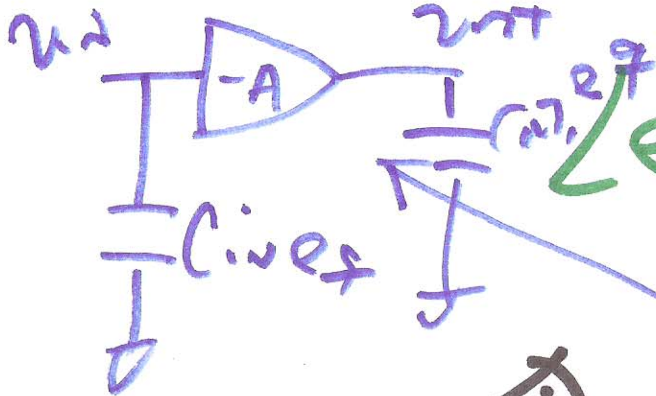
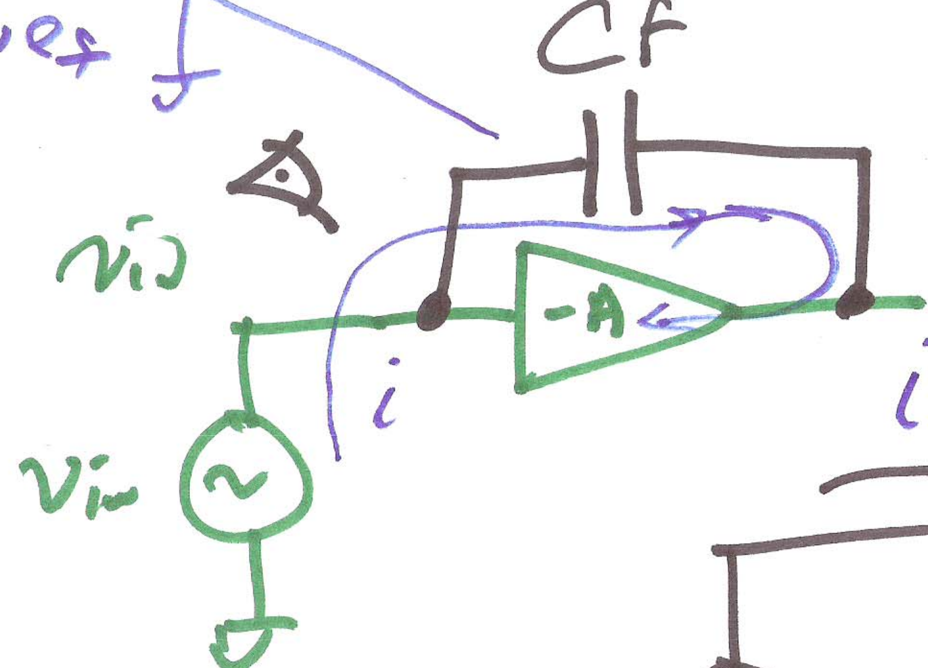
EE 420/ECG 620

