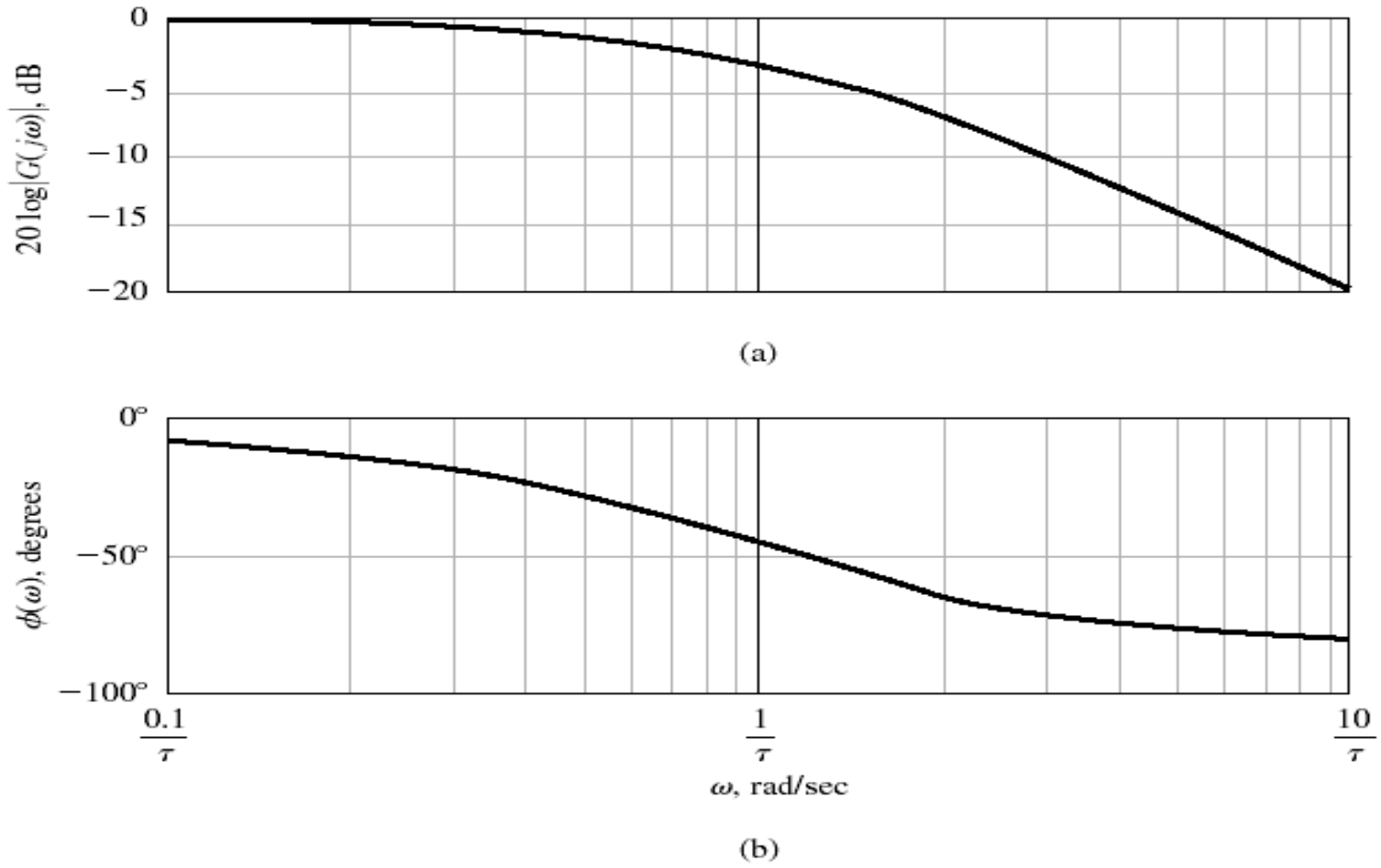
UNIT-5

(Lecture-8)

