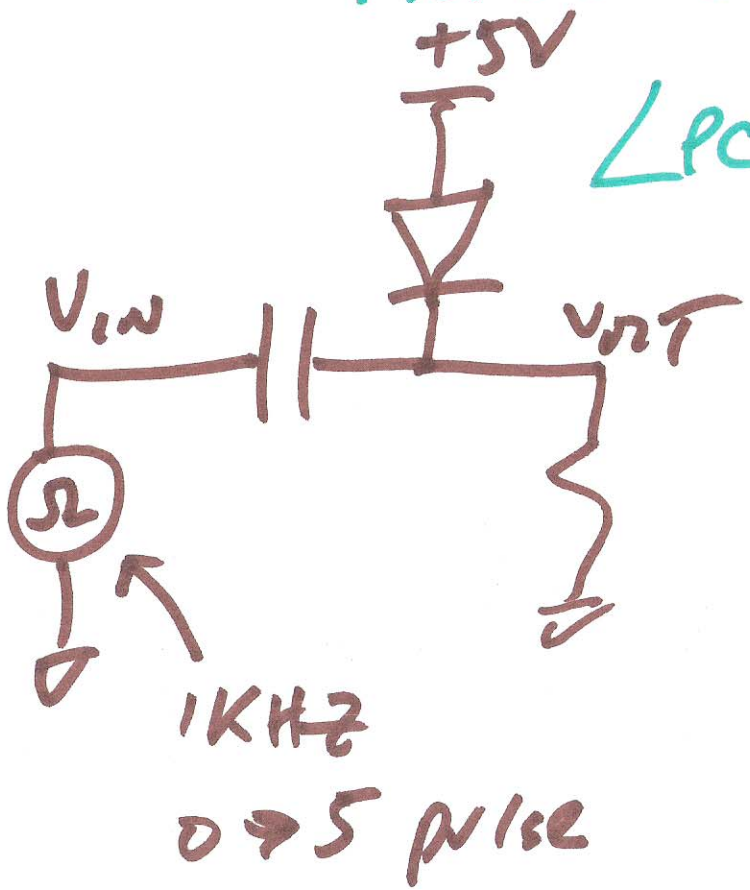
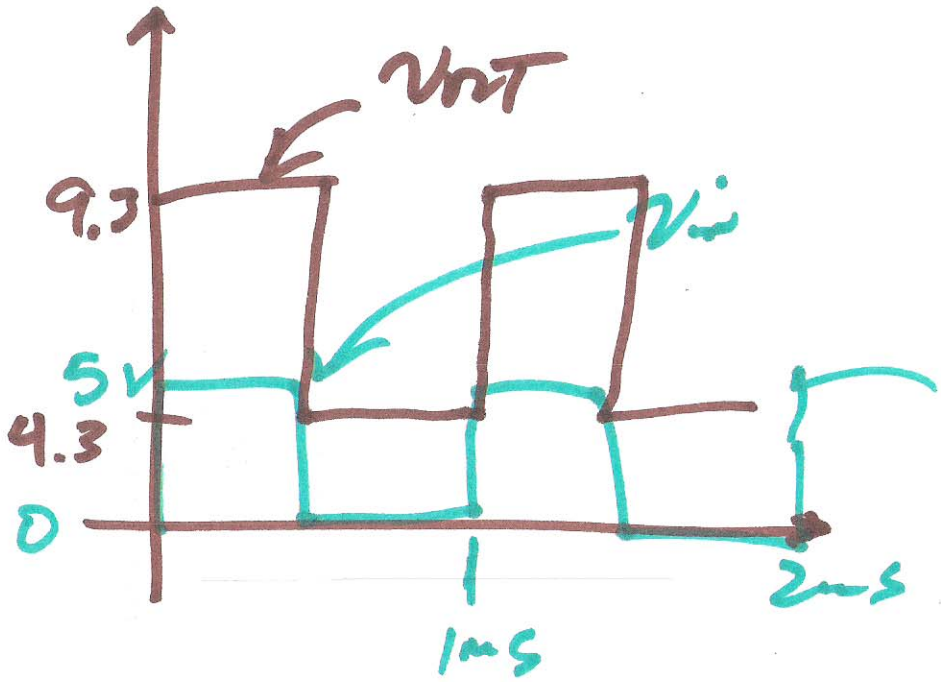
EE 320
Engineering Electronics I

