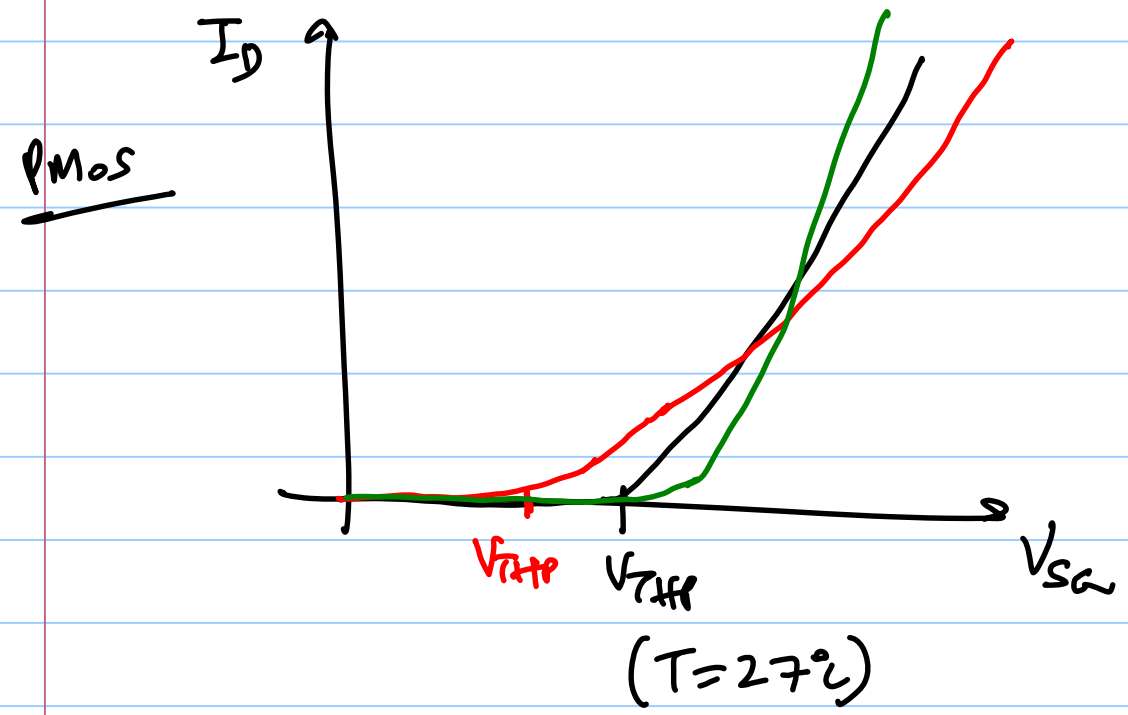
ECE 511 - Lecture

Note Title 2/26/2015



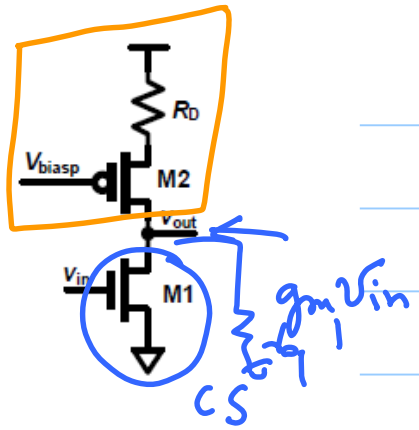
(T=27°C)

