

Homework #6

Frequency Responses

Assigned on Monday, Oct. 20, 2025, and due Friday, Oct. 24, 2025, by 11:59 pm via Gradescope

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 Mr. Dan Jacobellis (TA) at danjacobellis@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 for Mr. Jacobellis and Prof. Evans follow. Prof. Evans also holds office hours in person in EER 6.882 and online on Zoom.

<i>Time Slot</i>	<i>Monday</i>	<i>Tuesday</i>	<i>Wednesday</i>	<i>Thursday</i>	<i>Friday</i>
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		Jacobellis (EER 1.810)			
1:00 pm		Jacobellis (EER 1.810)			
1:30 pm		Jacobellis (EER 1.810)			
2:00 pm	Evans (EER 6.882)	Jacobellis (EER 1.810)			
2:30 pm	Evans (EER 6.882)				
3:00 pm	Evans (EER 6.882)			Jacobellis (Zoom)	
3:30 pm			Evans (EER 6.882)	Jacobellis (Zoom)	
4:00 pm			Evans (EER 6.882)	Jacobellis (Zoom)	
4:30 pm			Evans (EER 6.882)	Jacobellis (Zoom)	
5:00 pm				Jacobellis (Zoom)	Jacobellis (EER 1.810)
5:30 pm					Jacobellis (EER 1.810)
6:00 pm					Jacobellis (EER 1.810)

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

[EE 313 tutoring](#) is available on Sundays, Tuesdays, and Thursdays 7-10pm in person in EER 0.814.

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`.

- 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.*
- 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.*
- 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](#).