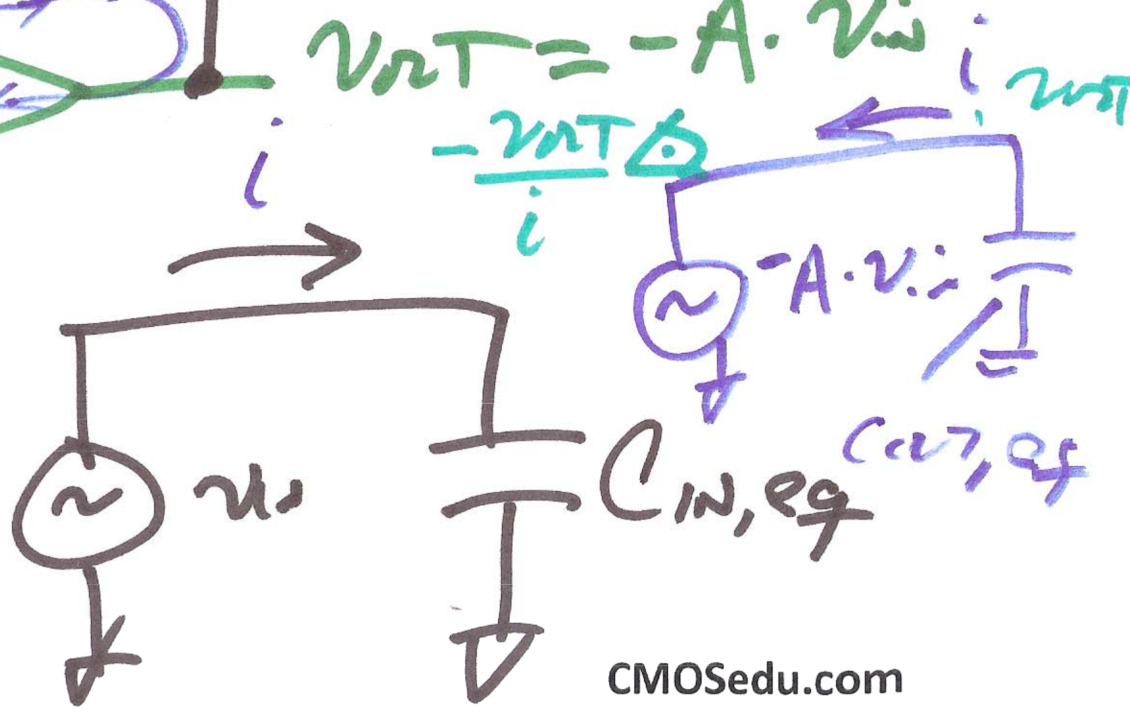
Analog IC Design

Lecture 15

MARCH 9, 2015





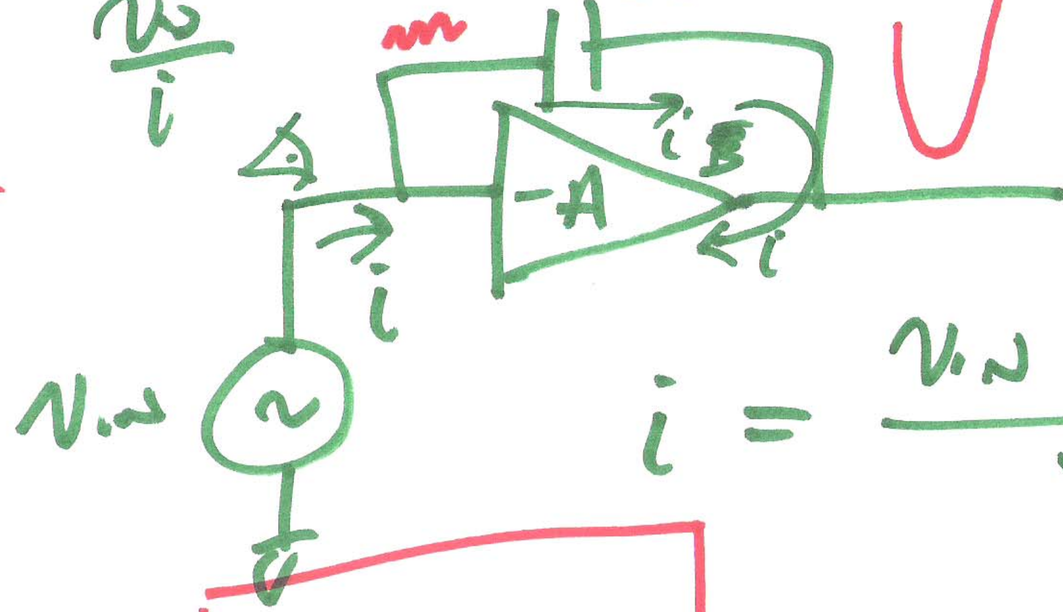


Miller's Theorem

1) neglects zero

$$i = C\frac{dv}{dt}$$

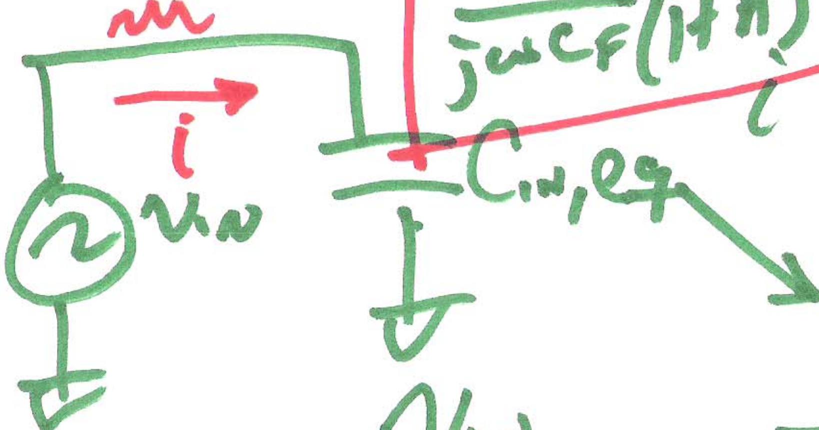
$$\frac{v_i}{i}$$



$$v_{out} = -Av_i$$

