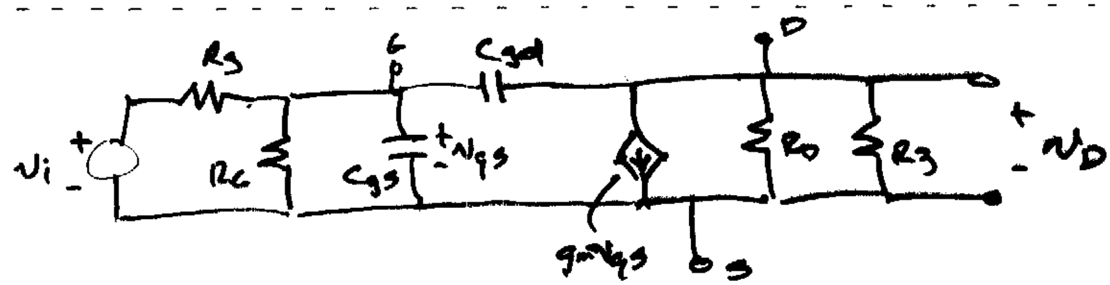


$$\frac{V_{gs}-V_i}{R_s} + \frac{V_{gs}}{R_G} + sC_{gs}V_{gs} + sC_{gd}(V_{gs}-V_o) = 0$$

$$\left(\frac{1}{R_s}+\frac{1}{R_G}+sC_{gs}+sC_{gd}\right)V_{gs} - sC_{gd}V_o = \frac{V_i}{R_s} \quad (1)$$

$$sC_{gd}(V_o - V_{gs}) + g_m V_{gs} + \frac{V_o}{R_D} + \frac{V_o}{R_3} = 0$$

$$(g_m - sC_{gd})V_{gs} + \left(\frac{1}{R_D}+\frac{1}{R_3}+sC_{gd}\right)V_o = 0$$

$$V_{gs} = \frac{-(G_D+G_3+sC_{gd})}{g_m - sC_{gd}}\, V_o \quad (2)$$

(2) into (1)

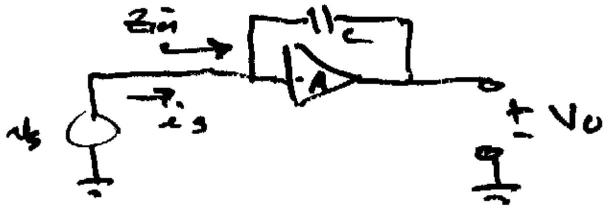
$$\therefore -(G_s+G_G+sC_{gs}+sC_{gd})\left(\frac{G_D+G_3+sC_{gd}}{g_m-sC_{gd}}\right)V_o - sC_{gd}V_o = G_sV_i$$

$$\rightarrow \frac{V_o}{V_i} = \frac{-G_s(g_m - sC_{gd})}{(G_s+G_G)(G_D+G_3) + sC_{gs}(G_D+G_3) + sC_{gd}(G_D+G_3+G_G) + sC_{gd}g_m + s^2C_{gd}C_{gs}}$$

$$\frac{V_o}{V_i} = \frac{-5\times10^{19}(1.23\times10^{-3} - s2\times10^{-12})}{s^2 + 3.628\times10^8 s + 1.165\times10^6} \rightarrow \begin{array}{l} z_1 = 6.15\times10^8 \\ p_1 = -0.356\times10^8 \\ p_2 = -3.272\times10^8 \end{array}$$

$$\omega_H \simeq |p_1| = 35.6\times10^6 \text{ r/s} \rightarrow \underline{f_H = 5.67\text{ mHz}}$$

