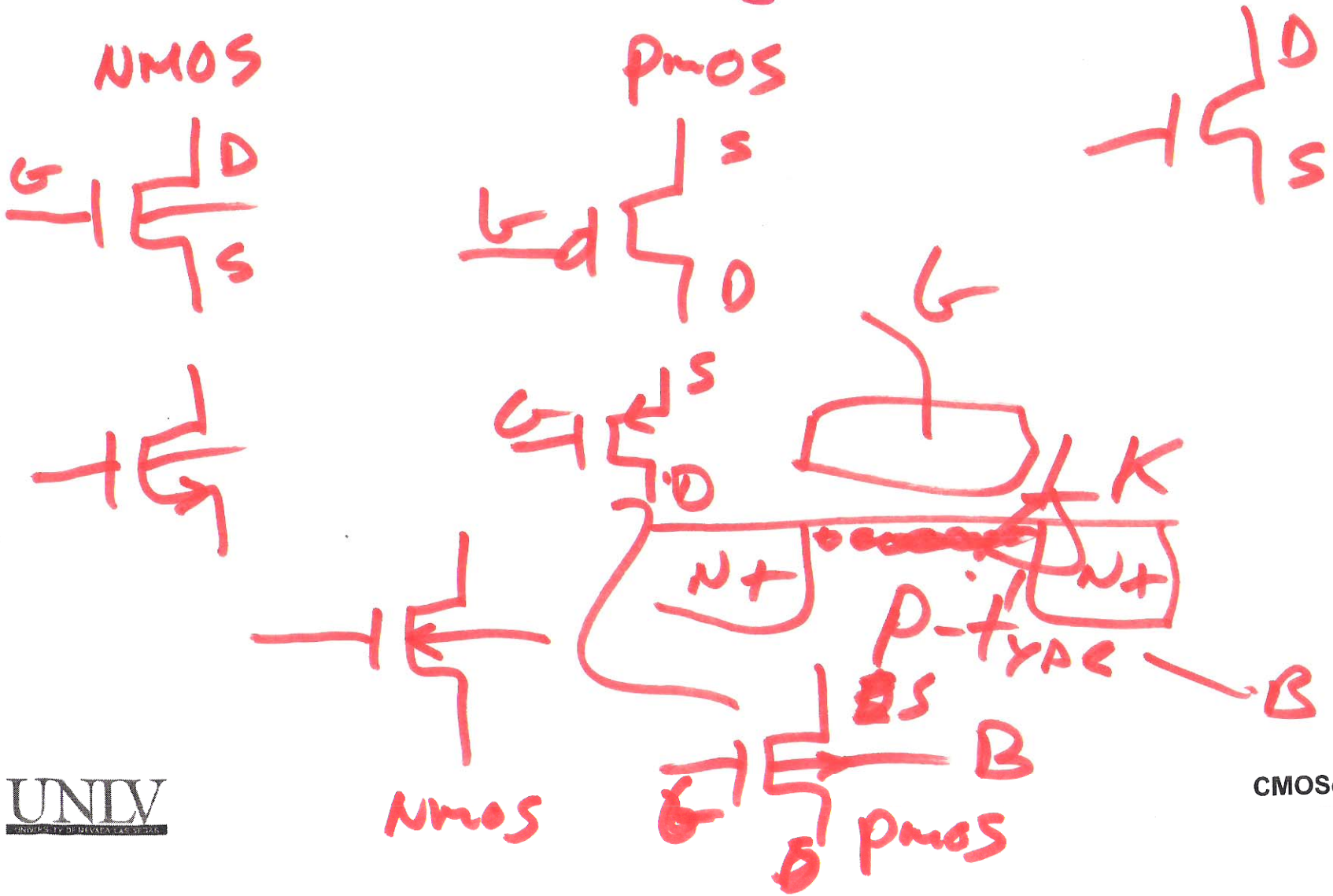
EE 320 Electronics

3/18/2013

Lecture 15



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