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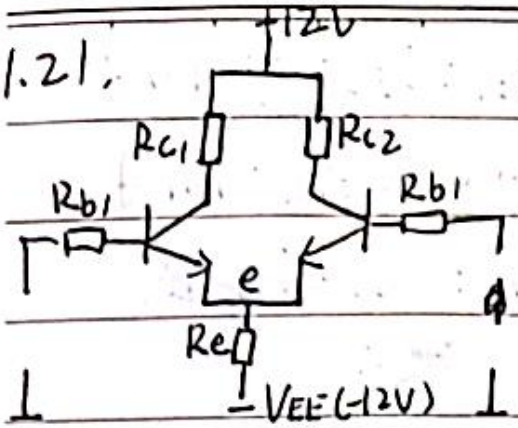
1.21.



(1) $I_{BQ} = \frac{V_{EE} - V_{BE}}{R_{b1} + 2(1+\beta)R_e} = 5.56\mu A$

$I_{EQ} \approx I_{CQ} = \beta I_{BQ} = 0.56mA$

$V_{CC} + V_{EE} = I_{CQ} R_{C1} + V_{CEQ} + 2 I_{EQ} R_e$

$V_{CEQ} = 7.2V$

短路 R_{C1} 后

$I_{C1Q} = I_{C2Q} = 0.56mA$

$V_{CEQ2} = 7.2V$

$V_{CEQ1} = V_{CC} + V_{EE} - 2I_{EQ} R_e = 12.8V$

(2) $R_{id} = 2(r_{be} + R_b)$

$r_{be} = r_{bb}' + (1+\beta)\frac{V_T}{I_{EQ}} = 4.88k\Omega$

$R_{id} = 29.76k\Omega$

$A_{vd2} = \frac{\beta R_{C2}}{2(r_{be} + R_b)} = 33.6$

(3) $A_{vc2} = -\frac{\beta R_{C2}}{r_{be} + R_b + (1+\beta)2R_e} = -0.49$

$K_{CMR} = \left|\frac{A_{vd2}}{A_{vc2}}\right| = 68.37$

(4) $V_{id} = V_{i1} - V_{i2} = 10mV$

$V_{ic} = \frac{V_{i1} + V_{i2}}{2} = 100mV$

$V_{o2} = V_{id} \cdot A_{vd2} + V_{ic} \cdot A_{vc2} = 287mV$

$\Delta V_E = V_{ic} = 100mV$

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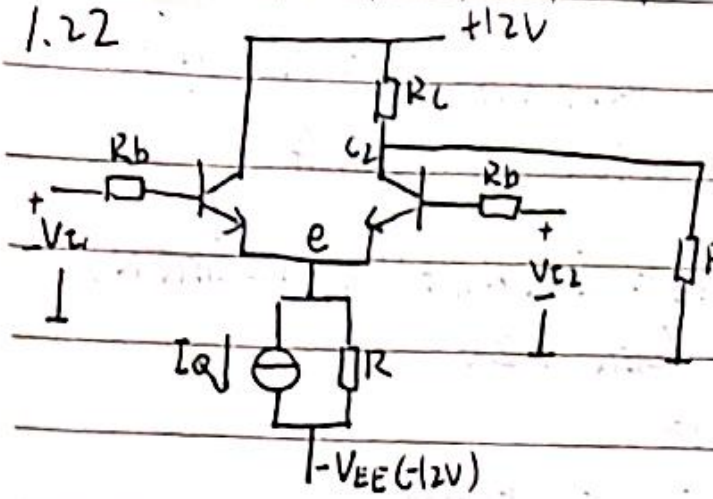


