

4.116

Since $I_E = 0.5 \text{ mA}$ and $\beta = 100$

$$\therefore I_B = \frac{I_E}{\beta + 1} = 4.95 \times 10^{-6} \text{ A}$$

$$I_C = \alpha I_E = \frac{100}{101} (0.5 \text{ mA}) = 0.495 \text{ mA}$$

$$\text{KVL : } 2.5 \text{ k} I_B + V_{BE} + R_E I_E - 15 = 0$$

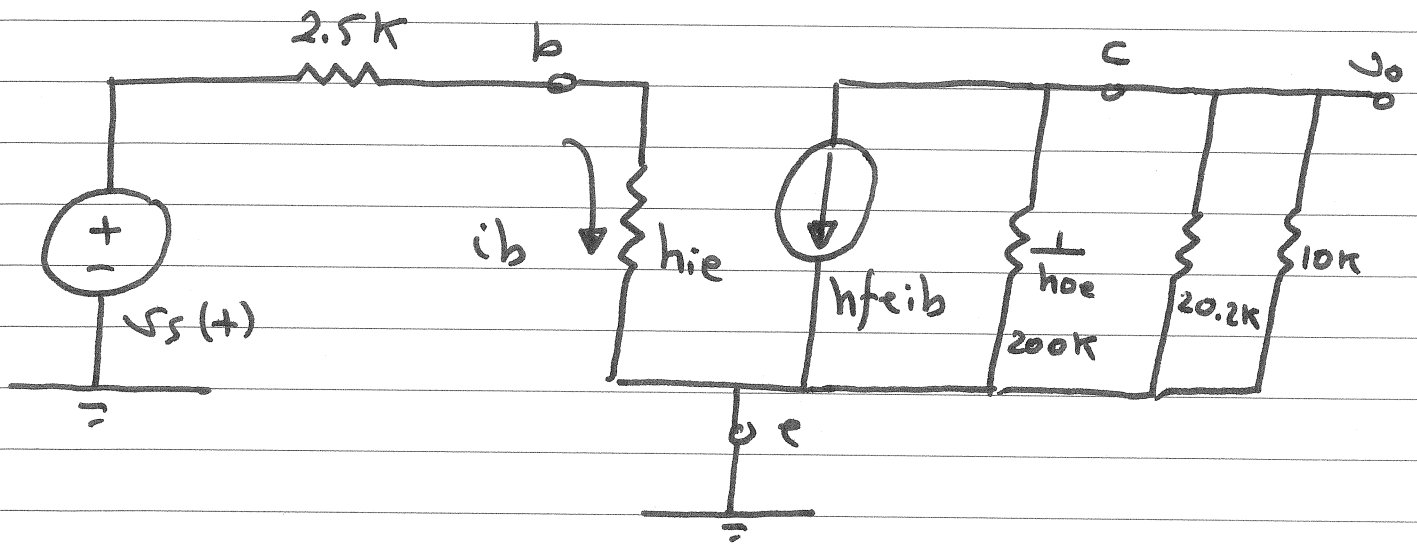
$$\therefore R_E = \frac{15 - V_{BE} - 2.5 \text{ k} I_B}{I_E} = 28.575 \text{ k}$$

