EXPERIMENT NO.5

Minimum Scanning Tree

Reg. No.:-24141045

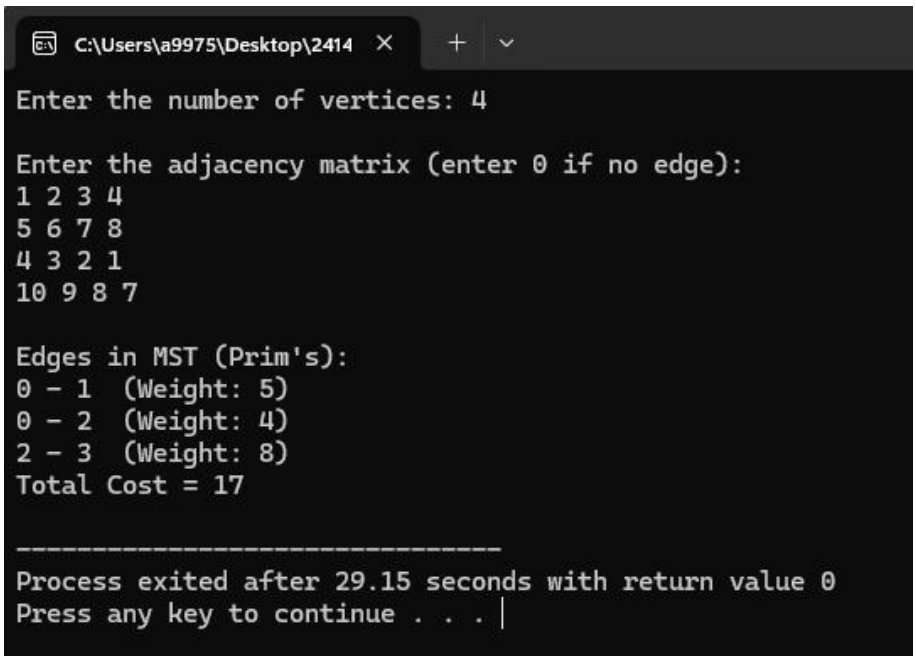
Program:-

```
#include <iostream>
#include <vector>
#include <climits>
using namespace std;
int findMinVertex(vector<int>& weights, vector<bool>& visited, int n) {
   int minVertex = -1;
   for (int i = 0; i < n; i++) {
      if (!visited[i] && (minVertex == -1 || weights[i] < weights[minVertex]))
         minVertex = i;
   }
   return minVertex;
}
void prims(vector<vector<int> >& graph, int n) {
   vector<int> parent(n);
   vector<int> weights(n, INT_MAX);
   vector<bool> visited(n, false);
   parent[0] = -1;
   weights[0] = 0;
```

```
    for (int i = 0; i < n - 1; i++) {
        int minVertex = findMinVertex(weights, visited, n);
        visited[minVertex] = true;
        for (int j = 0; j < n; j++) {
            if (graph[minVertex][j] != 0 && !visited[j]) {
                if (graph[minVertex][j] < weights[j]) {
                    weights[j] = graph[minVertex][j];
                    parent[j] = minVertex;
                }
            }
        }
    }
    cout << "\nEdges in MST (Prim's):\n";
    int totalWeight = 0;
    for (int i = 1; i < n; i++) {
        cout << parent[i] << " - " << i << "  (Weight: " << graph[i][parent[i]] << ")\n";
        totalWeight += graph[i][parent[i]];
    }
    cout << "Total Cost = " << totalWeight << endl;
}
int main() {
    int n;
    cout << "Enter the number of vertices: ";
```

```
    cin >> n;
    vector< vector<int> >graph(n, vector<int>(n));
    cout << "\nEnter the adjacency matrix (enter 0 if no edge):\n";
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            cin >> graph[i][j];
        }
    }
    prims(graph, n);
    return 0;
}
}
```

