1ª Lista de Exercícios – Capítulo 2

2.1. For each of the following systems, determine whether the system is (1) stable, (2) causal, (3) linear, (4) time invariant, and (5) memoryless:

(a) $T(x[n]) = g[n]x[n]$ with $g[n]$ given
(b) $T(x[n]) = \sum_{k=n_0}^{n} x[k]$
(c) $T(x[n]) = \sum_{k=n-n_0}^{n+n_0} x[k]$
(d) $T(x[n]) = x[n - n_0]$
(e) $T(x[n]) = e^{x[n]}$
(f) $T(x[n]) = ax[n] + b$
(g) $T(x[n]) = x[-n]$
(h) $T(x[n]) = x[n] + 3u[n + 1]$

2.11. Consider an LTI system with frequency response

$$H(e^{j\omega}) = \frac{1 - e^{-j2\omega}}{1 + \frac{1}{2}e^{-j4\omega}}, \qquad -\pi < \omega \leq \pi.$$

Determine the output $y[n]$ for all n if the input $x[n]$ for all n is

$$x[n] = \sin\left(\frac{\pi n}{4}\right).$$

2.22. For each of the pairs of sequences in Figure P2.22-1, use discrete convolution to find the response to the input $x[n]$ of the linear time-invariant system with impulse response $h[n]$.

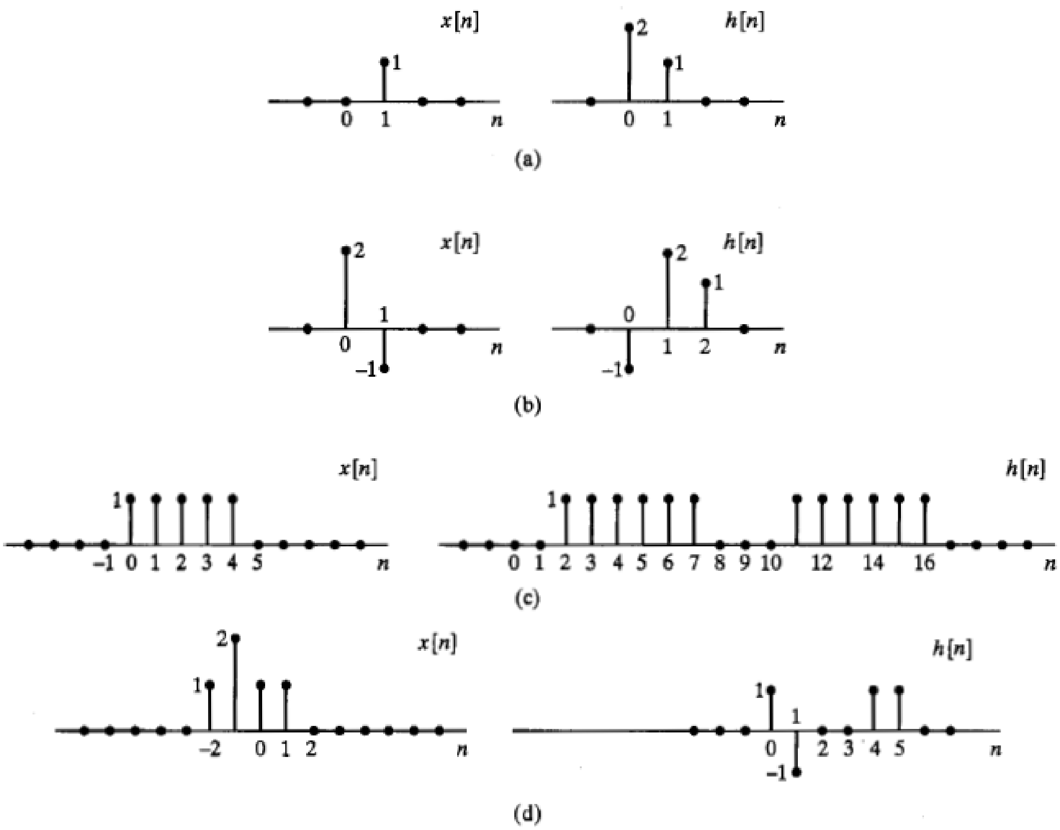

Figure P2.22-1

2.24. The impulse response of a linear time-invariant system is shown in Figure P2.24-1. Determine and carefully sketch the response of this system to the input $x[n] = u[n-4]$.