$$V_C = V_{CC} - R_C I_C$$

$$\therefore R_C = \frac{15 - 5}{0.495 \text{ mA}} = 20.2 \text{ k}$$

$$h_{ie} = \frac{(\beta + 1) V_T}{I_E} = 5.19 \text{ k}$$

ac small signal equivalent ckt



$$v_o = -h_{fe}i_b (200k \parallel 20.2k \parallel 10k)$$

$$i_b = \frac{v_s}{2.5k + h_{ie}}$$

$$\therefore A_v = \frac{v_o}{v_s} = -84.17$$

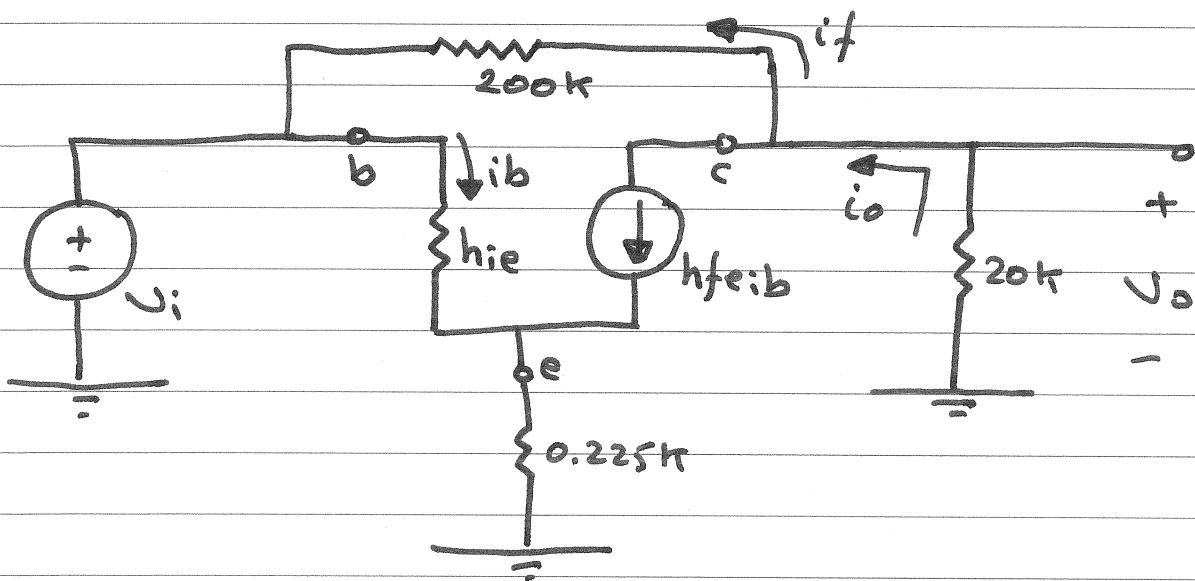
4.119

$$I_E = 1 \text{ mA} ; I_C = \alpha I_E = 0.99 \text{ mA}$$

$$V_C = (200 \text{ k}) I_B + 0.7 + (0.225 \text{ k}) I_E = 2.9 \text{ V}$$

$$h_{ie} = h_{fe} \frac{V_T}{I_C} = 2.6 \text{ k}$$

ac small signal equivalent ckt



$$V_o = -(20 \text{ k}) i_o ; i_o = i_f + h_{fe} i_b$$

$$i_b = \frac{v_i}{h_{ie} + (h_{fe} + 1) 0.225}$$

$$i_f = \frac{V_o - v_i}{200 \text{ k}}$$

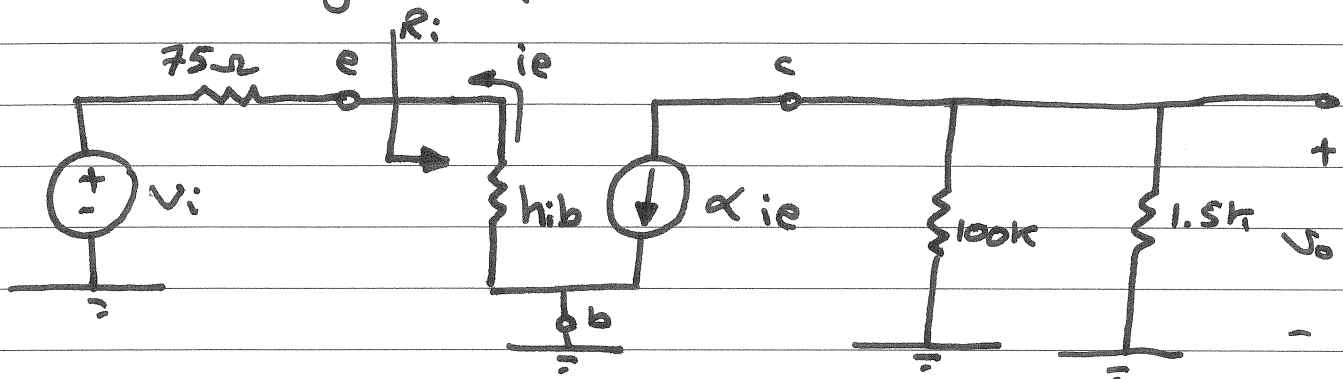
$$\therefore A_v = \frac{V_o}{v_i} \approx -71$$

