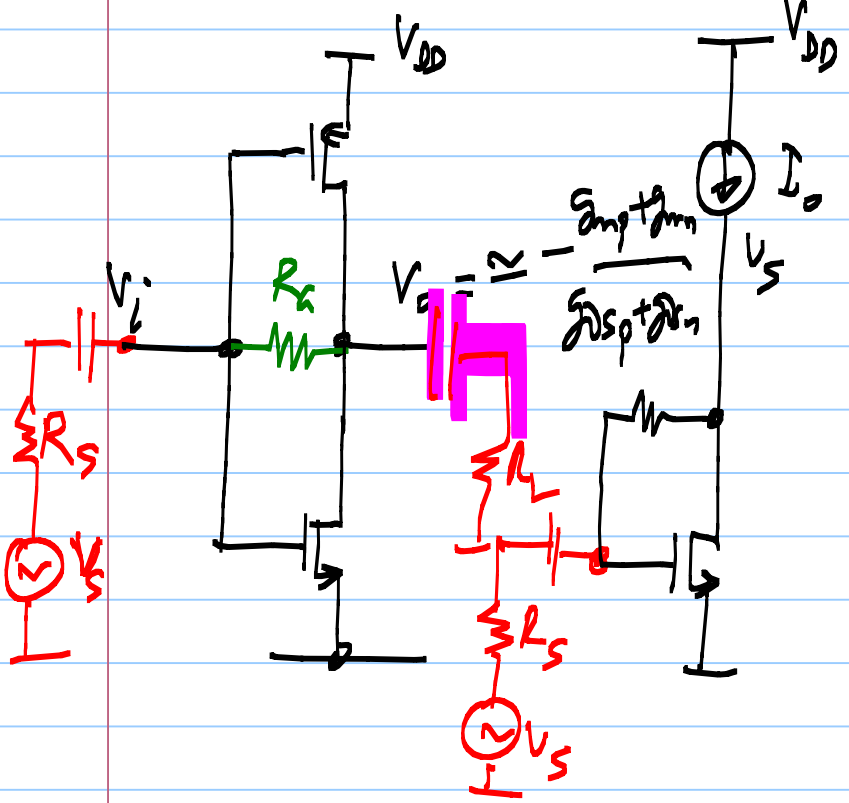
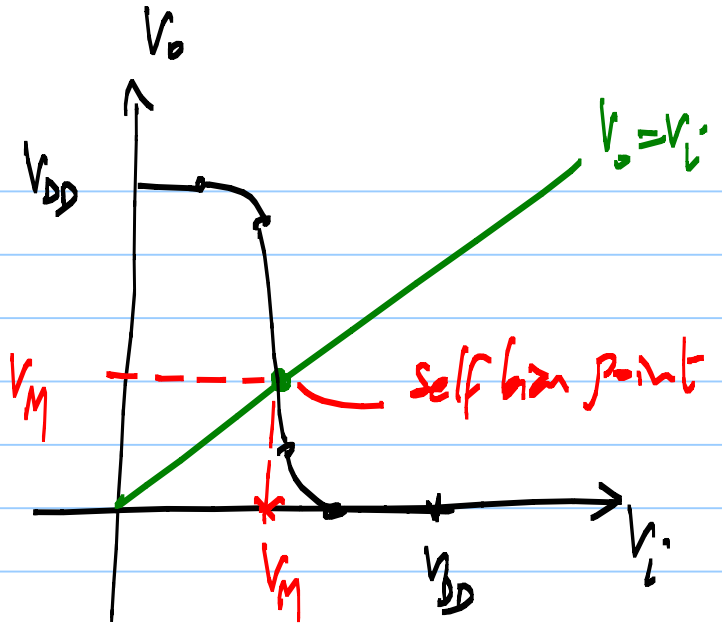
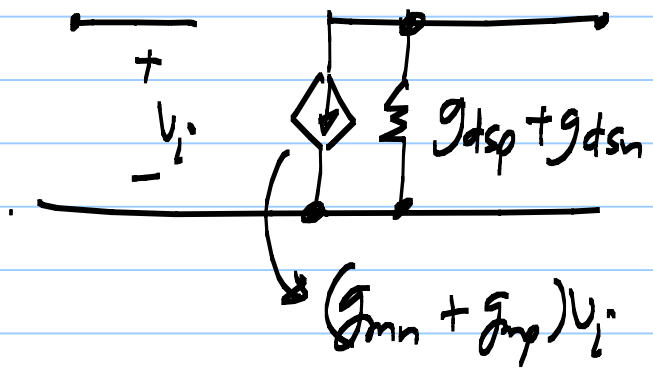
Lecture 32

