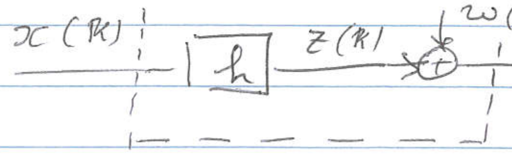
DIGITAL TRANSMISSION — APRIL 8, 2016

HW 2 — DUE APRIL 20

PROBLEM 1 (20p)

Given the real value system for $k \geq 0$



where $z(k) = a\, z(k-1) + x(k)$, $a = 0.68129$, $z(-1) = 0$.
The receiver only knows the transmitted signal $\{x(k)\}$ and a bound on the length of h, equal to 15.

- Describe a suitable set up to estimate h by a FIR filter with impulse response $\hat{h}_i$, $i = 0, 1, \ldots, N-1$, and the noise variance by $\hat{\sigma}_w^2$.

In the evaluation of $\Lambda_n = \sigma_w^2 / (\sigma_x^2 \cdot \| \underline{h} - \underline{\hat{h}} \|^2)$ assume you know h and σ_w^2. Similarly in other expressions of Λ_n.

For an estimate of h, use both the correlation method (COR, solid line) and the LS method (LS, dashed line), for a max-length PN sequence of length L, partially repeated, as input. Report two plots, one with $(\mathcal{E}/L)_{dB}$ vs. N ($N = 2, 3, \ldots, L$) and parameter L, and one with $(\Lambda_n)_{dB}$ vs. N and parameter L. On this last figure draw by a red solid line values of Λ_n as given by theory. From the receiver prospective what are best values of N and L? Comment your choice. Report $\hat{\sigma}_w^2$ and $\{\hat{h}_i\}$, $i = 0, 1, \ldots, N-1$, as all expressions and parameters used.

PROBLEM 2 (10 p)

Prove expressions (3.271) and (3.272) of the textbook

PROBLEM 3 (20 p)

Let $\{h_i(nT_c)\}$, $i=0,1,\cdots,N_h-1$, be the impulse response of a radio channel at time nT_c. Index 'i' denotes ray i-th with delay iT_c.

- The power delay profile (PDP) is obtained by sampling a continuous time exponential PDP with $\bar{\tau}_{rms}=0.2T$. Moreover, assume $T_c=\frac{T}{4}$ and $N_h=5$.

- The LOS component of h_0 yields a global Rice factor $(K)_{dB}=2$ dB.

- Normalize the discrete time PDP to have a statistical power equal to one. Report the PDP in dB, i.e. $(E[|h_i|^2])_{dB}$, $i=0,1,\cdots,4$, by a Table and a Figure.

- All rays have a 'Classical' Doppler spectrum with $f_d T_c = 25\ 10^{-5}$

- Simulate taps h_0, h_2 and h_4 of the impulse response.
- Plot $|h_0|$, $|h_2|$ and $|h_4|$ vs n for 12000 samples. Remember to drop the transient.

- Estimate the probability density function of $|h_0|/\sqrt{M_{|h_0|}}$ using a realization of h_0 of length 80.000 samples.
- Plot the estimated PDF together with the theoretical curve
- Estimate the spectrum of h_0 using the Welch method. Plot the estimate together with the theoretical curve.