作业

5-7 在图 5-24 所示电路中，晶体管的$\beta = 80$，$r_{bb'} = 200\Omega$，$U_{BE} = 0.7V$，（1）计算静态工作点的数值。（2）计算 A_{us}，R_i，R_o。

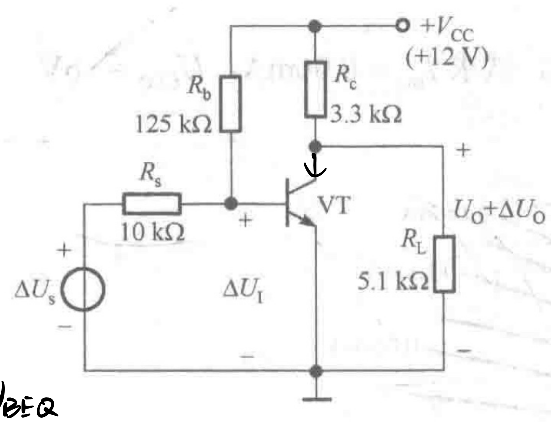
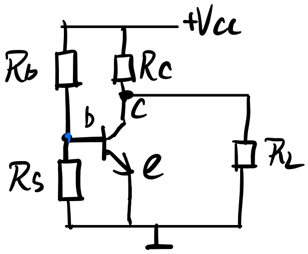


图 5-24 【习题 5-7】晶体管电路

(1)

静态通路：



$$I_{BQ} = \frac{V_{CC}-U_{BEQ}}{R_b} - \frac{U_{BEQ}}{R_s} = \frac{12-0.7}{125} - \frac{0.7}{10} = 20.4\mu A$$

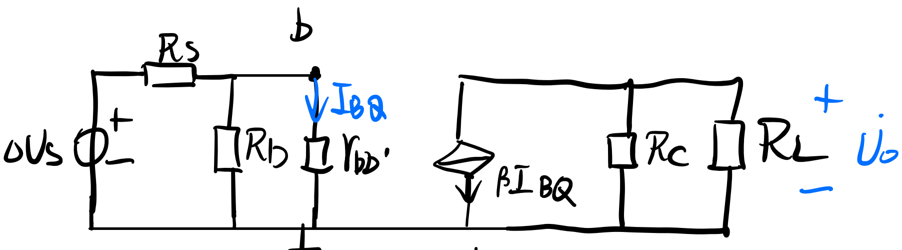
$$I_{CQ} = \beta I_{BQ} = 1.632\,mA$$

$$I_{EQ} = (1+\beta) I_{BQ} = 1.6524\,mA$$

$$V_{CC} = U_{CEQ} + \left(\frac{U_{CEQ}}{R_L} + I_{CQ}\right) R_C$$

$$\Rightarrow U_{CEQ} \approx 4.01V$$

(2) 动态通路微变等效



$$r_{be} = r_{bb'} + (1+\beta)\frac{26}{I_{EQ}} = 200 + 81 \times \frac{26}{1.6524} = 1474.5\Omega \approx 1.5k\Omega$$

$$\dot{U}_o = -\beta I_{BQ} \cdot \frac{R_C \times R_L}{R_C + R_L}$$

$$\dot{U}_i = \frac{R_i}{R_s+R_i}\dot{U}_s \Rightarrow \dot{U}_s = \frac{R_s+R_i}{R_i}\dot{U}_i$$

$$\dot{U}_i = I_{BQ} r_{be}$$

$$R_i = \frac{R_b \times r_{be}'}{R_b + r_{be}'} \approx 1.5k\Omega$$

$$A_{us} = \frac{\dot{U}_o}{\dot{U}_s} = \frac{-\beta \frac{R_C \times R_L}{R_C+R_L}}{\frac{R_s+R_i}{R_i} r_{be}} \approx -13.9$$

$$R_o = R_C = 3.3k\Omega$$

5-8 共集电极放大电路如图5-26所示。晶体管VT的$\beta=50$，$r_{bb'}=300\Omega$，$U_{BE}=0.7V$。（1）若使$U_{CEQ}=5V$，R_{b1}应选多大阻值？（2）R_{b1}取（1）中确定的阻值，画出微变等效电路，并计算A_u，R_i，R_o。

