



**PROBLEM Spring-02-Q.3.1:**(Circle exactly one answer<sup>5</sup> for each system,  $S_i$ )

$S_1$ :	#1	#2	#3	#4	#5	#6	#7	#8	#9
$S_2$ :	#1	#2	#3	#4	#5	#6	#7	#8	#9
$S_3$ :	#1	#2	#3	#4	#5	#6	#7	#8	#9
$S_4$ :	#1	#2	#3	#4	#5	#6	#7	#8	#9
$S_5$ :	#1	#2	#3	#4	#5	#6	#7	#8	#9
$S_6$ :	#1	#2	#3	#4	#5	#6	#7	#8	#9
$S_7$ :	#1	#2	#3	#4	#5	#6	#7	#8	#9
$S_8$ :	#1	#2	#3	#4	#5	#6	#7	#8	#9

**PROBLEM Spring-02-Q.3.2:**(Circle exactly one answer for each system,  $S_i$ )

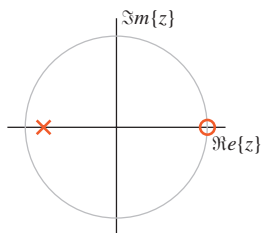
$S_1$ :	(A)	(B)	(C)	(D)	(E)	(F)	None
$S_2$ :	(A)	(B)	(C)	(D)	(E)	(F)	None
$S_3$ :	(A)	(B)	(C)	(D)	(E)	(F)	None
$S_4$ :	(A)	(B)	(C)	(D)	(E)	(F)	None
$S_5$ :	(A)	(B)	(C)	(D)	(E)	(F)	None
$S_6$ :	(A)	(B)	(C)	(D)	(E)	(F)	None
$S_7$ :	(A)	(B)	(C)	(D)	(E)	(F)	None
$S_8$ :	(A)	(B)	(C)	(D)	(E)	(F)	None

**PROBLEM Spring-02-Q.3.4:**(Circle exactly one answer for each part)

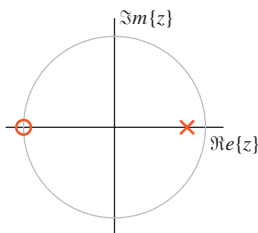
(a)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
(b)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
(c)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
(d)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
(e)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
(f)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
(g)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
(h)	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]

<sup>5</sup>If more than one answer is circled, the response will be considered wrong and will receive no credit.

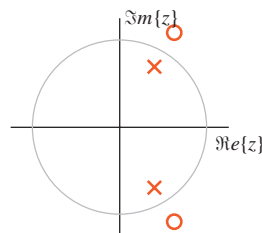
**PROBLEM Spring-02-Q.3.1:**



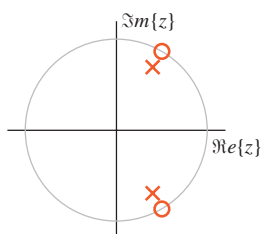
**Pole-Zero Plot #1**



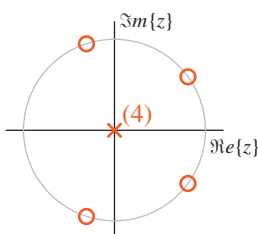
**Pole-Zero Plot #2**



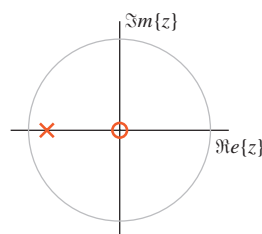
**Pole-Zero Plot #3**



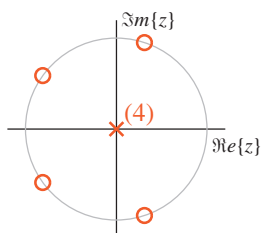
**Pole-Zero Plot #4**



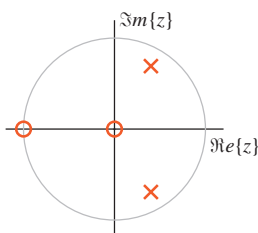
**Pole-Zero Plot #5**



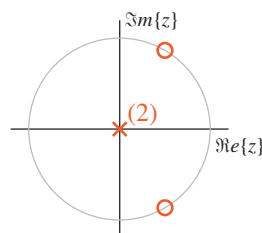
**Pole-Zero Plot #6**



**Pole-Zero Plot #7**



**Pole-Zero Plot #8**



**Pole-Zero Plot #9**

For each of systems below<sup>6</sup> determine which of the pole-zero diagrams, (#1, #2, #3, #4, #5, #6, #7, #8, #9), is a match. **Mark your answers on the answer sheet provided.**

