Jadavpur University

Department of Computer Science and Engineering

M.Tech in Computer Technology

1st Year, 1st Semester

Programming Lab

Assignment-6

For this assignment consider graphs are stored as an adjacency matrix

1. Write a function void addVertex(int n) that adds a vertex with name n to the graph. If there is already a vertex with name n, then the function should do nothing. Otherwise the new vertex should be made the last vertex in the vertex list of the graph.

2. Write a function void addEdge (int u int v) that does the following. The function should add a new edge from the vertex with name u to vertex with name v to the graph. If there is no vertex named u or no vertex named v, then the function should do nothing. If there is already an edge between u and v, the function should not do anything

3. Write a function void delEdge(int u, int v) that does the following. The function should remove the edge from vertex with name u to vertex with name v from the graph. If there is no such edge in the graph, then the function should do nothing.

4. Write a function void delVertex(int u) that does the following. The function should remove the vertex named u and all edges that either come into u or go out of u. If there is no vertex with name u, then the function should do nothing.

5. Write a program to find approachable nodes from a given source of a given graph using queue as an intermediate data structure (BFS).

6. Write a program to traverse various nodes of a given graph using stack as an intermediate data structure (DFS).

7. Write a program to find shortest path from a given source to all the approachable nodes (Single source shortest path Dijkstra's algorithm).

8. Write a program to find shortest path between all the source destination pairs (All pairs shortest path Floyd's algorithm.

9. Write a program to arrange all the nodes of a given graph (Topological sort).

10. Write a program to find Minimal spanning tree of a graph using Kruskal's algorithm.

11. Write a program to find Minimal spanning tree of a graph using Prim's algorithm.

Program 1 & Program 2 & Program 3 & Program 4:-

```
#include<stdio.h>

void addVertex(int nodeNumber, int n, int graph[][n]){
  if(nodeNumber == 0){
    graph[0][0] = 0;
  }
  else {
    int i;
    for(i = 0; i < nodeNumber; i++){
      graph[i][nodeNumber] = 0;
    }
    for(i = 0; i <= nodeNumber; i++){
      graph[nodeNumber][i] = 0;
    }
  }
}

void addEdge(int n, int graph[][n], int u, int v){
  if(u < n && v < n){
    graph[u][v] = 1;
    graph[v][u] = 1;
  }
}

void delEdge(int n, int graph[][n], int u, int v){
  if(u < n && v < n){
    graph[u][v] = 0;
    graph[v][u] = 0;
  }
```

```
}

void delVertex(int n, int graph[][n], int v, int *n_ptr){
   if(v < n){
      int i;
      for(i = 0; i < n; i++){
         graph[v][i] = 0;
         graph[i][v] = 0;
      }
      *n_ptr = *n_ptr - 1;
   }
}

int main(){
   int n, i, j;
   printf("Enter the number of nodes in the graph: ");
   scanf("%d",&n);

   int graph[100][100];
   for(i = 0; i < n; i++){
      addVertex(i, n, graph);
   }

   addEdge(n, graph, 0, 1);
   printf("Edge betwen %dth verted and %dth vertex has been added...\n",0,1);

   delEdge(n, graph, 0, 1);
   printf("Edge betwen %dth verted and %dth vertex has been deleted...\n",0,1);

   delVertex(n, graph, n - 1, &n);
   printf("vertex %d has been deleted...\n",n);
```

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

    return 0;
}
```

Program 5:-

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

struct queue{
    int front, rear;
    int *list;
};

void bfs_algo(int n, int graph[][n], int bfs[], struct queue queue){
    int i, ind = 0, node = 0, visited[n];
    queue.list[queue.rear] = node;
    queue.rear++;

    for(i = 0; i < n; i++){
        visited[i] = 0;
    }

    while(queue.front < queue.rear){
        node = queue.list[queue.front];
        queue.front++;
        visited[node] = 1;
        bfs[ind] = node;
        ind++;

        for(i = 0; i < n; i++){
            if(visited[i] == 0 && graph[node][i] == 1){
                queue.list[queue.rear] = i;
                queue.rear++;
            }
        }
    }
}

int main(){
    int n, i, j;
    printf("Enter the number of nodes: ");
    scanf("%d",&n);

    int val, graph[n][n], bfs[n];
    struct queue queue;
    queue.list = (int *)malloc(sizeof(int) * n * n);
    queue.front = 0;
    queue.rear = 0;

    for(i = 0; i < n; i++){
        for(j = i; j < n; j++){
            printf("Enter the edge for %d<-->%d: ",i,j);
            scanf("%d",&val);
            graph[i][j] = val;
            graph[j][i] = val;
        }
    }

    bfs_algo(n, graph, bfs, queue);

    printf("bfs of the graph is: \n");
    for(i = 0; i < n; i++){
        printf("%d ",bfs[i]);
    }

    return 0;
}
```

