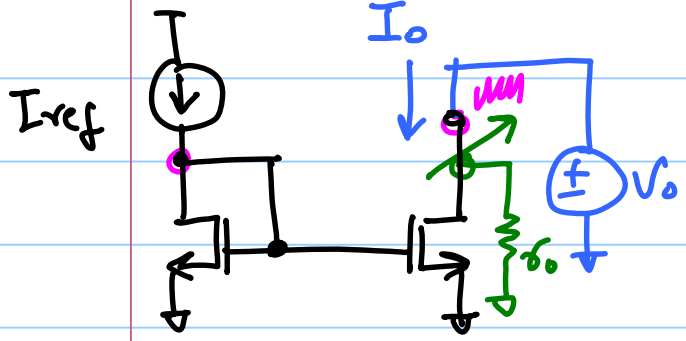
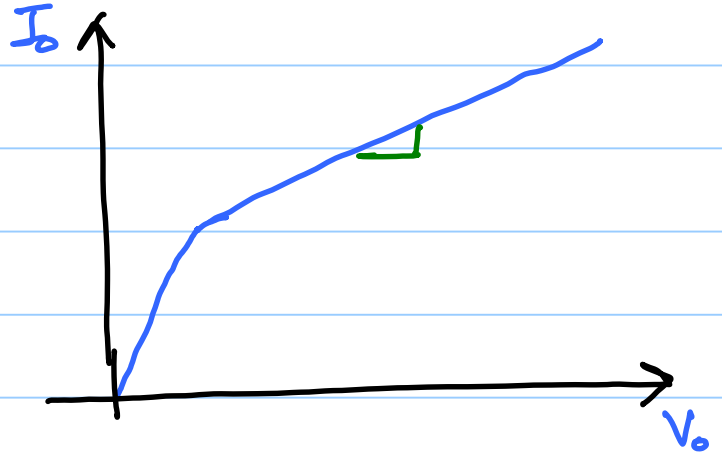
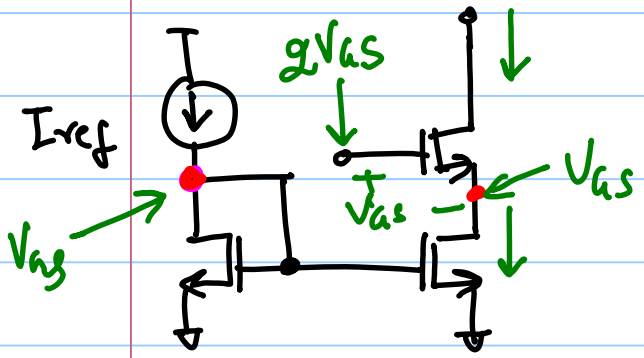
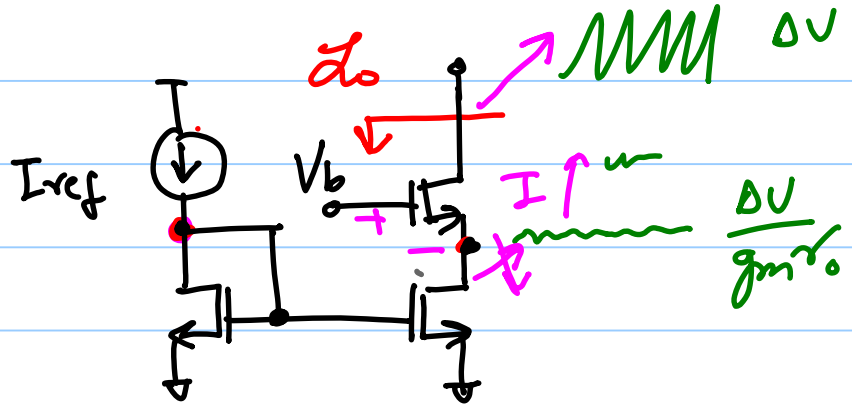
ECE 511 – Lecture 7

