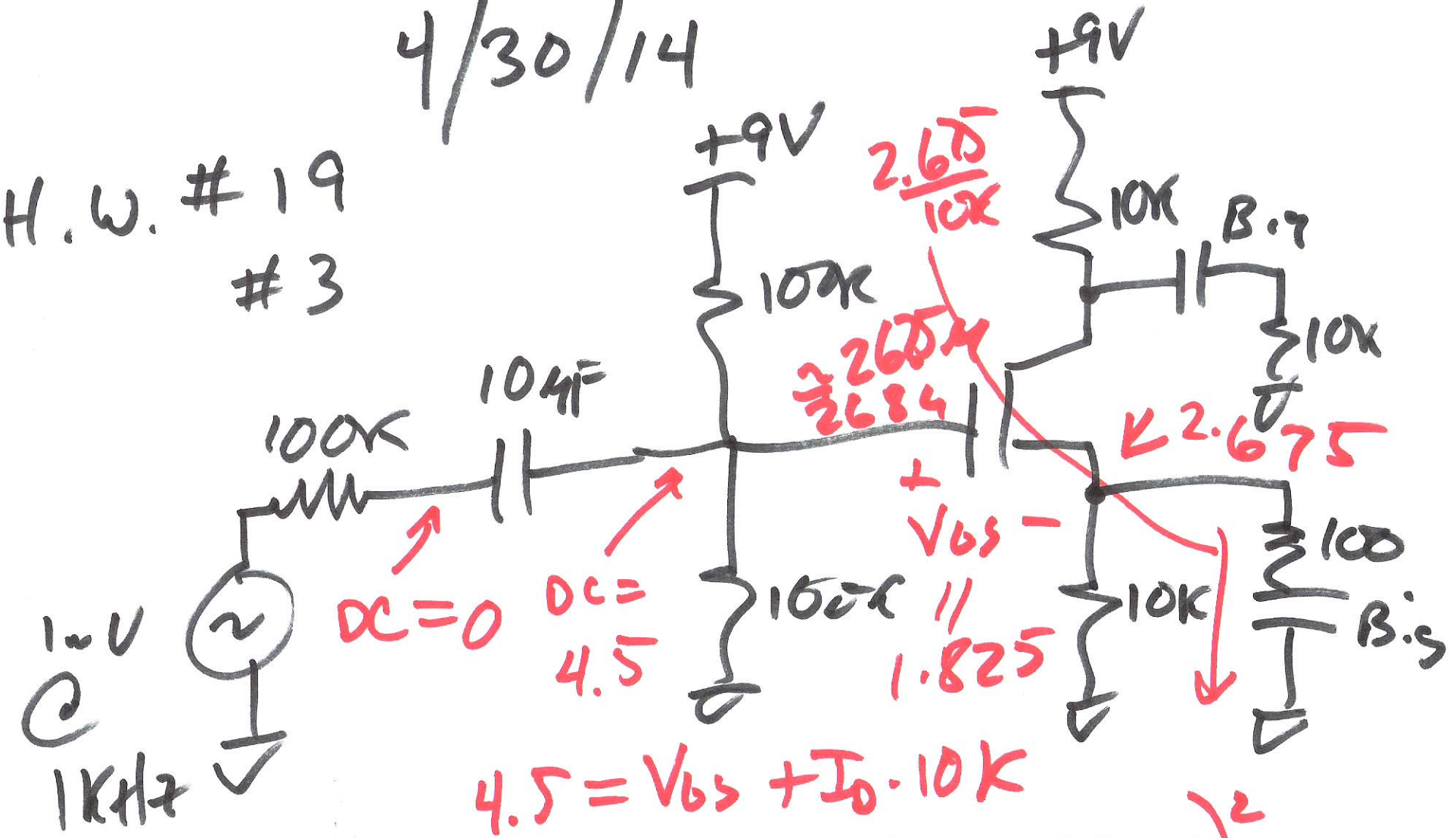
Lecture 25

EE 320

4/30/14

H.W. #19

#3



$4.5 = V_{DS} + I_D \cdot 10K$

$I_D = \frac{KP}{2}\frac{W}{L}\left(V_{DS} - V_{t,HW}\right)^2$

1)

