CS 421: COMPUTER NETWORKS **FALL 2011**

FINAL
January 12, 2012
150 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.

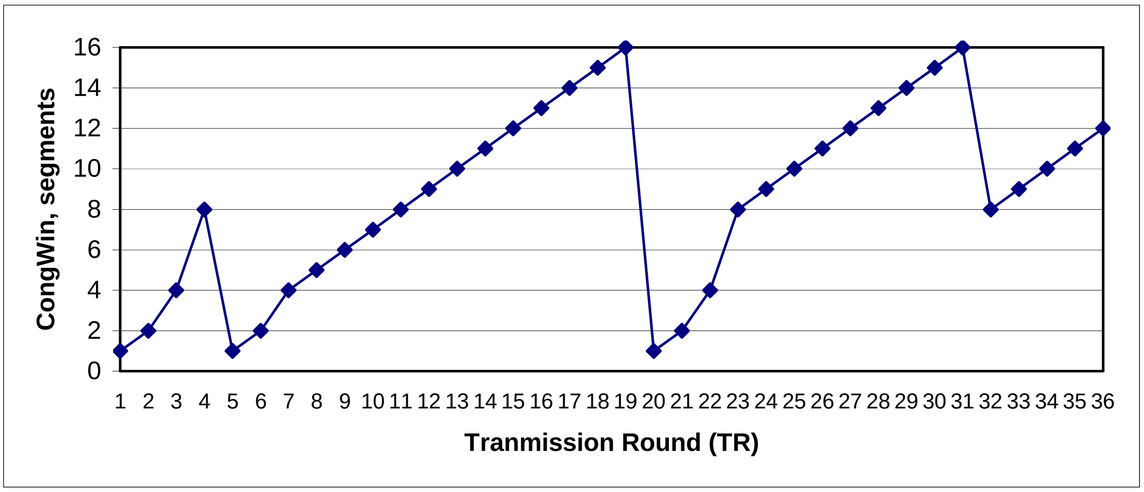
Q1	
Q2	
Q3	
TOT	

1)

a) (7 pts) Assume that the bandwidth of a connection is 10 Mbits/sec ($10x10^6$ bits/sec) and the round-trip propagation delay for the connection is 20 msec. Each data segment is 1250 Bytes long including the headers and the ACK packets are 25 Bytes long. Assuming that no packets are lost, what should be the **minimum window size (in integer units of data segments)** in order to achieve full bandwidth utilization for this connection?

b) (5 pts) Explain the differences between flow control and congestion control.

c) (6 pts) The following figure shows the evolution of the Congestion Window for a TCP connection as a function of time. The x-axis denotes the Transmission Round (TR), where each tick corresponds to one round-trip-time (RTT) (assume that all packets have negligible transmission times). The y-axis is the Congestion Window in segments at the beginning of each TR. Use the table below in order to identify the time intervals during which Congestion Control algorithm is in a certain phase, i.e., Slow Start (SS) or Congestion Avoidance (CA), the value of the Slow Start threshold (ssthresh) parameter during that time interval and the reason for the phase/parameter change which ends that time interval, for TR = 1,…,36.



Time Interval [starting TR,ending TR]	Phase (SS or CA)	ssthresh (in segments)	Event causing phase or parameter change
[1 ,]			
[,]			
[,]			
[,]			
[,]			
[, 36]			

d) (6 pts) Suppose that there are 16 packets (sequence numbers from 1 to 16) to be sent using the Go-Back-N protocol with a window size of N = 6 packets. Assume that the **first transmissions** of data packet with sequence number 5 and ACK packet with acknowledgement number 15 are lost during transmission and no other data or ACK packets are lost or errored. The timeout period is sufficiently large and the ACK for a packet is received within a very small delay after the completion of the transmission of the packet. How many packets are retransmitted during this transmission and what are their sequence numbers?

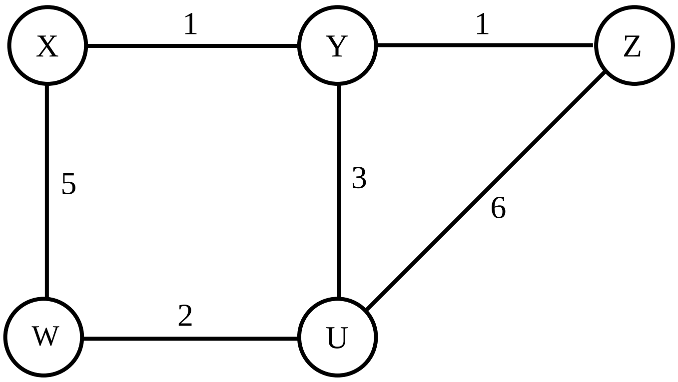
e) (6 pts) Answer d) assuming that Selective Repeat with N = 6 packets is used instead.

2)

a) 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, link costs are as shown below and routing tables have been stabilized. At time t = 0.5, the cost of the link (Y,Z) becomes 10. 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 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, X, Y, 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	$D^U(Z)$ 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										

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 tables valiad at t=6 sec.

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 using the forwarding tables valiad at t=6 sec.

b) (6 pts) Assume a university has the network prefix 141.168.192.0/18 (i.e., this is the network address space of the university that it can use to generate subnets and assign IP addresses to hosts). Assume the university has 5 campuses, each campus having the number of hosts indicated in the table below. Assume you are the network administrator and you will generate subnets, one subnet per campus. Show in the table below the subnets that you will generate.

Campus	Host Count	Subnet Number (i.e. Prefix) (in form 141.168……/x)
1	5000	
2	3000	
3	2000	
4	1000	
5	1000	

c) (5 pts) Why does Network Address Translation (NAT) protocol violate the end-to-end principle of the transport layer?

d) (5 pts) Give an advantage of the link state routing algorithm compared with the distance vector routing algorithm.

e) (5 pts) Does intra-AS routing algorithm play any role in determining the route that will be used by a packet destined for another autonomous system (AS)? Why or why not?

3)

a) (7 pts) Suppose the data sequence 10110011 is transmitted using the generator sequence 10001001. Compute the CRC bits and the transmitted bit sequence. If the 4th, 8th and 11th 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) (6 pts) Consider an Ethernet LAN using CSMA/CD running at 100 Mbits/sec. The propagation speed for the signal over the cable is $2x10^8$ m/sec. There are three network adapters (A, B and C) on this LAN and the distances between these adapters are d_{A-B}=100 m, d_{B-C}=200 m and d_{A-C}=300 m. Compute the minimum Ethernet frame size such that the CSMA/CD algorithm will work properly on this Ethernet LAN.

c) Suppose that nodes A, B and C are connected to the same Ethernet. Assume that nodes A, B and C are involved in a collision, which is the 1^{st}, 2^{nd} and 3^{rd} collisions for nodes A, B and C, respectively.

   i. (5 pts) What is the probability that the next transmission after the initial collision will be made by node A and this will be a successful transmission?

   ii. (5 pts) What is the probability that the next transmission after the initial collision will be made by node C and this will be a successful transmission?

   iii. (5 pts) What is the probability that the next transmission after the initial collision will be another collision?

d) (5 pts) Why does the efficiency of the CSMA/CD MAC protocol used in the Ethernet decrease when the frame size (i.e., frame transmission time) decreases?