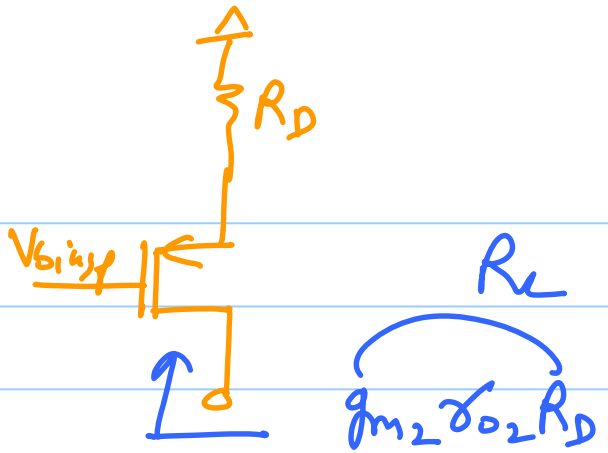
$T = 50°C$

$V_{TH_P} \downarrow \quad kp_p \downarrow$

$$I_D = \frac{1}{2} kp_p \frac{W}{L} (V_{SG} - V_{TH_P})^2$$

$T = 0°C$

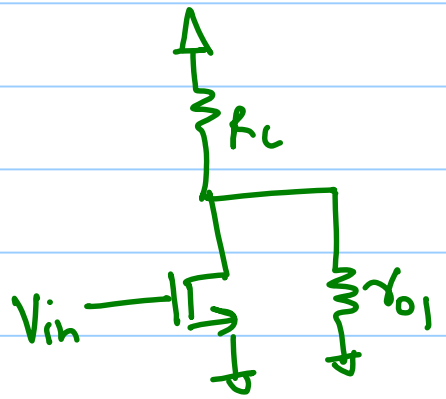


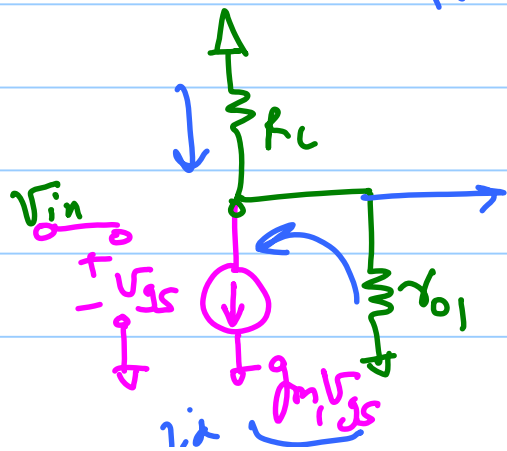


$$v_{out} = -i_d (r_{o_1} \| R_L)$$

$$= -g_{m_1} v_{in} (r_{o_1} \| R_L)$$

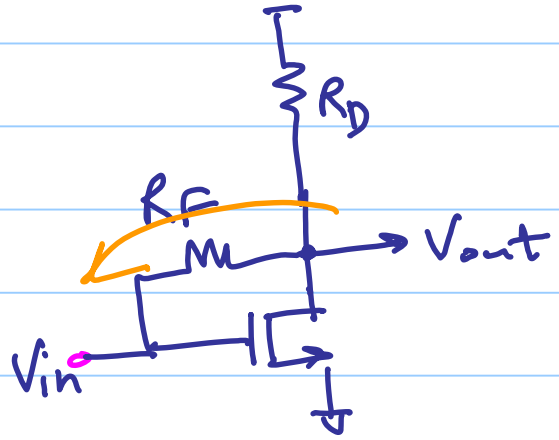
$$\Rightarrow A_v = \frac{v_{out}}{v_{in}} = -g_{m_1} (r_{o_1} \| R_L)$$

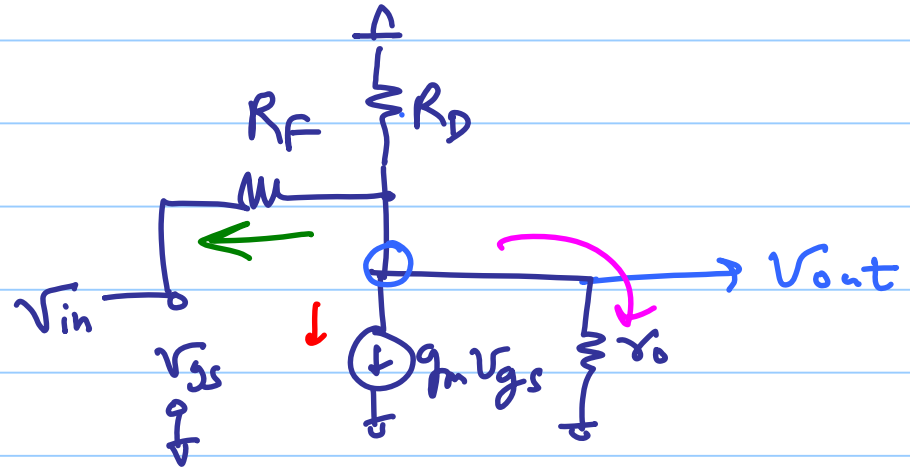




$$v_{out} = -i_d (r_{o_1} \| R_L)$$

$$= -g_{m_1} v_{in} (r_{o_1} \| R_L)$$





KCL

$$\frac{-V_{out}}{r_o \| R_D} - \frac{(V_{out} - V_{in})}{R_F} - g_m V_{in} = 0$$