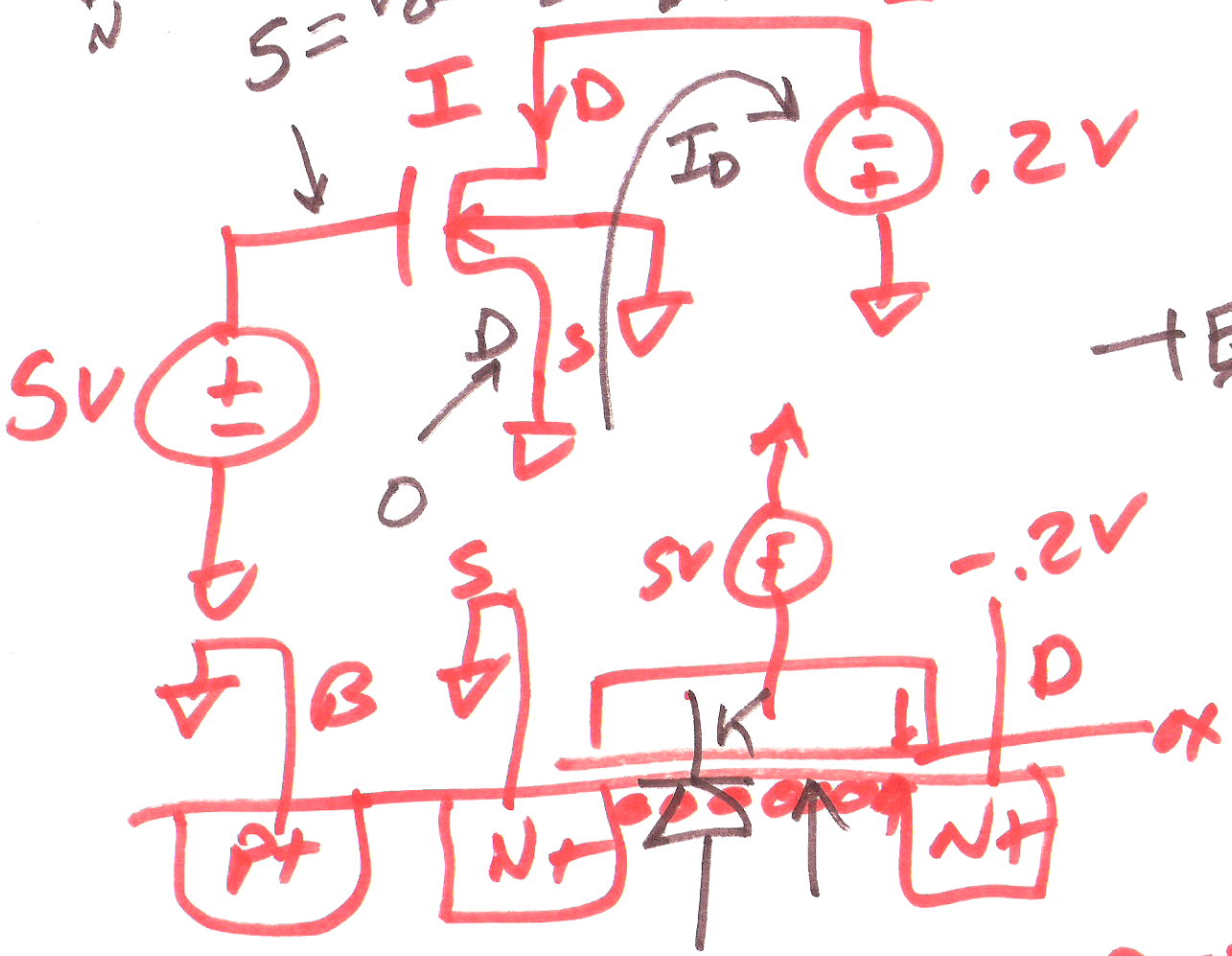
$I_D = K_n\left((V_{GS}-V_{THN})V_{DS} - \frac{V_{DS}^2}{2}\right)$ $2V = V_S$

