Chapter 03

Signals, Systems, and Spectral Analysis

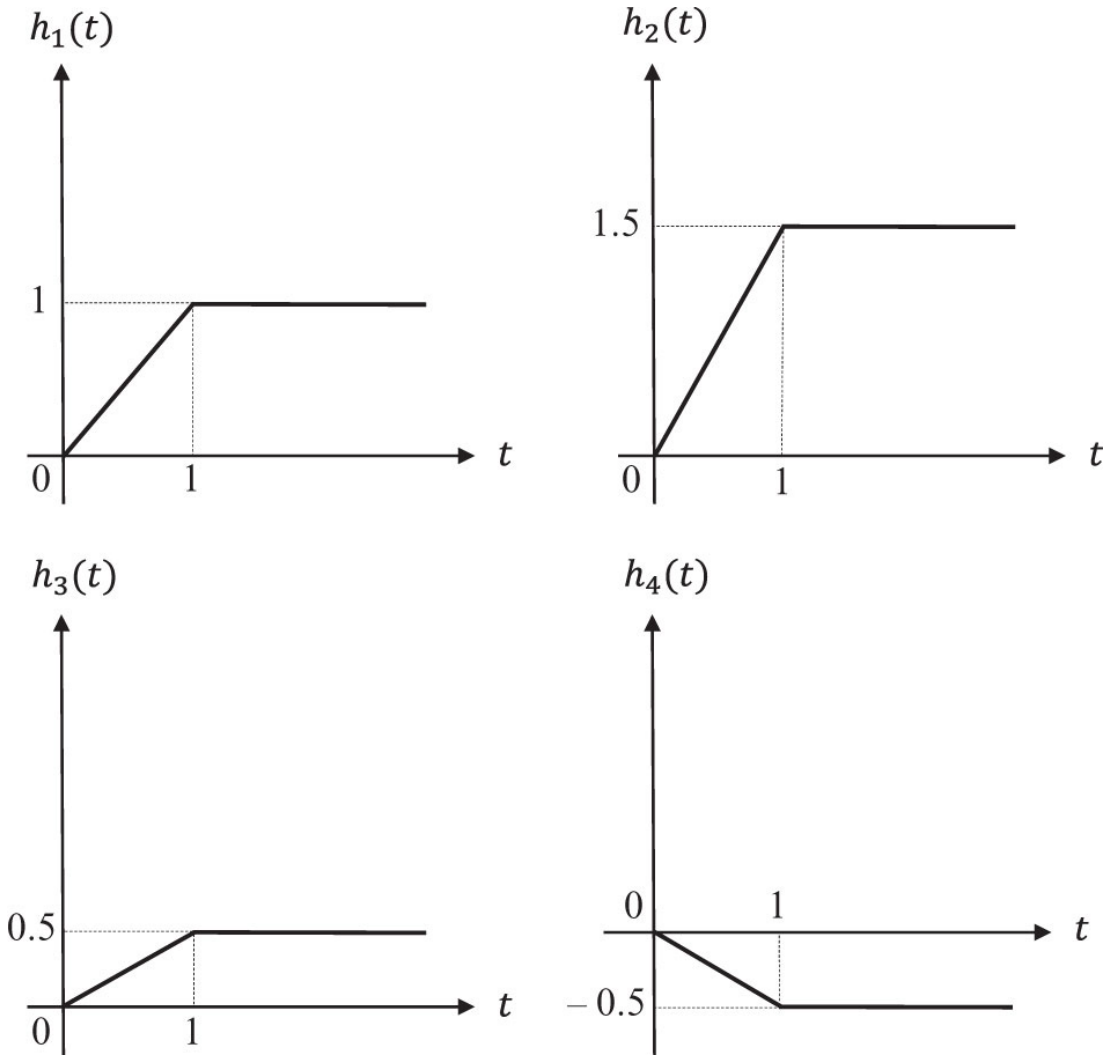


Figure 3.1 Signals in Example 3.1.

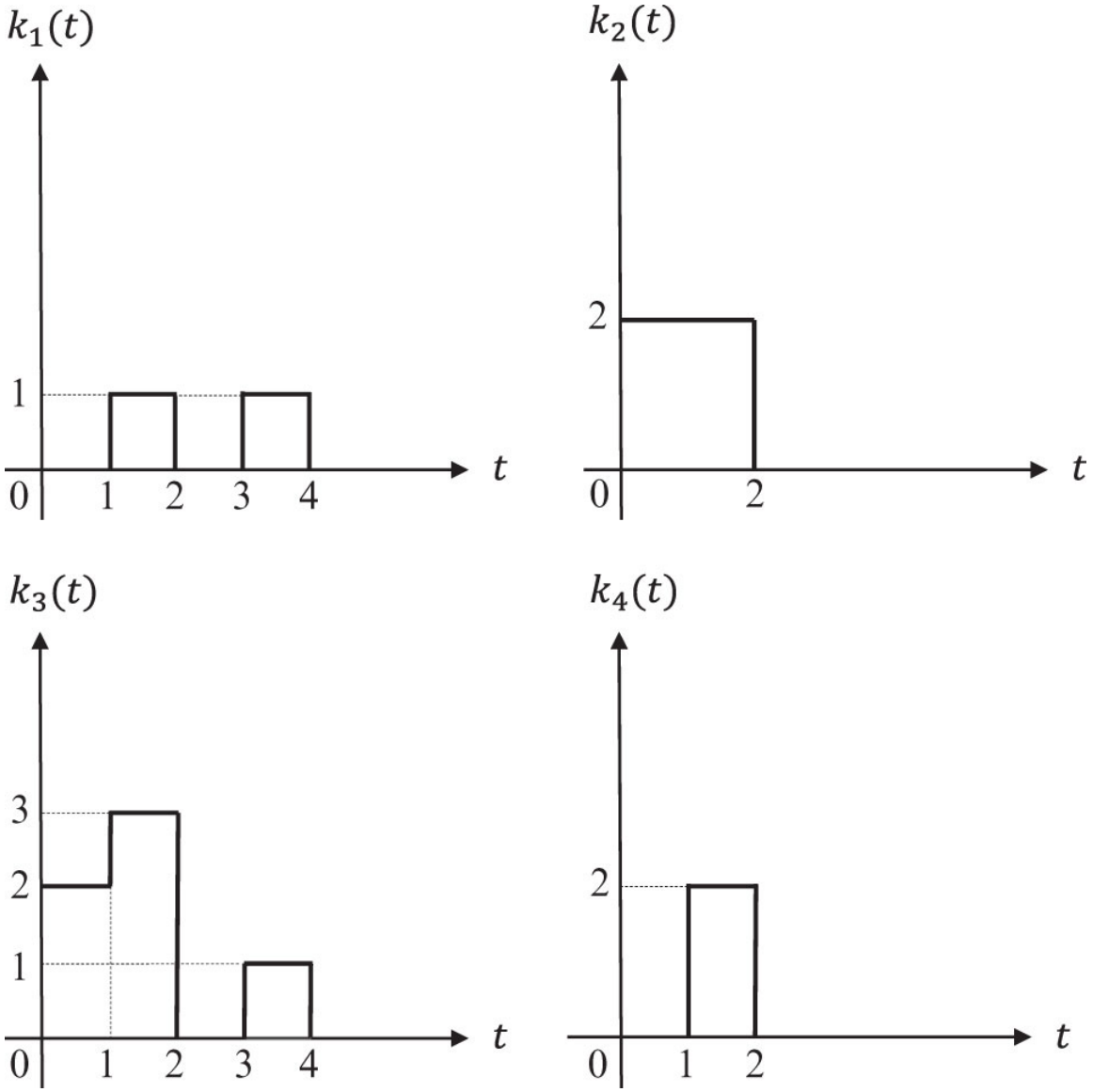


Figure 3.2 Signals in Example 3.2.

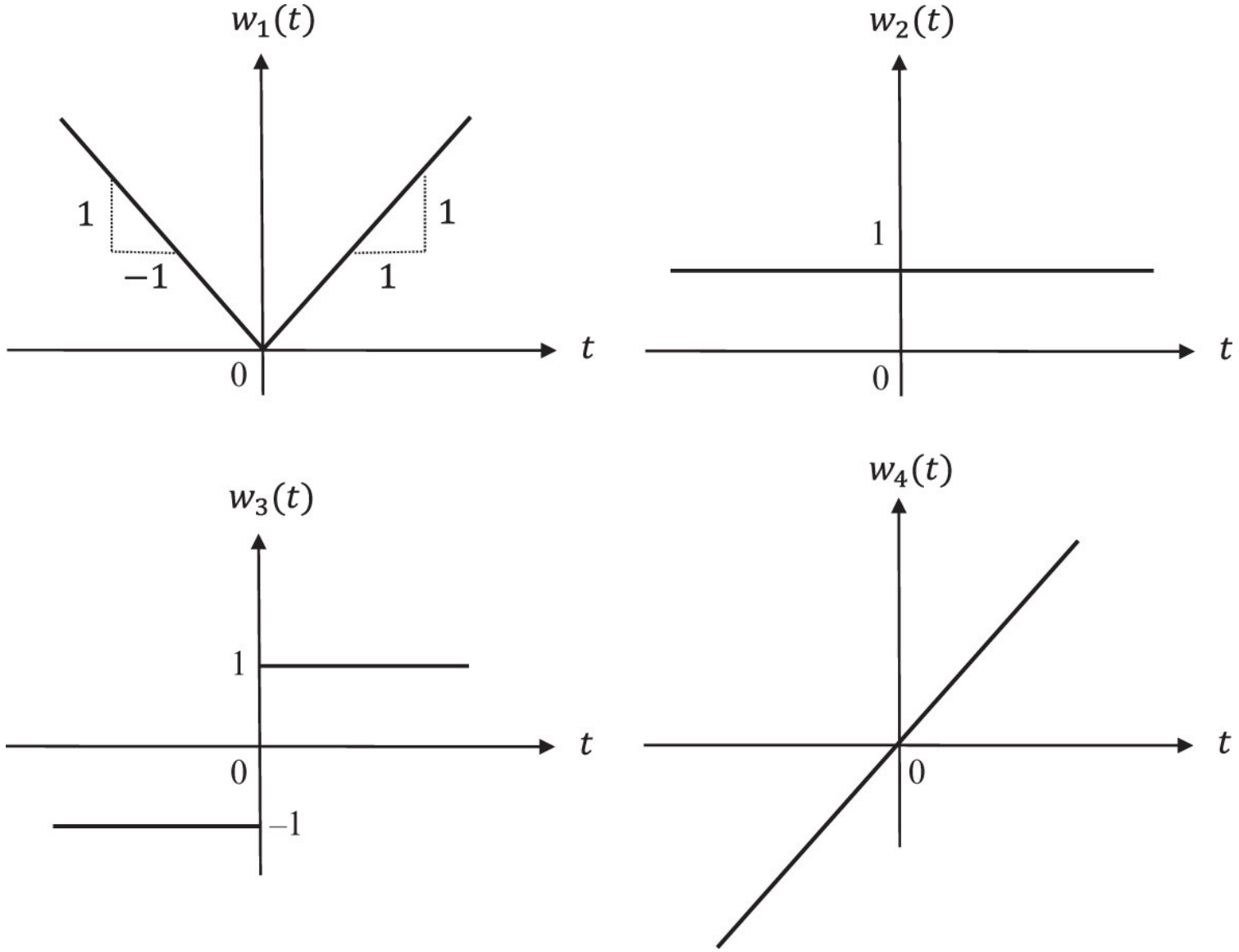


Figure 3.3 Signals in Example 3.3.

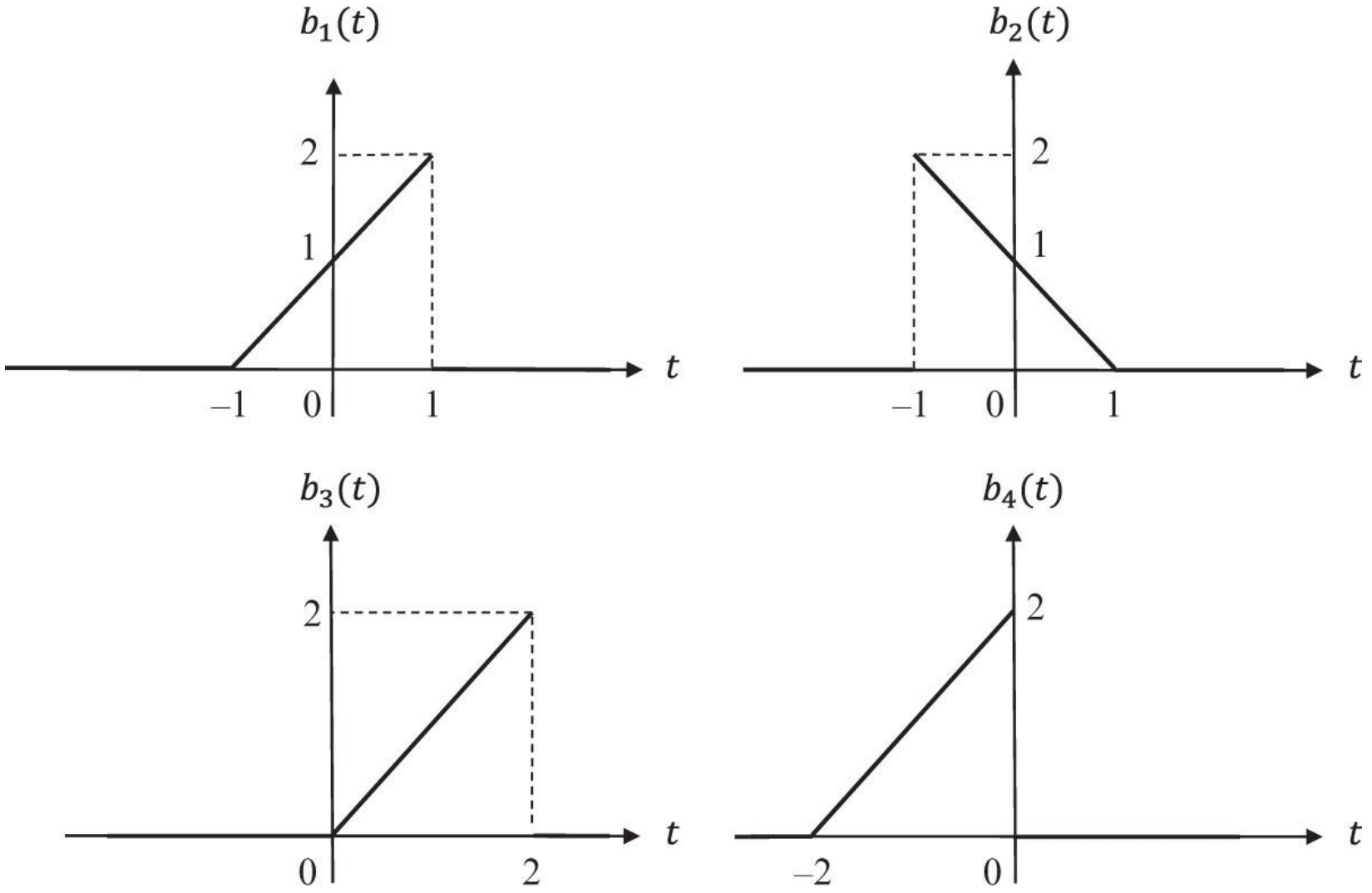


Figure 3.4 Signals in Example 3.4.

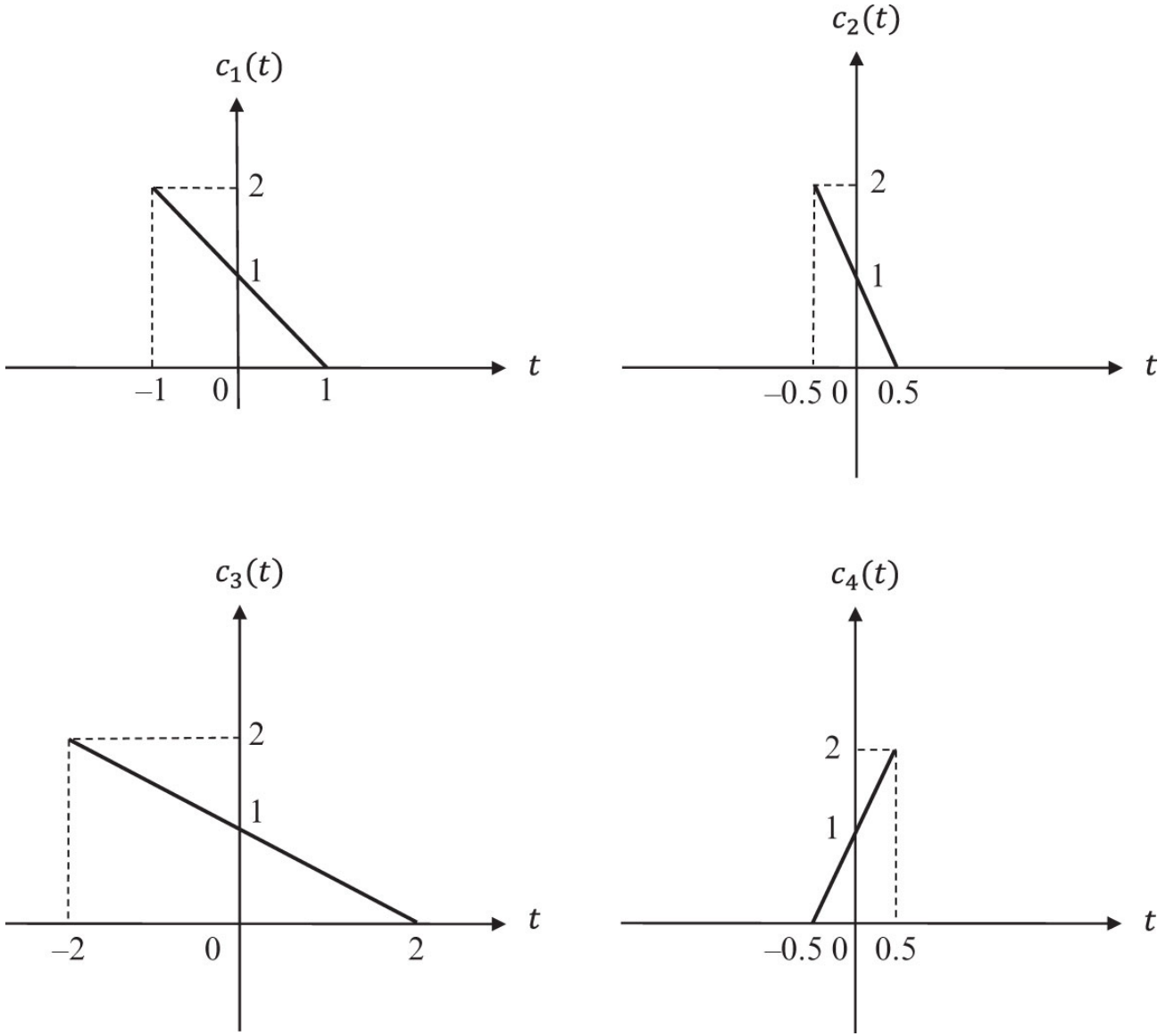


Figure 3.5 Signals in Example 3.5.