$$4.5 = V_{GS} + 10K \cdot .1233 \cdot (V_{GS} - 1.824)^2$$

$$4.5 = V_{GS} + 1233\left(V_{GS}^2 - 3.648V_{GS} + 3.33\right)$$

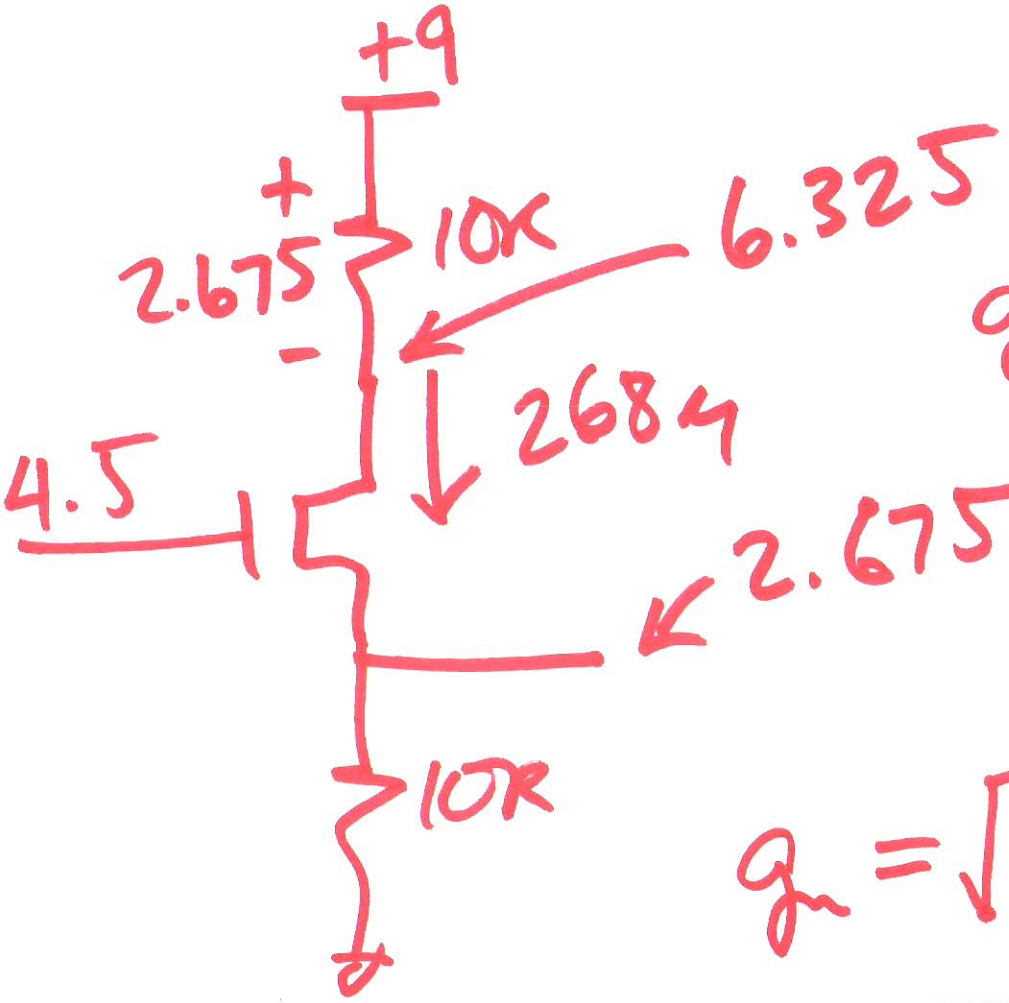
$$4.5 = V_{GS} + 1233V_{GS}^2 - 4498V_{GS} + 4106$$

