Design of Digital Filters IIR

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Design of IIR Filters From Analog Filters

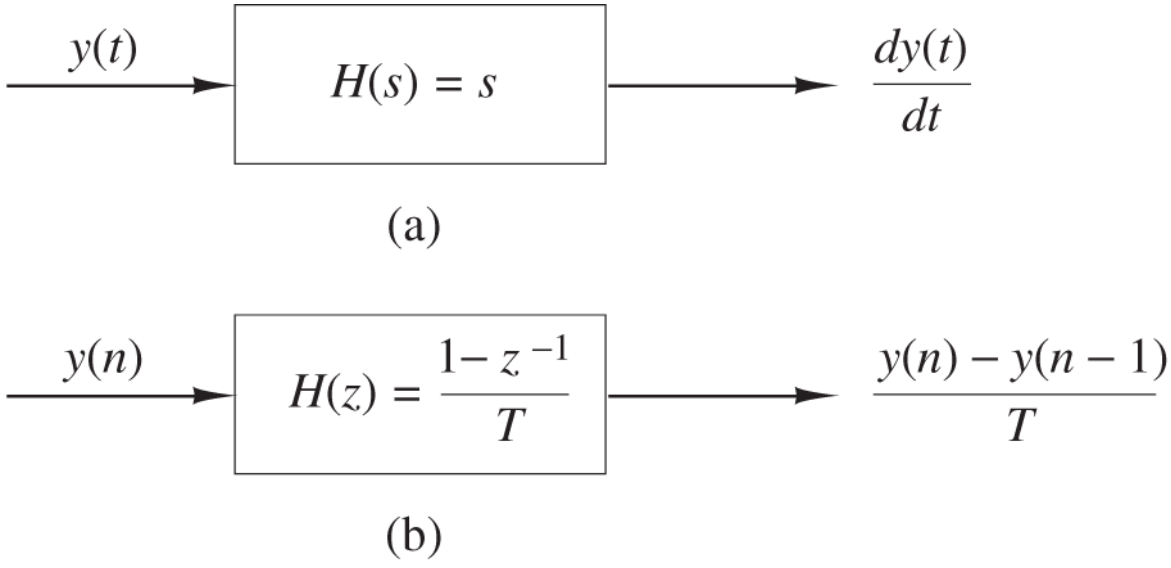

Figure 10.3.1 Substitution of the backward difference for the derivative implies the mapping $s = (1 - z^{-1})/T$.

Design of IIR Filters by Approximation of Derivatives

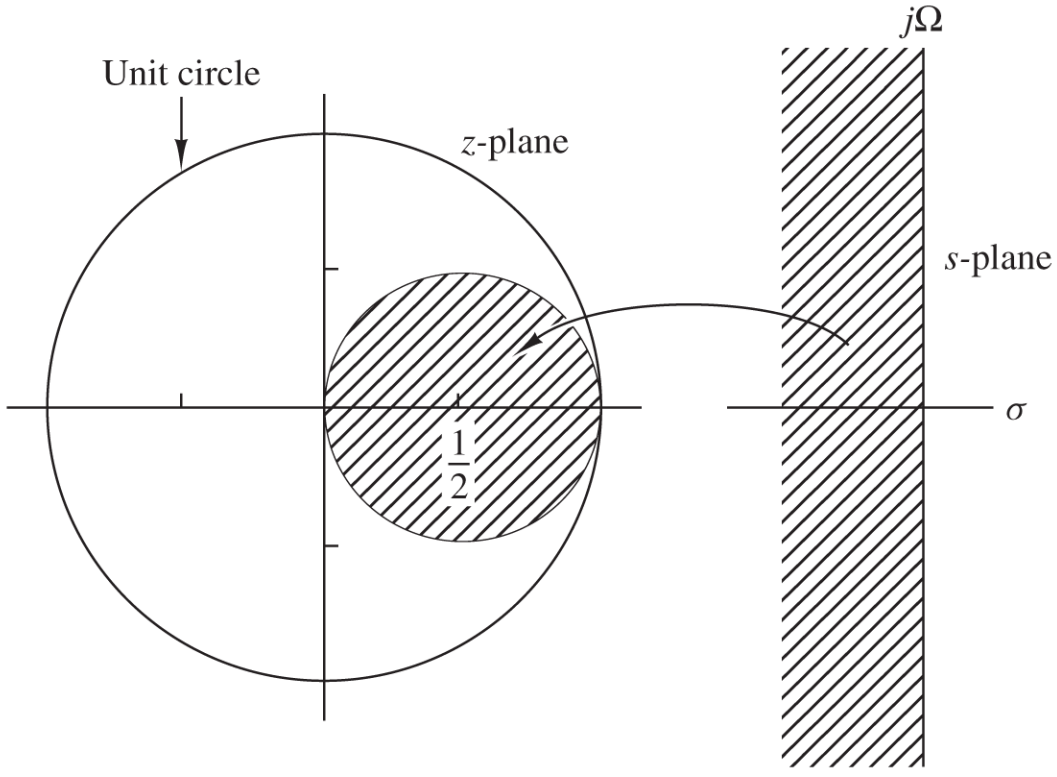

Figure 10.3.2 The mapping $s = (1 - z^{-1})/T$ takes LHP in the s-plane into points inside the circle of radius $\frac{1}{2}$ and center $z = \frac{1}{2}$ in the z-plane.

