FALL TERM MIDTERM
EXAMINATION
October 2021

DURATION: 1.5 HOURS

No. Of Students: 171

Department Name & Course Number: Systems and Computer Engineering
SYSC 4602

Course Instructor (s): Changcheng Huang

AUTHORIZED MEMORANDA
Simple calculator

Students MUST count the number of pages in this examination question paper before beginning to write, and report any discrepancy to a proctor. This question paper has ____1____pages + cover page = _2__ pages in all.

This examination question paper may not be taken from the examination room.

In addition to this question paper, students require:

an examination booklet	yes
Scantron Sheet	no

Name: ____

Student Number: ______________________________________

1. (25%) Consider sending a large file of F bits from Host A to Host B, traversing three uncongested links with lengths D_1, D_2, D_3 km respectively (and two switches) between A and B. Signal propagation speed in the three links is p km/sec. Host A segments the file into segments of S bits each and adds H bits of header to each segment, forming packets of $L = H + S$ bits. Each link has a transmission rate of R bps. Find the value of S that minimizes the delay of moving the file from Host A to Host B. Ignore processing delay.

   Solution:

   Because each link has the same bandwidth R bps and processing delay is negligible, the queuing delay will be 0.

   There are F/S packets (when F is large, the fractional part can be ignored). Each packet is $S + H$ bits. Time at which the first packet is received at Host B is $3 \times \frac{S+H}{R} + \frac{D_1+D_2+D_3}{p}$ sec. Thus delay in sending the whole file is $(\frac{F}{S} + 2) \times \frac{S+H}{R} + \frac{D_1+D_2+D_3}{p}$.

   To calculate the value of S which leads to the minimum delay,

$$\frac{d}{dS} delay = 0 \Rightarrow S = \sqrt{\frac{FH}{2}}$$

2. (25%) A CDMA receiver gets the following chips: (0 -2 0 +2 +2 0 0 2). Assuming the following chip sequences used by four sending stations, which stations transmitted, and which bits did each one send?

   A = (–1 –1 –1 +1 +1 –1 +1 +1)

   B = (–1 –1 +1 –1 +1 +1 +1 –1)

   C = (–1 +1 –1 +1 +1 +1 –1 –1)

   D = (–1 +1 –1 –1 –1 –1 +1 –1)

   Solution: Let X = (0 -2 0 +2 +2 0 0 2). Then $X \cdot A = 8$, $X \cdot B = 0$, $X \cdot C = 0$, $X \cdot D = -8$. Station A sent 1, Stations B and C did not send, Station D sent 0.

3. (25%) Consider a CRC scheme with the 5-bit generator, G = 10011, and suppose that D has the value 1010101010. What is the value for R?

   Solution:

   If we divide 10011 into 1010101010 0000, we get 1011011100, with a remainder of R=0100. Note that, G=10011 is CRC-4-ITU standard.

4. (25%) Consider two stations, A and B, that use the slotted ALOHA protocol to contend for a channel. Suppose node A has more data to transmit than node B, and node A's transmission/retransmission probability in a slot p_A is greater than node B's transmission/retransmission probability in a slot, p_B.
   a. Provide a formula for node A's average throughput measured in frames/slot. What is the total efficiency of the protocol with these two nodes?
   b. If $p_A= 2p_B$, is node A's average throughput twice as large as that of node B? Why or why not? If not, how can we choose p_A and p_B to make that happen?

   Solution:
   a. A's average throughput is given by $p_A(1-p_B)$.
      Total efficiency is $p_A(1-p_B) + p_B(1-p_A)$.

   b. A's throughput is $p_A(1-p_B)=2p_B(1-p_B)= 2p_B- 2(p_B)^2$.
      B's throughput is $p_B(1-p_A)=p_B(1-2p_B)= p_B- 2(p_B)^2$.
      Clearly, A's throughput is not twice as large as B's.
      In order to make $p_A(1-p_B)= 2\ p_B(1-p_A)$, we need that $p_A= 2p_B/(1+p_B)$