EE 303
02/17/06

$$T(s) = \frac{-g_m + sC_{gd}}{R_S\left(C_{gs}C_{gd}\, s^2 + \left[G_{in}C_{gs} + G_o(C_{gs}+C_{gd}) + g_m C_{gd}\right] s + G_{in}G_o\right)}.$$

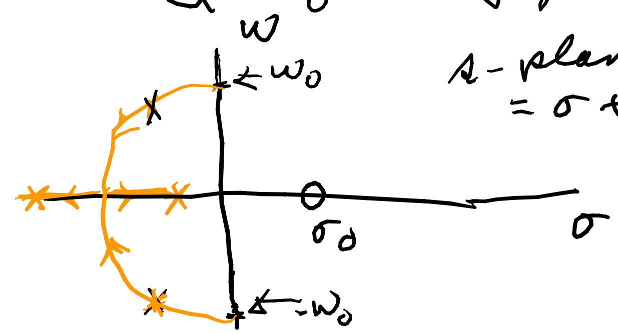
$$= \frac{\cancel{C_{gd}}}{R_S C_{gs}\cancel{C_{gd}}}\left[\frac{s - g_m/C_{gd}}{s^2 + \left[G_{in}\frac{1}{C_{gd}} + G_o\left(\frac{1}{C_{gd}} + \frac{1}{C_{gs}}\right) + \frac{g_m}{C_{gs}}\right]s + \frac{G_{in}}{C_{gd}}\cdot\frac{G_o}{C_{gs}}}\right]$$

$$= \frac{K(s - \sigma_0)}{s^2 + \frac{\omega_0}{Q}s + \omega_0^2}$$

$\omega_0 = \sqrt{\frac{G_{in}}{C_{gd}}\cdot\frac{G_o}{C_{gs}}}$ = undamped natural radian frequency

$= 2\pi f_0$

Q = quality factor



s-plane $= \sigma + j\omega$

let $C_{gs} = 2\,pFd$, $C_{gd} = 1\,pFd$

$R_s = 50\,\Omega$, $R_1 = R_2 = 10\,Meg\Omega \Rightarrow R_{\parallel} = \frac{1}{2}10\,Meg\Omega = 5\,meg$

$G_{in} = \frac{R_S + R_{\parallel}}{R_S R_{\parallel}} \approx \frac{R_{\parallel}}{R_S R_{\parallel}} = 1/R_S$; $g_m = 10^{-3}\,\mho$

$g_o = \frac{1}{1\,Meg\Omega}$; $R_L = 10K\Omega$

$G_o = \frac{1Meg + 10K\Omega}{1Meg \cdot 10K\Omega} \approx \frac{1}{10K\Omega} = \frac{1}{100} = 10^{-2}$

$$K = \frac{1}{R_s C_{gs}} = \frac{1}{50 \times 2 \times 10^{-12}} = \frac{10^2 \times 10^{10}}{100} = 10^{10}$$

$$\frac{g_m}{C_{gd}} = \frac{10^{-3}}{1 \times 10^{-12}} = 10^9$$

$$\frac{G_{in}}{G_{gd}} \cdot \frac{G_o}{C_{gs}} = \frac{1}{50 \times 1 \times 10^{-12}} \times \frac{10^{-2}}{2 \times 10^{-12}} = \frac{1}{5} \times 10^{-3} \times (10^{12})^2$$

$$= 2 \times (10^{-2})^2 (10^{12})^2 = 2 \times 10^{20}$$

$$\omega_o = \sqrt{2 \times 10^{20}} = \sqrt{2} \times 10^{10}$$

$$\frac{G_{in}}{C_{gd}} + G_o\left(\frac{1}{C_{gd}} + \frac{1}{C_{gs}}\right) + \frac{g_m}{C_{gs}} = \frac{10^{12}}{50} + 10^{-2}\left(\frac{10^{12}}{1} + \frac{10^{12}}{2}\right) + \frac{10^{-3} \times 10^{12}}{2}$$