$$0 = 1233V_{GS}^2 - 4497V_{GS} + 4101.5$$

$$0 = V_{GS}^2 - 3.65V_{GS} + 3.33$$

$$V_{GS} = \frac{3.65 \pm \sqrt{13.32 - 13.32}}{2}$$

$$V_{GS} = \frac{3.65}{2} = 1.825$$

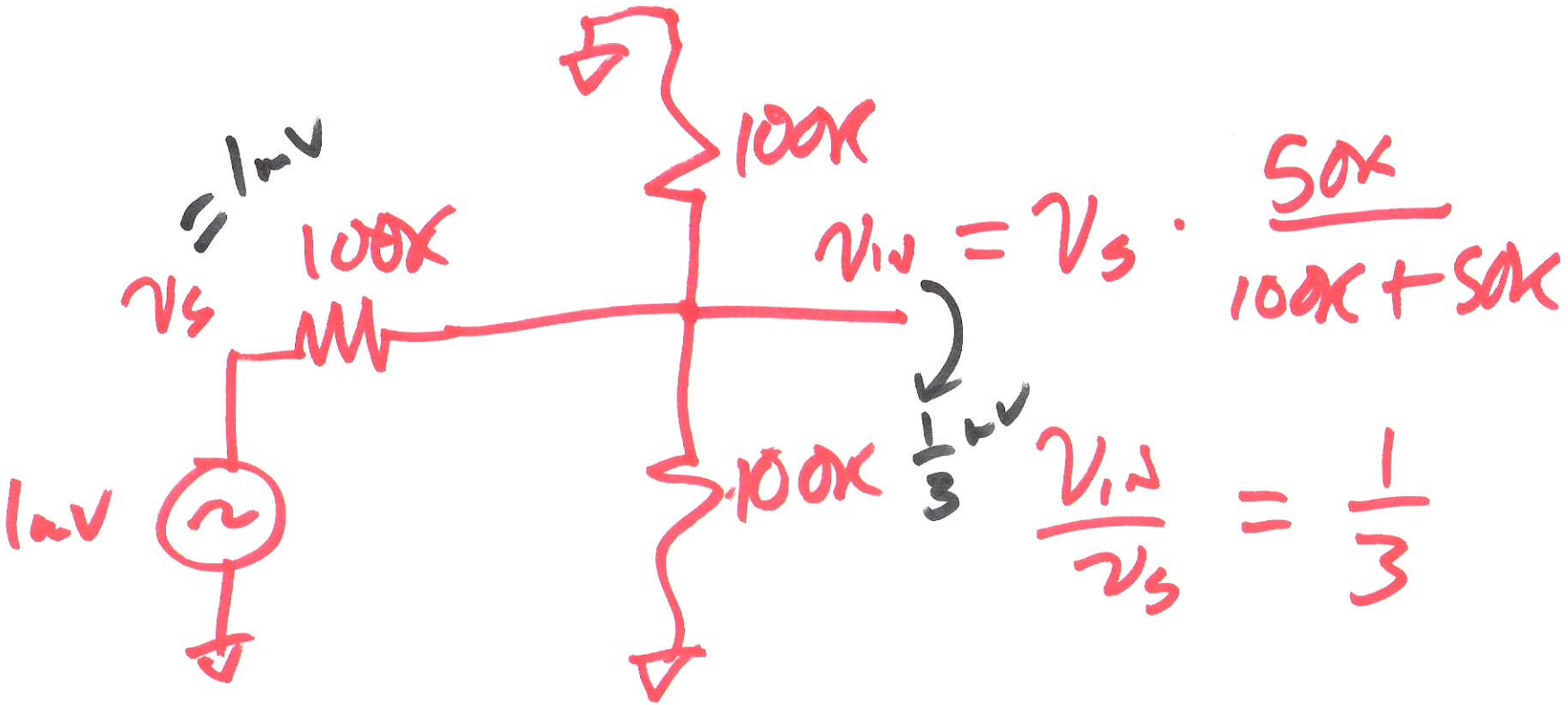


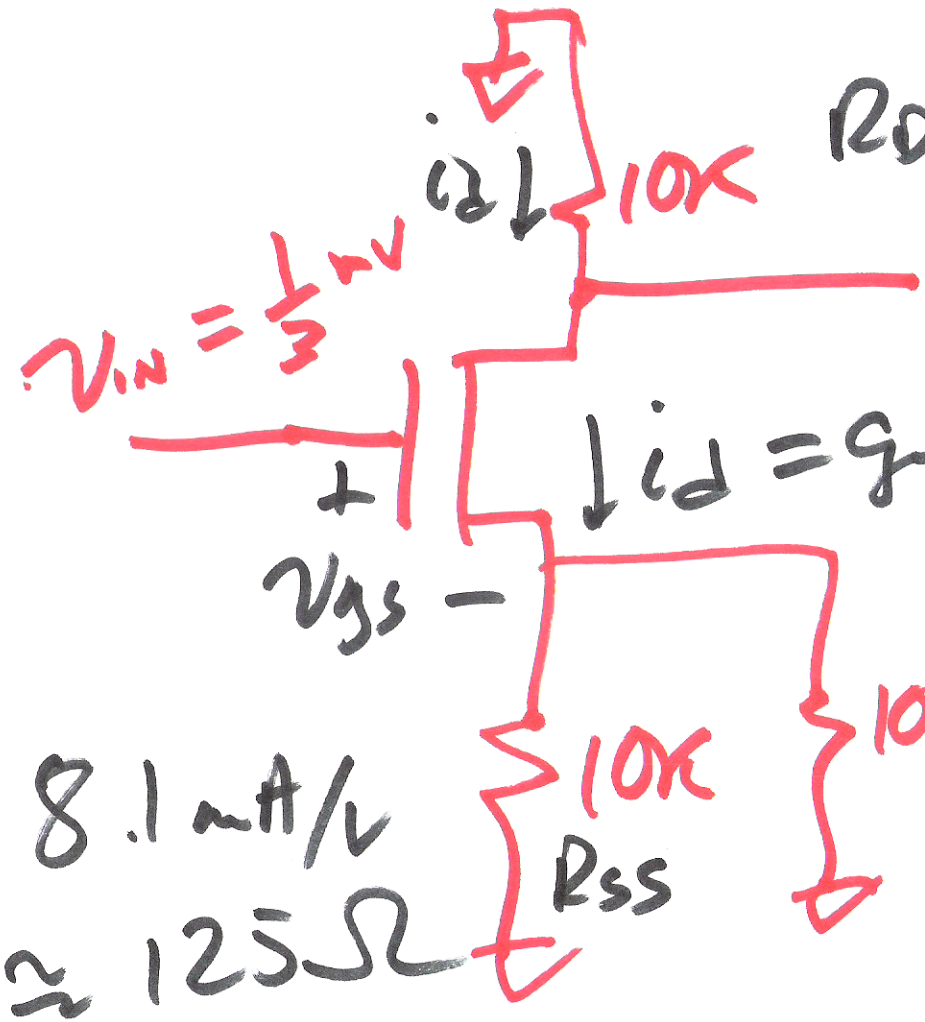
$$g_m = KP \cdot \frac{W}{L}(V_{GS} - V_{TH})$$