Design of IIR Filters by Impulse Invariance

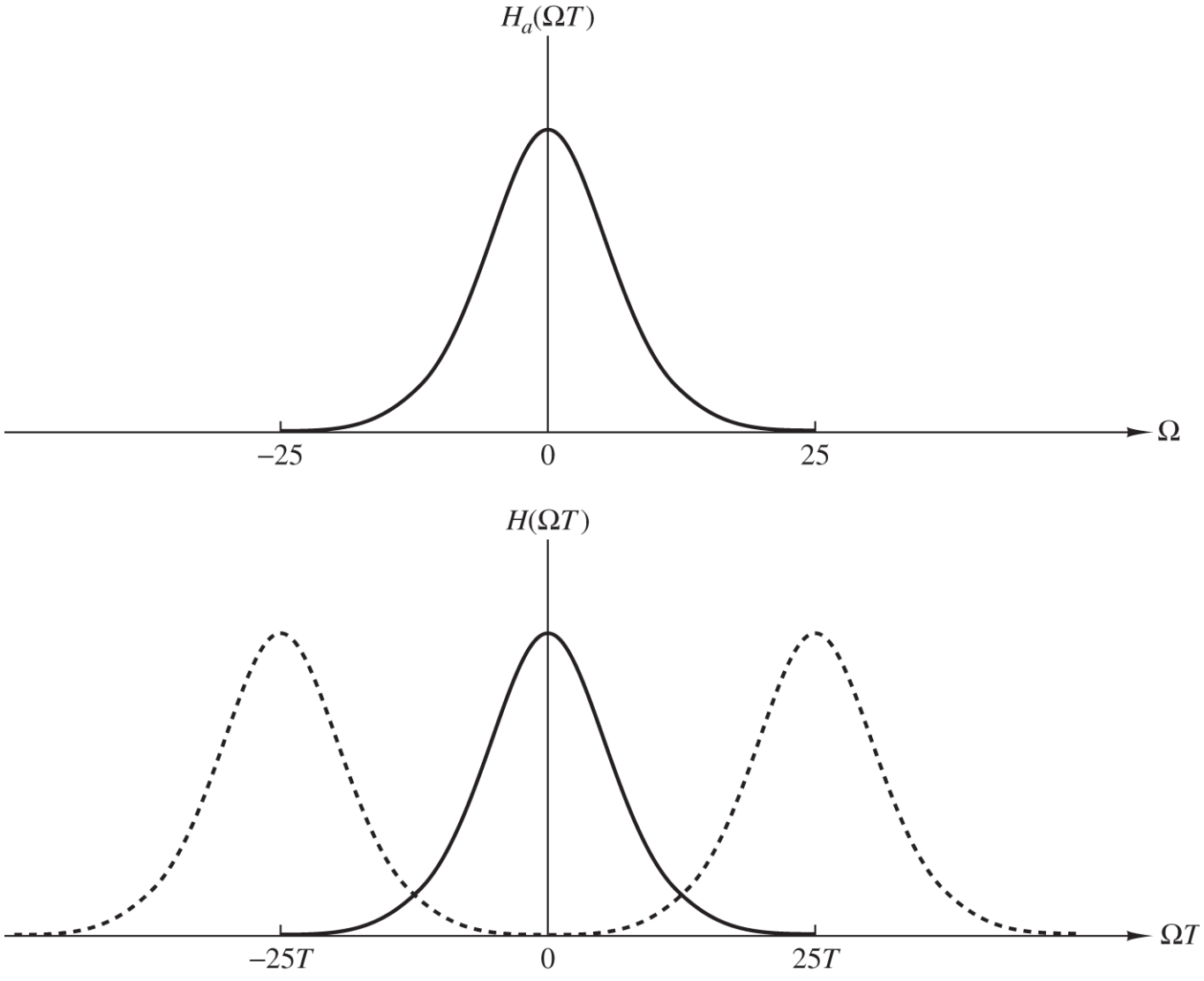

Figure 10.3.3 Frequency response $H_a(\Omega)$ of the analog filter and frequency response of the corresponding digital filter with aliasing.

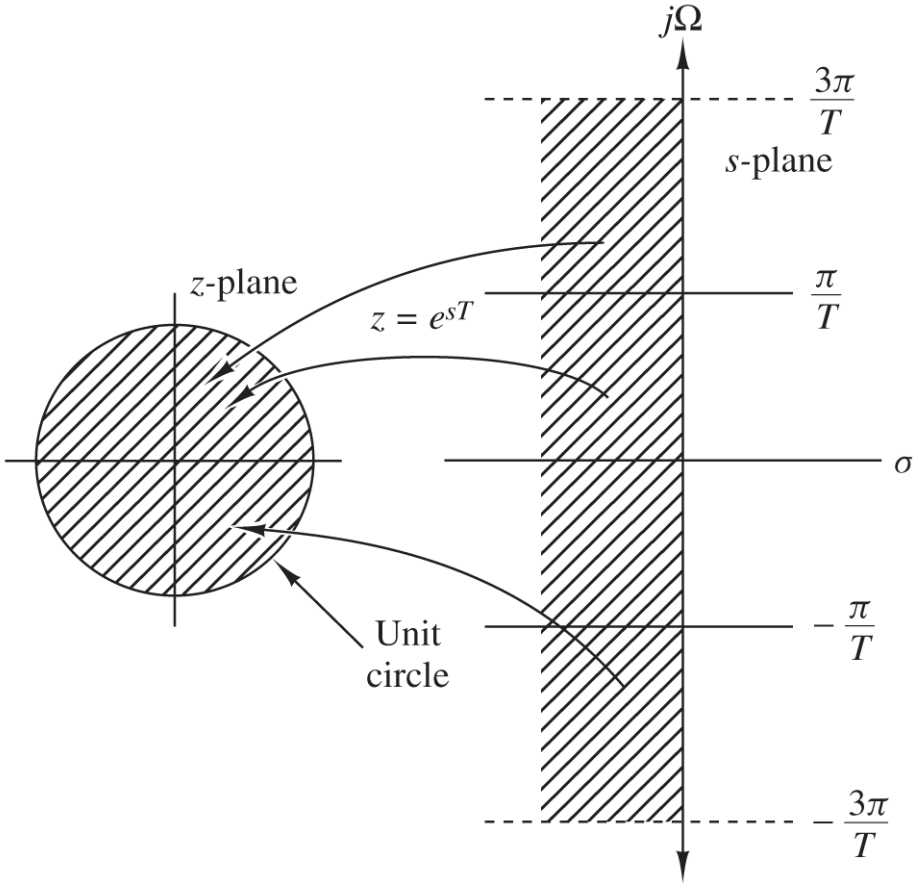

Figure 10.3.4 The mapping of $z = e^{sT}$ maps strips of width $2\pi/T$ (for $\sigma < 0$) in the s-plane into points in the unit circle in the z-plane.

