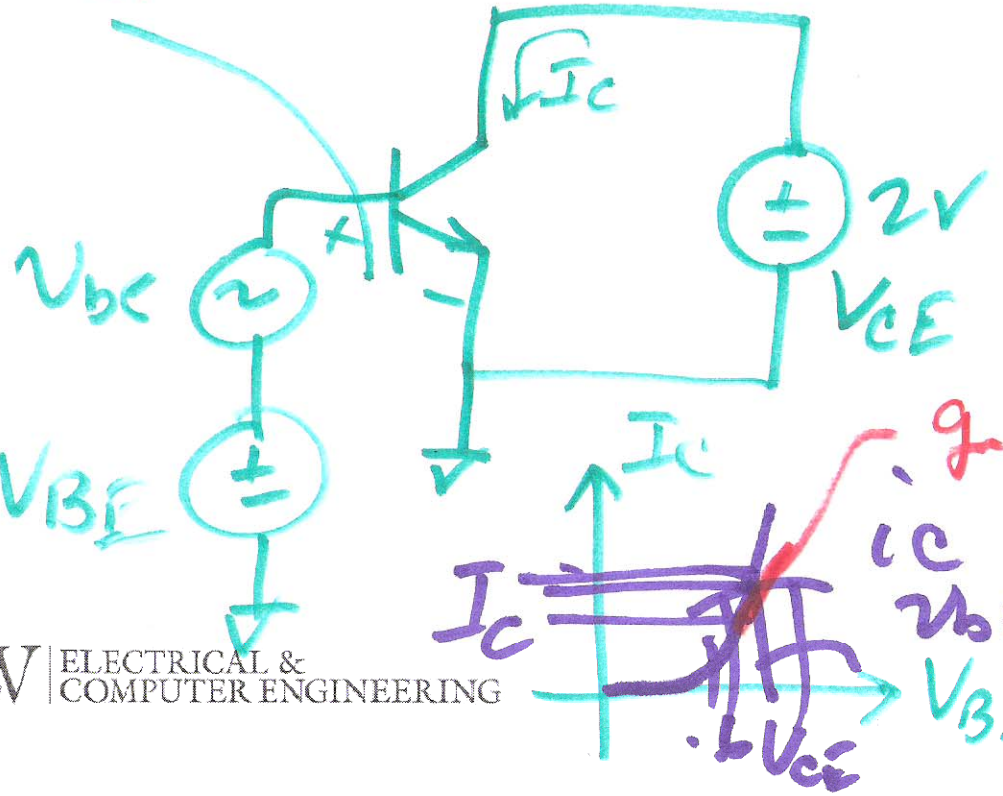
Lecture 22

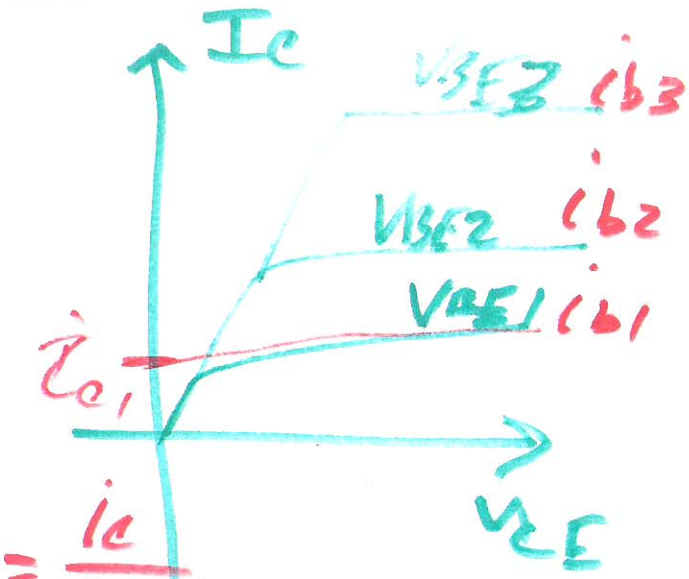
April 15, 2015

EE 320 Engineering Electronics I

AC DC

$V_{BE} = v_{be} + V_{BE}$





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

$i_{b1} \cdot \beta = i_{c1}$

$$i_C = I_C + i_c = I_S e^{v_{BE}/nV_T} = I_S e^{v_{BE}/nV_T}$$

$$g_m \equiv \left.\frac{\delta i_C}{\delta v_{BE}}\right|_{\substack{I_C = \text{CONST} \\ V_{BE} = \text{CONST}}} = I_S e^{v_{BE}/nV_T} \cdot \frac{\delta\left(\frac{v_{BE}}{nV_T}\right)}{\delta v_{BE}}$$

