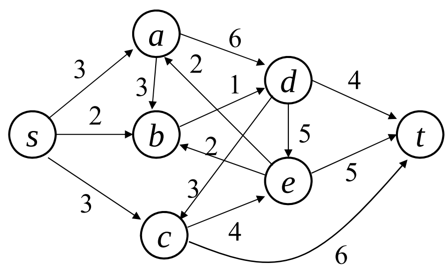
Name: Student ID: Algorithm ID:

Problem 1. (15 pts total) In the flow network shown below, the number beside an edge denotes its corresponding capacity. Apply the **Edmonds-Karp** algorithm to find a maximum flow from s to t in the network. Show **every augmentation path** and explain why the flow you found is maximum.



Problem 2. (10 pts total) Professor Chang claims the apparent paradox between statements S1 and S2. Nevertheless, he may not be wrong (i.e., both S1 and S2 could be true simultaneously). Give **two possible reasons** for this phenomenon.

S1: P $\neq$ NP. In other words, there does not exist a polynomial time algorithm for any NP-complete problem.

S2: There exists a transformation (reduction) from **some particular instance** of the NP-complete HP problem to a shortest path problem solvable by Dijkstra's algorithm.

Problem 3. (15 pts total) The Travelling Salesman Problem (TSP) is defined as follows:

- Instance: a set of n cities, distance between each pair of cities, and a bound B.
- Question: is there a route that starts and ends at a given city, visits every city exactly once, and has total distance $\leq B$?

The Hamiltonian Circuit Problem (HC) is defined as follows:

- Instance: an undirected graph $G = (V, E)$.
- Question: is there a cycle in G that includes every vertex exactly once?

The Hamiltonian Circuit Problem (HC) is known to be NP-complete. Prove that TSP is also NP-complete.