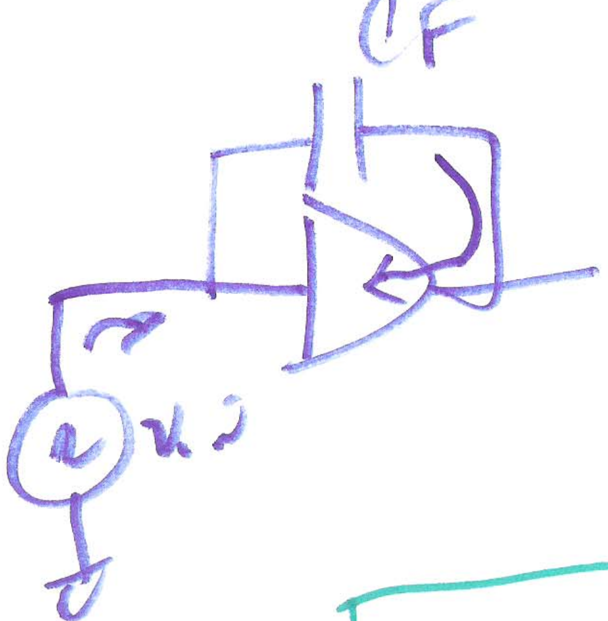
$$i = \frac{v_{in} - v_{out}}{1/j\omega C_F}$$

$$\boxed{\frac{1}{j\omega C_F(1+A)}}$$



$$i = \frac{v_{in}(1+|A|)}{1/j\omega C_F}$$

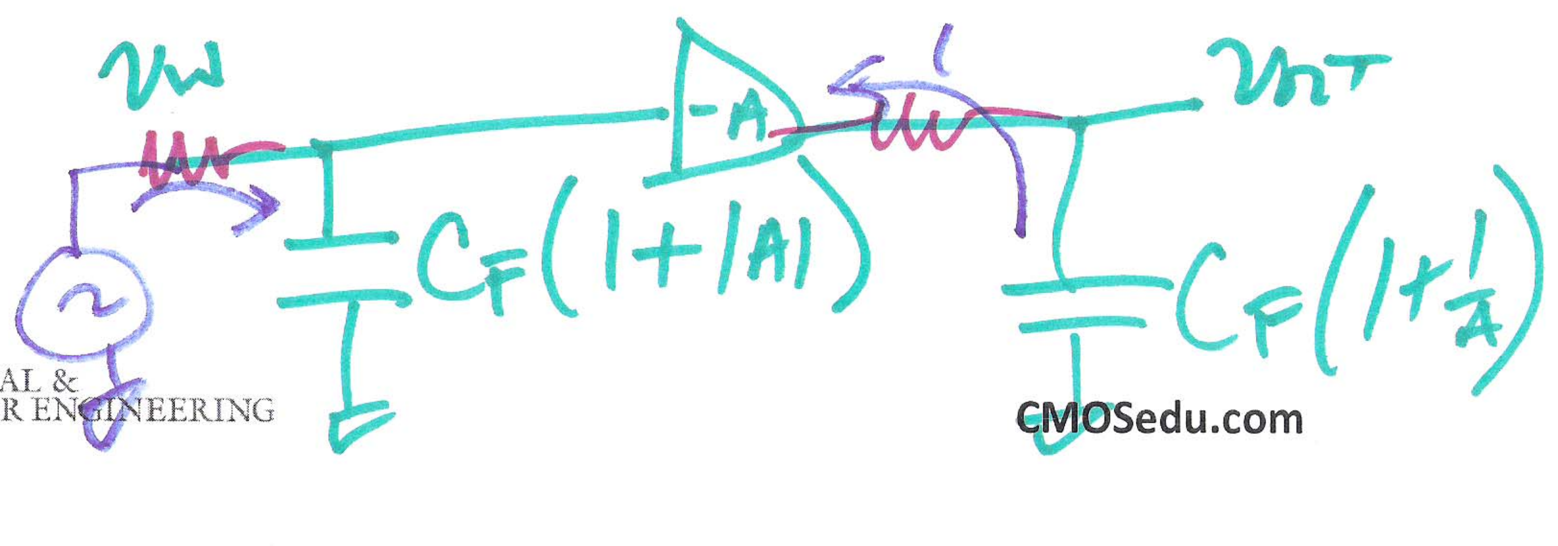
$$\frac{v_{in}}{i} = \frac{1}{j\omega C_F(1+|A|)} = C_{in,eq}$$

