Spring 2015 COMP4621 Homework Assignment #3
Due Date: April 20, 2015 (Monday)

Name: _____ ID: _____
E-Mail: _____ Section L __

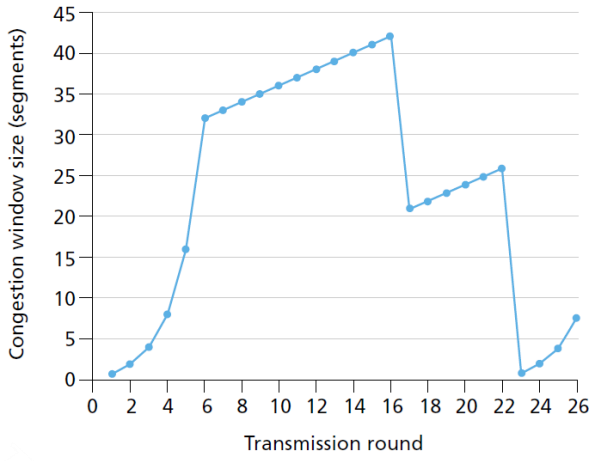
Please read the following instructions carefully before answering the questions:

- This assignment must be completed **individually**.
- When you write your answers, please try to be precise and concise.
- Fill in your name, student ID, email and Section number at the top of the first page.
- Please print this homework and fill in your answers in the space provided, or you can type your answers in the MS word file and print it out.
- **Homework Collection:** the **hardcopy** is required and the homework is collected at the **Collection BOX** outside **Room 4030 (Lift 1).**

1. (20 points) Compare GBN, SR, and TCP AIMD (Additive Increase Multiplicative Decrease) with W larger than 5 (no delayed ACK). Assume that the timeout values for all three protocols are sufficiently long such that 5 consecutive data segments (pkt1, pkt2, pkt3, pkt4 and pkt5) and their corresponding ACKs (ack1, ack2, ack3, ack4 and ack5) can be received by the receiving host (Host B) and the sending host (Host A) respectively (i.e., no premature timeout), if not lost in the channel. Suppose that Host A sends 5 data segments (pkt1, pkt2, pkt3, pkt4 and pkt5) to Host B, and the 2nd segment (sent from A) is lost. Ultimately, all five data segments are correctly received by Host B.
   a) How many segments has Host A sent in total and how many ACKs has Host B sent in total? Answer this question for all three protocols.

   b) If the timeout values for all three protocols are much longer than 5 RTT, then which protocol successfully delivers all five data segments in shortest time interval?

2. (30 points) Consider Figure below, assuming TCP Reno is the protocol experiencing the behavior shown above, answer the following questions. In all cases, you should provide a short discussion justifying your answer.



TCP window size as a function of time

a) Identify the intervals of time when TCP slow start is operating. (2 points)

b) Identify the intervals of time when TCP congestion avoidance is operating. (2 points)

c) After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? (3 points)

d) After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? (3 points)

e) What is the initial value of *ssthresh* at the first transmission round? (2 points)

f) What is the value of *ssthresh* at the 18th transmission round? (3 points)

g) What is the value of ssthresh at the 24th transmission round? (3 points)

h) During what transmission round is the 70th segment sent? (3 points)

i) Assuming a packet loss is detected after the 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of *ssthresh*? (3 points)

j) Suppose TCP Tahoe is used (instead of TCP Reno), and assume that triple duplicate ACKs are received at the 16th round. What are the ssthresh and the congestion window size at the 19th round? (3 points)

k) Again suppose TCP Tahoe is used, and there is a timeout event at 22nd round. How many packets have been sent out from 17th round till 22nd round, inclusive? (3 points)

3. (20 points)Refer to Figure 3.56 of the book (p. 3-108 of the slides) that illustrates the convergence of TCP's additive increase, multiplicative decrease algorithm to fairness. Suppose that instead of a multiplicative decrease, TCP decreased the window size by a constant value. Would the resulting additive increase additive decrease converge to an equal share? Justify your answer using a diagram similar to the figure in the notes.

4. (20 points) Consider sending a large file from a host to another over a TCP connection that has no loss.
   a) Suppose TCP uses AIMD for its congestion control without slow start. Assuming *cwnd* increases by 1 MSS every time a batch of ACKs is received and assuming approximately constant round-trip times, how long does it take for *cwnd* increase from 5 MSS to 11 MSS (assuming no loss events)? (the initial *cwnd* =5MSS)(10 points)

   b) What is the average throughout in terms of RTT and MSS for this connection when the time =6 RTT? (the initial *cwnd* =5MSS) (10 points)

5. (10 points)A router's routing table has the following entries:

IP address	*Outgoing Port*
192.168.24.0/21	*1*
192.168.28.0/22	*2*
192.168.12.0/22	*3*
192.168.30.0/23	*4*
0/0	*2*

Assume CIDR is used in the network.

(a) Which port should be used for an incoming packet 192.168.31.33?, (b) 192.168.15.67, and (c) 192.168.8.32.