GEORGIA INSTITUTE OF TECHNOLOGY

SCHOOL of ELECTRICAL & COMPUTER ENGINEERING

QUIZ #3

DATE: 4/1/05 COURSE: ECE-2025

NAME: ______________________________ GT #: ________________

LAST, FIRST (ex: `gtz123q`)

3 points 3 points 3 points

Recitation Section: Circle the date & time when your **Recitation Section** meets (not Lab):

	L05:Tues-Noon (Chang)		L06:Thur-Noon (Ingram)
	L07:Tues-1:30pm (Chang)		L08:Thurs-1:30pm (Zhou)
L01:M-3pm (Williams)	L09:Tues-3pm (Casinovi)	L02:W-3pm (Juang)	L10:Thur-3pm (Zhou)
L03:M-4:30pm (Casinovi)	L11:Tues-4:30pm (Casinovi)	L04:W-4:30pm (Juang)	GTSav: (Moore)

- Write your name on the front page ONLY. **DO NOT** unstaple the test.
- Closed book, but a calculator is permitted.
- One page ($8\frac{1}{2}'' \times 11''$) of **HAND-WRITTEN** notes permitted. OK to write on both sides.
- **JUSTIFY** your reasoning clearly to receive partial credit.
  Explanations are also required to receive **FULL** credit for any answer.
- You must write your answer in the space provided on the exam paper itself.
  Only these answers will be graded. Circle your answers, or write them in the boxes provided.
  If space is needed for scratch work, use the backs of previous pages.

Problem	*Value*	*Score*
1	25	
2	25	
3	25	
4	25	
No Rec	–3	

PROBLEM Spring-05-Q.3.1:

(a) Determine the frequency response of the FIR system:

$$y[n] = 8x[n-3] - 8x[n-6]$$

Give your answer as a formula ***in the following form:*** $H(e^{j\hat{\omega}}) = je^{-j\alpha\hat{\omega}}\,\beta\,\sin(\lambda\hat{\omega})$ by finding numerical values for α, β and λ.

$\alpha =$	$\beta =$	$\lambda =$

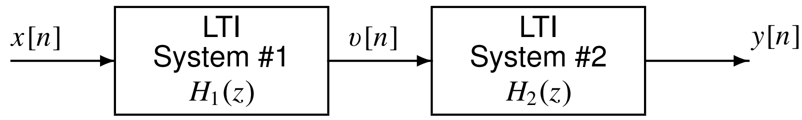
(b) For the system in part (a), determine the output signal $y[n]$ when the input signal is

$$x[n] = e^2 + 20\cos(0.4\pi n)$$

(c) Write a few lines of MATLAB code that would compute the specific values of the frequency response needed in part (b).

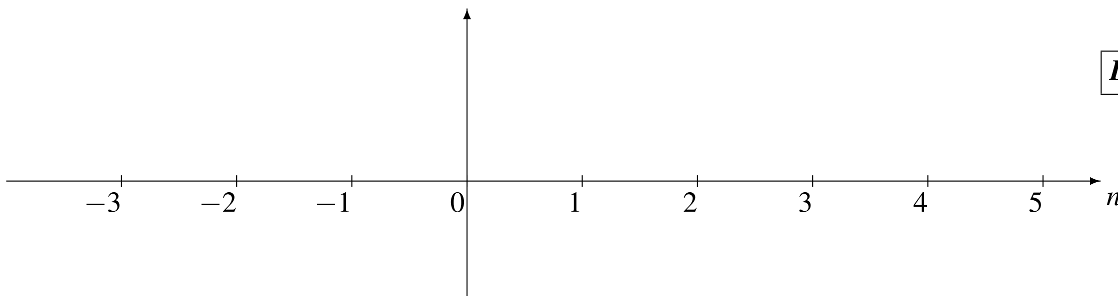
PROBLEM Spring-05-Q.3.2:

The diagram in Fig. 1 depicts a *cascade connection* of two linear time-invariant systems, i.e., the output of the first system is the input to the second system, and the overall output is the output of the second system.



System #1 is an IIR filter described by the system function: $H_1(z) = \dfrac{z^{-2} + 8z^{-3}}{1 + 0.5z^{-1}}$

(a) Determine the impulse response sequence, $h_1[n]$, of the first system. Give your answer as a ***plot.***

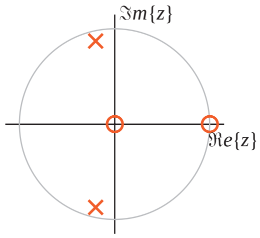


Label Carefully

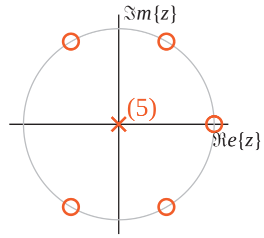
(b) Determine the ***difference equation*** of the second system so that the following condition is true: When the input is a *shifted impulse*, $x[n] = \delta[n-1]$, the output is another shifted impulse, $y[n] = \delta[n-3]$. The difference equation must be given in the following form: $y[n] = a_1 y[n-1] + b_0 v[n] + b_1 v[n-1]$, so find the numerical values for a_1, b_0 and b_1.