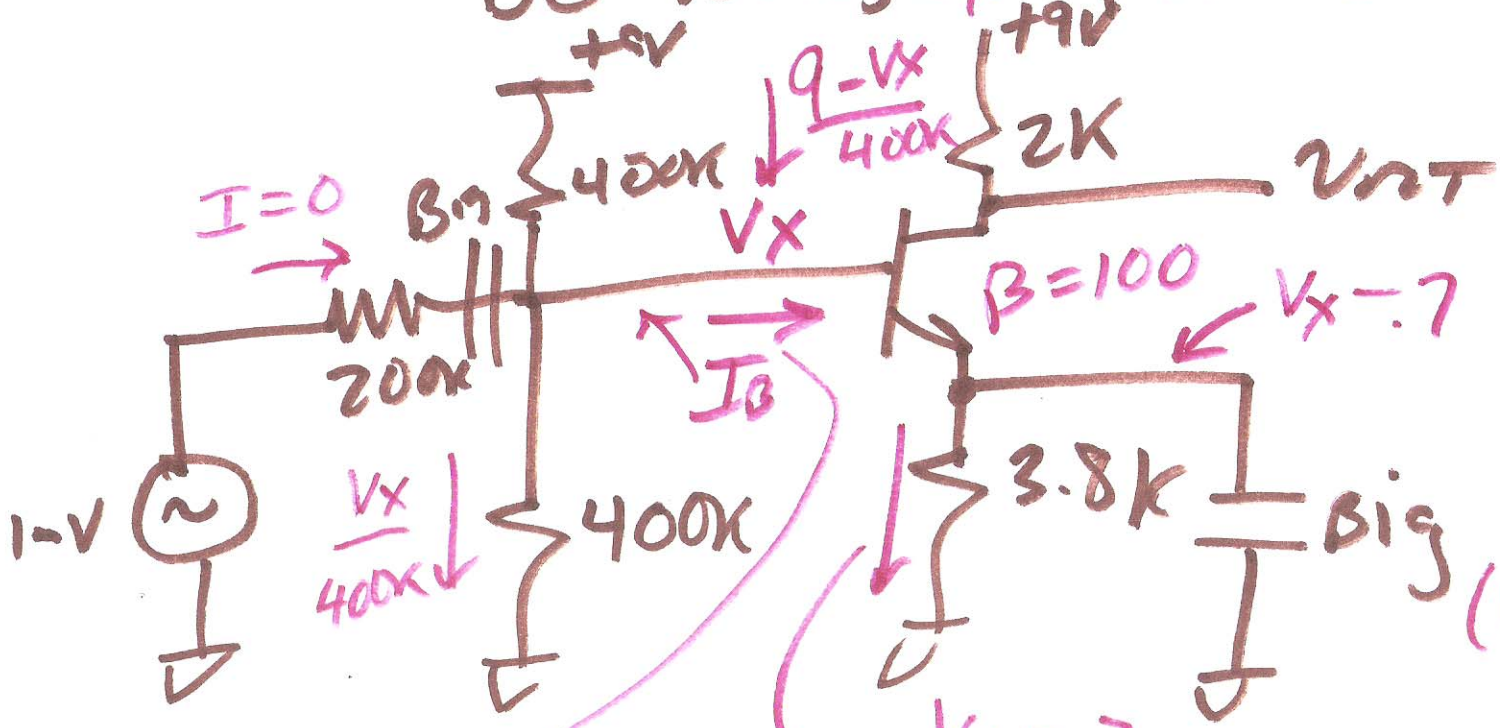
$I_C \gg i_c$

$$g_m \approx \frac{I_C}{V_T \cdot n}$$

$$= \frac{I_S e^{v_{BE}/nV_T}}{nV_T}$$

$$g_m = \frac{I_C + i_c}{nV_T}$$

DC voltages/currents AC currents/voltages



$I_B + I_E = I_B$

$\beta I_B = I_C$

$\alpha I_E = I_C$

$\frac{\alpha}{1-\alpha} = \beta$

$(1+\beta) I_B = I_E$

$$\frac{V_x - .7}{3.8K} = I_E$$

$$I_B = \frac{V_x - .7}{3.8K\,(1+\beta)} = \frac{V_x - .7}{3.8K \cdot 101}$$

