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

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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 **G Sai Vikrant (1BM21CS061),** 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.

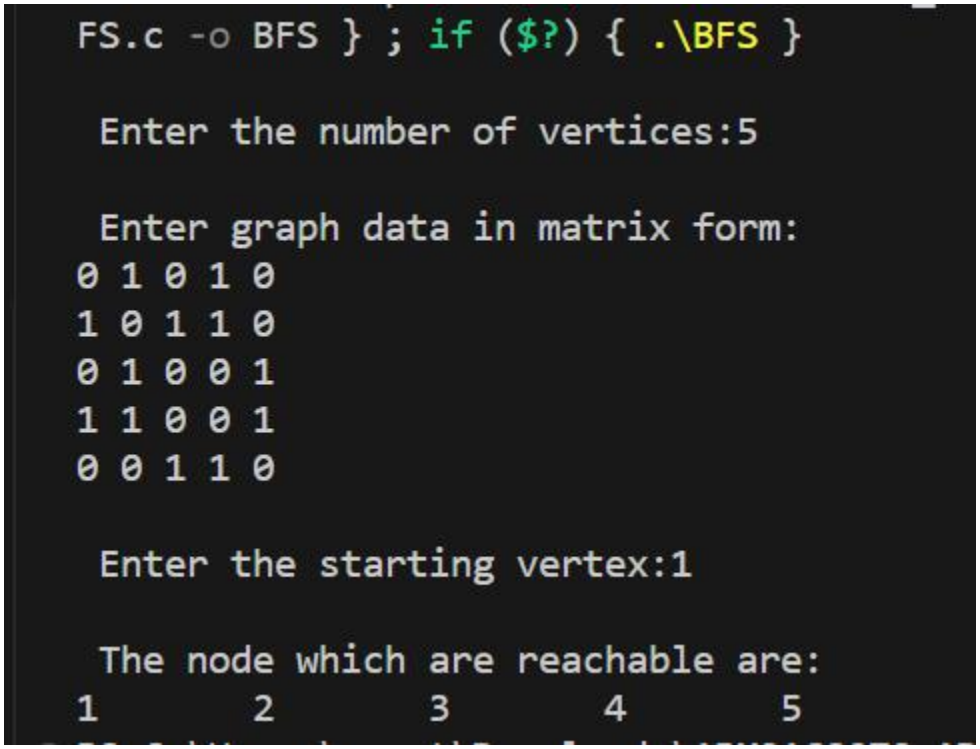
Solution:

Code:

```
#include<stdio.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() {
```

```
nt v;
printf("\n Enter the number of vertices:");I
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);
else {
printf("\n Bfs is not possible. Not all nodes are reachable");
break;
}
}
}
```

Output:



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

Solution:

