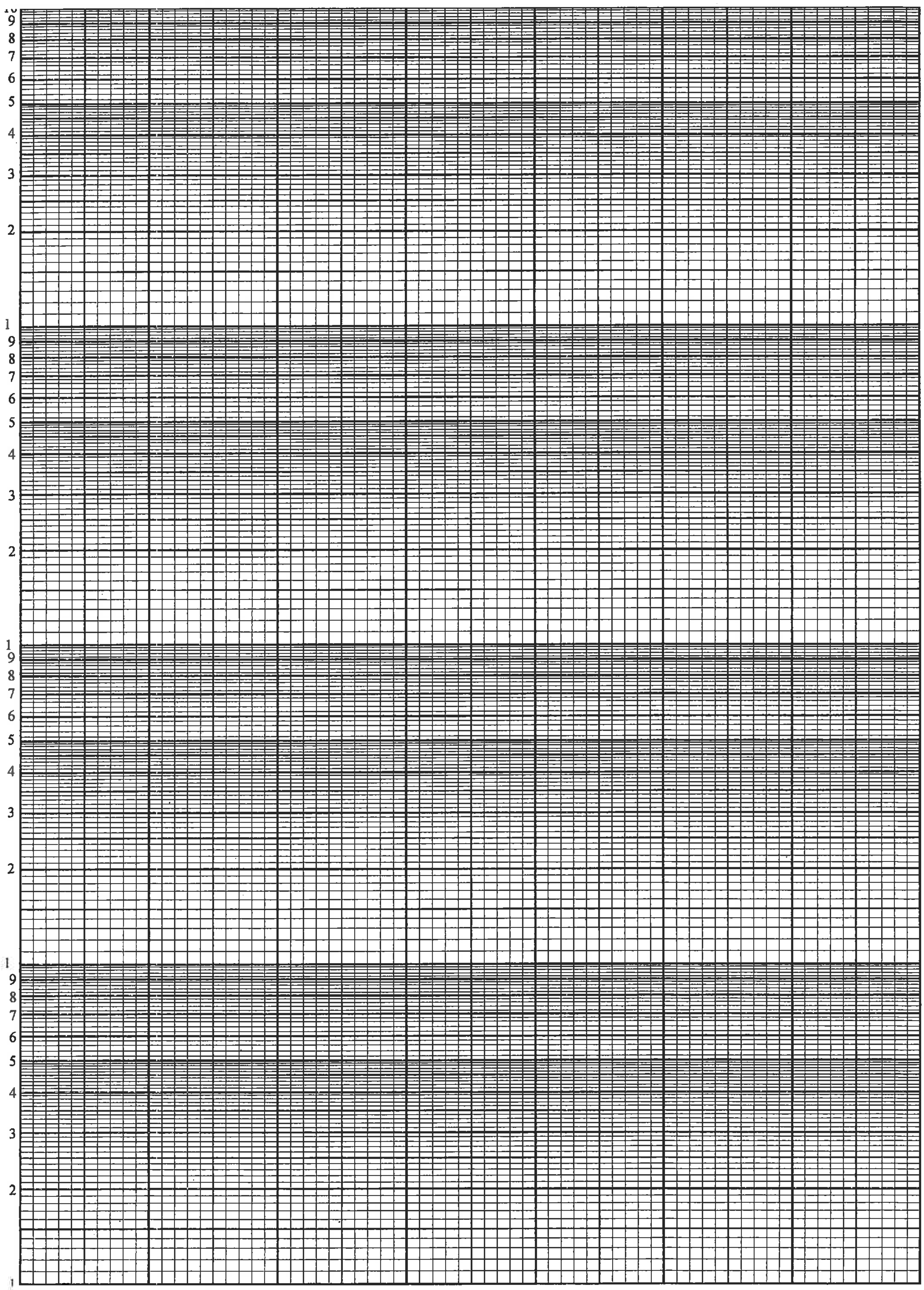
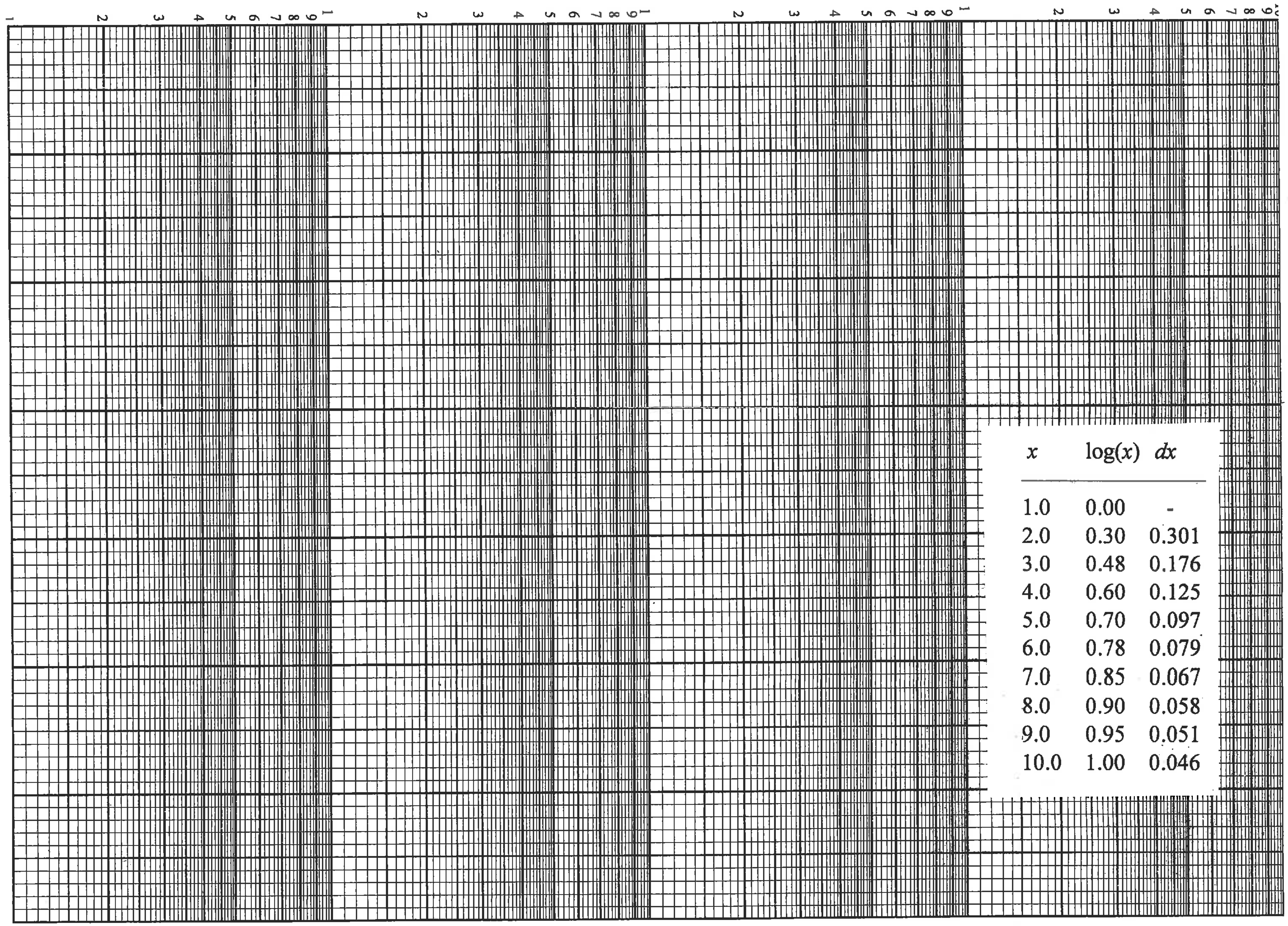
The frequency response of a system is defined as the steady-state response of the system to a sinusoidal input signal.