Note Title 2/5/2015



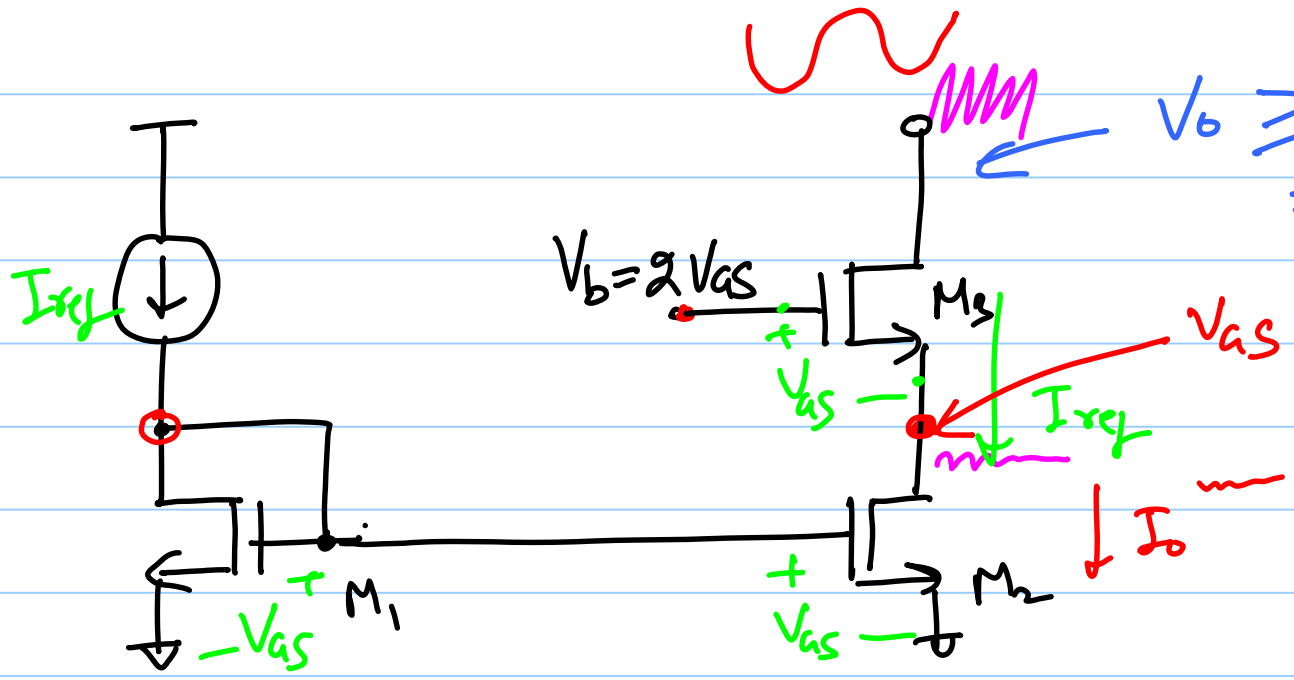






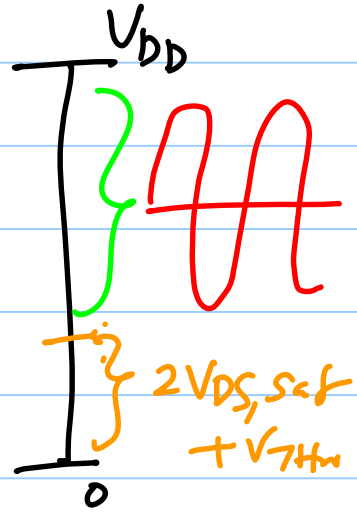
$V_b = 2V_{GS}$

$I_o \triangleq I_{ref}$

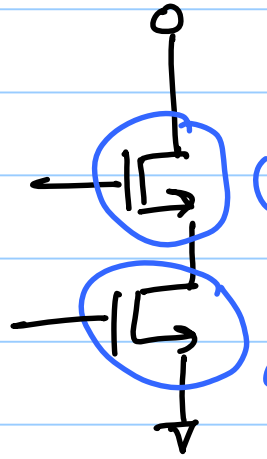


$V_o \geq V_{GS} + V_{DS,sat}$

$= 2V_{DS,sat} + V_{THN}$



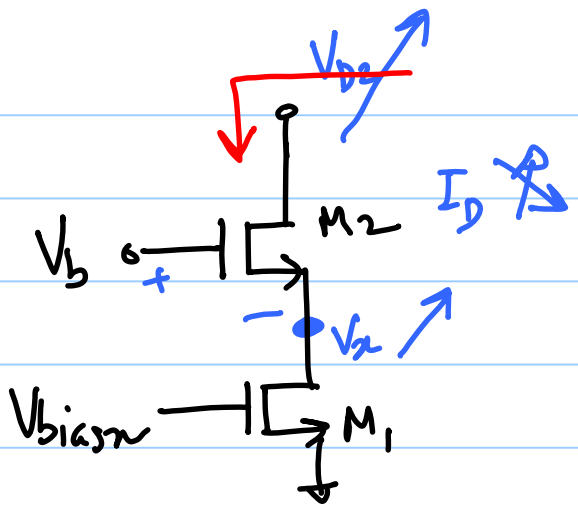
headroom reduces by $V_{DS,sat} + V_{THN}$