$S = V_G$ S $-.2$



$V_G - V_S = V_{GS}$

$= 5 - (-.2)$

$V_{GS} = 5.2V$

$V_{DS} =$

$V_D - V_S =$

$0 - (-.2)$

$V_{DS} = 0.2V$

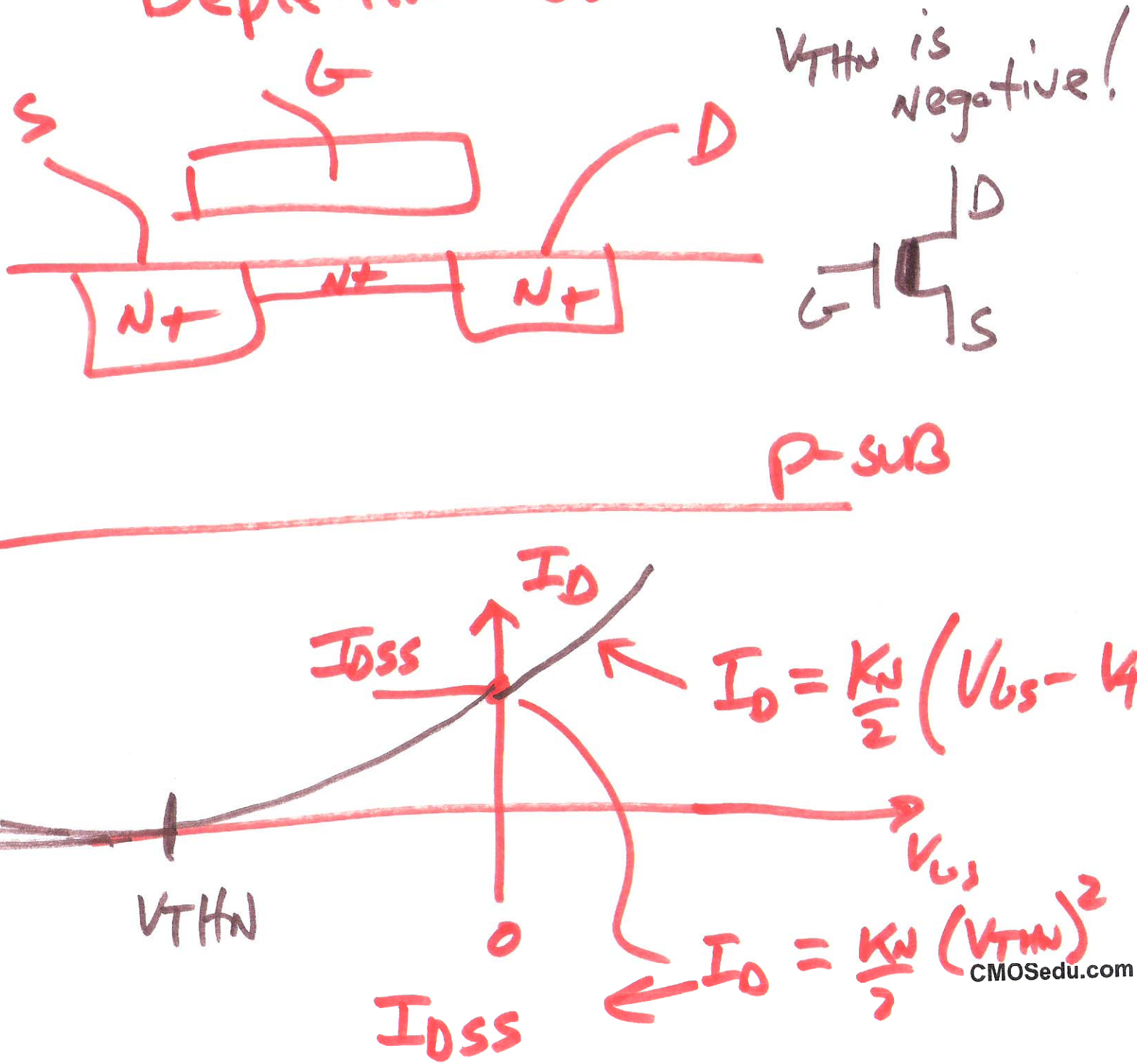
$V_{DS} \overset{?}{\geq} V_{GS} - V_{THN}$

