Fall 2017 EE 313 Linear Systems and Signals Prof. Evans

Homework #9

Continuous-Time Frequency Response and Fourier Transforms

Assigned on Friday, December 1, 2017
Due date delayed until Monday, December 11, 2017, by 12:30 pm via Canvas submission

Late homework will not be accepted.

Reading: McClellan, Schafer & Yoder, *Signal Processing First*, 2003, Ch. 16.
Chapter 16 is supplemental chapter to *Signal Processing First*. It is only available on Canvas:
https://utexas.instructure.com/courses/1202937/discussion_topics/2911288

Office hours for Ms. Ghosh and Prof. Evans follow, as well as Prof. Evans' coffee hours on Friday.

Time Slot	***Tuesday (12/5)***	***Wednesday (12/6)***	***Thursday (12/7)***	***Friday (12/8)***	***Monday (12/11)***
9:00 am					**Ghosh (EER 5.854)**
9:30 am					**Ghosh (EER 5.854)**
10:00 am					**Ghosh (EER 5.854)**
10:30 am					
11:00 am			**Ghosh (EER 1.810)**		
11:30 am			**Ghosh (EER 1.810)**		
12:00 pm			**Ghosh (EER 1.810)**	Evans (EER cafe)	
12:30 pm	Evans (EER 1.516)		Evans (EER 1.516)	Evans (EER cafe)	
1:00 pm	Evans (EER 1.516)	Evans (EER 6.882)	Evans (EER 1.516)	Evans (EER cafe)	
1:30 pm	Evans (EER 1.516)	Evans (EER 6.882)	Evans (EER 1.516)	Evans (EER cafe)	
2:00 pm		Evans (EER 6.882)	Evans (EER 6.882)		
2:30 pm			Evans (EER 6.882)		
3:00 pm			Evans (EER 6.882)	**Ghosh (EER 5.854)**	
3:30 pm				**Ghosh (EER 5.854)**	
4:00 pm				**Ghosh (EER 5.854)**	

EE 313 tutoring is available on Sundays through Thursdays from 7:00pm to 10:00pm in ETC 4.150:

http://www.ece.utexas.edu/undergraduate/tutoring

1. Laplace Transforms Using Transform Properties and Pairs. ***20 points.***

Signal Processing First, problem P-16.2, Chapter 16, page 59.

2. **Finding a Laplace Transform of a Two-Sided Signal.** ***25 points.***

Signal Processing First, problem P-16.3, Chapter 16, page 59.

3. Transfer Function in the Laplace Domain. ***30 points.***

A continuous-time system with input $x(t)$ and output $y(t)$ is described by the following linear constant coefficient differential equation for $t > 0^-$:

$$\frac{d}{dt}y(t) + 2y(t) = x(t)$$

The initial condition $y(0^-) = 0$ so that the system will have linearity and time-invariant properties. (Notice the two different uses of "linear". In the case of linear constant different equation, "linear" refers to "affine" which is a line that does not necessarily go through the origin.)

(a) What is the transfer function $H(s)$ of the system in the Laplace domain including the region of convergence?

(b) What is the impulse response $h(t)$ of the system?

(c) Find the frequency response $H(j\omega)$ of the system from the transfer function. Why is the substitution $s = j\omega$ valid?

(d) From part (c), plot the magnitude response. What is the frequency selectivity— lowpass, highpass, bandpass, bandstop, allpass or notch?

(e) For $x(t) = u(t)$, find $X(s)$ and $Y(s)$.

(f) From part (e), find $y(t)$ by taking the inverse Laplace transform of $Y(s)$.

4. Solving a Differential Equation. ***25 points.***

Signal Processing First, problem P-16.8, Chapter 16, page 61.

For part (c), please plot the magnitude response using MATLAB.

Please also complete the following:

(d) What is the frequency selectivity— lowpass, highpass, bandpass, bandstop, allpass or notch?

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.