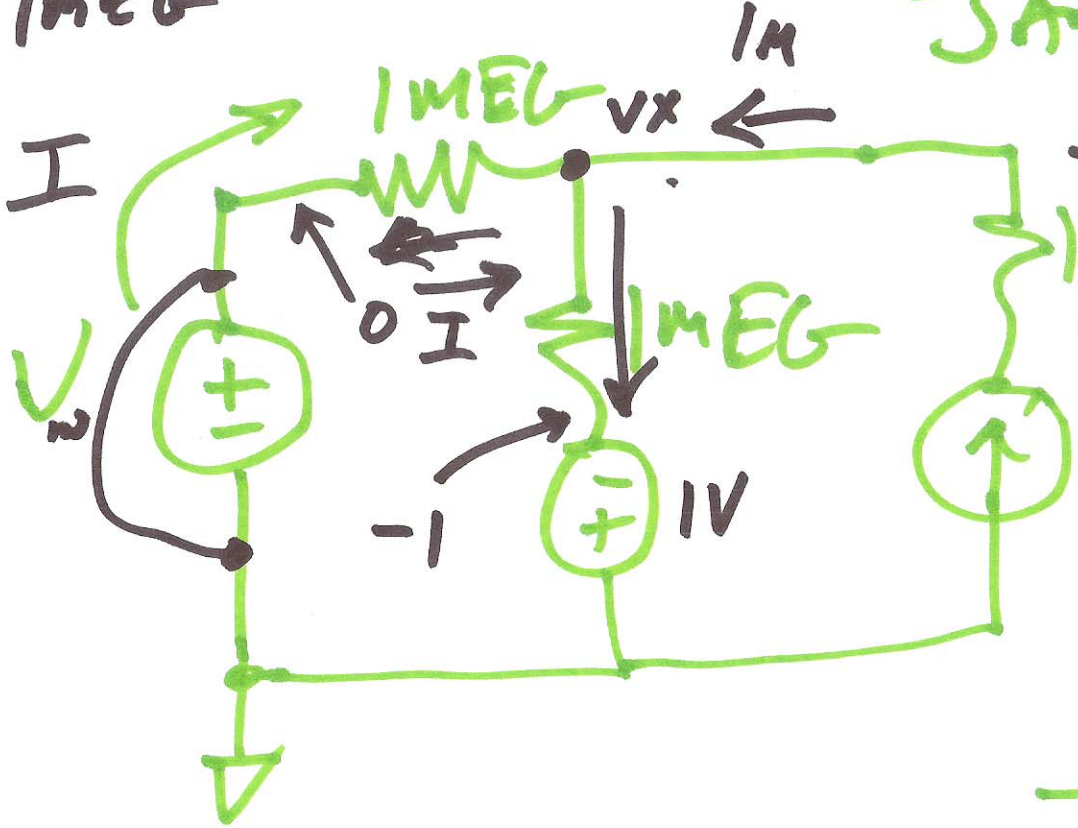
$V_x = V_{in} - 10^6 I$

Lecture 4

EE 420/ECE 620

$I = \frac{V_{in} - V_x}{1 M\Omega}$

JAN. 28, 2015



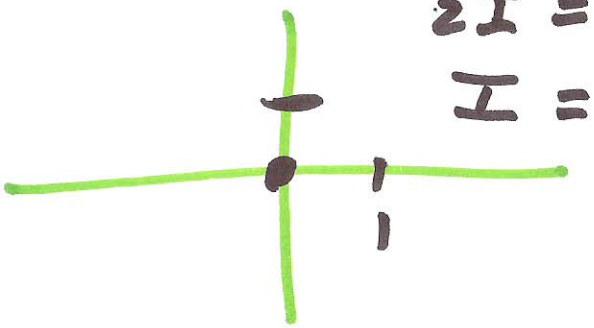
$I + I_x = \frac{V_x - (-1)}{1 M\Omega}$

