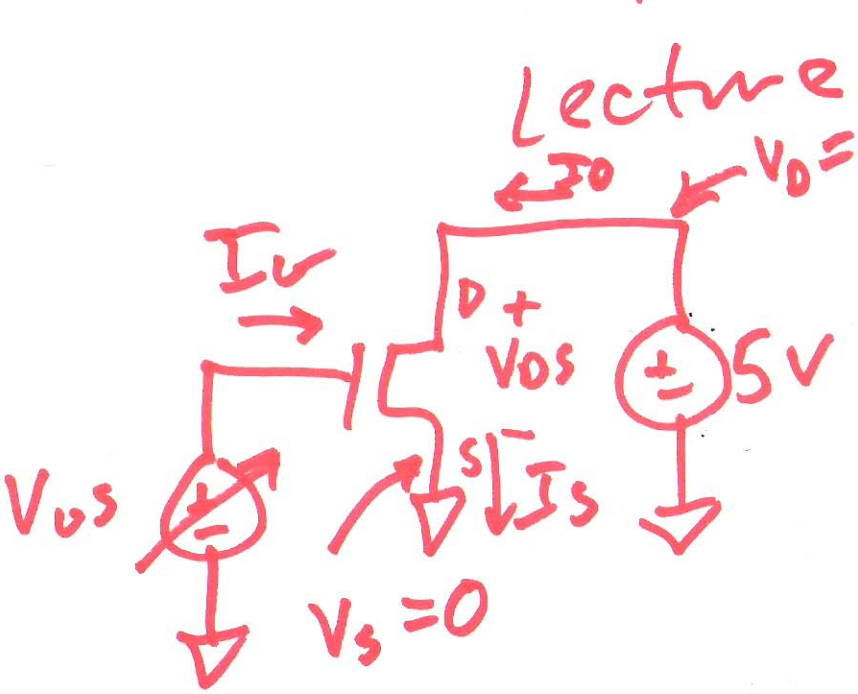
EE 320 Electronics I

3/26/14

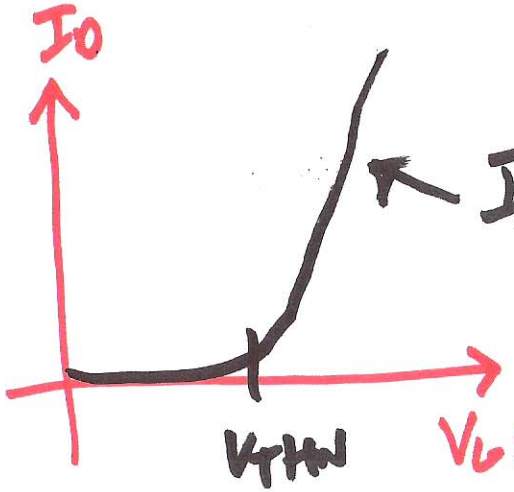
Lecture 15



$V_D - V_S = V_{DS} = 5 - 0$

$V_G - V_S = V_{GS}$

$I_D = I_S$, $I_G = 0$



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

