Name: Ajoy Saha
Roll: 2207037

A Brief Overview of the Problem

In this assignment, we are given a directed weighted graph and a root node. Our job is to build something called a Minimum Spanning Arborescence. This is almost like a tree, but here the edges have directions.

The root node must not have any incoming edge. Every other node must have exactly one incoming edge. The arborescence must also reach all nodes that are reachable from the root. Among all the possible ways to make this structure, we want the one with the smallest total weight. If some nodes cannot be reached from the root, then the arborescence cannot be created. In that case, the program should clearly say that it is not possible.

Explanation of Edmonds' / Chu–Liu Algorithm

Edmonds' algorithm is used to find the minimum-cost arborescence in a directed graph. It works by first choosing, for every node except the root, the incoming edge that has the smallest weight. This gives each node the cheapest way to be reached. But sometimes, these chosen edges may form a cycle. A cycle is not allowed in a tree, so it must be fixed.

To fix this problem, all the nodes that are part of the cycle are joined together into one temporary node. This is called contraction. After this, the graph becomes smaller, and the cycle is treated as a single node. Some edge weights are adjusted so the total cost stays correct.

The same steps are then repeated again: pick minimum incoming edges, look for cycles, and contract again if needed. After some steps, there will be no cycles left. At this point, the chosen edges form a proper arborescence. Finally, the contracted cycles are opened back to their original form to get the complete solution.

This process makes sure that we get the minimum-cost arborescence and that all reachable nodes are included.

Test Input 1 (Valid Case):

5 6

A

A B 3

A C 5

B D 2

C E 1

B C 4

A E 10

Output:

Root: A

Edges:

A B 3

A C 5

B D 2

C E 1

Cost: 11

Test Input 2 (Impossible Case):

4 3

A

A B 2

B C 3

C B 1

Output:

Root: A

No arborescence