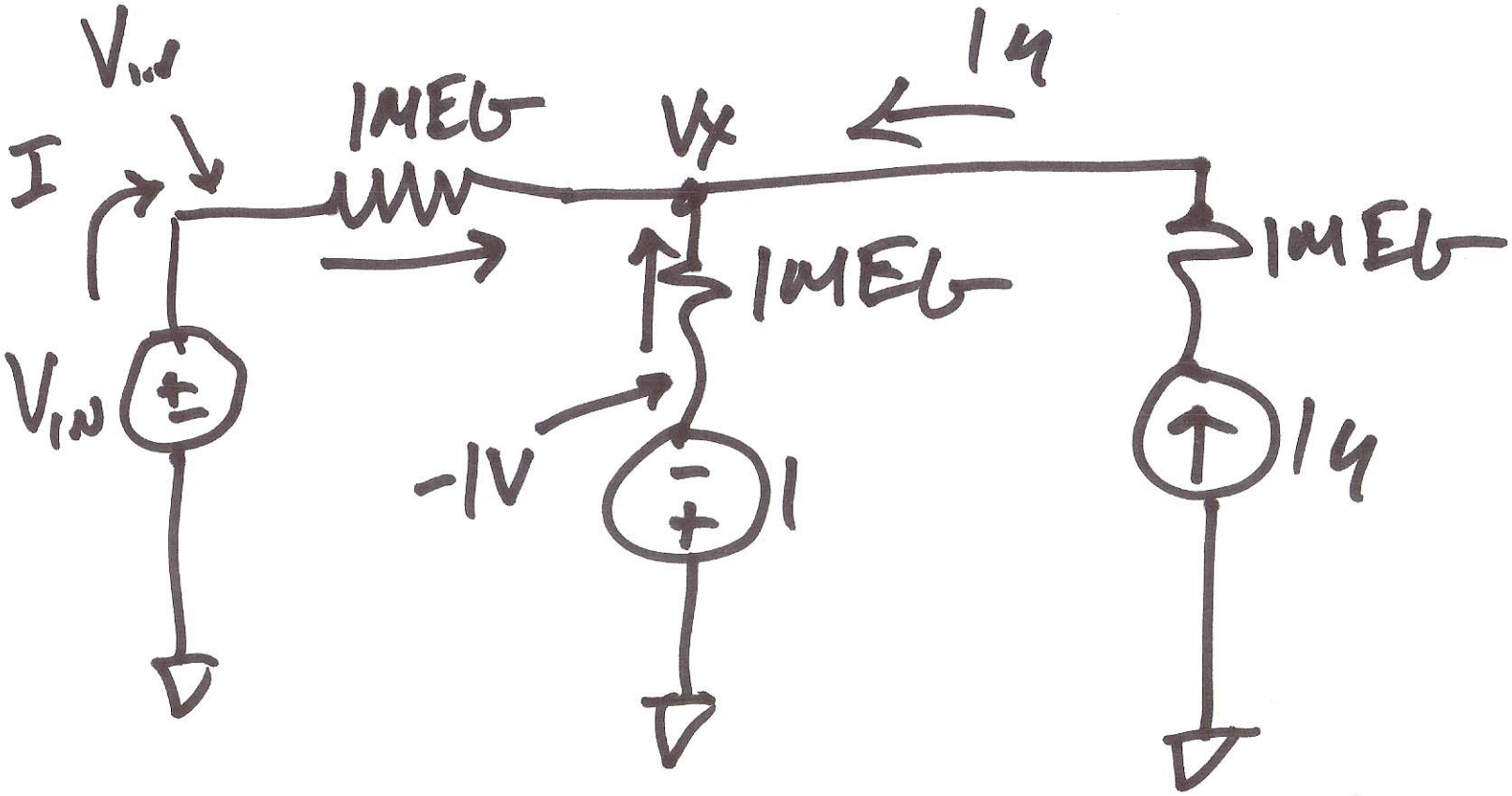
$I + I_x = \frac{V_{in} - 10^6 I + 1}{1 M\Omega}$