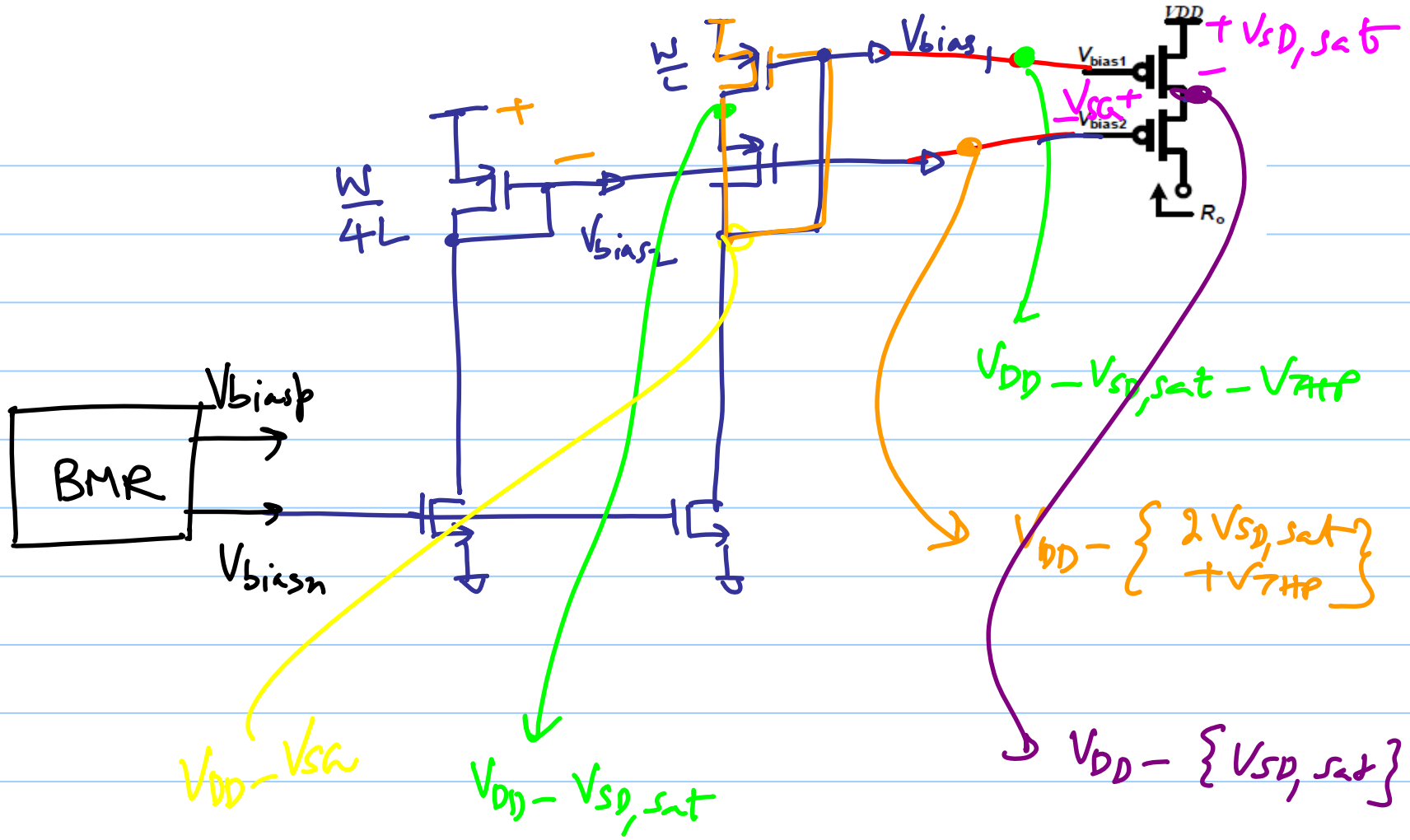
$$-V_{out}\left[\frac{1}{r_o \| R_D} + \frac{1}{R_F}\right] = g_m V_{in} - \frac{V_{in}}{R_F}$$

