Fundamentals of Computer Networking	**Homework 3**
CS4700/CS5700 Spring 2011	**14 March 2011**

This homework is due at the beginning of class on March 21st, 2011.

Name: _____

Problem	**Possible**	**Score**
1	40	
2	25	
3	35	
Total	100	

1a. Host A is transferring a file of size S to host B using TCP. A sends the file data in fixed size packets equal to the Maximum Segment Size (MSS), a predetermined value. B sends an acknowledgement immediately upon receiving a data segment. Let R be the round trip delay between A and B. The advertised receiver window size of host B is W. In this problem, we assume the TCP connection is already established and that the transmission time is negligable. TCP performs the slow start and congestion avoidance mechanisms, and there is no error or packet loss during transmission.

Given $W = 3 * \text{MSS}$, $L = 10 * \text{MSS}$, how long does it take for the file to be sent and acknowledged? Show your work. (20 points)

1b. (continuation of 1a) Given $W = 5 * \text{MSS}$, $L = 15 * \text{MSS}$, how long does it take for the file to be sent and acknowledged? Show your work. (20 points)

2a. TCP packets are being sent from a client to a server. The MSS is equal to 1480 bytes, and each TCP packet is sent with the maximum capacity. How many TCP packets can be sent before the sequence number field in the TCP header will wrap around? (10 points)

2b. (continuation of 2a) How much time (in seconds) will this take on a 1 Mbit/s link? (5 points)

2c. (continuation of 2b) How much time (in seconds) will this take on a 1 Gbit/s link? (5 points)

2d. (continuation of 2c) How much time (in seconds) will this take on a 100 Gbit/s link? (5 points)

3a. Consider a network link with a link speed of 1 Gb/s, a round trip time of 100ms, and a data packet size of 1000 bytes. Assume all traffic is transmitted using a TCP-like window-based transmission protocol with the following congestion control algorithm:

congestion avoidance: $cwnd = cwnd + 1$ after one RTT

fast recovery: $cwnd = cwnd/2$ when a loss occurs

What is the congestion window size W_0 such that when the traffic is transmitted using this window size, the network link is fully utilized? Show your work. (10 points)

3b. Suppose exactly when the congestion window size W reaches W_0, a loss occurs and the sender immediately (assume the loss is instantaneously known by the sender) activates the fast recovery algorithm. What is the asymptotic average throughput of this transmission? Show your work. (25 points)