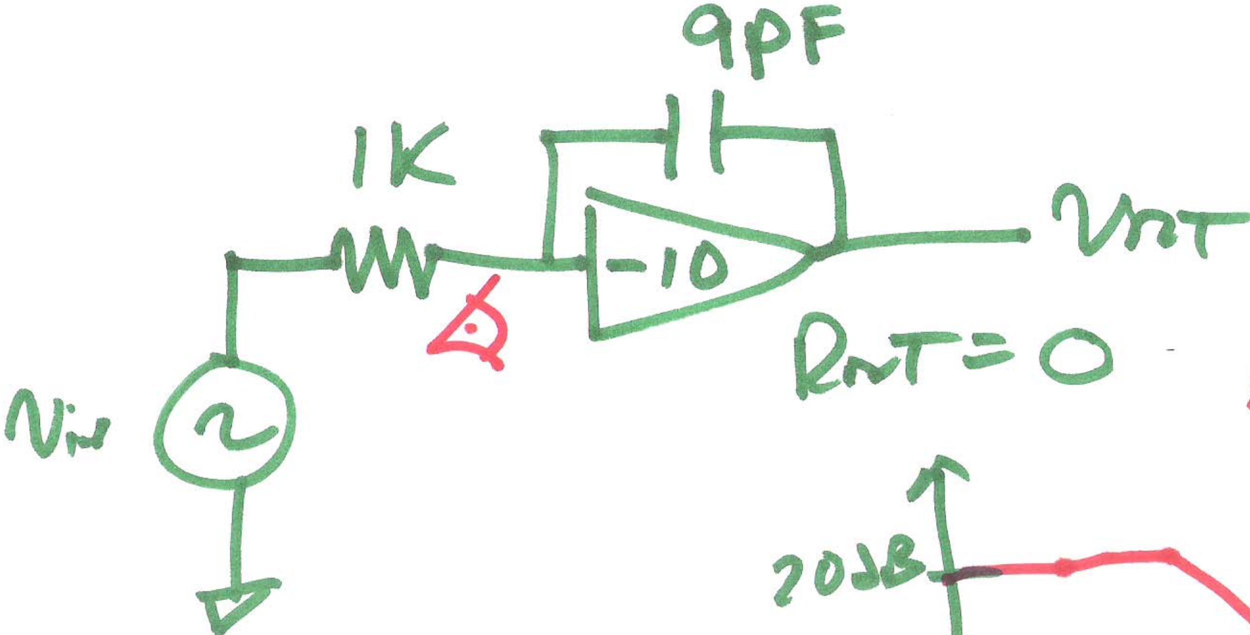


$$v_{in} = \frac{v_{out}}{-A}$$

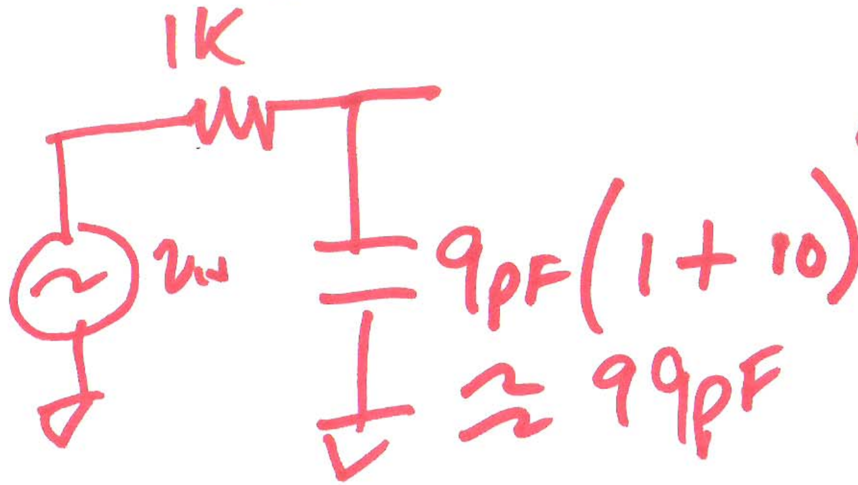
$$i = \frac{-v_{out}\left(1 + \frac{1}{|A|}\right)}{1/j\omega C_F}$$

