EE420 / ECE 620

Analog IC Design

Lecture 2

JAN. 28, 2019

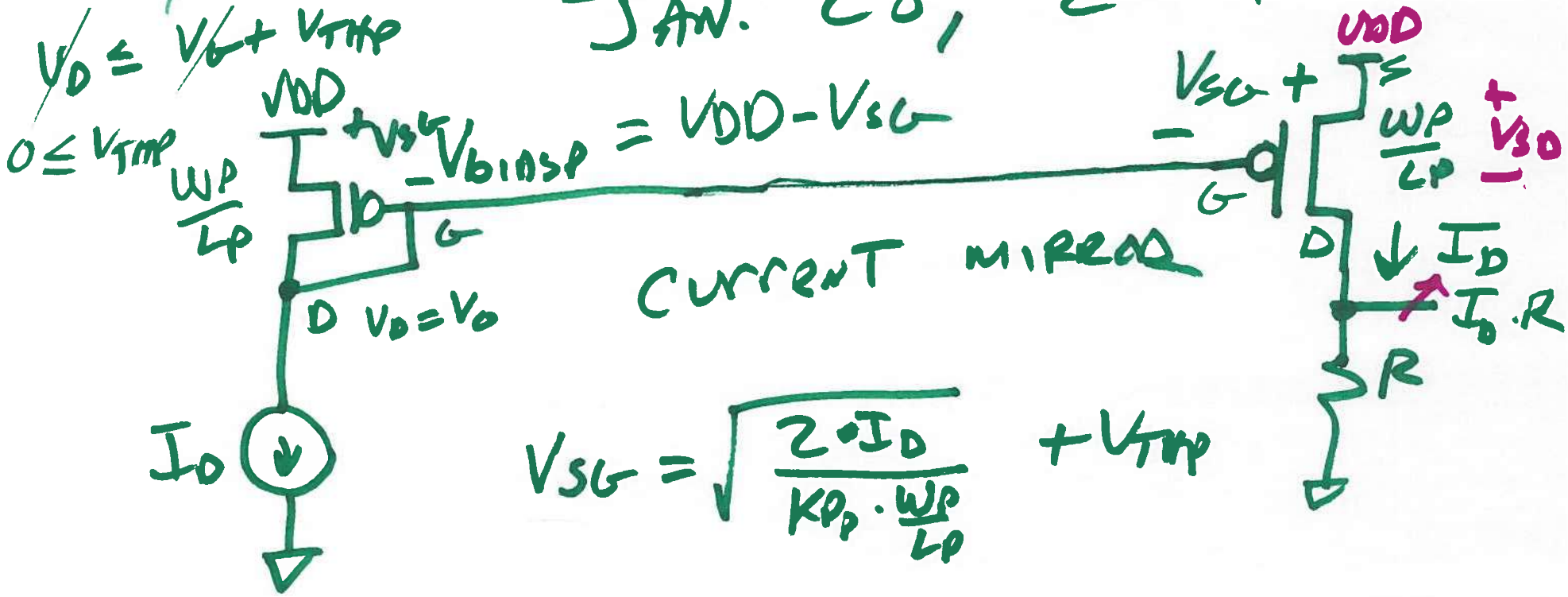
$V_{SG} > V_{THP}$

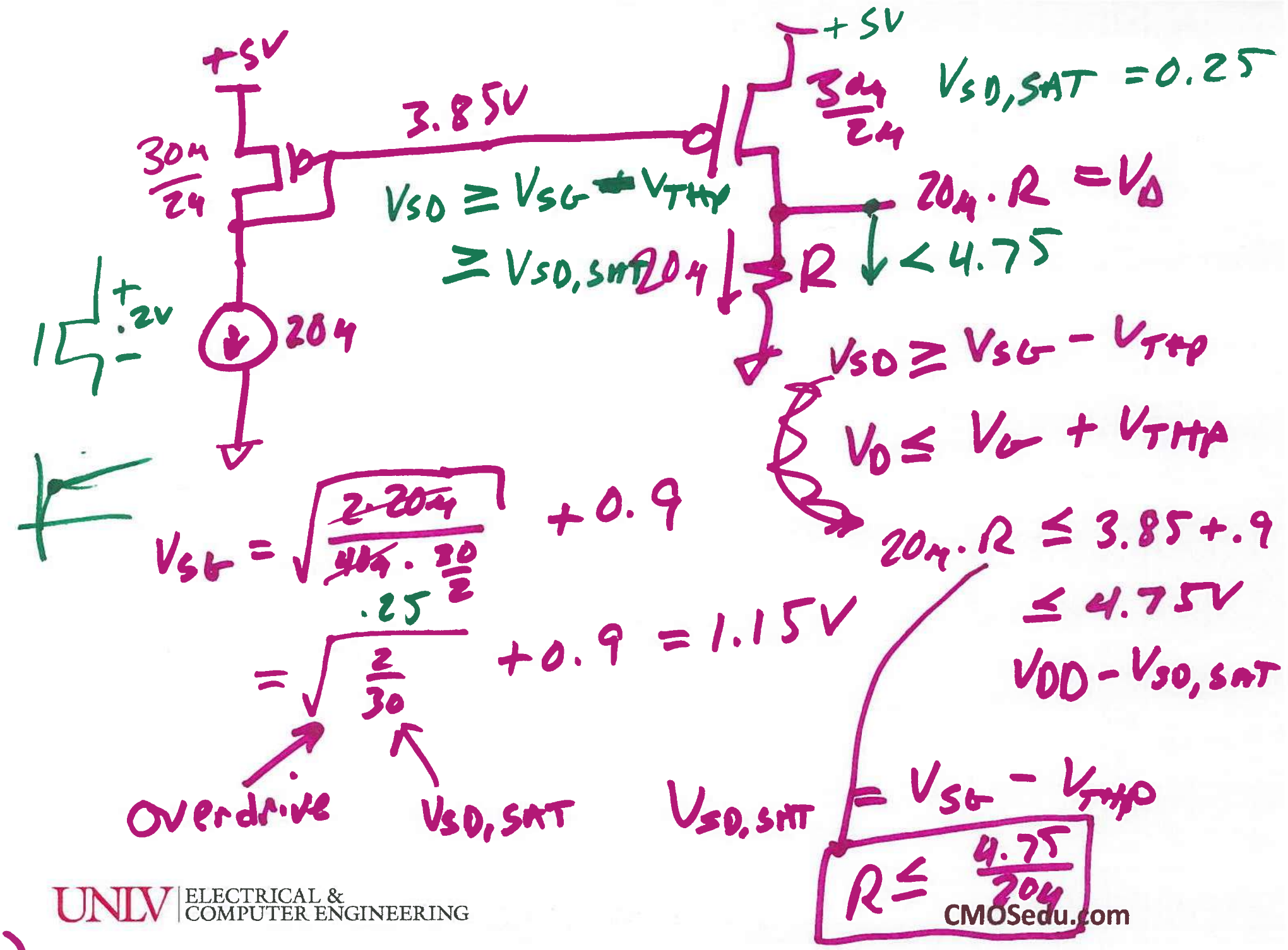
$V_{SD} \geq V_{SG} - V_{THP}$

