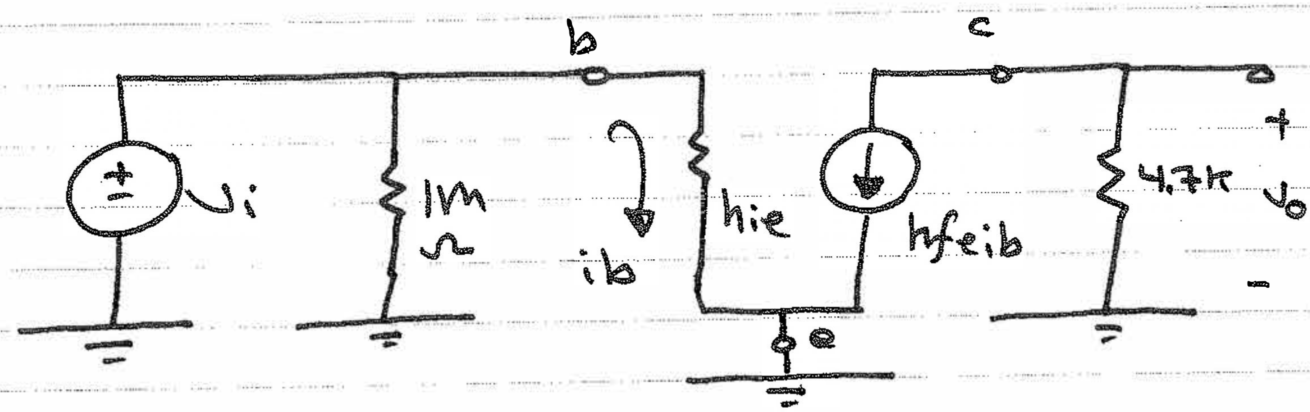
ENEE2360 CH5 Homework Solutions

5.12

* ac small signal equivalent circuit :



$$V_o = -h_{fe} i_b (4.7k)$$

$$i_b = \frac{V_i}{h_{ie}}$$

$$\therefore A_v = \frac{V_o}{V_i} = -\frac{h_{fe}}{h_{ie}}(4.7k) = -160$$

$$\therefore h_{ie} = 2.644 k\Omega$$

$$h_{ie} = \frac{\beta V_T}{I_{CQ}}$$

$$\therefore I_{CQ} = 0.875 mA \quad ; \beta = 90$$

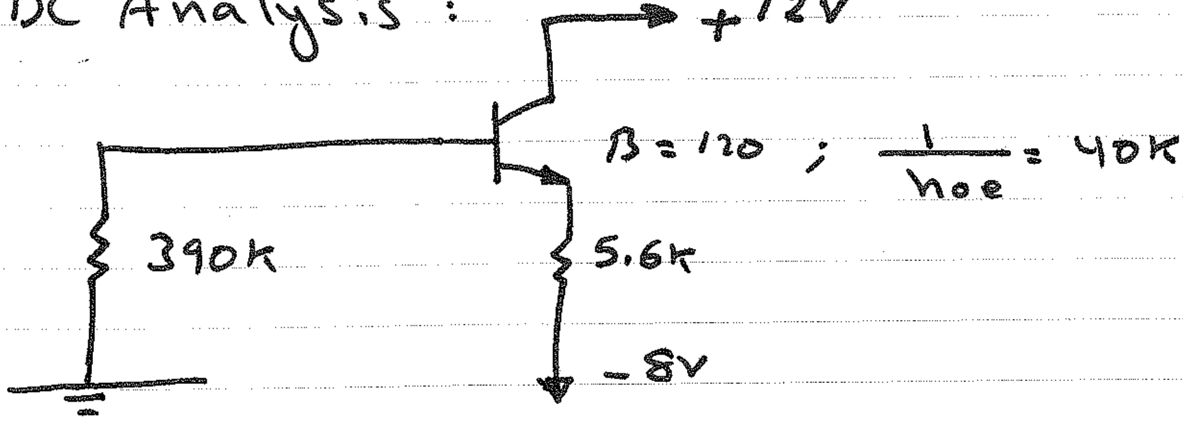
$$\therefore I_B = \frac{I_{CQ}}{\beta} = 9.7 \mu A$$

$$I_B = \frac{V_{CC} - V_{BE}}{1M\Omega} = 9.7 \mu A$$

$$\therefore V_{CC} = 10.42V$$

5.25

DC Analysis :