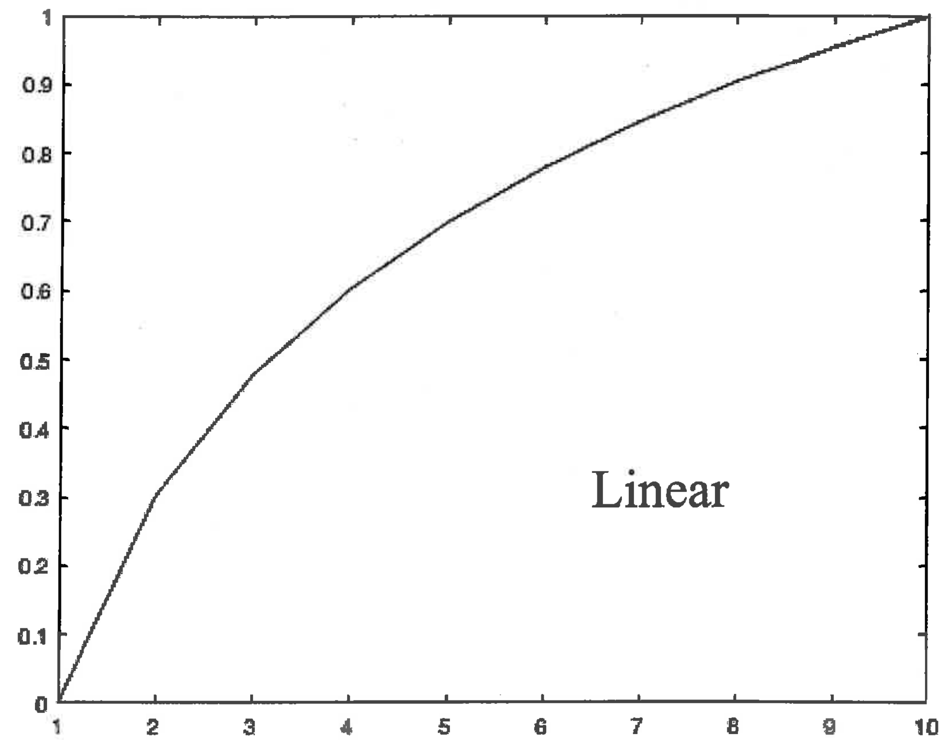
The sinusoid is a unique input signal. For linear time invariant systems sinusoid in always produces a sinusoid out. The output differs from the input only in magnitude and phase.

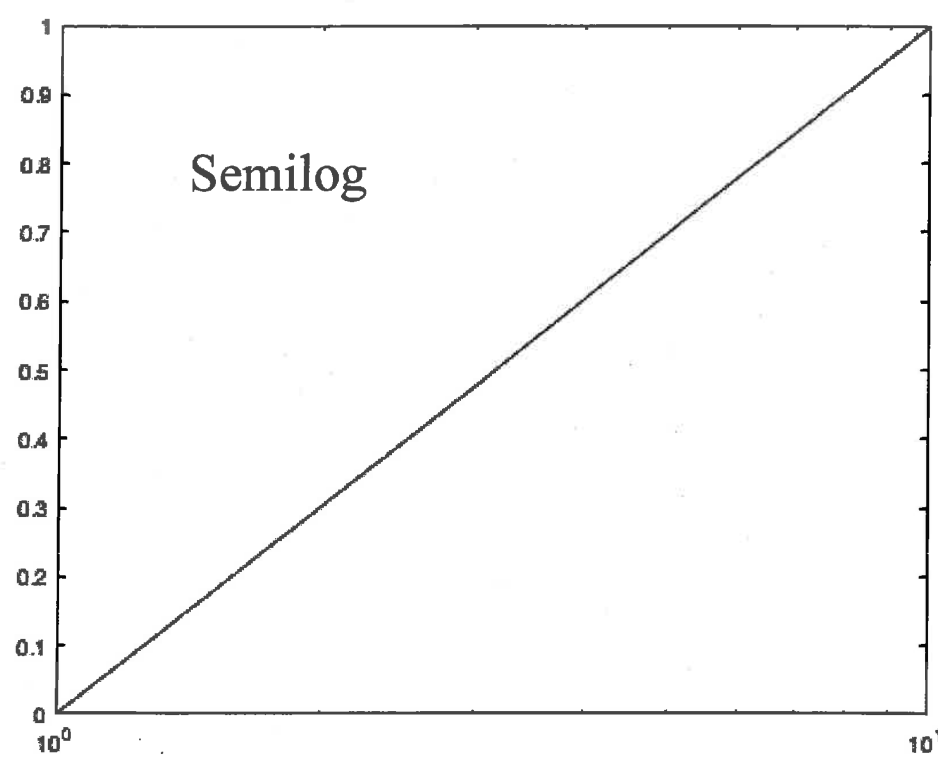

1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 10



x	$\log(x)$	dx
1.0	0.00	-
2.0	0.30	0.301
3.0	0.48	0.176
4.0	0.60	0.125
5.0	0.70	0.097
6.0	0.78	0.079
7.0	0.85	0.067
8.0	0.90	0.058
9.0	0.95	0.051
10.0	1.00	0.046

