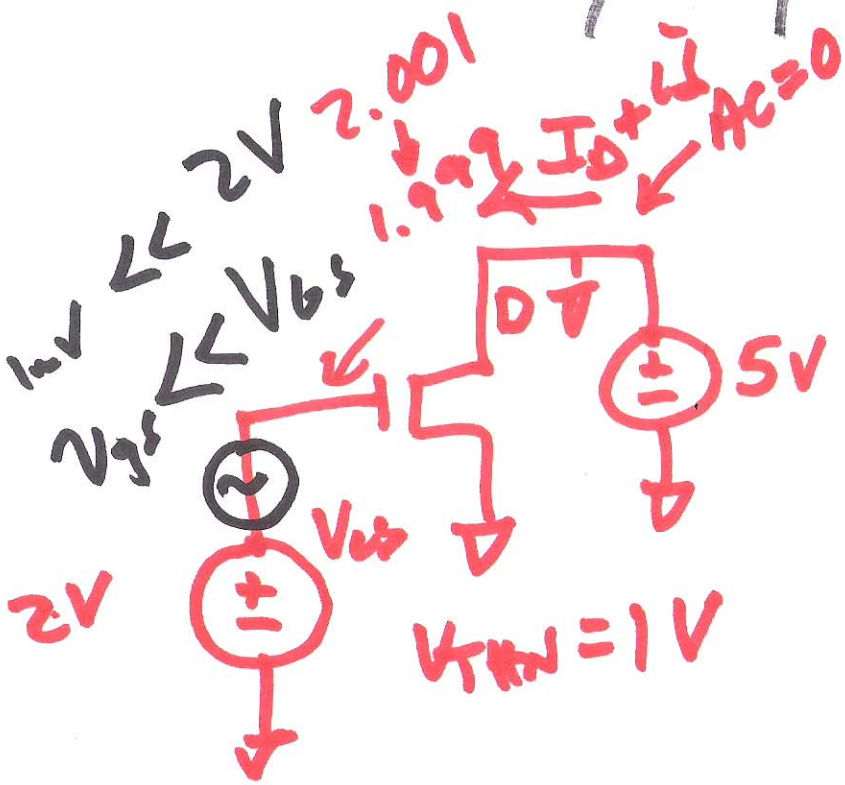
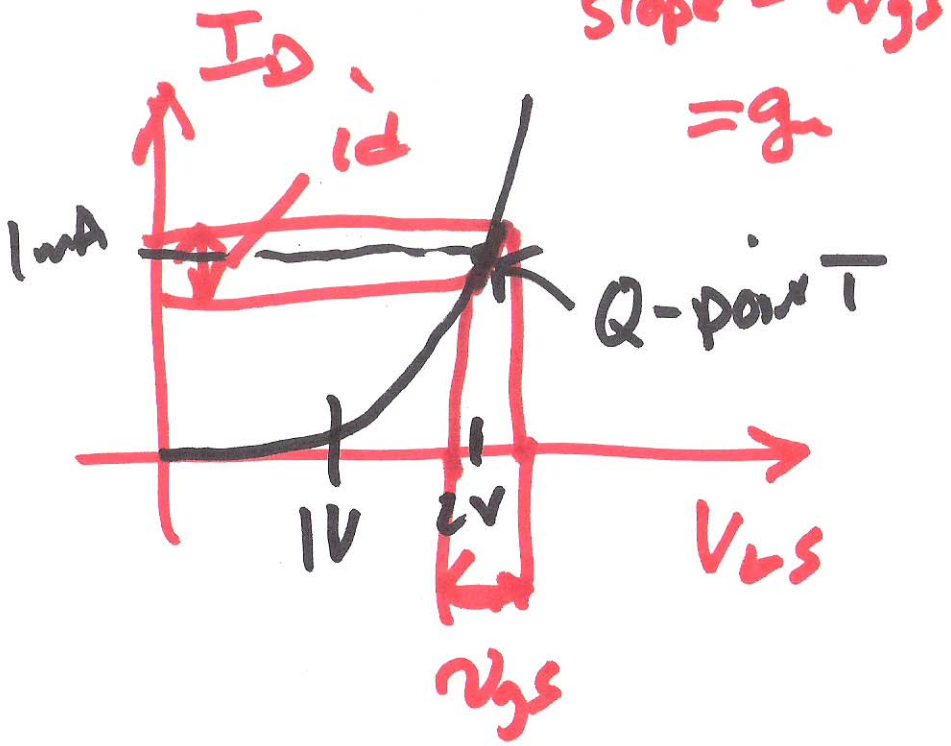
EE 320 Electronics I