$$10^{10} \times \frac{10^{-1}}{2} = 10^{10} \times \frac{10}{2} \times 10^{-2} = 0.05 \times 10^{10}$$

$$= 2 \times 10^{10} + \frac{3}{2} \times 10^{10} + \frac{10^9}{2} \approx$$

$$= 3.55 \times 10^{10}$$

$$\approx \frac{7}{2} \times 10^{10} = \frac{\omega_o}{Q} \Rightarrow Q = \frac{\sqrt{2} \times 10^{10}}{\frac{7}{2} \times 10^{10}} = \frac{2\sqrt{2}}{7} \approx \frac{1}{2}$$

added after class

$$T(s) = 10^{10} \frac{s - 10^9}{s^2 + 3.55 \times 10^{10} s + 2 \times 10^{20}}$$

factor denominator, $s_{1,2} = -\frac{3.55}{2} \times 10^{10} \pm \frac{1}{2}\sqrt{(3.55 \times 10^{10})^2 - 4 \times 2 \times 10^{20}}$

$$= \frac{10^{10}}{2}\left(-3.55 \pm \sqrt{(3.55)^2 - 8}\right) = \frac{10^{10}}{2}(-3.55 \pm 1.898)$$

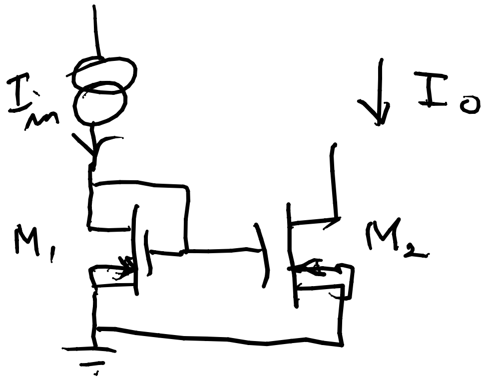
$$= -2.724 \times 10^{10} \ \& \ -0.826 \times 10^{10}$$

or $T(s) = 10^{10} \dfrac{s - 10^9}{(s + 2.724 \times 10^{10})(s + 0.826 \times 10^{10})}$

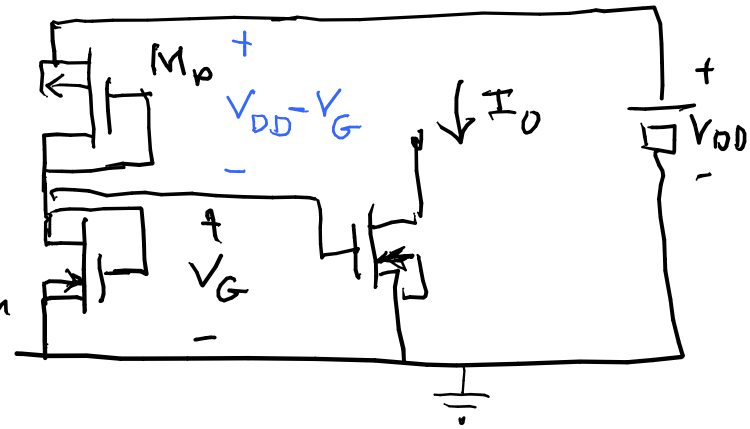
if we let $s' = s/10^{10}$

$T(s) = T'(s') = \dfrac{s' - 0.1}{(s' + 2.724)(s' + 0.826)}$ as a normalized form

Design of a current mirror or source



$\Rightarrow$



$$I_{S_p} = I_{D_n} = -I_{D_p}$$

$$= \frac{KP_p}{2}\frac{W_p}{L_p}\left((V_{DD}-V_G)-|VTO_p|\right)^2 = \frac{KP_n}{2}\frac{W_n}{L_n}\left(V_G - VTO_n\right)^2$$

can solve for V_G, can achieve almost any V_G by $\frac{W}{L}$ choices