6-11-12

Lec 41

Example

$$LG(s) = \frac{A_0 f}{(1+s/\omega_p)^3} \qquad A_0 f\Big|_{max.} = 8$$

$$\Downarrow$$

$$LG(s) = \frac{A_0 f}{(1+s/\omega_p)^3\left(1+\frac{1000s}{\omega_p}\right)} \Rightarrow \omega_d = \frac{\omega_p}{1000}$$

$$LG = f \cdot A(s) \quad ; \quad CLG(s) = \frac{1}{f} \cdot \frac{LG(s)}{1+LG(s)}$$

$$LG(s) = \frac{X(s)}{Y(s)}$$

$X(s) \leftarrow A_0 f$

$Y(s) \leftarrow$ 4th order poly.

$$CLG(s) = \frac{1}{f}\,\frac{X(s)/Y(s)}{1+X(s)/Y(s)} = \frac{N(s)}{D(s)}$$

poles $\Rightarrow$ roots of $D(s) = 0$

$\Rightarrow$ roots of $X(s) + Y(s) = 0$

roots of $1 + LG(s) = 0$

$$\boxed{LG(s) = -1}$$

$$LG(s) = \frac{A_0 f}{\left(1+s/\omega_p\right)^3\left(1+\frac{1000s}{\omega_p}\right)} = -1 \qquad \frac{1}{\left(1+j\omega_0/\omega_p\right)^3}$$

$$LG(j\omega_0) = -1$$

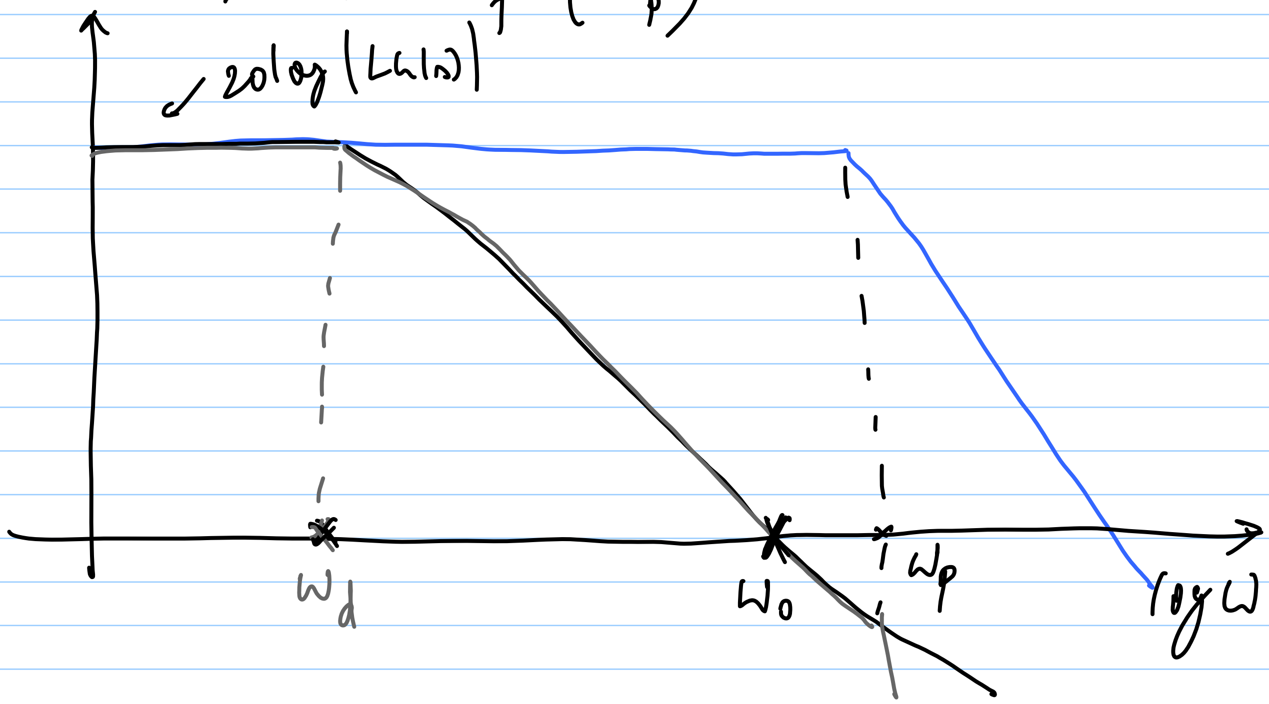
mag $\quad |LG(j\omega_0)| = 1$

phase $\quad \angle LG(j\omega_0) = \pi$

$$\hookrightarrow 0 - 3\tan^{-1}\left(\frac{\omega_0}{\omega_p}\right) - \tan^{-1}\left(\frac{1000\,\omega_0}{\omega_p}\right) = -\pi$$

