Subject :	**SEHH2238 : Computer Networking**
Lab/Tutorial :	**Session 3 : PCM and Error Detection**

1) PCM

1. We have sampled a low-pass signal with a bandwidth of 200 kHz using 1024 levels of quantization.
   a. Calculate the number of bits per sample. 2^{10} levs = 10 bit.
   b. Calculate the bit rate of the digitized signal Bitrate = 2 * 200k * log_2 1024 = 4Mbps
   c. Calculate the SNR_{dB} for this signal. $6.02 \times 10 + 1.7 = 61.9\%$

2. An analog signal has voltage level in the range of 0 to 5 V. The signal is digitized using PCM with the signal-to-noise ratio due to quantization confined to 55 dB. $\Rightarrow SNR_{dB}$
   a. Determine the minimum number of bits required. $55 = 6.02n + 1.76$ $n \geq 8.84$ $= 9$
   b. Suppose that all "0"s represents the lowest signal voltage level and all "1"s represents the highest signal voltage. If the quantization value is round-up and assigned linearly to each signal level, what is the binary code for 1.75 V?

2) Error Detection

1. What is the maximum effect of a 2-ms burst of noise on data transmitted at the following rates?
   a. 1500 bps $1500 \times 2e^{-3} = 3$ bit
   b. 100 Kbps $100k \times 2m = 200$ bits

2. Assuming even parity, find the parity bit for each of the following data units.
   a. 1011011
   b. 0001100 0

3. 01001 01101 11000 10001 00101 is received using two dimensional even parity bit. The first 4 blocks are data with the parity bit in the rightmost bit, while the last block is all parity. Assume that no more than 2 bits contain error. Find the error bit(s).

4. Given the dataword 1010011110 and the polynomial $x^4 + x^2 + x + 1$.
   a. Show the generation steps of the codeword at the sender site.
   b. Assuming no error, show the checking of the codeword at the receiver site.