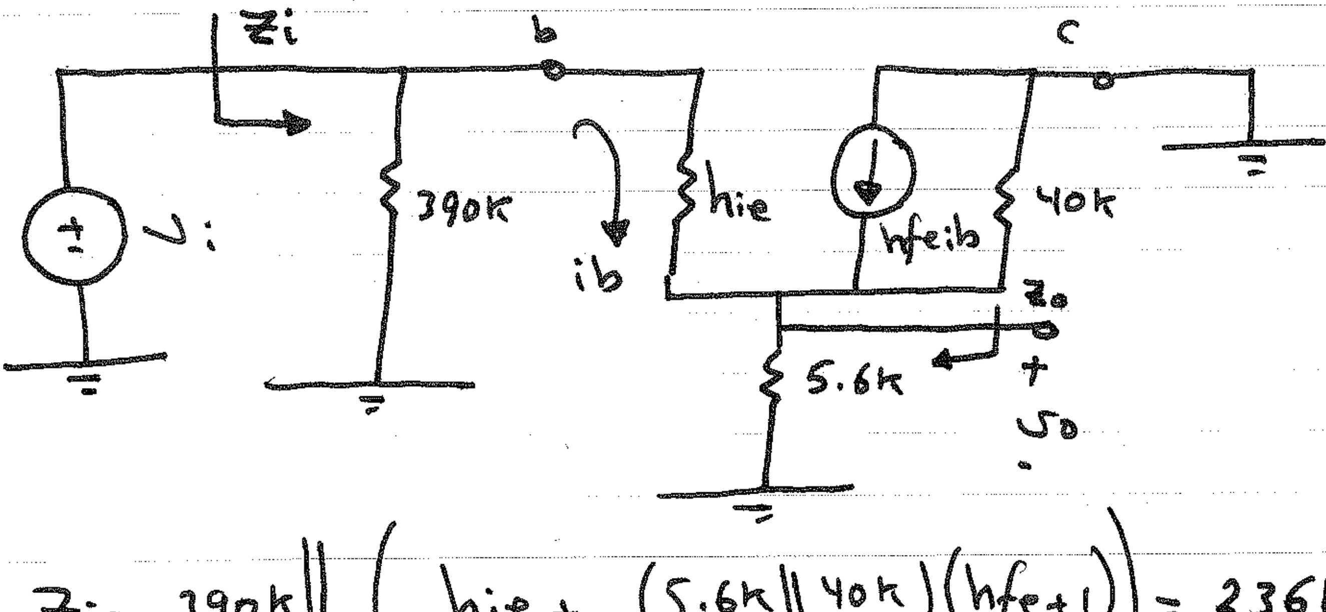
$390K\, I_B + V_{BE} + 5.6K\, I_E - 8 = 0$

$$\therefore I_B = \frac{8 - 0.7}{390k + (\beta+1)\, 5.6k} = 6.838\, \mu A$$

$$I_C = \beta I_B = 0.820\, mA$$

$$h_{ie} = \frac{\beta V_T}{I_{CQ}} = 3.76k$$

ac Small Signal equivalent Circuit:



$$Z_i = 390k \,\Big\|\, \Big(h_{ie} + (5.6k \| 40k)(h_{fe}+1) \Big) = 236K$$

$$v_o = (5.6k \parallel 40k)\, i_e$$

$$i_e = (1+h_{fe})\, i_b$$

$$i_b = \frac{v_i}{h_{ie} + (5.6k \parallel 40k)(h_{fe}+1)}$$

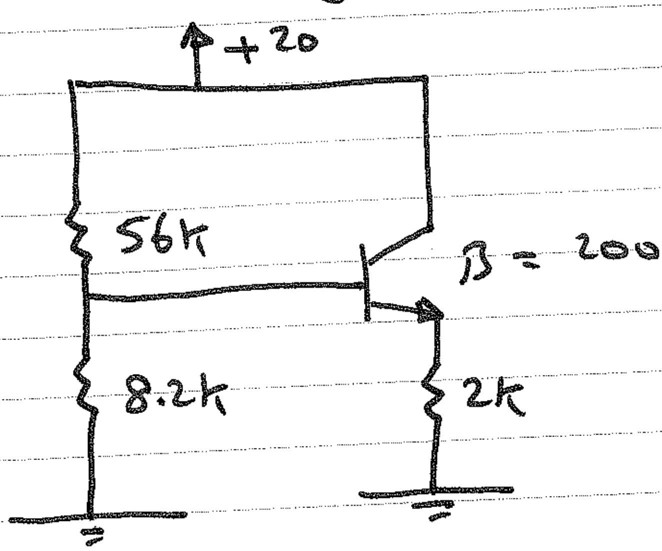
$$\therefore A_v = 0.993$$

$$Z_o = 5.6k \parallel 40k \parallel \frac{h_{ie}}{h_{fe}+1}$$

$$Z_o = 30.8\ \Omega$$

5.26

DC Analysis :



$R_{TH} = 8.2k \parallel 56k = 7.153\,k\Omega$

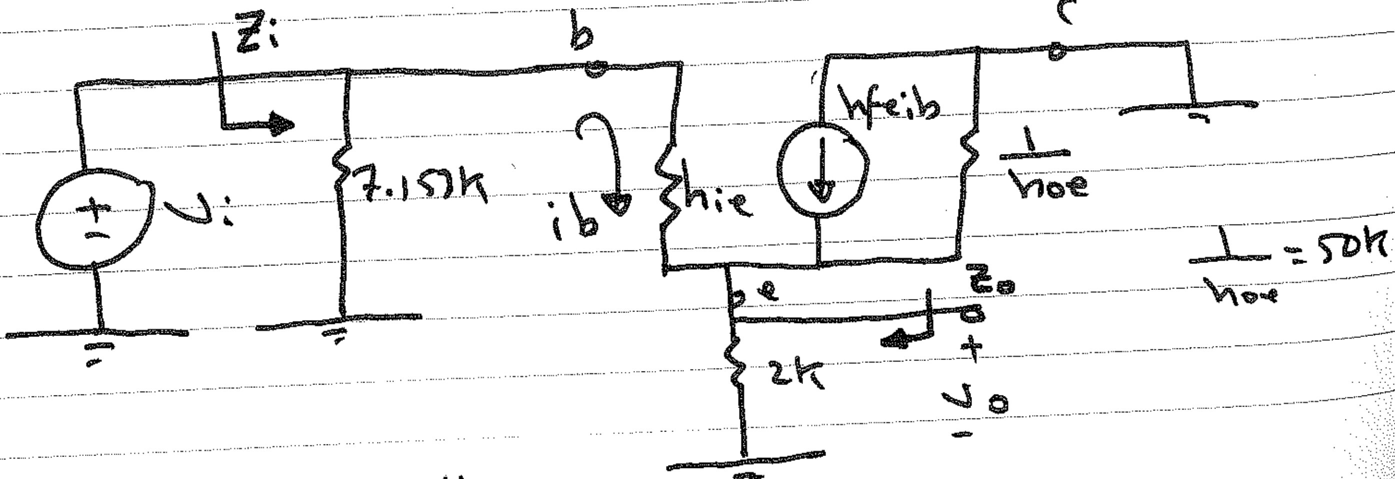
$V_{TH} = \frac{8.2k}{8.2k + 56k} \cdot 20 = 2.55\,V$

