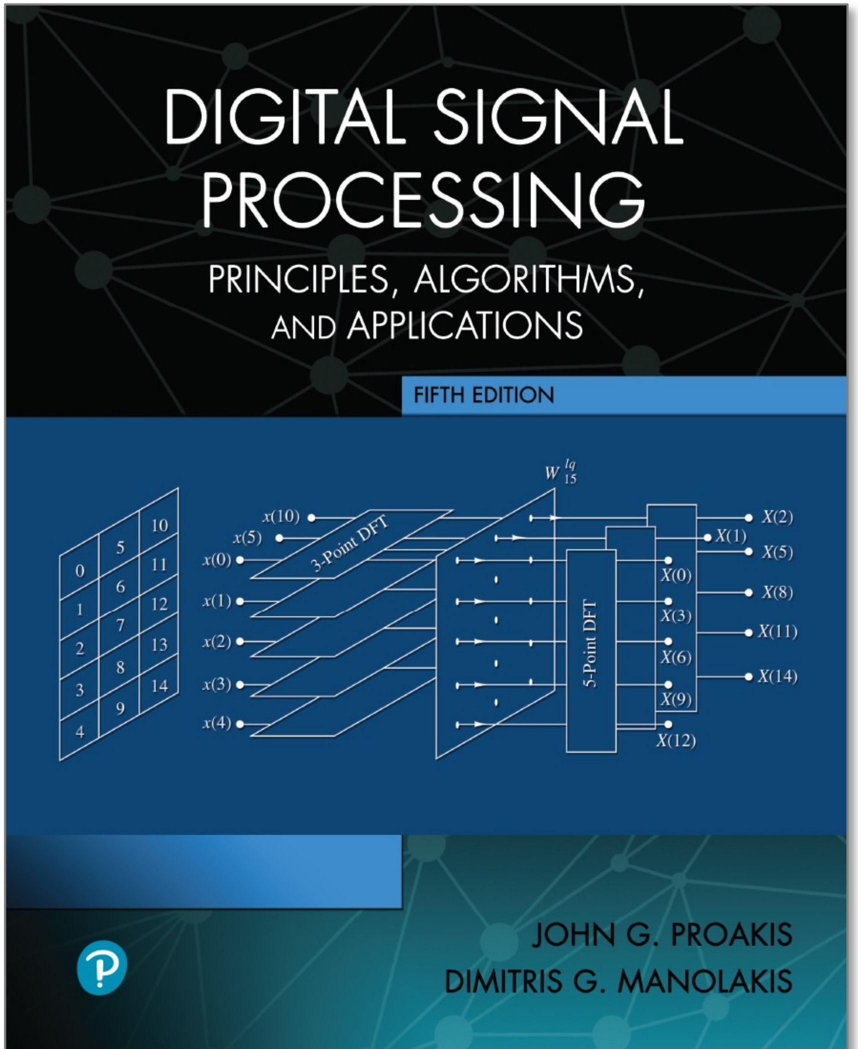
Digital Signal Processing

Fifth Edition



Chapter 2

Discrete-Time Signals and Systems

Figure 2.1.1 Graphical representation of a discrete-time signal.

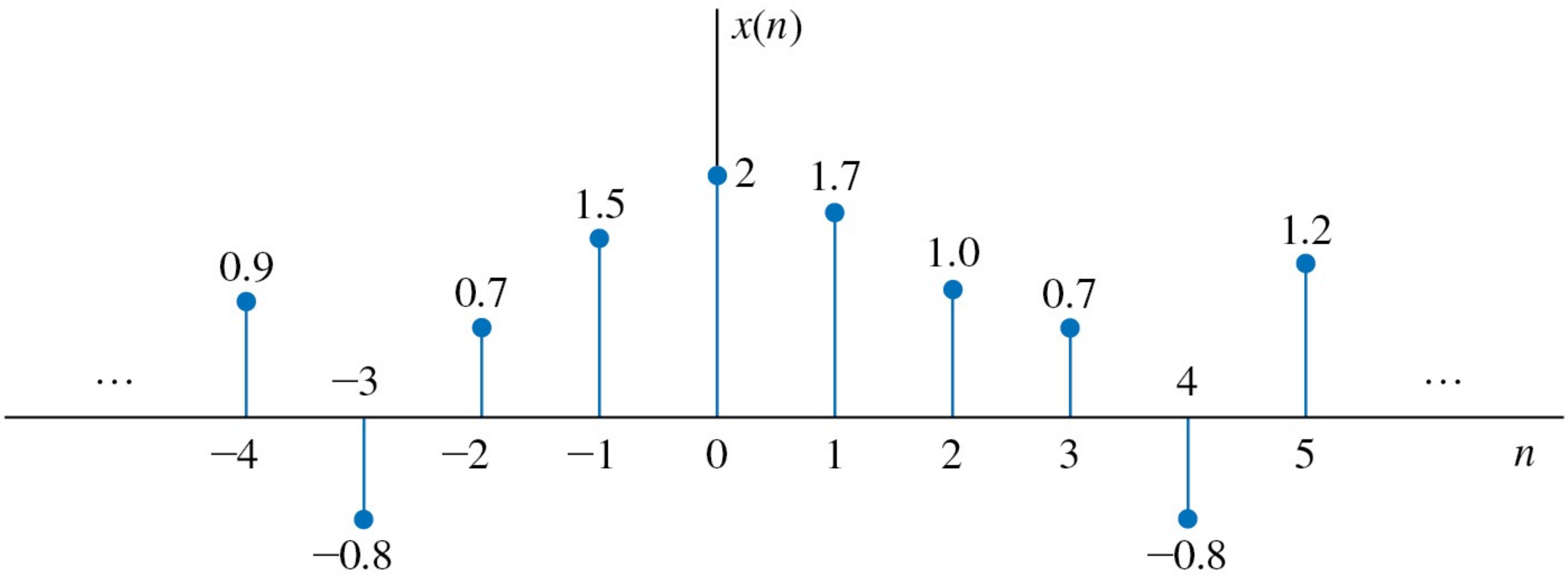


Figure 2.1.2 Graphical representation of the unit sample signal.

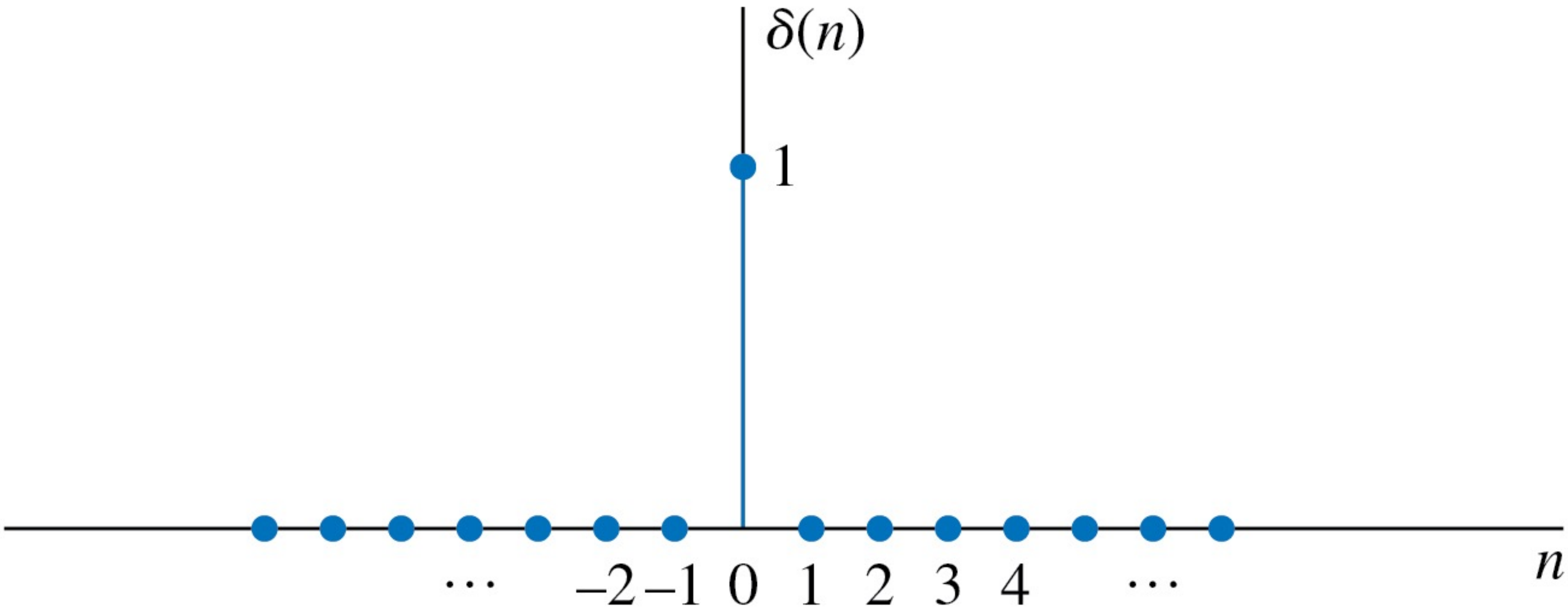


Figure 2.1.3 Graphical representation of the unit step signal.

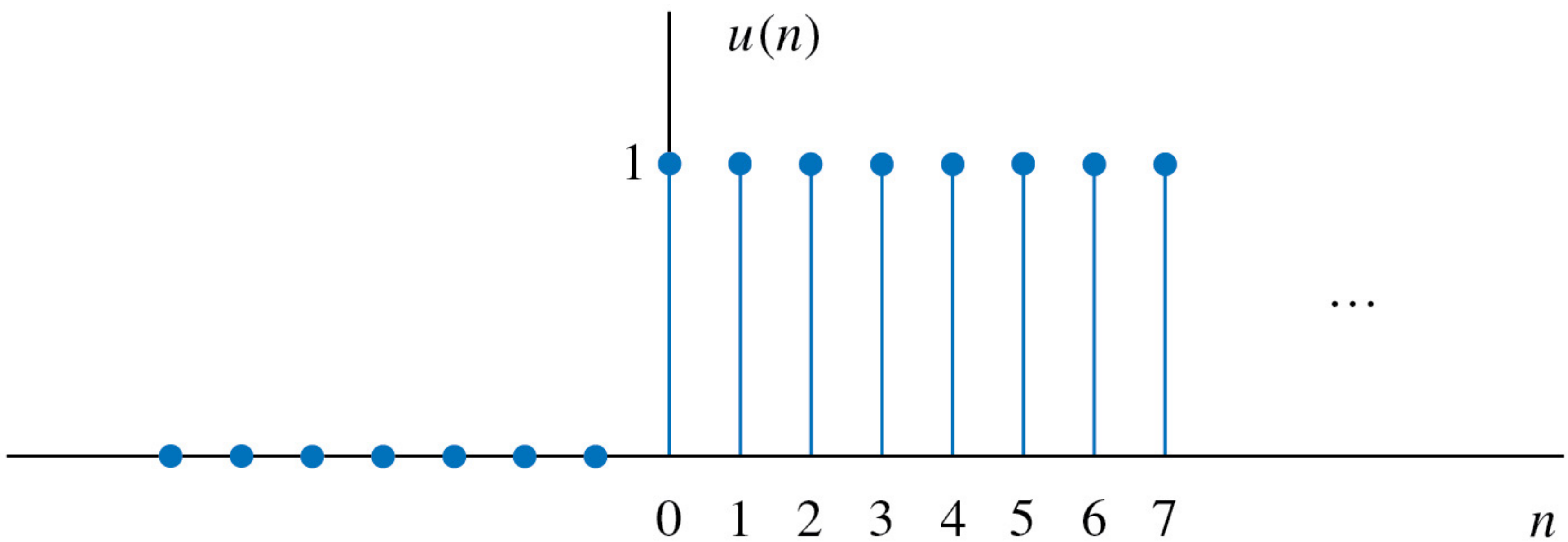


Figure 2.1.4 Graphical representation of the unit ramp signal.

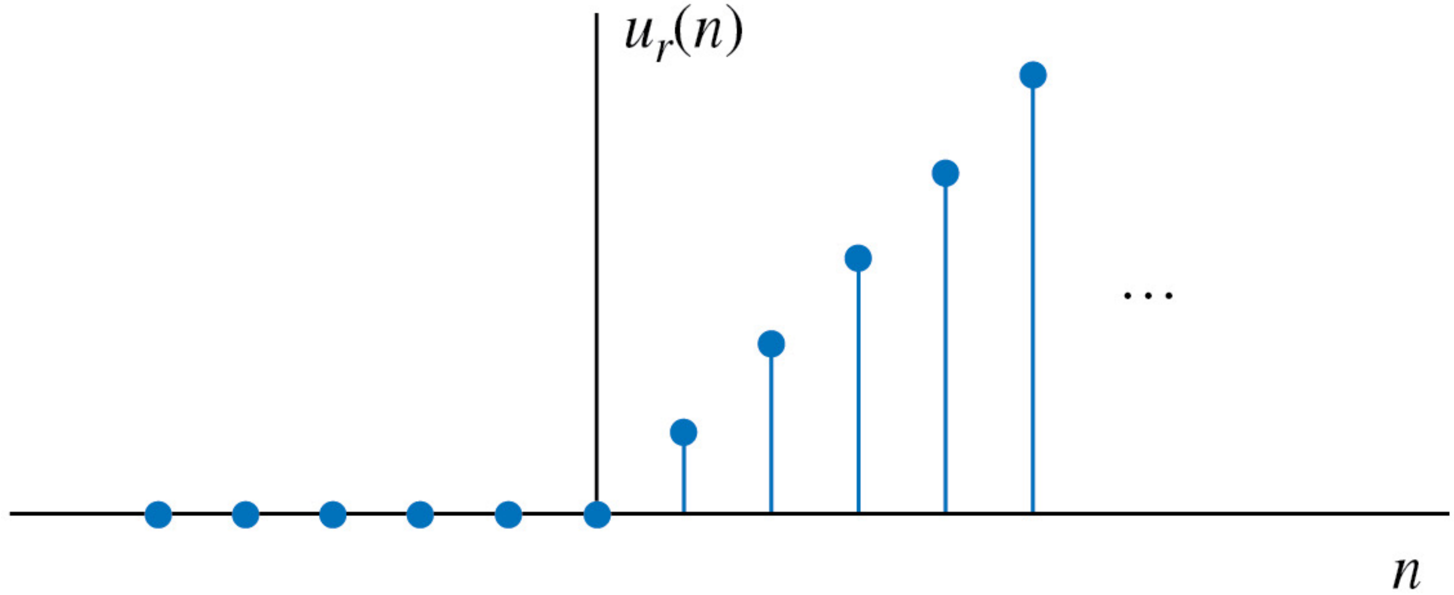


Figure 2.1.5 Graphical representation of exponential signal.

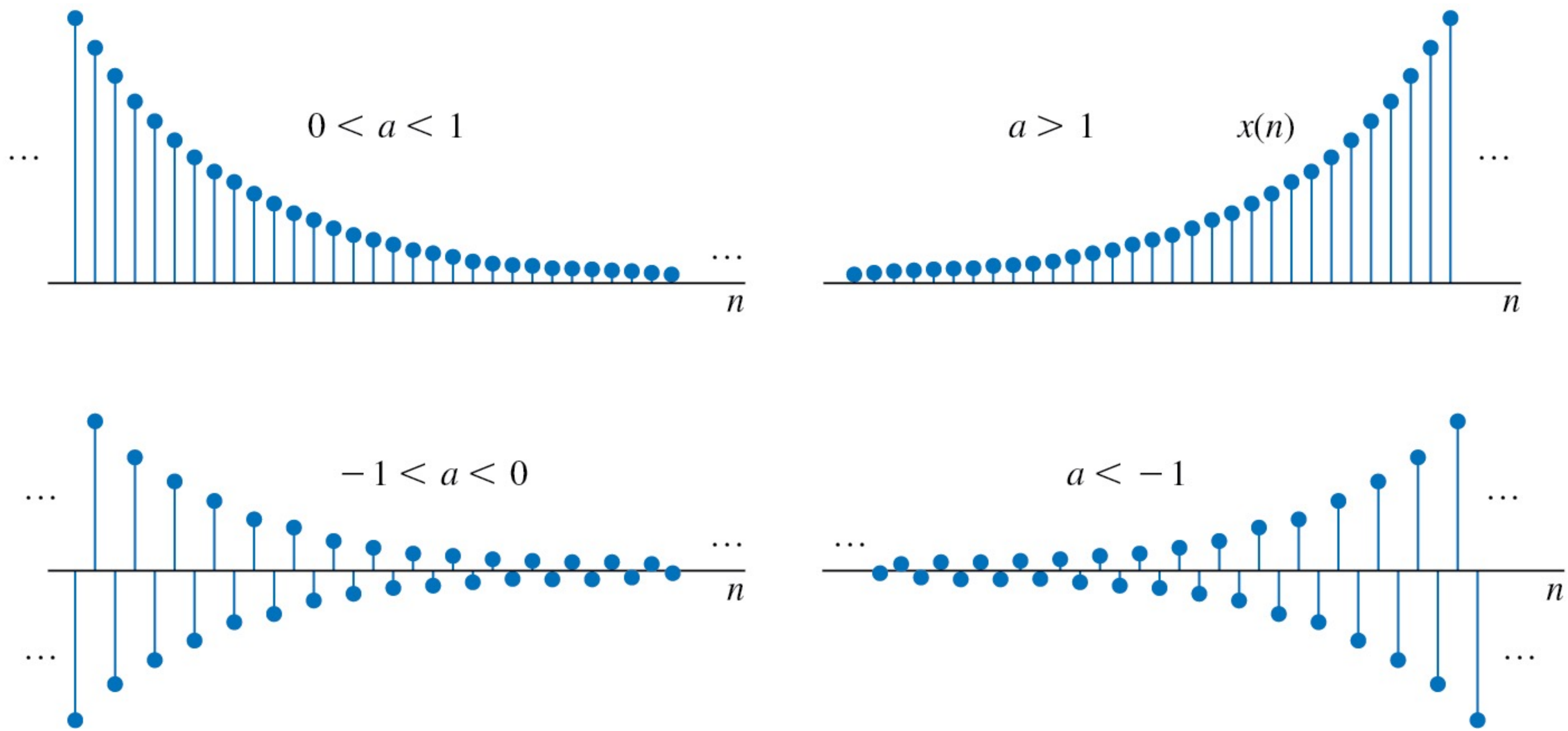


Figure 2.1.6 Graph of the real and imaginary components of a complex-valued exponential signal.

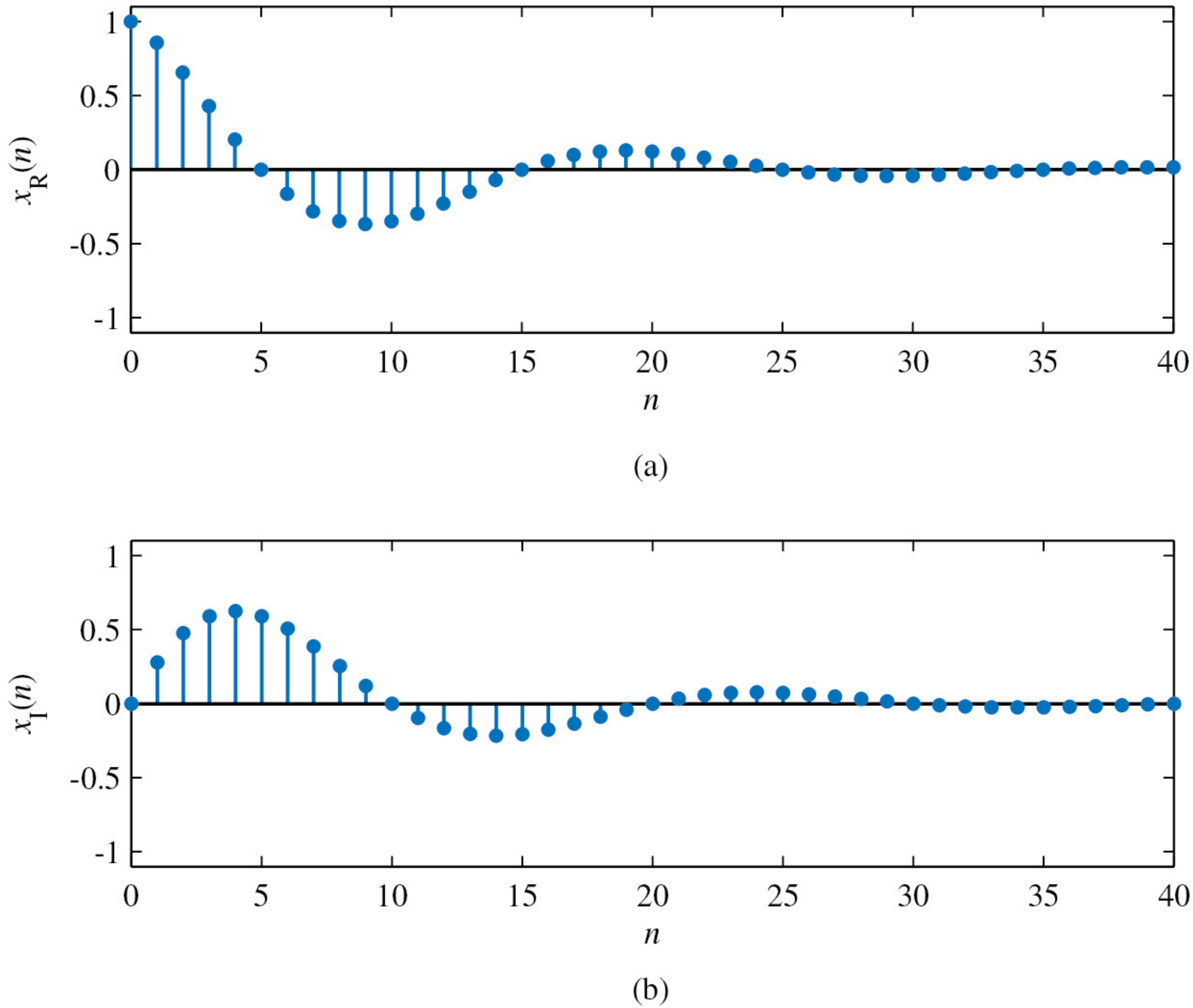
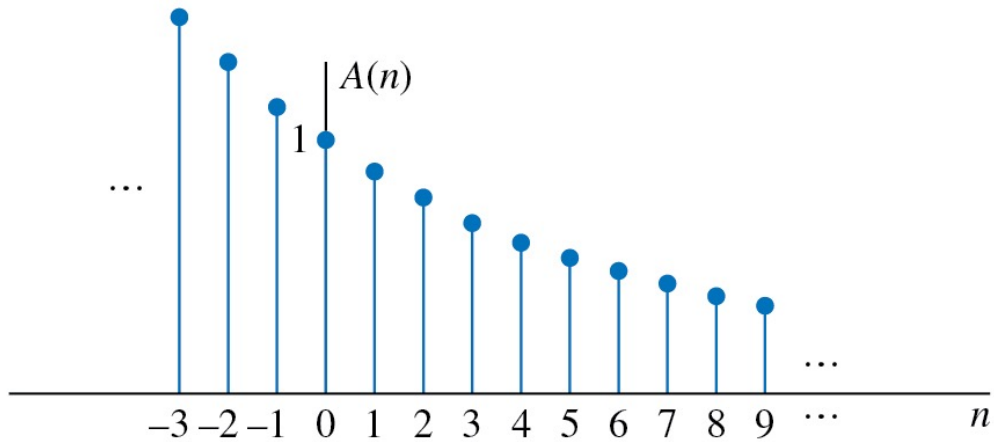
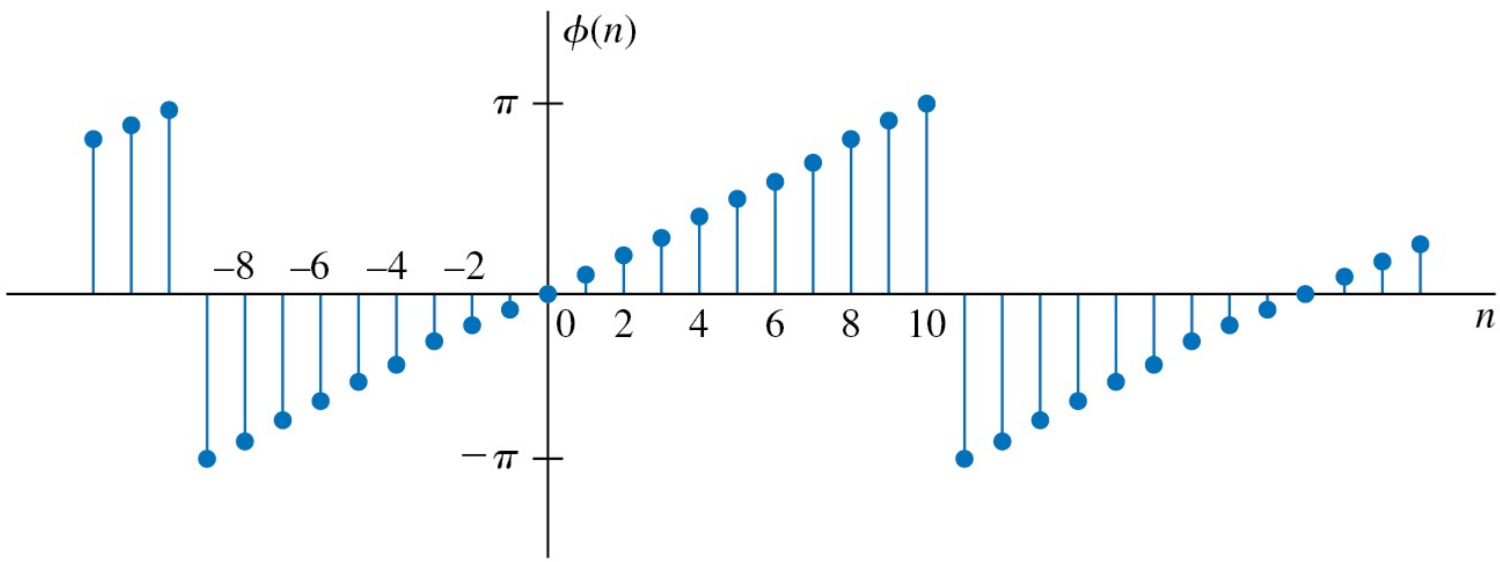