Output:-



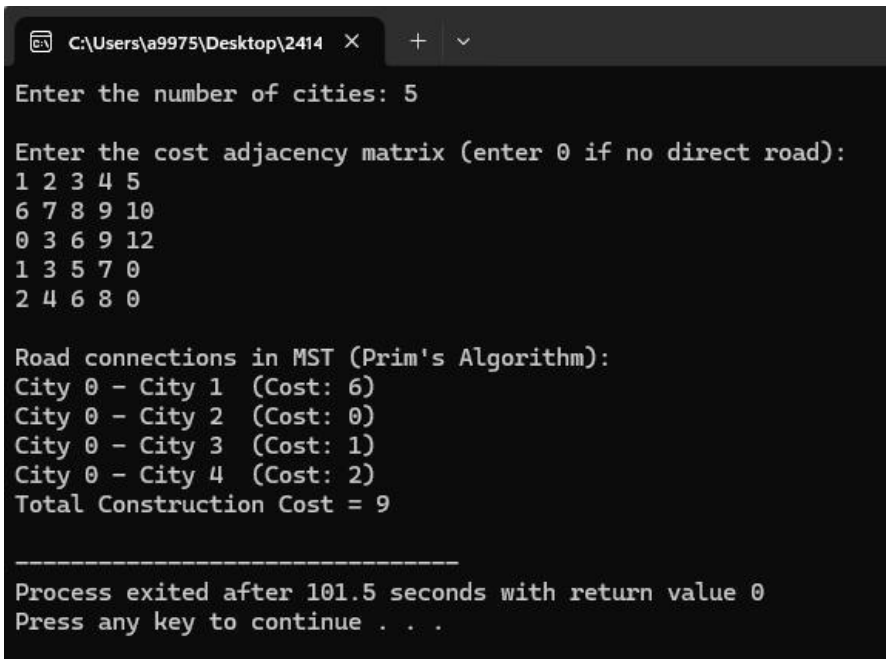
Application:-

```
#include <iostream>
#include <vector>
#include <climits>
using namespace std;
int findMinVertex(vector<int>& weights, vector<bool>& visited, int n) {
   int minVertex = -1;
   for (int i = 0; i < n; i++) {
      if (!visited[i] && (minVertex == -1 || weights[i] < weights[minVertex]))
         minVertex = i;
   }
   return minVertex;
}
void prims(vector <vector< int > >& graph, int n) {
   vector<int> parent(n);
   vector<int> weights(n, INT_MAX);
   vector<bool> visited(n, false);
   parent[0] = -1;
   weights[0] = 0;
   for (int i = 0; i < n - 1; i++) {
      int minVertex = findMinVertex(weights, visited, n);
      visited[minVertex] = true;
      for (int j = 0; j < n; j++) {
         if (graph[minVertex][j] != 0 && !visited[j]) {
```

```
            if (graph[minVertex][j] < weights[j]) {
                weights[j] = graph[minVertex][j];
                parent[j] = minVertex;
            }
        }
    }
    cout << "\nRoad connections in MST (Prim's Algorithm):\n";
    int totalCost = 0;
    for (int i = 1; i < n; i++) {
        cout << "City " << parent[i] << " - City " << i
             << "  (Cost: " << graph[i][parent[i]] << ")\n";
        totalCost += graph[i][parent[i]];
    }
    cout << "Total Construction Cost = " << totalCost << endl;
}
int main() {
    int n;
    cout << "Enter the number of cities: ";
    cin >> n;
    vector< vector< int > > graph(n, vector<int>(n));
    cout << "\nEnter the cost adjacency matrix (enter 0 if no direct road):\n";
    for (int i = 0; i < n; i++) {
```

```
    for (int j = 0; j < n; j++) {
        cin >> graph[i][j];
    }
  }
  prims(graph, n);
  return 0;
}
```

