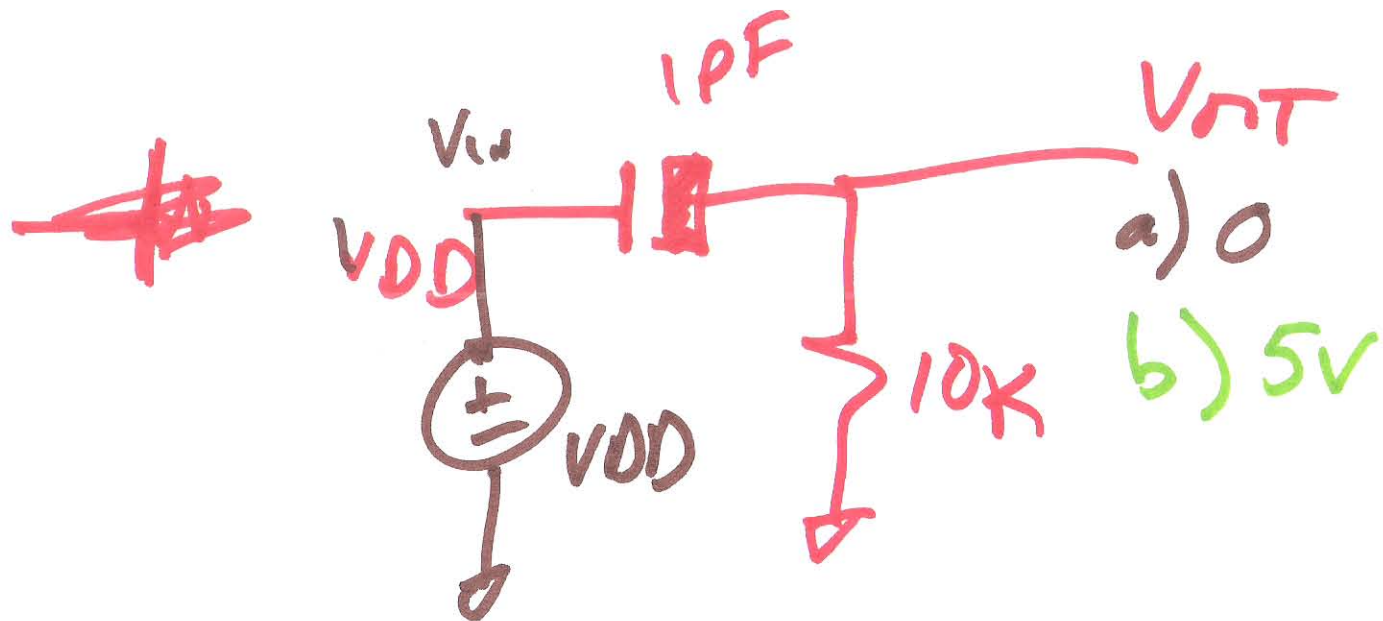


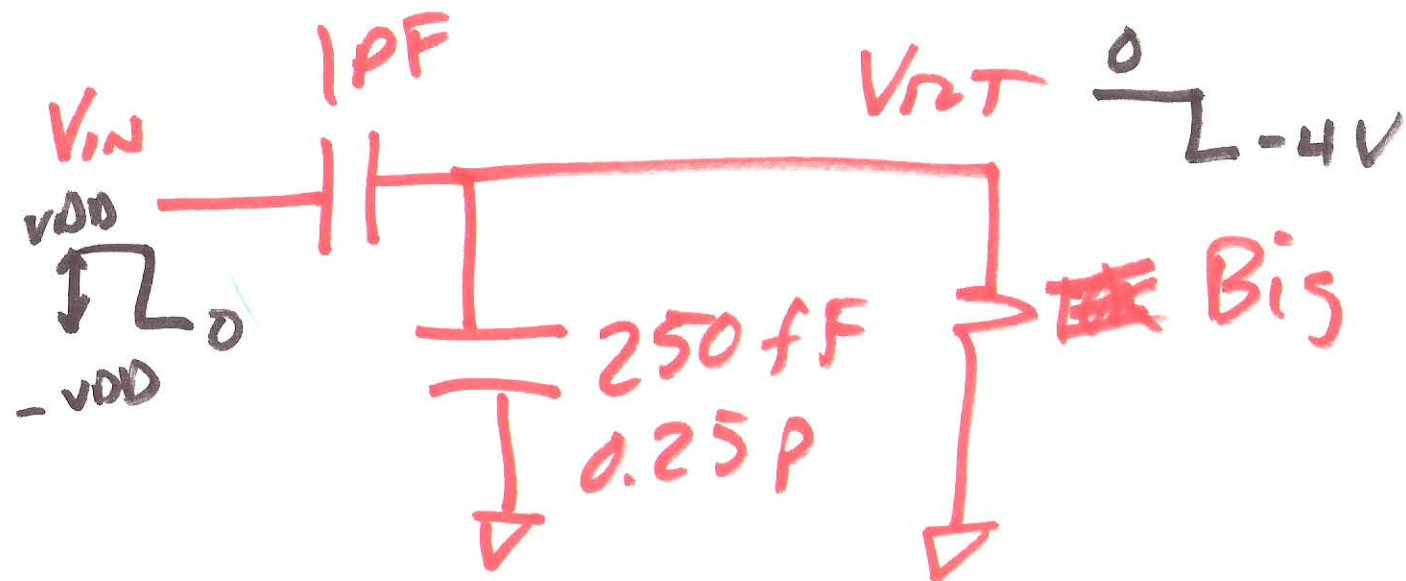
Lecture 12

OCT. 5, 2015

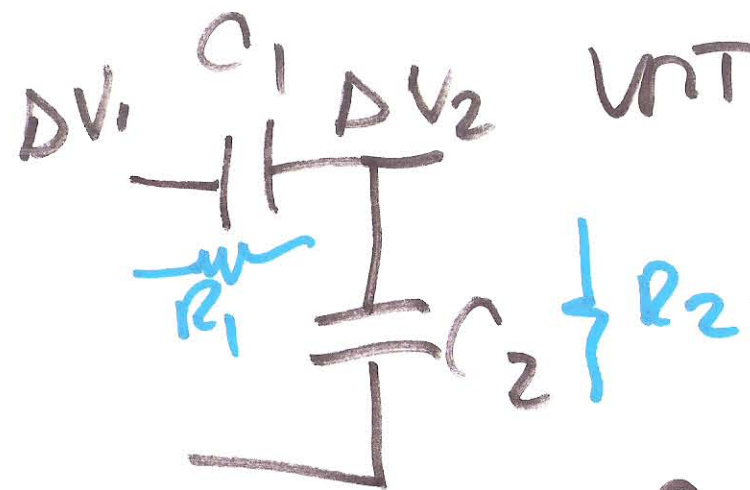
WORK the Quiz



1)



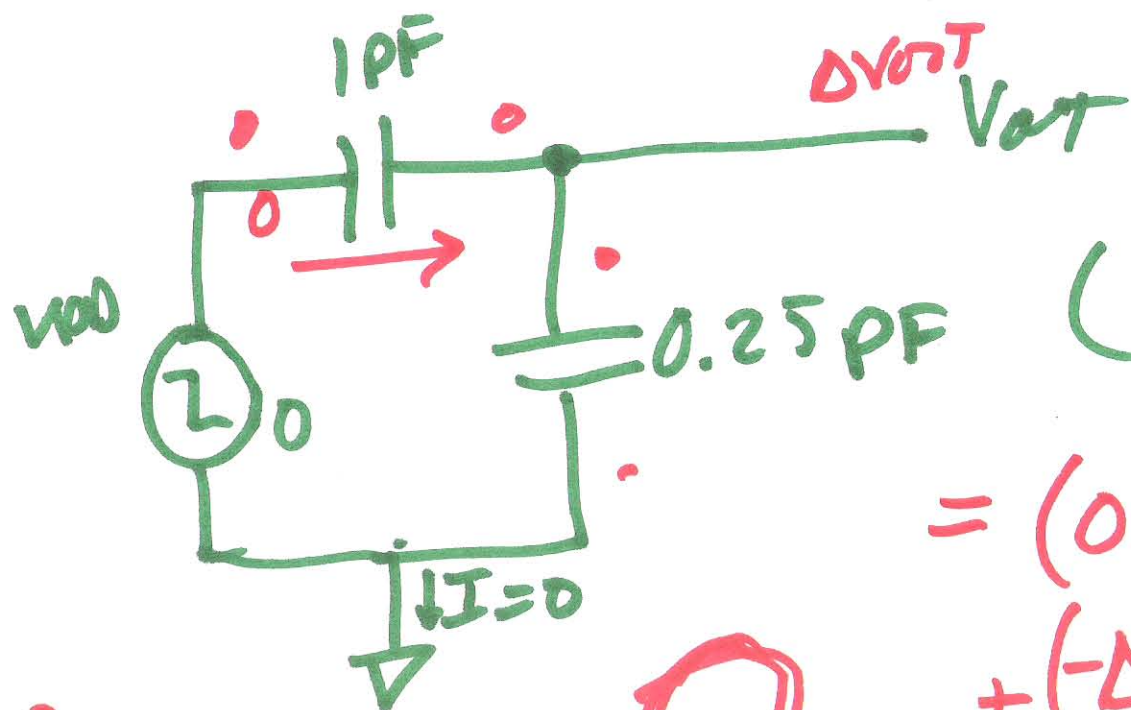
$$\begin{aligned}
 V_{NT} &= \frac{-V_{DD} \cdot \frac{1}{j\omega \cdot 250 \text{ fF}}}{\frac{1}{j\omega \cdot 250 \text{ fF}} + \frac{1}{j\omega \cdot 1 \text{ pF}}} \\
 &= -V_{DD} \cdot \frac{1 \text{ p}}{1 \text{ p} + 250 \text{ f}} \\
 &= -V_{DD} \cdot 0.8 \\
 &= \underline{\underline{-4 \text{ V}}}
 \end{aligned}$$



$$\Delta V_2 = \Delta V_1 \cdot \frac{C_1}{C_1 + C_2}$$

$$\Delta V_2 = \Delta V_1 \cdot \frac{R_2}{R_1 + R_2}$$

2)