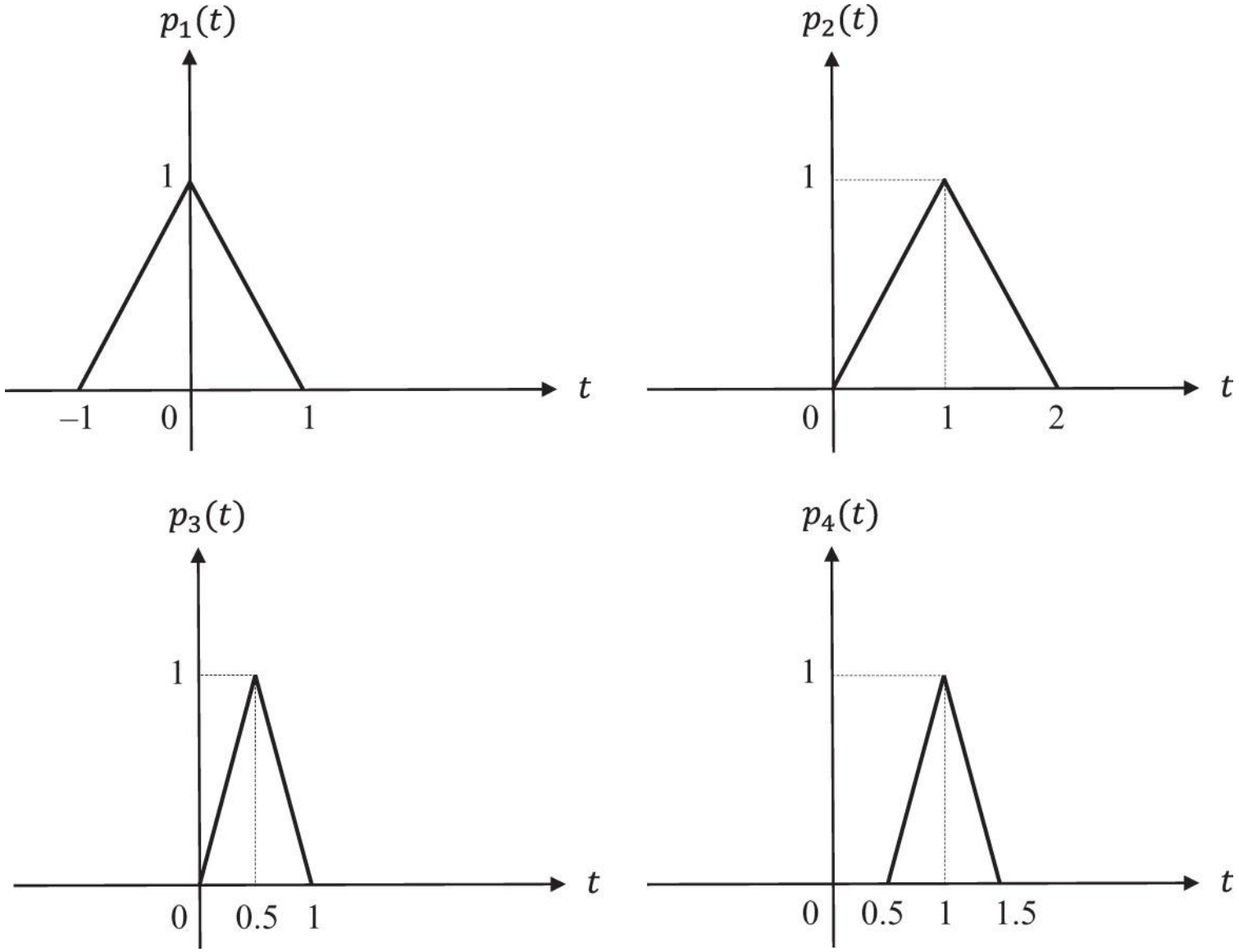


Figure 3.6 Signals in Example 3.6.

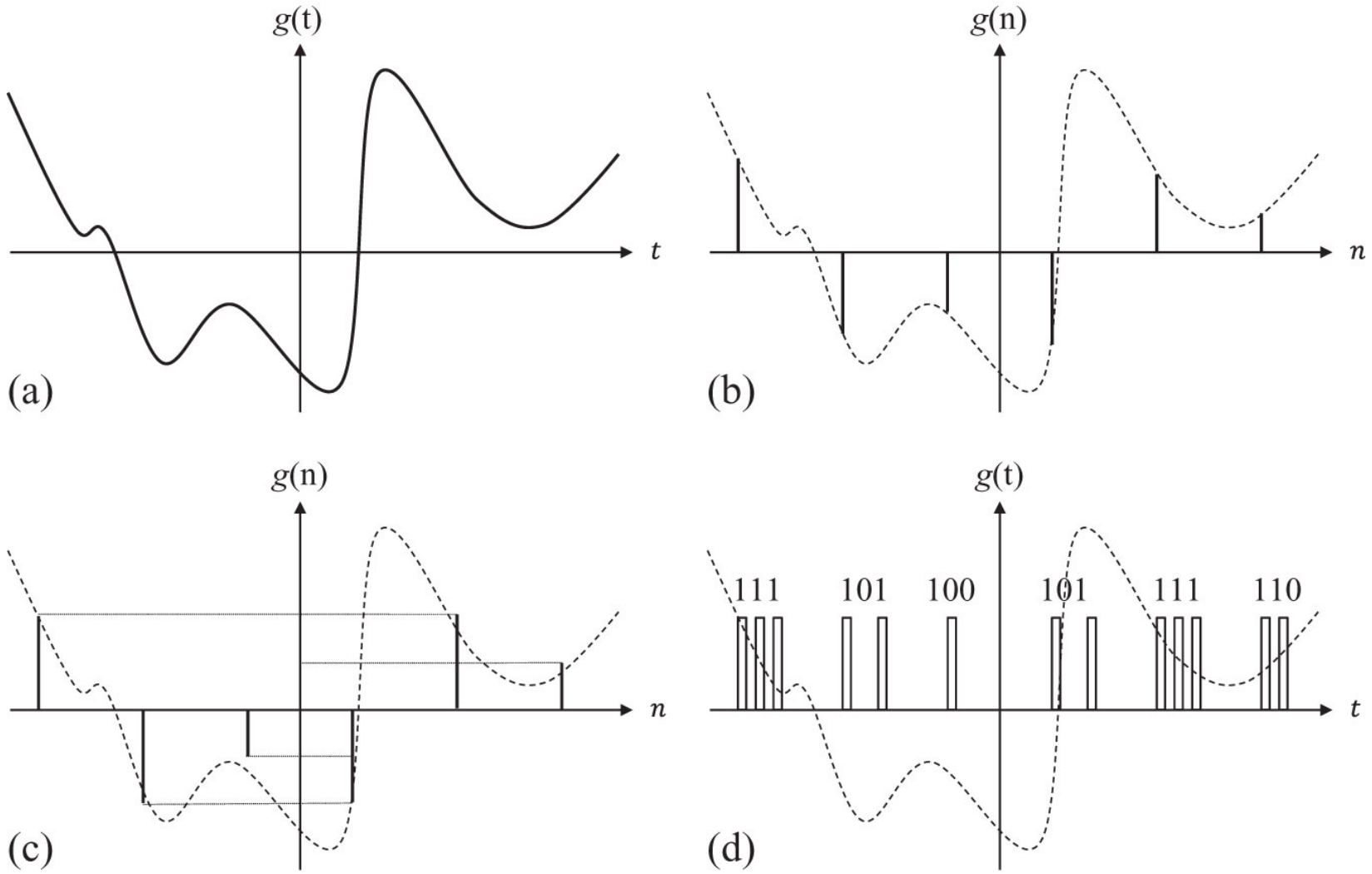


Figure 3.7 Continuous/discrete-value, continuous/discrete-time signals: (a) continuous-value, continuous-time signal; (b) continuous-value, discrete-time signal; (c) discrete-value, discrete-time signal; and (d) discrete-value, continuous-time signal.

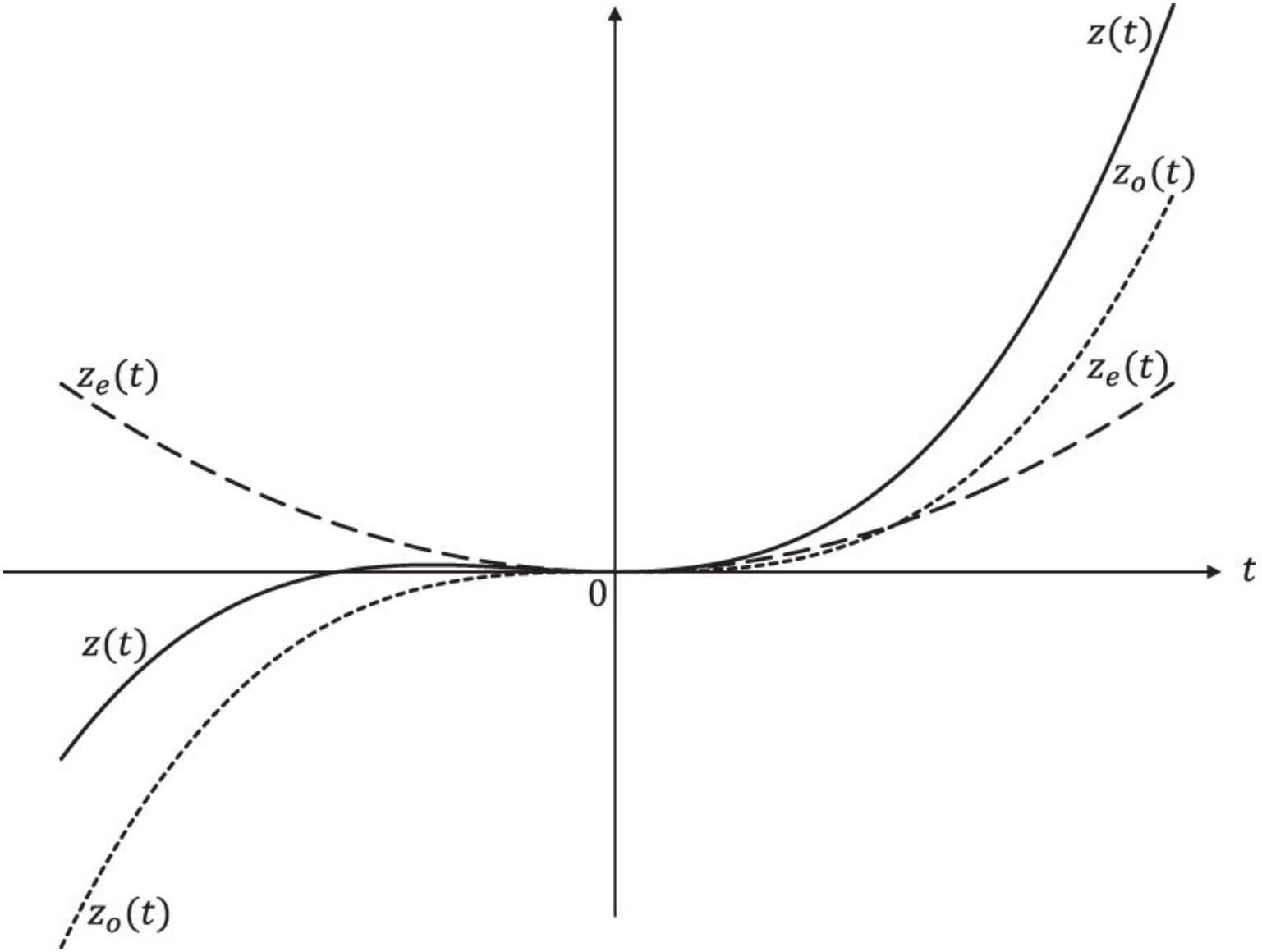


Figure 3.8 Signals in Example 3.7.

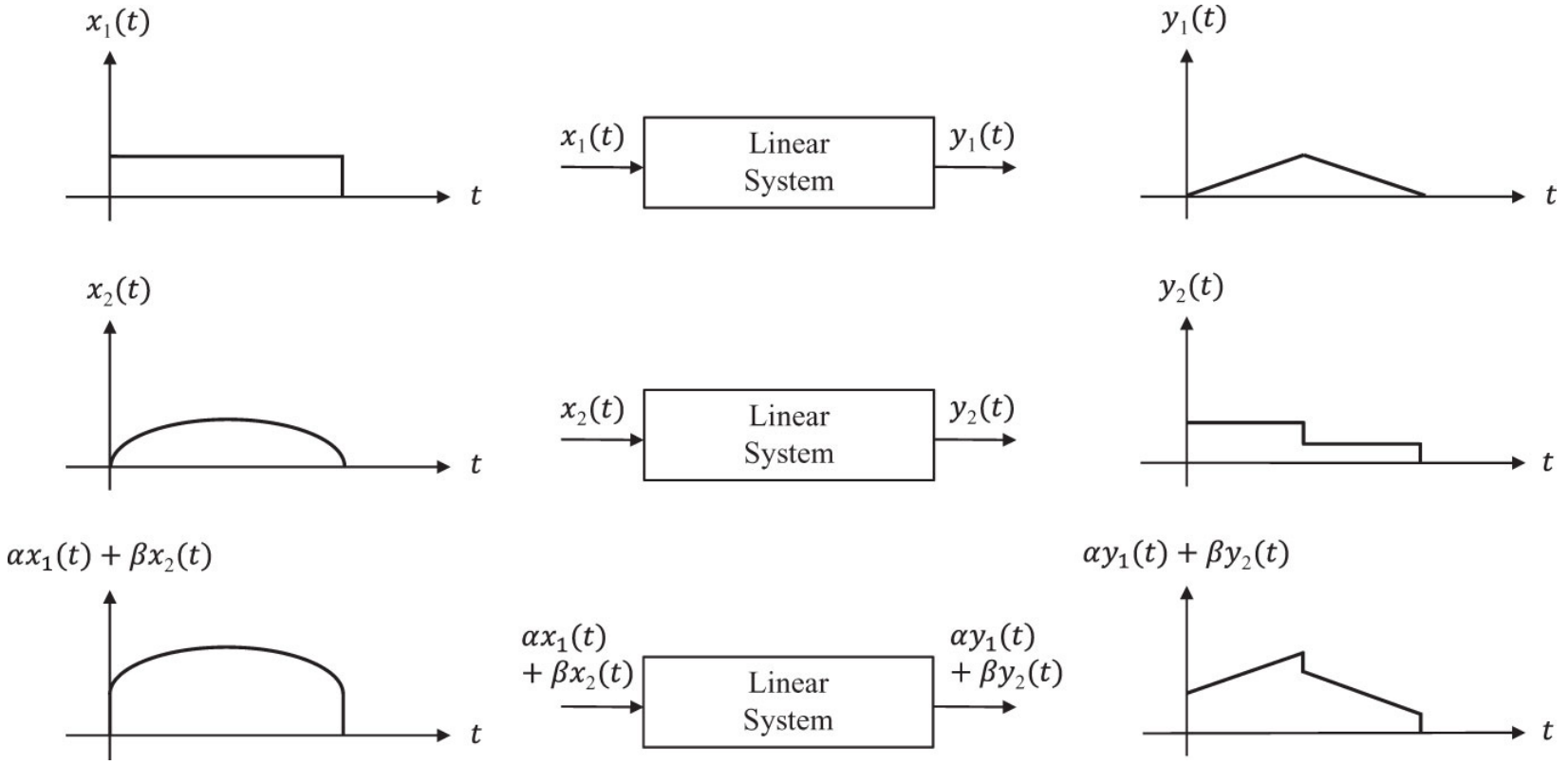


Figure 3.9 A linear system.

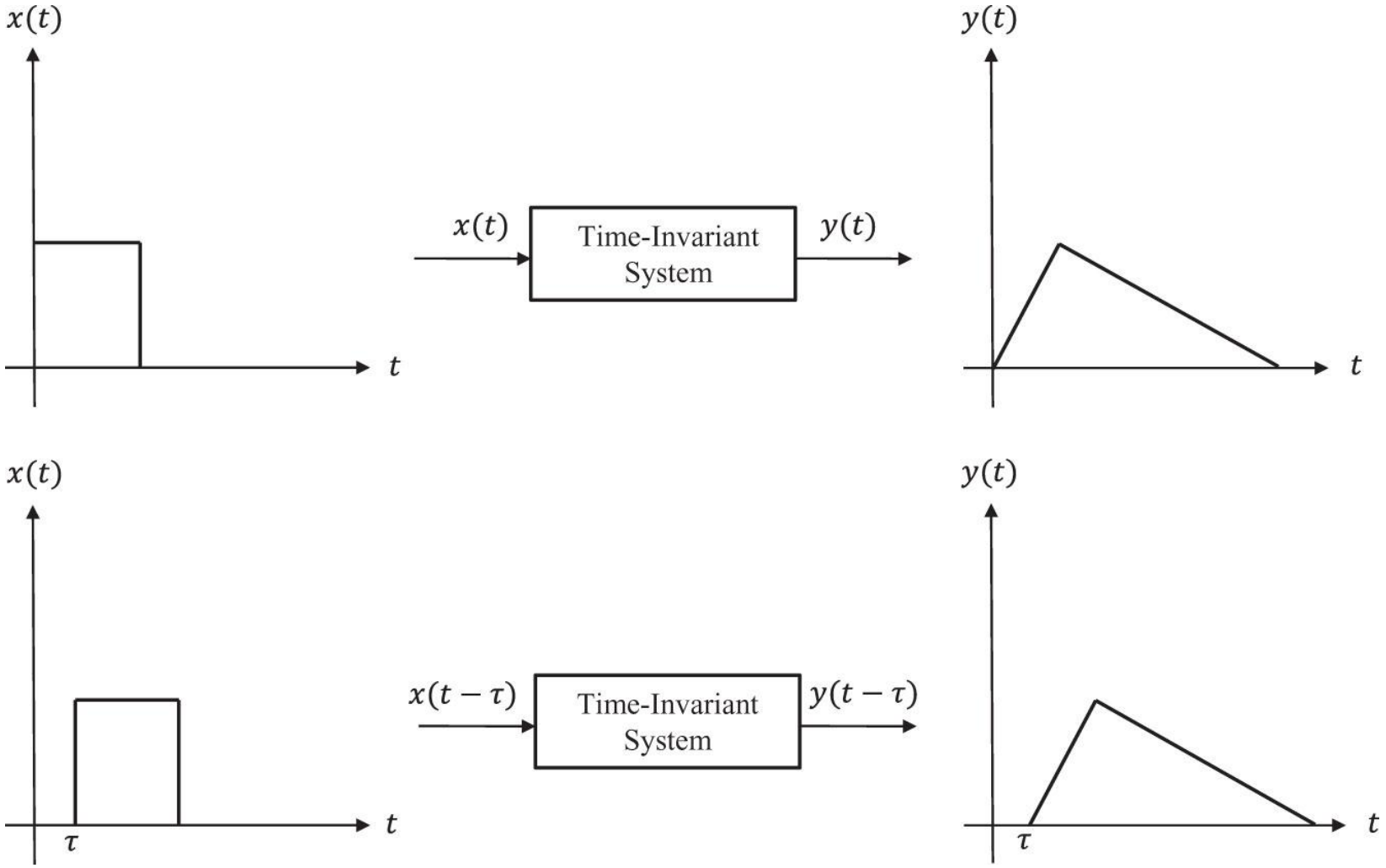


Figure 3.10 A time-invariant system.

