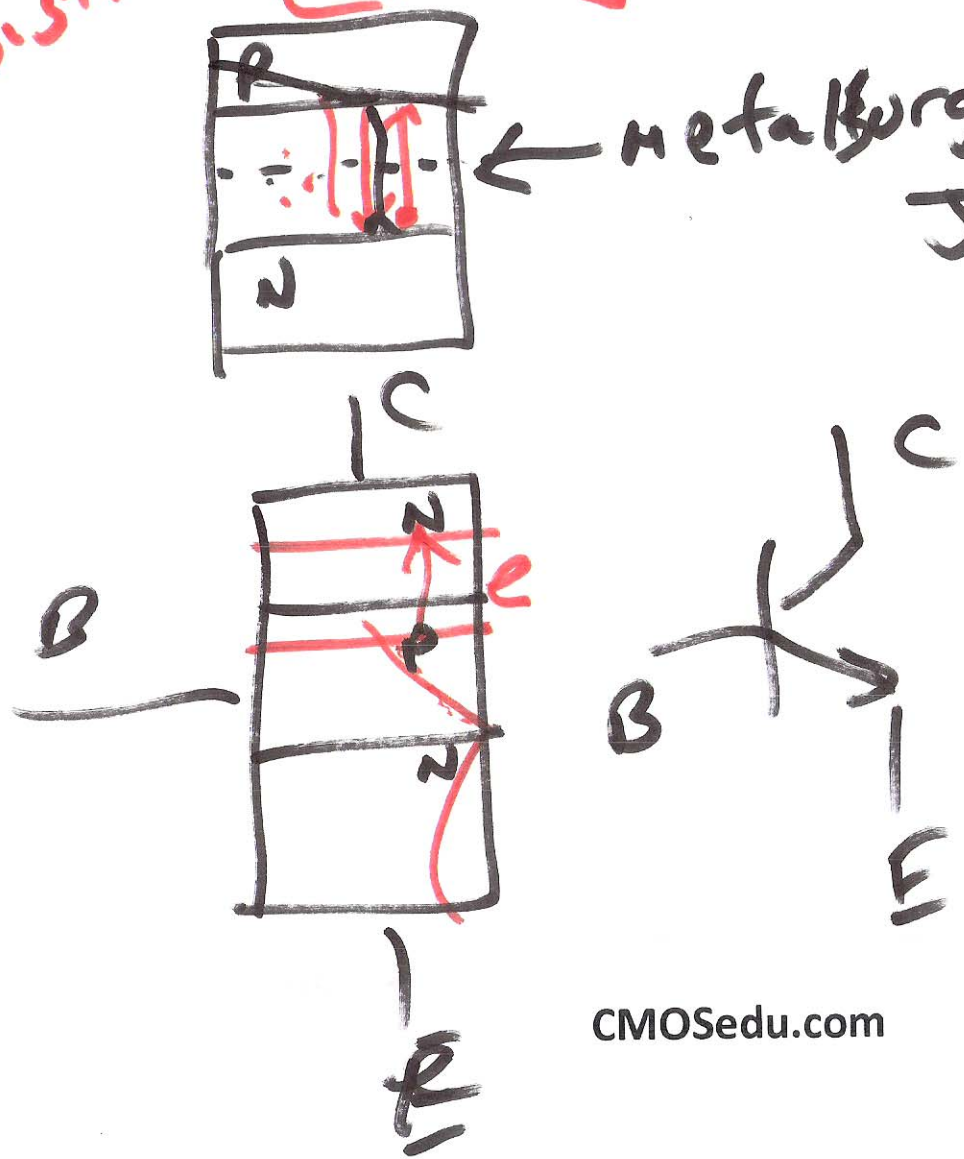
EE 320 5/6/13

Lecture 26

Transistor = transfer resistance

$\left[(\beta+1) r_e\right]^{-1} = r_{be}^{-1} = \frac{I_B}{NV_T}$ $r_e^{-1} = \frac{I_E}{NV_T}$ $g = \frac{I_C}{NV_T}$