Program 6:-

```
#include<stdio.h>

void dfs_stack(int n, int graph[][n], int dfs[]){
    int node, dfs_ind = 0, i, top = 0, stack[2*n], visited[n];
    for(i = 0; i < n; i++){
        visited[i] = 0;
    }
    stack[0] = 0;

    while(top >= 0){
        node = stack[top];
        top--;

        dfs[dfs_ind] = node;
        dfs_ind++;
        for(i = 0; i < n; i++){
            if(visited[i] == 0 && graph[node][i] == 1)
                stack[++top] = i;
        }

        visited[node] = 1;
    }

}

int main(){
    int n, i, j;
    printf("Enter the number of nodes: ");
    scanf("%d",&n);

    int val, graph[n][n], dfs[n];
    for(i = 0; i < n; i++){
        for(j = i; j < n; j++){
            printf("Enter the edge for %d<-->%d: ",i,j);
            scanf("%d",&val);
            graph[i][j] = val;
            graph[j][i] = val;
        }
    }

    dfs_stack(n,graph,dfs);
    printf("dfs of the graph is: \n");
    for(i = 0; i < n; i++)
        printf("%d ",dfs[i]);
}
```

Program 7:-

```
#include<stdio.h>
#define INT_MAX 1000009

void dijkstras_algo(int n, int graph[][n], int visited[], int distance[]){

    int loop;
    for(loop = 0; loop < n; loop++){
        int i,ind = -1, min_val = INT_MAX;
        for(i = 0; i < n; i++){
            if(visited[i] == 0 && distance[i] < min_val){
                min_val = distance[i];
                ind = i;
            }
        }

        visited[ind] = 1;

        for(i = 0; i < n; i++){
            if(visited[i] == 0 && graph[ind][i] > 0){
                if(distance[ind] + graph[ind][i] < distance[i])
                    distance[i] = distance[ind] + graph[ind][i];
            }
        }
    }
}

int main(){

    int n,i,j;
    printf("Enter the number of nodes: ");
    scanf("%d",&n);

    int graph[n][n], visited[n],distance[n];
    for(i = 0; i < n; i++){
        for(j = 0; j < n; j++){
            printf("Enter the weight of the edge %d --> %d: ",i,j);
            scanf("%d",&graph[i][j]);
        }
    }

    for(i = 0; i < n; i++){
        visited[i] = 0;
        distance[i] = INT_MAX;
    }
    distance[0] = 0;

    dijkstras_algo(n, graph, visited, distance);

    printf("The shortest distance to each node is(starting from 0): ");
    for(i = 0; i < n; i++){
        printf("%d ",distance[i]);
    }

    return 0;
}
```

Program 8:-

```
#include<stdio.h>
#define INT_MAX 1000009
```

```
void floyd_algo(int n, int srt_paths[][n]){
    int i, j, k;
    for(i = 0; i < n; i++){
        for(j = 0; j < n; j++){
            for(k = 0; k < n; k++){
                if(j == k || j == i || k == i)
                    continue;
                if(srt_paths[j][k] > srt_paths[j][i] + srt_paths[i][k])
                    srt_paths[j][k] = srt_paths[j][i] + srt_paths[i][k];
            }
        }
    }
}

int main(){
    int n, i, j;
    printf("Enter the numebr of nodes: ");
    scanf("%d",&n);

    int val, graph[n][n], srt_paths[n][n];
    for(i = 0; i < n; i++){
        for(j = 0; j < n; j++){
            printf("Enter the edge for %d --> %d : ",i,j);
            scanf("%d",&val);
            if(val == -1){
                graph[i][j] = INT_MAX;
                srt_paths[i][j] = INT_MAX;
            }
            else{
                graph[i][j] = val;
                srt_paths[i][j] = val;
            }
        }
    }
    floyd_algo(n, srt_paths);
    printf("The paths are: \n");
    for(i = 0; i < n; i++){
        for(j = 0; j < n; j++){
            printf("%d ",srt_paths[i][j]);
        }
        printf("\n");
    }
}
```