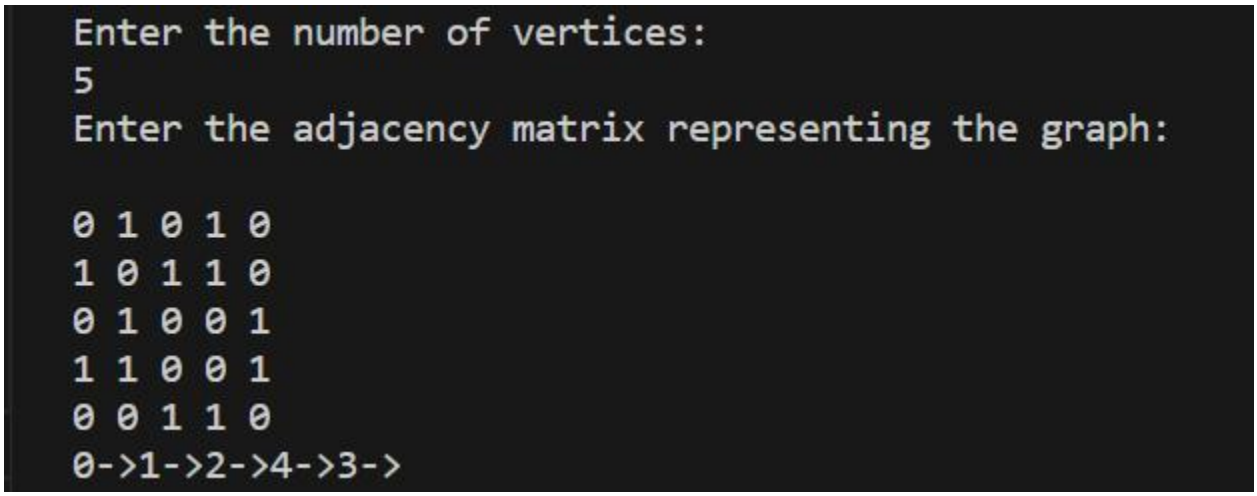
Code:

```
#include<stdio.h>

int graph[20][20];

void DFS(int i,int vis[],int n)

{

int j;

printf("%d ->",i);

vis[i]=1;
```

```
or(j=0;j<n;j++)
{
if(graph[i][j]==1 && vis[j]==0)
{
DFS(j,vis,n);
}
}
}
void main()
{
int n,i,j,top=-1;

printf("Enter the number of vertices:\n"); scanf("%d",&n);
printf("Enter the adjacency matrix representing the graph:\n");

int vis[n],st[n];
for(int i=0;i<n;i++)
{
for(int j=0;j<n;j++)
{
scanf("%d",&graph[i][j]);
}
}
for(int i=0;i<n;i++)
{
vis[i]=0;
}
```

```
DFS(0,vis,n);

}
```

Output:



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

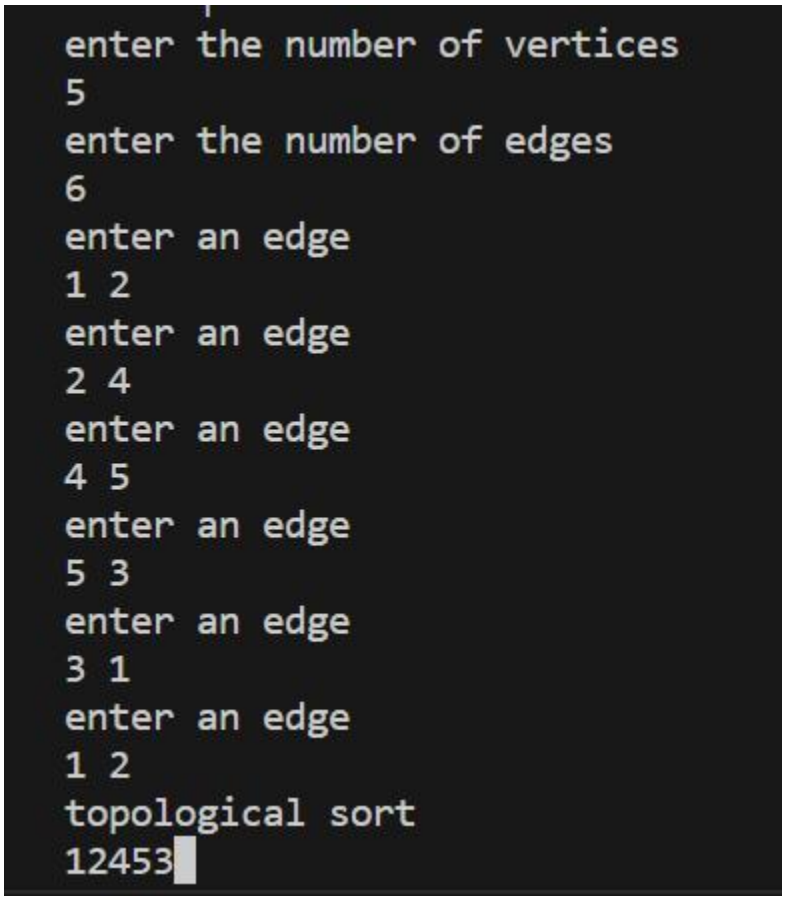
Solution:

Code:

```
#include<stdio.h>

#include<conio.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[i]=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("topological sort\n");
for(i=n-1;i>=0;i--)
{
printf("%d",exp[i]);
}
getch();
}
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
topological sort
12453

3. Implement Johnson Trotter algorithm to generate permutations.

Solution:

Code:

```
#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.