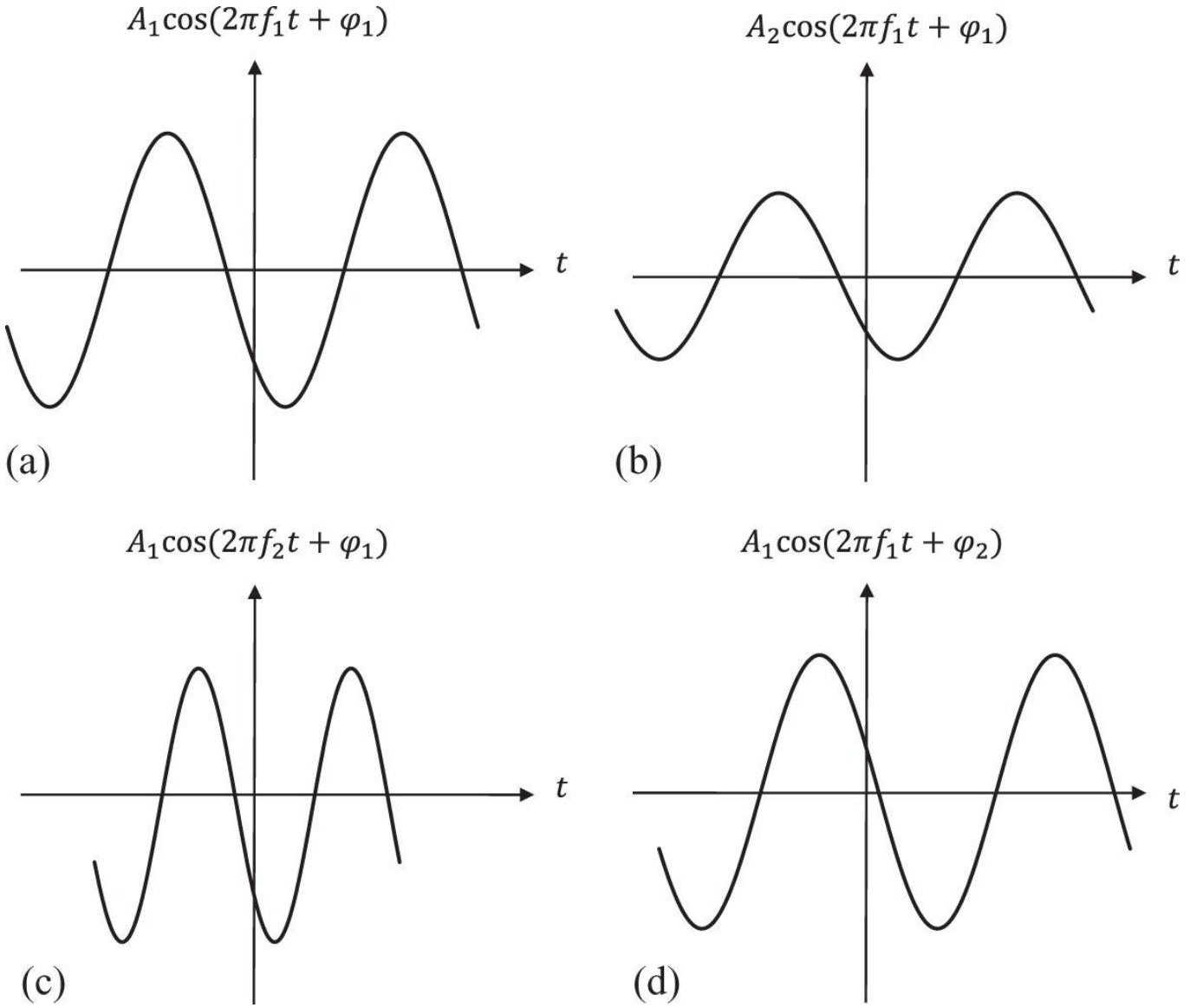


Figure 3.11 Sinusoidal signals with various amplitudes, frequencies, and initial phases: (a) a generic sinusoidal signal; (b) a sinusoidal signal whose amplitude is different from that in (a); (c) a sinusoidal signal whose frequency is different from that in (a); and (d) a sinusoidal signal whose initial phase is different from that in (a).

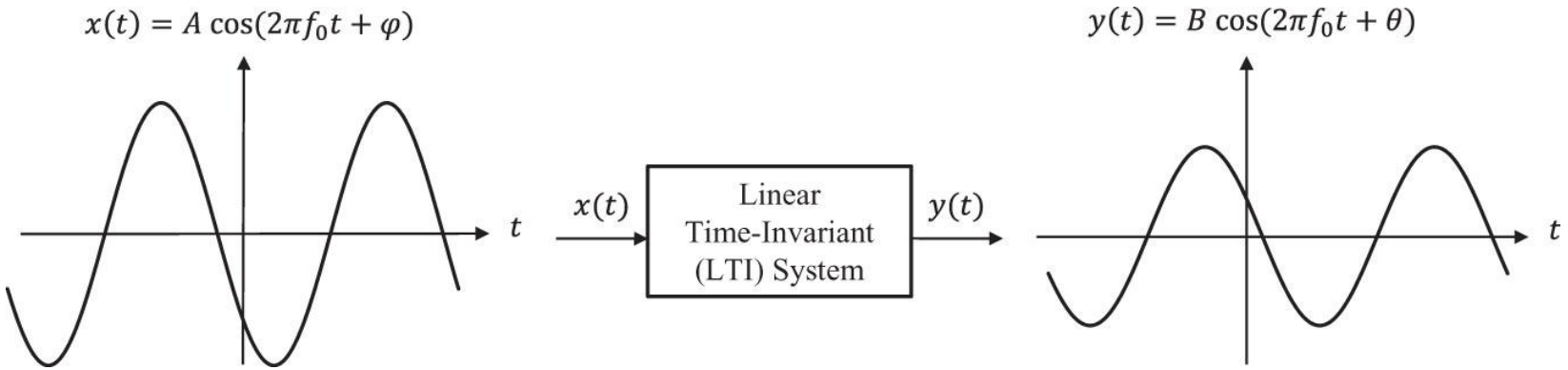


Figure 3.12 Sinusoidal signals in LTI systems.

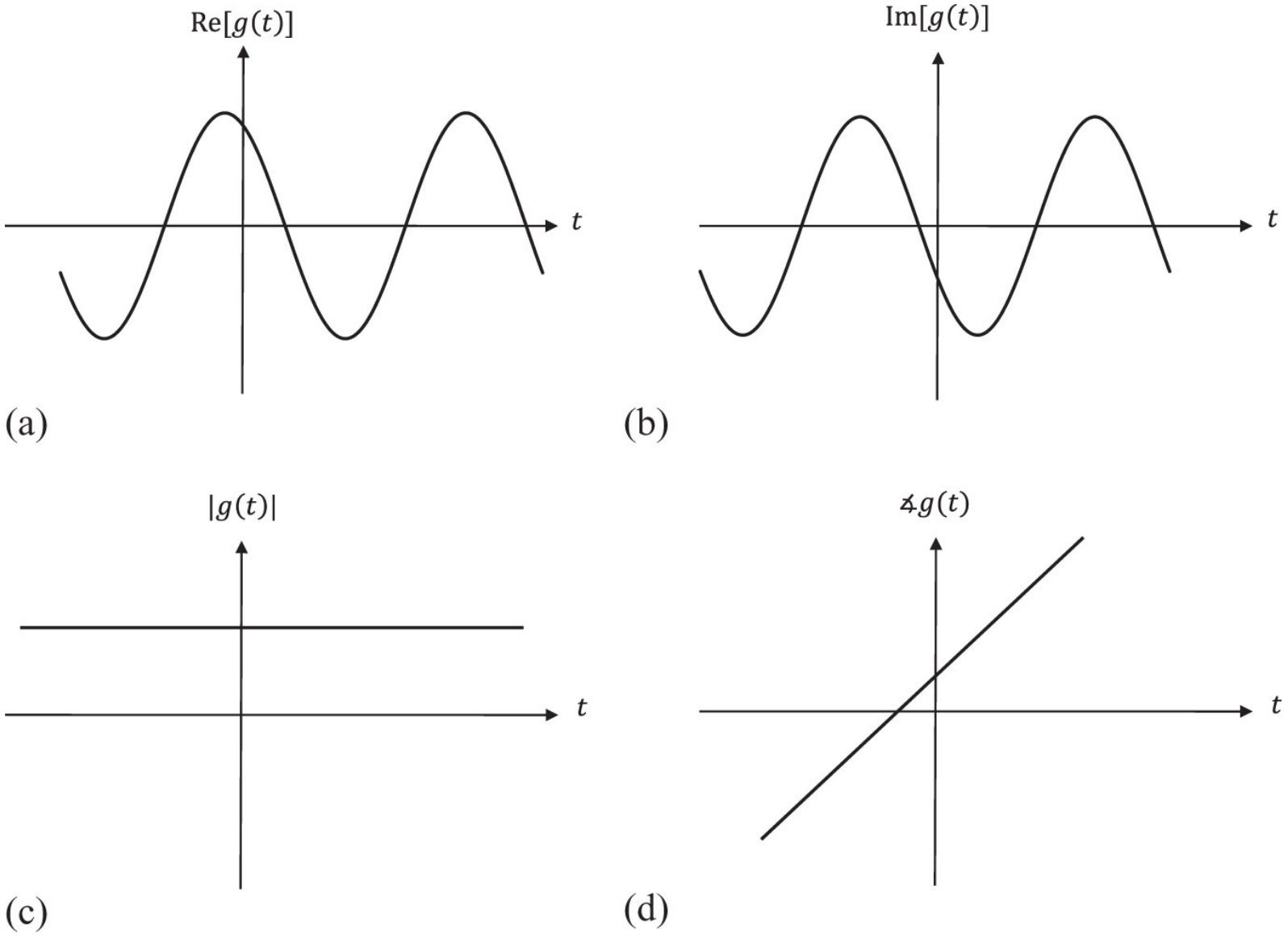


Figure 3.13 Components of complex exponential signal: (a) real part; (b) imaginary part; (c) magnitude value; and (d) phase value.

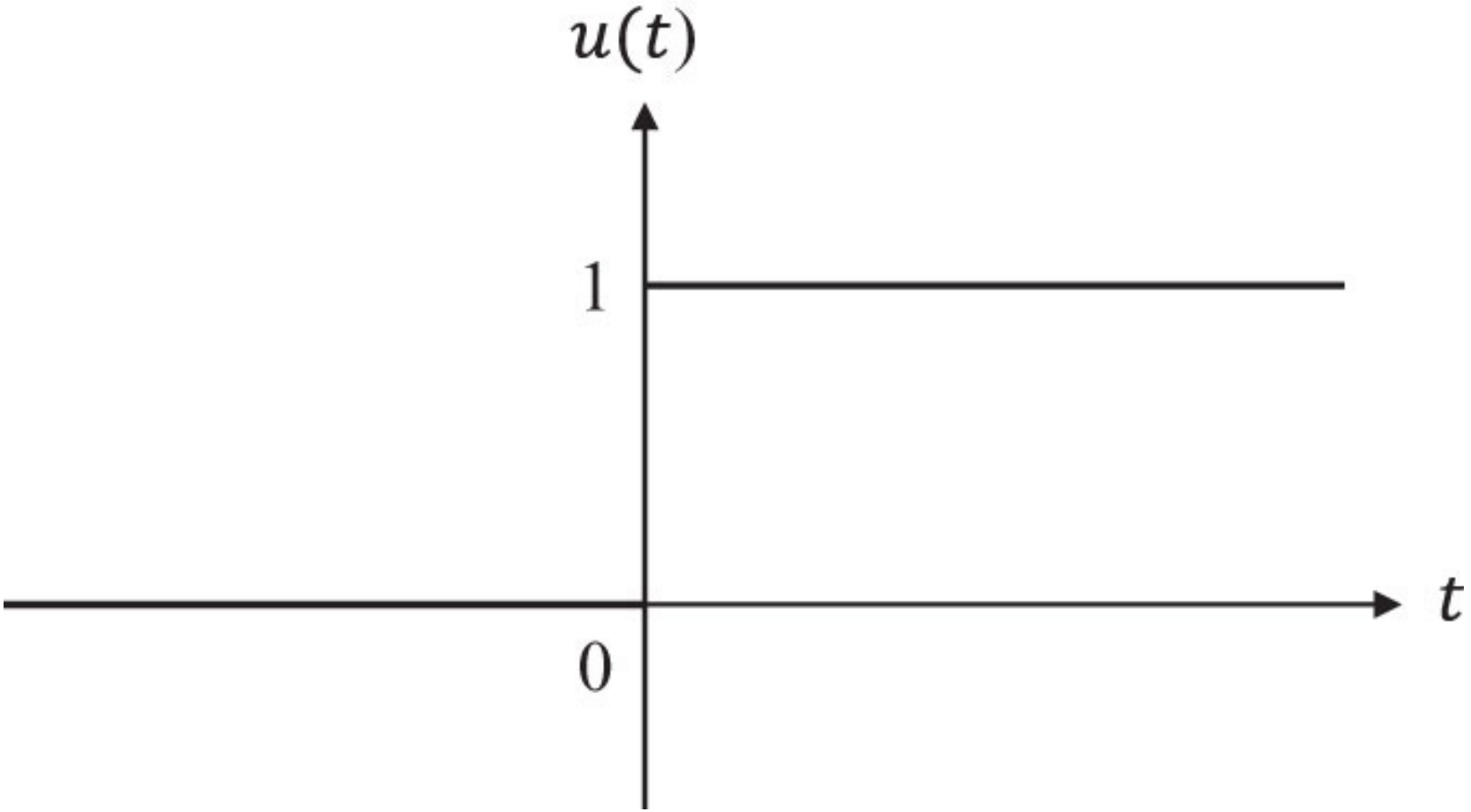


Figure 3.14 Unit step function.

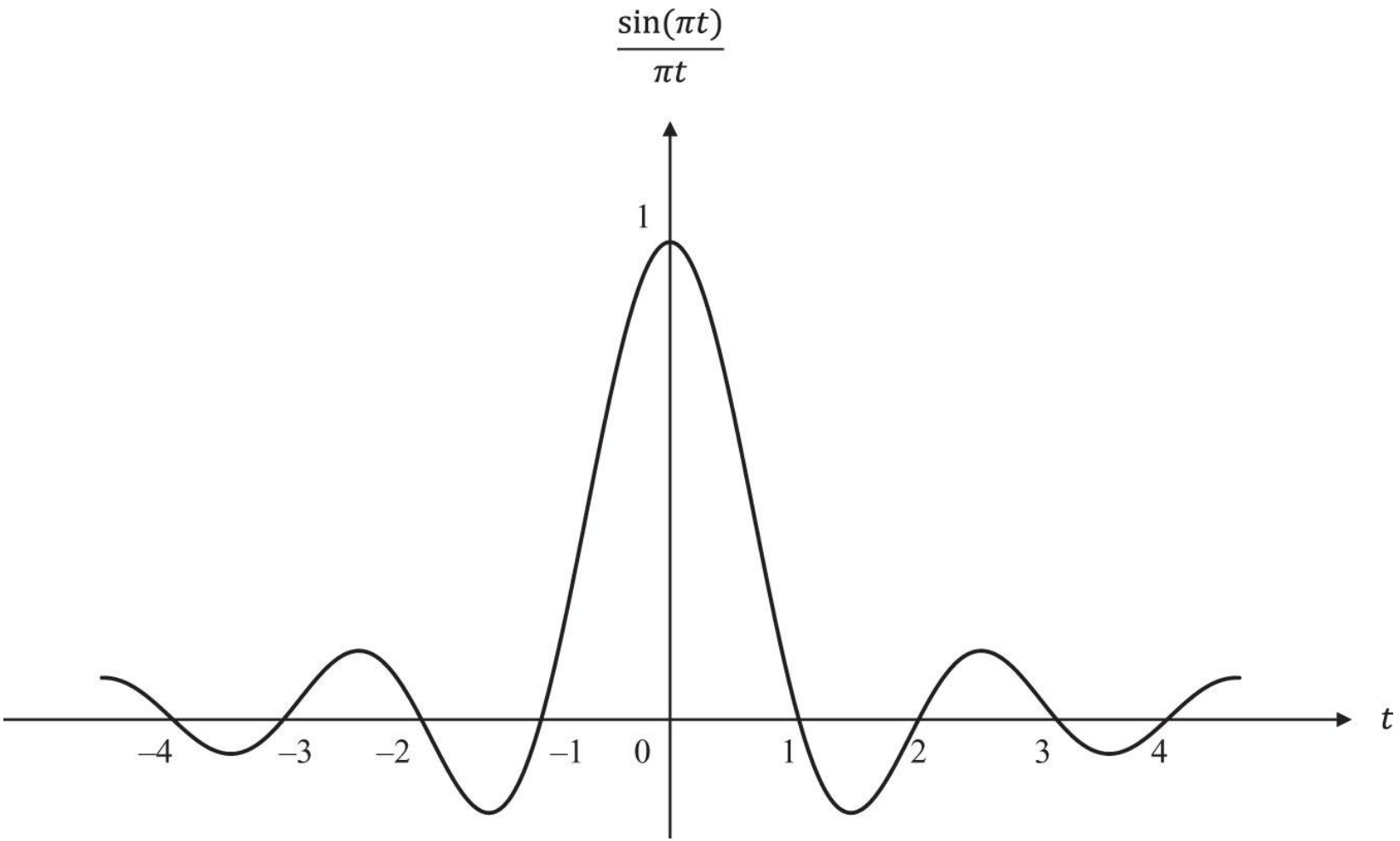


Figure 3.15 Sinc function.

