Program –

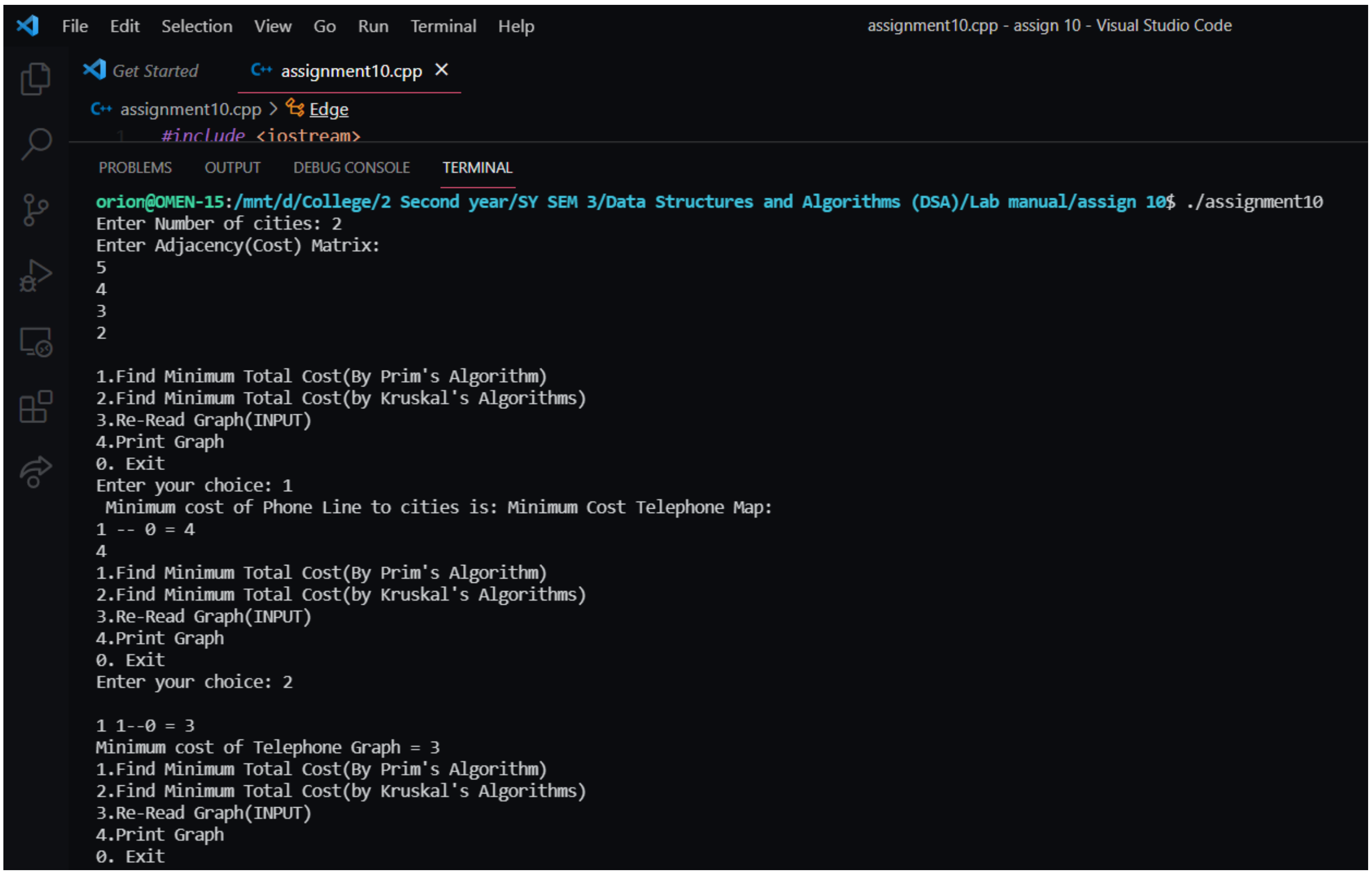
```
#include <iostream>
#include <iomanip>
using namespace std;
const int MAX = 10;
class EdgeList;
//forward declaration
class Edge //USED IN KRUSKAL
{
    int u, v, w;

public:
    Edge() {}
    //Empty Constructor
    Edge(int a, int b, int weight)
    {
        u = a;
        v = b;
        w = weight;
    }
    friend class EdgeList;
    friend class PhoneGraph;
};
//---- EdgeList Class ----------
class EdgeList
{
    Edge data[MAX];
    int n;

public:
    friend class PhoneGraph;
    EdgeList()
    {
        n = 0;
    }
    void sort();
    void print();
};
//----Bubble Sort for sorting edges in increasing weights' order
void EdgeList::sort()
{
    Edge temp;
    for (int i = 1; i < n; i++)
        for (int j = 0; j < n - 1; j++)
            if (data[j].w > data[j + 1].w)
            {
                temp = data[j];
                data[j] = data[j + 1];
                data[j + 1] = temp;
            }
}
void EdgeList::print()
{
    int cost = 0;
    for (int i = 0; i < n; i++)
    {
        cout << "\n"
             << i + 1 << " " << data[i].u << "--" << data[i].v << " = " << data[i].w;
        cost = cost + data[i].w;
    }
    cout << "\nMinimum cost of Telephone Graph = " << cost;
}
// Phone Graph Class
class PhoneGraph
{
    int data[MAX][MAX];
    int n;

public:
    PhoneGraph(int num)
    {
        n = num;
    }
    void readgraph();
    void printGraph();
    int mincost(int cost[], bool visited[]);
    int prim();
    void kruskal(EdgeList &spanlist);
    int find(int belongs[], int vertexno);
    void unionComp(int belongs[], int c1, int c2);
};
void PhoneGraph::readgraph()
{
    cout << "Enter Adjacency(Cost) Matrix: \n";
    for (int i = 0; i < n; i++)
    {
        for (int j = 0; j < n; j++)
            cin >> data[i][j];
    }
}
void PhoneGraph::printGraph()
{
    cout << "\nAdjacency (COST) Matrix: \n";
    for (int i = 0; i < n; i++)
    {
        for (int j = 0; j < n; j++)
        {
            cout << setw(3) << data[i][j];
        }
        cout << endl;
    }
}
int PhoneGraph::mincost(int cost[], bool visited[]) //finding vertex with minimum cost
{
    int min = 9999, min_index; //initialize min to MAX value(ANY) as temporary
    for (int i = 0; i < n; i++)
    {
        if (visited[i] == 0 && cost[i] < min)
        {