$.2 \overset{?}{\geq} 5.2 - .7$

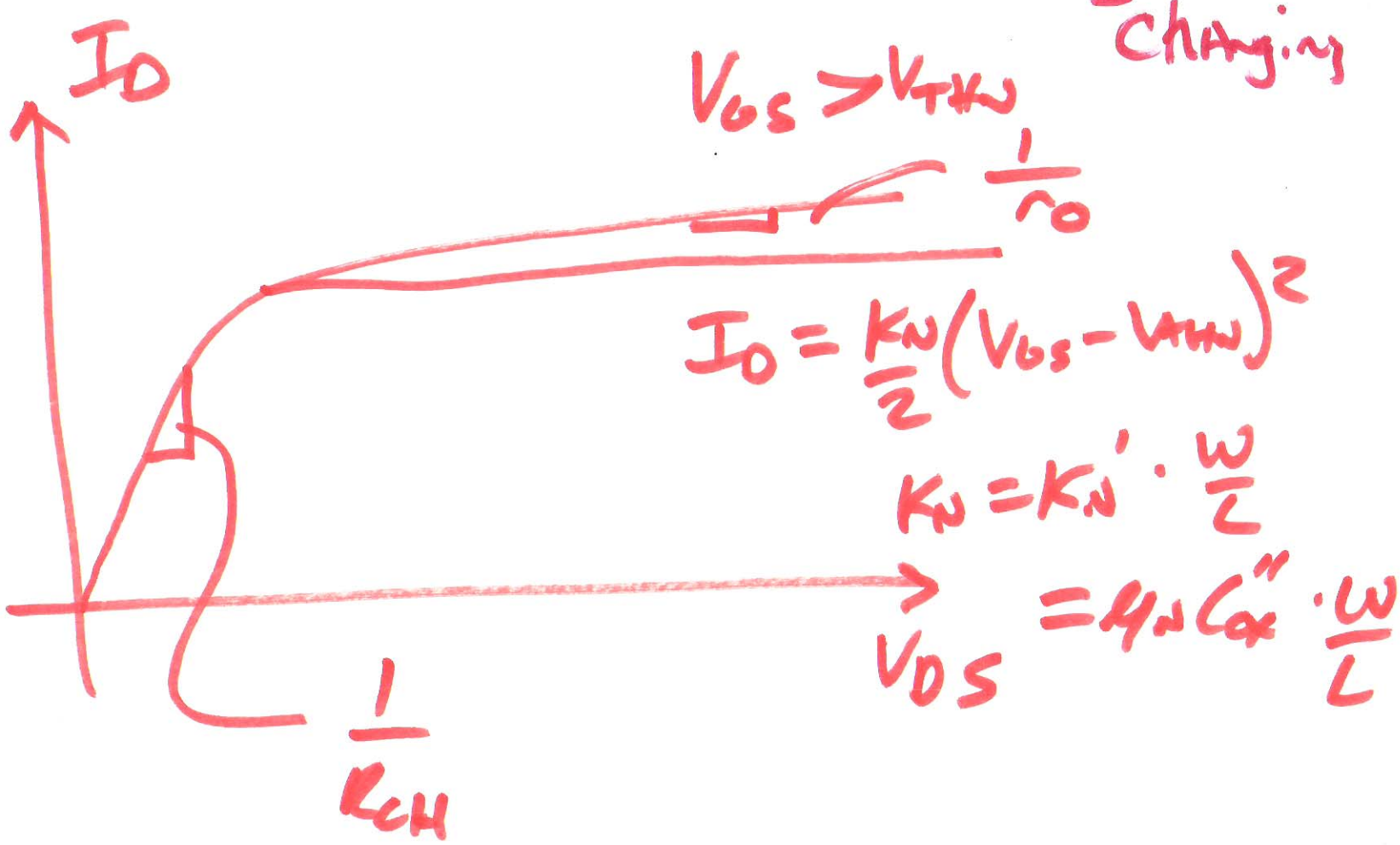
NO

IN triode!