<u>Program 9</u>:-

```
#include<stdio.h>

void topological_sort(int n,int graph[][n],int visited[],int stack[],int node,int *top){
    visited[node] = 1;
    for(int i=0;i < n;i++){
        if(graph[node][i] == 1 && visited[i] == 0)
            topological_sort(n,graph,visited,stack,i,top);
    }
    stack[*top] = node;
    *top = *top + 1;
}

int main(){
    int n,i,j,val;
    printf("Enter the number of node: ");
    scanf("%d",&n);
    int graph[n][n],stack[n],visited[n],top=0;
    for(i = 0;i < n;i++){
        for(j = 0;j< n;j++){
            printf("enter the edge for %d and %d: ",i,j);
            scanf("%d",&val);
            graph[i][j] = val;
            // graph[j][i] = val;
        }
    }
    for(i = 0;i < n;i++){
        visited[i] = 0;
    }
    topological_sort(n,graph,visited,stack,0,&top);
    for(i=n-1;i>=0;i--){
        printf("%d ",stack[i]);
    }
}
```

Program 10:-

```
#include<stdio.h>

void insert_edge(int arr1[],int arr2[]){
    for(int i=0;i<3;i++){
        arr1[i] = arr2[i];
    }
}

void right_shift(int edges[][3],int start,int end){
    int i;
    for(i=start;i > end; i--){
        insert_edge(edges[i],edges[i-1]);
    }
}

int getParent(int parent[], int node){
    if(parent[node] == node)
        return node;
    parent[node] = getParent(parent,parent[node]);
    return parent[node];
}

void union_node(int parent[],int rank[],int node1,int node2){
    int parent_node1 = getParent(parent,node1);
    int parent_node2 = getParent(parent,node2);

    if(rank[parent_node1] > rank[parent_node2])
        parent[parent_node2] = parent_node1;
    else if(rank[parent_node2] > rank[parent_node1])
        parent[parent_node1] = parent_node2;
    else {
        parent[parent_node2] = parent_node1;
        rank[parent_node1]++;
    }
}

int mst(int n, int graph[][n], int parent[], int rank[]){
    int i,j,k,edges[n*n][3],last_index = 0;
    for(i=0;i<n;i++){
        for(j=i + 1;j<n;j++){
            if(graph[i][j] != 0){
                int arr[3] = {i,j,graph[i][j]};
            if(last_index == 0){
                insert_edge(edges[last_index],arr);
                last_index++;
            } else {
                if(edges[last_index-1][2] < graph[i][j]){
                    insert_edge(edges[last_index],arr);
                    last_index++;
                } else {
                    for(k=0;k<last_index;k++){
                        if(graph[i][j] < edges[k][2]){
                            right_shift(edges,last_index,k);
                            last_index++;
                            insert_edge(edges[k],arr);
                            break;
                        }
                    }
                }
            }
        }
    }
}

int weight = 0;
for(i = 0; i < last_index; i++){
    int parent1 = getParent(parent,edges[i][0]);
    int parent2 = getParent(parent,edges[i][1]);
    if(parent1 != parent2){
        union_node(parent, rank, edges[i][0], edges[i][1]);
        weight += edges[i][2];
    }
}
```

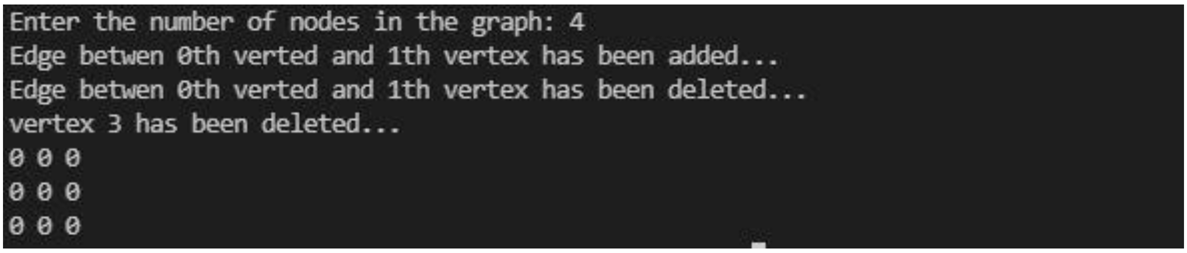
```
    return weight;
}

int main(){
    int n;
    printf("Enter the number of nodes in the graph: ");
    scanf("%d",&n);

    int i,j,graph[n][n],val;
    for(i=0;i<n;i++){
        for(j=i;j<n;j++){
            printf("Enter the weight for the edge %d<-->%d: ",i,j);
            scanf("%d",&val);
            graph[i][j] = val;
            graph[j][i] = val;
        }
    }
    int parent[n],rank[n];
    for(i=0;i<n;i++){
        parent[i] = i;
        rank[i] = 0;
    }
    int mst_weight = mst(n,graph, parent, rank);
    printf("The weight of the minimum spanning tree of this graph is: %d",mst_weight);
    return 0;
}
```

