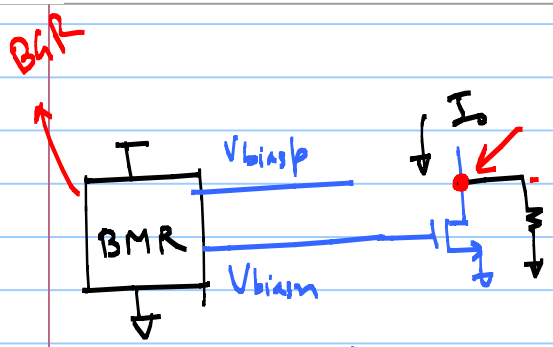
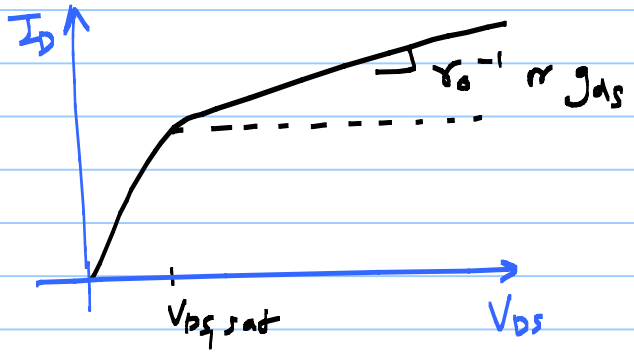
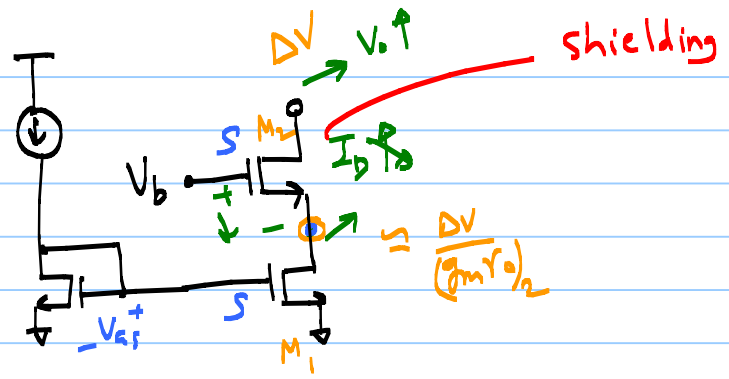
ECE 511 – Lecture 7

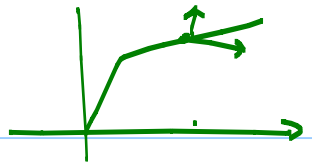
Note Title 2/12/2013



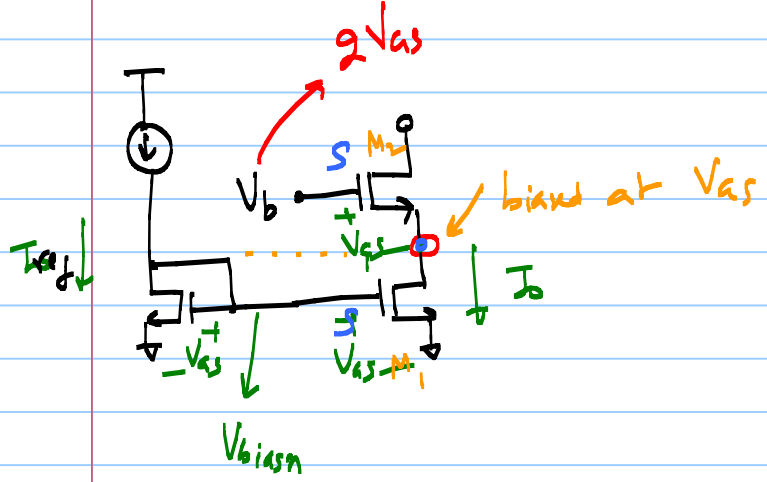


* hold the V_{DS} of the current mirror device to be more constant





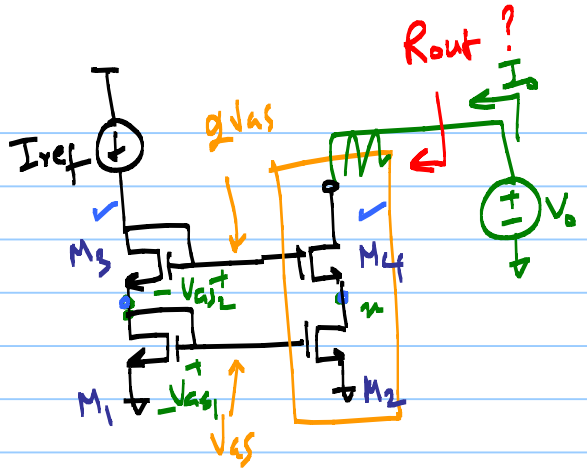
* How to set V_b ?