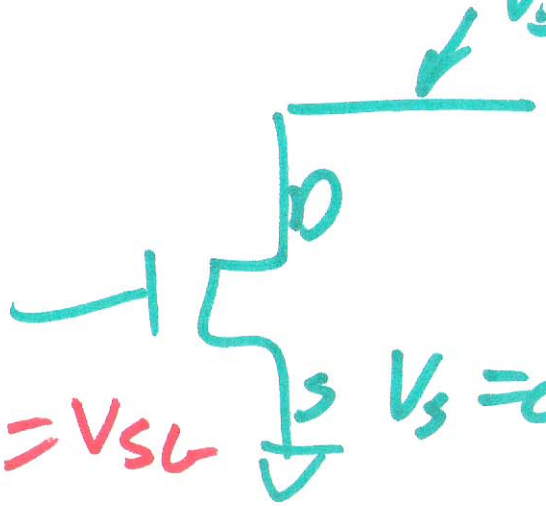
March 25, 2015

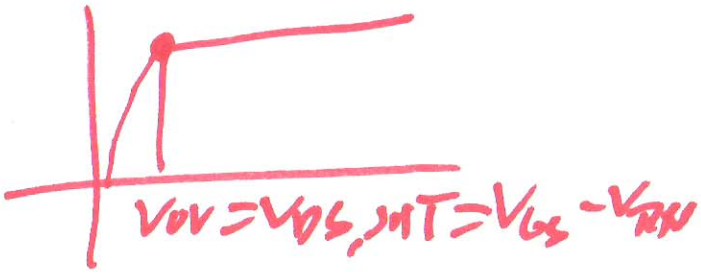
Lecture 19





$V_S = V_{DS} = V_D - V_S > 0$



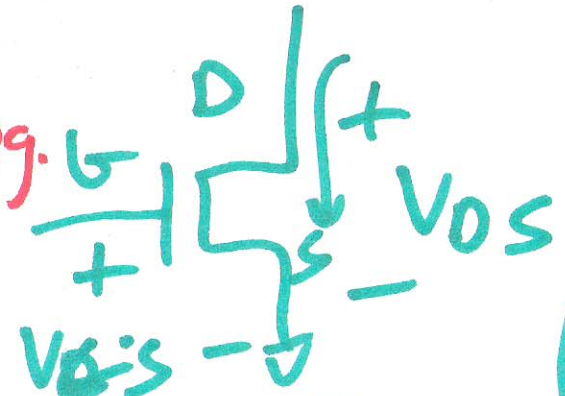


$V_S - V_G = V_{SG}$

$V_G - V_S = V_{GS}$ triode

pmos

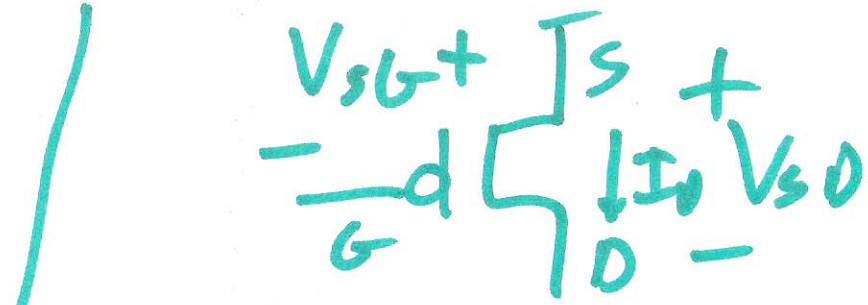
$V_{THP} = V_{TH,G}$



SAT: $V_{GS} > V_{TH}$

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

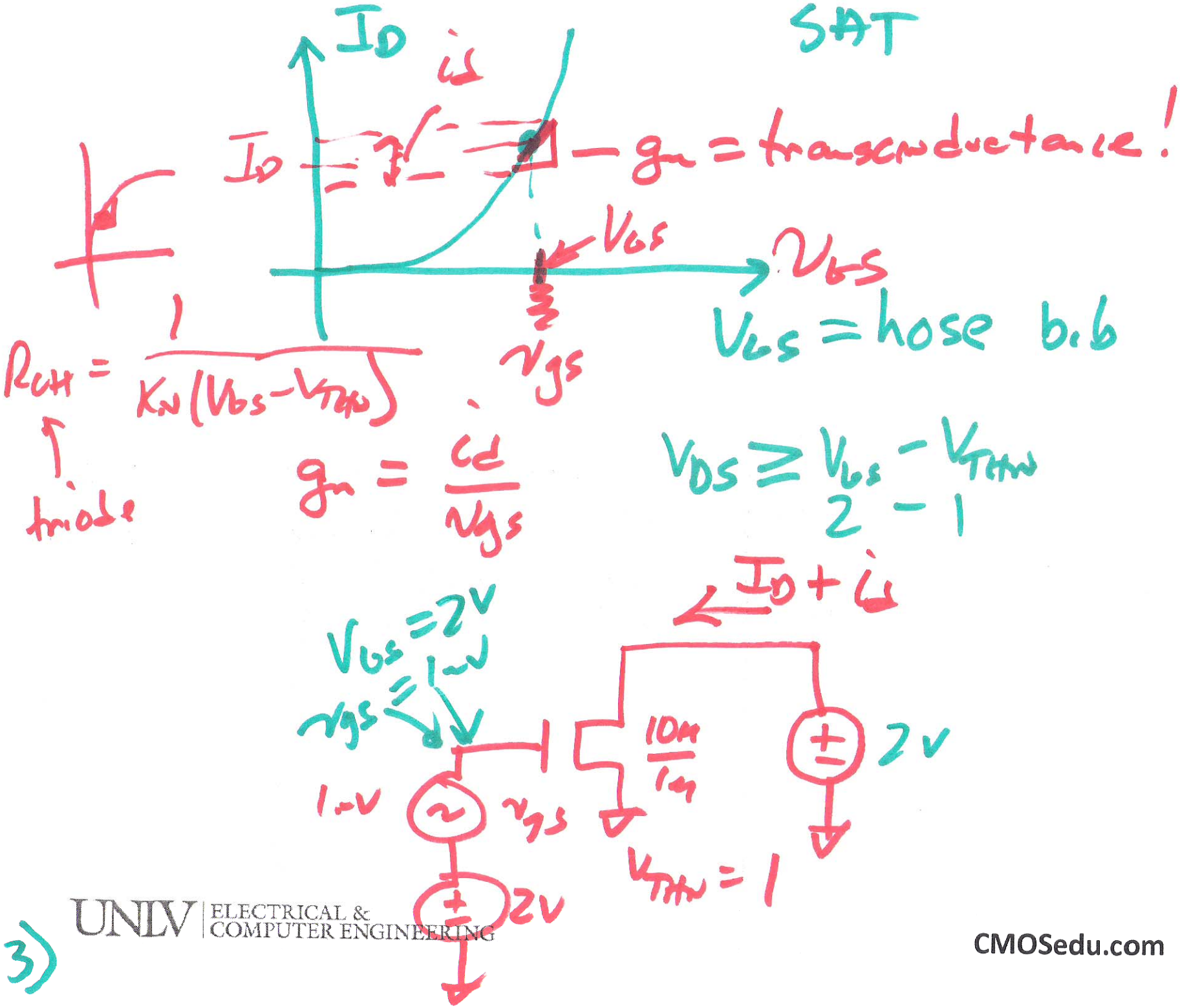