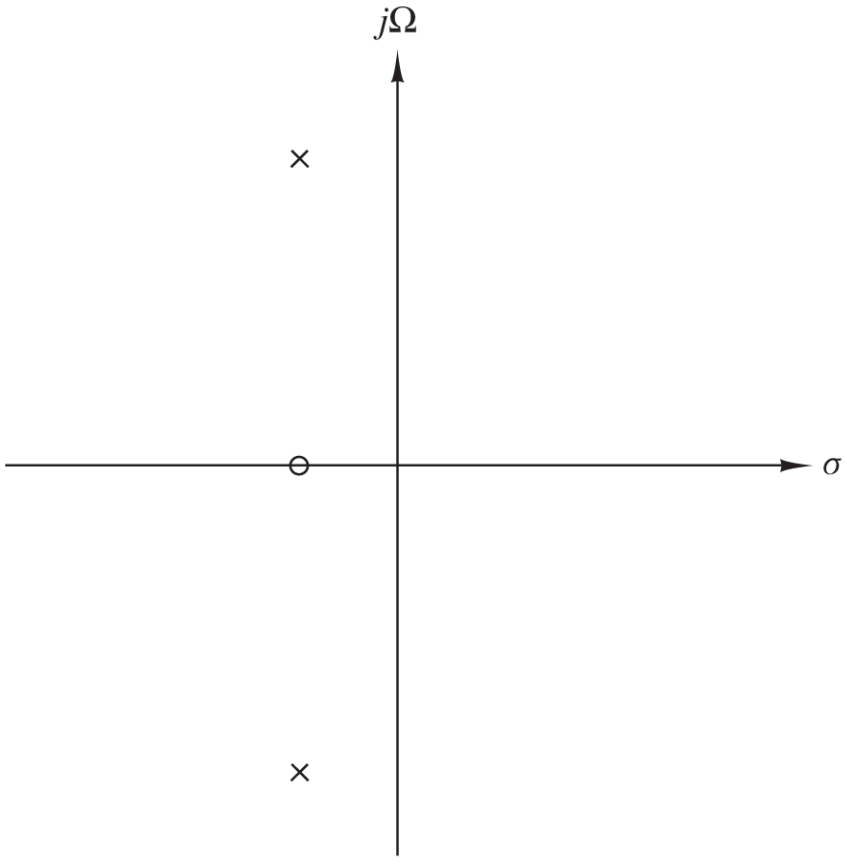

Figure 10.3.5 Pole–zero locations for analog filter in Example 10.3.3.

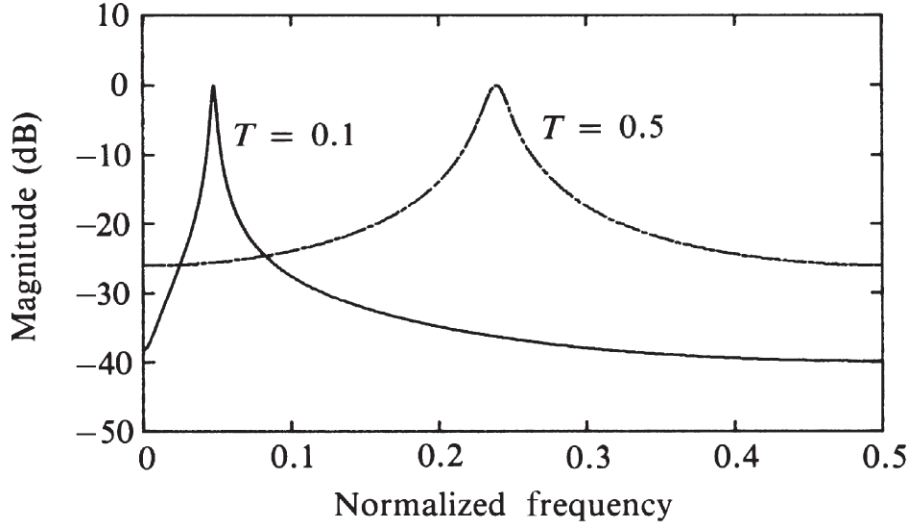

Figure 10.3.6 Frequency response of digital filter in Example 10.3.3.

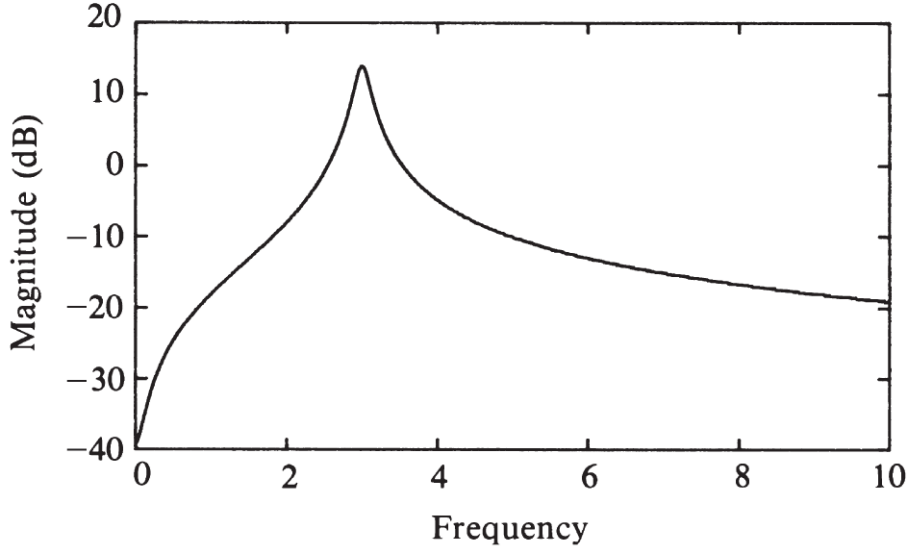

Figure 10.3.7 Frequency response of analog filter in Example 10.3.3.