$I_C + I_B = I_E$

$I_E \alpha = I_C$

$I_C = \beta \cdot I_B$

current gain

$I_B(\beta+1) = I_E$

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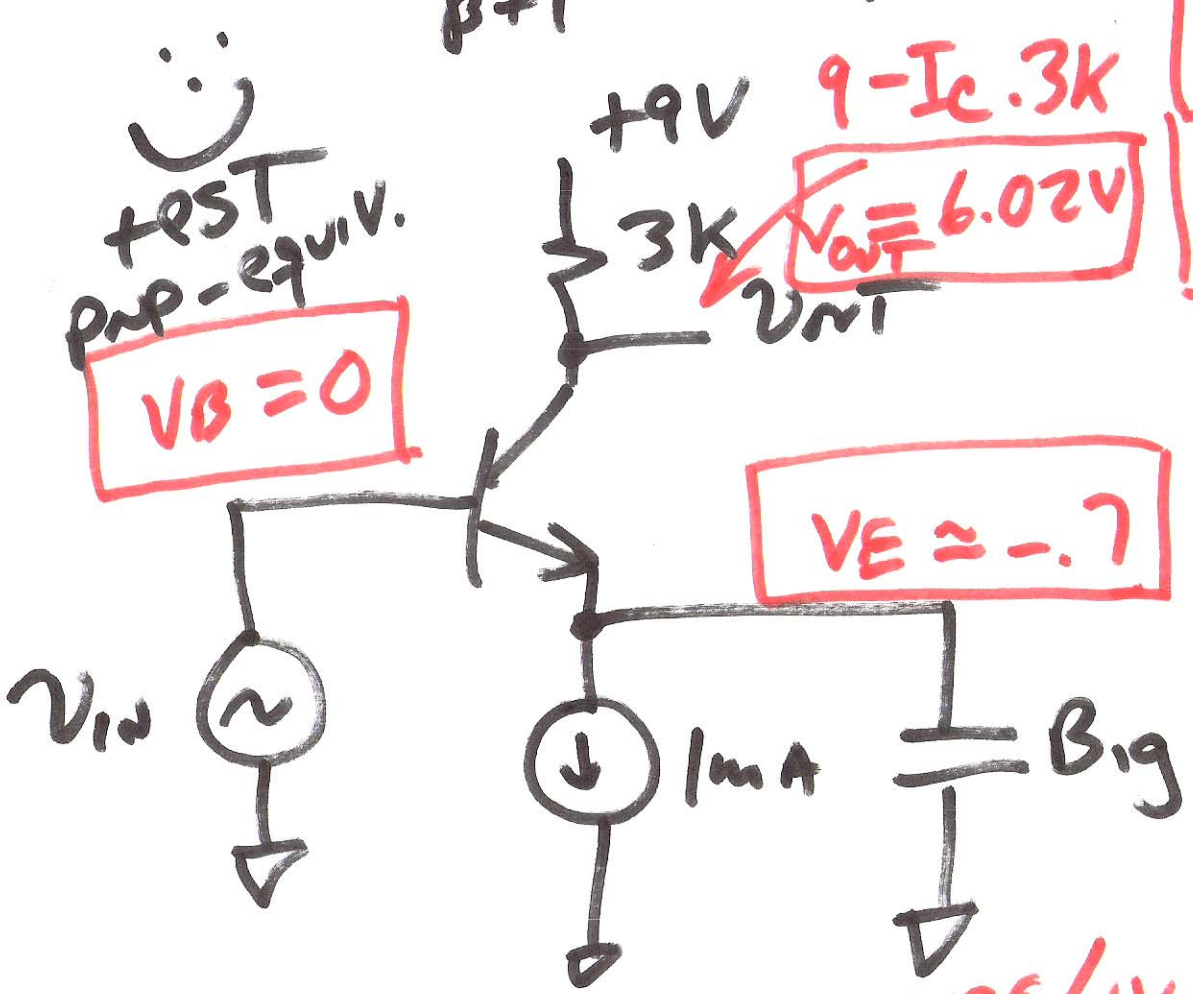
$\beta = 100$

$\alpha = \frac{\beta}{\beta+1} = \frac{100}{101} = .99$



+ PST
PNP-equiv.

$V_B = 0$

$V_E \simeq -.7$

$9 - I_C \cdot 3K$

$V_{OUT} = 6.02V$

$I_E = 1mA$

$I_C = 990.4\mu A$

$I_C = \alpha I_E$

$I_B = \frac{I_C}{\beta}$

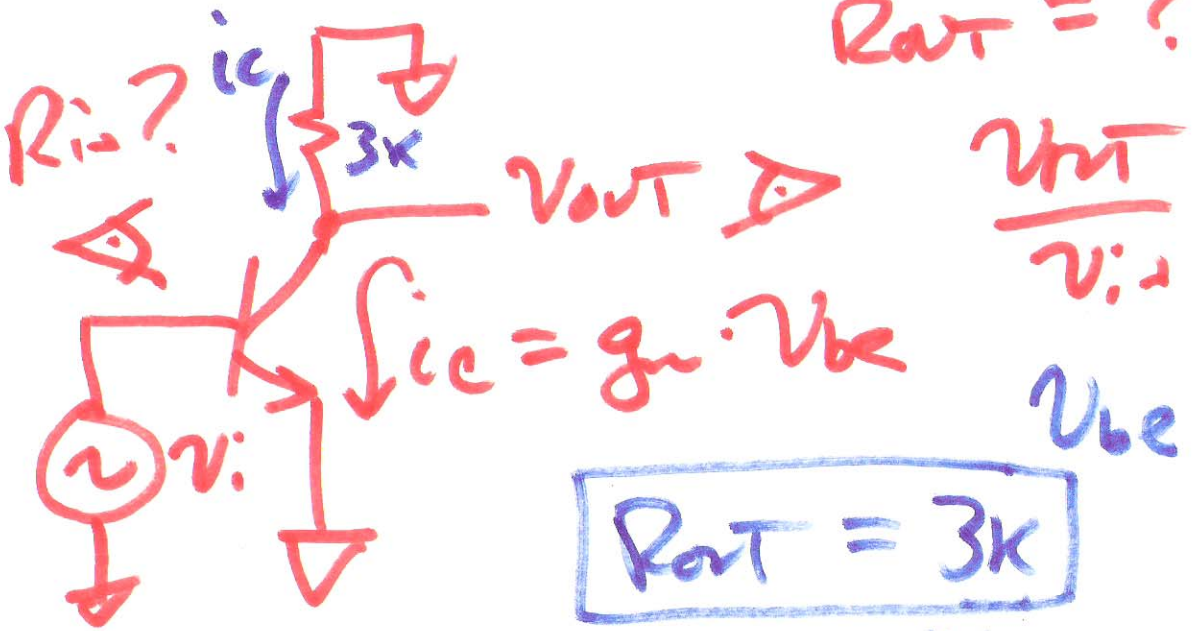
$I_B = 9.9_4 \mu A \simeq 10$

$I_B = \frac{I_E}{\beta+1}$

$I_C = I_S e^{V_{BE}/nV_T}$

$V_{BE} = nV_T \ln \frac{I_C}{I_S}$

2)

