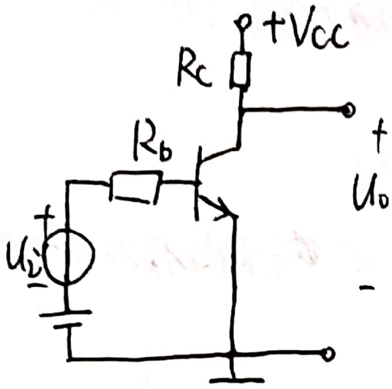
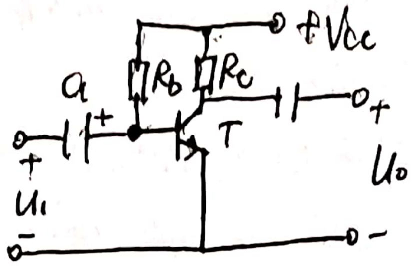
模电 第二章习题 自动化1班 1904010102 方尧

2.1



(a)



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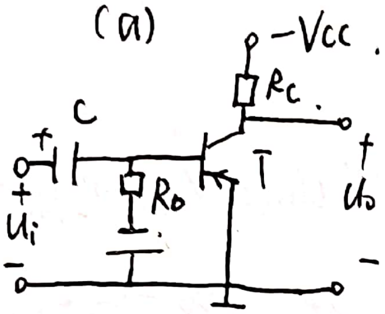
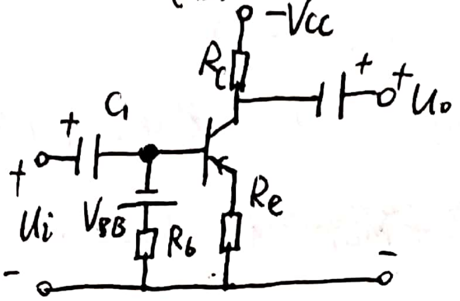


(c)



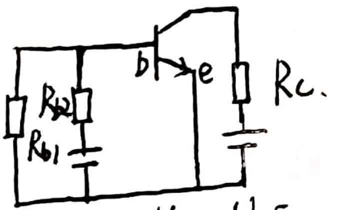
2.5 (1) ①(X) ②(X) ③(X) ④(V) (2) ①(X) ②(X) ③(V) ④(X)

(3) ①(X) ②(V) ③(X) (4) ①(X) ②(V)

故 (1)④ (2)③ (3)② (4)② 正确，其余错误。

2.6 解：直流电压表测量为直流电位即求 $U_i=0$ 时集电极电位

(1) 正常情况下



$I_{BQ}=\frac{V_{CC}-U_{BE}}{R_{b2}}-\frac{U_{BE}}{R_{b1}}$

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

$U_C=V_{CC}-I_{CQ}\cdot R_C=7.9V$

(2) R_{b1} 短路，$U_{BE}=0$，T截止，$U_C=V_{CC}=15V$

(3) R_{b1} 开路。

$I_{BQ}=\frac{V_{CC}-U_{BE}}{R_{b2}}=0.174mA$，临界饱和基极电流 $I_{BS}=\frac{V_{CC}-U_{CES}}{\beta R_C}\approx 0.024mA$

故 $I_B>I_{BS}$，故T饱和，$U_C=U_{CES}=0.5V$

(4) R_{b2} 开路 则T截止，$U_C=V_{CC}=15V$

(5) R_{b2} 短路，$U_{BE}=V_{CC}=15V$，

b-e烧断 $U_C=15V$，b-e短路，V_{CC} 短路，无法判断

(6) R_C 短路，$U_C=V_{CC}=15V$

2.7 解

(1) 空载情况下

$I_{BQ} = \frac{V_{CC}-U_{BEQ}}{R_b} - \frac{U_{BEQ}}{R_s} = 22\mu A$

$I_{CQ} = \beta I_{BQ} = 1.76mA$

$U_{CEQ} = V_{CC} - I_{CQ}\cdot R_c = 6.19V$.

be 动态电阻 $r_{be} = r_{bb'} + \frac{26mV}{I_{BQ}} = 1.28k\Omega$

$\dot{A}_u = \frac{-\beta R_c}{r_{be}} = -312.5$

$R_i = R_b // r_{be} = 1.25k\Omega$.

$R_o = R_c = 5k\Omega$.