$V_{GS} > V_{THN}$

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

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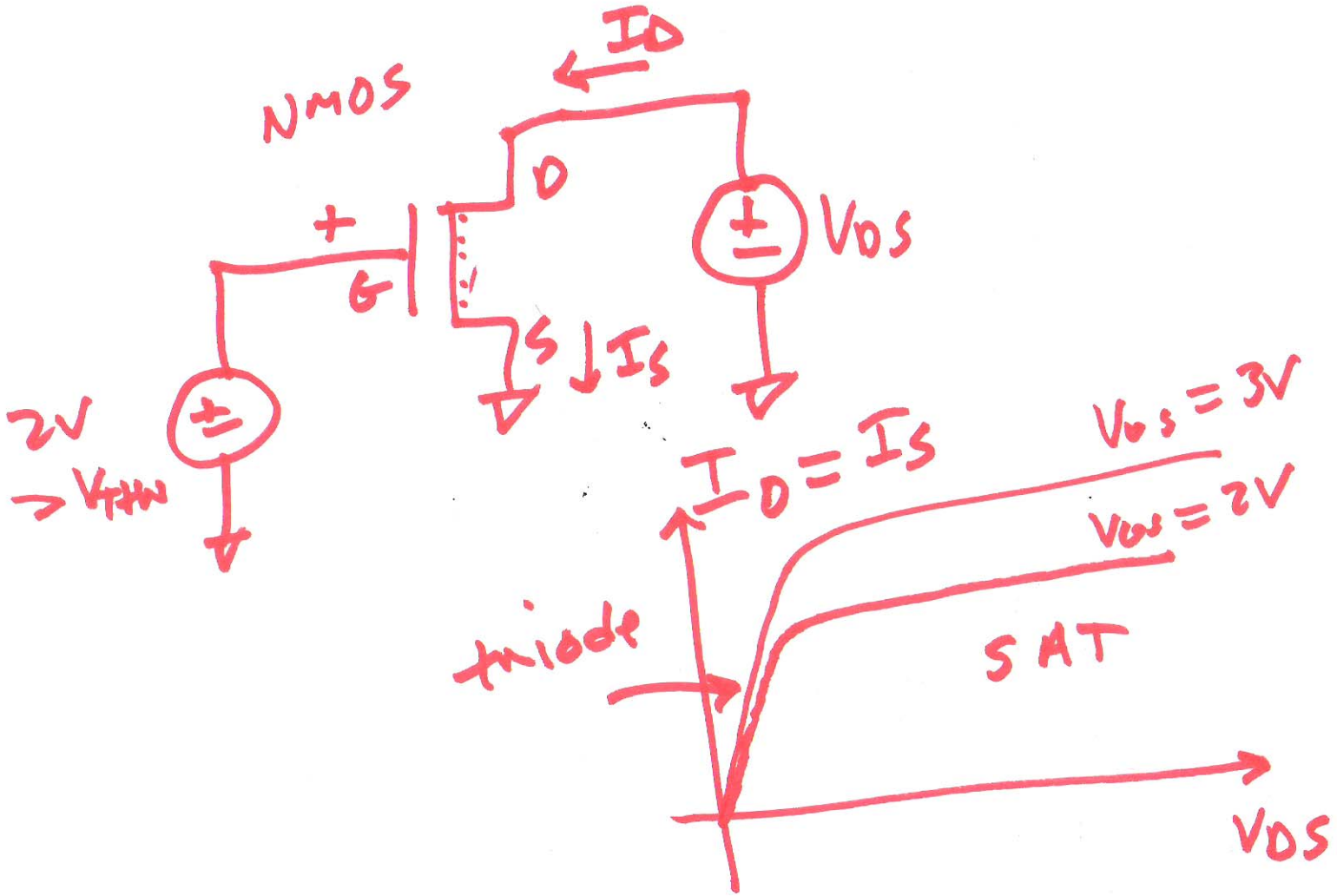
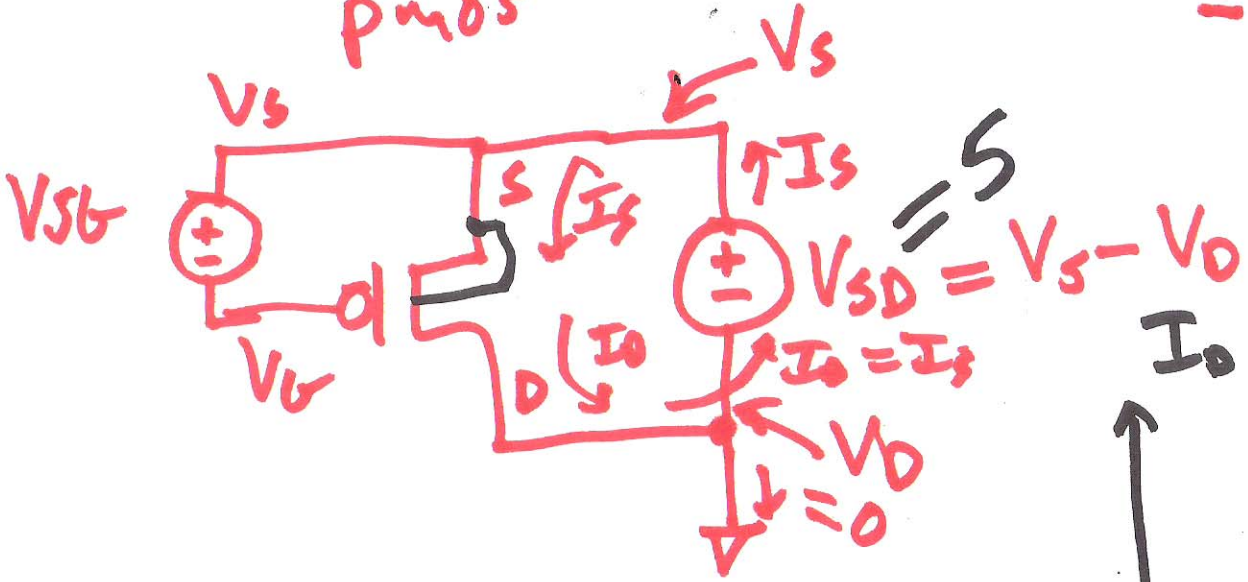
for SAT!

