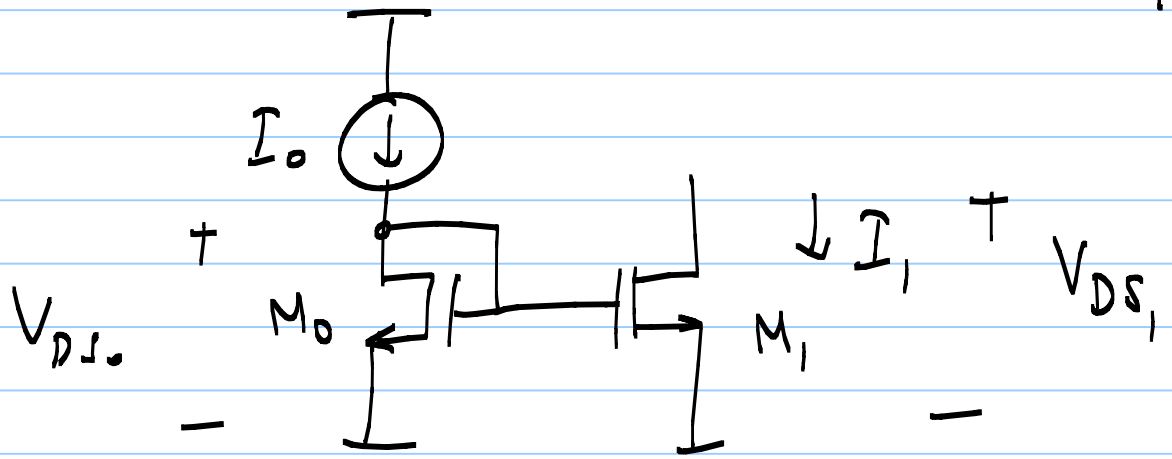
27|8|2020

Lecture 14



$V_{GS_0} = V_{GS_1} = V_{DS_0}$

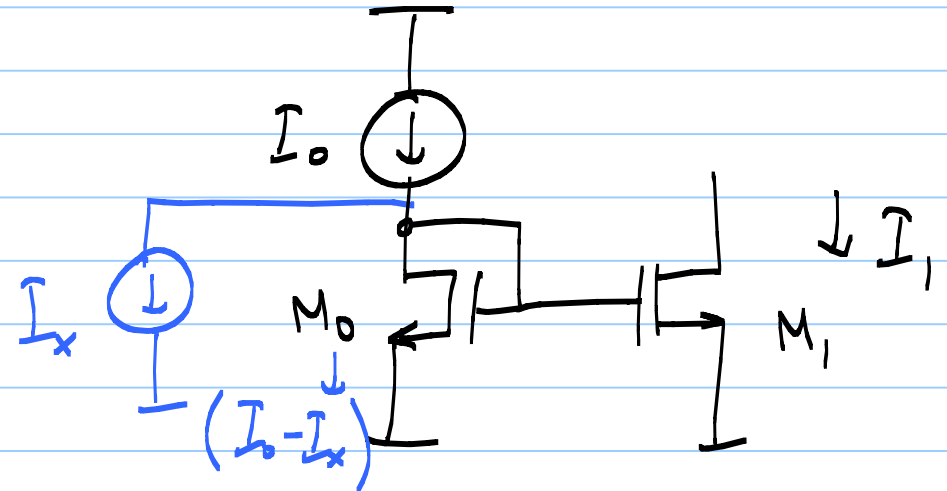
$I_1 = I_o$ if M_1 is in sat.

$V_{DS_1} \geq V_{GS_1} - V_T$

* small deviations due to CLM (r_{ds})