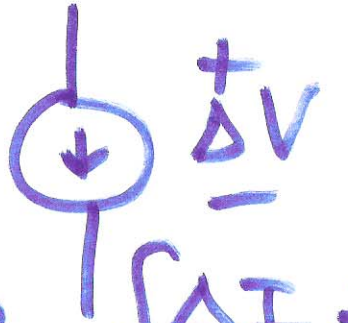


$R_{out} = ?$

$\frac{v_{out}}{v_i}$

$i_c = g_m \cdot v_{be}$

$v_{be} = \frac{i_c}{g_m}$



$\Delta I = 0$

$\frac{\Delta V}{\Delta I} = \infty$

$\Delta I \to 0$

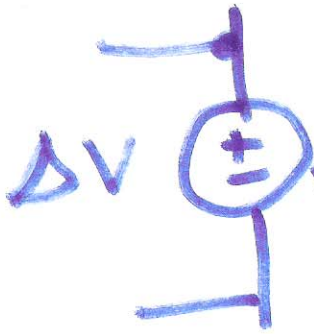
$R_{out} = 3k$

$\frac{v_{out}}{v_i} = \frac{-i_c \cdot 3k}{v_{be}}$

$R_\pi = \frac{NV_T}{I_B}$

$= \frac{25\,mV}{9.94\,\mu A}$

$= 2.5\,k\Omega$



$\frac{\Delta V}{\Delta I} = 0$

$= \frac{-i_c \cdot 3k}{i_c / g_m}$

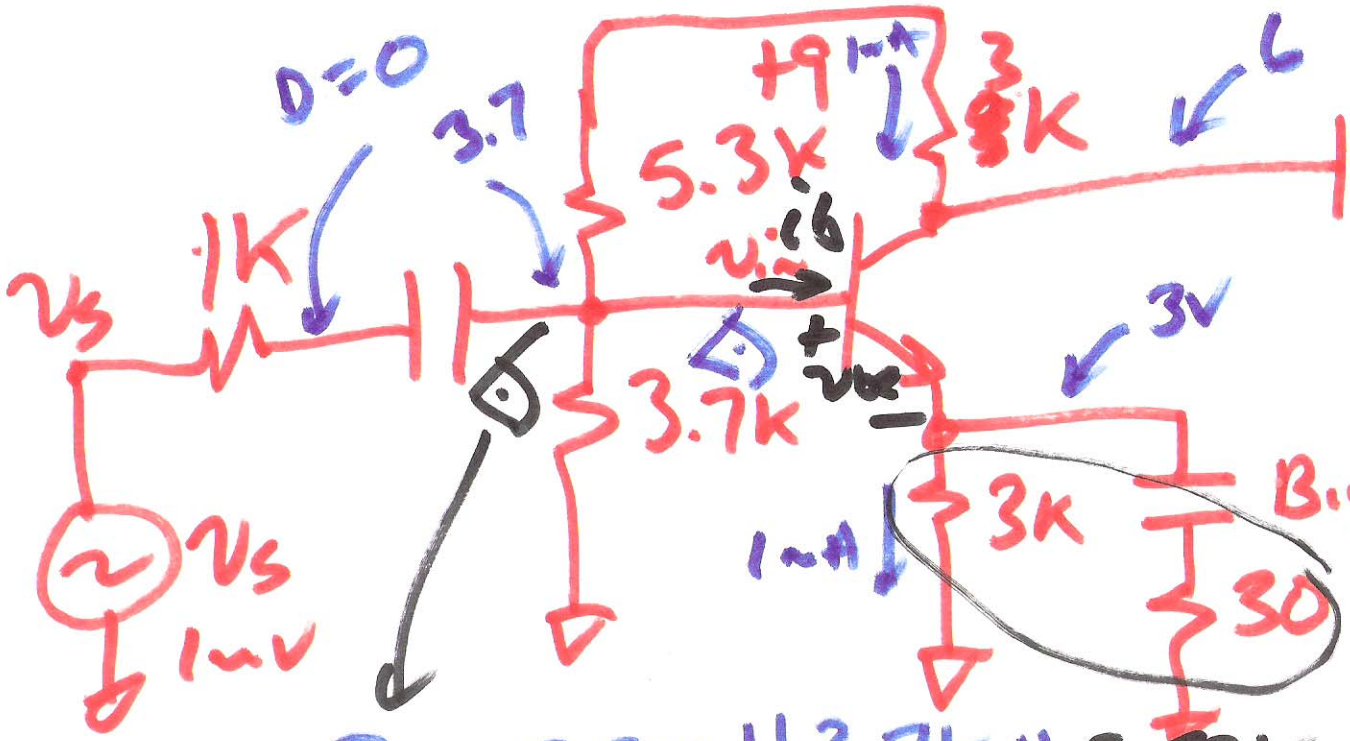
$= \frac{-3k}{1/g_m}$

$= -g_m \cdot 3k$

$g_m = \frac{1\,mA}{25\,mV} = \frac{40\,mA}{V}$

$= -40 \cdot 3 = \boxed{-120\,\frac{V}{V}}$

3)