3/24/14

Lecture 14

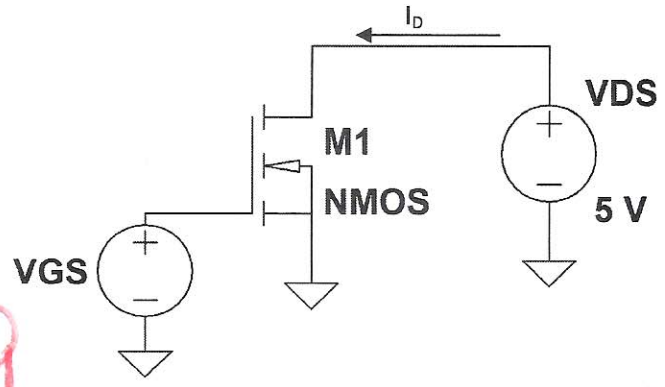


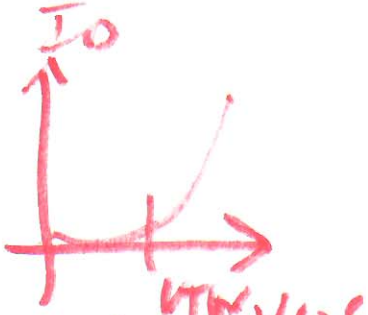


Quiz 7 EE 320 Electronics, Spring 2014 Name:_____

Closed book and notes.

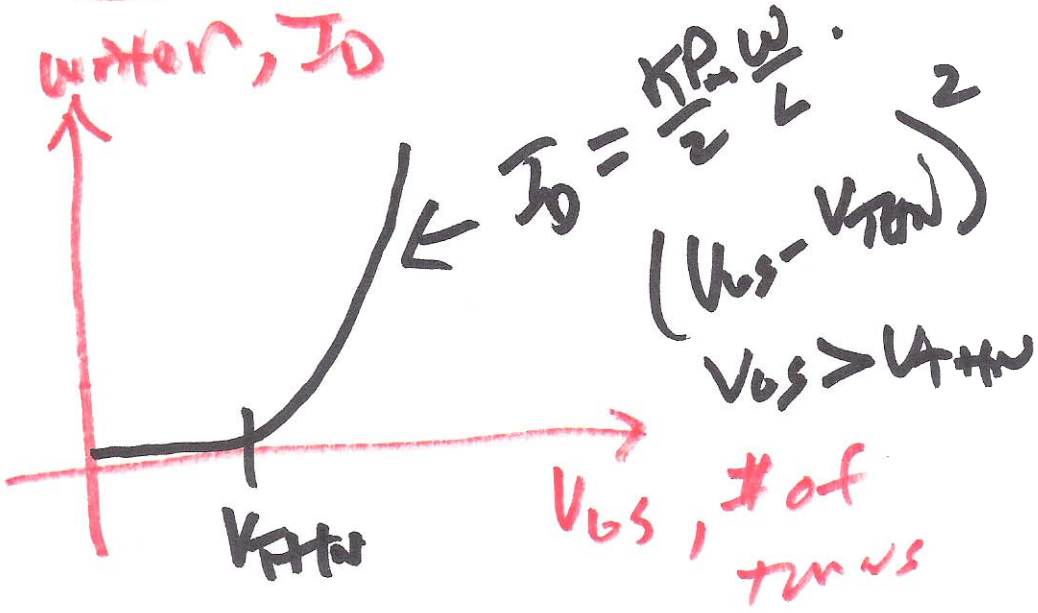
1. Sketch the drain current, I_D, against VGS in the following circuit. Assume the MOSFET's threshold voltage is 1 V (show the threshold voltage on your plot).