$V_S - V_D \geq V_S - V_G - V_{THP}$

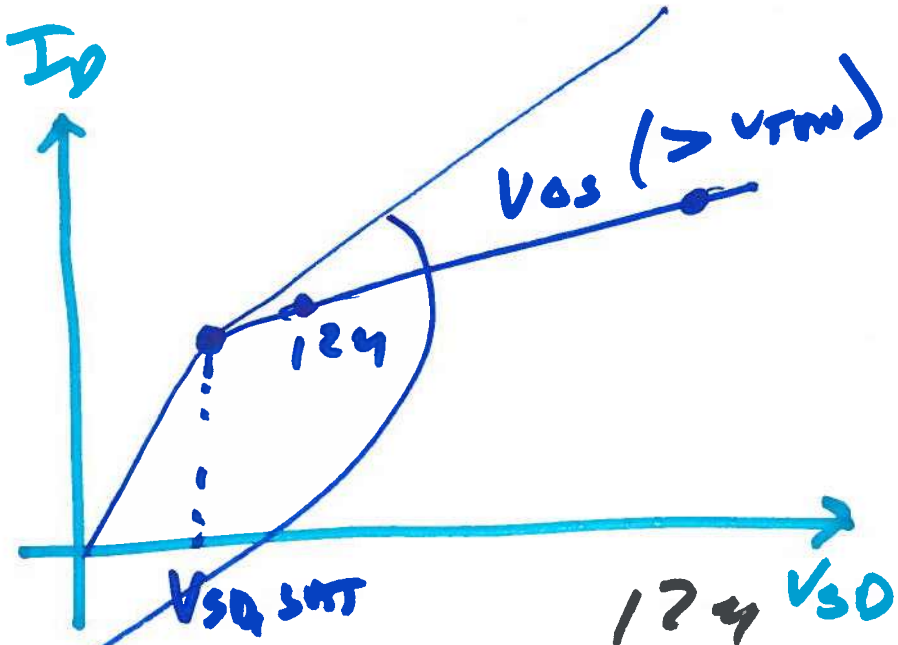
$V_D \leq V_G + V_{THP}$

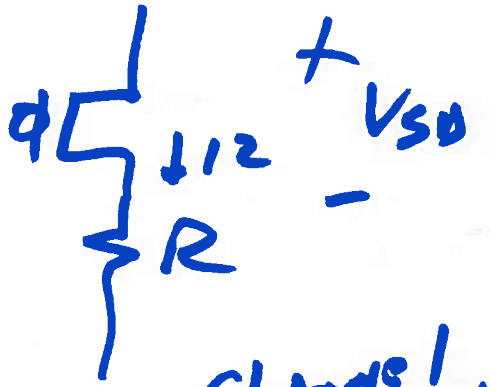
$0 \leq V_{THP}$





2)





