ECE 642 - Final Spring 2017

Please justify all your responses (responses without justifications will not be considered). Please label your axes and plot with care.

1. (7 points) Consider two waveforms defined as $x_{z,0}(t) = A$ and $x_{z,1}(t) = A\exp(-j2\pi t)$ in the interval $t \in [0,1]$ and equal to zero elsewhere. Assume that $\pi_0 = \pi_1 = 1/2$.

a. Compute A as a function of E_b.

b. Assuming that the filter $H(f)$ equals 1 at all frequencies, compute m_0 and m_1, i.e., the values of the sufficient statistic in the absence of noise when the message is 0 and 1, respectively, at the sampling time $T_P = 1$.

c. Evaluate the probability of error as a function of E_b and $\sigma^2_{N_I}$ (i.e., the variance of the noise affecting the sufficient statistic) for an optimal threshold test when the filter is selected as at the previous point.

d. Evaluate the effective signal.

e. Assuming that the optimal bit demodulator is used, compute m_0, m_1 and $\sigma^2_{N_I}$ at the sampling time $T_P = 1$ as a function of E_b and N_0.

f. Evaluate the probability of error as a function of E_b and N_0 if the optimal bit demodulator is used. How large should E_b/N_0 be so that the computed probability of error is smaller than that obtained at point c?

g. Detail the simplest decoder structure using a single correlator.

2. (3 points) Consider the waveforms

$$
\begin{aligned}
x_{z,0}(t) &= A\text{sinc}(t) \\
x_{z,1}(t) &= -A\text{sinc}(t) \\
x_{z,2}(t) &= jA\text{sinc}(t) \\
x_{z,3}(t) &= -jA\text{sinc}(t)
\end{aligned}
$$

a. Compute A as a function of E_b.

b. Is the modulation linear? If so, evaluate the constellation.

c. Compute the union bound approximation as a function of E_b and N_0.