DIGITAL TRANSMISSION MARCH 25, 2016

DUE APRIL 7

HW1

a) Please, in the report write used equations, do not just recall them from the book.

b) Form a group with another student.

c) Besides the report with solutions, turn in also listing of Matlab simulations: keep the two items separated

PROBLEM 1 (10 p)

Let $\{x(k)\}$ be a r.p. such that $x(k) = e^{j(2\pi f_1 k + \varphi_1)} + e^{j(2\pi f_2 k + \varphi_2)} + w(k)$

where $w(k) \sim \mathcal{N}(0, \sigma_w^2)$, having i.i.d. samples,

$f_1 = 0.125$, $f_2 = 0.80$, $\varphi_1, \varphi_2 \sim U(0, 2\pi)$ stat. ind.

For $\sigma_w^2 = 1.26$, and based on a single realization of $\{x(k)\}$ of 1000 samples, estimate the PSD of $\{x(k)\}$ by using:
a) Correlogram, b) Periodogram, c) Welch, and d) AR model. Plot the four estimates on the same figure (use different colors), together with the theoretical PSD (where a Dirac delta is represented by a triangle of high K and base $2/K$, K being the number of samples)

PROBLEM 2 (10 p)

Repeat the above problem for $\sigma_w^2 = 0.0002$.

In both plots of Problem 1 and Problem 2 use a frequency scale $(0, 1)$ and an amplitude scale, in dB, with a dynamic range of 50 dB. (Eventually clamp the Dirac delta). For each estimation method report all parameters. Do not use macros of Matlab for estimating the PSD.

PROBLEM 3 (10p)

Always for $\tilde{\sigma}_w^2 = 0.0002$, by analysis, design the best predictor of $\{x(n)\}$. Report the predictor coefficients c_i, $i = 1, 2, \ldots, N$. On the z-plane draw the zeros of the predictor error filter $A(z)$.

PROBLEM 4 (10p)

Consider a realization of the r.p. $\{x(n)\}$ at Problem 3. Run an LMS predictor with an order as in Problem 3. Report the predictor coefficients at convergence and compare them with those determined by the direct method. Draw the convergence curve for $\mathrm{Re}[\bar{c}_1]$, $\mathrm{Im}[\bar{c}_1]$, $\mathrm{Re}[\bar{c}_2]$, $\mathrm{Im}[\bar{c}_2]$ and their theoretical value at convergence. In another plot draw $\{|e(n)|^2 = |f_N(n)|^2\}$ vs n and its average across 200 realizations. Use a suitable log-scale (see textbook). Report value of μ.

PROBLEM 5 (10p)

Based on a LMS predictor, as in Problem 4, what could be a method to determine whether the process contains spectral lines. If yes how would you estimate frequency of each spectral line? Methods which need the DFT should not be considered.