Log(x) ; $1 \le x \le 10$





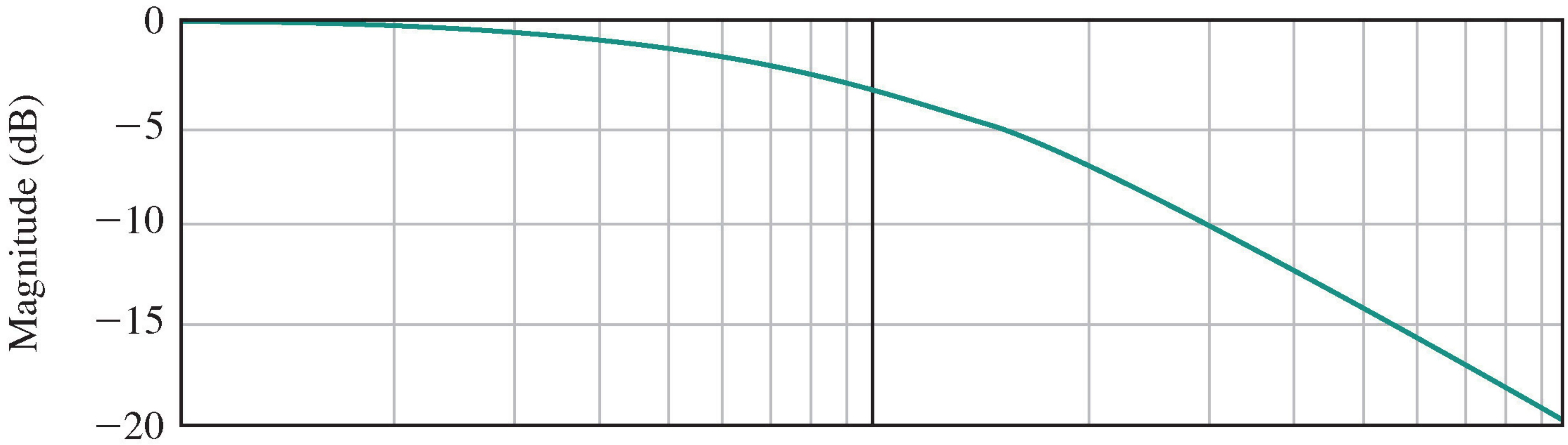
$$G(j\omega) = \frac{K_b \prod_{i=1}^{Q} (1 + j\omega\tau_i)}{(j\omega)^N \prod_{m=1}^{M} (1 + j\omega\tau_m) \prod_{k=1}^{R} [(1 + (2\zeta_k/\omega_{nk})j\omega + (j\omega/\omega_{nk})^2)]}. \quad (8.26)$$

$$\begin{aligned} 20 \log|G(j\omega)| = {} & 20 \log K_b + 20 \sum_{i=1}^{Q} \log|1 + j\omega\tau_i| \\ & -20 \log|(j\omega)^N| - 20 \sum_{m=1}^{M} \log|1 + j\omega\tau_m| \\ & -20 \sum_{k=1}^{R} \log\left|1 + \frac{2\zeta_k}{\omega_{nk}} j\omega + \left(\frac{j\omega}{\omega_{nk}}\right)^2\right|. \quad (8.27) \end{aligned}$$

$$G(j\omega) = \frac{K_b \prod_{i=1}^{Q} (1 + j\omega\tau_i)}{(j\omega)^N \prod_{m=1}^{M} (1 + j\omega\tau_m) \prod_{k=1}^{R} [(1 + (2\zeta_k/\omega_{nk})j\omega + (j\omega/\omega_{nk})^2)]}. \quad (8.26)$$

$$\phi(\omega) = +\sum_{i=1}^{Q} \tan^{-1}(\omega\tau_i) - N\frac{\pi}{2} - \sum_{m=1}^{M} \tan^{-1}(\omega\tau_m) - \sum_{k=1}^{R} \tan^{-1} \frac{2\zeta_k\omega_{nk}\omega}{\omega_{nk}^2 - \omega^2}, \quad (8.28)$$

FIGURE 8.6 Bode plot for $G(j\omega) = 1/(j\omega\tau + 1)$; (a) magnitude plot and (b) phase plot.



(a)

continued on next slide

FIGURE 8.6 Bode plot for $G(j\omega) = 1/(j\omega\tau + 1)$; (a) magnitude plot and (b) phase plot.

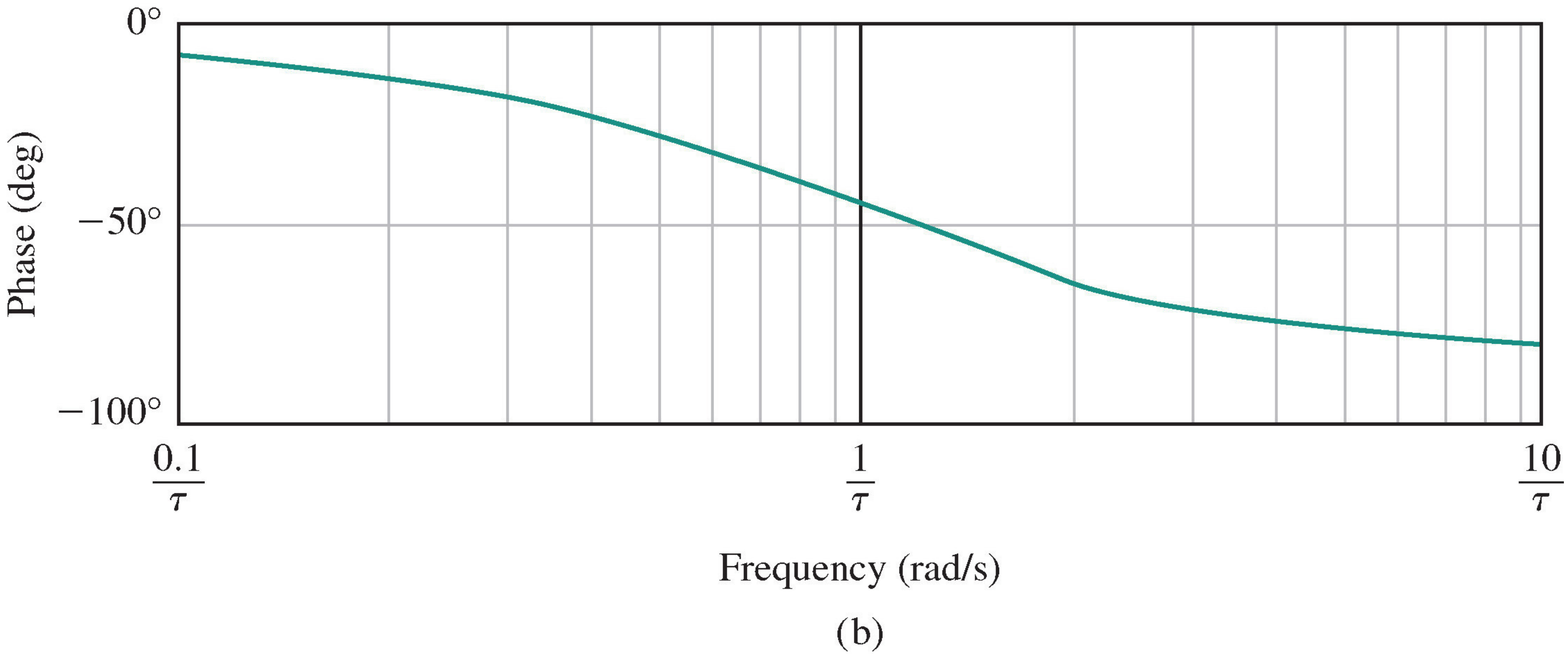


FIGURE 8.8 Bode plot for $(j\omega)^{\pm N}$.

