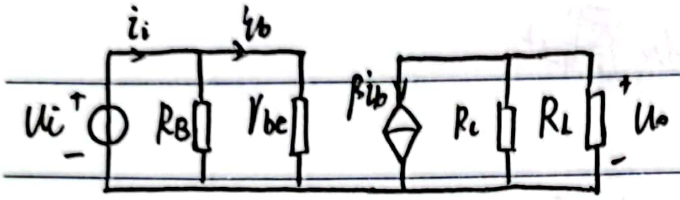
2.11

微变等效电路



(a)

对直流通路 $I_{BQ} = \frac{-V_{CC} - U_{BEQ}}{R_B} = -17.3\mu A$

$$I_{CQ} = \beta I_{BQ} = \frac{\alpha}{1-\alpha} I_{BQ} = -1.7 mA$$

$$U_{CEQ} = -V_{CC} - I_{CQ} R_c = -6.6 V$$

$$U_{opp} = 2\min\{|U_{CEQ}|, |I_{CQ}|R_c\} = 6.8 V.$$

(b) $r_{be} = r_{bb'} + (1+\beta)\frac{26}{|I_{EQ}|} = 1.7 k\Omega$

$$\dot{A}_U = -\frac{\dot{U}_o}{\dot{U}_i} = -\beta \cdot \frac{R_L'}{r_{be}} = -\beta \cdot \frac{R_c}{r_{be}} = -116.$$

$$R_i = R_B // r_{be} = 1.7 k\Omega$$

2.14

解 (1) 分析直流通路 由于 $I \gg I_{BQ}$

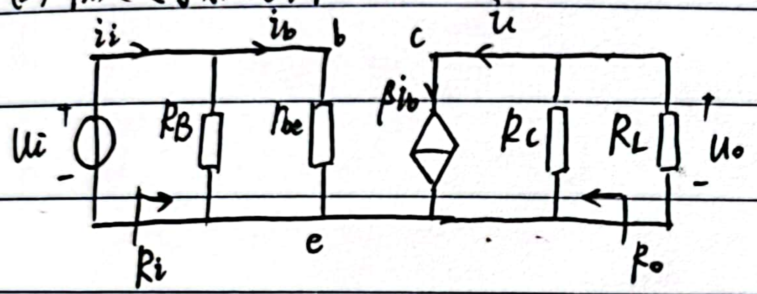
$$\therefore U_{BQ} = \frac{R_{B2}}{R_{B1}+R_{B2}} V_{CC} = 4.7V$$

$$\because U_{BQ} = U_{BEQ} + I_{EQ} \cdot R_E \Rightarrow I_{EQ} = \frac{U_{BQ}-U_{BEQ}}{R_E} = 1.3mA$$

由于 $I \gg I_{BQ}$ 故 $I_{EQ} = I_{CQ} = 1.3mA$

$$\therefore U_{EQ} = I_{EQ} \cdot R_E = 3.9V$$

(2) 微变等效电路



$$R_B = R_{B1} // R_{B2}$$

$$r_{be} = r_{bb'} + (1+\beta)\frac{26}{|I_{EQ}|} = 1.12k\Omega$$

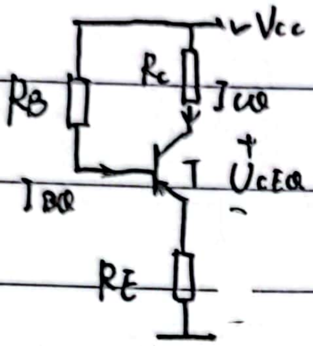
(3) $$\dot{A}_U = -\beta \cdot \frac{R_L'}{r_{be}} = -\beta \cdot \frac{R_C // R_L}{r_{be}} = -68$$

$$R_i = R_B // r_{be} = R_{B1} // R_{B2} // r_{be} = 1.03k\Omega$$

$$R_o \Big|_{\substack{u_i=0 \\ R_L=\infty}} = R_C = 3k\Omega$$

2.17

解：(a). 直流通路：

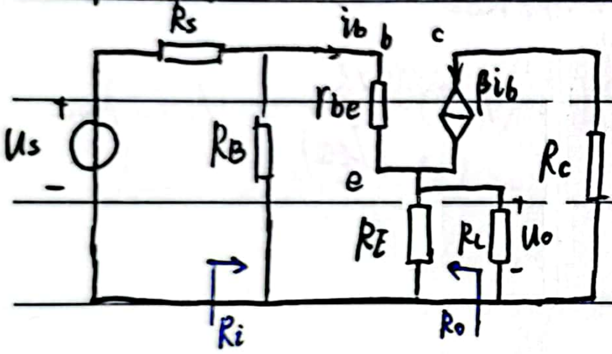


$$I_{EQ}=(1+\beta)I_{BQ} \Rightarrow I_{BQ}=\frac{-V_{cc}}{R_B+(1+\beta)R_E}=-0.11mA$$