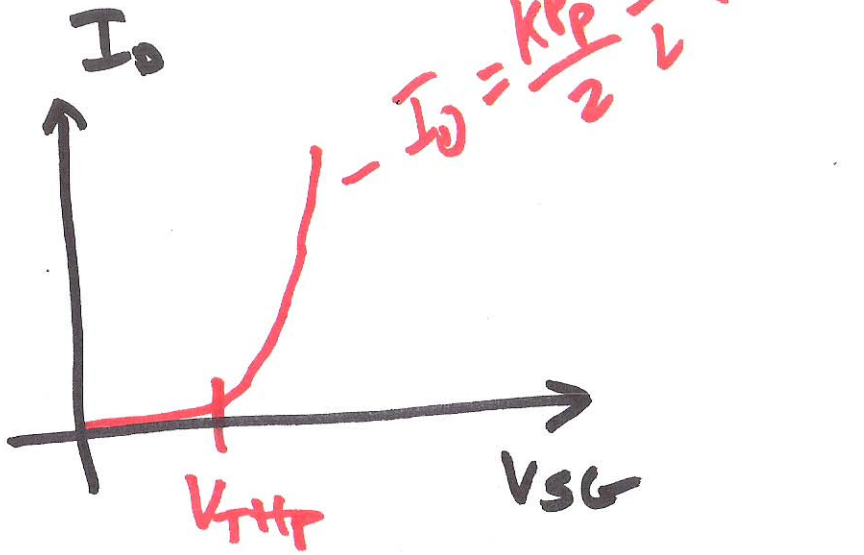

NMOS
ID
D
+
G
S
IS
VDS
2V
> Vtn
ID = IS
VDS = 3V
VDS = 2V
triode
SAT
VDS

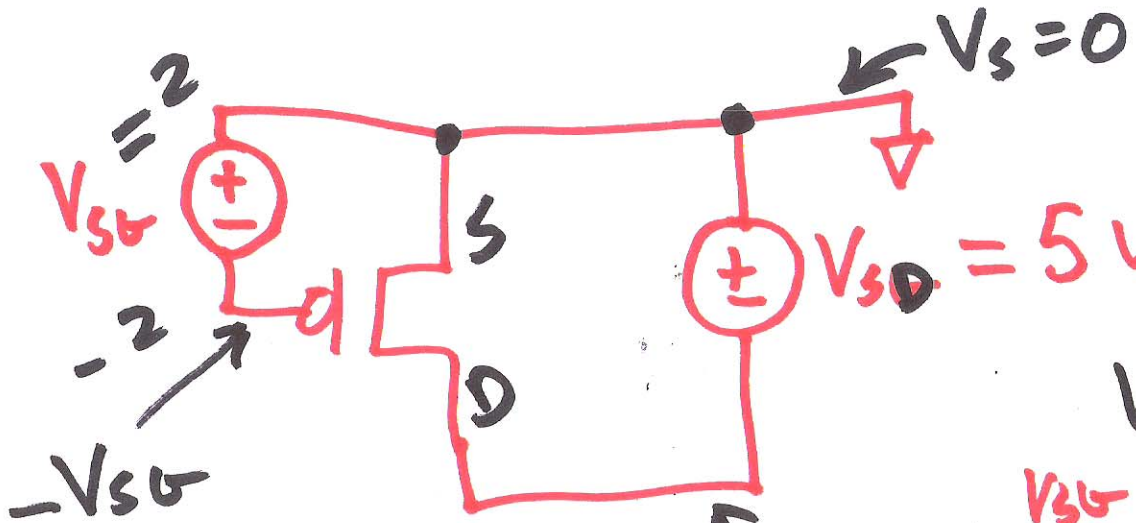
Complimentary CMOS

pMOS

$-V_{GS} = V_{SG}$





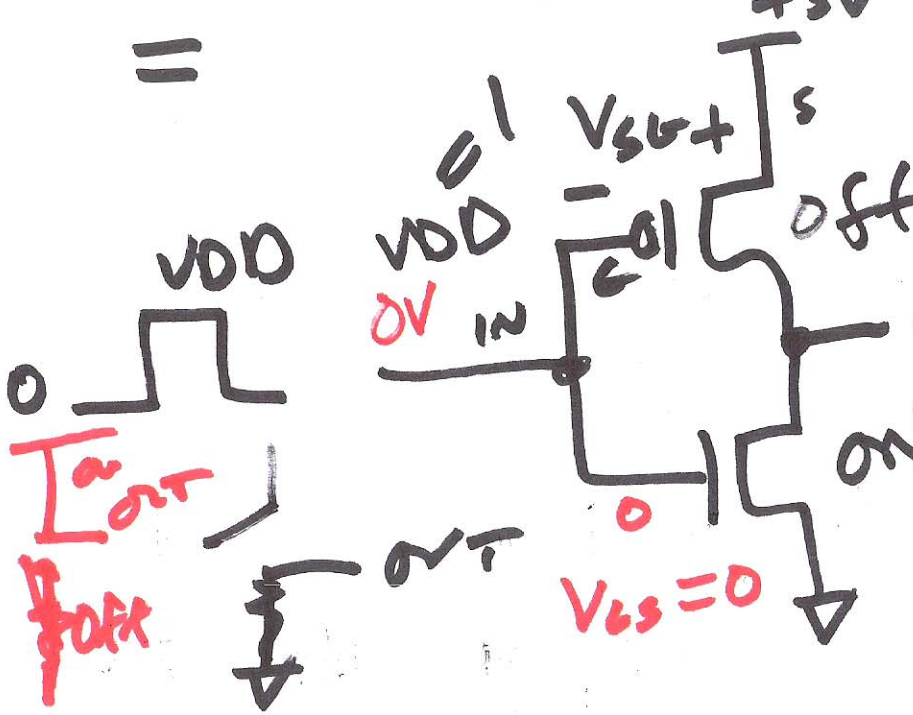


$V_{SD} = 0 - (-5) = +5V$