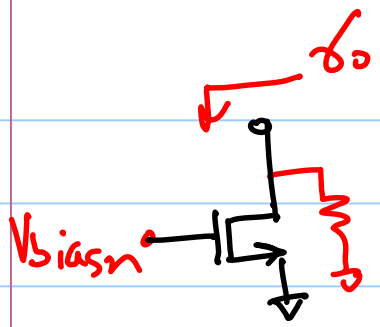
Common ~~gate~~ grid

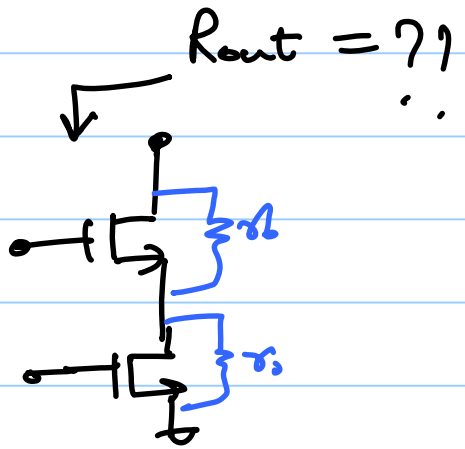
Common ~~source~~ cathode

"CASCODE" = Cascade of common cathode & common grid amplifi.

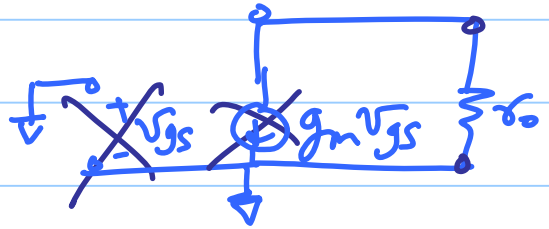


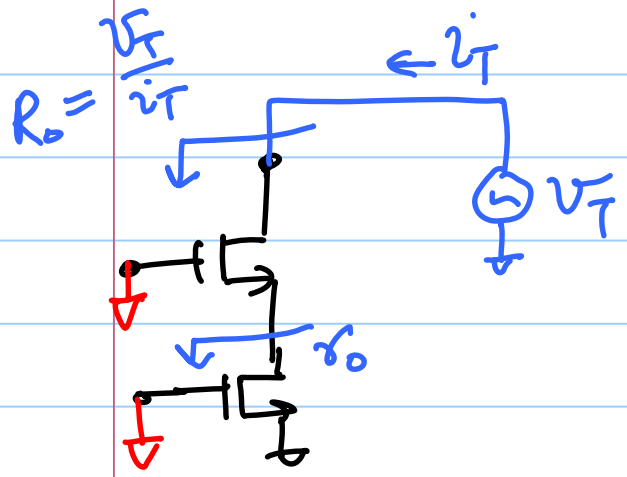
$$\Delta V_x = \frac{\Delta V_{D2}}{1 + g_{m2} r_{o2}}$$

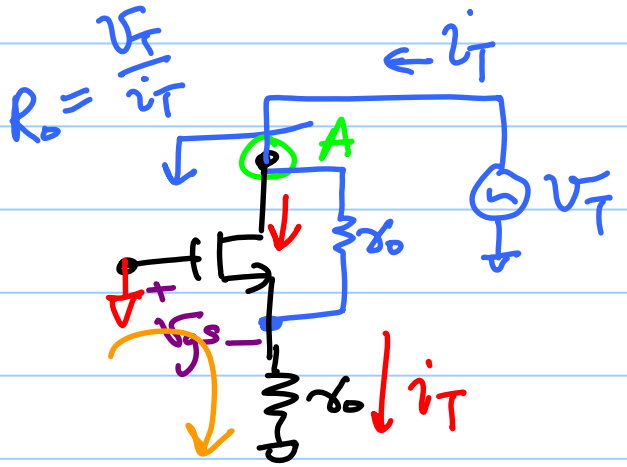




A







KVL:

$$v_{gs} + i_T r_o = 0 \quad \Rightarrow \quad v_{gs} = -i_T r_o \longrightarrow (1)$$

