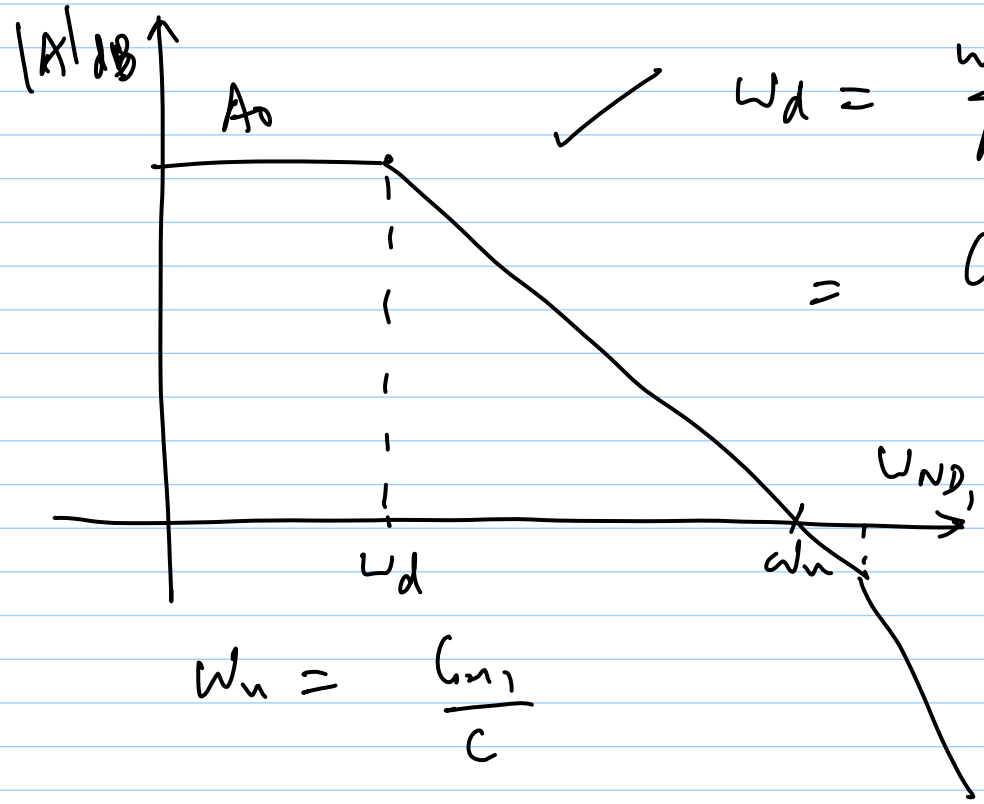
4-3-13

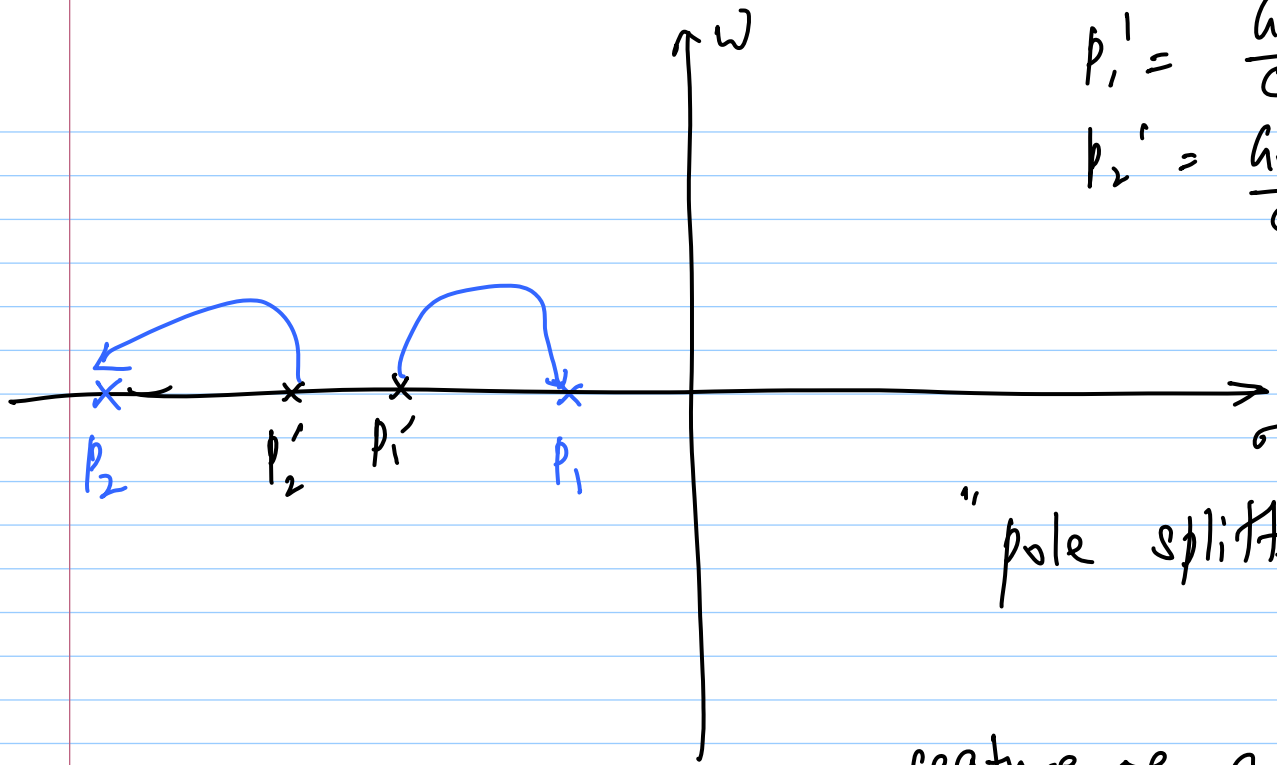
Lec 30



$$\omega_d = \frac{\omega_u}{A_0} = \frac{G_{m1}/C}{\frac{G_{m1}G_{m2}}{G_{o1}G_{o2}}}$$

$$= \frac{G_{o1}G_{o2}}{G_{m2}} \cdot \frac{1}{C}$$

$$\omega_u = \frac{G_{m1}}{C}$$



$$p_1' = \frac{G_{o1}}{C_1}$$

$$p_2' = \frac{G_{o2}}{C_2}$$

"pole splitting"

feature of a lowled system

Conditions for Stability

$$|\omega_{p_2}| \gg |\omega_u|$$

$$\phi_{UGF} = -90^\circ - \tan^{-1}\left(\frac{\omega_u}{\omega_{p_2}}\right) - \tan^{-1}\left(\frac{\omega_u}{\omega_{z_1}}\right)$$

ω_d ω_{p_2} ω_{z_1}

1) ω_z

$G_{m_1} = G_{m_2} \Rightarrow 45^\circ$ phase from zero

$-\tan^{-1}\left(\frac{G_{m_1}}{G_{m_2}}\right)$

We want $G_{m_2} \gg G_{m_1}$

2) ω_{p_2}

$\omega_{p_2} \gg \omega_u$

$$\Rightarrow \frac{G_{m_2} \cdot \frac{C}{C+C_1}}{C_2 + \frac{CC_1}{C+C_1}} \gg \frac{G_{m_1}}{C}$$