Bode Plots

Bode Plots – Real Poles

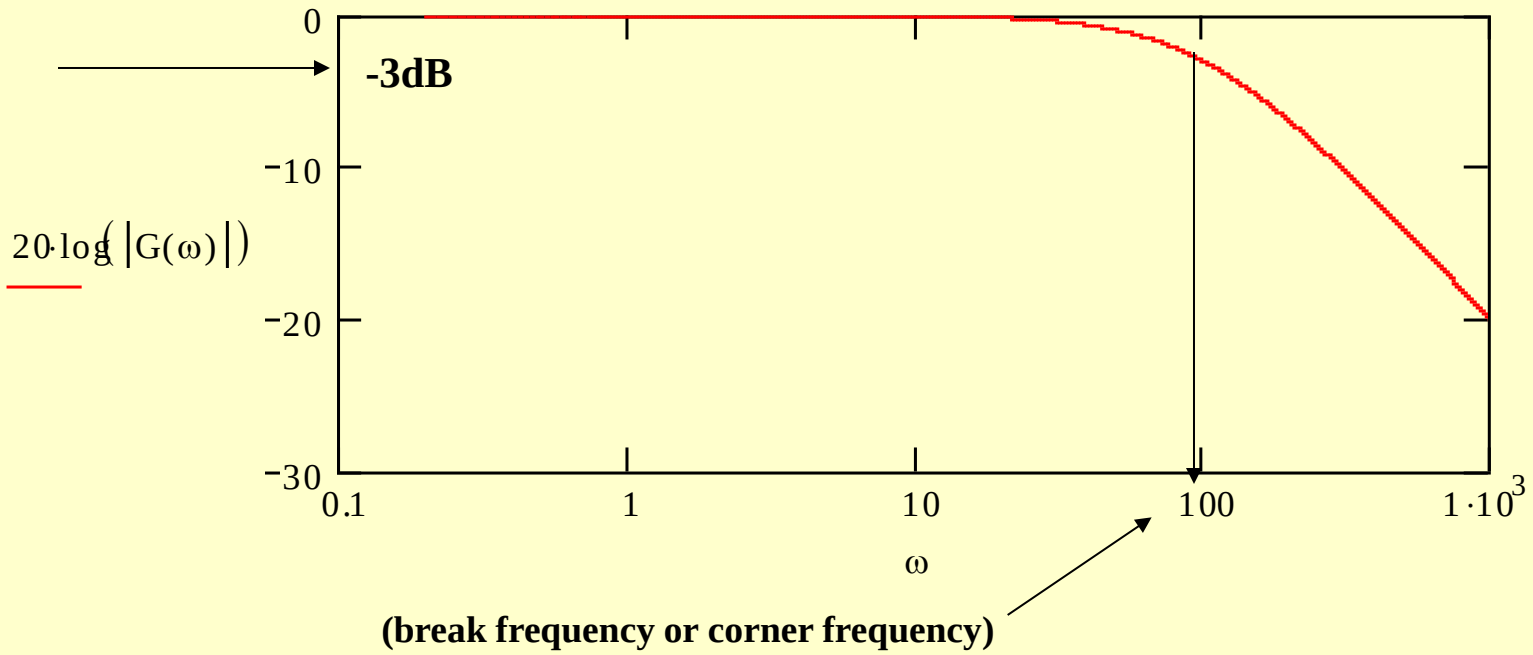


Bode diagram for $G(j\omega) = 1/(j\omega\tau + 1)$: (a) magnitude plot and (b) phase plot.

Bode Plots – Real Poles

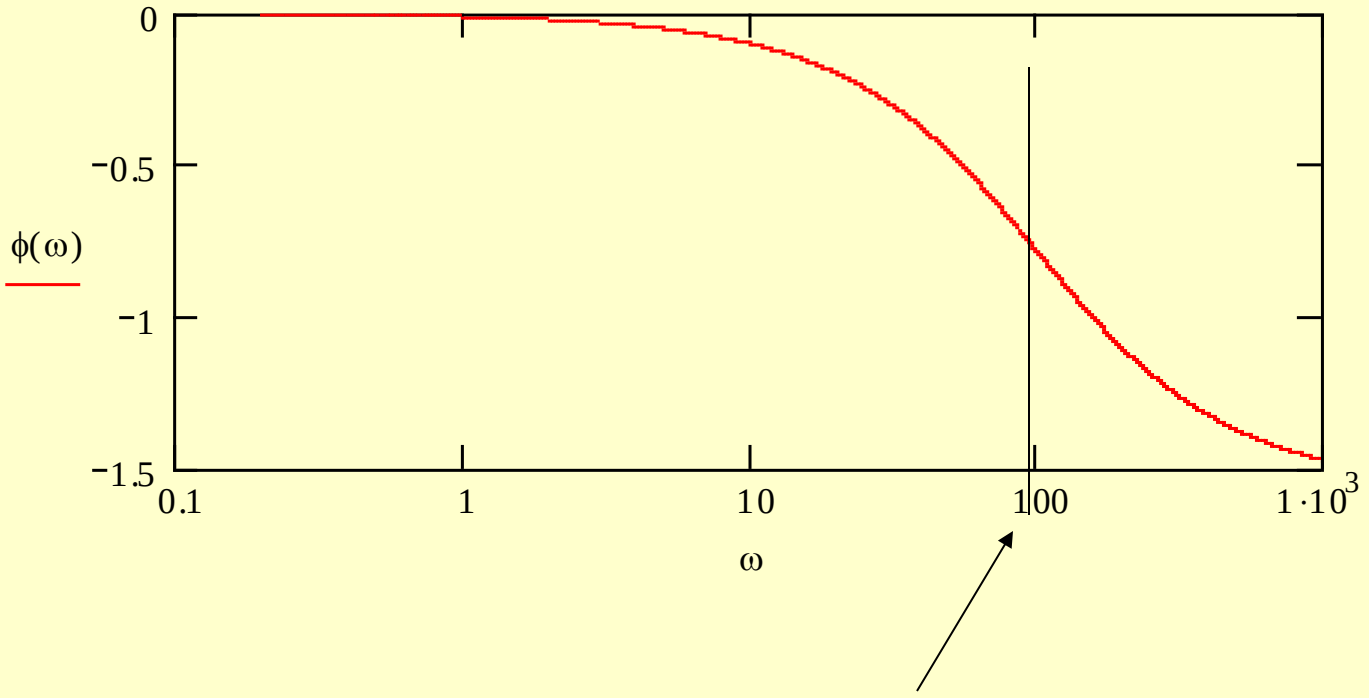
$\omega := \frac{0.1}{\tau}, \frac{0.11}{\tau} .. 1000$ $\quad j := \sqrt{-1}$ $\quad R := 1$ $\quad C := 0.01$ $\quad \tau := R \cdot C$