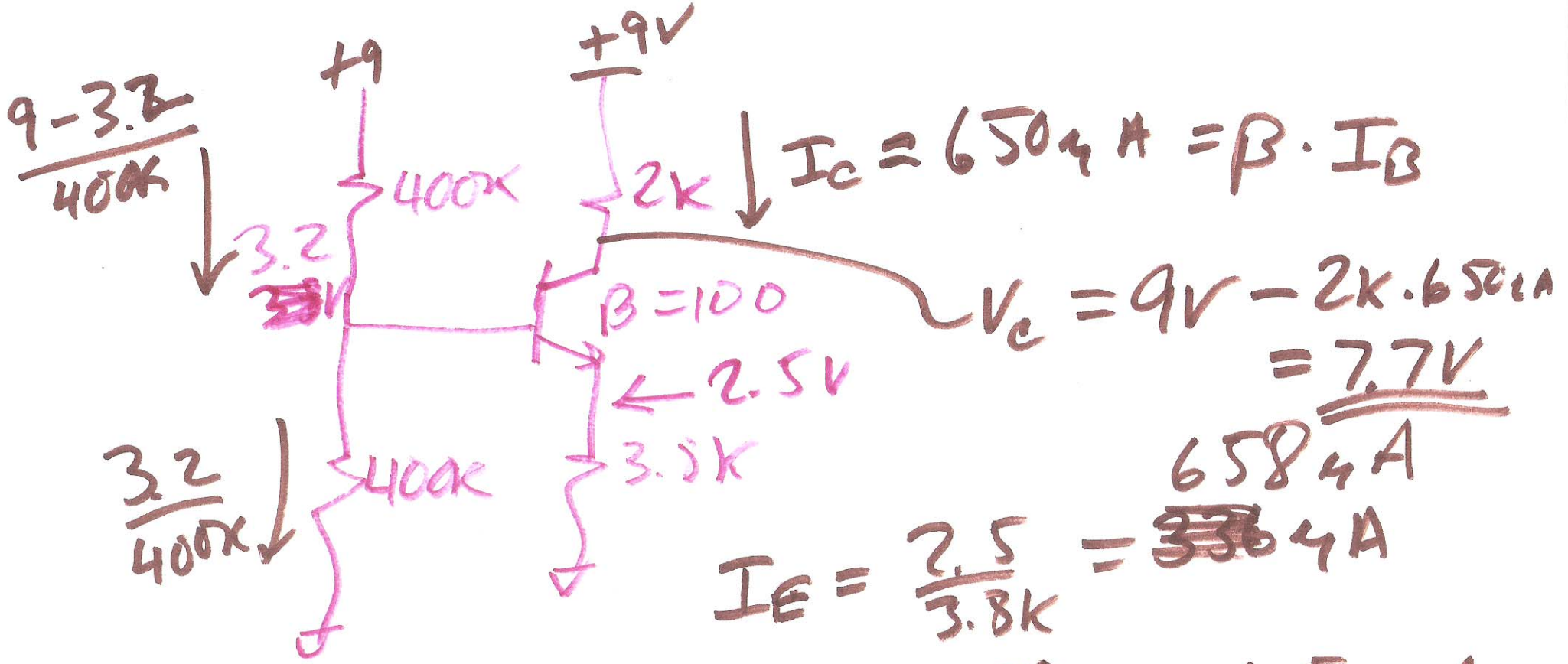
$\beta = 101$

$$\frac{9 - V_x}{400k} = \frac{V_x}{400k} + \frac{V_x - .7}{3.8k \cdot 101}$$

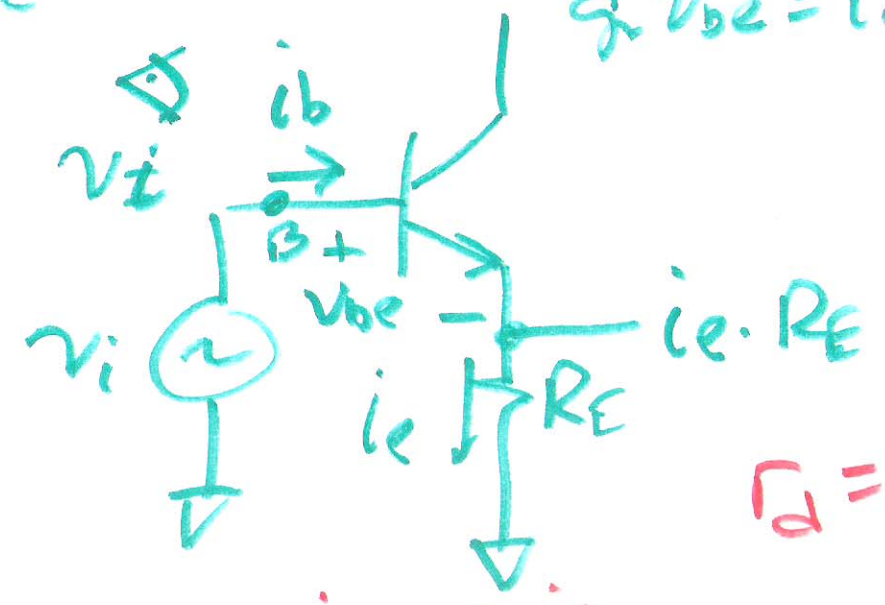
$$9 - V_x = V_x + (V_x - .7)1.042$$

$$9.728 = 3.042 V_x \Rightarrow V_x = \underline{\underline{3.2V}}$$

4)


+9
+9V
400K
2K
3.2
B=100
2.5V
400K
3.3K
$I_C = 650\mu A = \beta \cdot I_B$
