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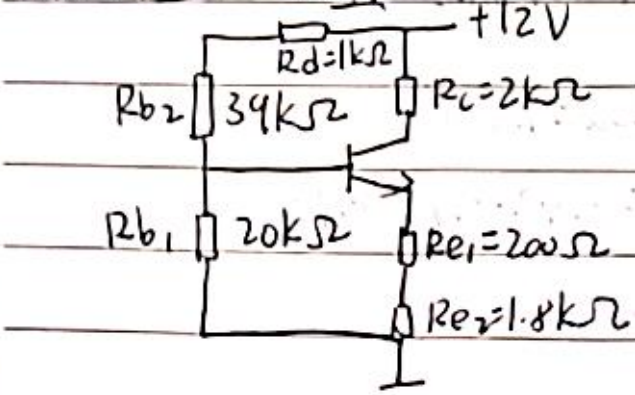
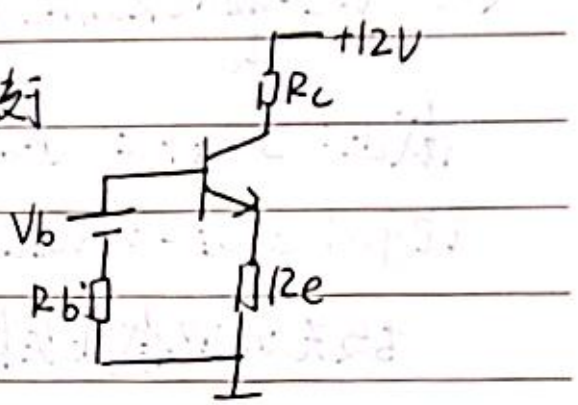
1.10(1) 直流偏置




等效




$V_b = \frac{R_{b1}}{R_{b1}+R_{b2}+R_d} \times 12V = 4V$

$R_b = R_{b1} // (R_{b2}+R_d) = 13.33k\Omega$

$R_e = R_{e1}+R_{e2} = 2k\Omega$

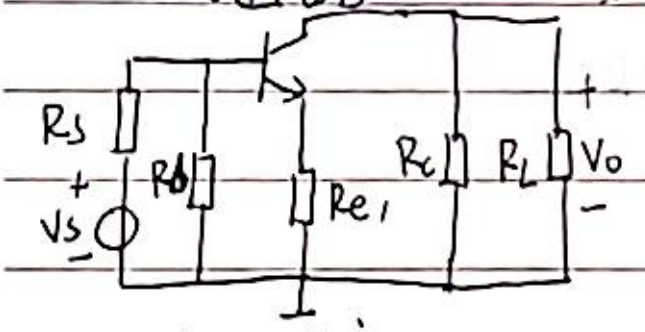
$I_{BQ} = \frac{V_b - V_{BE}}{R_b+(1+\beta)R_e} = 34.6\mu A$

$I_{CQ} = \beta I_{BQ} = 1.38mA$

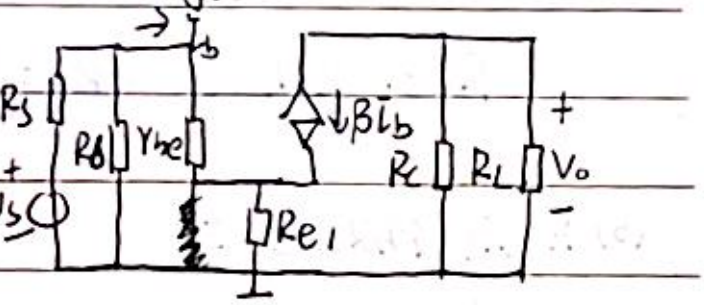
$V_{CE} = V_{CC} - R_c I_C - R_e I_E$

$= 6.42V$

(2) 交流通路，Rd被短接




微变等效




$\dot{V}_o = -\beta \dot{I}_b (R_c // R_L)$ $\dot{V}_i = I_b r_{be} + (1+\beta) I_b R_{e1}$