Figure 2.1.7 Graph of amplitude and phase function of a complex-valued exponential signal: (a) graph of $A(n) = r^n$, $r = 0.9$; (b) graph of $\phi(n) = (\pi/10)n$, modulo 2π plotted in the range $(-\pi, \pi]$.



(a) Graph of $A(n) = r^n$, $r = 0.9$



(b) Graph of $\phi(n) = \frac{\pi}{10}n$, modulo 2π plotted in the range $(-\pi, \pi)$

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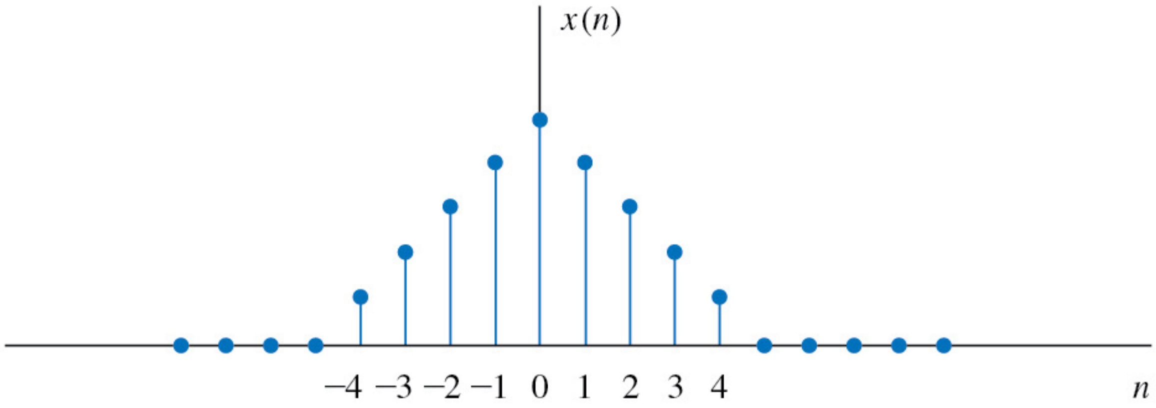
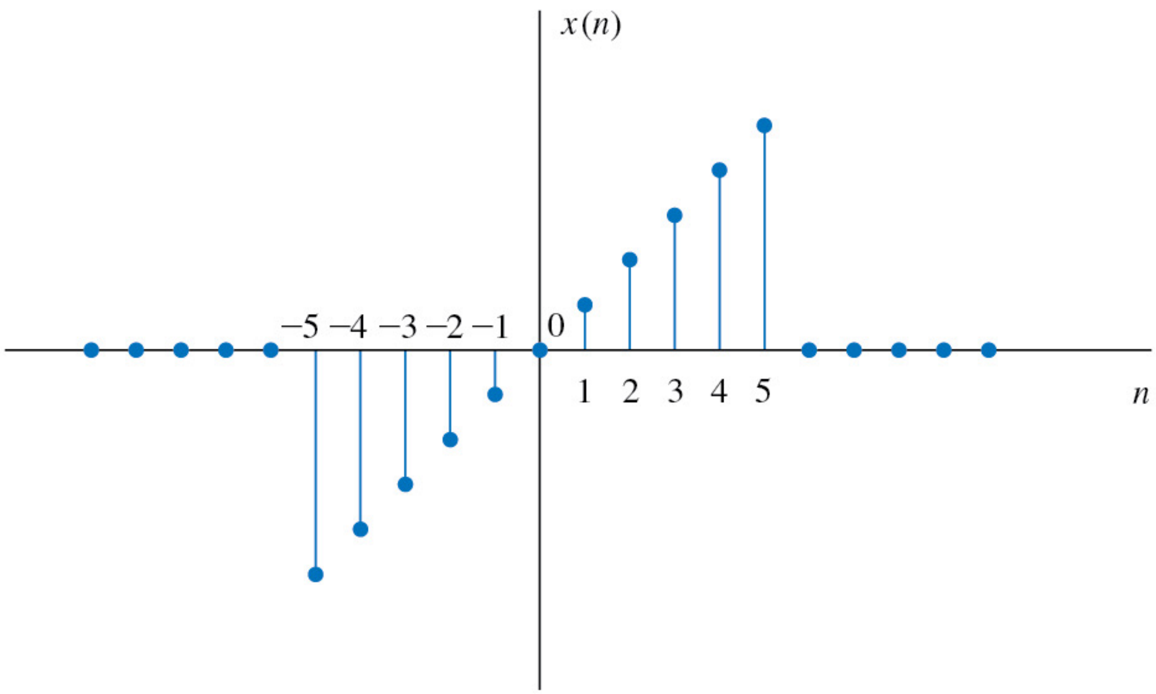
Figure 2.1.8 Example of even (a) and odd (b) signals.



(a)



(b)

Figure 2.1.9 Graphical representation of a signal, and its delayed and advanced versions.

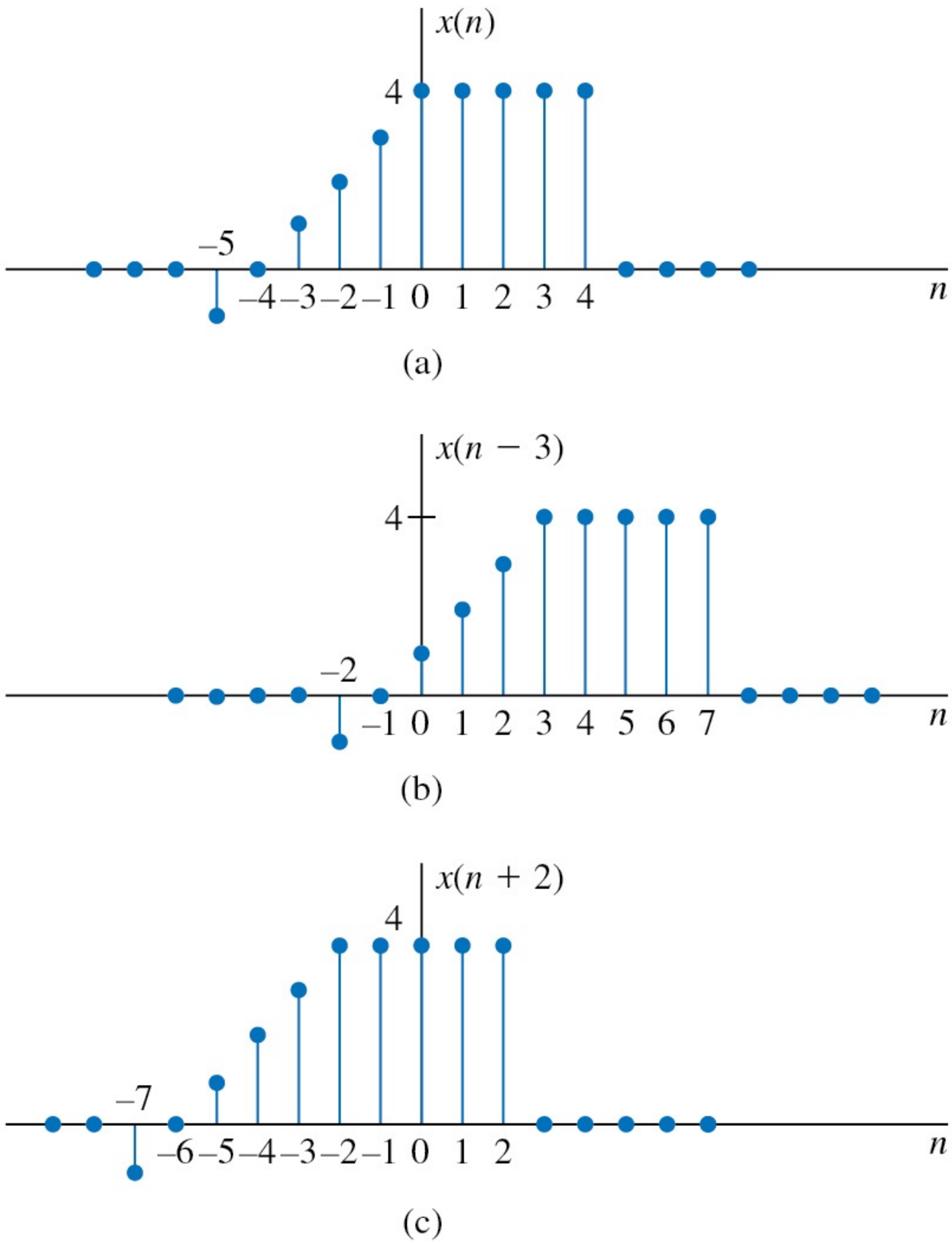


Figure 2.1.10 Graphical illustration of the folding and shifting operations.

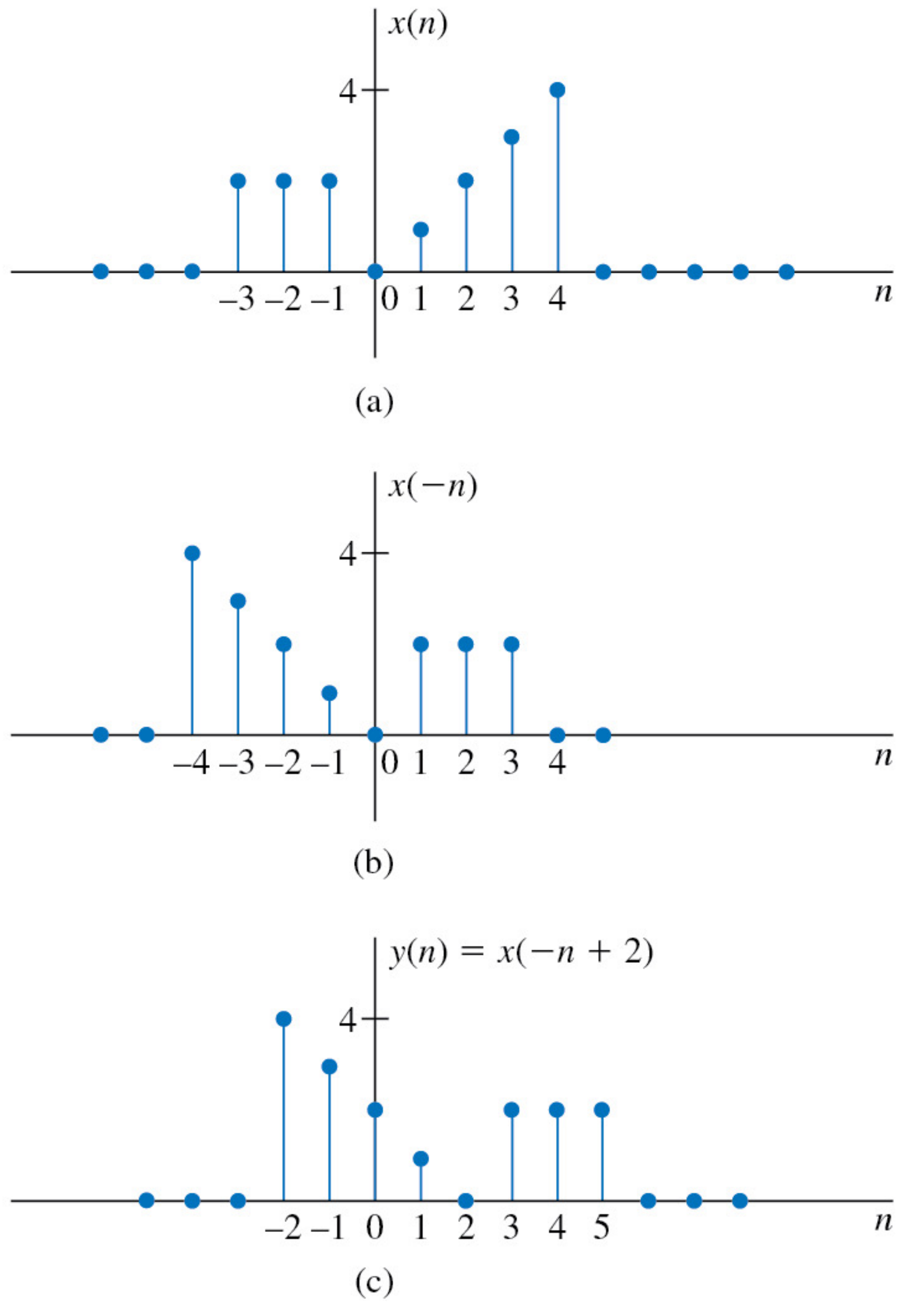


Figure 2.1.11 Graphical illustration of down-sampling operation.

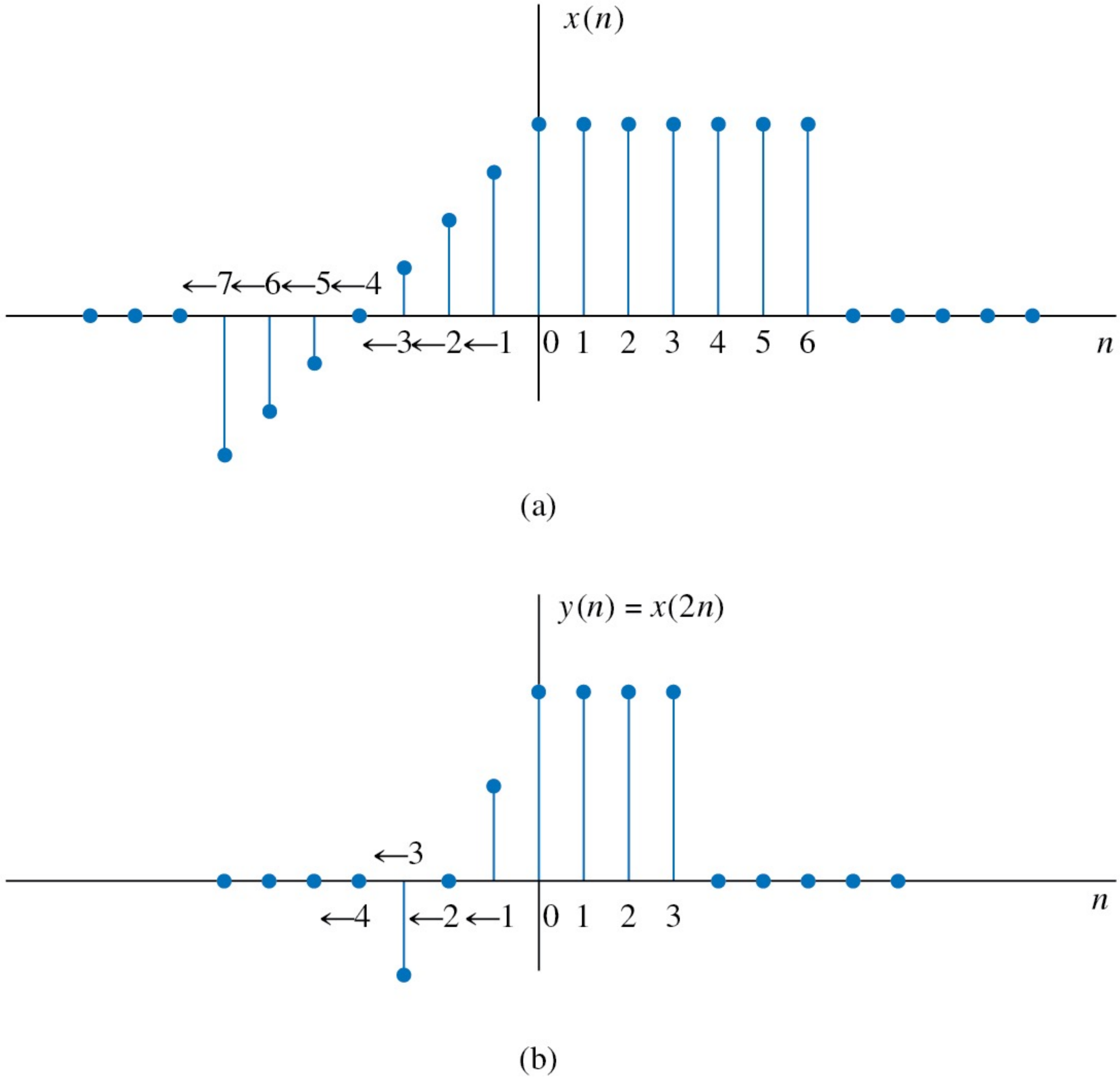


Figure 2.2.1 Block diagram representation of a discrete-time system.

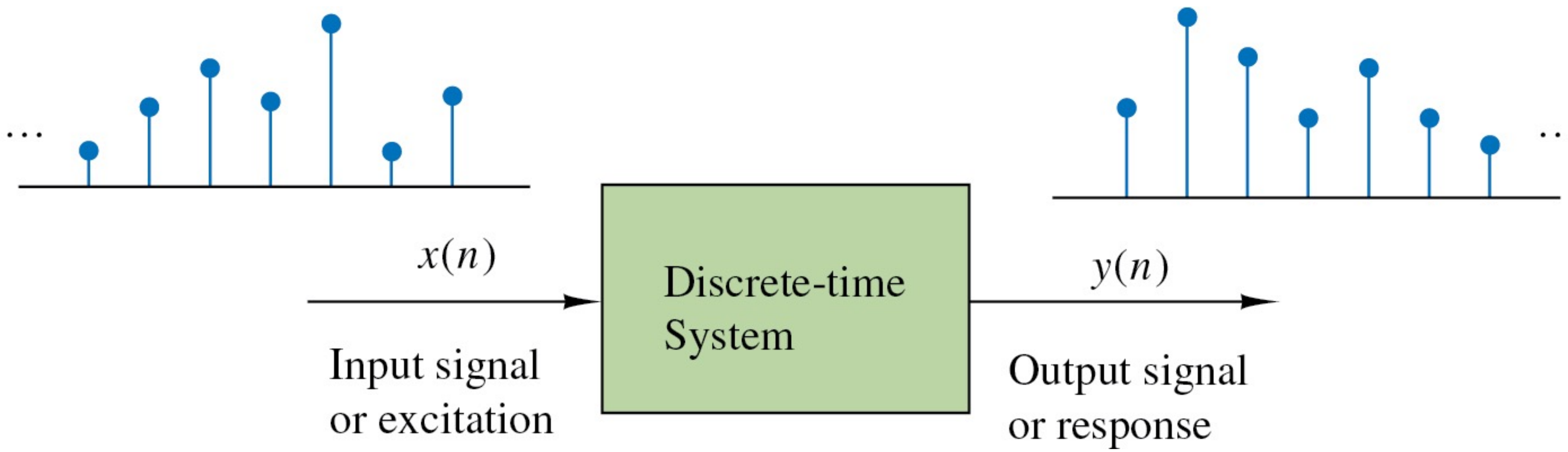


Figure 2.2.2 Graphical representation of an adder.