$V_C = 9V - 2K \cdot 650\mu A$
$= 7.7V$
$658\mu A$
$I_E = \frac{2.5}{3.8K} = 658\mu A$
$I_B = \frac{658}{104} = 6.5\mu A$
$\beta + 1$
$\beta = \frac{\alpha}{1-\alpha}$
$\alpha = .99$

AC



$g_m v_{be} = i_c$

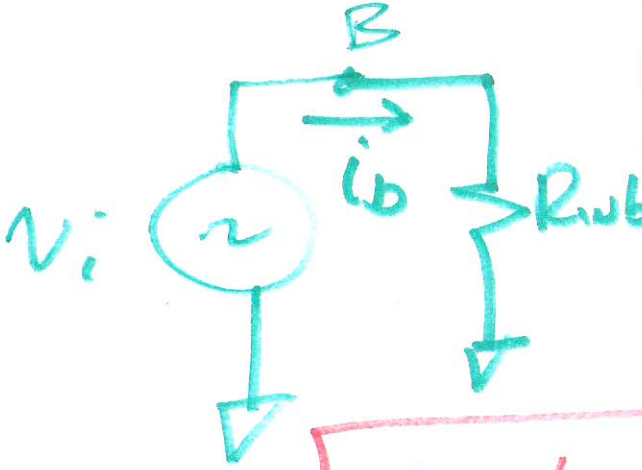
$v_i = v_{be} + i_e \cdot R_E$

$= \frac{i_c}{g_m} + i_e \cdot R_E$

$r_d = \frac{NV_T}{I_D} = \frac{1}{\frac{1}{\beta}} \frac{\beta \cdot i_b}{g_m} + (\beta+1) i_b R_E$