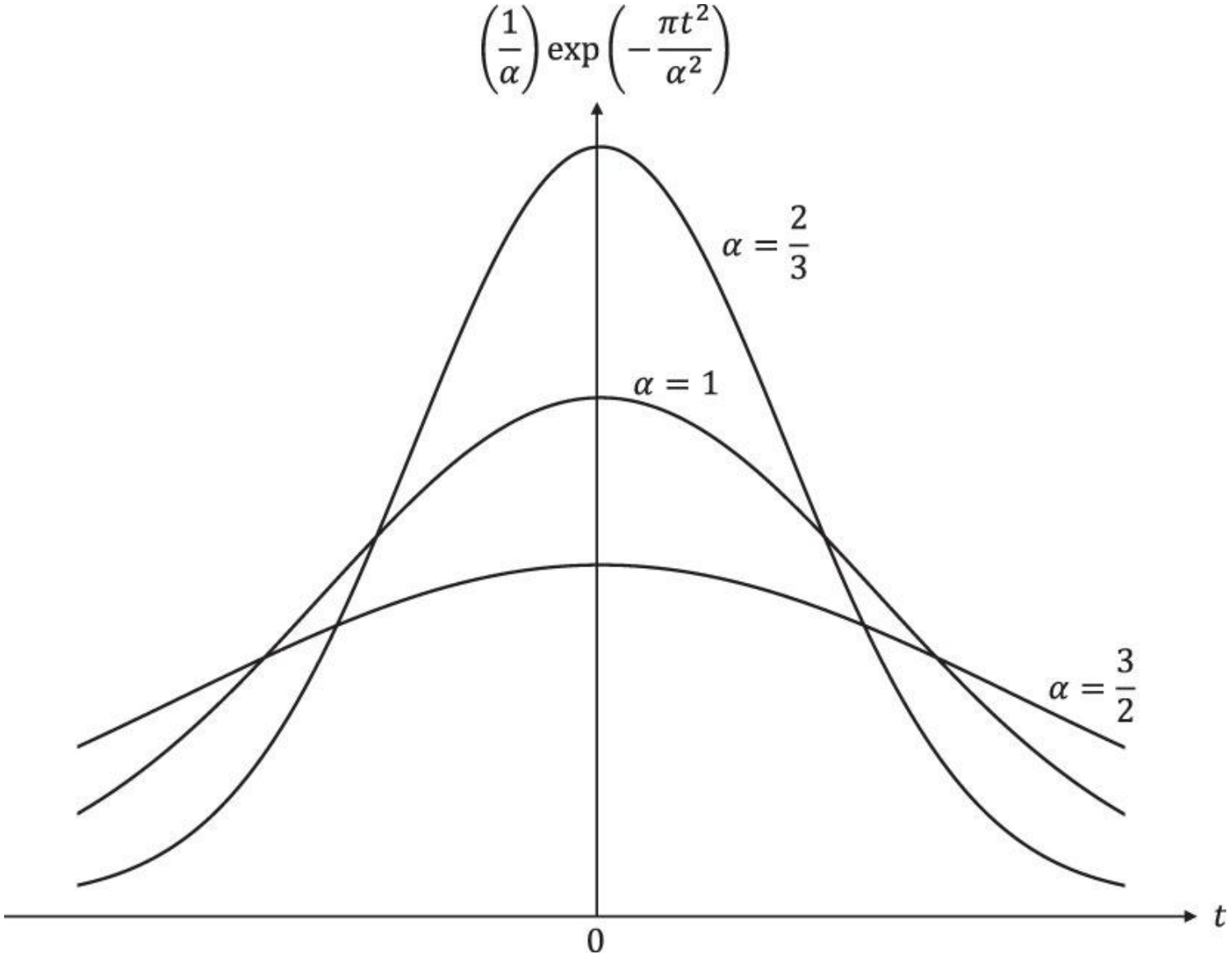


Figure 3.16 Gaussian function.

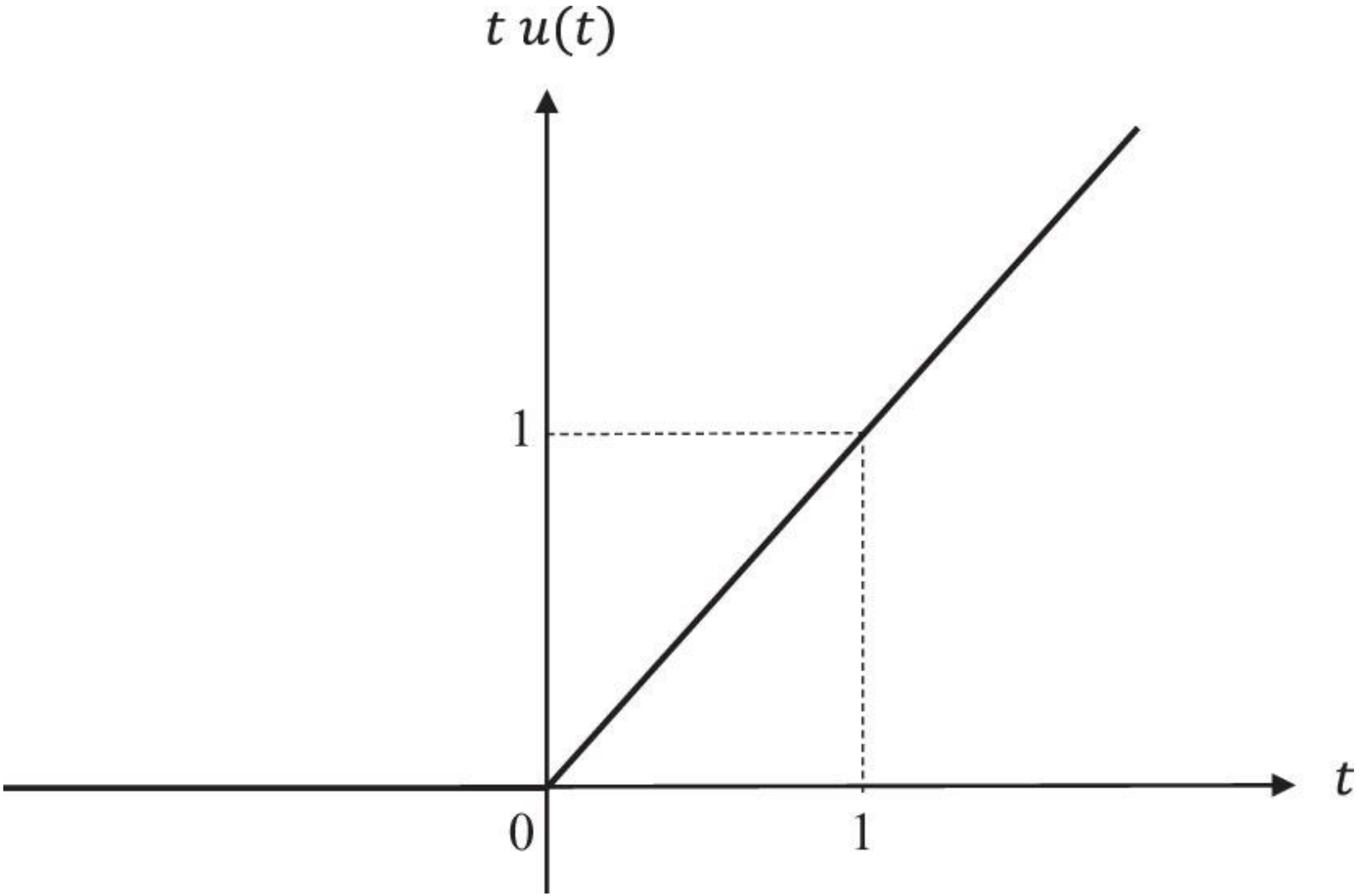


Figure 3.17 Unit ramp function.

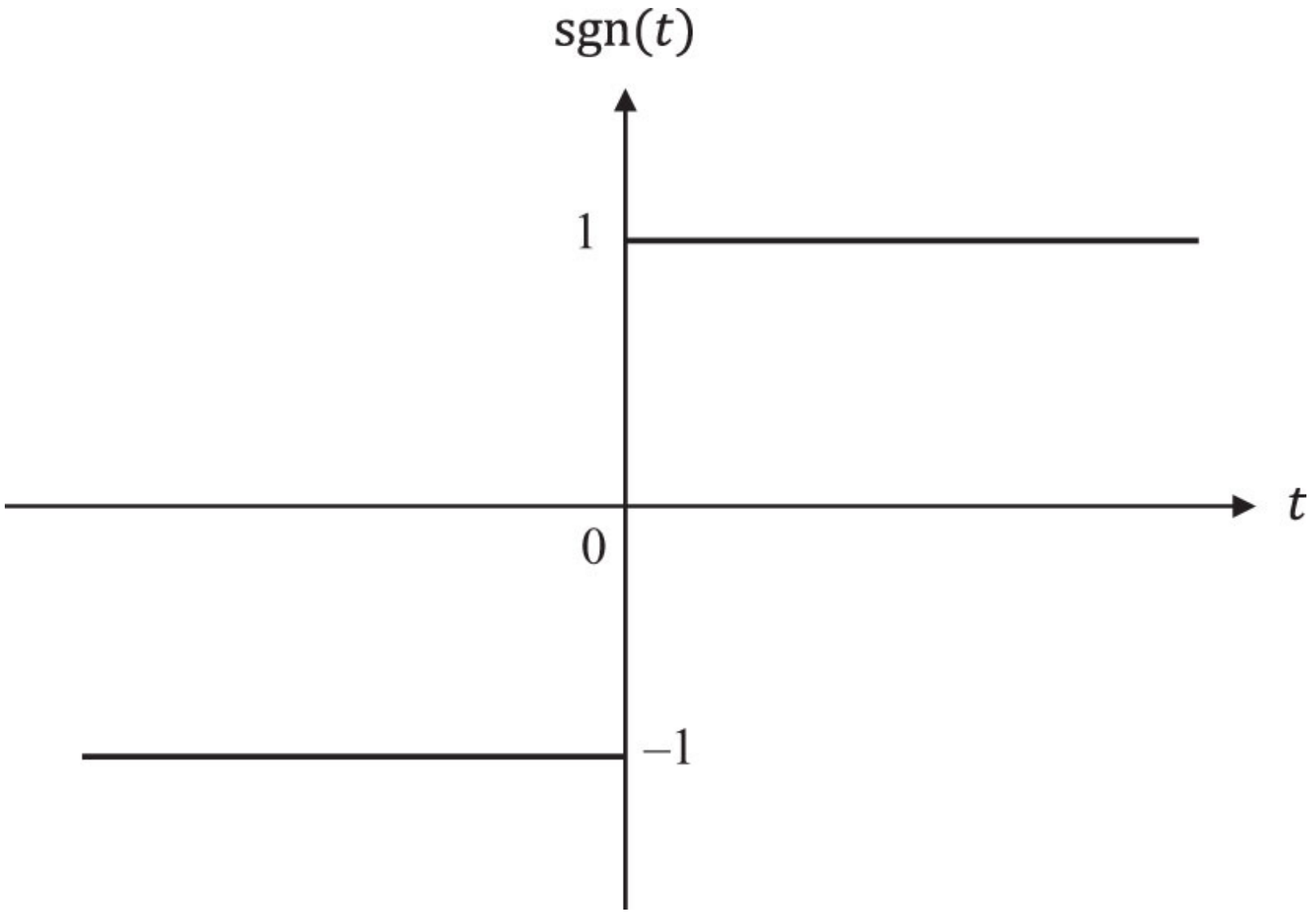


Figure 3.18 Signum function.

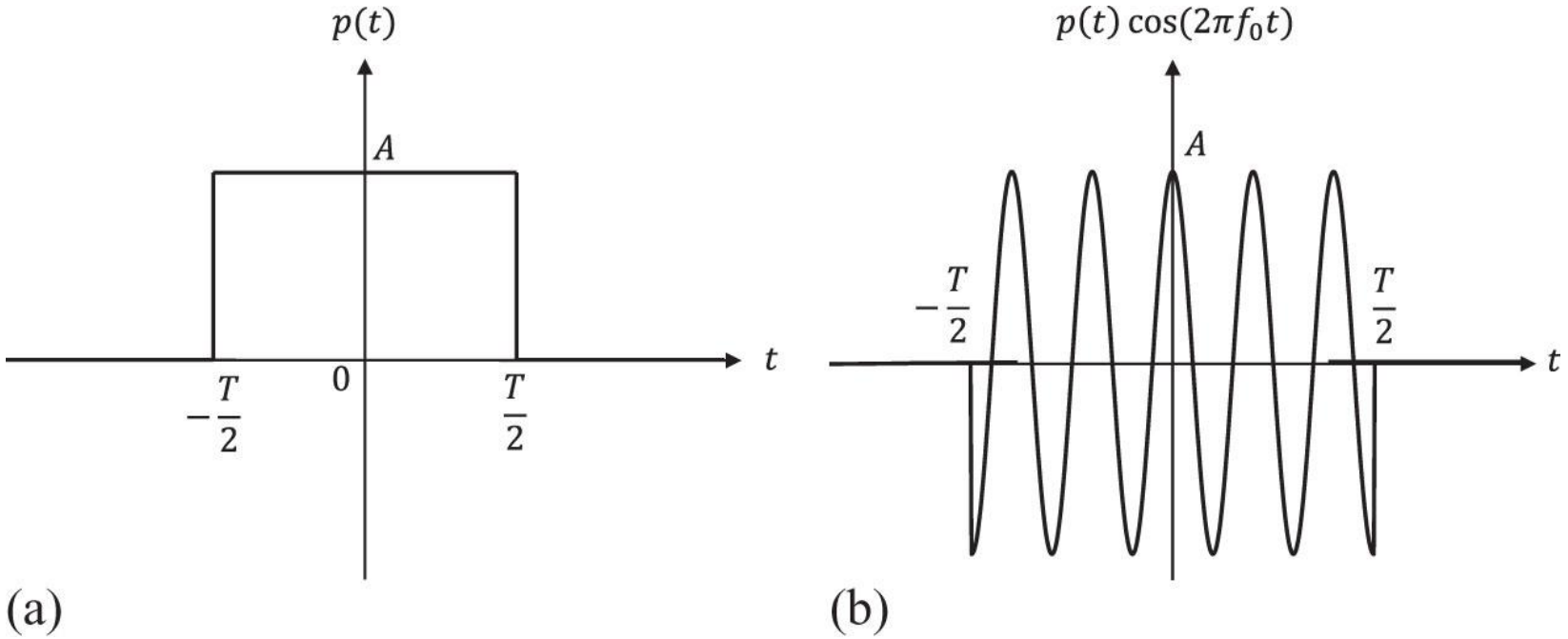


Figure 3.19 (a) Rectangular pulse and (b) radio frequency pulse.

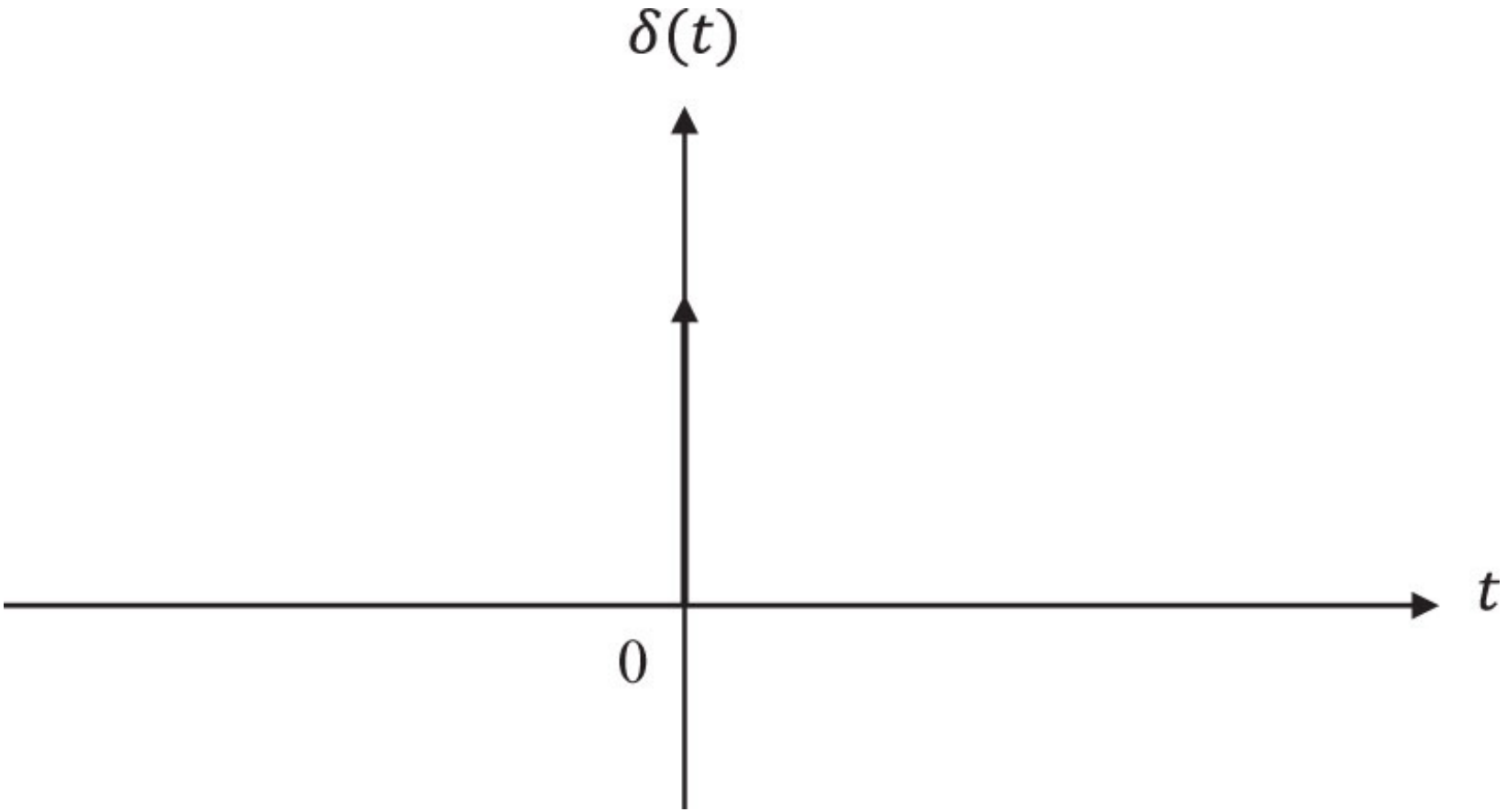


Figure 3.20 Unit impulse function.

