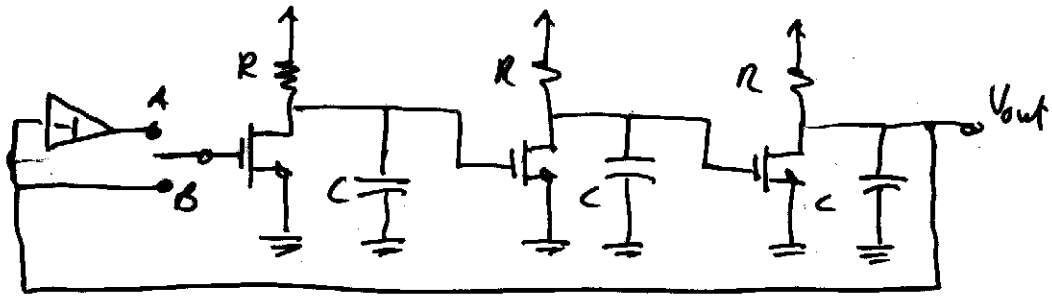
Fall02, Final Ex., Prob. 1



Suppose switch is connected to A

$$T(s) = -\left(\frac{-g_m R}{sRC+1}\right)^3 \rightarrow \frac{(g_m R)^3}{s^3R^3C^3 + 3s^2R^2C^2 + 3sRC + 1}$$

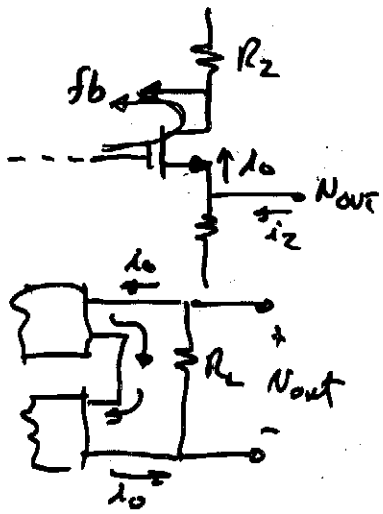
$$T(j\omega) = \frac{(g_m R)^3}{1 - 3\omega^2R^2C^2 + j\left[3\omega RC - \omega^3R^3C^3\right]} = 1 + j0$$

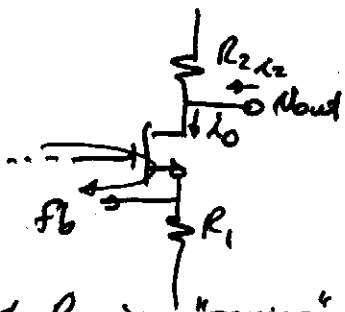
$$3\omega RC = \omega^3R^3C^3 \rightarrow \omega^2 = \frac{3}{R^2C^2} \rightarrow \omega_{osc} = \frac{\sqrt{3}}{RC}$$

$$\frac{(g_m R)^3}{1 - 3R^2C^2\left(\frac{3}{R^2C^2}\right)} = \frac{(g_m R)^3}{1-9} = -\frac{(g_m R)^3}{8} \neq 1$$

$\therefore$ Switch must be at B.

Question on Series Output Resistance Calculation



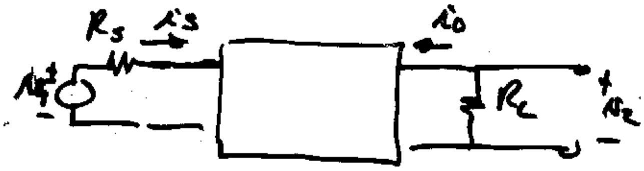


Find R_o in "series" with the i_o path.

$$R_{of} = R_o(1+AB)$$

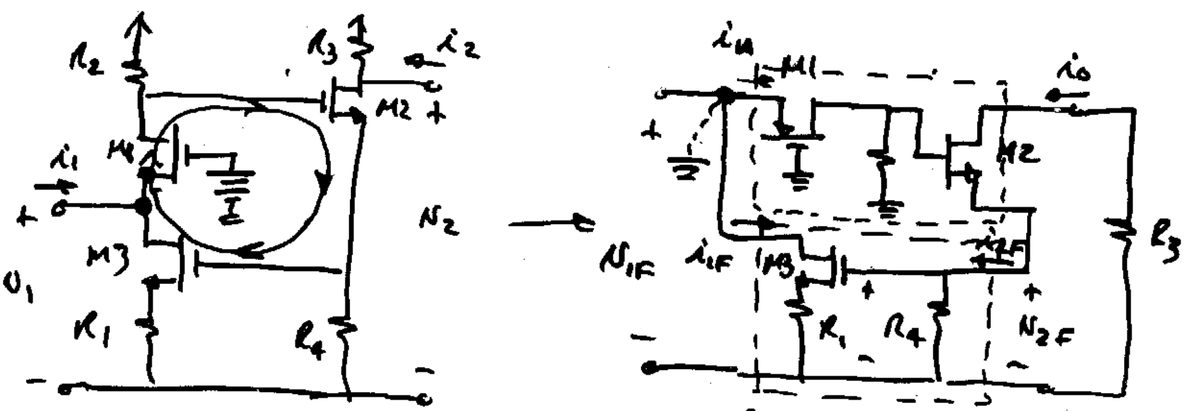
$$\frac{N_2}{i_2} = (R_{of} - R_L) \| R_L$$

Converting A_F to $\frac{v_2}{v_1}$



Knowing $\frac{i_o}{i_s} \rightarrow \frac{v_2}{v_1} = \frac{i_o}{i_s}\frac{(-R_L)}{(R_s+R_{inF})} = \left(\frac{i_o}{i_s}\right)\left(\frac{v_2}{i_o}\right)\left(\frac{i_s}{v_1}\right)$

Final F02, Prob. 3 –
How do you find β?