triode



SAT: $V_{SG} > V_{THP}$

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

$V_{DS} \geq V_{GS} - V_{TH}$ $= V_{OV} = V_{DS,SAT}$



$$i_D = i_d + I_D = \frac{K_N}{2}\left(\underbrace{v_{gs} + V_{bs}}_{v_{GS}} - V_{THN}\right)^2$$

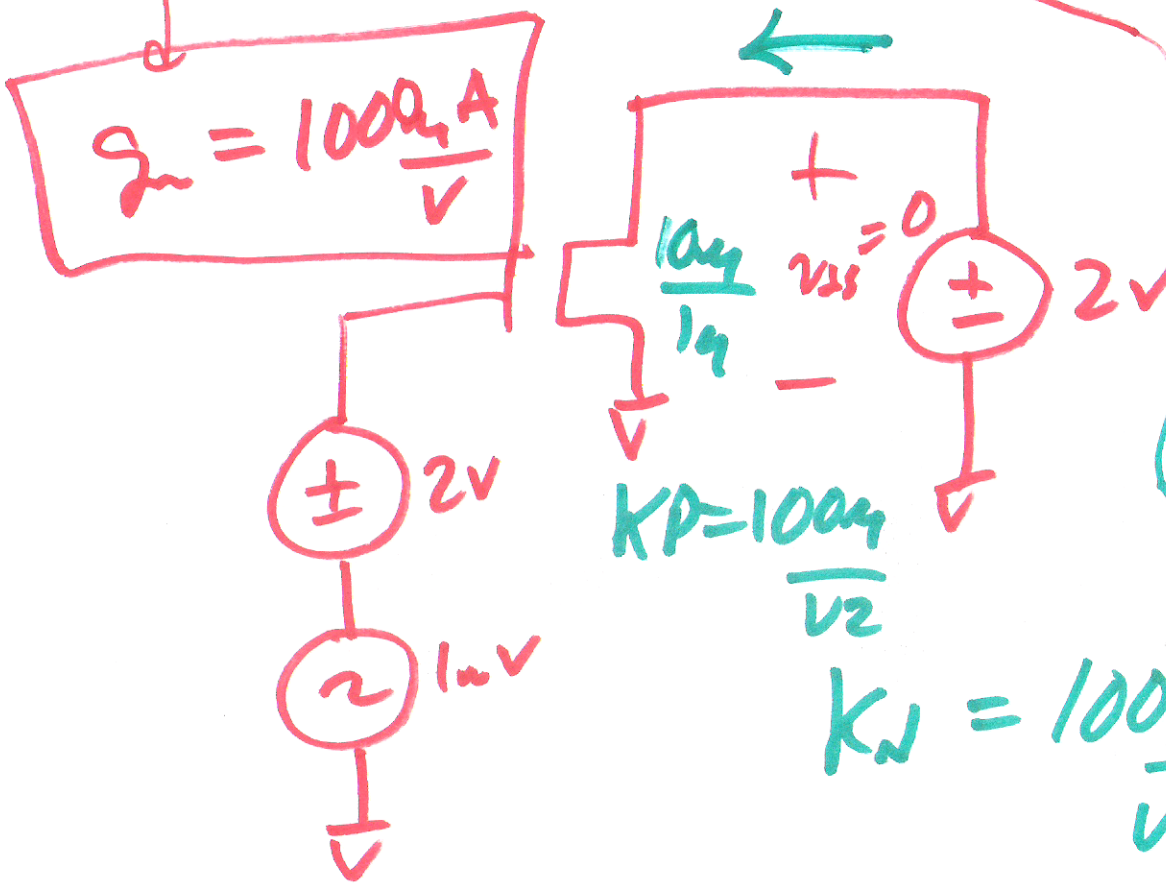
$$g_m = \left.\frac{\delta i_D}{\delta V_{GS}}\right|_{\substack{I_D = \text{CONST} \\ V_{bs} = \text{CONST}}} = K_N\left(v_{GS} - V_{THN}\right)$$