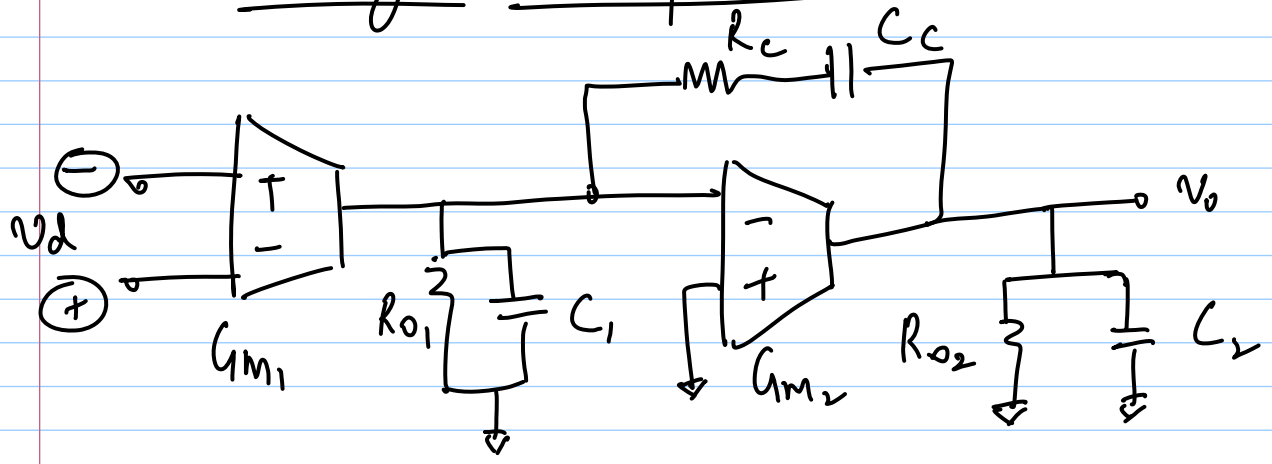
$G_{m_2} \gg G_{m_1}$

$\uparrow \left(\frac{W}{L}\right) \Rightarrow$ C_1, C_2 also increase

$\Rightarrow \uparrow I_2$ (keep $\frac{W}{L}$ small)

wwry about Voltage swings

Moving zero position



After long analysis:

$C_2 \gg C_1, C$

$$p_1 \simeq \frac{G_{O_1} G_{O_2}}{G_{m_2} C_c}$$

$$p_2 \simeq \frac{G_{m_2} C_c}{C_1 C_2 + C_c (C_1 + C_2)} \simeq \frac{G_{m_2}}{G_{O_2}} \cdot \frac{G_{O_2}}{C_2}$$

$$p_3 \simeq \frac{1}{R_c C_1} \quad ; \quad z_1 = \frac{1}{\left(\frac{C_c}{G_{m_2}} - R_c C_c\right)}$$