$I = 10^{-6} V_{in} - I$

$2I = 10^{-6} V_{in}$

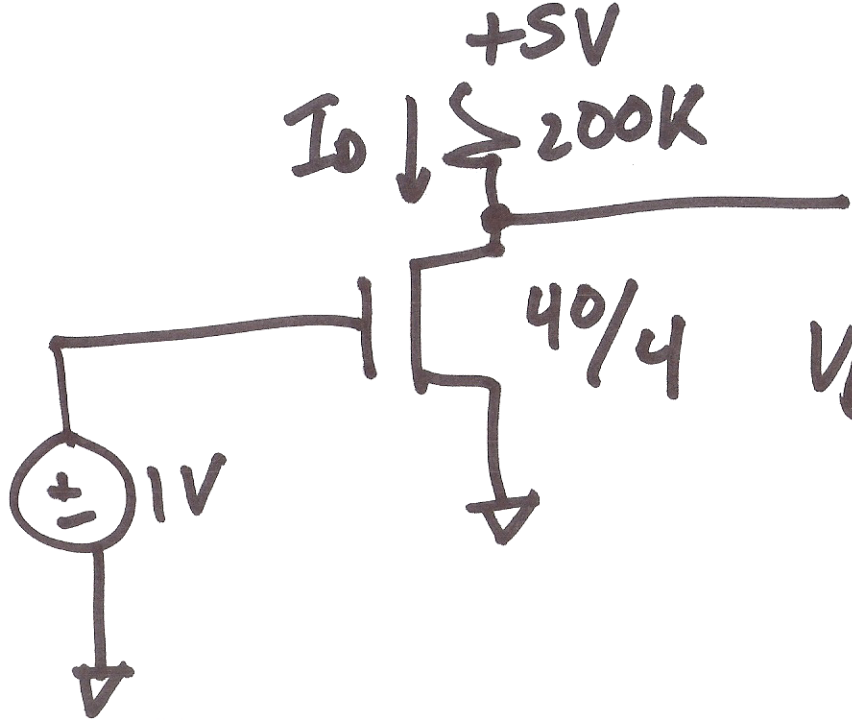
$I = \frac{1}{2} \mu V_{in}$





$$\frac{V_{IN}-V_x}{10^6} + I_4 + \frac{-1-V_x}{10^6} = 0$$

$$I = \frac{V_{IN}-V_x}{10^6}, \quad V_x = V_{IN} - I\cdot 10^6$$



$V_x = 0.2$? Assume Sat.