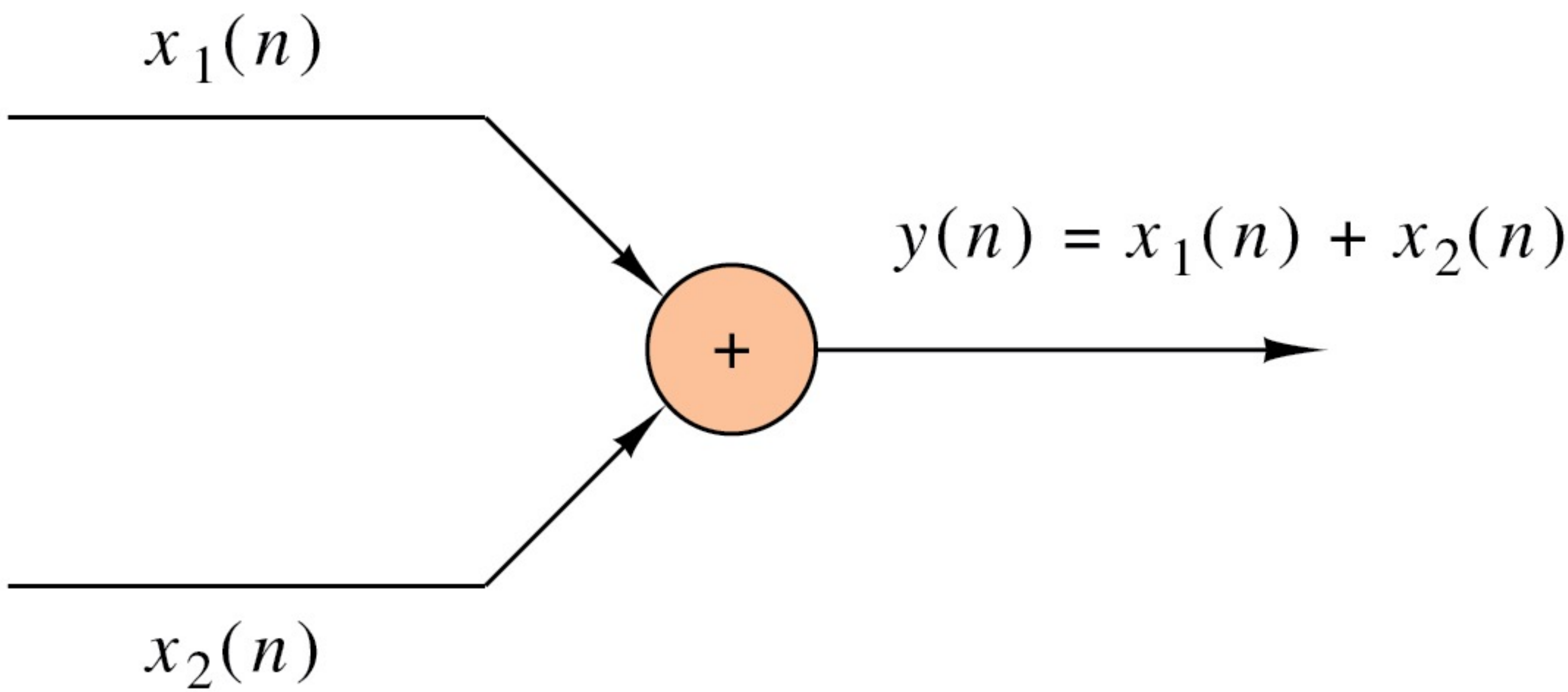


Figure 2.2.3 Graphical representation of a constant multiplier.

Figure 2.2.4 Graphical representation of a signal multiplier.

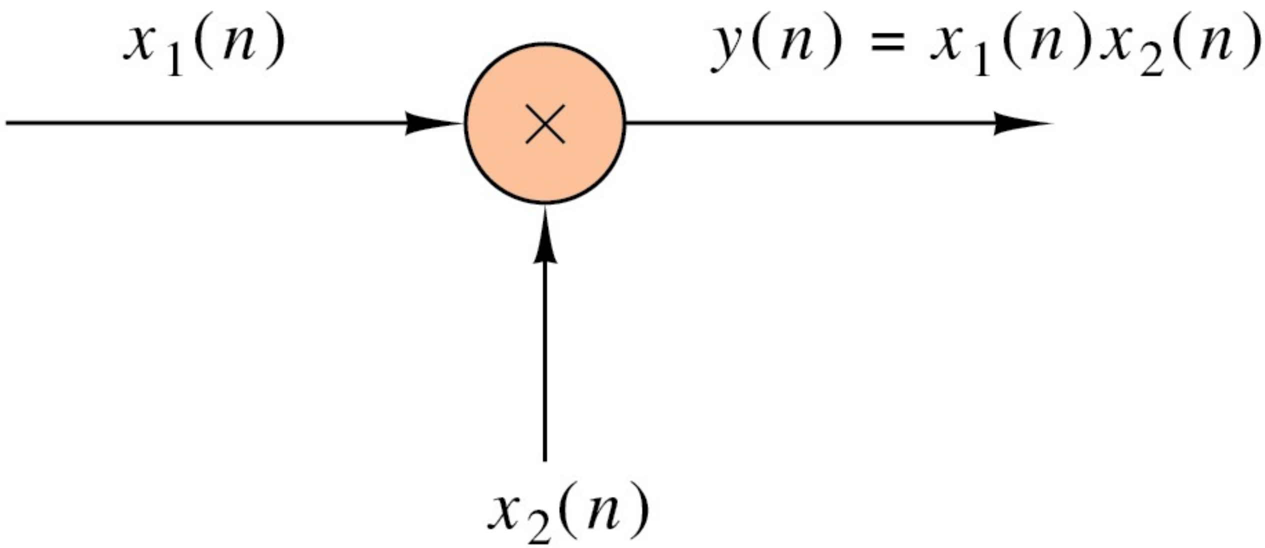
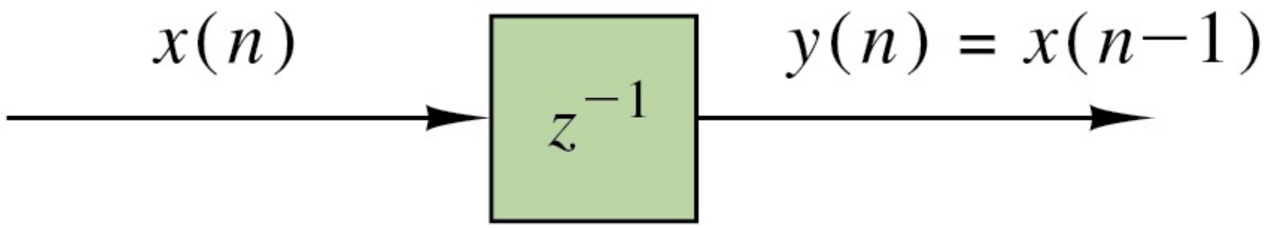


Figure 2.2.5 Graphical representation of the unit delay element.



Pearson

Figure 2.2.6 Graphical representation of the unit advance element.

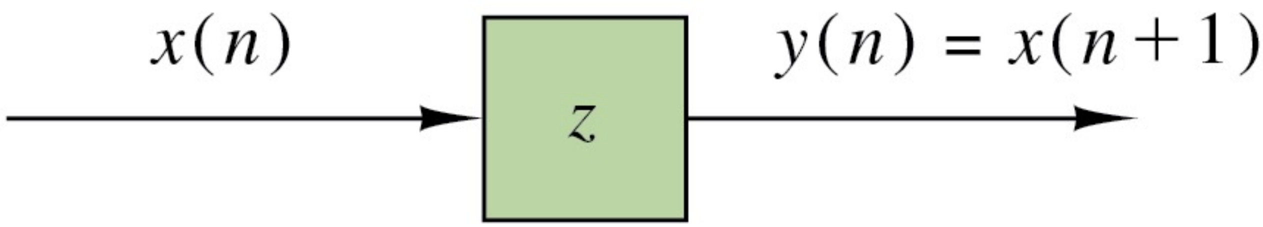


Figure 2.2.7 Block diagram realizations of the system $y(n) = 0.25y(n-1) + 0.5x(n) + 0.5x(n-1)$.

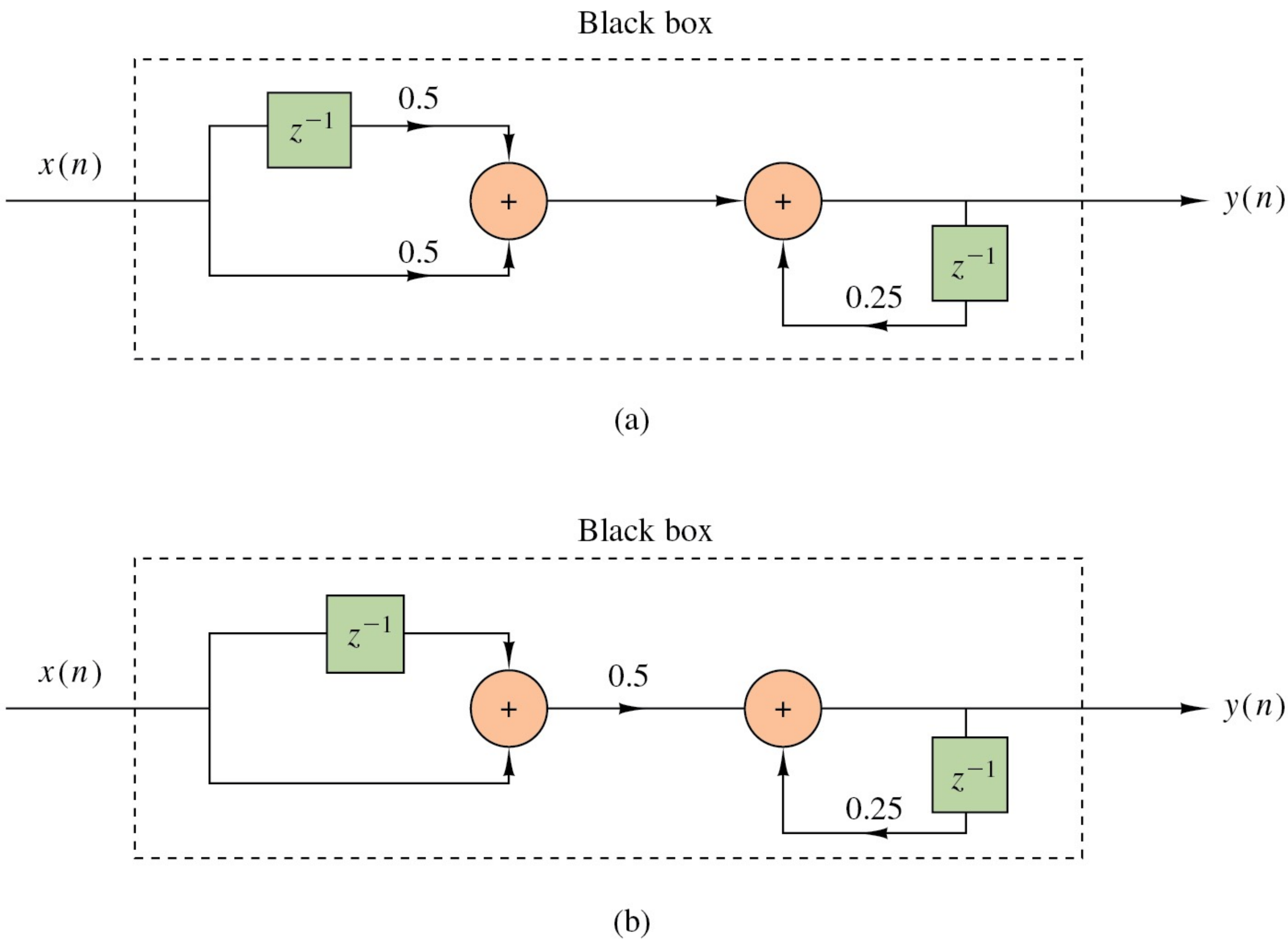


Figure 2.2.8 Examples of a time-invariant (a) and some time-variant systems (b)–(d).

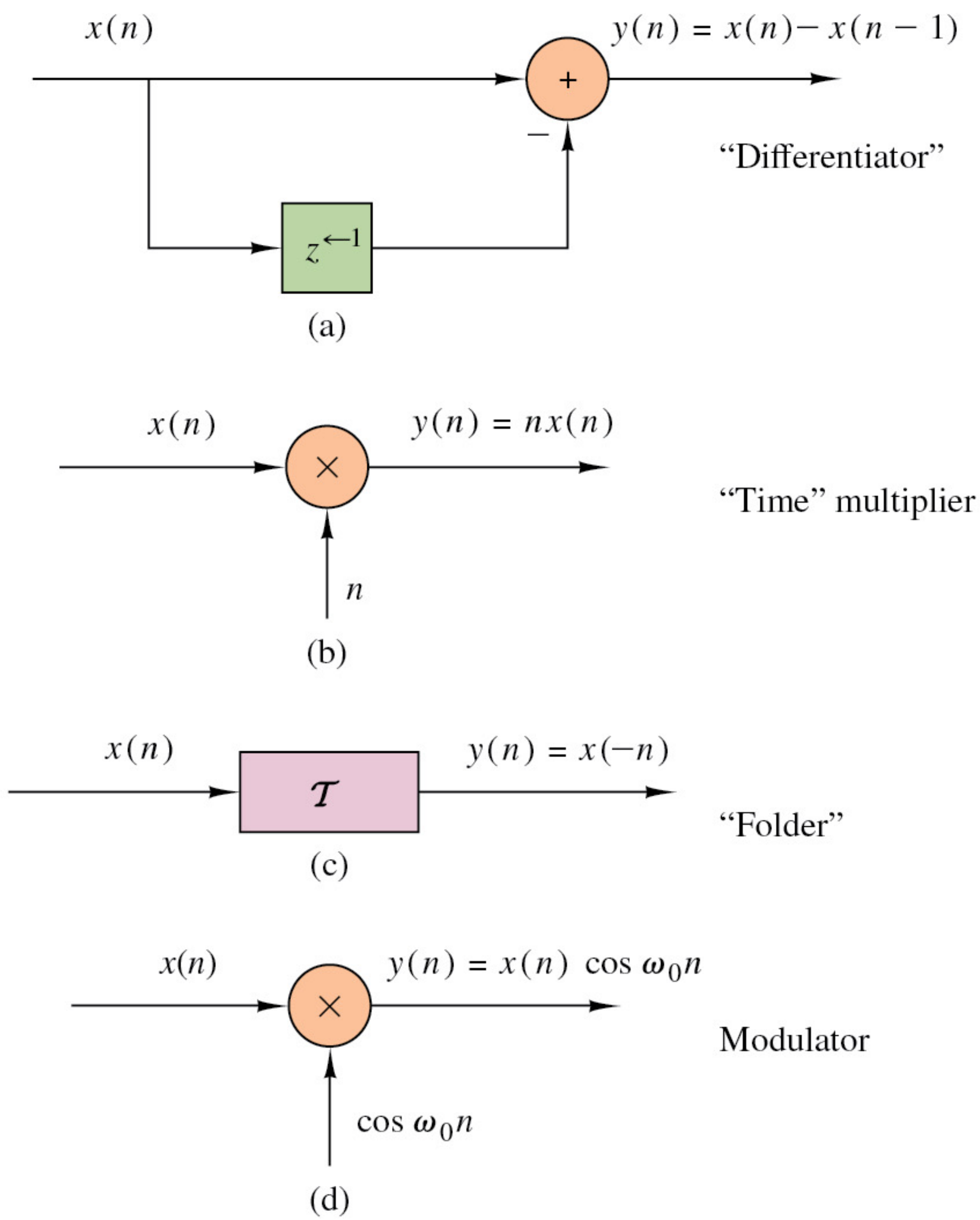


Figure 2.2.9 Graphical representation of the superposition principle. T is linear if and only if $y(n) = y'(n)$.

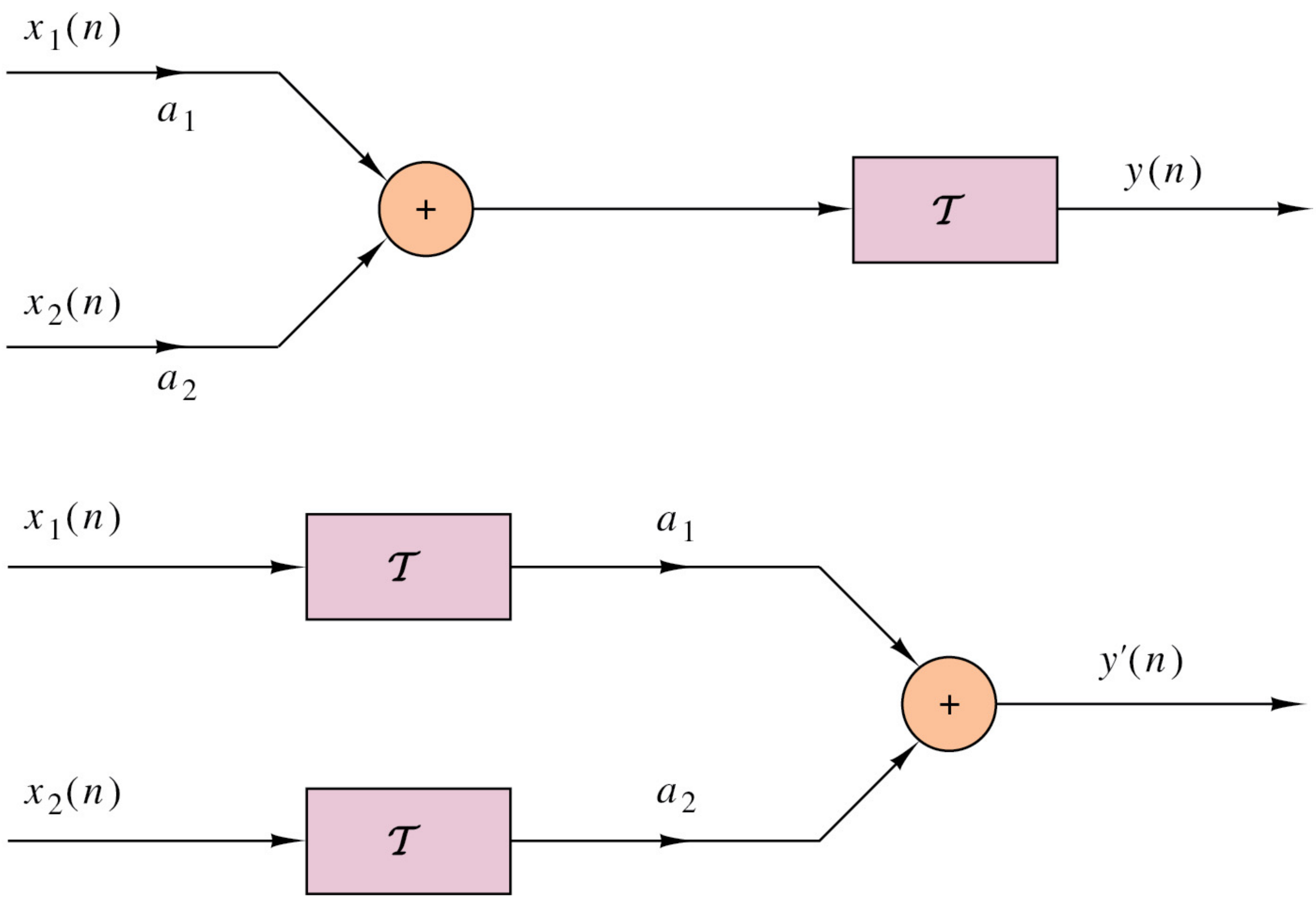
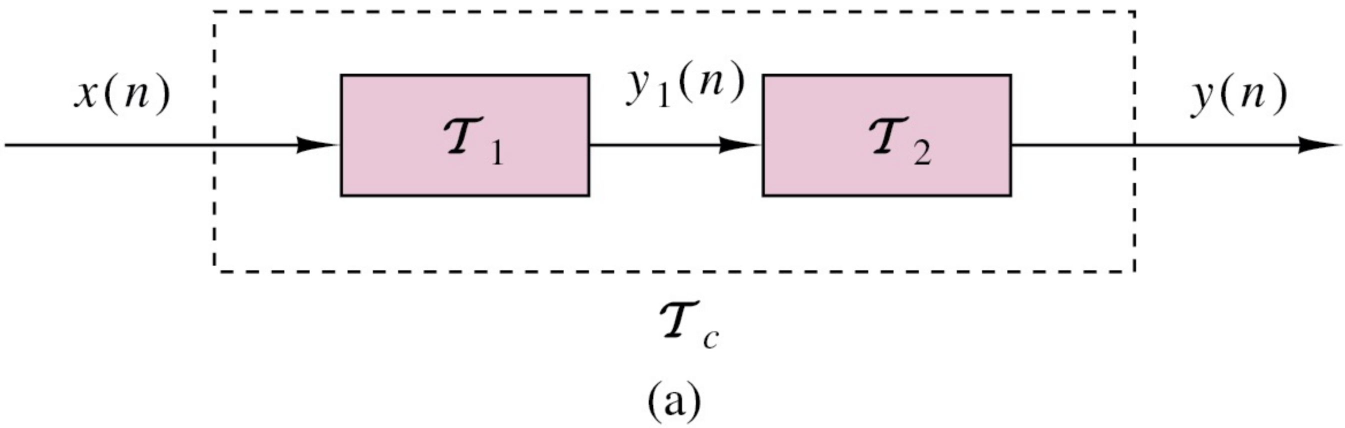


Figure 2.2.10 Cascade (a) and parallel (b) interconnections of systems.



