Midterm

Spring 2023

Instructor: Ali Sharifian

44 points possible

Questions: 8

Points Possible: 44

For all questions, your answers must be based on what was taught in class this semester. Anything else will get you points deducted, up to and including zero credit. You must complete this exam individually.

Show as much work as possible to attempt to get partial credit. No work = no credit.

If you are writing out your answers, I recommend you give yourself about 15 minutes of buffer time to scan your exam and upload/submit it to Canvas. Otherwise, if typing in your answer to the word document, you should still give yourself enough time to save the document and upload/submit it to Canvas.

First question starts on the next page.

1. (4 points)
   A transcontinental channel with a one-way latency of 50 ms and a bandwidth of 200 Mbps can hold how many Megabits (Mb) at a given instant?

   Volume of the pipe = delay * bandwidth
   0.05 * 200 Mbps = 10 Mb

2. (4 points)
   Let's say you have a sender, a receiver, a one-way latency of 50 ms, and the bandwidth is 200 Mbps. Let's say the receiver tells the sender to stop transmitting. The receiver may receive up to how many megabits (Mb) of data from the sender before the sender stops transmitting?

   RTT = 2 *50 = 100 ms = 0.1s

   0.1s * 200Mbps = 20Mb

3. (4 points)
   What is the wavelength, in kilometers (km), when a 900 Hz wave travels through copper? Assume speed of light through copper is (2/3) * 3* 10^8 m/s.

   Round your answer to one decimal place.

   Speed of light in copper/frequency = (2/3)*3*10^8 m/s divided by 900 Hz = 222.2 km

4. (8 points)
   What is the NRZ encoding of the below stream?

010010100

For questions 5 to 7, consider a 5 Mbps link with a 90 ms round trip time (RTT). The three questions are related to each other.

5. (4 points)
   What is the delay x bandwidth product? Provide your answer in kilobits (Kb).

   Delay * bandwidth = bandwidth * RTT *90ms = 5Mbps * 90ms = 450Kb

6. (4 points)
   Assuming a frame size of 1 KB and the network uses the Stop and Wait Protocol, what is the maximum sending rate? Assume 1 KB = 1,000 bytes. Provide your answer in bps and round to the nearest whole number.

Bits per frame divided by time per frame = 1000 bytes * bits / byte / 0.075s = 88889 bps

7. (4 points)
   Continuing from question 6, what fraction of the link's total capacity is being used in this network using the Stop and Wait Protocol?
   Provide your answer as a percentage, rounded to the nearest decimal.

   88889 bps/ 5000000 bps = 0.0178 = 1.8%

8. Suppose you are designing a sliding window protocol for a 10-Mbps point-to-point link to the stationary satellite revolving around the Earth at an altitude of 3*10^4 km. Assuming that each frame carries 1 KB of data, what is the minimum number of bits you need for the sequence number in the following cases?
   Assume the speed of light is 3 * 10^8 m/s and assume 1 KB = 1,000 bytes.

   Determine the number of frames the link can be hold at given rounudtrip time:
   Roundtrip time * bandwidth / frame size

   To find the roundtrip time: 1000 bytes * 8 bits/bytes = 8000 bits
   Delay = distances/speed

   3*10^4 km = 3*10^7m
   3*10^7m/3*10^8=0.1s
   Roundtrip is double that: 2*0.1s = 0.2s
   Number of packets the link can hold at a given roundtrip time:
   Frame size is 1000 bytes * 8 bits/bytes = 8000 bits
   0.2s * 1000000 * 10 bps / 8000 b =250 packets
   Thus, SWS needs to be 250 frames large

   a. (6 points)
      RWS=1
      If RWS = 1, then the max sequence number needs to be at least 1+ SWS,

      So 8 bits are needed.

b. (6 points)
RWS=SWS

RWS stands for receiving window size.

SWS stands for sending window size.

SWS<(MaxSeqNum+1)/2,

So we can calculate the answer based on the SWS value we get question a,

So at minmum, MaxSeqNum needs to be (2*250-1)+1=500,

So that would require 9 bits.