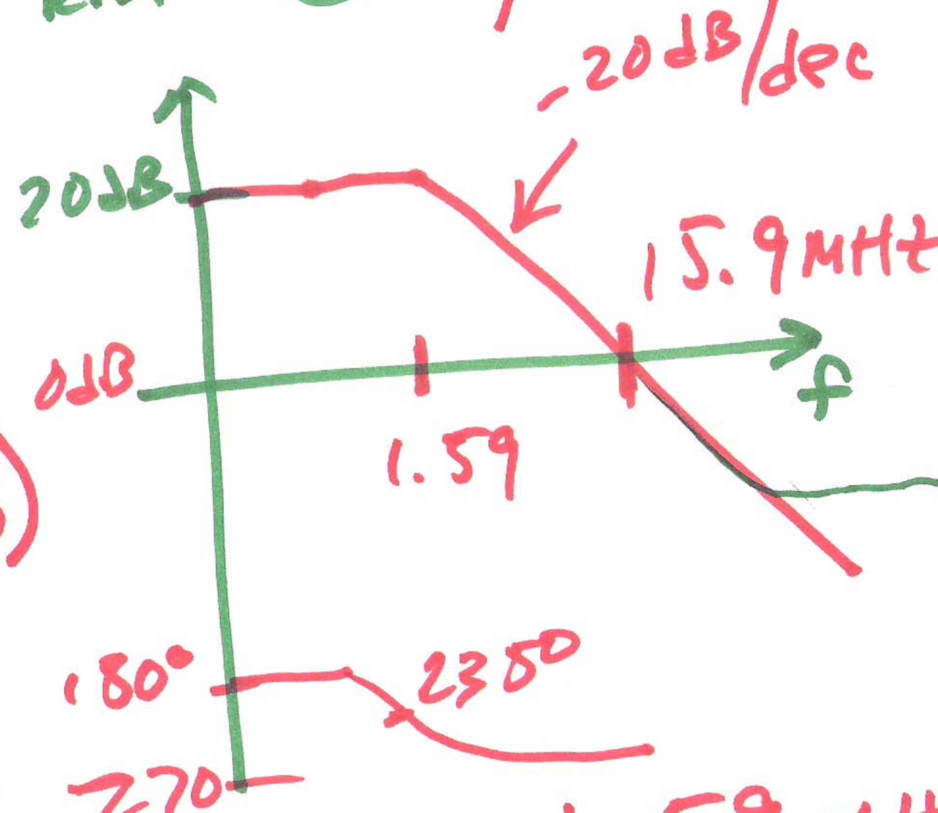
$$\boxed{\frac{v_{out}}{-i} = \frac{1}{j\omega C_F\left(1 + \frac{1}{|A|}\right)}} = C_{out,eff}$$



