5.45. The pole–zero plots in Figure P5.45 describe six different causal LTI systems.

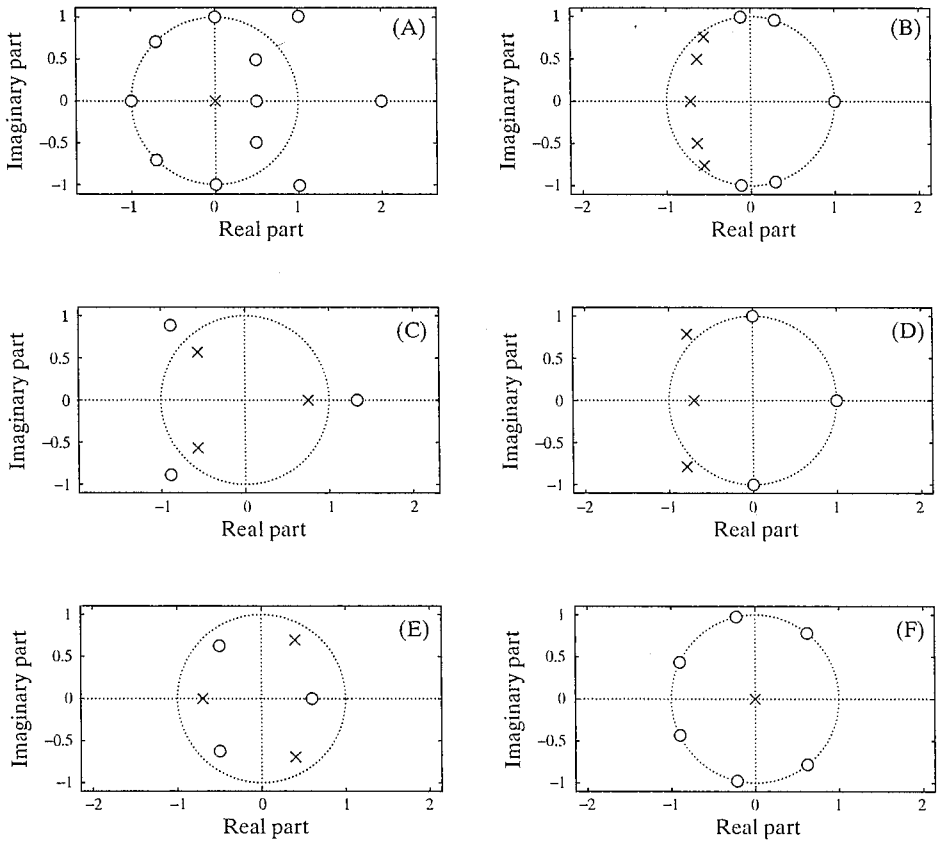

Figure P5.45

Answer the following questions about the systems having the above pole–zero plots. In each case, an acceptable answer could be *none* or *all*.

(a) Which systems are IIR systems?
(b) Which systems are FIR systems?
(c) Which systems are stable systems?
(d) Which systems are minimum-phase systems?
(e) Which systems are generalized linear-phase systems?
(f) Which systems have $|H(e^{j\omega})|$=constant for all ω?
(g) Which systems have corresponding stable and causal inverse systems?
(h) Which system has the shortest (least number of nonzero samples) impulse response?
(i) Which systems have lowpass frequency responses?
(j) Which systems have minimum group delay?

5.46. Assume that the two linear systems in the cascade shown in Figure P5.46 are linear-phase FIR filters. Suppose that $H_1(z)$ has order M_1 (impulse response length $M_1 + 1$) and $H_2(z)$ has order M_2. Suppose that the frequency responses are of the form $H_1(e^{j\omega}) = A_1(e^{j\omega})e^{-j\omega M_1/2}$ and $H_2(e^{j\omega}) = jA_2(e^{j\omega})e^{-j\omega M_2/2}$, where M_1 is an even integer and M_2 is an odd integer.

5.49. The system function of an LTI system is given by

$$H(z) = \frac{21}{\left(1 - \frac{1}{2}z^{-1}\right)(1 - 2z^{-1})(1 - 4z^{-1})}.$$

It is known that the system is not stable and that the impulse response is two sided.

(a) Determine the impulse response $h[n]$ of the system.
(b) The impulse response found in part (a) can be expressed as the sum of a causal impulse response $h_1[n]$ and an anticausal impulse response $h_2[n]$. Determine the corresponding system functions $H_1(z)$ and $H_2(z)$.

5.50. The Fourier transform of a stable LTI system is purely real and is shown in Figure P5.50. Determine whether this system has a stable inverse system.

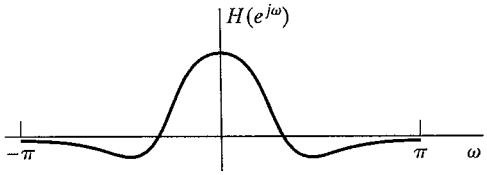

Figure P5.50

5.51. A causal LTI system has the system function

$$H(z) = \frac{(1 - 1.5z^{-1} - z^{-2})(1 + 0.9z^{-1})}{(1 - z^{-1})(1 + 0.7jz^{-1})(1 - 0.7jz^{-1})}.$$

(a) Write the difference equation that is satisfied by the input and the output of the system.
(b) Plot the pole–zero diagram and indicate the ROC for the system function.
(c) Sketch $|H(e^{j\omega})|$.
(d) State whether the following are true or false about the system:

(i) The system is stable.
(ii) The impulse response approaches a constant for large n.
(iii) The magnitude of the frequency response has a peak at approximately $\omega = \pm\pi/4$.
(iv) The system has a stable and causal inverse.

5.52. Consider a causal sequence $x[n]$ with the z-transform

$$X(z) = \frac{\left(1 - \frac{1}{2}z^{-1}\right)\left(1 - \frac{1}{4}z^{-1}\right)\left(1 - \frac{1}{5}z\right)}{\left(1 - \frac{1}{6}z\right)}.$$

For what values of α is $\alpha^n x[n]$ a real, minimum-phase sequence?