$R_b = R_{b1} // R_{b2}$, $R_i = R_b // [(1+\beta)R_e + r_{be}]$

$\dot{A}_V = \frac{\dot{V}_o}{\dot{V}_i} = -\frac{40}{9}$

$\dot{A}_{VS} = \dot{A}_V \times \frac{R_i}{R_i + R_S} = -4.07$

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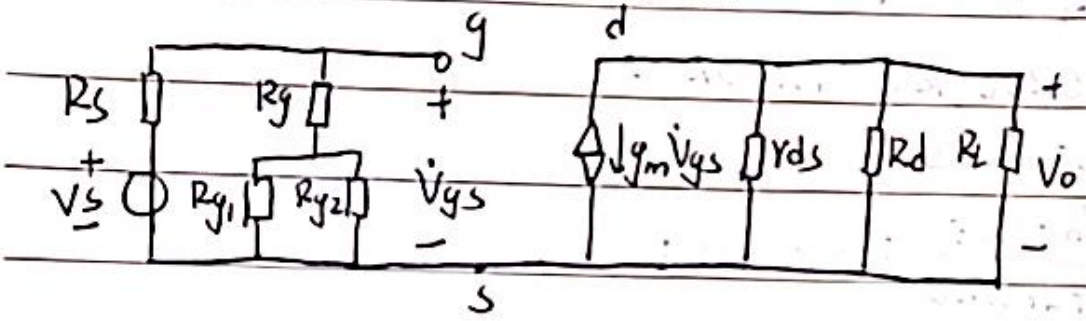
(3) $V_o = -\frac{\beta i_b}{-i_c} \times (R_c // R_L)$ 饱和 $\to -\frac{1}{R_c // R_L}$

截止: $\Delta V_{CE+} = (R_c // R_L) \times I_{CQ} = 1.38V$

饱和: $\Delta V_{CE-} = V_{CEQ} - V_{CES} = 6.42 - 0.7 = 5.72V$

故先出现截止失真, $V_{om} = 1.38V$

例1.12 (a) 共源极放大电路

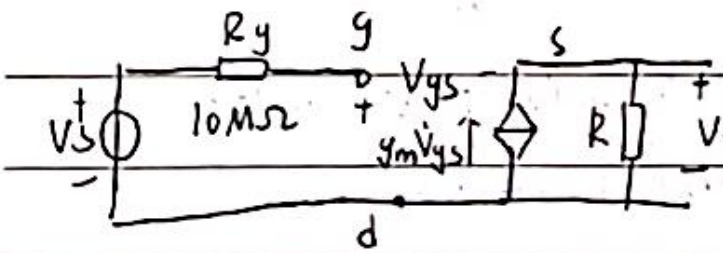



(2) $A_V = \frac{\dot{V}_o}{\dot{V}_i} = \frac{-g_m \dot{V}_{gs}(r_{ds} // R_d // R_L)}{\dot{V}_{gs}} = -g_m \cdot R_d // R_L = -5.1$

$R_i = \frac{\dot{V}_i}{\dot{I}_i} = R_g + R_{g1} // R_{g2} = 5.047 M\Omega$

$R_o = R_d // r_{ds} \approx R_d = 5.1 k\Omega$

(b) 共漏极放大电路

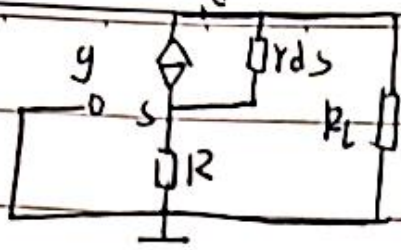



(2) $A_V = \frac{V_o}{V_i} = \frac{g_m V_{gs} \cdot R}{V_{gs} + g_m V_{gs} \cdot R} = 0.8$

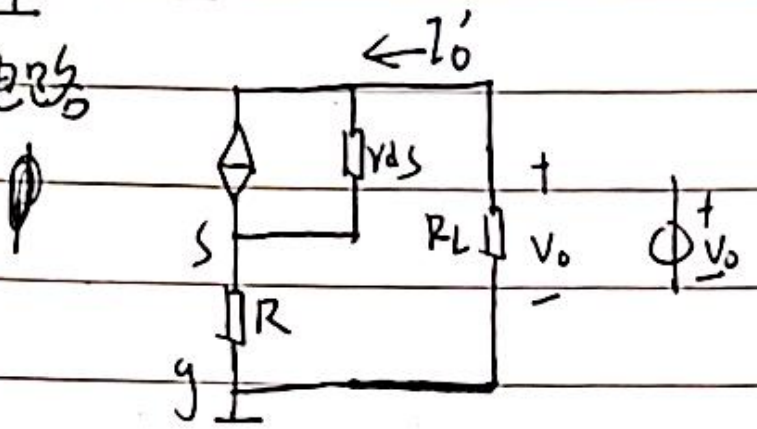
$R_i = \frac{V_i}{I_i}$, $I_i = 0$, $R_i = +\infty$