$v_{GS} \rightarrow v_{gs} + V_{bs}$

$$g_m \simeq K_N\left(V_{GS} - V_{THN}\right)$$

Small-signal Approx

$$V_{GS} \gg v_{gs}$$



$$g_m = K_N(V_{GS} - V_{THN})$$

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

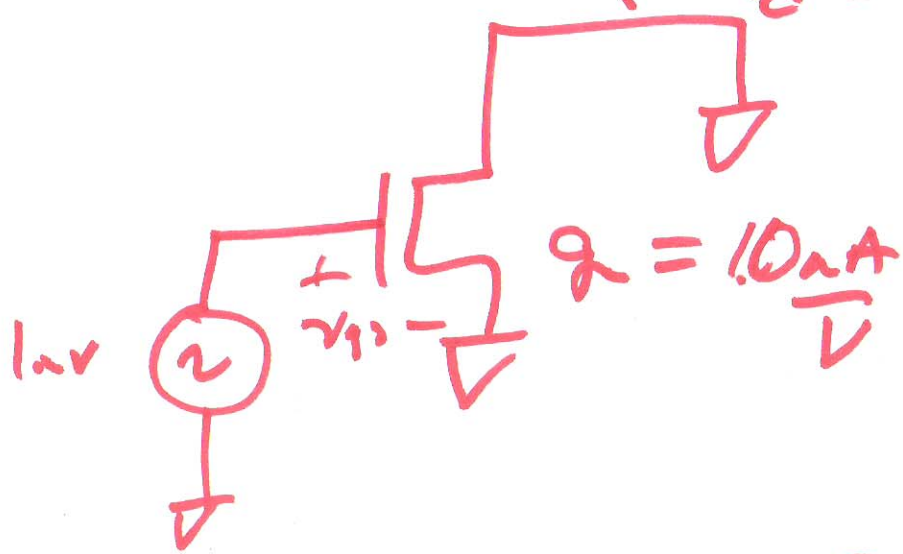
$$V_{GS} - V_{THN} = \sqrt{\frac{2I_D}{K_N}}$$

