CSE 3213: Communication Networks, Fall 2009
Instructor: Natalija Vlajic
Time Allowed: **15 minutes**

Quiz 2

Student Name: ______________________________

Student Number: ______________________________

1. [1 point]
In which cases would Pulse-Code Modulation (PCM) be preferable over Delta Modulation in encoding of analog signal/data into digital signal? Briefly justify your answer.

Using PCM over Delta Modulation would be preferable in case of analog signals with sudden changes in the signal values; this essentially means that the frequency spectrum of the underlying signal is wide.
PCM is better at encoding such signals since it attempts to approximate the actual signal value and can handle large variations in short time (high frequency components). On the other hand, Delta Modulation encodes the difference within some level of precision, and would have high overload/underload effects when signal values have large sudden variations.

2. [2 point]
What is the minimum Hamming distance of a code that is (should be) able to detect any 3-bit errors as well as successfully correct any 2-bit errors in codewords of size n [bits]?

To detect 3-bit errors (s=3) the minimum Hamming distance of the code should be:
d_{min}= s + 1 = 4.

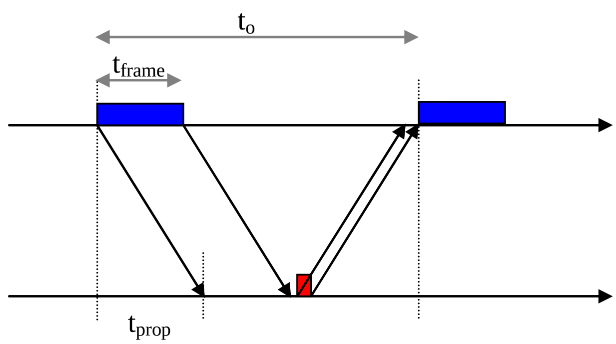
To correct 2-bit errors (2=3) the minimum Hamming distance of the code should be:
d_{min}= 2*t + 1 = 5.

Since the second of the requirements is more strict, we conclude that the minimum Hamming distance of such a code is d_{min} = 5. That is – any code capable of correcting 2-bit errors will also able to detect 3-bit errors.

3. [2 point]

A channel has a bit rate of 4 kbps and a propagation delay of 20 msec. For what <u>range</u> of frame sizes does Stop-and-Wait give an efficiency of at least 50%, i.e. $\eta_{SW} = 0.5$.

(Assume the processing delay (t_{proc}), header size (n_{header}), acknowledgment size (n_{ACK}), and probability of bit/frame error are all negligible.)



$$\eta_{SW} = \frac{t_{frame}}{t_0} = \frac{t_{frame}}{t_{frame} + 2t_{prop}} \geq 0.5 = \frac{1}{2}$$

$$2 \cdot t_{frame} \geq t_{frame} + 2t_{prop}, \qquad \text{where } t_{frame} = \frac{L}{R}$$

$$\frac{L}{R} \geq 2t_{prop} \qquad \Rightarrow \qquad L \geq 2t_{prop} \cdot R = 40[\text{msec}] \cdot 4000\left[\frac{\text{bit}}{\text{sec}}\right] = 160[\text{bits}]$$