$$CV = Q$$

$$(V_{DD} - 0) 1\text{ pF}$$

$$= (0 - \Delta V_{out}) 1\text{ pF}$$

$$+ (-\Delta V_{out} + 0) 0.25\text{ pF}$$

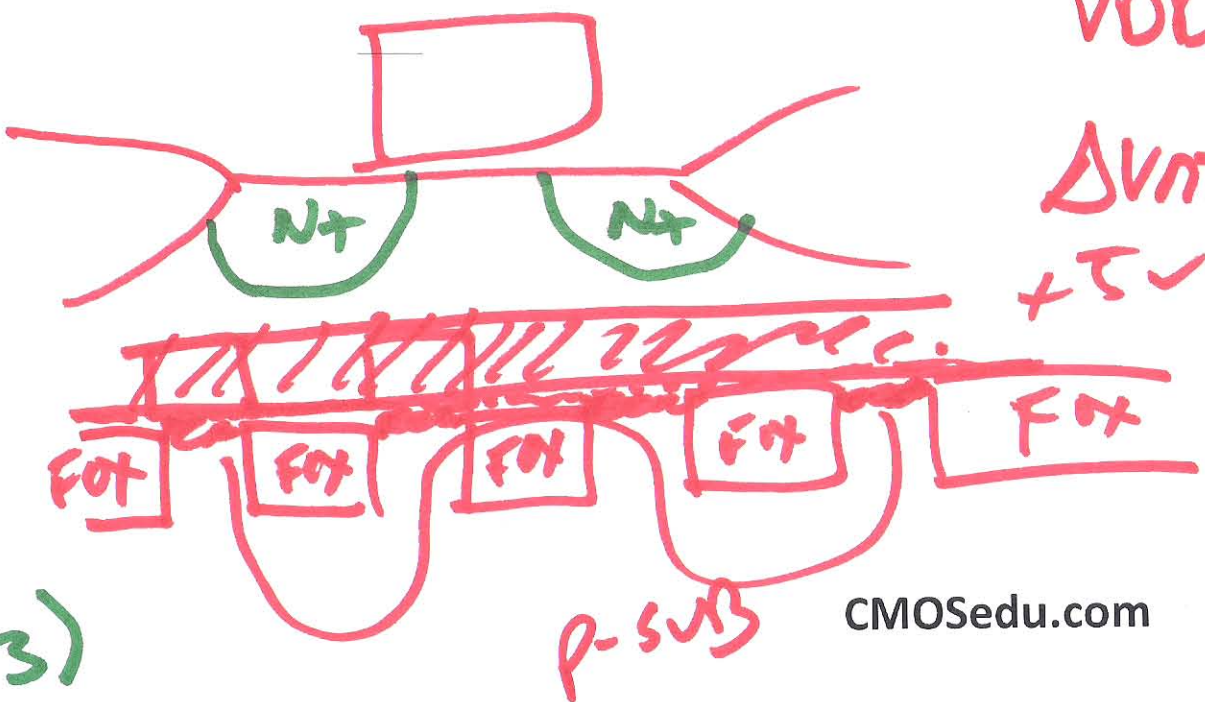
$$V_{DD} \cdot 1\text{ pF} = -1.25\text{ pF} \cdot \Delta V_{out}$$

$$\Delta V_{out} = V_{DD} \cdot \frac{1}{1.25}$$

$$= -4\text{ V}$$

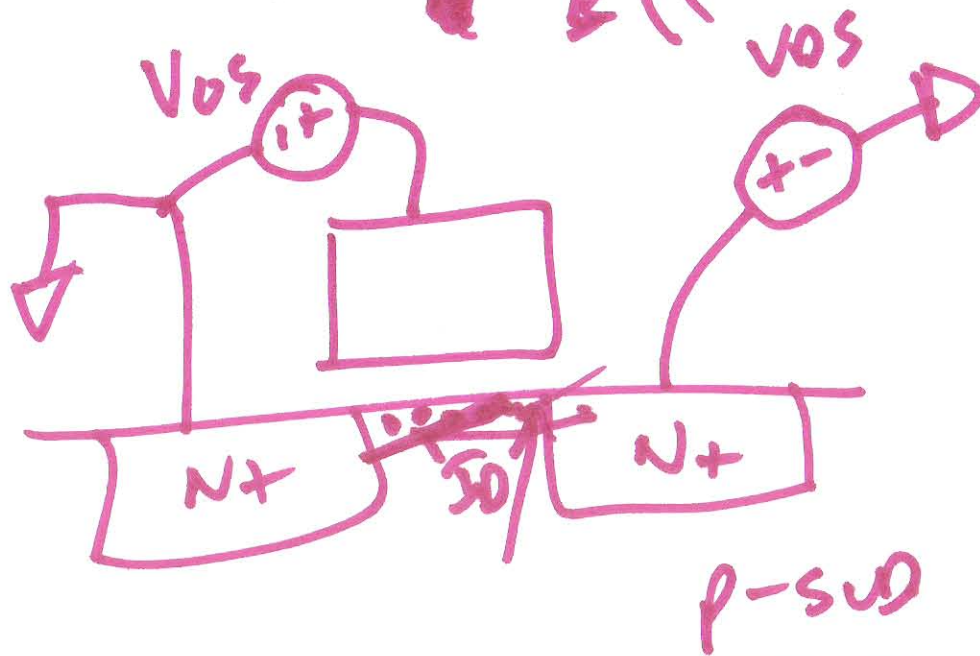
you did not challenge me!

