EE 567

Homework 8

Due Tuesday, November 6, 2018 at 6:40 p.m.

Work all 5 problems.

Problem 1. In class we derived the probability of bit error for BPSK modulation as

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

Plot this expression for E_b/N_0 ranging from -3 to 16 dB. Your y-axis should be on a log scale.

Problem 2. A binary communication system is used where at the receiver the test statistic is $z(T) = a_i + n_0,\ i = 1, 2$ where $a_1 = +1$ and $a_2 = -1$ and the noise n_0 is distributed as

$$p(n_0) = \begin{cases} \frac{4}{9}(n_0 + 1.5),\ -1.5 \leq n_0 \leq 0 \\ \\ -\frac{4}{9}(n_0 - 1.5),\ 0 \leq n_0 \leq 1.5 \\ \\ 0 \text{ elsewhere.} \end{cases}$$

Find the probability of bit error, P_b, for the case of equally likely signaling and the use of an optimum threshold.

Problem 3. A receiver front end has a noise figure of 9 dB and a gain of 50 dB and a bandwidth of 10 MHz. The input signal power is 10^{-11} W. The antenna temperature is 175 K. Find $T_e,\ T_s,\ N_{out},\ SNR_{in}$ and SNR_{out}. You may use $T_0 = 290$ K and Boltzmann's constant equals 1.38×10^{-23} J/K.

Problem 4. Using the same design as Problem 3 an additional amplifier is inserted in the system before the one described in Problem 3 (a preamplifier) so that now the antenna feeds energy to two networks in cascade. The preamp has a noise figure of 3 dB and a gain of 12 dB and a bandwidth of 10 MHz. Find $T_s,\ F_{out},\ N_{out}$ and SNR_{out}, where F_{out} is the overall or composite F. Indicate how much this design improved SNR_{out} relative to the design in Problem 3.

Problem 5. Consider an RS(255,231) code. Note that each symbol of this Reed-Solomon code is 8 bits long. Denote the probability of a bit error (before decoding) as P_b. Denote the probability of a symbol error as P_s.

a. Compute (before decoding) P_s in terms of P_b.

b. Plot P_s vs. P_b after decoding has taken place. Your P_b should range from 0.1 to 0.001. Your x-axis and y-axis should be on a log scale.