Program 11:-

```
#include<stdio.h>
#define INT_MAX 1000009
```

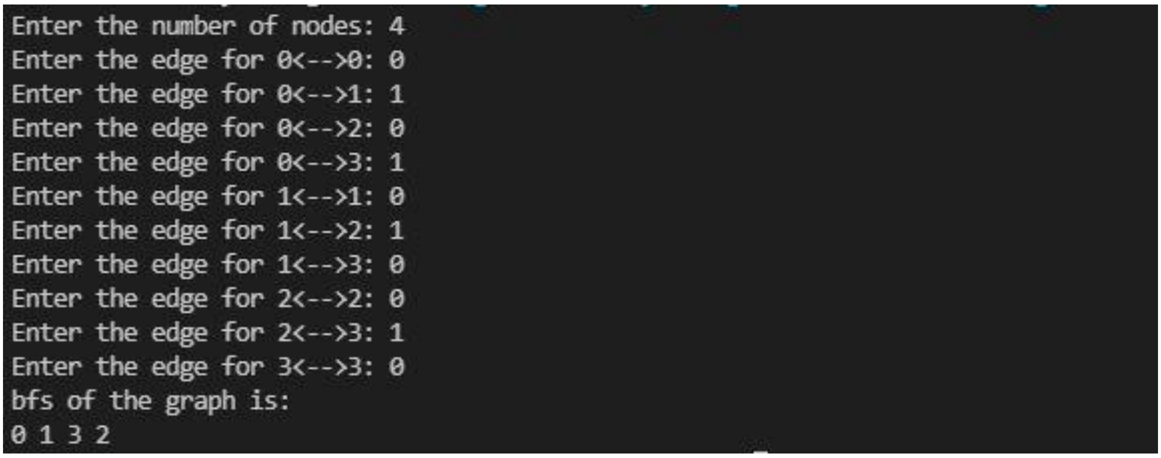
```
int prims_mst(int n, int graph[][n], int key[], int mst[], int parent[]){
    int j, sum = 0;
    for(j = 0; j < n; j++){
        int i, u = -1, min_val = INT_MAX;

        for(i = 0; i < n; i++){
            if(mst[i] == 0 && key[i] < min_val){
                min_val = key[i];
                u = i;
            }
        }

        mst[u] = 1;

        for(i = 0; i < n; i++){
            if(mst[i] == 0 && graph[u][i] != 0 && key[i] > graph[u][i]){
                key[i] = graph[u][i];
                parent[i] = u;
            }
        }
    }
    for(j = 0; j < n; j++)
        sum += key[j];

    return sum;
}

int main(){
    int n;
    printf("Enter the number of nodes in the graph: ");
    scanf("%d",&n);

    int i,j,graph[n][n],val;
    for(i=0;i<n;i++){
        for(j=i;j<n;j++){
            printf("Enter the weight for the edge %d<-->%d: ",i,j);
            scanf("%d",&val);
            graph[i][j] = val;
            graph[j][i] = val;
        }
    }

    int key[n],mst[n],parent[n];
    for(i = 0; i < n; i++){
        key[i] = INT_MAX;
        mst[i] = 0;
        parent[i] = -1;
    }
    key[0] = 0;

    int min_weight = prims_mst(n,graph,key,mst,parent);
    printf("The weight of the minimum spanning tree of this graph is: %d",min_weight);

    return 0;
}
```

