EECS 455 Problem Set 3

Due: Friday October 1.

1. (a) Is it possible to have reliable communication with a data rate of 2.5Mbps using power $P = 3 \times 10^{-12}$ watts with a bandwidth of $W = 1$ MHz and a noise power spectral density of $\frac{N_0}{2} = \frac{10^{-18}}{2}$ watts/Hz?

   (b) A communication system uses BPSK in a (null-to-null) bandwidth of 1 MHz with power $P = 5 \times 10^{-12}$ watts in the presence of white Gaussian noise with two-side power spectral density $\frac{N_0}{2} = \frac{10^{-18}}{2}$. An error probability of $Q(\sqrt{20})$ is desired. What data rate is possible?

   (c) For the same parameters as part (b) except the error probability requirement is $Q(\sqrt{2})$ what data rate would be possible?

2. (a) Simulate a communication system that uses rectangular pulses of amplitude ± 1 to transmit data. The channel is an additive white Gaussian noise channel. The receiver uses a matched filter followed by a sampler and a decision device. For $E_b/N_0 = 0, 1, \ldots, 8$ determine (and plot) the simulated bit error probability. Compare with the theoretical bit error probability.

   (b) Repeat the above experiment except with a RC filter with impulse response $h(t) = \alpha e^{-\alpha t} u(t)$. Use the value $\alpha = 1.25/T$. Compare the result to part (a).

3. Simulate the communication system shown below. The system uses square-root raised cosine pulses with $\beta = 0.35$ data amplitude ± 1 to transmit data on the cosine and sine branch. Show the data waveform, the transmitted signal in the time domain $s(t)$ and frequency domain $S(f)$. Plot the output of the mixers at the receiver in the frequency domain (show the double frequency terms). Plot the waveform at the output of the receiver filters for a sequence of 8 bits. Make an eye diagram for one of the outputs (use 512 bits for the eye diagram). Assume $T = 1$ and $f_c = 4$ for the simulation. Use a maximum frequency for the simulation of 16Hz.