$G(\omega) := \frac{1}{j \cdot \omega \cdot \tau + 1}$ $\quad \omega 1 := \frac{1}{\tau}$ $\quad \omega 1 = 100$ **(break frequency or corner frequency)**



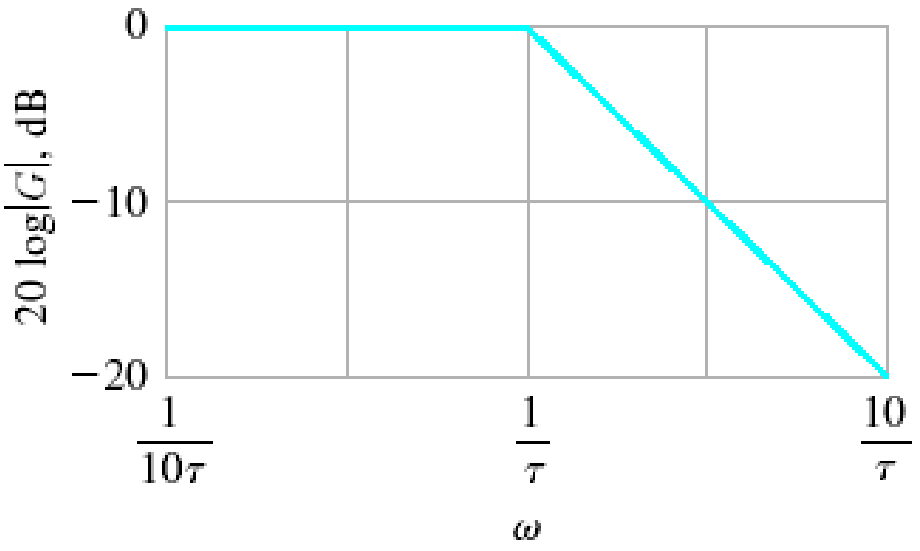
Bode Plots – Real Poles

$$\phi(\omega) := -\text{atan}(\omega \cdot \tau)$$



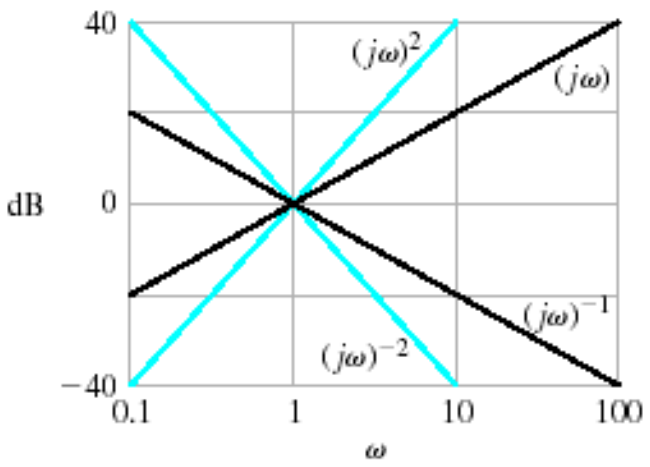
(break frequency or corner frequency)

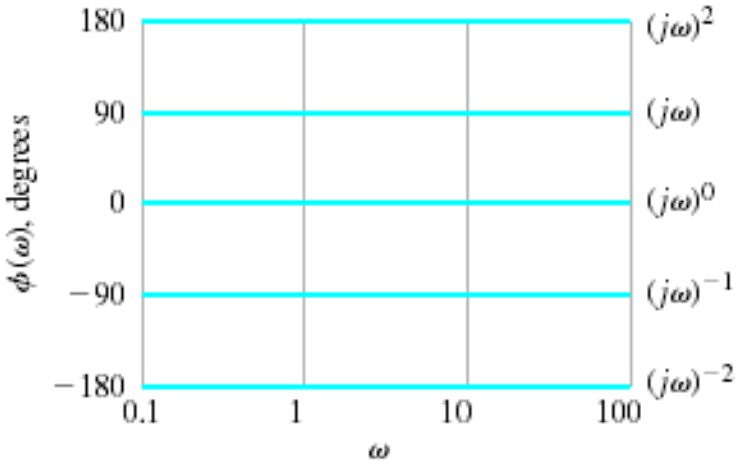
Bode Plots – Real Poles (Graphical Construction)



Asymptotic curve for $(j\omega\tau + 1)^{-1}$.

