EE7000 Advanced Digital Signal Processing for Wireless Communications

Homework 3

Due on April 21, 2003, by 11:40 am. (NO LATE SUBMISSION IS ALLOWED!)

1. A single-access M-ary QAM system is modeled. The transmitted signal under Hypothesis i, $0 \le i \le M-1$, is written as

$$s(t) = \sum_{k=-\infty}^{\infty} \{a_k \cos[\omega_c (t - kT_b)] + b_k \sin[\omega_c (t - kT_b)]\} p(t - kT_b),$$

$$\text{where } p(t) = \begin{cases} 1, & 0 \le t \le T_b \\ 0, & elsewhere \end{cases}.$$

   If the channel impulse response $h(t)$ is causal and of finite support such that $h(t) = 0$, $t<0$ or $t>B_f T_b$. The channel noise $n(t)$ is additive white Gaussian noise and the received signal can be described as $r(t) = s(t) \otimes h(t) + n(t)$. We apply the signal analysis method at the receiver.
   (a) What are the appropriate basis functions for this QAM system?
   (b) Depict the demodulator of the QAM system.
   (c) What is the discrete-time received sequence?
   (d) Write down the autocorrelation functions of demodulated noise?
   (e) What is the discrete-time channel impulse response?
   (f) Justify the whole system can be modeled as a discrete-time complex system after demodulation when ω_c is very large.

2. Similar to Problem 1, the impulse response is
   $h(t) = \delta(t) + 0.6310\delta(t - 2\mu\,\text{sec}) + 0.1\delta(t - 4\mu\,\text{sec}) + 0.01\delta(t - 6\mu\,\text{sec})$,

   and ω_c is $10^{10}\pi$ rad/sec, T_b is 0.05 μsec.
   (a) What is the discrete-time complex channel for this QAM system?
   (b) What is the perfect discrete-time equalizer for this channel?
   (c) What is the approximated FIR (finite-impulse response) equalizer $W(z)$ $= \sum_{l=0}^{15} w_l z^{-l}$?

3. Redo Problem 1 while a BPSK system is considered.
4. Redo Problem 2 while a BPSK system is considered.