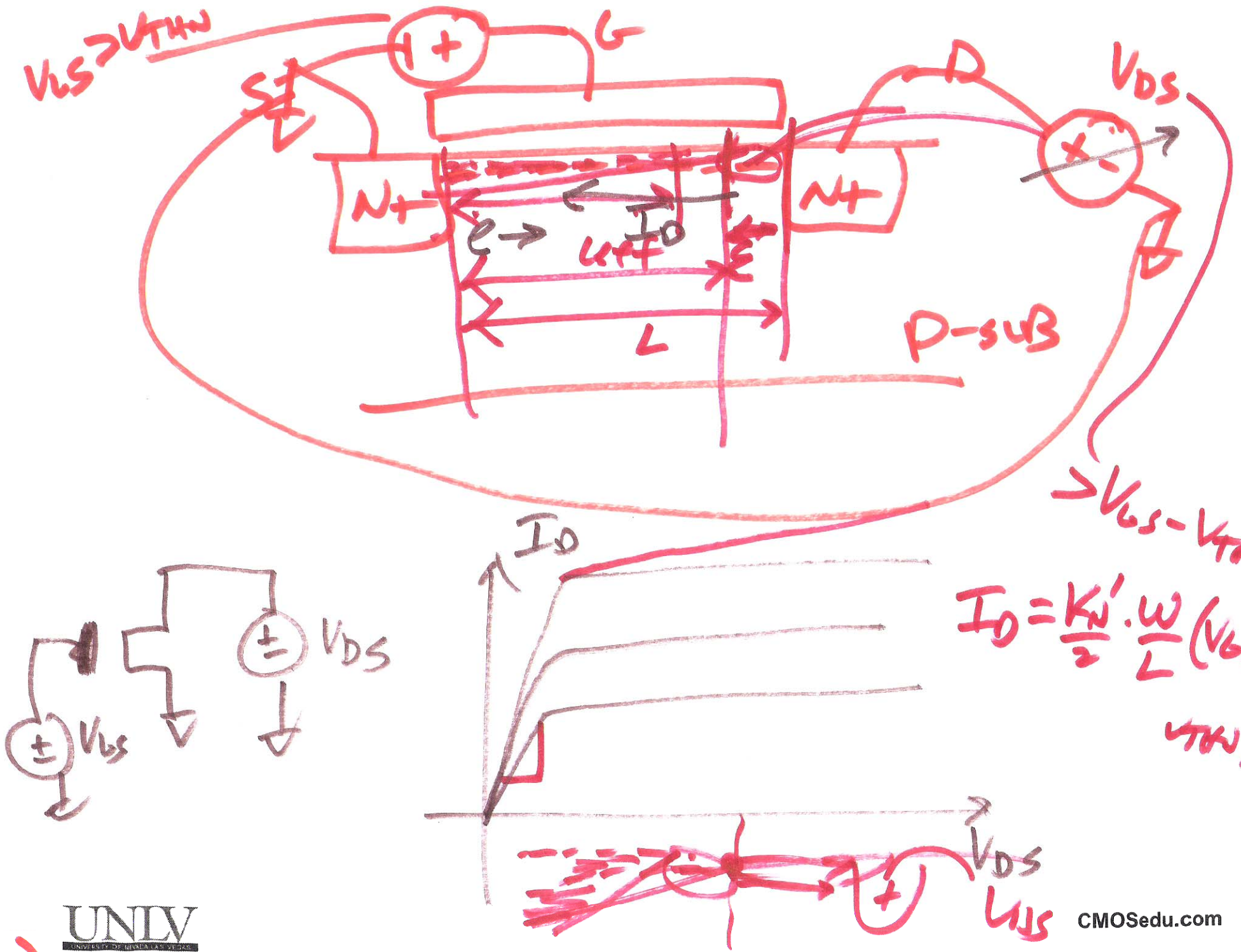
Depletion Devices

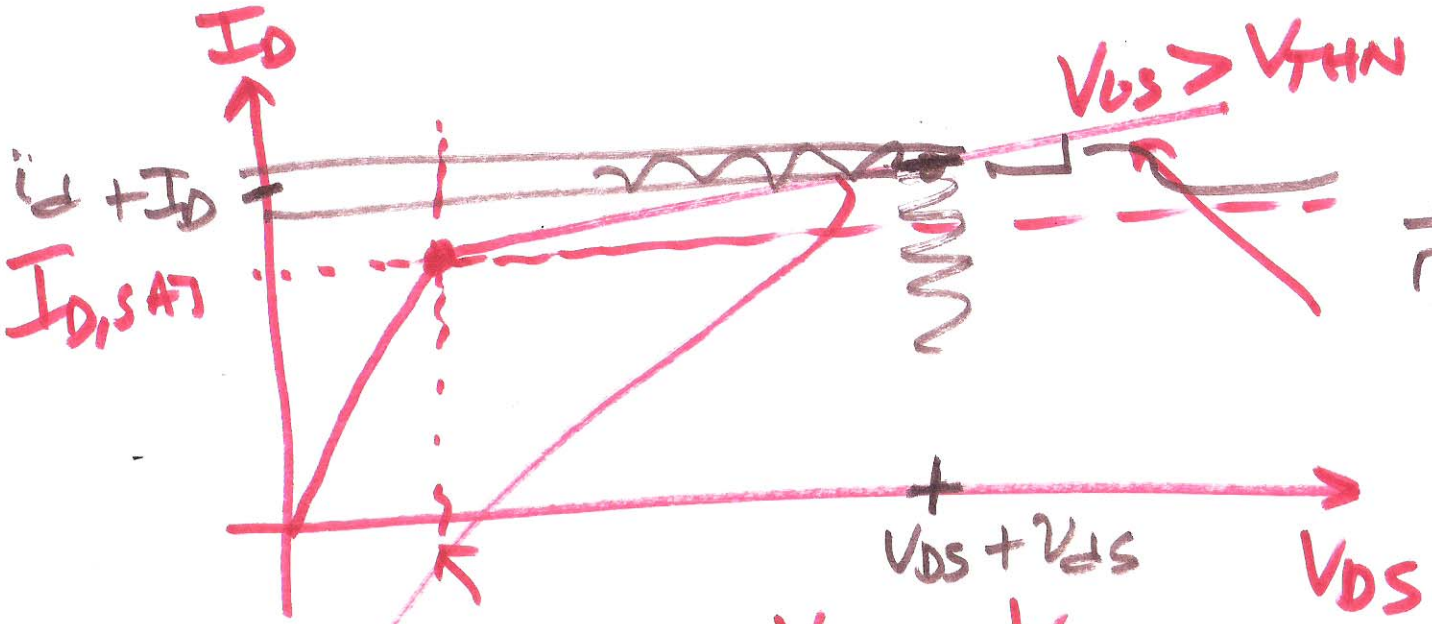


Channel Length Modulation



changing


$V_{GS} > V_{THN}$
S
G
D
V_{DS}
N+
N+
I_D
L_{eff}
L
P-SUB
$> V_{GS} - V_{THN}$
I_D
V_{DS}
V_{GS}
$I_D = \frac{K_N'}{2} \cdot \frac{W}{L} (V_{GS} - V_{THN})^2$
V_{DS}
V_{GS}



