

- Homework for Module 4 Part 2

Quiz, 9 questions

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1.

(Difficulty: ★) Consider the following causal CCDE

$$y[n] + 2y[n-1] = 3x[n] + 2.5x[n-1].$$

Which of the following statements are correct?

- ☐ Its ROC contains the unit circle.
- ☐ The system is stable.
- ☐ It has two poles at -2 and $-\frac{5}{6}$.
- ☒ If the input signal is $\delta[n] - \delta[n+1]$, then the z-transform of the output would be $(-3z + 1/2 + 5/2z^{-1})/(1 + 2z^{-1})$.

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2.

(Difficulty: ★★) Suppose that the ROC of the sequence $x[n]$ is $r_L < |z| < r_U$. What is the ROC of $x^*[-n]$?

- ☐ $r_U < |z| < r_L$
- ☐ $r_L < |z| < r_U$
- ☐ $\frac{1}{r_U} < |z| < \frac{1}{r_L}$
- ☒ $\frac{1}{r_L} < |z| < \frac{1}{r_U}$

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3.

(Difficulty: ★) Consider an LTI system $h[n]$, whose transfer function's ROC is R_h . Consider a second LTI system $g[n]$ with ROC R_g . Now consider the cascade of the two filters.

What is the ROC of the cascade?

- ☐ It contains $R_g \cup R_h$.

It is only R_h .**- Homework for Module 4 Part 2**It is only R_g .

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It contains $R_g \cap R_h$.

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4.

(Difficulty: ★) Consider the following CCDE

$$y[n] - \frac{1}{2}y[n-1] = 2x[n] - 5x[n-1] - x[n-2].$$

Let $H(e^{j\omega})$ denote the transfer function of this system. What is $H(e^{j\pi})$?

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5.

(Difficulty: ★★) Write some code in your preferred programming language that implements the following CCDE:

$$y[n] + 2y[n-1] = x[n+1] - \frac{1}{2}x[n]$$

Use $y[n] = 0$ for $n < 0$ as initial conditions and run the algorithm for $x[n] = \delta[n] + \frac{1}{2}\delta[n-1]$.The output shows a diverging oscillation around zero: as n grows, it assumes always larger values with alternated signs.The filter is stable but the output $y[n]$ diverges because of the chosen input $x[n]$. $y[5] = 1$  $y[4] = 2$ The filter is mathematically unstable. Even in practice, you can see the output diverging $|y[50]| > 10^{13}$.

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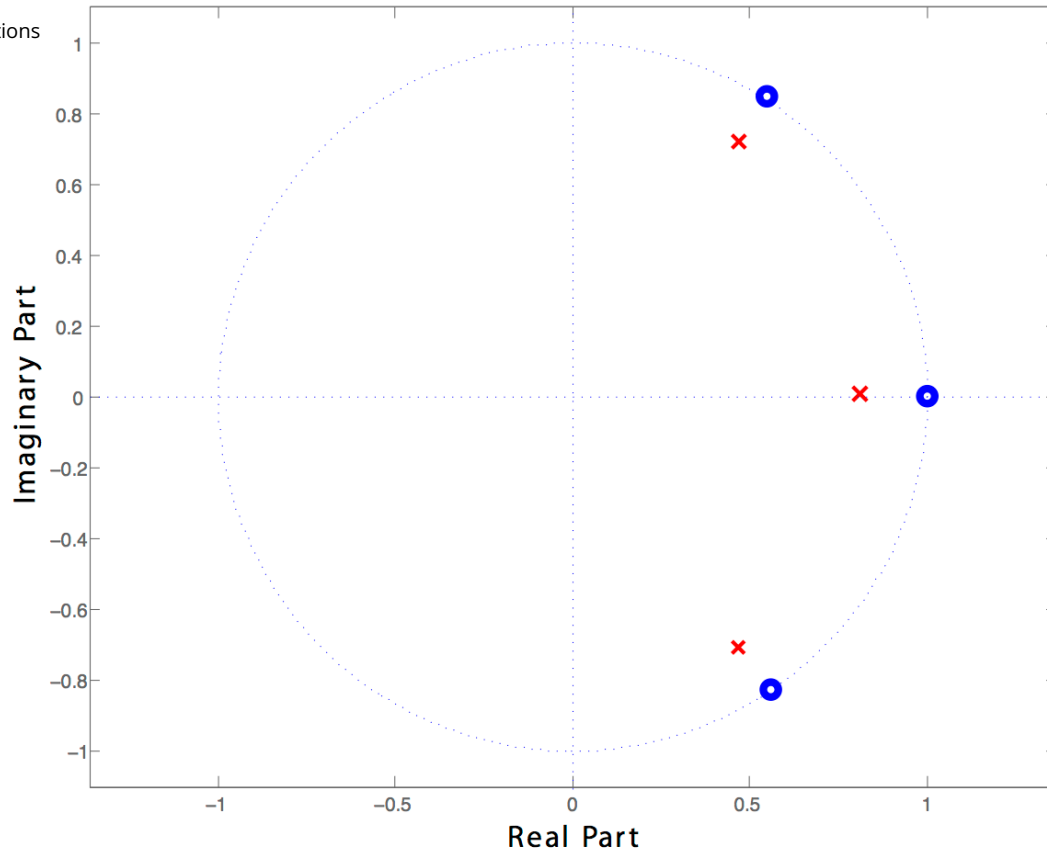
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6.