CMOS inverter





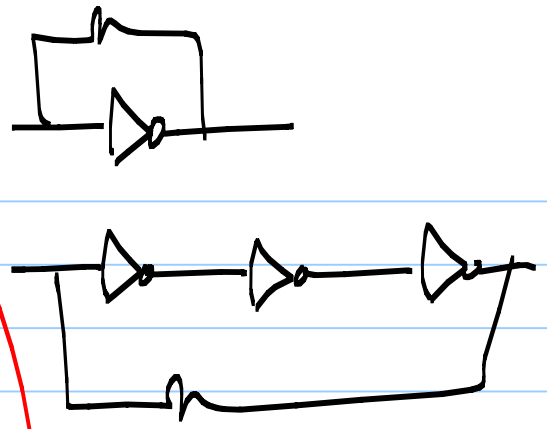


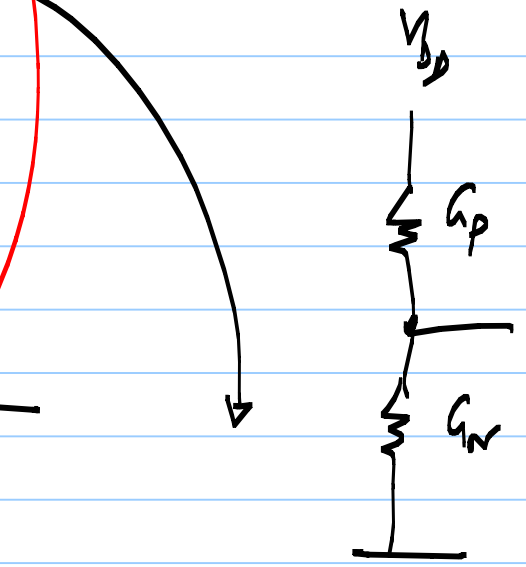
Self bias voltage:

$$V_{DD}\left[\frac{\sqrt{k_p}}{\sqrt{k_p}+\sqrt{k_n}}\right]$$

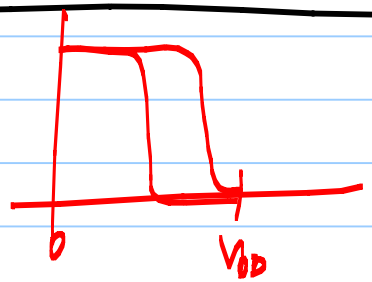
$$V_M = \frac{(V_{DD}-V_{Tp})\sqrt{k_p} + V_{Tn}\sqrt{k_n}}{\sqrt{k_p}+\sqrt{k_n}}$$

$$I_Q = (V_{DD}-V_{Tp}-V_{Tn})^2 \cdot \frac{k_p k_n}{2\left(\sqrt{k_p}+\sqrt{k_n}\right)^2}$$