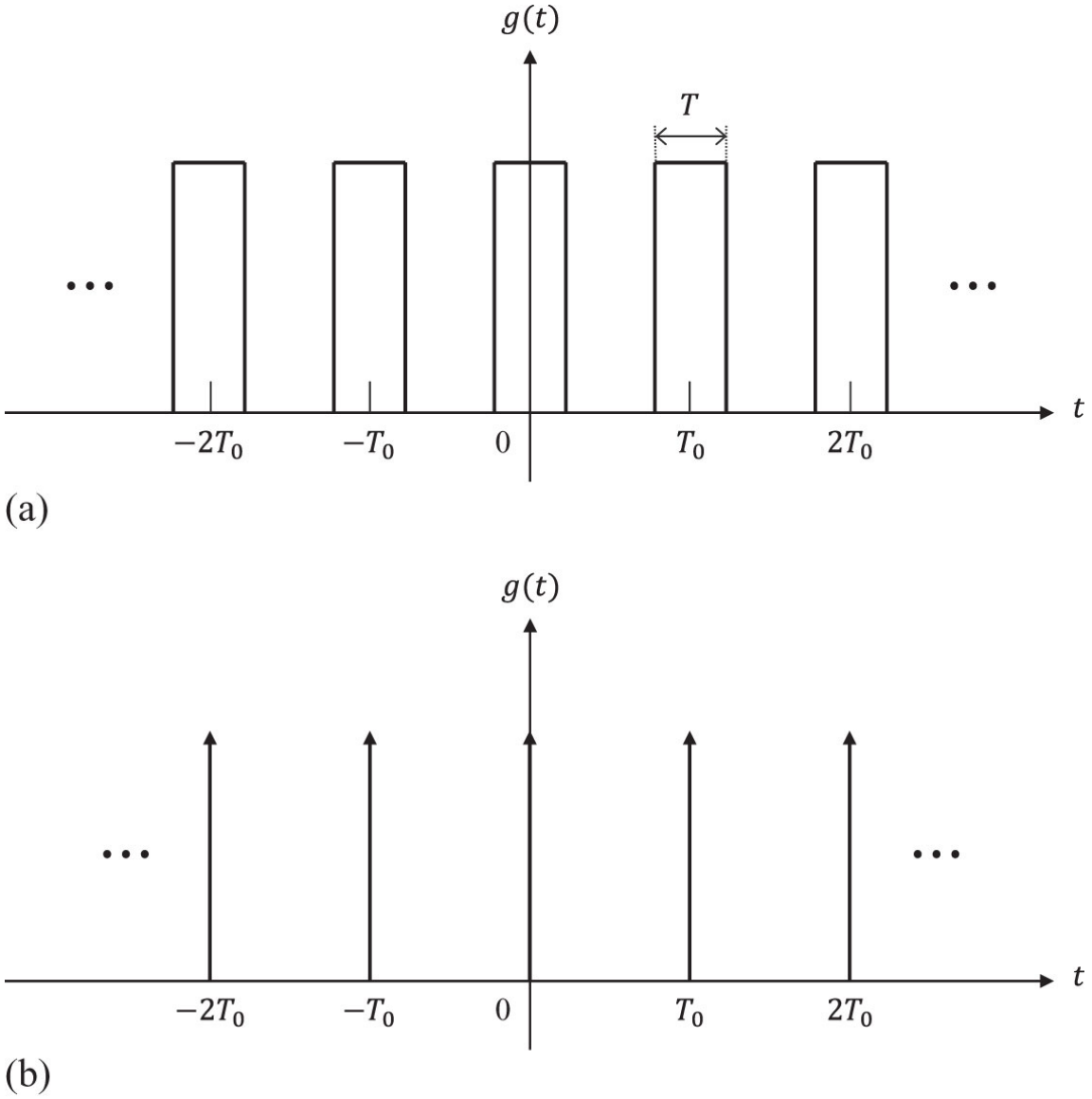


Figure 3.21 Periodic trains: (a) pulse train and (b) impulse train.

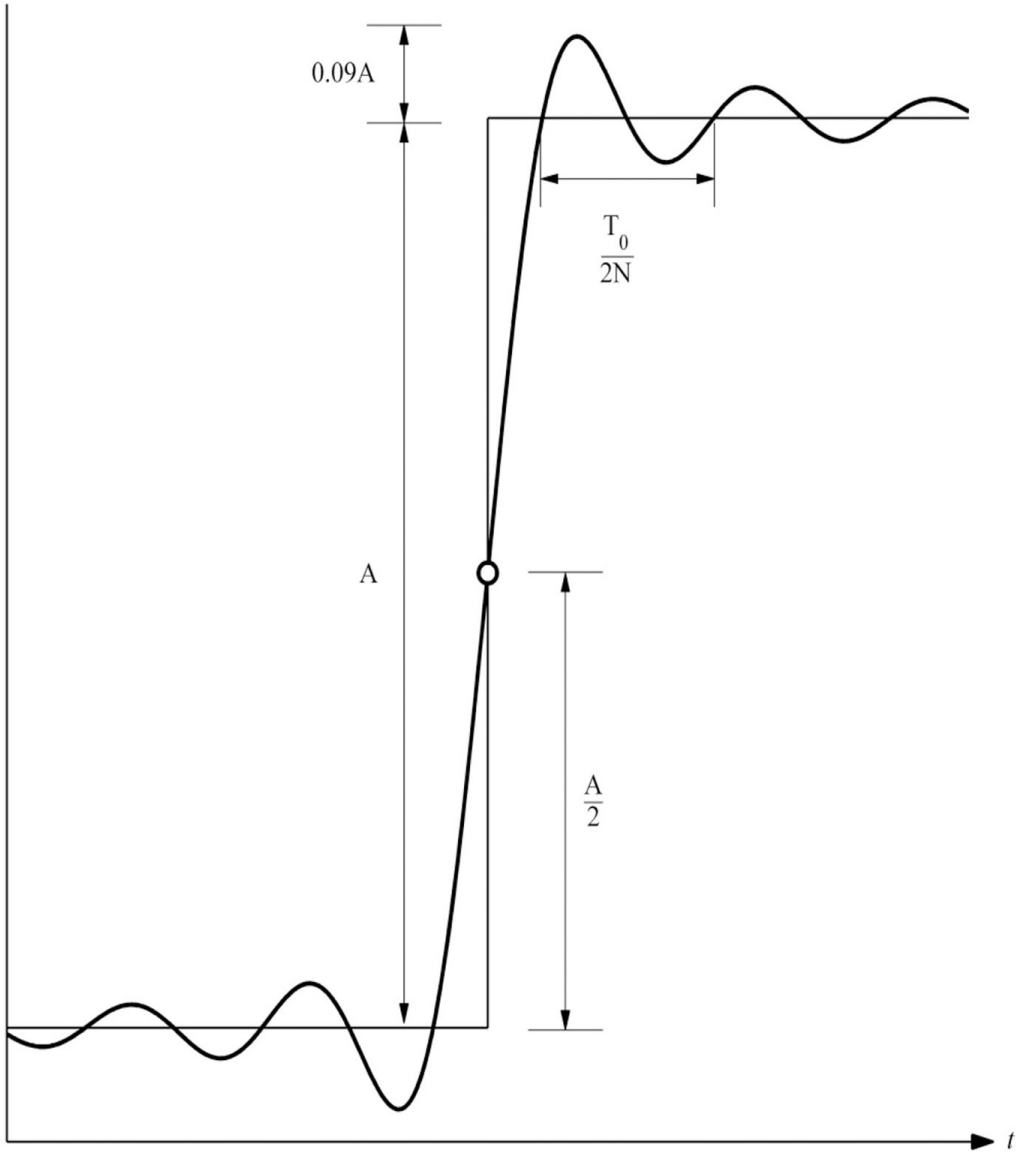
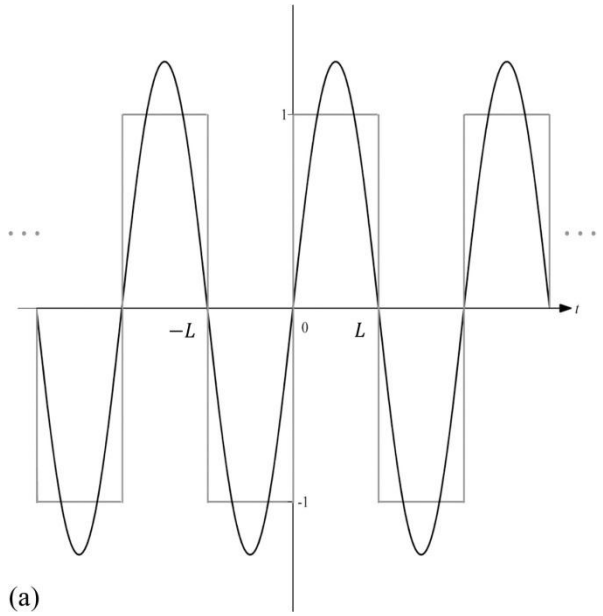
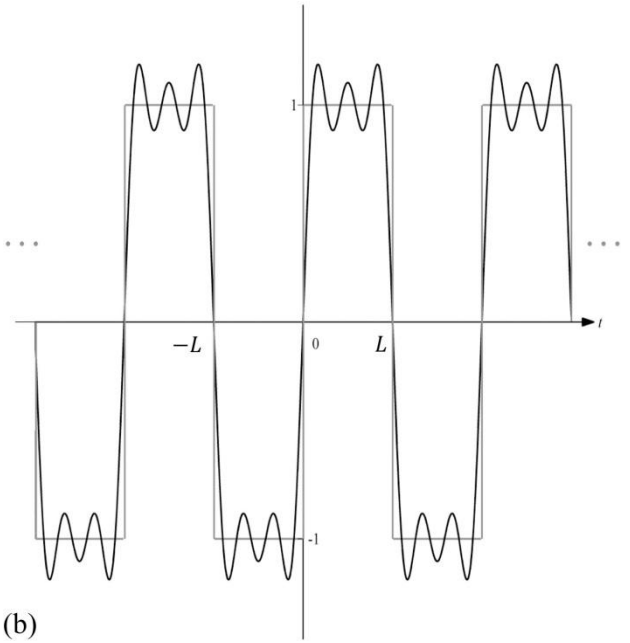


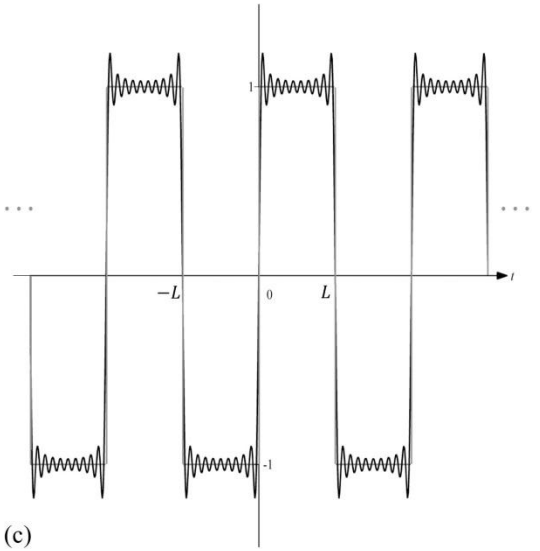
Figure 3.22 Gibbs phenomenon.



(a)



(b)



(c)

Figure 3.23 Signals in Example 3.16: (a) Fourier series approximation using first term; (b) Fourier series approximation using first five terms; and (c) Fourier series approximation using first twenty terms.

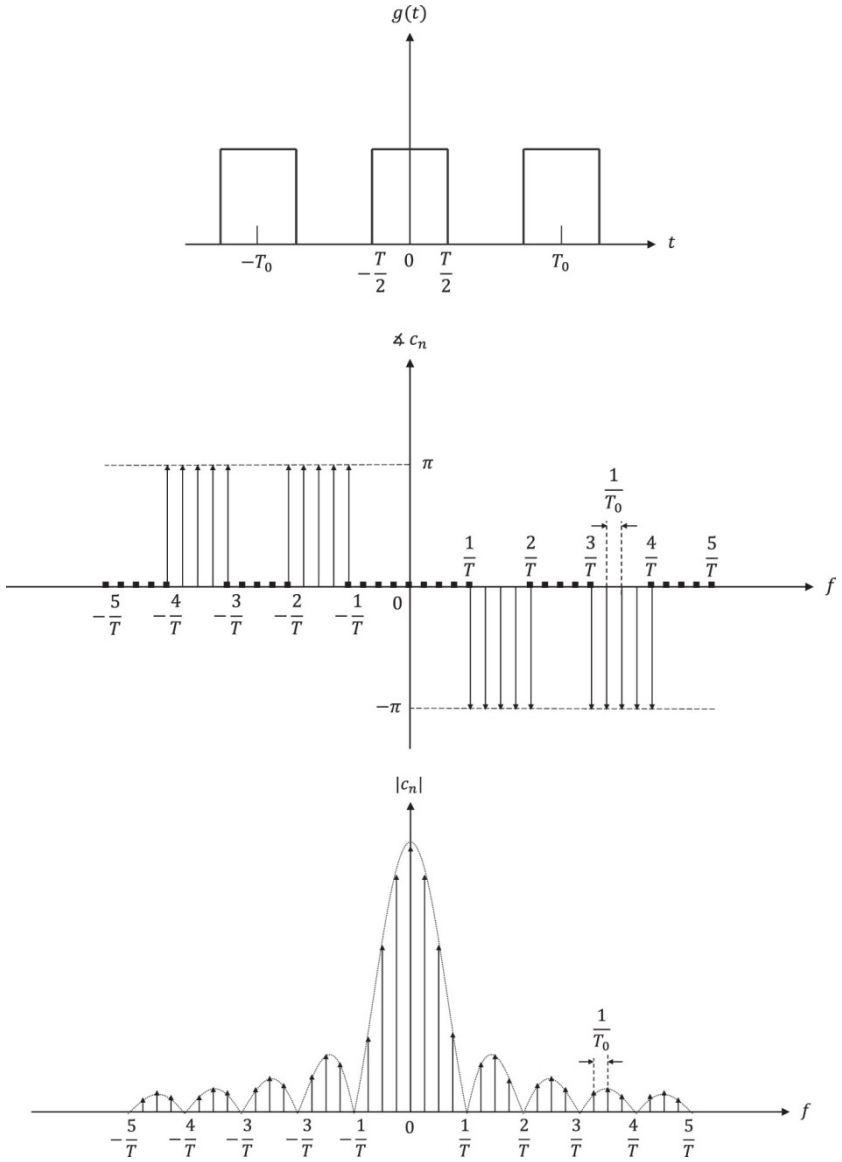


Figure 3.24 Signals in Example 3.17.

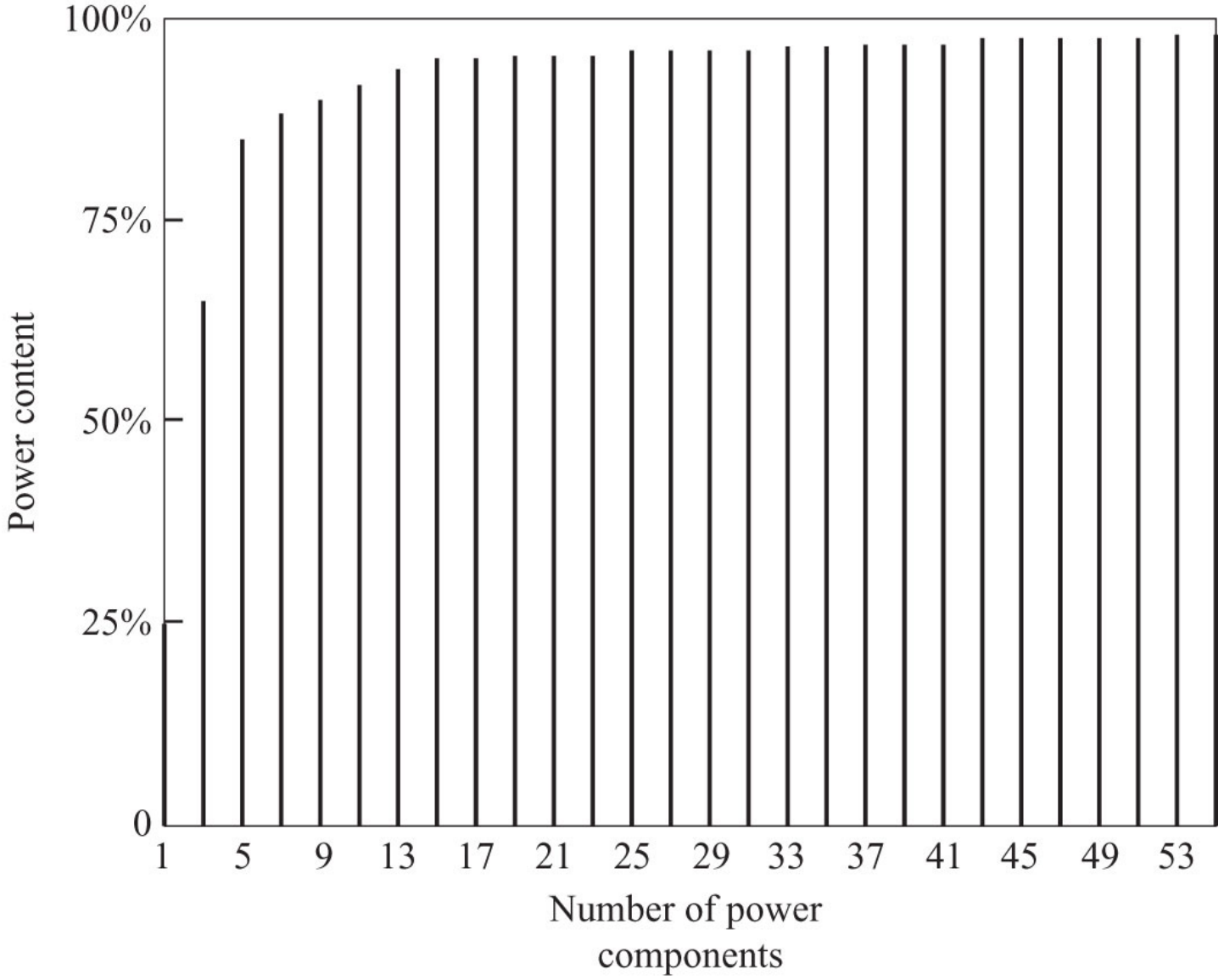


Figure 3.25 Signals in Example 3.18.