            min = cost[i];
            min_index = i;
        }
    }
    return min_index; //return index of vertex which is not visited and having minimum cost
}
int PhoneGraph::prim()
{
    bool visited[MAX];
    int parents[MAX];
    int cost[MAX]; //saving minimum cost
    for (int i = 0; i < n; i++)
    {
        cost[i] = 9999; //set cost as infinity/MAX_VALUE
        visited[i] = 0; //initialize visited array to false
    }
    cost[0] = 0;     //starting vertex cost
    parents[0] = -1; //make first vertex as a root
    for (int i = 0; i < n - 1; i++)
    {
        int k = mincost(cost, visited);
        visited[k] = 1;
        for (int j = 0; j < n; j++)
        {
            if (data[k][j] && visited[j] == 0 && data[k][j] < cost[j])
            {
                parents[j] = k;
                cost[j] = data[k][j];
            }
        }
    }
    cout << "Minimum Cost Telephone Map:\n";
    for (int i = 1; i < n; i++)
    {
        cout << i << " -- " << parents[i] << " = " << cost[i] << endl;
    }
    int mincost = 0;
    for (int i = 1; i < n; i++)
        mincost += cost[i]; //data[i][parents[i]];
    return mincost;
}
// ------- Kruskal's Algorithm
void PhoneGraph::kruskal(EdgeList &spanlist)
{
    int belongs[MAX]; //Separate Components at start (No Edges, Only vertices)
    int cno1, cno2;   //Component 1 & 2
    EdgeList elist;
    for (int i = 1; i < n; i++)
        for (int j = 0; j < i; j++)
        {
            if (data[i][j] != 0)
            {
                elist.data[elist.n] = Edge(i, j, data[i][j]); //constructor for initializing
edge
                elist.n++;
            }
        }
    elist.sort(); //sorting in increasing weight order
    for (int i = 0; i < n; i++)
        belongs[i] = i;
    for (int i = 0; i < elist.n; i++)
    {
        cno1 = find(belongs, elist.data[i].u); //find set of u
        cno2 = find(belongs, elist.data[i].v); ////find set of v
        if (cno1 != cno2)                      //if u & v belongs to different sets
        {
            spanlist.data[spanlist.n] = elist.data[i]; //ADD Edge to spanlist
            spanlist.n = spanlist.n + 1;
            unionComp(belongs, cno1, cno2); //ADD both components to same set
        }
    }
}
void PhoneGraph::unionComp(int belongs[], int c1, int c2)
{
    for (int i = 0; i < n; i++)
    {
        if (belongs[i] == c2)