$g_m = 40\frac{mA}{V}$

$30 \| 3K \simeq 30$

$R_{in} = 5.3K \| 3.7K \| 5.53K$

$\simeq 1.4K$

$i_c = i_b \cdot \beta$

$v_i = v_{be} + i_e \cdot 3K \| 30$

$i_e = (\beta+1)\, i_b$

$$v_i = \frac{i_c}{g_m} + i_e \cdot 30$$

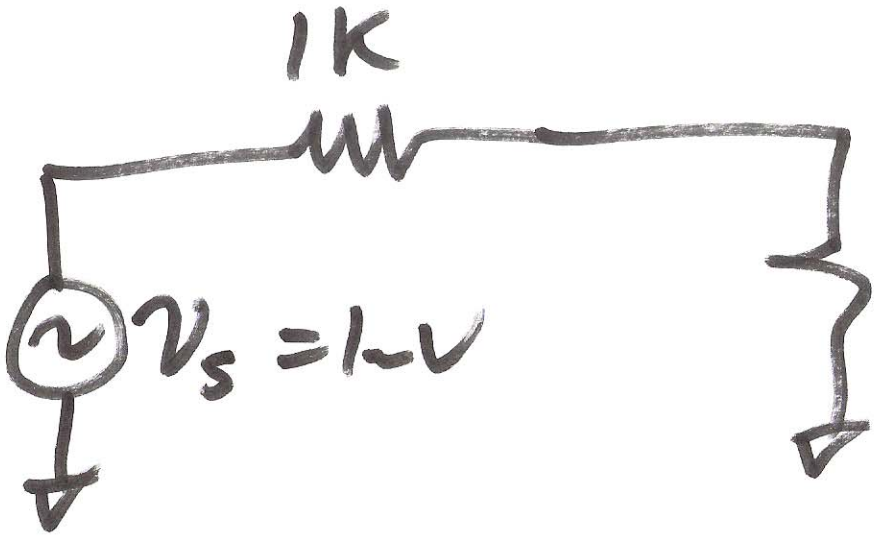
$$\frac{v_i}{i_b} = R_{in\,to\,base} = i_b\left(\frac{\beta}{g_m} + (\beta+1)\cdot 30\right)$$

4)

$$R_{into\ base} = \frac{100}{.040} + 101(30)$$

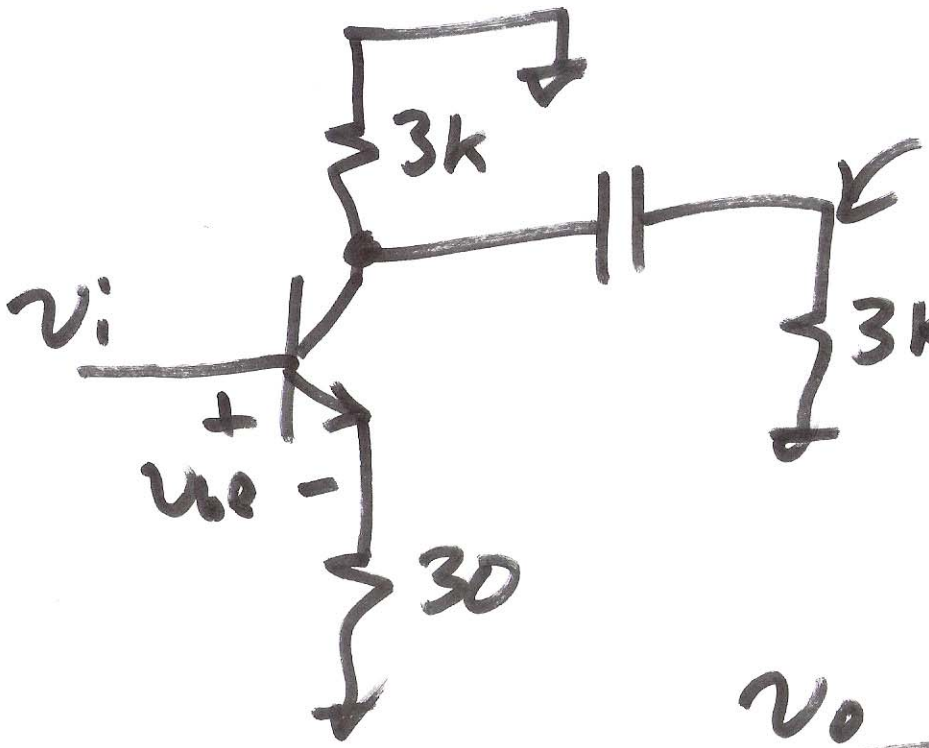
$$= 2.5k + 3030$$

$$= 5.53k$$



$$1mV \cdot \frac{1.4}{1.4+1} \simeq .6mV$$

5)