$i_c = \beta i_b$

$i_e = (\beta+1) i_b$



$R_{inbase} = \frac{v_i}{i_b}$

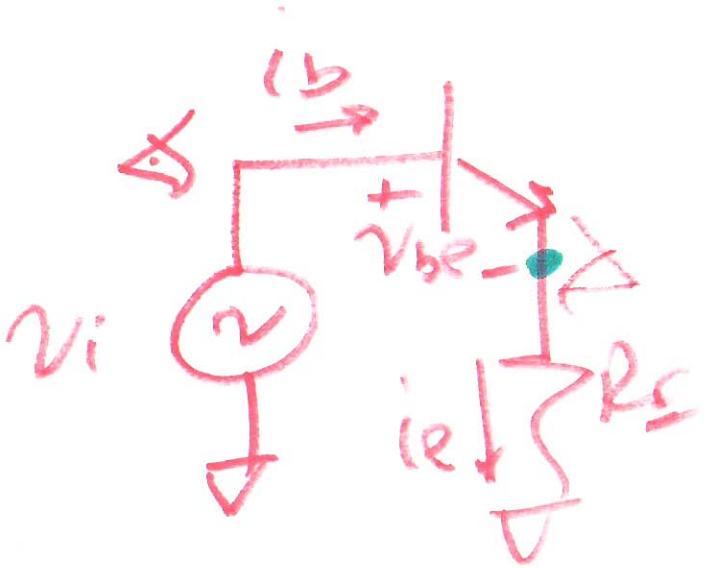
$\frac{g_m}{\beta} = \frac{I_C}{NV_T \cdot \beta} = \frac{I_B}{NV_T}$

$\frac{1}{r_{be}} = r_\pi = \frac{I_B}{NV_T}$

$\boxed{\frac{v_i}{i_b} = (\beta+1) R_E + r_{be}}$

$r_e = \frac{NV_T}{I_E}$

6)