Solution:

Code:

```
#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;
```

```
f (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[2000], n, i;
clock_t st, et;
double ts;
printf("Enter the size of the array\n"); scanf("%d", &n);
//          printf("enter the elements of the array\n");
//          for(i=0;i<n;i++)
//          {
//          scanf("%d",&arr[i]);
//          }
printf("Providing random numbers");
for (i = 0; i < n; i++)
{
arr[i] = rand();
}
//          printf("before sorting \n"); st = clock();
print(arr, n);
mergesort(arr, 0, n - 1); et = clock();
ts = (double)(et - st) / CLOCKS_PER_SEC; printf("\nafter sorting using mergesort\n"); print(arr, n);
printf("\n");
printf("the time taken is %f", ts);
}
```

Output:

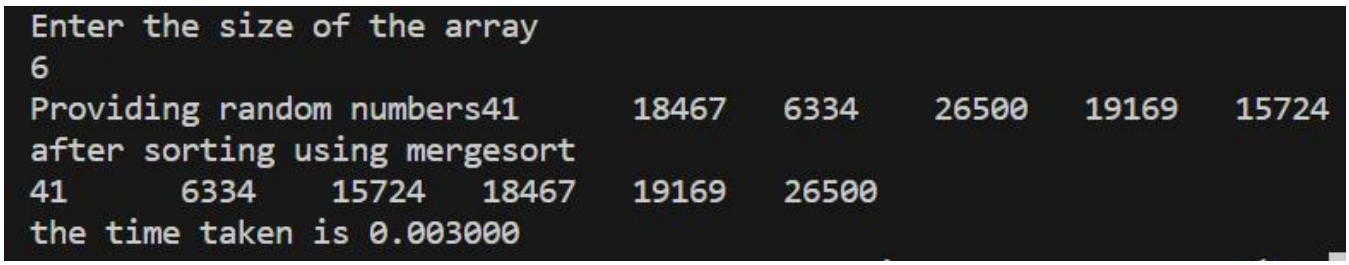
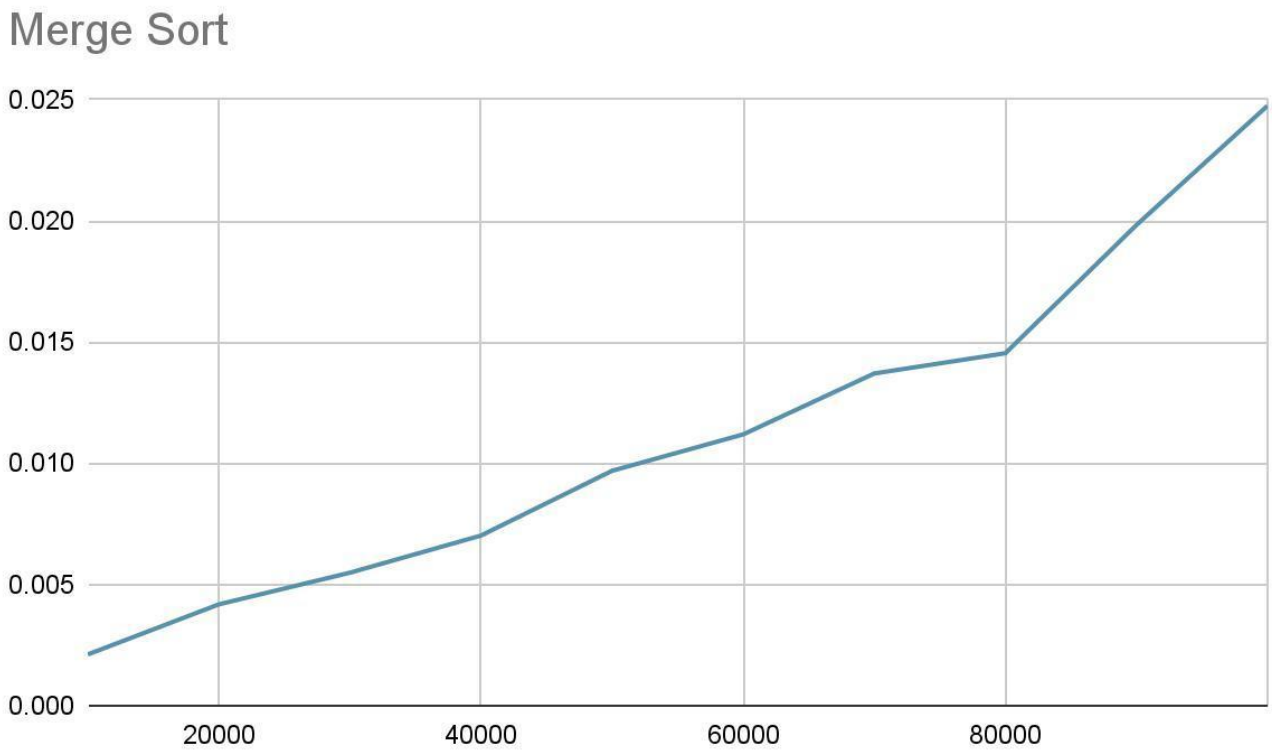