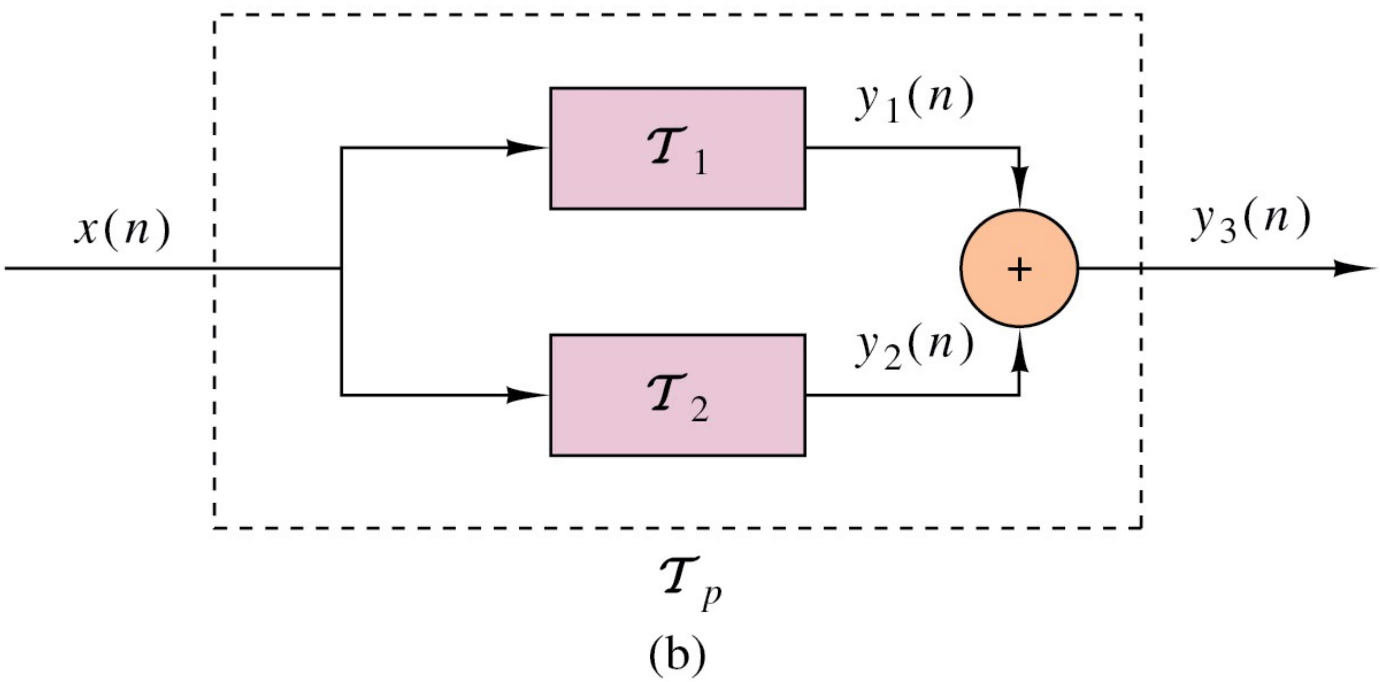


Figure 2.3.1 Multiplication of a signal $x(n)$ with a shifted unit sample sequence.

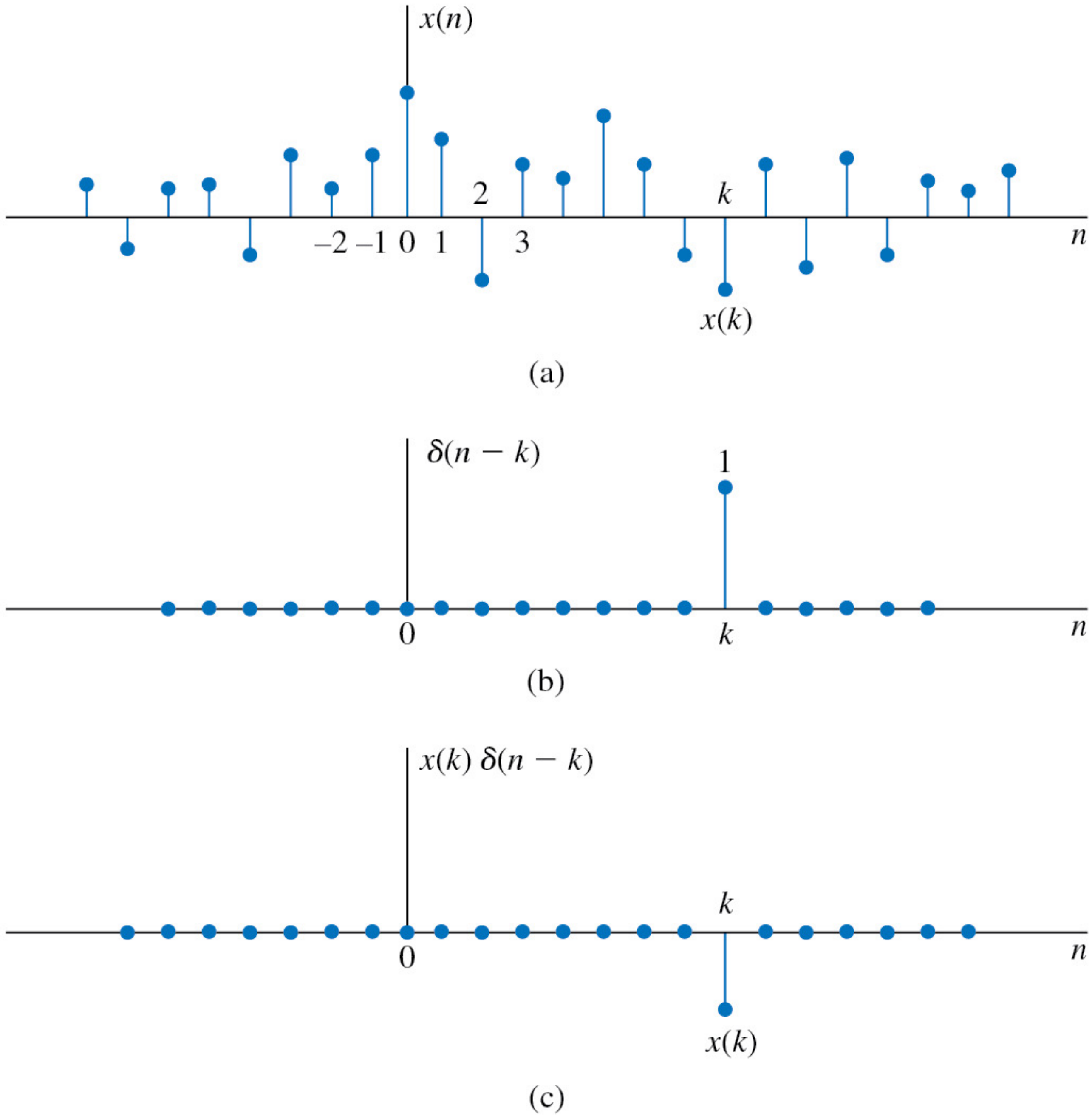


Figure 2.3.2 Graphical computation of convolution.

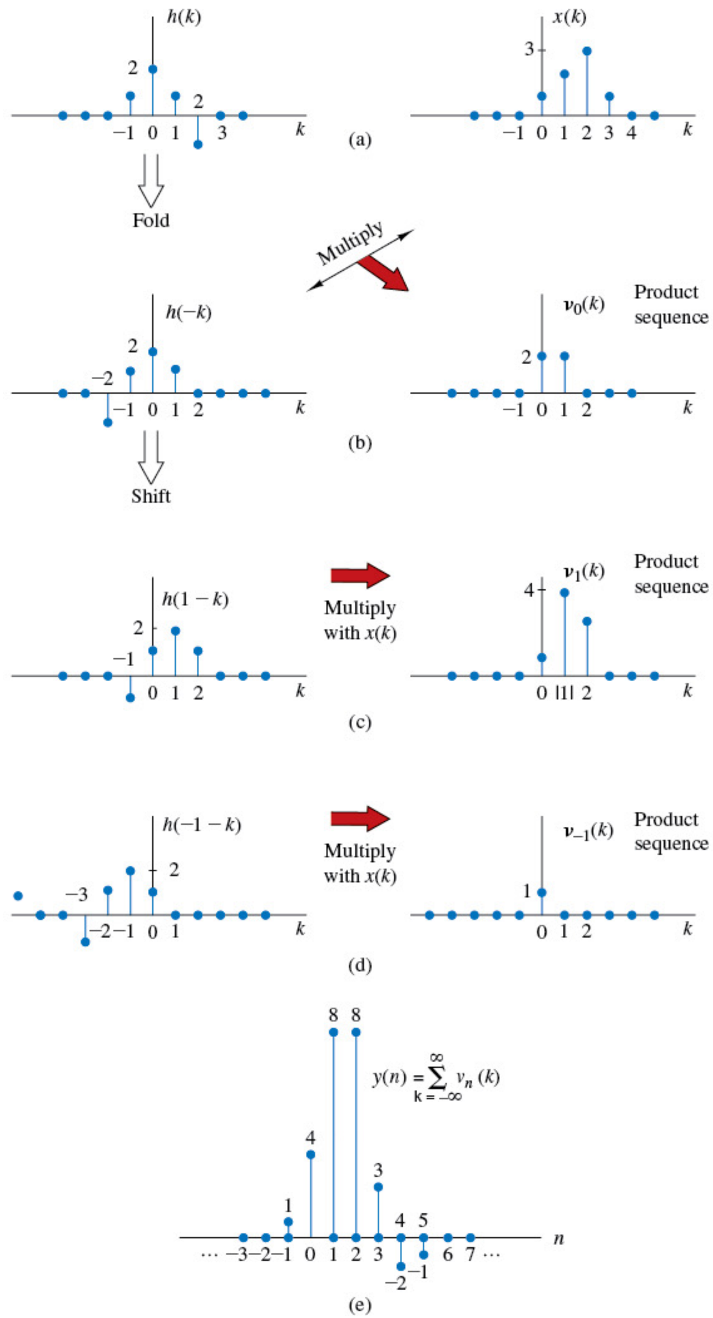


Figure 2.3.3 Graphical computation of convolution in Example 2.3.3.

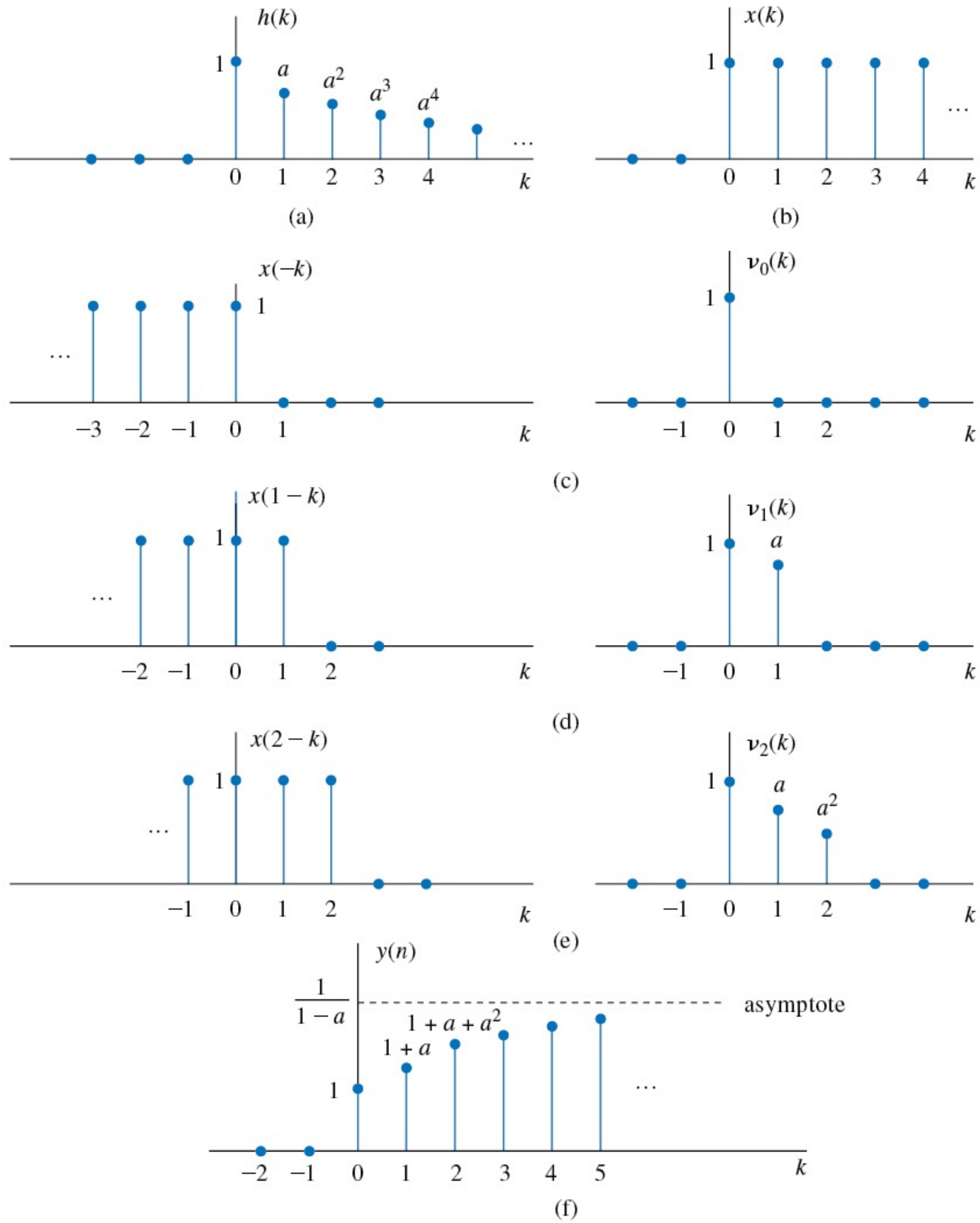


Figure 2.3.4 Interpretation of the commutative property of convolution.

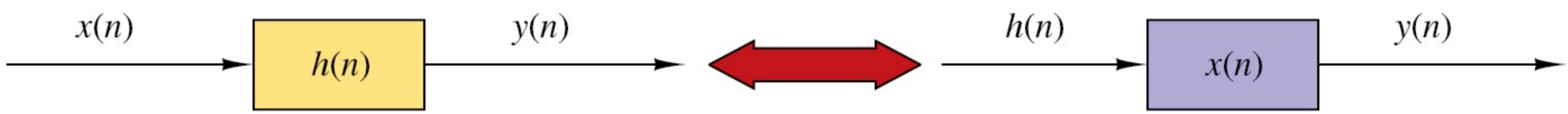


Figure 2.3.5 Implications of the associative (a) and the associative and commutative (b) properties of convolution.

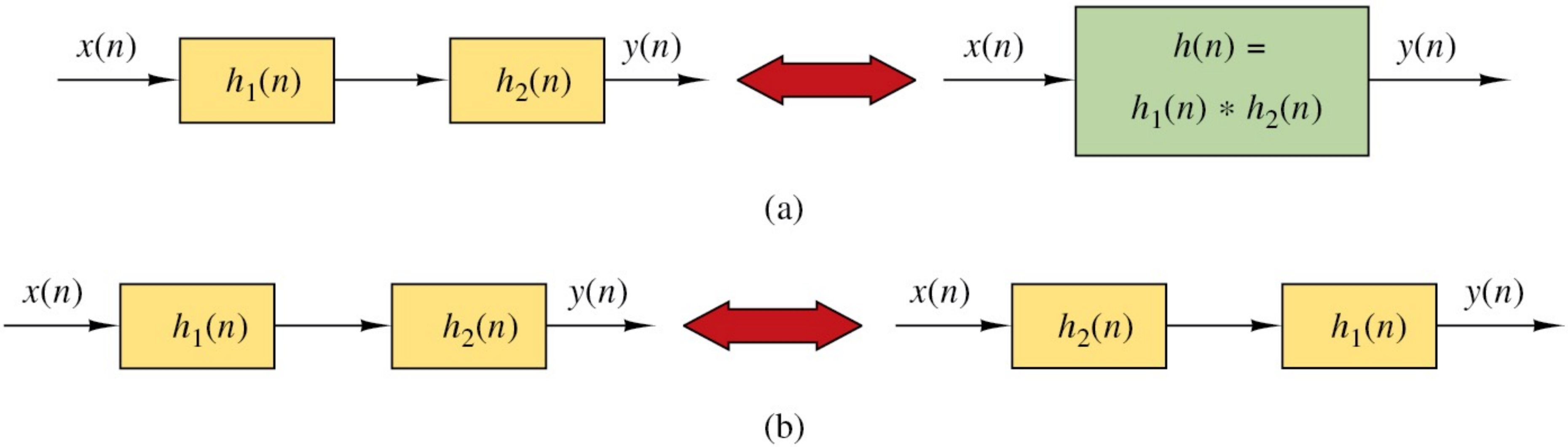


Figure 2.3.6 Interpretation of the distributive property of convolution: two LTI systems connected in parallel can be replaced by a single system with $h(n) = h_1(n) + h_2(n)$.

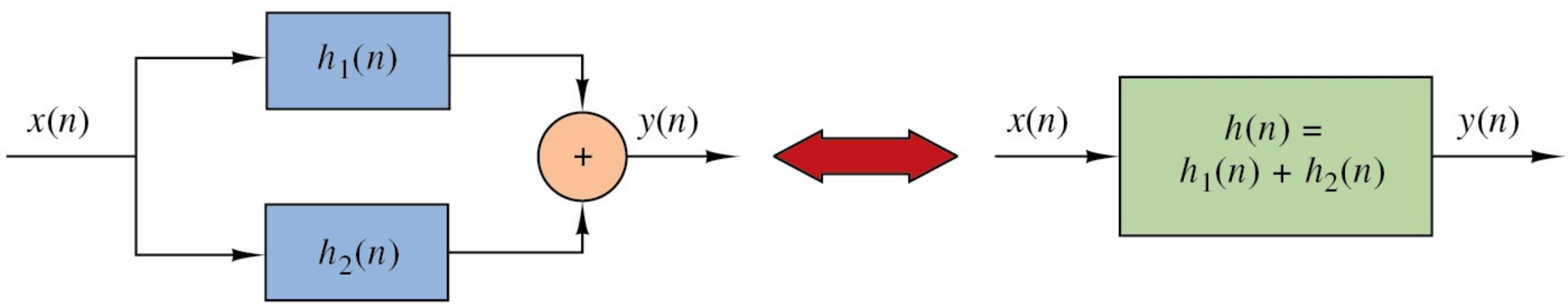


Figure 2.4.1 Realization of a recursive cumulative averaging system.

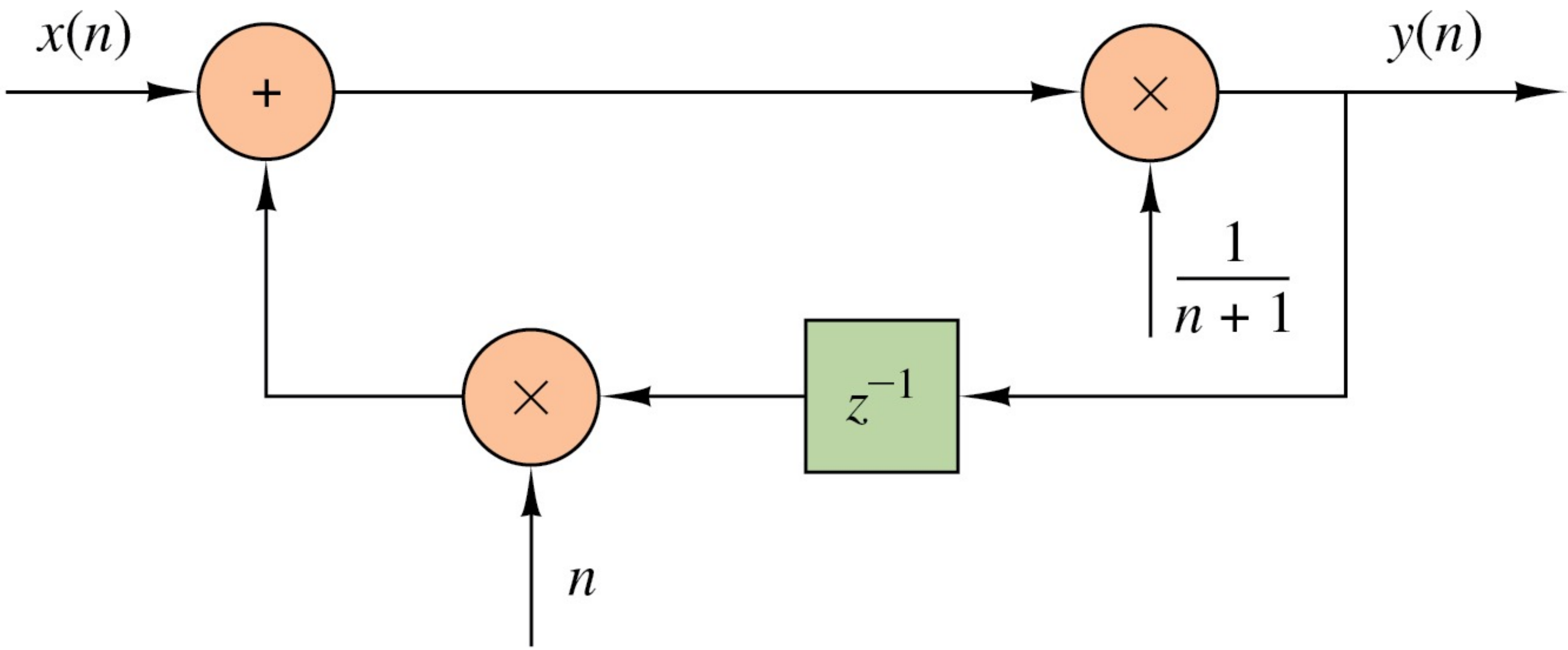


Figure 2.4.2 Realization of the square-root system.