$$K_N = \frac{100\mu}{V2} \cdot \frac{10}{1} = \frac{1m A}{V2}$$

$$I_D = \frac{1mA/V2}{2}(2-1)^2 = 500\mu A$$

$$g_m = K_N\sqrt{\frac{2I_D}{K_N}} \quad \boxed{= g_m = \sqrt{2I_D \cdot K_N}}$$

Ac ckt



$\leftarrow i_d = g_m v_{gs} = \frac{1mA}{V} \cdot 1mV$

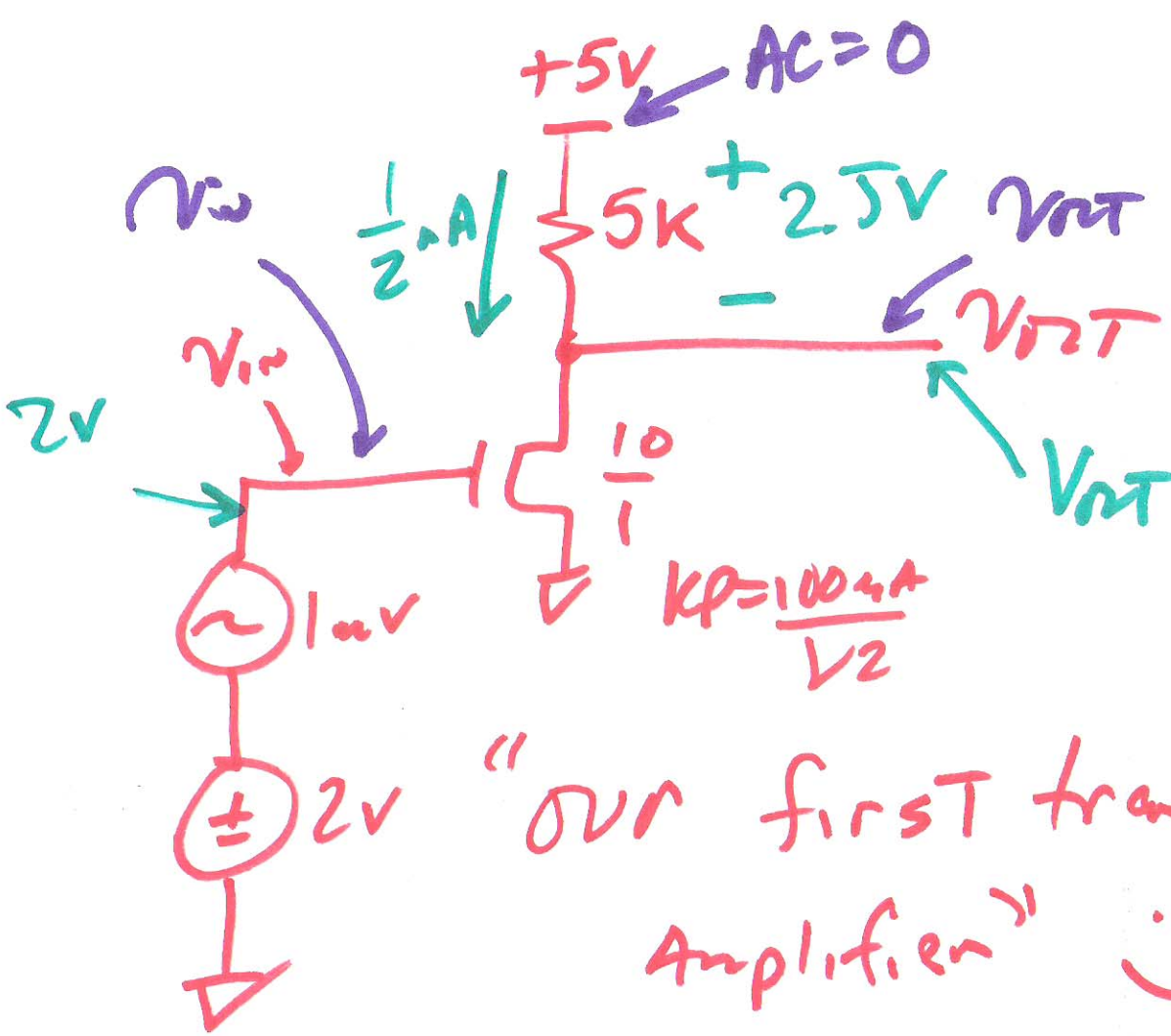
$= 1\mu A$

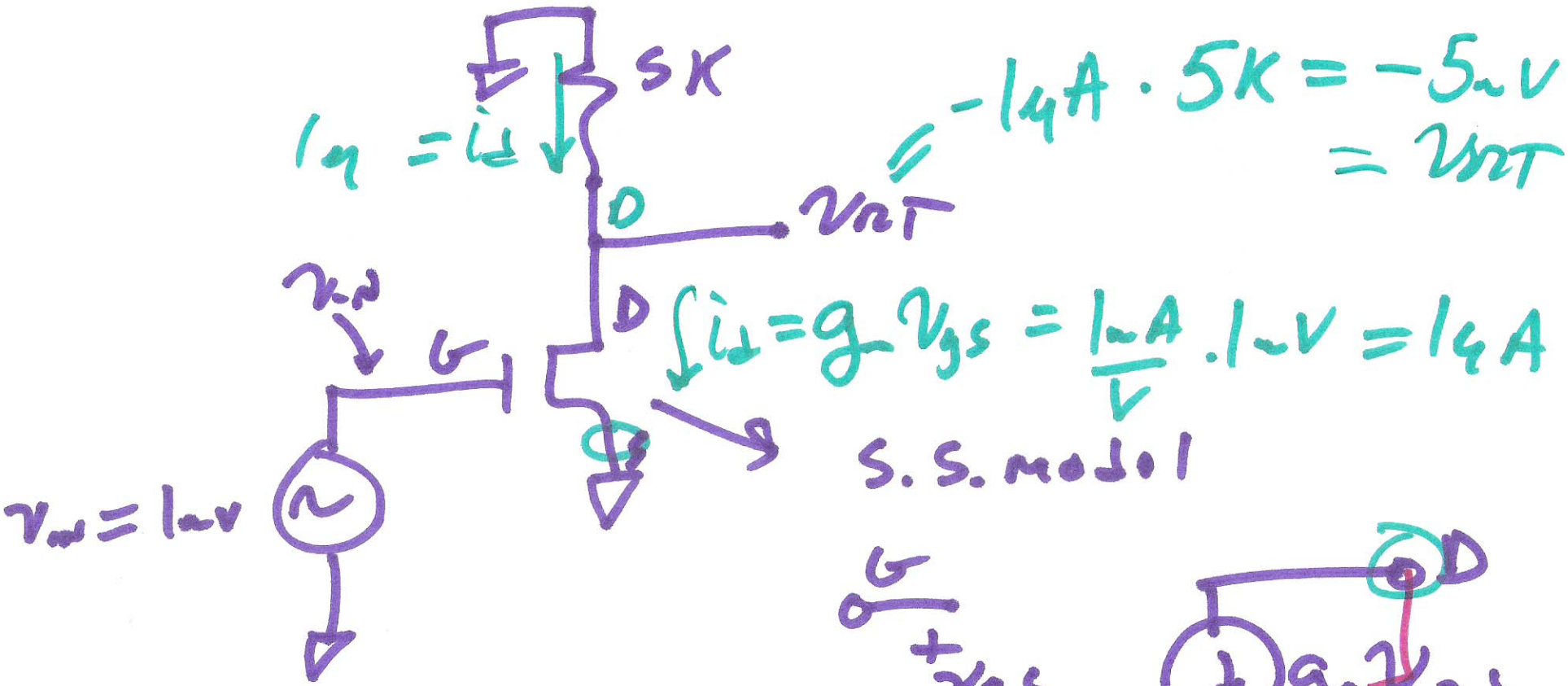
$20 \log 10^{-3} = -60 \log 10$

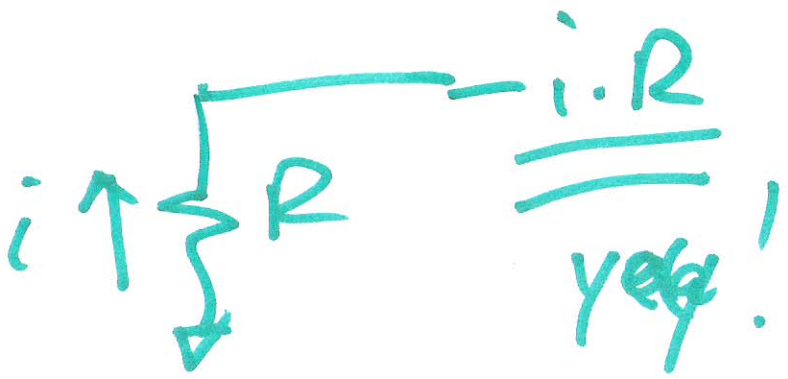
$= -60dB = 1mV$

$-20 \log 10^{-6} = -120dB = 1\mu A$

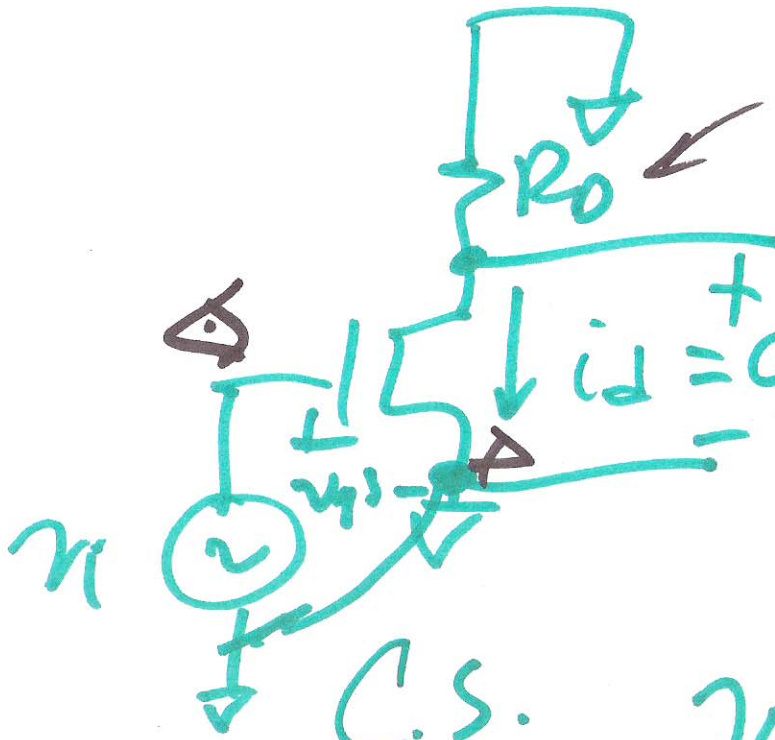
6)


