Assignment 1
Due Friday before 12pm on Gradescope

Problem 1 - [P2 from textbook]
Equation 1.1 gives a formula for the end-to-end delay of sending one packet of length L over N links of transmission rate R. Generalize this formula for sending P such packets back-to-back over the N links.

Problem 2 - [P3 from textbook]
Consider an application that transmits data at a steady rate (for example, the sender generates an N-bit unit of data every k time units, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time.

Answer the following questions, briefly justifying your answer:
   a) Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?
   b) Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?

Problem 3 - [P4 from textbook]
Consider the circuit-switched network in Figure 1.13. Recall that there are 4 circuits on each link. Label the four switches A, B, C and D, going in the clockwise direction.

   a) What is the maximum number of simultaneous connections that can be in progress at any one time in this network?
   b) Suppose that all connections are between switches A and C. What is the maximum number of simultaneous connections that can be in progress?
   c) Suppose we want to make four connections between switches A and C, and another four connections between switches B and D. Can we route these calls through the four links to accommodate all eight connections?

Problem 4 – [P8 from textbook]
Suppose users share a 3 Mbps link. Also, suppose each user requires 150 kbps when transmitting, but each user transmits only 10 percent of the time. (See the discussion of packet switching versus circuit switching in Section 1.3.)

   a) When circuit switching is used, how many users can be supported?
   b) For the remainder of this problem, suppose packet switching is used. Find the probability that a given user is transmitting.
   c) Suppose there are 120 users. Find the probability that at any given time, exactly n users are transmitting simultaneously. (Hint: Use the binomial distribution.)

Part d is out of scope – unless you want to try it and discuss it with me.