CS 421: Computer Networks **SPRING 2004**

MIDTERM II
May 5, 2004
120 minutes

Name: ______________________________

Student No: ___________________________

1)

a) (8 pts) List the reasons why Internet has a hierarchical routing architecture. **(<u>Use at most four sentences</u>)**

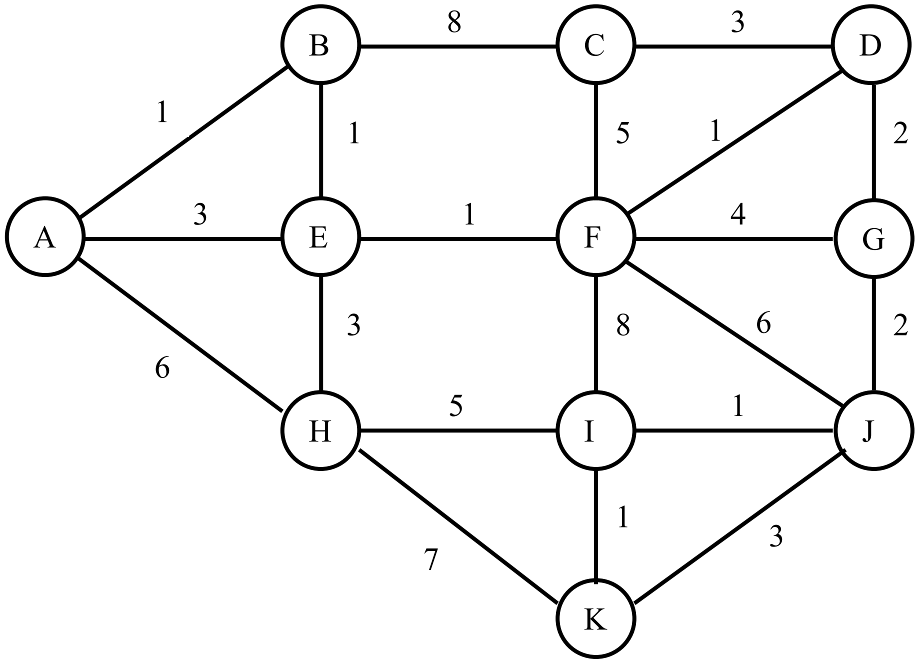
b) (8 pts) Does a link state routing such as OSPF have the counting-to-infinity problem? Why or why not? **(<u>Use at most four sentences</u>)**

c) (8 pts) Explain how the *Traceroute* program work. Specifically point out the Internet protocol(s) and IP header field(s) used by the *Traceroute*. **(<u>Use at most four sentences</u>)**

d) (6 pts) Which fields of the IP header of a packet may be changed by an intermediate router which is forwarding the packet?

2)

a) (10 pts) Execute the Dijkstra algorithm at node A for the network shown below by filling in the following table.



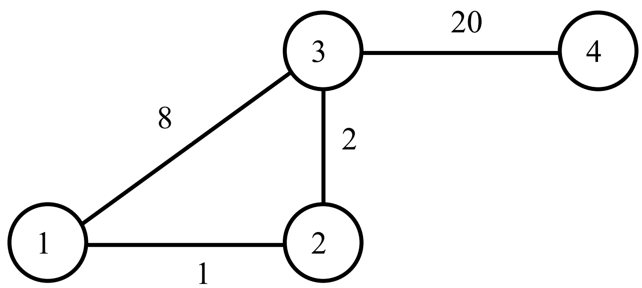
iter.	*N*	*D(B), p(B)*	*D(C), p(C)*	*D(D), p(D)*	*D(E), p(E)*	*D(F), p(F)*	*D(G), p(G)*	*D(H), p(H)*	*D(I), p(I)*	*D(J), p(J)*	*D(K), p(K)*

b) (10 pts) The network below uses the distance-vector routing algorithm **without poisoned reverse**. Assume the following:

- Links have the same cost in both directions.
- Nodes exchange their routing info once every second, in perfect synchrony and with negligible transmission delays. Specifically, at every t = i, i = 0, 1, 2, 3,..., each node sends and receives routing info instantaneously, and updates its routing table; the update is completed by time t=i+0.1.
- At time t = 0, the link costs are as shown below and the routing tables have been stabilized. At time t = 0.5, the cost of the link (2,3) becomes 20. There are no further changes in the link costs.
- Route advertisements are **only exchanged periodically**, i.e., there are no immediate route advertisements after a link cost change. Hence the first route advertisement after the link cost change at t = 0.5 sec occurs at t = 1.0 sec. *Note:* However, whenever a link cost change occurs, the

two nodes at the endpoints of this link immediately make corresponding changes in their distance tables.

Give the evolution of the distance tables with respect to destination 4. Specifically, give the distance table entries for destination 4 at nodes 1-3, for t = 0.1, 0.5, 1.1, 2.1, ..., **until** all distance vectors stabilize. Present your final answer in the table given below where $D^i(j)$ is the distance vector denoting the distance from i to j .