$V_{SG} = V_S - V_G = 5 - 0 = 5V$

$V_S - V_G = V_{SG} = -V_G = -5 = V_D$

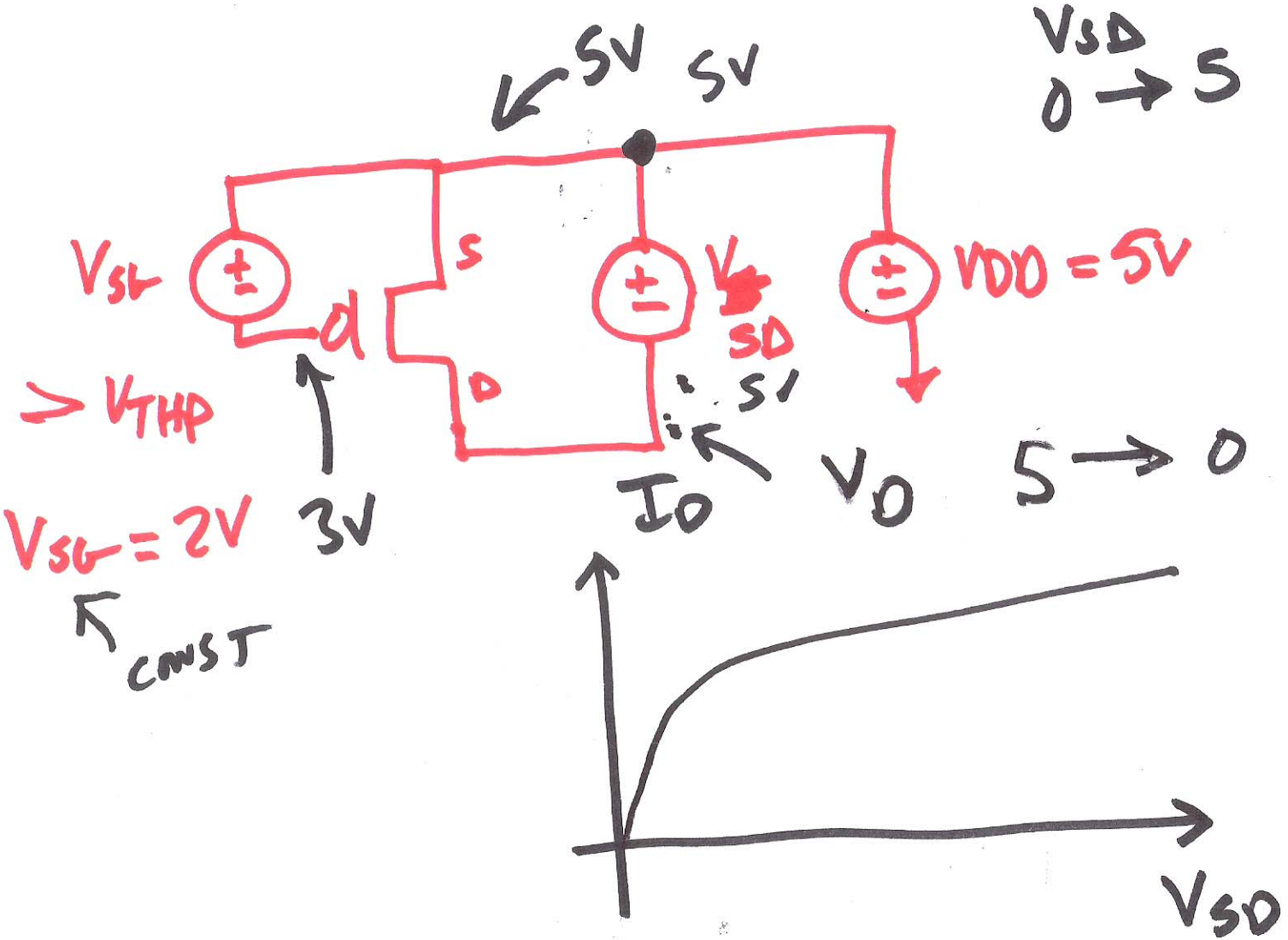
$V_S - V_G = 5 - 5 = 0$



$OUT = VDD$

$OUT = 0 = gnd$

$V_{GS} = VDD - 0 = VDD$

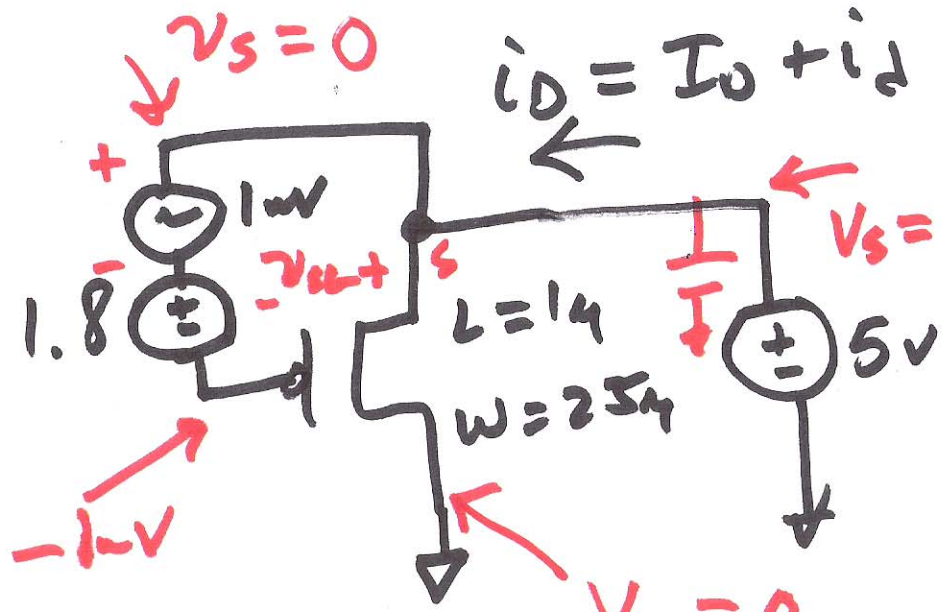

5V
5V
VSD
0 → 5
VSG
> VTHP
VSG = 2V
CONST
3V
S
D
VSD
S1
VDD = 5V
ID
VD
5 → 0
VSD

$V_S = 5$

$5 - 1.8 = 3.2$

$= V_G$

$V_S - V_G = 1.8$



$KP_p = 20\,\mu A/V^2$

$V_{THP} = .8$

$V_{SD} = V_S - V_D = 5V$

$V_{SG} = V_S - V_G = 3.2$

$5 - 1.8 = 3.2$

$v_s - v_g = 0 - (-1mV)$

$v_{sg} = 1mV$

$I^2 = 1V^2$

$V_{SG} > V_{THP}$

$3.2 > .8$?