IIR Filter Design by the Bilinear Transformation

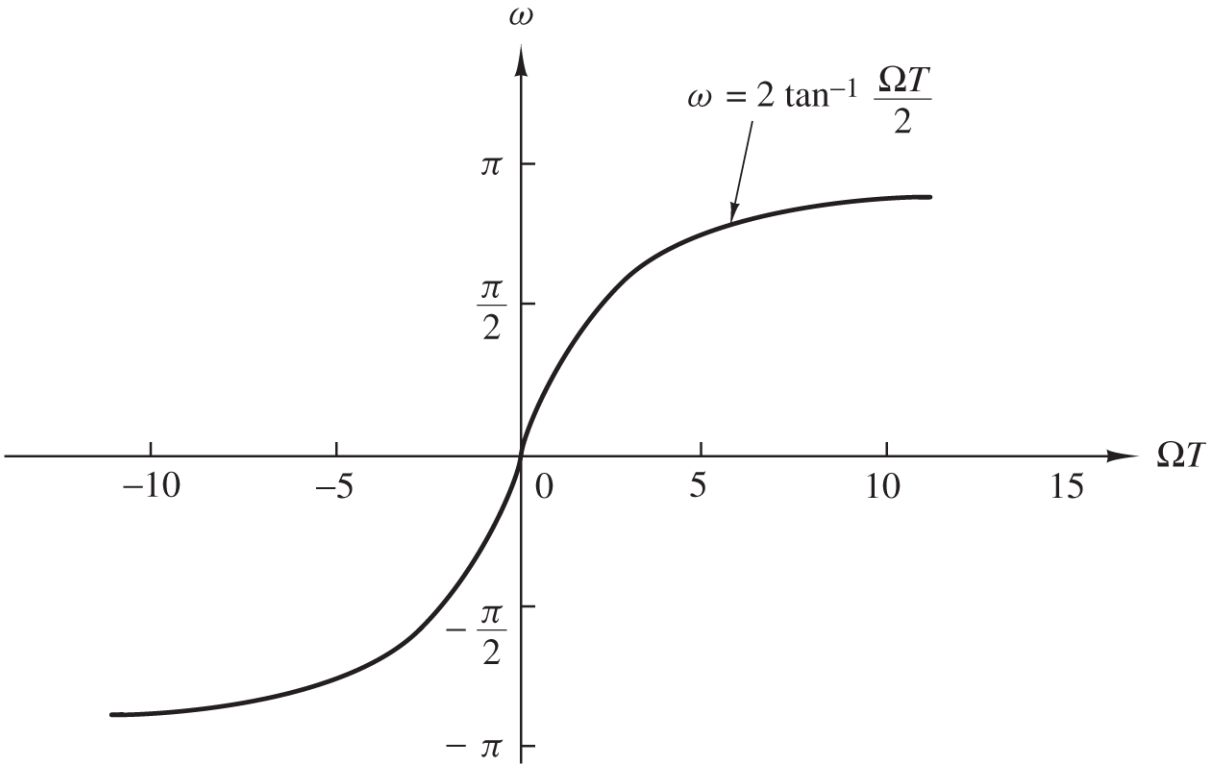

Figure 10.3.8 Mapping between the frequency variables ω and Ω resulting from the bilinear transformation.