~~nooooo~~



3)

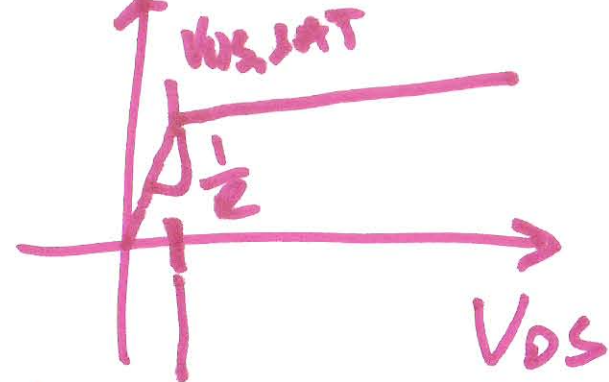
$$I_D = \beta_n \cdot \frac{1}{2} \left((V_{GS} - V_{THN}) V_{DS} - \frac{V_{DS}^2}{2} \right) \text{ Triode}$$



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

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

I_D triode



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

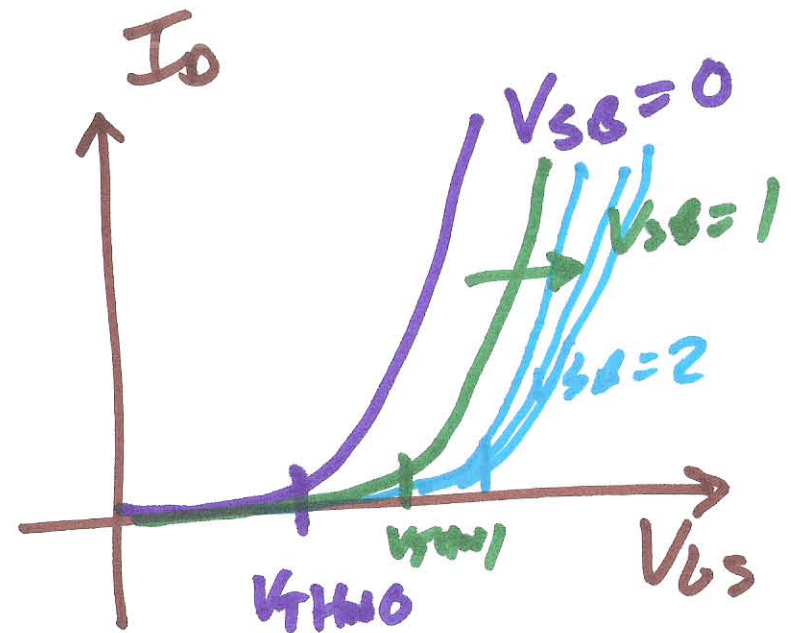
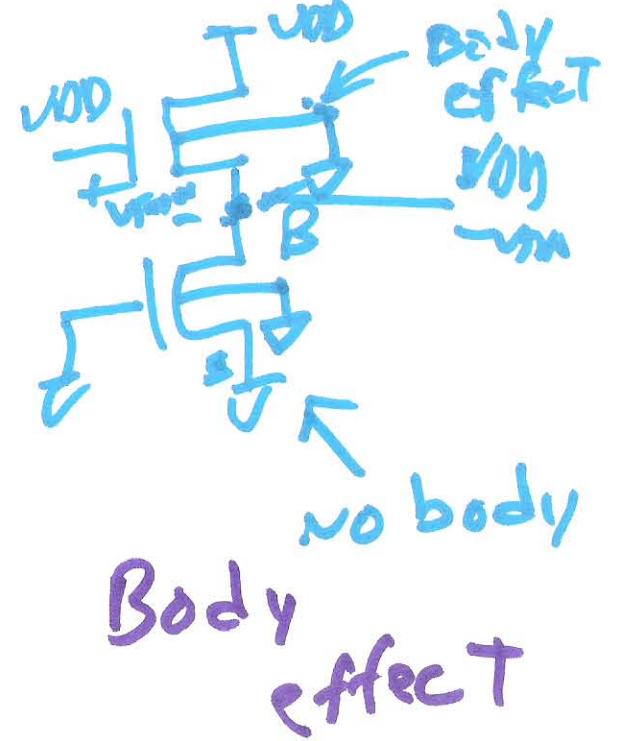
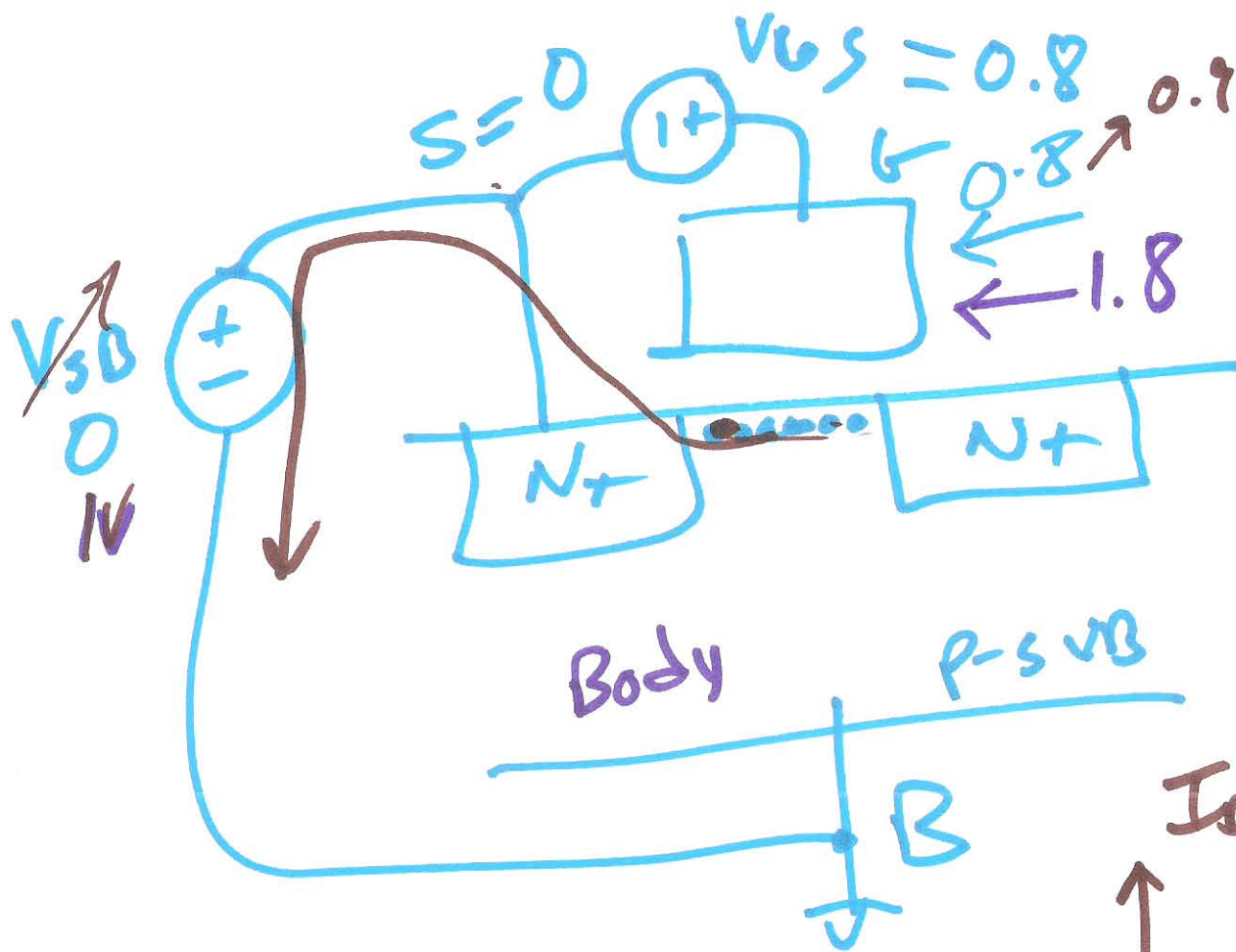
$$V_{DS} = \underline{V_{GS} - V_{THN}}$$