V_{DS}

$$I_D = \frac{120\mu}{2} \cdot \frac{40}{4} (1-.8)^2$$

$$= 600\mu \cdot .04$$

$$= 24\mu A$$

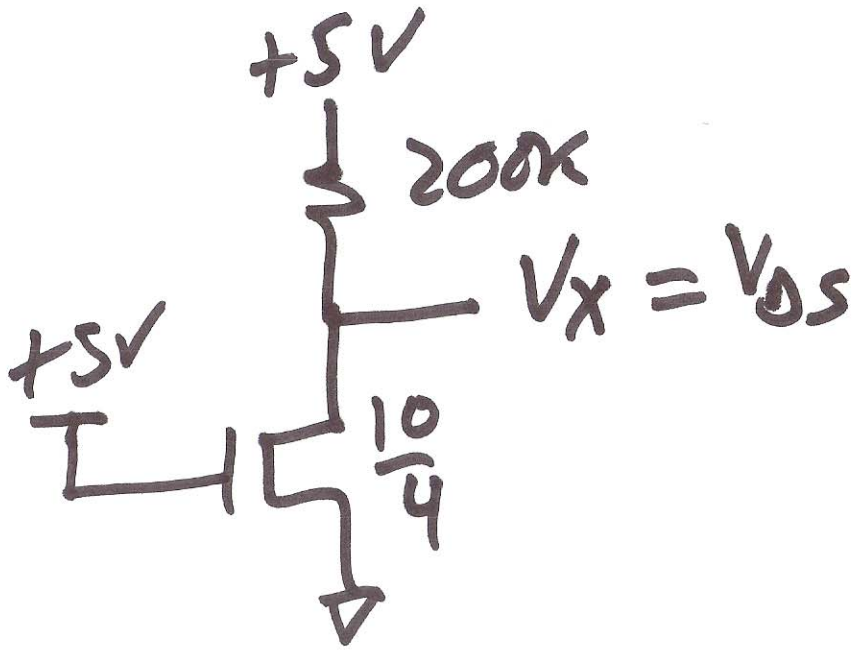
verify

$$V_x = 5 - \frac{200K \cdot 24\mu}{4.8}$$

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

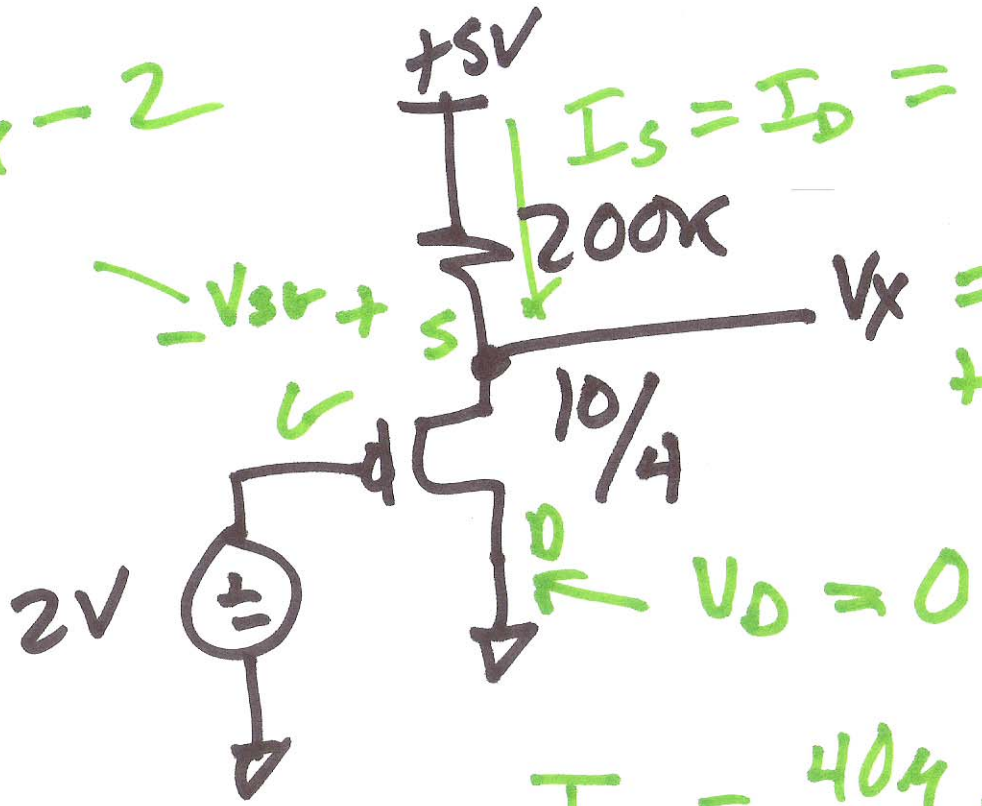
$$0.2 \geq ? \frac{1-.8}{.2}$$

V_x yes



$$\frac{5 - V_X}{200k} = I_D = 120u \cdot \frac{10}{4}\left((5 - .8)V_X - \frac{V_X^2}{2}\right)$$