$3.2 - .8 \geq V_{SG} - V_{THP}$

yes

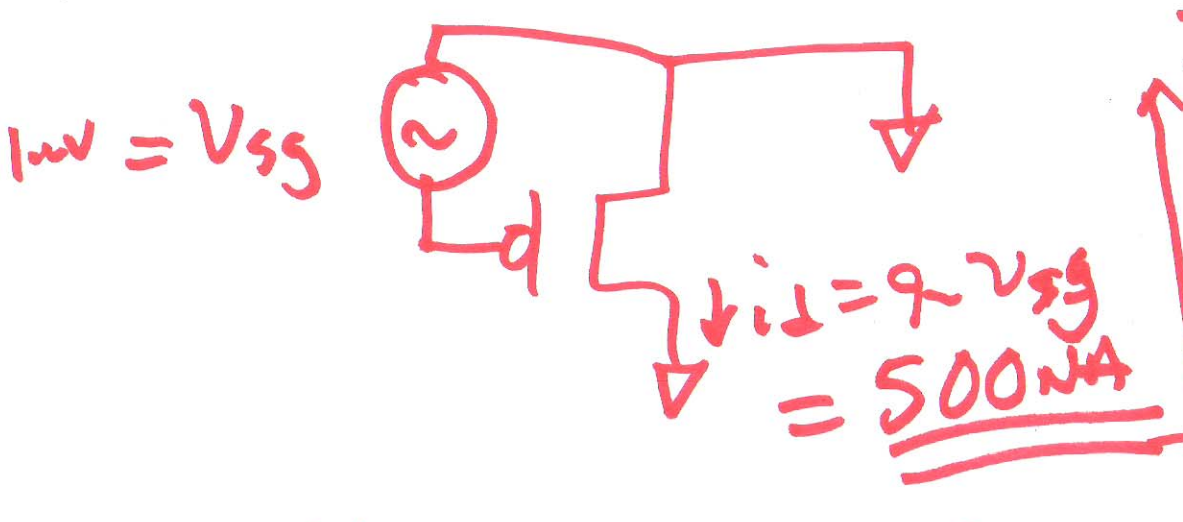
yes

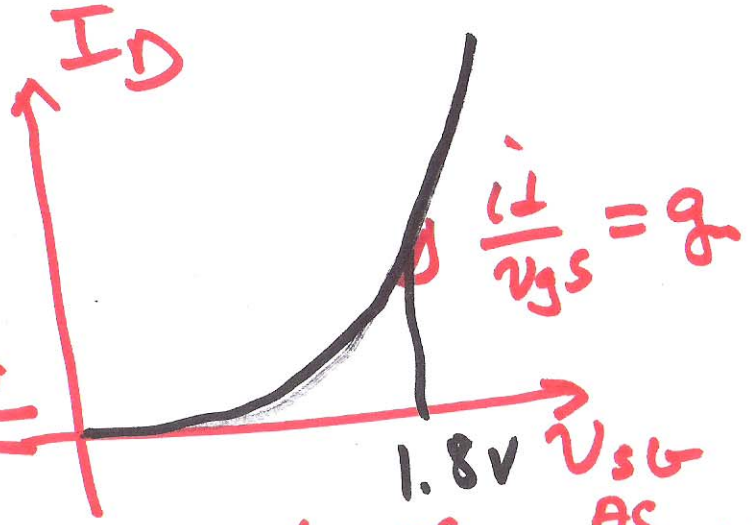
$I_D = \frac{KP}{2} \cdot \frac{W}{L} (1.8 - .8)^2$

$= \frac{20\mu \frac{A}{V^2}}{2} \cdot \frac{25}{1}$

V_{SG} V_{THP} V_{SD} 5

$I_D = 250\,\mu A$





$$g_m = \left.\frac{\delta i_D}{\delta v_{SG}}\right|_{\substack{I_D=\text{CONST}\\ V_{DS}=\text{CONST}}} = \frac{\delta}{\delta v_{SG}} \frac{K_P}{2}\frac{W}{L}\left(\underbrace{V_{SG}}_{DC} + \underbrace{v_{sg}}_{AC} - V_{THp}\right)^2$$

$$v_{SG}$$

$$20\mu \cdot \frac{25}{1}(1.8-.8)^1 = g_m = K_P \cdot \frac{W}{L}\left(V_{SG} + v_{sg} - V_{THp}\right)\cdot 1$$

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

$$g_m = K_P \cdot \frac{W}{L}\left(V_{SG} - V_{THp}\right)$$

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