$v_o = -i_c \cdot 1.5k$

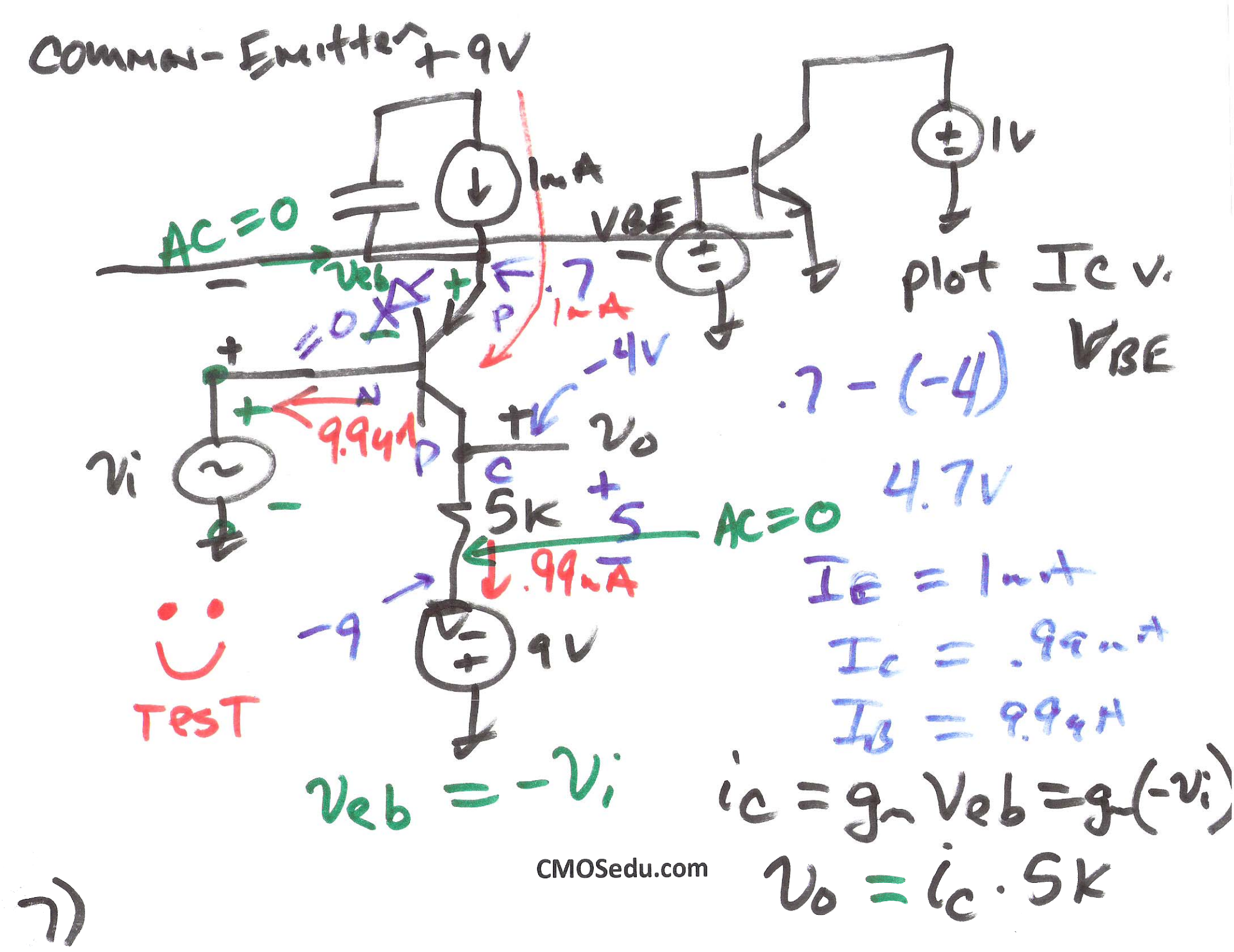
i_c / β

$v_i = v_{be} + i_c \cdot 30$

$$\frac{v_o}{v_i} = \frac{-1.5k}{\frac{1/g_m}{25} + 30}$$

$$= \frac{-1.5}{55} \approx -27$$

c)


COMMON-Emitter
+9V
1mA
AC=0
VBE
11V
plot Ic v. VBE
.7
1mA
-4V
.7-(-4)
4.7V
9.941
Vi
Vo
5K
5
AC=0
.99mA
-9
9V
TEST
IE = 1mA
Ic = .99mA
IB = 9.9μA
Veb = -Vi
ic = gm Veb = gm(-Vi)
Vo = ic · 5K
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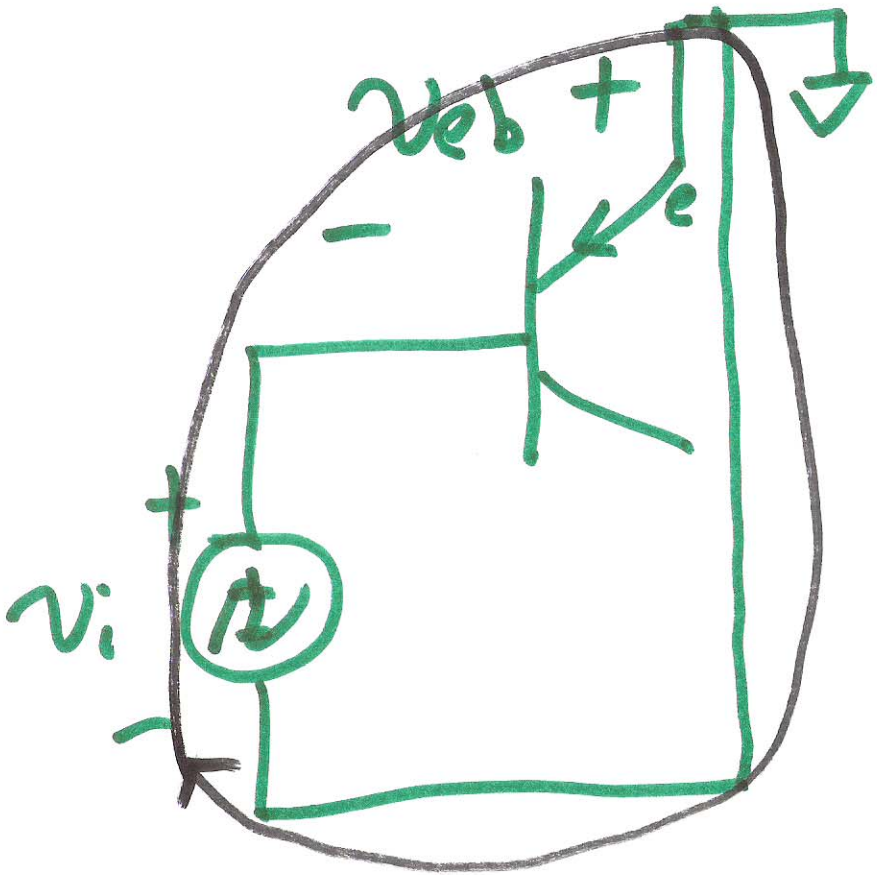
7)