(2) 带负载 $R_L = 3k\Omega$ 下.

静态基极, 集电极及 r_{be} 不变

$I_{BQ} = 22\mu A$, $I_{CQ} = 1.76mA$

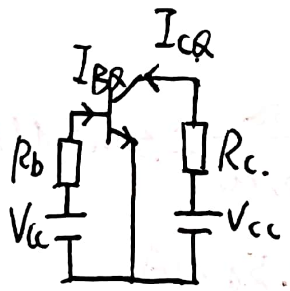
$r_{be} = 1.3k\Omega$.

$U_{CEQ} = (\frac{V_{CC}'}{R_c} - I_{CQ}) / (\frac{1}{R_L} + \frac{1}{R_c}) = 2.3V$.

$\dot{A}_u = \frac{-\beta(R_L//R_c)}{r_{be}} = -115.4$

$R_i = R_b // r_{be} = 1.25k\Omega$.

$R_o = R_c = 5k\Omega$.



2.9 (1) $I_{CQ} = \frac{V_{CC}-U_{CEQ}}{R_c} = 2mA$

$I_{BQ} = \frac{I_{CQ}}{\beta} = 20\mu A$.

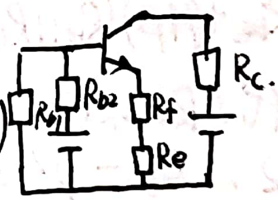
$R_b = \frac{V_{CC}-U_{BEQ}}{I_{BQ}} = 565k\Omega$

(2) 动态分析. $\dot{A}_u = -\frac{\beta R_L'}{r_{be}}$ 得 $R_L' = 2k\Omega$. $R_L' = \frac{R_L\cdot R_c}{R_L+R_c} = 2k\Omega$. $R_c = 3.3k\Omega$.

R_c 取值应大于 $3.3k\Omega$.

2.11 (1) 左端等效为 $U_{OC} = \frac{R_{b1}}{R_{b1}+R_{b2}} V_{CC} = 2V$.

$R_i = R_{b1}//R_{b2} = \frac{25}{6}k\Omega$.



输入回路 $V_{OC} = I_{BQ}R_i + U_{BEQ} + (\beta+1)I_{BQ}(R_f+R_e)$

得 $I_{BQ} = 9.6\mu A$ $I_{CQ} = \beta I_{BQ} = 960\mu A$

$U_{CEQ} = V_{CC} - I_{CQ}\cdot R_c - (\beta+1)I_{BQ}\cdot(R_f+R_e) = 5.7V$

$r_{be} = r_{bb'} + \frac{26mV}{I_{BQ}} = 2.81k\Omega$.

$\dot{A}_u = -\frac{\beta\cdot(R_c//R_L)}{r_{be}+R_f(1+\beta)} = -7.55$.

$R_i = \frac{U_i}{I_i} = \frac{1}{\frac{1}{R_{b1}} + \frac{1}{r_{be}+(1+\beta)R_f} + \frac{1}{R_{b2}}} = 3.7k\Omega$ $R_o = R_c = 5k\Omega$.

(2) 若改用$\beta=200$晶体管. I_{EQ}基本不变 $I_{EQ}\approx 1mA$ $U_{CEQ}\approx 5.7V$.

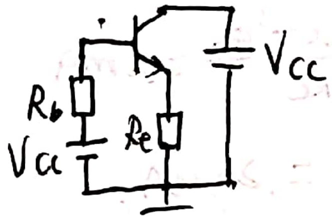
则 $I_{BQ}=\frac{I_{EQ}}{1+\beta}\approx 5\mu A$.

(3) R_i会变 $R_i=R_{b1}//R_{b2}//(R_{be}+(1+\beta)(R_f+R_e))=4.1k\Omega$.

$\dot{A}_u$会变 $\dot{A}_u=-\frac{\beta(R_c//R_L)}{R_{be}+(1+\beta)(R_e+R_f)}=-1.89$

2.12 解:

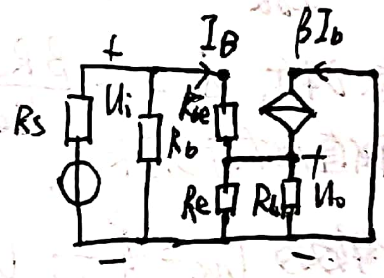
(1) $I_{BQ}=\frac{V_{CC}-U_{BEQ}}{R_b+(1+\beta)R_e}=32.3\mu A$



$I_{EQ}=(1+\beta)I_{BQ}=2.62\ mA$.

