Quiz 2 for EE419: Digital Communication Systems

Date: Oct 13, 2008 Time Limit: 50 minutes

1. (5 marks) Consider a 2D signal constellation $\{-2, 2, 1+5j, -1-5j\}$ labeled with bits $\{00, 01, 10, 11\}$, respectively. Assume bits are *iid* uniform.

   (a) (4 marks) Draw the decision regions for a minimum distance detector.

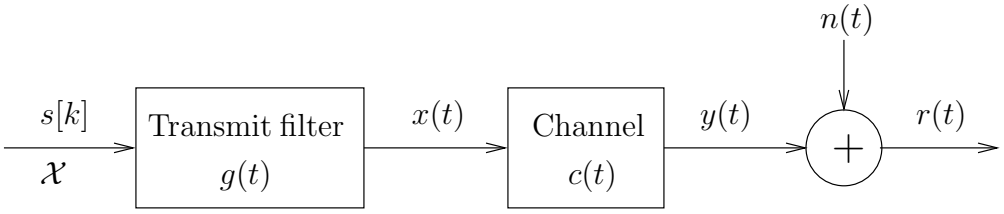
   (b) (1 mark) Find approximate probability of error expressions for each bit.

2. (8 marks) Consider a discrete-time communication system model with an ideal channel $H(z) = 1$ and additive Gaussian noise with PSD

$$S_n(e^{j\omega}) = \frac{1}{3 - 2\cos^2\omega}, \quad |\omega| \leq \pi.$$

   Derive the precursor and postcursor filters for ZF-DFE and MMSE-DFE. Compute their MSEs and compare performance versus implementation complexity.

3. (12 marks) Consider a communication system model shown below operating at a symbol rate of $1/T$ symbols per second. Assume $\mathcal{X} = \{-1, 1\}$ and data symbols are



   equally likely. The transmit filter is a square-root raised-cosine filter with excess bandwidth α at a symbol rate of $1/T$ i.e.

$$G(f) = \begin{cases} \sqrt{T} & |f| \leq \frac{1-\alpha}{2T} \\ \sqrt{T}\cos\left[\frac{\pi T}{2\alpha}\left(|f| - \frac{1-\alpha}{2T}\right)\right] & \frac{1-\alpha}{2T} < |f| \leq \frac{1+\alpha}{2T} \\ 0 & |f| > \frac{1+\alpha}{2T} \end{cases}$$

   The channel response is given by $c(t) = \delta(t) + \frac{5}{2}\delta(t-T) + \delta(t-2T)$ i.e. $y(t) = x(t) + \frac{5}{2}x(t-T) + x(t-2T)$. The noise $n(t)$ is WGN with PSD 0.1.

   (a) (8 marks) Determine the whitened matched filter front-end and the equivalent discrete-time minimum phase channel.

   (b) (4 marks) Design the ZF-DFE for the discrete-time equivalent channel. Compute the figure of merit and compare with matched filter bound.