17.7 Miller Multiplication



$$Z_{in} = \frac{V_s}{i_s}$$

$$i_s = \frac{V_s - V_o}{\frac{1}{sC}} = (V_s - V_o)sC$$

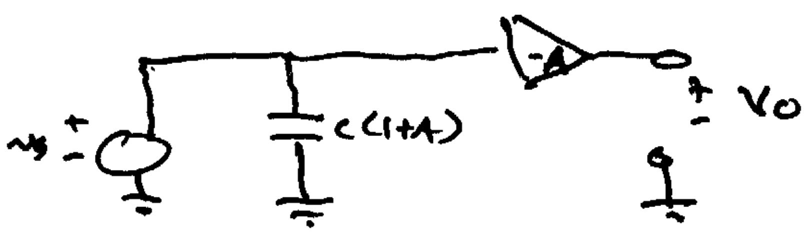
$$V_o = -AV_s$$

$$i_s = (V_s + AV_s)sC = V_s(1+A)sC$$

$$\frac{V_s(s)}{i_s(s)} = \frac{1}{(1+A)sC}$$

Total input C is equal to capacitor, C, multiplied by (1+A)

⇓ can redraw the ckt.

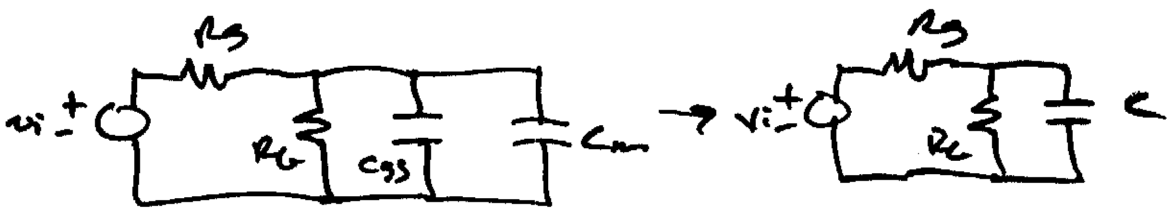


Miller Effect → our CS Amp example

assume $\frac{1}{\omega C_{gd}} \gg R_D \| R_3$

$\therefore V_o = -g_m R_D \| R_3 V_{gs} = -1.23(4.3 \| 100) V_{gs}$
$= -5.07 V_{gs}$

$C_m = C_{gd}(1+5.07) = 6.07 C_{gd}$



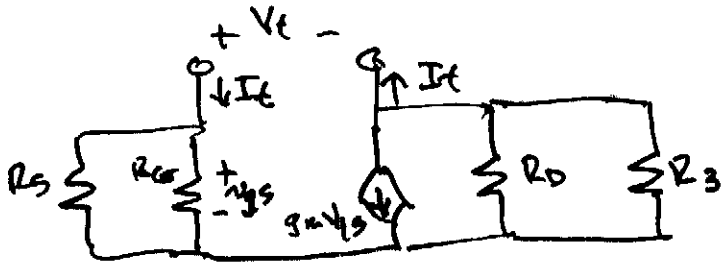
$C = C_{gs} + C_m$
$= 22.14 pF$

$\omega_H \approx \frac{1}{(R_s \| R_G) C} = \frac{1}{(994K)(6.07 \times 2 + 10pF)}$

$f_H \Rightarrow 7.22 MHz$

OPEN CIRCUIT TIME CONSTANT → to FIND ω_H

$$R_{eqs} = R_G \parallel R_S = 0.996K \quad , \quad R_{eqD} = ?$$



$$V_t = \underbrace{I_t (R_S \parallel R_G)}_{V_{gs}} + (g_m V_{gs} + I_t) R_D \parallel R_3$$

$$= I_t (R_S \parallel R_G) + (g_m R_D \parallel R_3)(R_S \parallel R_G) I_t + I_t R_D \parallel R_3$$

$$R_{eqd} = \frac{V_t}{I_t} = (R_S \parallel R_G)\left[1 + g_m (R_D \parallel R_3)\right] + R_D \parallel R_3$$

$$= 0.996K\,[1 + 5.07] + 4.122K = 10.168K$$

$$\therefore \omega_H = \frac{1}{(0.996K)(10pF) + 10.168K(2pF)} = 33.33 \times 10^6 \text{ RAD/SEC}$$

$$\rightarrow \quad f_H = 5.3 \text{ MHZ}$$