(1) $I_{E1}=I_{E2}=\frac{I_Q}{2}=1mA$

$I_{C1Q}\approx I_{E1Q}=1mA$

~~$I_{BQ}=\frac{V_{CC}-I_{CQ}R_L}{\beta}$~~

$V_{EQ}=-V_{BE}-I_{BQ}R_b$

$=-0.71V$

$V_{C2Q}=\frac{V_{CC}\times R_L}{R_L+R_L}-I_{C2Q}(R_L//R_L)=6V$ 4.5V

(2) $A_{Vd2}=\frac{\beta(R_L//R_L)}{2(r_{be}+r_b)}=18.75$

$R_{id}=2(r_{be}+r_b)=8k\Omega$

$R_o=R_L//R_L=1.5k\Omega$

(3) $A_{VC2}=-\frac{\beta(R_L//R_L)}{R_b+r_{be}+(1+\beta)2R_e}=-7.42\times10^{-4}$

$R_e=R=1M\Omega$

$K_{CMR}=\left|\frac{A_{Vd2}}{A_{VC2}}\right|=25250.5$

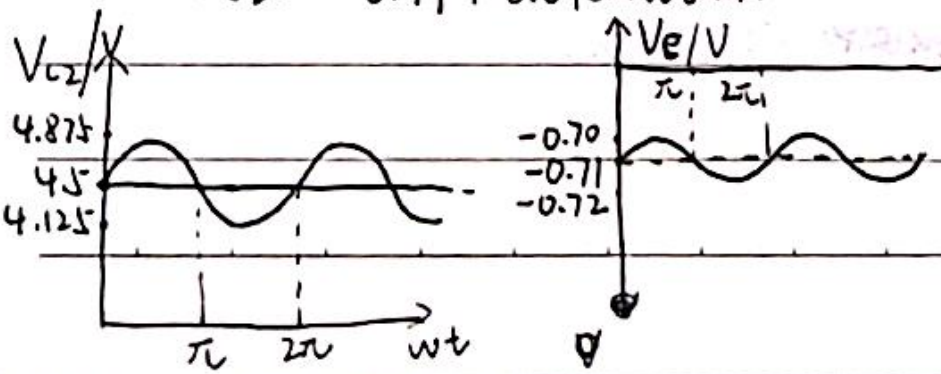
(4) $V_{C2}=A_{Vd2}\cdot(V_{i1}-V_{i2})+A_{VC2}\times\frac{V_{i1}+V_{i2}}{2}$

$=0.375\sin\omega t\ V$

$V_{C2}=4.5+0.375\sin\omega t\ V$

$V_E=V_{i1}=10\sin(\omega t)\ mV$

$V_{e2}=-0.71+0.01\sin\omega t\ mV$



V_{C2}与差模信号相位相同

V_e与共模信号相位相同

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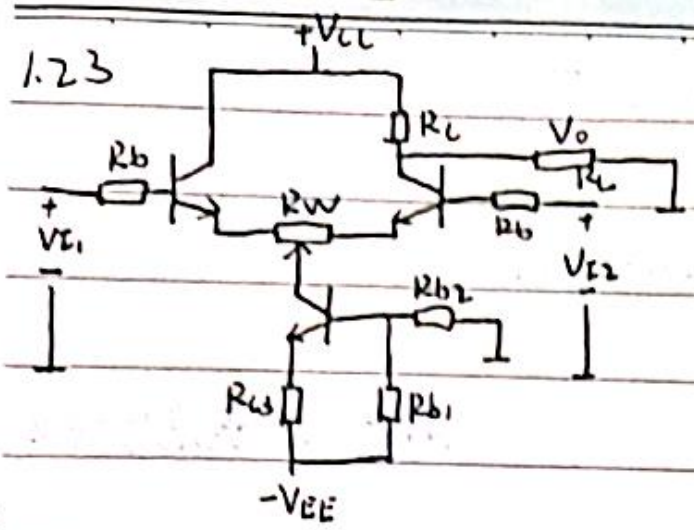

~~(1) $V_{B3}=\frac{R_{b1}\cdot V_{EE}}{R_{b1}+R_{b2}}=3V$~~

~~$R_{b3}=R_{b1}//R_{b2}=7.5K\Omega$~~

~~$I_{B3}=\frac{7.25-0.7}{R_{b3}+(1+\beta_3)R_{c3}}=18.4\mu A$~~

~~$I_{E3}\approx I_{C3}=\beta I_{B3}$~~

(1) $V_{B3}=\frac{R_{b1}}{R_{b1}+R_{b2}}V_{EE}=3V$ $R_{b3}=R_{b1}//R_{b2}=7.5K\Omega$