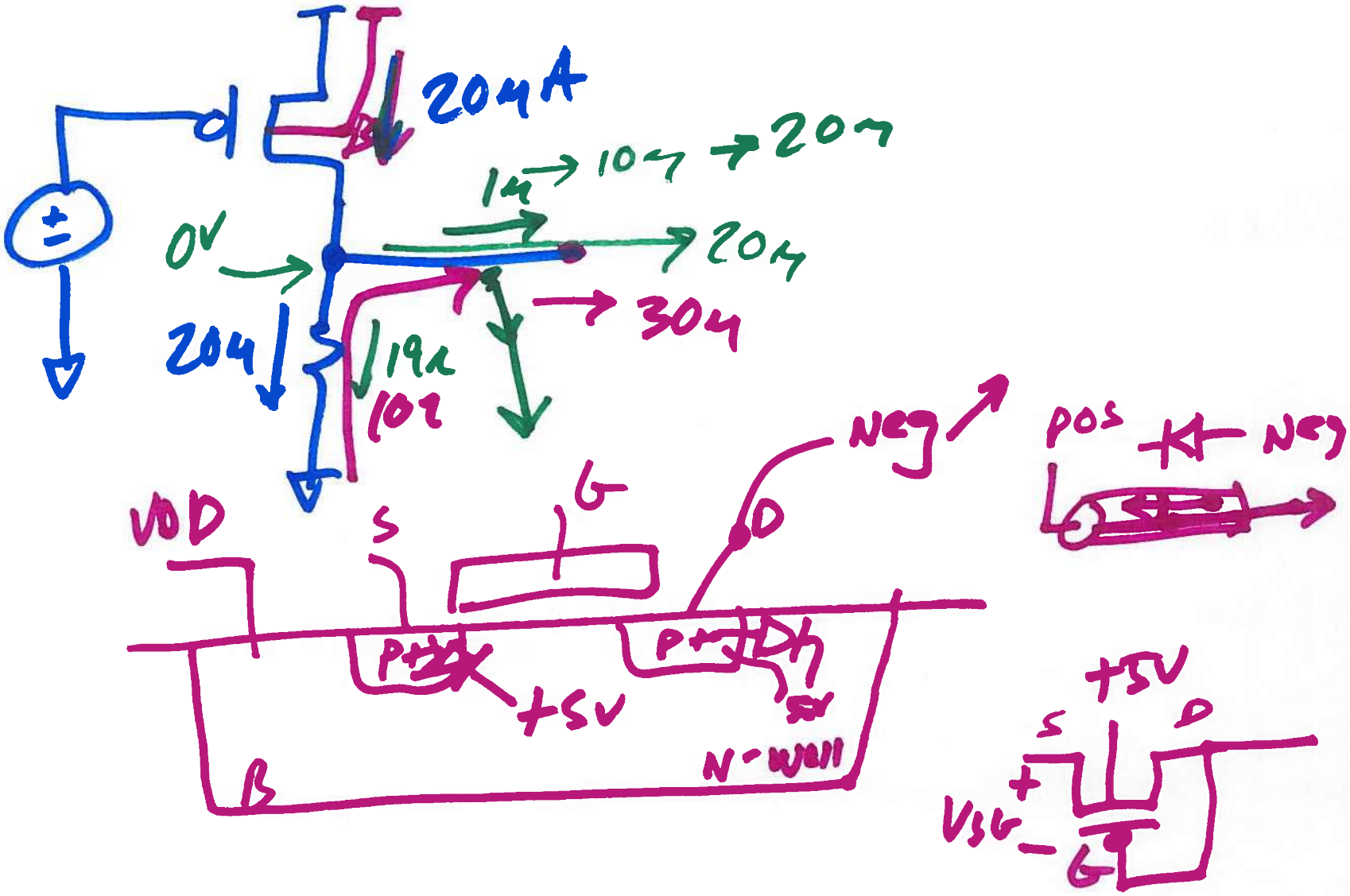
Channel modulation parameter V_A

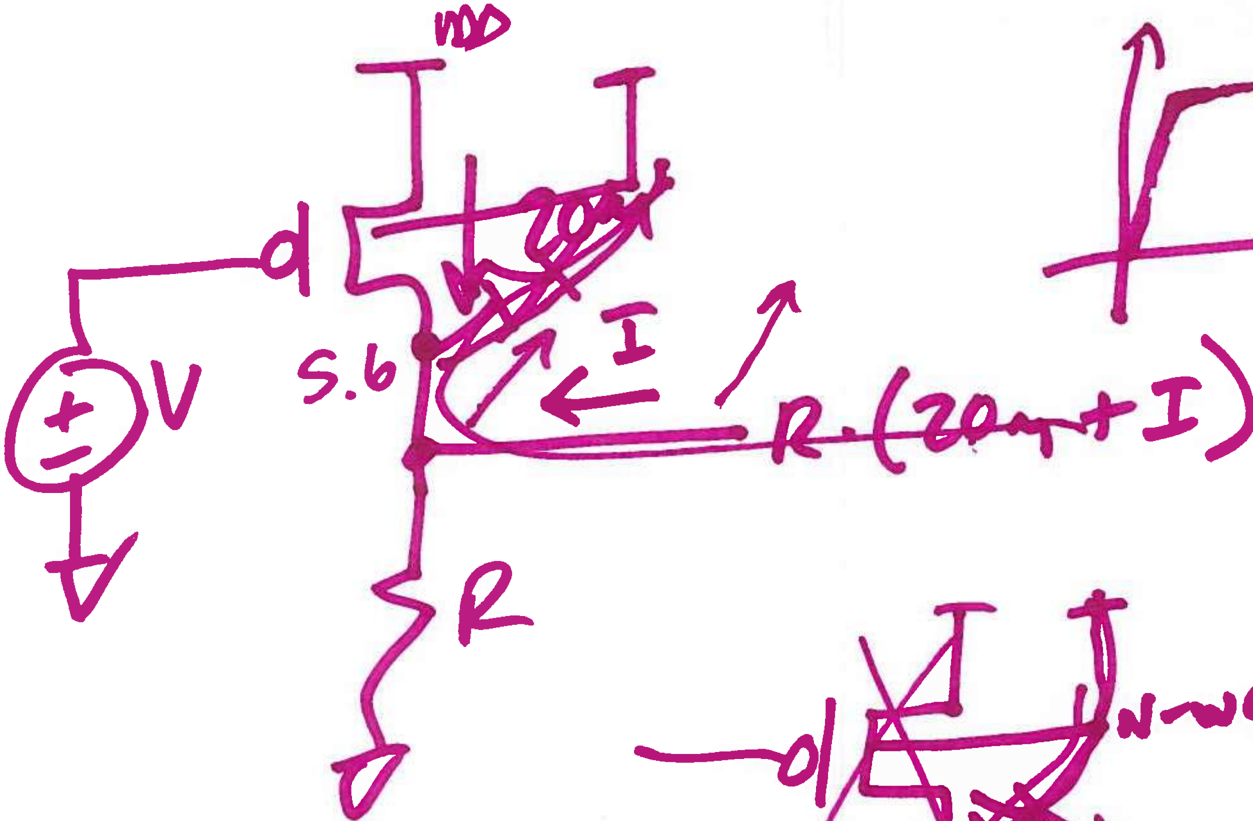
$$I_D = \frac{K_P}{2}\frac{W_P}{L_P}\left(V_{SG} - V_{THP}\right)^2\left(1 + \underbrace{\lambda}_{0.02 \cdot 2}\left(V_{SD} - V_{SD,SAT}\right)\right)$$

