Fall 2023 EE 313 Linear Systems and Signals Prof. Evans

Homework #9

Fourier and Laplace Transforms

Assigned on Saturday, November 11, 2023
Due on Friday, December 1, 2023, 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, Ch. 11 and Supplemental Chapter on The Laplace Transform.
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. Balti (ebalti@utexas.edu) and Prof. Evans follow.

Office Hours	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*
11:00 am		**Evans (ECJ 2.104)**		**Evans (ECJ 2.104)**	
11:30 am		**Evans (ECJ 2.104)**		**Evans (ECJ 2.104)**	
12:00 pm		**Evans (ECJ 2.104)**		**Evans (ECJ 2.104)**	
12:30 pm					
1:00 pm					
1:30 pm					
2:00 pm			**Evans (EER 6.882 and Zoom)**	**Evans (EER 6.882 and Zoom)**	**Balti (EER 3.648)**
2:30 pm			**Evans (EER 6.882 and Zoom)**	**Evans (EER 6.882 and Zoom)**	**Balti (EER 3.648)**
3:00 pm			**Evans (EER 6.882 and Zoom)**	**Evans (EER 6.882 and Zoom)**	**Balti (EER 3.648)**
3:30 pm		**Balti (EER 3.648)**			
4:00 pm		**Balti (EER 3.648)**			
4:30 pm		**Balti (EER 3.648)**			
5:00 pm				**Balti (EER 3.648)**	
5:30 pm				**Balti (EER 3.648)**	
6:00 pm				**Balti (EER 3.648)**	

Please read the homework guidelines and homework hints.

** Prof. Evans holds coffee/advising hours on Fridays 12:00-2:00pm in the EER café.
EE 313 tutoring is available 7-10pm on Sundays through Thursdays online.

1. **Forward Continuous-Time Fourier Transform.** ***45 points.***

   Compute the continuous-time Fourier transform $X(j\omega)$ for continuous-time signal $x(t)$ using the definition in *Signal Processing First* in equation (11.1)

$$X(j\omega) = \int_{-\infty}^{\infty} x(t)\, e^{-j\,\omega\, t}\, dt$$

   for the following time-domain signals $x(t)$: *6 points for each.*

   (a) $\delta(t)$

   (b) Rectangular pulse of unit amplitude that lasts from $-\frac{T}{2}$ to $\frac{T}{2}$ seconds.

   (c) $e^{-a\,t}\, u(t)$ for positive and real-valued a

   (d) $e^{b\,t}\, u(-t)$ for positive and real-valued b

   (e) $e^{-a\,|t|}$ for $-\infty < t < \infty$ for positive and real-valued a.
   Hint: You can reuse results from parts (c) and (d).

   Signal Processing First Section 11.4 covers examples (a)-(d). You can check your answers using continuous-time Fourier transform pairs in Table 11-2 of on page 338 in *Signal Processing First.*

   In addition, for each part, describe the frequency selectivity of the magnitude response as lowpass, highpass, bandpass, bandstop, allpass, or notch. *3 points for each.*

   Same as Homework Problem 8.3 in Fall 2021.

2. **Continuous-Time Fourier Transforms Using Transform Properties and Pairs.** ***28 points.***

   Signal Processing First, problem P-11.8, page 343. *7 points for each part.*

   Same as Homework Problem 9.1 from Fall 2021.

3. **Laplace Transforms.** ***27 points.***

   Plot each signal in the time domain for -1 < t < 1, compute the Laplace transform including the region of convergence.

   (a) $h(t) = \cos(20\,\pi\, t)\, u(t)$. *6 points.*

   (b) $h(t) = e^{-8t}\, u(t)$. *6 points.*

   (c) $h(t) = (1 - e^{-8t})\, u(t)$. *6 points.*

   For each part, what is the frequency content— lowpass, highpass, bandpass, bandstop, allpass or notch? *2 points for each part.*

   Similar to Homework Problem 9.2 from Fall 2021.

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

Please read the homework guidelines and homework hints.