$I_{B3}=\frac{3-0.7}{R_{b3}+(1+\beta_3)R_{c3}}=27.38\mu A$ $I_{E3}=(1+\beta)I_{B3}=1.4mA$

$I_{EQ1}=I_{EQ2}=\frac{I_{E3}}{2}=0.7mA$

$I_{BQ1}=I_{EQ1}=0.7mA$, $I_{CQ2}=0.7mA$, $I_{CQ3}=I_{E3}=1.4mA$

$V_{C2Q}=\frac{R_L}{R_L+R_C}V_{CC}-I_{C2Q}(R_L//R_C)=3.5V$, $V_{OQ}=\frac{R_L}{R_L+R_C}V_{CC}-V_{C2Q}=2.5V$

(2) $A_{Vd2}=\frac{\beta(R_C//R_L)}{2(r_{be}+R_b)+(1+\beta)\frac{R_W}{2}}$ $r_{be}=r_{bb}'+(1+\beta)\frac{V_T}{I_{EQ}}=2.2K\Omega$

$A_{Vd2}=12.8$

$R_{id}=2(R_{b1}+r_{be}+(1+\beta)\frac{R_W}{2})$

$=19.5K\Omega$

$R_{od}=R_C=10K\Omega$

(3) 对电流源电路: $R_{O3}=(1+\frac{\beta R_{c3}}{r_{be}+R_{e3}+R_{b1}//R_{b2}})r_{ce}+R_{c3}//(r_{be}+R_{b1}//R_{b2})$

$r_{be}=r_{bb}'+(1+\beta)\frac{V_T}{I_{EQ3}}=1.25K\Omega$

$R_{O3}=833K\Omega$

$A_{VC2}=-\frac{\beta\times(R_C//R_L)}{R_b+r_{be}+(1+\beta)\times(\frac{R_W}{2}+2R_{O3})}=-0.003$

$K_{CMR}=\left|\frac{A_{Vd2}}{A_{VC2}}\right|=4266.67$

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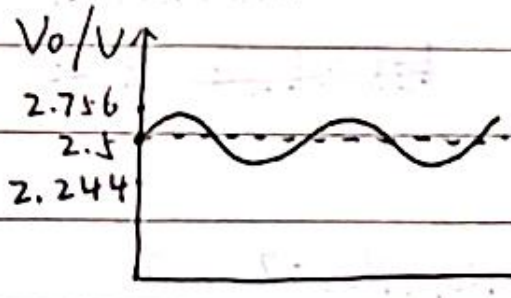
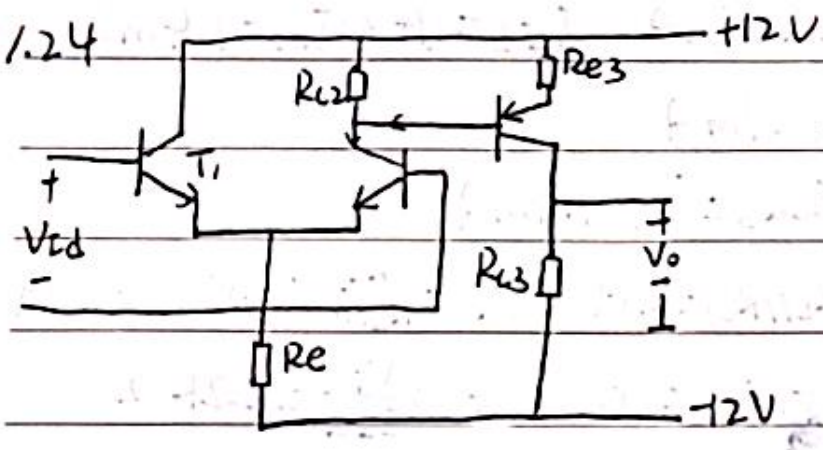
(4) $V_{O2} = A_{Vd2}(V_{i1}-V_{i2}) + A_{Vc2}\left(\frac{V_{i1}+V_{i2}}{2}\right)$

