PROBLEM:

The system function of a linear time-invariant filter is given by the formula

$$H(z) = (1 - z^{-1})(1 + z^{-2})(1 + z^{-1})$$

(a) Write the difference equation that gives the relation between the input $x[n]$ and the output $y[n]$.

(b) What is the output if the input is $x[n] = \delta[n]$?

(c) Use multiplication of z-transform polynomials to find the output when the input is

$$x[n] = 2\delta[n-1] + 2\delta[n-3] - 2\delta[n-4].$$

(d) If the input to the system is of the form

$$x[n] = e^{j\hat{\omega}n} \qquad -\infty < n < \infty,$$

for what values of $\hat{\omega}$ will the output be zero for all n? We cannot use z-transforms directly to solve this problem, but we can find the frequency response from $H(z)$ and then solve the problem. Note that the factored form will tell you the answer and so will the pole zero plot for $H(z)$.

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PROBLEM:

A linear time-invariant filter is described by the difference equation

$$y[n] = (x[n] + x[n-1] + x[n-2])/3$$

(a) Determine the system function $H(z)$ for this system.

(b) Plot the poles and zeros of $H(z)$ in the z-plane.

(c) From $H(z)$, obtain an expression for $H(e^{j\hat{\omega}})$, the frequency response of this system.

(d) What is the output if the input is

$$x[n] = 4 + \cos[0.25\pi(n-1)] - 3\cos[(2\pi/3)n]$$

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SOLUTION