$R_o = R // \frac{1}{g_m} = 0.4 k\Omega$

1.13




等效为共栅极放大电路




把 $R_L$ 用 $\oplus^{+}_{-}V_o$ 替换

$V_{gs} = -I_o'R$

$I_o' = g_m V_{gs} + \frac{V_o + V_{gs}}{r_{ds}}$

$I_o' r_{ds} + I_o' R g_m r_{ds} + I_o' R = V_o$

得 $\frac{V_o}{I_o'} = r_{ds}(1 + R g_m) + R = R_o$

即输出端等效内阻 $R_o = r_{ds}(1 + R g_m) + R$

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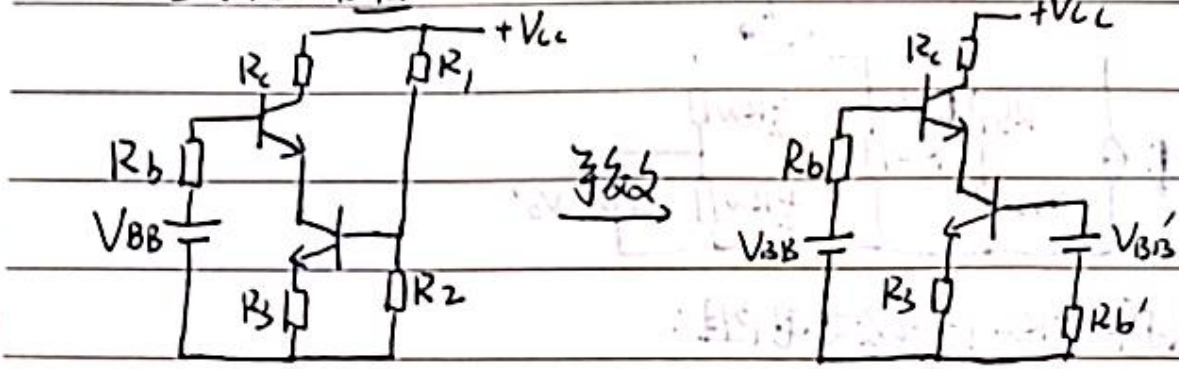
1.14 (1) T. CC. 射极跟随, $T_2$ CE. 放大

(2) 直流偏置



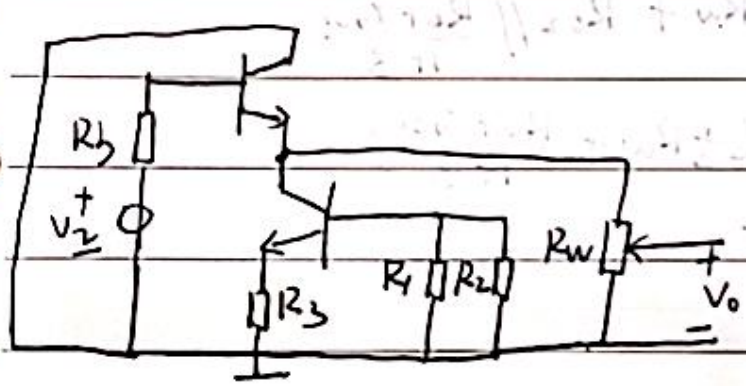

$R_b' = R_1 // R_2 = 727.27\Omega$

$V_{BB}' = \frac{R_2}{R_1+R_2} V_{cc} = 1.21V$

$I_{B2} = \frac{V_{BB}' - V_{BE}}{R_b' + (1+\beta)R_3} = 153\mu A$

$I_{C1} \approx I_{E1} = I_{C2} = \beta I_{B2} = 7.7mA$

(3)




由图 $\dot{V}_o = (1+\beta)\dot{i}_{b1} \times (R_{o2} // R_w)$

$\dot{V}_i = \dot{i}_{b1}(R_b + r_{be1}) + \dot{V}_o$

$\dot{A}_v = \frac{\dot{V}_o}{\dot{V}_i} = \frac{(1+\beta)(R_{o2}//R_w) \times \frac{1}{2}}{R_b + r_{be1} + (1+\beta)(R_{o2}//R_w)}$

