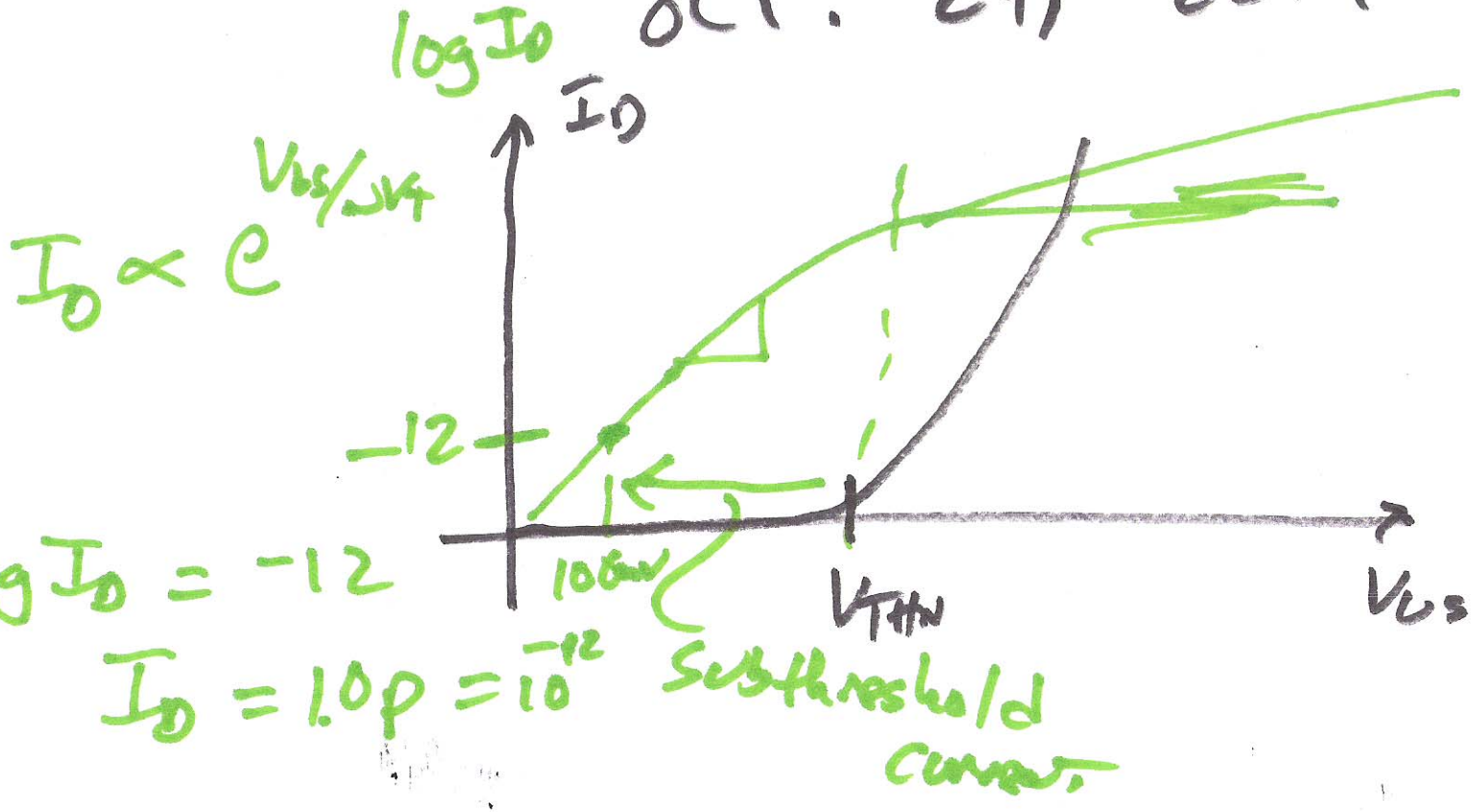
