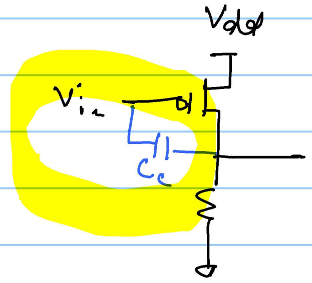
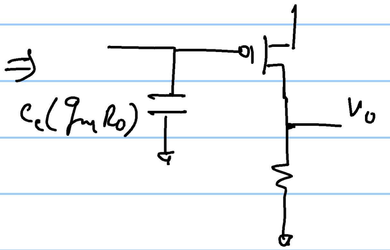


$V_0 = -g_m R_o \times V_{in}$ $\Rightarrow$



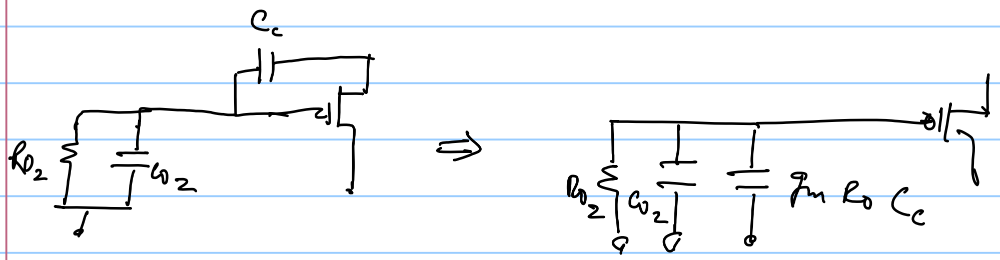
If $g_m R_o$ is large the C_c is quite small.

Assume previous case, C_c required was 5nF

$g_m R_o = 300$

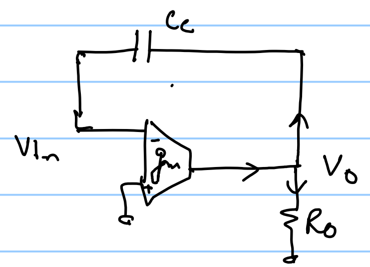
$$C_c = \frac{5nF}{300} = 16.6pF$$

$C_c = 16.67pF$



$g_m R_o C_c >> C_{o2}$

Right Half Plane Zero



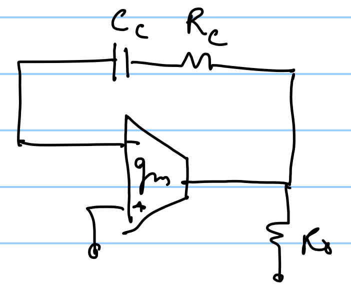
$$(V_o - V_{in}) s C_c + \frac{V_o}{R_o} = -V_{in} g_m$$

$$V_o s C_c - V_{in} s C_c + \frac{V_o}{R_o} = -V_{in} g_m$$

$$V_o\left(\frac{1}{R_o} + sC_c\right) = V_{in}\left(sC_c - g_m\right)$$

$$\frac{V_o}{V_{in}} = \frac{sC_c - g_m}{\frac{1}{R_o} + sC_c}$$

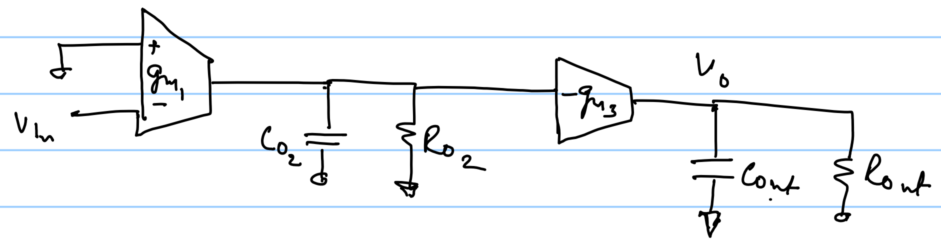
$$\text{Zero} = \frac{g_m}{C_c} \quad \text{R.H.P.}$$



$$\text{Zero} = \frac{1}{\left(\frac{1}{g_m} - R_c\right)C_c} \qquad R_c > \frac{1}{g_m}$$

Zero → L.H.P.

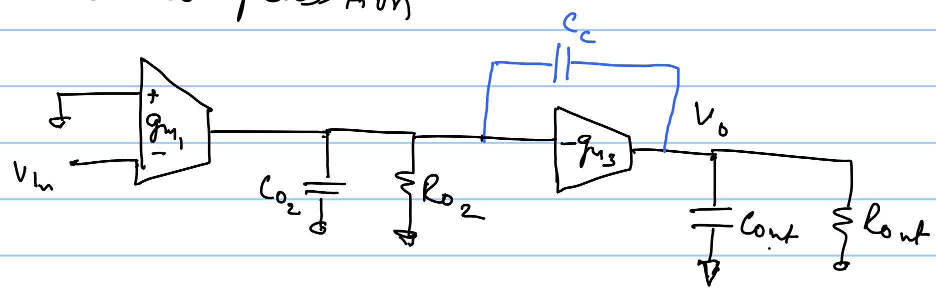
Uncompensated poles

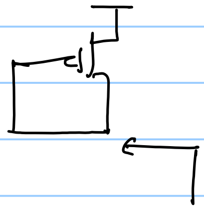


$$\omega p_1 = \frac{1}{R_{o_2} C_{o_2}} \qquad \omega p_2 = \frac{1}{R_{out} C_{out}}$$

