7.57 Let $H(z)$ be a lowpass filter with unity passband magnitude, a passband edge at ω_p, and a stopband edge at ω_s, as shown in Figure P7.8.

(a) Sketch the magnitude response of the digital filter $G_1(z) = H(z^M)F_1(z)$, where $F_1(z)$ is a lowpass filter with unity passband magnitude, a passband edge at ω_p/M, and a stopband edge at $(2\pi - \omega_s)/M$. What are the bandedges of $G_1(z)$?

(b) Sketch the magnitude response of the digital filter $G_2(z) = H(z^M)F_2(z)$, where $F_2(z)$ is a bandpass filter with unity passband magnitude, and with passband edges at $(2\pi - \omega_p)/M$ and $(2\pi + \omega_p)/M$ and stopband edges at $(2\pi - \omega_s)/M$ and $(2\pi + \omega_s)/M$, respectively. What are the bandedges of $G_2(z)$?

7.65 (a) Show that the phase delay $\tau_p(\omega)$ of the first-order allpass transfer function

$$A_1(z) = \frac{d_1 + z^{-1}}{1 + d_1 z^{-1}},$$

is given by $\tau_p(\omega) \cong (1 - d_1)/(1 + d_1) = \delta$ [Ste96].

(b) Design a first-order allpass filter with a phase delay of $\delta = 0.5$ sample and operating at a sampling rate of 20 kHz. Determine the error in samples at 1 kHz in the phase delay from its design value of 0.5 sample.

7.70 Is the transfer function

$$H(z) = \frac{(2z + 3)(4z - 1)}{(z + 0.4)(z - 0.6)}$$

minimum-phase? If it is not minimum-phase, then construct a minimum-phase transfer function $G(z)$ such that $\left|G(e^{j\omega})\right| = \left|H(e^{j\omega})\right|$. Determine their corresponding unit sample responses, $g[n]$ and $h[n]$, for $n = 0, 1, 2, 3, 4$. For what values of m is $\sum_{n=0}^{m} |g[n]|^2$ bigger than $\sum_{n=0}^{m} |h[n]|^2$?

8.5 Analyze the digital filter structure of Figure P8.4, and determine its transfer function $H(z) = Y(z)/X(z)$. (a) Is this a canonic structure? (b) What should be the value of the multiplier coefficient K so that $H(z)$ has a unity gain at $\omega = 0$? (c) What should be the value of the multiplier coefficient K so that $H(z)$ has a unity gain at $\omega = \pi$? (d) Is there a difference between these two values of K? If not, why not?

M 8.2 Consider the fourth-order IIR transfer function

$$G(z) = \frac{0.3901 + 0.6426z^{-1} + 0.8721z^{-2} + 0.6426z^{-3} + 0.3901z^{-4}}{1 + 0.5038z^{-1} + 0.8923z^{-2} + 0.3844z^{-3} + 0.1569z^{-4}}.$$

(a) Using MATLAB, express $G(z)$ in factored form.
(b) Develop two different cascade realizations of $G(z)$.
(c) Develop two different parallel form realizations of $G(z)$.
Realize each second-order section in direct form II.

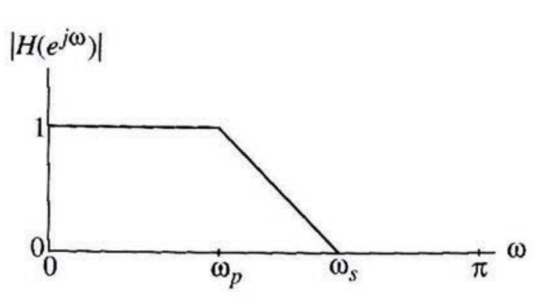

Figure P7.8

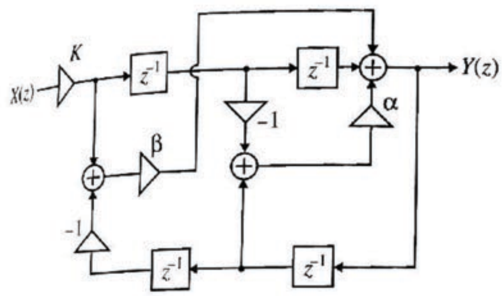

Figure P8.4