$$I_D = \beta_n \cdot \frac{1}{2} \left((V_{GS} - V_{THN})(V_{GS} - V_{THN}) - \frac{(V_{GS} - V_{THN})^2}{2} \right)$$

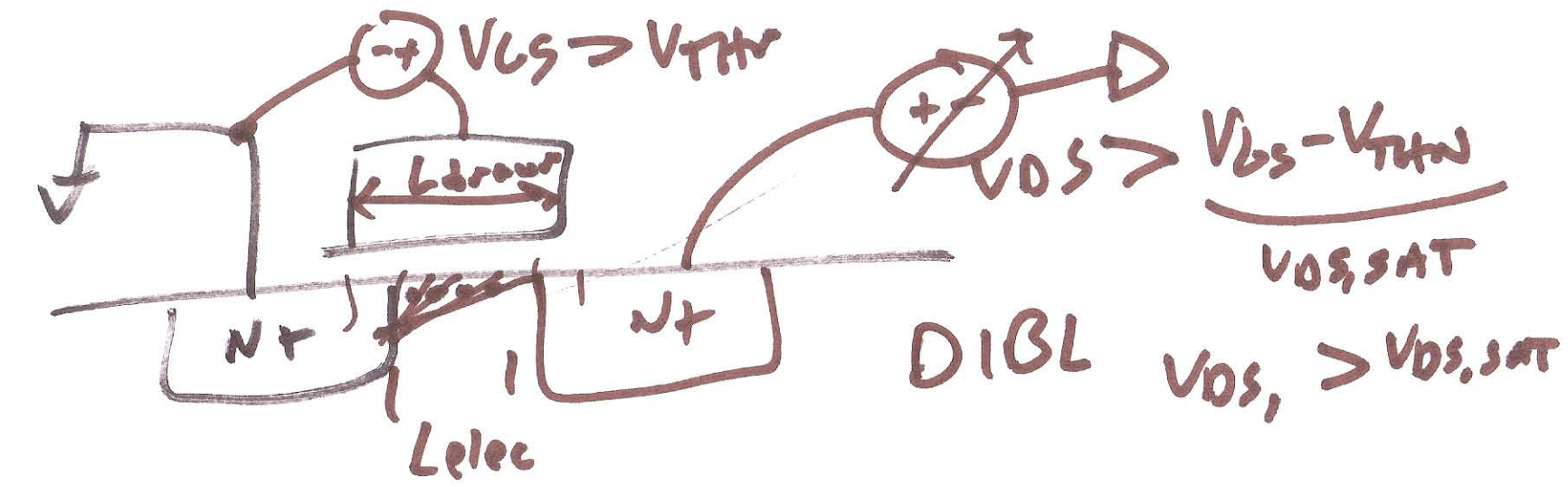
\swarrow $V_{DS,SAT}$
 $\frac{(V_{GS} - V_{THN})^2}{2}$