$$= 300u \cdot 4.2V_X - \frac{300u}{2} V_X^2$$



$V_{SG} = V_X - 2$

$I_S = I_D = \frac{5 - V_X}{200K}$

$-V_{SG} +$

$V_X = V_S$

$+ V_{SD} = V_S = V_X$

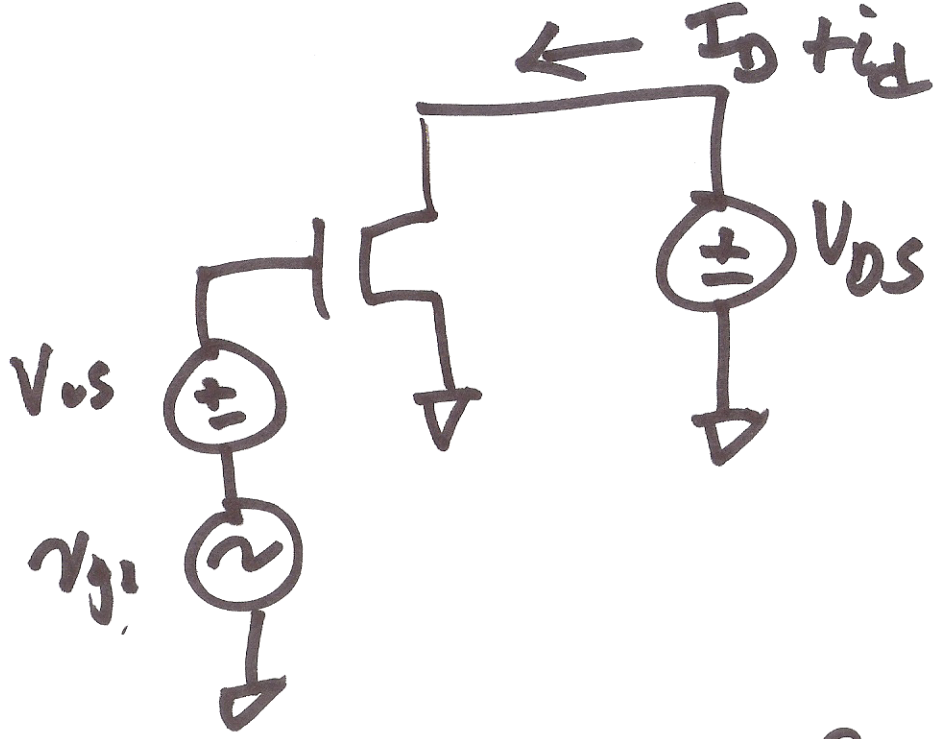
$V_D = 0$

$I_D = \frac{40\mu}{2} \cdot \frac{10}{4}\left(V_X - 2 - .9\right)^2$

Check

$V_{SD} \geq V_{SG} - V_{THP}$?