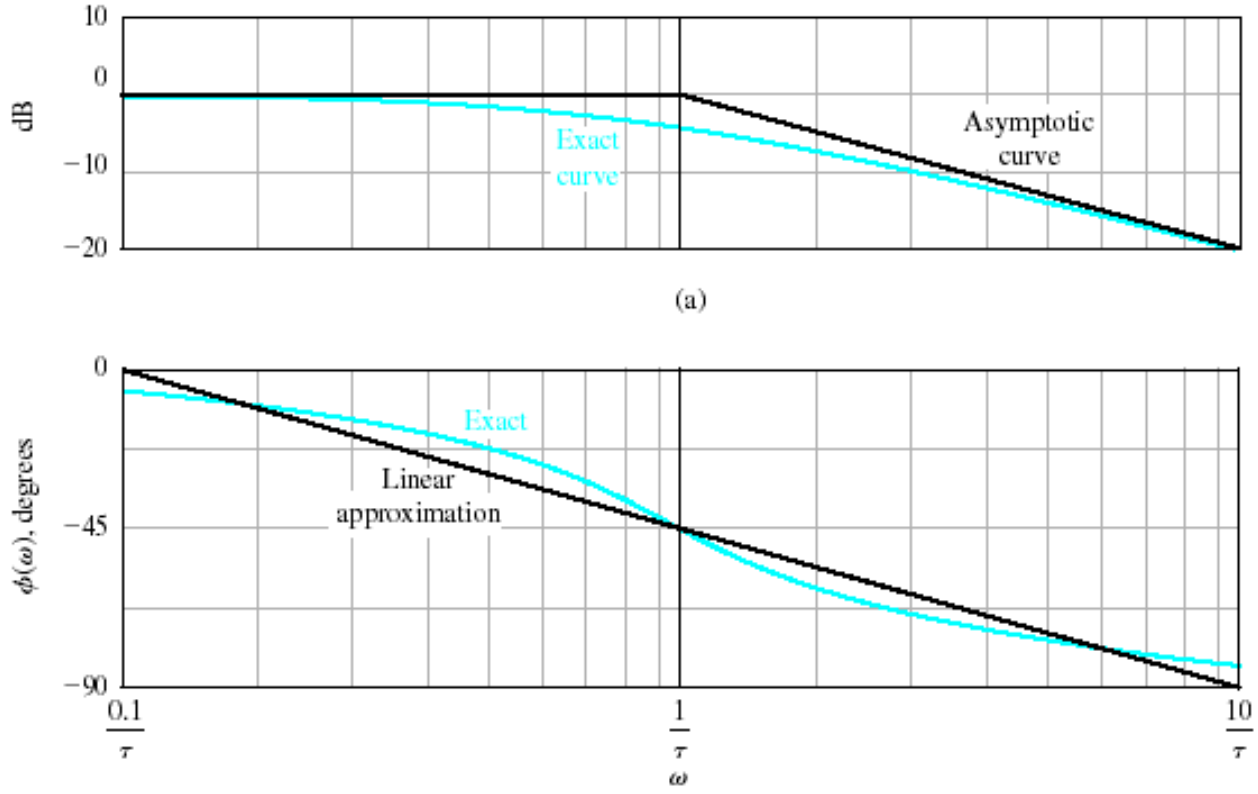
Bode Plots – Real Poles





Bode diagram for $(j\omega)^{\pm N}$.

Bode Plots – Real Poles



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

Bode Plots – Real Poles

Magnitude:

$$db(G,\omega) := 20\cdot\log(|G(j\cdot\omega)|)$$

Phase shift:

$$ps(G,\omega) := \frac{180}{\pi}\cdot\arg(G(j\cdot\omega)) - 360\cdot(\text{if}(\arg(G(j\cdot\omega)) \geq 0, 1, 0))$$

Assume

$$K := 2 \qquad G(s) := \frac{K}{s\cdot(1+s)\cdot\left(1+\frac{s}{3}\right)}$$

Next, choose a frequency range for the plots (use powers of 10 for convenient plotting):

lowest frequency (in Hz): $\omega_{start} := .01$ number of points: $N := 50$

highest frequency (in Hz): $\omega_{end} := 100$

step size: $r := \log\left(\frac{\omega_{start}}{\omega_{end}}\right)\cdot\frac{1}{N}$

range for plot: $i := 0..N$ range variable: $\omega_i := \omega_{end}\cdot 10^{i\cdot r}$ $s_i := j\cdot\omega_i$