KCL @ A

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

Eliminating v_{gs}:

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

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

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

$$= 2r_o + g_m r_o^2$$

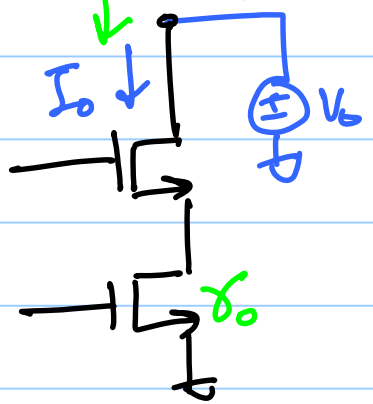
$$\simeq g_m r_o^2 \quad \text{for } g_m r_o >> 1$$

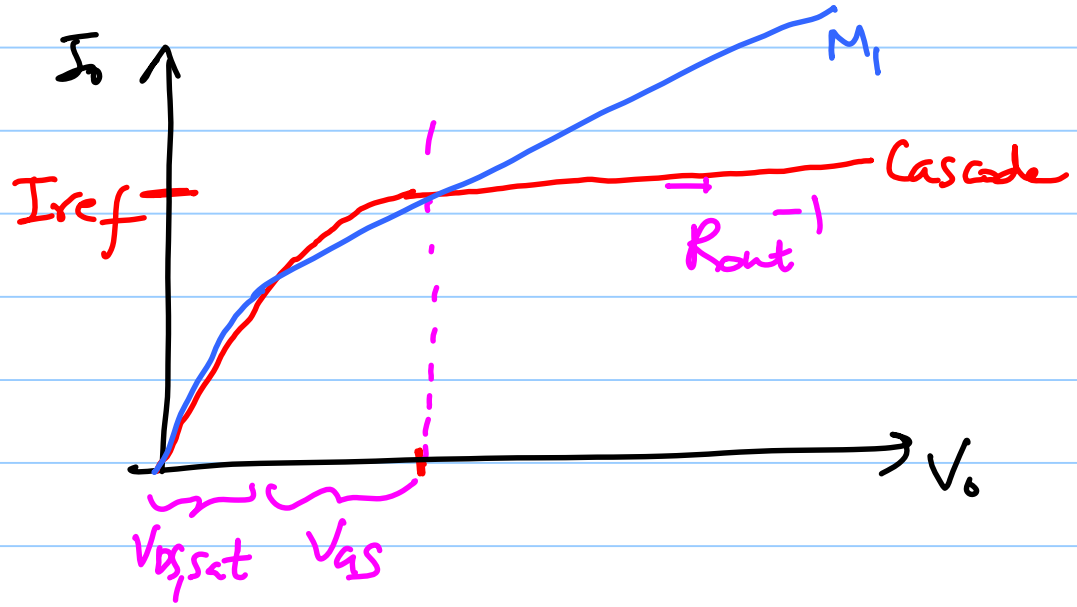
$g_m r_o^2 = r_o (g_m r_o)$

