Homework #4

Random Signals and Correlation

Assigned on Friday, March 21, 2014
Due on Friday, March 28th, by 11:00am sharp

Homework submitted after 11:00am will be subject to a penalty of 2 points per minute late.

Reading: Johnson, Sethares & Klein, chapters 4, 5, 6, and 8, and Appendix B; and Haykin, *Communication Systems*, excerpts from chapter 4 to be given in a handout.

Here are key sections from Lathi's *Linear Systems and Signals* book (2nd ed) and Oppenheim & Willsky's *Signals and Systems* book (2nd ed) with respect to material in EE 445S:

O&W	Lathi	Topic
1.6	1.7	System properties
1.3 – 1.4	1.4	Basic continuous-time signals
3.2 ##	2.4-4	Fundamental theorem for continuous-time linear systems **
1.3 – 1.4	3.3	Basic discrete-time signals
3.2 ##	3.8-3	Fundamental theorem for discrete-time linear systems **
9.7.2	2.6	Stability of continuous-time filters
10.7.2	3.10	Stability of discrete-time filters
10.1 – 10.3	5.1	Z transforms
10.5	5.2	Properties of the *z*-transform
10.7.3 – 10.7.4	5.3	Transfer functions
10.8	5.4	Realizations of transfer functions
4.3 – 4.4	7.3	Fourier transform properties
7.1	8.1	Sampling theorem

** Please see Appendix F and slide 5-13 in the course reader for the fundamental theorem.
O&W covers a slightly different version of the fundamental theorem in which a complex exponential is the input to a linear time-invariant system. Lathi also has that version as well.

Other signals and systems textbooks should contain equivalent material.

You may use any computer program to help you solve these problems, check answers, etc. ***Please submit any MATLAB code that you have written for the homework solution.*** The MATLAB code in the Johnson, Sethares and Klein book also runs in LabVIEW Mathscript and GNU Octave. Please see the note on page vii of the SRD book for more information

As stated on the course descriptor, "Discussion of homework questions is encouraged. Please be sure to submit your own independent homework solution."

Office hours for the teaching assistants and Prof. Evans; **bold** indicates a 30-minute timeslot:

Time Slot	Monday	Tuesday	Wednesday	Thursday	Friday
9:30 am					**Jia** **(ENS 137)**
10:00 am					**Jia** **(ENS 137)**
10:30 am					
11:00 am	Evans (ETC 5.148)		Evans (ETC 5.148)		Evans (ETC 5.148)
12:00 pm	**Evans** **(ETC 5.148)**		**Evans** **(ETC 5.148)**		**Evans** **(cafe)**
12:30 pm				**Evans** **(ENS 433B)**	**Evans** **(cafe)**
1:00 pm				Evans (ENS 433B)	Evans (cafe)
2:00 pm				**Evans** **(ENS 433B)**	
2:30 pm					
3:00 pm			**Sinno** **(ENS 137)**		
3:30 pm			**Sinno** **(ENS 137)**	**Jia** **(ENS 137)**	
4:00 pm			**Sinno** **(ENS 137)**	**Jia** **(ENS 137)**	
4:30 pm			**Sinno** **(ENS 137)**	**Jia** **(ENS 137)**	
5:00 pm				**Jia** **(ENS 137)**	
5:30 pm				**Sinno** **(ENS 137)**	
6:00 pm				**Sinno** **(ENS 137)**	

4.1. Spectral Analysis of a Random Signal. *40 points.*

a) Johnson, Sethares & Klein, exercise B.2 on page 414. *12 points.*
b) Johnson, Sethares & Klein, exercise 3.4, on page 43. Please submit the plots with your homework solution. *12 points.*
c) Plot spectrum of a pseudo-noise (PN) sequence of length 31 of +1 and -1 amplitudes; i.e., a bit of value '1' maps to +1 and a bit of value '0' maps to -1. You can find a length 31 PN sequence in Appendix L of the course reader, or you could use seqgen.pn to generate one in Matlab. Are there any frequencies at which the magnitude spectrum is exactly zero? *16 points.*

4.2 Finding a Known Marker in a Noisy Received Signal. *30 points.*

Johnson, Sethares & Klein, exercise 8.6, page 159. In the code for correx.m, define `header` to be
(a) A sequence of length 31 of all +1 entries. The Matlab command `ones` might be helpful.
(b) A maximal length pseudo-noise sequence of length 31 with entries +1 and -1.

Explain why there is a difference in detection performance between the two different headers.

4.3 Finding a Known Marker in a Distorted Received Signal. *30 points.*

Johnson, Sethares & Klein, exercise 8.18, page 164.