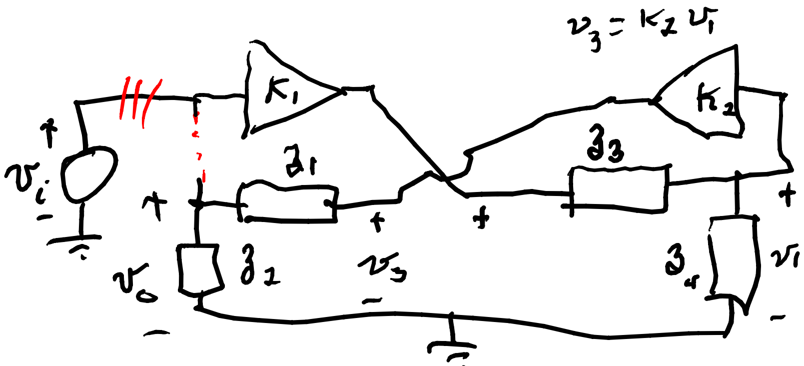
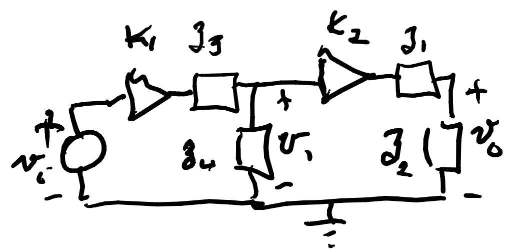
Note Title 5/9/2011

EE 303
05/09/11
updated





$$T(s) = \frac{V_o}{V_i} \Rightarrow \qquad V_o(s) = \frac{z_2}{z_1 + z_2} \cdot K_2 \cdot v_1$$

$$v_1 = \frac{z_4}{z_3 + z_4} \cdot K_1 \cdot v_i \Rightarrow V_o = \frac{1}{1 + \frac{z_1}{z_2}} \cdot K_2 \cdot \frac{1}{1 + \frac{z_3}{z_4}} \cdot K_1 \cdot V_i$$

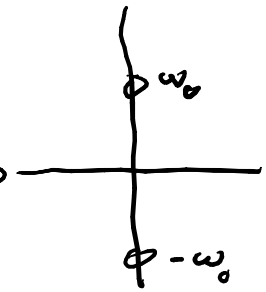
$$T(s) = \frac{K_1 K_2}{\left(1 + \frac{z_1}{z_2}\right)\left(1 + \frac{z_3}{z_4}\right)} = \frac{V_o}{V_i}(s)$$

; close the feedback loop

$$v_o = \frac{K_1 K_2}{(1 + z_1/z_2)(1 + z_3/z_4)} \cdot v_i \Rightarrow \left(1 - \frac{K_1 K_2}{\left(1 + \frac{z_1}{z_2}\right)\left(1 + \frac{z_3}{z_4}\right)}\right) \cdot v_o = 0$$

for oscillations $v_0 \neq 0$

s-plane



$$P(s) = \left(1 + \frac{z_1}{z_2}\right)\left(1 + \frac{z_3}{z_4}\right) - K_1 K_2 = 0$$

$\therefore$ set $s = j\omega$ & the s dom of $P(j\omega_0) = 0$

need an s in denominator of $P(s)$

let $\frac{z_1}{z_2} = \frac{G_1}{sC}$, $\frac{z_3}{z_4} = \frac{sL}{R_2}$ (alternate is $z_1 = R_1$, $z_2 = sL_2$)

$$\left(1 + \frac{G_1}{sC}\right)\left(1 + \frac{sL}{R_2}\right) - K_1 K_2 = \left.\frac{(sC + G_1)(R_2 + sL) - K_1 K R_2 sC}{R_2 sC}\right|_{s = j\omega_0} = 0$$

$$sCR_2 + s^2 LC + G_1 R_2 + sG_1 L - KK_2 R_2 C s \Big|_{s = j\omega_0} = 0$$

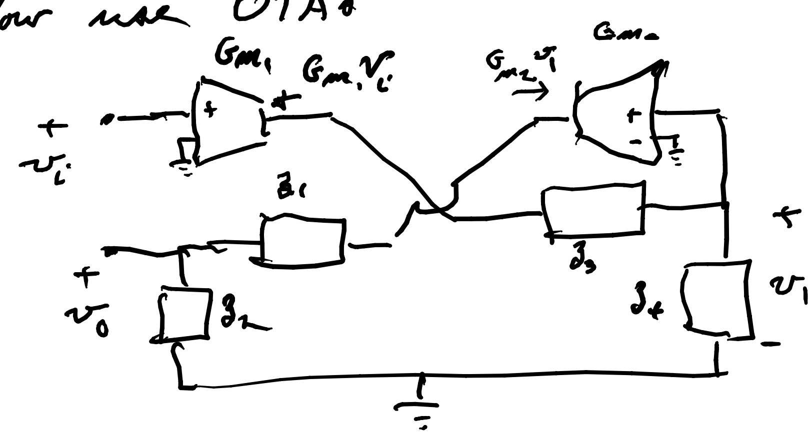
$$LCs^2 + (CR_2 + G_1 L - K_1 K_2 R_2 C)s + G_1 R_2 = 0$$

