<u>Experiment 3.2</u>

Aim: *Develop a program and analyze complexity to find shortest paths in a graph with positive edge weights using Dijkstra's algorithm.*

Objectives: *Code and analyze to find shortest paths in a graph with positive edge weights using Dijkstra.*

Input/Apparatus Used: *VS CODE*

Procedure/Algorithm:

- *Create a set sptSet (shortest path tree set) that keeps track of vertices included in the shortest-path tree, i.e., whose minimum distance from the source is calculated and finalized.Initially, this set is empty.*
- *Assign a distance value to all vertices in the input graph. Initialize all distance values as INFINITE. Assign the distance value as 0 for the source vertex so that it is picked first.*
- *While sptSet doesn't include all vertices*
- *Pick a vertex u which is not there in sptSet and has a minimum distance value.*
- *Include u to sptSet.*
- *Then update distance value of all adjacent vertices of u.*
- *To update the distance values, iterate through all adjacent vertices.*
- *For every adjacent vertex v, if the sum of the distance value of u (from source) and weight of edge u-v, is less than the distance value of v, then update the distance value of v.*

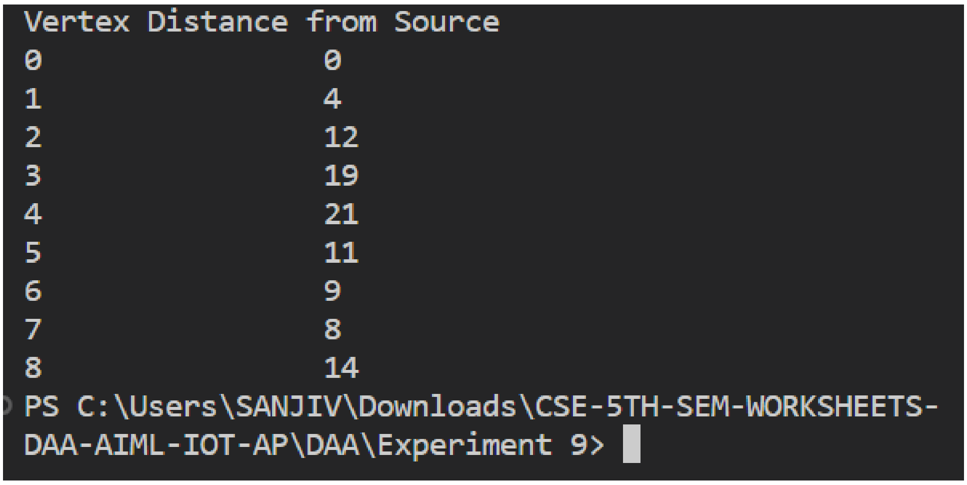
Code:

```
#include <bits/stdc++.h>
using namespace std;

#define INF 0x3f3f3f3f

typedef pair<int, int> iPair;
```

```
class Graph {
    int V;
    list<pair<int, int>>* adj;

public:
    Graph(int V);
    void addEdge(int u, int v, int w);
    void shortestPath(int src);
};

Graph::Graph(int V) {
    this->V = V;
    adj = new list<pair<int, int>>[V];
}

void Graph::addEdge(int u, int v, int w) {
    adj[u].push_back(make_pair(v, w));
    adj[v].push_back(make_pair(u, w));
}

void Graph::shortestPath(int src) {
    priority_queue<iPair, vector<iPair>, greater<iPair>> pq;
    vector<int> dist(V, INF);
    pq.push(make_pair(0, src));
    dist[src] = 0;

    while (!pq.empty()) {
        int u = pq.top().second;
        pq.pop();
        for (auto i = adj[u].begin(); i != adj[u].end(); ++i) {
            int v = (*i).first;
            int weight = (*i).second;
            if (dist[v] > dist[u] + weight) {
                dist[v] = dist[u] + weight;
                pq.push(make_pair(dist[v], v));
            }
        }
    }

    printf("Vertex Distance from Source\n");
    for (int i = 0; i < V; ++i) {
        printf("%d \t\t %d\n", i, dist[i]);
    }
}

int main() {
    int V = 9;
    Graph g(V);

    g.addEdge(0, 1, 4);
    g.addEdge(0, 7, 8);
    g.addEdge(1, 2, 8);
    g.addEdge(1, 7, 11);
    g.addEdge(2, 3, 7);
    g.addEdge(2, 8, 2);
    g.addEdge(2, 5, 4);
    g.addEdge(3, 4, 9);
    g.addEdge(3, 5, 14);
    g.addEdge(4, 5, 10);
    g.addEdge(5, 6, 2);
    g.addEdge(6, 7, 1);
    g.addEdge(6, 8, 6);
    g.addEdge(7, 8, 7);
```

```
        g.shortestPath(0);

        return 0;
}
```

Observations/Outcome :



```
Vertex Distance from Source
0                0
1                4
2                12
3                19
4                21
5                11
6                9
7                8
8                14
PS C:\Users\SANJIV\Downloads\CSE-5TH-SEM-WORKSHEETS-
DAA-AIML-IOT-AP\DAA\Experiment 9>
```

Time Complexity:

- *Time Complexity: O(E * logV), Where E is the number of edges and V is the number of vertices.*