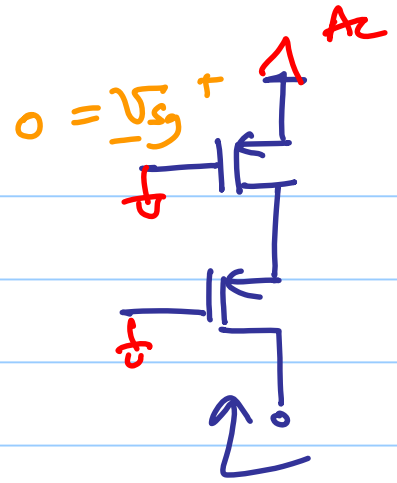
$$\Rightarrow \quad \frac{-V_{out}}{r_o \| R_D \| R_F} = \left(g_m - \frac{1}{R_F}\right) V_{in}$$

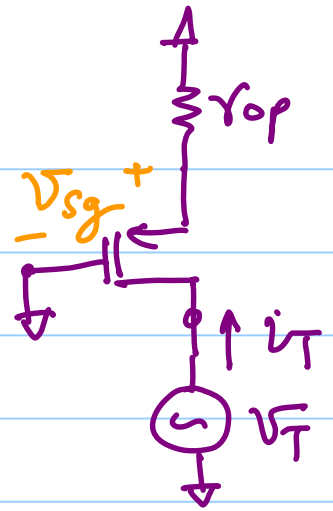
$$A_V = \frac{V_{out}}{V_{in}} = -\left(g_m - \frac{1}{R_F}\right)\left(r_o \| R_D \| R_F\right)$$

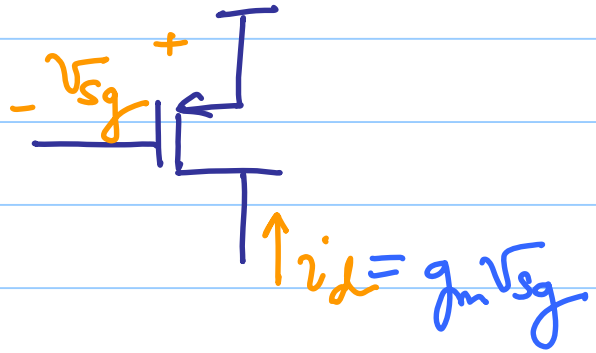
$g_m r_o$ dimensions

$$g_m \ll \frac{1}{R_F}$$

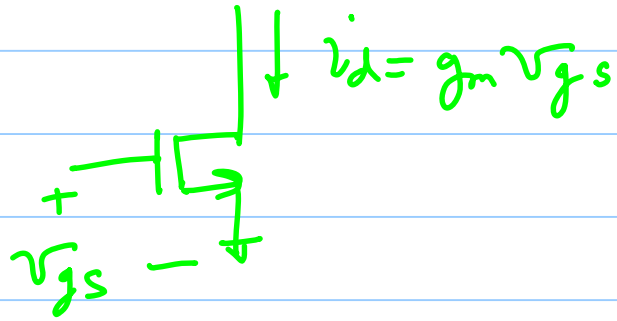

BMR
Vbiasp
Vbiasn
W/4L
Vbias1
Vbias2
VDD
Ro
+ VSD,sat −
VSG +
VDD − VSG
VDD − VSD,sat
VDD − VSD,sat − VTHP
VDD − { 2 VSD,sat + VTHP }
VDD − { VSD,sat }