$I_B = \frac{V_{TH} - 0.7}{R_{TH} + (\beta+1)(2k)} = 4.52\,\mu A$

$I_C = \beta I_B = 0.904\,mA$

$h_{ie} = \frac{\beta V_T}{I_{CQ}} = 5.68k$

ac small signal equivalent circuit :



$$v_o = \left(2k \parallel \frac{1}{h_{oe}}\right) i_e$$

$$i_e = (h_{fe}+1) i_b$$

$$i_b = \frac{v_i}{h_{ie} + \left(2k \parallel \frac{1}{h_{oe}}\right)(h_{fe}+1)}$$

$$\therefore A_v = 0.984$$

$$Z_i = 7.153k \parallel \left(h_{ie} + (2k \parallel 50k)(201)\right)$$

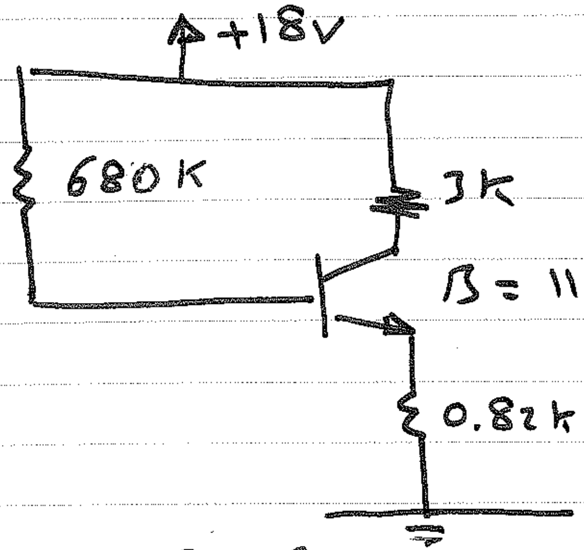
$$Z_i = 7k$$

$$Z_o = (2k \parallel 50k) \parallel \frac{h_{ie}}{201}$$

$$Z_o = 27.9\ \Omega$$

5.40

DC Analysis :