4.121

$$I_E = 0.33 \text{ mA}$$

$$h_{ib} = \frac{\sqrt{T}}{I_E} = 77.848 \Omega$$

ac small signal equivalent ckt



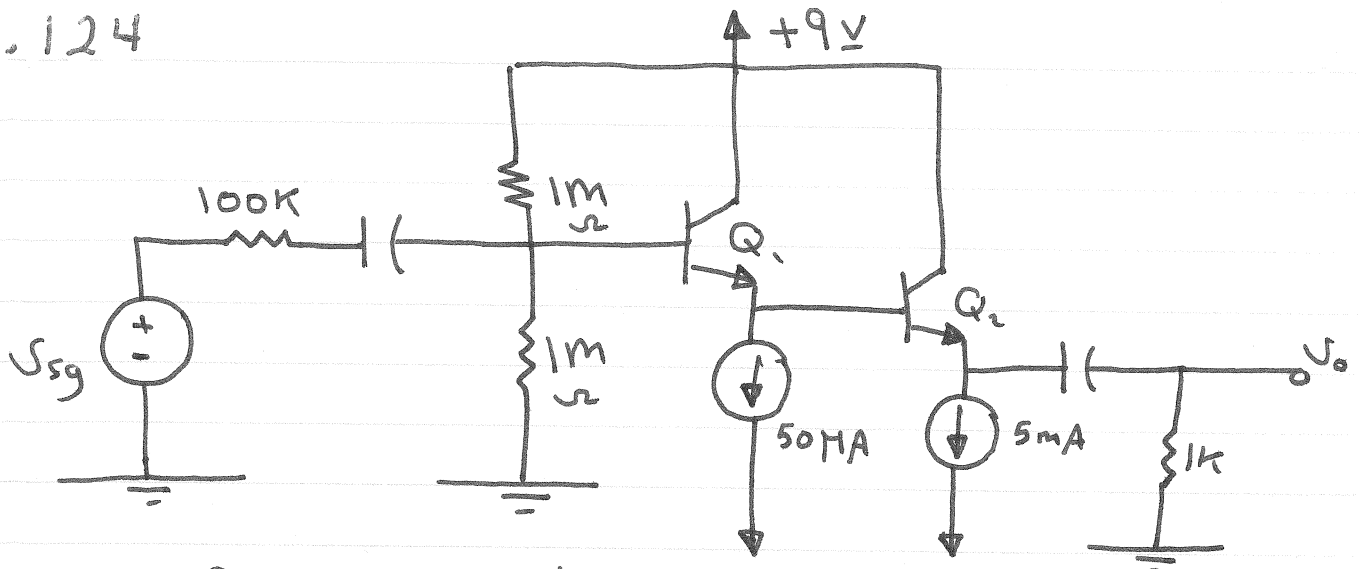
$$v_o = - (100k \parallel 1.5k) \alpha i_e$$

$$i_e = \frac{-v_i}{75\Omega + h_{ib}}$$

$$\therefore A_v = \frac{v_o}{v_i} = 9.66$$

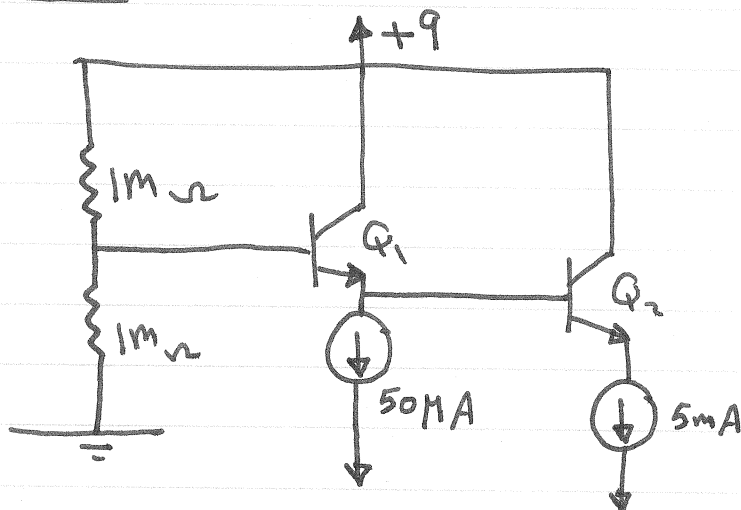
$$R_i = h_{ib} = 77.848 \Omega$$

4.124



$$\beta_1 = 50, \text{ and } \beta_2 = 100$$

DC Analysis



$$I_{E2} = 5\text{mA} \longrightarrow h_{ie2} = 0.513\text{k}\Omega$$

$$I_{B2} = \frac{I_{E2}}{\beta_2 + 1} \approx 50\text{mA}$$

$$I_{E1} = 50\text{mA} + I_{B2} = 0.1\text{mA} \longrightarrow h_{ie1} = 12.845$$