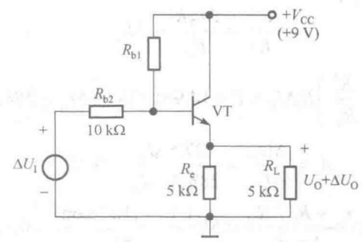
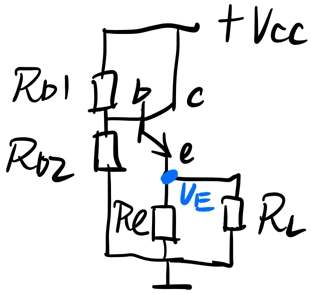


图5-26 【习题5-8】共集电极放大电路

(1) 静态通路



$$V_{cc} = U_{CEQ} + U_E$$

$$U_E = 9-5 = 4V$$

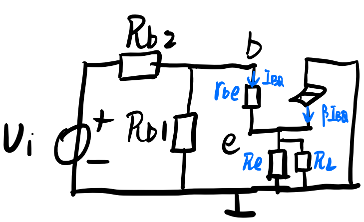
$$I_{EQ} = \frac{U_E}{R_e} + \frac{U_E}{R_L} = \frac{8}{5k} = 1.6mA$$

$$I_{BQ} = \frac{I_{EQ}}{1+\beta} \approx 31.3\mu A$$

$$I_{b2} = \frac{U_{BEQ}+U_E}{R_{b2}} = \frac{4.7}{10k} = 0.47mA$$

$$R_{b1} = \frac{V_{cc}-U_{BEQ}-U_E}{I_{b2}+I_{BQ}} = \frac{4.3}{(470+31.3)\times10^{-6}} \approx 8.6k\Omega$$

(2) 微变等效



$$\dot{U}_o = (1+\beta)I_B(R_e/\!/R_L)$$

$$\dot{U}_i' = I_{BQ}r_{be} + (1+\beta)I_{BQ}(R_e/\!/R_L)$$

$$r_{be} = r_{bb'} + (1+\beta)\frac{26}{I_{EQ}} = 300 + \frac{51\times26}{1.6} \approx 1.1k\Omega$$

$$R_L' = \frac{R_e\times R_L}{R_e+R_L} = 2.5k\Omega$$

$$\dot{U}_i = \dot{U}_i' + \left(\frac{\dot{U}_i'}{R_{b1}} + I_{BQ}\right)R_{b2}$$

$$A_u = \frac{\dot{U}_o}{\dot{U}_i} \approx 0.44$$

$$R_i = R_{b2} + R_{b1} /\!/ [r_{be} + (1+\beta)R_L'] = 10k + \frac{8.6k\times(1.1k+51\times2.5k)}{8.6k+1.1k+51\times2.5k} = 18.06k\Omega$$

$$R_o = R_e /\!/ \frac{1}{1+\beta}[r_{be} + (R_{b1}/\!/R_{b2})] \approx 0.11k\Omega$$

9.5 $V_- = V_+ = 0$

$$\frac{2}{6} - \frac{6}{3} + \frac{6}{4} = \frac{0-V_{o1}}{24} \Rightarrow V_{o1} = 4V$$

$$\frac{-3}{4} = \frac{V_{o2}}{8} \Rightarrow V_{o2} = -6V$$

$$\frac{U_{o1}-U_{o2}}{12} = \frac{U_{o2}-U_{o3}}{6} \Rightarrow U_{o3} = -11V$$

9.6

(1) $$\frac{0-U_{I1}}{R_1} = \frac{U_{I1}-U_{o1}}{R_{f1}} \Rightarrow U_{o1} = (1+\frac{R_{f1}}{R_1})U_{I1}$$

$$\frac{U_{o1}-U_{I2}}{R_2} = \frac{U_{I2}-U_o}{R_{f2}} \Rightarrow U_o = (1+\frac{R_{f2}}{R_2})U_{I2} - \frac{R_{f2}}{R_2}(1+\frac{R_{f1}}{R_1})U_{I1}$$

(2) 设 A_1 输出为 U_{o1}，A_2 输出 U_{o2}

$$\begin{cases} \dfrac{U_{o1}-U_{I1}}{R} = \dfrac{U_{I1}-U_{I2}}{R_p} \\ \dfrac{U_{I2}-U_{o2}}{R} = \dfrac{U_{I1}-U_{I2}}{R_p} \end{cases} \Rightarrow U_{o1}-U_{o2} = (1+\frac{2R}{R_p})(U_{I1}-U_{I2})$$

A_3 为减法电路 $\Rightarrow U_o = -\frac{R_f}{R_1}(U_{o1}-U_{o2}) = -\frac{R_f}{R_1}(1+\frac{2R}{R_p})(U_{I1}-U_{I2})$

ab 都是差分电路，a 的比例系数可不同，b 的总比例系数可调