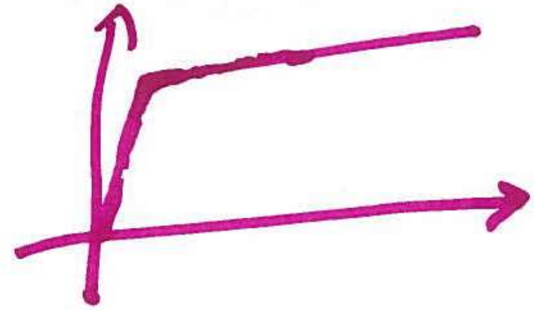
$V_{SG} > V_{THP}$

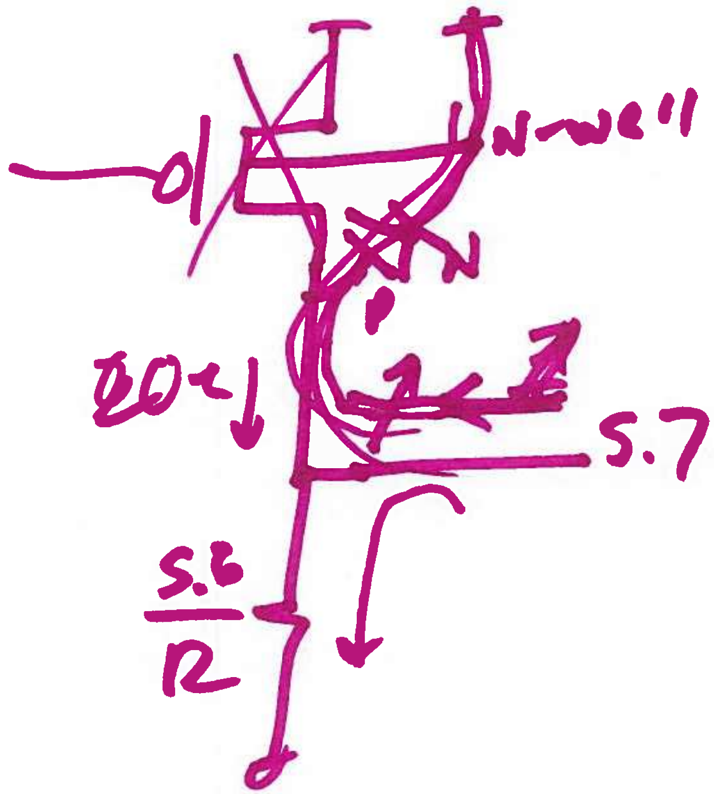
$V_{SD} \geq V_{SG} - V_{THP}$

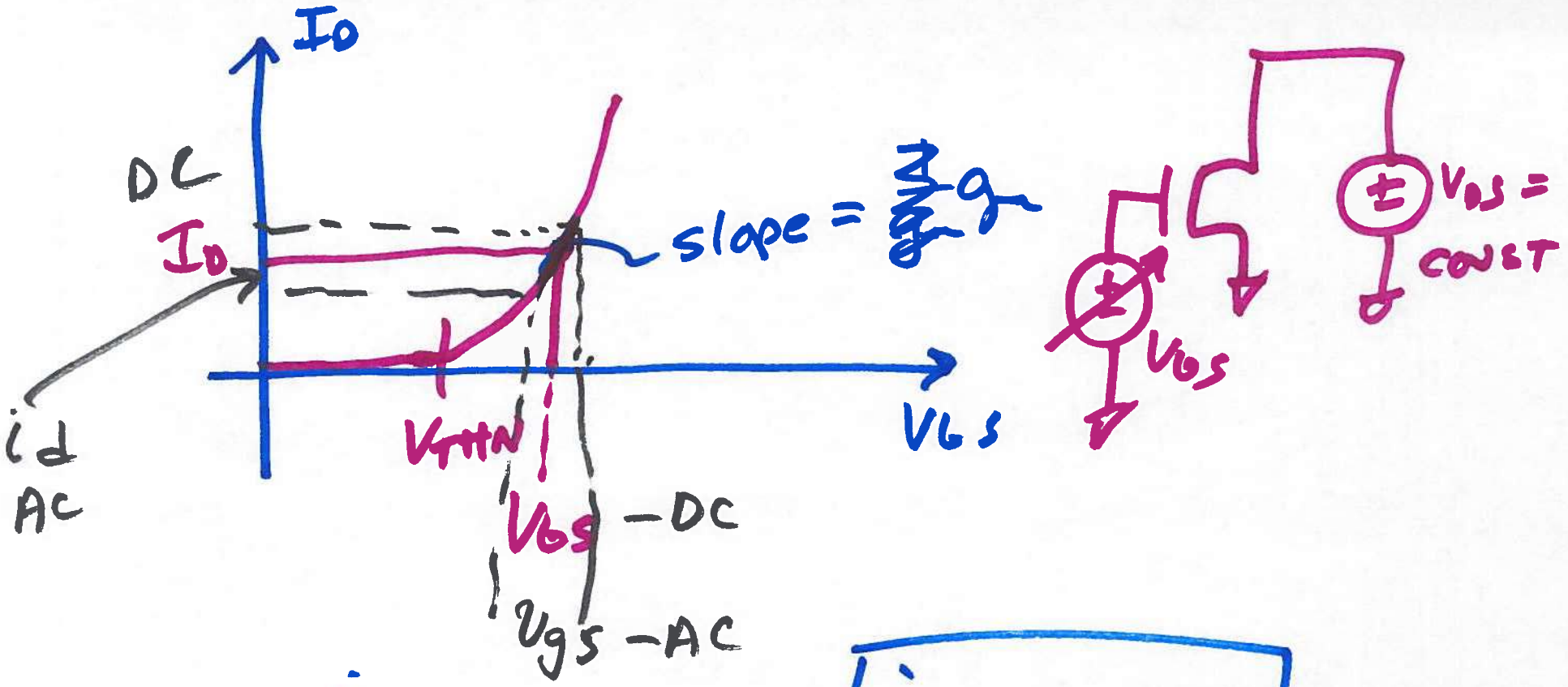
$.04 \cdot 12\mu = \frac{1}{2}\mu$


20μA
1μ → 10μ → 20μ
0V
1μ
20μ
20μ
30μ
19μ
10μ
VDD
S
G
D
NEG
POS
NEG
P+
P+
+5V
N-well
B
+5V
S
D
+
VSG
−
G