$$I_D = \frac{\beta_n}{2} (V_{GS} - V_{THN})^2 \text{ SATURATION}$$

4)



5)



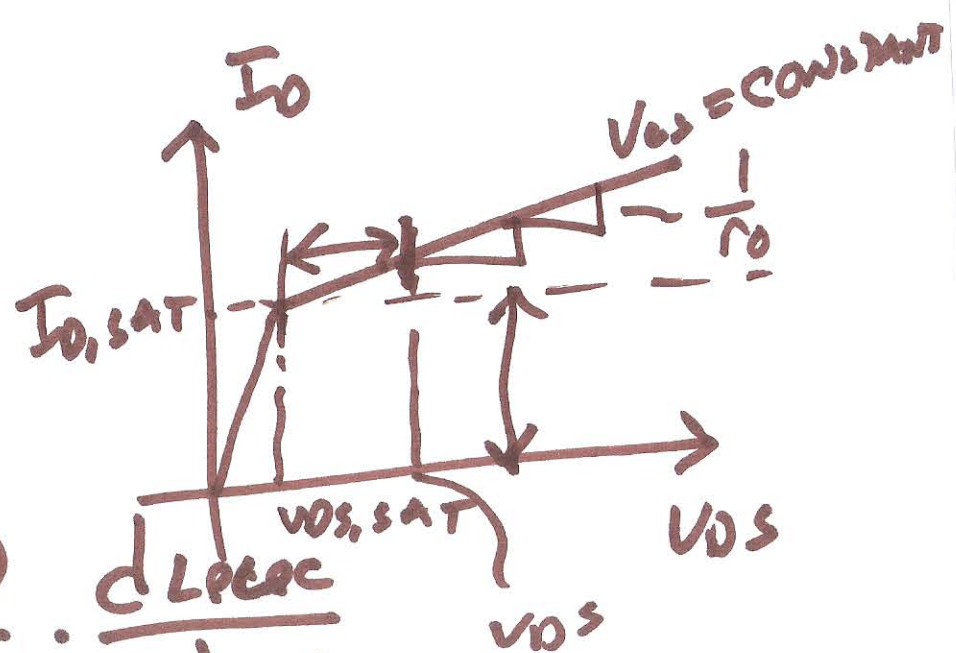
$$|I_D| = \frac{\mu_n C_{ox}}{2} \cdot \frac{W}{L_{elec}} (V_{GS} - V_{THN})^2$$

$\nearrow V_{DS}$



6)

$$\frac{\delta I_D}{\delta V_{OS}} = \frac{\left(\frac{K P_n}{2} \cdot \frac{W}{L} (V_{GS} - V_{TH})^2 \right)}{\delta V_{OS}}$$



$$= \frac{d}{dV_{OS}} K \cdot L \cdot e^{\dots} = k \cdot \frac{d L e^{\dots}}{dV_{OS}}$$