$r_{be1} = r_{bb}' + (1+\beta)\frac{V_T}{I_{EQ1}}$

$I_{EQ1} \approx I_{C1}$ $V_T = 26mA$

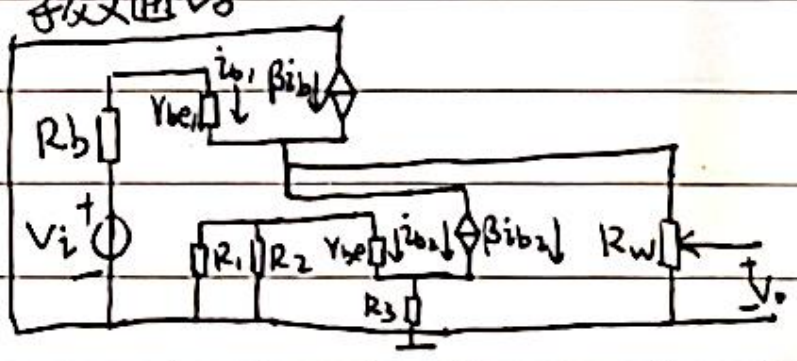
$r_{be1} = 0.47K\Omega$

$A_v \approx \frac{R_w(1+\beta)\times\frac{1}{2}}{R_b + r_{be1} + (1+\beta)R_w} = 0.5$

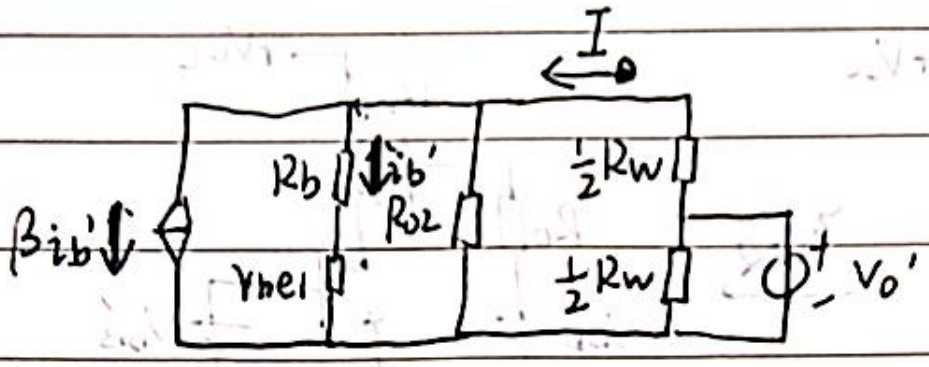
$R_i = R_{i1} = \frac{\dot{V}_{i2}}{\dot{I}_2} = \frac{\dot{V}_i}{\dot{i}_{b1}} = R_b + r_{be1} + (1+\beta)(R_o // R_w)$

$= 2.613 M\Omega$

等效电路



将 $V_S$ 短路，$T_2$ 等效为 $R_{O2}$，加压法




去掉 $\frac{1}{2}R_W$ 后等效电阻：

$$\frac{-\frac{1}{2}R_W I + V_o'}{R_{O2}} + \frac{-\frac{1}{2}R_W I + V_o'}{R_b + r_{be1}}(1+\beta) = I$$

$$\frac{V_o'}{I} = \frac{1}{\frac{1}{R_{O2}} + \frac{1}{\frac{r_{be1}+R_b}{1+\beta}}}$$

$$= R_{O2} // \frac{r_{be1}+R_b}{1+\beta}$$

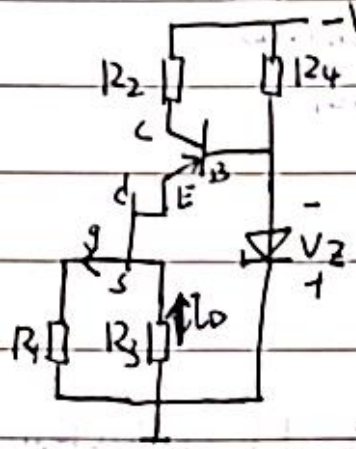
等效 $R_o' = \frac{1}{2}R_W + R_{O2} // \frac{R_b + r_{be1}}{1+\beta}$

$$R_o = \frac{1}{2}R_W // \left(\frac{1}{2}R_W + \frac{R_b + r_{be1}}{1+\beta}\right)$$

$$= 12.8K\Omega$$

1.(1). (1) $T_1$ 共源放大；$T_2$ 共基放大

(2) 直流偏置




$T_1$ 自给偏置

$$\begin{cases} I_{DQ} = I_{DSS}\left(1-\dfrac{V_{GSQ}}{V_P}\right)^2 \\ V_{GSQ} = I_{DQ}R_3 \end{cases}$$

