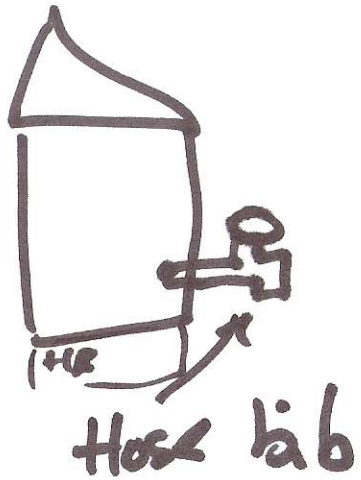
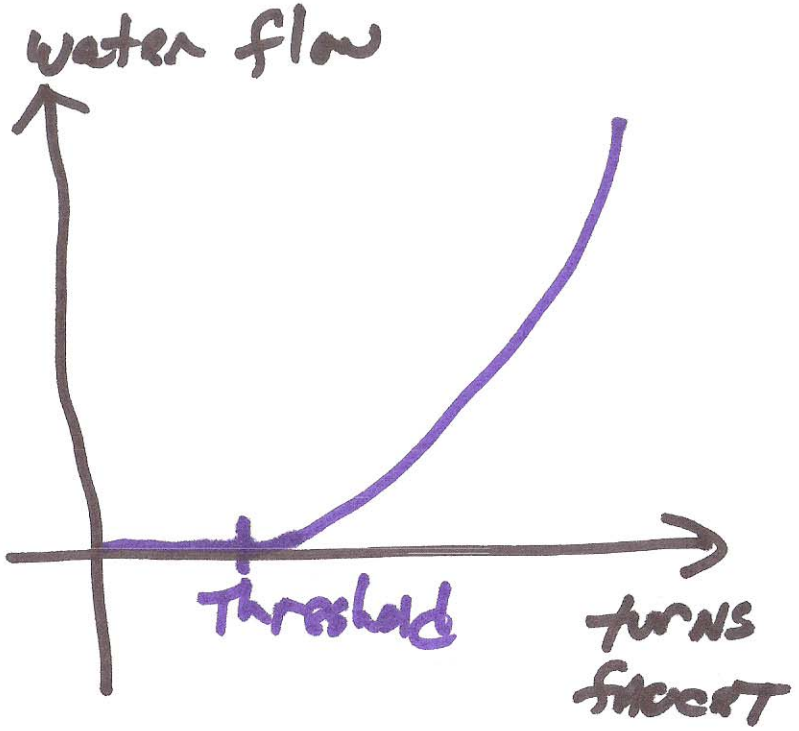
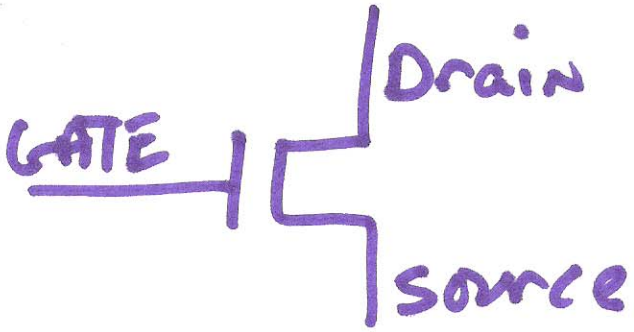
EE 320
Electronics
MARCH 18, 2015
Lecture 17