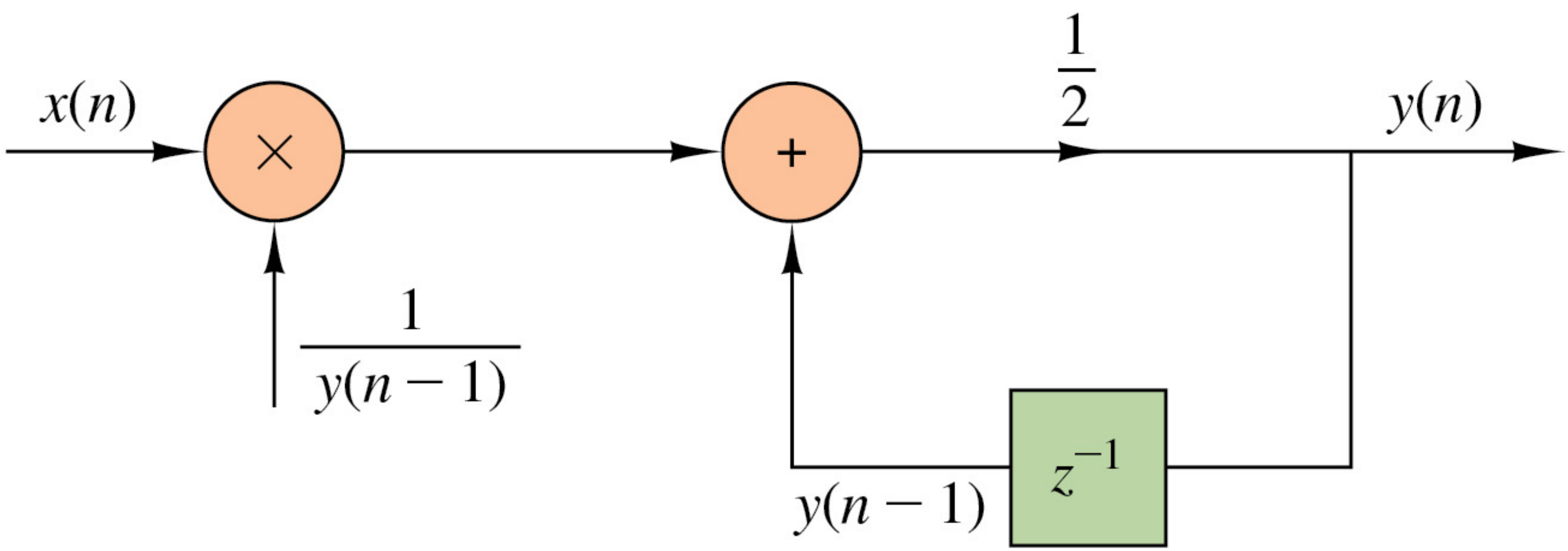


Figure 2.4.3 Basic form for a casual and realizable (a) nonrecursive and (b) recursive system.

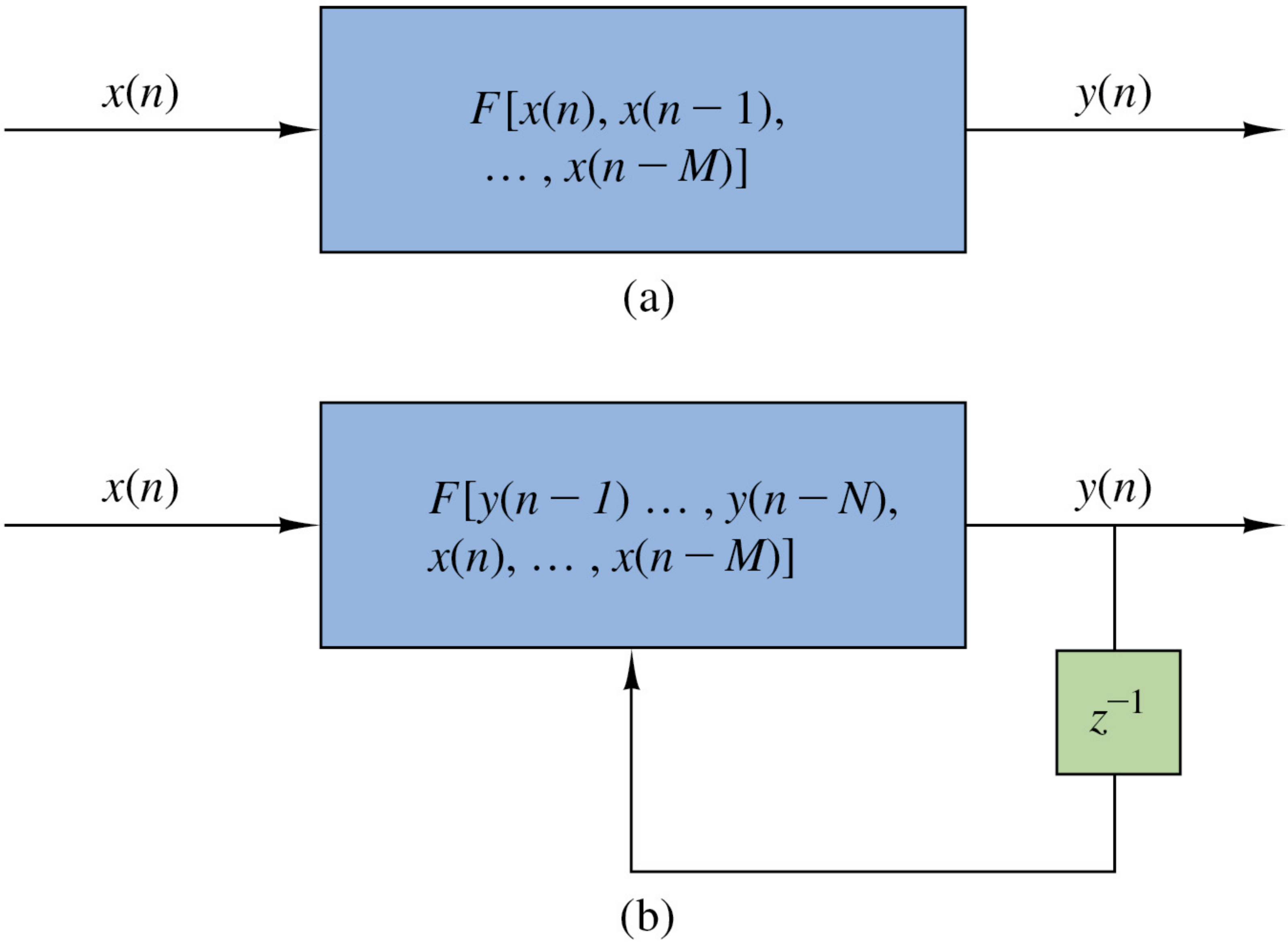


Figure 2.4.4 Block diagram realization of a simple recursive system.

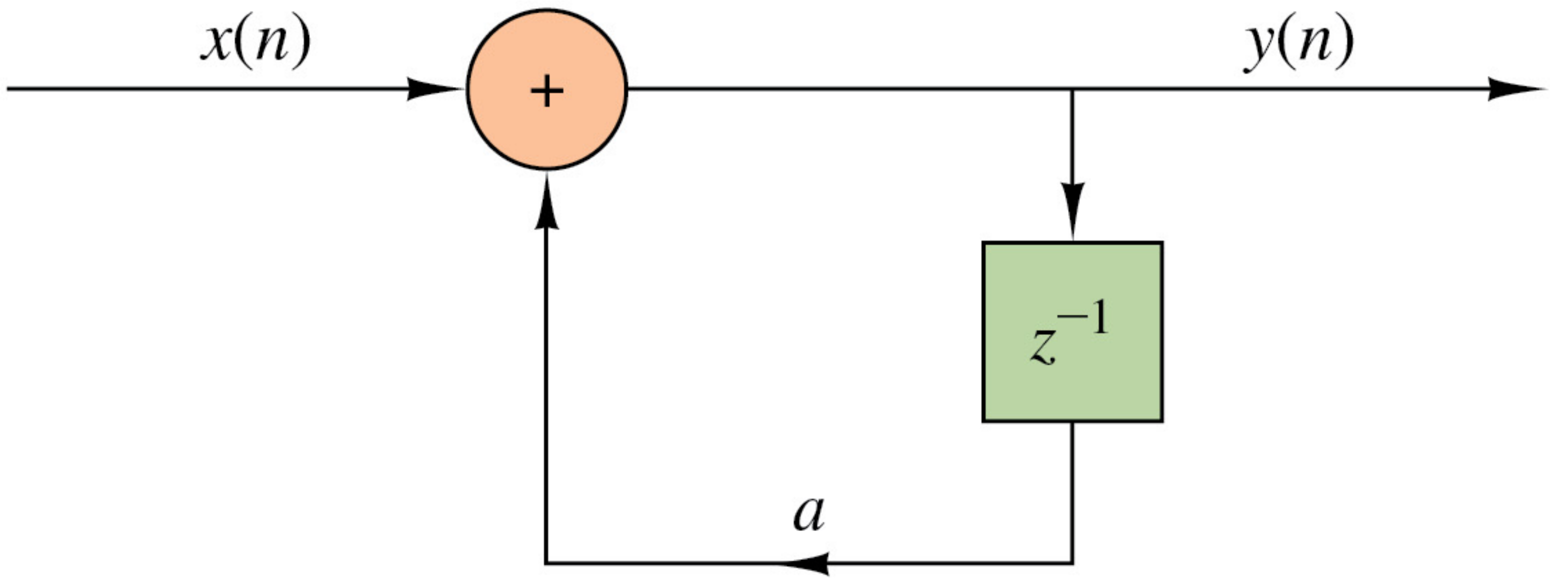


Figure 2.4.5 Illustration of the transient and steady-state response of a first-order recursive system with $a = 0.8$ (top) and $a = -0.8$ (bottom).

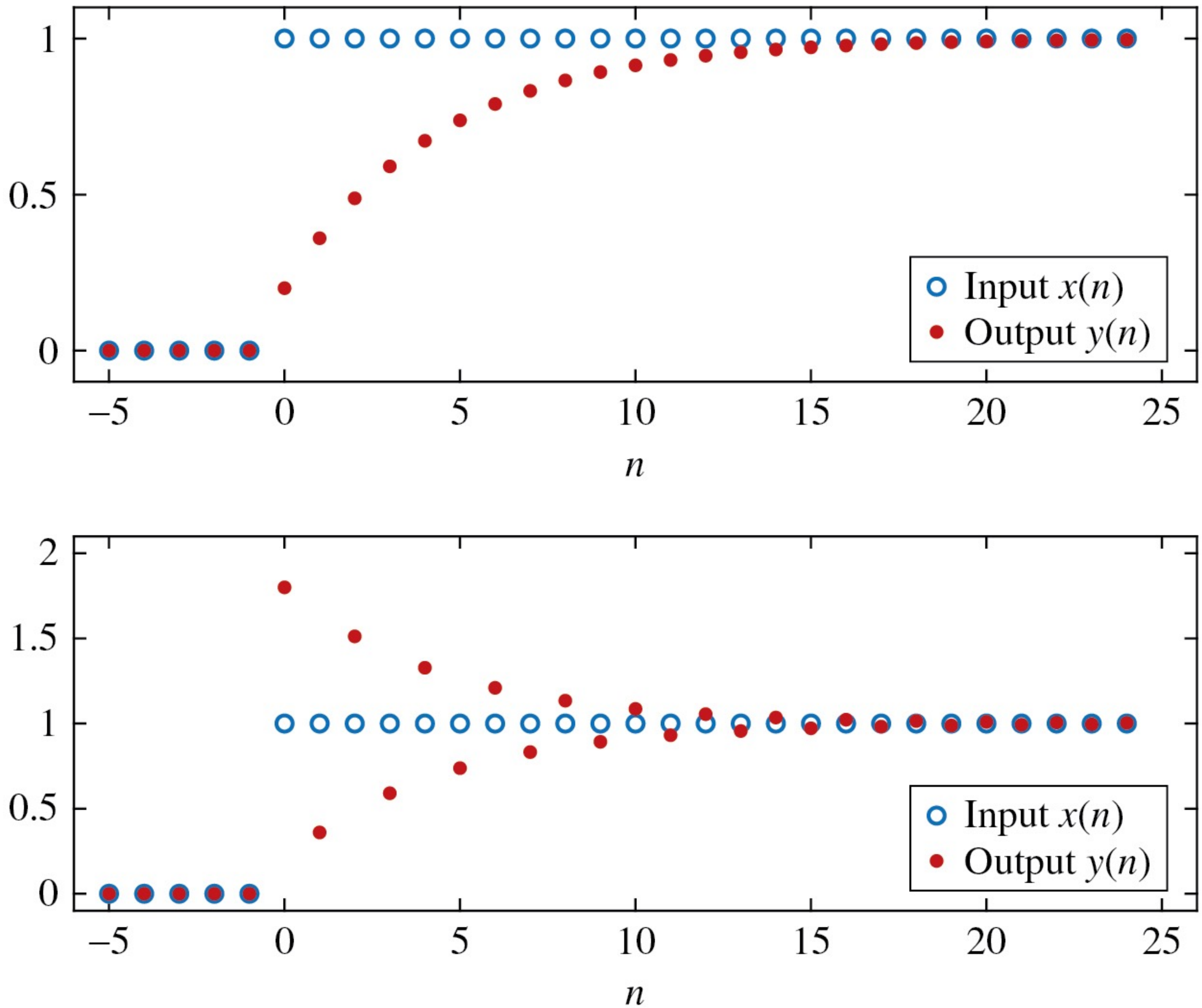


Figure 2.4.6 The weekly Dow Jones Industrial Average index, an SMA smoothed version with M = 31, and a MA smoothed version with M = 31.

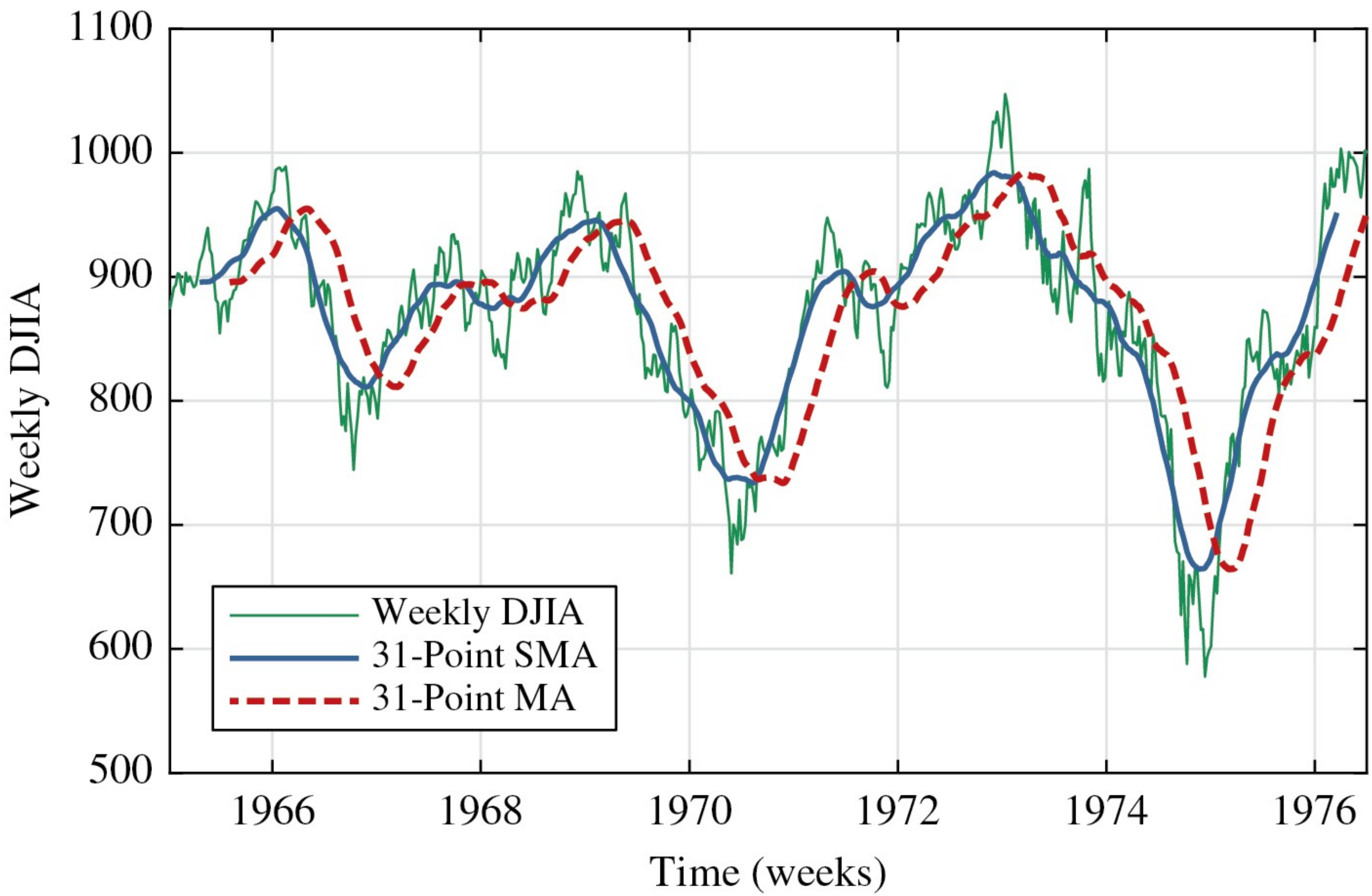


Figure 2.4.7 The DJIA and an exponentially smoothed version with $\lambda = 0.1$.

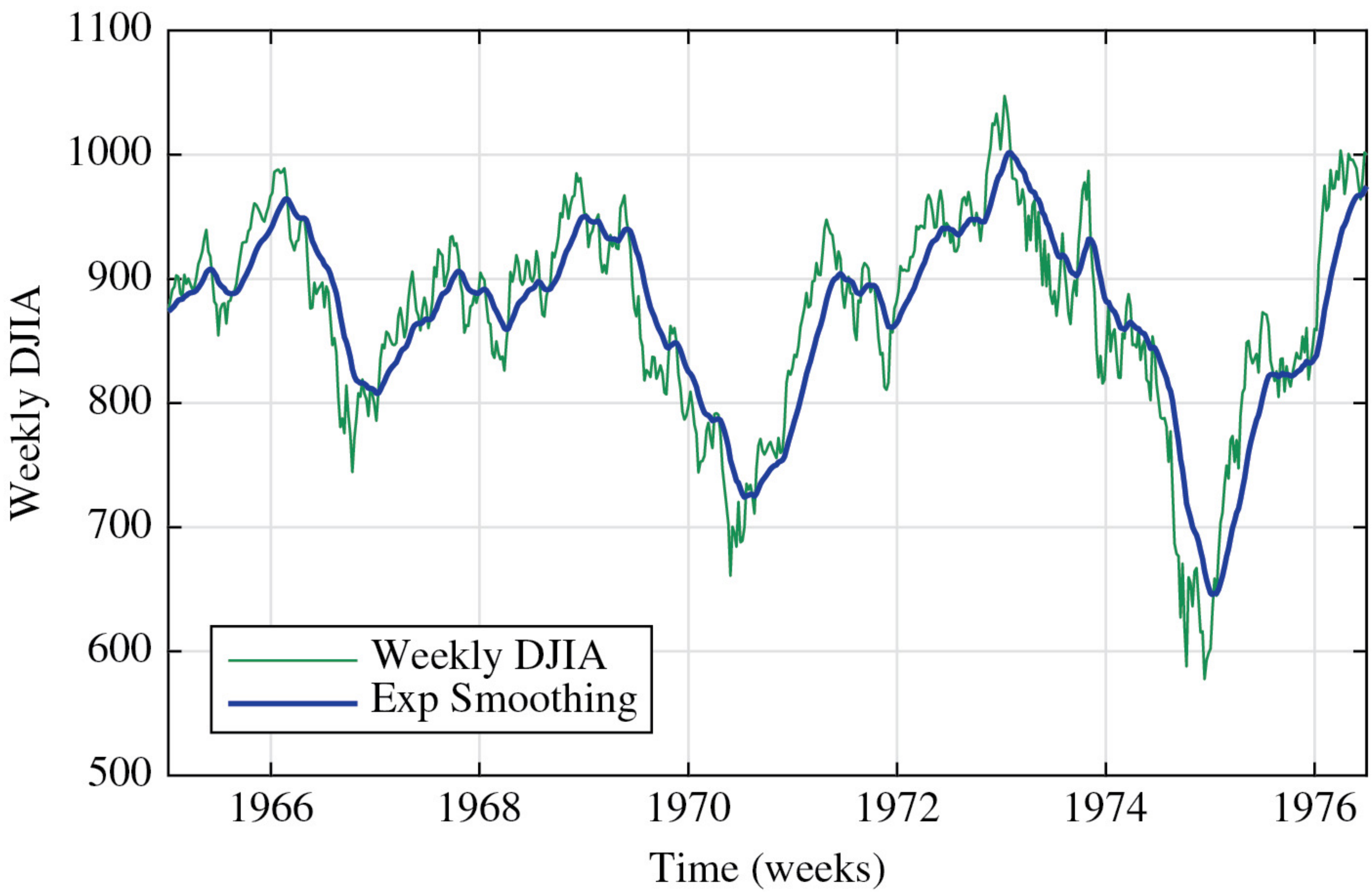


Figure 2.5.1 Steps in converting from the direct form I realization in (a) to the direct form II realization in (c).

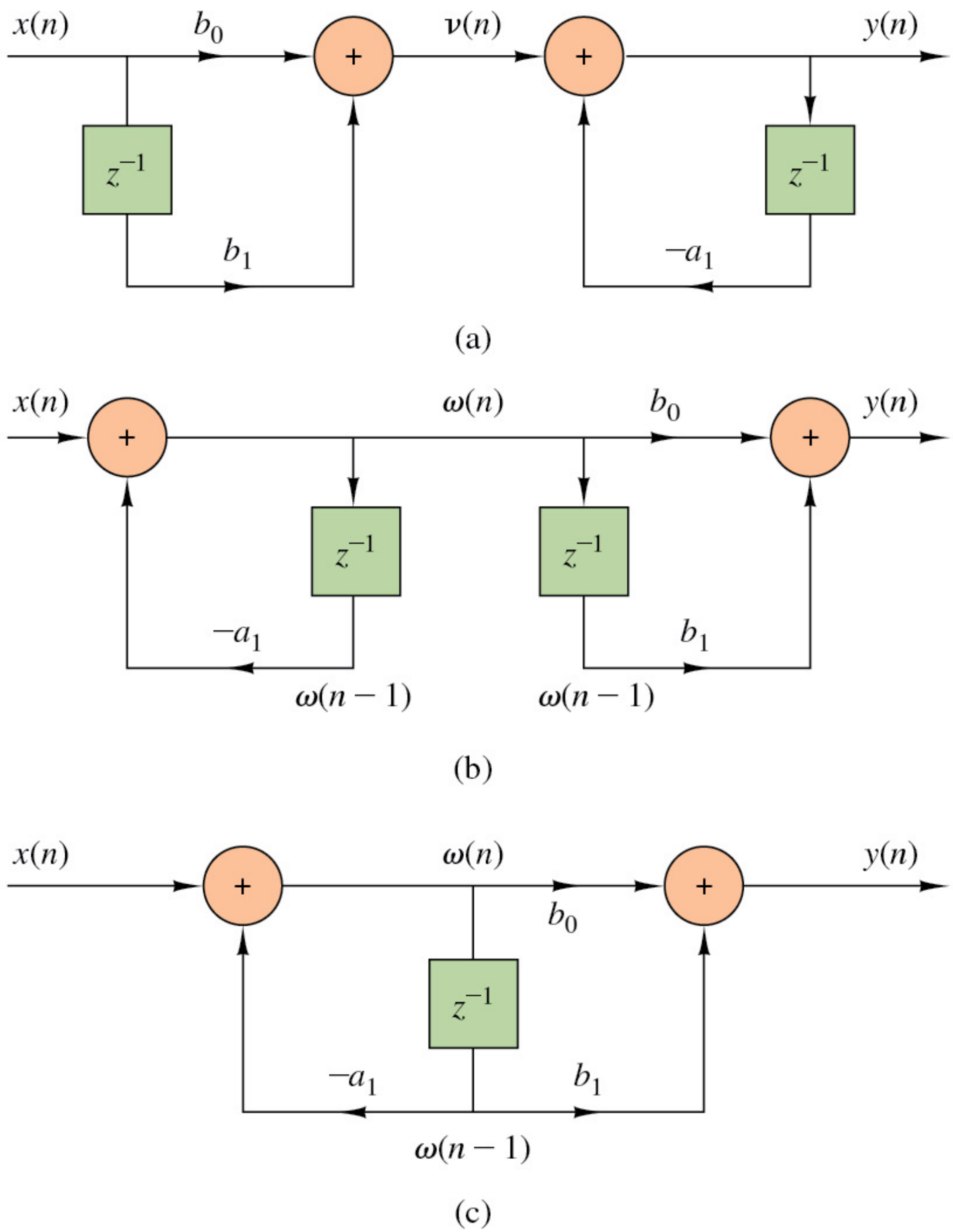


Figure 2.5.2 Direct form I structure of the system described by (2.5.6).

