VE216 Lecture 11

> CT Frequency Response and Bode Plots

Asymptotic Magnitude Behavior

Isolated Zero

<table>
<tr><th>Magnitude</th><th>Asymptotic</th></tr>
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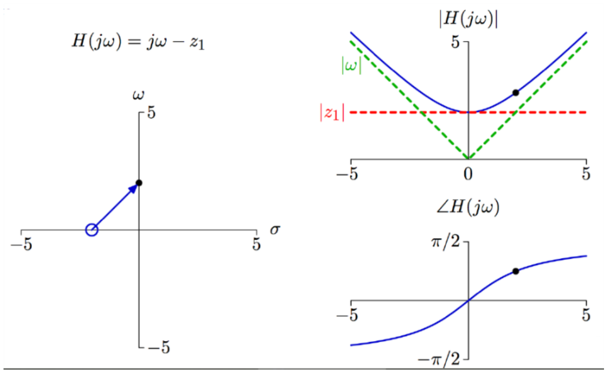

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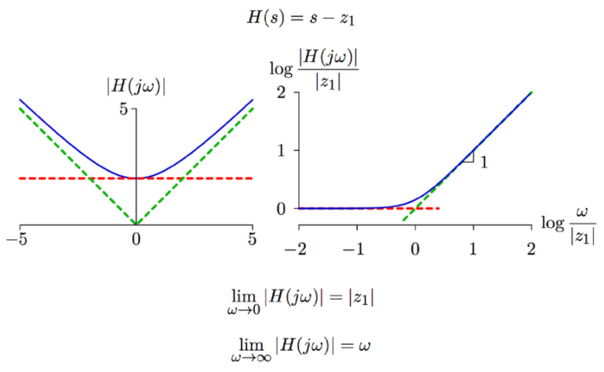

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Isolated Pole

<table>
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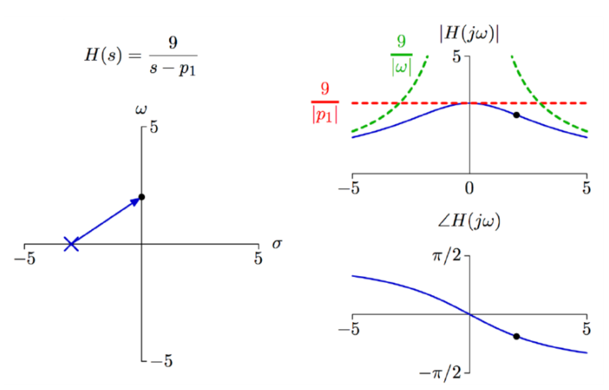

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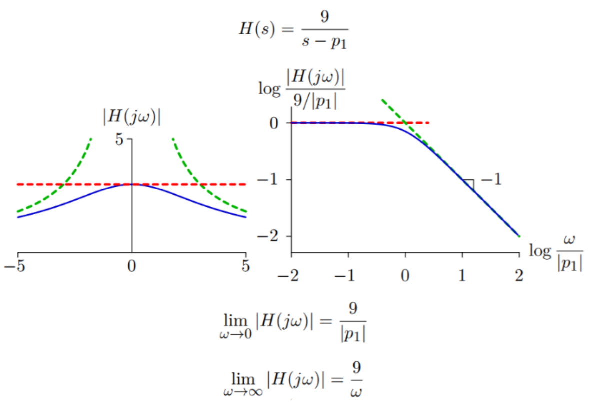

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Complicated Systems Asymptotic Behavior

$H(s_0) = K\frac{\prod_{q=1}^{Q}(s_0 - z_q)}{\prod_{p=1}^{P}(s_0 - p_p)}$, then $|H(s_0)| = \left|K\frac{\prod_{q=1}^{Q}(s_0 - z_q)}{\prod_{p=1}^{P}(s_0 - p_p)}\right| = |K|\frac{\prod_{q=1}^{Q}|s_0 - z_q|}{\prod_{p=1}^{P}|s_0 - p_p|}$

