National Taiwan Normal University
Department of Computer Science and Information Engineering

CSC0056 - Data Communication

Homework 1

(Six questions in total; due on 10/1/2019 11:55 p.m.; submit your answer via Moodle)

1. (10 points) Mr. Wang was learning to make some yogurt. In the making process, it is important to ensure the temperature of the yogurt remains between 90F (32.2C) and 120F (48.9C). He used a temperature sensor to track and report his yogurt's temperature every five minutes. Each temperature data is 8 bytes long and is sent over a transmission line. The line's bit rate is 10 bits per second. What is the line's link utilization for this purpose?

2. (20 points) In class, we have learned several error detection algorithms at the data link layer. Give one reason why higher layers (such as the transport layer) may perform yet another error detection (such as checksum) even if the data link layer has already performed error detection on each frame? Explain your answer.
(Hint: consider that in the layered architecture, a lower layer may appear to a higher layer as a black box.)

3. (20 points) Let $s(D) = D^6+D^5+D^3+D+1$ and $g(D) = D^2+1$. Performing a long division $s(D)/g(D)$ modular 2, we have $s(D) = g(D)z(D) + c(D)$. Write down each step of your calculation for the long division $s(D)/g(D)$, and give the resulting polynomials $z(D)$ and $c(D)$.

4. (10 points) In error detection, a *false alarm* occurs when an error detection algorithm said that the receiving data contains error(s) while the data is actually error-free. Could the single parity check scheme produce a false alarm? Explain you answer. (Hint: recall that the code word contains both *data* and *parity check*.)

5. (40 points) Another way of error detection and correction is to use a k-fold repetition scheme, where we send each bit k times and decode each block of three bits received by majority rule. For example, let $k = 3$. For four-bit sequence 1010 we can construct a three-fold repetition, 111000111000, and send out those 12 bits. If somehow the received sequence is 110000101001, we may still correct errors and obtain the original four-bit sequence, since by majority rule we decode $110 \rightarrow 1$, $000 \rightarrow 0$, $101 \rightarrow 1$, $001 \rightarrow 0$.

   Now, assuming that we wish to send a 200-bit sequence. Suppose that the probability that an error will be made in the transmission of any particular bit is 2%.

   5a. (10 points) Let $k = 1$, i.e., no redundancy. What is the probability that the 200-bit sequence will be received error free?

   5b. (10 points) Let $k = 3$, what is the probability that a 0 in the original sequence will be decoded as a 1 at the receiving side?

   5c. (10 points) Let $k = 3$, what is the probability that the receiver can get back the whole, 200-bit sequence?

   5d. (10 points) Let $k = 5$, what is the probability that the receiver can get back the whole, 200-bit sequence? And what percentage of transmitted bits is redundant?

6. (Bonus 15 points) Please provide your feedback regarding lectures 01-03. Those will help me in preparing future lectures that hopefully may help your learning of data communication. How was the pace of the lectures? Which aspects of the lectures were helpful to you? Which aspects need to be improved?