$$v_i + v_{eb} = 0$$

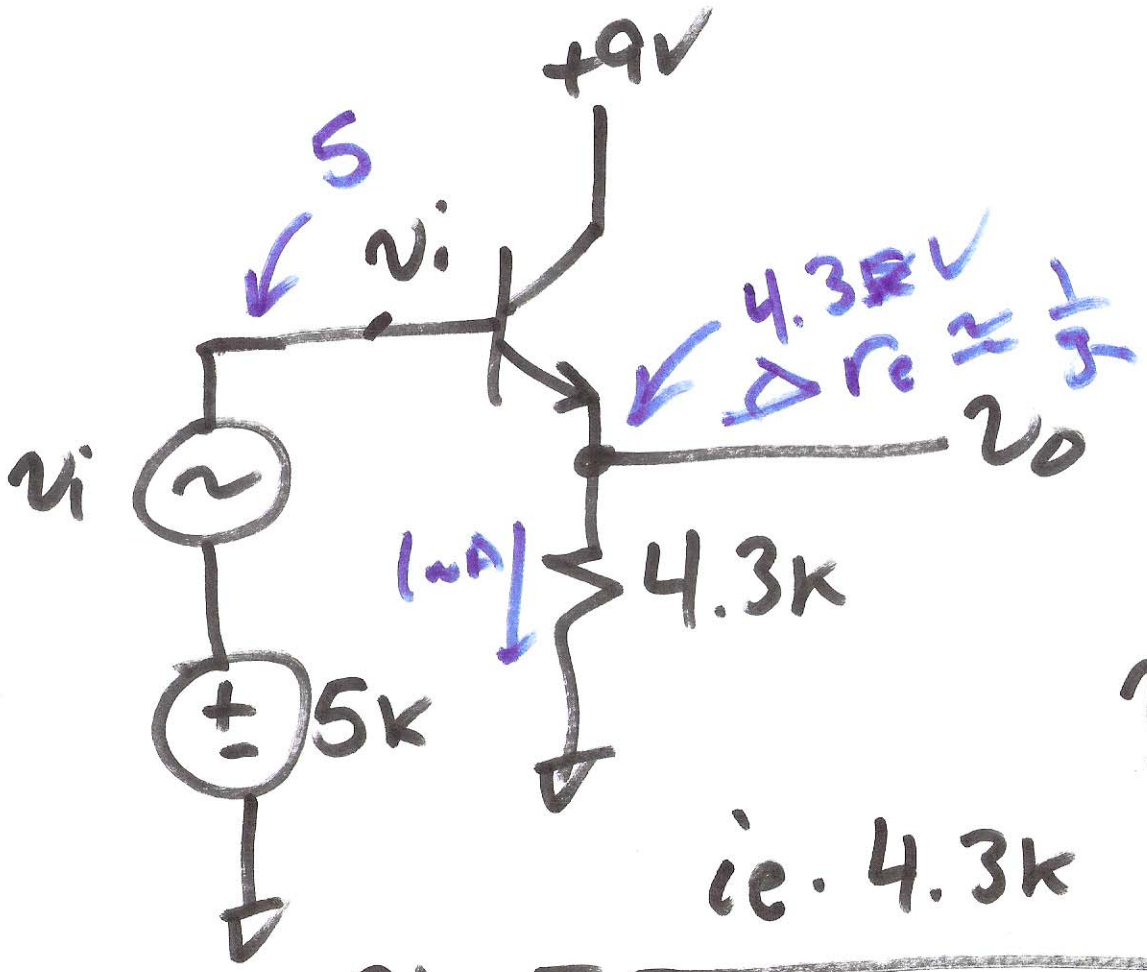
$$v_i = -v_{eb}$$

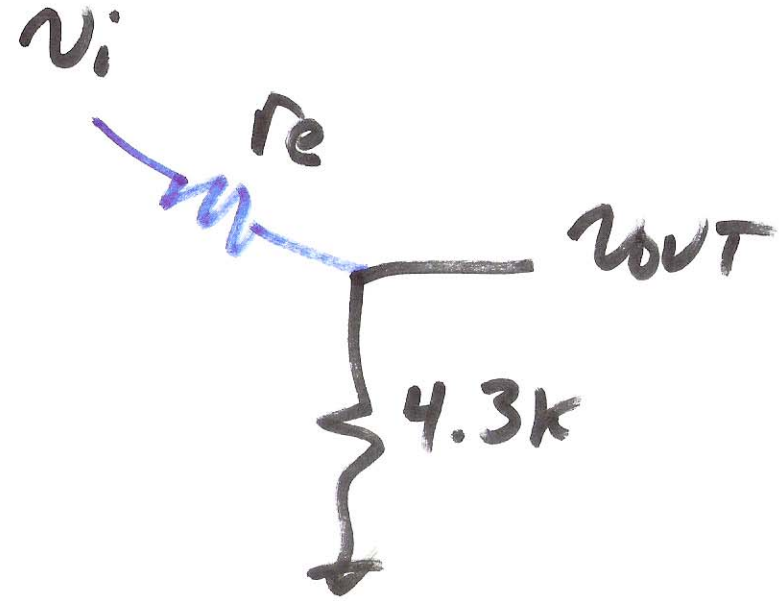
$$\frac{v_o}{v_i} = \frac{i_c \cdot 5k}{-i_c/g_m}$$

$$= -g_m 5k$$

8)