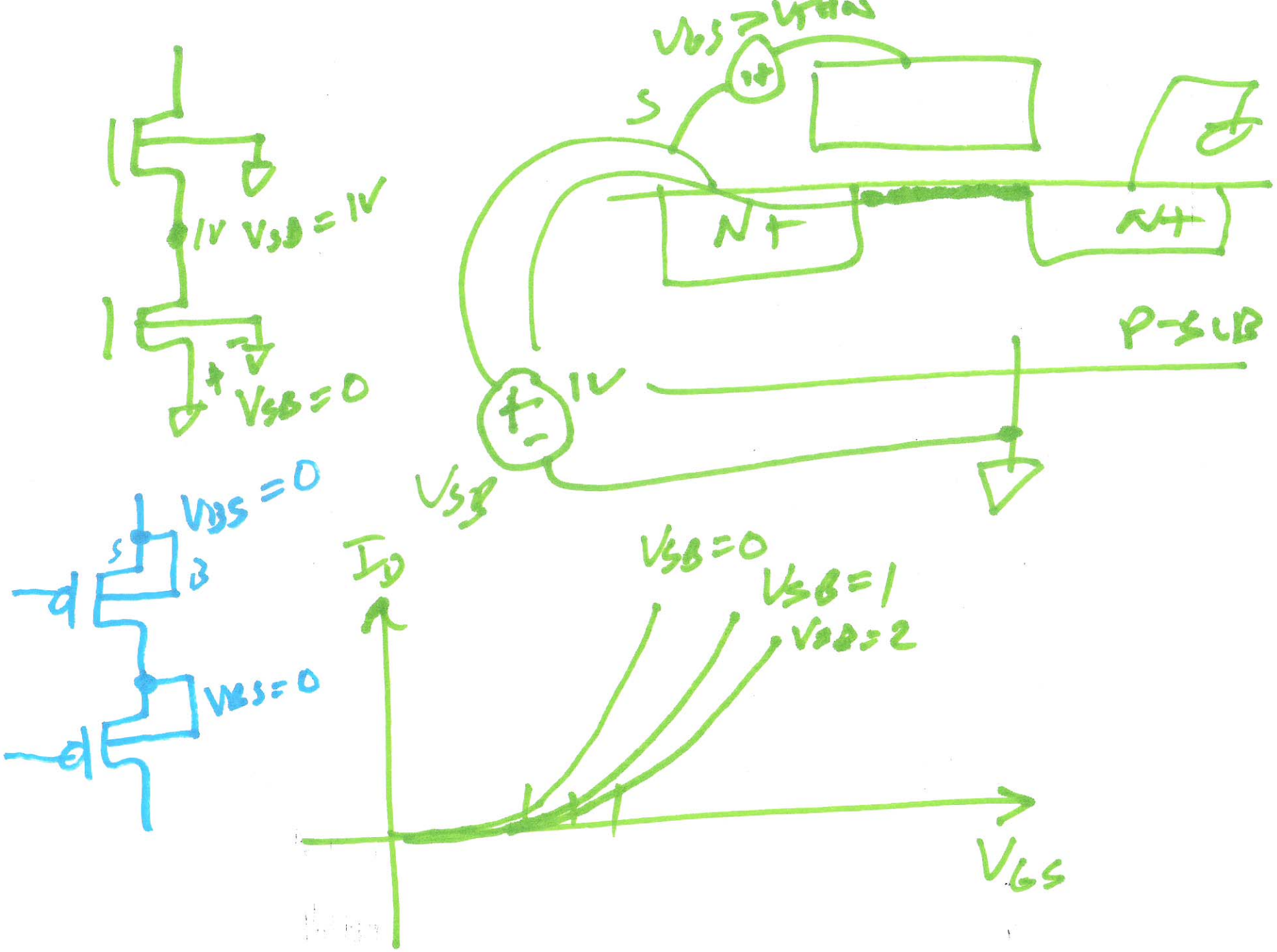
Lecture 17