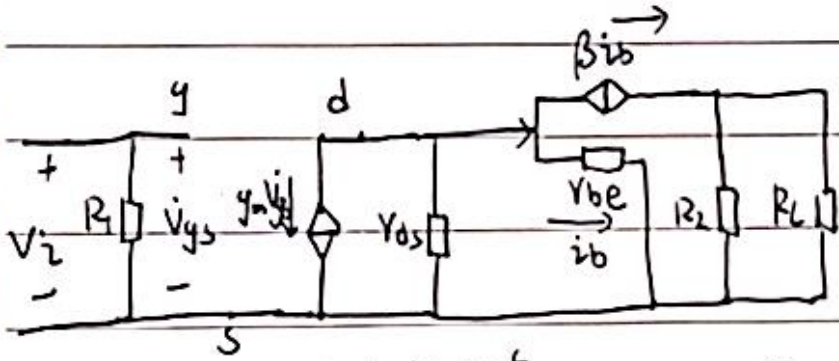
$$I_{DQ} = I_{DSS}\left(1-\frac{I_{DQ}R_3}{V_P}\right)^2$$ 解为 $I_{DQ}$

$$I_{DQ} = I_{EQ} \approx I_{CQ}$$

$$\begin{cases} V_Z - V_{BE} + V_{DS} - I_D R_3 = 0 \\ I_D R_3 \oplus -V_{DS} + V_{EC} + I_D R_2 = V_{CC} \end{cases}$$

$$V_{ECQ} = V_{CC} - I_{DQ}R_2 - V_Z + V_{BE}$$

(3)




$$A_{V1} = -g_m(r_{DS} // R_{i2})$$

$$R_{i2} = \frac{i_b r_{be}}{(1+\beta) i_b} = \frac{r_{be}}{1+\beta}$$

$$A_{V2} = \frac{\beta i_b (R_2 // R_L)}{i_b r_{be}} = \frac{\beta R_2 // R_L}{r_{be}}$$

设 $r_Z = 0$，$R_4$ 忽略不记

$$A_V = A_{V1} \cdot A_{V2} = -g_m \times \frac{r_{be}}{1+\beta} \times \frac{\beta (R_2 // R_L)}{r_{be}}$$

$$\approx -g_m (R_2 // R_L)$$

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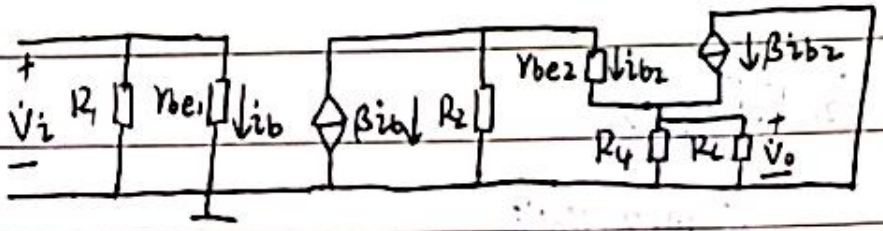
$R_i = R_{i1} = R_1$

$R_o = R_{o2} = R_2$

1.16. (1) $T_1$ 共射放大；$T_2$ 共集放大

(2) 小信号电路




(3) $\dot{A}_{V1} = \dfrac{-\beta \dot{I}_b (R_2 // R_{i2})}{\dot{I}_b r_{be1}} = -\dfrac{\beta (R_2 // R_{i2})}{r_{be1}}$

$R_{i2} = r_{be2} + (1+\beta)(R_4 // R_L)$

$\dot{A}_{V2} = \dfrac{(1+\beta)(R_4 // R_L)}{r_{be2} + (1+\beta)(R_4 // R_L)}$

$\dot{A}_{V1} \cdot \dot{A}_{V2} = \dfrac{-\beta \{R_2 // [(1+\beta)(R_4 // R_4) + r_{be2}]\}}{r_{be1}} \cdot \dfrac{(1+\beta)(R_4 // R_L)}{r_{be2} + (1+\beta)(R_4 // R_4)}$