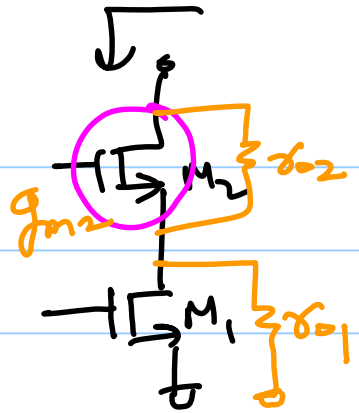
$r_o = 1\,k\Omega$

$g_m r_o = 100$

$R_o = g_m r_o^2 = 100\,k$





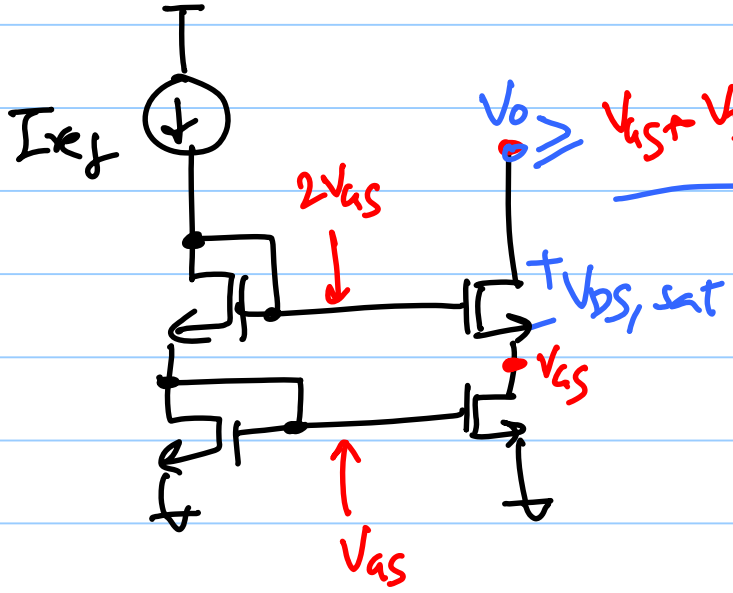


$$R_{out} = (g_{m2} r_{o2}) r_{o1} + r_{o1} + r_{o2}$$

$V_{DD} = 1.8\,V$

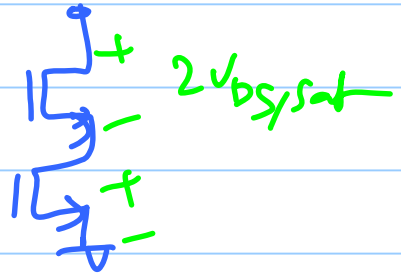
$V_{THN} = 350\,mV$

$V_{DS,sat} = 120\,mV$

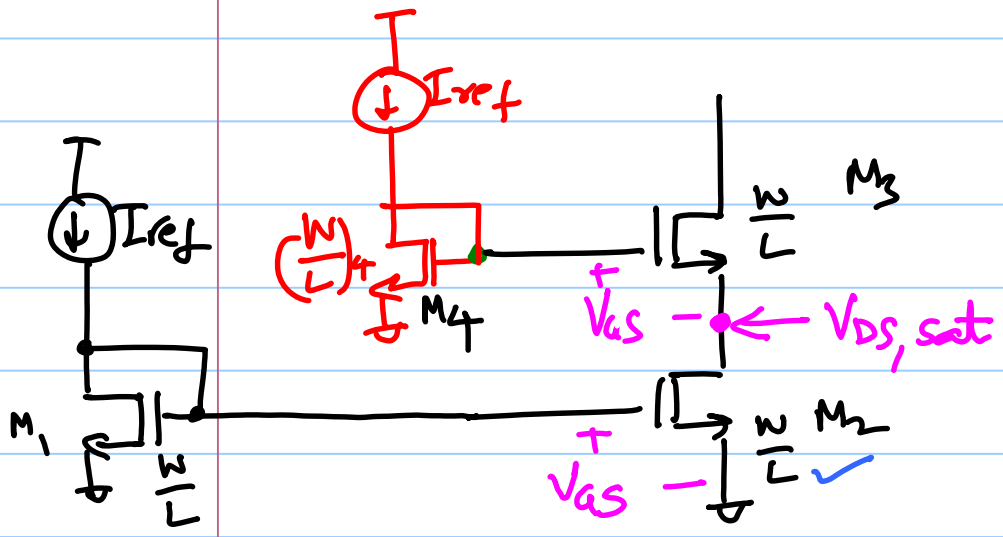


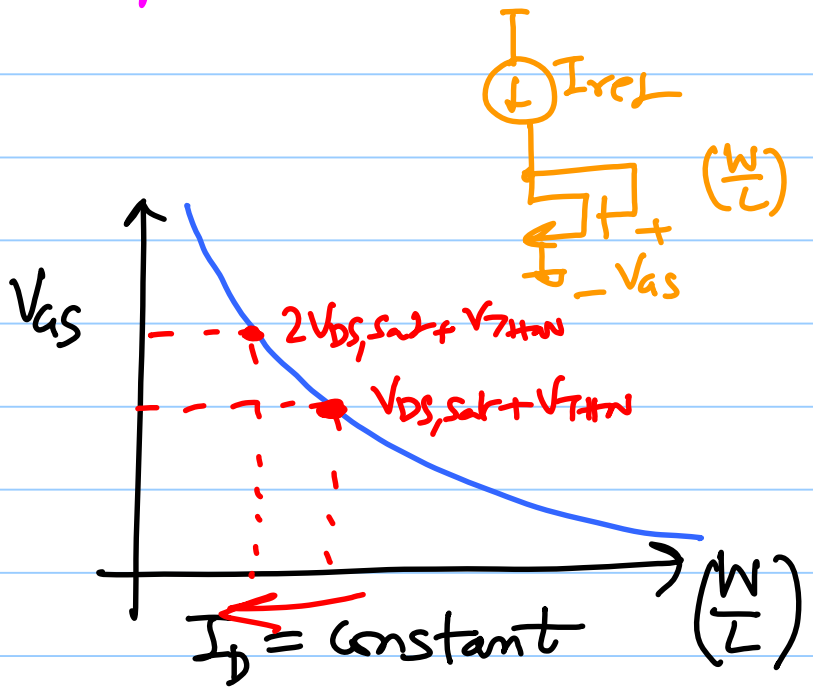
$V_o \geq V_{GS} + V_{DS,sat} = 2V_{DS,sat} + V_{THN}$