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

$$= \sqrt{2 \cdot .1233 \cdot 268\mu}$$

$$g_m = .8\,mA/V$$


100K
100K
v_s
1mV
1mV
100K
$\frac{1}{3}$mV
$v_{in} = v_s \cdot \frac{50K}{100K + 50K}$
$\frac{v_{in}}{v_s} = \frac{1}{3}$



$$\frac{-1}{3}\text{mV} \; (44.44) \approx 14.8\text{mV}$$

$$v_{OUT} = -i_d \cdot 10\text{K}$$

$$-444 \approx \frac{-10\text{K}}{225}$$

$$\frac{v_{OUT}}{v_{in}} = \frac{-10\text{K}}{\frac{1}{g_m} + 10\text{K} \| 100}$$

$$= \frac{-R_D}{\frac{1}{g_m} + R_{SS} \| R_{SS2}}$$

$g_m = 8.1\,\text{mA/V}$

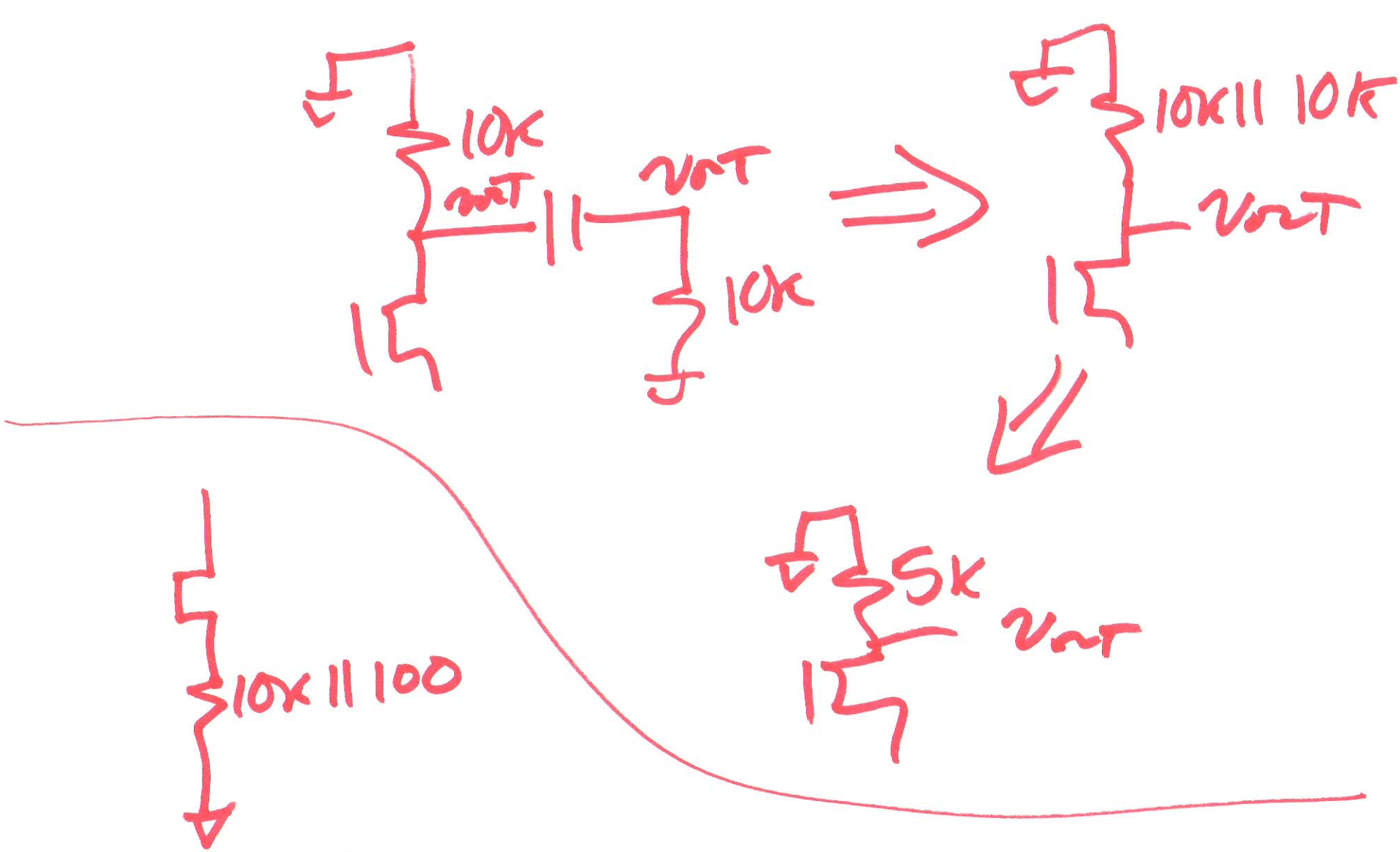
$\frac{1}{g_m} \simeq 125\,\Omega$

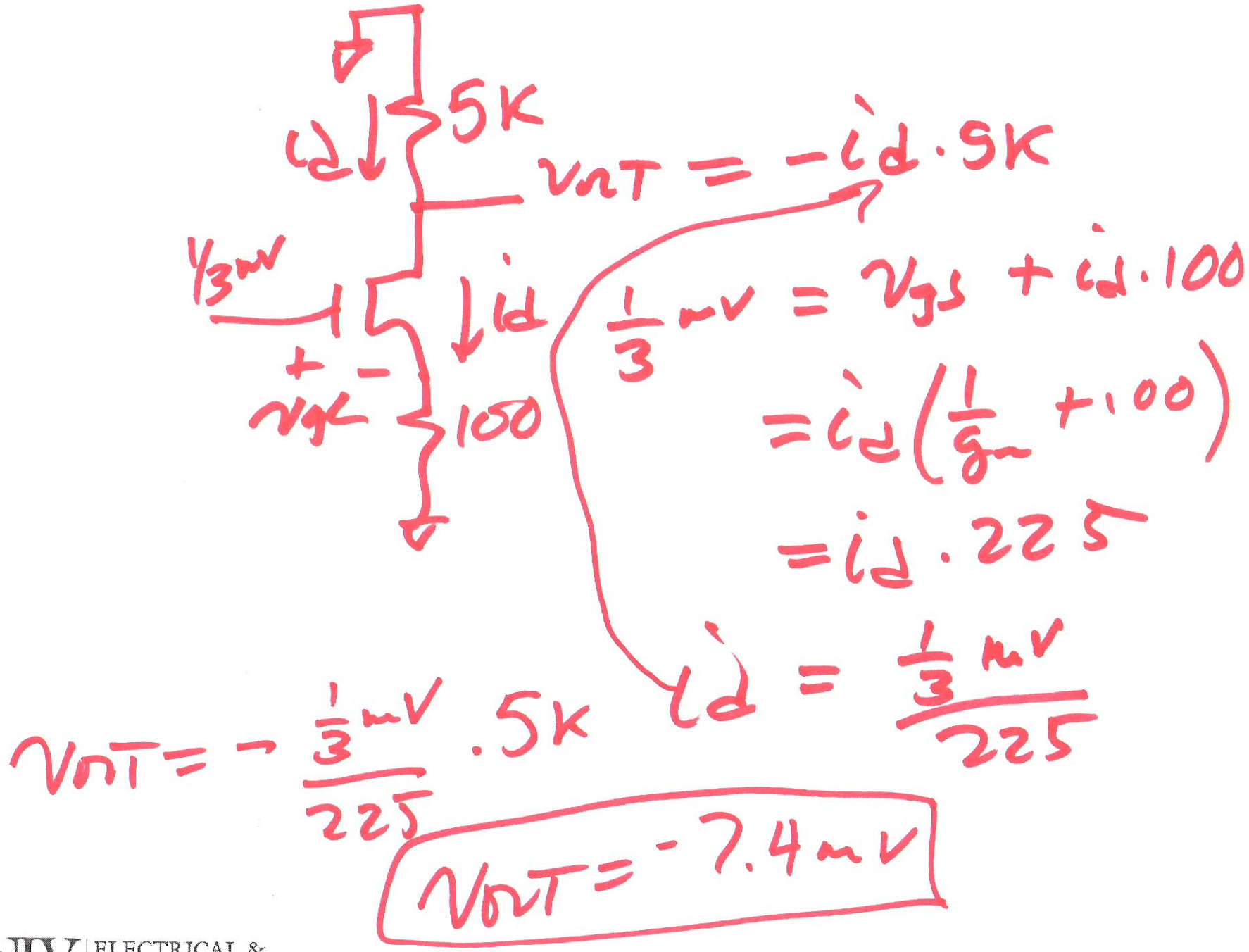
$10\text{K} \| 100 \simeq 100$

$v_{in} = v_{gs} + i_d \cdot 10\text{K} \| 100$

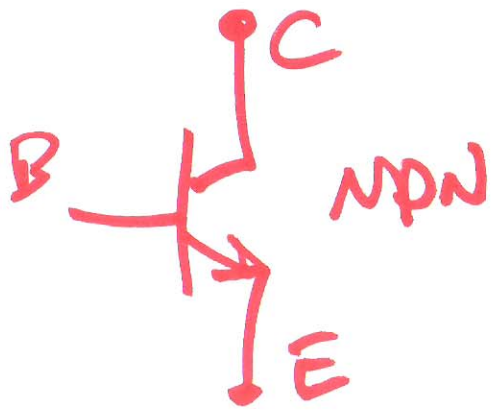
$= i_d\left(\frac{1}{g_m} + 10\text{K} \| 100\right)$

