ECE 642 - Final Fall 2014

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

1. (6 points) Consider the two waveforms defined as $x_{z,0}(t) = 1 - 2t$ and $x_{z,1}(t) = -1$ in the interval $t \in [0, 1]$ and zero elsewhere. Assume $\pi_0 = \pi_1 = 1/2$.

a. Calculate E_0 and E_1.

b. Evaluate the Euclidean distance and the correlation coefficient (Hint: Start with the correlation coefficient).

c. Evaluate and plot the matched filter in the time domain.

d. Draw the block diagram of the optimal baseband demodulator assuming $\pi_0 = \pi_1 = 1/2$. Derive and indicate the values of all the required quantities (e.g., threshold) and simplify the structure as much as possible.

e. If the received signal is $y_z(t) = 1$ for $0 \leq t \leq 1$, what is the optimal decision?

f. Calculate m_0, m_1 and $\sigma^2_{N_I}$ if $N_0 = 1$.

2. (3 points) In a digital communication system, the sufficient statistic is given as $V_I(T_P) = m_i + N_I$, where $m_0 = -1$, $m_1 = 1$ and the noise N_I has a uniform (not Gaussian!) distribution in the interval $[-1.5, 1.5]$, that is, the pdf of the noise is $f(n_I) = 1/3$ for $n_I \in [-1.5, 1.5]$. The message M has probabilities $\pi_0 = \pi_1 = 0.5$.

a. Find the optimal threshold (can there be more than one?).

b. Evaluate the probability of bit error for the optimal threshold.

c. How does the optimal threshold change if $\pi_1 = 1/3$?

3. (3 points) Consider the linear modulation with constellation $\Omega = \{A + j2A,\ A - j2A,\ -A + j2A,\ -A - j2A\}$.

a. Calculate A.

b. Evaluate the union bound by detailing the conditional distance spectra and the distance spectrum.

c. What is the loss with respect to 4-PSK?