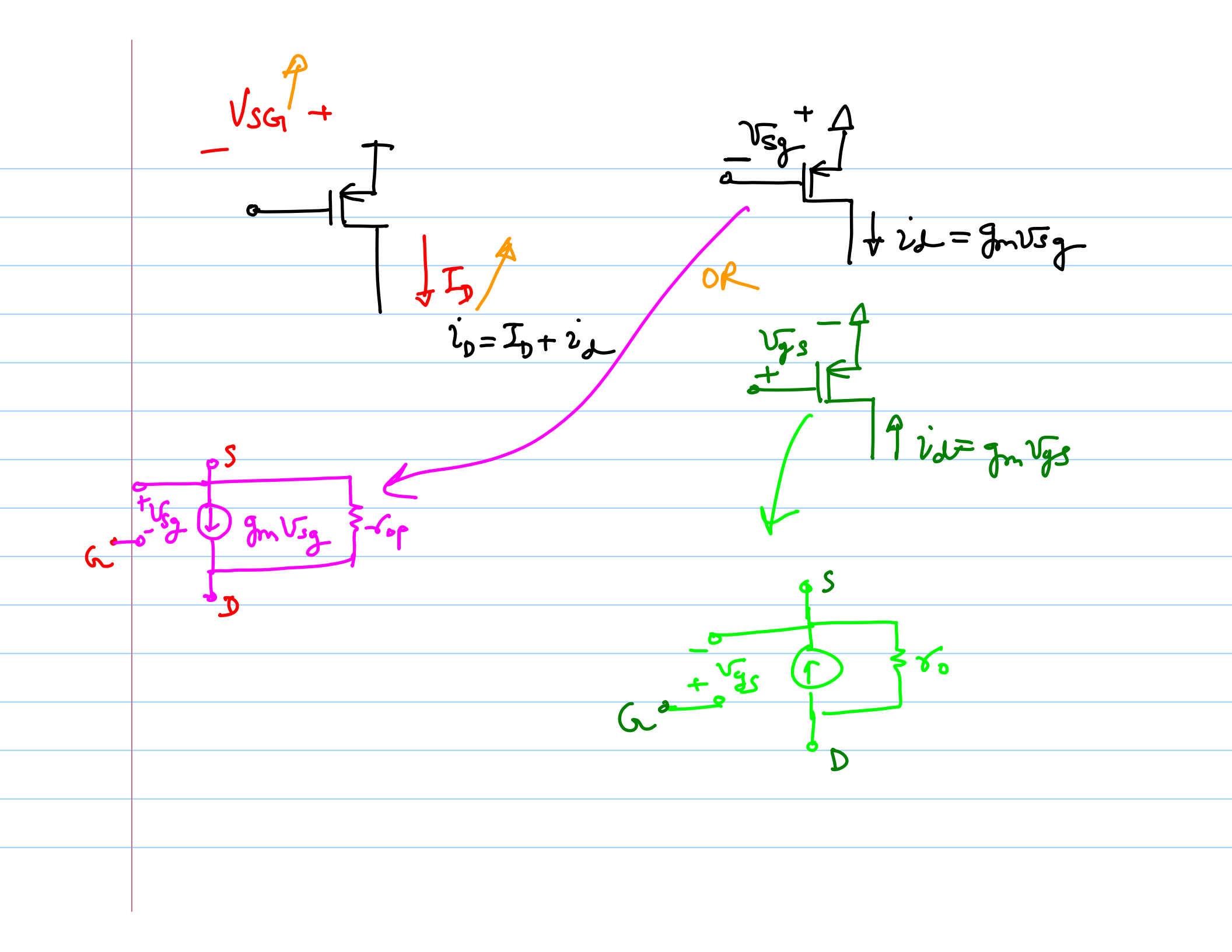


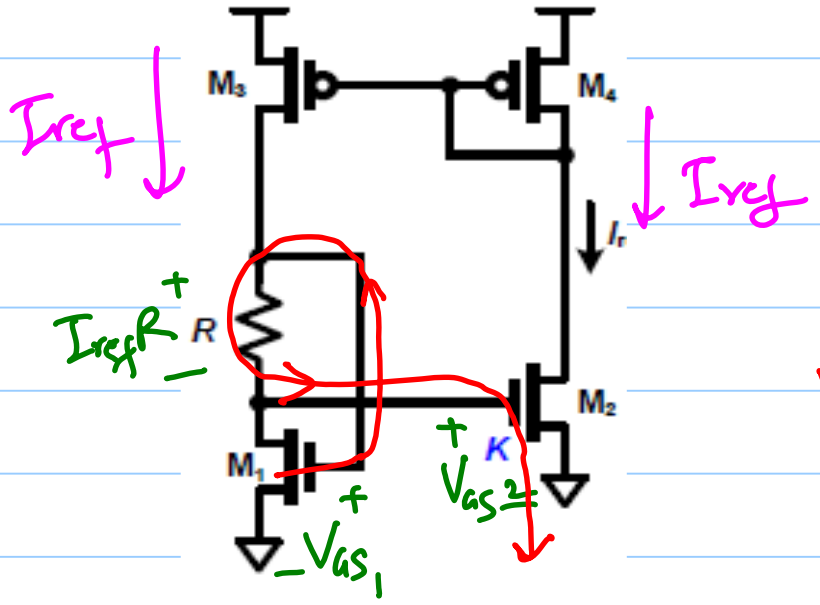




(1)