$$3\tan^{-1}\left(\frac{\omega_0}{\omega_p}\right) = \pi - \tan^{-1}\left(\frac{1000\,\omega_0}{\omega_p}\right)$$

$$\hookrightarrow \omega_0 = f(\omega_p)$$



1) @ $\omega_d \Rightarrow \underset{(\omega_d)}{-45^\circ} + \underset{3\times(\omega_p)}{0} \approx -45^\circ$

2) @ $\omega_p \Rightarrow \underset{(\omega_d)}{-90^\circ} + (-135^\circ) \approx -225^\circ$

$\omega_d < \omega_0 < \omega_p$

$\omega_0 \gg \omega_d$ ($\because A_0 f \gg 1$)

$\Rightarrow$ contribution from $\omega_d = -90^\circ$

$\Rightarrow$ contrib. from $3\times(\omega_p) = -90^\circ$

" " each $\omega_p = -30^\circ$

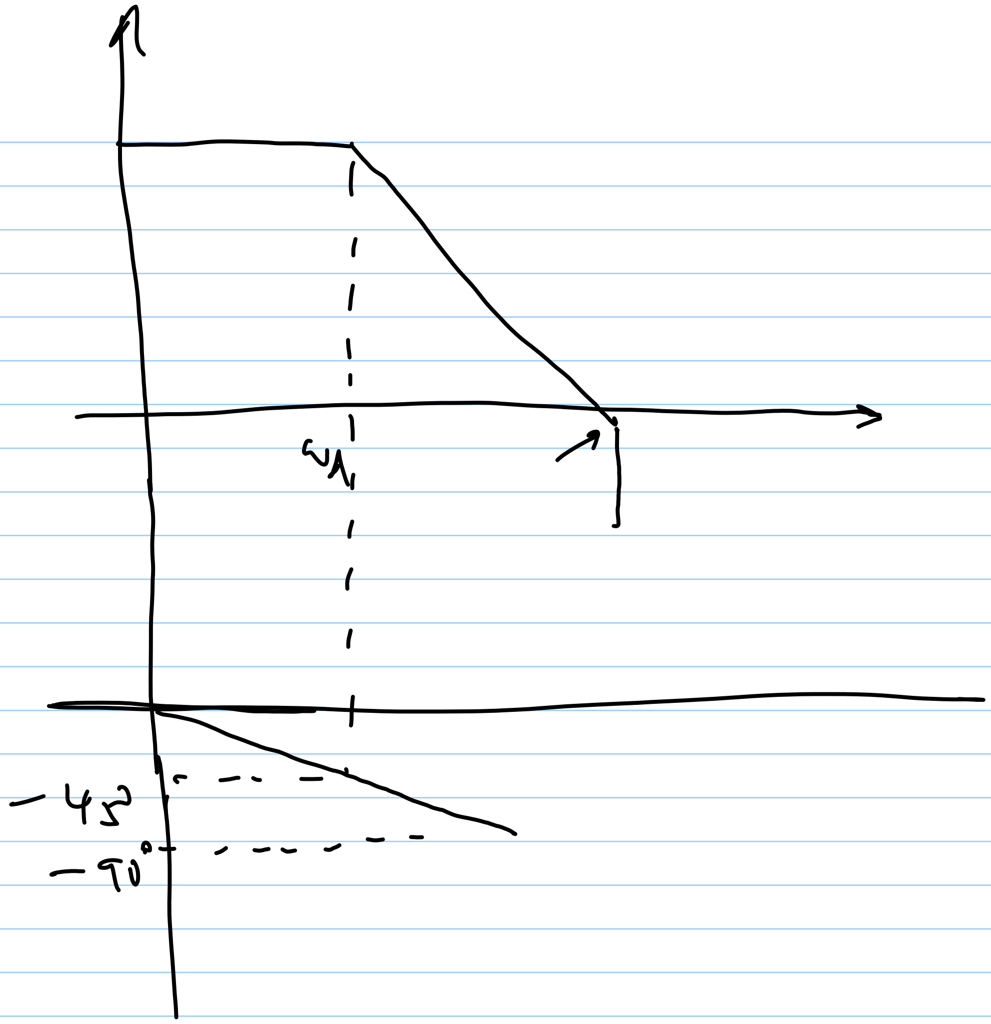
$$\Rightarrow \frac{\omega_0}{\omega_p} \approx \frac{1}{\sqrt{3}} \checkmark$$