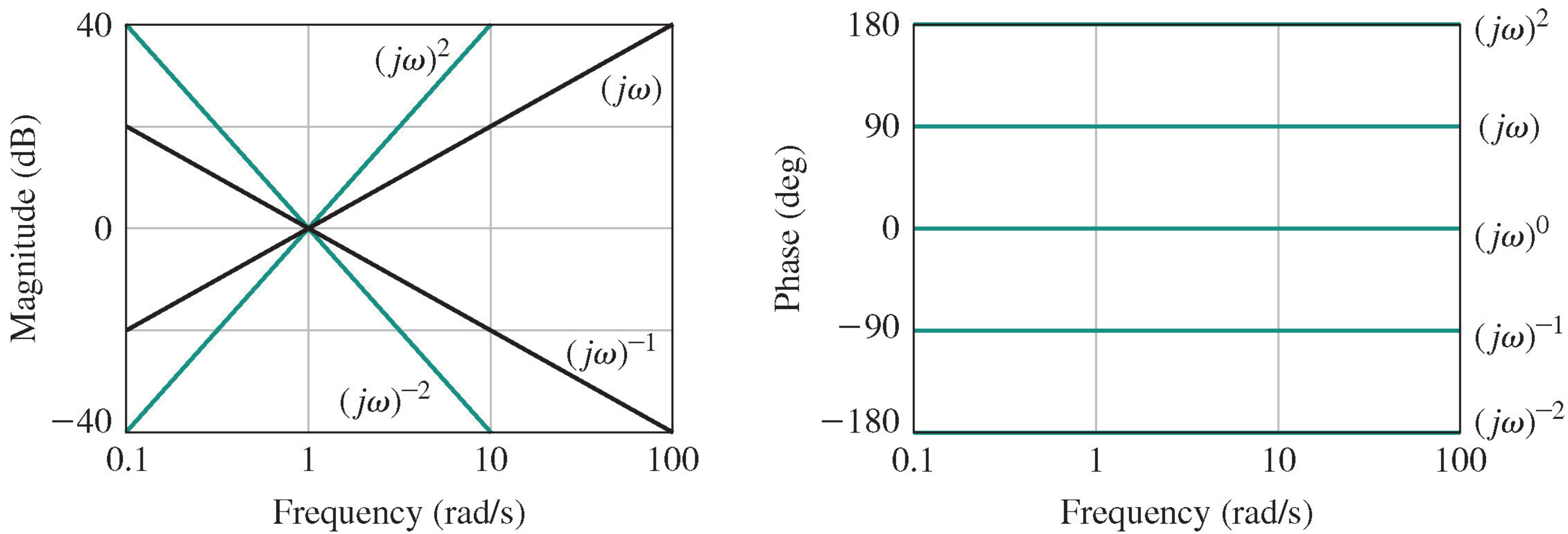
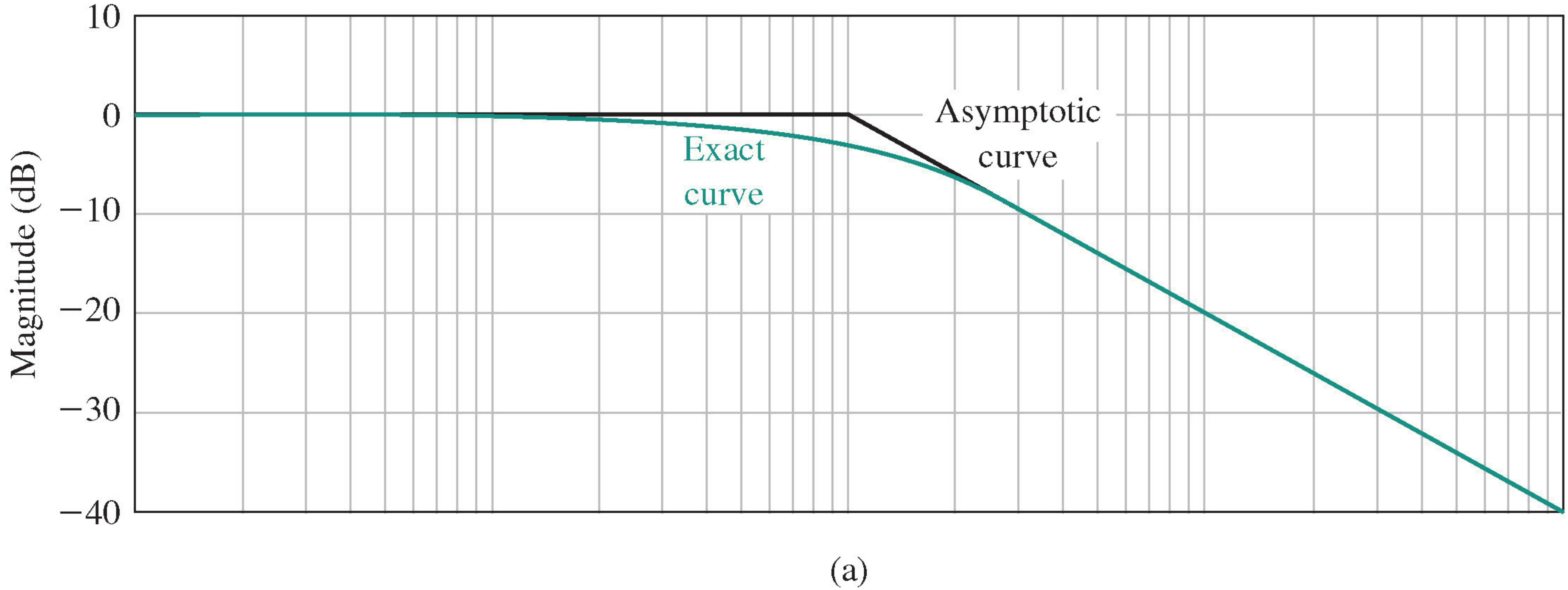


FIGURE 8.9 Bode diagram for $(1 + j\omega\tau)^{-1}$.



continued on next slide

FIGURE 8.9 Bode diagram for $(1 + j\omega\tau)^{-1}$.