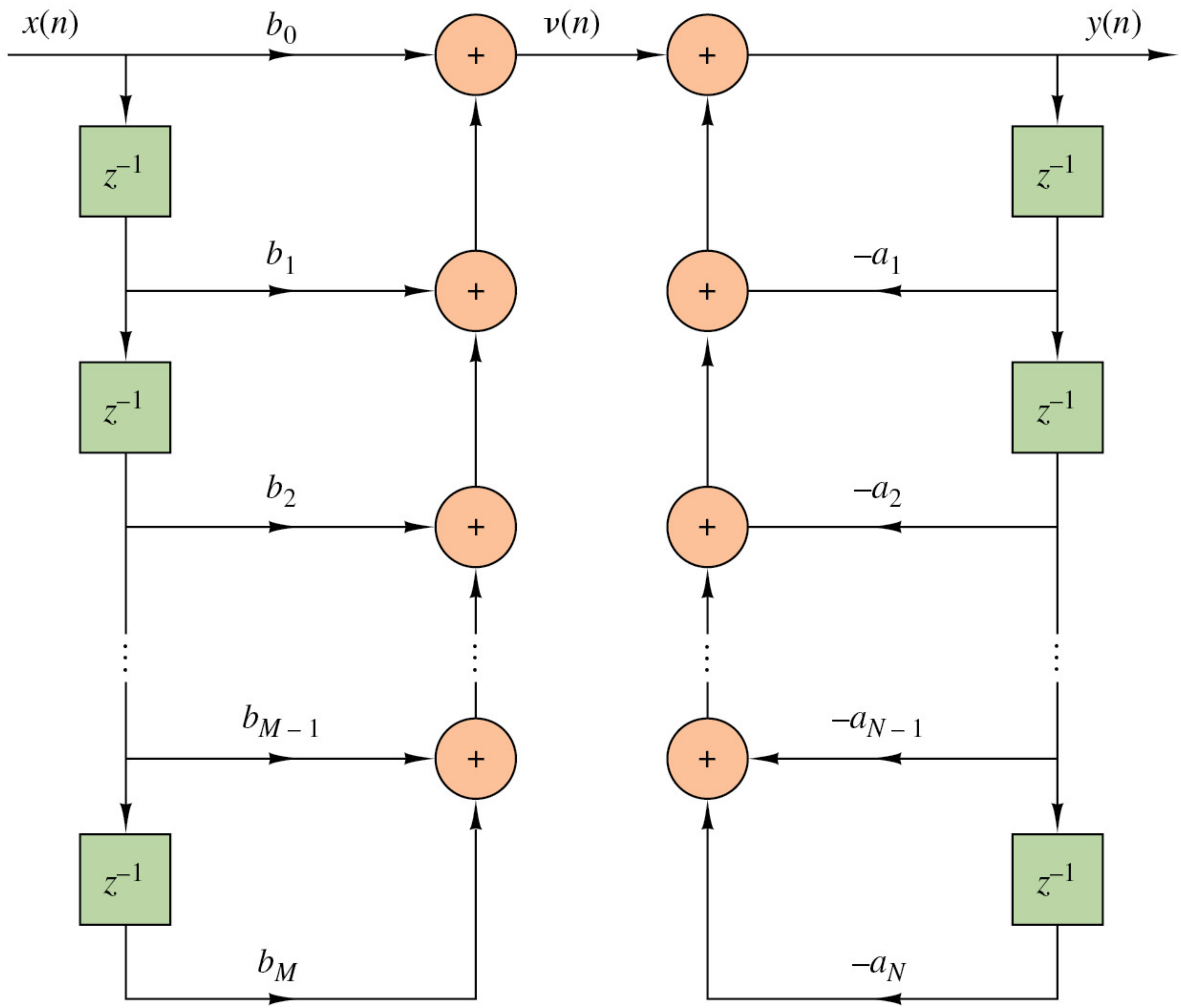


Figure 2.5.3 Direct form II structure of the system described by (2.5.6).

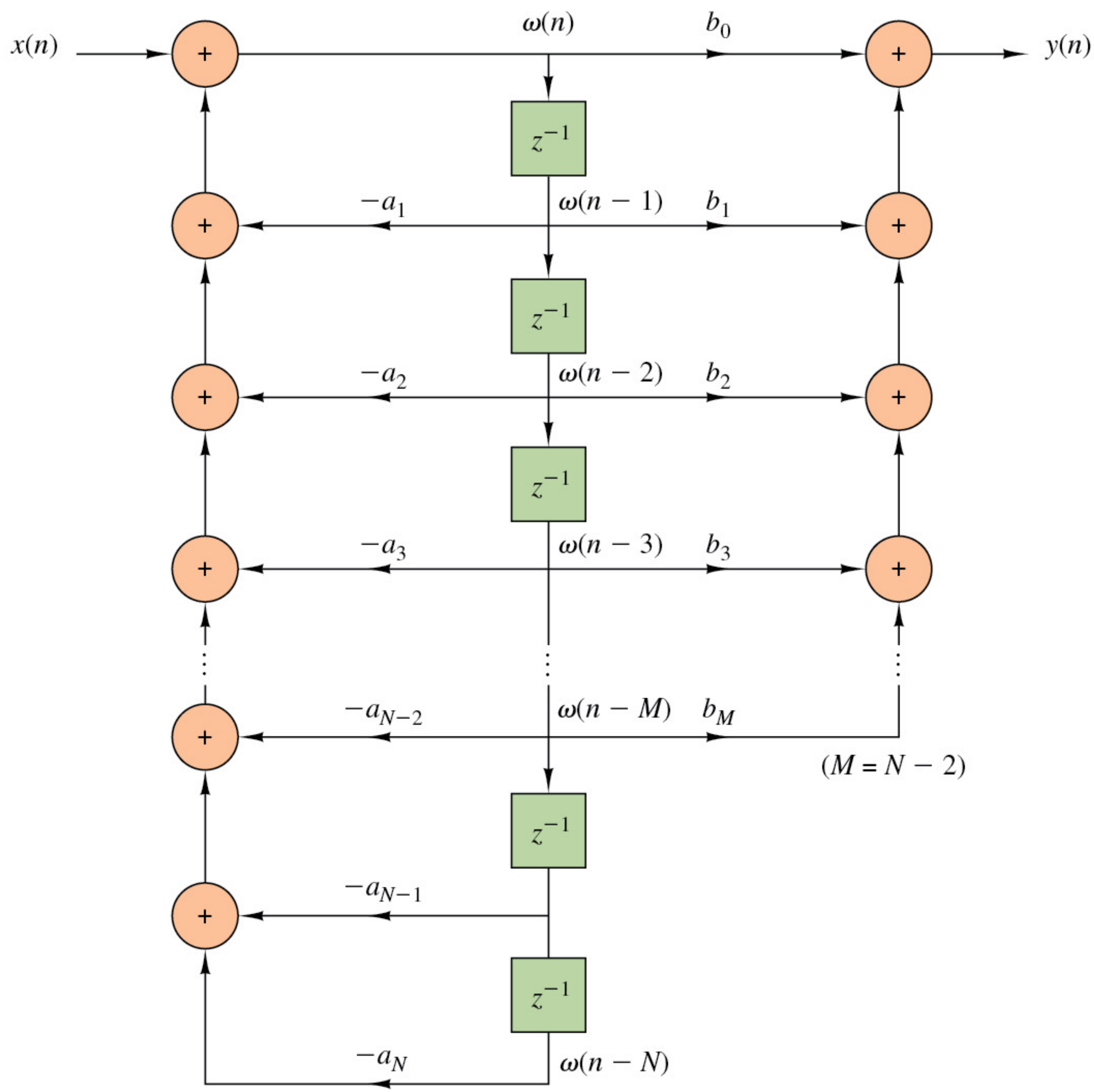


Figure 2.5.4 Structures for the realization of second-order systems: (a) general second-order system; (b) FIR system; (c) "purely recursive system."

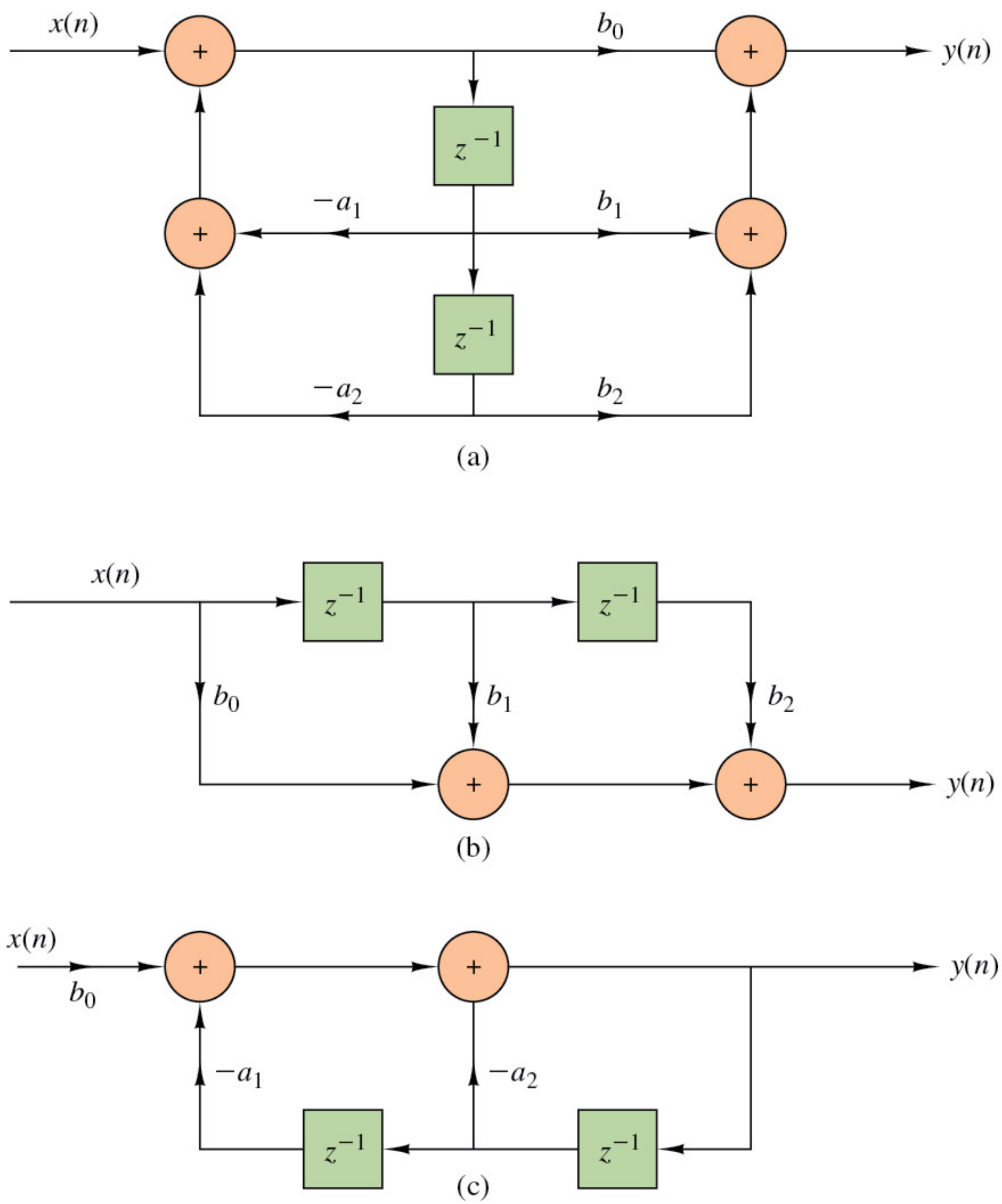


Figure 2.5.5 Nonrecursive realization of an FIR moving average system.

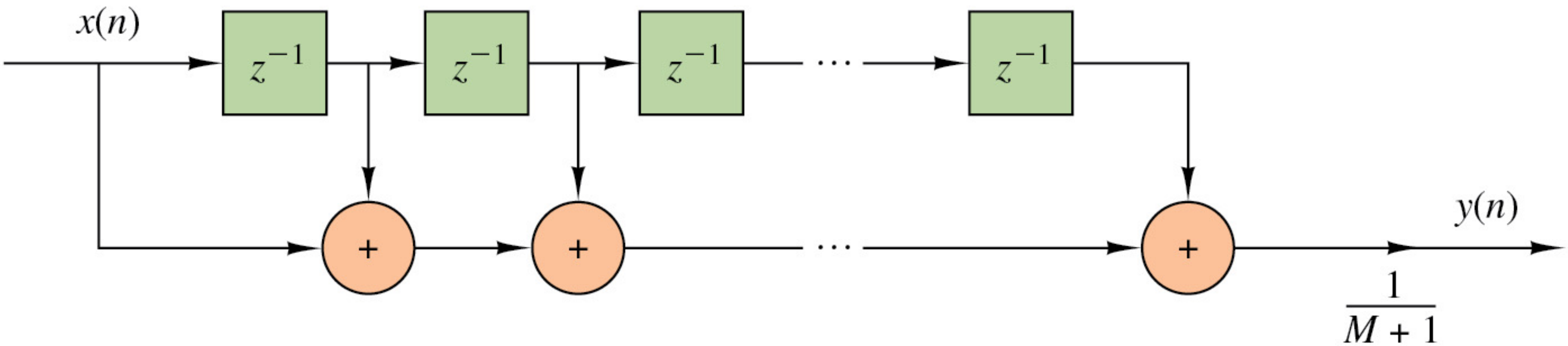


Figure 2.5.6 Recursive realization of an FIR moving average system.

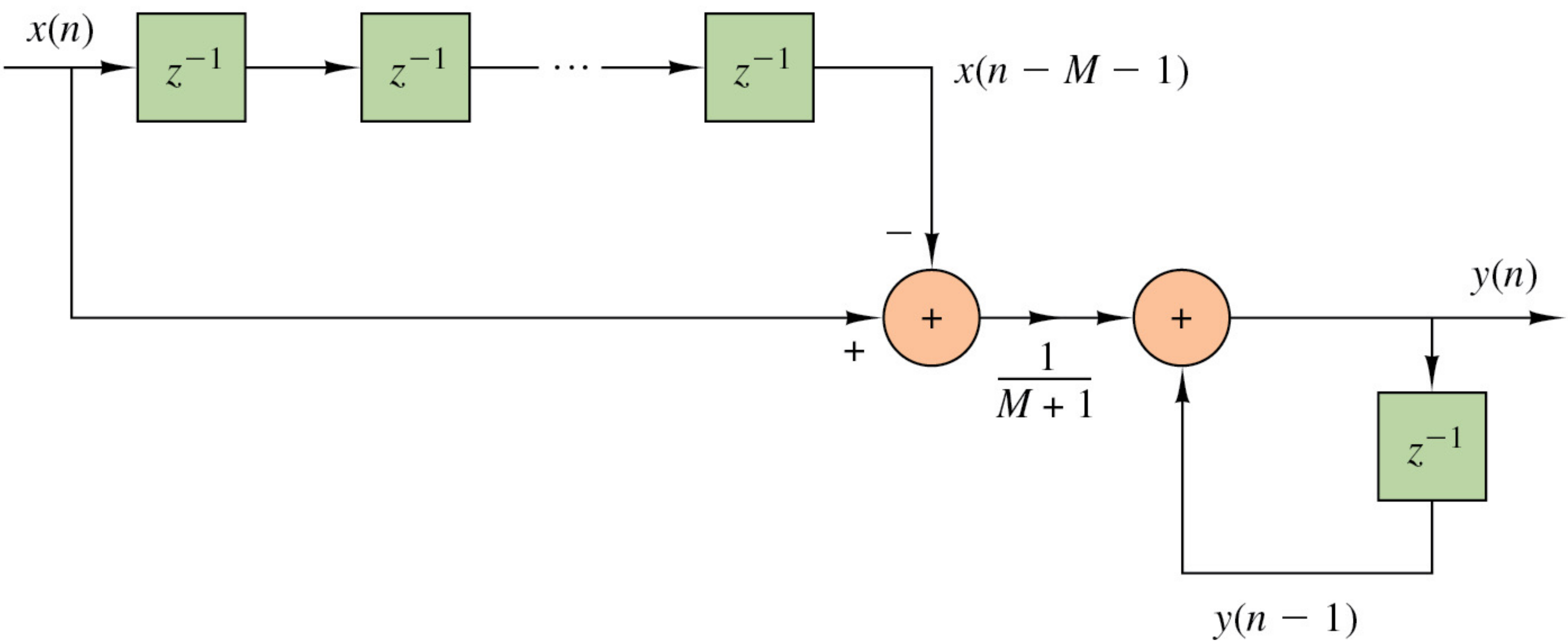


Figure 2.6.1 Radar target detection.

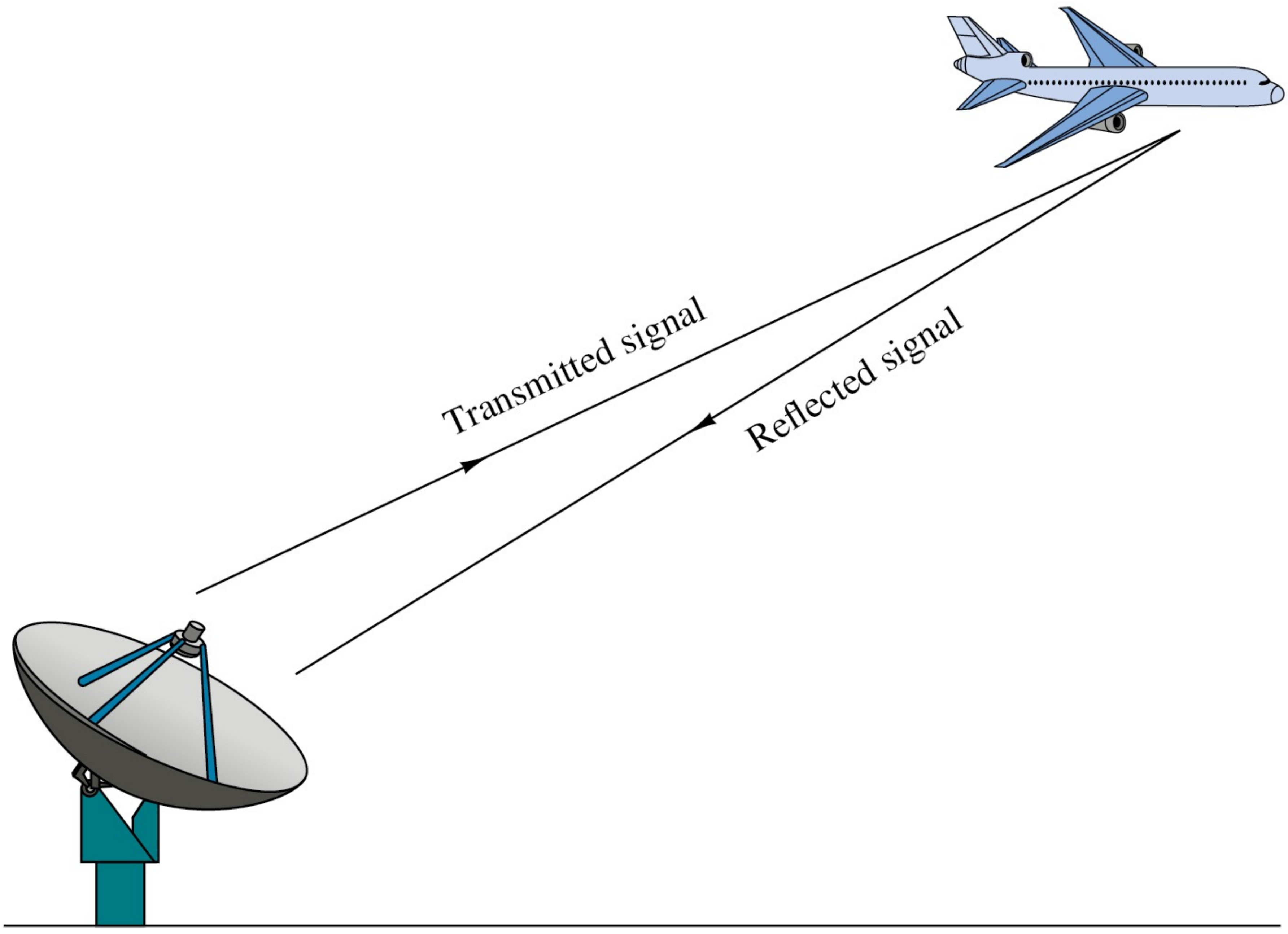


Figure 2.6.2 Computation of the autocorrelation of the signal $x(n) = a^n$, $0 < a < 1$.

