Full Name: ______________________________

EEL 4750 / EEE 5502 (Fall 2018) – HW #10 **Due Date: Nov. 15, 2018**

Question #1: *(1 pts)* How many hours did you spend on this homework?

Question #2: *(12 pts)* Consider a desired frequency response defined by

$$H_d(\omega) = \sum_{k=-\infty}^{\infty} \delta(\omega - 5\pi/6 + 2\pi k) + \delta(\omega + 5\pi/6 + 2\pi k)$$

(a) Compute the discrete-time FIR filter coefficients $h[n]$ using the windowing method with a Hann window

$$w[n] = \frac{1}{2}\left[1 - \cos\left(\frac{2\pi n}{N-1}\right)\right]$$

with length of $N = 6$

(b) Sketch the magnitude response $|H(\omega)|$ derived using the windowing method.

(c) Compute discrete-time FIR filter coefficients $g[n]$ with a 12-point frequency sampling method.

(d) Sketch the magnitude response $|G(\omega)|$ derived using the frequency sampling method.

(e) Compute discrete-time FIR filter coefficients $r[n]$ with a 6-point frequency sampling method.

(f) Sketch the magnitude response $|R(\omega)|$ derived using the frequency sampling method.

Question #3: *(12 pts)* Consider a desired filter corresponding to an infinite impulse response and z-transform defined by

$$H_d(z) = \frac{1}{1 - (1/2)z^{-2}}$$

Our goal is to approximate this as a finite-length filter. Assume all poles are causal.
Note that this infinite impulse response is **not** linear phase and is already casual. Therefore, for the windowing method, you do **not** have to shift the signal to make it causal.

(a) Compute discrete-time FIR filter coefficients $h[n]$ with the windowing method with a 2-point rectangular window.

(b) Sketch the magnitude response $|H(\omega)|$ derived using the 2-point windowing method.

(c) Compute discrete-time FIR filter coefficients $v[n]$ with the windowing method with a 4-point rectangular window.

(d) Sketch the magnitude response $|V(\omega)|$ derived using the 4-point windowing method.

(e) Compute discrete-time FIR filter coefficients $g[n]$ with a 2-point frequency sampling method.

(f) Sketch the magnitude response $|G(\omega)|$ derived using the frequency sampling method.

Question #4: *(12 pts)* Consider a continuous-time filter defined by the transfer function

$$H(s) = \frac{1}{s^2 + \pi}$$

(a) Compute the discrete-time filter z-transform $H(z)$ using the discrete-time approximation for the differential equation. Assume a sampling period of $T = 1$.

(b) Sketch the magnitude response $|H(\omega)|$ derived using the discrete-time approximation for the differential equation.

(c) Compute the discrete-time filter z-transform $G(z)$ using the impulse invariance method. Assume a sampling period of $T = 1$.

(d) Sketch the magnitude response $|G(\omega)|$ derived using the impulse invariance method.

(e) Compute the discrete-time filter z-transform $R(z)$ using the bilinear transform. Assume a sampling period of $T = 1/\sqrt{\pi}$.

(f) Sketch the magnitude response $|R(\omega)|$ derived using the bilinear transform.

Question #5: *(22 pts)* Consider a continuous-time filter defined as an ideal differentiator

$$H(s) = s$$

(a) Start by computing the ideal continuous-time magnitude response $|H(s = j\omega)|$ for this system. What type of filter is this: low pass, band pass, high pass? How is this response problematic for discrete-time differentiation?

(b) Compute the discrete-time filter z-transform $H(z)$ using the discrete-time approximation for the differential equation. Assume a sampling period of $T = 1$.

(c) Sketch the magnitude response $|H(\omega)|$ derived using the discrete-time approximation for the differential equation.

(d) Sketch the pole-zero plot for the transfer function $H(\omega)$.

(e) Compute the discrete-time filter z-transform $G(z)$ using the impulse invariance method. Assume a sampling period of $T = 1$.

(f) Sketch the magnitude response $|G(\omega)|$ derived using the impulse invariance method.

(g) Sketch the pole-zero plot for the transfer function $G(\omega)$.

(h) Compute the discrete-time filter z-transform $R(z)$ using the bilinear transform. Assume a sampling period of $T = 1$.

(i) Sketch the magnitude response $|R(\omega)|$ derived using the bilinear transform.

(j) Sketch the pole-zero plot for the transfer function $R(\omega)$.

(k) In your opinion, which discrete-time filter is the best differentiator?

Question #6: *(3 pts)* *Project (EEE 5502 only)*

We now have an abstract. The final paper will be a 4-page IEEE conference style paper that reviews and connects the three papers you have chosen. Note that in the paper, you are not restricted to only those three papers. These papers simply act as a guide for your review.

For this assignment, provide a 1-page 10pt size font in Times New Roman summary of the chosen technical method that you are studying. Feel free to use mathematical equations in your summary. Long or important equations should be placed on their own line of text.