+5V
AC=0
$\frac{V_{out}}{V_{in}} = ?$
V_{in}
$\frac{1}{2}$mA
5k
+
2.5V
V_{out}
−
V_{out}
V_{in}
2V
10
1
$V_{out} = 2.5V$
$V_{DS} \geq V_{GS} - V_{TH}$
2.5 ≥ 2 − 1 yes!
1mV
$K_P = \frac{100\mu A}{V^2}$
2V
"our first transistor Amplifier"





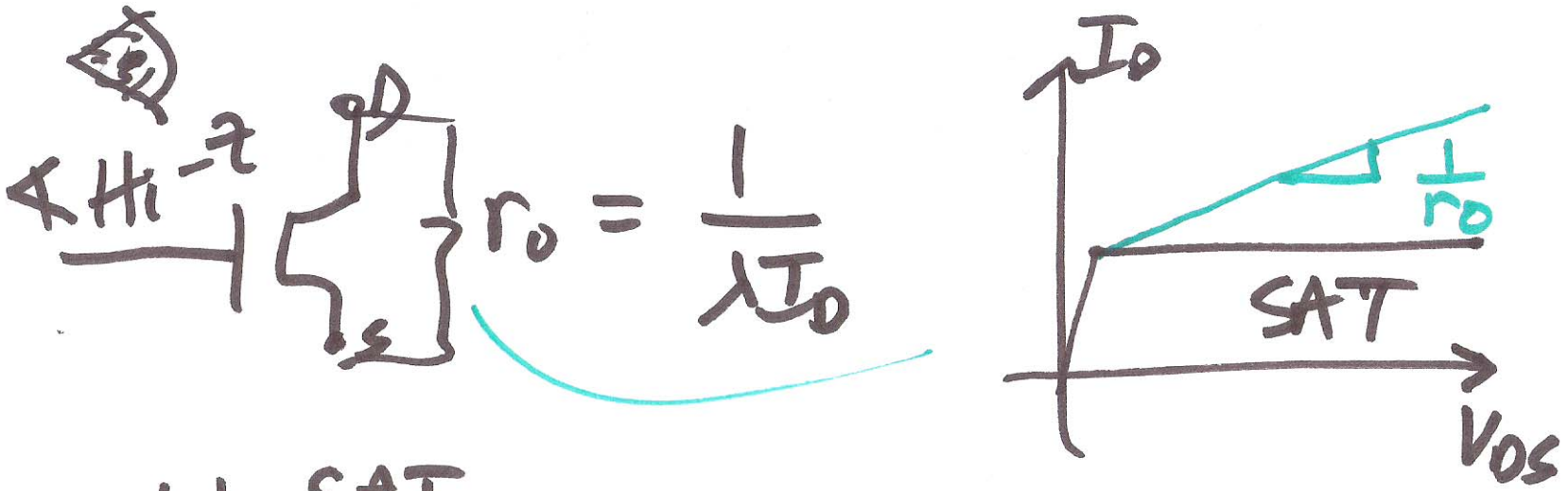
$$\frac{v_{xT}}{v_{in}} = -5V$$