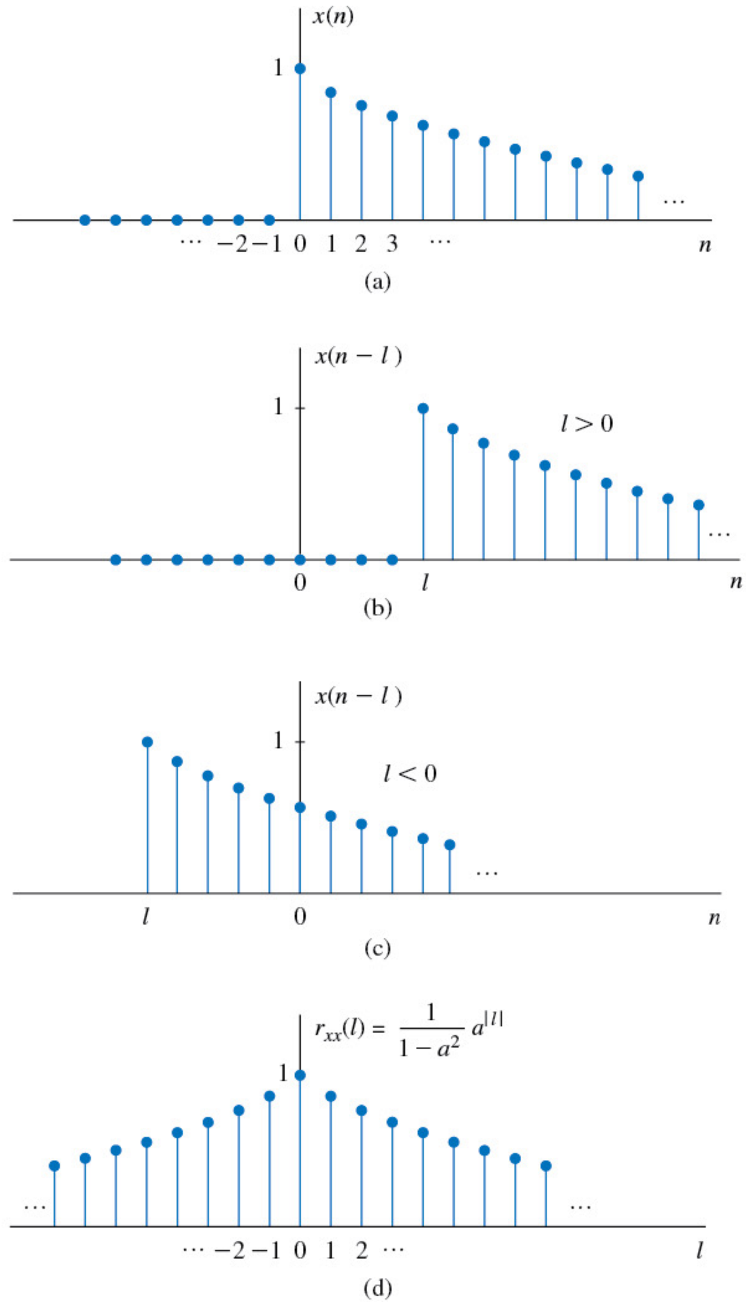


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Figure 2.6.3 Identification of periodicity in the Wölfer sunspot numbers: (a) annual Wölfer sunspot numbers; (b) normalized autocorrelation sequence.

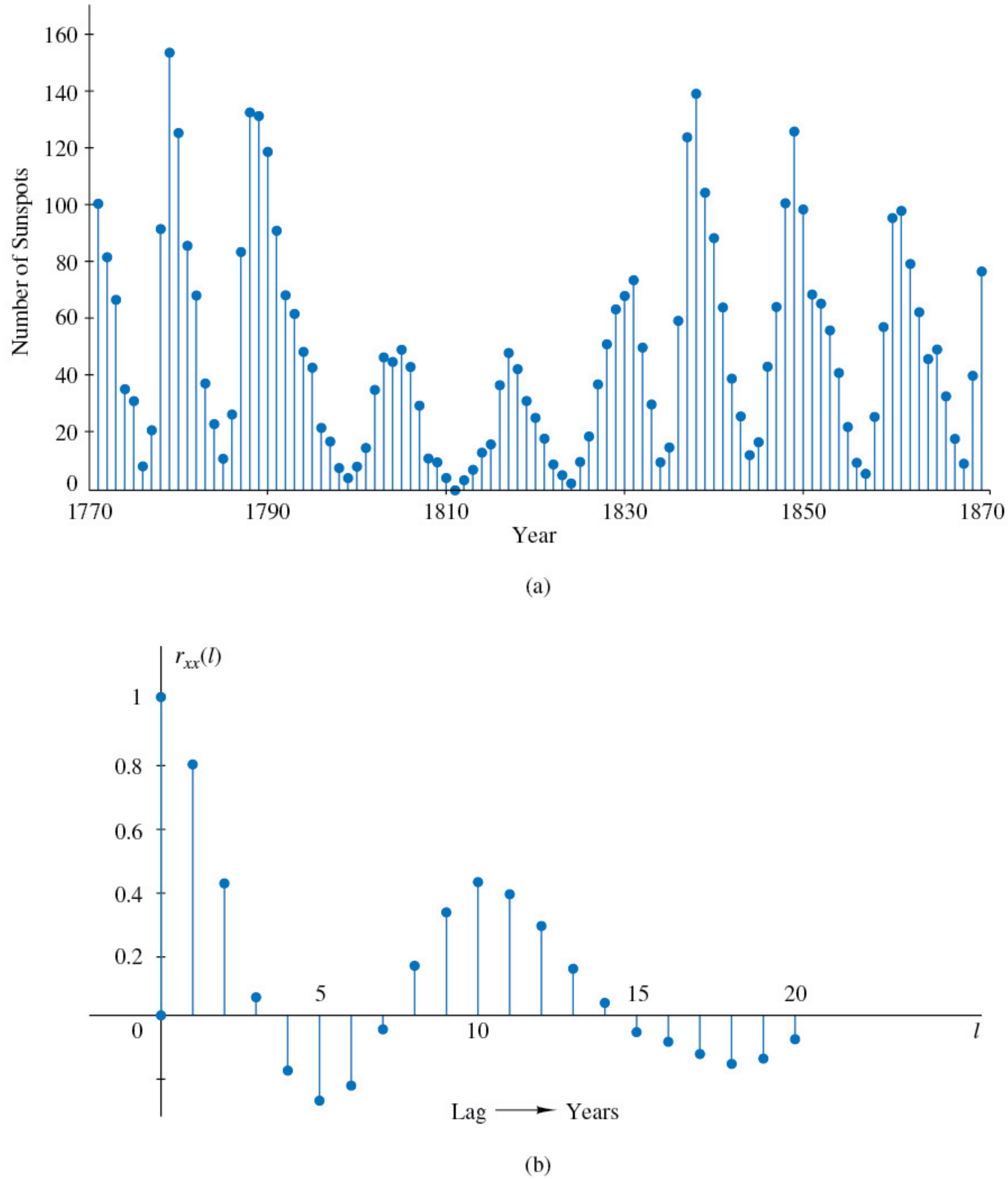


Figure 2.6.4 Use of autocorrelation to detect the presence of a periodic signal corrupted by noise.