$$I_{D,SAT} = \frac{K P_n}{2} \cdot \frac{W}{L} (V_{GS} - V_{TH})^2$$

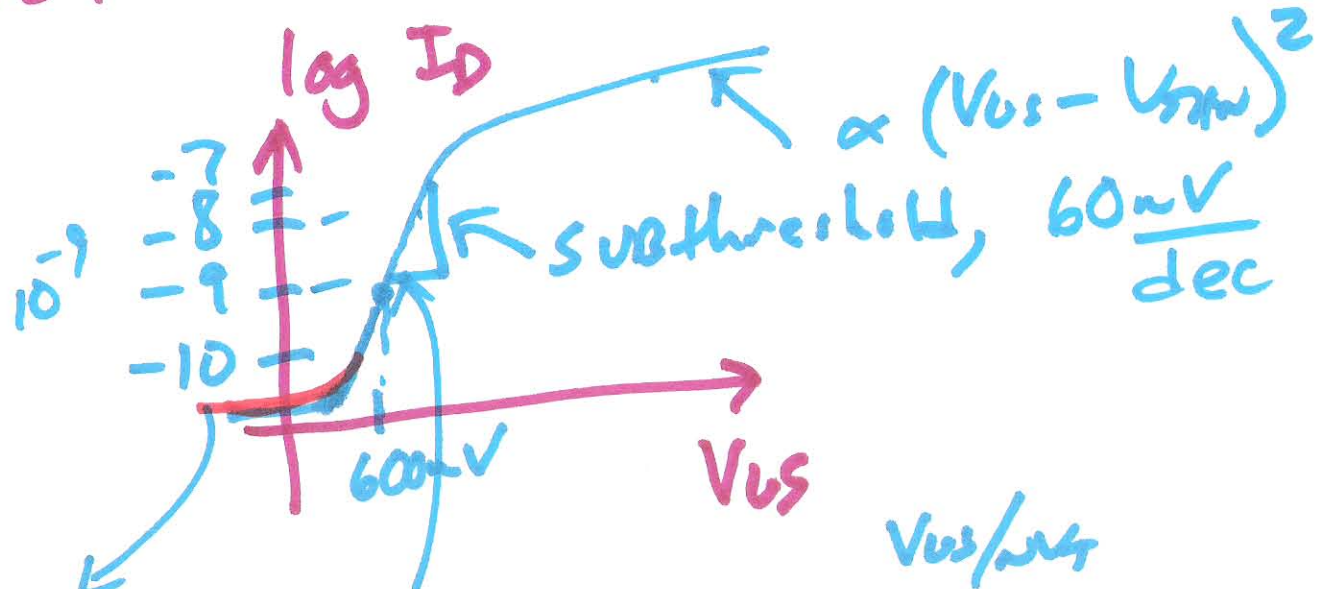
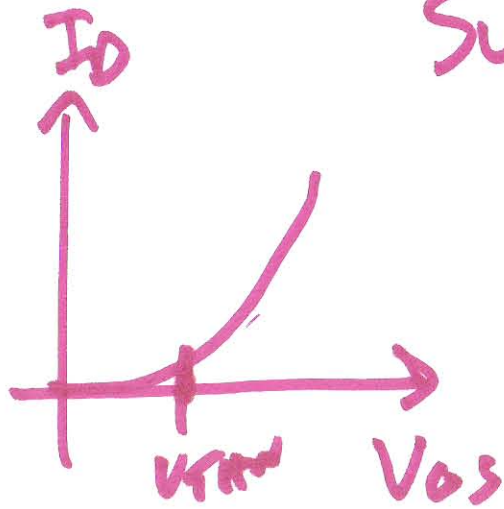
$$I_D = I_{D,SAT} + C(V_{OS})$$

$$I_D = \frac{K P_n}{2} \cdot \frac{W}{L} (V_{GS} - V_{TH})^2 \left(1 + \lambda (V_{OS} - V_{OS,SAT}) \right)$$

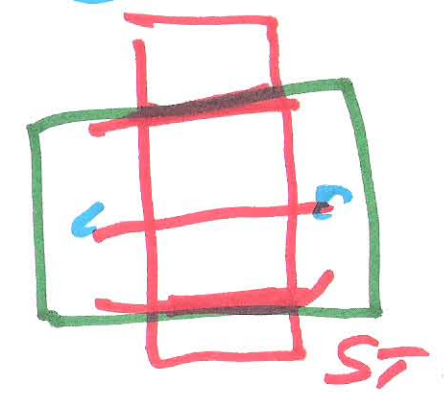
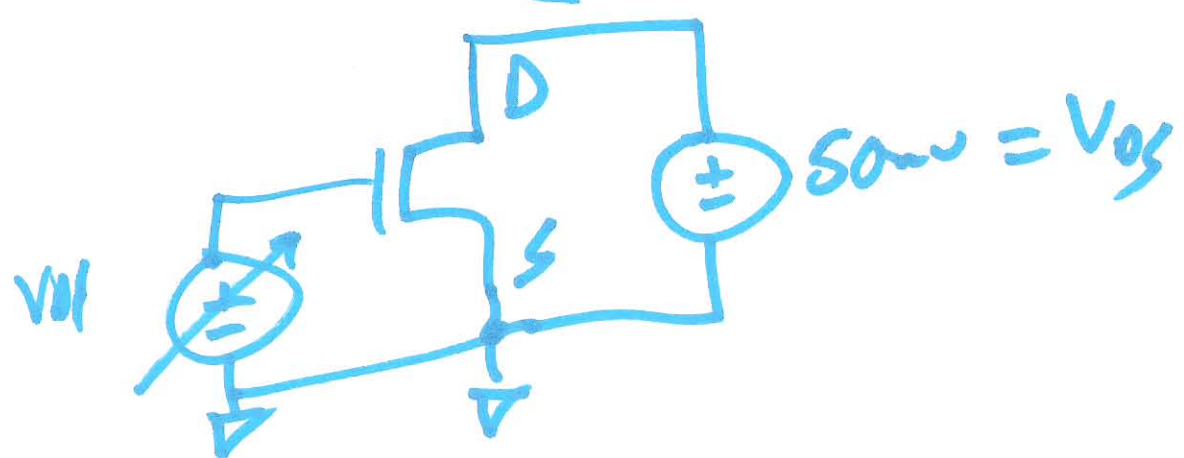
change / last parameter