V_{SG}
+
−
I_D
$i_D = I_D + i_d$
OR
v_{sg}
+
−
$i_d = g_m v_{sg}$
S
+
v_{sg}
−
G
$g_m v_{sg}$
r_{op}
D
v_{gs}
−
+
$i_d = g_m v_{gs}$
S
−
v_{gs}
+
G
r_o
D



$$V_{gs_1} - I_{ref} R = V_{gs_2}$$

$$V_{gs_1} = V_{gs_2} + I_{ref} R$$

$$V_{THN_1} = V_{THN_2}$$

as V_{SB} are same

no body-effect

$$I_{ref} = \frac{2}{\beta R^2}\left(1 - \frac{1}{\sqrt{K}}\right)^2$$

$V_{bias} \Leftarrow V_{GS} = \sqrt{\frac{2I_{ref}}{\beta}} + V_{THN}$

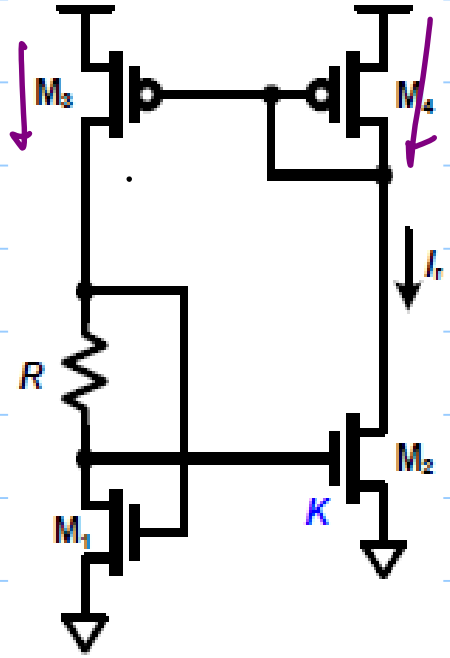
$$= \sqrt{\frac{2}{\beta} \cdot \frac{2}{\beta R^2}\left(1-\frac{1}{\sqrt{K}}\right)^2} + V_{THN}$$

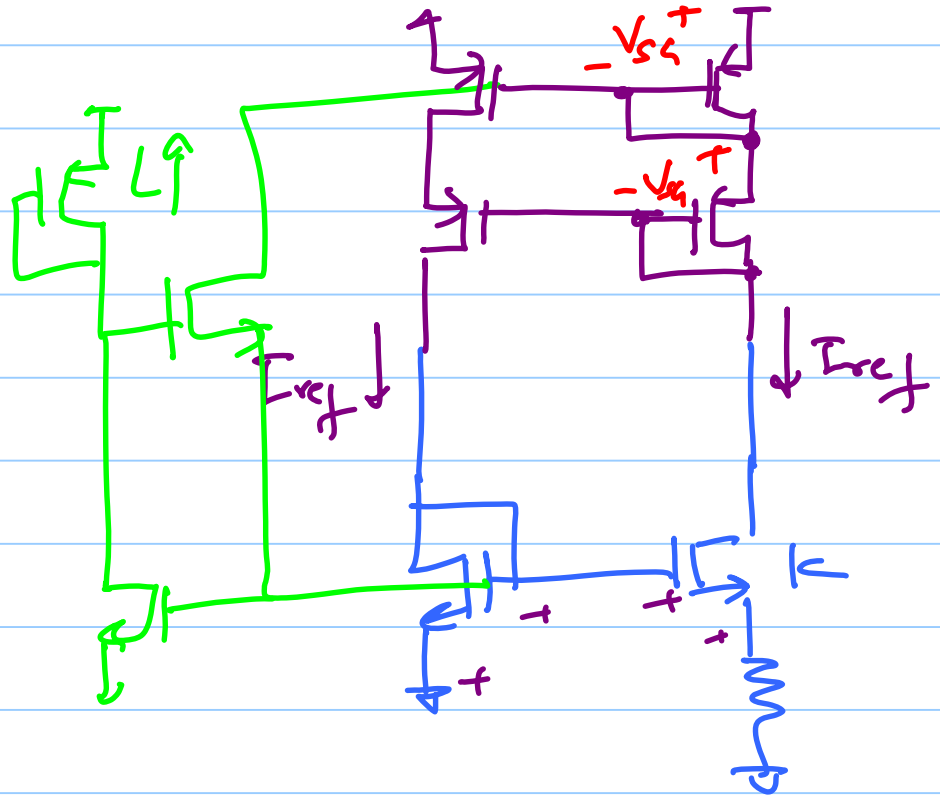
$$= \frac{2}{\beta R}\left(1-\frac{1}{\sqrt{K}}\right) + V_{THN}$$