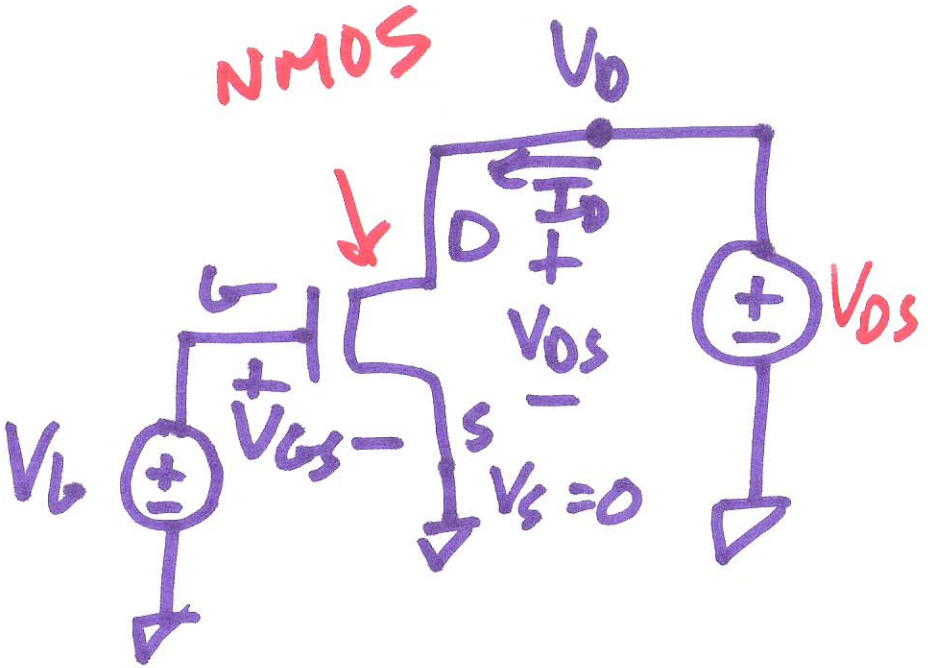
MOSFET

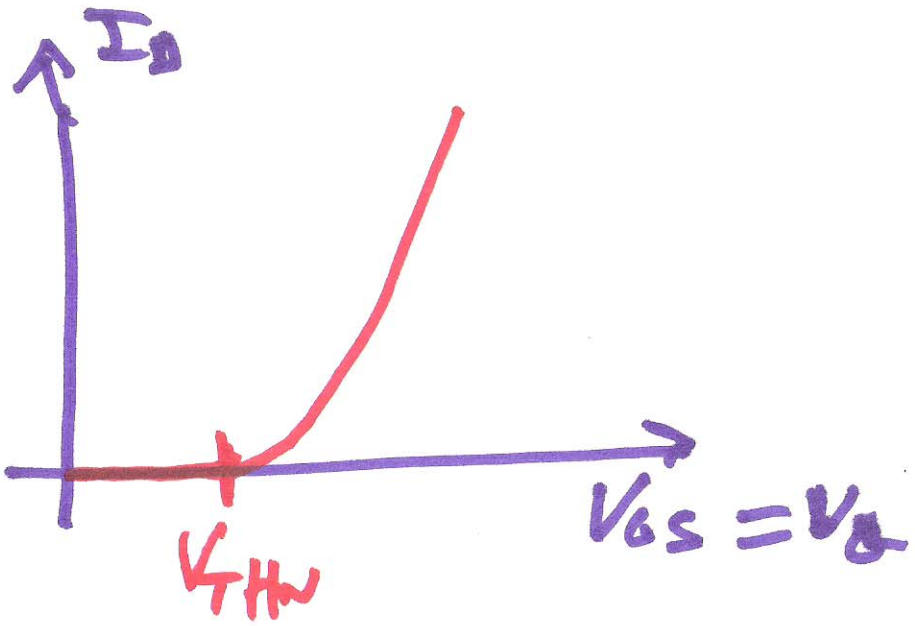
metal oxide field effect transistor

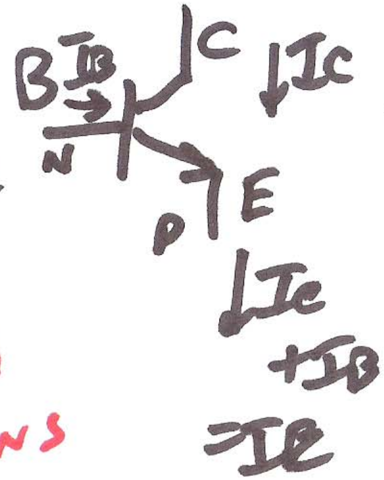


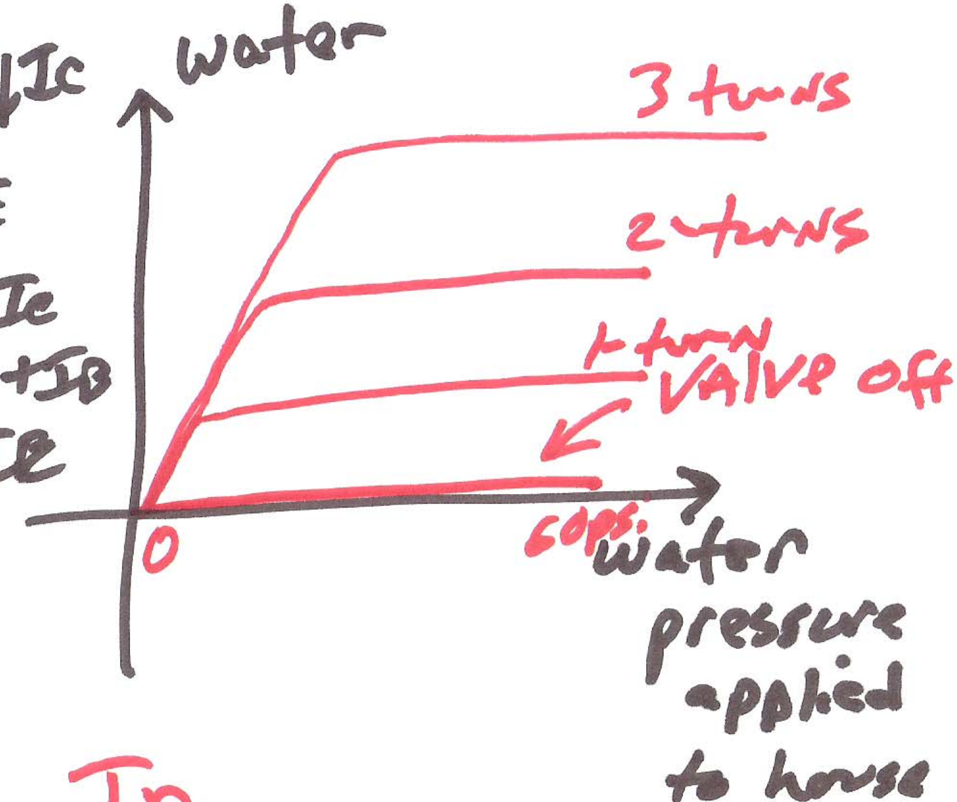
$V_{GS} = V_G - V_S = V_G$

