Spring 2014 EE 445S Real-Time Digital Signal Processing Laboratory Prof. Evans

Homework #5

Steepest Descent, Transceiver Simulation and Phase Recovery

Assigned on Saturday, March 29, 2014
Due on Friday, April 4, 2014, 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 6, 9 and 10
Haykin, *Communication Systems*, excerpts from chapter 4 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)	
2:00 pm				**Evans (ENS 433B)**	
2:30 pm			**Sinno (ENS 137)**		
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				**Jia (ENS 137)**	
5:00 pm				**Jia (ENS 137)**	
5:30 pm				**Sinno (ENS 137)**	
6:00 pm				**Sinno (ENS 137)**	

A ***Hamming window*** is an even symmetric pulse about the midpoint with endpoints having value 0.08. The Matlab command for the Hamming window is `hamming`. The amplitude values of the causal Hamming window of length N samples is defined as

$w[n] = 0.54 - 0.46 \cos(2 \pi n / (N - 1))$ for $n = 0, 1, ..., N-1$.

The group delay of a Hamming pulse of length N samples is $(N-1)/2$ samples.

5.1 Steepest Descent. 30 points.

Johnson, Sethares & Klein, exercise 6.23, page 117, but use $J(x) = x^2 - 8x + 16$. Derive the adaptive equations. For part (a), use values of μ of -0.01, 0.00, 0.01, 0.1, 1.0, 10.0. For part (b), use μ of 0.01.

5.2 Transceiver Simulation. 40 points.

Johnson, Sethares & Klein, exercise 9.2, page 175. Use M = 100, 20, 18 instead of M = 1000, 25, 10.

You might look at the solution for problem 1.3 on midterm #1 in spring 2012 in the course reader.

5.3 Preprocessing for Carrier Phase Recovery. 30 points.

Johnson, Sethares & Klein, exercise 10.1, page 198.

Please read the online hints for homework #5 at

http://users.ece.utexas.edu/~bevans/courses/rtdsp/homework/hints5.html