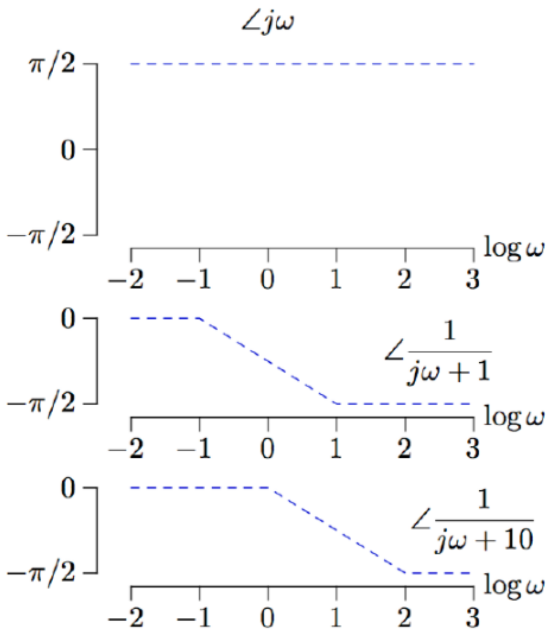
Thus $log|H(j\omega)| = log|K| + \sum_{q=1}^{Q} log|j\omega - z_q| - \sum_{p=1}^{P} log|j\omega - p_p|$

With proportion to the $log(\omega)$, we get the bode plot.

Bode Plot Angle

According to the previous lectures:

$\angle H(s_0) = \angle(K\frac{\prod_{q=1}^{Q}(s_0 - z_q)}{\prod_{p=1}^{P}(s_0 - p_p)}) = \angle K + \sum_{q=1}^{Q} \angle(s_0 - z_q) - \sum_{p=1}^{P} \angle(s_0 - p_p)$



If we need more calculation, then we can add them together as a graph.

Bode Plot: dB

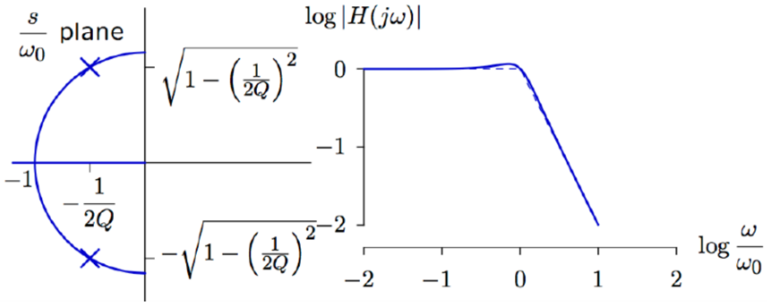
$|H(j\omega)|[\mathrm{dB}] = 20log_{10}|H(j\omega)|$

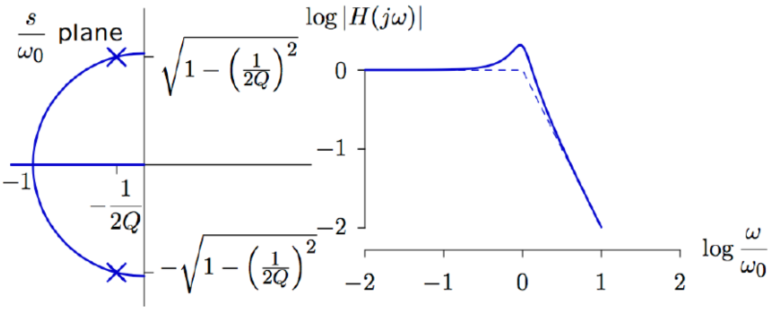
For $H(j\omega) = \frac{1}{j\omega+1}$, the approximation is here

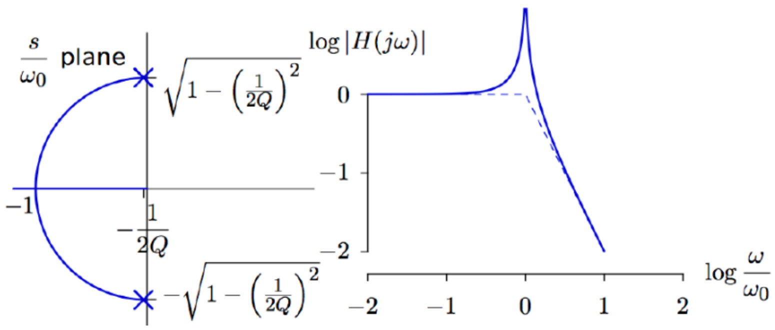
X	$20log_{10}X$
1	0 dB
$\sqrt{2}$	3 dB
2	6 dB
10	20 dB
100	40 dB

