Rensselaer Polytechnic Institute
Department of Electrical, Computer, and Systems Engineering
ECSE 4530: Digital Signal Processing, Fall 2020

Homework #3: due Monday, Oct. 26th, at the beginning of class.

MATLAB Grader Problems

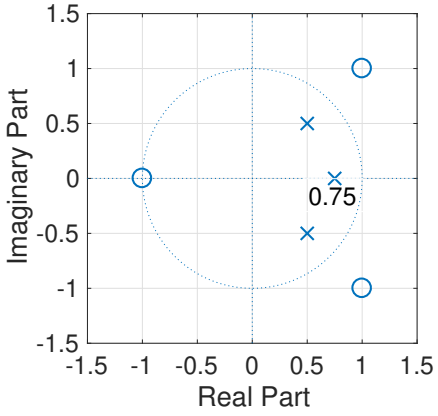
A full description of all the Grader problems is provided at the Grader link. You don't need to physically hand anything in for the Grader problems (but make sure that you hit Submit and see a green check mark to make sure your solution has been recorded).

1. (10 points). Compute the z-transform using numerical integration.
2. (20 points). Write a function to automatically solve a partial fraction expansion of a transfer function for cascading single-pole systems.
3. (20 points). Write a function to automatically solve for the sine and cosine terms for a transfer function involving complex poles.

Analytical Problems: Clearly show your work and label your answers.

4. (20 points) **Discrete time system analysis and z-transform.**

   (a) Estimate the transfer function $H(z)$ corresponding to the below pole-zero plot.



   (b) Sketch the magnitude of the frequency response for $\omega \in (-\pi, \pi)$.

   (c) What is the governing system difference equation for this filter?

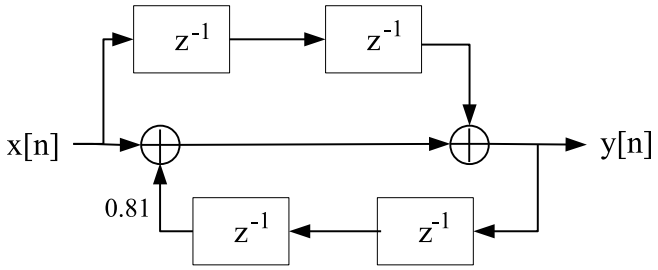
   (d) Draw a block diagram implementation of this discrete time filter using simple delay elements (one clock cycle flip flops), constant multipliers, and adders.

   (e) Find the output $y[n]$ of this system for the following inputs:

      i. $x[n] = 3^n$
      ii. $x[n] = 3^{(n-10)}$
      iii. $x[n] = 3^{(10-n)}$

5. (20 points) **Digital filter design.**

   Consider an implementation of a simple digital filter, as shown in the below block diagram using simple delay elements, 2-input adders, and a single constant multiplier.



   Provide the following items.

   (a) A valid difference equation that describes the system.

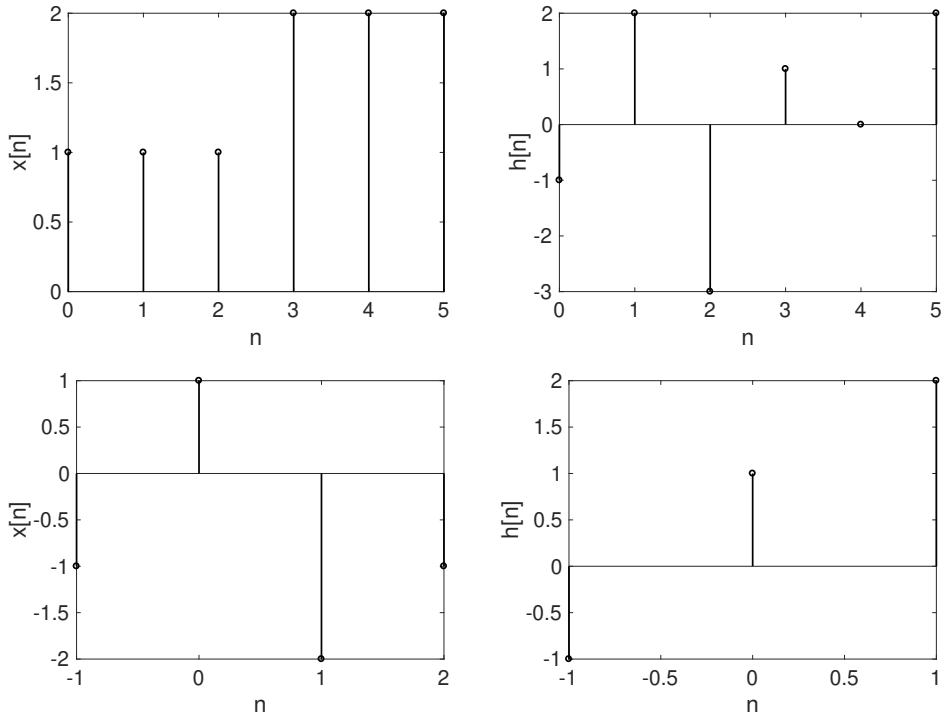
   (b) The corresponding transfer function $H(z)$.

   (c) A pole zero plot of $H(z)$, including the unit circle. Is this system stable?

   (d) Plot its amplitude response $|H(\omega)|$ for $\omega \in (-\pi, \pi)$. What kind of filter is this?

6. (10 points) **Circular convolution.**

   Compute the length-6 circular convolutions of the following pairs of signals:



Suggested reading material from textbook: 3.1-3.4 (z-transform) along with the Examples and their solutions.

Suggested practice problems from textbook: 3.35, 3.47.