

Concept Question 9-10: For which of the seven standard factors are the Bode plots identical to the exact plots and for which are they different?

Table 9-2: Bode straight-line approximations for magnitude and phase.

Factor	Bode Magnitude	Bode Phase
Constant K	$20 \log K$ 0 dB 	$\pm 180^\circ$ if $K < 0$ 0° if $K > 0$
Zero @ Origin $(j\omega)^N$	0 dB 1 slope = $20N$ dB/decade 	$(90N)^{\circ-\omega}$ 0°
Pole @ Origin $(j\omega)^{-N}$	0 dB 1 slope = $-20N$ dB/decade 	0° $(-90N)^{\circ-\omega}$
Simple Zero $(1 + j\omega/\omega_c)^N$	0 dB ω_c slope = $20N$ dB/decade 	$0^{\circ-\omega}$ $0.1\omega_c$ ω_c $10\omega_c$ $(90N)^{\circ-\omega}$
Simple Pole $\left(\frac{1}{1 + j\omega/\omega_c}\right)^N$	0 dB ω_c slope = $-20N$ dB/decade 	$0^{\circ-\omega}$ $0.1\omega_c$ ω_c $10\omega_c$ $(-90N)^{\circ-\omega}$
Quadratic Zero $[1 + j2\zeta\omega/\omega_c + (j\omega/\omega_c)^2]^N$	0 dB ω_c slope = $40N$ dB/decade 	$0^{\circ-\omega}$ $0.1\omega_c$ ω_c $10\omega_c$ $(180N)^{\circ-\omega}$
Quadratic Pole $\frac{1}{[1 + j2\zeta\omega/\omega_c + (j\omega/\omega_c)^2]^N}$	0 dB ω_c slope = $-40N$ dB/decade 	$0^{\circ-\omega}$ $0.1\omega_c$ ω_c $10\omega_c$ $(-180N)^{\circ-\omega}$

The Bode plots are identical to the exact plots for only the top three in the above table. For the others, the exact plots exhibit continuous change, instead of straight-line approximations, at the corner frequencies.