Time, t	$D^1(4)$ via		$D^2(4)$ via		$D^3(4)$ via		
	2	3	1	3	1	2	4
0.1							
0.5							
1.1							
2.1							
3.1							
4.1							
5.1							
6.1							
7.1							
8.1							

c) (10 pts) Suppose now that the distance vector routing **with poisoned reverse** is used in the above question. Fill the distance table entries for destination 4 at nodes 1-3, for t=0.1, 0.5, 1.1, 2.1, ..., **until** all distance vectors stabilize.

Time, t	$D^1(4)$ via		$D^2(4)$ via		$D^3(4)$ via		
	2	3	1	3	1	2	4
0.1							
0.5							
1.1							
2.1							
3.1							
4.1							
5.1							
6.1							
7.1							
8.1							

3)

a) (10 pts) Suppose host A transmits a 1600 byte IP packet over a 2-hop path to host B. The MTU of the first link (A to router) is 720 bytes, and the MTU of the second link (router to B) is 420 bytes. Assuming that IP header does not contain any options, indicate the length, more flag, and offset field values of the fragment(s) transmitted over each link in the tables below.

First link

Fragment	Length	Offset	Flag
1			
2			
3			
4			
5			
6			

Second link

Fragment	Length	Offset	Flag
1			
2			
3			
4			
5			
6			

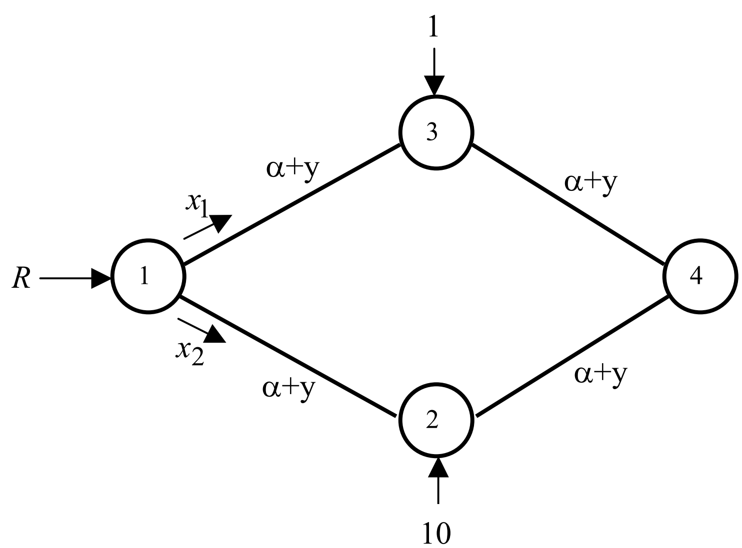
b) (10 pts) A company has a class C network with network number 200.1.1.0 and wants to form four subnets for four departments, with the number of hosts in each department shown in the following table. Give a possible arrangement of network addresses and subnet masks to the departments in the table below.

Department	# of hosts	Network number	Subnet Mask
A	67		
B	61		
C	28		
D	12		

4)

a) (10 pts) Consider the 4-node network shown below. Nodes 1, 2 and 3 are source nodes, and node 4 is the only destination node. The incoming traffic rates into nodes 1, 2 and 3 are *R*, 10 and 1 packets/unit time, respectively. For any link (*i*,*j*) the link delay from *i* to *j* is given by $\alpha + y_{ij}$, where y_{ij} is the total traffic routed from *i* to *j* (in packets/unit time), and α is a constant. On the other hand, the link delay from *j* to *i* is given by $\alpha + y_{ji}$, where y_{ji} is the total traffic routed from *j* to *i*.

Suppose that all the traffic from nodes 2 and 3 are routed over their min-hop paths, i.e., directly over the single-link paths 2-4 and 3-4. Find the assignments of traffic sourced at node 1 to the paths 1-3-4 and 1-2-4, i.e., calculate x_1 and x_2, when packets from node 1 are routed such that the average delay per packet for the packets sent by node 1 is to be minimized. Then, find the maximum value of *R* such that node 1 routes all its traffic along the path 1-3-4, i.e., $x_1 = R$.



b) (10 pts) Now suppose that $R = 1$. The link delays are computed the same way as defined in part a). Assume that nodes are running an iterative distributed shortest path routing algorithm and routing all their traffic along the shortest path computed at that iteration. We assume that nodes are synchronized, i.e., they perform the iterations in a perfectly synchronous manner. The desired routing pattern is such that nodes 2 and 3 route all their traffic along their min-hop paths (as in part a.), and node 1 routes all its traffic along the path 1-3-4. Find the minimum value of α such that this iterative distributed routing algorithm converges to this desired routing pattern independent of the initial routing pattern.