*Note:* the unit circle is shown for reference.

$$\mathcal{S}_1 : y[n] = 0.8y[n-1] - 0.64y[n-2] + 1.8x[n] + 1.8x[n-1]$$

$$\mathcal{S}_2 : H(z) = \frac{8 - 8z^{-1} + 8z^{-2}}{1 - 0.8z^{-1} + 0.64z^{-2}}$$

$$\mathcal{S}_3 : y[n] = 2x[n] + 2x[n-1] + 2x[n-2] + 2x[n-3] + 2x[n-4]$$

$$\mathcal{S}_4 : H(z) = \frac{6.4 - 8z^{-1} + 10z^{-2}}{1 - 0.8z^{-1} + 0.64z^{-2}}$$

$$\mathcal{S}_5 : y[n] = -0.8y[n-1] + 2x[n]$$

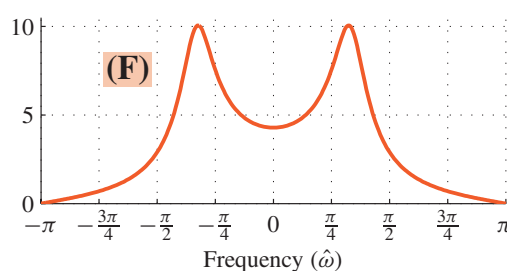
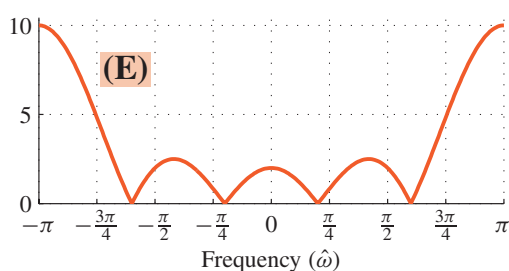
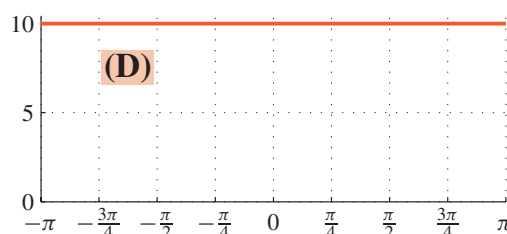
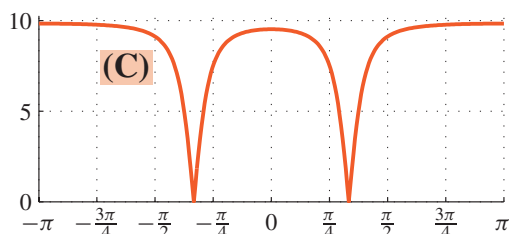
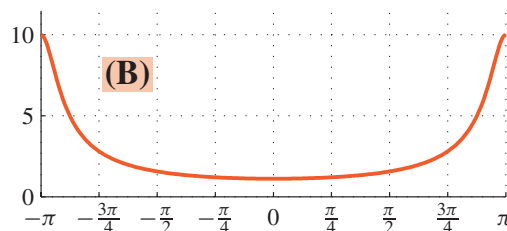
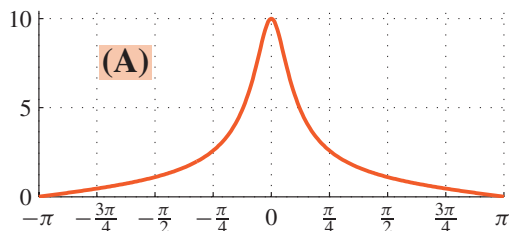
$$\mathcal{S}_6 : H(z) = 2(1 - z^{-1} + z^{-2} - z^{-3} + z^{-4})$$

$$\mathcal{S}_7 : y[n] = 0.8y[n-1] + x[n] + x[n-1]$$

$$\mathcal{S}_8 : H(z) = \frac{1 - z^{-1}}{1 + 0.8z^{-1}}$$

<sup>6</sup>These same systems are also used in the next problem.