$= 0.256 \sin\omega t \ V$

$V_O = V_{OQ} + V_{O2} = (2.5 + 0.256\sin\omega t)V$



相位与差模信号一致



1.24

(1) $V_{OQ} = 0$

$I_{CQ3}R_{C3} = 12V$

$I_{EQ3} \approx I_{CQ3} = 1mA$, $I_{BQ3} = 0.01mA$

$V_{BE} + 2I_{EQ2}R_e = 12$

$I_{CQ2} \approx I_{EQ2} = 0.12mA$

$I_{C2} = I_{CQ2} - I_{BQ3} = 0.11mA$

$V_{BE} + R_{e3}\cdot I_{EQ3} = I_{C2}R_{C2}$ $R_{C2} = 8.64k\Omega$

(2) 相当于在差分放大后接了个共射放大

$A_{Vd2} = + \frac{\beta(R_{C2}\|R_{i2})}{2r_{be2}}$

$r_{be1} = r_{be2} = r_{bb'} + (1+\beta)\frac{V_T}{I_{EQ2}} = 22.1k\Omega$

$r_{be3} = 2.83k\Omega$

$R_{i2} = r_{be3} + (1+\beta)R_{e3} = 28.1k\Omega$

代入 $A_{Vd2} = 14.95$

共射 $A_V = -\frac{\beta(R_{C3})}{r_{be3} + (1+\beta)\|R_{e3}} = -42.7$

$A_{Vd} = A_{Vd2}\cdot A_V = 638.37$

(3) 假设 T_1、T_2 导通 $V_{BE}+2I_{EQ2}R_e=0$ 自解为负，不成立

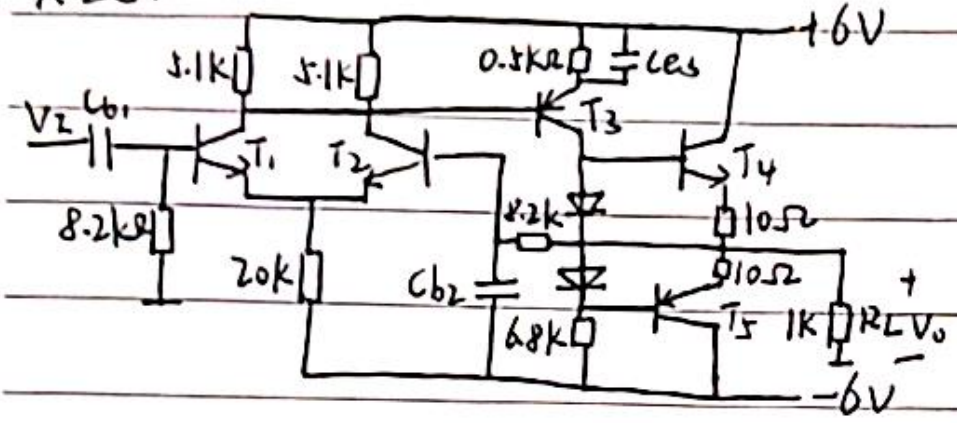
故 T_1、T_2 截止，$I_{CQ2}=0$，

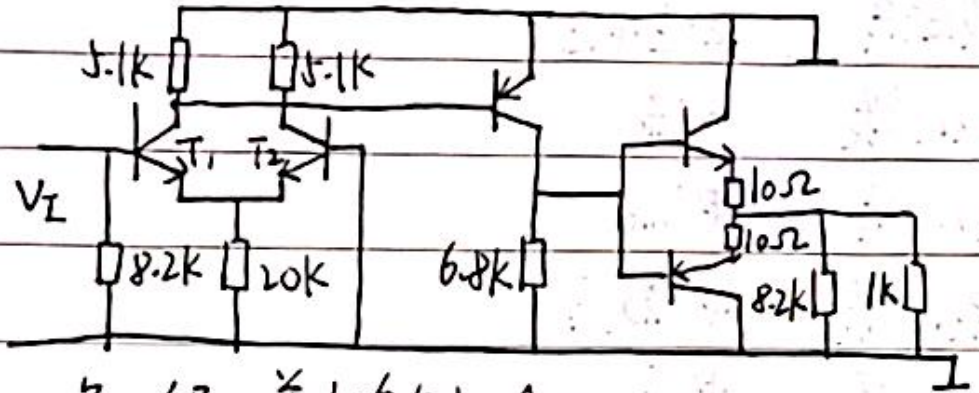
假设 T_3 导通，有 $I_{EQ3}R_{e3}+V_{BE}+I_{BQ3}R_{c2}=0$，解为负不成立