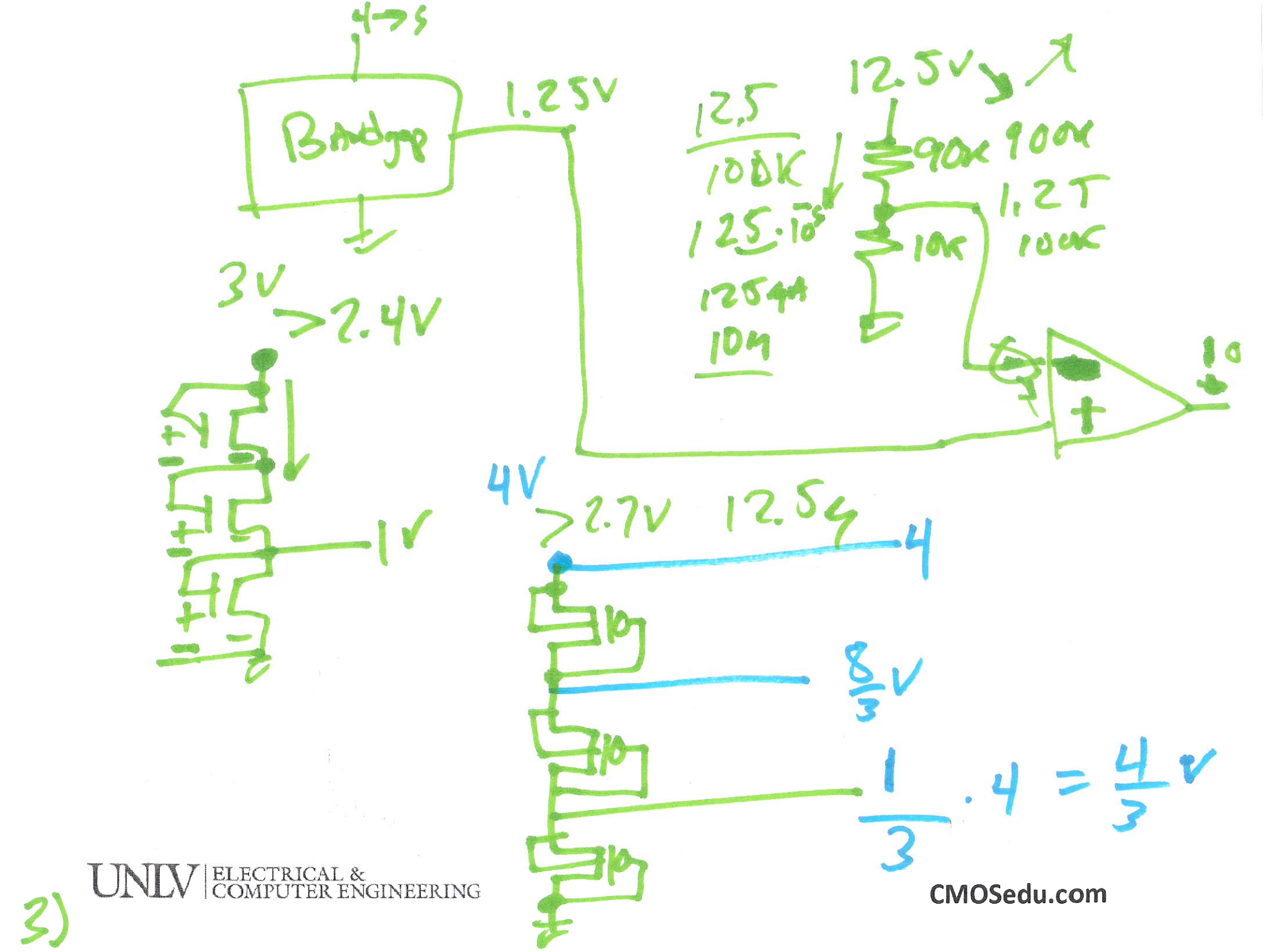
SPICE modeling MOSFETs

short channel MOSFETs

OCT. 24, 2014




1V
$V_{SB}=1V$
$V_{SB}=0$
$V_{BS}=0$
$V_{BS}=0$
S
B
D
S
N+
N+
P-SUB
1V
V_{SB}
I_D
$V_{SB}=0$
$V_{SB}=1$
$V_{SB}=2$
V_{GS}



3)

