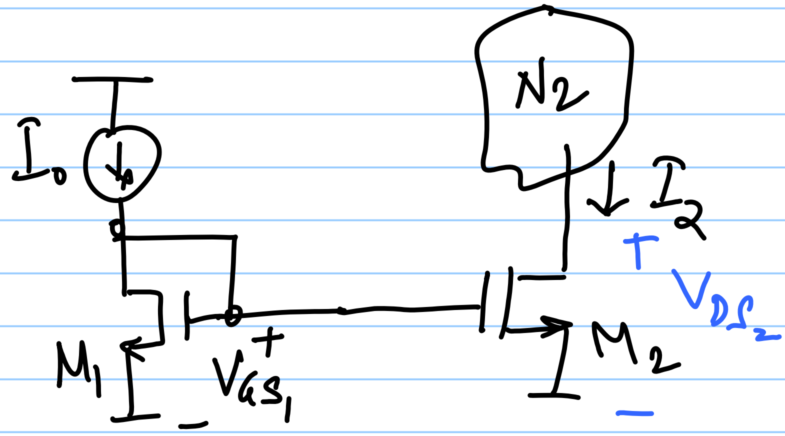
21/8/19

Lec 10

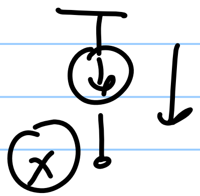


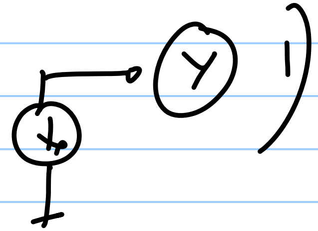
"Current Mirror"

$$I_{D_1} = I_0$$

$$V_{GS_1} = \sqrt{\frac{2I_0}{\mu_n C_{ox}\left(\frac{W}{L}\right)_1}} + V_T$$

$$I_{D_2} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_2 \left(V_{GS_1} - V_T\right)^2$$





1) If $V_{DS_2} > V_{GS_1} - V_T$

2) $\underline{\lambda \neq 0}$

$$I_0 = I_{D_1} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_2 (V_{GS_1}-V_T)^2 \left(1+\lambda \overbrace{V_{DS_1}}^{V_{GS_1}}\right)$$

$$I_{D_2} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_2 (V_{GS_1}-V_T)^2 \left(1+\lambda \overbrace{V_{DS_2}}^{?}\right)$$

$$I_{D_2} \neq I_0$$

If $V_{DS_2} > V_{GS_1}$, $\quad I_{D_2} = I_0 + \delta I$

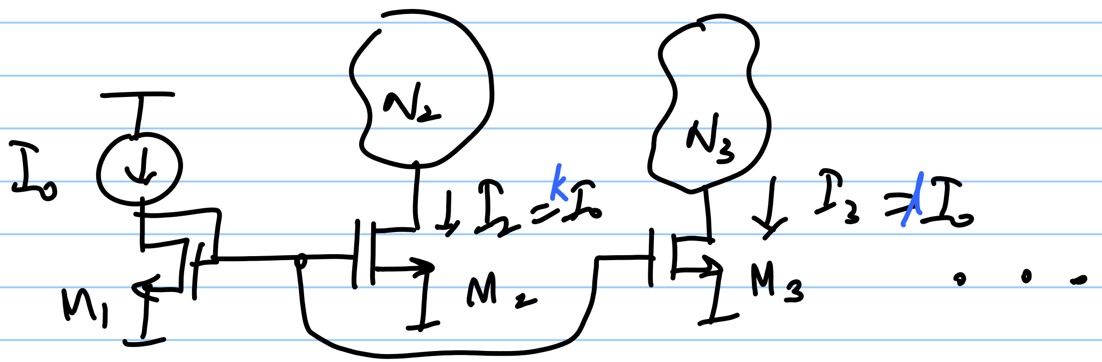
$V_{DS_2} < V_{GS_1}$, $\quad I_{D_2} = I_0 - \delta I$