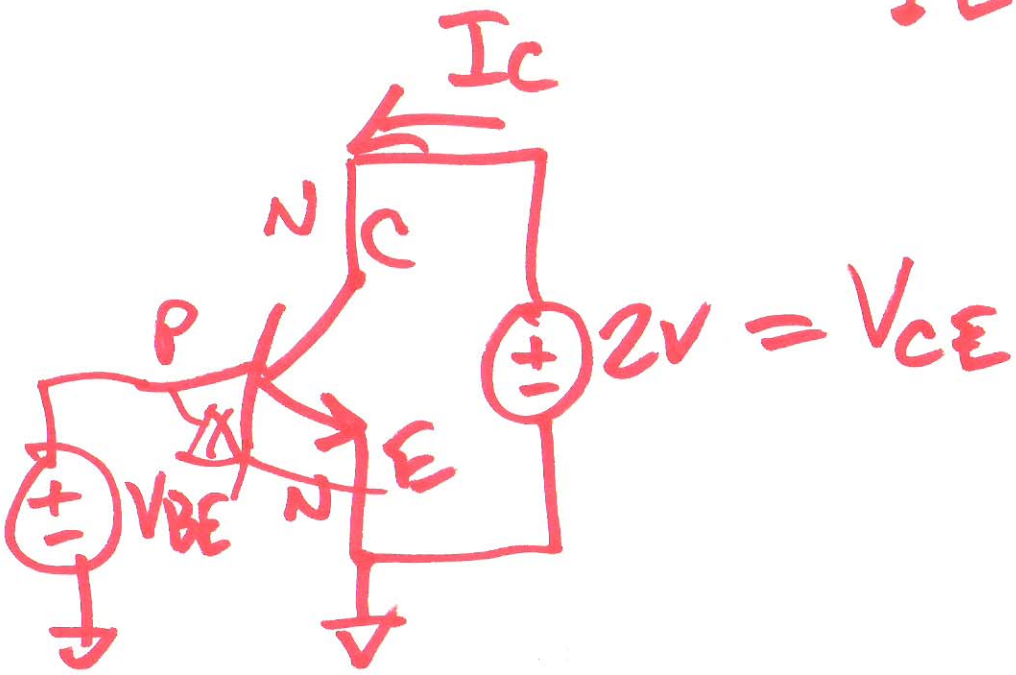
5)

