

Homework #6

Frequency Responses

Assigned on Saturday, October 19, 2024, and Reassigned on Thursday, October 24, 2024

Due on Friday, October 25, 2024, by 11:59 pm via Gradescope 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*.

E-mail address for Mr. Elyes Balti (TA) is ebalti@utexas.edu. Please consider posting questions on [Ed Discussion](#), which can be answered by anyone in the class. You can post anonymously. Lecture and office hours follow. Prof. Evans is also available immediately after lecture

Time Slot	Monday	Tuesday	Wednesday	Thursday	Friday
11:00 am		Evans (ECJ 1.204)		Evans (ECJ 1.204)	
11:30 am		Evans (ECJ 1.204)		Evans (ECJ 1.204)	
12:00 pm		Evans (ECJ 1.204)		Evans (ECJ 1.204)	
12:30 pm					
1:00 pm			Balti (EER 5.652)		
1:30 pm			Balti (EER 5.652)		
2:00 pm	Evans (EER 6.882; Zoom)		Balti (EER 5.652)		Balti (EER 4.650)
2:30 pm	Evans (EER 6.882; Zoom)		Balti (EER 5.652)		Balti (EER 4.650)
3:00 pm	Evans (EER 6.882; Zoom)				Balti (EER 4.650)
3:30 pm			Evans (EER 6.882; Zoom)		Balti (EER 4.650)
4:00 pm			Evans (EER 6.882; Zoom)		
4:30 pm			Evans (EER 6.882; Zoom)		
5:00 pm				Balti (EER 4.702)	
5:30 pm				Balti (EER 4.702)	
6:00 pm				Balti (EER 4.702)	
6:30 pm				Balti (EER 4.702)	

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

[EE 313 tutoring](#) is available on Mondays and Thursdays 7-10pm in person.

1. Frequency and Step Responses. 60 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 $x[-1] = 0$ as a necessary condition for LTI properties to hold. *Note: The phase of the frequency response is linear.*
- b) First-order difference filter (highpass filter): $y[n] = x[n] - x[n - 1]$ for $n \geq 0$ and the initial condition $x[-1] = 0$ as a necessary condition for LTI properties to hold. *Note: The phase of the frequency response is linear.*
- c) Second-order difference filter (highpass filter): $y[n] = x[n] - 2x[n - 1] + x[n - 2]$ for $n \geq 0$ and the initial conditions $x[-1] = 0$ and $x[-2] = 0$ as necessary conditions for LTI properties to hold. *Note: The phase of the frequency response is linear.*

2. Cascade of Three Systems. 40 points.

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

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](#).