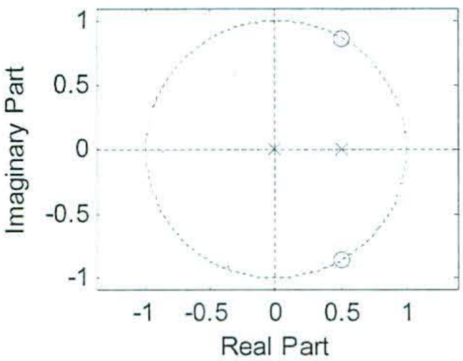
Name *Answers*

EE-3220-11 – Dr. Durant – Quiz 7
Winter 2015-'16, Week 7

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



$p = \{0, \frac{1}{2}\}$

$q = \{1\angle\frac{\pi}{3}, 1\angle\frac{-\pi}{3}\} = \{\frac{1}{2}+j\frac{\sqrt{3}}{2}, \frac{1}{2}-j\frac{\sqrt{3}}{2}\}$

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.

$$H(z) = \frac{(z-z_1)(z-z_2)}{(z-p_1)(z-p_2)} = \frac{\left(z-\left(\frac{1}{2}+j\frac{\sqrt{3}}{2}\right)\right)\left(z-\left(\frac{1}{2}-j\frac{\sqrt{3}}{2}\right)\right)}{z(z-\frac{1}{2})} = \frac{z^2-z+1}{z^2-\frac{1}{2}z}$$

$$= \frac{1-z^{-1}+z^{-2}}{1-\frac{1}{2}z^{-1}}$$

(-1/2) $\frac{Y}{X} \leftrightarrow \frac{X}{Y}$
(-1/4) drops/misscale z^{1} coefficient 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).

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

$$\left(1-\tfrac{1}{2}z^{-1}\right)Y(z) = \left(1-z^{-1}+z^{-2}\right)X(z)$$

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

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

(-1/2) $\frac{Y}{X} \leftrightarrow \frac{X}{Y}$ introduced
(-1/4) didn't solve for y(n)

4. (1 point) A voice signal sampled at 16 kHz is intermittently jammed with a loud, 6 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).

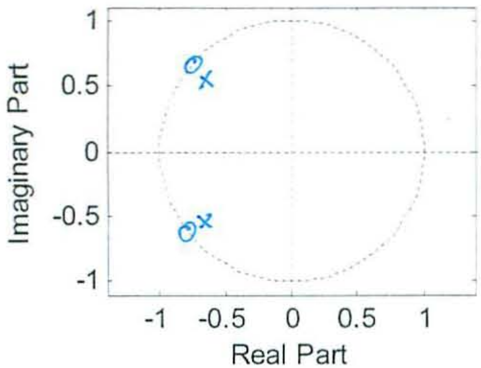
(-1/4) forgot ±∠

$w_n = \frac{F_1}{f_s} 2\pi = \frac{6k}{16k} 2\pi = \frac{3\pi}{4}$

$z = \{1 \angle \pm \frac{3\pi}{4}\}$

$p = \{r \angle \pm \frac{3\pi}{4}\}$ $0.9 \leq r_{typ} < 1$

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?

create a null in the frequency response @ 6 kHz.

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

restore near-unity gain at frequencies near 6kHz notch.