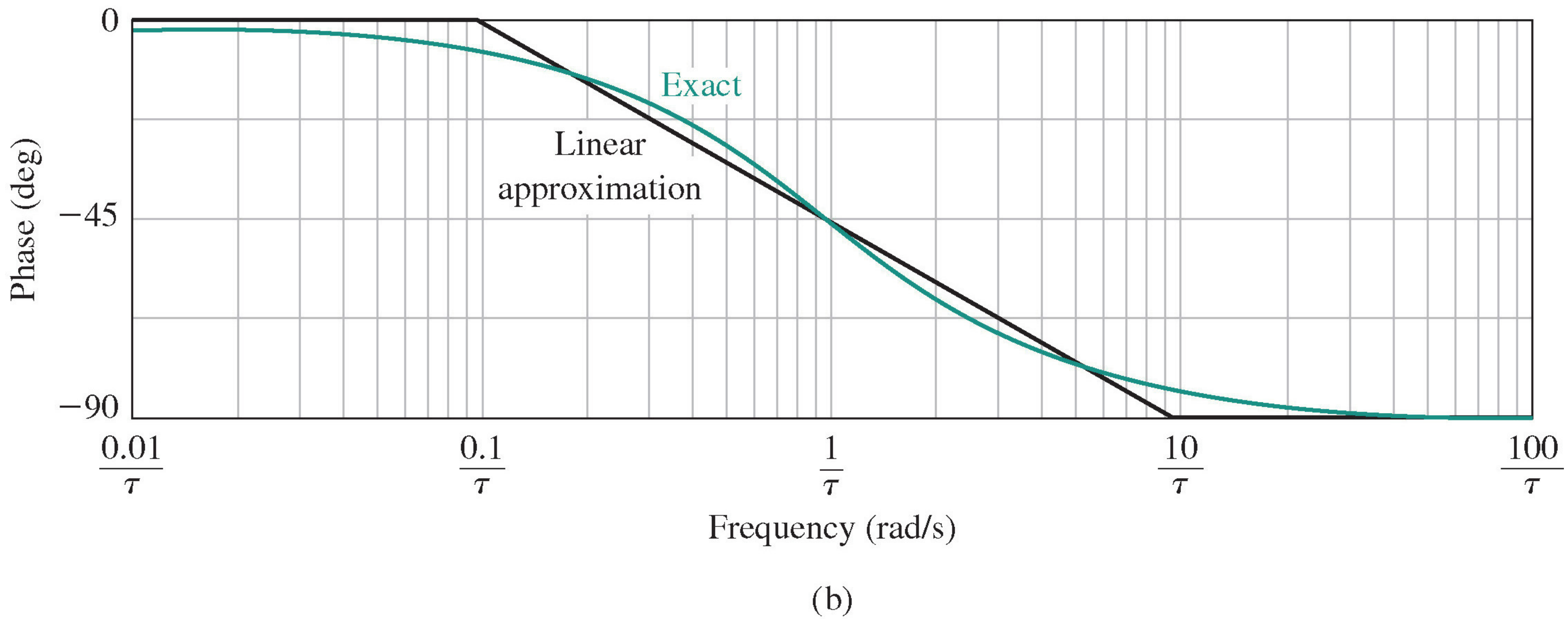
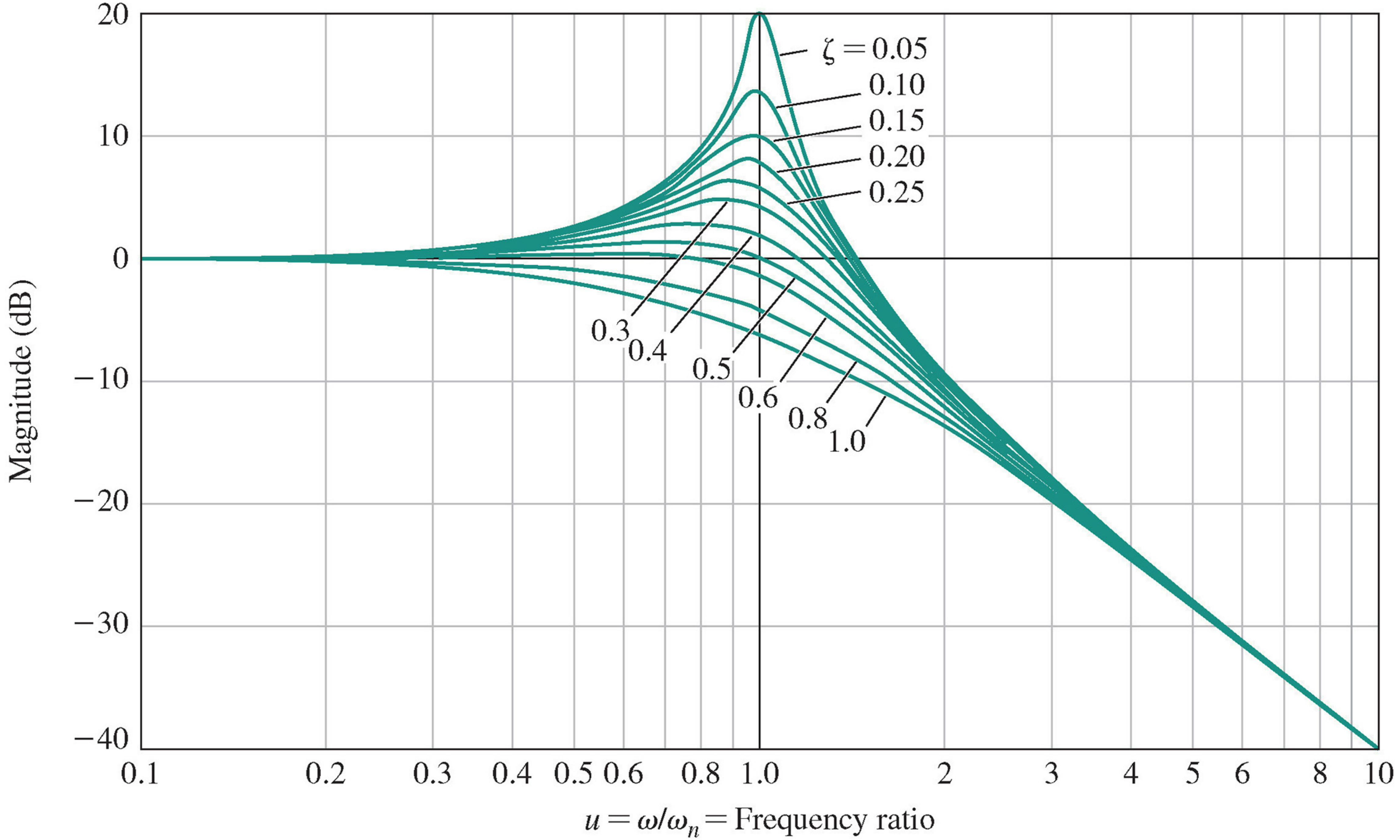