VDD
5.6
V
I
R
R·(20μ+I)

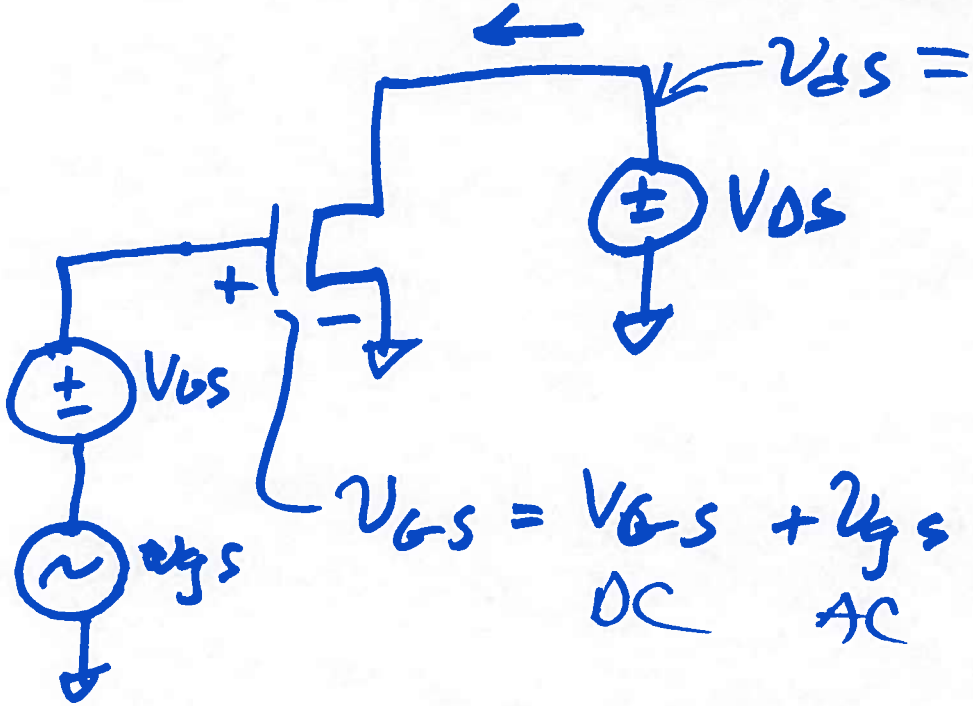



N-well
20μ
5.7
5.6/R

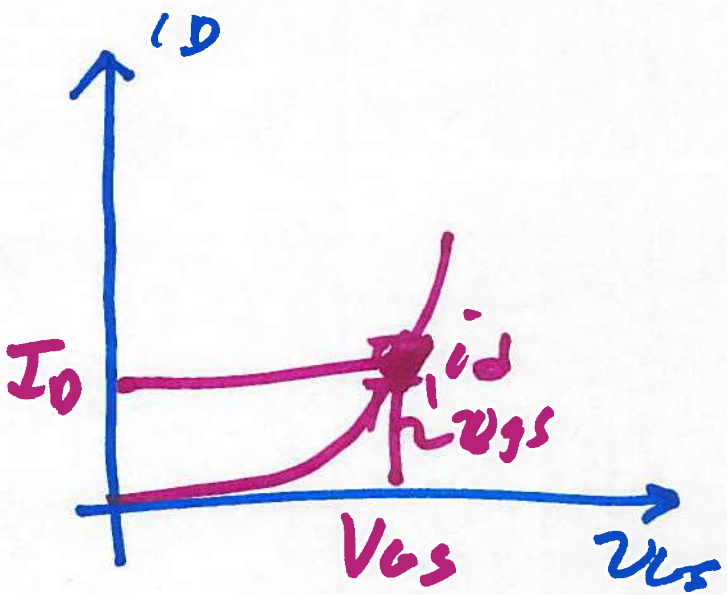


$$\frac{i_d}{v_{gs}} = g_m \rightarrow \boxed{i_d = g_m v_{gs}}$$

$i_D = i_d + I_D$ $\quad \beta_N = K_{PN} \cdot \frac{W}{L}$



$$i_D = \frac{\beta_N}{2}\left(v_{GS} - V_{THN}\right)^2$$



$$g_m \equiv \left.\frac{\delta i_D}{\delta v_{GS}}\right|_{\substack{I_D = \text{CONST} \\ V_{DS} = \text{CONST}}} = \frac{\delta}{\delta v_{GS}} \frac{\beta_N}{2}\left(\underbrace{V_{GS} + v_{gs}}_{v_{GS}} - V_{THN}\right)^2 \qquad (I_D + i_d)$$