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





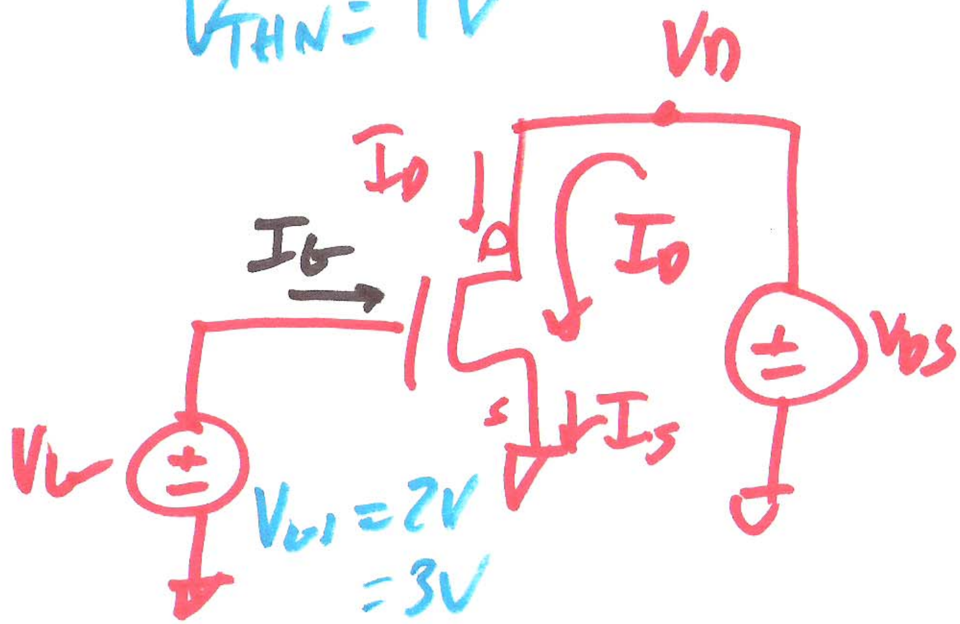


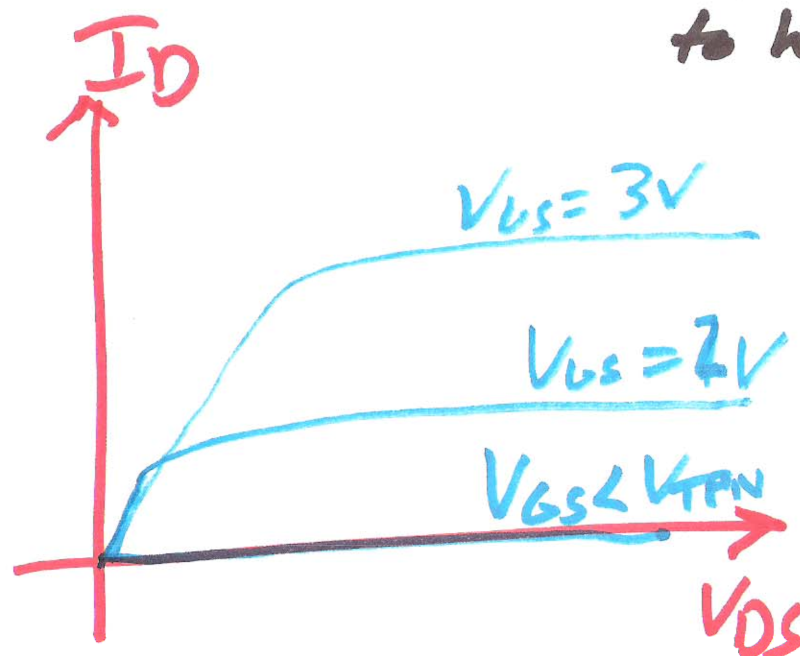


$2^{15} = 32K$

1-turn
2-turns
3-turns

$V_{THN} = 1V$



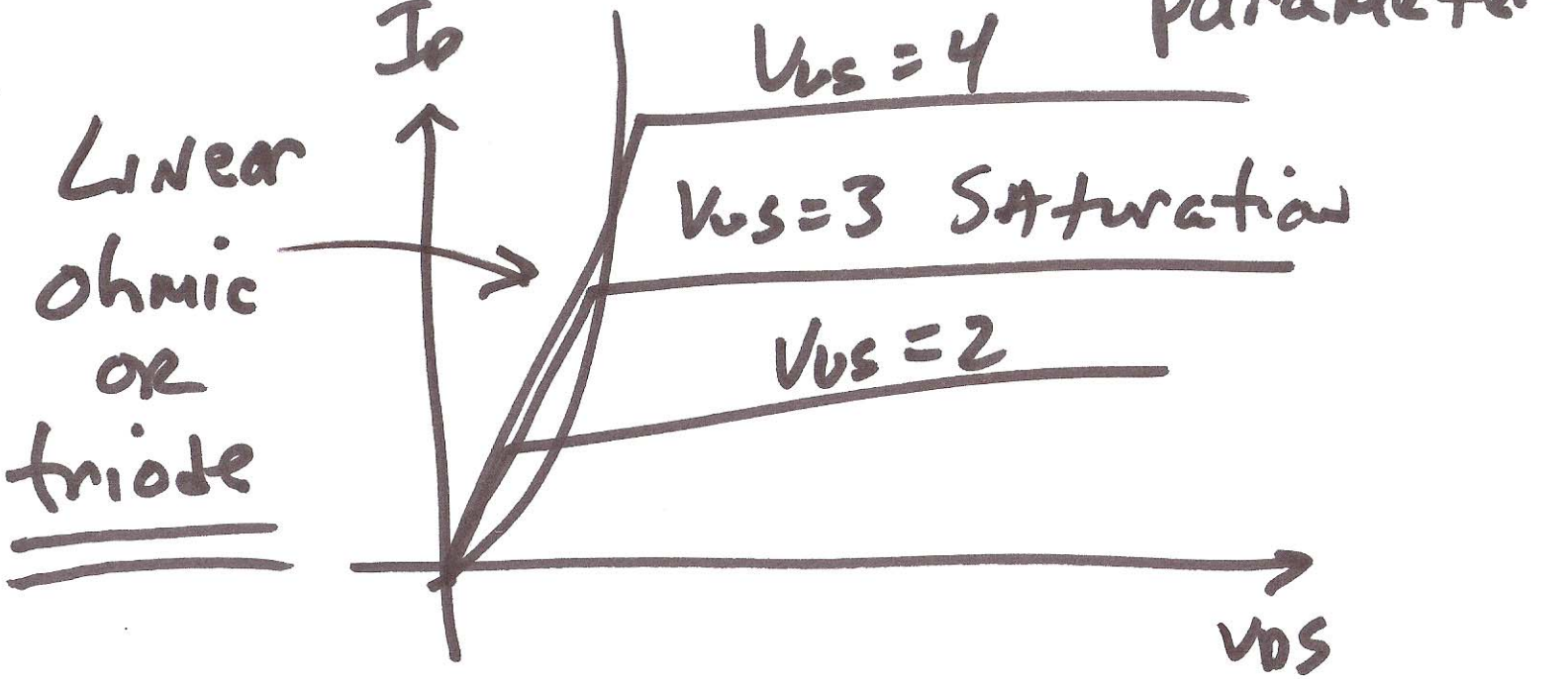


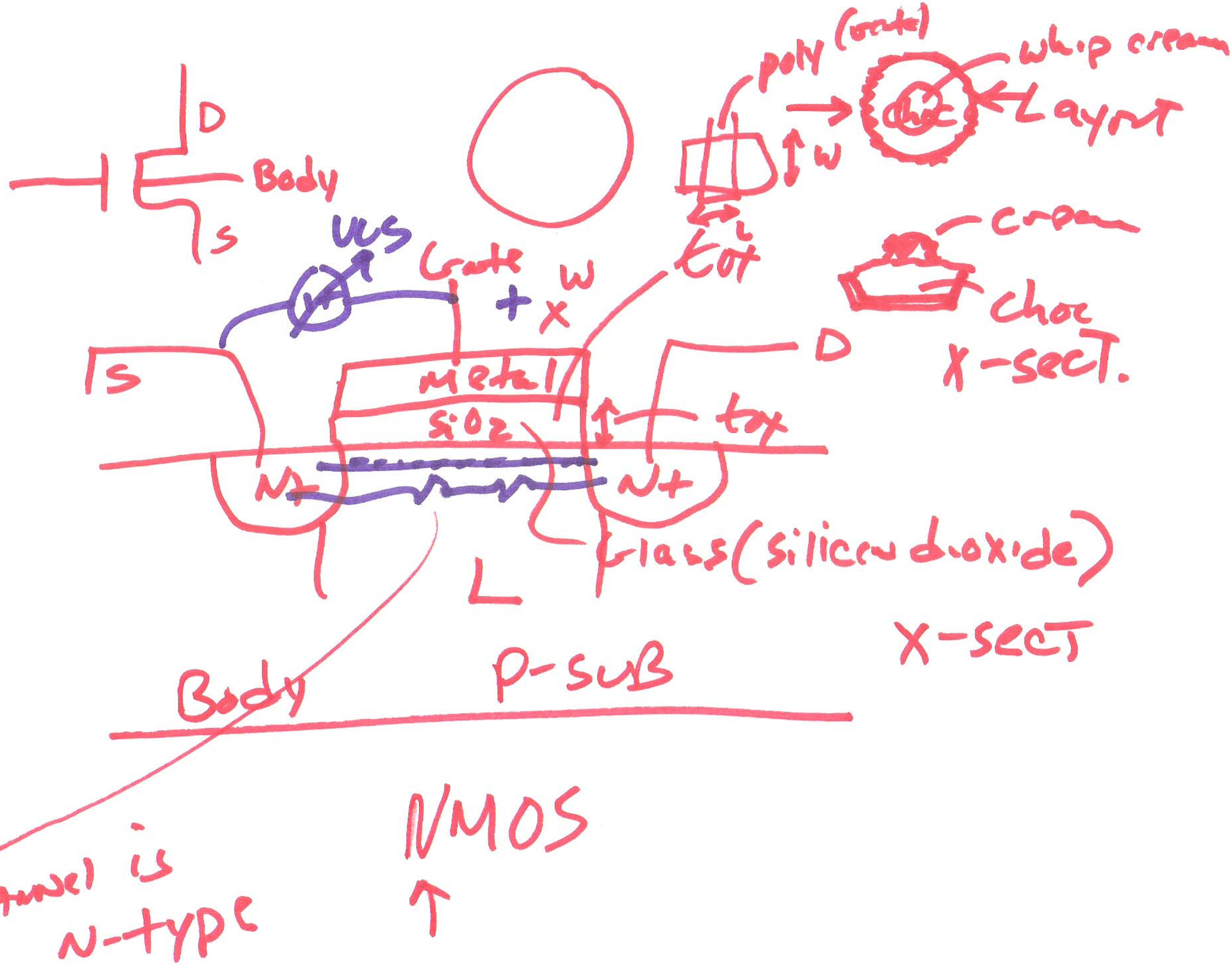