Indep of supply term

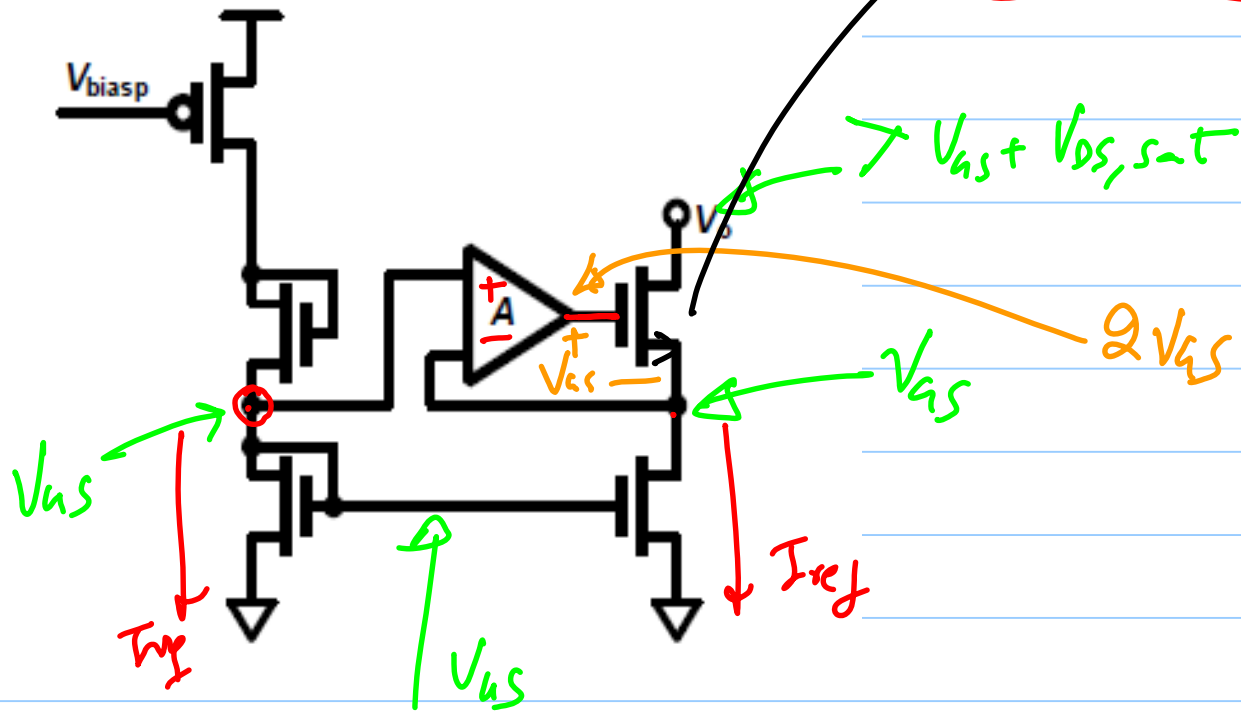
$$g_m = \beta(V_{GS}-V_{THN}) = \frac{2}{R}\left(1-\frac{1}{\sqrt{K}}\right)$$

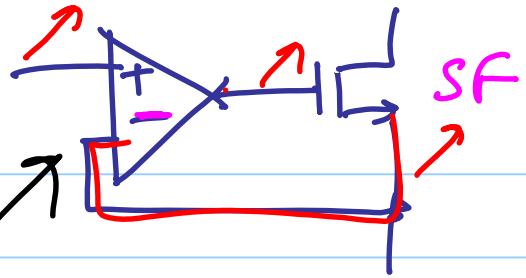
for $K \gg 4$ $\quad g_m = \frac{1}{R}$


M3
M4
Ir
R
M2
M1
K


Iref
Iref

the regulated drain current mirror shown below.





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

$2V_{GS}$

Aside