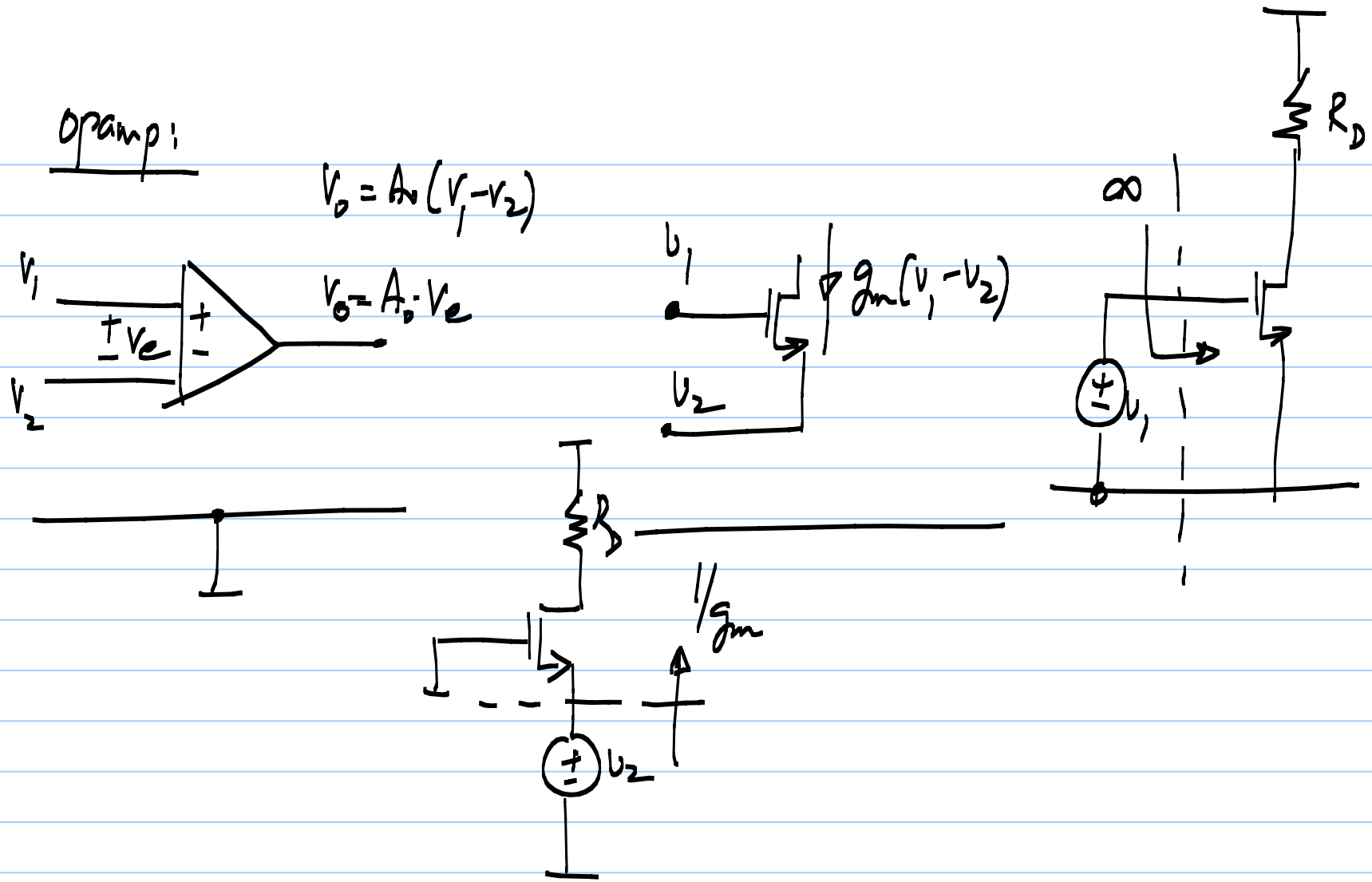


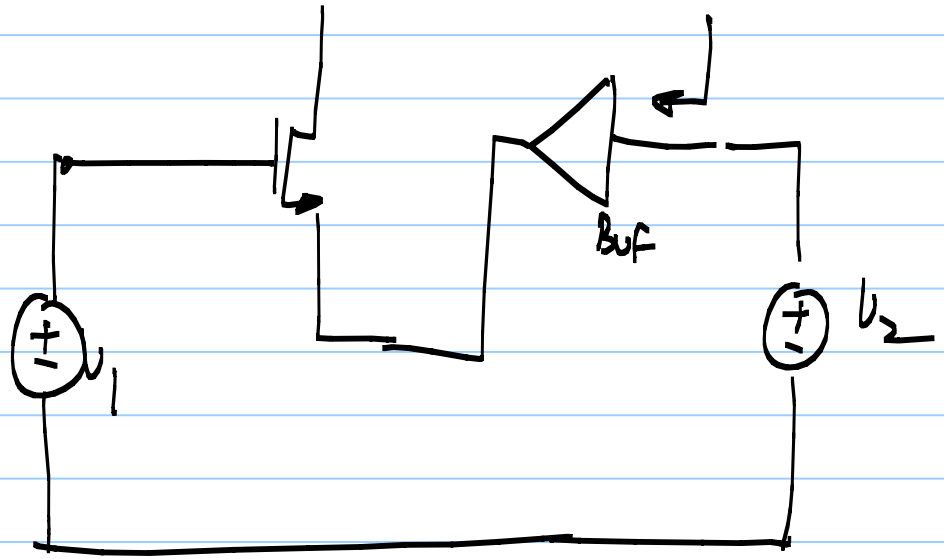


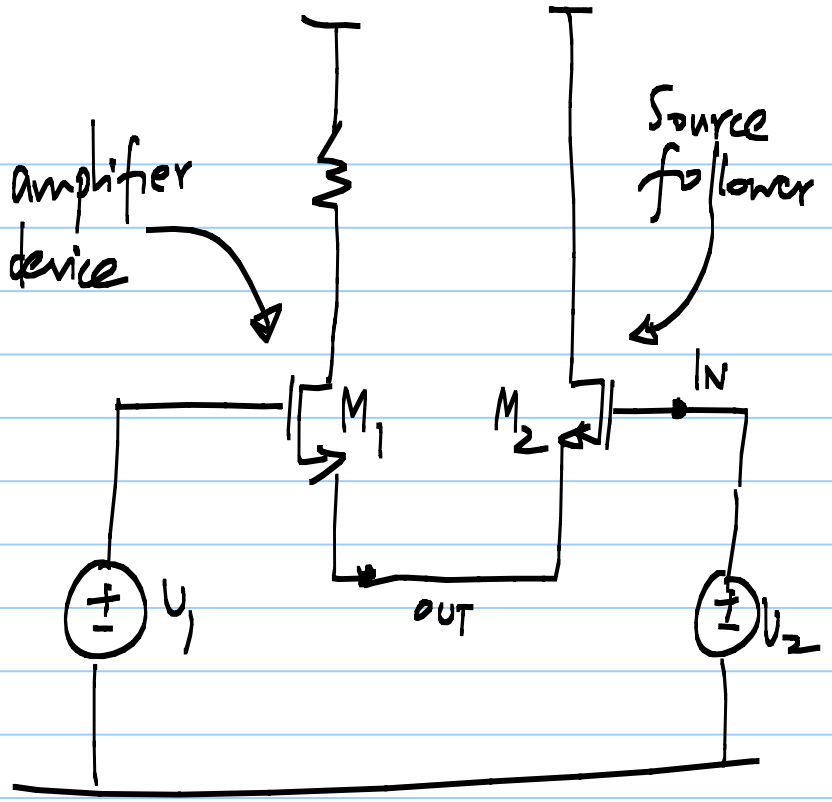