$V_{GS} < V_{THN}$

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

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

KP = transconductance parameter





NMOS

↑

$$KP_N = KP = K_N' = \mu_N \cdot C_{ox} = \mu_N \cdot \frac{\epsilon_{ox}}{t_{ox}}$$

KP_N ← nmos, KP ← spice

transconductance parameter

$$C_{ox} = \frac{\epsilon_{ox}}{t_{ox}}$$

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

$$KP_P = KP = K_P' = \mu_P \cdot C_{ox} = \frac{\epsilon_{ox}}{t_{ox}} \cdot \mu_P$$

KP_P ← pmos, KP ← spice

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

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

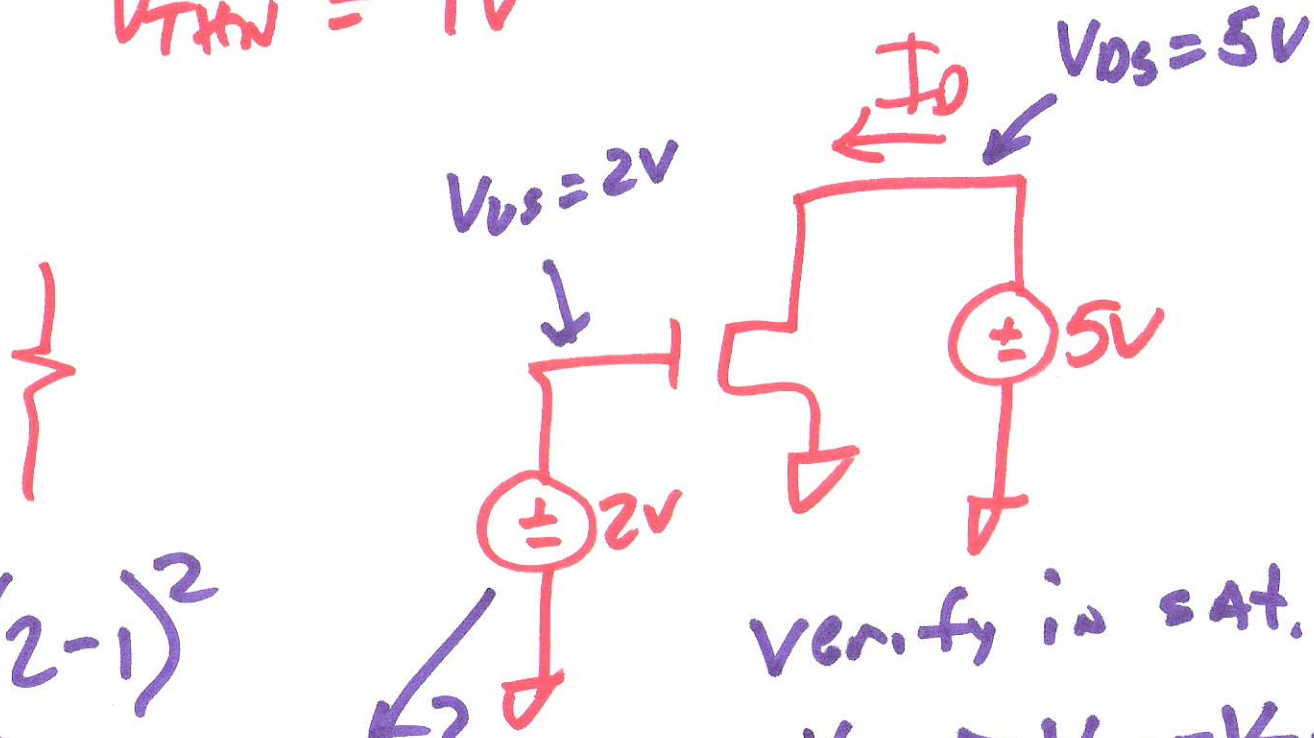
$$= \frac{KP_N}{2} \cdot \frac{W}{L}\left(V_{GS} - V_{THN}\right)^2$$

