Fall 2018 EE 313 Linear Systems and Signals Prof. Evans

Homework #6

# Frequency Responses and Z-Transforms

Assigned on Saturday, October 20, 2018

Due on Friday, October 26, 2017, 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, 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*.

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:

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| --- | --- | --- | --- | --- | --- |
| ***Time Slot*** | ***Monday*** | ***Tuesday*** | ***Wednesday*** | ***Thursday*** | ***Friday*** |
| **11:00 am** |  | **Salimian (EER 0.814 Table #4)** |  | **Salimian (EER 0.814A)** | **Salimian (EER 0.814D)** |
| **11:30 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 1.516) |  |
| **1:30 pm** |  | Evans (EER 1.516) |  | Evans (EER 1.516) |  |
| **2:00 pm** |  | Evans (EER 6.882) | Evans (EER 6.882) | Evans (EER 6.882) |  |
| **2:30 pm** |  | Evans (EER 6.882) | 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 from 12:00-1:00pm 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. Applying Discrete-Time Four-Point Averaging Filter to a Discrete-Time Signal. 30 points.**

*Signal Processing First*, problem P-6.14, page 160.

For part (b), please express the frequency response for the four-point averaging filter in terms of the Dirichlet function described in Section 6-7 on page 145.

For part (c), you should be able to see that the averaging filter is a lowpass filter with a “null” bandwidth of 2/*N* rad/sample, which is the distance from 0 rad/sample to the first null (zero) of the magnitude response at 2/*N* rad/sample. *N*-1 frequencies will be zeroed out in the range (-, ].

**2. Applying Discrete-Time Four-Point Averaging Filter to a Continuous-Time Signal. 20 points.**

*Signal Processing First*, problem P-6.15, page 160.

**3. Transfer Functions in the *z* domain. 25 points.**

For each of the following linear time-invariant (LTI) systems, determine the impulse response, derive the transfer function, compute the poles and zeros, plot the poles and zeros using zplane:

1. First-order unnormalized averaging filter (lowpass filter): and the initial condition
2. First-order difference filter (highpass filter): and the initial condition
3. Second-order difference filter (highpass filter): and the initial condition

**4. Using *z*-transforms to Compute Discrete-Time Convolution. 25 points.**

*Signal Processing First*, problem P-7.10, page 193.

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>