Common Collector



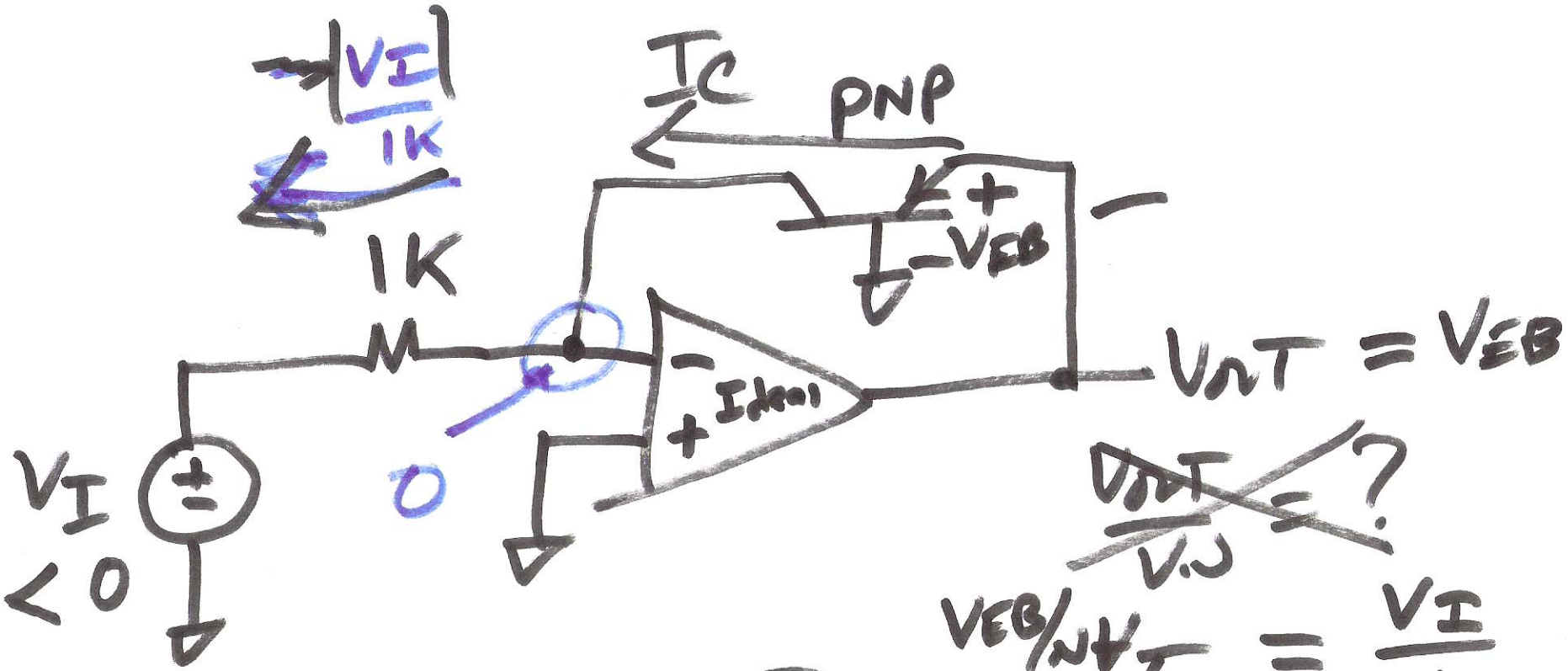


$$\frac{v_{OUT}}{v_i} = \frac{4.3k}{4.3k + r_e}$$

$$\frac{v_o}{v_i} = \frac{i_e \cdot 4.3k}{v_{be} + i_e \cdot 4.3k} \simeq \frac{4.3k}{4.3k + 1/g_m}$$

