1ª Lista de Exercícios – Capítulo 5

5.2. Consider a stable linear time-invariant system with input $x[n]$ and output $y[n]$. The input and output satisfy the difference equation

$$y[n-1] - \frac{10}{3}y[n] + y[n+1] = x[n].$$

(a) Plot the poles and zeros in the z-plane.
(b) Find the impulse response $h[n]$.

5.4. When the input to a linear time-invariant system is

$$x[n] = \left(\frac{1}{2}\right)^n u[n] + (2)^n u[-n-1],$$

the output is

$$y[n] = 6\left(\frac{1}{2}\right)^n u[n] - 6\left(\frac{3}{4}\right)^n u[n].$$

(a) Find the system function $H(z)$ of the system. Plot the poles and zeros of $H(z)$, and indicate the region of convergence.
(b) Find the impulse response $h[n]$ of the system for all values of n.
(c) Write the difference equation that characterizes the system.
(d) Is the system stable? Is it causal?

5.5. Consider a system described by a linear constant-coefficient difference equation with initial-rest conditions. The step response of the system is given by

$$y[n] = \left(\frac{1}{3}\right)^n u[n] + \left(\frac{1}{4}\right)^n u[n] + u[n].$$

(a) Determine the difference equation.
(b) Determine the impulse response of the system.
(c) Determine whether or not the system is stable.

5.6. The following information is known about a linear time-invariant system:
(a) The system is causal.
(b) When the input is

$$x[n] = -\frac{1}{3}\left(\frac{1}{2}\right)^n u[n] - \frac{4}{3}(2)^n u[-n-1],$$

the z-transform of the output is

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

(c) Find the z-transform of $x[n]$.
(d) What are the possible choices for the region of convergence of $Y(z)$?
(e) What are the possible choices for the impulse response of the system?

5.11. The system function of a linear time-invariant system has the pole–zero plot shown in Figure P5.11-1 Specify whether each of the following statements is true, is false, or cannot be determined from the information given.
(a) The system is stable.
(b) The system is causal.
(c) If the system is causal, then it must be stable.
(d) If the system is stable, then it must have a two-sided impulse response.

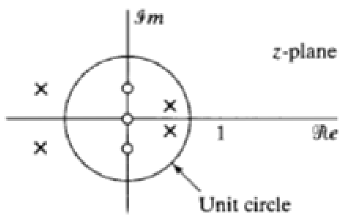

Figure P5.11-1

5.22. Consider a causal linear time-invariant system with system function

$$H(z) = \frac{1 - a^{-1}z^{-1}}{1 - az^{-1}},$$

where a is real.

(a) Write the difference equation that relates the input and the output of this system.
(b) For what range of values of a is the system stable?
(c) For $a = \frac{1}{2}$, plot the pole–zero diagram and shade the region of convergence.

5.36. A causal linear time-invariant 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 region of convergence 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.