EE 484

Homework 7

Due 6:00 p.m. on Wednesday, March 23, 2016

Work all 3 problems.

Problem 1. This is a Matlab exercise. Analog to digital converters are used in most digital communication systems today. These devices accept analog signals as input, quantize them at a defined sample rate, and assign a set of bits (a symbol) to each sample according to the amplitude. For example, an ideal n-bit converter will quantize input signals into one of 2^n levels. For this exercise, assume that the quantization steps are uniform in amplitude.

a. Generate the signal $s(n) = A \cdot sin(2\pi f_c \Delta t \cdot n)$, for $f_c = 2$, A=1.0, $\Delta t = 0.005$, and $1 \leq n \leq 20,000$. Assume there are four physical bits of resolution in the ADC, then generate and plot the first 200 samples of the input waveform and the quantized waveform (together on the same plot), using a "mid-point" quantizer, so that input values are mapped to the midpoint of the corresponding bin.

b. Generate and plot the error signal between the quantized signal and the input signal. Numerically calculate the mean and variance of this signal, and compare to the theoretical values discussed in class.

c. Generate and plot the quantized waveform for five and six bits of resolution in the analog-to-digital converter, along with the mean and variance of the error signals, and compare to the theoretical values.

d. Calculate the signal to noise ratio for the four, five and six bit cases. What effect do you think non-uniformities in the step sizes have on the signal-to-noise ratio?

Problem 2. A receiver front end has a noise figure of 8 dB and a gain of 60 dB and a bandwidth of 5 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}. Recall that $T_0 = 290$ K.

Problem 3. Using the same design as Problem 2 an additional amplifier is inserted in the system before the one described in Problem 1 (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 13 dB and a bandwidth of 5 MHz. Find $T_s,\ F_{out},\ N_{out}$ and SNR_{out}, where F_{out} is the overall or composite F.