ICE503 DSP-Homework#12

1. Figure 1 shows the pole-zero plots for eight different causal LTI systems with real impulse responses. Indicate which of the following properties apply to each of the systems pictured: stable, IIR, FIR, all-pass, generalized linear phase (which type).

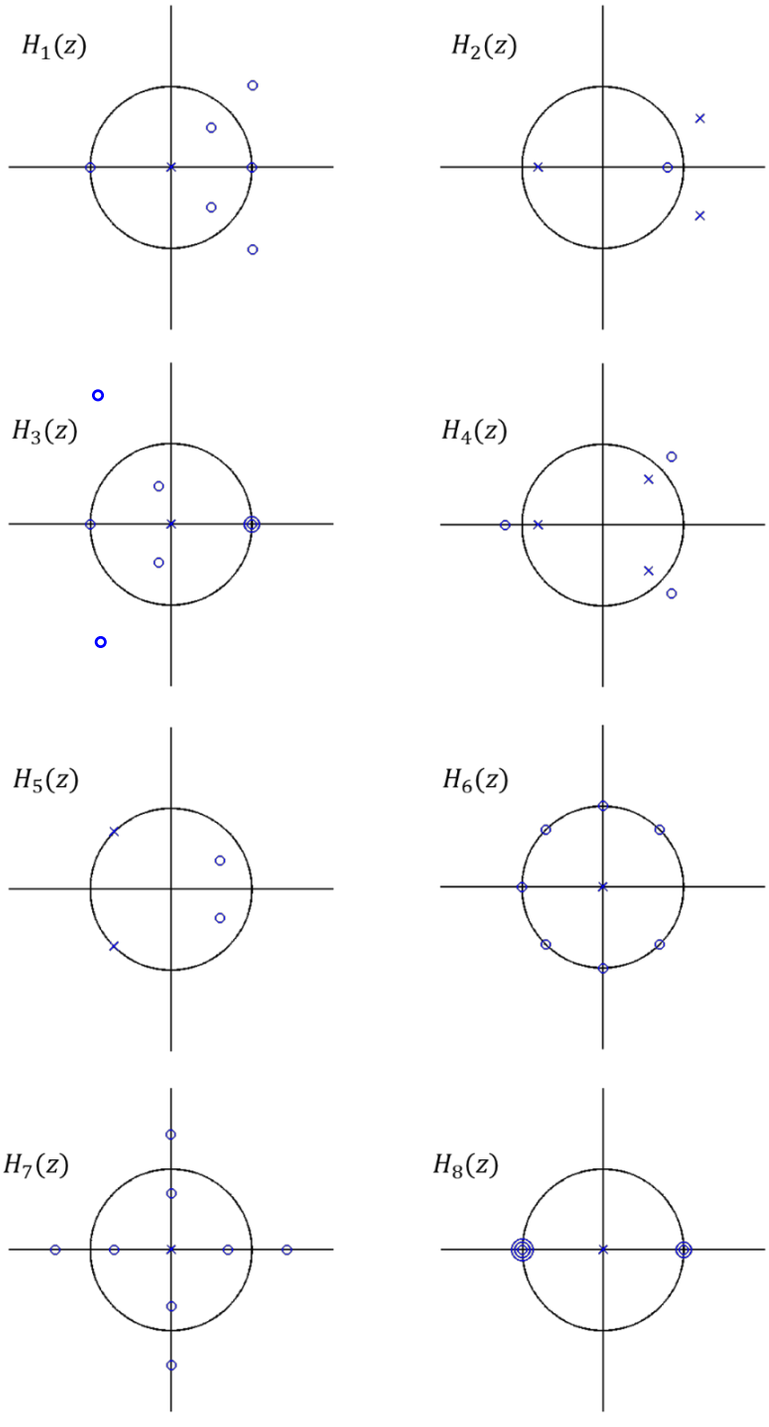
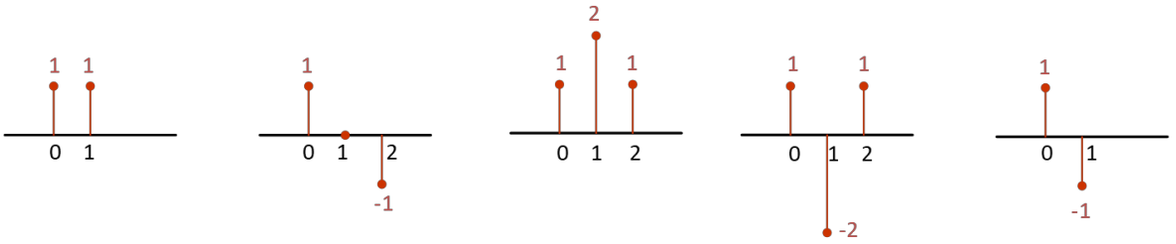


Figure 1: The pole-zero plots for eight different causal LTI systems

2. Given the following impulse responses



(1) (2) (3) (4) (5)

(a) Determine their phase delay.

