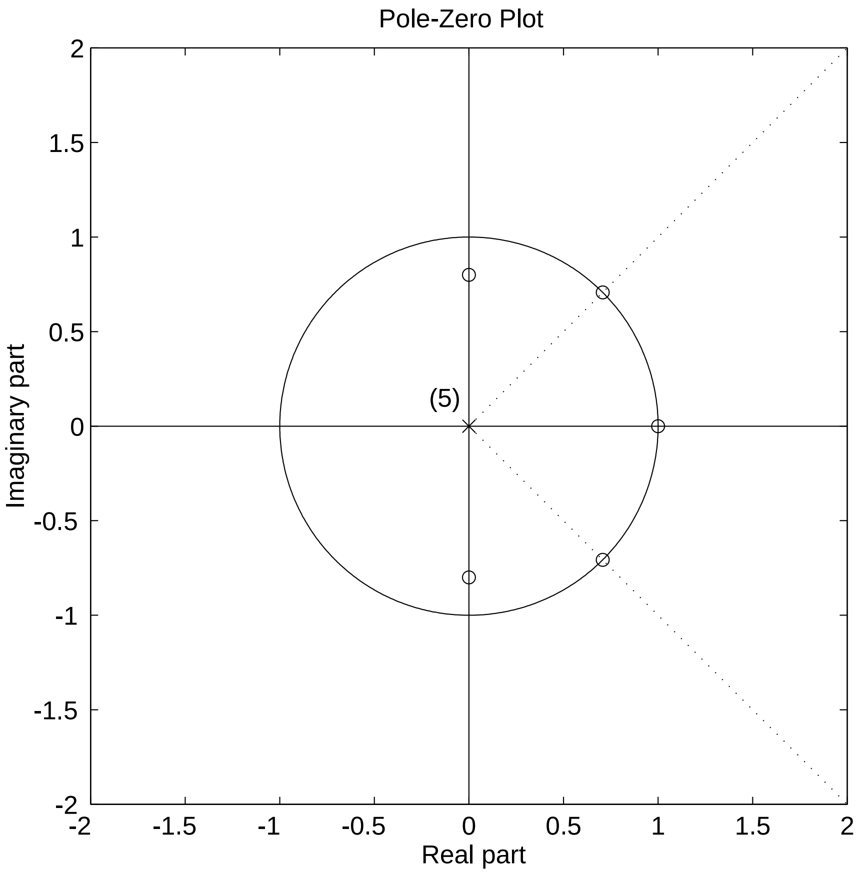
PROBLEM:



The above figure gives the pole-zero plot of a LTI discrete-time system with system function $H(z)$ whose input is $x[n]$ and whose output is $y[n]$.

(a) If the input is of the form

$$x[n] = 10e^{j\pi/3}e^{j\hat{\omega}n}$$

for what values of $\hat{\omega}$ will the output be zero for all n?

(b) The input $x[n]$ and output $y[n]$ are related by a difference equation of the form

$$y[n] = \sum_{k=0}^{M} b_k x[n-k]$$

What is the value of M?

McClellan, Schafer and Yoder, *Signal Processing First,* ISBN 0-13-065562-7.
Prentice Hall, Upper Saddle River, NJ 07458. © 2003 Pearson Education, Inc.

SOLUTION

From the Figure,

$$H(z) = (1-z^{-1})(1-e^{j\pi/4}z^{-1})(1-e^{-j\pi/4}z^{-1})$$
$$\cdot (1-re^{j\pi/2}z^{-1})(1-re^{-j\pi/2}z^{-1})$$

where $0<r<1$.

(a) This means that $H(e^{j\hat{\omega}}) = H(z)\Big|_{z=e^{j\hat{\omega}}}$

will be zero at $\hat{\omega}=0$, $\hat{\omega}=\frac{\pi}{4}$ & $\hat{\omega}=-\pi/4$

Therefore since if $x[n]=Ae^{j\phi}e^{j\hat{\omega}n}$, the output will be $y[n] = H(e^{j\hat{\omega}})Ae^{j\phi}e^{j\hat{\omega}n}$

$y[n]=0$ if $\hat{\omega}=0, \pm\frac{\pi}{4}$

Note that the other zeros are <u>not</u> <u>on</u> the unit circle so $\hat{\omega}=\pm\frac{\pi}{2}$ will <u>not</u> be filtered out completely.

(b) There are 5 zeros, i.e. $H(z)$ is a 5th-order polynomial so $\underline{\underline{M=5}}$

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