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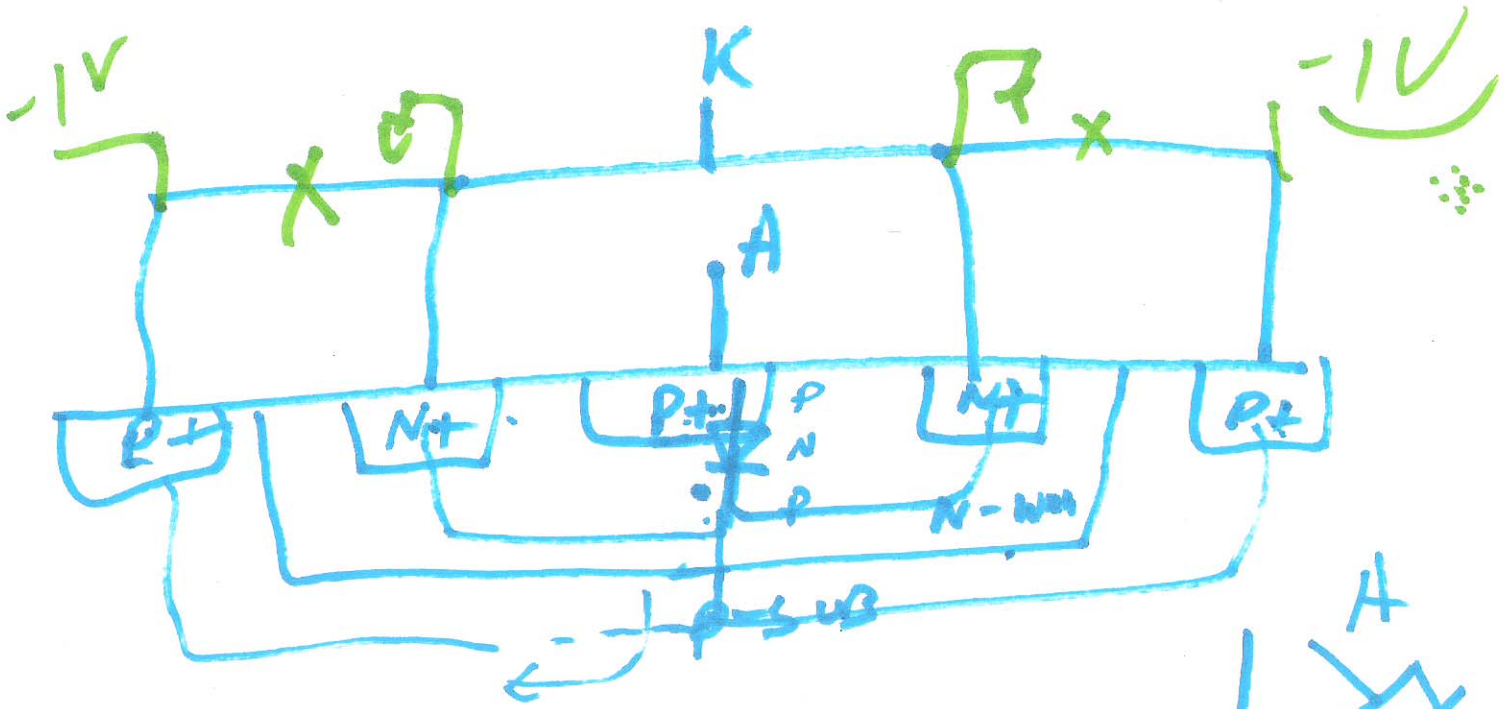