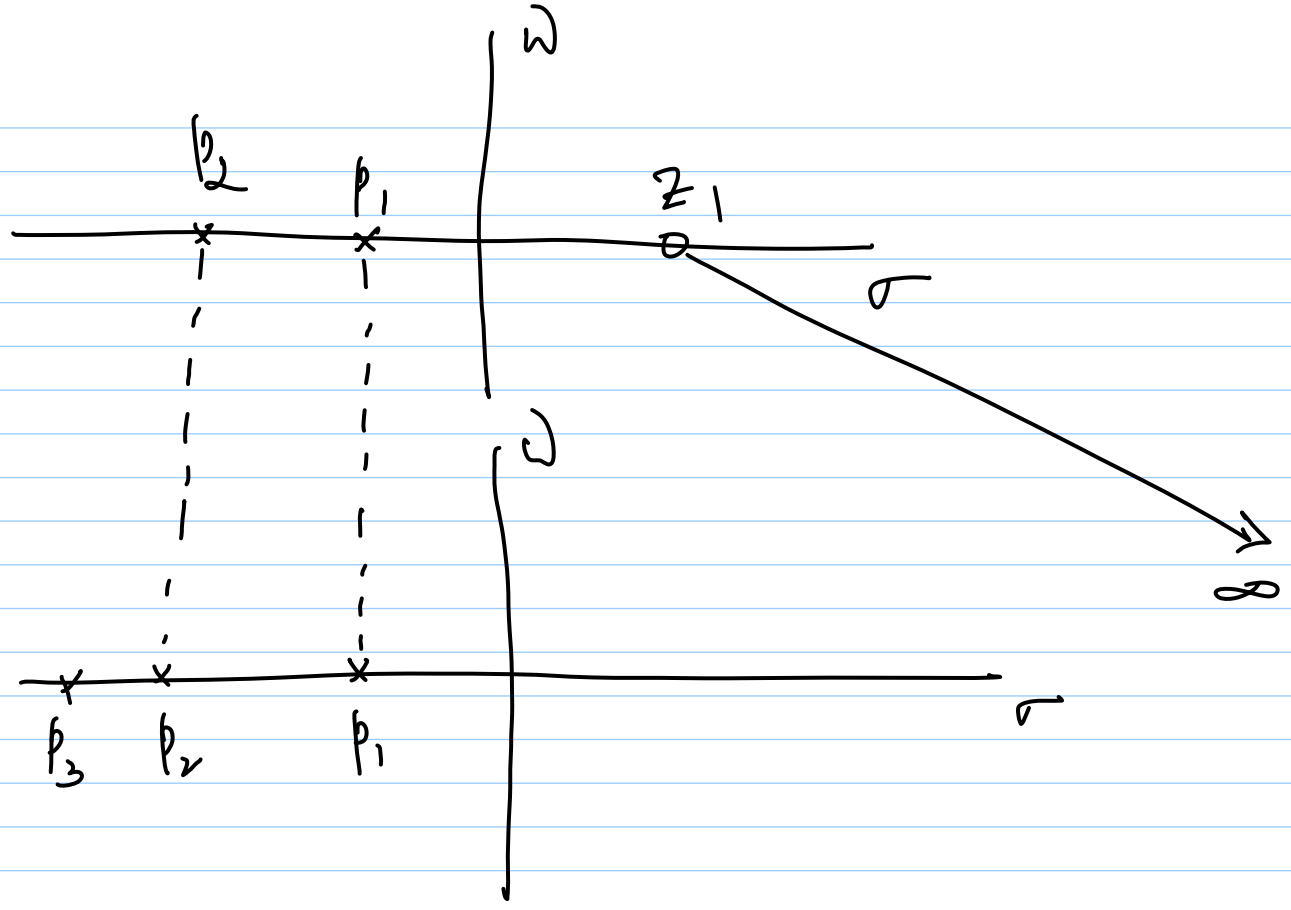
1) Move z_1 to ∞

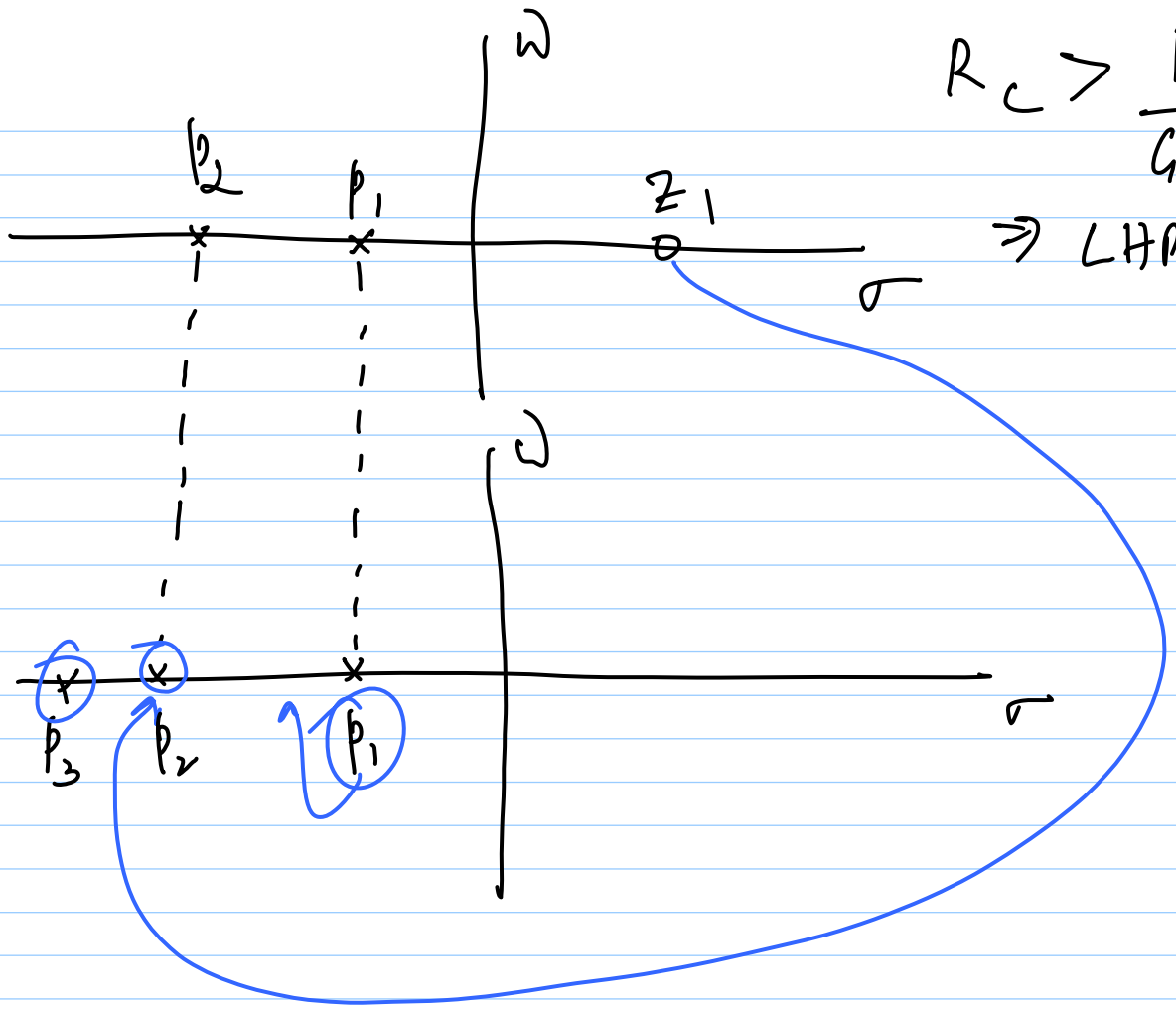
$$R_C = \frac{1}{g_{m_2}}$$

$$p_1 \simeq \frac{g_{o_1} g_{o_2}}{g_{m_2} C_C} \; ; \; p_2 \simeq \frac{g_{m_2}}{g_{o_2}} \cdot \frac{g_{o_2}}{C_2}$$

$$p_3 \simeq \frac{1}{R_C C_1} = \frac{g_{m_2}}{C_1} \approx p_2 \cdot \frac{C_2}{C_1}$$

$C_2 \gg C_1$





$$R_c > \frac{1}{G m_2}$$

$\Rightarrow$ LHP zero

2) $z_1 \quad \dfrac{1}{\dfrac{C_c}{G m_2} - R_c C_c}$

move z_1 in LHP by $R_c > \dfrac{1}{G m_2}$

& cancel p_2

$$z_1 = p_2 \Rightarrow R_c = \frac{1}{G m_2}\left[1 + \frac{C_2}{C_c}\right]$$

for $PM \geq 45^\circ \Rightarrow p_3 \geq \underbrace{A_0 p_1}_{\omega_u}$

$$\frac{1}{R_c \cdot C_1} \geq \frac{G_{m1}}{C_c}$$

$$\frac{1}{C_1} \cdot \frac{G_{m2} \cdot C_c}{C_c + C_2} \geq \frac{G_{m1}}{C_c} \quad \checkmark$$

$$C_c \geq \frac{G_{m1} C_1 + \sqrt{G_{m1}^2 C_1^2 + 4 G_{m1} G_{m2} C_1 C_2}}{2 G_{m2}}$$