Fall 2018 EE 313 Linear Systems and Signals Prof. Evans

Homework #6

Frequency Responses and Z-Transforms

Assigned on Saturday, October 20, 2018
Due on Friday, October 26, 2017, by 5:00 pm via Canvas submission

Late homework is subject to a penalty of two points per minute late.

Reading: McClellan, Schafer & Yoder, *Signal Processing First*, 2003, Chapters 6 and 7.
Companion Web site with demos and other supplemental information: http://dspfirst.gatech.edu/
Web site contains solutions to selected homework problems from *DSP First*.

The e-mail address for Mr. Houshang Salimian (TA) is salimian.houshang@gmail.com.
Office hours for Mr. Salimian and Prof. Evans follow:

Time Slot	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*
11:00 am		**Salimian (EER 0.814 Table #4)**		**Salimian (EER 0.814A)**	**Salimian (EER 0.814D)**
11:30 am		**Salimian (EER 0.814 Table #4)**		**Salimian (EER 0.814A)**	**Salimian (EER 0.814D)**
12:00 pm		**Salimian (EER 0.814 Table #4)**		**Salimian (EER 0.814A)**	**Salimian (EER 0.814D)**
12:30 pm		Evans (EER 1.516)		Evans (EER 1.516)	**Salimian (EER 0.814D)**
1:00 pm		Evans (EER 1.516)		Evans (EER 1.516)	
1:30 pm		Evans (EER 1.516)		Evans (EER 1.516)	
2:00 pm		Evans (EER 6.882)	Evans (EER 6.882)	Evans (EER 6.882)	
2:30 pm		Evans (EER 6.882)	Evans (EER 6.882)	Evans (EER 6.882)	
3:00 pm		Evans (EER 6.882)	**Salimian (EER 1.810)**	Evans (EER 6.882)	
3:30 pm			**Salimian (EER 1.810)**		
4:00 pm			**Salimian (EER 1.810)**		
4:30 pm					

Prof. Evans' coffee hours this week will be from 12:00-1:00pm on Friday in the EERC café.

EE 313 tutoring is available on Sundays through Thursdays from 7:00pm to 10:00pm in EER 0.814:
http://www.ece.utexas.edu/undergraduate/tutoring

1. Applying Discrete-Time Four-Point Averaging Filter to a Discrete-Time Signal. 30 points.

Signal Processing First, problem P-6.14, page 160.

For part (b), please express the frequency response for the four-point averaging filter in terms of the Dirichlet function described in Section 6-7 on page 145.

For part (c), you should be able to see that the averaging filter is a lowpass filter with a "null" bandwidth of $2\pi/N$ rad/sample, which is the distance from 0 rad/sample to the first null (zero) of the magnitude response at $2\pi/N$ rad/sample. N-1 frequencies will be zeroed out in the range $(-\pi, \pi]$.

2. Applying Discrete-Time Four-Point Averaging Filter to a Continuous-Time Signal. 20 points.

Signal Processing First, problem P-6.15, page 160.

3. Transfer Functions in the z domain. 25 points.

For each of the following linear time-invariant (LTI) systems, determine the impulse response, derive the transfer function, compute the poles and zeros, plot the poles and zeros using `zplane`:

a) First-order unnormalized averaging filter (lowpass filter): $y[n] = x[n] + x[n-1]$ for $n \geq 0$ and the initial condition $x[-1] = 0$ to satisfy LTI properties.

b) First-order difference filter (highpass filter): $y[n] = x[n] - x[n-1]$ for $n \geq 0$ and the initial condition $x[-1] = 0$ to satisfy LTI properties

c) Second-order difference filter (highpass filter): $y[n] = x[n] - 2\,x[n-1] + x[n-2]$ for $n \geq 0$ and the initial condition $x[-1] = 0$ and $x[-2] = 0$ to satisfy LTI properties

4. Using z-transforms to Compute Discrete-Time Convolution. 25 points.

Signal Processing First, problem P-7.10, page 193.

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

NOTE: In your solutions, please put all work for problem 1 together, then all work for problem 2 together, etc. Please see additional homework guidelines on the homework page.

Please read the homework guidelines at
http://users.ece.utexas.edu/~bevans/courses/signals/homework/index.html