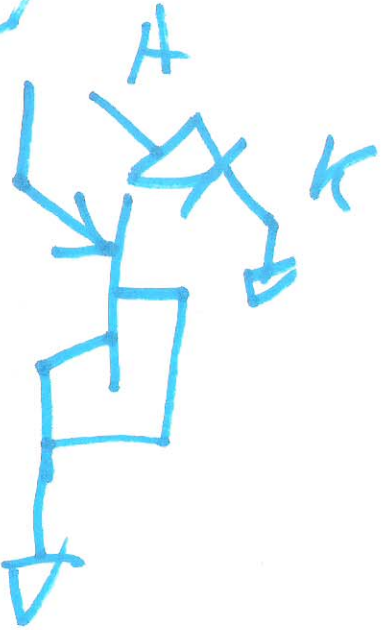
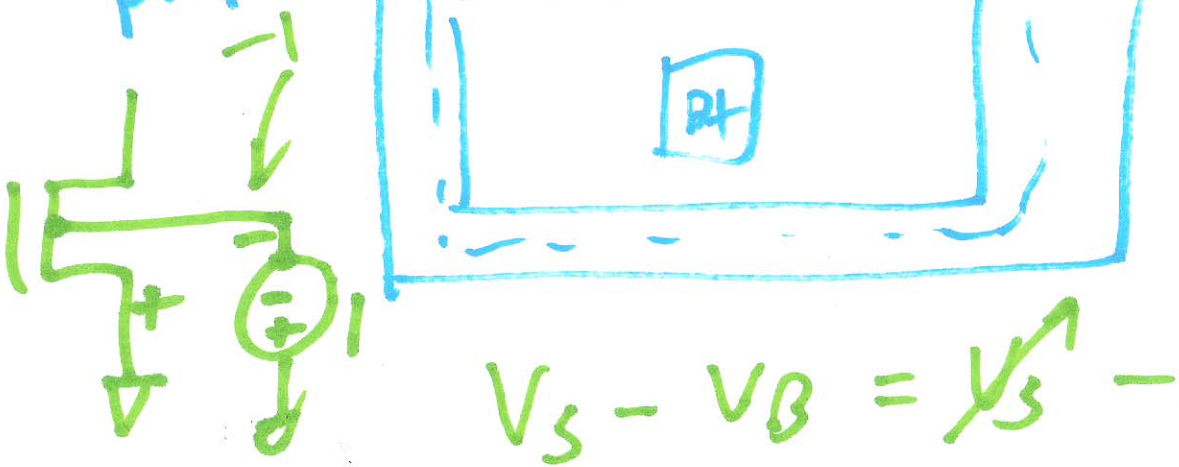
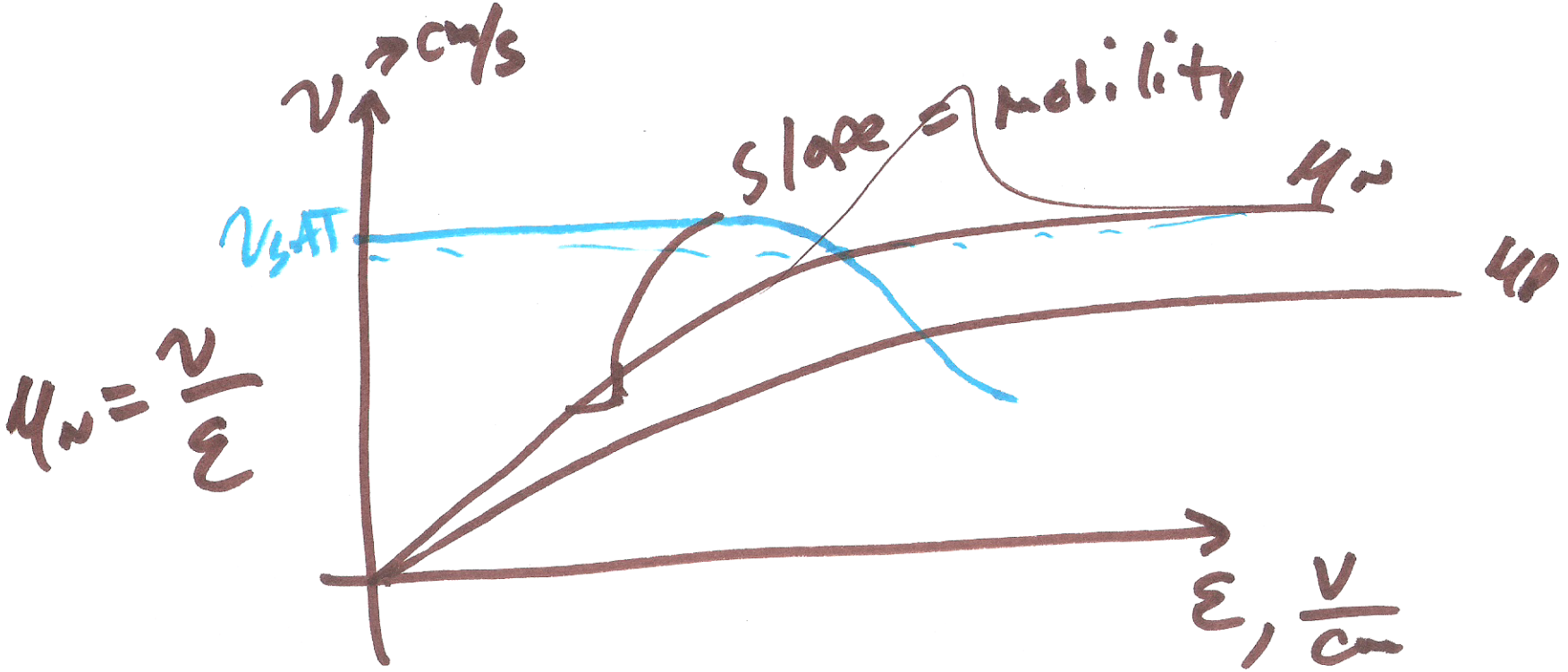




