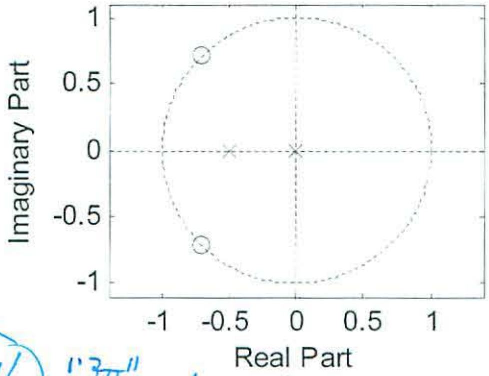
Name Answers

EE-3220-11 – Dr. Durant – Quiz 6
Spring 2015, Week 6

1. (2 points) Make a list of zeros and a list of poles given this z-plane view of a system H(z).



$z_\ell = \frac{-1}{\sqrt{2}} \pm j\frac{1}{\sqrt{2}} = 1\angle \pm \frac{3\pi}{4} = 1\angle \pm 135^\circ$

$p_k = -\frac{1}{2}, 0$

(−1/2) "$\frac{3\pi}{4}$" vs "$1\angle\frac{3\pi}{4}$"

(−1/2) z not ±1

2. (2 points) Given the roots you listed above, write out H(z). Fully expand the numerator and the denominator. Multiply by z^{-1}/z^{-1} as many times as needed to eliminate positive exponents.

$$H(z) = \frac{\prod(z-z_\ell)}{\prod(z-p_k)} = \frac{(z-1\angle 135^\circ)(z-1\angle -135^\circ)}{(z+1/2)(z-0)} = \frac{z^2 - z(1\angle 135^\circ + 1\angle -135^\circ)+1}{z^2+z/2}$$

$$= \frac{z^2-2z\cos(135^\circ)+1}{z^2+z/2} = \frac{z^2+\frac{2}{\sqrt{2}}z+1}{z^2+z/2}\cdot\frac{z^{-2}}{z^{-2}} = \frac{1+\sqrt{2}z^{-1}+z^{-2}}{1+0.5z^{-1}} =$$

(−1/2) dropped j/center term in numerator

3. (2 points) Recall that H(z) = Y(z) / X(z). Take the inverse z-transform of your result in 2 and solve for y(n) to determine the difference equation that implements the system H(z).

$$H(z) = \frac{Y(z)}{X(z)} = \frac{1+\sqrt{2}z^{-1}+z^{-2}}{1+0.5z^{-1}} \rightarrow Y(z)(1+0.5z^{-1}) = X(z)(1+\sqrt{2}z^{-1}+z^{-2})$$

$$y(n)+0.5y(n-1) = x(n)+\sqrt{2}x(n-1)+x(n-2)$$

$$y(n) = x(n)+\sqrt{2}x(n-1)+x(n-2)-0.5y(n-1)$$

(−1/4) not stated as y(n) = ...

4. (1 point) A voice signal sampled at 12 kHz is intermittently jammed with a loud, 3 kHz tone. Begin the design an IIR notch filter to suppress this tone. What are the radii and angles of the poles and zeros? Present angles in terms of π (e.g., 0.7π).

near 1, must be ≤ 1 for stability (less than)

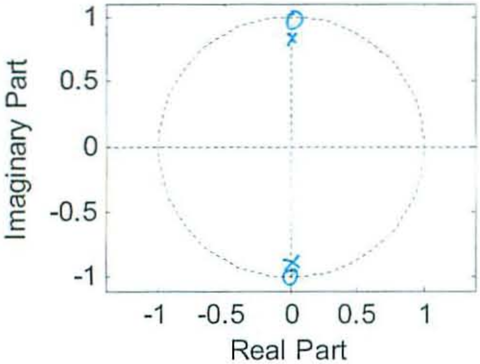
$\omega_0 = \frac{F}{F_s} \cdot 2\pi = \frac{3}{12} \cdot 2\pi = \frac{\pi}{2}$

poles: $0.99 \angle \pm \frac{\pi}{2}$

Zeros: $1 \angle \pm \frac{\pi}{2}$

$(-1/4)$ $\pm\angle$

5. (1 point) Using the zeros and poles you calculated for your notch filter, complete this zero-pole plot.



6. (1 point) What is the purpose of the zeros in this transfer function?

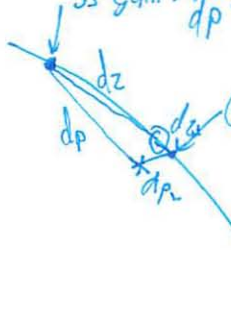
to cancel the sinusoid input @ ω_0
→ the zeros cancel the poles in $X(z)$ → $Y(z) = H(z)X(z)$

we put 0s here to cancel sinusoid poles; sinusoid gives poles here

7. (1 point) What is the purpose of the poles in this transfer function?

to make the magnitude response quickly reach ~0dB @ frequencies a short distance from ω_0

SS gain $= \frac{d_z}{d_p} = 1 \to 0$dB (similar cancellation for conjugates)



@ this freq. gain $= \frac{d_{z2}}{d_{p2}} = \frac{1}{2} = -3dB_V = -6dB_W$