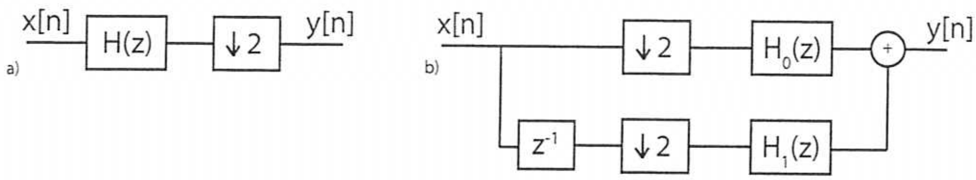
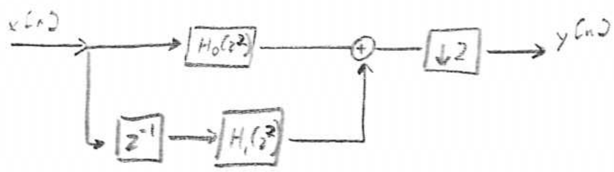
ECEn 487 - Introduction to Digital Signal Processing

Winter 2013

Quiz 4

1. (5 pts) Suppose you have the following system in (a) with response $y[n] = 1x[n]+2x[n-1]+3x[n-2]+4x[n-3]$. For efficiency, you decide to use a polyphase decomposition shown in (b). What will the linear equations be for the filters $H_0(z)$ and $H_1(z)$?





$$H(z) = 1 + 2z^{-1} + 3z^{-2} + 4z^{-3}$$

$$H(z) = H_0(z^2) + z^{-1} H_1(z^2)$$

$$= h_0[0]z^0 + h_1[0]z^{-1} + h_0[1]z^{-2} + h_1[1]z^{-3}$$

$h_0[0] = 1$
$h_1[0] = 2$
$h_0[1] = 3$
$h_1[1] = 4$

$$\boxed{\begin{array}{l} H_0(z): \; y[n] = x[n] + 3x[n-1] \\ H_1(z): \; y[n] = 2x[n] + 4x[n-1] \end{array}}$$

2. (5 pts) Suppose you have a filter with the following properties:

$$H(z) = \frac{(1-0.3z^{-1})(1+4z^{-1})}{(1-0.7e^{j\pi/4}z^{-1})(1-0.7e^{-j\pi/4}z^{-1})}$$

Since $H(z)$ is non-minimum phase, please (I'm asking politely) convert $H(z)$ into the form $H(z) = H_1(z)H_{ap}(z)$ where $H_1(z)$ is a minimum phase filter and $H_{ap}(z)$ is an all-pass filter.

$$H(z) = \frac{(1-0.3z^{-1})}{(1-0.7e^{j\pi/4}z^{-1})(1-0.7e^{-j\pi/4}z^{-1})} \cdot \frac{(1+\frac{1}{4}z^{-1})}{(1+\frac{1}{4}z^{-1})} \cdot \frac{(1+4z^{-1})}{1}$$

$$= \underbrace{\frac{(1-0.3z^{-1})(1+\frac{1}{4}z^{-1})}{(1-0.7e^{j\pi/4}z^{-1})(1-0.7e^{-j\pi/4}z^{-1})}}_{H_1(z)} \cdot \underbrace{\frac{(1+4z^{-1})}{(1+\frac{1}{4}z^{-1})}}_{H_{ap}(z)}$$