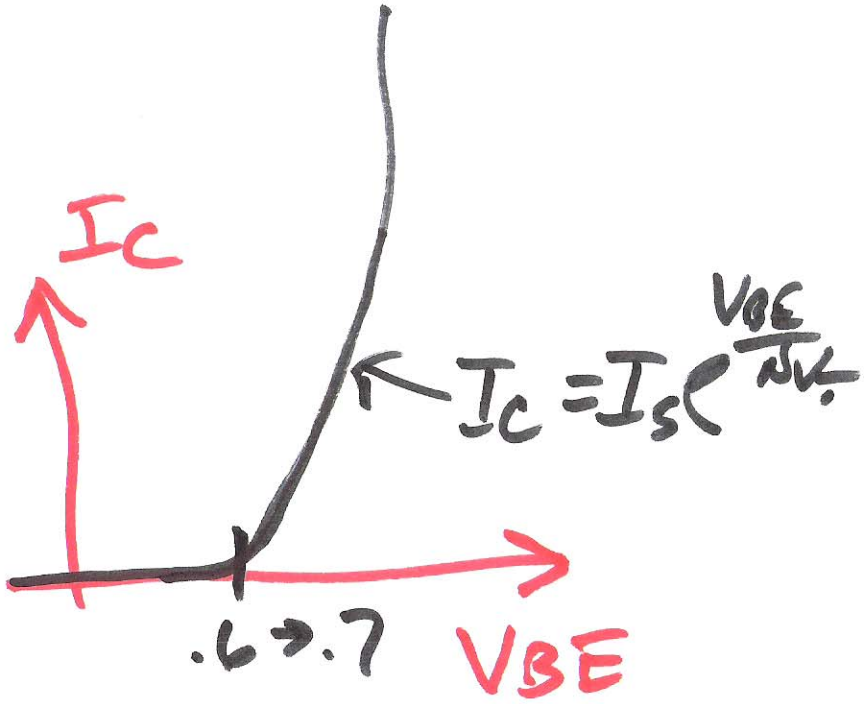

10K
10K
10K
10K11 10K
5K
10K11100

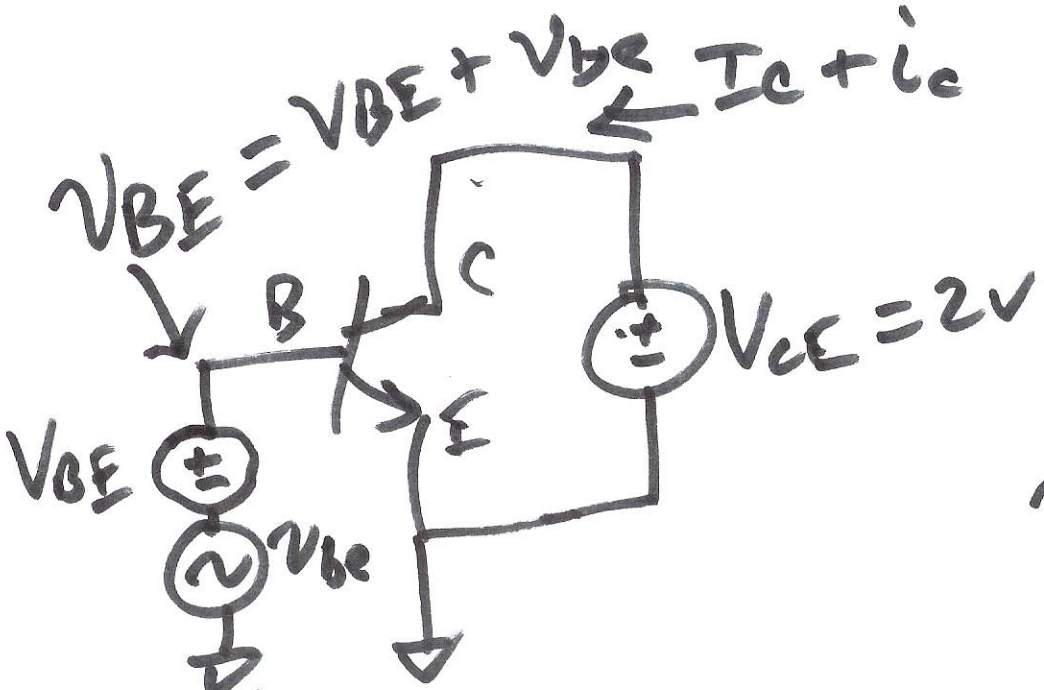

5K
i_d
$v_{OT} = -i_d \cdot 5K$
1/3mV
i_d
+
v_{gs}
−
100
$\frac{1}{3}mV = v_{gs} + i_d \cdot 100$
$= i_d\left(\frac{1}{g_m} + 100\right)$
$= i_d \cdot 225$
$i_d = \frac{\frac{1}{3}mV}{225}$
$v_{OT} = -\frac{\frac{1}{3}mV}{225} \cdot 5K$