故 T_3 截止 $I_{CQ3}=0$

$V_{OQ}=I_{CQ3}R_{c3}=0V$

1.25.





第一级：差分放大 A_{vd1}

第二级：共射放大

第三级：互补对称放大

$$A_{vd1}=-\frac{\beta(5.1K//R_{i2})}{r_{be1}} \qquad R_{i2}=r_{be3}=1.7K\Omega$$

$$A_{vd2}=-\frac{\beta(6.8K//R_{i3})}{r_{be3}} \qquad R_{i3}=r_{be4}+(1+\beta)(10\Omega+8.2K//1K)\approx 45.6K\Omega$$

$$A_{vd3}=\frac{(1+\beta)(8.2K//1K)}{r_{be4}+(1+\beta)(20+8.2K//1K)}$$

$A_{vd1}=-7.97$，$A_{vd2}=-174$ $A_{vd3}=1$

$A_v=A_{vd1}\cdot A_{vd2}\cdot A_{vd3}=$ 1386.78

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$R_i = R_{i1} = 8.2k\Omega // (2r_{be1}) = 4.05k\Omega$

~~$R_3 = R_{33}$ $r_{be4} + (0.01 + \frac{r_{be4}+0.8k}{1+\beta})$~~

$R_o = R_{o5} = 8.2k\Omega // (0.01 + \frac{r_{be4}+0.8k}{1+\beta}) = 0.13k\Omega$

1.26 (1) 错

(2) 对

(3) 错

(4) 对

(5) 对

2.1 (a) 电压并联负反馈　　稳定电压

(b) 电流串联负反馈　　电流

(c) 电流并联负反馈　　电流

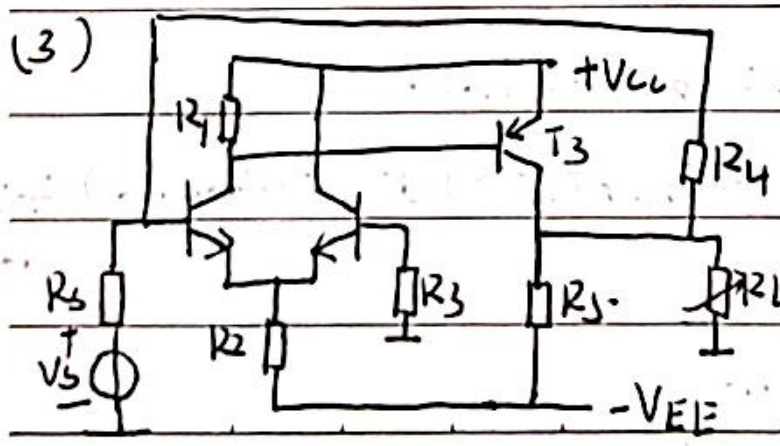
(d) 电压串联负反馈　　电压

(e) 电压并联负反馈　　电压

(f) 电压串联负反馈　　电压

(g) 电压串联负反馈　　电压

(3)