Enter the size of the array
6
Providing random numbers41 18467 6334 26500 19169 15724
after sorting using mergesort
41 6334 15724 18467 19169 26500
the time taken is 0.003000

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.

Solution:

Code:

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>

//          Function to swap two elements in an array void swap(int* a, int* b) {

int temp = *a; *a = *b;

*b = temp;

}

//          Function to partition the array and return the pivot index int partition(int arr[], int low, int high) {

int pivot = arr[high]; int i = low - 1;

for             (int j = low; j <= high - 1; j++) { if (arr[j] < pivot) {

i++;

swap(&arr[i], &arr[j]);

}

}

swap(&arr[i + 1], &arr[high]);

return i + 1;

}

// Function to implement Quick Sort

void quickSort(int arr[], int low, int high) { if (low < high) {

int pivotIndex = partition(arr, low, high); quickSort(arr, low, pivotIndex - 1); quickSort(arr, pivotIndex + 1, high);

}

}

int main() {
```

```
int n;

printf("Enter the number of elements in the array: "); scanf("%d", &n);

// Allocate memory for the array

int* arr = (int*)malloc(n * sizeof(int));

// Generate random numbers and fill the array

srand(time(0)); // Seed the random number generator with the current time for (int i = 0; i < n; i++) {

arr[i] = rand() % 100; // Generate random numbers between 0 and 99

}

//          Display the original array printf("Original Array:\n"); for (int i = 0; i < n; i++) {

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

}

printf("\n");

//          Measure the execution time of quick sort clock_t start_time = clock(); quickSort(arr, 0, n - 1);

clock_t end_time = clock();

//          Display the sorted array

printf("Sorted Array:\n");

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

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

}

printf("\n");

// Calculate and display the time taken for the sorting process

double time_taken = ((double)(end_time - start_time)) / CLOCKS_PER_SEC; printf("Time taken for sorting: %f
seconds\n", time_taken);

//          Free the dynamically allocated memory free(arr);

return 0;