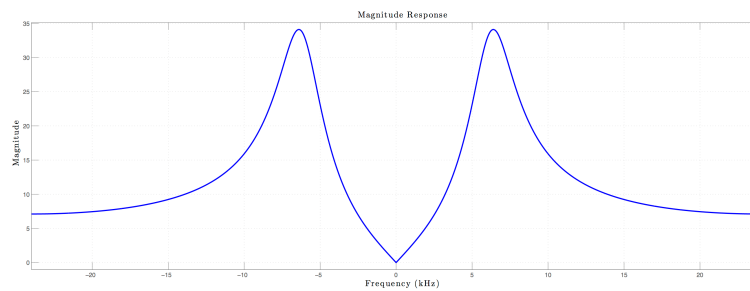
(Difficulty: ★ ★ ★) A filter $H(z)$ has the following pole-zero plot:

- Homework for Module 4 Part 2 Pole/Zero Plot

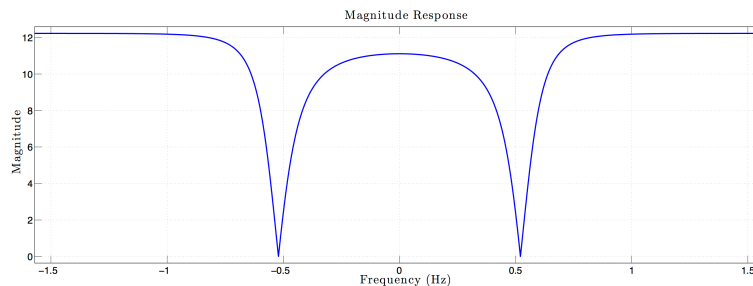
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Which of the following figures shows the magnitude response of the filter? Assume an implementation where the "internal clock" is $T_s = 1s$ so that the frequency axis is labeled in Hz and 1Hz corresponds to the digital frequency of $\omega = 1$ radians.