$V_b = 2V_{gs}$

I_o mirrors I_{ref} closely.

$I_o \triangleq I_{ref}$

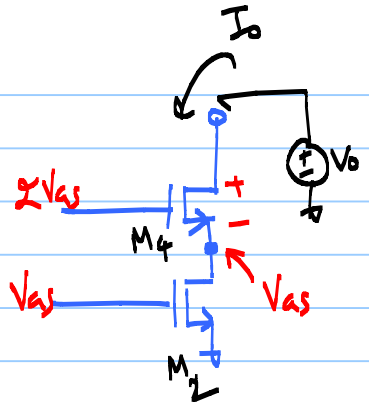


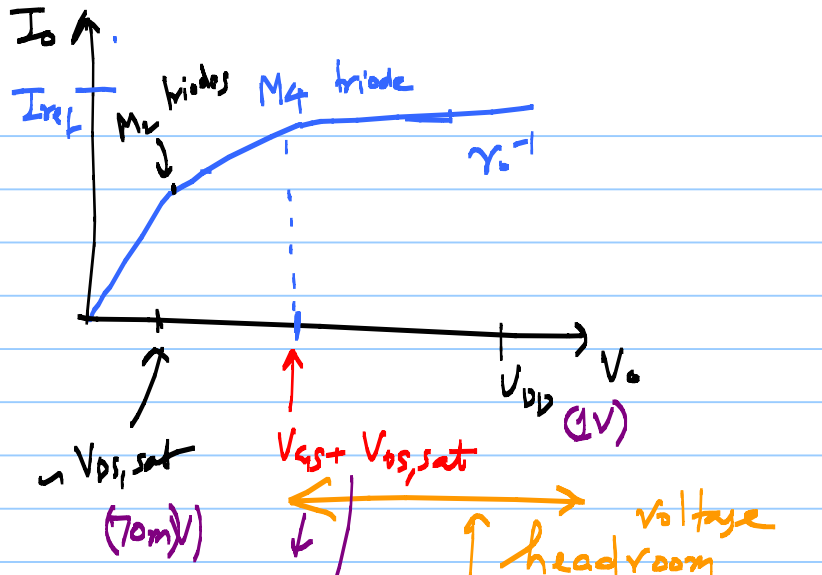
✗ Body effect in M_3 & M_4

↳ CM is intact

$V_{o_1} = V_{o_2} \Rightarrow I_2 = I_1$

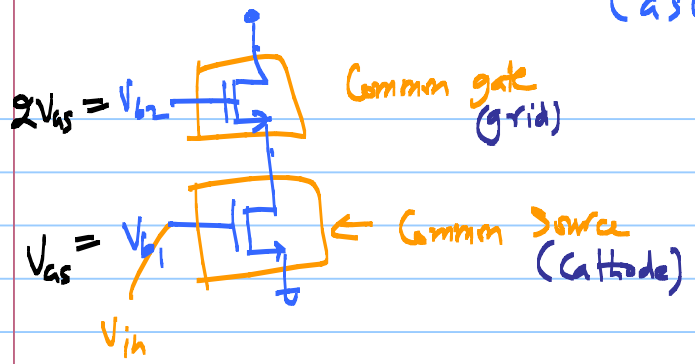
✗ higher Rout





↳ reduced swings for the CM

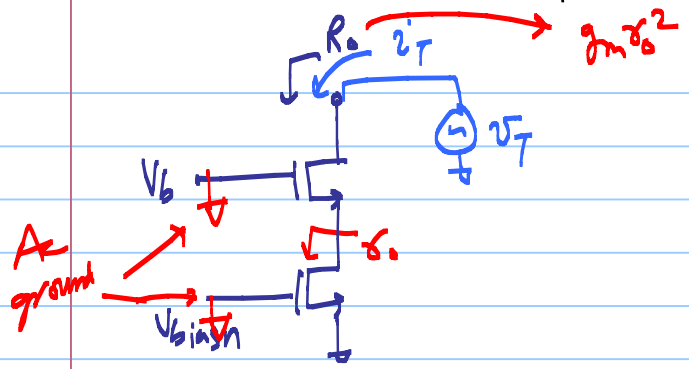
"Cascode Current Mirror"

