Home assignment 1

Due on: May 29 ,2009 (Friday's Lecture)

Question 1

Consider the system in Figure P2.42-1.

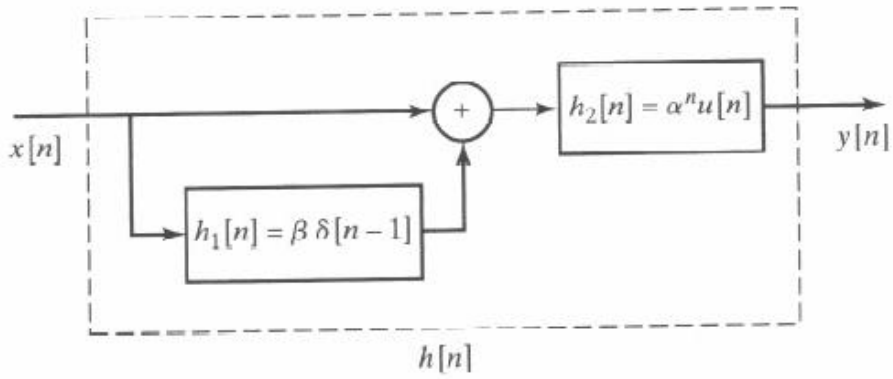

Figure P2.42-1

(a) Find the impulse response $h[n]$ of the overall system.
(b) Find the frequency response of the overall system.
(c) Specify a difference equation that relates the output $y[n]$ to the input $x[n]$.
(d) Is this system causal? Under what condition would the system be stable?

Question 2

An ideal lowpass filter with zero delay has impulse response $h_{lp}[n]$ and frequency response

$$H_{lp}(e^{j\omega}) = \begin{cases} 1, & |\omega| < 0.2\pi, \\ 0, & 0.2\pi \le |\omega| \le \pi. \end{cases}$$

(a) A new filter is defined by the equation $h_1[n] = (-1)^n h_{lp}[n] = e^{j\pi n} h_{lp}[n]$. Determine an equation for the frequency response of $H_1(e^{j\omega})$, and plot the equation for $|\omega| < \pi$. What kind of filter is this?
(b) A second filter is defined by the equation $h_2[n] = 2h_{lp}[n]\cos(0.5\pi n)$. Determine the equation for the frequency response $H_2(e^{j\omega})$, and plot the equation for $|\omega| < \pi$. What kind of filter is this?

Question 3

Consider the three sequences

$$v[n] = u[n] - u[n-6],$$
$$w[n] = \delta[n] + 2\delta[n-2] + \delta[n-4],$$
$$q[n] = v[n] * w[n].$$

(a) Find and sketch the sequence $q[n]$.
(b) Find and sketch the sequence $r[n]$ such that $r[n] * v[n] = \sum_{k=-\infty}^{n-1} q[k]$.
(c) Is $q[-n] = v[-n] * w[-n]$? Justify your answer.

Question 4

The system function of a causal linear time-invariant system is

$$H(z) = \frac{1 - z^{-1}}{1 + \frac{3}{4}z^{-1}}.$$

The input to this system is

$$x[n] = \left(\tfrac{1}{3}\right)^n u[n] + u[-n-1].$$

(a) Find the impulse response of the system, $h[n]$.
(b) Find the output $y[n]$.
(c) Is the system stable? That is, is $h[n]$ absolutely summable?

Question 5

An LTI system is characterized by the system function

$$H(z) = \frac{\left(1 - \frac{1}{2}z^{-2}\right)}{\left(1 - \frac{1}{2}z^{-1}\right)\left(1 - \frac{1}{4}z^{-1}\right)}, \qquad |z| > \frac{1}{2}.$$

(a) Determine the impulse response of the system.
(b) Determine the difference equation relating the system input $x[n]$ and the system output $y[n]$.