Output:-



Program:-

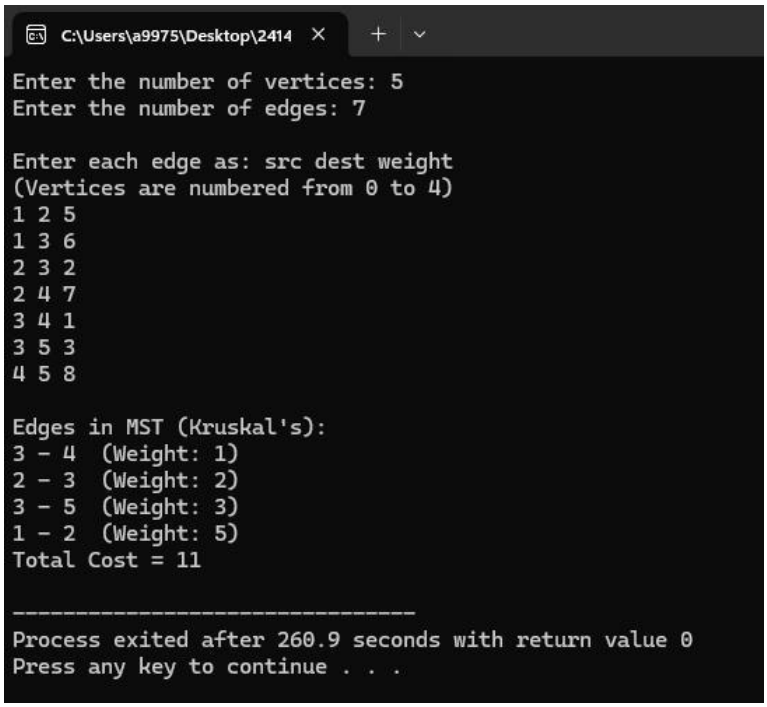
```
#include <iostream>
#include <vector>
#include <algorithm>
Using namespace std;
Struct Edge {
```

```
    Int src, dest, weight;
};
Bool compare(Edge a, Edge b) {
    Return a.weight < b.weight;
}
Int findParent(int v, vector<int>& parent) {
    If (parent[v] == v)
        Return v;
    Return parent[v] = findParent(parent[v], parent);
}
Void kruskal(vector<Edge>& edges, int n) {
    Sort(edges.begin(), edges.end(), compare);
    Vector<int> parent(n);
    For (int i = 0; i < n; i++) parent[i] = i;
    Vector<Edge> mst;
Int i ;
    Int totalWeight = 0;
    For (i=0; i<edges.size(); i++) {
        Int srcParent = findParent(edges[i].src, parent);
        Int destParent = findParent(edges[i].dest, parent);
        If (srcParent != destParent) {
            Mst.push_back(edges[i]);
            totalWeight += edges[i].weight;
```

```
        parent[srcParent] = destParent;
      }
    }
    Cout << “\nEdges in MST (Kruskal’s):\n”;
    For (i=0; i<mst.size(); i++) {
      Cout << edges[i].src << “ – “ << edges[i].dest << “  (Weight: “ <<
edges[i].weight << “)\n”;
    }
    Cout << “Total Cost = “ << totalWeight << endl;
}
Int main() {
    Int n, e;
    Cout << “Enter the number of vertices: “;
    Cin >> n;
    Cout << “Enter the number of edges: “;
    Cin >> e;
    Vector< Edge > edges(e);
    Cout << “\nEnter each edge as: src dest weight\n”;
    Cout << “(Vertices are numbered from 0 to “ << n-1 << “)\n”;
    For (int i = 0; i < e; i++) {
      Cin >> edges[i].src >> edges[i].dest >> edges[i].weight;
    }
    kruskal(edges, n);
```

```
    return 0;
}
```