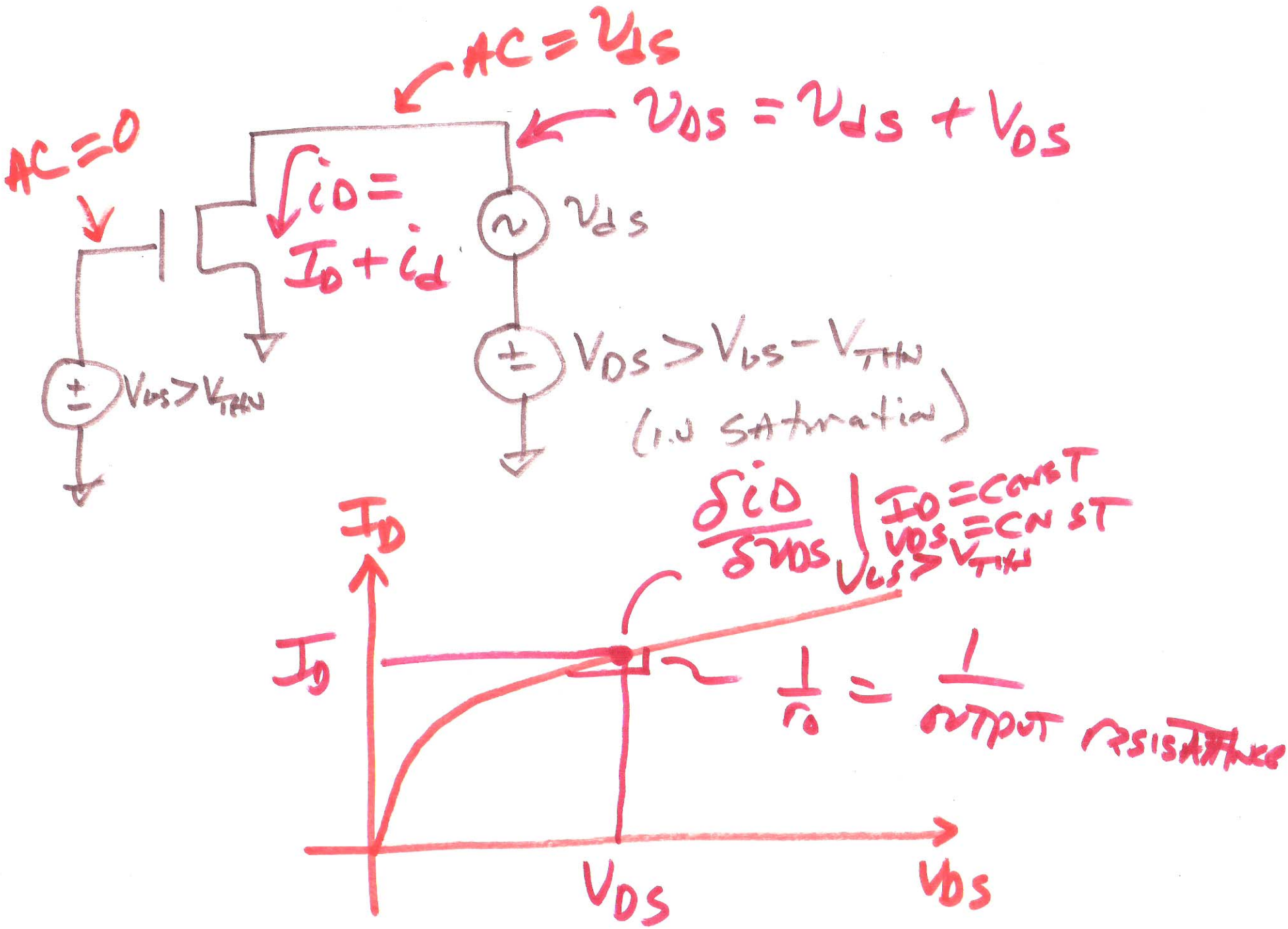
$$V_{DS,SAT} = V_{GS} - V_{THN}$$

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

when $V_{DS} = V_{DS,SAT}$

$$I_D = \overbrace{\frac{K_N'}{2}\frac{W}{L}\left(V_{GS} - V_{THN}\right)^2}^{I_{D,SAT}}\left(1 + \lambda V_{DS}\right)$$

λ: channel length modulation parameter (units V^{-1})