Bode Plots – Real Poles

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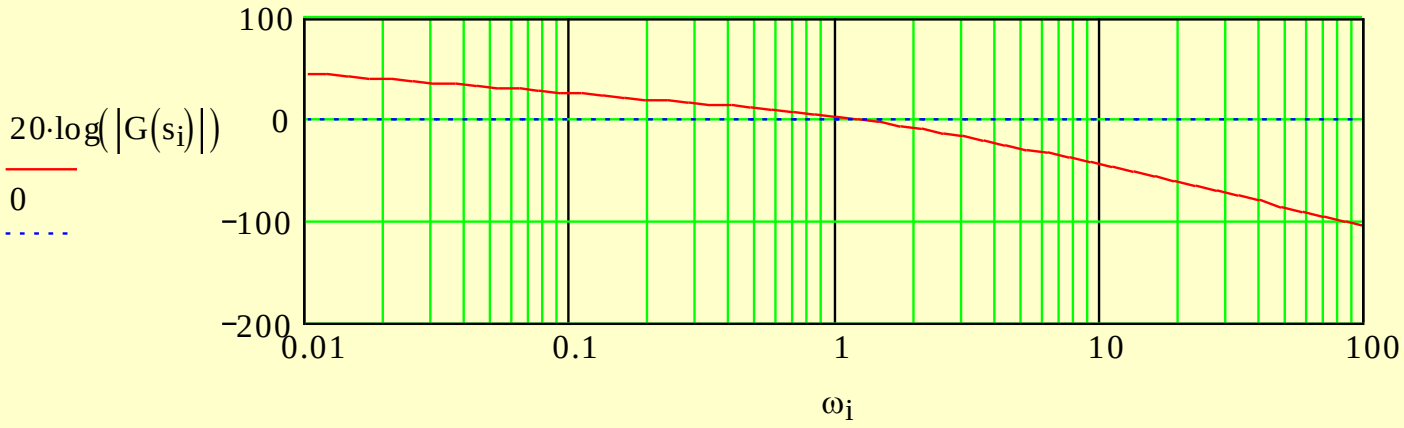
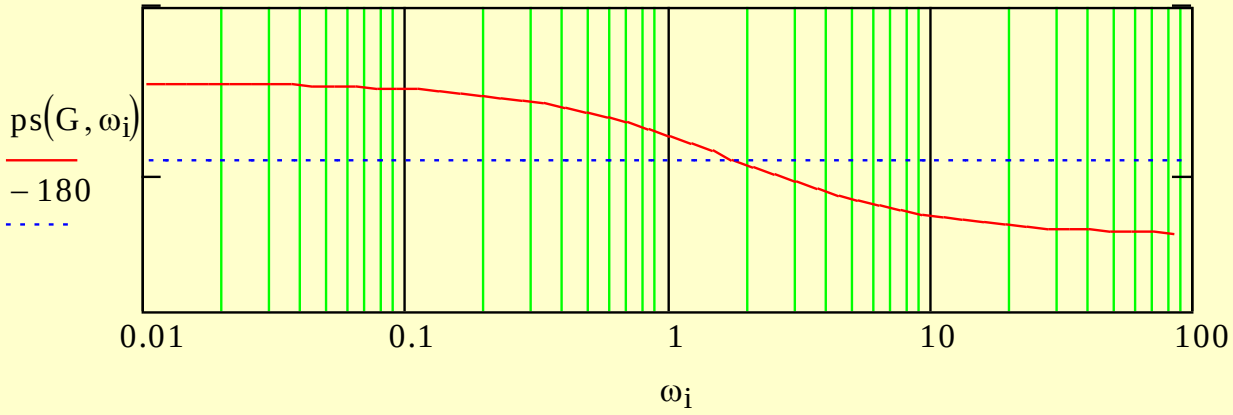
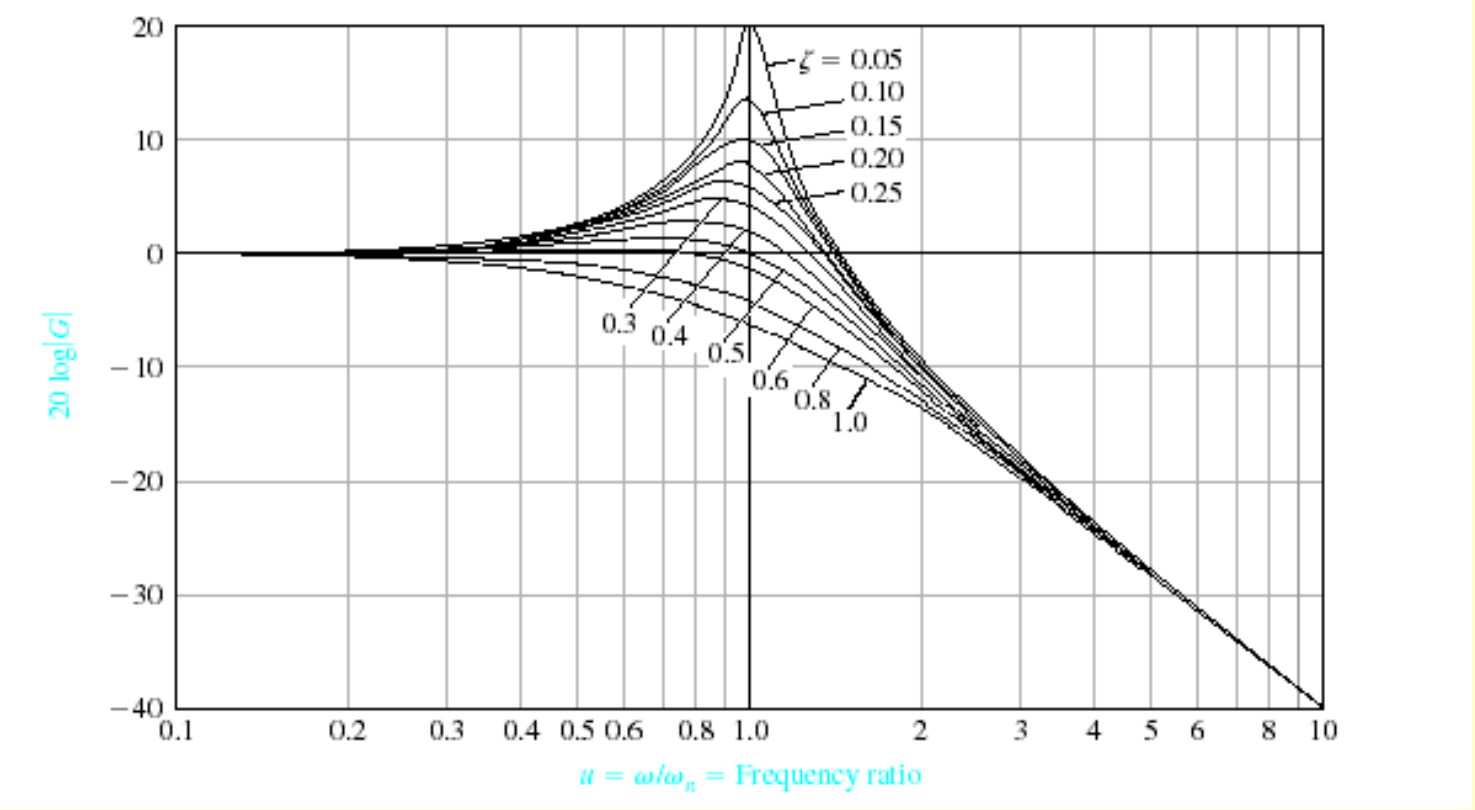


