1. Suppose two hosts, A and B, are separated by 2,500km and are connected by a link with a transmission rate of$R = 5Mbps$. The propagation delay is $2.9 * 10^8$m/s.

   (a) Calculate the time to send a 2Mbit file (assuming it is sent as one large message):

   (b) What is the length of a bit in meters?

2. Suppose an institution is connected to the Internet with a link with bandwidth R=4Mbps and that on average, its users retrieve objects from the Web that are 800Kbits in size with an average request rate of 4/s.

   (a) If the average amount of time that it takes for an HTTP request to be received, responded to and returned is 1.5 seconds, what is the average response time? Recall that the average response time is modeled as the sum of the average access delay and the average Internet delay. The average access delay is: $\Delta/(1-\Delta\beta)$, where Δ is the average time to send an object over the Internet and β is the arrival rate of objects on the link.

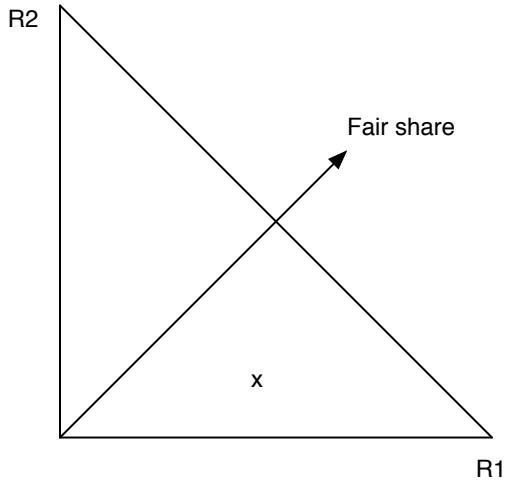
   (b) Suppose the institution installs a cache which achieves a hit rate of 15%. Find the new average response time.

3. Suppose two hosts, A and B, are connected through the Internet with a 1Mbps link with an RTT of 100ms. Assume we are sending a 200Mbit file and that our transfer is one way so that acknowledgements are only 20 bytes in size. In addition, assume that the MSS is 568 bytes and that we experience no packet loss.

   (a) If the window size (WS) advertised by the receiver is 5, calculate how long it will take to transfer the file. Are we limited by the WS or by the bandwidth of the link?

   (b) If the WS is 25, how long will it take to transfer the file? Are we limited by the WS or by the bandwidth of the link?

4. We know that TCP uses AIMD to determine the congestion window. We can show that two or more connections 'play fair' by graphing their window sizes and calculating the results of packet loss with two or more dimensions. Assume two hosts, A and B, are competing for the bandwidth. Host A increases its window by α_1 and decreases by α_2. Host B increases its window by β_1 and decreases its window by β_2.
   (a) In the given figure, assume that AIMD is used with $\alpha_1 = 1$, $\alpha_2 = 1/2$, $\beta_1 = 2$ and $\beta_2 = 3/4$. Determine if a fair share is achieved by graphing the results on the diagram starting at x.



5. Find the checksum, as calculated by UDP for the following:

   (a)
   $$\begin{array}{r} 0\,1\,0\,1\,0\,0\,1\,0\,1\,0\,1\,1\,1\,0\,1\,0 \\ 1\,1\,0\,1\,0\,0\,1\,1\,0\,0\,0\,1\,1\,0\,0\,0 \\ \hline \end{array}$$