(b) Determine the types of the FIR filters.

(c) Sketch the zeros of the corresponding system.

3. MATLAB simulation:

Using the impulse response for two different causal LTI systems in Figure 2 and sketch the magnitude of the filter in dB, group delay, pole-zero diagram and discuss the result.

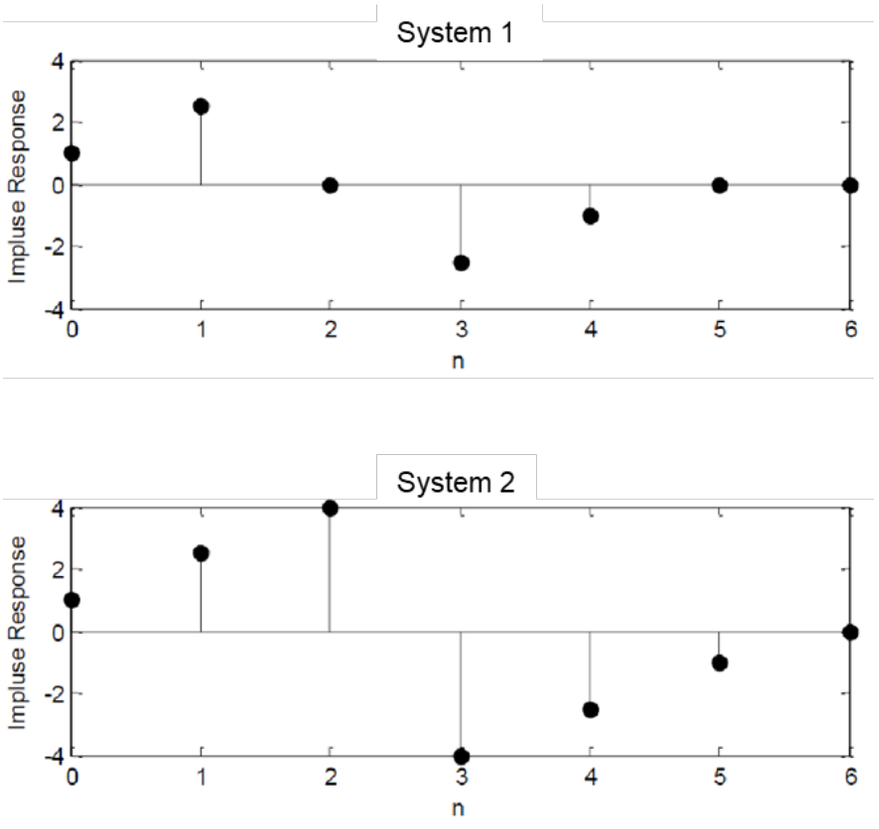


Figure 2: The impulse response for two different causal LTI systems

1. ① stable ⇒ ROC includes the unit circle

stable : $H_1(z)$, $H_3(z)$, $H_4(z)$, $H_6(z)$, $H_7(z)$, $H_8(z)$

unstable : $H_2(z)$, $H_5(z)$

② FIR ⇒ no poles , IIR ⇒ poles and zeros

FIR: 1. 3. 6. 7. 8

IIR : 2. 4. 5

③ All-pass Filter : all zeros $\xi = \frac{1}{\lambda}$, where λ is pole

All-pass : 4

④ Type 1 :

Type 2 :

Type 3 : 1

Type 4 :

2.

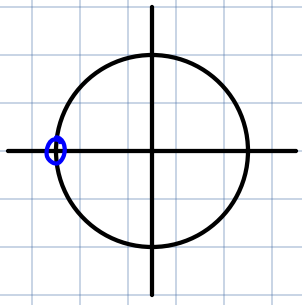
(1)

$h[n] = \delta[n] + \delta[n-1] \Rightarrow H(e^{j\omega}) = 1 + e^{-j\omega} = e^{-j0.5\omega}\,(e^{j0.5\omega} + e^{-j0.5\omega}) = e^{-j0.5\omega} \cdot 2\cos 0.5\omega$

$\theta(\omega) = -0.5\omega \Rightarrow \tau_g(\omega) = -\frac{d\theta}{d\omega} = 0.5$

Symmetric, even length ⇒ Type II

$H(z) = 1 + z^{-1} \Rightarrow$ zero : -1



(2)

$h[n] = \delta[n] - \delta[n-2] \Rightarrow H(e^{j\omega}) = 1 - e^{-j2\omega} = e^{-j\omega}(e^{j\omega} - e^{-j\omega}) = e^{-j(\omega-\frac{\pi}{2})}\, 2\sin\omega$

$\theta(\omega) = -(\omega - \frac{\pi}{2}) \Rightarrow \tau_g(\omega) = 1$

Antisymmetric , odd length ⇒ Type III

$H(z) = 1 - z^{-2} = (1+z^{-1})(1-z^{-1}) \Rightarrow$ zeros: ± 1