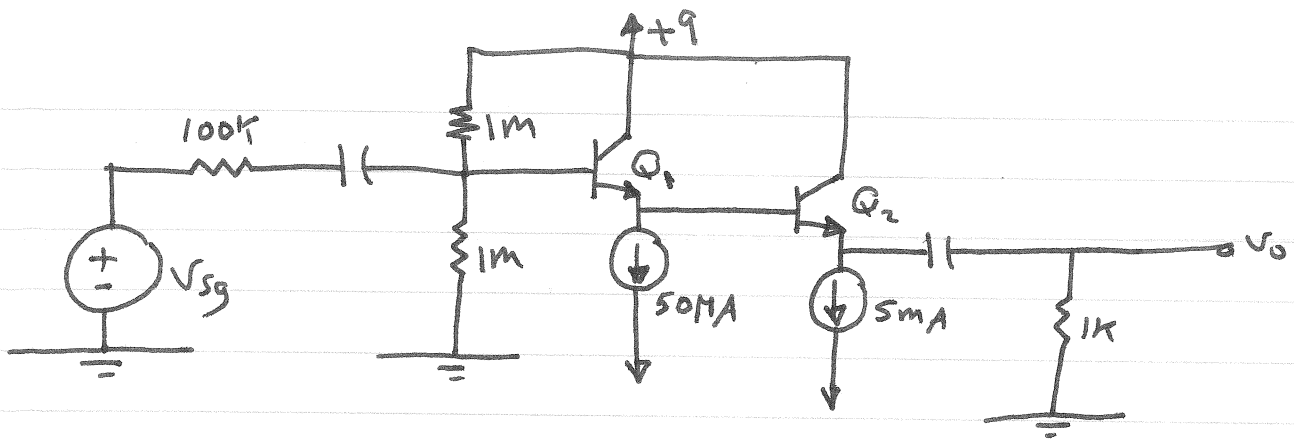
$$I_{B1} = \frac{I_{E1}}{\beta_1 + 1} = 1.96\text{mA}$$

