CS 421: COMPUTER NETWORKS **SPRING 2010**

FINAL
May 24, 2010
180 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) (4 pts) What is the propagation delay for a one-way transmission by satellite link from Ankara to Istanbul? (assume that TURKSAT uses a geostationary satellite which is orbiting about 36,000 km above the earth.)

b) (3 pts) What is the transmission delay for a 1 Megabyte file sent over a 56Kbps dial-up modem line?

c) (4 pts) A connection uses the Selective Repeat protocol for reliability. The round-trip time for the connection is 10 milliseconds. What is the minimum size of the sender buffer (in Bytes) so that it **will be possible** for the connection to achieve an average transfer rate of 80 Mbps **under idealistic conditions**?

d) (4 pts) What advantages does the peer-to-peer architecture offer over the client-server architecture, for network application programs?

e) (8 pts) Consider 4 approaches to reliable data transfer: Stop and Wait, Go-Back-N, Selective Repeat and TCP. Use the following table to mark whether the following statements are True or False for each of the four reliable data transfer mechanisms.

	Stop and Wait	Go-Back-N	Selective Repeat	TCP
sends more than one packet per round-trip time				
requires a single retransmission timer				
requires sequence numbers				
requires buffering of data packets at the receiver				
needs a checksum for both data packets and ACKnowledgments				
loss of an ACKnowledgment always results in a data packet retransmission				

f) (4 pts) Is it possible for an application to enjoy reliable data transfer even when the application runs over UDP? If so, how?

g) (4 pts) What are the advantages of having congestion control be included in a protocol? What are the disadvantages?

2)

a) (7 pts) The Dikjstra algorithm that we studied in class is given below. Dijkstra's algorithm computes all least-cost (shortest) paths from node u to all other nodes in the network where the cost of a path (x_1, x_2, x_3,…, x_p), denoted as pc(x_1, x_2, x_3,…, x_p), is given by the sum of all the link costs along the path, i.e., pc(x_1, x_2, x_3,…, x_p) = c(x_1,x_2) + c(x_2,x_3) + … + c(x_{p-1},x_p). Now assume that we modified the definition of the path cost as the maximum of all the link costs along the path, i.e., pc(x_1, x_2, x_3,…, x_p) = max{c(x_1,x_2),c(x_2,x_3),…,c(x_{p-1},x_p)}. Use the following table to give the Modified Dijkstra Algorithm, which computes all least-cost paths from node u to all other nodes using the modified definition of the path cost.

Hint: Do not try to write the algorithm from scratch. You can obtain the Modified Dijkstra Algorithm by making very few changes on the Dijkstra algorithm.

Dijkstra Algorithm	**Modified Dijkstra Algorithm**
N' = {u}	
for all nodes v	
if v adjacent to u	
then D(v) = c(u,v)	
else D(v) = ∞	
repeat	
find w not in N' such that D(w) is a minimum	
add w to N'	
for all v adjacent to w and not in N'	
D(v) = min(D(v), D(w) + c(w,v))	
until all nodes in N'	

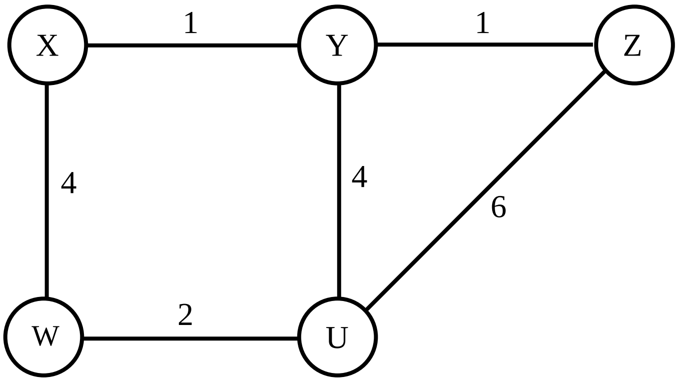
b) The network below uses the distance-vector routing algorithm **without poisoned reverse**. Assume the following:

- 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 = 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 **(Y,Z) becomes 16**. 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. (10 pts) Give the evolution of the distance tables with respect to destination Z. Specifically, give the distance table entries for destination Z at nodes U,W,Y, Z, 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* .

ii. (3 pts) Suppose you have a packet generated by node Y at t = 6 sec which is destined for node Z. Determine the path traversed by this packet using the forwarding .

iii. (3 pts) Suppose you have a packet generated by node W at t = 6 sec which is destined for node Z. Determine the path traversed by this packet.



Time, t	$D^U(Z)$ via			$D^W(Z)$ via		$D^X(Z)$ via		$D^Y(Z)$ via		
	W	Y	Z	U	X	W	Y	U	X	Z
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										
12.1										

c) (5 pts) You are given the assignment of setting subnet addresses for 5 campuses of your company. The number of Internet connected PCs in each campus is given in the following table. Assume that the 118.189.128.0/17 address block is given to you for this purpose. Use the following table to show the addresses of the five subnets that you created.

Campus	**# of PCs**	**Subnet address (CIDR format)**
1	9000	
2	4500	
3	2200	
4	2000	
5	1800	

d) (4 pts) Give three reasons why Network Address Translation (NAT) protocol is widely used today in small office and home networks.

e) (5 pts) Consider the hierarchical routing architecture used in the Internet. Let A, B, and C be three routers, possibly in different Autonomous Systems (AS). Let d_{AB} be the cost of the path between routers A and B, let d_{BC} be the path cost between nodes B and C, and let d_{AC} be the path cost between routers A and C. Is it possible that the path costs do not satisfy the triangular inequality, i.e., $d_{AB} + d_{BC} < d_{AC}$? Why or why not? You need to fully justify your answer.

3)

a) (7 pts) Suppose the data sequence 10111001 is transmitted using the generator sequence 1001. Compute the CRC bits and the transmitted bit sequence. If the 2^{nd} and 5^{th} bits starting from the highest order (leftmost) bit in the received sequence are errored, determine whether this error can be detected by the receiver.

b) (5 pts) Consider an Ethernet LAN using CSMA/CD running at 100 Mbits/sec. The propagation speed for the signal over the cable is $2.5x10^8$ m/sec and the minimum Ethernet frame size is 64 Bytes. Compute the maximum possible distance between any two adapters in the Ethernet LAN so that the CSMA/CD algorithm will work properly.

c) Consider a pair of nodes A and B on a 10 Mbits/sec Ethernet. Suppose nodes A and B are involved in a collision which is the second collision for A and fifth collision for B. After the collision is detected (we assume that both nodes detect the collision exactly at the same time), both nodes calculate their backoff times according to the binary exponential backoff algorithm.

i. (5 pts) What is the probability that the first transmission after the above collision will be a successful retransmission by A?

ii. (5 pts) What is the probability that there will be another collision in the next retransmission attempt after the above collision?

d) (5 pts) Although there is a minimum frame size limitation for Ethernet, why does 802.11 protocol **not have** such a minimum frame size limitation?

e) (5 pts) The largest IP router can hold 200,000 entries in its forwarding table while the largest Ethernet switch can hold 1,000,000 entries in its forwarding table. However, the IP router can support many more hosts than the Ethernet switch. Why?