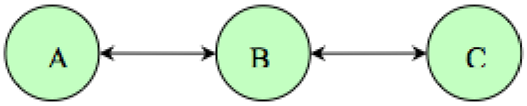
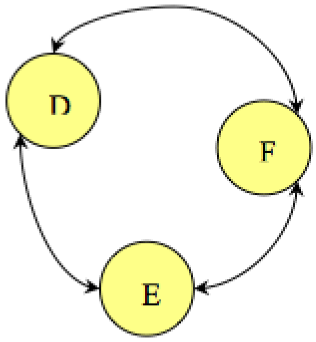
Problem 1. Consider the following networks: network I (containing nodes A, B, C) and network II (containing nodes D, E, F).





A. The Distance Vector Protocol described in class is used in both networks. Assume advertisements are sent every 5 time steps, all links are fully functional and there is no delay in the links. Nodes take zero time to process advertisements once they receive them. The HELLO protocol runs in the background every time step in a way that any changes in link connectivity are reflected in the next DV advertisement. We count time steps from t=0 time steps.

Please fill in the following table:

Event	**Number of time steps**
A's routing table has an entry for B	
A's routing table has an entry for C	
D's routing table has an entry for E	
F's routing table has an entry for D	

Problem 2. Now assume the link B-C fails at t = 51 and link D-E fails at t = 71 time steps. Please fill in this table:

Event	**Number of time steps**
B's *advertisements* reflect that C is unreachable	
A's routing table reflects C is unreachable	
D's routing table reflects a new route for E	

Problem 3. Alyssa P. Hacker manages MIT's internal network that runs link-state routing. She wants to experiment with a few possible routing strategies. Of all possible paths available to a particular destination at a node, a routing strategy specifies the path that must be picked to create a routing table entry. Below is the name Alyssa has for each strategy and a brief description of how it works.

MinCost: Every node picks the path that has the smallest sum of link costs along the path. (This is the minimum cost routing you implemented in the lab).

MinHop: Every node picks the path with the smallest number of hops (irrespective of what the cost on the links is).

SecondMinCost: Every node picks the path with the second lowest sum of link costs. That is, every node picks the second best path with respect to path costs.

MinCostSquared: Every node picks the path that has the smallest sum of squares of link costs along the path.

Assume that sufficient information (e.g., costs, delays, bandwidths, and loss probabilities of the various links) is exchanged in the link state advertisements, so that every node has complete information about the entire network and can correctly implement the strategies above. You can also assume that a link's properties don't change, e.g., it doesn't fail.

A. Help Alyssa figure out which of these strategies will work correctly, and which will result in routing with loops. In case of strategies that do result in routing loops, come up with an example network topology with a routing loop to convince Alyssa.

Problem 4. How would you implement MinCostSquared in a distance-vector protocol?

Problem 5. Alice and Bob are responsible for implementing Dijkstra's algorithm at the nodes in a network running a link-state protocol. On her nodes, Alice implements a minimum-cost algorithm. On his nodes, Bob implements a "shortest number of hops" algorithm. Give an example of a network topology with 4 or more nodes in which a routing loop occurs with Alice and Bob's implementations running simultaneously in the same network. Assume that there are no failures.

(Note: A routing loop occurs when a group of $k \geq 1$ distinct nodes, n_0 , n_1 , n_2 , …, n_(k-1) have routes such that n_i's next-hop (route) to a destination is n_(i+1 mod k).