PARASITIC PNP



$$V_S - V_B = V_S - (-1) = 1V$$



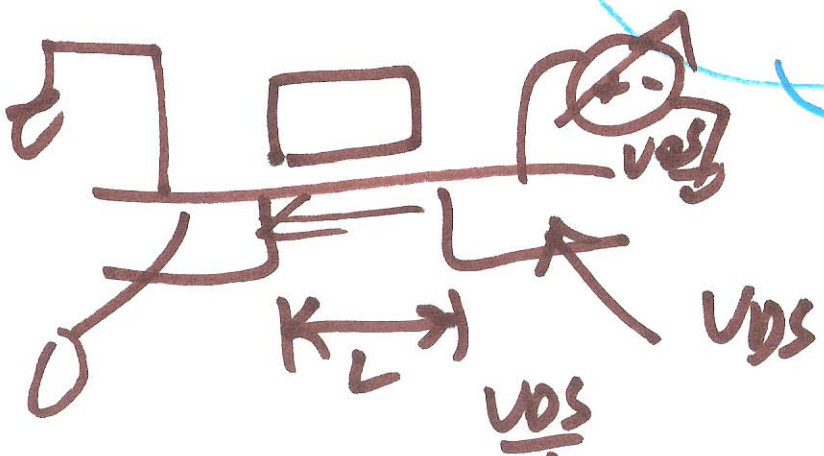
Mobility

$$\mu = \frac{cm/s}{V/cm} = \frac{cm^2}{V \cdot s}$$

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

$$I_D = \mu_N \cdot \frac{dV(y)}{dy} \cdot W \cdot C'_{ox}\left(V_{GS} - V_{THN} - V(y)\right)$$

$$\mathcal{E} = \frac{v_{SAT}}{\mu} \Rightarrow \mu_n = \frac{v_{SAT}}{\frac{dV(y)}{dy}}$$



$$I_D = W \cdot v_{SAT} \cdot C'_{ox} \cdot \left(V_{GS} - V_{THN} - V_{DS,SAT}\right)$$

for short channel

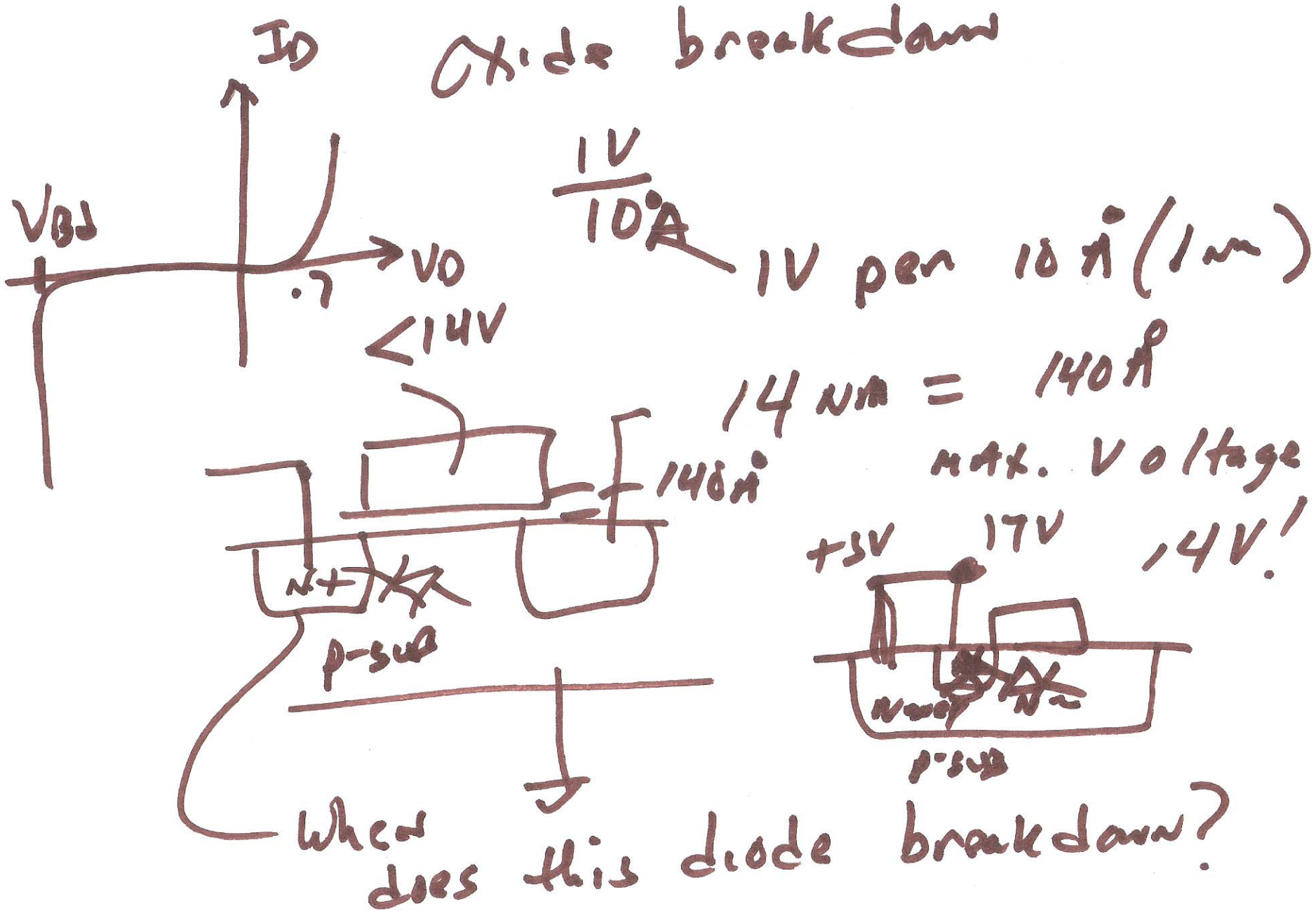
No longer square-law!

