1/9/20

Lecture 16

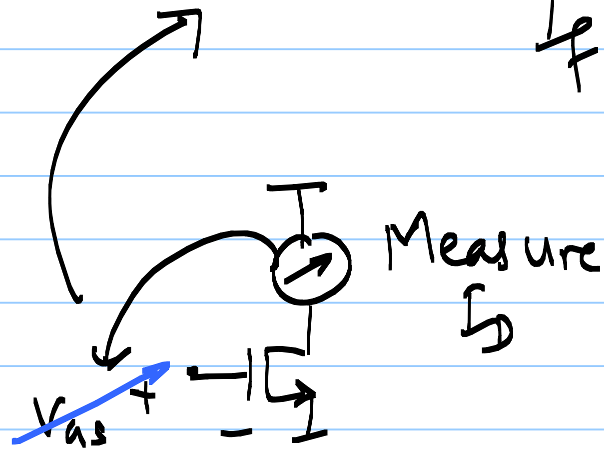
We want to bias the MOSFET with stable Queiscent current:

1) Measure I_D (I_S)

2) Compare I_D (I_S) with I_o

3) If $I_D > I_o$ ⇒ reduce V_{GS} ($\downarrow V_G$ or $\uparrow V_S$)

If $I_D < I_o$ ⇒ increase V_{GS} ($\uparrow V_G$ or $\downarrow V_S$)



For MOSFET: $I_G = 0$

⇒ $I_S = I_D$ always (1)

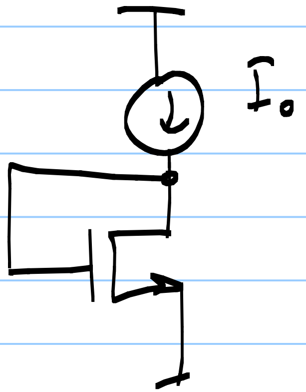
→ Measure I_S or I_D

We control $V_{GS} = V_G - V_S$ (2)

keep S fixed, vary G | keep G fixed, vary S

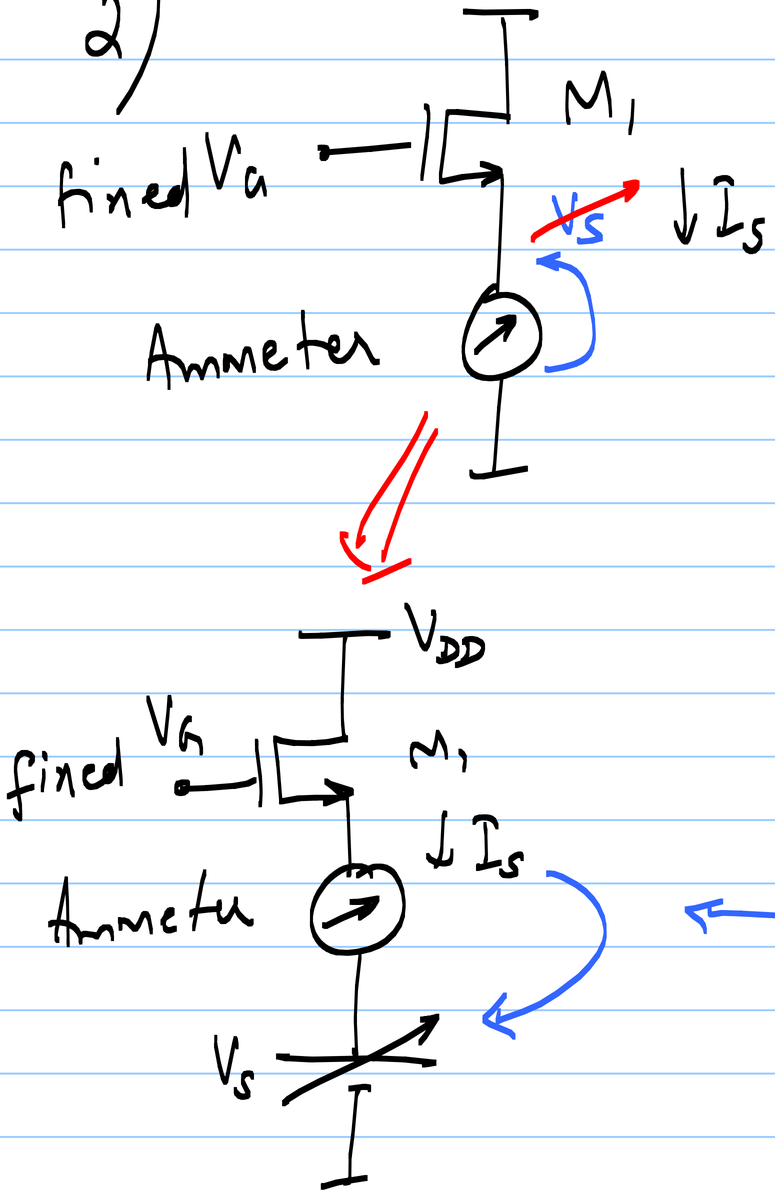
* 4 ways of negative feedback bias stabilization

1)



Measure I_D, f.b. to V_G, keep V_S fixed

2)



Measure I_s, f.b to V_s,

keep V_G fixed

step 0: M_1 in sat.