$\therefore I_{CQ}=\beta I_{BQ}=-8.80mA$

$$U_{CEQ}\approx -V_{cc}-I_{CQ}\cdot(R_C+R_E)=-5.8V$$

(b) 微变等效电路



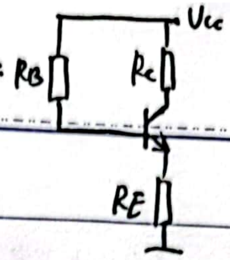
(c) $\dot{A}_u=\frac{\dot{U}_o}{\dot{U}_i}=\frac{(1+\beta)R_L'}{r_{be}+(1+\beta)R_L'}$ $\quad R_L'=R_E // R_L=0.14k\Omega$

$$r_{be}=r_{bb'}+(1+\beta)\cdot\frac{26}{|I_{EQ}|}=0.34k\Omega$$

$\therefore A_u=0.97\approx 1$

$$R_i=R_B//[r_{be}+(1+\beta)R_L']=9.2k\Omega$$

$R_o=R_E//\frac{r_{be}+R_B'}{1+\beta}$ $\quad R_B'=R_B//R_S$ $\quad$ 则 $R_o=0.015k\Omega$

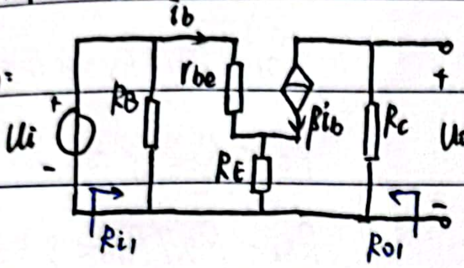
直流通路：

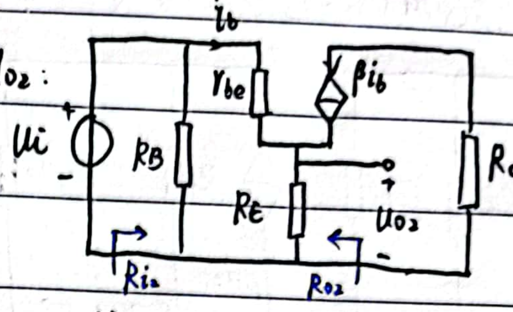
$$I_{BQ} = \frac{V_{CC}}{R_B + (1+\beta) R_E} = 0.16\text{mA}$$

$$\therefore I_{EQ} = (1+\beta) I_{BQ} = 3.4\text{mA}$$

2.19.

解：(a) 微变等效电路：

U_{o1}：

U_{o2}：

$\beta = 20$ $\dot{A}_{u1} = -\beta \cdot \frac{R_L'}{r_{be} + (1+\beta) R_E}$ $r_{be} = r_{bb'} + (1+\beta) \frac{U_T}{|I_{EQ}|} = 0.24\,\text{k}\Omega$ $R_L' = R_c // \infty = R_c$

$\therefore \dot{A}_{u1} = -0.95$ $|\dot{U}_{o1}| = |\dot{A}_{u1}| \cdot \dot{U}_i = 0.95\text{V}$

$\dot{A}_{u2} = \frac{(1+\beta) R_E}{(1+\beta) R_E + r_{be}} = 0.995$ $|\dot{U}_{o2}| = |\dot{A}_{u2}| \cdot \dot{U}_i = 0.995\text{V}$.