gain, $(A_o) = g_{m_1} R_{o_2} g_{m_3} R_{out}$

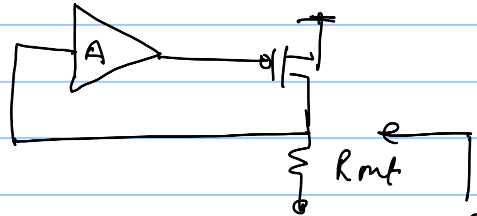
After Miller compensation



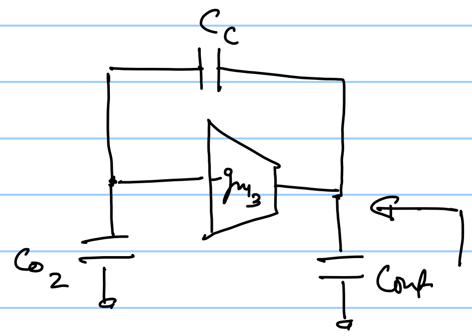


$R_{out} = \frac{1}{g_m} = \frac{R_o}{g_m R_o} = \frac{1}{g_m}$

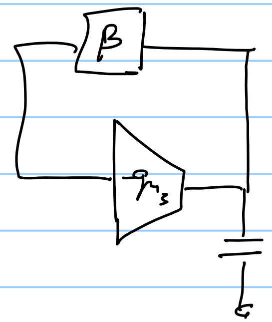
Intrinsic gain $= g_m R_o$



$\frac{R_{out}}{(1 + A g_m r_o)} \approx \frac{R_{out}}{A g_m r_o}$



$R_{out} =$ ⇒



$$\beta = \frac{C_c}{C_c + C_{o_2}}$$

Transconductance

$$g_{m_3}' = g_{m_3} \times \frac{C_c}{C_c + C_{o_2}}$$

compensated pole at Vout

$$\omega_{p_2}' = \frac{\frac{C_c}{C_c + C_{o_2}} g_{m_3}}{C_{out} + \frac{C_{o_2} C_c}{C_c + C_{o_2}}}$$

If $C_c \gg C_{o2}$

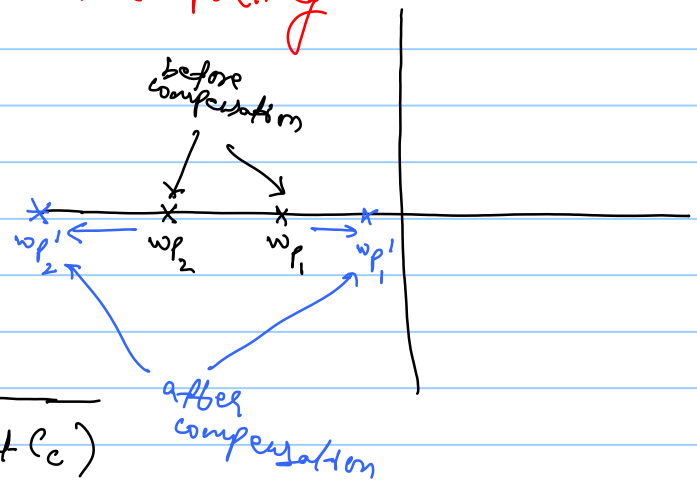
$$\omega p_2' = \frac{g_{m3}}{C_{o2} + C_{out}}$$

Compensated ωp_1

$$\omega p_1' = \frac{1}{R_{o2}\left(C_{o2} + g_{m3} R_{out} C_c\right)}$$

$$\approx \frac{1}{R_{o2}\, g_{m3} R_{out} C_c}$$

Pole splitting



Phase Margin after compensation.

$$\omega_{UGB} = \omega p_2' \times (\text{dc Loop gain})$$

$$= \omega p_2' \, (\beta A_0)$$

assume.

$\beta = 1$

$$A_0 = g_{m2} R_{o2}\, g_{m3} R_{out}$$

$$\omega_{p_1}' = \frac{1}{R_{o2} \times g_{m3} R_{out}\, C_c}$$

$$\omega_{ugb} = \frac{g_{m2} R_{o2}\, g_{m3} R_{out}}{R_{o2} \times g_{m3} R_{out}\, C_c} = \frac{g_{m2}}{C_c}$$

$$\omega_2 = \frac{g_{m3}}{C_c}$$

$$\text{Phase Margin} = 180^\circ - \tan^{-1}\frac{\omega_{ugb}}{\omega_{p_1}'} - \tan^{-1}\frac{\omega_{ugb}}{\omega_{p_2}'} - \tan^{-1}\frac{\omega_{ugb}}{\omega_2}$$

($\tan^{-1}\frac{\omega_{ugb}}{\omega_{p_1}'} \rightarrow 90^\circ$)

$$= 90^\circ - \tan^{-1}\frac{g_{m2}/C_c}{g_{m3}/(C_2+C_1)} - \tan^{-1}\frac{g_{m2}/C_c}{g_{m3}/C_c}$$

Phase shift due to R.H.P. zero

$$\phi_z = -\tan^{-1} \frac{g_{m2}}{g_{m3}}$$

$$g_{m3} >> g_{m2}$$

$$\phi_z \simeq 0$$