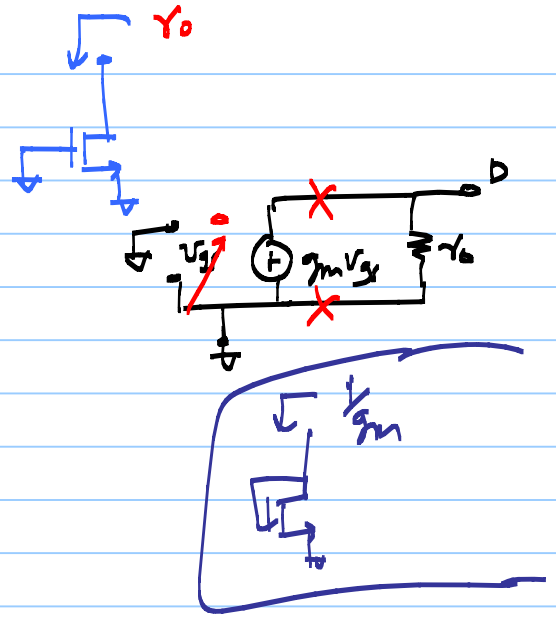


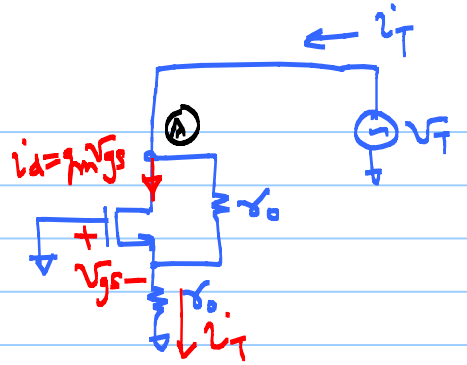
cascade of Common Cathode and Common grid amplifier

CASCODE

* What is R_{out} for the cascode current mirror?







KVL: $v_{gs} + i_T r_o = 0$

$\Rightarrow v_{gs} = -i_T r_o \longrightarrow (1)$

KCL @ (A):

$$i_T - g_m v_{gs} - \frac{(v_T - (-v_{gs}))}{r_o} = 0 \longrightarrow (2)$$

Eliminate v_{gs}

$$\Rightarrow \quad i_T + g_m r_o i_T - \frac{v_T}{r_o} + i_T = 0$$

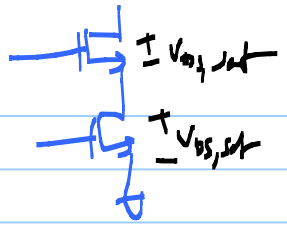
$$\Rightarrow \quad \frac{v_T}{r_o} = i_T (2 + g_m r_o)$$

$$R_o = \frac{v_T}{i_T} = (2 + g_m r_o) r_o = 2 r_o + g_m r_o^2 \quad \text{if } g_m r_o \gg 1$$