$+ V_{DS,sat}$



Wide Swing current Mirror





$$V_b = V_{GS} + V_{DS,sat}$$

$$= \underline{2V_{DS,sat} + V_{THN}}$$

$$V_{GS} = \sqrt{\frac{2I_D}{\mu_n C_{ox} \frac{W}{L}}} + V_{THN}$$

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

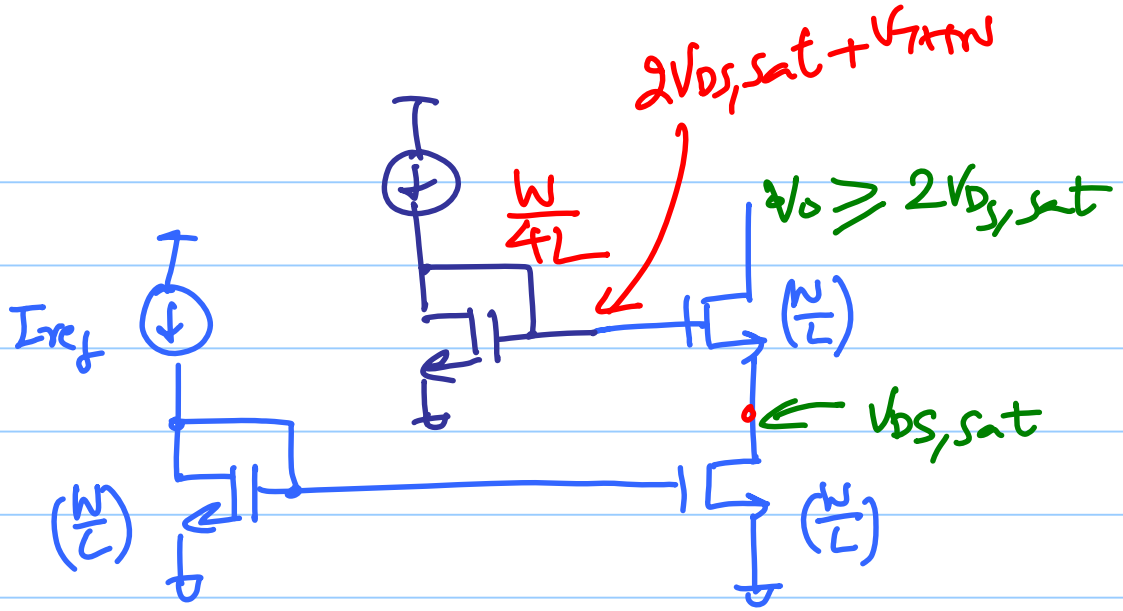
$$2\sqrt{\frac{2I_{REF}}{\beta_2}} + V_{THN} = \sqrt{\frac{2I_{REF}}{\beta_4}} + V_{THN}$$

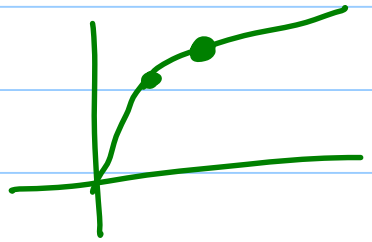
$$\frac{4}{\beta_2} = \frac{1}{\beta_4}$$