**PROBLEM Spring-02-Q.3.2:**



For each of the discrete-time systems below, determine which of the frequency response (magnitude) plots, (A, B, C, D, E, F, or None), is a match. **Mark your answers on the answer sheet provided.**

*Note:* the frequency axis is  $\hat{\omega}$ .

$$S_1 : y[n] = 0.8y[n - 1] - 0.64y[n - 2] + 1.8x[n] + 1.8x[n - 1]$$

$$S_2 : H(z) = \frac{8 - 8z^{-1} + 8z^{-2}}{1 - 0.8z^{-1} + 0.64z^{-2}}$$

$$S_3 : y[n] = 2x[n] + 2x[n - 1] + 2x[n - 2] + 2x[n - 3] + 2x[n - 4]$$

$$S_4 : H(z) = \frac{6.4 - 8z^{-1} + 10z^{-2}}{1 - 0.8z^{-1} + 0.64z^{-2}}$$

$$S_5 : y[n] = -0.8y[n - 1] + 2x[n]$$

$$S_6 : H(z) = 2(1 - z^{-1} + z^{-2} - z^{-3} + z^{-4})$$

$$S_7 : y[n] = 0.8y[n - 1] + x[n] + x[n - 1]$$

$$S_8 : H(z) = \frac{1 - z^{-1}}{1 + 0.8z^{-1}}$$

**PROBLEM Spring-02-Q.3.3:**

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.

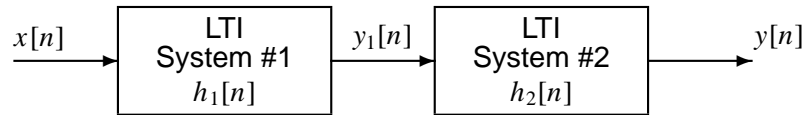


Figure 1: Cascade connection of two discrete-time LTI systems.

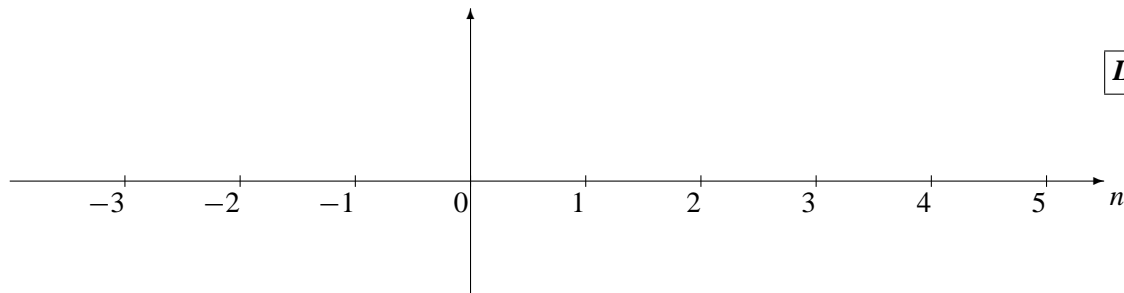
- (a) Suppose that System #1 is an IIR filter described by the system function:

$$H_1(z) = \frac{1 + 2z^{-1}}{1 + 0.5z^{-1}}$$

and System #2 is described by the impulse response

$$h_2[n] = 2\delta[n - 2] - \delta[n - 3] - \delta[n - 4]$$

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



- (b) Determine the output,  $y[n]$ , of the overall cascade system when the input,  $x[n]$ , is a *unit-step* signal.  
*Hint:* The output,  $y[n]$ , will be finite-length.

**PROBLEM Spring-02-Q.3.4:**

For each of the following expressions, select the correct match from the second list below.

*Write your answers on the answer sheet provided.* (The operator \* denotes convolution.)

(a)  $e^{-t}u(t) * u(t - 3)$

(b)  $\delta(t - 1) * \delta(t - 2)$

(c)  $e^{-t}u(t)\delta(t - 3)$

(d)  $\frac{d}{dt} \{e^{-t}u(t - 3)\}$

(e)  $u(3)$

(f)  $u(t - 1) * u(t - 2)$

(g)  $e^{-t}u(t) * \delta(t - 3)$

(h)  $\int_{-\infty}^0 \delta(t - 3)dt$

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Each of the expressions above is equivalent to one (and only one) of the expressions below:

[1]  $-e^{-t}u(t - 3)$

[2]  $u(t - 3)$

[3]  $-e^{-t}u(t - 3) + e^{-3}\delta(t - 3)$

[4]  $(t - 3)u(t - 3)$

[5]  $(1 - e^{-t+3})u(t - 3)$

[6]  $e^{-(t-3)}u(t - 3)$

[7]  $e^{-3}\delta(t - 3)$

[8] 0

[9]  $\delta(t - 3)$

[10] 1

[11]  $e^{-3}$