apply $|L\angle(j\omega_0)| = 1$

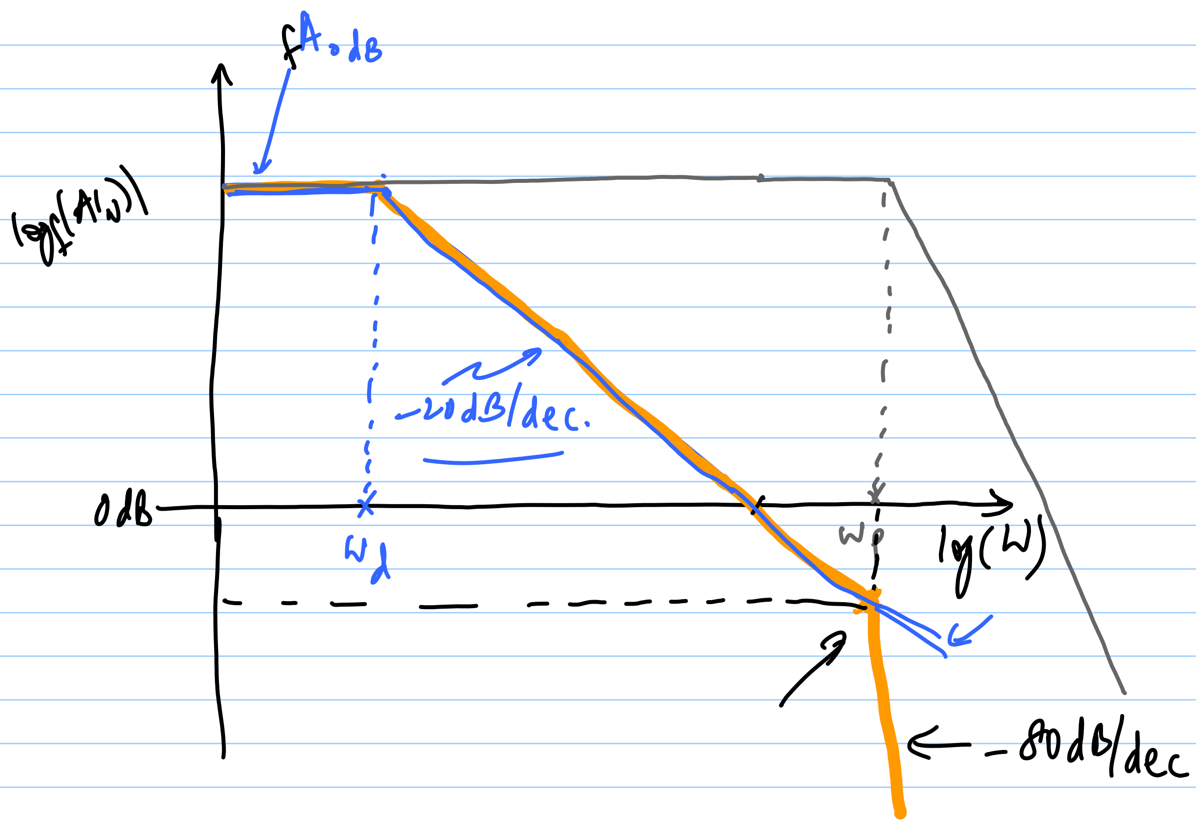
$$\left| \frac{A_0 f}{\left(1+j/\sqrt{3}\right)^3\left(1+j\frac{1000}{\sqrt{3}}\right)} \right| = 1$$

$$\frac{A_0 f}{\left(\sqrt{1+1/3}\right)^3\left(\frac{1000}{\sqrt{3}}\right)} = 1 \Rightarrow A_0 f = \frac{8000}{9}$$

$$\approx 890$$



ω1
-45°
-90°



fA0dB
log(|A'v|)
-20dB/dec.
0dB
ωd
ωp
log(ω)
-80dB/dec

ω_d = "Dominant Pole"

"Frequency Compensation"

Dominant pole compensation

$$\frac{A_o f}{(1+s/\omega_p)^3} \times \frac{(1+s/\omega_p)^2}{(1+s/\omega_{p_1})^2}$$

$\omega_{p_1} >> \omega_p$

pole-zero compensation

$$\approx \frac{A_o f}{(1+s/\omega_p)(1+s/\omega_{p_1})^2}$$

ω_p is the dominant pole