Fall 2021 EE 313 Linear Systems and Signals Prof. Evans

Homework #6

Frequency Responses and Z-Transforms

Assigned on Thursday, October 14, 2021
Due on Friday, October 22, 2021, by 11:59 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*.

Office hours for Mr. Tabbara and Prof. Evans follow:

Time Slot	***Monday***	***Tuesday***	***Wednesday***	***Thursday***	***Friday***
9:30 am				Evans (Zoom)	
10:00 am				Evans (Zoom)	
10:30 am					
11:00 am		Evans (EER 1.516)		Evans (EER 1.516)	
11:30 am		Evans (EER 1.516)		Evans (EER 1.516)	
12:00 pm		Evans (EER 1.516)		Evans (EER 1.516)	
12:30 pm		Evans (Zoom)			
1:00 pm		Evans (Zoom)			
1:30 pm					
2:00 pm					Evans (Zoom)
2:30 pm					Evans (Zoom)
3:00 pm					Tabbara (Zoom)
3:30 pm			Tabbara (Zoom)		Tabbara (Zoom)
4:00 pm			Tabbara (Zoom)		Tabbara (Zoom)
4:30 pm			Tabbara (Zoom)		

Prof. Evans holds coffee/advising hours on Fridays 12:00-2:00pm in the EERC café.

EE 313 tutoring is available 7-10pm on Sundays through Thursdays online.

1. Frequency and Step Responses. 36 points.

For each of the following linear time-invariant (LTI) systems, determine the impulse response, step response, and frequency response. Plot the magnitude and phase of the frequency response using `freqz`:

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

2. Cascade of Three Systems. 28 points.

Signal Processing First, problem P-6.13, page 159.

3. Transfer Functions in the *z* domain. 36 points.

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

d) 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.

e) 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

f) 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

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.