$v_{OUT} = -7.4mV$

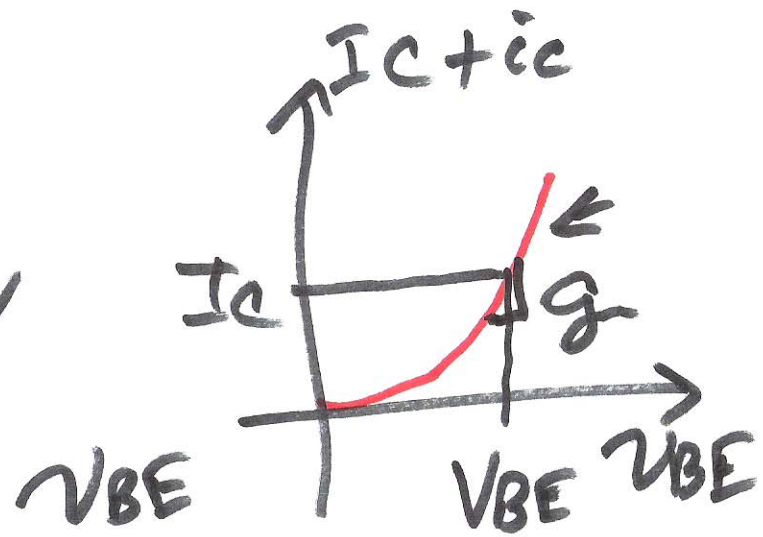
B.J.T











$$\frac{\delta e^x}{\delta x} = e^x$$

$$\frac{\delta e^{x/a}}{\delta x} = \frac{1}{a} e^{x/a}$$

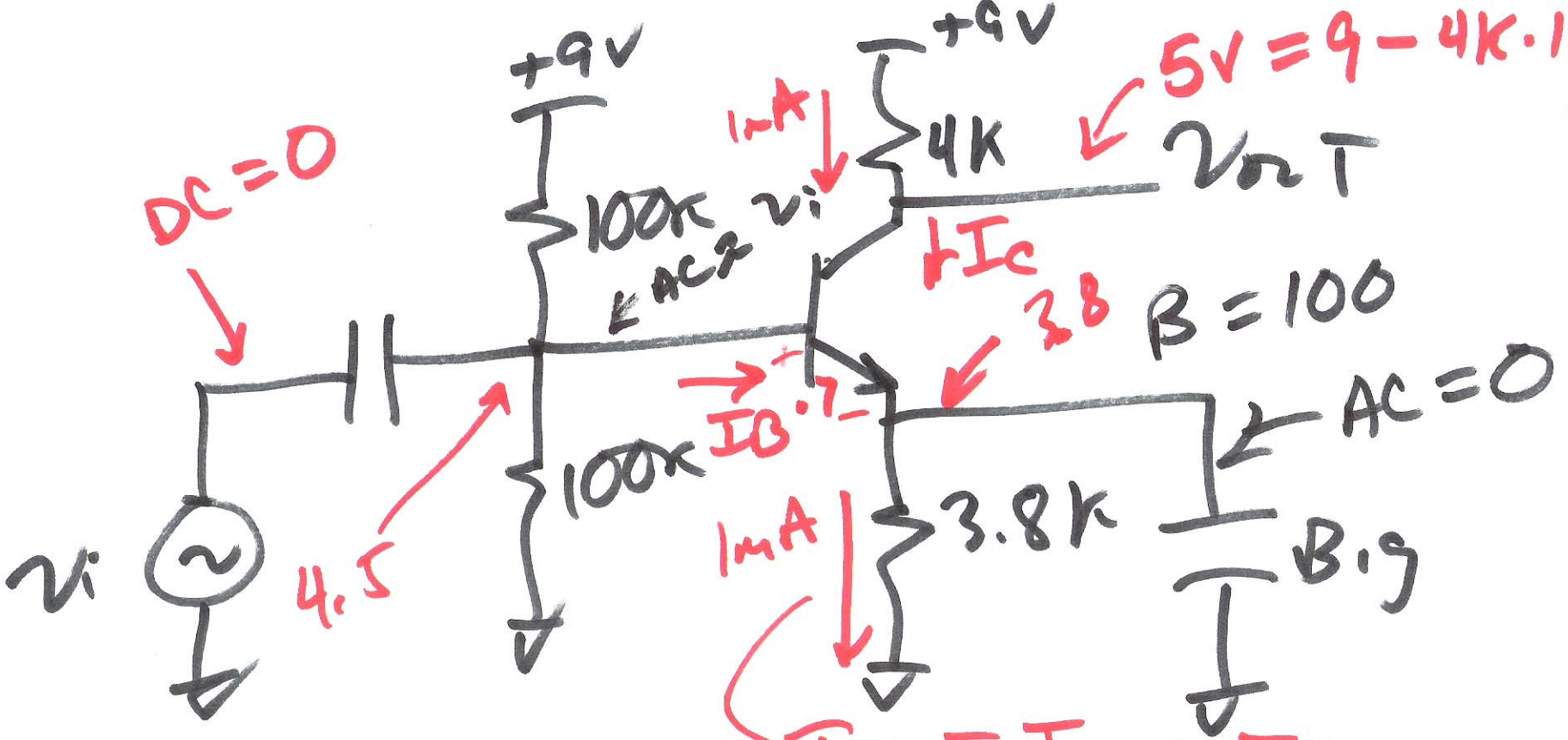
$$g_m = \frac{\delta i_c}{\delta v_{BE}} = \frac{\delta I_C}{\delta v_{BE}} = \frac{\delta}{\delta v_{BE}} I_S e^{\frac{v_{be} + V_{BE}}{N V_T}}$$