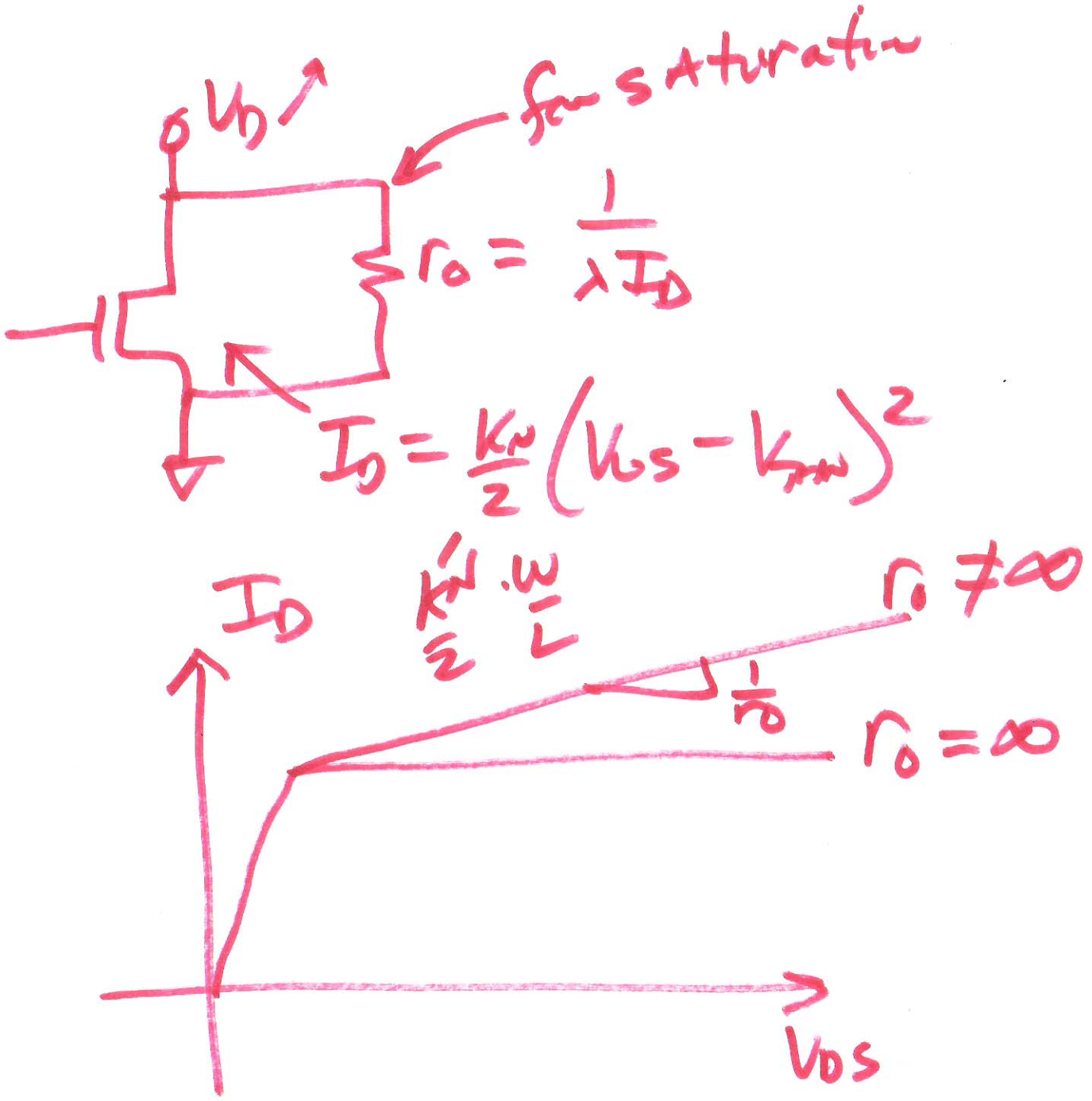

AC = v_{ds}
$v_{DS} = v_{ds} + V_{DS}$
AC = 0
$i_D = I_D + i_d$
v_{ds}
$V_{GS} > V_{THN}$
$V_{DS} > V_{GS} - V_{THN}$
(i.e saturation)
$\frac{\delta i_D}{\delta v_{DS}}\Big|_{V_{GS} > V_{THN}}$
$I_D = CONST$
$V_{DS} = CONST$
I_D
I_D
$\frac{1}{r_o} = \frac{1}{OUTPUT\ RESISTANCE}$
V_{DS}
V_{DS}

$$r_o^{-1} = \left.\frac{\delta i_O}{\delta v_{DS}}\right|_{\substack{I_O=\text{CONST} \\ V_{DS}=\text{CONST}}} = \frac{\delta}{\delta v_{DS}}\left\{\frac{W}{L}\frac{k_N'}{2}\left(\overbrace{V_{GS}}^{V_{GS}} - V_{THN}\right)^2\left(1+\lambda\underbrace{\left(V_{DS}+v_{ds}\right)}_{v_{DS}}\right)\right\}$$

$$r_o^{-1} = \lambda \cdot \frac{k_N'}{2}\frac{W}{L}\left(V_{GS}-V_{THN}\right)^2 \cdot \frac{\delta v_{DS}'}{\delta v_{DS}}$$