$\frac{5 - V_X}{200K} = I_D$

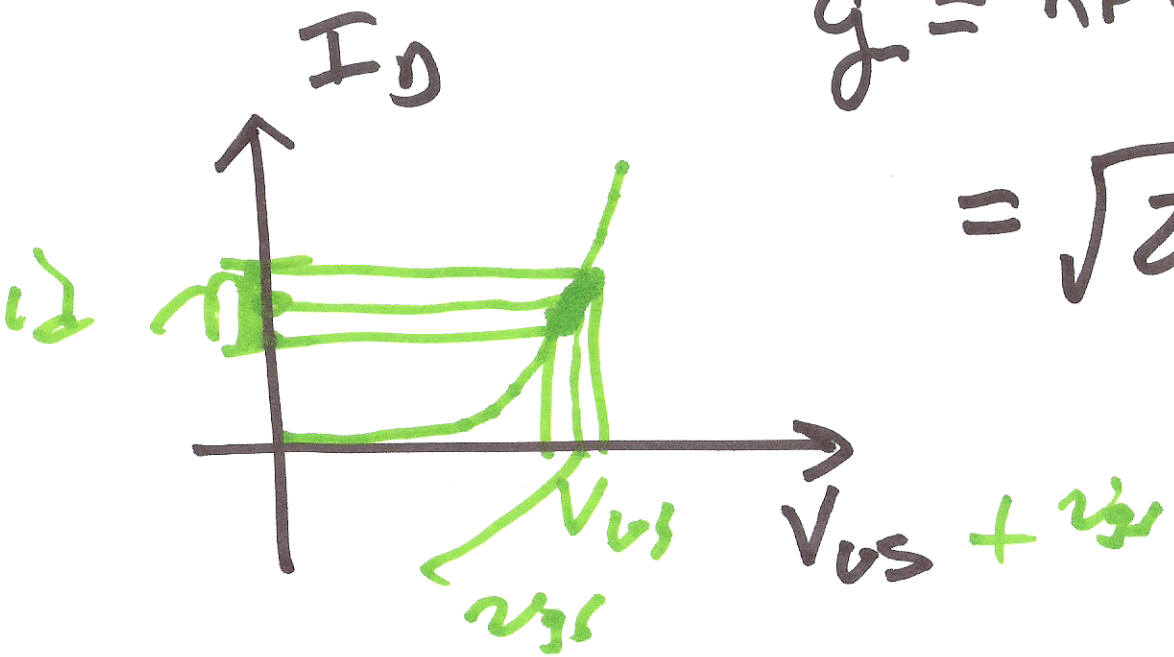


$$I_D = \frac{KP}{2}\frac{W}{L}\left(V_{GS} - V_{THN}\right)^2$$

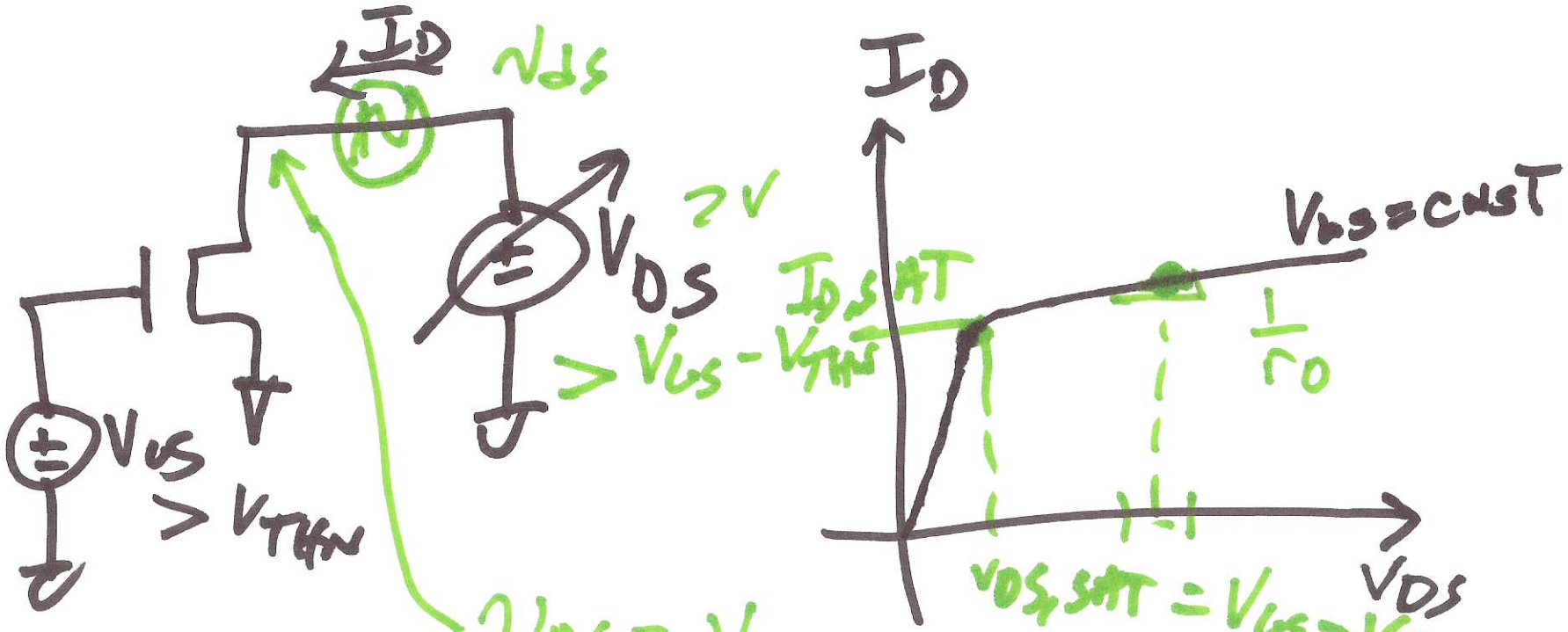
$$i_d = g \, v_{gs}$$

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

$$= \sqrt{2KP \cdot \frac{W}{L} I_D} = \sqrt{2\beta I_D}$$



b)



$$v_{DS} = V_{DS} + v_{ds}$$

$$I_{D,SAT} \quad i_d = \frac{v_{ds}}{r_O}$$

$$V_{DS} + V_{GS}$$

$$\frac{\delta I_D + i_d}{\delta v_{DS}} \Big|_{V_{DS}} = \frac{K_P}{2}\frac{W}{L}\left(V_{GS} - V_{THN}\right)^2\left(1 + \lambda\left(V_{DS} - V_{DS,SAT}\right)\right)$$

$I_D = CONST$

$V_{DS} = CONST$

$$\frac{1}{r_O} = \frac{\partial}{\partial V_{DS}}\left(I_{D,SAT}\left(1+\lambda(V_{DS}+V_{ds}-V_{DS,SAT})\right)\right)$$