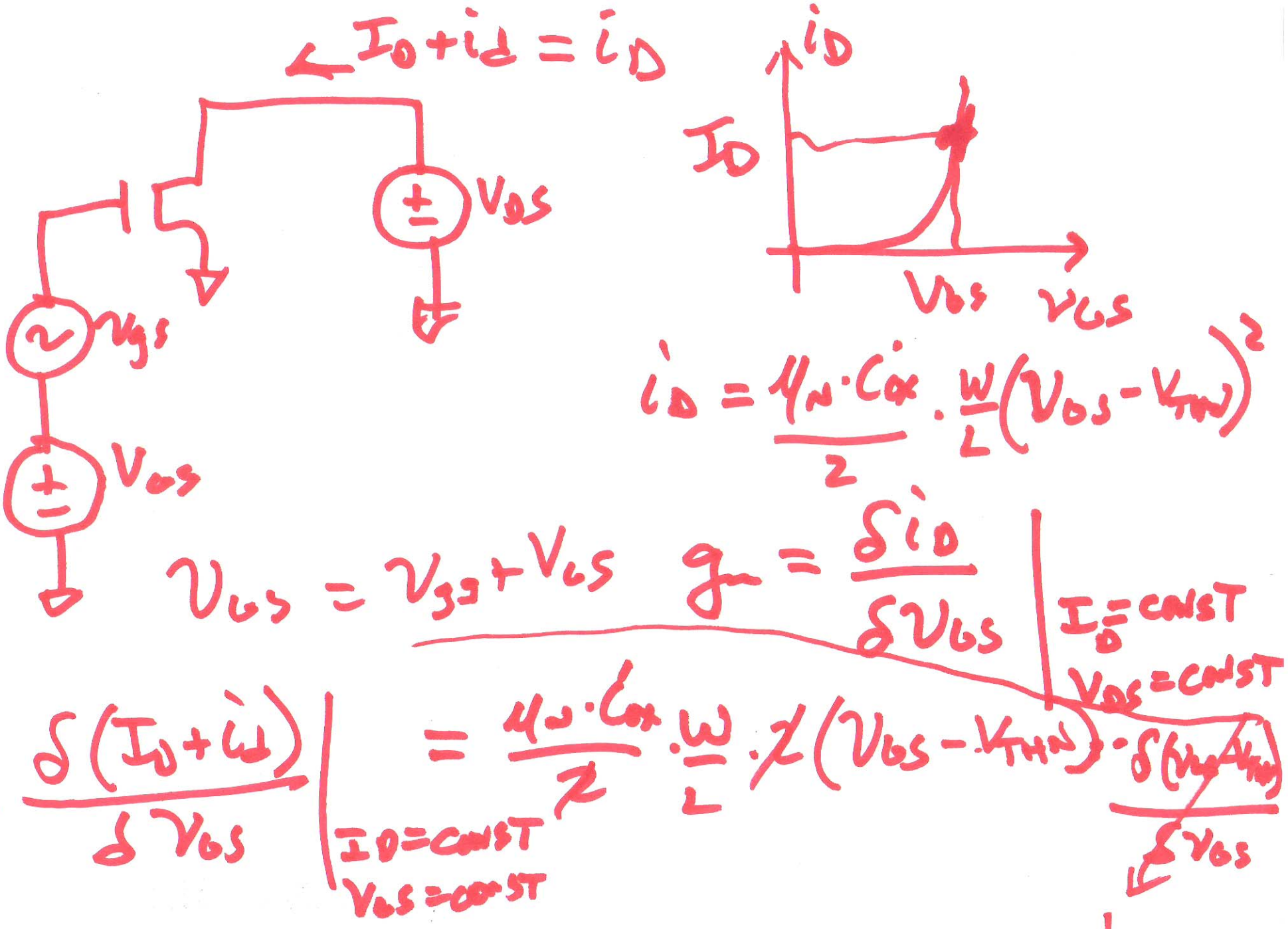


b.b

$K_N = K P_n \frac{W}{L}$



2)


