

4 章作业答案

4.11 题. (a), 计算静态工作点. 忽略 I_{CQ}

$$\text{则 } I_{CQ} \approx I_{ZQ} = \frac{V_{Z2} - V_{BEQ}}{2R_2 + \frac{R_P}{2}} \approx 1.4 \text{ mA}$$

~~静态电压值不用计算~~

$$V_{CZQ} = V_{CC} + V_{Z2} - I_{CQ} \left(R_C + \frac{R_P}{2} + 2R_2 \right) = 8.5 \text{ V}$$

(b) 计算 A_{ud} , A_{uc} 与 K_{CMR} .

$$r_{be} = r_{bb'} + (1+\beta) \frac{V_T}{I_{ZQ}} = 1.43 \text{ k}\Omega$$

$$A_{ud} = - \frac{\beta R_C // \frac{R_P}{2}}{R_B + r_{be} + (1+\beta) \frac{R_P}{2}} \approx -50.7$$

电路对称 双端输出. 故 $A_{uc} = 0$

$$K_{CMR} = \left| \frac{A_{ud}}{A_{uc}} \right| = \infty$$

$$\text{差模输入电阻 } R_{id} = 2 \left[R_B + r_{be} + (1+\beta) \frac{R_P}{2} \right] \\ \approx 11 \text{ k}\Omega$$

$$\text{共} \dots \dots \dots R_{ic} = R_B + r_{be} + (1+\beta) \left(2R_2 + \frac{R_P}{2} \right) \\ \approx 628 \text{ k}\Omega$$

$$\text{输出电阻 } R_o = 2R_C = 10.2 \text{ k}\Omega$$

(c) 当 R_L 改接 T_1 集电极与地之间,
电路变为单端输出, 重新计算 A .
由于 $R_L \gg R_c$ 故 Q 点基本不变.

$$I_{CQ} = 1.4 \text{ mA} \quad U_{CEQ} = 8.5 \text{ V}$$

$$A_{nd} = - \frac{\beta R_c \parallel R_L}{2 [R_B + r_{be} + \frac{R_P}{2} (1 + \beta)]} = -27.9$$

(说明, 单出时 R_L 不用分. 增益需减半)

$$A_{uc} = - \frac{\beta R_c \parallel R_L}{R_B + r_{be} + (1 + \beta) (\frac{R_P}{2} + 2R_E)} \approx -0.49.$$

$$K_{CMR} = \left| \frac{A_{nd}}{A_{uc}} \right| = 57$$

差模输入电阻 $R_{id} = 2 [R_B + r_{be} + (1 + \beta) \frac{R_P}{2}]$
 $= 11 \text{ k}\Omega$

共 - - - - - $R_{ic} = R_B + r_{be} + (1 + \beta) (\frac{R_P}{2} + 2R_E)$
 $\approx 628 \text{ k}\Omega$

单端输出 $R_o = R_c = 5.1 \text{ k}\Omega$

4.13 题 (a) 单端输出且 u_o 与 u_i 同相. R_L 直接接在 C_2 处.

$$\begin{aligned}\Delta u_o &= A_{ud} \Delta u_{id} + A_{uc} \Delta u_{2c} \\ &= A_{ud}(u_{i1} - u_{i2}) + A_{uc} \frac{u_{i1} + u_{i2}}{2}\end{aligned}$$

单端输入 $u_{i1} = u_i$, $u_{i2} = 0$.

$$\text{则 } \Delta u_o = A_{ud} u_i + A_{uc} \frac{u_i}{2} = A_{ud} u_i + A_{uc} \frac{u_i}{2}$$

$$\text{故 } u_i = \frac{\Delta u_o}{A_{ud} + \frac{A_{uc}}{2}}$$

计算 T_1 与 T_2 的 Q . (设为硅管)

$$I_{EQ} = \frac{V_{Z2} - U_{BEQ}}{2R_2 + \frac{R_P}{2}} = 1.39 \text{ mA}$$

可不计算 Q 点电压值. 后面分析不需要. 题中也没有问.

$$r_{be} = r_{bb'} + (1 + \beta) \frac{U_T}{I_{EQ}} = 2.0 \text{ k}\Omega$$

$$A_{ud} = \frac{1}{2} \frac{\beta(R_C \parallel R_L)}{R_B + r_{be} + (1 + \beta) \frac{R_P}{2}} \approx 18.7$$

$$A_{uc} = - \frac{\beta R_C \parallel R_L}{R_B + r_{be} + (1 + \beta) (\frac{R_P}{2} + 2R_2)} = -0.32$$

书上页 4.13 题

当输出电压 $\Delta U_o \geq 2V$. 输入信号

$$U_i \geq \frac{\Delta U_o}{A_{ud} + \frac{A_{uc}}{2}} = \frac{2}{18.7 - \frac{0.32}{2}} \approx 107 mV$$

故. 输入信号至少应为 $107 mV$

(b) 差模输入电阻

$$R_i = 2 \left[R_B + r_{be} + (1 + \beta) \frac{R_D}{2} \right] = 18.1 k\Omega$$

当考虑信号源内阻时.

$$U_i = \frac{R_i}{R_i + R_s} U_s$$

$$U_s = \frac{R_i + R_s}{R_i} U_i = 118.8 mV$$

(c) 共模抑制比.

$$K_{CMR} = \left| \frac{A_{ud}}{A_{uc}} \right| = 58.4$$

方法二. (9) $\Delta U_o = A_{ud} \cdot \Delta U_{id} + A_{uc} \cdot \Delta U_{ic}$

忽略共模的影响.

$$\Delta U_o \approx A_{ud} \cdot \Delta U_{id}$$

$$\text{则 } U_{id} = \frac{\Delta U_o}{A_{ud}} = \frac{2}{18.7} = 106.95$$

$$\approx 107 mV$$

忽略共模信号的影响

4.19题. 电路是带恒流源的差分放大电路. 静态工作点应从恒流源计算.

$$I_{E3} = \frac{V_Z - V_{BE3}}{R_Z} = \frac{6 - 0.7}{2.3} = 2.3 \text{ mA}$$

$$T_1, T_2 \text{ 管 } I_{C1} = I_{C2} = \frac{I_{E3}}{2} = 1.15 \text{ mA}$$

$$V_{C1} = V_{C2} = V_{CC} - I_C R_C = 4.87 \text{ V}$$

(b) 动态指标

$$r_{be} = r_{bb'} + (1 + \beta) \frac{V_T}{I_{E1}} = 1.45 \text{ k}\Omega$$

$$A_{ud} = - \frac{\beta R_C}{R_B + r_{be}} = -126.38$$

$$A_{uc} = R_{id} = 2(R_B + r_{be}) = 4.9 \text{ k}\Omega$$

$$R_o = 2R_C = 12.4 \text{ k}\Omega \quad (\text{双端})$$