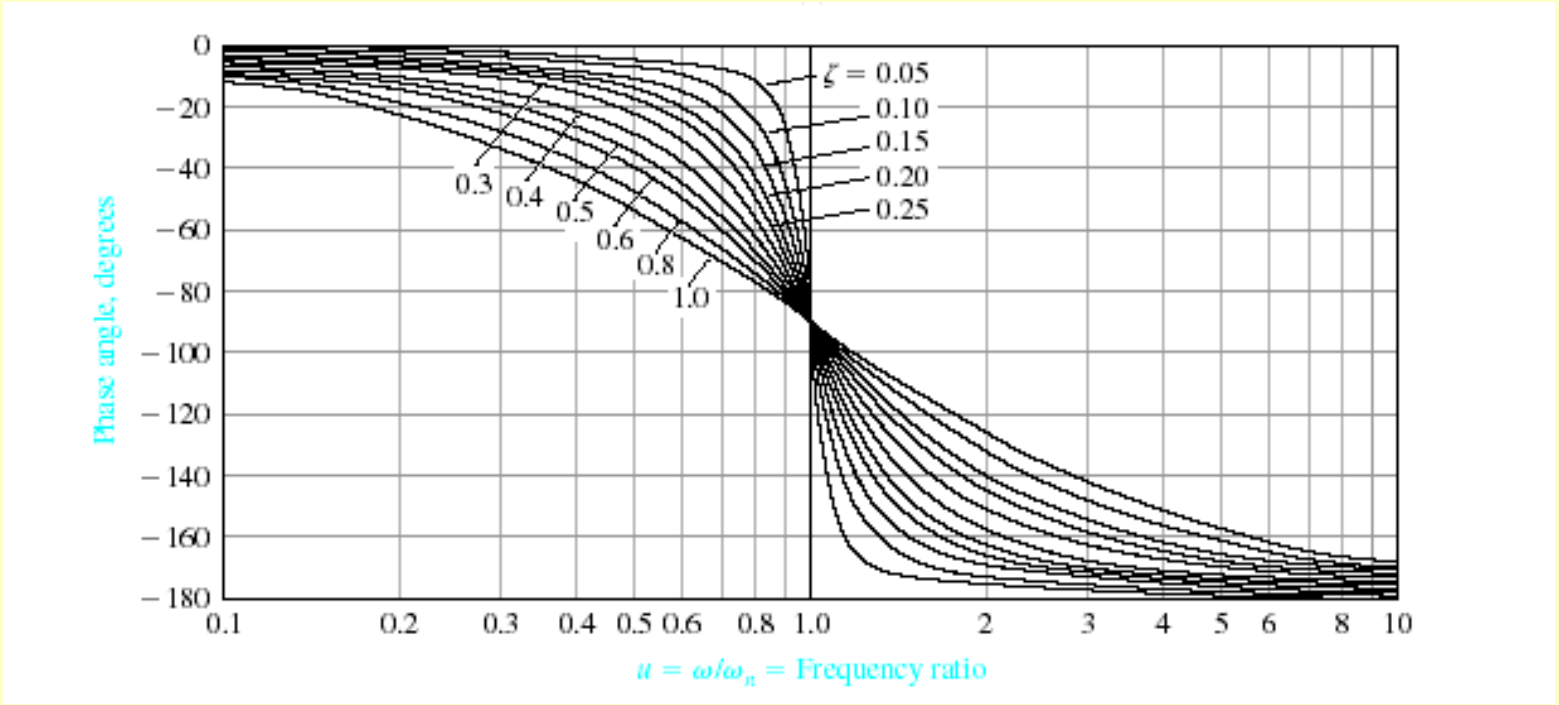


Bode Plots – Complex Poles



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

Bode Plots – Complex Poles



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Bode Plots – Complex Poles

$$\omega_r = \omega_n \cdot \sqrt{1 - 2\cdot\zeta^2} \qquad \zeta < 0.707$$

$$M_{p\omega} = \left|G(\omega_r)\right| = \frac{1}{\left(2\cdot\zeta\cdot\sqrt{1-\zeta^2}\right)} \qquad \zeta < 0.707$$