$I_D + i_d = i_D$
V_{DS}
v_{gs}
V_{GS}
i_D
I_D
V_{GS}
V_{DS}
$i_D = \frac{\mu_n \cdot C_{ox}}{2} \cdot \frac{W}{L}(V_{GS} - V_{THN})^2$
$V_{GS} = v_{gs} + V_{GS}$
$g_m = \frac{\delta i_D}{\delta V_{GS}}\Big|_{\substack{I_D = CONST \\ V_{DS} = CONST}}$
$g_m = \frac{\delta (I_D + i_d)}{\delta V_{GS}}\Big|_{\substack{I_D = CONST \\ V_{DS} = CONST}} = \frac{\mu_n \cdot C_{ox}}{2} \cdot \frac{W}{L} \cdot 2(V_{GS} - V_{THN}) \cdot \frac{\delta (V_{GS} - V_{THN})}{\delta V_{GS}}$
1

$$g_m = \mu_n \cdot C'_{ox} \cdot \frac{W}{L}\left(V_{GS} + v_{gs} - V_{THN}\right)$$

$V_{GS} \gg v_{gs}$ Small-signal

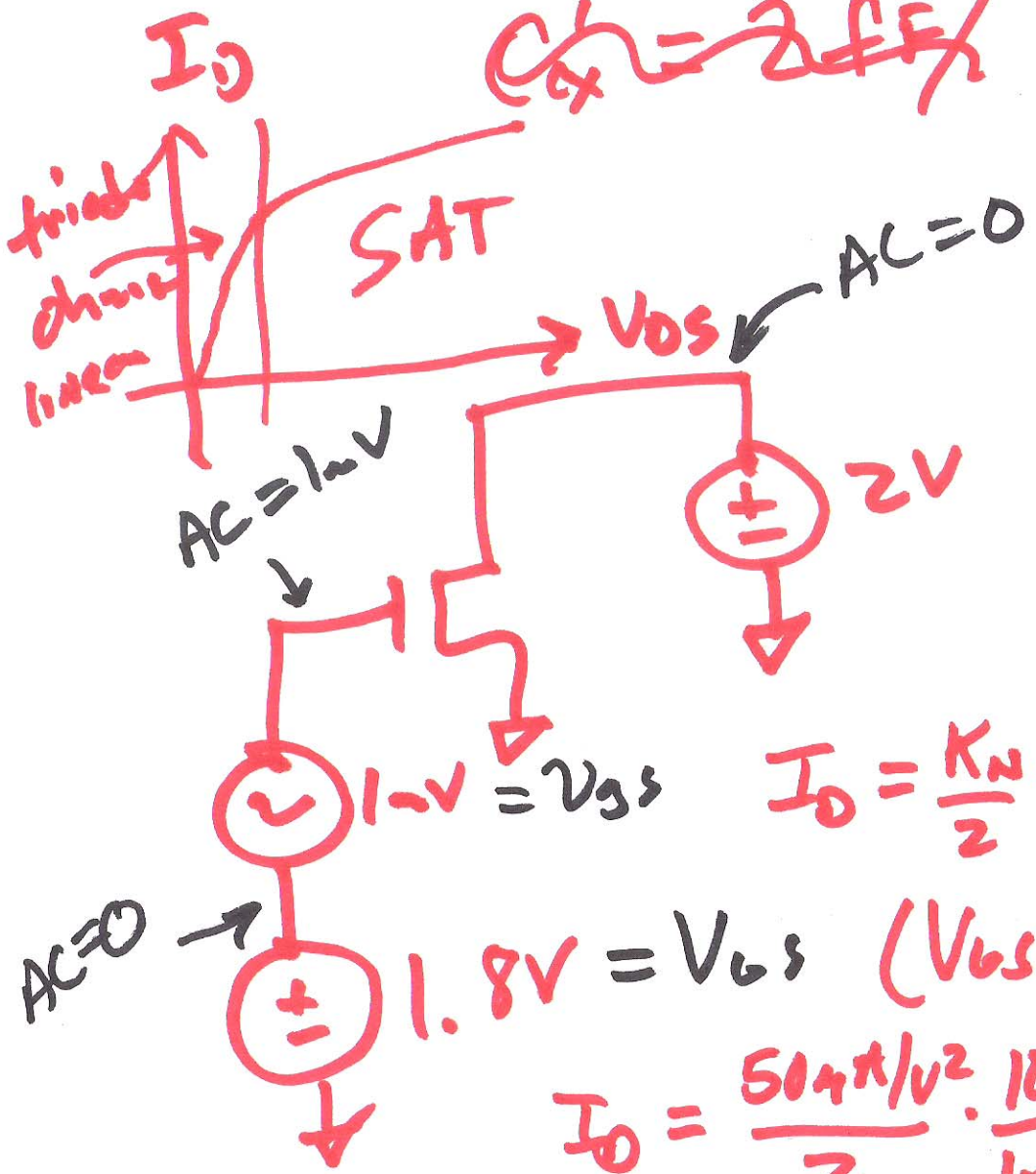
$$\boxed{g_m \approx \mu_n C'_{ox} \frac{W}{L}\left(V_{GS} - V_{THN}\right)}$$