$\mu_p < \mu_n$

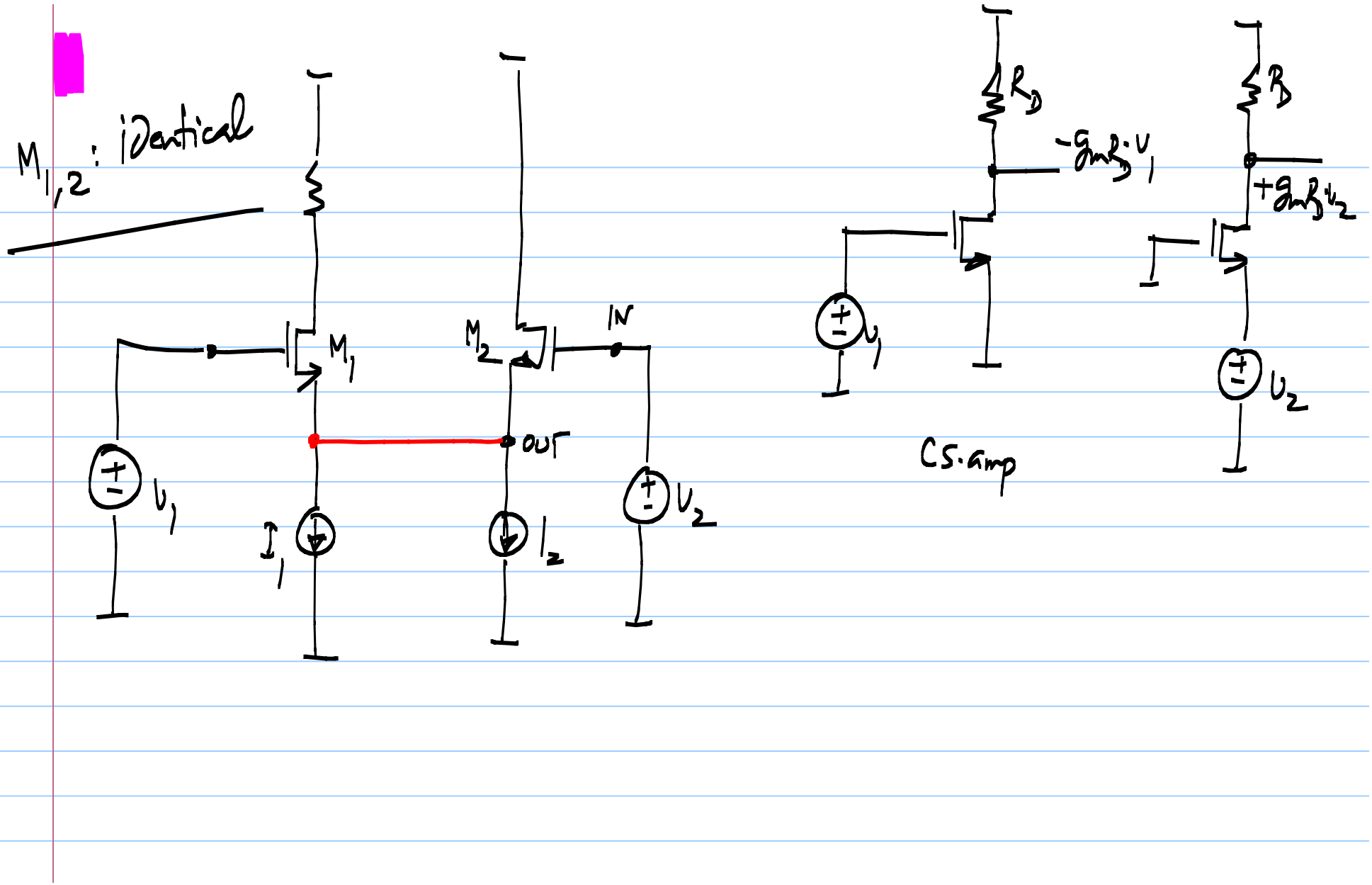


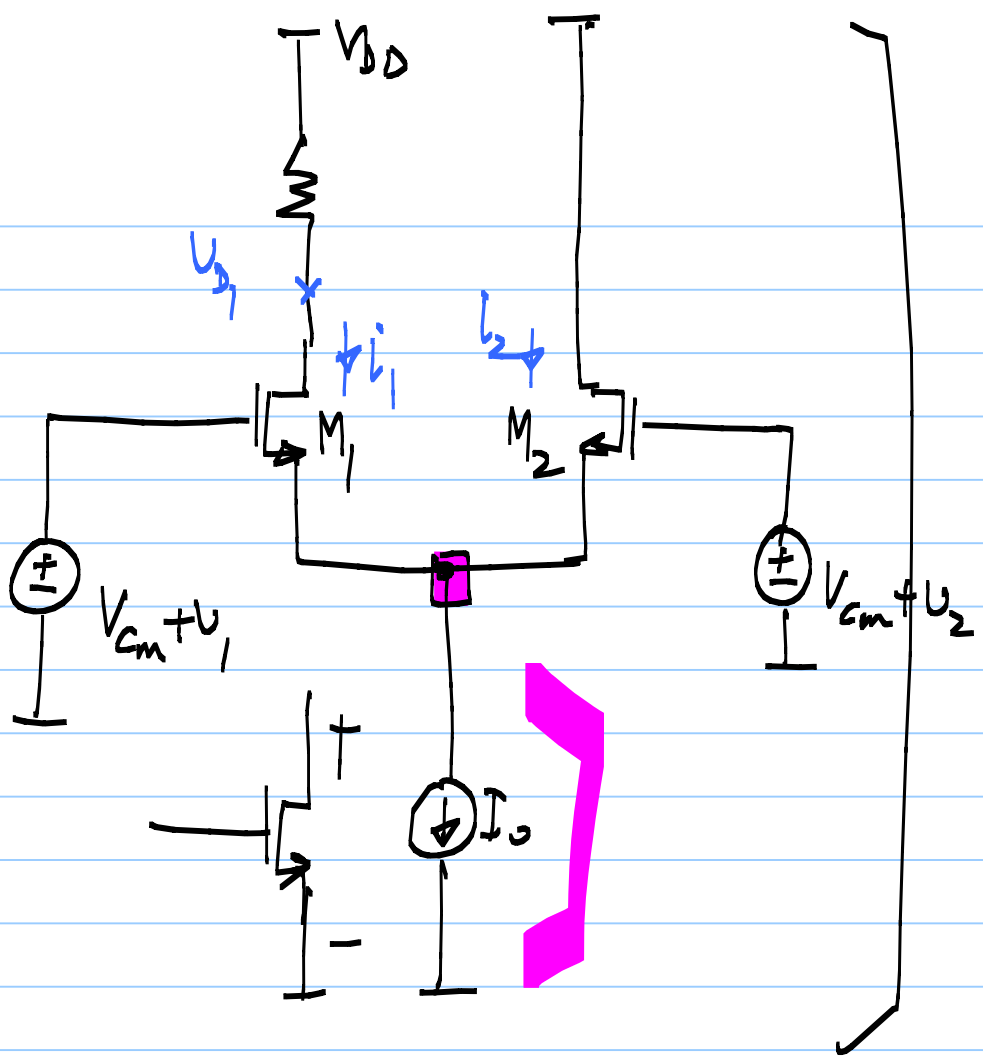