$V_{DS_1} \neq V_{DS_0}$

$V_{DS_1} \neq V_{GS_1}$



1) I want $I_1 = k I_o$

$$I_1 = \frac{1}{2} \mu_n C_{ox} \left(\frac{W}{L}\right)_1 (V_{GS_1} - V_T)^2$$

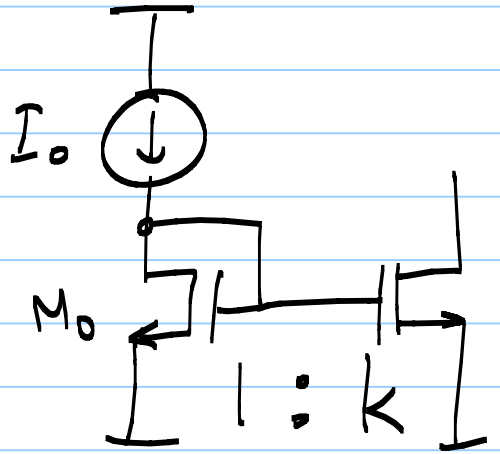
$$V_{GS_1} = V_{GS_0}$$

$$V_{GS_1} - V_T = V_{GS_0} - V_T$$

$$(V_{GS_1} - V_T)^2 = (V_{GS_0} - V_T)^2 = \frac{2I_0}{\mu_n C_{ox} \left(\frac{W}{L}\right)_0}$$

$$I_1 = I_0 \cdot \frac{(W/L)_1}{(W/L)_0}$$

k



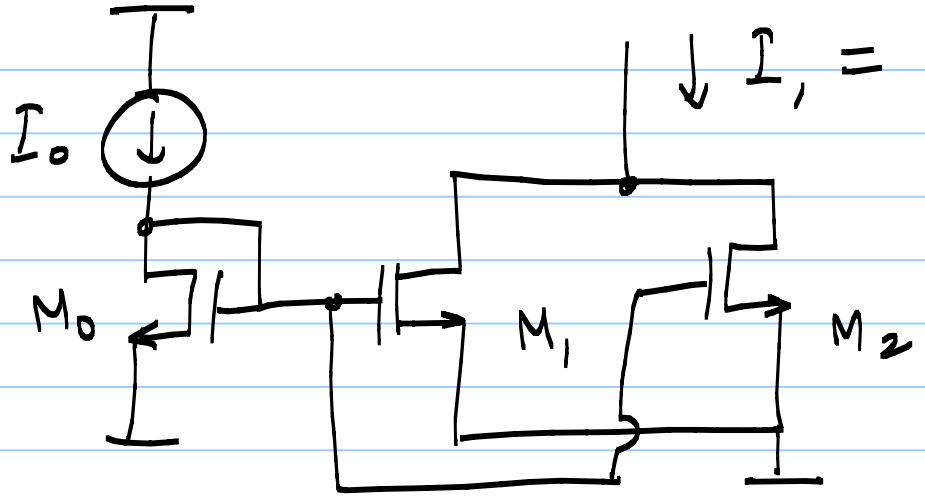
$$I_1 = kI_0$$

Ensure: $L_1 = L_0$

$W_1 = kW_0$

λ — models $\Delta L/L$ (CLM)