$$\beta_N = K_N = KP_N \cdot \frac{W}{L} = K_N' \cdot \frac{W}{L}$$

$$\beta_P = K_P = KP_P \cdot \frac{W}{L} \cdot K_P' \cdot \frac{W}{L}$$

$W = 10\mu$ $\quad KP_N = K_N = 100\mu A/V^2$

$L = 1\mu$ $\quad V_{THN} = 1V$



$$I_D = \frac{100\mu}{2} \cdot \frac{10}{1}(2-1)^2$$

$$= 500\mu A$$

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

yes

verify in sat.

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

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

$V_D \geq V_G - V_{TH}$

yes, in sat!

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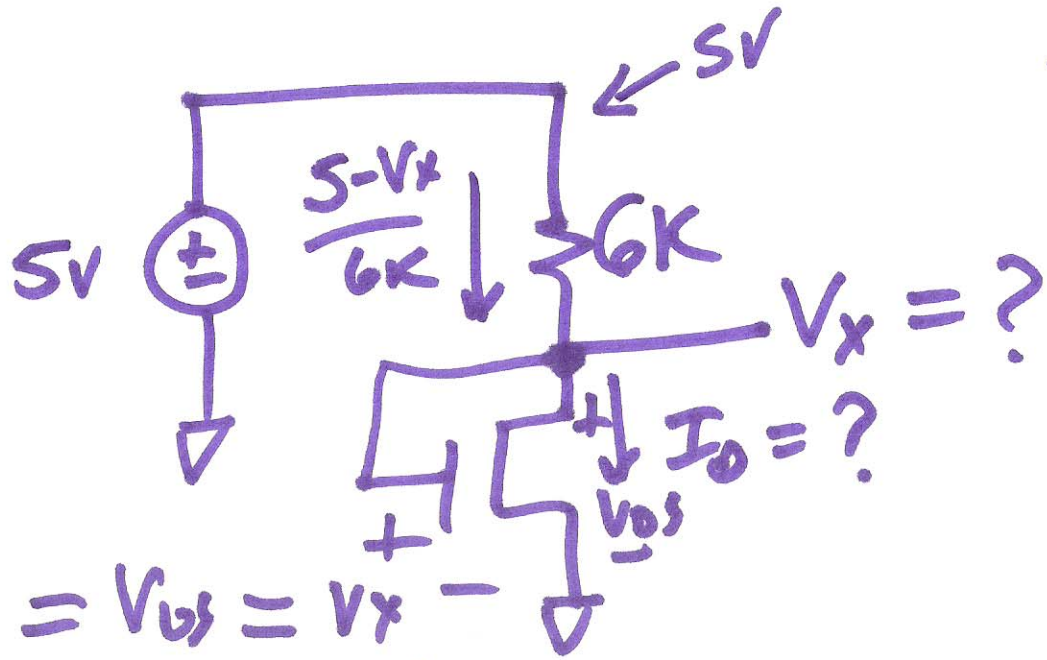

$2V = V_{DS} = V_x -$

diode connected

for

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

$V_{DS} = V_{GS}$

$0 \geq -V_{THN}$

yes, in sat.

$$\frac{5 - V_x}{6K} = \frac{KP}{2} \cdot \frac{W}{L} \left(V_x - V_{THN} \right)^2$$

V_x	L	R