DC AC

$$g_m = \beta_N\left(V_{GS} + v_{gs} - V_{THN}\right) \cdot 1$$

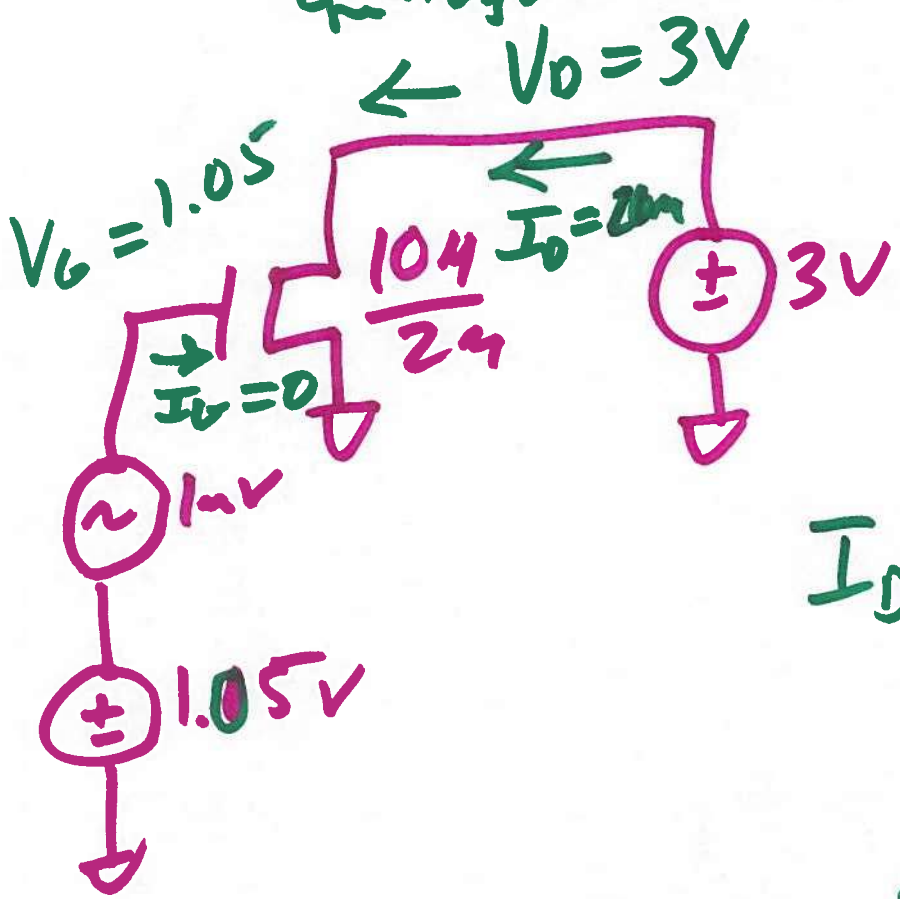
$$\simeq \beta_N\left(V_{GS} - V_{THN}\right)$$

$$g_m \approx \beta_N (V_{GS} - V_{THN})$$

$g_m \cdot v_{gs} = 150nA$

$V_{GS} >> v_{gs}$

SMALL-SIGNAL APPROXIMATION



$$I_D = \frac{120\mu}{2} \cdot \frac{10}{2} (1.05 - .8)^2$$

$$= 20\mu A$$

$$g_m = 120\mu \cdot \frac{10}{2} (1.05 - .8)$$

$$= 150\mu A/V$$