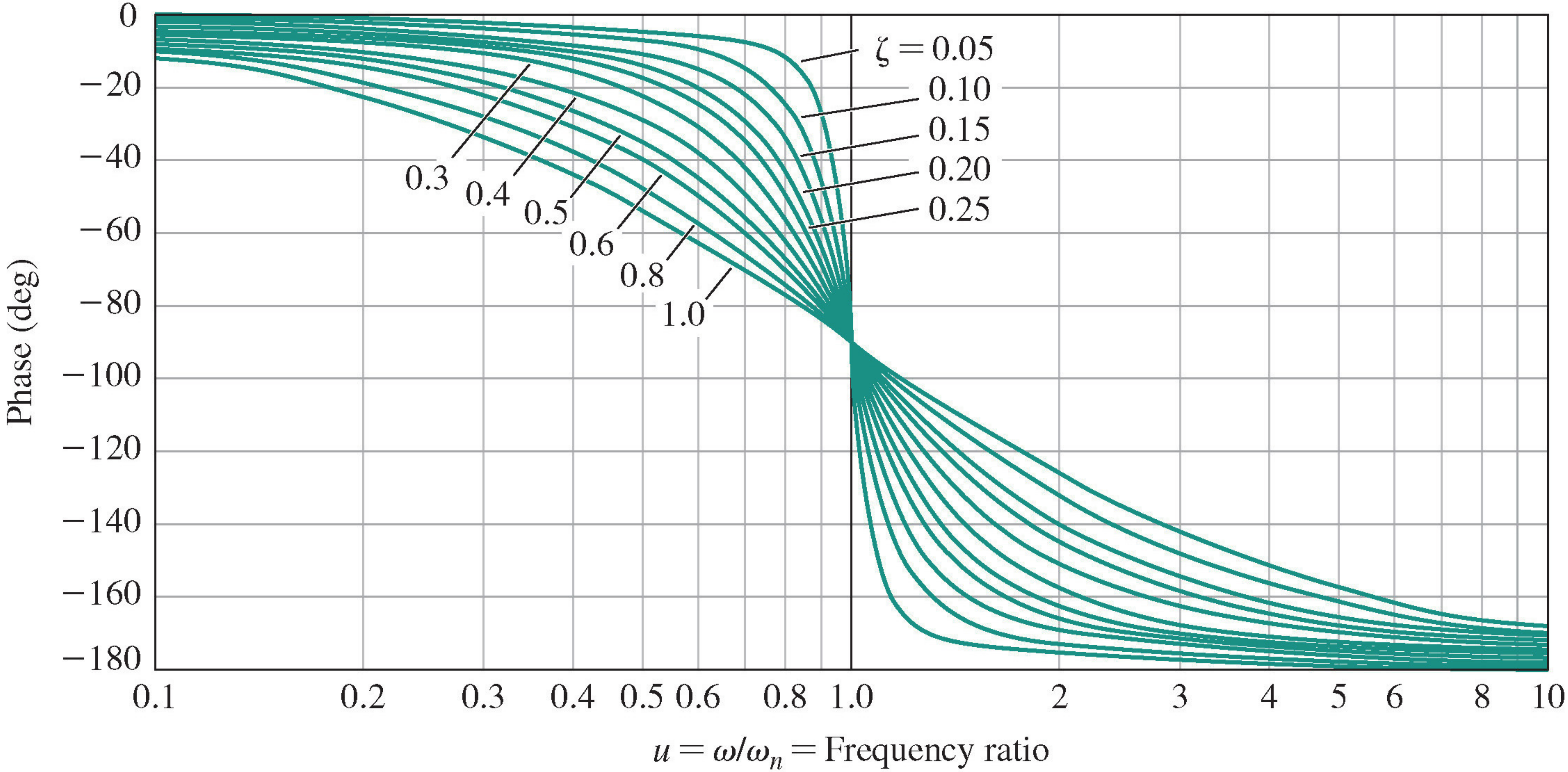
FIGURE 8.10 Bode diagram for $G(j\omega) = [1 + (2\zeta/\omega_n)\, j\omega = (j\omega/\omega_n)^2]^{-1}$.



(a)

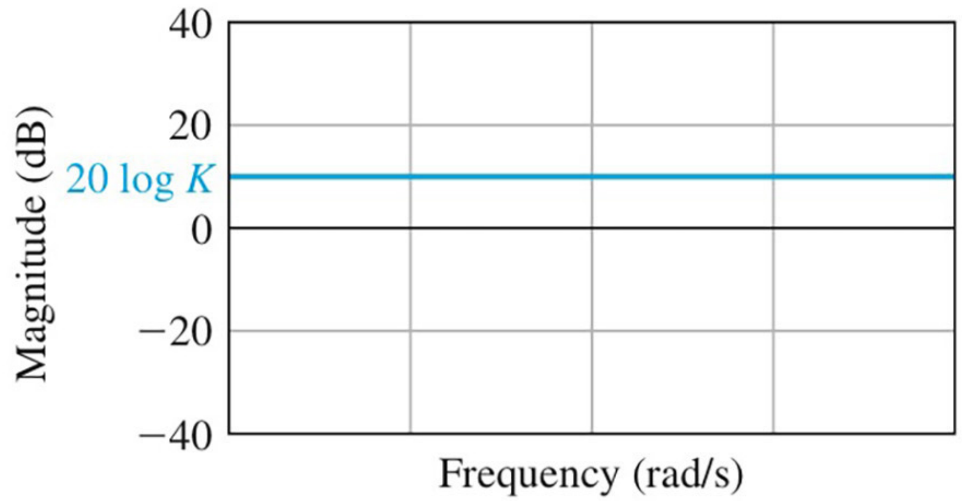
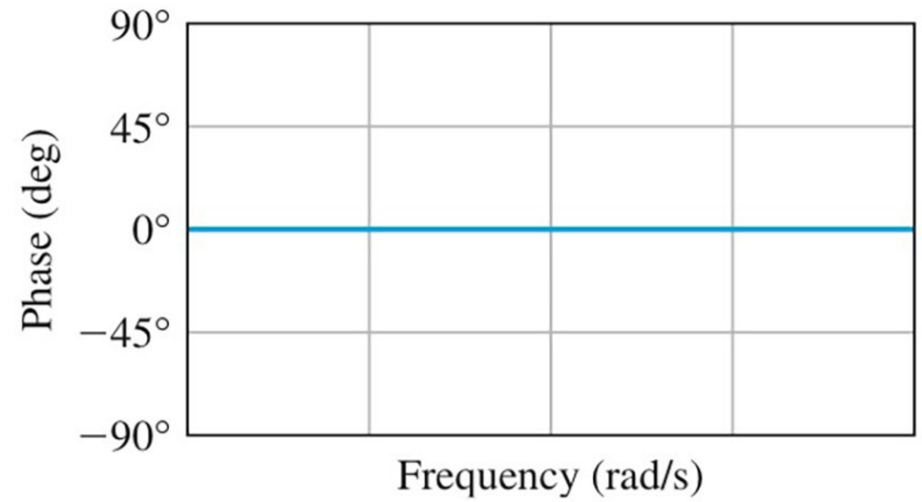
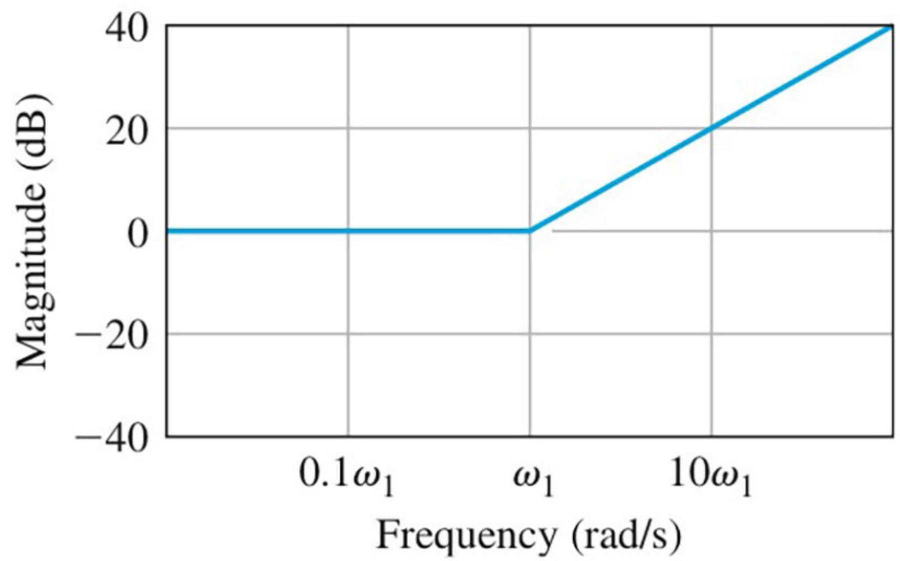
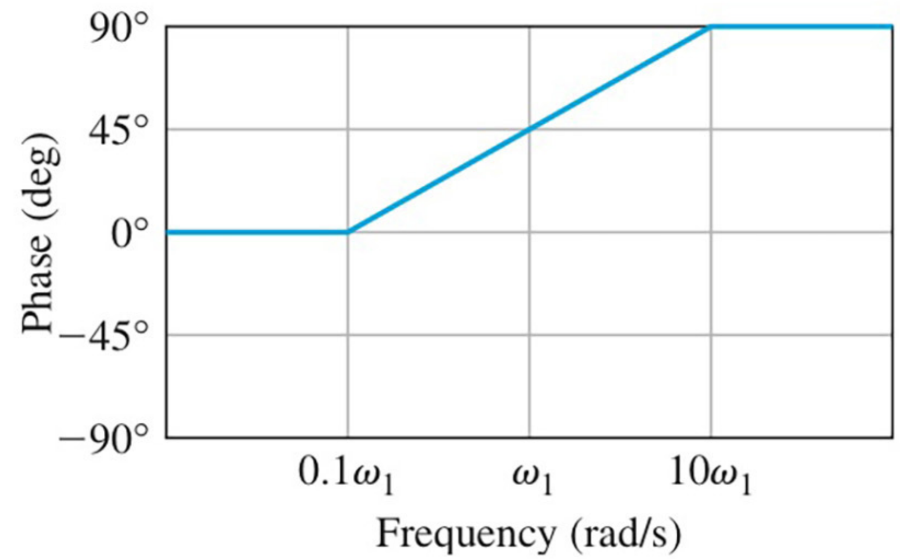
continued on next slide

