PROBLEM:

Define a discrete-time signal via the formula:

$$y[n] = A\cos(0.16\pi n + \phi) \qquad \text{for } n \geq 0$$

(a) Design a feedback filter that will synthesize $y[n]$. Give your answer in the form of a difference equation with numerical values for the coefficients. Assume that the synthesis will be accomplished by using an impulse input to "start" the difference equation (which has zero initial conditions).

(b) Determine the pole locations for the system function $H(z)$ that will synthesize $y[n]$.

(c) If this signal is played out through a D-A converter with $f_s = 8000$ Hz, what frequency will be heard?

McClellan, Schafer and Yoder, *Signal Processing First*, ISBN 0-13-065562-7.

SOLUTION

Define a discrete-time signal via the formula:

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(a) Design a feedback filter that will synthesize $y[n]$. Give your answer in the form of a difference equation with numerical values for the coefficients. Assume that the synthesis will be accomplished by using an impulse input to "start" the difference equation (which has zero initial conditions).

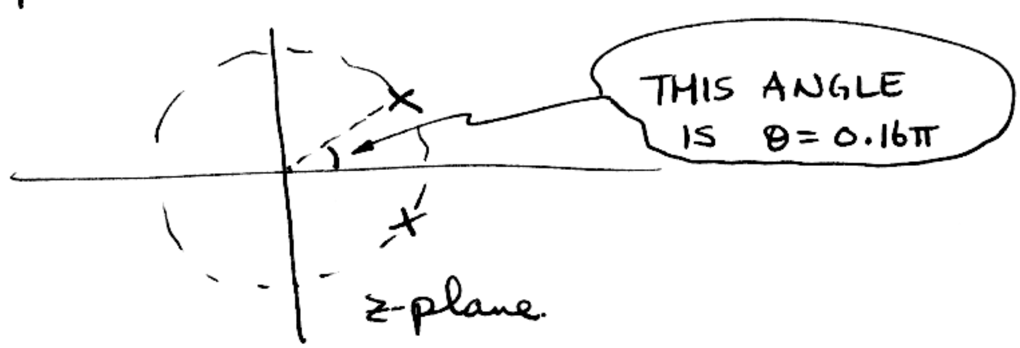
$$H(z) = \frac{1}{(1 - e^{-j0.16\pi}z^{-1})(1 - e^{+j0.16\pi}z^{-1})}$$

$$= \frac{1}{1 - 2\cos(0.16\pi)z^{-1} + z^{-2}}$$

$$\therefore \; y[n] = \underbrace{(2\cos(0.16\pi))}_{=1.7526} y[n-1] - y[n-2] + x[n]$$

(b) Determine the pole locations for the system function $H(z)$ that will synthesize $y[n]$.

Need poles at $1e^{\pm j0.16\pi}$



(c) If this signal is played out through a D-A converter with $f_s = 8000$ Hz, what frequency will be heard?

$$\hat{\omega}_0 = 0.16\pi = 2\pi(0.08).$$

$$\Rightarrow f_{ANALOG} = \frac{\hat{\omega}_0}{2\pi} \times f_s = 0.08 \times 8000 = 640 \text{ Hz}.$$

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