$$v_{be} = \frac{i_c}{g_m} = \frac{\alpha i_e}{g_m} = \frac{i_e}{r_e}$$

$\alpha \simeq 1$



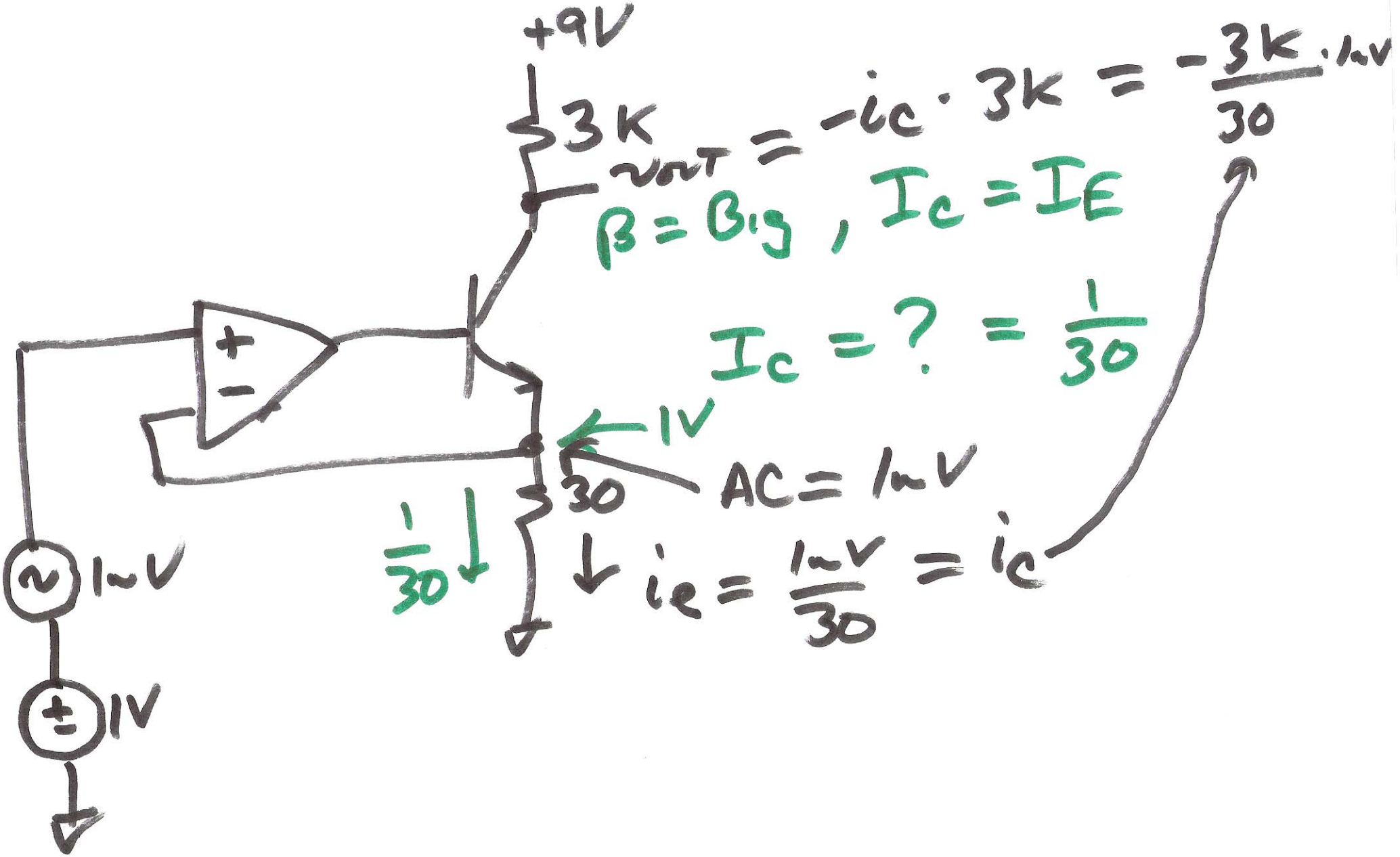
$$V_{EB}/nV_T = \frac{V_I}{1K}$$

$$I_C = I_S\, e^{V_{EB}/nV_T}$$

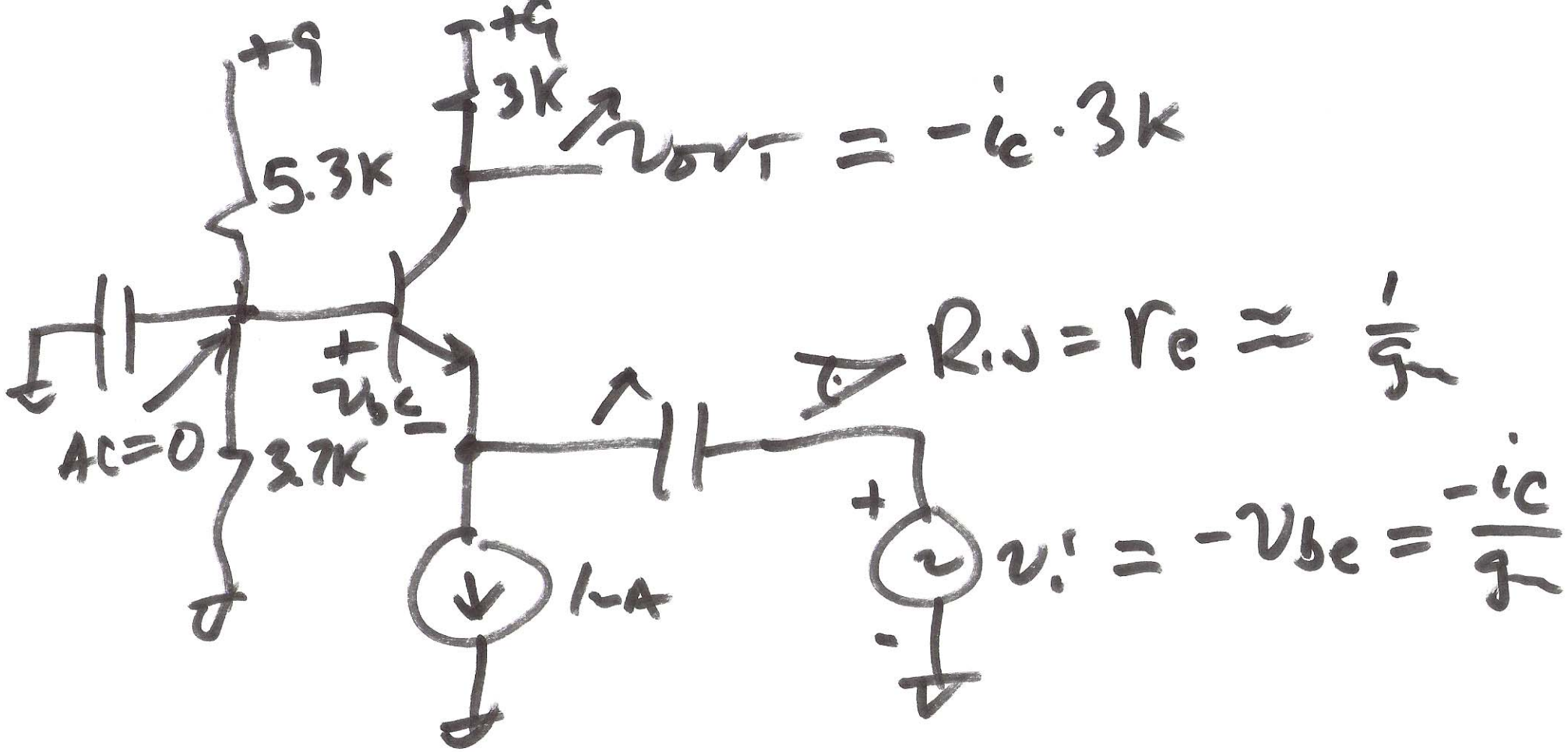
$$V_{OUT} = n V_T \ln \frac{I_C}{I_S}$$

$$\boxed{V_{OUT} = n V_T \ln \frac{V_I}{1K \cdot I_S}}$$

10)



11)



$$\frac{v_{OUT}}{v_i} = \frac{-i_c \cdot 3k}{-i_c/g_m} = g_m 3k$$

12)