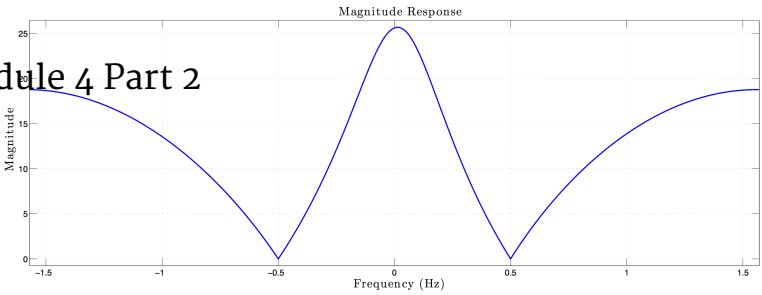
Magnitude response



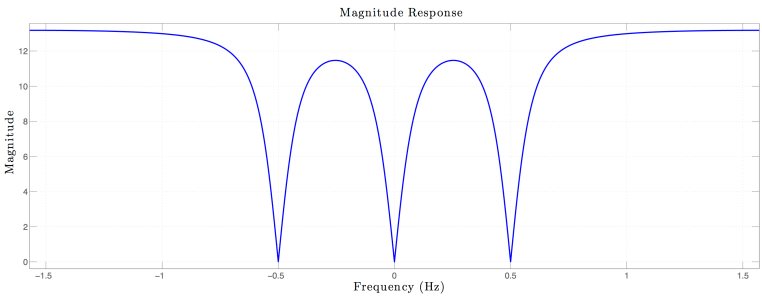
Magnitude response

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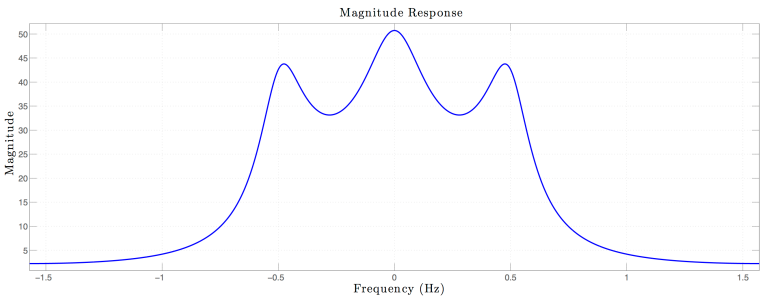
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Magnitude response



Magnitude response



Magnitude response

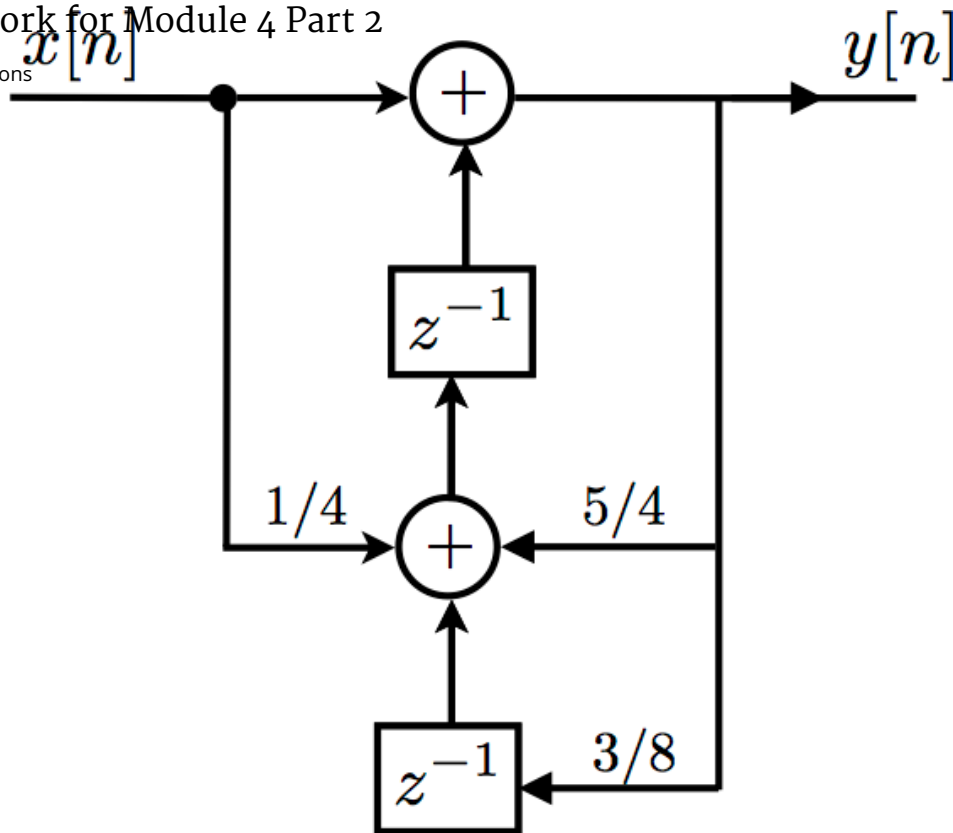
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7.