$I_C = CONST$

$V_{BE} = CONST$

$$g_m = \frac{I_S e^{\frac{v_{be} + V_{BE}}{N V_T}}}{N V_T}$$

$$\boxed{g_m = \frac{I_C}{N V_T}}$$

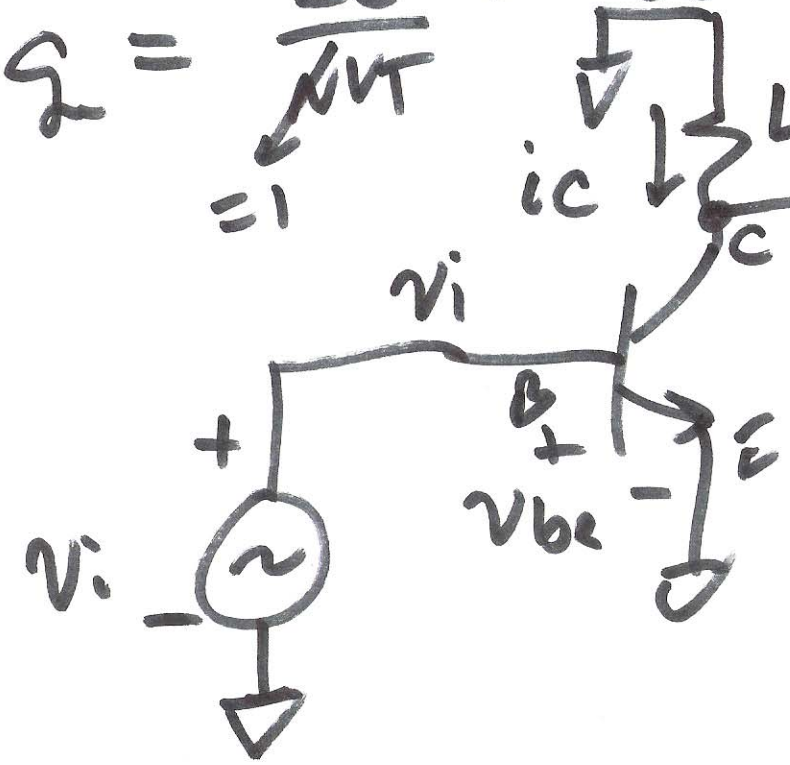


$I_C = B \cdot I_B$

current gain B is big

$I_C \simeq I_E$

$$g = \frac{I_C}{V_T} = \frac{1\text{mA}}{25\text{mV}} = 40\frac{\text{mA}}{\text{V}}$$



$$v_{out} = -i_c \cdot 4K$$

$$v_i = v_{be}$$

$$i_c = g\, v_{be} = g\, v_i$$

$$v_{be} = v_i = \frac{i_c}{g} \quad \left(r_\pi = \frac{i_c}{g}\right)$$

$$\frac{v_{out}}{v_i} = \frac{-i_c \cdot 4K}{i_c \cdot \frac{1}{g}} = -g\,4K$$

$$= -40\frac{\text{mA}}{\text{V}} \cdot 4K$$

$$= -160\,!$$