Output 1 & Output 2 & Output 3 & Output 4:-



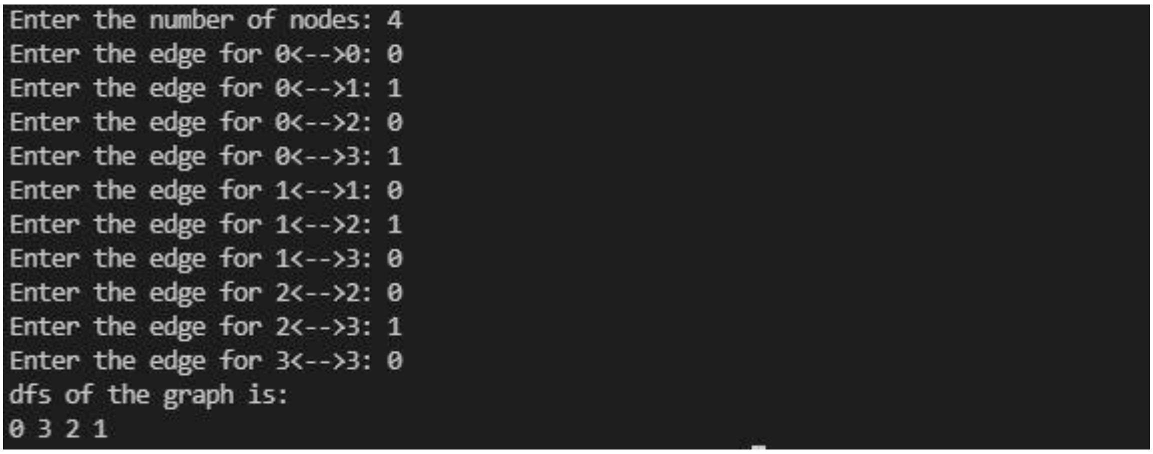
```
Enter the number of nodes in the graph: 4
Edge betwen 0th verted and 1th vertex has been added...
Edge betwen 0th verted and 1th vertex has been deleted...
vertex 3 has been deleted...
0 0 0
0 0 0
0 0 0
```

Output 5:-



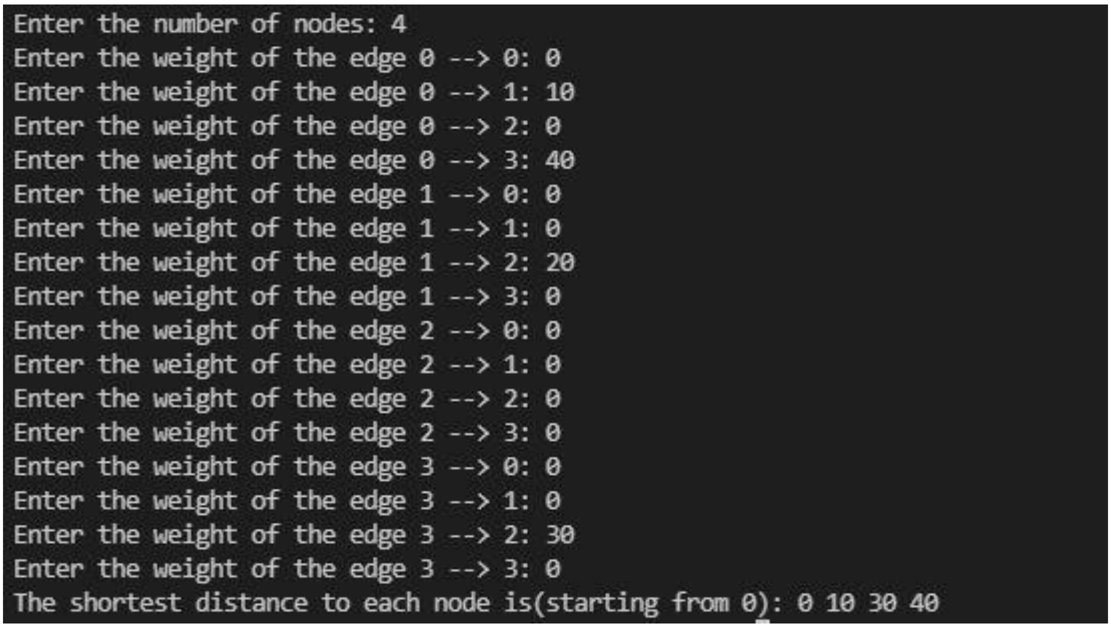
```
Enter the number of nodes: 4
Enter the edge for 0<-->0: 0
Enter the edge for 0<-->1: 1
Enter the edge for 0<-->2: 0
Enter the edge for 0<-->3: 1
Enter the edge for 1<-->1: 0
Enter the edge for 1<-->2: 1
Enter the edge for 1<-->3: 0
Enter the edge for 2<-->2: 0
Enter the edge for 2<-->3: 1
Enter the edge for 3<-->3: 0
bfs of the graph is:
0 1 3 2
```