$a_1 =$	$b_0 =$	$b_1 =$

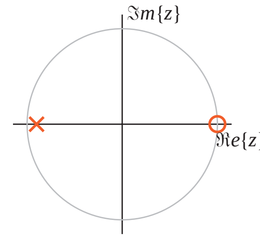
PROBLEM Spring-05-Q.3.3:



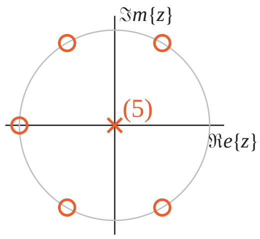
Pole−Zero Plot #1



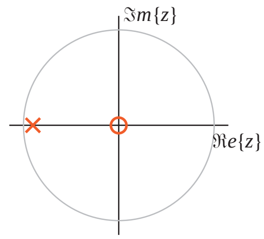
Pole−Zero Plot #2



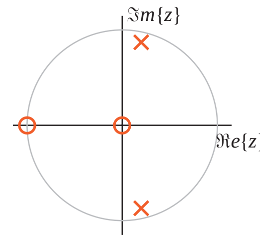
Pole−Zero Plot #3



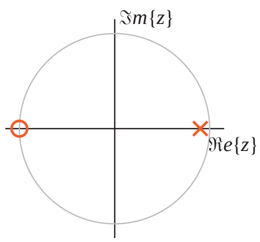
Pole−Zero Plot #4



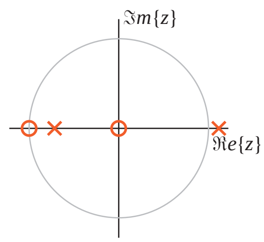
Pole−Zero Plot #5



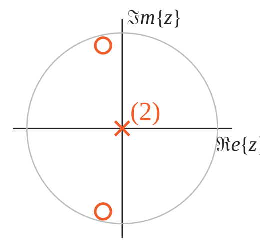
Pole−Zero Plot #6



Pole−Zero Plot #7



Pole−Zero Plot #8



Pole−Zero Plot #9

For each of systems below determine which of the pole-zero diagrams, (#1, #2, #3, #4, #5, #6, #7, #8, #9), is a match. *Note:* the unit circle is shown for reference.

Enter your answers here:

$\mathcal{S}_1$:	$\mathcal{S}_2$:	$\mathcal{S}_3$:	$\mathcal{S}_4$:	$\mathcal{S}_5$:	$\mathcal{S}_6$:

$$\mathcal{S}_1: \quad y[n] = 0.4y[n-1] - 0.8y[n-2] + 1.2x[n] + 1.2x[n-1]$$

$$\mathcal{S}_2: \quad H(z) = \tfrac{5}{3}(1 + z^{-1} + z^{-2} + z^{-3} + z^{-4} + z^{-5})$$

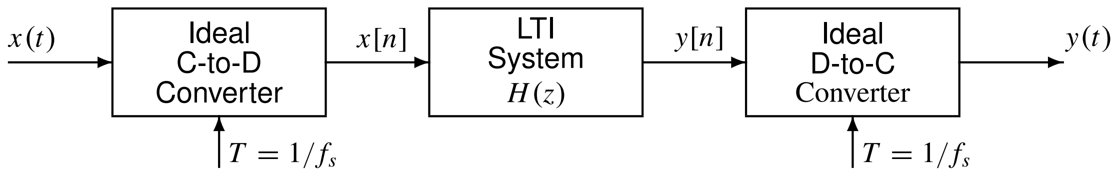
$$\mathcal{S}_3: \quad y[n] = -0.9y[n-1] + x[n]$$

$$\mathcal{S}_4: \quad h[n] = \tfrac{5}{3}\delta[n] - \tfrac{5}{3}\delta[n-1] + \tfrac{5}{3}\delta[n-2] - \tfrac{5}{3}\delta[n-3] + \tfrac{5}{3}\delta[n-4] - \tfrac{5}{3}\delta[n-5]$$

$$\mathcal{S}_5: \quad H(z) = \frac{\frac{1}{2} + \frac{1}{2}z^{-1}}{1 - 0.9z^{-1}}$$

$$\mathcal{S}_6: \quad h[n] = \tfrac{1}{2}\delta[n] - 0.95(-0.9)^{n-1}u[n-1]$$

PROBLEM Spring-05-Q.3.4:



In all parts below, the sampling rates of the C-to-D and D-to-C converters **are equal to** $f_s = 50$ **samples/sec,** and the LTI system is a 25-point running-sum filter whose system function is $H(z) = \dfrac{1 - z^{-25}}{1 - z^{-1}}$.

(a) Determine the DC response of the digital filter, i.e., the output $y[n]$ when the input is $x[n] = 1$.

(b) If the input signal is $x(t) = 100\cos(14\pi t)$, and the sampling rate of the C-to-D and D-to-C converters is $f_s = 50$ samples/sec, determine the output signal, $y(t)$.

(c) If the input signal is a sinusoid of the form $x(t) = \cos(2\pi f_0 t + \phi)$, and the sampling rates are $f_s = 50$ samples/sec, determine a value for the input frequency f_0 so that the output signal is zero. ***Explain.***

$f_0 = \boxed{\qquad\qquad \text{Hz}}$