$$\frac{v_{DT}}{v_i} = \frac{-i_d \cdot R_d}{i_d / g_m}$$

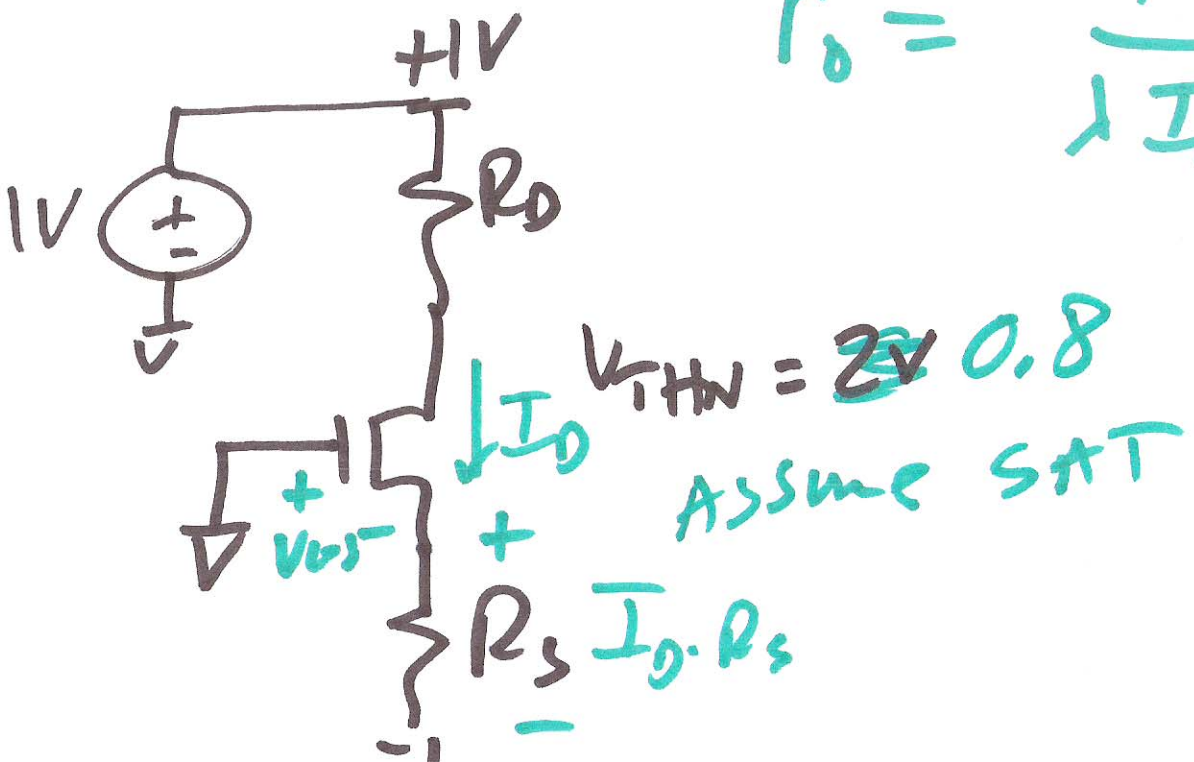
Common source $v_{gs} = v_i$ Amplifier

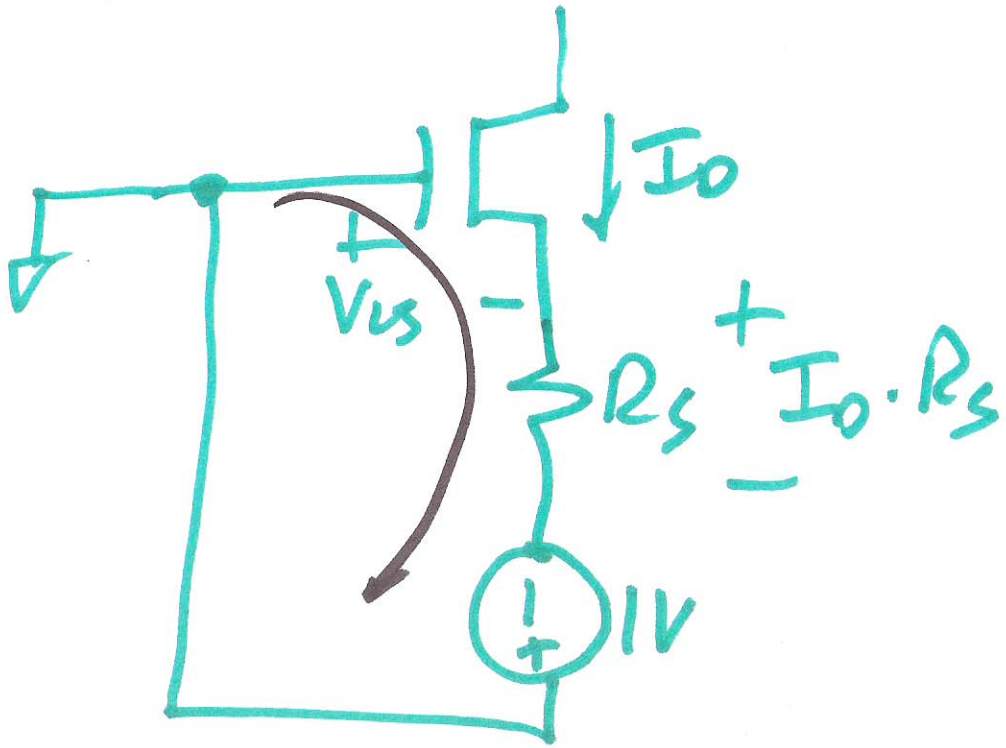
$$= \frac{-R_d}{1/g_m} = -g_m R_d$$



IN SAT

$r_o = \frac{1}{\lambda I_D}$





$$V_{GS} + I_D \cdot R_S - 1 = 0$$

ASSUME SAT

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