FIGURE 8.10 Bode diagram for $G(j\omega) = [1 + (2\zeta/\omega_n)\, j\omega = (j\omega/\omega_n)^2]^{-1}$.



(b)

Table 8.1 Asymptotic Curves for Basic Terms of a Transfer Function

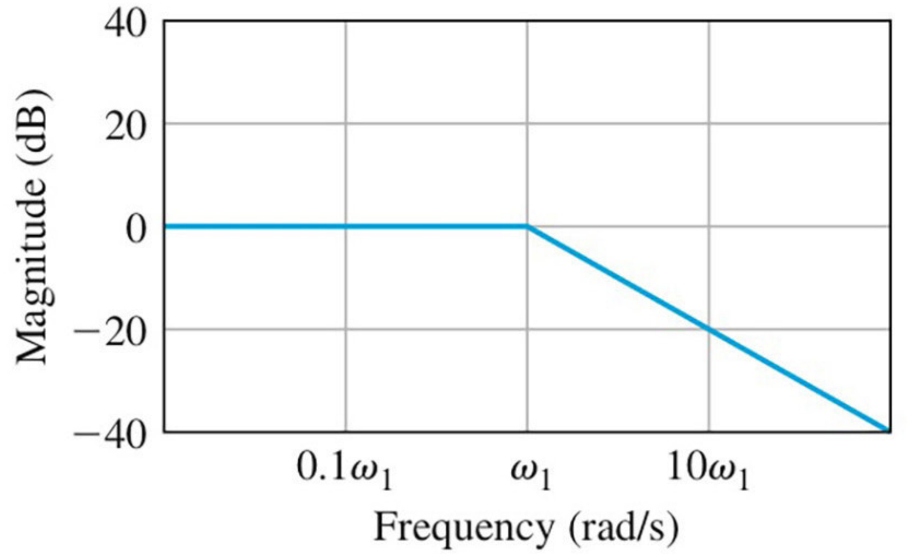
Term	Magnitude $20 \log_{10}\lvert G(j\omega)\rvert$	Phase $\phi(\omega)$
1. Gain, $G(j\omega) = K$		
2. Zero, $G(j\omega) = 1 + j\omega/\omega_1$		