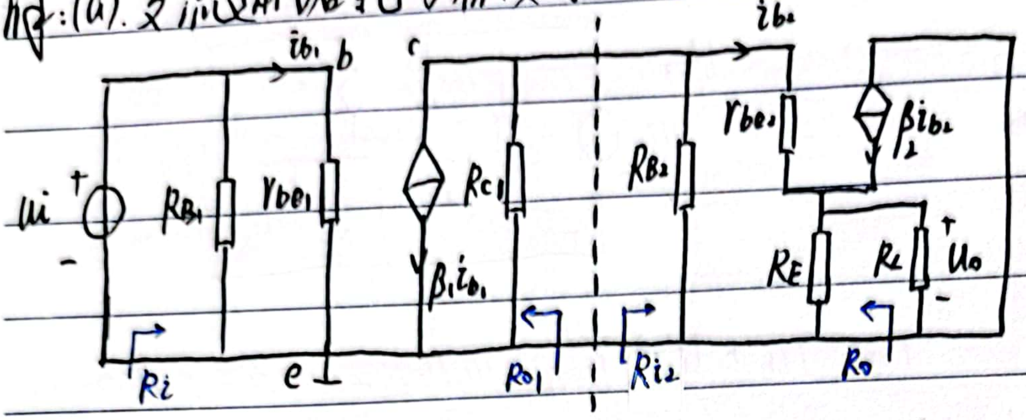
(b) 即 $R_L = 10\,\text{k}\Omega$

$\dot{A}_{u1}' = -\beta \frac{(R_c // R_L)}{r_{be} + (1+\beta) R_E} = -0.75$ $\therefore \dot{U}_{o1}' = 0.75\text{V}$.

$\dot{A}_{u2} = \frac{(1+\beta)(R_E // R_L)}{(1+\beta)(R_E // R_L) + r_{be}} \approx 0.994$ $\therefore \dot{U}_{o2}' = 0.994\text{V}$.

2.20

解：(a). 交流通路化为微变等效电路：



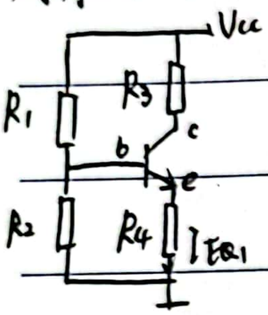
$R_{B1} = R_1 // R_2 = 3.4k\Omega$

$R_{C1} = R_3 = 1k\Omega$

$R_{B2} = R_9 // R_{10} = 3.5k\Omega$

$R_E = R_{11} \quad R_L = 10k\Omega$

对第一级直流通路为

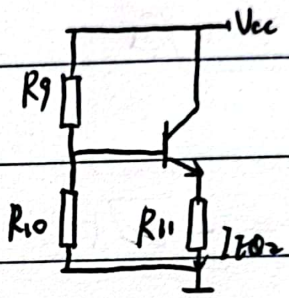


$U_{BQ_1} = V_{CC} \cdot \frac{R_2}{R_1+R_2} = 4.1V$

$I_{EQ_1} = \frac{U_{BQ} - U_{BEQ}}{R_4}$

$= 2.8mA$

对第二级直流通路为



$U_{BQ_2} = \frac{R_{10}}{R_9+R_{10}} V_{CC} = 3.5V$

$I_{EQ_2} = \frac{U_{BQ_2} - U_{BEQ}}{R_{11}}$

$= 2.3mA$

$r_{be1} = r_{bb'} + (1+\beta)\frac{U_T}{|I_{EQ1}|} = 0.55k\Omega$

$r_{be2} = r_{bb'} + (1+\beta)\frac{U_T}{|I_{EQ2}|} = 0.66k\Omega$

$\dot{A}_{u1} = -\beta \cdot \frac{R_{C1}//R_{i2}}{r_{be1}}$

$\dot{A}_{u2} = \frac{(1+\beta)(R_E//R_L)}{r_{be2}+(1+\beta)(R_E//R_L)} = 0.98$

$R_{i2} = R_{B2} // [r_{be2} + (1+\beta)(R_E//R_L)]$

$= 3.3k\Omega$

$\therefore \dot{A}_{u1} = -50 \times \frac{3.3}{4.3 \times 0.55} = -69$

$\therefore \dot{A}_u = \dot{A}_{u1}\dot{A}_{u2} = -68$

(b) $R_i = R_{B1} // r_{be1} \approx r_{be1} = 0.55k\Omega$

$R_o = R_E // \frac{r_{be2} + (R_{B2}//R_{o1})}{1+\beta}$ $\quad R_{o1} = R_{C1} = 1k\Omega$

$\therefore R_o = 0.027k\Omega$