$$V_{DD}\left[\frac{G_p}{G_p+G_n}\right]$$

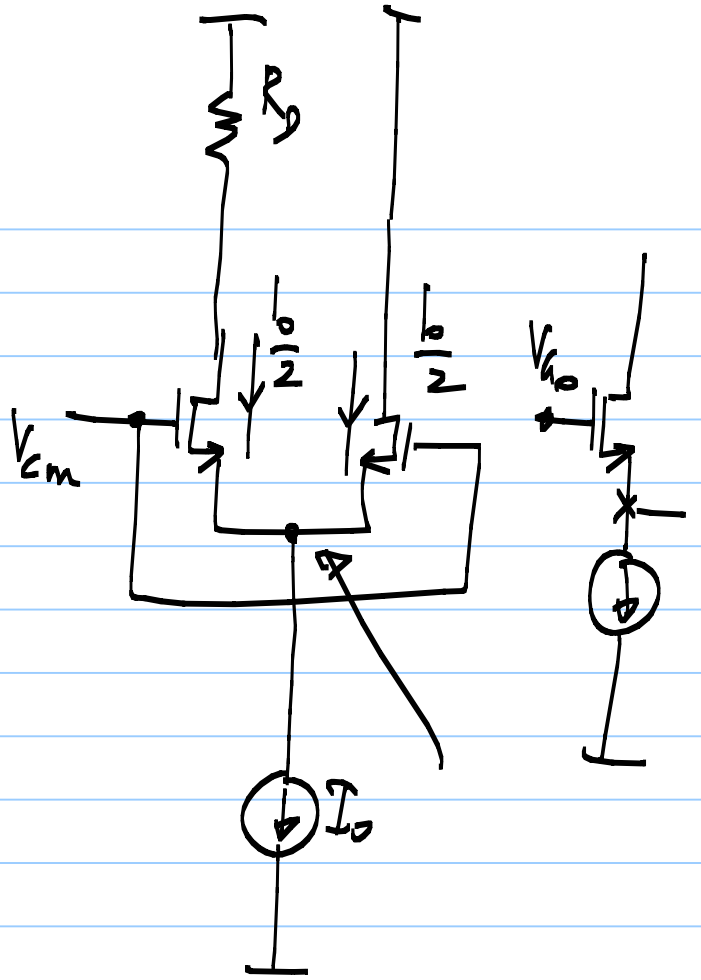

opamp:
$V_o = A_v(V_1 - V_2)$
V_1
$\pm V_e$
V_2
$V_o = A_v \cdot V_e$
v_1
$g_m(v_1 - v_2)$
v_2
R_D
∞
v_1
R_D
$1/g_m$
v_2