}
```

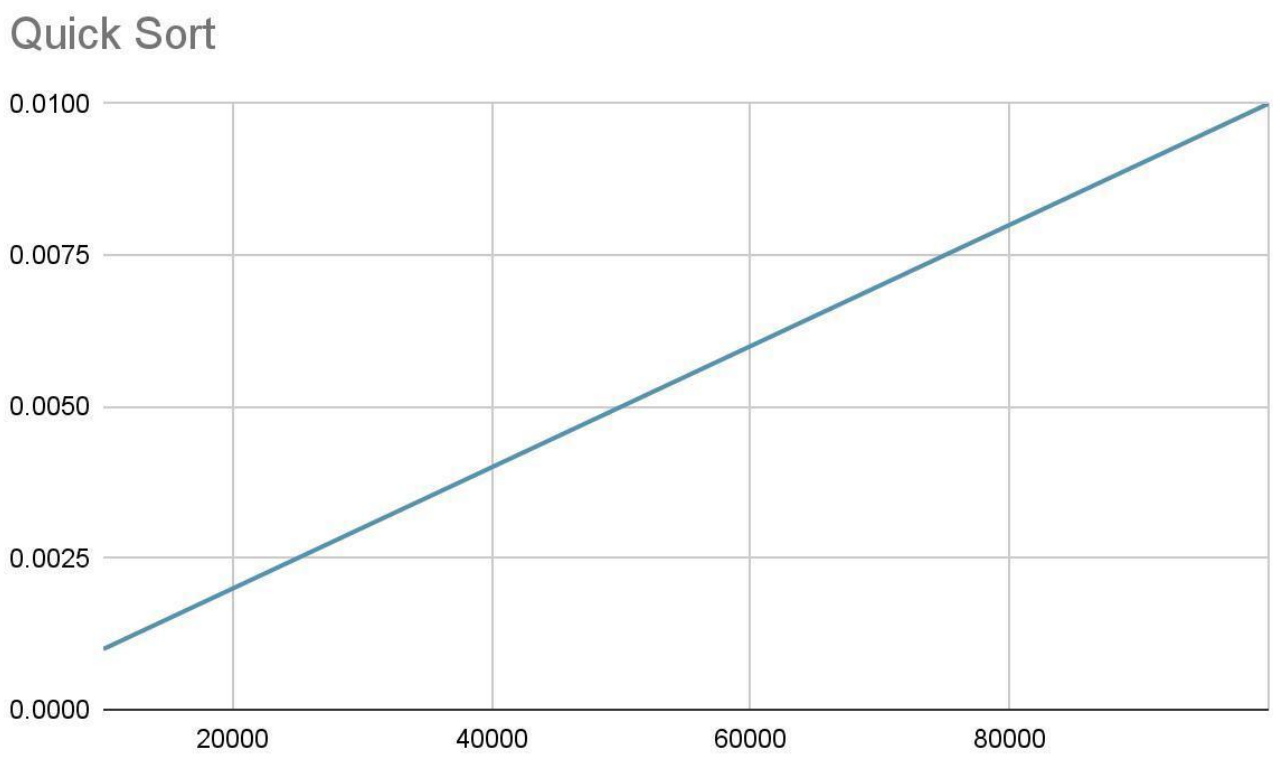
Output:

```
Enter the number of elements in the array: 10
Original Array:
53 74 31 47 30 47 12 39 37 29
Sorted Array:
12 29 30 31 37 39 47 47 53 74
Time taken for sorting: 0.000000 seconds
```

Table of values:

Input size(n)	Time taken
10000	0.001
20000	0.002
30000	0.003
40000	0.004
50000	0.005
60000	0.006
70000	0.007
80000	0.008
90000	0.009
100000	0.010

Graph:



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

Solution:

Code:

```
#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;
int l = 2 * i + 1;
int r = 2 * i + 2;

if (l < n && a[l] > a[largest])
{
largest = l;
}
if (r < n && a[r] > a[largest])
{
largest = r;
}

if (largest != i)
{
swap(&a[i], &a[largest]);
heapify(a, n, largest);
}
}

void heapSort(int a[], int n)
{
// Build heap (rearrange array)
for (int i = n / 2 - 1; i >= 0; i--)
```