$$I_D = \frac{\mu_n C'_{ox}}{2} \cdot \frac{W}{L}\left(V_{GS} - V_{THN}\right)^2$$

$$V_{GS} - V_{THN} = \sqrt{\frac{2 I_D \cdot L}{\mu_n C'_{ox} \cdot W}}$$

$$\boxed{g_m = \sqrt{2 \cdot \mu_n C'_{ox} \cdot \frac{W}{L} I_D}}$$

$W = 10\mu \quad L = 1\mu$



$C_{ox} = 2fF/\mu$

$K_N = 50\mu A/V^2 = \mu_n C_{ox}$

$V_{THN} = 0.8V$

find all AC & DC voltages & currents for saturation

$V_{GS} \geq V_{THN}$

$V_{DS,} \geq V_{GS} - V_{THN}$

$I_D = \frac{K_N}{2} \cdot \frac{W}{L} (V_{GS} - V_{THN})^2$

$I_D = \frac{50\mu A/V^2}{2} \cdot \frac{10\mu}{1\mu} (1.8 - 0.8)^2$

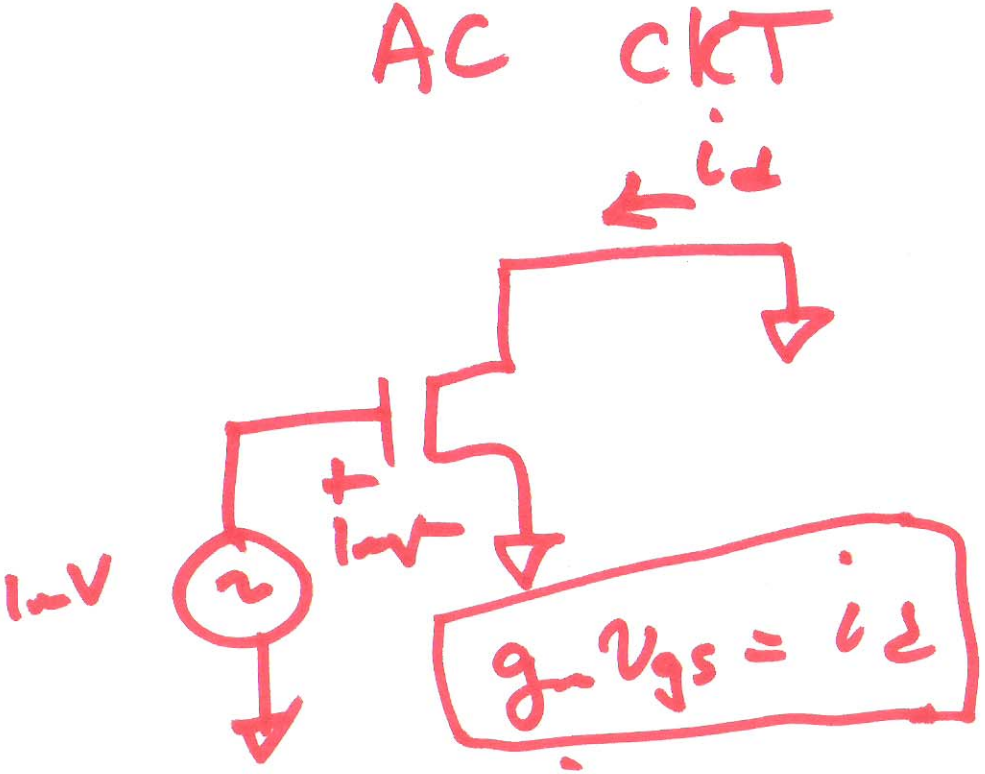
$2.2 \geq 1.8 - .8$ yes!