$$R_{TH} = 1\text{M}\Omega \parallel 1\text{M}\Omega = 0.5\text{M}\Omega$$

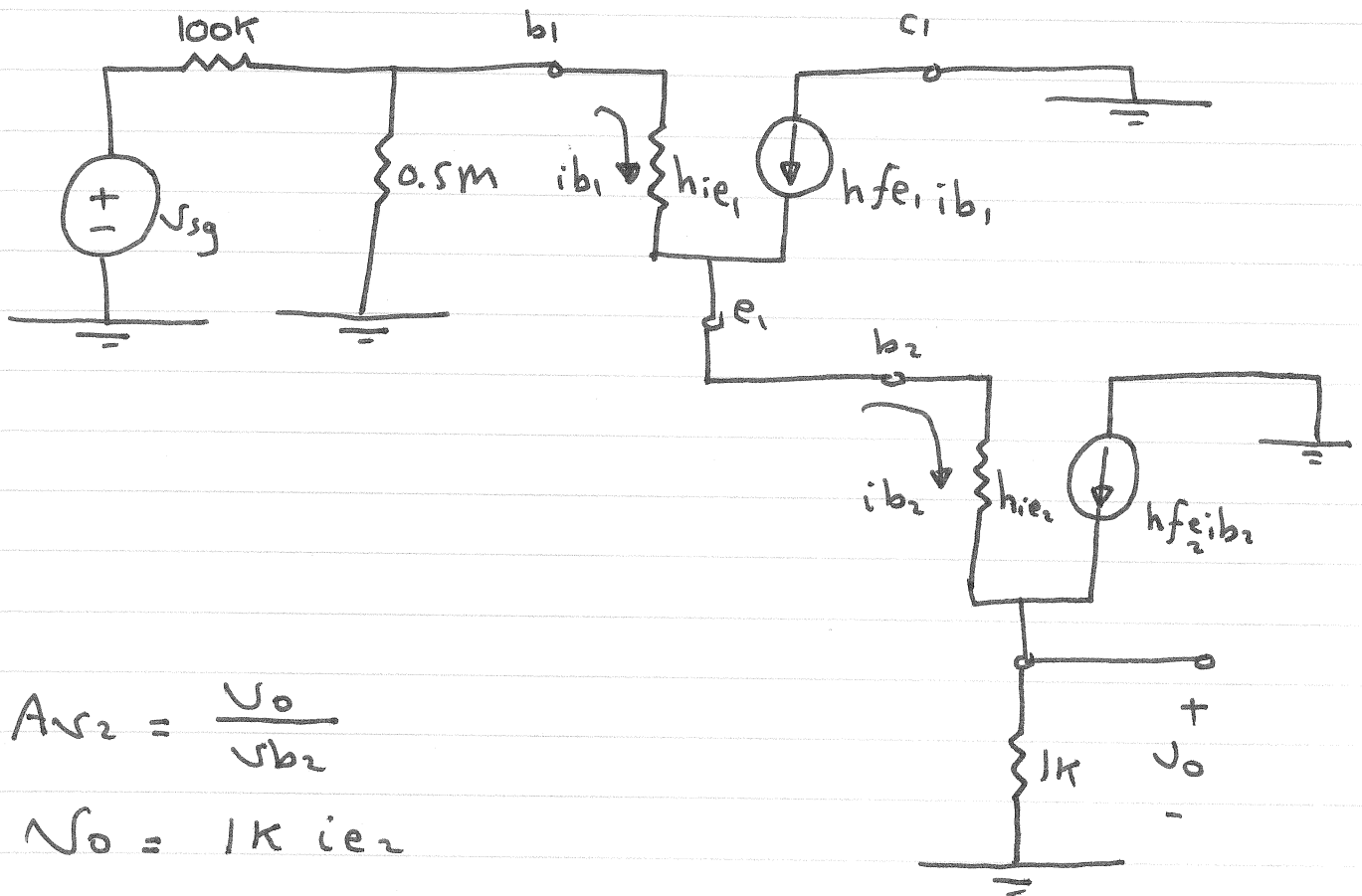
$$V_{TH} = \frac{1\text{M}}{1\text{M} + 1\text{M}} \cdot 9 = 4.5\text{V}$$