```
{

heapify(a, n, i);

}


//          Extract elements from heap one by one for (int i = n - 1; i > 0; i--)
{

swap(&a[0], &a[i]); heapify(a, i, 0);
}

}


void print(int arr[],int n)

{

int i;

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

{

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

}

}


void main()

{

int arr[10001],n,i;

clock_t st,et;

double ts;

printf("Enter the size of the array\n"); scanf("%d",&n);

if(n<10)

{

printf("enter the elements of the array\n");

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

{
```

```
scanf("%d",&arr[i]);
}
}
else
{
printf("Providing random numbers");
for(i=0;i<n;i++)
{
arr[i] = rand();
}
}
if(n<10)
{
printf("before sorting \n");
print(arr,n);

}

st = clock();
heapSort(arr, n);
et = clock();
ts = (double)(et-st)/CLOCKS_PER_SEC;
if(n<10)
{
printf("\nafter sorting using mergesort\n"); print(arr,n);
}

printf("the time taken is %f",ts);
}
```

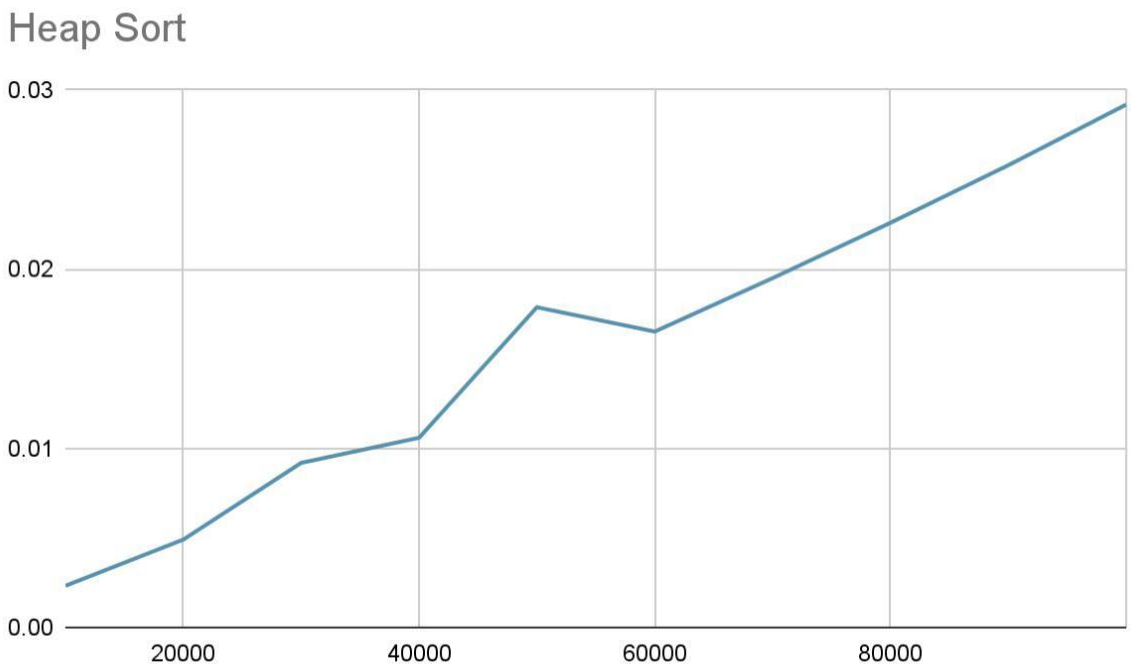
Output:

```
Enter the size of the array
7
enter the elements of the array
10334
14314
64765
42423
75675
42343
76456
before sorting
10334   14314   64765   42423   75675   42343   76456
after sorting using mergesort
10334   14314   42343   42423   64765   75675   76456   the time taken is 0.000000
```

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:



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

Solution:

Code:

```
#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.

