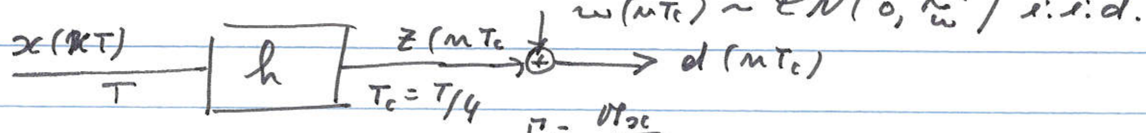
DIGITAL TRANSMISSION APRIL 16, 2015

HW2 DUE APRIL 30, 2015

PROBLEM 1 (20 p)

Simulate a radio channel with a multirate structure and a SNR $\Gamma = 10$ dB:



$$\Gamma = \frac{M_x}{4\sigma_w^2}$$

Let $\{h_i(mT_c)\}$, $i=0,1,\dots,N_h-1$, be the channel impulse response at time mT_c, where 'i' is the ray index at lag iT_c.

- The power delay profile of the discrete time channel is obtained by sampling a continuous time exponential power delay profile with $\bar{\tau}_{rms}/T = 0.3$.
- The first ray h_0 contains a LOS component. Globally the Rice factor is $(K)_{dB} = 3$ dB.

- Determine a suitable length of h, N_h: define criterion.

- Normalize the PDP of h to have a unitary statistical power.
- All rays have a 'Classical' Doppler spectrum with $f_d T = 5\ 10^{-3}$.

- Determine $E[|h_i(mT_c)|^2]$, for $i=0,1,\dots,N_h-1$, in dB (PDP). Report values in a Table and in a Figure.
- Show the behaviour of $|h_1(mT_c)|$ for $m=0,1,\dots,1999$. (Drop the transient).
- Based on values of $|h_1(mT_c)|$, $m=0,1,\dots,999$, plot the "histogram" of $|h_1|/\sqrt{E[|h_1|^2]}$ and compare it with the theoretical pdf. Discuss the result.

- Simulate 1000 realizations of the system; plot the "histogram" of $|h_1(151\,T_c)|/\sqrt{E[|h_1(151\,T_c)|^2]}$ and compare it with the theoretical pdf. Discuss the result.

PROBLEM 2 (20p)

We want to estimate the channel impulse response at Problem 1. Obviously the receiver does not know N_h nor σ_w^2.
Let $\{x(kT)\}$ be a suitable M-L sequence of length L, partially repeated, and assume the receiver is using a LS estimation method.

- Give the set up of the receiver in order to estimate h_i, $i=0,1,\ldots,N_h-1$, of length N_h, by $\hat{h}_i$, $i=0,1,\ldots,N-1$ of length N.

- By repeated estimates determine suitable values for L and N.

- Repeat the estimate 1000 times and determine an estimate of $E[\|\hat{\underline{h}}-\underline{h}\|^2]$, assuming we know $\underline{h}$. If selected N is smaller than N_h, assume in $\hat{\underline{h}}$ that $\hat{h}_N=\hat{h}_{N+1}=\cdots=\hat{h}_{N_h-1}=0$.

- Compare the estimate of $E[\|\hat{\underline{h}}-\underline{h}\|^2]$ with the theoretical value (where we assume $N=N_h$). Note that the input is at T while the output of the system and the estimate are at $T_c=T/4$.