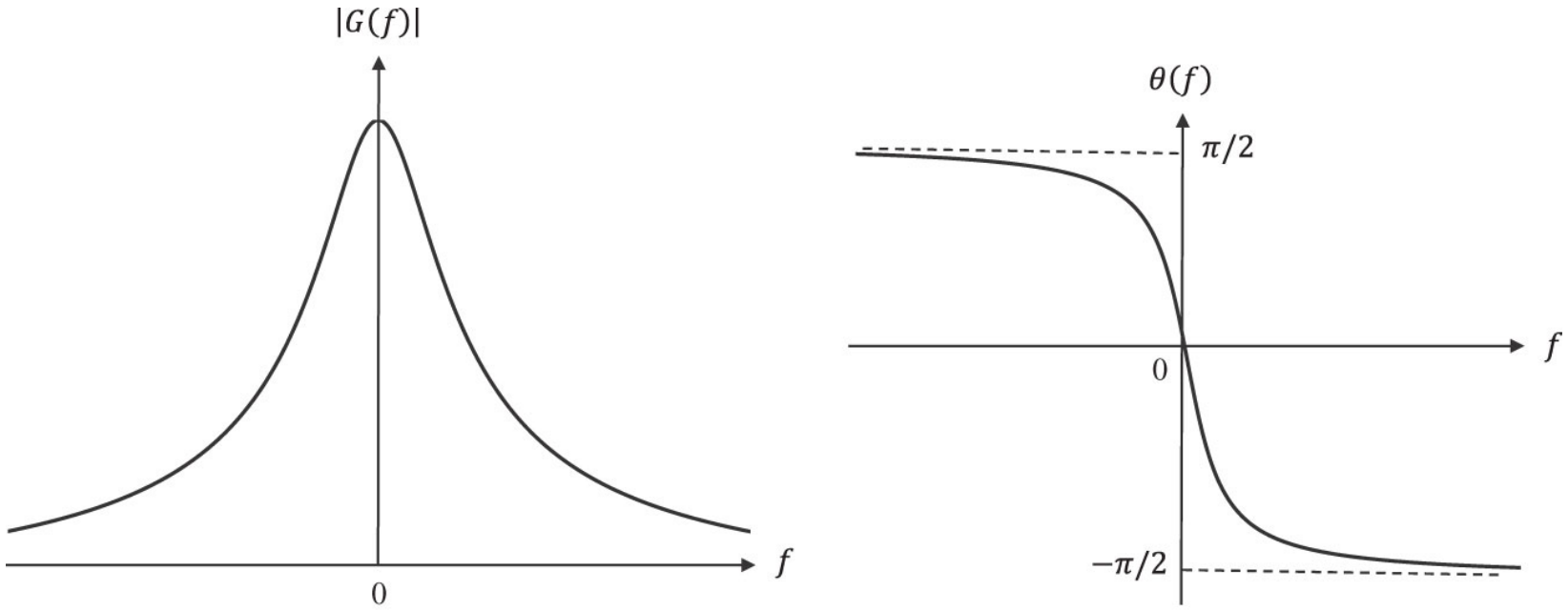


Figure 3.26 Signals in Example 3.19.

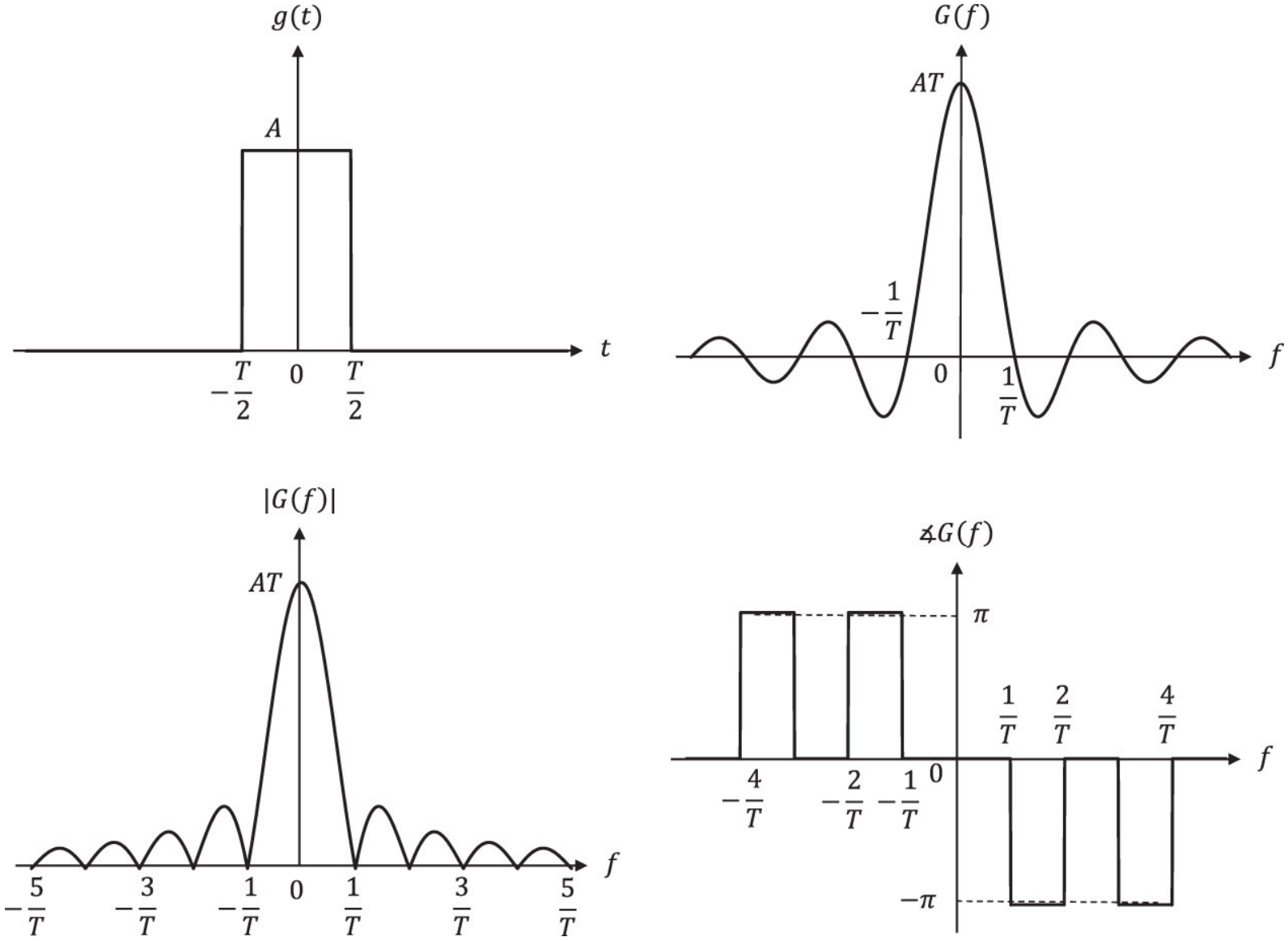


Figure 3.27 Signals in Example 3.20.

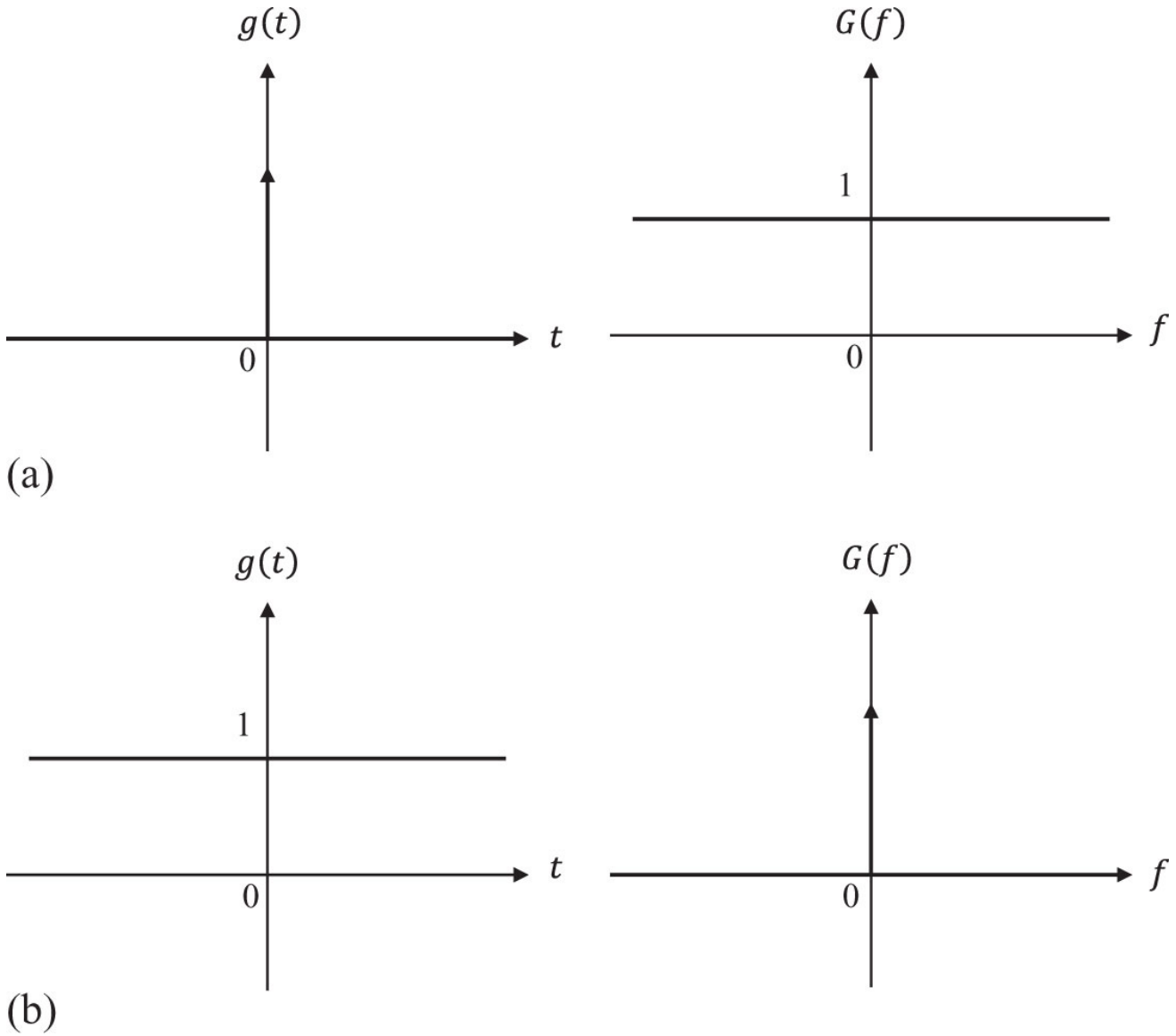


Figure 3.28 Signals in Example 3.21: (a) Dirac delta function and its Fourier transform and (b) DC signal and its Fourier transform.

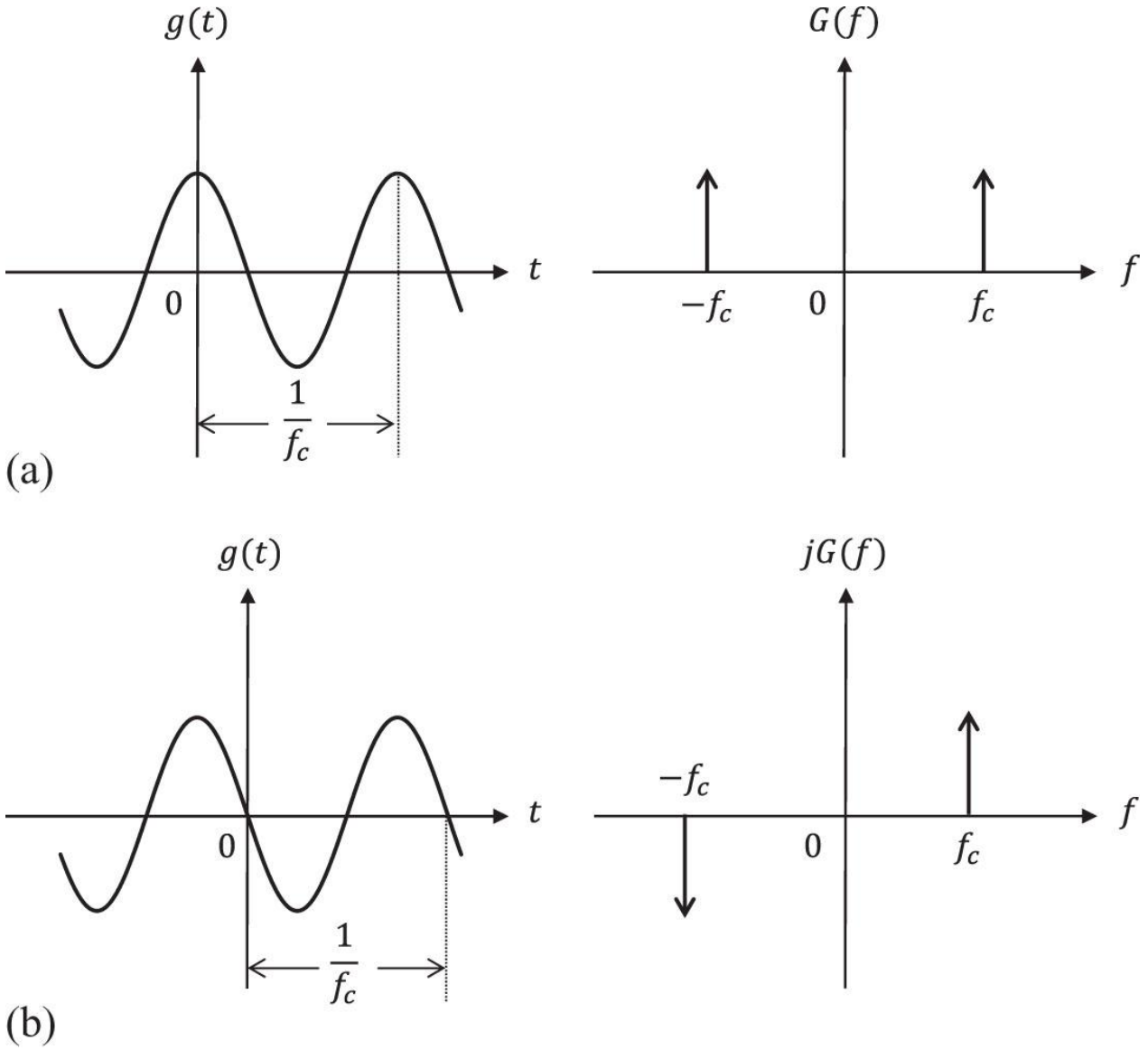


Figure 3.29 Signals in Example 3.22: (a) cosine function and its Fourier transform and (b) sine function and its Fourier transform.

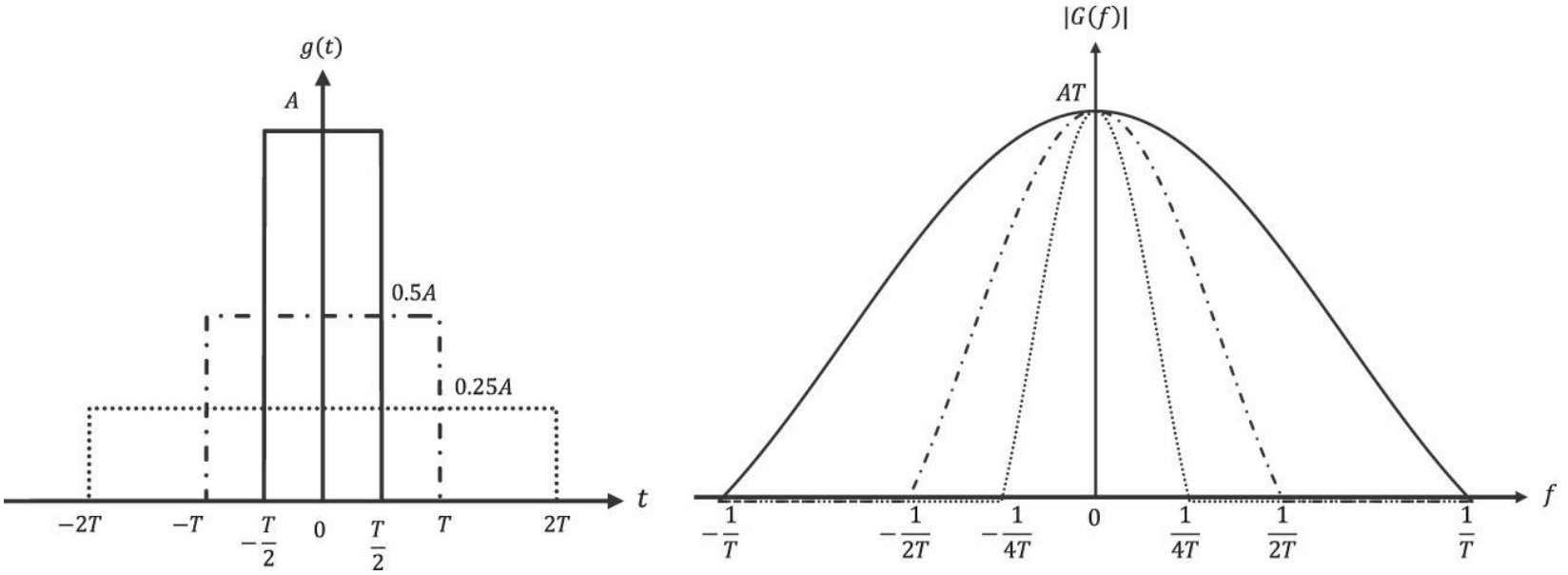


Figure 3.30 Signals in Example 3.28.