larger L → smaller $\Delta L/L$ → smaller λ → larger r_{ds}

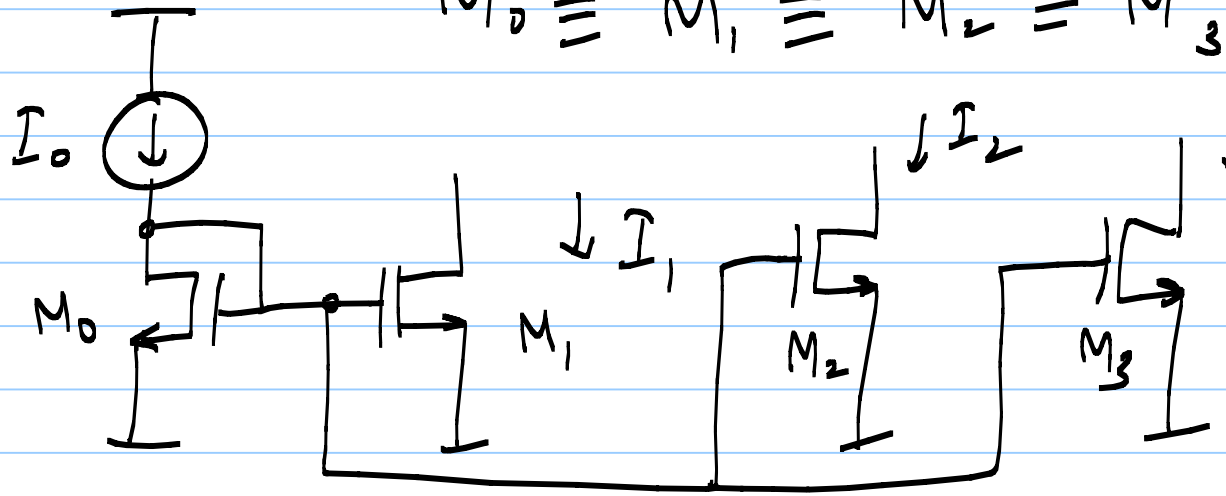


$I_1 = I_{D1} + I_{D2} = 2I_0$

$M_0 \equiv M_1 \equiv M_2$

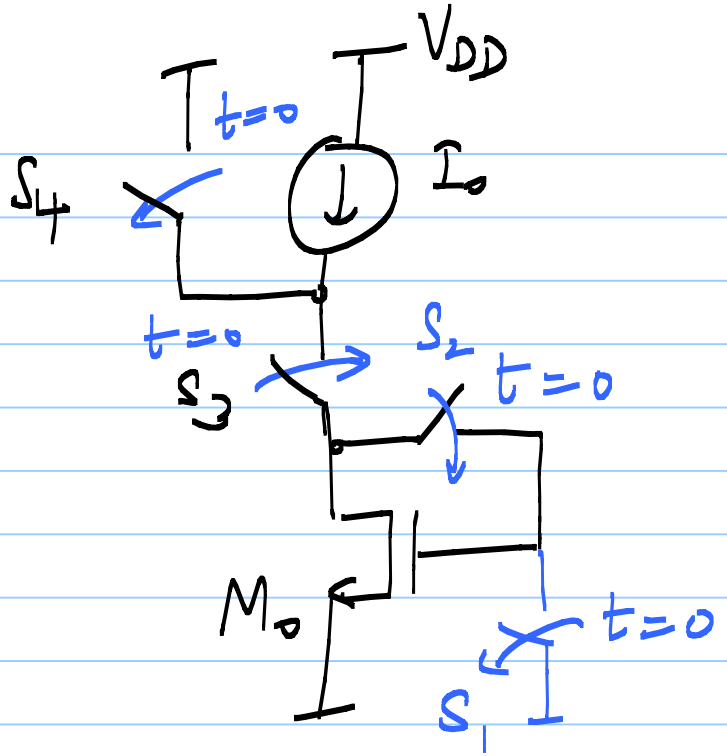
2)

$M_0 \equiv M_1 \equiv M_2 \equiv M_3 \ldots$

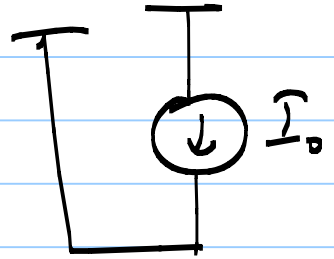


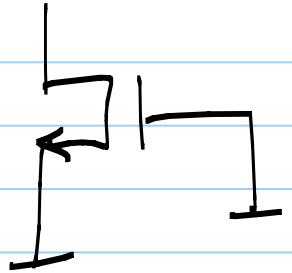
all V_{DS}'s $\geq V_{GS1} - V_t$ . . . [all devices in sat.]

Make as many copies as you want

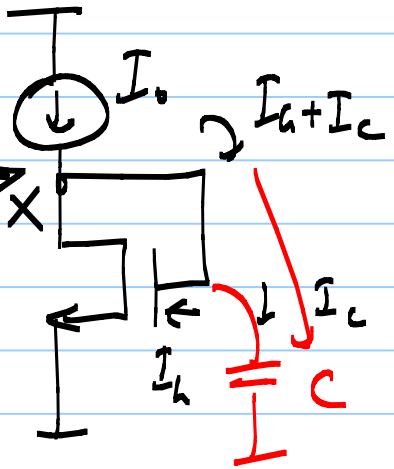


$t < 0$:





