CS 421: Computer Networks **SPRING 2007**

MIDTERM II
April 26, 2007
120 minutes

Name: ______________________________

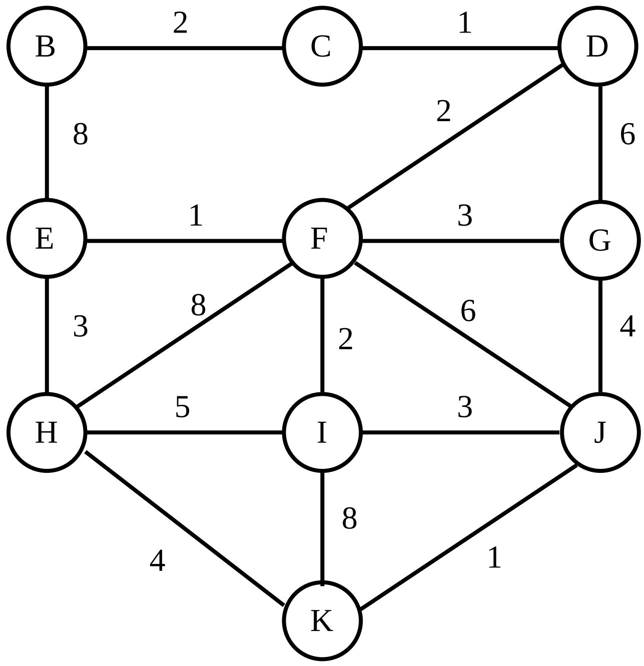
Student No: ____________________________

Show all your work very clearly. Partial credits will only be given if you carefully state your answer with a reasonable justification.

Q1	
Q2	
Q3	
TOT	

1)

a) (12 pts) Execute the Dijkstra algorithm **at node B** for the network shown below by filling in the following table. In the table, you need to give both the distance *D(v)* and the previous node *p(v)*.



iter.	*N*	*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) The network below uses the distance-vector routing algorithm. 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 = k, k = 0, 1, 2, 3,..., each node sends and receives routing info instantaneously, and updates its routing table; the update is completed by time t=k+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 link (1,4) becomes unavailable, i.e., its cost becomes ∞. 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 occurs at t = 1.0. *Note:* However, whenever a link cost change occurs, two nodes at the endpoints of this link immediately make corresponding changes in their distance tables.

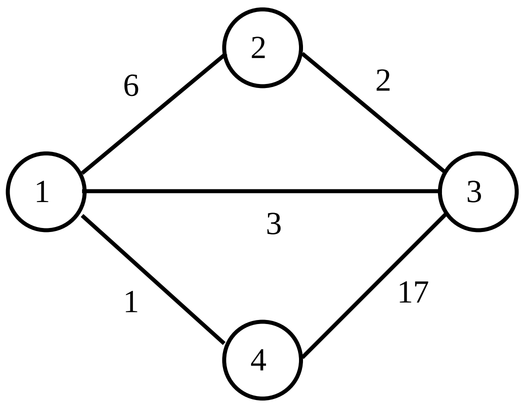
i) (12 pts) Assume that the distance vector algorithm **does not use poisoned reverse**. Give the evolution of the distance tables with respect to destination 4. Specifically, give the distance table entries for destination 4 at nodes 1-3, for t = 0.1, 0.5, 1.1, 2.1, ..., **until** all distance vectors 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	4	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								
9.1								
10.1								
11.1								

ii) (12 pts) Redo part i. assuming that the distance vector algorithm **uses poisoned reverse**.

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

iii) (5 pts) Using the forwarding tables valid at t=3.5, find the paths followed by a packet sourced at node 1 and destined to node 4 for both parts i and ii above, i.e., with and without poisoned reverse.



2)

a) You are given the assignment of setting subnet addresses for 4 buildings of your company. The number of Internet connected PCs in each building is given in the following table. Assume that the 131.155.192.0/19 address block is given to you for this purpose.

i) (10 pts) Use the following table to show the addresses of the four subnets that you have created.

Building	# of PCs	Subnet address (CIDR format)
1	2200	
2	1620	
3	550	
4	500	

ii) (5 pts) What is the size of the **largest single** CIDR address block that you can assign from the unassigned addresses in the address block 131.155.192.0/19 remaining after you assigned the addresses to these four buildings?

b) Suppose an IPv4 router has four links, numbered 0 through 3, and packets are to be forwarded to the link interfaces according to their destination IP addresses as follows:

Destination Address Range	Interface
10100100 00000000 00000000 00000000 through 10100100 11111111 11111111 11111111	0
10100100 00000000 00000000 00000000 through 10100100 00000000 00000000 11111111	1
10100101 00000001 00000000 00000000 through 10100101 00000001 11111111 11111111	2
Others	3

i) (5 pts) Using the a.b.c.d/x CIDR format, write down the forwarding table for this router that has four entries so that the router forwards packets to the correct link interfaces given above while using the longest-prefix matches algorithm.

ii) (5 pts) Use your forwarding table to determine the appropriate link interface for the datagrams which have the following destination addresses.

Datagram	Destination Address	Interface
1	10100100 00100100 01010100 10010100	
2	10100101 00100100 01010100 10010100	
3	10100100 00000000 00000000 10110101	
4	10100101 00000001 11011100 11010100	
5	10101100 10100100 01010100 10010100	

3)

a) (6 pts) Why is there only one standard inter-AS routing protocol (BGP) whereas there are several intra-AS routing protocols (RIP, OSPF, IGRP)?

b) (6 pts) Explain why a network operator might not use the traffic load, i.e., traffic carried over a link, as the link cost metric for the routing protocol.

c) (6 pts) Describe a possible scenario where an **IPv4** router sends an ICMP message to host A after processing a packet which is destined to host B.

d) (6 pts) Describe a possible scenario where an **IPv6** router sends an ICMP message to host A after processing a packet which is destined to host B. **Make sure that the scenario you give is specific to IPv6**, i.e., it only occurs when IPv6 is used, but not in IPv4.

e) This question is about the geometry of routing. In particular, you are asked whether the triangular inequality holds under two different scenarios.

   i) (5 pts) Consider a network that employs the shortest path routing, e.g., the path between two nodes is the shortest path between them computed by the Dijkstra algorithm. For three routers A, B, and C, let d_{AB} be the cost of the path between nodes A and B, let d_{BC} be the path cost between nodes B and C, and let d_{AC} be the path cost between nodes A and C. Is it possible that the inequality $d_{AB} + d_{BC} < d_{AC}$ holds? Fully justify your answer.

   ii) (5 pts) Consider now the routing architecture used in the Internet. Is it possible that the inequality $d_{AB} + d_{BC} < d_{AC}$ holds? Fully justify your answer.