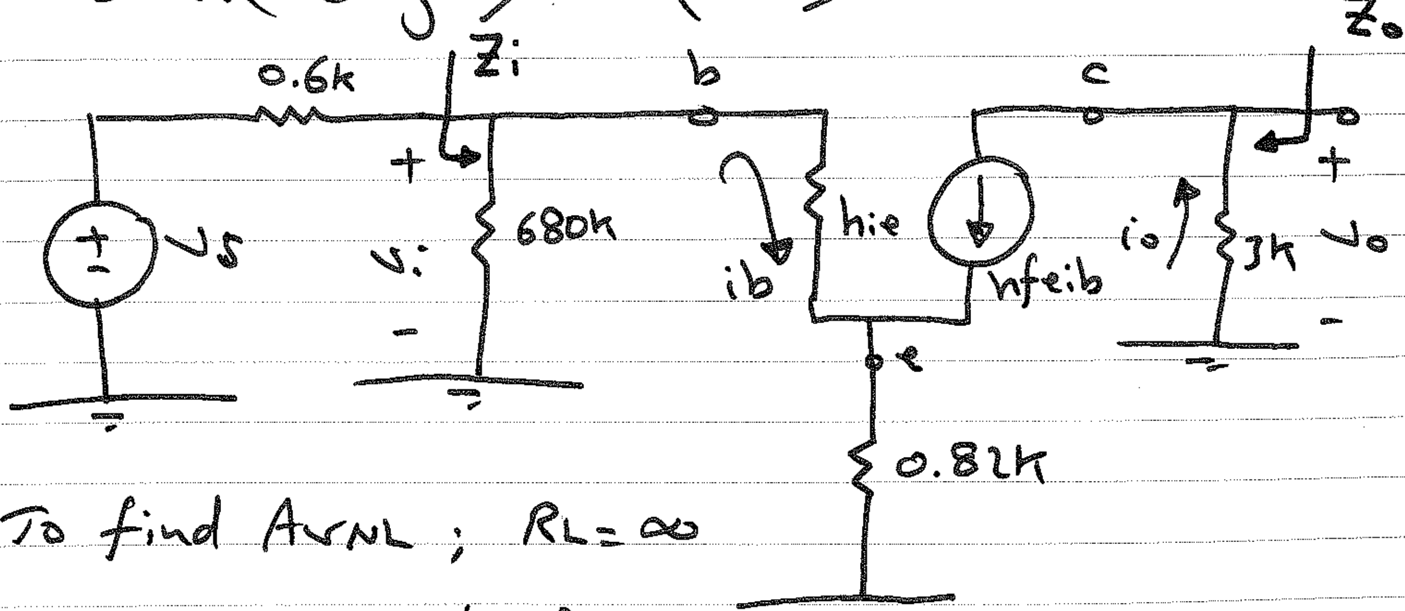


$$I_B = \frac{18 - 0.7}{680k + 111(0.82k)} = 22.44\ \mu A$$

$$I_C = \beta I_B = 2.468\ mA$$

$$h_{ie} = \frac{\beta V_T}{I_{CQ}} = 1.145k$$

ac small signal equivalent circuit:



To find A_{vNL} ; $R_L = \infty$

$$v_o = -h_{fe} i_b (3k)$$

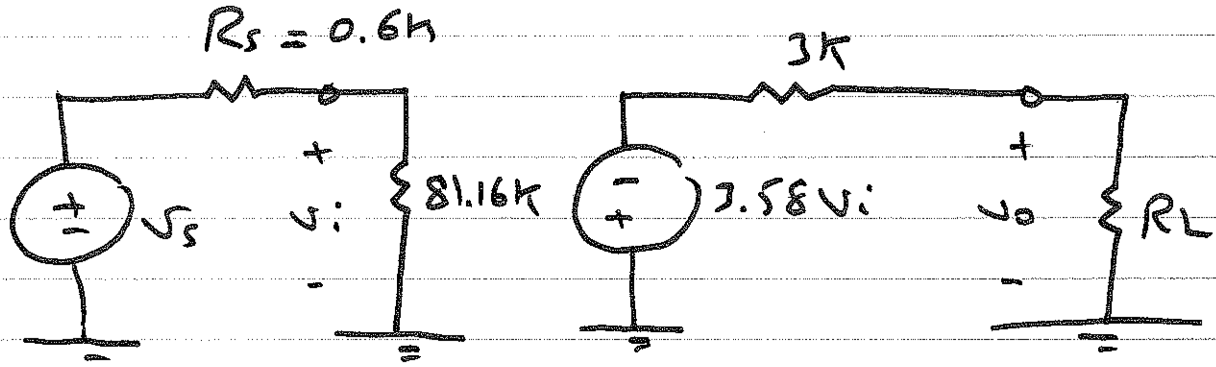
$$i_b = \frac{v_i}{h_{ie} + (h_{fe}+1)(0.82k)}$$

$\therefore A_{vNL} = -3.58$

$Z_o = 3k$

$Z_i = 680k \,\|\, \left(h_{ie} + (h_{fe}+1)(0.82k) \right)$

$Z_i = 81.16k$



$$A_{vL} = \frac{R_L}{R_L + 3k} (-3.58)$$

$$\therefore A_{vL} = \frac{v_o}{v_i} = -2.185$$

$$A_{vs} = \frac{v_o}{v_s} = \frac{v_o}{v_i} \cdot \frac{v_i}{v_s}$$

$$v_i = \frac{81.16k}{81.16k + 0.6k} v_s$$

$\therefore A_{vs} = -2.169$

To find A_i : $A_i = \frac{i_o}{i_i}$

$i_o = h_{fe} i_b$

$i_b = i_i \frac{680k}{680k + h_{ie} + (h_{fe}+1)(0.82k)}$

$\therefore A_i = 96.87$