⇒ $V_{DD} > V_G - V_T$

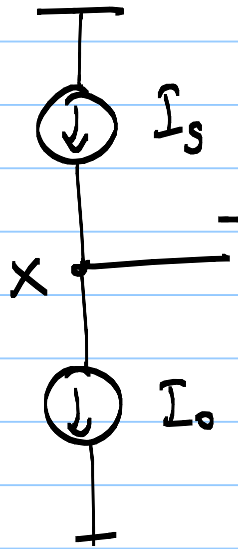
step 1: Measure I_s

step 2: If $I_s > I_o$ ⇒ need to ↓ V_{GS}

⇒ ↑ V_s

If $I_s < I_o$ ⇒ need to ↑ V_{GS}

⇒ ↓ V_s



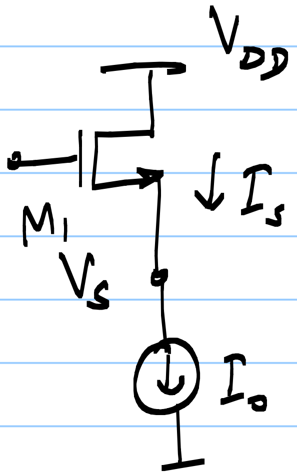
→ magnitude & sign of $(I_s - I_o)$ tells you what to do

If $I_s > I_o \Rightarrow V_x \uparrow$ [need to $\uparrow V_s$]

$I_s < I_o \Rightarrow V_x \downarrow$ [need to $\downarrow V_s$]

$I_s = I_o \Rightarrow V_x$ same [V_s same]

V_{G_o} = fixed V_G



Due to negative f.b. action:

$$I_s = I_o = I_D$$

$$V_s = ?$$

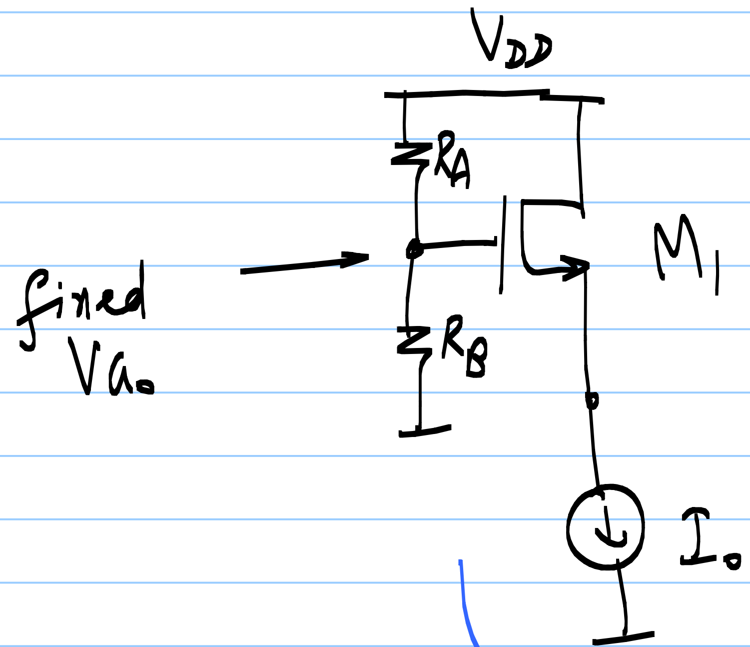
M_1 is in sat. $\Rightarrow$ $I_D = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)(V_{GS} - V_T)^2$

$$V_G - V_s = V_{GS} = V_T + \sqrt{\frac{2I_D}{\mu_n C_{ox}\left(\frac{W}{L}\right)}}$$

$= V_{OV}$ or V_{Dsat}.