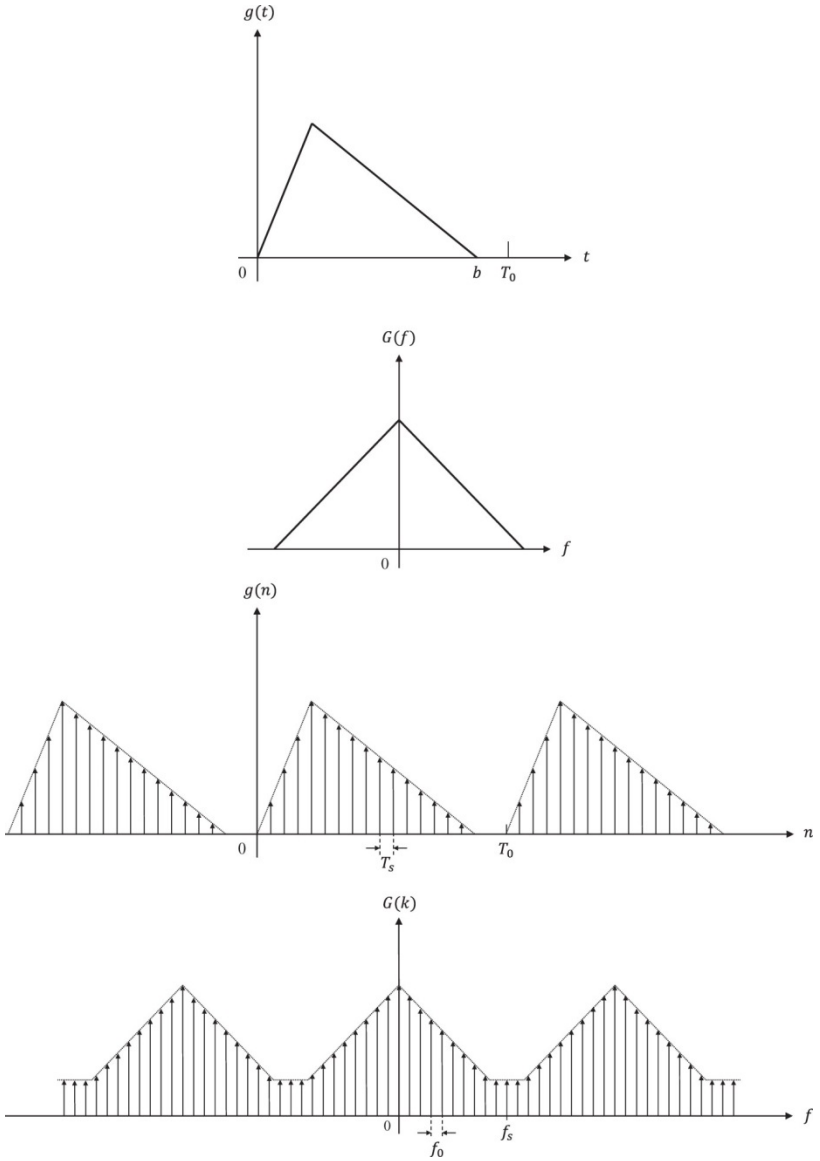


Figure 3.31 Relation between the samples of $g(t)$ and samples of $G(f)$.

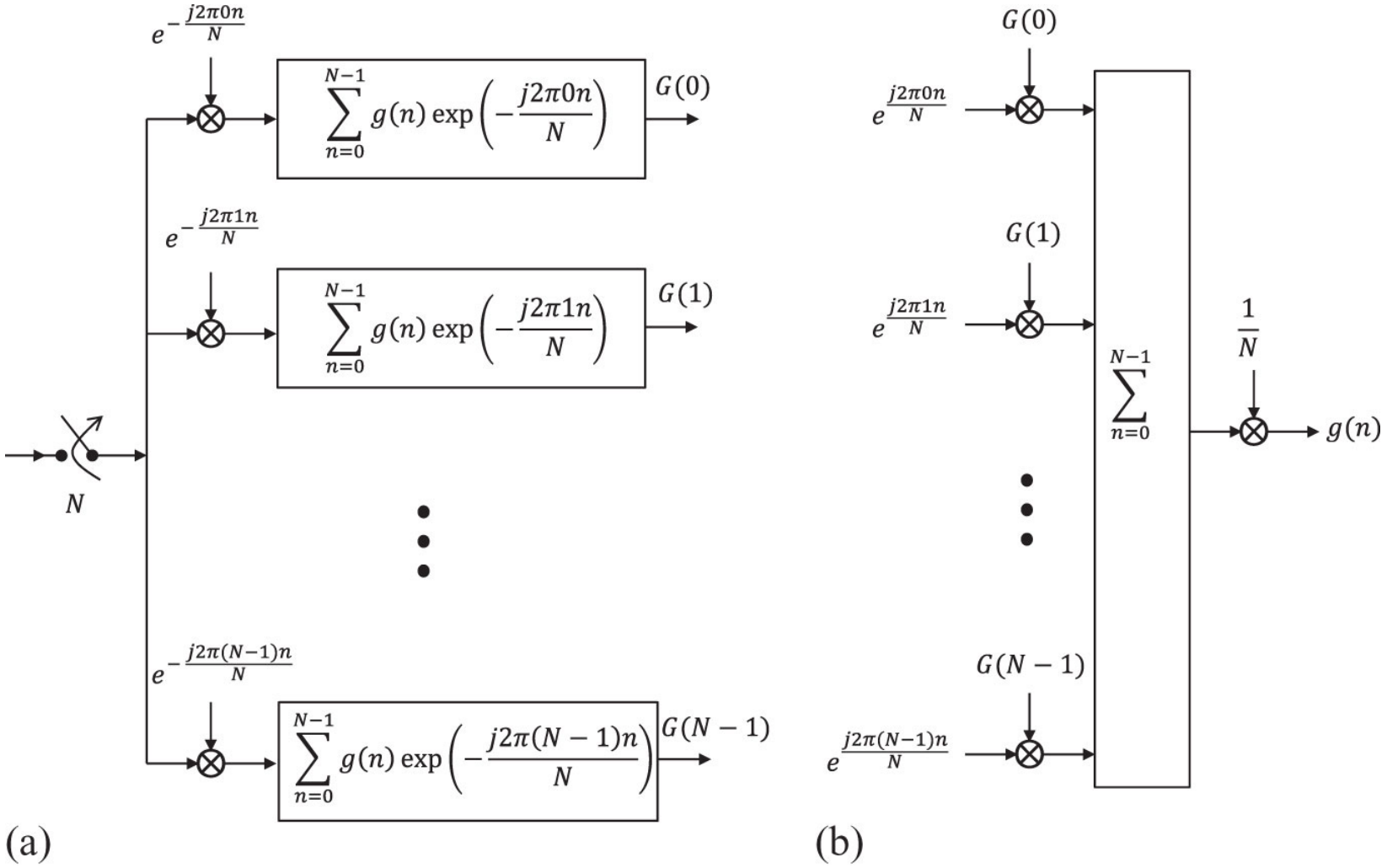


Figure 3.32 Implementation of DFT and IDFT.

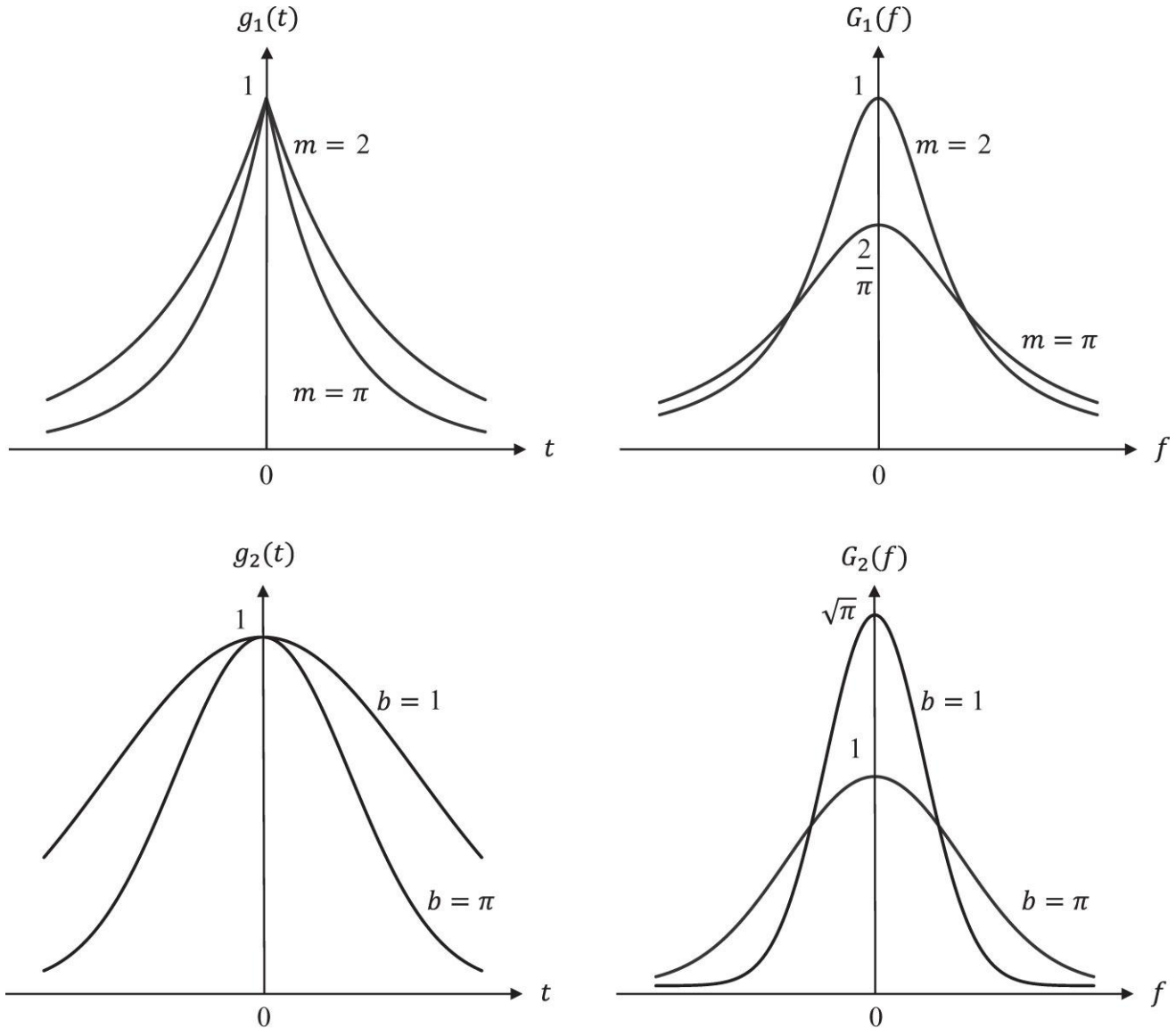


Figure 3.33 Signals in Example 3.44.

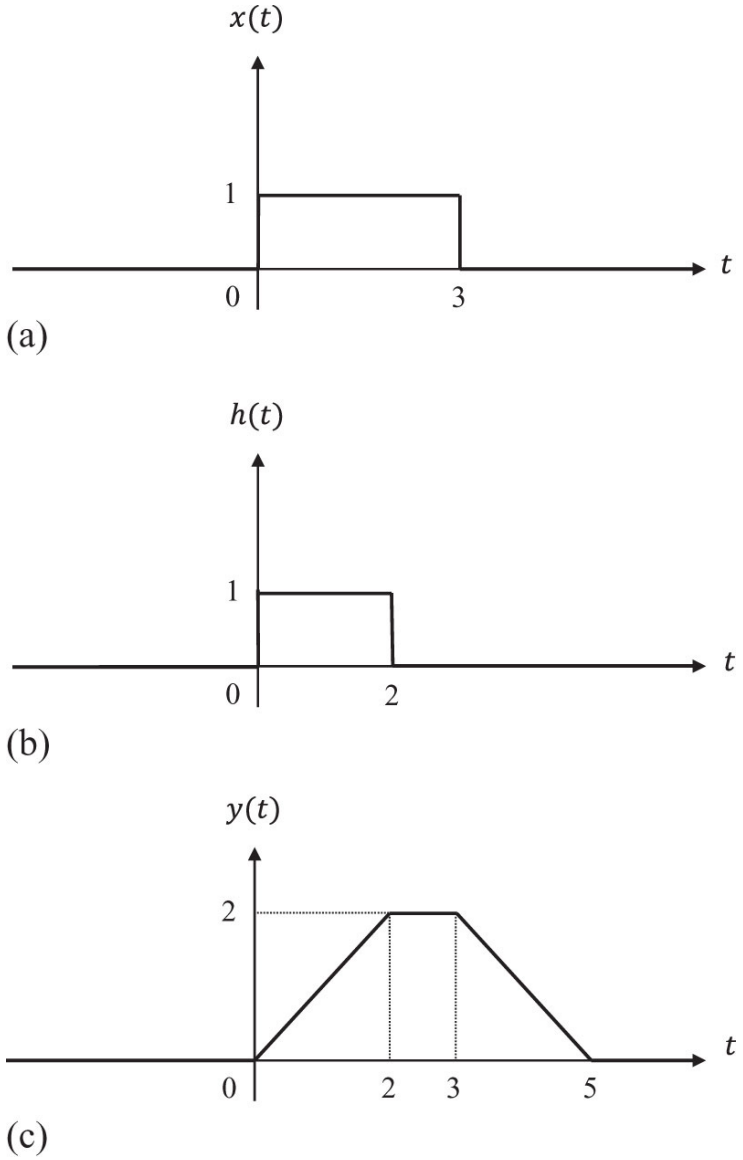


Figure 3.34 Signals in Example 3.45.

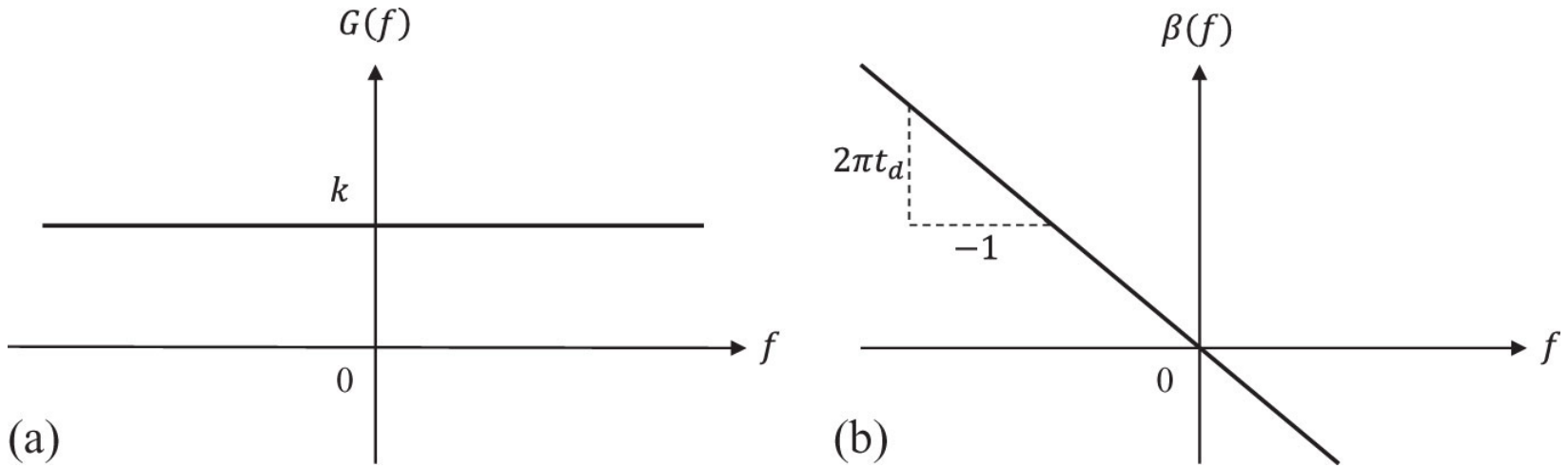


Figure 3.35 Frequency response of an ideal distortionless channel: (a) magnitude response and (b) phase response.

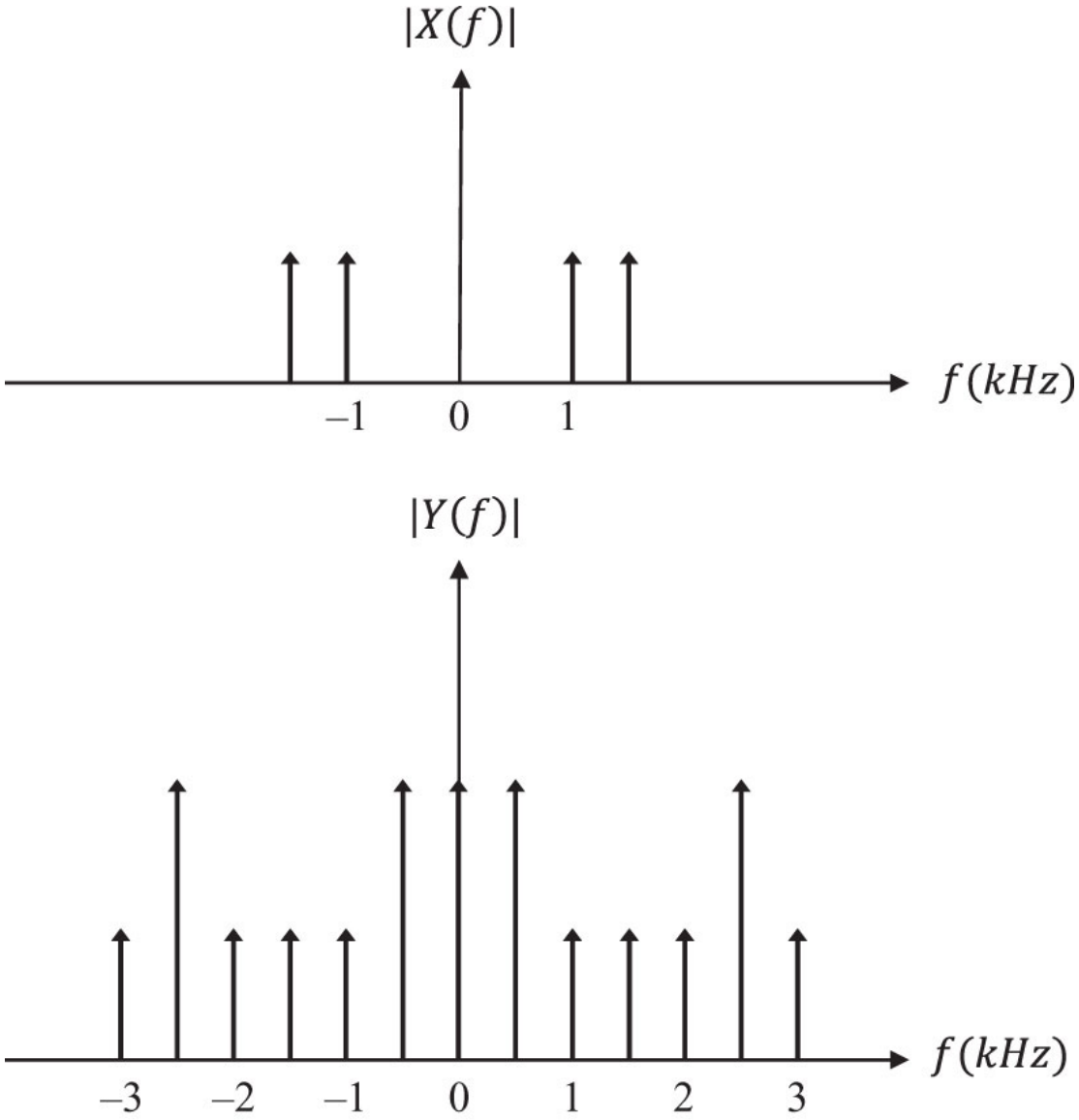


Figure 3.36 Signals in Example 3.49.