$I_D = 250\mu A$

in saturation!

5)

AC CKT



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

$$i_d = 500\mu A \cdot 1mV$$

$$= 500nA$$

$KP_N = 50\mu A/V^2$

$W = 10\mu m$

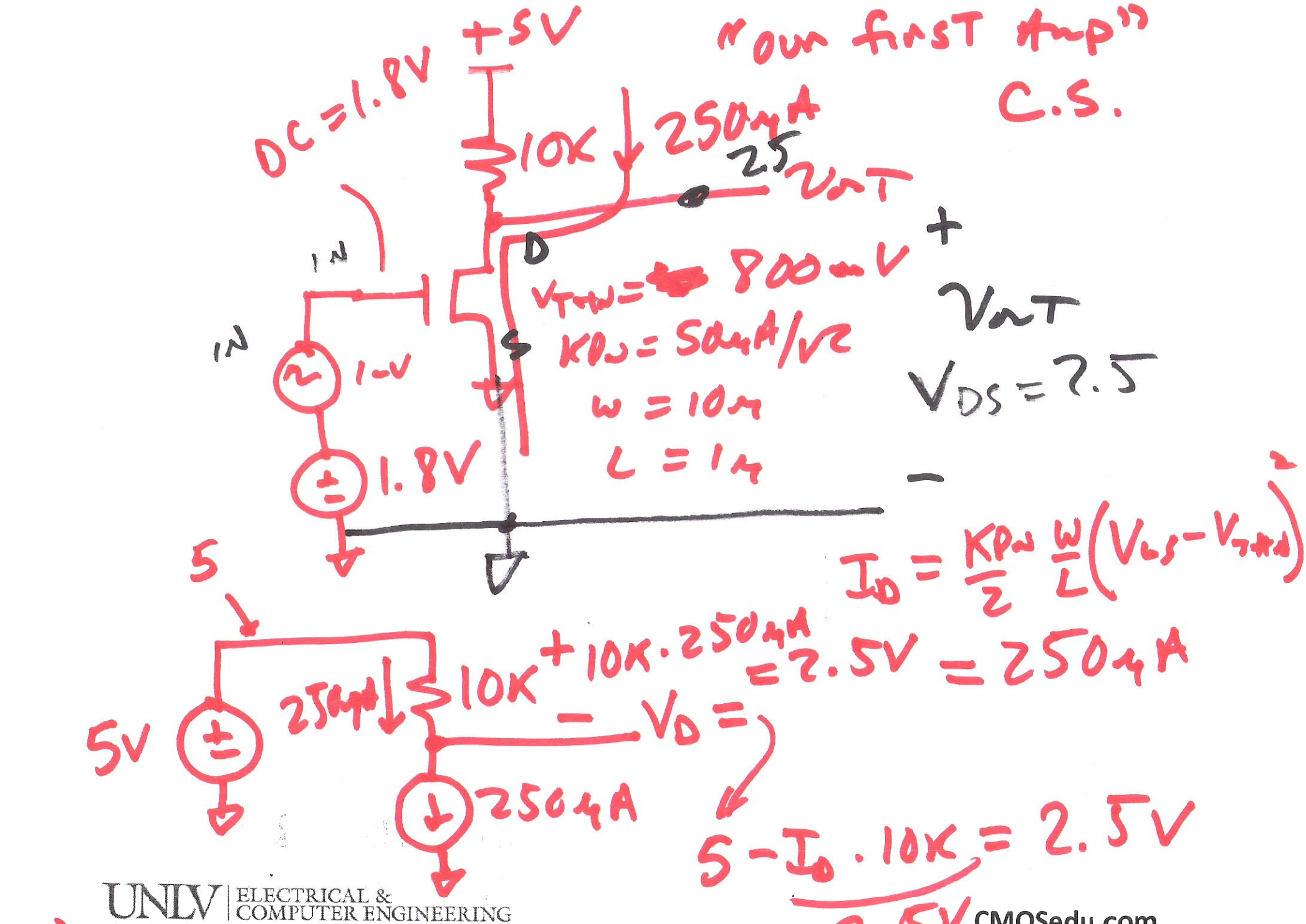
$L = 1\mu m$

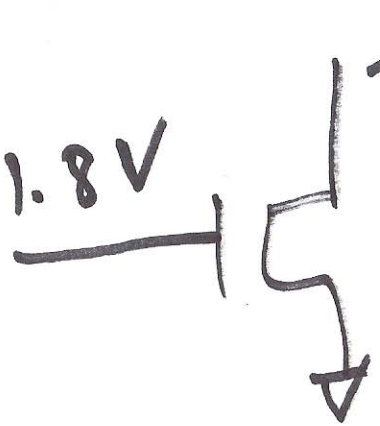
$I_D = 250\mu A$

$$g_m = KP \cdot \frac{W}{L}(V_{GS} - V_{TH})$$

$$= \frac{50\mu A}{V^2} \cdot \frac{10}{1}(1)^2 V^2$$

$$g_m = 500\frac{\mu A}{V}$$