$$\hookrightarrow \boxed{g_m r_o^2} = (g_m r_o) \cdot r_o$$

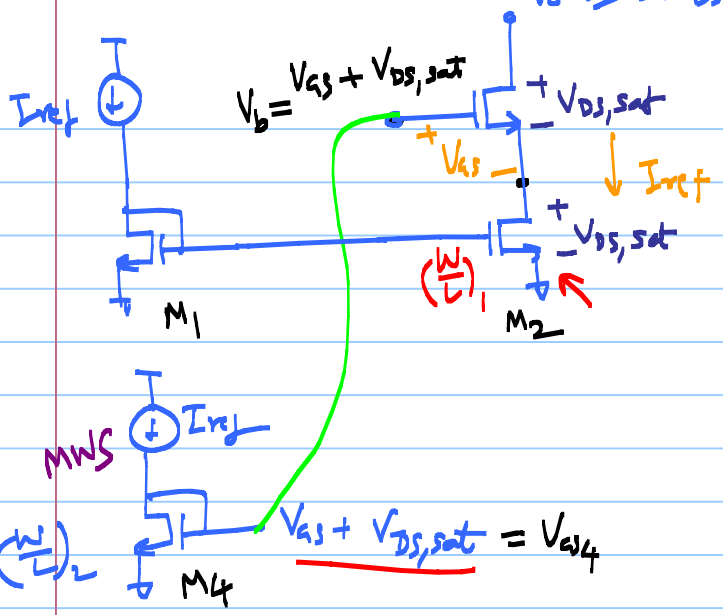
R_{ncas}

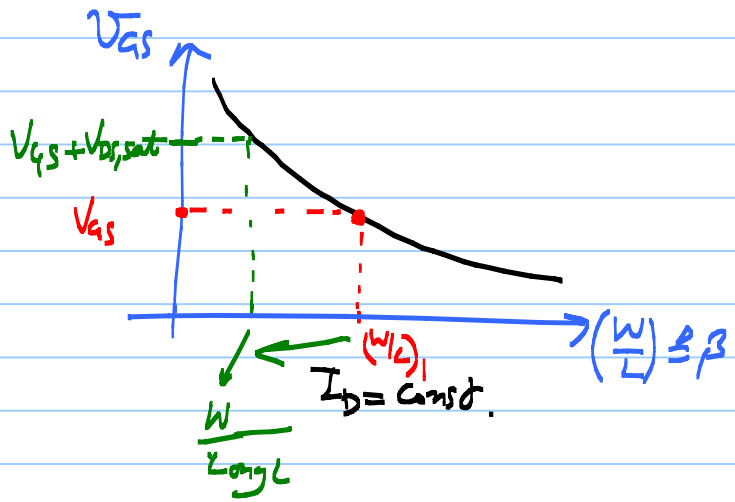
$$V_o \geq 2V_{DS,sat} + V_{THN}$$



Wide Swing Cascode CM

$V_o \geq 2V_{DS,sat}$ ← wide swing





$$V_{GS4} = 2V_{DS,sat} + V_{THN} = \sqrt{\frac{2I_{ref}}{\beta_4}} + V_{THN}$$

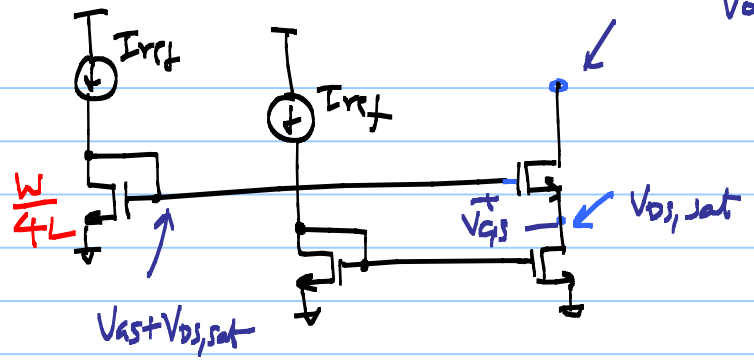
$$2\left(\sqrt{\frac{2I_{ref}}{\beta_2}}\right) = \sqrt{\frac{2I_{ref}}{\beta_4}}$$

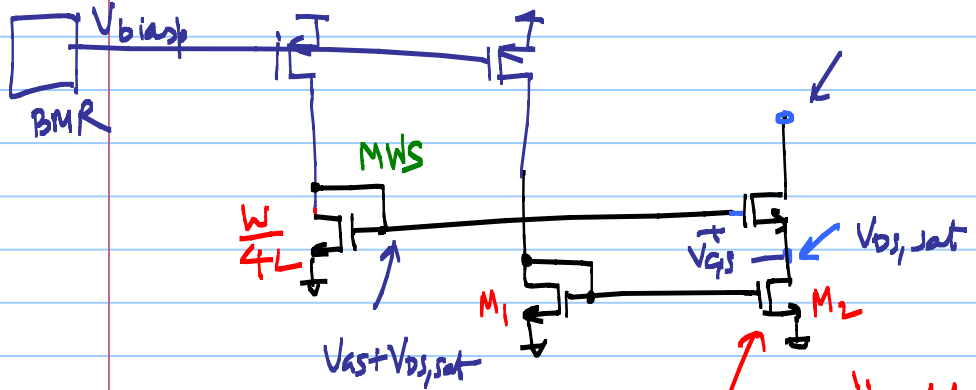
$$\Rightarrow \quad 2\sqrt{\beta_4} = \sqrt{\beta_2} \quad \text{or}$$