Output:-



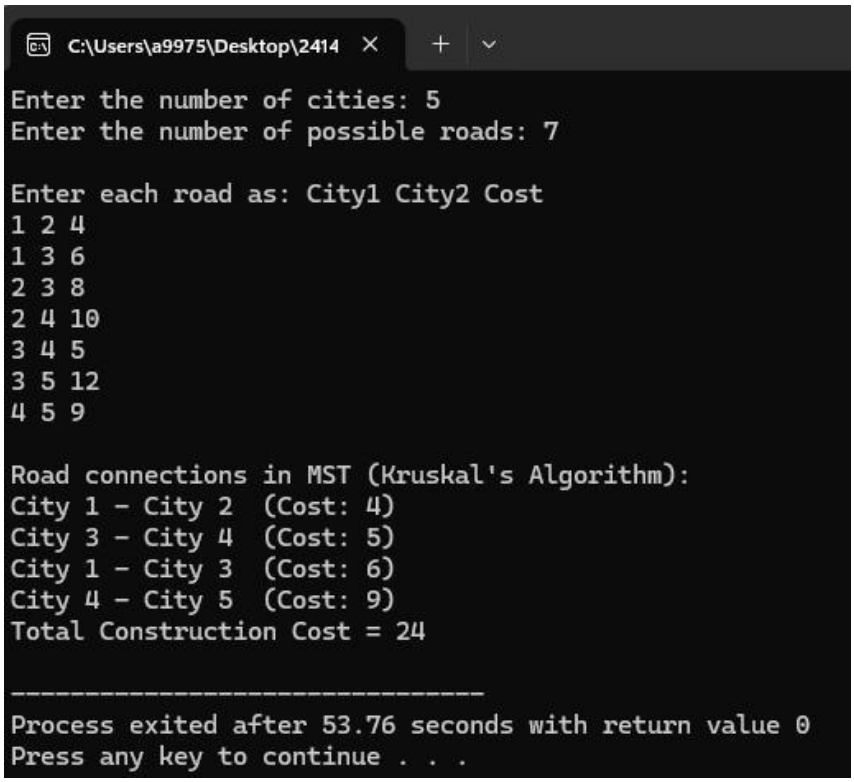
Application:-

```
#include <iostream>
#include <vector>
#include <algorithm>
Using namespace std;
Struct Edge {
   Int src, dest, weight;
};
Bool compare(Edge a, Edge b) {
```

```
    Return a.weight < b.weight;
}
Int findParent(int v, vector<int>& parent) {
    If (parent[v] == v)
        Return v;
    Return parent[v] = findParent(parent[v], parent);
}
Void kruskal(vector<Edge>& edges, int n) {
    Sort(edges.begin(), edges.end(), compare);
    Vector<int> parent(n);
    For (int i = 0; i < n; i++)
        Parent[i] = i;
    Vector<Edge> mst;
    Int totalCost = 0;
    For (int i = 0; i < edges.size(); i++) {
        Int srcParent = findParent(edges[i].src, parent);
        Int destParent = findParent(edges[i].dest, parent);
        If (srcParent != destParent) {
            Mst.push_back(edges[i]);
            totalCost += edges[i].weight;
            parent[srcParent] = destParent;
        }
    }
```

```
    Cout << “\nRoad connections in MST (Kruskal’s Algorithm):\n”;
    For (int i = 0; i < mst.size(); i++) {
        Cout << “City “ << mst[i].src << “ – City “ << mst[i].dest
            << “  (Cost: “ << mst[i].weight << “)\n”;
    }
    Cout << “Total Construction Cost = “ << totalCost << endl;
}
Int main() {
    Int n, e;
    Cout << “Enter the number of cities: “;
    Cin >> n;
    Cout << “Enter the number of possible roads: “;
    Cin >> e;
    Vector<Edge> edges(e);
    Cout << “\nEnter each road as: City1 City2 Cost\n”;
    For (int i = 0; i < e; i++) {
        Cin >> edges[i].src >> edges[i].dest >> edges[i].weight;
    }
    Kruskal(edges, n);
    Return 0;
}
```

Output:-



Prim's Algorithm:-

Algorithm Steps:

1. Pick an arbitrary starting vertex.
2. Mark it as visited (add to MST set).
3. From all edges that connect visited to unvisited vertices, choose the minimum-weight edge.
4. Add the chosen edge and the new vertex to the MST set.
5. Repeat steps 3–4 until all vertices are included.

Time Complexity:

With adjacency matrix → $O(V^2)$

With min-heap + adjacency list → $O(E \log V)$

Kruskal's Algorithm:-

Algorithm Steps:-

1. Sort all edges in non-decreasing order of their weights.

2. Initialize an empty MST (no edges).

3. For each edge (u, v):

If adding (u, v) does not form a cycle (use Disjoint Set/Union-Find to check), then include it in the MST.

4. Stop when you have (V – 1) edges in the MST.

Time Complexity:

Sorting edges → O(E log E) ≈ O(E log V).

Union-Find operations → nearly O(1) each (amortized)

List of Applications:-

Applications of Prim's Algorithm

- Network design (like LAN, WAN, or telecommunication)
- Designing least-cost spanning trees
- Electrical grid and circuit design
- Cluster analysis in data science
- Approximation algorithms for NP-hard problems (like TSP)

Applications of Kruskal's Algorithm

- Network and road connectivity design
- Laying cables or pipelines with minimal cost
- Image segmentation in computer vision
- Constructing hierarchical clustering trees
- Designing railway or transportation networks