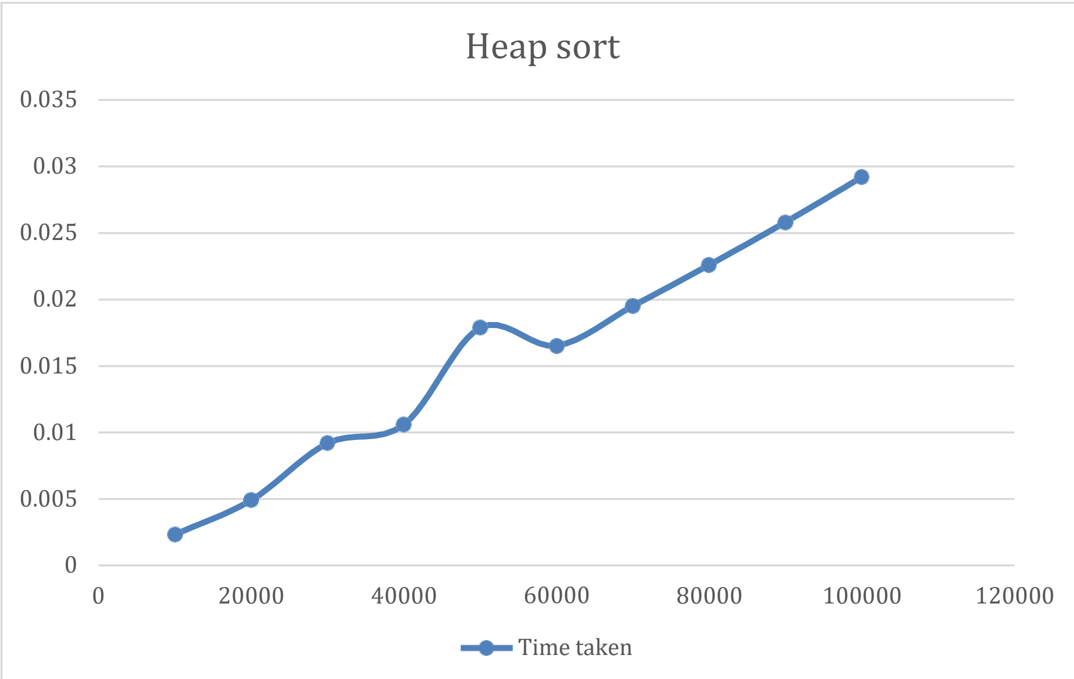
```
Enter the number of elements
5

After sorting elements are
41      6334    18467   19169   26500
```

Table of values:

Input size(n)	Time taken
10000	0.002324
20000	0.004903
30000	0.009185
40000	0.010584
50000	0.017871
60000	0.016515
70000	0.019496
80000	0.022587
90000	0.025799
100000	0.029185

Graph:



Heap sort
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
20000
40000
60000
80000
100000
120000
Time taken

7. Implement 0/1 Knapsack problem using dynamic programming.

```
#include<stdio.h>
void main()
{
   int i,j,w[10],p[10],opt[10][10],x[10],n,m;
   printf("Enter the number of items\n");
   scanf("%d",&n);
   printf("enter the weight and profit of each item\n");
   for(i=1;i<=n;i++)
   {
      scanf("%d %d",&w[i],&p[i]);
   }
   printf("enter the knapsack capacity\n");
   scanf("%d",&m);
   for(i=0;i<=n;i++)
   {
      for(j=0;j<=m;j++)
      {
         if(i==0 || j==0)
         {
            opt[i][j]=0;
         }
         else if(j-w[i]<0)
         {
```

```
            opt[i][j]=opt[i-1][j];
        }
        else
        {
            opt[i][j]=opt[i-1][j-w[i]]+p[i]>(opt[i-1][j])?opt[i-1][j-w[i]]+p[i]:(opt[i-1][j]);
        }
    }
}
//output
printf("\nknapsack table\n");
for(i=0;i<=n;i++)
{
    for(j=0;j<=m;j++)
    {
        printf("%d\t",opt[i][j]);
    }
    printf("\n");
}
for(i=n;i>=1;i--)
{
    if(opt[i][m]!=opt[i-1][m])
    {
        x[i]=1;
        m=m-w[i];
```

```
        }
        else
        {
           x[i]=0;
        }
    }
    printf("\nitems selected are designated 1\n");
    for(i=1;i<=n;i++)
    {
        printf("%d ",x[i]);
    }
}
```

Output:

```
Enter the number of items
4
enter the weight and profit of each item
2 12
1 10
3 20
2 15
enter the knapsack capacity
5

knapsack table
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

items selected are designated 1
1 1 0 1
```

8. Implement All Pair Shortest paths problem using Floyd’s algorithm.

```
#include<stdio.h>

void main()

{

   int adj[10][10],n,i,j,k;

   int result[10][10];

   printf("Floyd's algorithm\n");

   printf("enter the number of vertices\n");

   scanf("%d",&n);

   printf("Enter the distance matrix for %d vertices\n",n);

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

   {

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

      {

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

         result[i][j]=adj[i][j];

      }

   }

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

   {

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

      {

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

         {
```

```
                result[i][j]=result[i][j]<(result[i][k]+result[k][j])?result[i][j]:(result[i][k]+result[k][j]);
            }
        }
    }
    printf("\nResult\n");
    for(i=0;i<n;i++)
    {
        for(j=0;j<n;j++)
        {
            printf("%d\t",result[i][j]);
        }
        printf("\n");
    }

}
```

