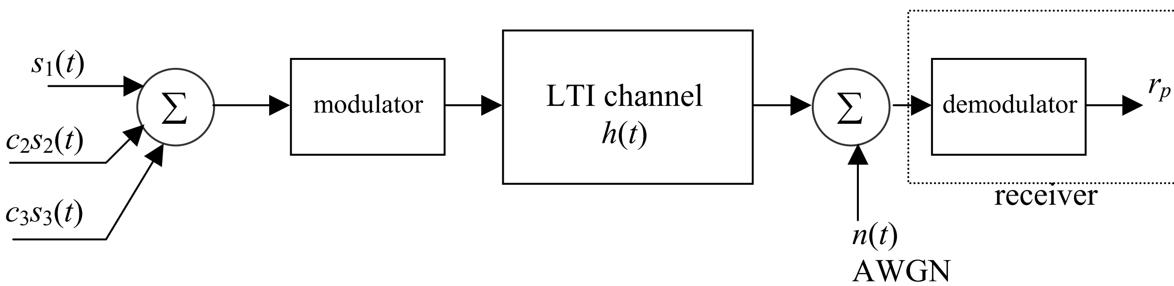
EE7000 Advanced Digital Signal Processing for Wireless Communications

Homework 2

Due on March 10, 2003, by 11:40 am. (NO LATE SUBMISSION IS ALLOWED!)

1. A Multi-access BPSK communication system is depicted as below. $n(t)$ is an additive



white Gaussian channel noise and the transmitted signal $s_k(t)$ is a BPSK rectangular pulse train such that

$$s_k(t) = \sum_{i=-\infty}^{\infty} m_{k,i}\, p(t - iT_b), \text{ where } m_{k,i} = \pm 1 \text{ and } p(t) = \begin{cases} 1, & 0 \le t \le T_b \\ 0, & elsewhere \end{cases}.$$

k=1,2,3 is the user index. The channel is assumed to be distortionless, i.e., $h(t) = \delta(t)$.

We define two hypotheses here:

H_0: Hypothesis for the negative pulse to be sent by user 1.

H_1: Hypothesis for the positive pulse to be sent by user 1.

(a) What are the a priori conditional probability density functions $f_{R|H_0}(r \mid H_0)$ and $f_{R|H_1}(r \mid H_1)$?

(b) What is the probability density function of the observation, $f_R(r)$?

(c) What are the a posteriori probability functions $\Pr[H_0|r]$ and $\Pr[H_1|r]$?

2. Show that r=0 is always a decision boundary for any combination of c_2 and c_3.

3. According to a single decision rule $r \underset{\hat{m}=-1}{\overset{\hat{m}=1}{\gtrless}} 0$, what is the error probability?

4. If the channel is assumed to be a LTI system, i.e., $h(t) = \delta(t)+0.7\delta(t-5.81T_b)$, redo the Problem 1 again.

5. According to the channel assumption in Problem 4, prove that r=0 is always a decision boundary for any combination of c_2 and c_3.

6. According to the channel assumption in Problem 4, redo the Problem 3 again.

7. For a BPSK communication system, what is the relationship between the variance of minimum-mean-square-error (MMSE) channel estimator and the size of non-overlapping training sequence?

8. Apply Matlab simulation to verify the theoretical analysis in Problem 7.