Characteristic of Commonly Used Analog Filters

Butterworth filters

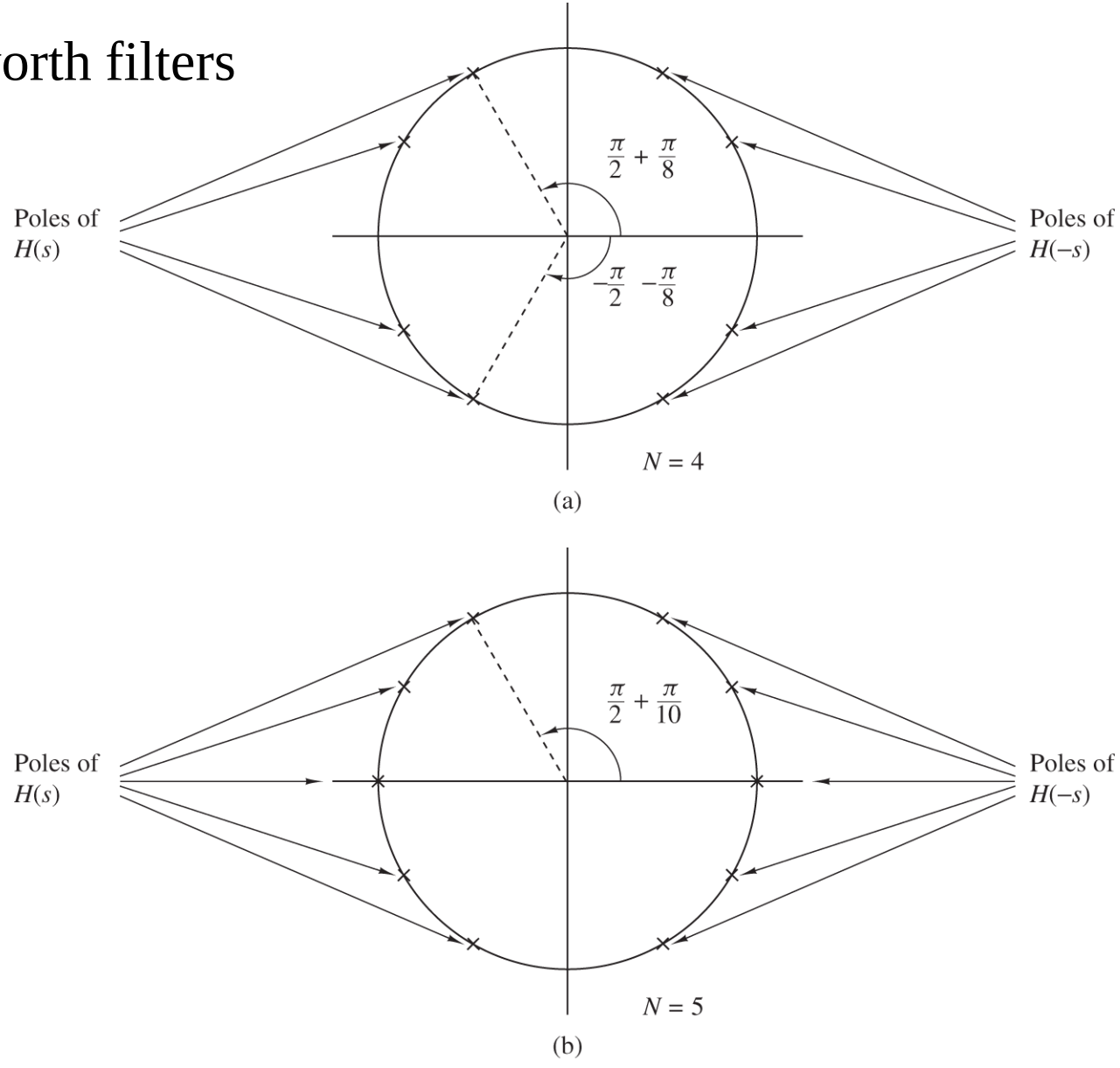

Figure 10.3.9 Pole positions for Butterworth filters.

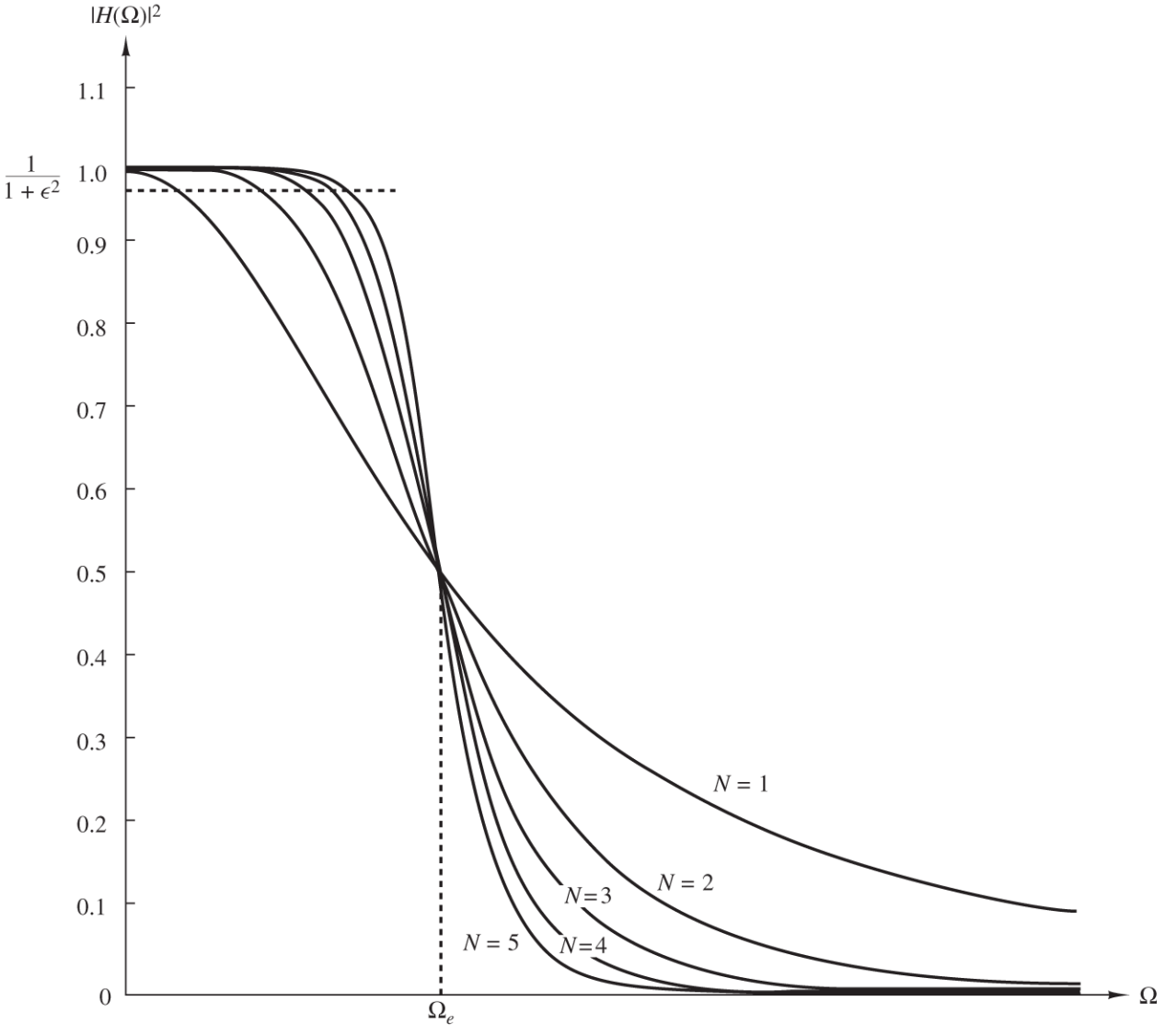

Figure 10.3.10 Frequency response of Butterworth filters.