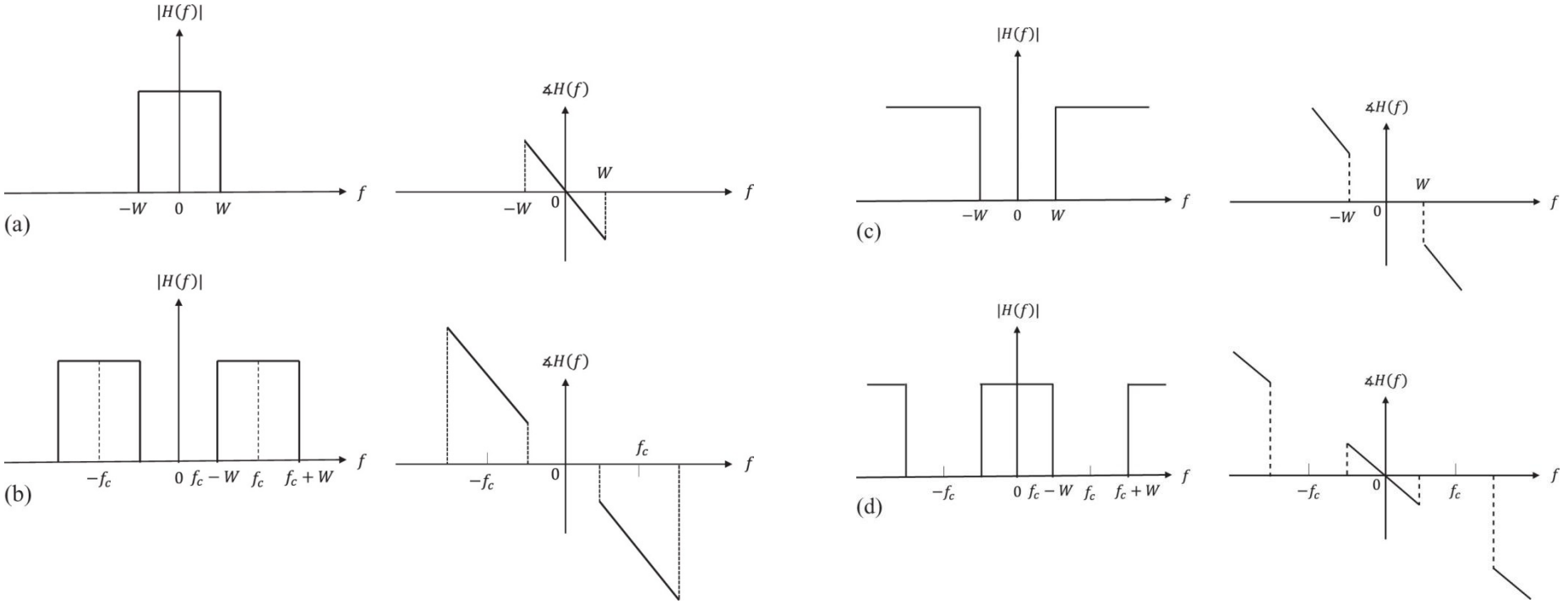


Figure 3.37 Magnitude and phases responses of ideal filters: (a) lowpass filter (LPF), (b) bandpass filter (BPF), (c) highpass filter (HPF), and (d) bandstop filter (BSF).

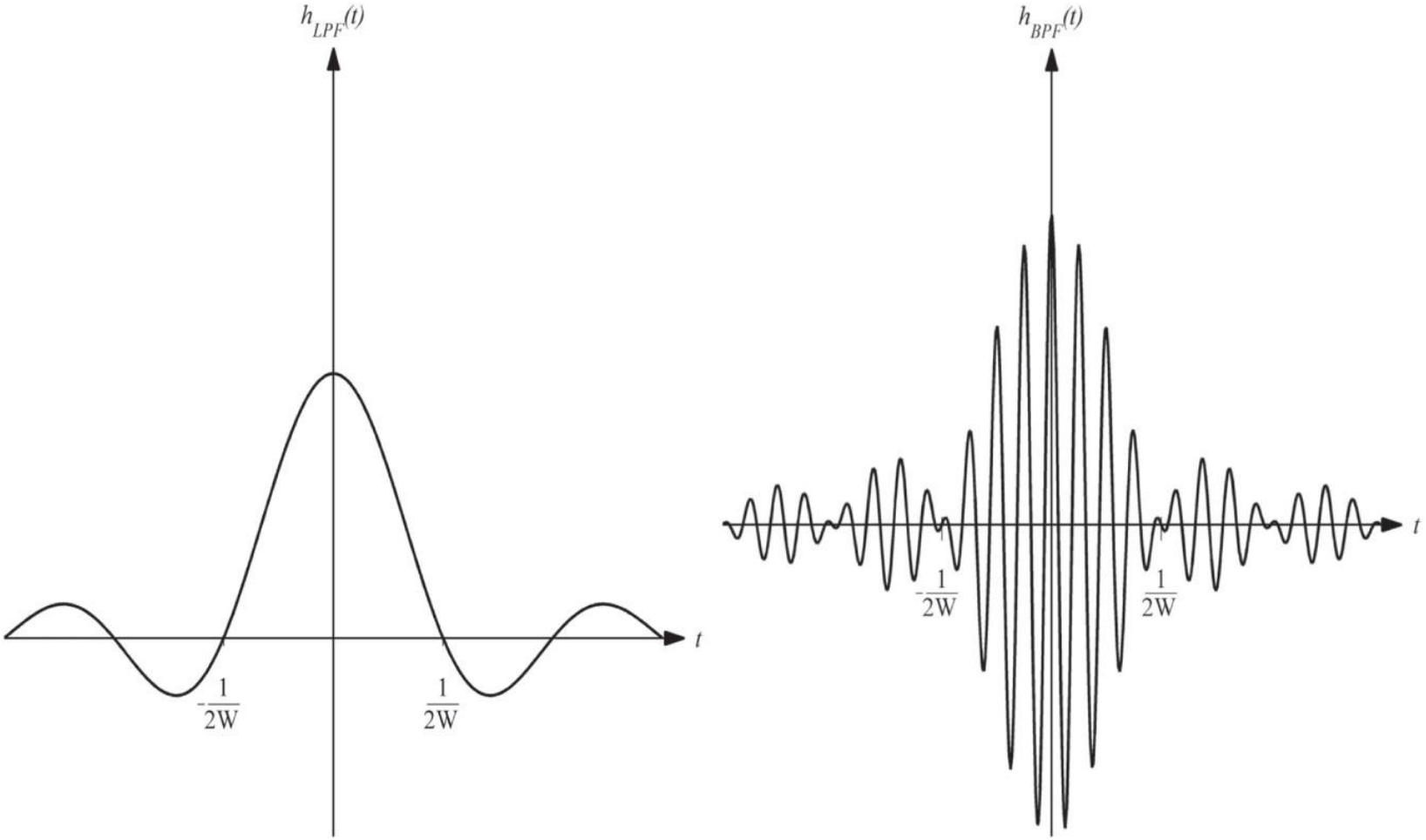


Figure 3.38 Signals in Example 3.50.

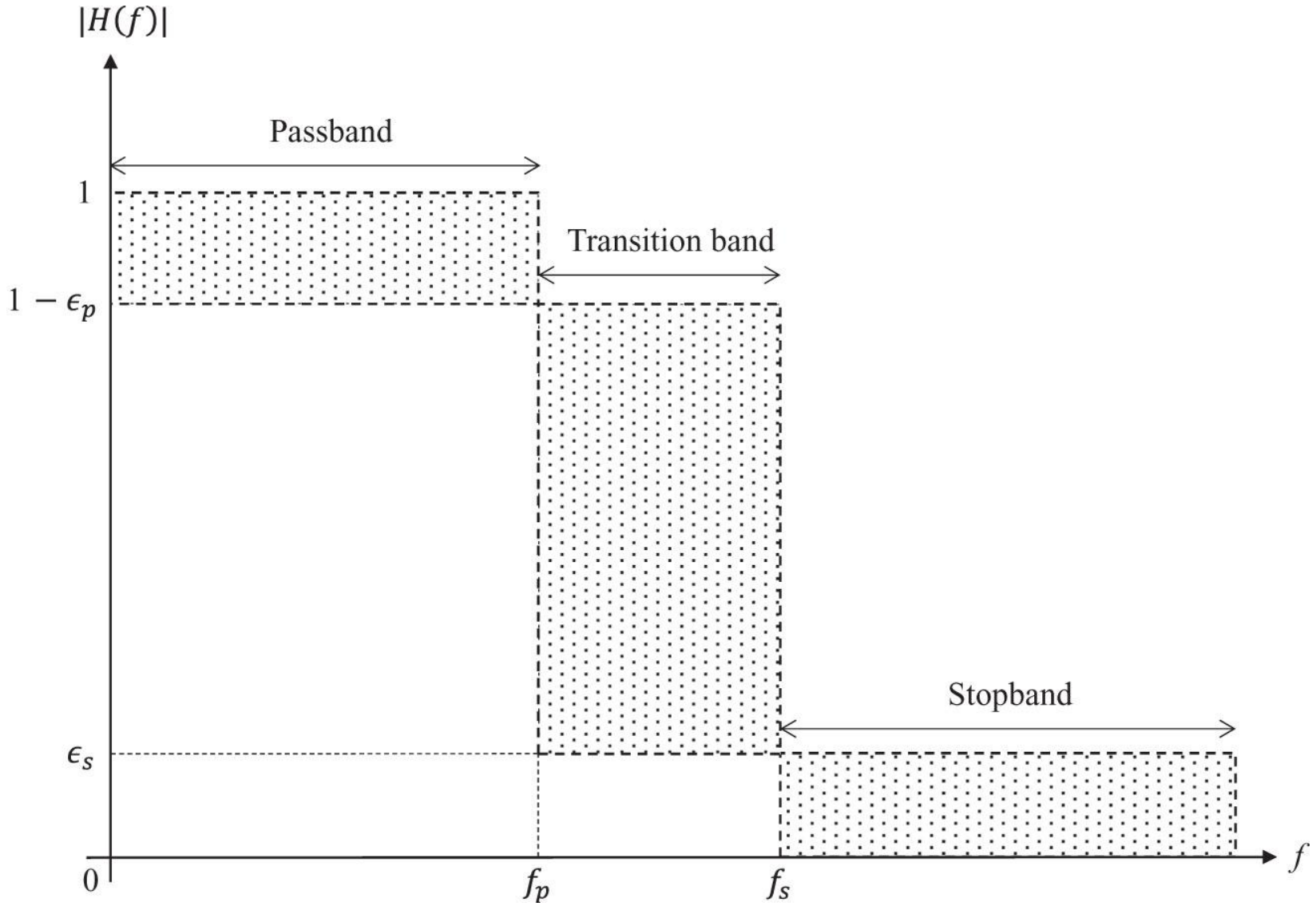


Figure 3.39 Tolerance diagram for a physically-realizable analog (continuous-time) LPF.

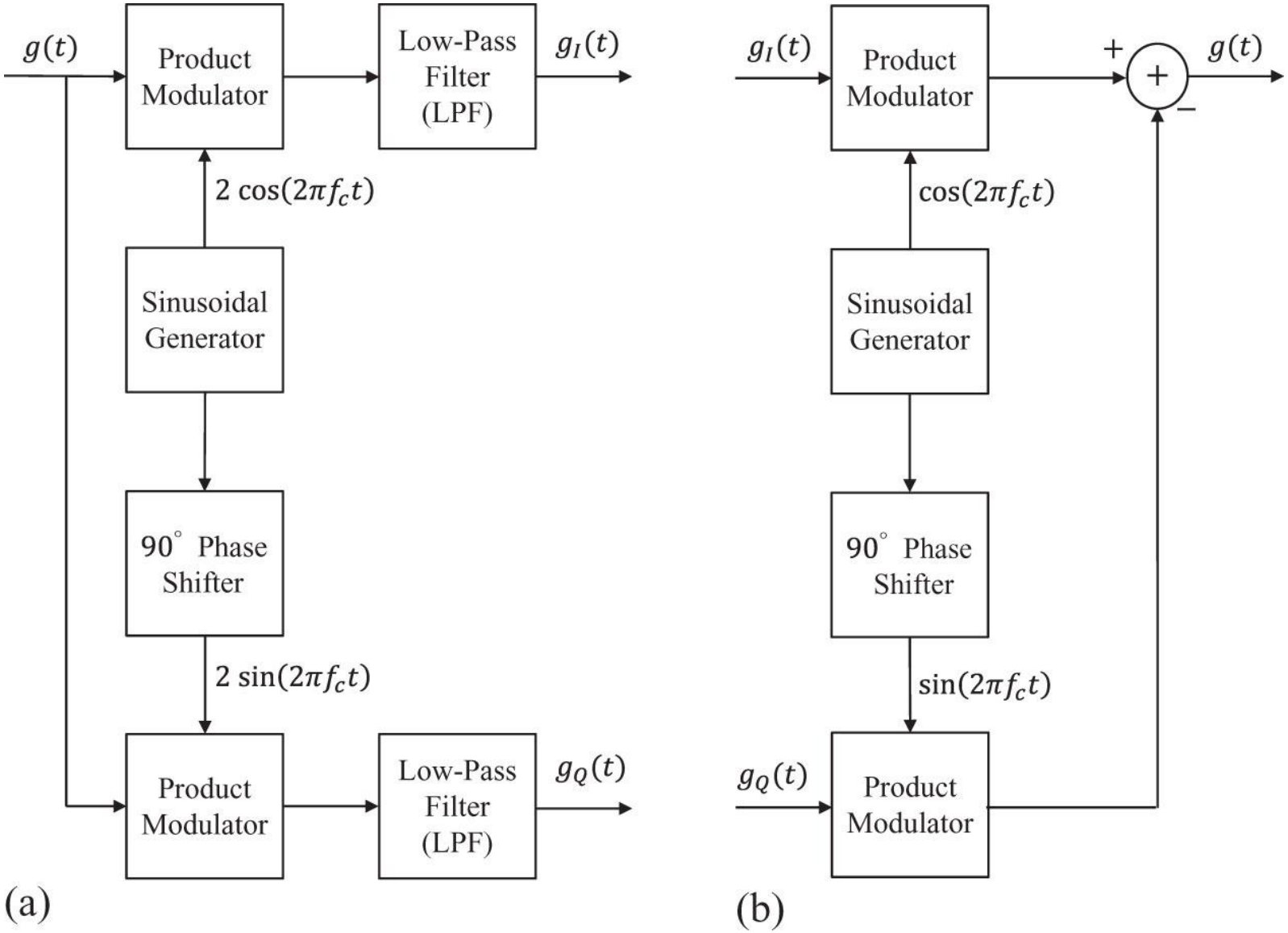


Figure 3.40 Bandpass signal from/to lowpass signal conversion: (a) derivation of in-phase and quadrature components from bandpass signal and (b) reconstruction of bandpass signal from in-phase and quadrature components.

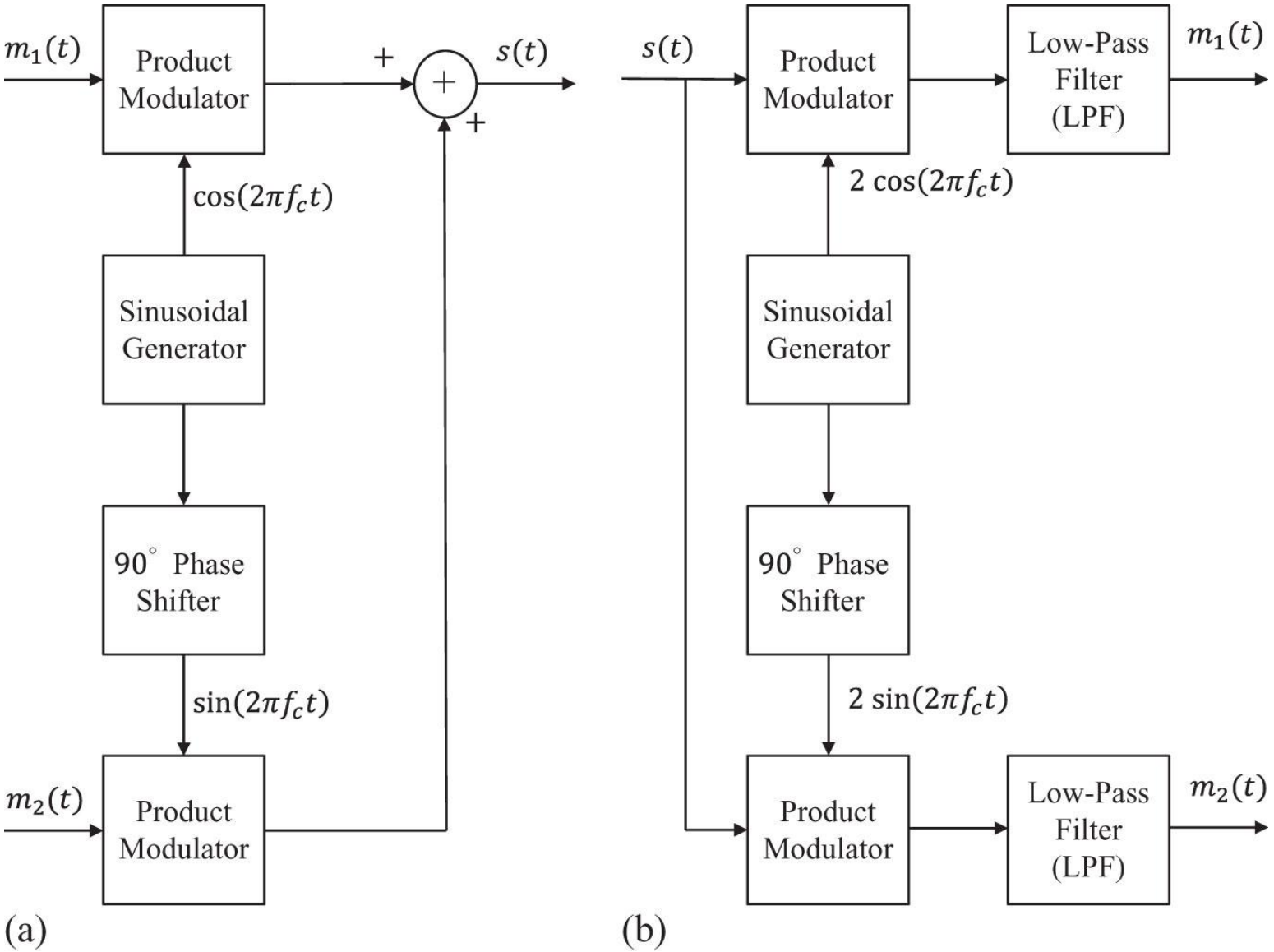


Figure 3.41 Quadrature amplitude modulation: (a) modulator and (b) demodulator.