            belongs[i] = c1;
    }
}
int PhoneGraph::find(int belongs[], int vertexno)
{
    return belongs[vertexno];
}
// MAIN PROGRAM
int main()
{
    int vertices, choice;
    EdgeList spantree;
    cout << "Enter Number of cities: ";
    cin >> vertices;
    PhoneGraph p1(vertices);
    p1.readgraph();
    do
    {
        cout << "\n1.Find Minimum Total Cost(By Prim's Algorithm)"
             << "\n2.Find Minimum Total Cost(by Kruskal's Algorithms)"
             << "\n3.Re-Read Graph(INPUT)"
             << "\n4.Print Graph"
             << "\n0. Exit"
             << "\nEnter your choice: ";
        cin >> choice;
        switch (choice)
        {
        case 1:
            cout << " Minimum cost of Phone Line to cities is: " << p1.prim();
            break;
        case 2:
            p1.kruskal(spantree);
            spantree.print();
            break;
        case 3:
            p1.readgraph();
            break;
        case 4:
            p1.printGraph();
            break;
        default:
            cout << "\nWrong Choice!!!";
        }
    } while (choice != 0);
    return 0;
}
```

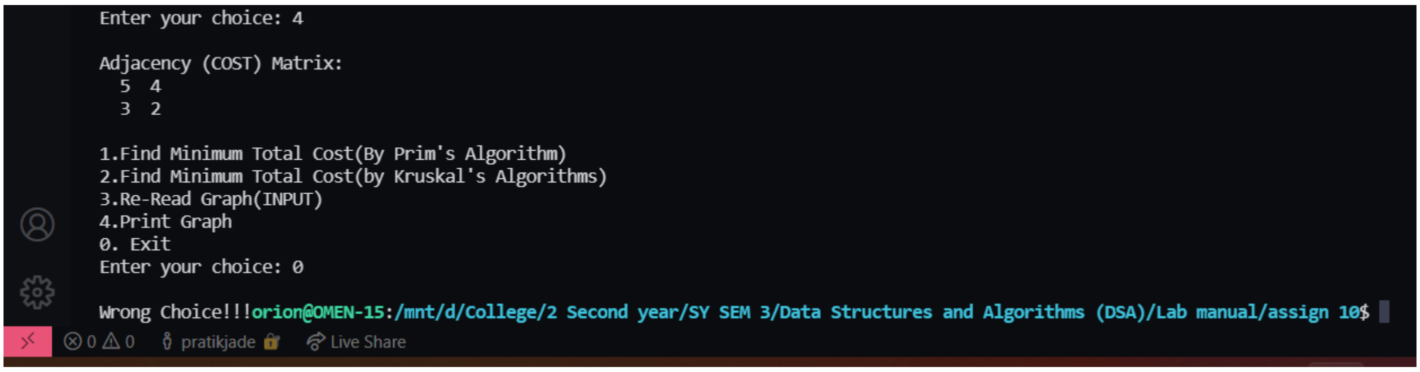
Output-



```
orion@OMEN-15:/mnt/d/College/2 Second year/SY SEM 3/Data Structures and Algorithms (DSA)/Lab manual/assign 10$ ./assignment10
Enter Number of cities: 2
Enter Adjacency(Cost) Matrix:
5
4
3
2

1.Find Minimum Total Cost(By Prim's Algorithm)
2.Find Minimum Total Cost(by Kruskal's Algorithms)
3.Re-Read Graph(INPUT)
4.Print Graph
0. Exit
Enter your choice: 1
 Minimum cost of Phone Line to cities is: Minimum Cost Telephone Map:
1 -- 0 = 4
4
1.Find Minimum Total Cost(By Prim's Algorithm)
2.Find Minimum Total Cost(by Kruskal's Algorithms)
3.Re-Read Graph(INPUT)
4.Print Graph
0. Exit
Enter your choice: 2

1 1--0 = 3
Minimum cost of Telephone Graph = 3
1.Find Minimum Total Cost(By Prim's Algorithm)
2.Find Minimum Total Cost(by Kruskal's Algorithms)
3.Re-Read Graph(INPUT)
4.Print Graph
0. Exit
```



```
Enter your choice: 4

Adjacency (COST) Matrix:
  5  4
  3  2

1.Find Minimum Total Cost(By Prim's Algorithm)
2.Find Minimum Total Cost(by Kruskal's Algorithms)
3.Re-Read Graph(INPUT)
4.Print Graph
0. Exit
Enter your choice: 0

Wrong Choice!!!orion@OMEN-15:/mnt/d/College/2 Second year/SY SEM 3/Data Structures and Algorithms (DSA)/Lab manual/assign 10$
```