"our first Amp"
C.S.
+5V
DC=1.8V
10K
250μA
25
VOUT
D
IN
IN
1mV
1.8V
S
VTHN= 800mV
KPN = 50μA/V²
W = 10μ
L = 1μ
+
VOUT
VDS = 2.5
−
5
5V
25μA
10K
10K·250μA
=2.5V
=250μA
VD =
250μA
5 − ID · 10K = 2.5V
2.5V
ID = KPN/2 W/L (VGS − VTHN)²



$V_{GS} > V_{THN}$?

$1.8 \geq .8$? yes!

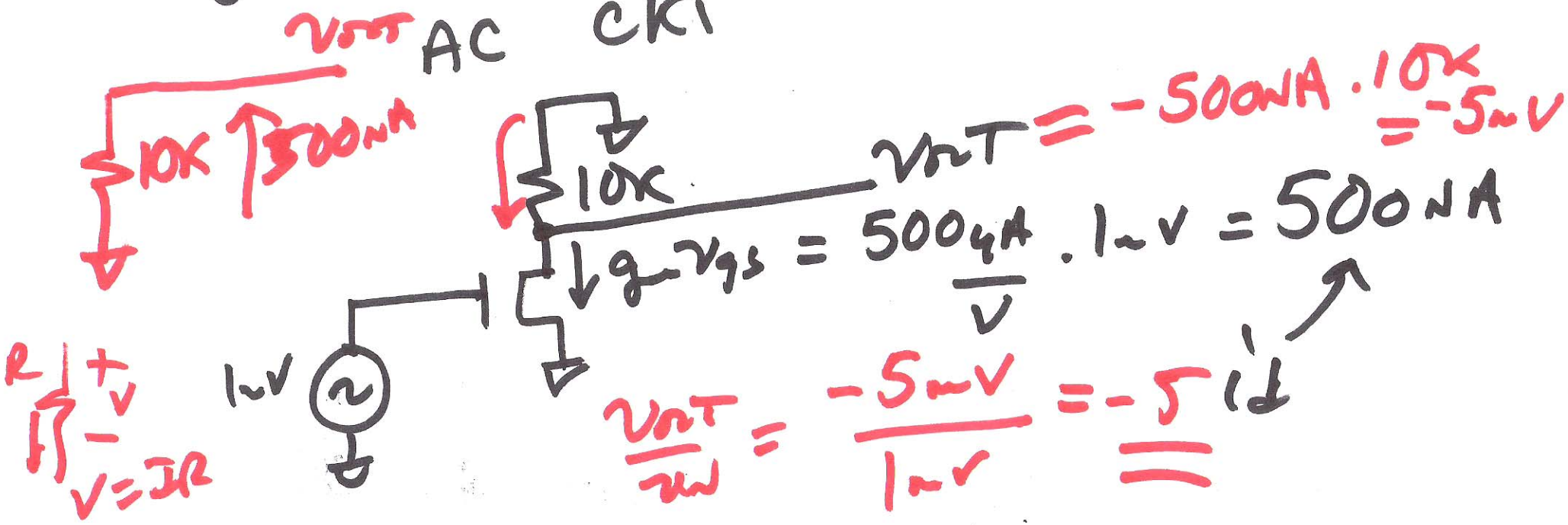
$V_{DS} \geq V_{GS} - V_{THN}$?

$2.5 \geq 1.8 - .8$?

yes!

$g_m = 500\,\mu A/V$

AC CKT



8)