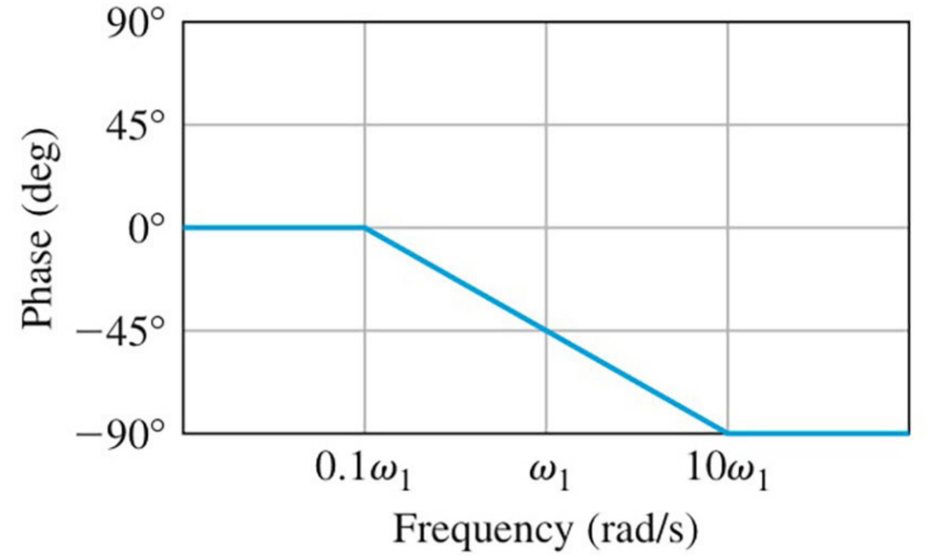
continued on next slide

Table 8.1 Asymptotic Curves for Basic Terms of a Transfer Function

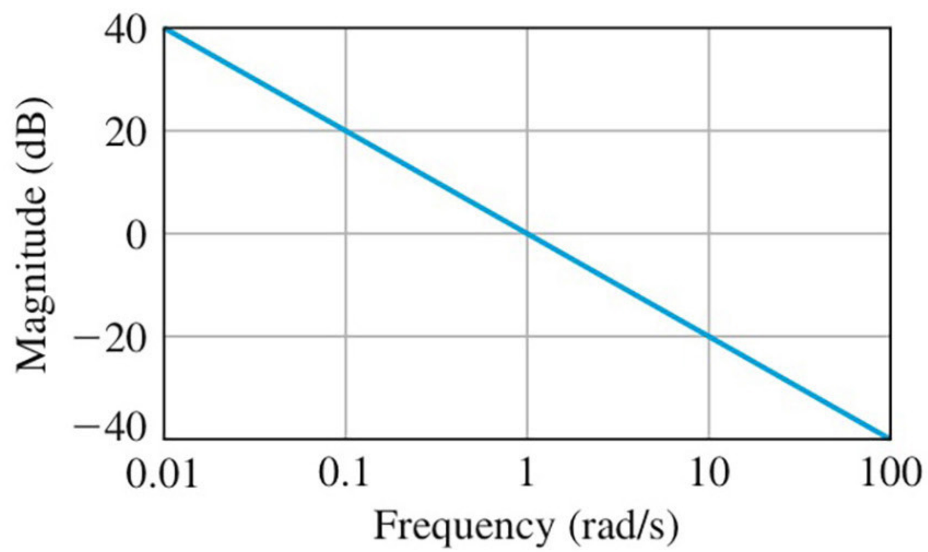
Term | **Magnitude $20 \log_{10}|G(j\omega)|$** | **Phase $\phi(\omega)$**

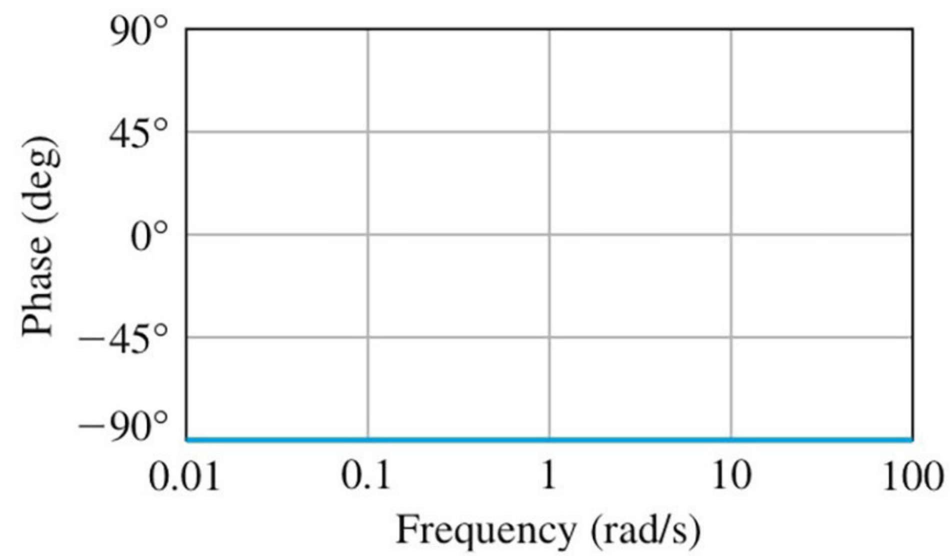
3. Pole, $G(j\omega) = (1 + j\omega/\omega_1)^{-1}$





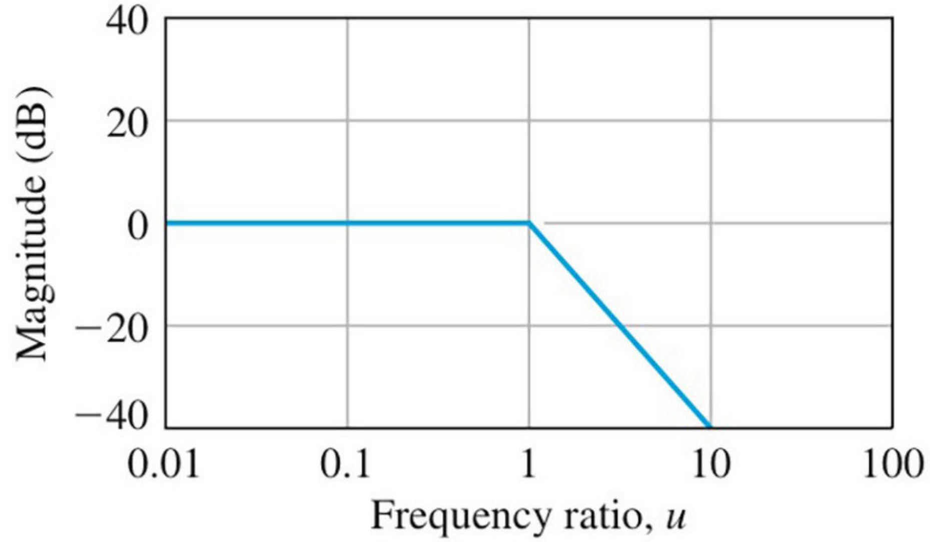
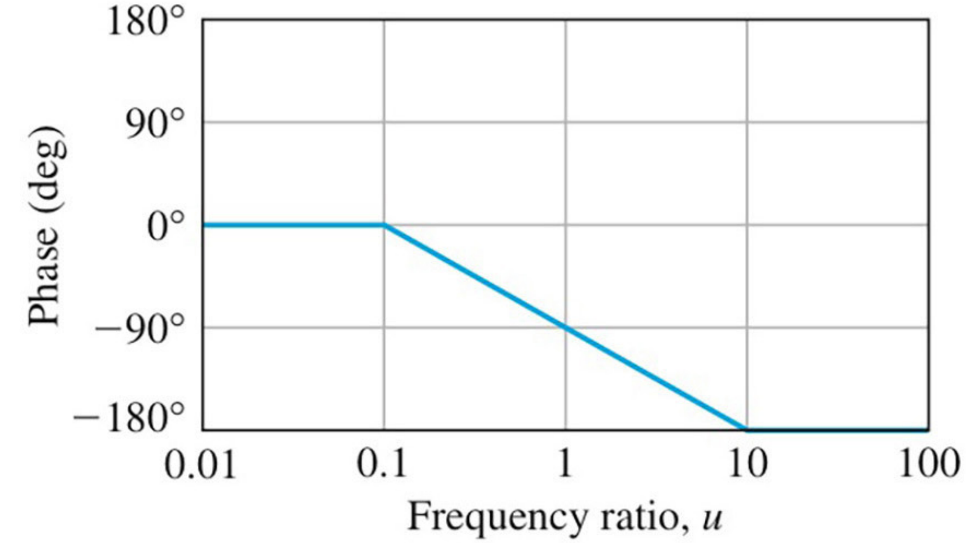
4. Pole at the origin, $G(j\omega) = 1/j\omega$





continued on next slide

Table 8.1 Asymptotic Curves for Basic Terms of a Transfer Function

Term	Magnitude $20 \log_{10}\lvert G(j\omega)\rvert$	Phase $\phi(\omega)$
5. Two complex poles, $0.1 < \zeta < 1$, $G(j\omega) = (1 + j2\zeta u - u^2)^{-1}$ $u = \omega/\omega_n$		

continued on next slide