$R_i = R_{i1} = R_1 // r_{be1}$

$R_o = R_{o2} = R_4 // \left(\dfrac{r_{be2} + R_2}{1+\beta}\right)$

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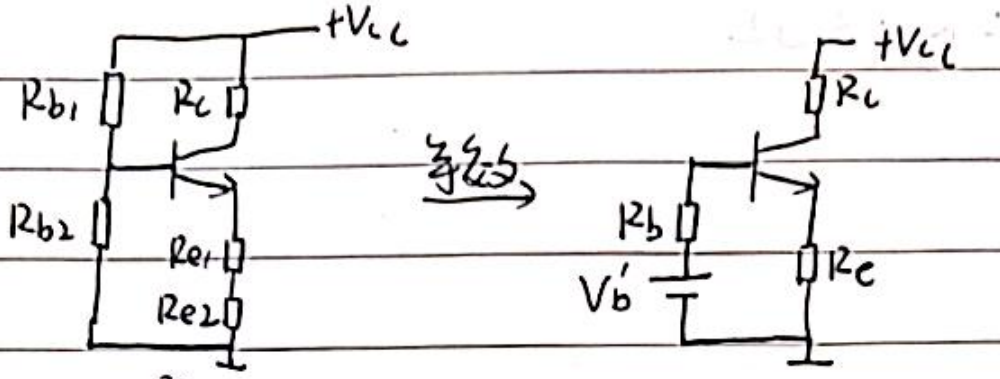
1.17.(1) 直流偏置




$V_b' = \frac{R_{b2}}{R_{b1}+R_{b2}} \times 15 = 3.75V$

$R_b = R_{b1} // R_{b2} = 15K\Omega$ $R_e = R_{e1} + R_{e2} = 2.1K\Omega$

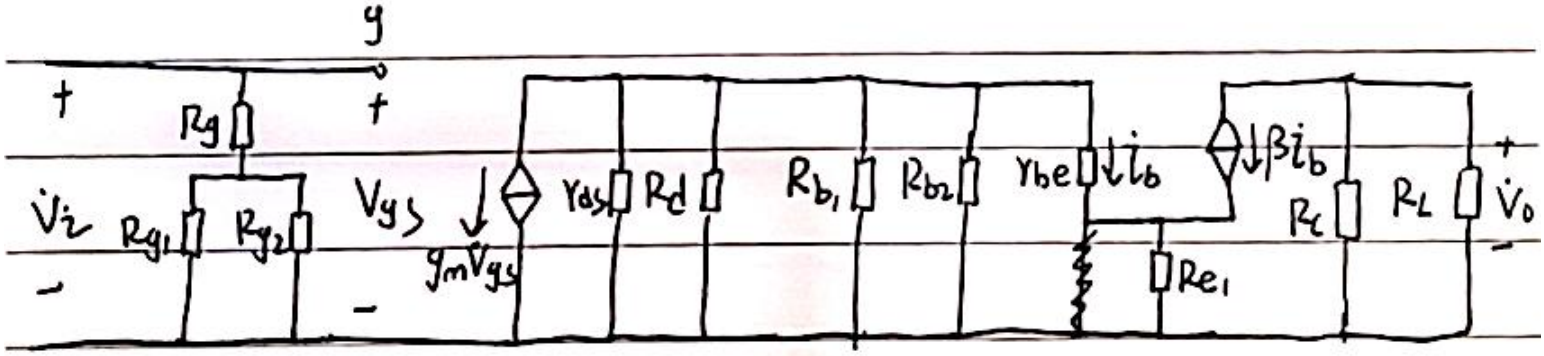
$I_{BQ_2} = \frac{V_b' - V_{BE}}{R_b + (1+\beta)R_e} = 25\mu A$

$I_{CQ_2} = \beta I_{BQ_2} = 1.25mA$

$V_{CEQ} = V_{CC} - I_{CQ_2}R_C - I_{EQ_2}R_e$

$= 8.6V$

(2)




(3) $A_{V_1} = -g_m(R_d // r_{ds} // R_{i2})$

$R_{i2} = R_{b1} // R_{b2} // (r_{be} + (1+\beta)R_{e1}) = 4.33K\Omega$

$A_{V_2} = \frac{-\beta(R_C // R_L)}{r_{be} + (1+\beta)R_{e1}} = -12.3$

总放大倍数 $A_V = A_{V_1} \cdot A_{V_2} = 73.8$

(4) $R_i = R_{i1} = R_g + R_{g1} // R_{g2} = 47.1 M\Omega$

$R_o = R_{o2} = R_L = 3 K\Omega$