(Difficulty: ★★) Let $h[n]$ represent the impulse response of the following system.

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Select the correct statement about the poles and zeros of $H(z)$.

- ☐ $H(z)$ has one zero at $z_1 = 1/4$ and two poles at $z_3 = 5/4$ and $z_2 = 3/8$.
- ☐ $H(z)$ has two zeros at $z_1 = 5/4$ and $z_2 = 3/8$ and one pole at $z_3 = 1/4$.
- ☐ It has one zero at $z_1 = -3/4$.
- ☐ It has one zero at $z_1 = 3/2$ and one pole at $z_2 = 5/6$.
- ☒ It has one pole at $z_1 = 3/2$

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8.

(Difficulty: ★★) The following bit of Python code implements a discrete-time filter (assume $x[n]$ and $y[n]$ are suitably defined arrays):

```
1 f = 0;
2 g = 0;
3 for n in range(0, L-1):
4     y[n] = x[n] + f;
5     g = -f;
6     f = -x[n] + 0.5 * y[n] + g;
```

What is the minimum number of delays necessary to implement this filter efficiently?

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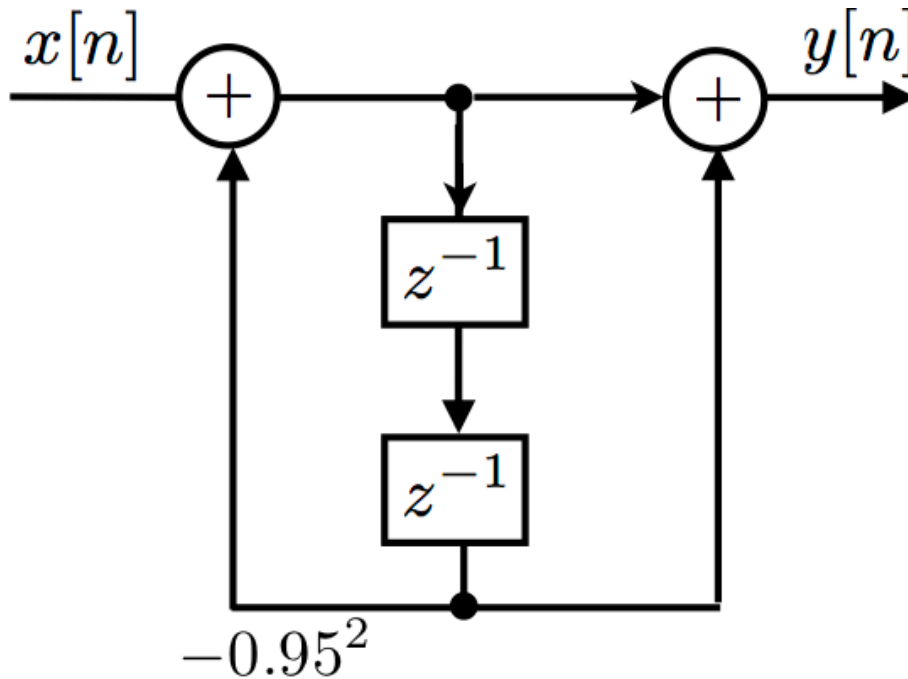
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9.

(Difficulty: ★★) Which of the following statements describes the system in this figure?



- ☒ The system is a hum removal filter with $\omega_0 = \pi/2$.
- ☐ This is a resonator at $\omega_0 = \pi/2$.
- ☐ The system is a hum removal filter with $\omega_0 = 3\pi/4$.
- ☐ The system is a resonator at $\omega_0 = 3\pi/4$.
- ☐ None of these statements describe this system.
- ☐ The system is a DC notch.



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