Solution:

Code:

```
#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:

Code:

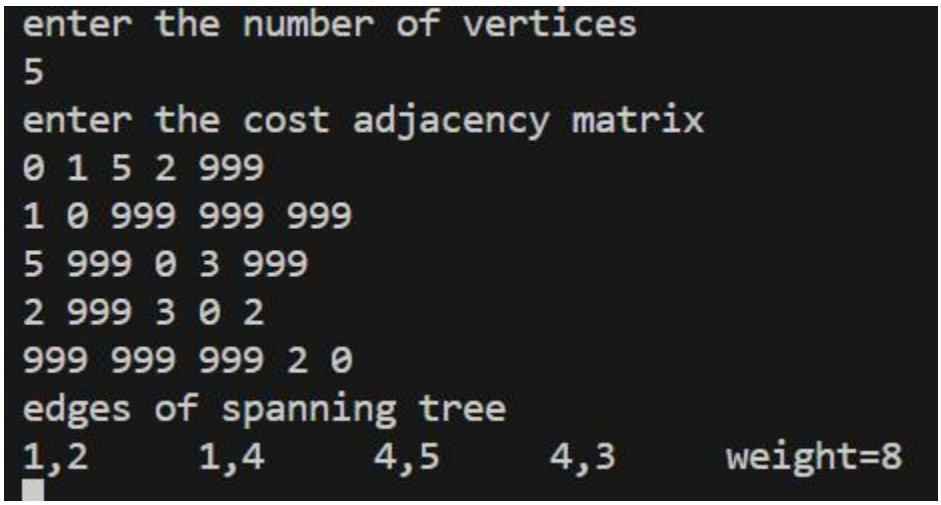
```
#include<stdio.h>
#include<conio.h>


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);

getch();
}


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:



Kruskal's algorithm:

Code:

```
#include<stdio.h>

#include<conio.h>


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

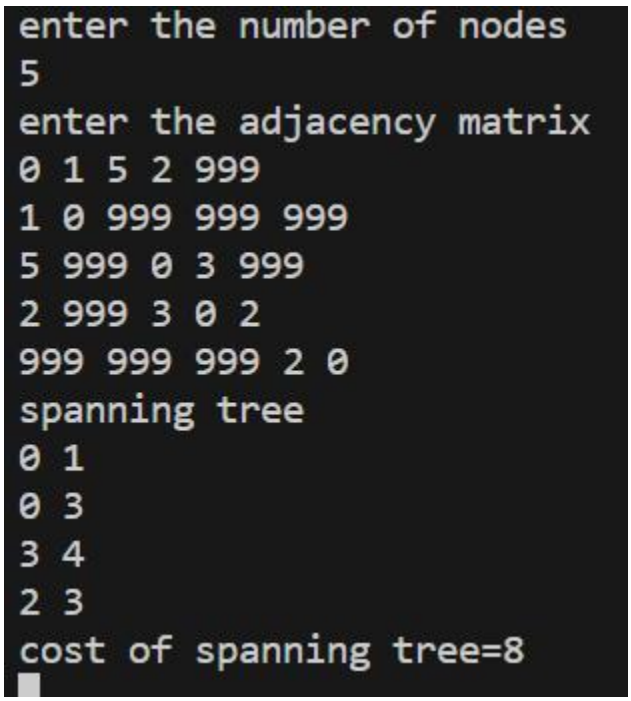
```
{
while(parent[v]!=v)


{

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];
```

```
clrscr();


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);

getch();



}
```

Output:



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

Solution:

Code:

```
#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.

Solution:

Code:

```
#include <stdio.h>

#include <math.h>
```

```
int board[20], count=0;
int main()

{

int n, i, j;

void queen(int row, int n);



printf(" - N Queens Problem Using Backtracking -"); while(1){

printf("\n\nEnter number of Queens:"); count=0;

scanf("%d", &n);

if(n<=3){

printf("No solution\n");

}

else{

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:

```
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       -       -

Enter number of Queens:2
No solution


Enter number of Queens:3
No solution
```