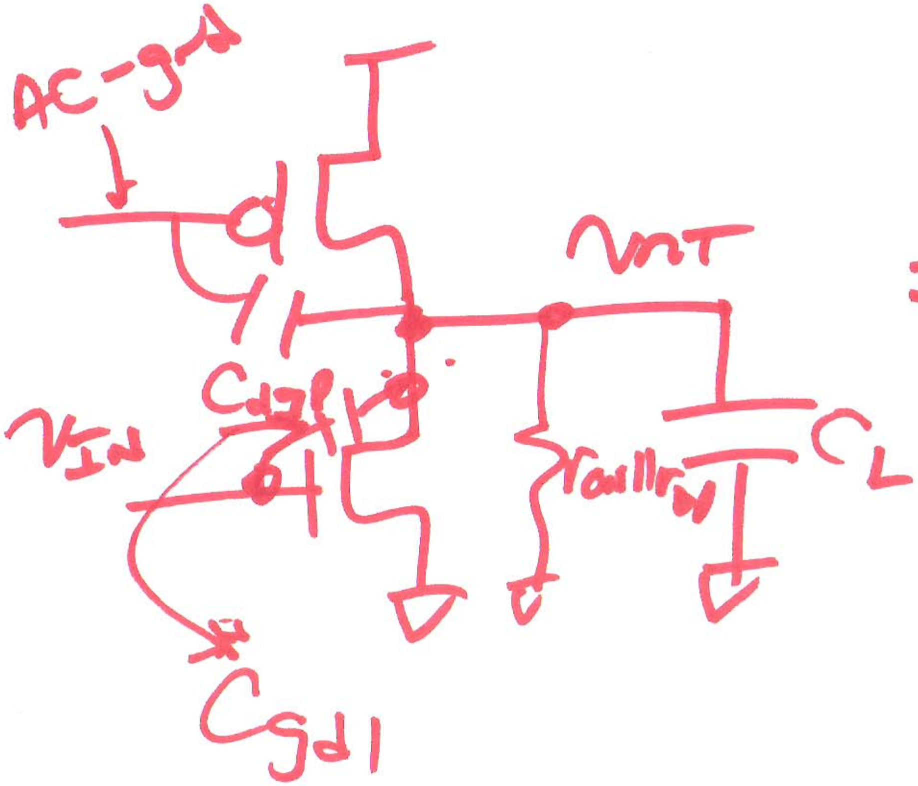


$$\frac{v_{out}}{v_{in}} = \frac{-10}{1 + j\frac{f}{1.59\,\text{MHz}}}$$

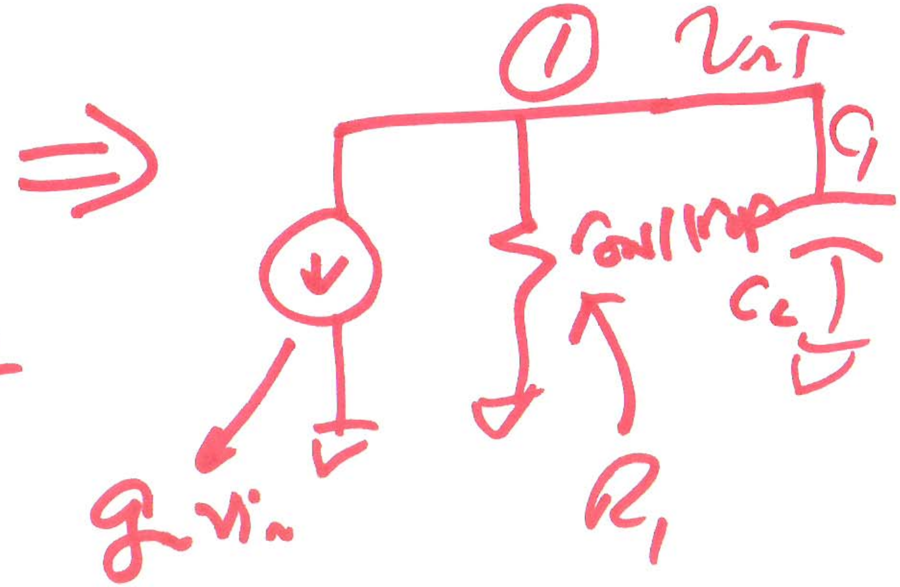




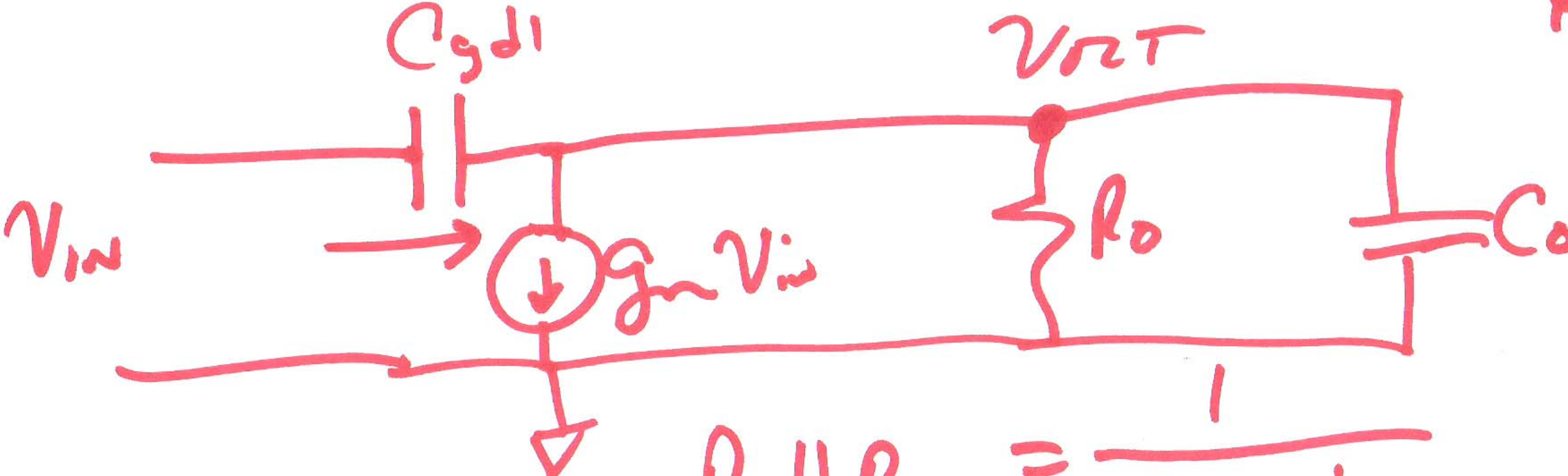
$$f_{3dB} = \frac{1}{2\pi \cdot 1K \cdot 99pF} = 1.59\,\text{MHz}$$



