Full Name: ____

EEL 3135 (Spring 2021) – Lab #10 **Due: 11:59 PM ET, Mar. 06 - 12 (On Lab Day)**

Question #1: *(Designing a Filter)*

There is (somewhat) no Question #1 this week (you do not have to submit anything)! Instead, we have included a demonstration on how you can design and apply your own filter. The demo isolates a single note from a clip of xylophone audio. There is also a new function in the comment code and skeleton code, `pz2ba`, which you can use to convert pole and zero locations into filter coefficients `b` and `a`. This should help you in the lab.

Question #2: *(Thinking in Three Domains 1)*

The next two problems represent the culmination of the past three z-transform weeks. We want you to design and implement filters with little additional guidance from us (excluding what is in `eel3135_lab10_comment`). Use your knowledge about filters in the time-domain, frequency-domain, and pole-zero space to design appropriate filter systems.

Included with the lab is an audio file "music.wav." Listen to the audio and you should hear three instruments: a bass, a mandolin (guitar-like string instrument), and a trumpet. Use MATLAB to design a filter that retains the **bass** and removes the mandolin and the trumpet.

Hint: The bass has to lowest frequency, the trumpet has the highest frequencies, and the mandolin frequencies are in-between..

(a) **Answer in your comments:** What type of filter did you design: low-pass, high-pass, band-pass, band-stop, all-pass? Why?

(b) **Answer in your comments:** Did you create an FIR or IIR filter? Why?

(c) Plot the frequency-domain magnitudes and the time-domains for the input and output signals ($|X(\omega)|$ and $|Y(\omega)|$) (use Question #1 as guidance).

(d) **Answer in your comments:** What do these plots tell should you about your filter?

(e) Plot the filter impulse response $h[n]$.

(f) **Answer in your comments:** What does the impulse response tell you about your filter?

(g) Plot the filter magnitude response $|H(w)|$.

(h) **Answer in your comments:** What does the frequency response tell you about your filter?

(i) Plot the pole-zero plot of your filter.

(j) **Answer in your comments:** What does the pole-zero plot tell you about your filter?

(k) Submit your filtered data as a .wav file.

Question #3: *(Thinking in Three Domains 2)*

Included with the lab is an audio file "music.wav." Listen to the audio and you should hear three instruments: a bass, a mandolin (guitar-like string instrument), and a trumpet. Use MATLAB to design a filter that retains the **mandolin** only (Note: you may not be able to entirely remove the other instruments entire since there is a little bit of overlap in frequencies – do the best you can).

Hint 1: The mandolin's frequency band is centered around approximately 505 Hz.

Hint 2: Remember that the normalized frequency $\widehat{\omega} = \pi$ maps to $f = f_s/2$ in conventional frequency, where f_s is the sampling rate.

(a) **Answer in your comments:** What type of filter did you design: low-pass, high-pass, band-pass, band-stop, all-pass? Why?

(b) **Answer in your comments:** Did you create an FIR or IIR filter? Why?

(c) Plot the frequency-domain magnitudes and the time-domains for the input and output signals ($|X(\omega)|$ and $|Y(\omega)|$) (use Question #1 as guidance).

(d) **Answer in your comments:** What do these plots tell should you about your filter?

(e) Plot the filter impulse response $h[n]$.

(f) **Answer in your comments:** What does the impulse response tell you about your filter?

(g) Plot the filter magnitude response $|H(w)|$.

(h) **Answer in your comments:** What does the frequency response tell you about your filter?

(i) Plot the pole-zero plot of your filter.

(j) **Answer in your comments:** What does the pole-zero plot tell you about your filter?

(k) Submit your filtered data as a .wav file.