Output 6:-



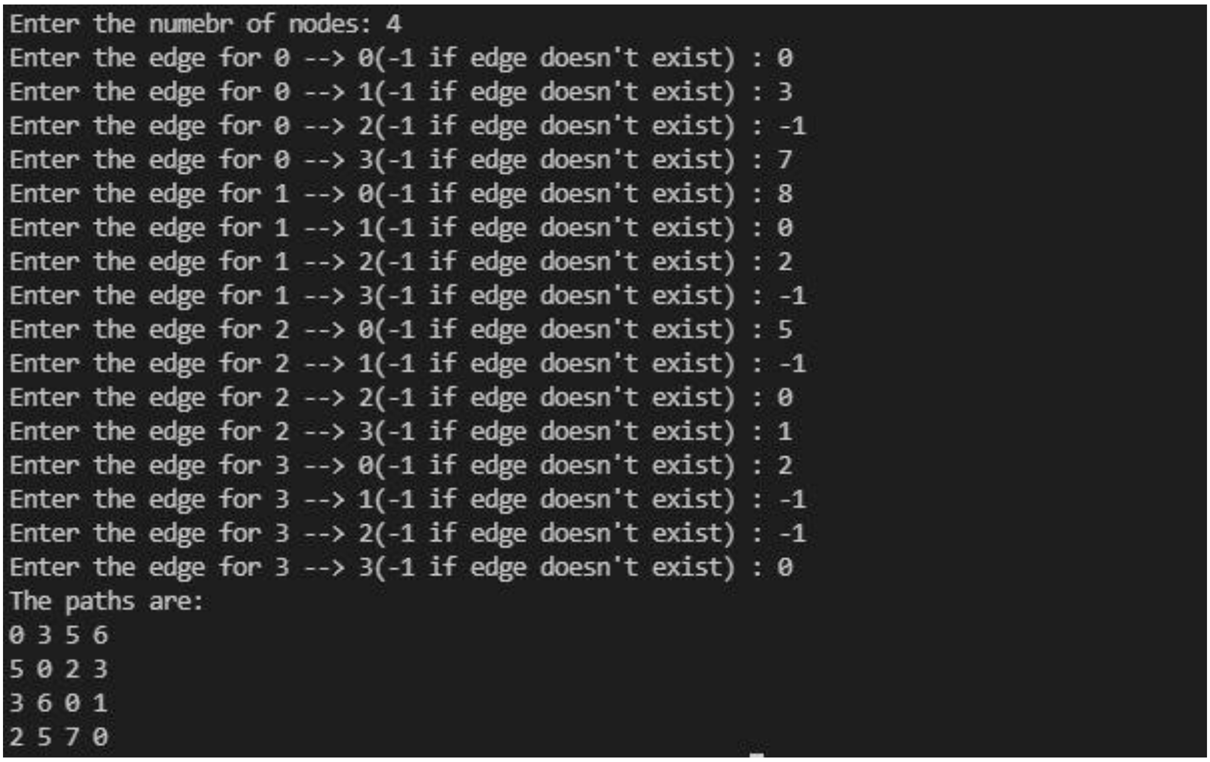
```
Enter the number of nodes: 4
Enter the edge for 0<-->0: 0
Enter the edge for 0<-->1: 1
Enter the edge for 0<-->2: 0
Enter the edge for 0<-->3: 1
Enter the edge for 1<-->1: 0
Enter the edge for 1<-->2: 1
Enter the edge for 1<-->3: 0
Enter the edge for 2<-->2: 0
Enter the edge for 2<-->3: 1
Enter the edge for 3<-->3: 0
dfs of the graph is:
0 3 2 1
```