$\Rightarrow$



$C_o = C_L + C_{dg}$ ← pmos



$$R_1 \| R_2 = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

$$\frac{v_{in} - v_{OUT}}{1/j\omega C_{gd}} = g_m v_{in} + \frac{v_{OUT}}{R_o \,||\, 1/j\omega C_o}$$

$$j\omega C_{gd} \cdot v_{in} - j\omega C_{gd} \cdot v_{OUT} = g_m v_{in} + \frac{v_{OUT}}{R_o} + v_{OUT} j\omega C_o$$

$$v_{in}\left(j\omega C_{gd} - g_m\right) = v_{OUT}\left(\frac{1}{R_o} + j\omega\left(C_o + C_{gd}\right)\right)$$

$$\frac{v_{OUT}}{v_{in}} = \frac{-\left(g_m - j\omega C_{gd}\right)}{\frac{1}{R_o} + j\omega\left(C_o + C_{gd}\right)}$$

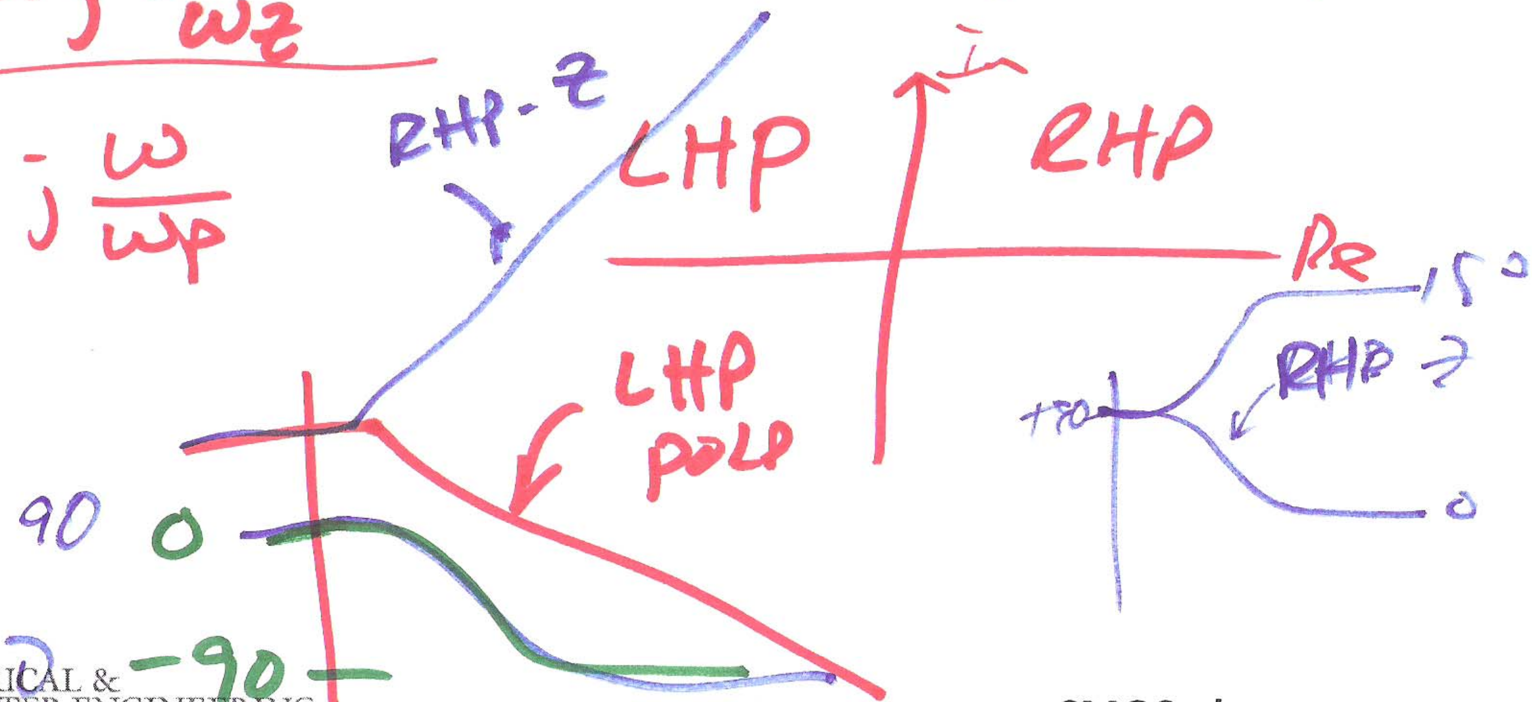
$$\frac{v_{out}}{v_{in}} = \frac{\left(-g_m R_o + j0\right)\left(1 - j\omega\frac{C_{gd}}{g_m}\right)}{1 + j\omega R_o\left(C_o + C_{gd}\right)}$$