$t = 0^+$

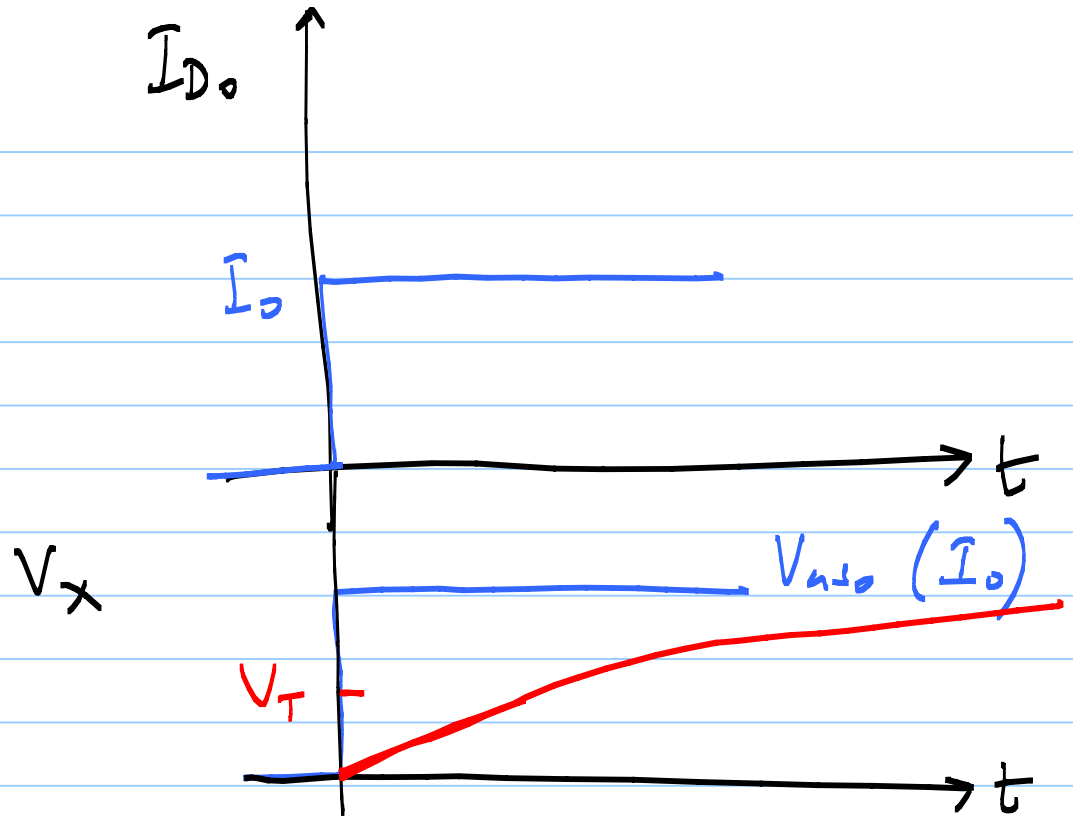


@ $t = 0^-$ $V_{GS} = 0$

@ $t = 0^+$: $I_4 = 0$, $I_D = 0$

$\rightarrow V_X \uparrow \rightarrow V_{GS} \uparrow \rightarrow I_D \uparrow$

$\rightarrow I_D = I_0$

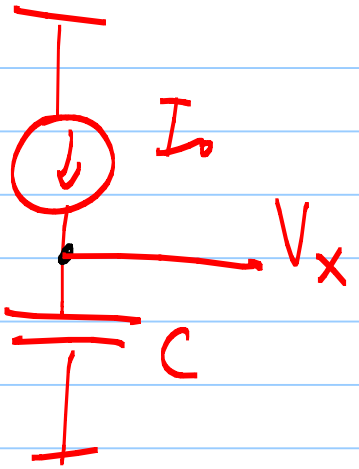


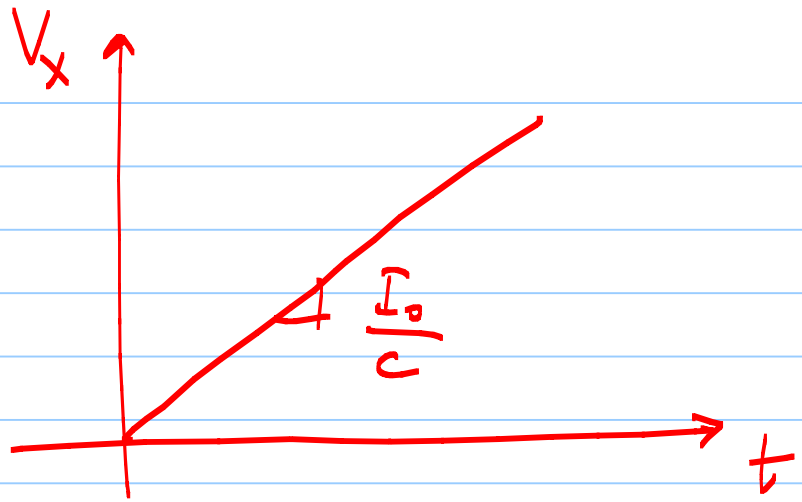
$$I_0 = I_C + I_{D_0} + \cancel{I_G}^{\,0}$$