Output 7:-



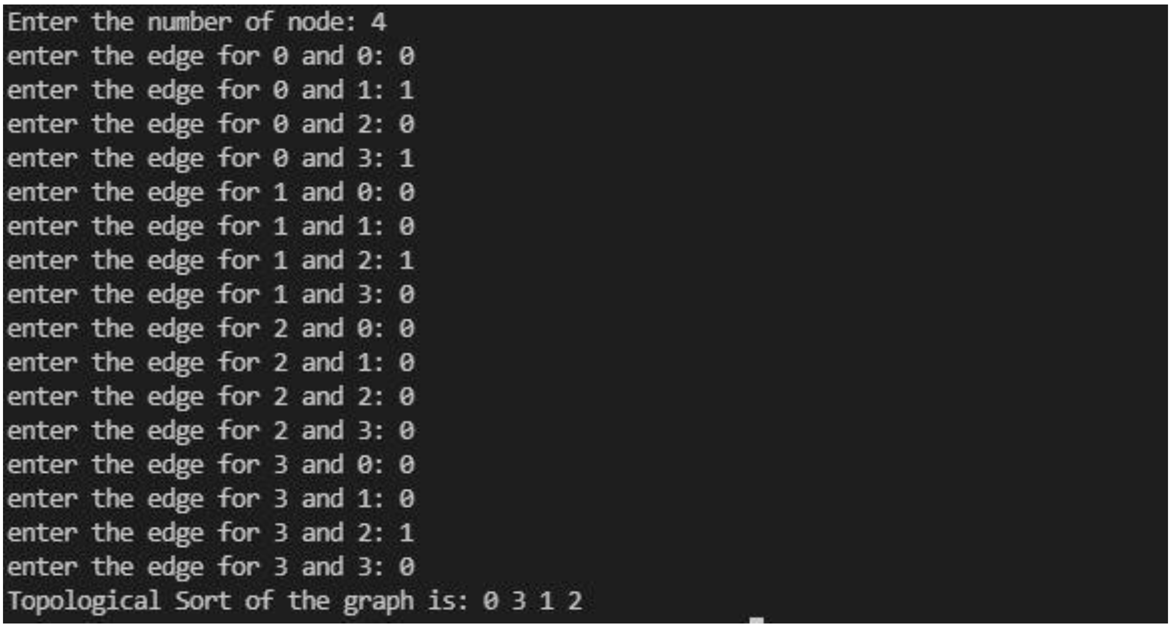
```
Enter the number of nodes: 4
Enter the weight of the edge 0 --> 0: 0
Enter the weight of the edge 0 --> 1: 10
Enter the weight of the edge 0 --> 2: 0
Enter the weight of the edge 0 --> 3: 40
Enter the weight of the edge 1 --> 0: 0
Enter the weight of the edge 1 --> 1: 0
Enter the weight of the edge 1 --> 2: 20
Enter the weight of the edge 1 --> 3: 0
Enter the weight of the edge 2 --> 0: 0
Enter the weight of the edge 2 --> 1: 0
Enter the weight of the edge 2 --> 2: 0
Enter the weight of the edge 2 --> 3: 0
Enter the weight of the edge 3 --> 0: 0
Enter the weight of the edge 3 --> 1: 0
Enter the weight of the edge 3 --> 2: 30
Enter the weight of the edge 3 --> 3: 0
The shortest distance to each node is(starting from 0): 0 10 30 40
```

Output 8:-



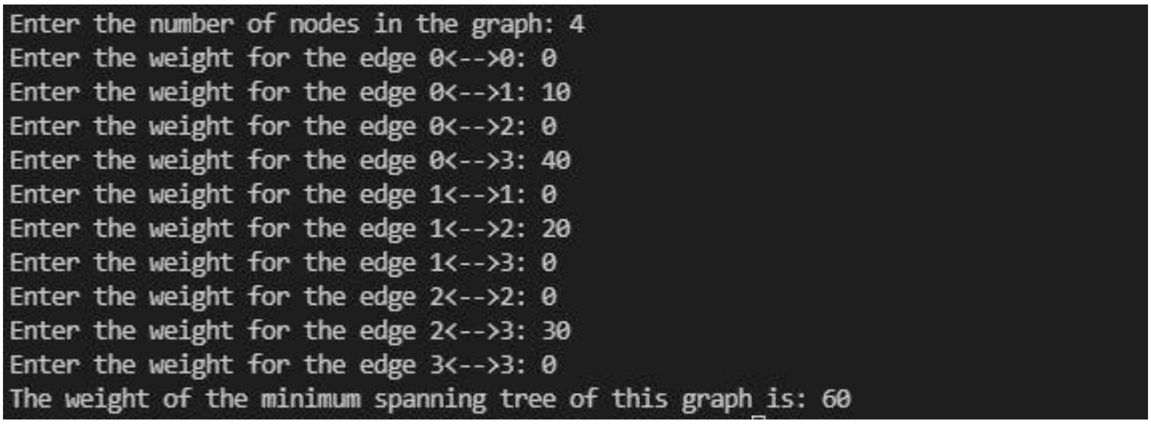
```
Enter the numebr of nodes: 4
Enter the edge for 0 --> 0(-1 if edge doesn't exist) : 0
Enter the edge for 0 --> 1(-1 if edge doesn't exist) : 3
Enter the edge for 0 --> 2(-1 if edge doesn't exist) : -1
Enter the edge for 0 --> 3(-1 if edge doesn't exist) : 7
Enter the edge for 1 --> 0(-1 if edge doesn't exist) : 8
Enter the edge for 1 --> 1(-1 if edge doesn't exist) : 0
Enter the edge for 1 --> 2(-1 if edge doesn't exist) : 2
Enter the edge for 1 --> 3(-1 if edge doesn't exist) : -1
Enter the edge for 2 --> 0(-1 if edge doesn't exist) : 5
Enter the edge for 2 --> 1(-1 if edge doesn't exist) : -1
Enter the edge for 2 --> 2(-1 if edge doesn't exist) : 0
Enter the edge for 2 --> 3(-1 if edge doesn't exist) : 1
Enter the edge for 3 --> 0(-1 if edge doesn't exist) : 2
Enter the edge for 3 --> 1(-1 if edge doesn't exist) : -1
Enter the edge for 3 --> 2(-1 if edge doesn't exist) : -1
Enter the edge for 3 --> 3(-1 if edge doesn't exist) : 0
The paths are:
0 3 5 6
5 0 2 3
3 6 0 1
2 5 7 0
```

