

Approximate Bode Plot Sketching Rules

	Magnitude	Phase
<u>1. Gain Factor</u>		
K	$20 \log K $	K>0: 0° K<0: -180°
<u>2. Integral Factor</u>		
$1/s$	-20 dB/dec, passing through 0 dB at $\omega = 1$	-90°
[s gives mirror image about 0 dB and 0°]		
<u>3. First-order Factor</u>		
$1/(\tau s + 1)$	<ol style="list-style-type: none"> 1. Draw low freq asymptote 0 dB 2. Draw high freq asymptote -20 dB/dec passing through 0 dB at break point $\omega = 1/\tau$ 3. Connect at -3 dB at break point 	<ol style="list-style-type: none"> 1. 0° at low freq 2. -90° at high freq 3. Connect with a straight line from $0.1/\tau$ to $10/\tau$
[[$\tau s + 1$] gives mirror image]		
<u>4. Second-order Factor</u>		
$1/((s/\omega_n)^2 + 2 \zeta s/\omega_n + 1)$	<ol style="list-style-type: none"> 1. Draw low freq asymptote at 0 dB 2. Draw high freq asymptote -40 dB/dec passing through 0 dB at break point ω_n 3. If $\zeta < 0.5$, draw approx peak of $-20 \log 2\zeta$ at ω_n 4. Connect (see examples in the text) 	<ol style="list-style-type: none"> 1. 0° at low freq 2. -180° at high freq 3. -90° at ω_n 4. Connect according to the damping (see examples in the text)
[[$((s/\omega_n)^2 + 2 \zeta s/\omega_n + 1)$ gives mirror image]		