→

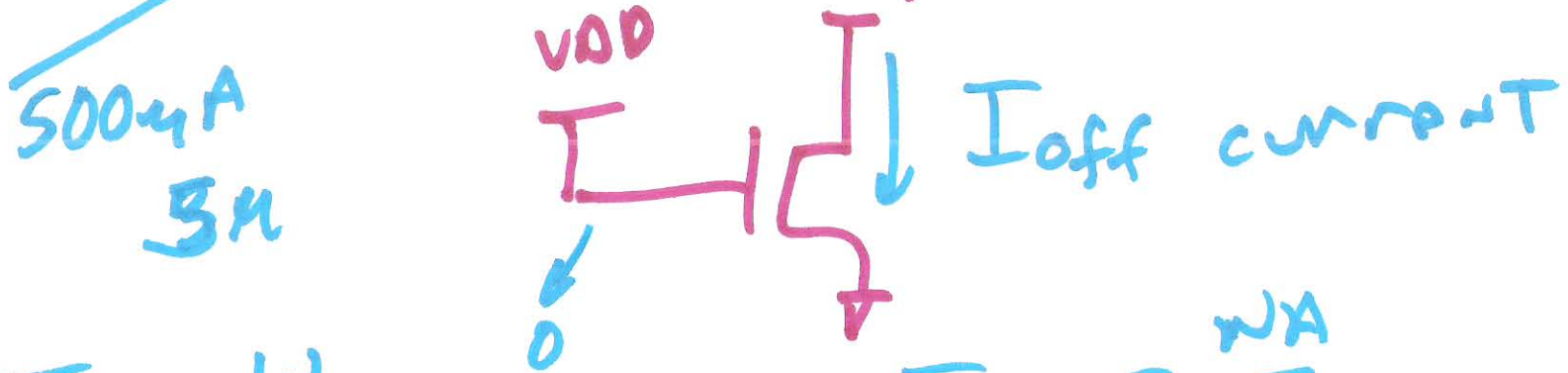
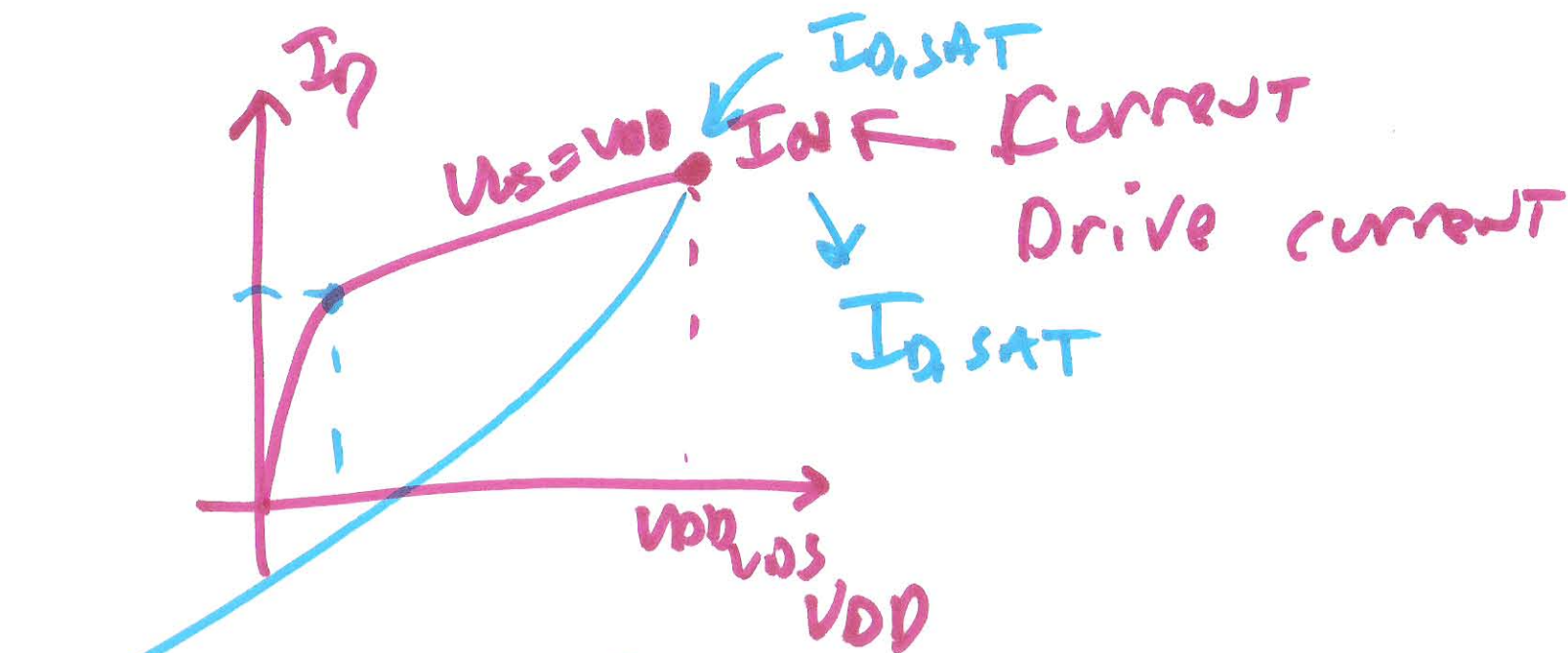
Subthreshold



$$I_D = I_{D0} e^{V_{GS}/nV_T}$$



8)



$$I_{off} = \frac{W}{L} \mu_n C_{ox} V_{DD}^2$$

$$I_0 = I_{on} \cdot W$$

$$500 \mu A = I_{on} \cdot 5 \mu m$$

$$I_{on} = \frac{100 \mu A}{\mu m}$$

9)