linearly dependent on V_{GS}

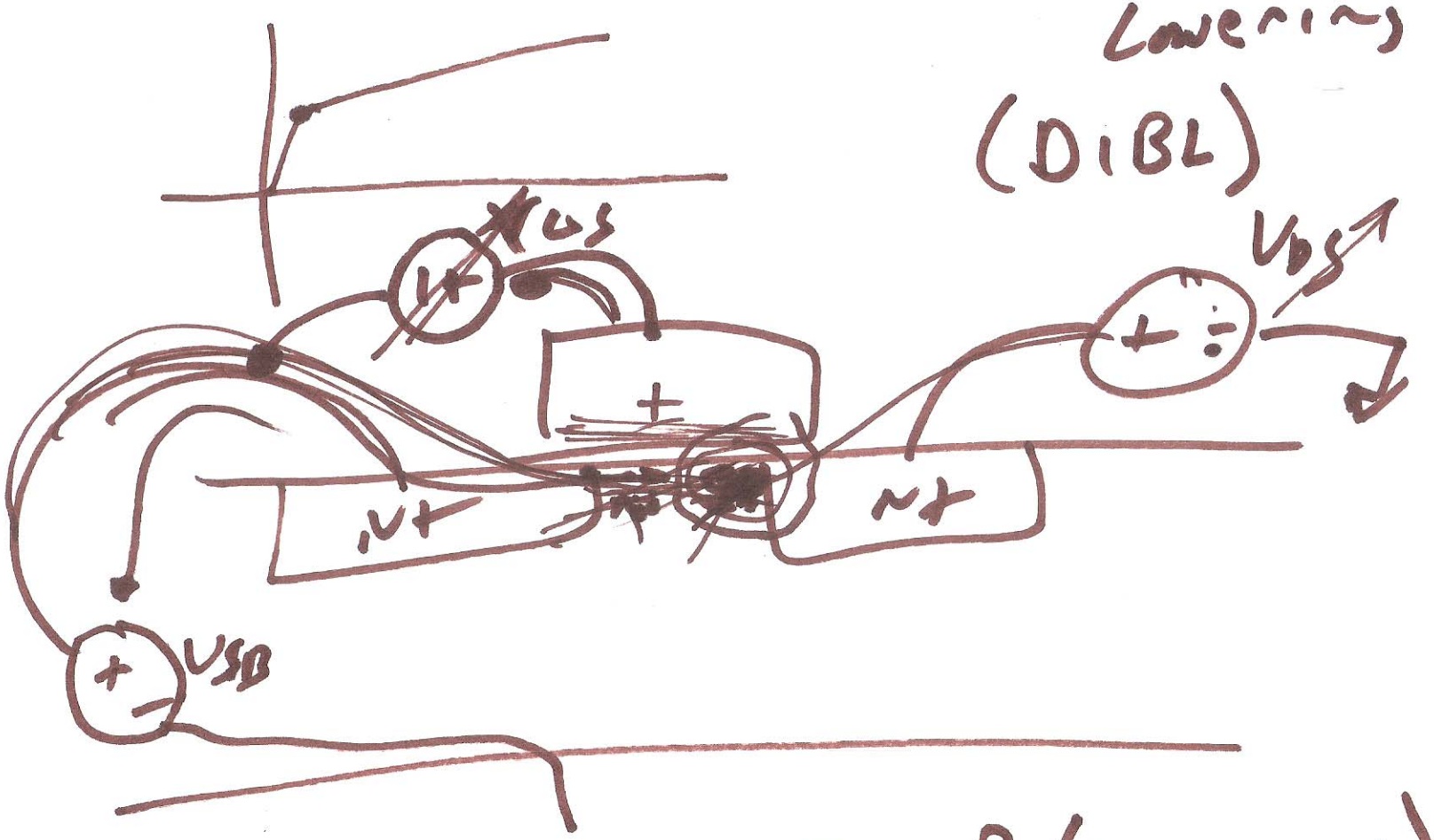
NOte! NOt dependent on L

velocity overshoot

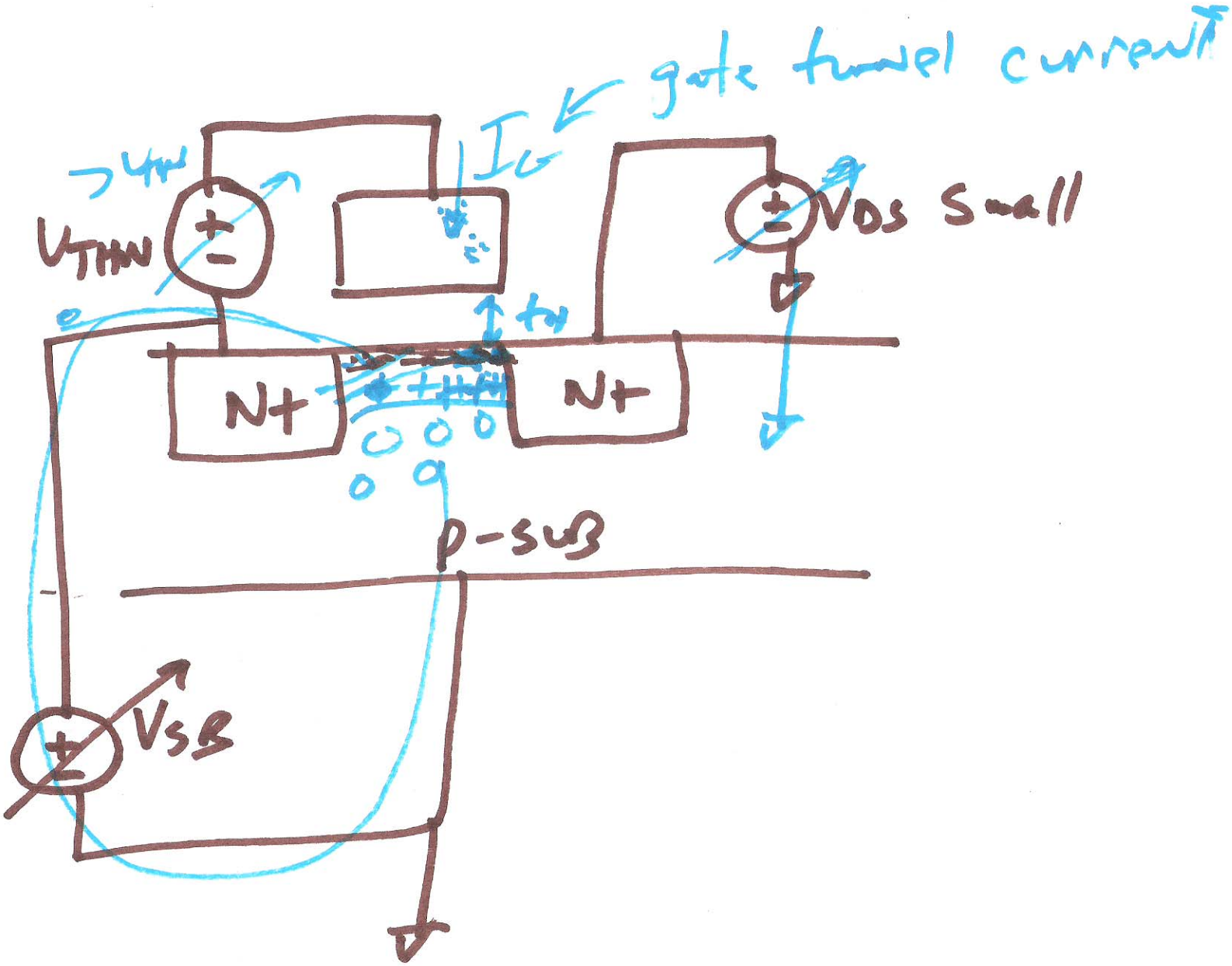
we do get I_D vary with L


ID
Oxide breakdown
VBD
VD
.7
1V
10Å
1V per 10 Å (1 nm)
<14V
14 nm = 140 Å
140Å
max. Voltage
+3V
17V
,4V!
n+
p-sub
p-sub
When does this diode breakdown?

Drain Induced Barrier Lowering (DIBL)



$$I_D = \frac{\beta}{2}\left(V_{DS} - V_{T(\text{eff})}\right)^2$$


gate tunnel current
I_G
V_{THN}
V_{DS} small
t_{ox}
N+
N+
p-sub
V_{SB}