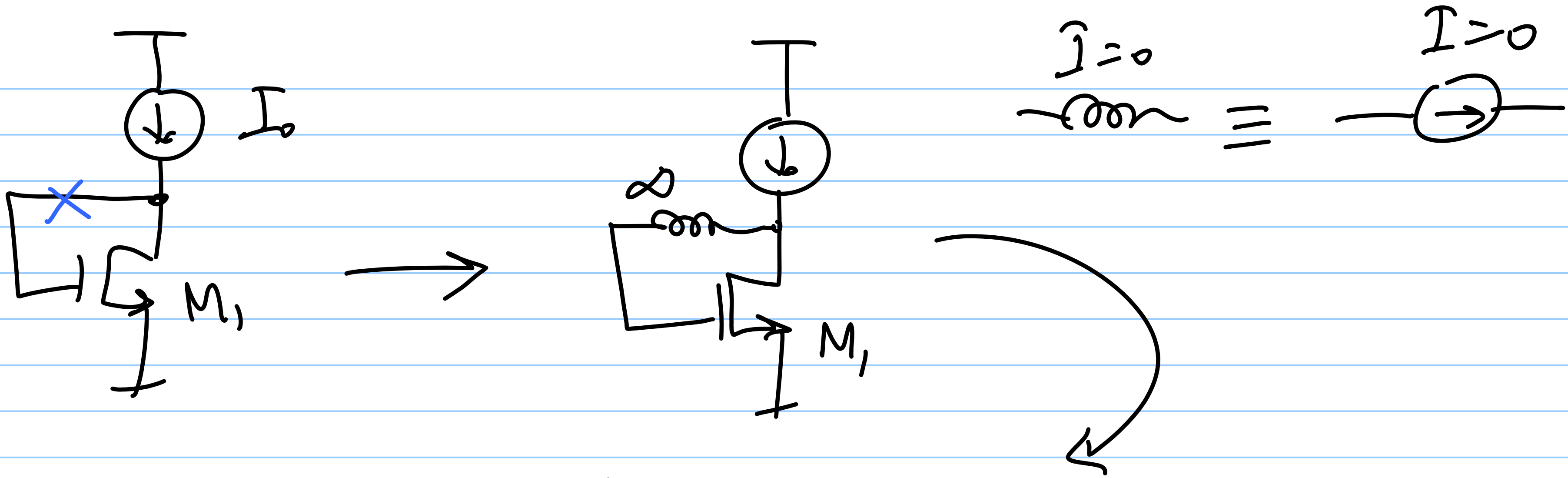
for small δI, we want small λ

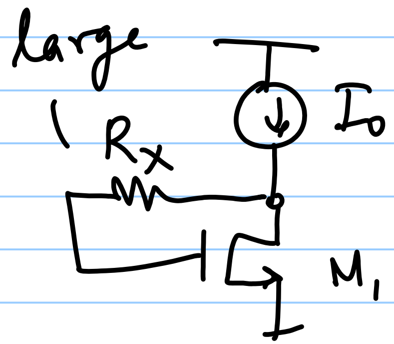
$\Rightarrow$ long devices $(\uparrow L_{1,2})$

* $L_2 = L_1$, $W_2 = \underset{n}{\cancel{2}}\,W_1$ $\quad I_{D_2} \approx \underset{n}{\cancel{2}}\,I_0$