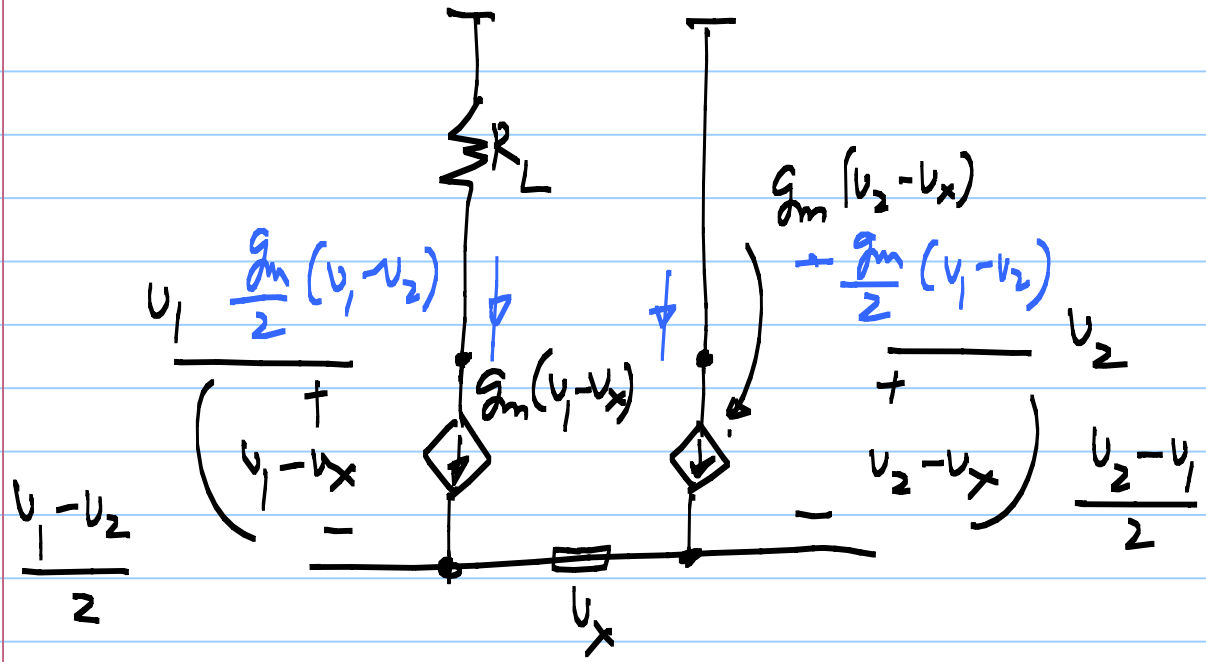

Buf
U_1
U_2


amplifier device
Source follower
M_1
M_2
IN
OUT
U_1
U_2


M1,2 : identical
M1
M2
IN
OUT
V1
I1
I2
V2
RD
-gmRD·V1
+gmRD·V2
CS. amp


V_{DD}
v_{o1}
i_1
i_2
M_1
M_2
$V_{cm}+v_1$
$V_{cm}+v_2$
I_o

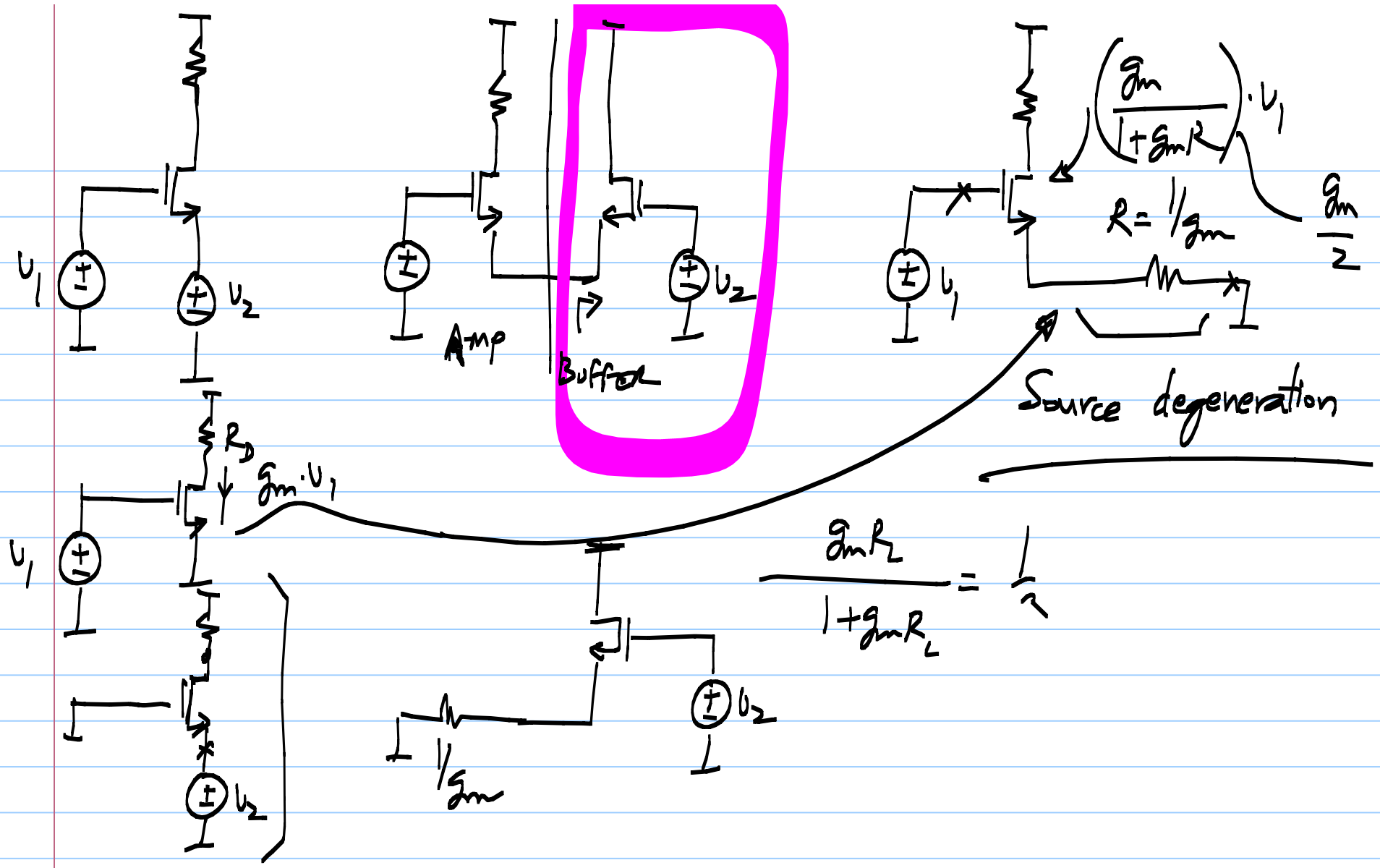

R_D
$\frac{I_o}{2}$
$\frac{I_o}{2}$
V_{cm}
V_{bo}
I_o



$$g_m[v_1-v_x)+g_m(v_2-v_x)$$

$$=0$$

$$v_x=\frac{v_1+v_2}{2}$$


v_1
v_2
R_D
$g_m \cdot v_1$
Amp
Buffer
$\frac{1}{g_m}$
$\left(\frac{g_m}{1+g_m R}\right) \cdot v_1$
$R = \frac{1}{g_m}$
$\frac{g_m}{2}$
Source degeneration
$\frac{g_m R_L}{1+g_m R_L} = \frac{1}{2}$