$$V_{B1} = -0.5\text{M}\Omega I_{B1} + 4.5 = 3.52\text{V}$$

$$V_{B2} = V_{E1} + V_{B1} = 2.82\text{V}$$



ac small signal Analysis

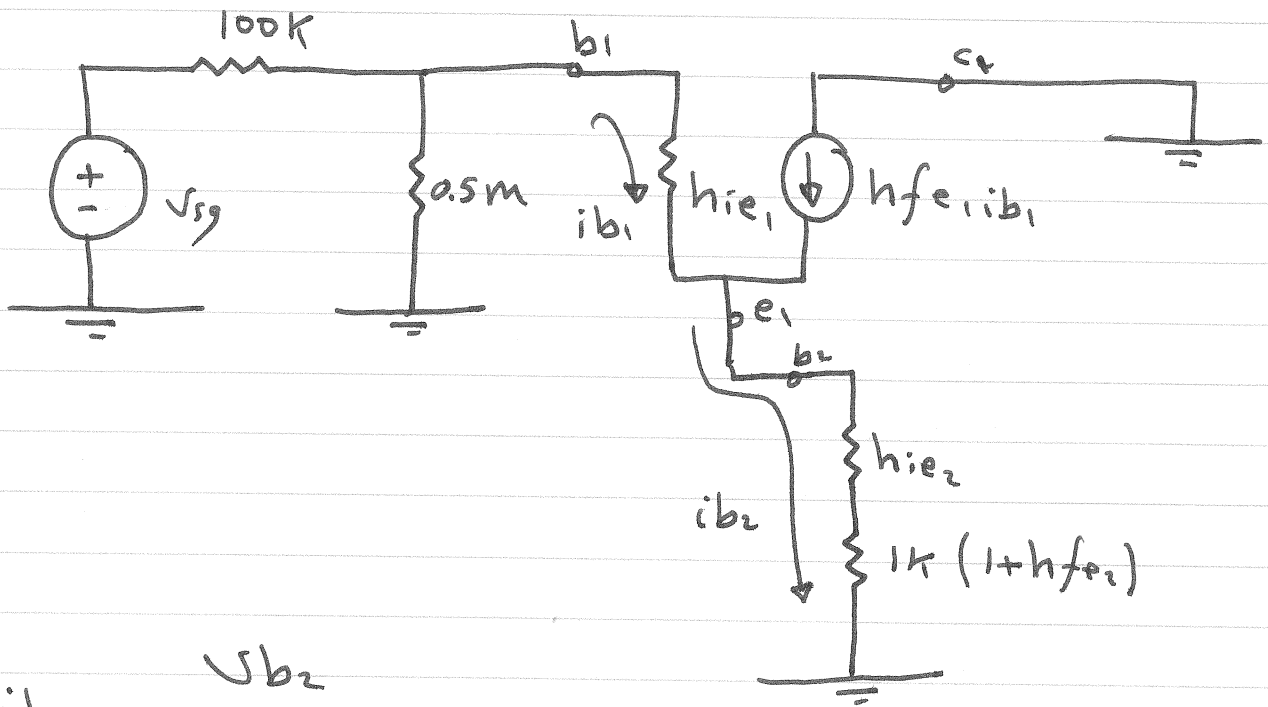


$$A_{v2} = \frac{V_o}{V_{b2}}$$

$$V_o = 1k \cdot i_{e2}$$

$$i_{e2} = (1 + h_{fe2}) i_{b2}$$

To find $i_{b2} \rightarrow$ base 2 equivalent circuit

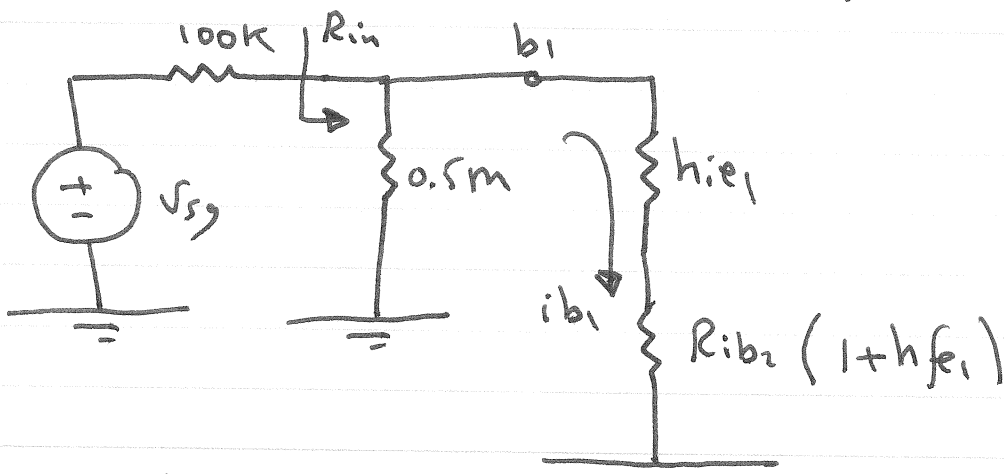


$$i_{b2} = \frac{v_{b2}}{h_{ie2} + 1k(1+h_{fe2})}$$

$$\therefore A_{v2} = \frac{v_o}{v_{b2}} = 0.995$$

$$R_{ib2} = h_{ie2} + 1k(1+h_{fe2}) = 101.5138k$$

To find $R_{ib1} \rightarrow$ base 1 equivalent circuit



$$R_{ib1} = h_{ie1} + R_{ib2}(1+h_{fe1}) = 5190k$$

$$A_{v1} = \frac{v_{e1}}{v_{b1}}$$

$$v_{e1} = v_{b2}$$

$$v_{b2} = (h_{ie2} + 1k(1+h_{fe2})) i_{b2}$$

$$i_{b2} = i_{e1}$$

$$i_{e1} = (1+h_{fe1}) i_{b1}$$

$$i_{b1} = \frac{v_{b1}}{h_{ie1} + R_{ib2}(1+h_{fe2})}$$

$$A_{v1} = 0.9975$$

$$v_{b1} = \frac{R_{in}}{R_{in} + 100k} v_{sg}$$

$$R_{in} = 0.5M \parallel [h_{ie1} + R_{ib2}(1+h_{fe2})]$$

$$R_i = 456k$$

$$\therefore v_{b1} = 0.82 v_{sg}$$

$$A_{vT} = \frac{v_o}{v_{sg}} = \frac{v_o}{v_{b2}} \cdot \frac{v_{b2}}{v_{b1}} \cdot \frac{v_{b1}}{v_{sg}} = 0.814$$