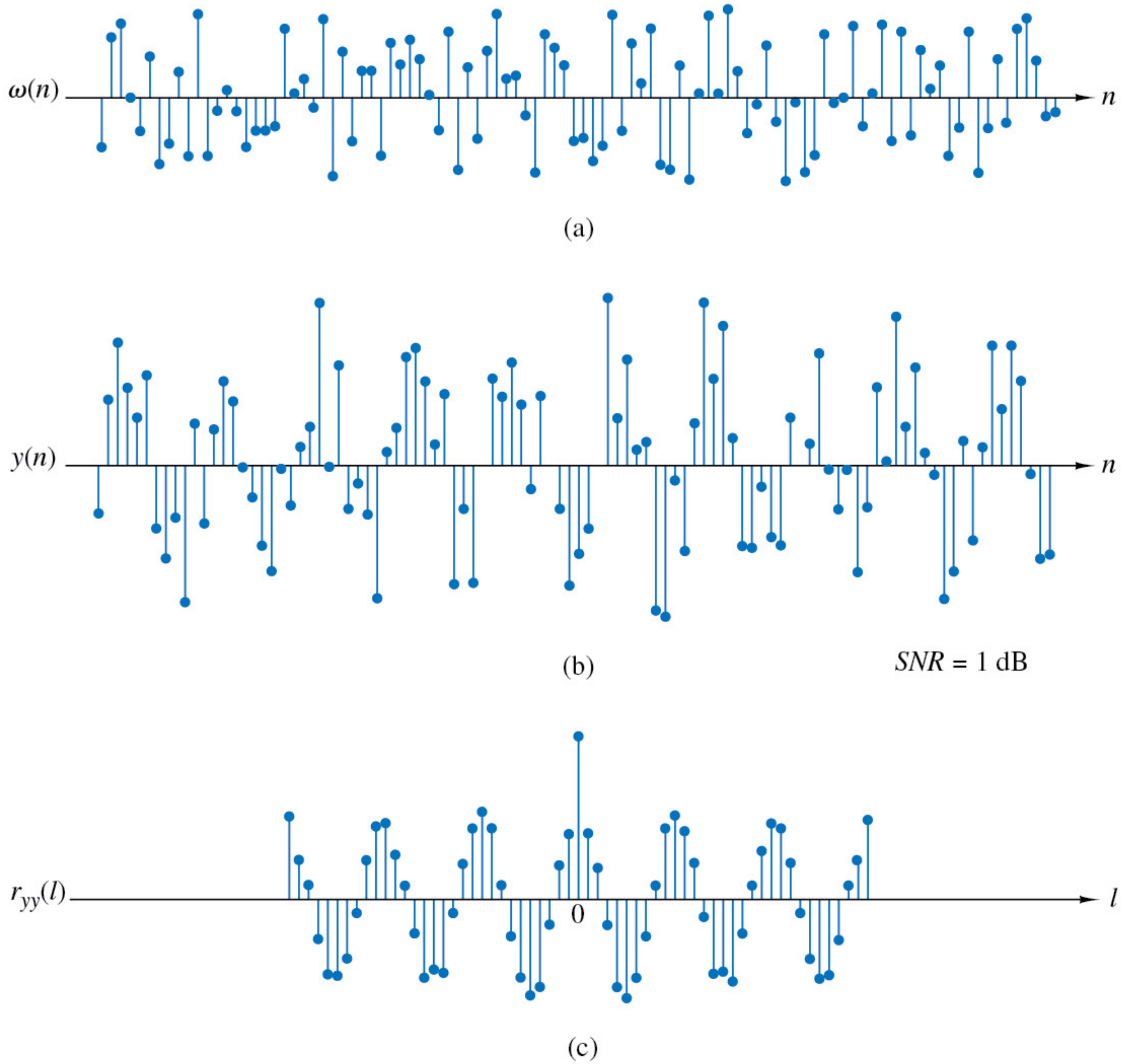


Figure P2.2

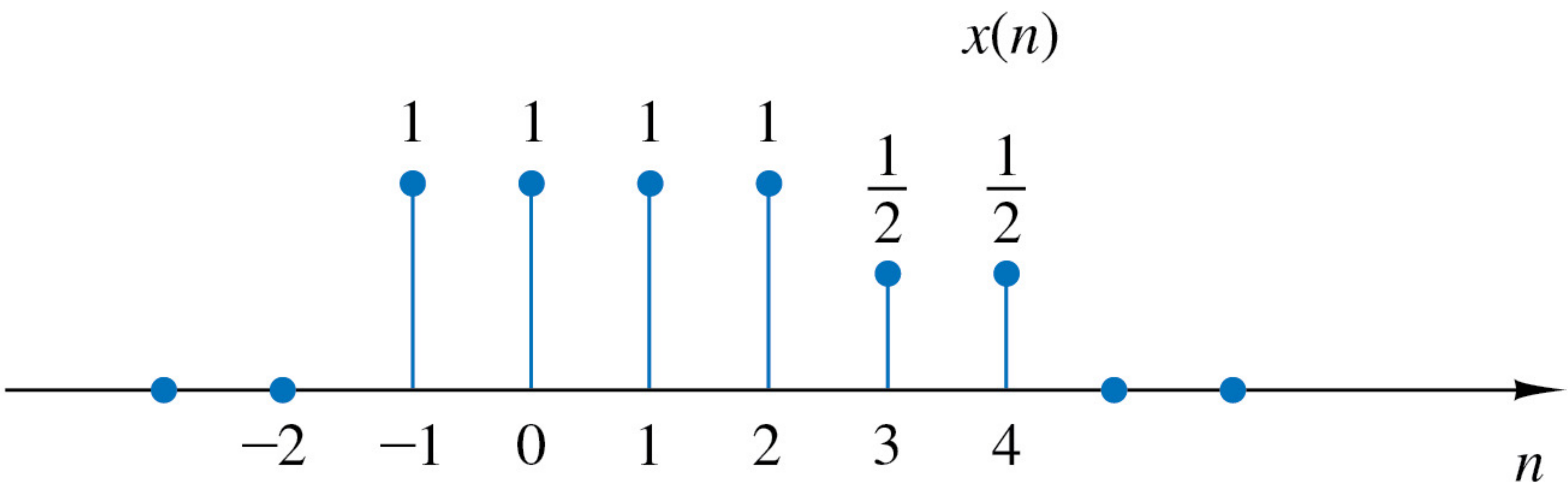


Figure P2.8

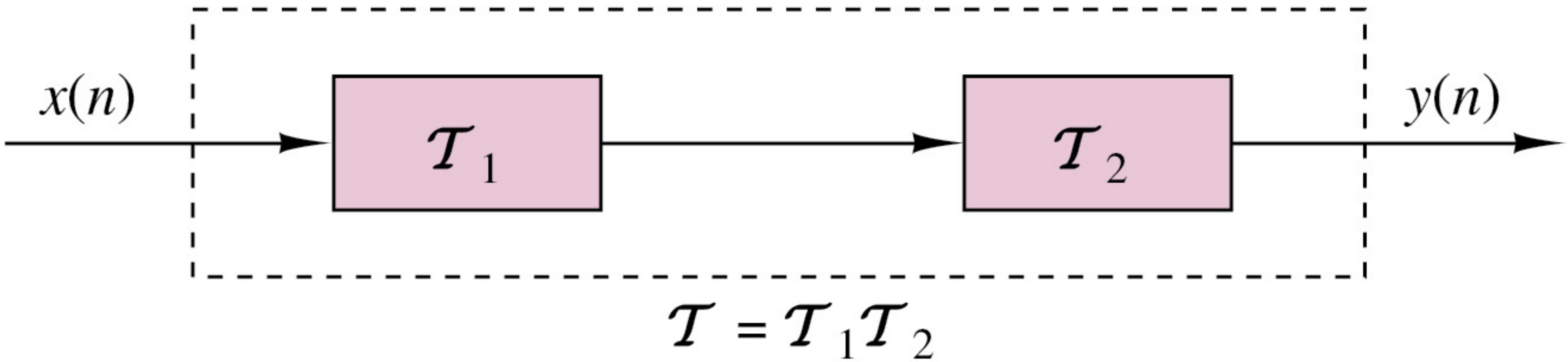


Figure P2.17

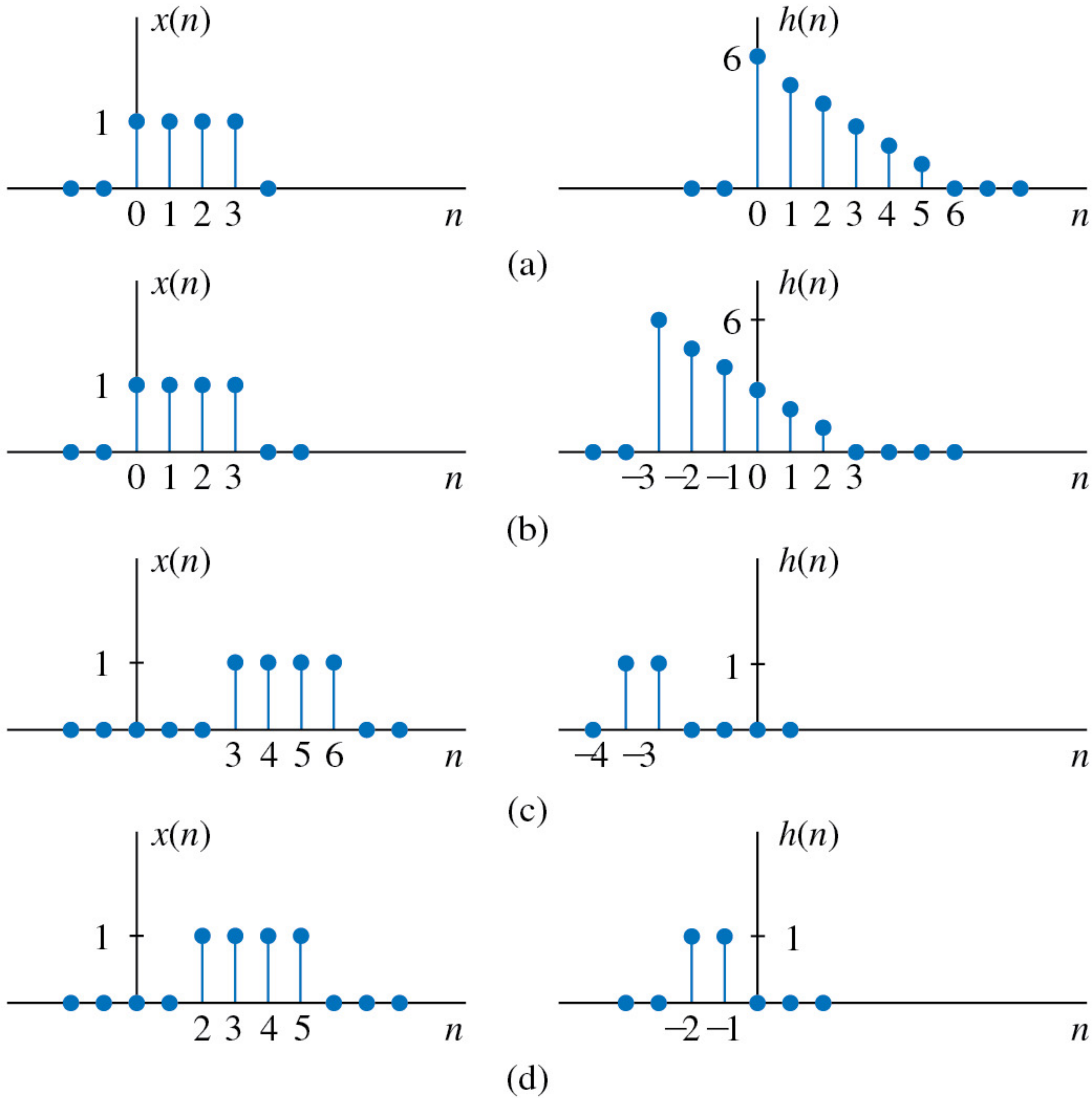


Figure P2.31

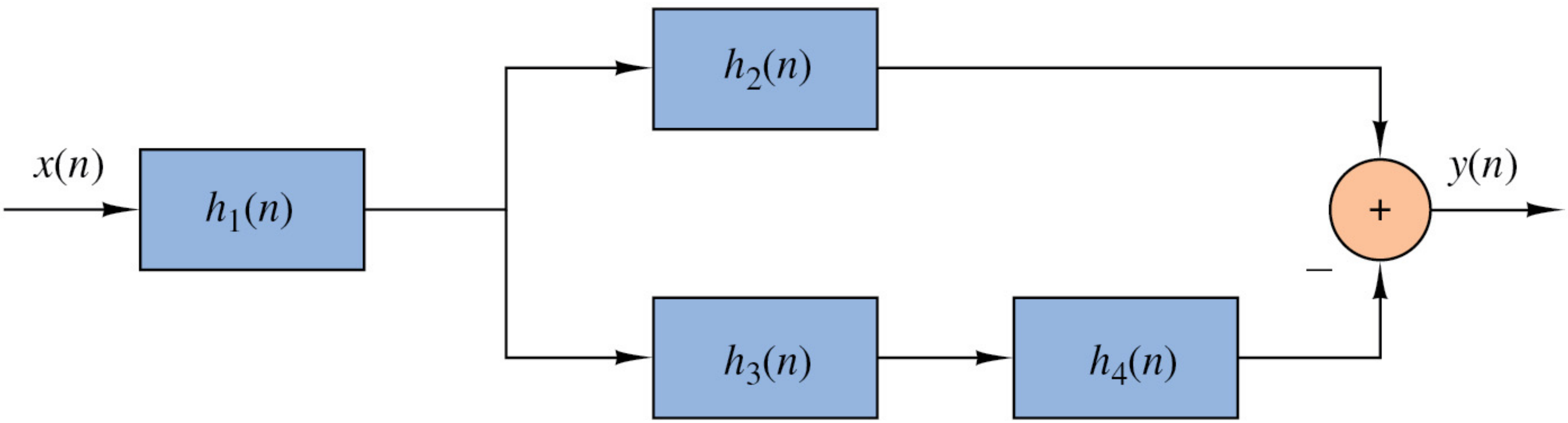


Figure P2.32

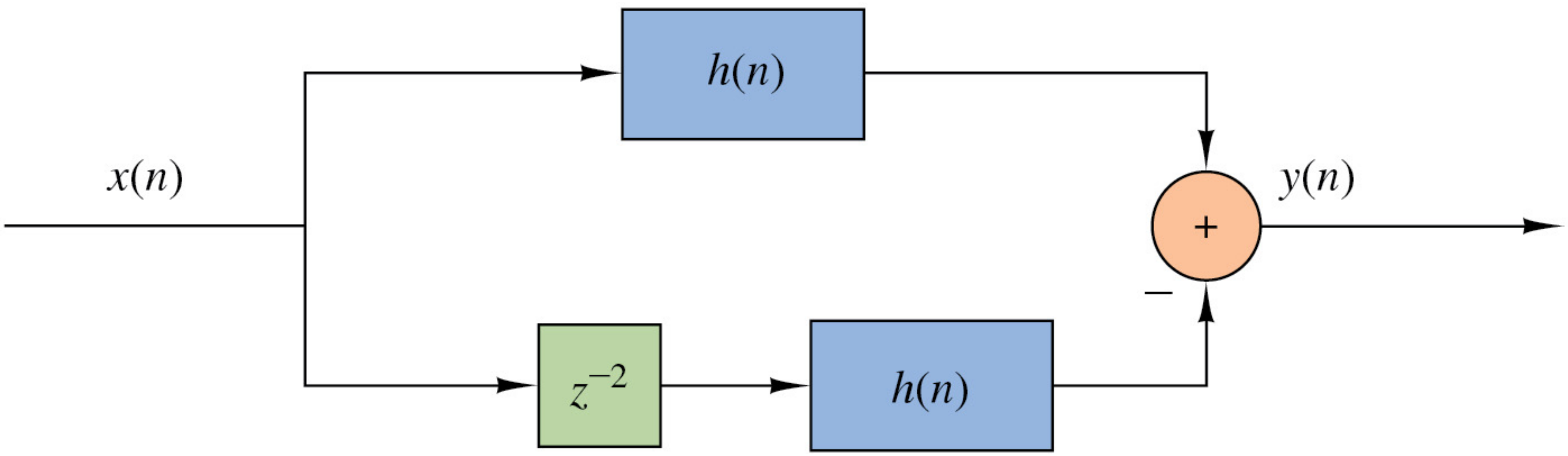


Figure P2.43

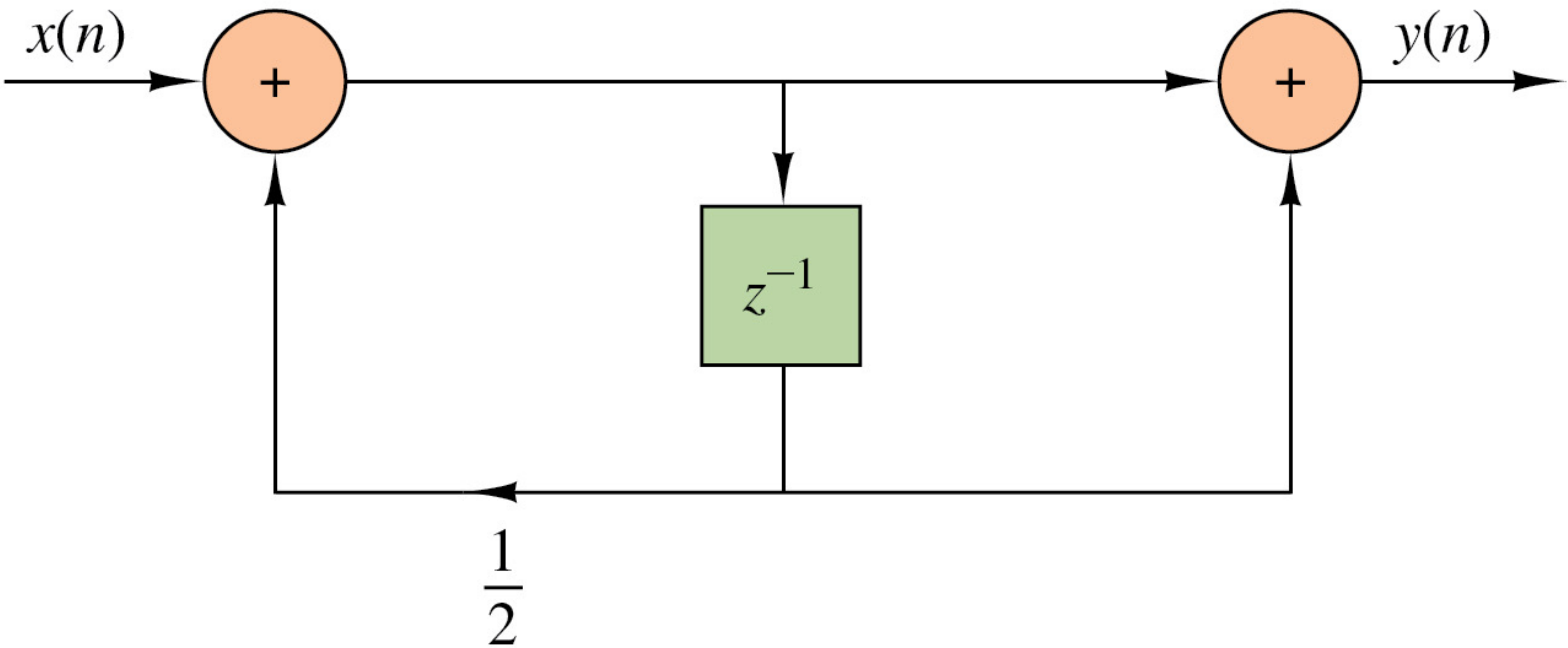


Figure P2.45

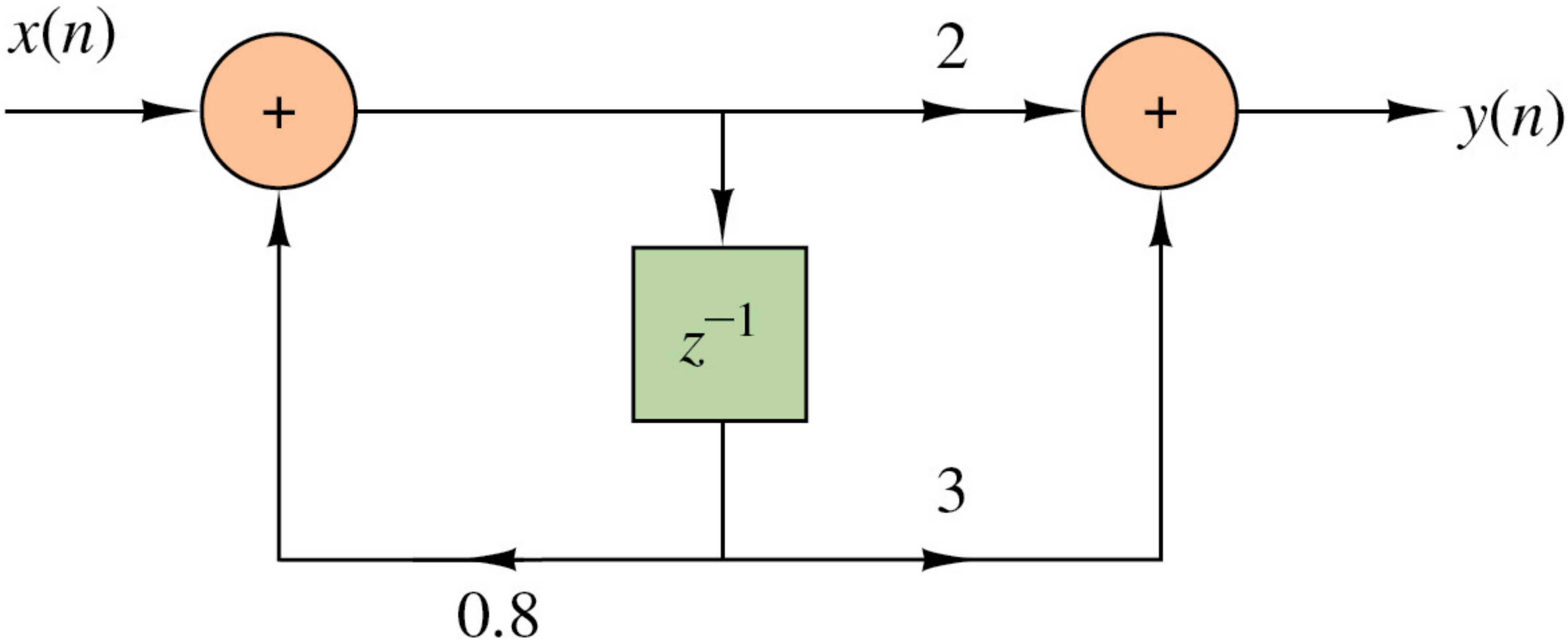
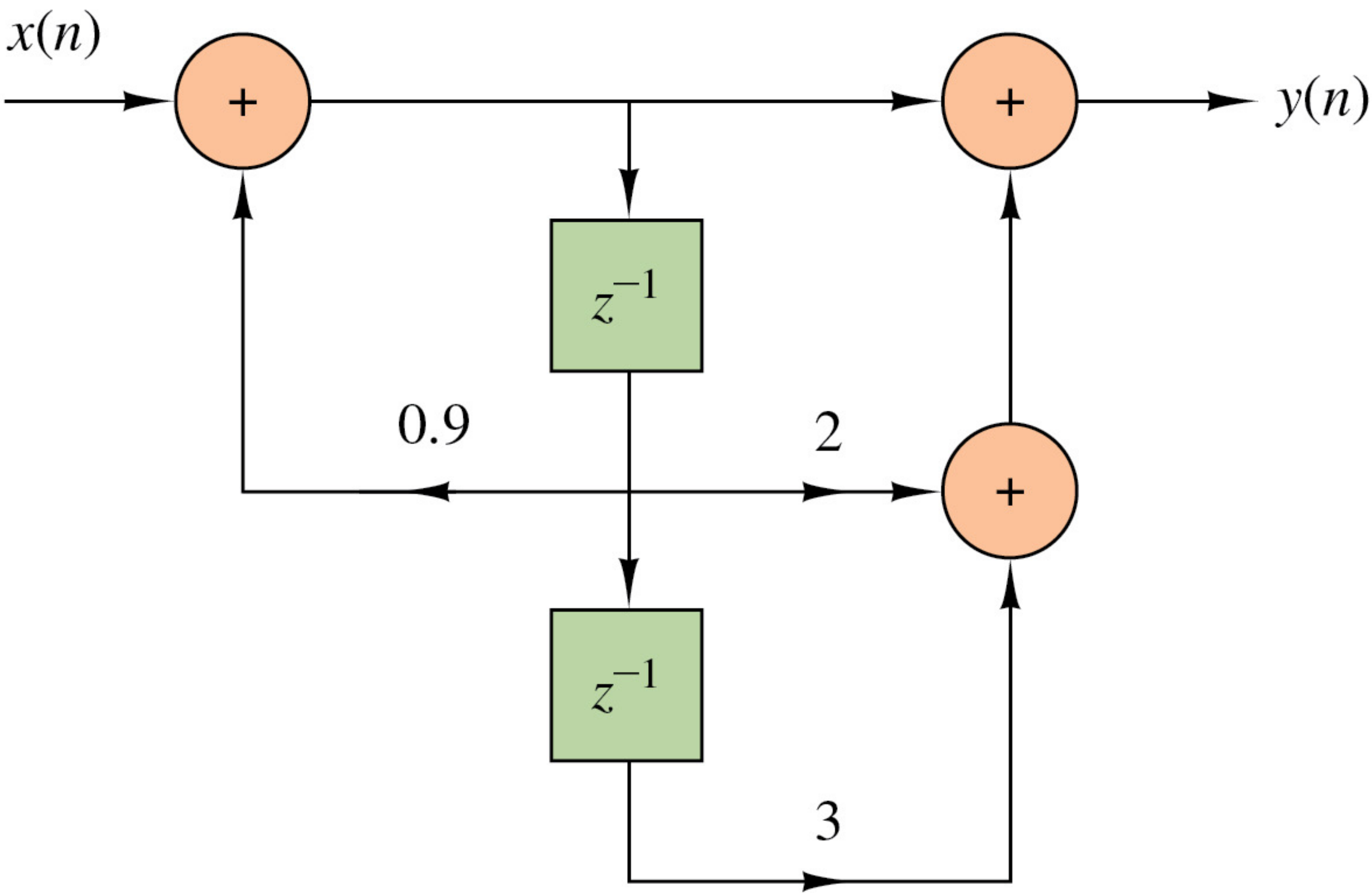


Figure P2.46



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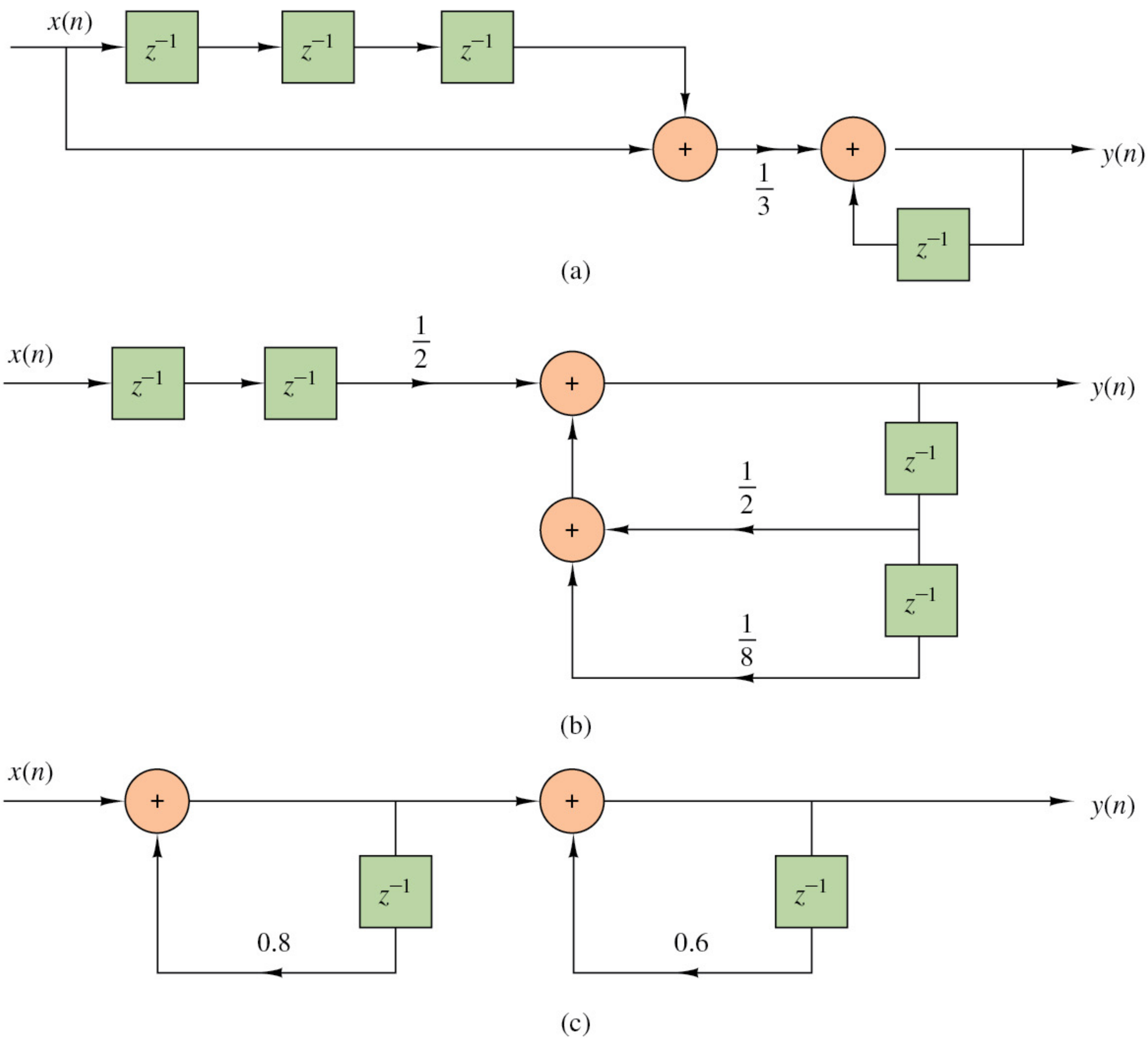
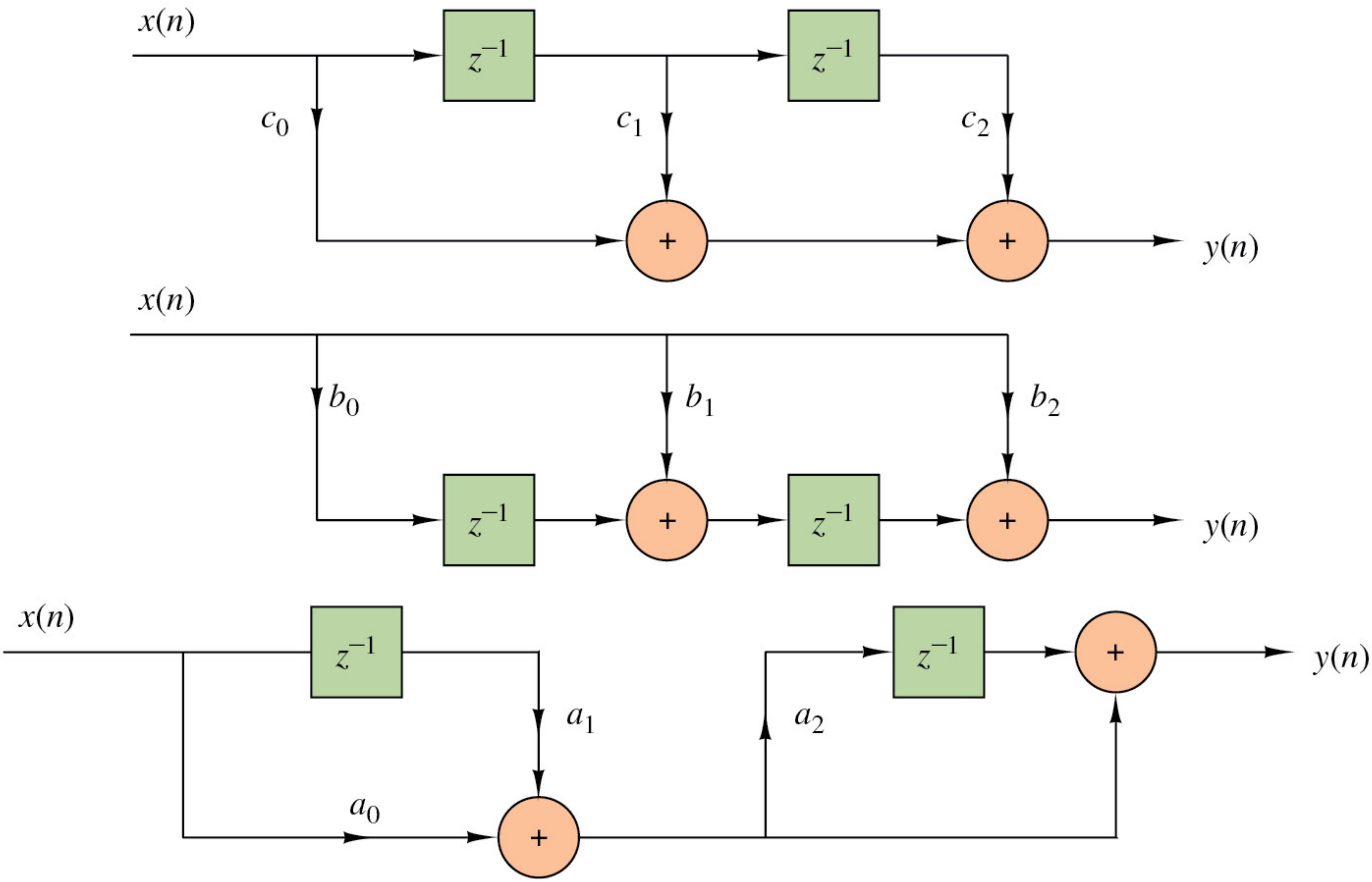


Figure P2.48



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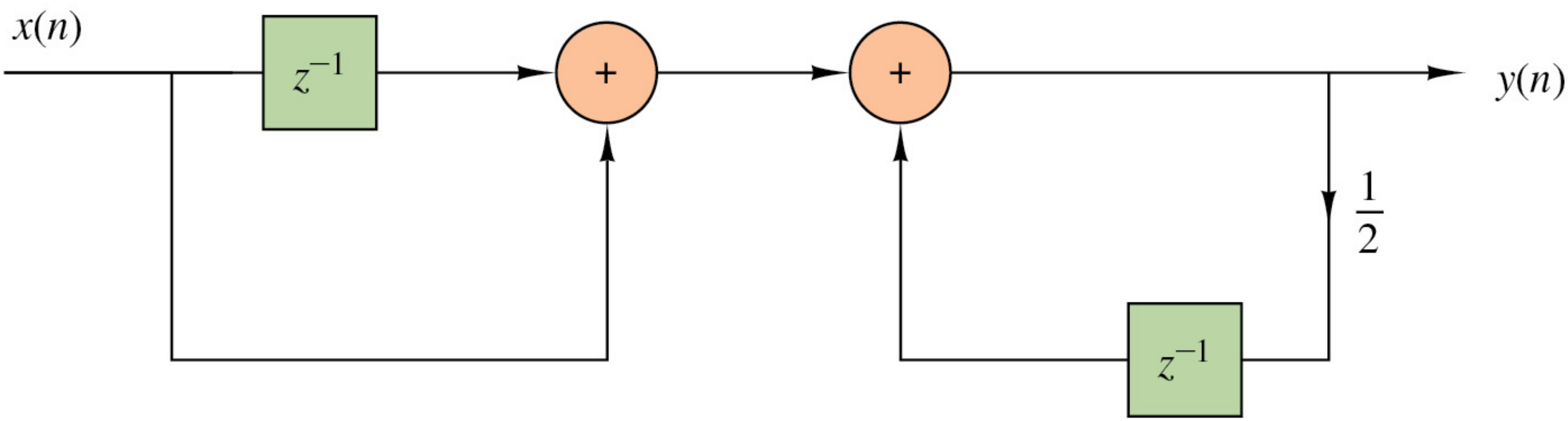
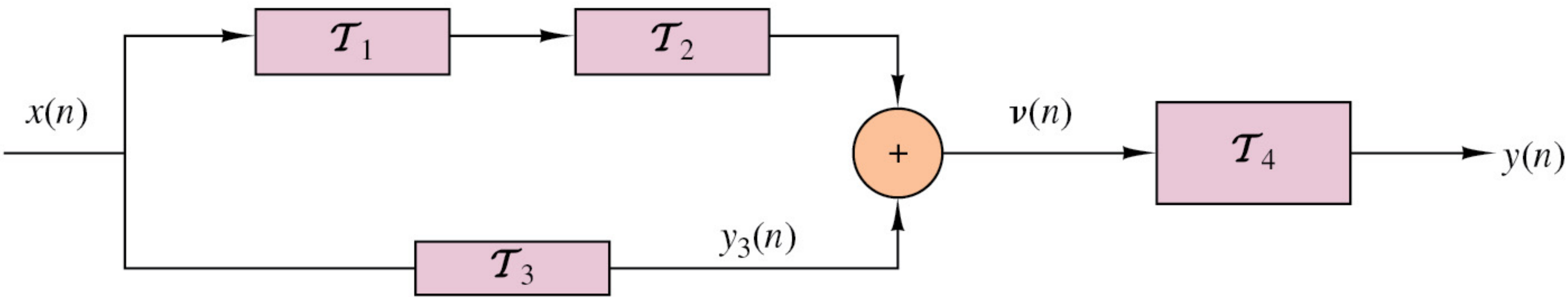


Figure CP2.15



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