$V_{GS}-V_{TH}$

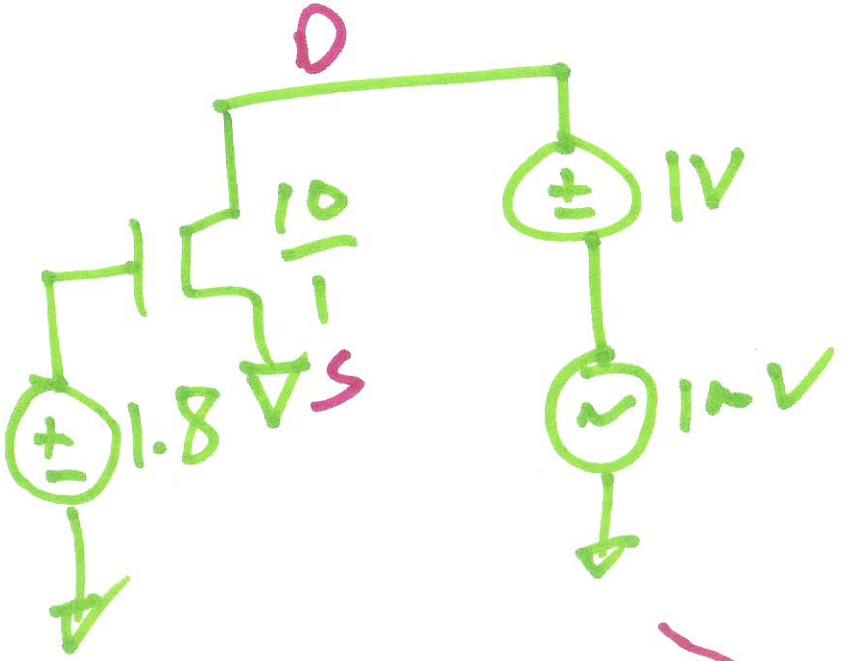
$I_D = \text{CONST}$

$V_{DS} = \text{CONST}$

$$\frac{\partial\, a\lambda x}{\partial x}$$

$$= I_{DSAT}\cdot\frac{\partial\left(V_{DS}+V_{ds}\right)}{\partial V_{DS}} \simeq V_{DS} \text{ for small-signal app.}$$

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



$I_D + i_d$

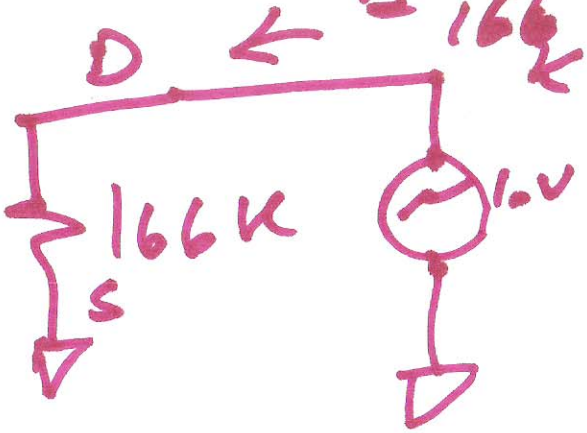
$I_D = \frac{120\mu}{2} \cdot \frac{10}{1}(1.8-\cancel{\phi})^2$