$$r_d = \frac{NV_t}{I_D}$$

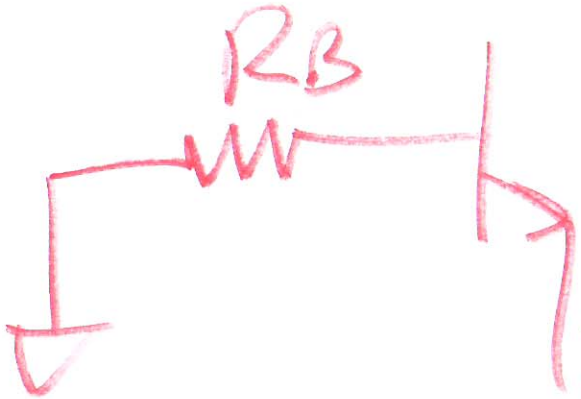
$$i_e = i_b(\beta+1)$$

$$v_i = i_b \cdot r_\pi + i_e \cdot R_E$$

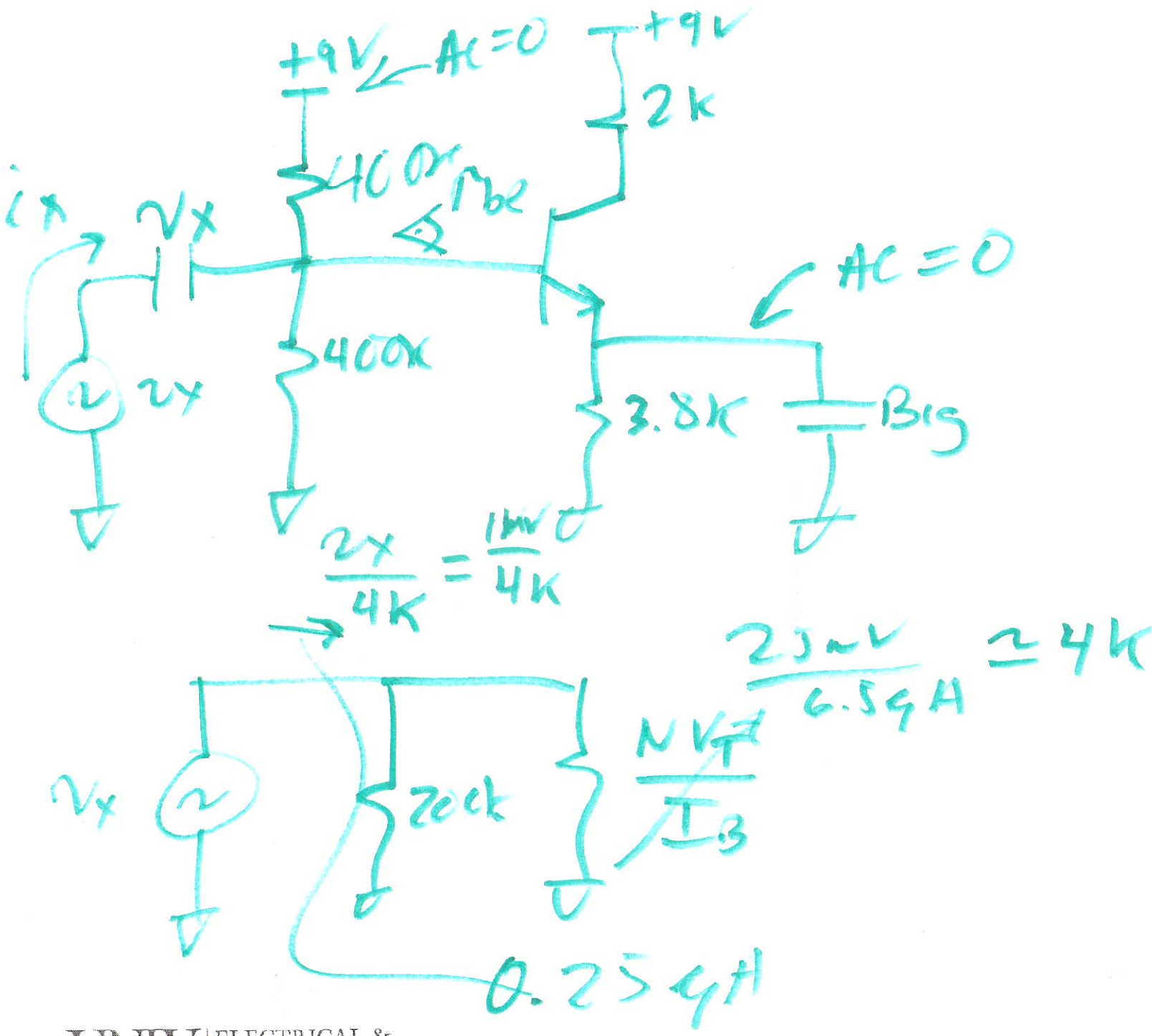
$$\frac{v_i}{i_b} = r_{be} + (\beta+1)R_E$$

$$\frac{NV_T}{I_B}$$

$$\frac{NV_t}{I_E}$$



$$R_{in,b} = r_e + \frac{R_B}{\beta+1}$$


+9V
AC=0
+9V
2k
400k
Mb2
ix
Vx
AC=0
400k
2x
3.8k
Big
2x/4k = 1mV/4k
2.3mV/6.5μA ≃ 4k
Vx
20k
NVT/IB
0.25μA