$U_{CEQ}=V_{CC}-(1+\beta)I_{BQ}R_e=7.15V$.

(2) $R_L=\infty$时



$\dot{A}_u=\frac{(1+\beta)(R_e//R_L)}{r_{be}+(1+\beta)(R_e//R_L)}=0.996$.

$R_i=R_b//(r_{be}+(1+\beta)(R_e//R_L))=109.9k\Omega$.

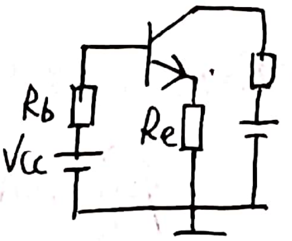
$R=3k\Omega$. 代入$R=3k\Omega$

$\dot{A}_u=0.992$, $R_i=76k\Omega$

输出电阻与负载无关

$R_o=R_e//\frac{(r_{be}+R_s//R_b)}{1+\beta}=37\Omega$.

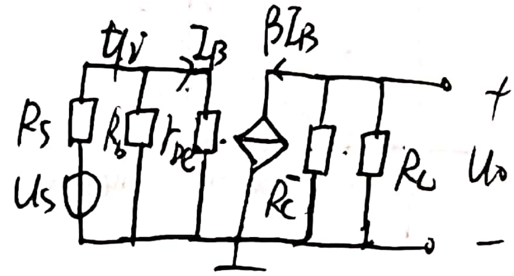
2.13 (1) $I_{BQ}=\frac{V_{CC}-U_{BEQ}}{R_b+(1+\beta)R_e}=31.3\mu A$



$I_{EQ}=(1+\beta)I_{BQ}=1.91mA$.

$U_{CEQ}=V_{CC}-\beta I_{BQ}\cdot R_c-(1+\beta)I_{BQ}\cdot R_e=4.46V$

$\dot{A}_u=\frac{-\beta(R_c//R_L)}{r_{be}}$



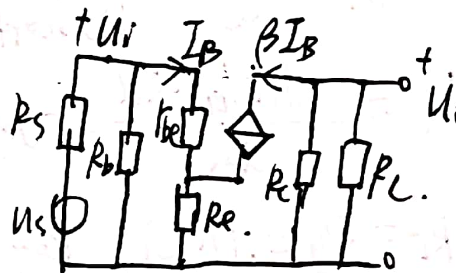
其中 $r_{be}=r_{bb'}+(1+\beta)\frac{26mV}{I_{EQ}}=931\Omega$.

$\dot{A}_u=-96.7$

$R_i=R_b//r_{be}=928\Omega$. $R_o=R_c=3k\Omega$.

(2). $U_i=\frac{R_b//r_{be}}{R_b//r_{be}+R_s}U_s=3.17mV$. $U_o=U_i|\dot{A}_u|=306.5mV$.

若C_3开路，静态工作点不变，r_{be}不变.

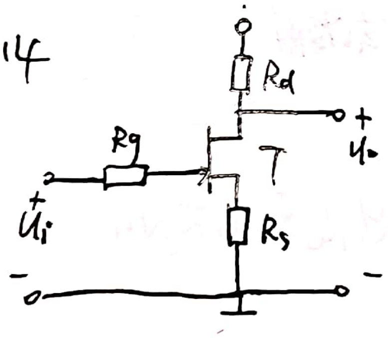


$\dot{A}_u=\frac{U_o}{U_i}=\frac{-\beta I_B(R_c//R_L)}{I_B r_{be}+(1+\beta)I_B R_e}=-1.453$

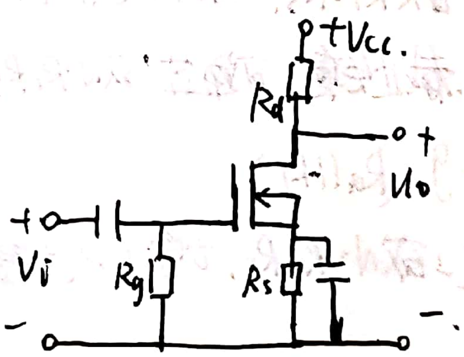
$R_i=\frac{U_i}{I_i}=\frac{U_i}{\frac{U_i}{R_b}+\frac{U_i}{r_{be}+(1+\beta)R_e}}=R_b//(r_{be}+(1+\beta)R_e)=51.3k\Omega$.