$I_D = 600\mu$

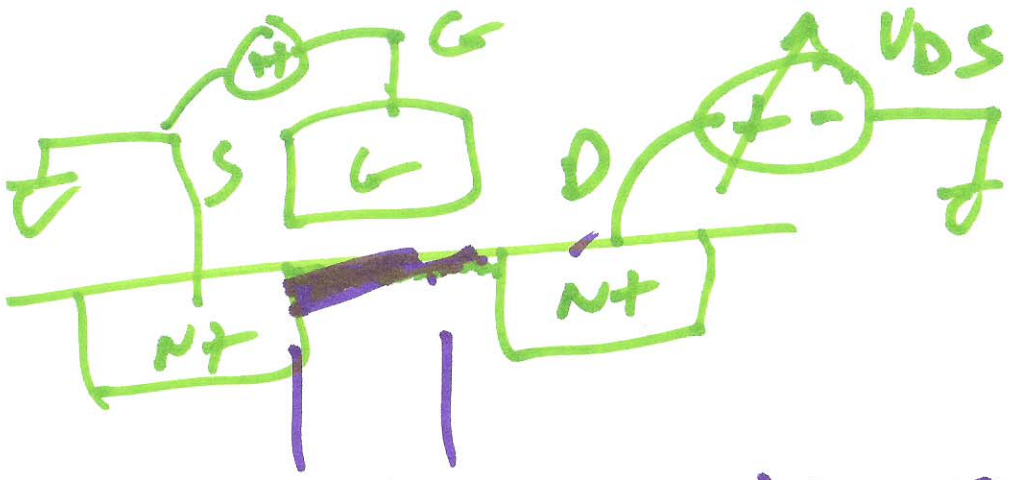
$\lambda_N = 0.01\,V^{-1}$

$r_o = \frac{1}{0.01 \cdot 600\mu}$

$= \frac{1}{6\mu} = \underline{166\,K}$



LNA



$L_{eclec} \downarrow \quad V_{DS} \uparrow$

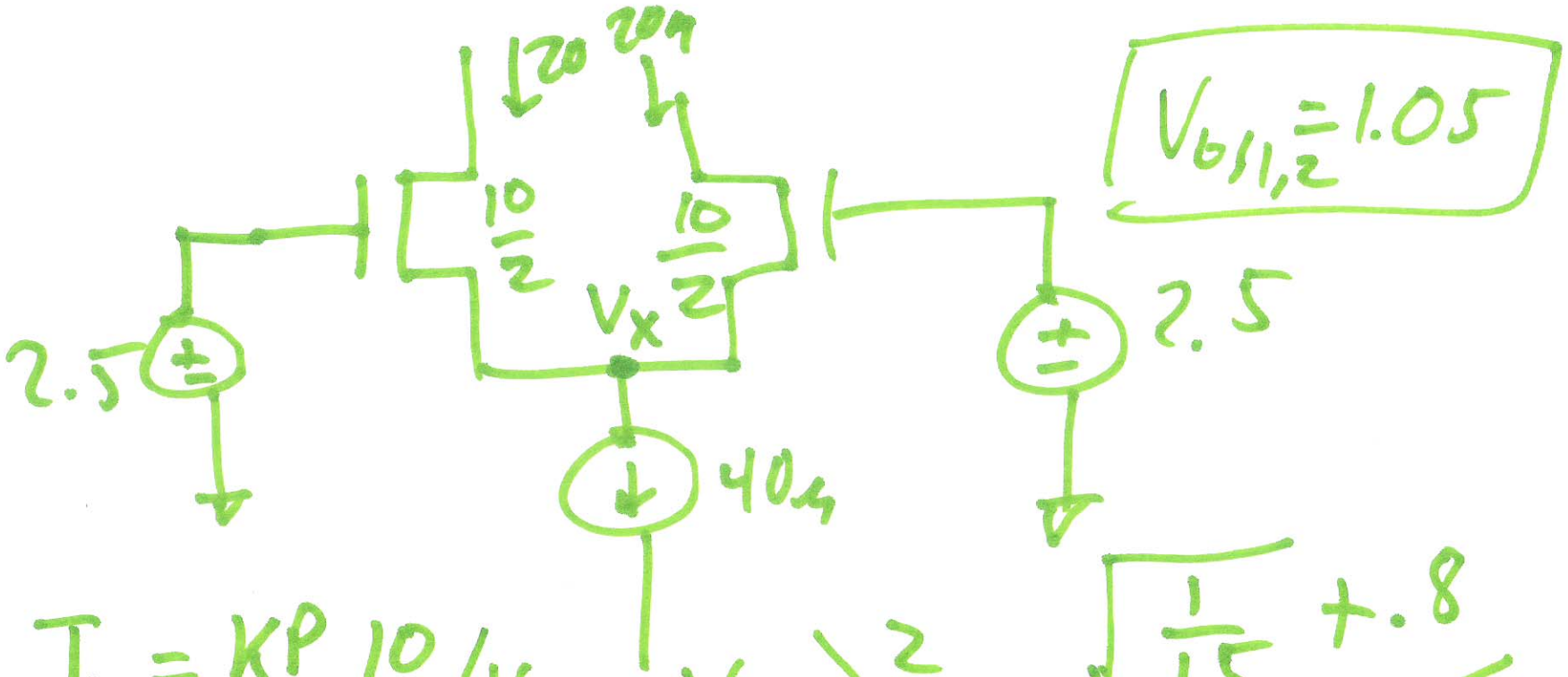
$$I_D = K_P \frac{W}{L} (V_{DS} - V_{TH})^2$$

$I_D \uparrow$

V_{DS}

EX. 9.5

$V_{GS1} = V_{GS2}$



$V_{GS1,2} = 1.05$

$I_D = \frac{KP}{2}\frac{10}{2}(V_{GS} - V_{THN})^2$

$\sqrt{\frac{1}{15}} + .8$

~~.54~~ 1.05

$V_{GS} = \sqrt{\frac{2I_D}{KP\frac{W}{L}}} + V_{THN} = 2.5 - V_X$

$\sqrt{\frac{2 \cdot 20\mu}{120\mu \cdot .5}} + .8 = 2.5 - V_X$

$\simeq 1.9$ 1.01

$V_X = 2.5 - .$ ~~.54~~