CS 421: COMPUTER NETWORKS **SPRING 2011**

FINAL
May 16, 2011
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.

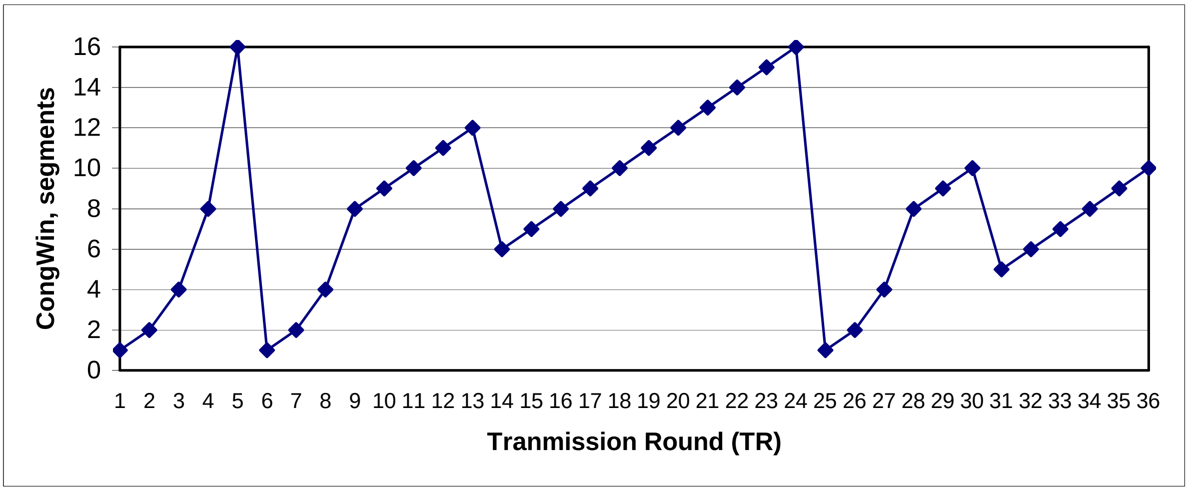
Q1	
Q2	
Q3	
TOT	

1)

a) (7 pts) Assume that the bandwidth of a connection is 100 Mbits/sec (100×10^6 bits/sec) and the round-trip propagation delay for the connection is 10 msec. Each data segment is 1000 Bytes long including the headers and the ACK packets are 40 Bytes long. Assuming that no packets are lost, what should be the **minimum window size (in units of data segments)** in order to achieve full bandwidth utilization for this connection?

b) (6 pts) Suppose that we would like to communicate over a connection where the packet loss rate is high and the round trip delay is large. Discuss which of the following protocols is more suitable for this scenario: Go-Back-N or Selective Repeat? Fully justify your answer.

c) (7 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) (7 pts) Suppose that there are 25 packets (sequence numbers from 1 to 25) to be sent using the Go-Back-N protocol with a window size of N = 8 packets. Assume that the first transmissions of two data packets with sequence numbers 7 and 21 are lost during transmission and no other data or ACK packets are lost or errored. The timeout period is sufficiently large and ACKs are received with a very small delay. How many packets are retransmitted during this transmission and what are their sequence numbers?

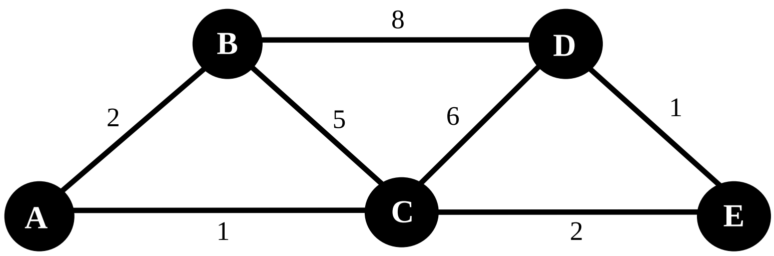
e) (7 pts) Answer the above problem assuming that Selective Repeat with N = 8 packets is used instead.

2)

a) (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 = 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 cost of the link (D,E) 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 distance tables.

Give the evolution of the distance tables with respect to destination D. Specifically, give the distance table entries for destination D at nodes A, B, C, E 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 .



t	**D^A(D), via**		**D^B(D), via**			**D^C(D), via**				**D^E(D), via**	
	B	C	A	C	D	A	B	D	E	C	D
0.1											
0.5											
1.1											
2.1											
3.1											
4.1											
5.1											
6.1											
7.1											
8.1											

b) Suppose that the cost of a link in a network decreases by 5. Answer the following questions. You need to justify your answer by either giving an example showing that the scenario in the question is possible or by proving that it is not possible.

i) (5 pts) Is it possible that the shortest distance between a node pair in the network decreases by 3?

ii) (5 pts) Is it possible that the shortest distance between a node pair in the network decreases by 6?

c) (6 pts) In RIP, which is a distance vector routing algorithm, the "infinity" link cost metric is taken as 16. Why does RIP use such a relatively small value for representing infinity? Are there any limitations coming as a result of choosing such a small value?

d) (6 pts) Assume a university has the network prefix 165.212.128.0/18 (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 165.212……/x)
1	4000	
2	3000	
3	3000	
4	2000	
5	2000	

3)

a) (8 pts) Suppose the data sequence 11100101 is transmitted using the generator sequence 10001001. Compute the CRC bits and the transmitted bit sequence. If the 4th and 9th 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 $2x10^8$ m/sec. The distances between network adapter pairs in the Ethernet LAN are 100 m, 250 m, 600 m, 400 m, 250 m and 500 m. Compute the minimum Ethernet frame size such that the CSMA/CD algorithm will work properly on this Ethernet LAN.

c) Assume that there are five active nodes competing for access to a channel using the Slotted-Aloha MAC protocol. Assume that each node has infinite number of packets to transmit. Each node attempts to transmit in each slot with probability p, and the slots are numbered as 1, 2, 3, … and so on.

   i) (5 pts) Calculate the probability that there is a successful transmission in a time slot.

   ii) (5 pts) Calculate the probability that there is no successful transmission in the first four time slots.

   iii) (5 pts) Given that there is no successful transmission in a specific time slot, calculate the probability that there is a collision in that time slot.

d) (6 pts) Why does the efficiency of the CSMA/CD MAC protocol used in the Ethernet increase when the propagation delay decreases?