*



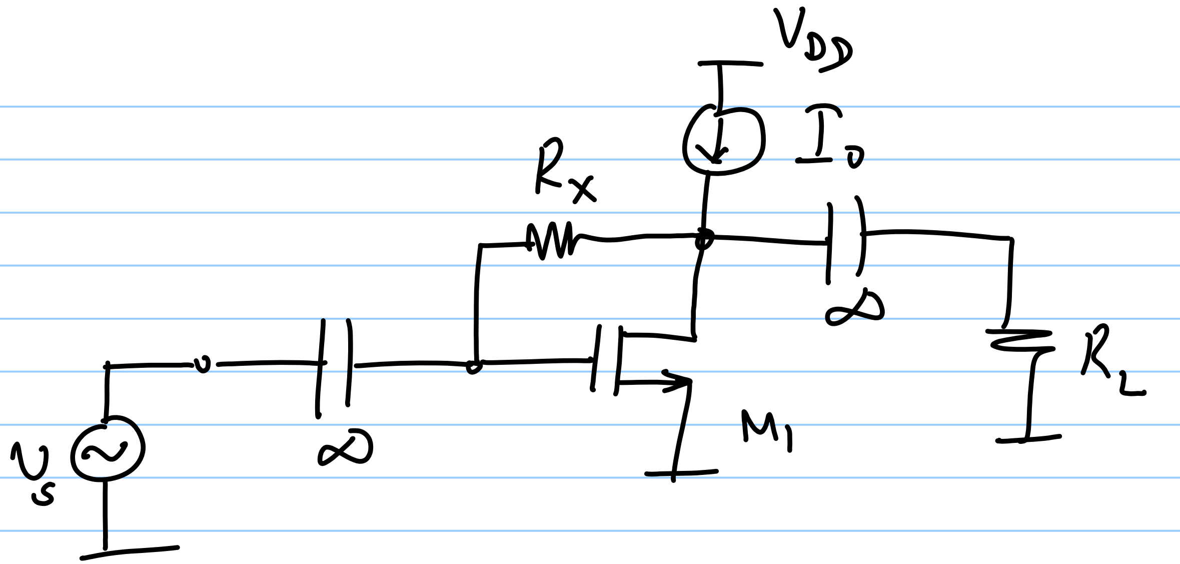




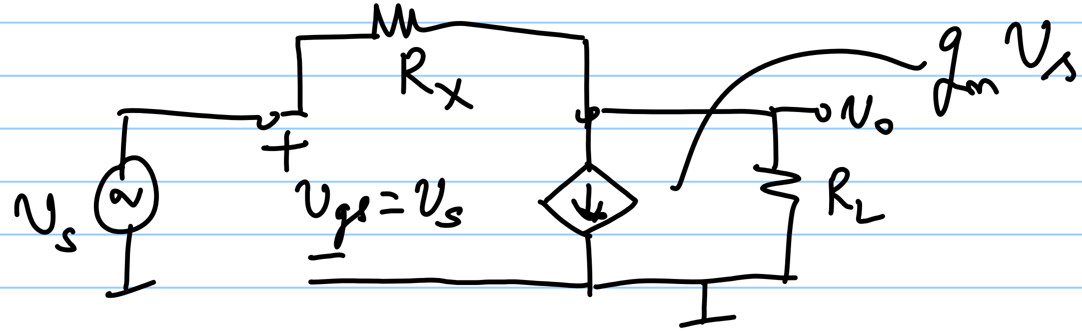
$$V_{GS_1} = V_{DS_1}$$

$$I_{R_x} = 0$$

$$I_{D_1} = I_0$$



V_DD
I_0
R_x
∞
∞
R_L
M_1
v_s



R_x
g_m v_s
v_o
R_L
v_s
+
v_gs = v_s
−

$$\frac{v_o}{v_s} = ?$$

KCL @ drain :

$$\frac{v_o}{R_L} + g_m v_s + \frac{(v_o - v_s)}{R_x} = 0$$

$$v_o \cdot G_L + g_m v_s + G_x v_o - G_x v_s = 0$$

$$\frac{v_o}{v_s} = \left(\frac{G_x - g_m}{G_x + G_L} \right)$$

We want $\frac{v_o}{v_s} = \frac{-g_m}{G_L} = -g_m R_L$

$\therefore$ 1) $G_x \ll g_m$

2) $G_x \ll G_L$ more significant

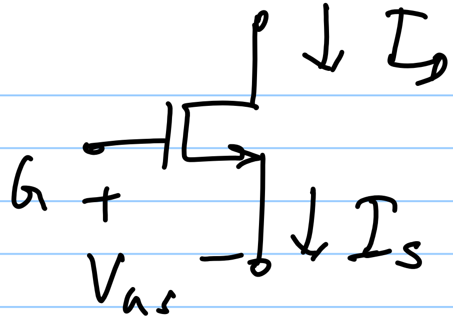
i.e. $R_x \gg R_L$

* This circuit will potentiall have lower triode swing limit compared to the original amplifier

* Cut off limit $|V_A| = \frac{I_D}{g_m}$ remains the same

<u>Negative fb.</u>

<u>So far:</u> measured I_D
compared to I_0
drove V_a so that $I_D = I_0$



$I_D = f(V_{GS})$

1) $I_G = 0 \Rightarrow I_D = I_S$ both can be sensed

2) change V_G or V_S

keep V_S constant

keep V_G constant

$\Rightarrow$ 4 ways of biasing the transistor using negative f.b.