Bode Plots – Complex Poles

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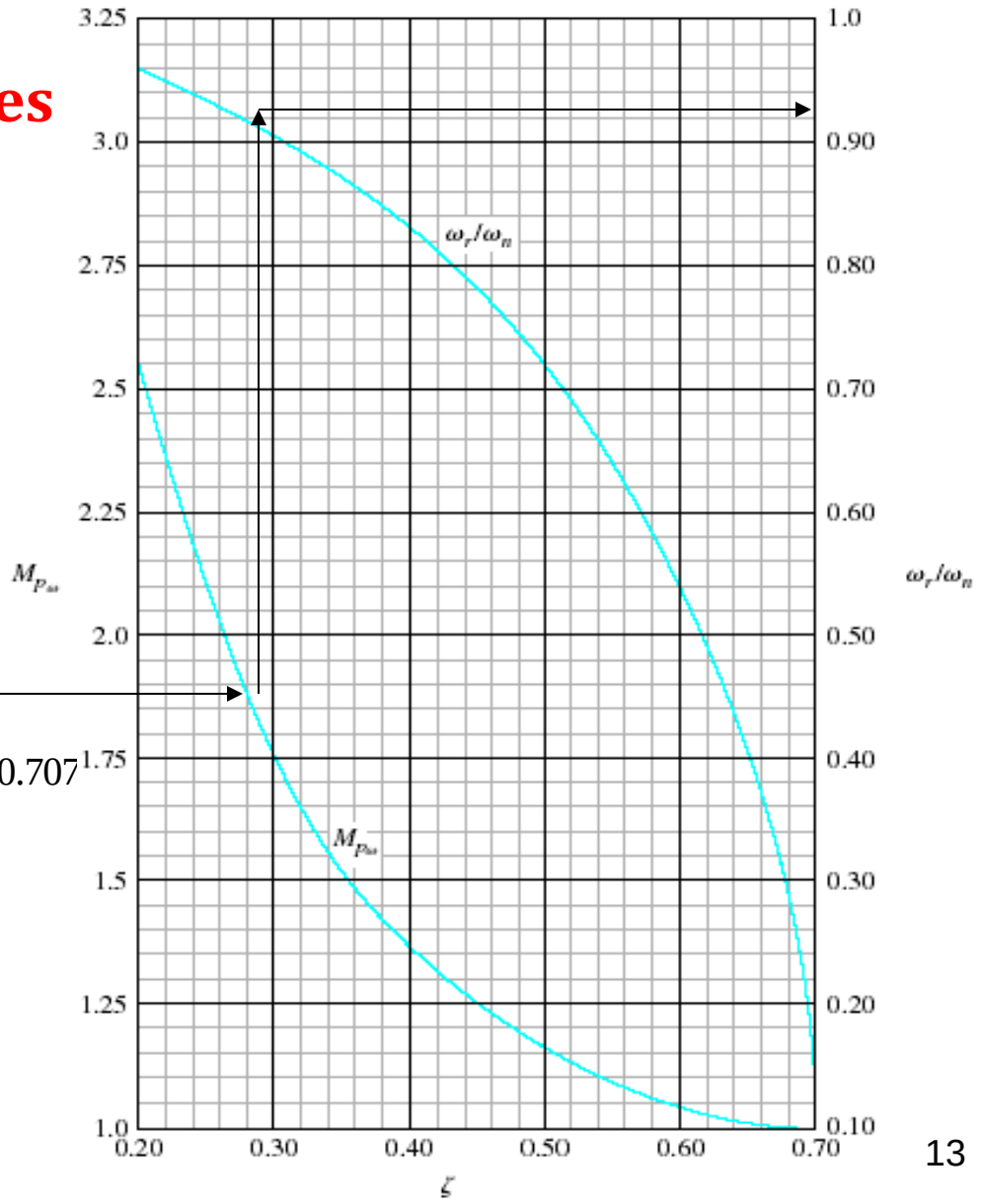
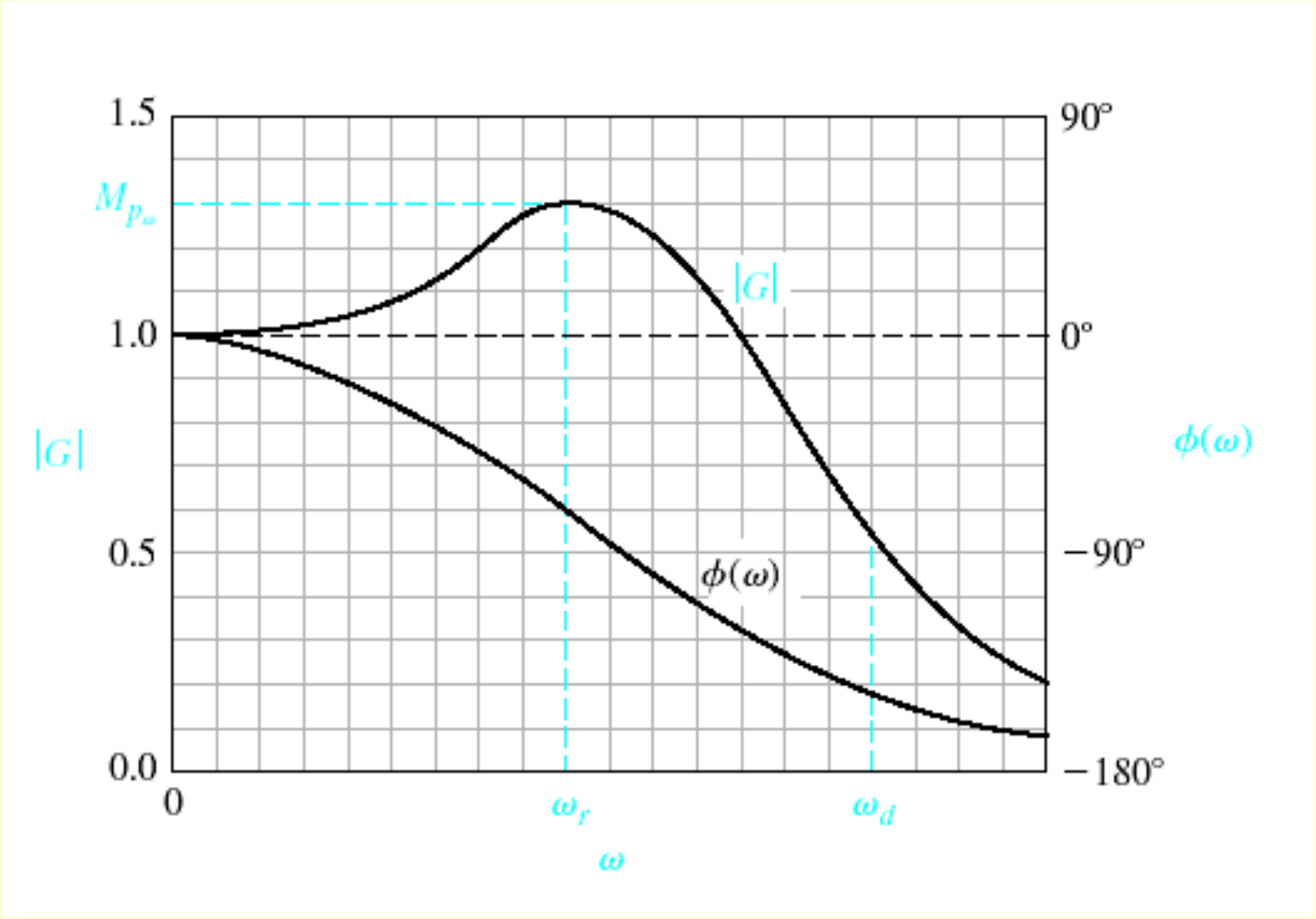


