EEL 6504
Homework 1
Due Sept 15, 2015

Problem 1

The first order MA process

$$d(n) = au(n) + bu(n-1) + cu(n-2)$$

where *a, b* and *c* are constants, $u(n)$ is a zero mean iid sequence (white noise) with uniform pdf and unit variance. $d(n)$ is the desired response for a FIR filter with input $x(n)$, which is also a white, uniform pdf with unit variance. Calculate the *optimal (in the MSE sense)* with one and two coefficient FIR models and the corresponding J_{min} values that approximate $d(n)$ under the two following conditions:

1.a. Using Z transforms
1.b. Using Wiener solution

Compare both solutions and explain the differences.

Problem 2

Consider the signal created by a superposition of a train of delayed delta functions (as in seismic signal processing)

$$x(n) = \delta(n) - \alpha\delta(n-n_0) + \alpha^2\delta(n-2n_0) - ...$$

Calculate the optimal inverse linear filter (in the MSE sense) which deconvolves $x(n)$, i.e. which gives back the impulse excitation $\delta(n)$. Is the resulting filter minimum phase?

Problem 3

Let $y(t) = a\cos[\omega_0 t - \phi(t) + \theta]$ where a and w_0 are constants and θ is a r.v. uniformly distributed in $0<\theta<2\pi$ and $\phi(t)$ is a stationary r.p. which is independent of θ. Compute the ACF and state if the process is wide sense stationary or not.
Let $w(t) = a\cos[(\omega_0 + \delta)t - \phi(t) + \theta]$, which is just a shift in frequency from y(t) (δ is a number). Is w(t) wide sense stationary? Find its spectral density in terms of that of y(t). Show that the cross-correlation between y(t) and w(t) is not stationary and show that y(t)+w(t) is not wide sense stationary. Can an addition of a random phase to w(t) make the additive process y(t)+w(t) stationary?