$$= \lambda \cdot I_{D,SAT}$$

$$\boxed{r_o = \frac{1}{\lambda I_{D,SAT}}}$$



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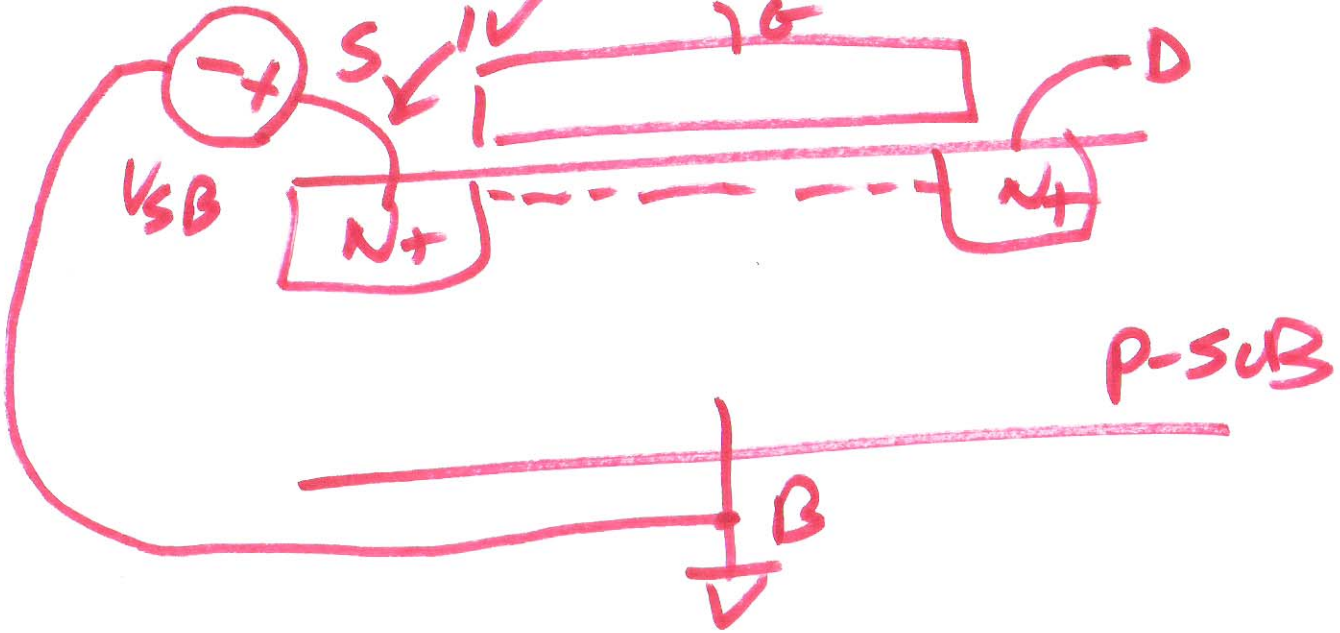
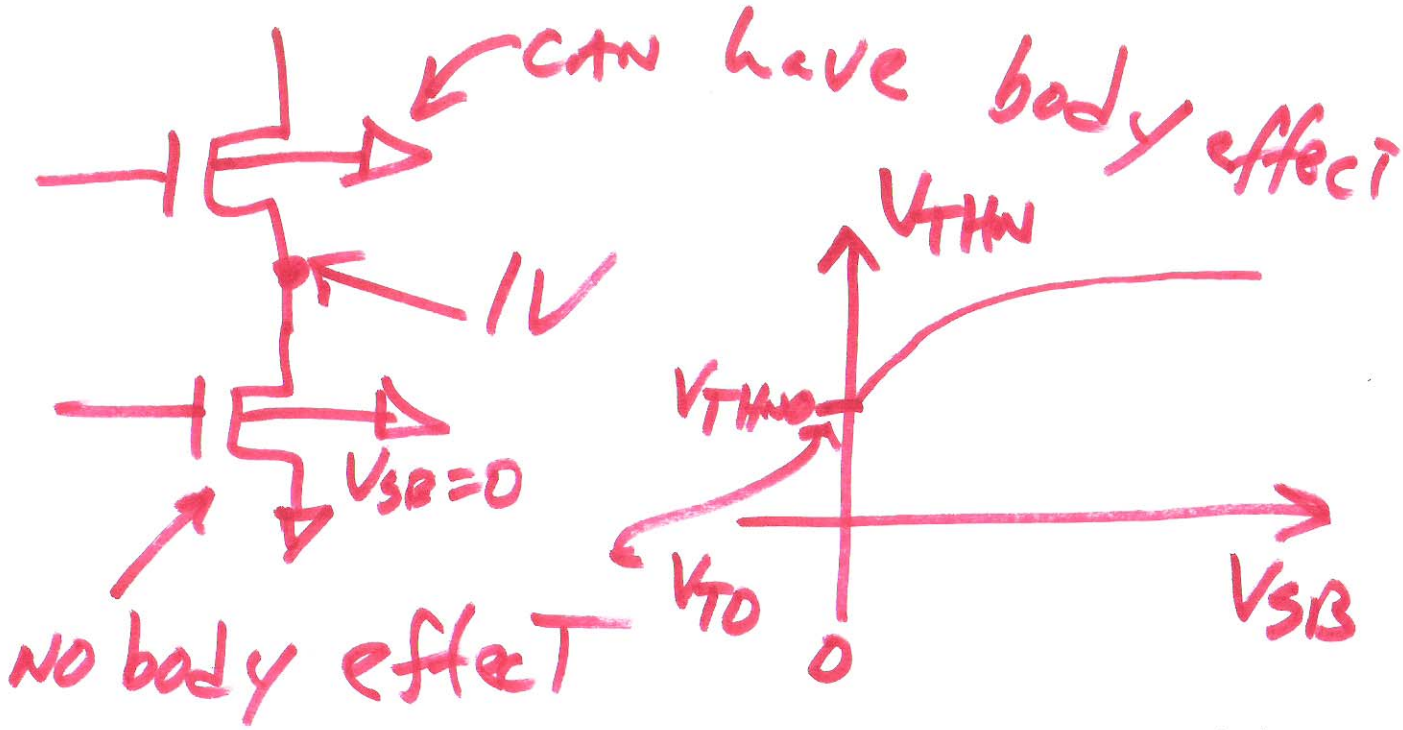

S
G
D
VSB
N+
N+
p-SUB
B


can have body effect
IV
VSB=0
no body effect
VTHN
VTHNO
VTO
0
VSB