Output 9:-



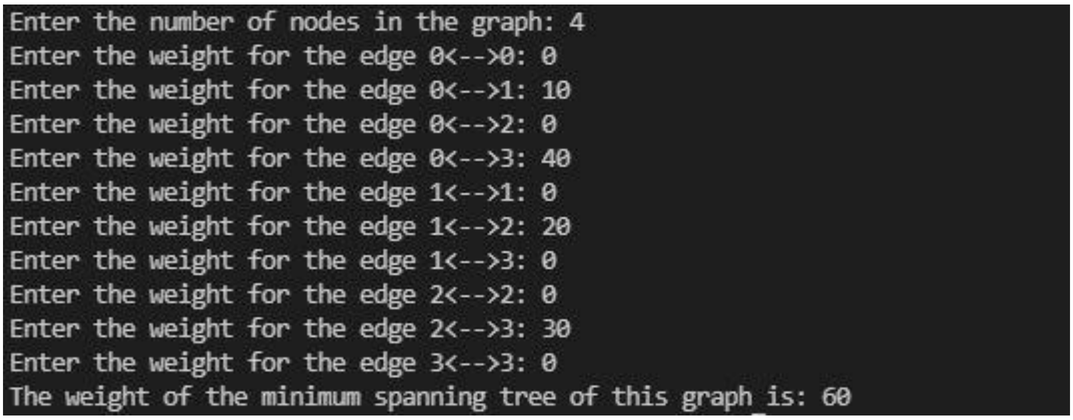
```
Enter the number of node: 4
enter the edge for 0 and 0: 0
enter the edge for 0 and 1: 1
enter the edge for 0 and 2: 0
enter the edge for 0 and 3: 1
enter the edge for 1 and 0: 0
enter the edge for 1 and 1: 0
enter the edge for 1 and 2: 1
enter the edge for 1 and 3: 0
enter the edge for 2 and 0: 0
enter the edge for 2 and 1: 0
enter the edge for 2 and 2: 0
enter the edge for 2 and 3: 0
enter the edge for 3 and 0: 0
enter the edge for 3 and 1: 0
enter the edge for 3 and 2: 1
enter the edge for 3 and 3: 0
Topological Sort of the graph is: 0 3 1 2
```

Output 10:-



```
Enter the number of nodes in the graph: 4
Enter the weight for the edge 0<-->0: 0
Enter the weight for the edge 0<-->1: 10
Enter the weight for the edge 0<-->2: 0
Enter the weight for the edge 0<-->3: 40
Enter the weight for the edge 1<-->1: 0
Enter the weight for the edge 1<-->2: 20
Enter the weight for the edge 1<-->3: 0
Enter the weight for the edge 2<-->2: 0
Enter the weight for the edge 2<-->3: 30
Enter the weight for the edge 3<-->3: 0
The weight of the minimum spanning tree of this graph is: 60
```

Output 11:-



```
Enter the number of nodes in the graph: 4
Enter the weight for the edge 0<-->0: 0
Enter the weight for the edge 0<-->1: 10
Enter the weight for the edge 0<-->2: 0
Enter the weight for the edge 0<-->3: 40
Enter the weight for the edge 1<-->1: 0
Enter the weight for the edge 1<-->2: 20
Enter the weight for the edge 1<-->3: 0
Enter the weight for the edge 2<-->2: 0
Enter the weight for the edge 2<-->3: 30
Enter the weight for the edge 3<-->3: 0
The weight of the minimum spanning tree of this graph is: 60
```