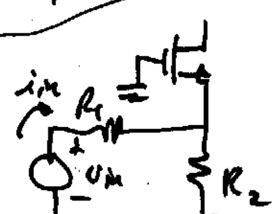
$$\beta = g_{12F} = \left.\frac{i_{1F}}{i_{2F}}\right|_{v_{1F}=0} \qquad \frac{i_{1F}}{i_{2F}} = \left(\frac{i_{1F}}{v_{gs3}}\right)\left(\frac{v_{gs3}}{v_{g3}}\right)\left(\frac{v_{g3}}{i_{2F}}\right)$$

(g_{m3}, R_4)

$$v_{gs3} = v_{g3} - v_{s3} = v_{g3} - g_{m3}R_1 v_{gs3} \Big\} \frac{1}{1+g_{m3}R_1}$$

$$\beta = \frac{g_{m3}R_4}{1+g_{m3}R_1}$$

Final Exam F02, Prob. 5



$$\omega_2 = \frac{1}{C_1\left[R_1 + R_2 \| \frac{1}{g_m}\right]} = \frac{1}{20\mu F\left[1k + 1k \| 500\Omega\right]}$$

$$\doteq \frac{1}{20\mu F(1.3k)} = \frac{1}{26.7\times 10^{-3}} = \frac{1000}{26.7} = 37.5$$

$$MBG = \frac{v_{out}}{v_{in}} = \frac{v_{out}}{i_{in}}\frac{i_{in}}{v_{in}} = (R_3 \| R_4)\frac{1}{R_1 + R_2\|\frac{1}{g_m}} \times \frac{R_2}{R_2 + \frac{1}{g_m}} = 10k\frac{1}{1.3k}\frac{1}{1.5} = 5$$

Cont'd

How to find ω_L?

1.) If you know all the roots, then

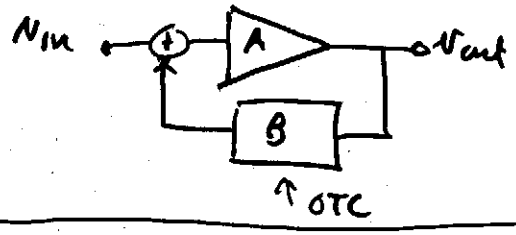
a.) $\omega_L \cong |P_{dominant}|$ → $|P_{dominant}| > +|Next\ smaller\ pole|$

b.) $\omega_L \approx \sqrt{\Sigma poles^2 - 2\Sigma zeros^2}$

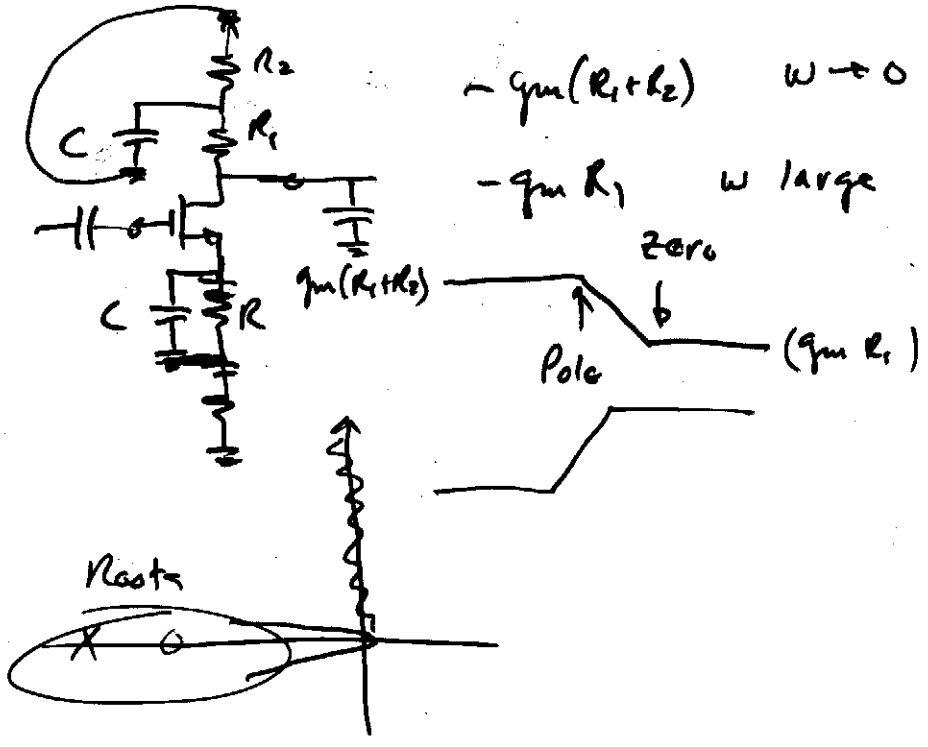
c.) Bode plot

2.) OTC method

$$\omega_L \cong \Sigma\left(\frac{1}{R_i C_i}\right)$$



$$\frac{V_{out}}{V_{in}} = \frac{A}{1+AB} \cong \frac{1}{B}$$



$-g_m(R_1+R_2)$ $\omega \to 0$

$-g_m R_1$ ω large

A Bode Plot of Prob.1 of Final F02

$$T(s) = \frac{-8}{\left(\frac{s}{10^5}+1\right)^3} = \left(\frac{-2}{\frac{s}{10^5}+1}\right)^3 \quad \text{and} \quad T(j\omega) = \frac{-8}{\left(1+j\frac{\omega}{10^5}\right)^3}$$