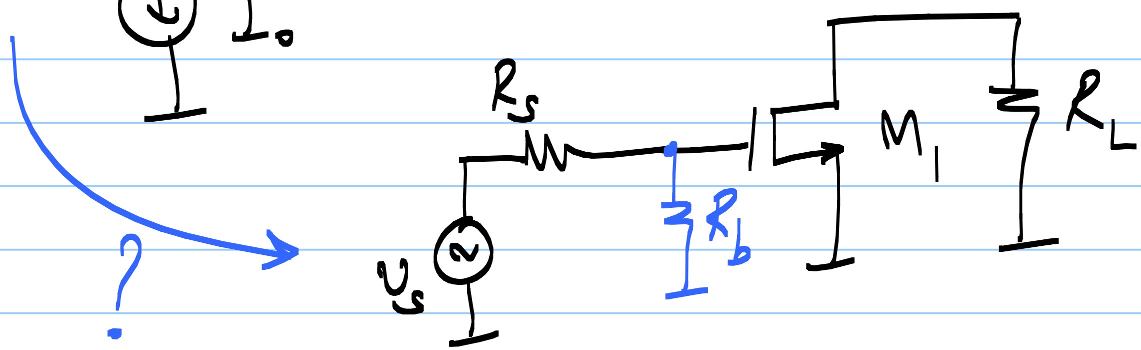
$$V_S = V_G - V_{GS}$$

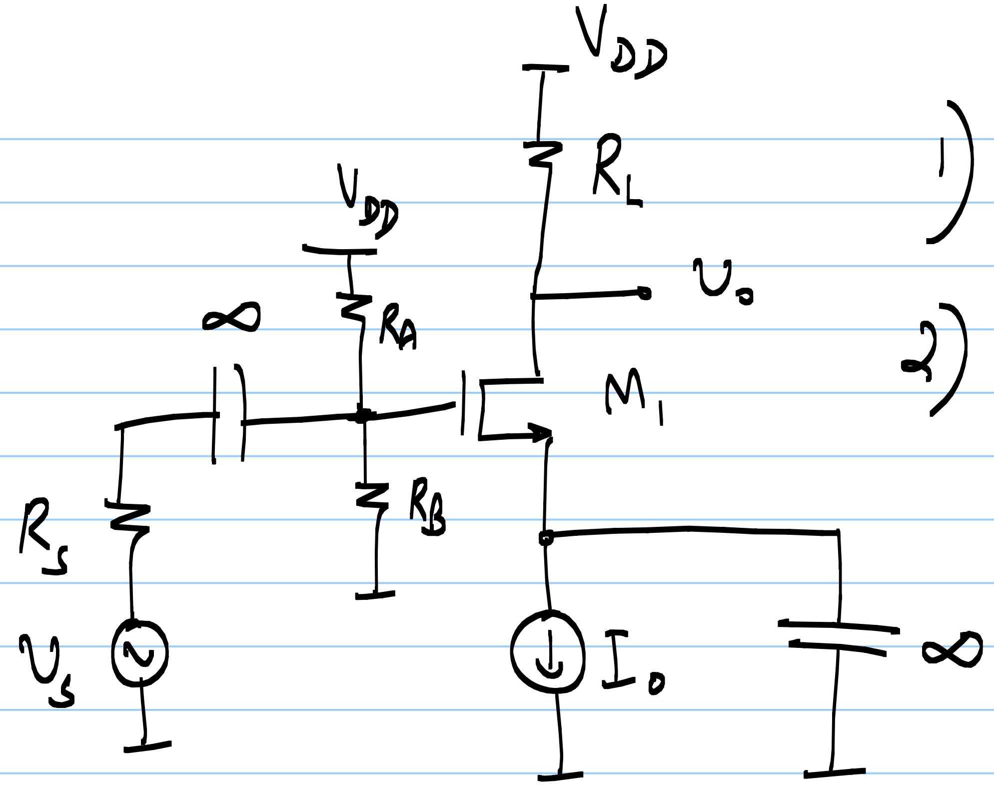
$$V_S = V_{G0} - \sqrt{\frac{2I_0}{\mu_n C_{ox}\left(\frac{W}{L}\right)}} - V_T$$



$$V_{G0} = \frac{R_B}{R_A + R_B} \cdot V_{DD}$$

Small-signal:





1) $R_A \| R_B \gg R_s$

2) M_1 in sat.:

$$V_D \geq V_G - V_T$$

$$V_{DD} - I_o R_L \geq \frac{R_B}{R_A + R_B} \cdot V_{DD} - V_T$$

Swing limits

1) Cut off limit: $I_o + g_m V_A \sin\omega t = 0$

$$V_{A,1} = \frac{I_o}{g_m}$$

2) Triode limit $\quad V_D(t) = V_G(t) - V_T$

$$V_{DD} - I_o R_L - g_m R_L V_A \sin \omega t = \frac{V_{DD} R_B}{R_A + R_B} + V_A \sin \omega t - V_T$$

$$V_{A_2} = \left[V_T + \frac{V_{DD} \cdot R_A}{R_A + R_B} - I_o R_L \right] \frac{1}{(1 + g_m R_L)}$$