$$\omega_z = +\frac{g_m}{C_{gd}}$$

RHP zero

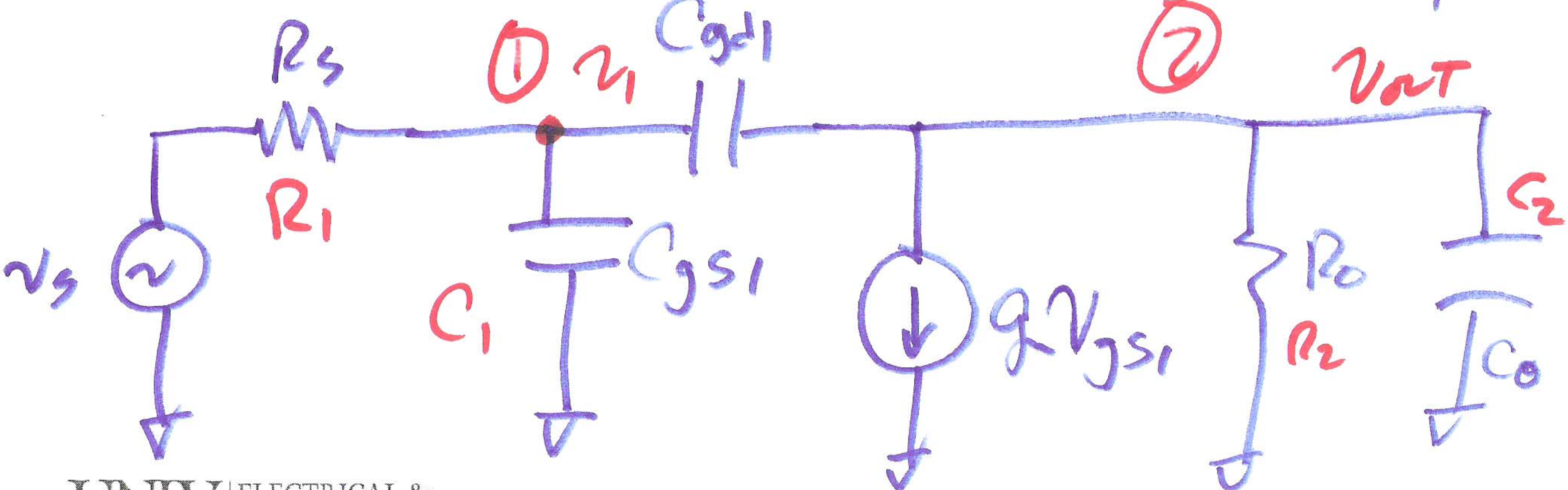
$$\omega_p = \frac{-1}{R_o\left(C_o + C_{gd}\right)}$$

$$\frac{1 - j\frac{\omega}{\omega_z}}{1 \pm j\frac{\omega}{\omega_p}}$$



$$\left|\frac{v_{out}}{v_{in}}\right| = \frac{g_m R_o \left(\sqrt{1+\left(-\omega\frac{C_{gd}}{g_m}\right)^2}\right)}{\sqrt{1+\left(2\pi f \cdot R_o(C_{gd}+C_o)\right)^2}}$$

$$\angle\frac{v_{out}}{v_{in}} = \tan^{-1}\left(-\omega\frac{C_{gd}}{g_m}\right) - \tan^{-1}\frac{\omega R_o(C_o+C_{gd})}{1}$$



8)

$$\frac{v_s - v_1}{R_s} = \frac{v_1}{1/j\omega C_{gs1}} + \frac{v_1 - v_{outT}}{1/j\omega C_{gd1}}$$

$$\frac{v_{outT}}{v_1} = \frac{-g_m R_o \cdot \left(1 - j\omega \frac{C_{gd1}}{g_m}\right)}{1 + j\omega \left(C_{gd1} + C_o\right) \cdot R_o}$$