Fall 2018 EE 313 Linear Systems and Signals Prof. Evans

Homework #10

# Laplace Transforms

Assigned on Friday, November 30, 2018

Due on Monday, December 10, 2018, by 5:00 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, Chapter 16:

<https://utexas.instructure.com/files/47383586/download?download_frd=1>

Companion Web site with demos and other supplemental information: <http://dspfirst.gatech.edu/>

Web site contains solutions to selected homework problems from *DSP First*.

The e-mail address for Mr. Houshang Salimian (TA) is [salimian.houshang@gmail.com](mailto:salimian.houshang@gmail.com).

Office hours for Mr. Salimian and Prof. Evans follow. Prof. is holding additional office hours on WF 9:00-10:00am. His Wednesday afternoon office hours have changed to 1:00-2:00pm.

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| ***Time Slot*** | ***Monday*** | ***Tuesday*** | ***Wednesday*** | ***Thursday*** | ***Friday*** |
| 9:00 am |  |  | Evans (EER 6.882) |  | Evans (EER 6.882) |
| 10:00 am |  |  |  |  |  |
| 11:00 am |  | Salimian (EER 0.814 Table #4) |  | Salimian (EER 0.814A) | Salimian (EER 0.814D) |
| **12:00 pm** |  | **Salimian (EER 0.814 Table #4)** |  | **Salimian (EER 0.814A)** | **Salimian (EER 0.814D)** |
| **12:30 pm** |  | **Evans (EER 1.516)** |  | **Evans (EER 1.516)** | **Salimian (EER 0.814D)** |
| 1:00 pm |  | Evans (EER 1.516) | Evans (EER 6.882) | Evans (EER 1.516) |  |
| 2:00 pm |  | Evans (EER 6.882) |  | Evans (EER 6.882) |  |
| **3:00 pm** |  | **Evans (EER 6.882)** | **Salimian (EER 1.810)** | **Evans (EER 6.882)** |  |
| **3:30 pm** |  |  | **Salimian (EER 1.810)** |  |  |
| **4:00 pm** |  |  | **Salimian (EER 1.810)** |  |  |
| **4:30 pm** |  |  |  |  |  |

***Prof. Evans’ coffee hours this week will be 12:00-2:00pm on Friday in the EERC café.***

EE 313 tutoring is available on Sundays through Thursdays from 7:00pm to 10:00pm in EER 0.814:

[http://www.ece.utexas.edu/undergraduate/tutoring](http://www.ece.utexas.edu/undergraduate/tutoring" \t "_blank)

1. **Laplace Transform Using Transforms and Properties. *24 points*.**

The time-shift property states that if *X*(*s*) is the bilateral Laplace transform of *x*(*t*), then

Use this property to find the bilateral Laplace transforms of the following signals, including their regions of convergence:

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

1. **Transfer Functions in the Laplace Domain. *18 points*.**

Plot each signal in the time domain for -1 < *t* < 1, compute the Laplace transform including the region of convergence, and sketch the pole-zero plot and region of convergence for the following signals:

**3. Transfer Function in the Laplace Domain. *34 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-:

Initial conditions are set to zero, i.e. *y*(0-) = 0 and *x*(0-) = 0, so 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.)

1. What is the transfer function *H*(*s*) of the system in the Laplace domain including the region of convergence?
2. What is the impulse response *h*(*t*) of the system?
3. Find the frequency response *H*(*j*) of the system from the transfer function. Why is the substitution *s* = *j* valid?
4. From part (c), plot the magnitude response. What is the frequency selectivity— lowpass, highpass, bandpass, bandstop, allpass or notch?
5. For *x*(*t*) = *u*(*t*), find *X*(*s*) and *Y*(*s*).
6. From part (e), find *y*(*t*) by taking the inverse Laplace transform of *Y*(*s*).

***Note: This problem is a variation on homework problem 9.3 from fall 2017.***

**4. Another Transfer Function in the Laplace Domain. 24 points.**

*Signal Processing First*, problem P-16.10, page 61.

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 at <http://users.ece.utexas.edu/~bevans/courses/signals/homework/index.html>