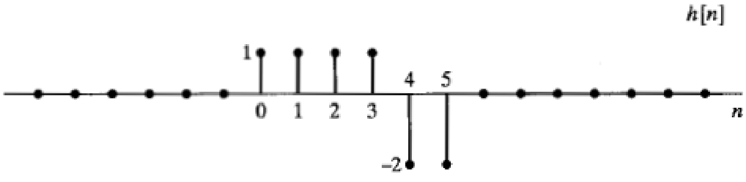

Figure P2.24-1

2.25. A linear time-invariant system has impulse response $h[n] = u[n]$. Determine the response of this system to the input $x[n]$ shown in Figure P2.25-1 and described as

$$x[n] = \begin{cases} 0, & n < 0, \\ a^n, & 0 \le n \le N_1, \\ 0, & N_1 < n < N_2, \\ a^{n-N_2}, & N_2 \le n \le N_2 + N_1, \\ 0, & N_2 + N_1 < n, \end{cases}$$

where $0 < a < 1$.

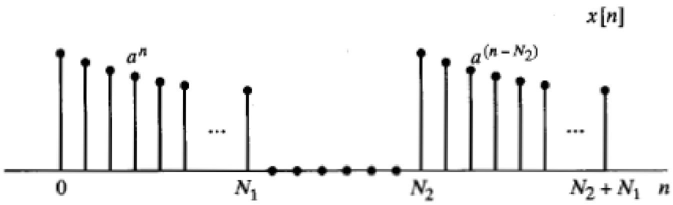

Figure P2.25-1

2.29. A discrete-time signal $x[n]$ is shown in Figure P2.29-1.

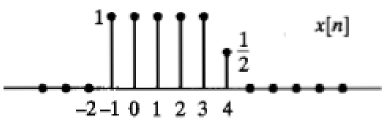

Figure P2.29-1

Sketch and label carefully each of the following signals:

(a) $x[n-2]$
(b) $x[4-n]$
(c) $x[2n]$
(d) $x[n]u[2-n]$
(e) $x[n-1]\delta[n-3]$

2.41. A linear time-invariant system has frequency response

$$H(e^{j\omega}) = \begin{cases} e^{-j\omega 3}, & |\omega| < \frac{2\pi}{16}\left(\frac{3}{2}\right), \\ 0, & \frac{2\pi}{16}\left(\frac{3}{2}\right) \le |\omega| \le \pi. \end{cases}$$

The input to the system is a periodic unit-impulse train with period $N = 16$; i.e.,

$$x[n] = \sum_{k=-\infty}^{\infty} \delta[n + 16k].$$

2.63. Consider a discrete-time system with input $x[n]$ and output $y[n]$. When the input is

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

the output is

$$y[n] = \left(\frac{1}{2}\right)^n \quad \text{for all } n.$$

Determine which of the following statements is correct:

- The system must be LTI.
- The system could be LTI.
- The system cannot be LTI.

2.68. Figure P1.68-1 shows the input–output relationships of Systems A and B, while Figure P1.68-2 contains two possible cascade combinations of these systems.

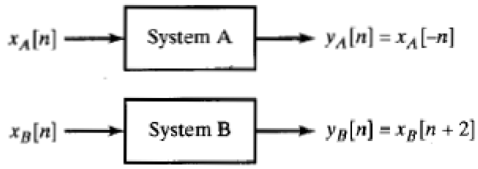

Figure P2.68-1

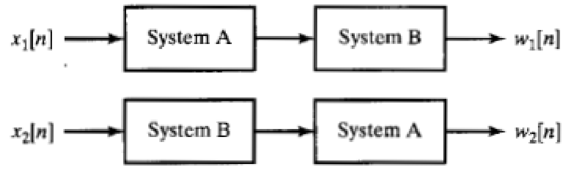

Figure P2.68-2

2.78. Let $x[n]$ and $X(e^{j\omega})$ represent a sequence and its Fourier transform, respectively. Determine, in terms of $X(e^{j\omega})$, the transforms of $y_s[n]$, $y_d[n]$, and $y_e[n]$. In each case, sketch $Y(e^{j\omega})$ for $X(e^{j\omega})$ as shown in Figure P2.78-1.

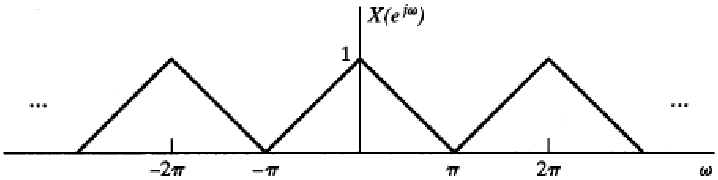

Figure P2.78-1

(a) Sampler:

$$y_s[n] = \begin{cases} x[n], & n \text{ even}, \\ 0, & n \text{ odd}. \end{cases}$$

Note that $y_s[n] = \frac{1}{2}\{x[n] + (-1)^n x[n]\}$ and $-1 = e^{j\pi}$.

(b) Compressor:

$$y_d[n] = x[2n].$$

(c) Expander:

$$y_e[n] = \begin{cases} x[n/2], & n \text{ even}, \\ 0, & n \text{ odd}. \end{cases}$$