EE 484

Homework 6

Due 6:00 p.m. on Wednesday, March 9, 2016

Work all 5 problems.

Note: For any Matlab exercises you should submit your Matlab code along with the rest of your solution to the given problem.

Problem 1. Recall that for BPSK signaling the probability of a bit error is

$$P_b = Q\left(\sqrt{\frac{2E_b}{N_0}}\right).$$

Now suppose we implement an error correction code, say, a (7,4) Hamming code ($n = 7,\ k = 4$). This code can correct 1 bit error in a block of size 7 bits. Plot on the same graph P_b vs. E_b/N_0 for both the uncoded and coded waveform. Remember to account for the coding overhead in your plot since E_b/N_0 applies to information bits. Your E_b/N_0 values should be in dB on the graph and should range from 0 to a large enough value so that $P_b \leq 10^{-12}$.

Problem 2. An uncoded BPSK signal is utilized at 20,000 bits/sec. The equally likely waveforms are $s_1(t) = A\cos(\omega_0 t)$ and $s_2(t) = -A\cos(\omega_0 t)$, where $A = 1$ mV and the single-sided noise density $N_0 = 5 \times 10^{-12}$ W/Hz. Assume the signal power and enery per bit are normalized to a 1-Ω resistive load. Find the expected number of bit errors made in one hour at the receiver.

Problem 3. A coded BPSK signal is utilized at 20,000 bits/sec. The error correction code is a (7,4) Hamming code ($n = 7,\ k = 4$) that can correct 1 error in a block of 7 bits. The equally likely waveforms are $s_1(t) = A\cos(\omega_0 t)$ and $s_2(t) = -A\cos(\omega_0 t)$, where $A = 1$ mV and the single-sided noise density $N_0 = 5 \times 10^{-12}$ W/Hz. Assume the signal power and enery per bit are normalized to a 1-Ω resistive load. Find the expected number of bit errors made in one hour at the receiver.

Problem 4. Suppose we have BPSK modulation and we implement an error correction code, say, a (15,5) BCH code ($n = 15,\ k = 5$). This code can correct 3 bit errors in a block of size 15 bits. Plot on the same graph P_b vs. E_b/N_0 for both the uncoded and coded waveform. Your E_b/N_0 values should be in dB on the plot. Your E_b/N_0 values should be in dB on the graph and should range from 0 to a large enough value so that $P_b \leq 10^{-12}$.

Problem 5. Matlab exercise. Simulate the signal and error correction code in Problem 1 (uncoded and the coded) and verify that your sim and analytic results match reasonably well by plotting all the curves on the same graph. Your E_b/N_0 values should be in dB on the graph and should range from 0 to a large enough value so that $P_b \leq 10^{-5}$.