$$\beta_4 = \frac{\beta_2}{4}$$

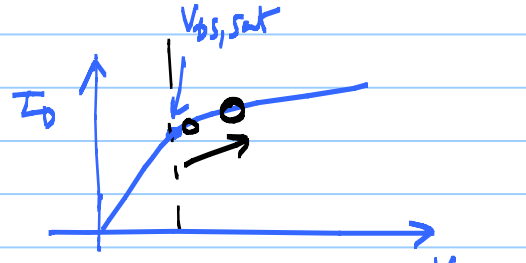
$$\left(\frac{W}{L}\right)_4 = \frac{W}{4L}$$

$V_o \in [2V_{DS,sat}, V_{DD}]$



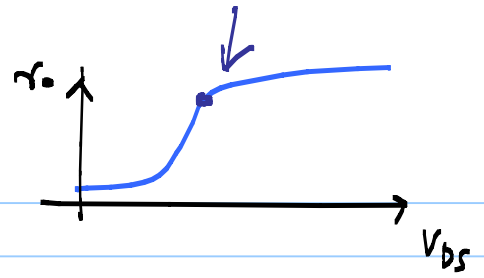


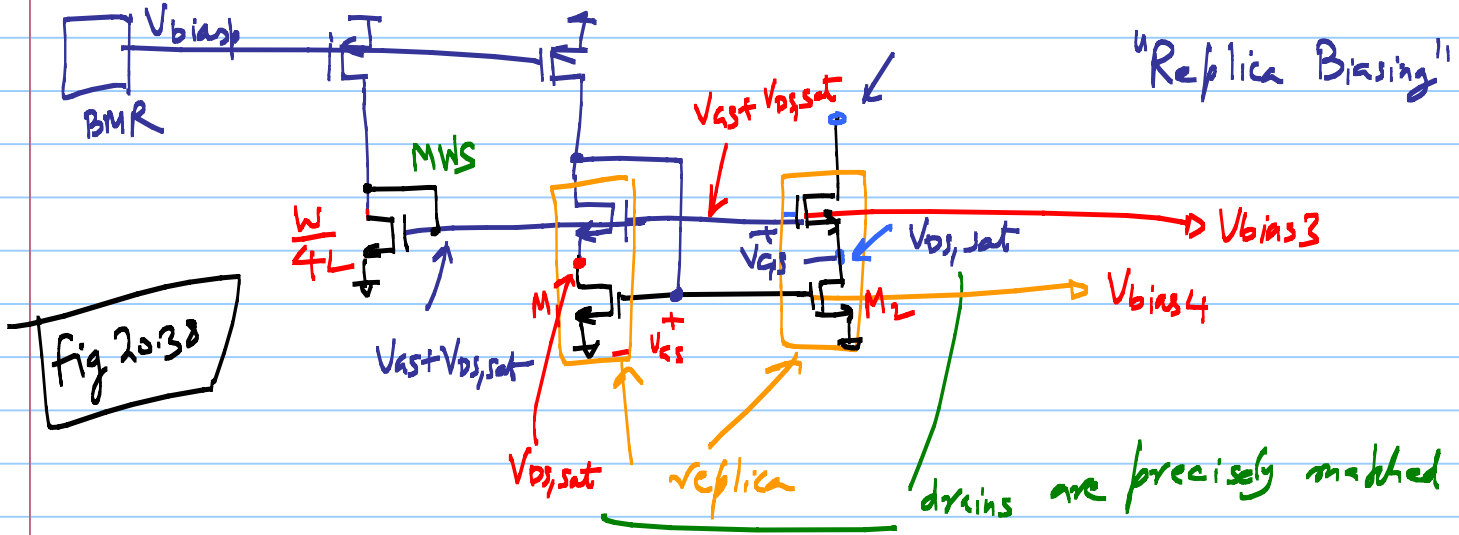
biased "safely" into saturation



$\frac{W}{5L}$

50nm → $\frac{W}{25L}$





"Replica Biasing"

Fig 2.38