$= 0$ @ $t = 0^+$

$I_D = 0$ till $V_{GS} = V_x = V_T \Rightarrow I_C = I_0$

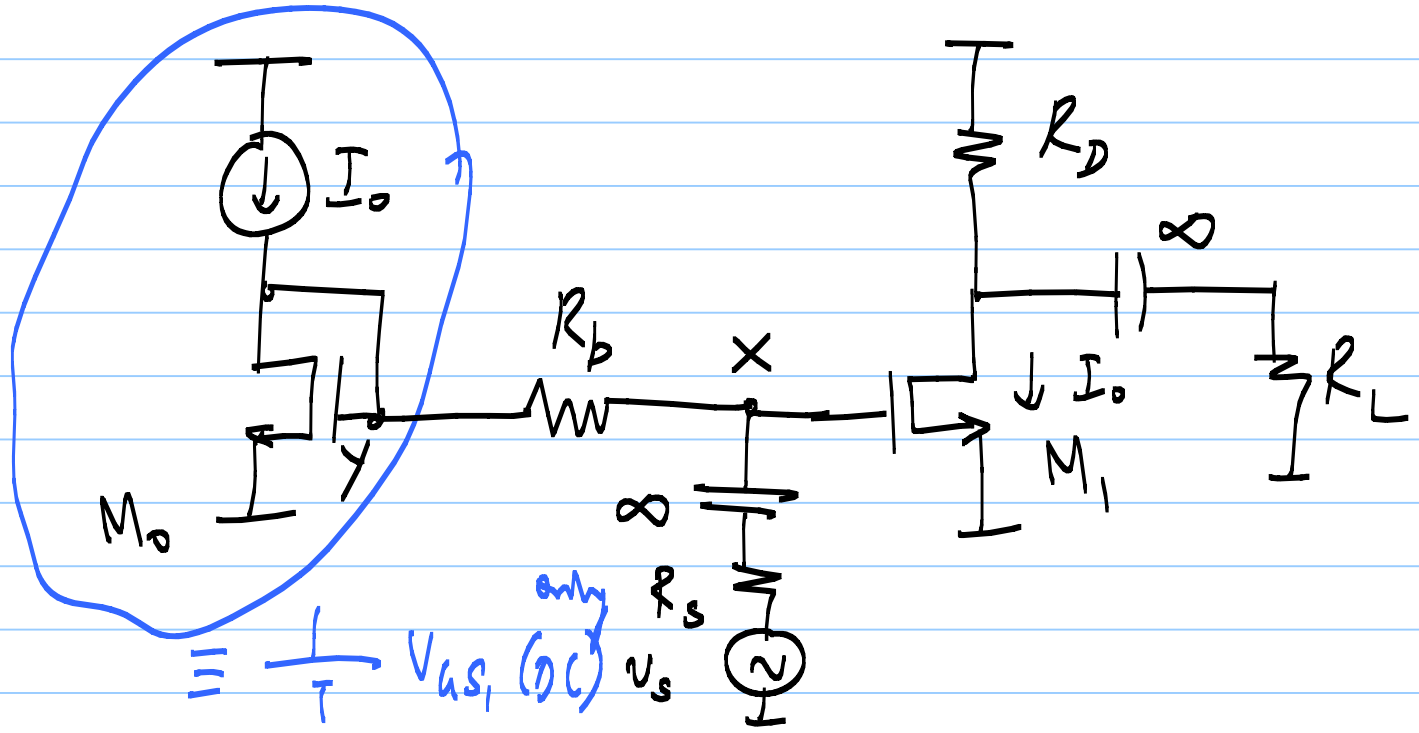
$$I = C\frac{dV}{dt}$$

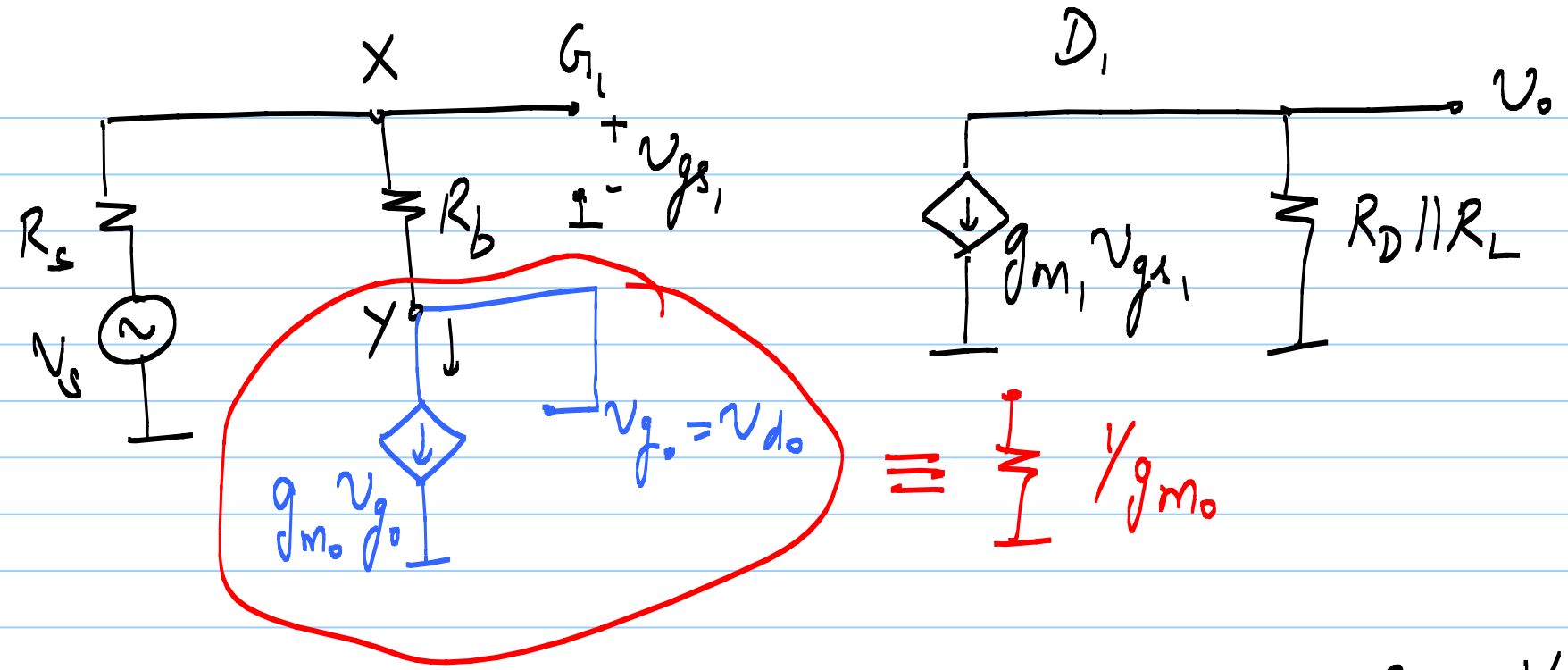


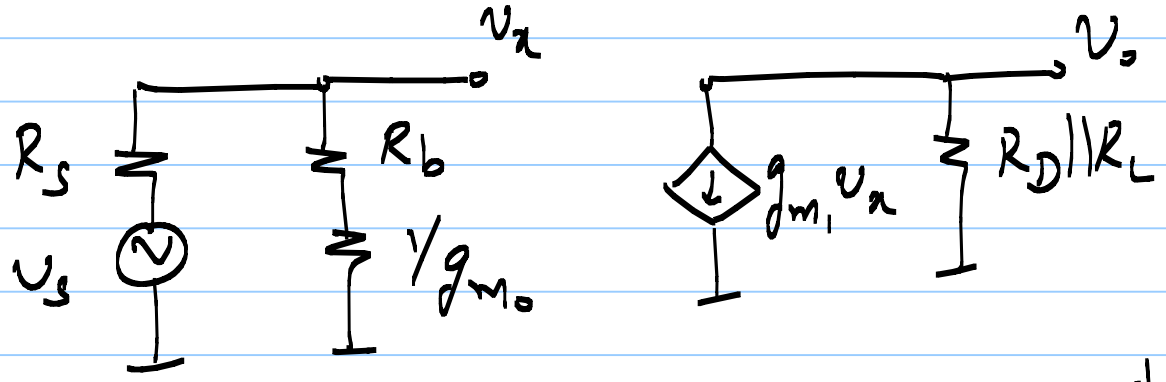


CSA

