EE 140 | RHP Zero

CTN

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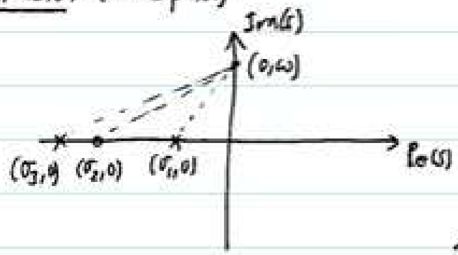
Again, we're mainly concerned here w/ phase margin; i.e., stability.

How does a RHP zero affect the PM?

→ compare a LHP zero w/ a RHP zero:

① LHP zero: (and 2 poles)



$$|H(j\omega)| = \frac{\sqrt{\omega^2+\sigma_2^2}}{\sqrt{\omega^2+\sigma_1^2}\sqrt{\omega^2+\sigma_3^2}}$$

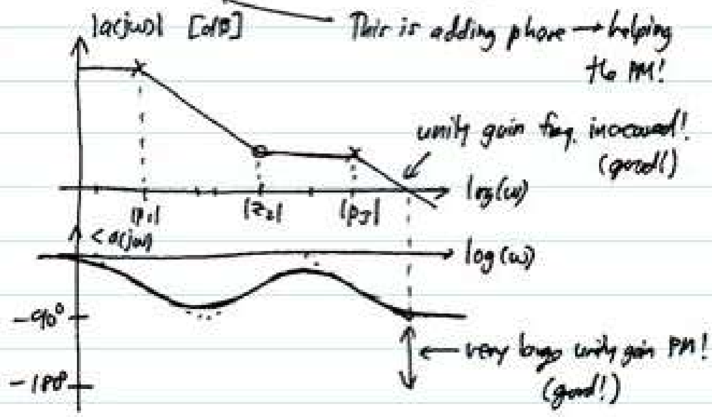
$\frac{\omega-0}{0-\sigma_2}$

$$\measuredangle H(j\omega) = +\tan^{-1}\left(\frac{\omega}{-\sigma_2}\right) - \tan^{-1}\left(\frac{\omega}{-\sigma_1}\right) - \tan^{-1}\left(\frac{\omega}{-\sigma_3}\right)$$

$$= \tan^{-1}\left(\frac{\omega}{|\sigma_2|}\right) - \tan^{-1}\left(\frac{\omega}{|\sigma_1|}\right) - \tan^{-1}\left(\frac{\omega}{|\sigma_3|}\right)$$

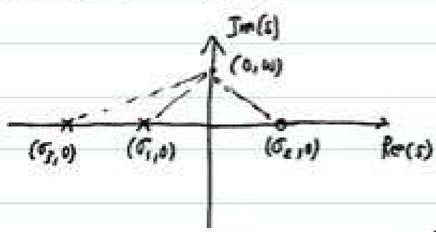
This is adding phase → helping the PM!

Thus:



A LHP zero can really improve the performance & stability of an op amp FB ckt.

② RHP zero: (and 2 poles)



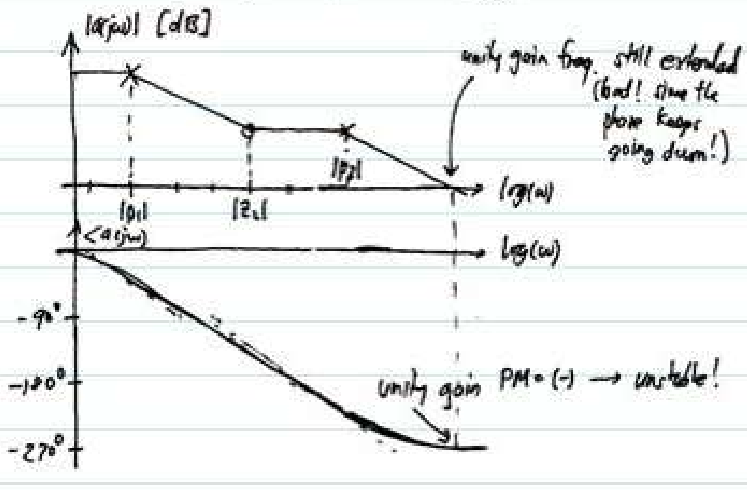
$$|H(j\omega)| = \frac{\sqrt{\omega^2+\sigma_2^2}}{\sqrt{\omega^2+\sigma_1^2}\sqrt{\omega^2+\sigma_3^2}}$$

now $\sigma_2 = (+)$

$$\measuredangle H(j\omega) = +\tan^{-1}\left(\frac{\omega}{-\sigma_2}\right) - \tan^{-1}\left(\frac{\omega}{-\sigma_1}\right) - \tan^{-1}\left(\frac{\omega}{-\sigma_3}\right)$$

$$= +\tan^{-1}\left(-\frac{\omega}{|\sigma_2|}\right) - \tan^{-1}\left(\frac{\omega}{|\sigma_1|}\right) - \tan^{-1}\left(\frac{\omega}{|\sigma_3|}\right)$$

Thus:



A RHP zero is detrimental because it:
① extends the ω_u
② while continuing to drop the phase
⇓
instability!

Problem!

⇒ to solve, must first understand where the zero comes from!