2.2, $A_f = \frac{A}{1+AF}$ $F = 0.02$

2.3, $dA_f = \frac{dA}{(1+AF)^2}$

$$\frac{dA_f}{A_f} = \frac{1}{(1+AF)^2}\cdot\frac{dA}{A_f} = \frac{1}{1+AF}\cdot\frac{dA}{A} = \frac{1}{1+AF}\times\frac{1}{5} \le \frac{1}{100}$$

$$A_f = \frac{A}{1+AF} = 100$$

得 $\frac{100}{A}\times\frac{1}{5} \le \frac{1}{100}$ $A \ge 2000$

$1+AF \ge 20$

$F \ge \frac{19}{A}$ $\frac{19}{A} \le \frac{19}{2000}$

$F \ge 0.0095$

2.6, (1) 相当于反相输入

在 R_W 最上端为时 输入 $V_S = 15V$, $V_o = -\frac{1k\Omega}{2M\Omega}\times V_S = -7.5mV$

最下端为时, 输入 $V_S = -15V$, $V_o = -\frac{1k\Omega}{2M\Omega}\times V_S = 7.5mV$

范围 $[-7.5mV, 7.5mV]$

(2) 同相输入

$$A_{Vf} = \frac{V_o}{V_i} = 1 + \frac{1k\Omega}{2M\Omega + R_{W1}//R_{W2}} =$$

2.7. (1) 反相输入, $V_o = -(\frac{R}{R})V_S = -V_S$

(2) 减法输入, $V_o = -\frac{R}{R}V_S + (1+\frac{R}{R})\times\frac{+\infty}{R+\infty}V_S$

其中 $R_2' = +\infty$, $= -V_S + 2V_S = V_S$

(3) 减法输入, 其中 $R_1 = +\infty$, $R_2' = +\infty$

$$V_o = -\frac{R}{+\infty}V_S + (1+\frac{R}{+\infty})\times\frac{+\infty}{R+\infty}V_S = V_S$$

(4) 减法电路，其中 $R_2'=0$

$$V_o=-\frac{R}{R}V_{S1}+\left(1+\frac{R}{R}\right)\frac{0}{R+0}\times V_{S2}=-V_S$$

2.8 (1) 反相输入，$V_o=-\frac{R_x}{R_1}(-V)$

$$V_o=\frac{2}{R_1}\cdot R_x \quad R_x\propto V_o$$

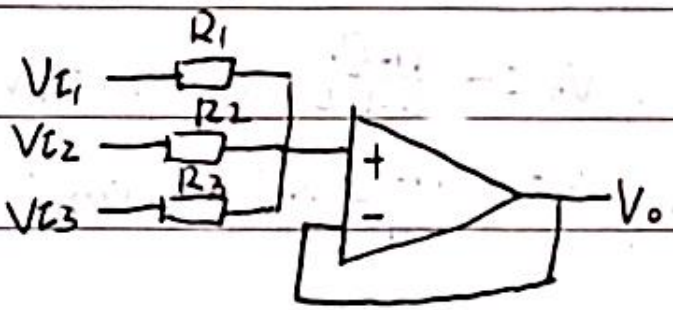
(2) 当电压表量程达最大时，R_x 达最大 $10k\Omega$

代入 $V_o=2V$，

$$2V=\frac{2}{R_1}\times 10k\Omega \quad R_1=10k\Omega$$

2.10. 左侧三个跟随器都有 $V_o=V_s$

等效于



为同相求和运算

且 $R_2'=0$，$R_1'=+\infty$

$$V_o=\left(1+\frac{R_2'}{R_1'}\right)(R_H/\!/R_2/\!/R_3)\left(\frac{V_{I1}}{R_1}+\frac{V_{I2}}{R_2}+\frac{V_{I3}}{R_3}\right)$$

$$=\frac{R_2/\!/R_3}{R_1+R_2/\!/R_3}V_{I1}+\frac{R_1/\!/R_3}{R_2+R_1/\!/R_3}V_{I2}+\frac{R_1/\!/R_2}{R_3+R_1/\!/R_2}V_{I3}$$