Chebyshev filters

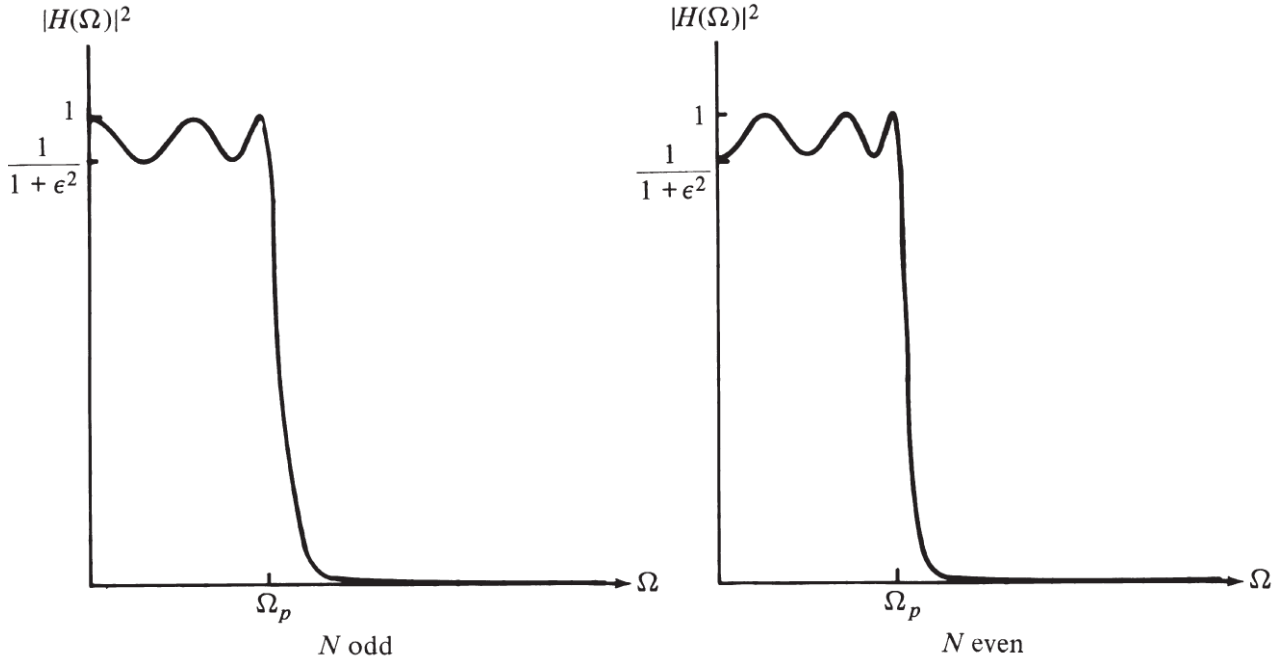

Figure 10.3.11 Type I Chebyshev filter characteristic.