$M_0 \equiv M_1$





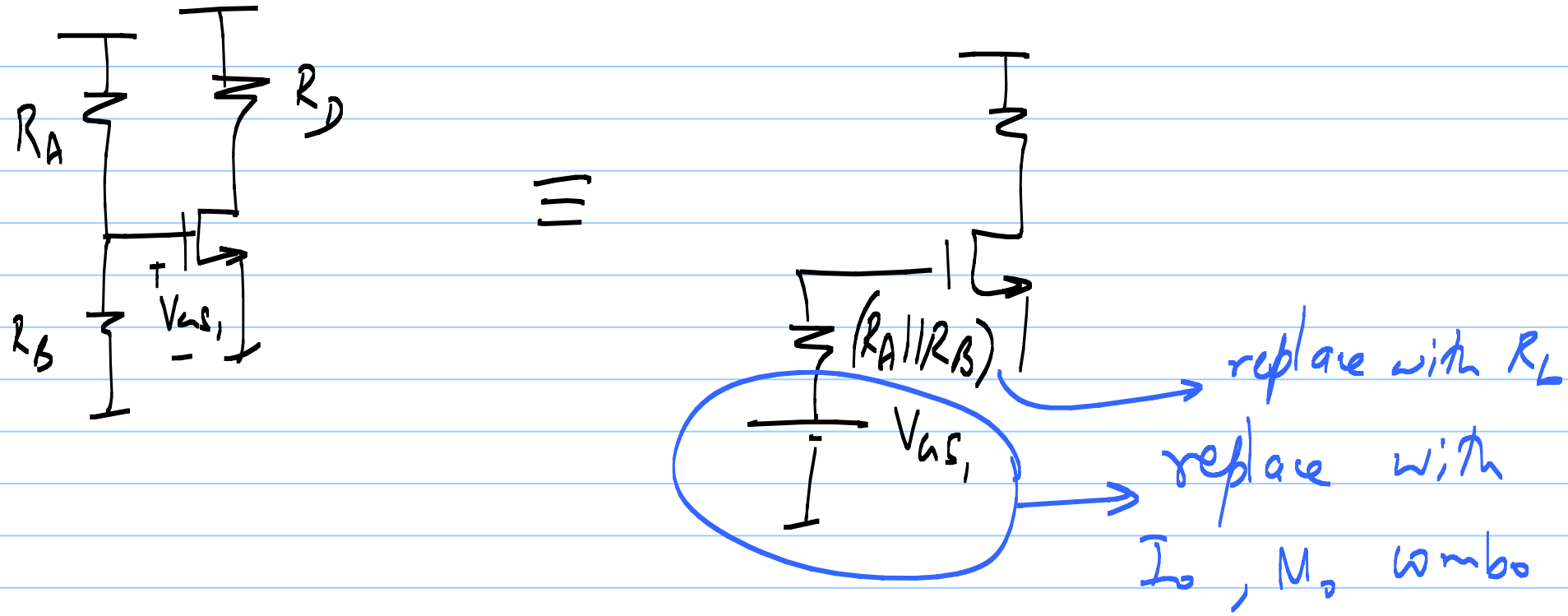


$$\frac{v_x}{v_s} = \frac{R_b + 1/g_{m_0}}{R_s + R_b + 1/g_{m_0}}$$

$g_{m_0} = g_{m_1}$ = large

choose $R_b \gg 1/g_{m_0}, R_s$

$\Rightarrow v_x \approx v_s$



$$v_o = -g_{m_1} v_1 (R_D \| R_L)$$

$$\simeq -g_{m_1} (R_D \| R_L) \cdot v_s$$

$$\frac{v_o}{v_s} \simeq -g_{m_1} (R_D \| R_L)$$ same as before

I_{D_1}, V_{th_1}, V_{DS_1} - same as before $\Rightarrow$ Swing limits are the same too.