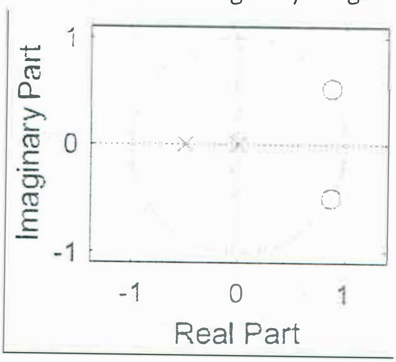
Name *Answer*

EE-3220 – Dr. Durant – Quiz 6
Winter 2016-'17, 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). Note that the non-0 imaginary magnitudes are ½.



$z_1 = \frac{\sqrt{3}}{2} + j\frac{1}{2}$ $\quad z_1^* = \frac{\sqrt{3}}{2} - j\frac{1}{2}$

$p_1 = \frac{-1}{2}$ $\quad p_2 = 0$

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.

$$H(z) = \frac{\left(z - \left(\frac{\sqrt{3}}{2} + j\frac{1}{2}\right)\right)\left(z - \left(\frac{\sqrt{3}}{2} - j\frac{1}{2}\right)\right)}{\left(z + \frac{1}{2}\right)(z - 0)} = \frac{z^2 - z\sqrt{3} + 1}{z^2 + \frac{1}{2}z} \cdot \frac{z^{-2}}{z^{-2}}$$

$$= \frac{1 - z^{-1}\sqrt{3} + z^{-2}}{1 + \frac{1}{2}z^{-1}}$$

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).

$$\frac{Y(z)}{X(z)} = \frac{1 - z^{-1}\sqrt{3} + z^{-2}}{1 + \frac{1}{2}z^{-1}}$$

$$X(z)\left(1 - z^{-1}\sqrt{3} + z^{-2}\right) = Y(z)\left(1 + \frac{1}{2}z^{-1}\right)$$

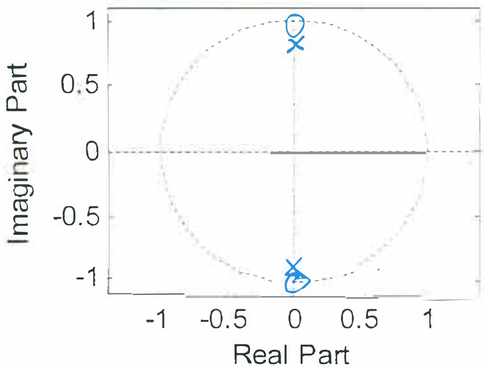
$$x(n) - \sqrt{3}\,x(n-1) + x(n-2) = y(n) + \frac{1}{2}y(n-1)$$

$$y(n) = -\frac{1}{2}y(n-1) + x(n) - \sqrt{3}\,x(n-1) + x(n-2)$$

4. (1 point) A voice signal sampled at 8 kHz is intermittently jammed with a loud, 2 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., 0.4π).

$w = \frac{f}{fs} 2\pi = \frac{2}{8} 2\pi = \frac{\pi}{2}$ $\therefore$ $z = 1 \angle \pm \frac{\pi}{2}$, $p = r \angle \pm \frac{\pi}{2}$ $0 < r < 1$, but close to 1, eg. $r = 0.99$

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?

remove steady state signals @ given frequency

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

push gain back up to nearly 1 (0 dB) at frequencies away from the notch