Name ______________________ Student No. ______________________

No aids allowed. Answer all questions on test paper. Use backs of sheets if necessary.

Total Marks: **30**

[10] 1. Define the following terms:

(a) Static versus dynamic routing.

(b) Routing mechanism versus routing policy.

(c) Exterior gateway protocols versus interior gateway protocols.

(d) RIP versus OSPF

Solution: Static routing is a data communication concept describing a way of configuring path selection in computer networks, where the paths are added manually to the table of each router, and the routers do not exchange information regarding the topology of the network. In dynamic routing, aka adaptive routing, routers communicate with each other and update their routing tables accordingly.

The routing mechanism is the way the kernel performs routing at the IP layer. The routing policy is the information that goes into the routing table; it is a set of rules that defines the routing decisions made by a router. These decisions are based on the source of a packet, or its destination, the size, the protocol, or the payload.

The Internet is organized into a collection of autonomous systems, such as a corporation or a college campus. EGPs are used between routers in different ASs, while IGPs are routing protocols within an autonomous system.

Both RIP and OSPF are IGPs. RIP uses a "distance vector" and Bellman-Ford algorithm for computing shortest paths, and OSPF uses a "path vector" and the Dijkstra's greedy algorithm for computing the shortest path.

2. Suppose that we have the following network:

$$s \xrightarrow{1.0} v_1 \xrightarrow{1.1} v_2 \xrightarrow{1.2} v_3 \xrightarrow{1.3} v_4 \xrightarrow{1.4} t$$

where the costs of the edges are specified. Now suppose that we are running the "space-saving" version of the Bellman-Ford algorithm:

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1. for i=1..5
2.   for all v
3.     x := min over all (v,w) of (M[w]+c(v,w))
4.     M[v] := min{M[v],x}
5.   end for
6. end for
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How many iterations of the outer-most loop, the i for-loop, are needed before the M, the solution, stabilizes? Is it possible to send an "early" stopping signal—why or why not? Assume that in line 2 the vertices v_i are examined in reverse order: v_4, v_3, v_2, v_1.

Justify your answer.

Solution: The value of M is "stabilized" if one more iteration of the i for-loop results in *no* changes to M. It is then possible to send an "early" stopping signal.

Just two iteration are enough: if the v_i's are added in reverse order, then the values of M become:

$$\begin{aligned} M[v_4] &= 1.4 \\ M[v_3] &= 1.4 + 1.3 = 2.7 \\ M[v_2] &= 2.7 + 1.2 = 3.9 \\ M[v_1] &= 3.9 + 1.1 = 5 \\ M[s] &= 5 + 1.0 = 6 \end{aligned}$$

after the first iteration; then for $i = 2, 3, 4, 5$ the values don't change, and so the stopping signal could have been given after the second iteration, $i = 2$.

3. Suppose that we are computing the "asynchronous shortest path" in the following network:

$$\begin{tikzcd} s \arrow[r, shift left, "1"] & v \arrow[l, shift left, "1"] \arrow[r, "1"] & t \end{tikzcd}$$

Suppose that the (v, t) edge is suddenly deleted; show how this results in an unbounded sequence of updates by s and v.

Solution: $M[s] = 2$ and $M[v] = 1$; then suddenly edge (v, t) is deleted. Now v wants to update its table, and sees that edge (v, t) is gone, so decides that the "shortest path" to v is via s, and so $M[v] = 2$. But then s updates its table $M[s] = 3$, but then v updates its table $M[v] = 4$, etc. This results in "counting to infinity."