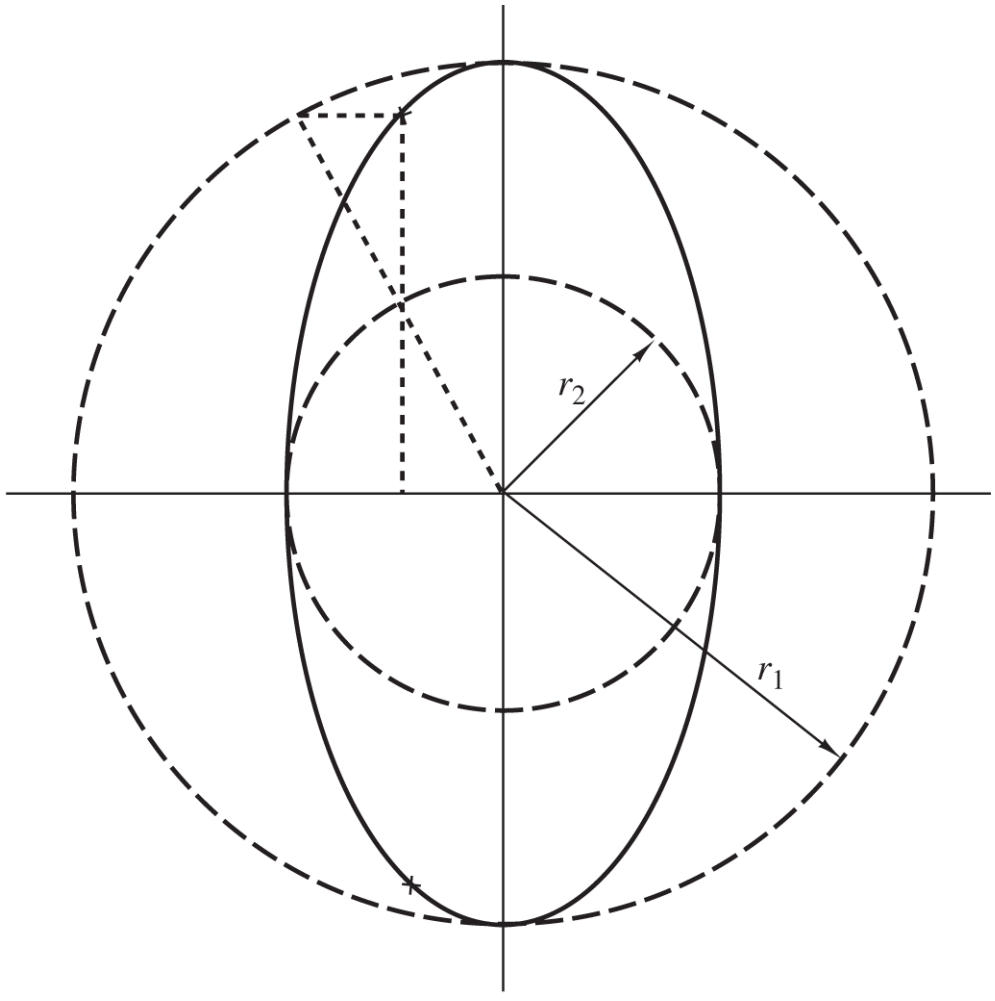

Figure 10.3.12 Determination of the pole locations for a Chebyshev filter.

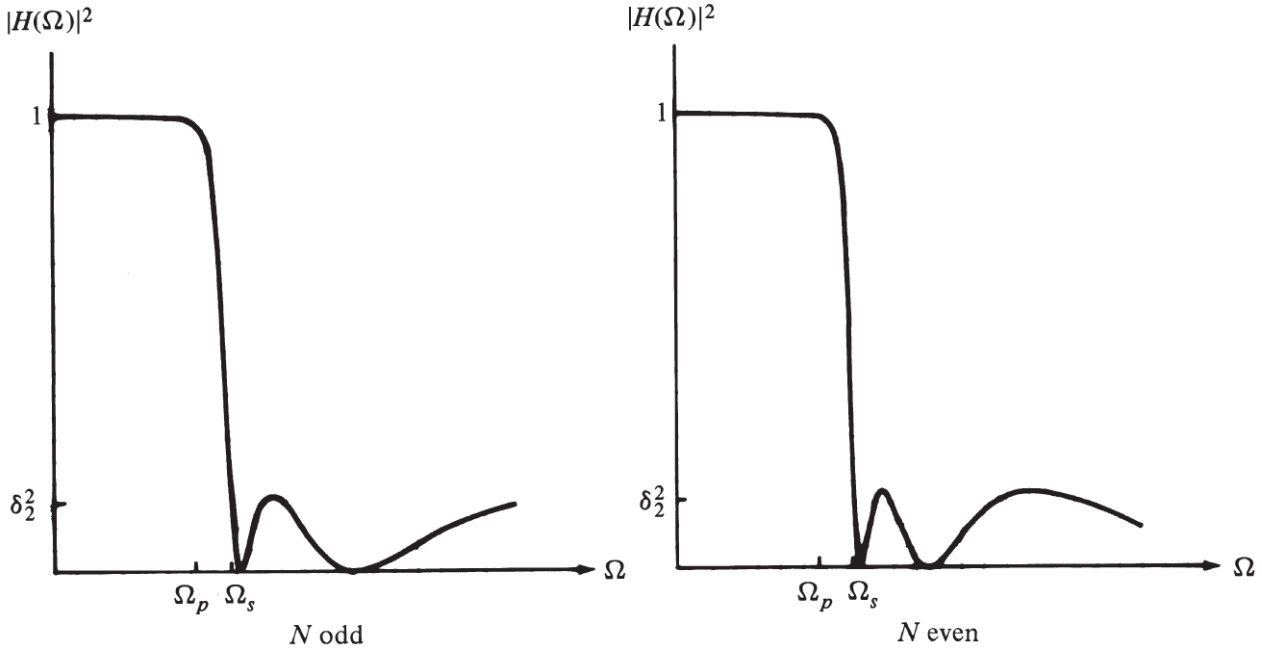

Figure 10.3.13 Type II Chebyshev filters.