Frequency Response of High-Q System

$H(s) = \frac{1}{1+\frac{1}{Q}\frac{s}{\omega_0}+(\frac{s}{\omega_0})^2}$

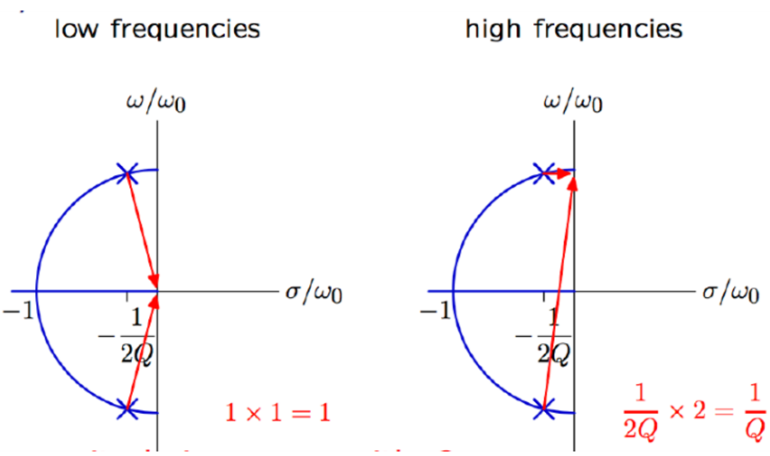






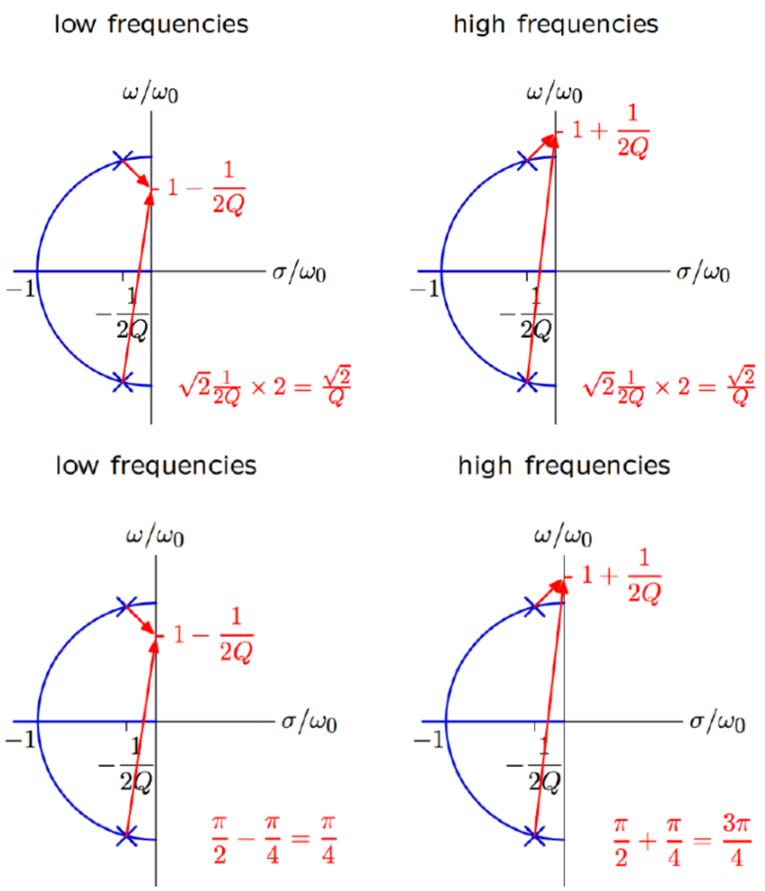
Peak Magnitude Dependence

Assume $Q > 3$. Then we see on the $\frac{s}{\omega_0}$ plane:



So the peak magnitude increase with Q.

3dB Bandwidth and Phase Change



Change in phase approximately $\pi/2$.

Frequency Response of a High-Q System

As Q increases, the phase changes more abruptly with ω.