Bode Plots – Complex Poles



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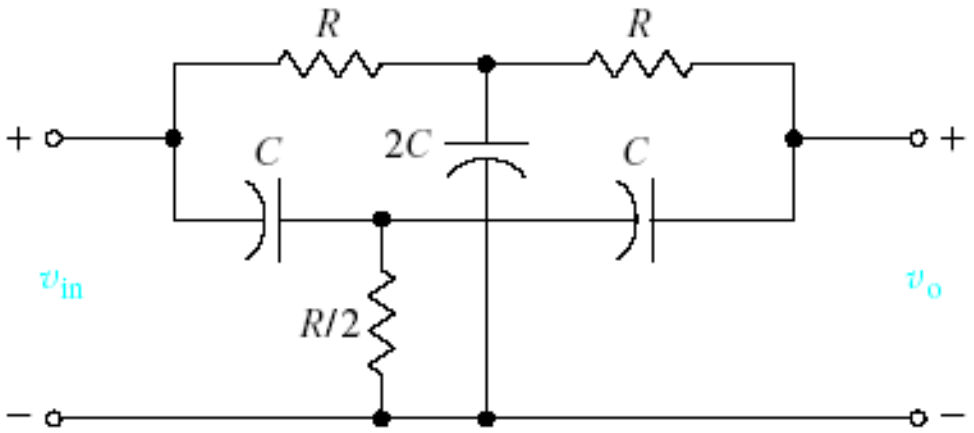
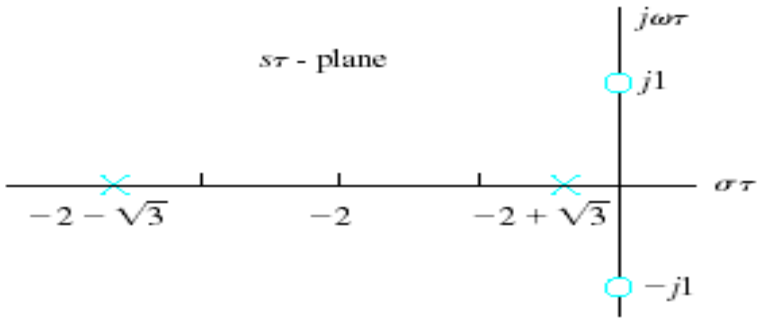
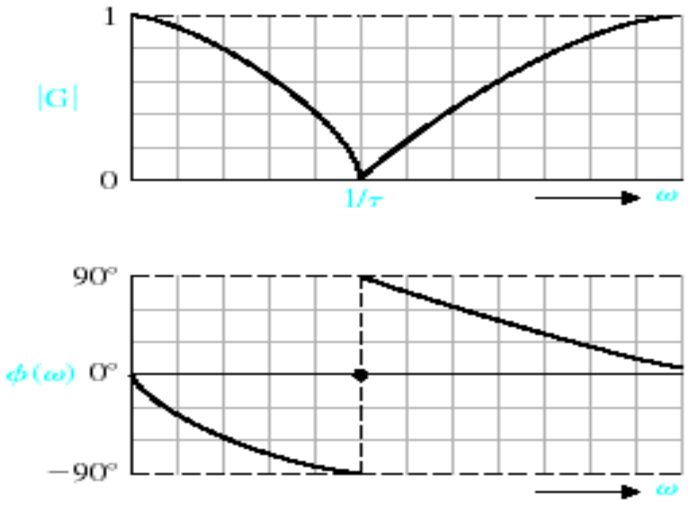




(a)



(b)