Elliptic filters

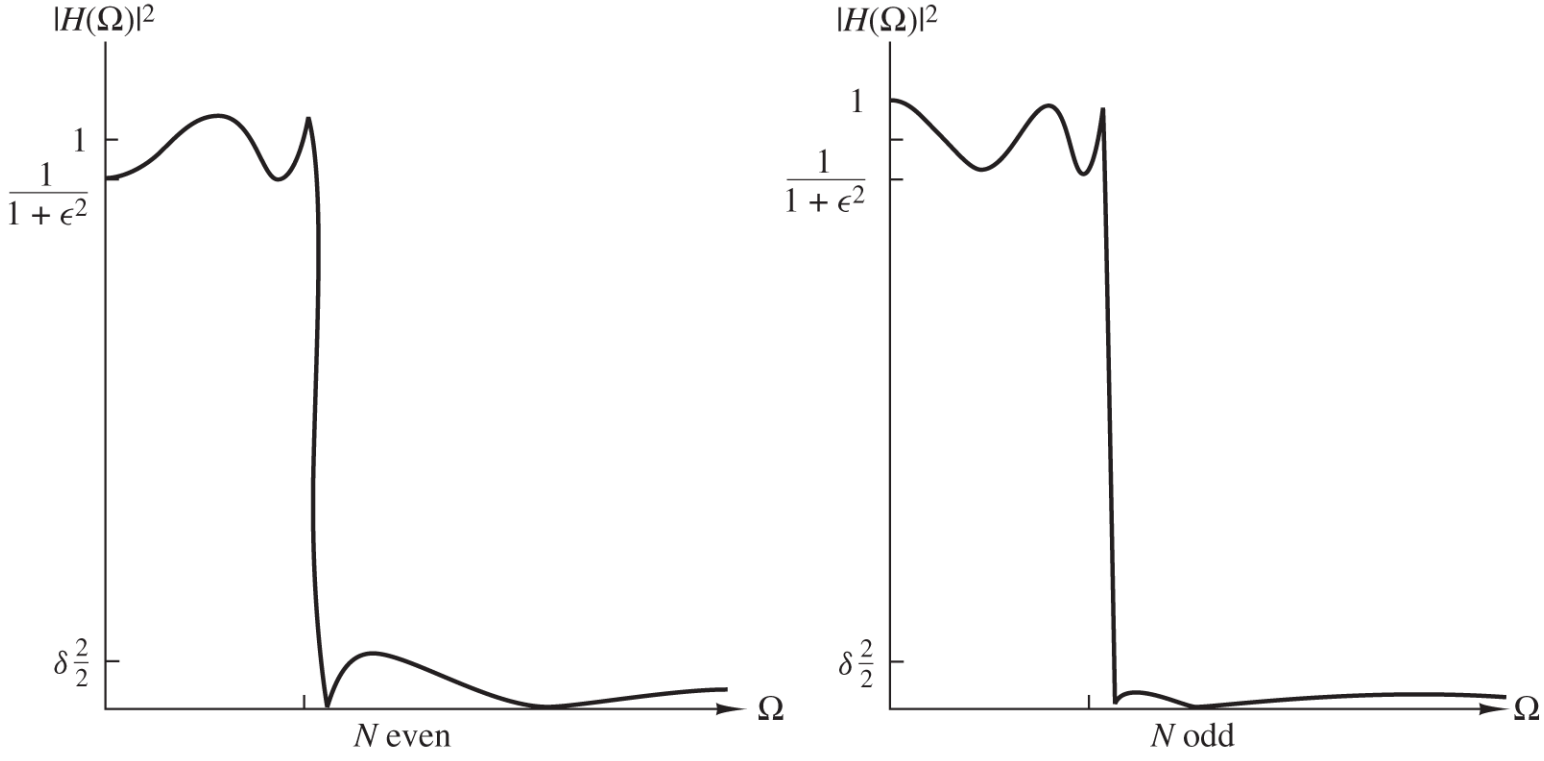

Figure 10.3.14 Magnitude-squared frequency characteristics of elliptic filters.

Bessel filters

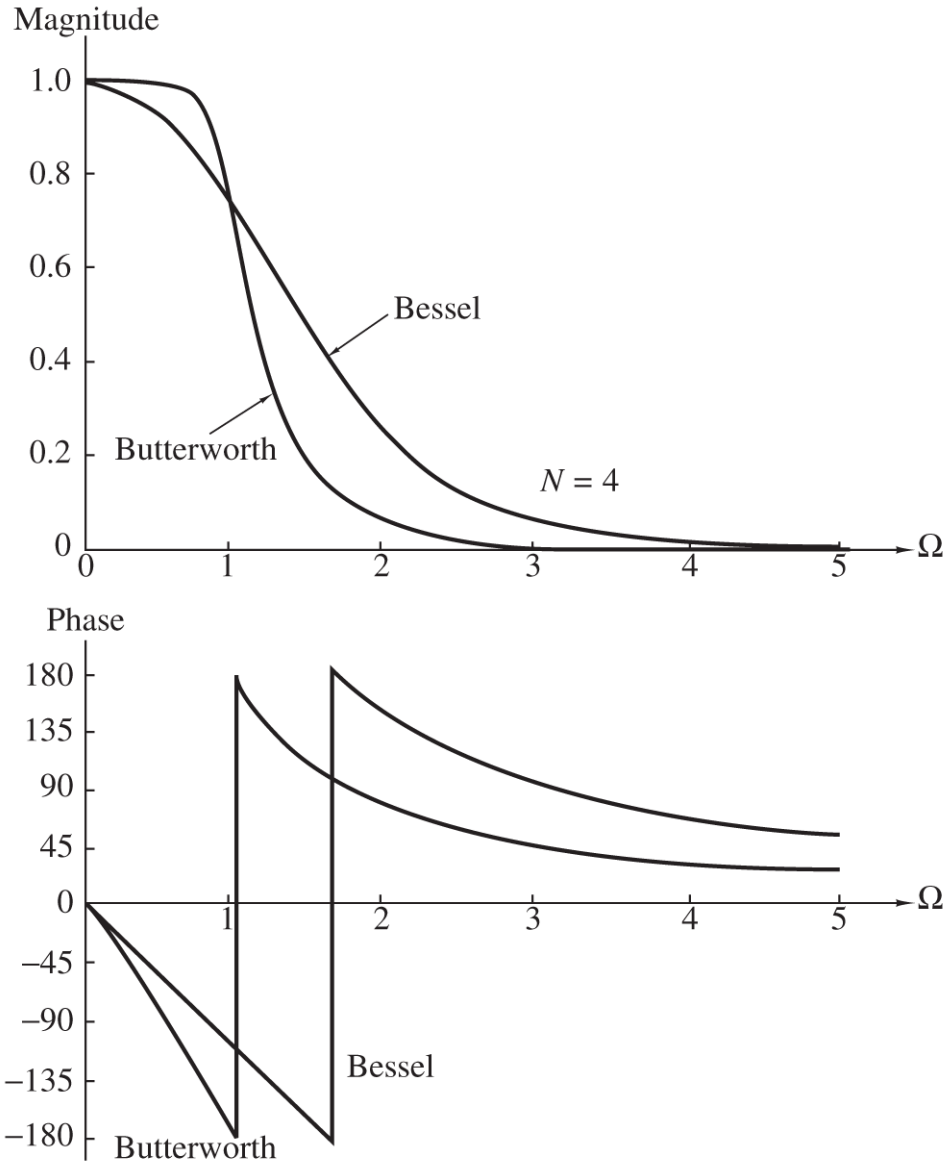

Figure 10.3.15 Magnitude and phase responses of Bessel and Butterworth filters of order $N = 4$.