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

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

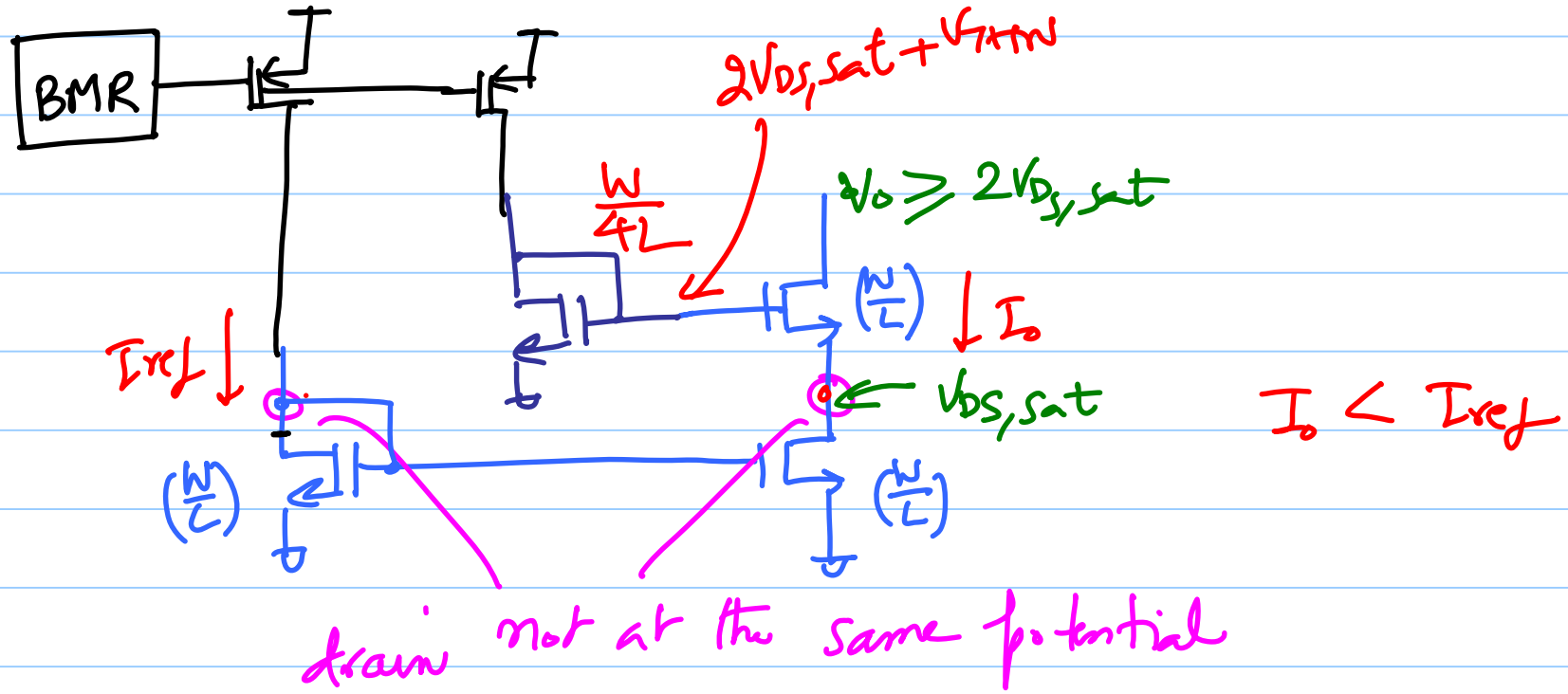
Wide Swing CM



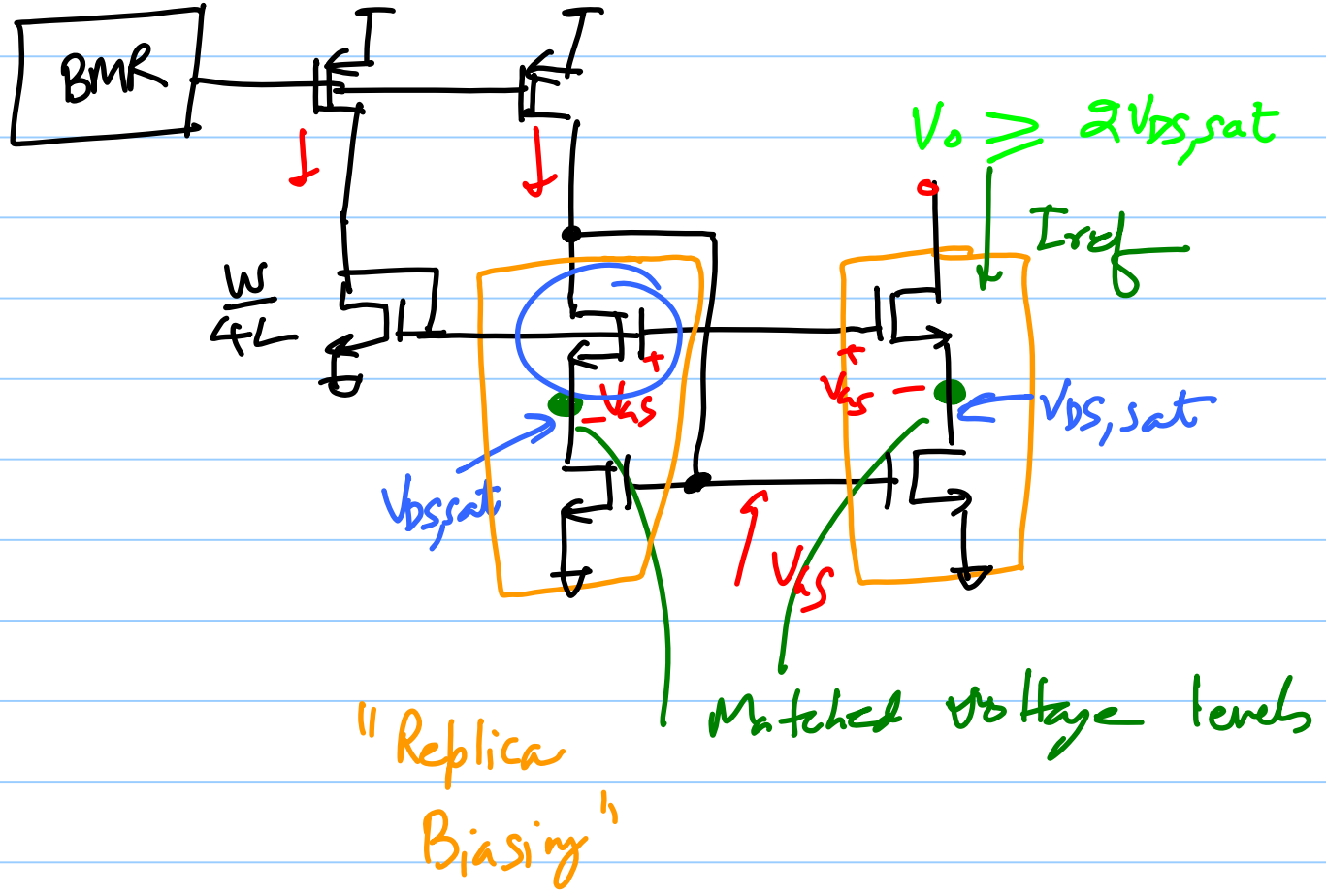


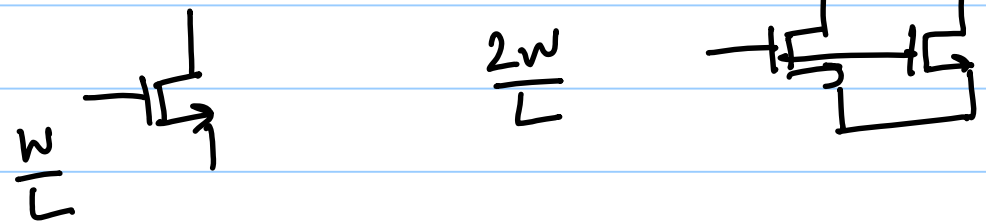
In short channel may want to bias in deep saturation

$\left(\frac{W}{5L}\right)$


BMR
$2V_{DS,sat}+V_{T+\eta}$
$\frac{W}{4L}$
$V_o \geq 2V_{DS,sat}$
$\left(\frac{W}{L}\right)$
I_o
I_{ref}
$V_{DS,sat}$
$\left(\frac{W}{L}\right)$
$\left(\frac{W}{L}\right)$
$I_o < I_{ref}$
drain not at the same potential

WS CM


BMR
W/4L
$V_o \geq 2V_{DS,sat}$ to V_{DD}
I_{ref}
V_{GS}
$V_{DS,sat}$
$V_{DS,sat}$
V_{GS}
"Replica Biasing"
Matched voltage levels


W/L
2W/L