$s = j\omega_0 \Rightarrow -\omega_0^2 LC + G_1 R_2 = 0$

$j\omega_0 (CR_2 + G_1 L - K_1 K_2 R_2 C) = 0$ for $\omega_0 \neq 0$

$$K_1 K_2 = \frac{CR_2 + G_1 L}{R_2 C} \; ; \quad \omega_0 = \pm\sqrt{\frac{G_1 R_2}{LC}}$$

Now use OTA's



$v_o = -Z_2 G_{m_2} v_1$, $v_1 = G_{m_1} v_i (-Z_4)$

$v_o = (-Z_2 G_{m_2})(-Z_4 G_{m_1}) v_i = Z_2 Z_4 G_{m_1} G_{m_2} v_i$

operating condition when close the loops

$1 - Z_2 Z_4 G_{m_1} G_{m_2} = 0$

can choose $Z_2(s)$ & $Z_4(s)$ to make an oscillator

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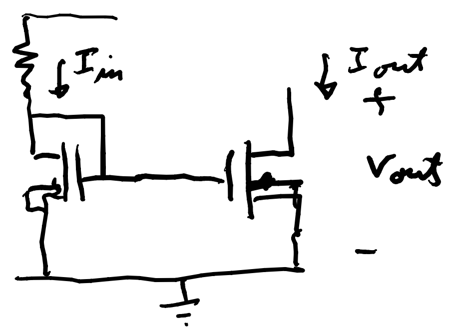
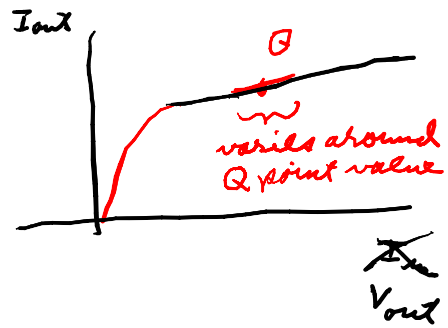
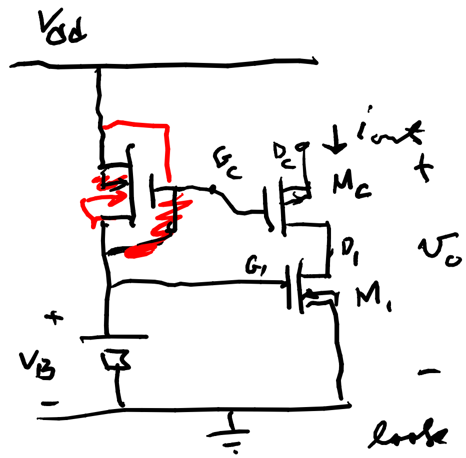
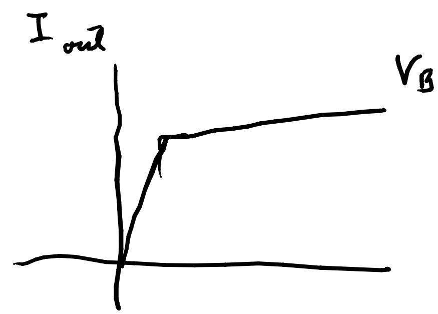
Current mirror output



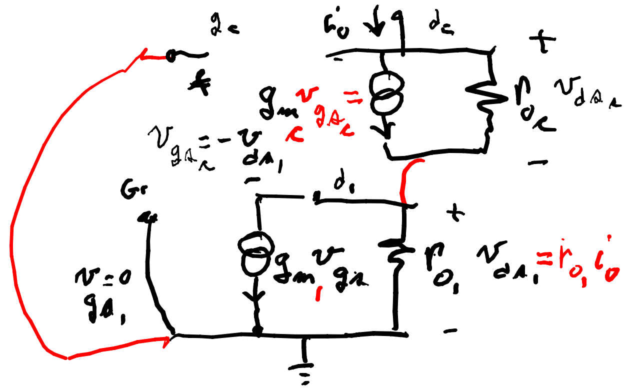


to cure output slope can cascode





look at small signal behavior to see r_{out}



$$i_o = v_{ds_2} \cdot g_{o2} + (-g_m v_{ds_1})$$
$$= v_{ds_1}(g_{o_1})$$

$$v_o = v_{r_{o2}} + v_{ds_1} \Rightarrow v_{r_{o2}} = v_o - v_{ds_1}$$

$$i_o = (v_o - v_{ds_1}) g_{o2} + (-g_{m_2} v_{ds_1}) = v_o g_{o2} - (g_{o2} + g_{m_2}) g_{o_1} v_o$$

$$= v_o g_{o2} - (g_{o2} + g_{m_2}) v_{ds_1} = g_{o2} v_o - (g_{o2} + g_{m_2}) r_{o_1} i_o$$

$$i_o = g_{o2} v_o - (g_{o2} + g_{m_2}) r_{o_1} i_o \Rightarrow i_o = \left(\frac{1}{1 + (g_{o2} + g_{m_2}) r_{o_1}}\right) g_{o2} v_o$$

$$\Rightarrow i_o = \frac{1}{r_{o_1}\left(1 + \frac{g_{m2}}{g_{o2}} + \frac{g_{o1}}{g_{o2}}\right)} \cdot v_o$$

$\Rightarrow$ lowers changes in output current

$r_{o_1} \Rightarrow r_{o_1} + \frac{r_{o_1}}{g_{o2}}(g_{m_2} + g_{o_1}) \Rightarrow$ increased output resistance

$\Rightarrow$ improved output current changes around Q point current