Output:

```
Floyd's algorithm
enter the number of vertices
4
Enter the distance matrix for 4 vertices
0 999 3 999
2 0 999 999
999 7 0 1
6 999 999 0

Result
0       10      3       4
2       0       5       6
7       7       0       1
6       16      9       0
```

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

Prim's algorithm:

```
#include <stdio.h>

int cost[10][10], vt[10], et[10][10], vis[10], j, n;

int 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 adjacency matrix\n");

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

  {

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

    {

      scanf("%d", &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=%d\n", sum);
}

void prims()
{
  int s, min, m, k, u, v;
  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:

```
enter the number of vertices
5
enter the cost adjacency matrix
0 1 5 2 999
1 0 999 999 999
5 999 0 3 999
2 999 3 0 2
999 999 999 2 0
edges of spanning tree
1,2     1,4     4,5     4,3     weight=8
```

Kruskal’s algorithm:

```
#include <stdio.h>

int find(int v, int parent[10])

{

  while (parent[v] != v)

  {

    v = parent[v];

  }

  return v;

}


void union1(int i, int j, int parent[10])

{

  if (i < j)

    parent[j] = i;

  else

    parent[i] = j;
```

```
}

void kruskal(int n, int a[10][10])
{
  int count, k, min, sum, i, j, t[10][10], u, v, parent[10];
  count = 0;
  k = 0;
  sum = 0;
  for (i = 0; i < n; i++)
    parent[i] = i;
  while (count != n - 1)
  {
    min = 999;
    for (i = 0; i < n; i++)
    {
      for (j = 0; j < n; j++)
      {

        if (a[i][j] < min && a[i][j] != 0)
        {
          min = a[i][j];
          u = i;
          v = j;
        }
```

```
    }
  }
  i = find(u, parent);
  j = find(v, parent);
  if (i != j)
  {
    union1(i, j, parent);
    t[k][0] = u;
    t[k][1] = v;
    k++;
    count++;
    sum = sum + a[u][v];
  }
  a[u][v] = a[v][u] = 999;
}
if (count == n - 1)
{
  printf("spanning tree\n");
  for (i = 0; i < n - 1; i++)
  {
    printf("%d %d\n", t[i][0], t[i][1]);
  }
  printf("cost of spanning tree=%d\n", sum);
}
```

```
  else
    printf("spanning tree does not exist\n");
}
void main()
{
  int n, i, j, a[10][10];

  printf("enter the 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]);
  kruskal(n, a);
}
```

Output:

```
enter the number of nodes
5
enter the adjacency matrix
0 1 5 2 999
1 0 999 999 999
5 999 0 3 999
2 999 3 0 2
999 999 999 2 0
spanning tree
0 1
0 3
3 4
2 3
cost of spanning tree=8
```

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

```
#include <stdio.h>

#define INFINITY 9999

#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:

```
Enter no. of vertices:6

Enter the adjacency matrix:
0 25 100 35 9999 9999
9999 0 9999 27 14 9999
9999 9999 0 50 9999 48
9999 9999 9999 0 29 9999
9999 9999 9999 9999 0 21
9999 9999 48 9999 9999 0

Enter the starting node:0

Distance of node1 = 25
Path = 1<-0
Distance of node2 = 100
Path = 2<-0
Distance of node3 = 35
Path = 3<-0
Distance of node4 = 39
Path = 4<-1<-0
Distance of node5 = 60
Path = 5<-4<-1<-0
```

11. 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 Queens Problem Using Backtracking -");

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

  scanf("%d", &n);

  queen(1, n);

  return 0;

}


// function for printing the solution

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) // for nxn board
    {
      if (board[i] == j)
        printf("\tQ"); // queen at i,j position
      else
        printf("\t-"); // empty slot
    }
  }
}

/*funtion to check conflicts
If no conflict for desired postion returns 1 otherwise returns 0*/
int place(int row, int column)
{
  int i;
  for (i = 1; i <= row - 1; ++i)
  {
    // checking column and digonal conflicts
    if (board[i] == column)
      return 0;
```

```
    else if (abs(board[i] - column) == abs(i - row))
      return 0;
  }

  return 1; // no conflicts
}

// function to check for proper positioning of queen
void queen(int row, int n)
{
  int column;
  for (column = 1; column <= n; ++column)
  {
    if (place(row, column))
    {
      board[row] = column; // no conflicts so place queen
      if (row == n)       // dead end
        print(n);         // printing the board configuration
      else                // try queen with next position
      queen(row + 1, n);
    }
  }
}
```

Output:

```
 - N Queens Problem Using Backtracking -

Enter number of Queens:4


Solution 1:

        1       2       3       4

1       -       Q       -       -

2       -       -       -       Q

3       Q       -       -       -

4       -       -       Q       -

Solution 2:

        1       2       3       4

1       -       -       Q       -

2       Q       -       -       -

3       -       -       -       Q

4       -       Q       -       -
```