故 $U_i=\frac{R_i}{R_s+R_i}U_s=9.6mV$. $U_o=|\dot{A}_u|\cdot U_i=14.4mV$.

2.14



(a)



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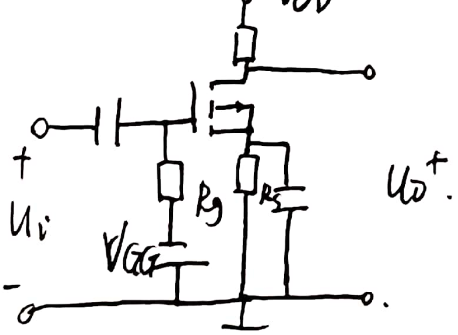
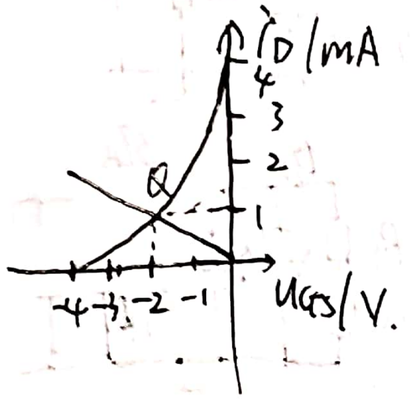
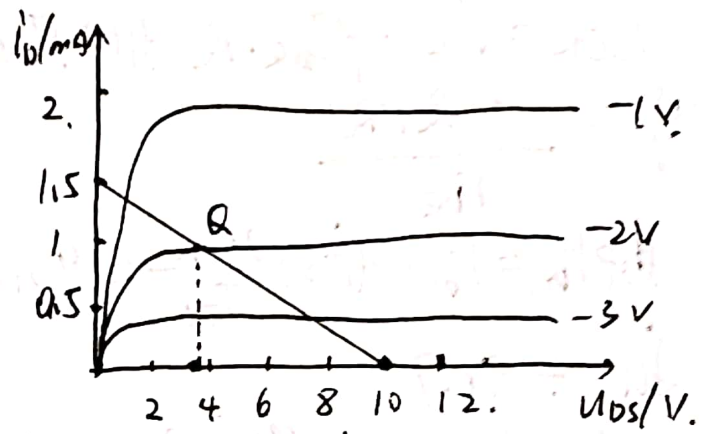


2.15 (1) $u_{GS}=-i_D\cdot R_S$ 做出 $u_{GS}=-i_D R_S$ 曲线，做直流负载线 $U_{DS}=V_{DD}-i_D(R_d+R_S)$

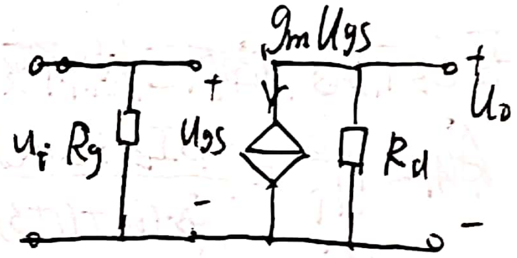




得 $i_{DQ}=1mA$，$U_{GSQ}=-2V$.　　得 $I_{DQ}=1mA$. $U_{DSQ}=3V$

(2) $g_m=\frac{\partial i_D}{\partial u_{GS}}=-\frac{2\sqrt{I_D\cdot I_{DSS}}}{U_{GS(off)}}=1mS$.

$\dot{A}_u=\frac{-g_m U_{gs}\cdot R_d}{U_{gs}}=-g_m\cdot R_d=-5$.



$R_i=R_g=1M\Omega$.　$R_o=R_d=5k\Omega$.

2.17 底部失真，饱和失真

(1) 可通过增大 R_1.R_S，减小 R_2.R_d；

顶部失真，截止失真，可通过减小 $R_1 R_S$，增大 R_2，R_d 方法消除。

(2) $\dot{A}_u=-g_m(R_d//R_L)$

故可通过减小 $R_1 R_S$，增大 R_2 增大 g_m，或增大 $R_d R_L$ 来增大 $|\dot{A}_u|$