模拟电子技术基础作业　1120193040 万梦颖 自动化 1907 班

北京理工大学 BEIJING INSTITUTE OF TECHNOLOGY

第2章

作 业 纸

课程名称：模拟电子技术基础

班级：自动化1907　教学班级：0601907　姓名：万梦颖　学号：1120193040　第 1 页

2-1

1. 晶体管工作在放大区时，发射结为 a.正向偏置；集电结为 b.反向偏置；工作在饱和区时，发射结为 a.正向偏置；集电结为 a.正向偏置.

2. 工作在放大区的晶体管，当基极电流 I_B 从 20μA 增大到 40μA 时，集电极电流 I_C 从 1mA 变成 2mA，则该管的 β 约为 b.50.

3. 工作在放大状态的晶体管，流过发射结的主要是 a.扩散电流，流过集电结的主要是 b.漂移电流.

4. 环境温度升高时，晶体管的 β a.增大，反向电流 a.增大，发射结压降 b.减小.

5. 两个晶体管，其中A管的 $\beta=200$，$I_{CEO}=200\mu A$；B管的 $\beta=50$，$I_{CEO}=10\mu A$，其他参数基本相同. 相比之下，b.B 管性能好.

2-4 解：

A管：$U_X=12V$　$U_Y=11.7V$　$U_Z=6V$

$U_Y>U_X>U_Z$ → y为基极b

$U_{YX}=-0.3V$ → x为发射极e，z为集电极c

$U_C<U_B<U_E$ → PNP型

B管：$U_X=-5.2V$　$U_Y=-1V$　$U_Z=-5.5V$

$U_Y>U_X>U_Z$ → x为基极b

$U_{XZ}=0.3V$ → z为发射极e，y为集电极c

$U_C>U_B>U_E$ → NPN型

2-7 解：

a) ∵ PNP型管中 $U_C>U_B>U_E$

∴ 不能正常放大

改正：$+V_{CC}$ → $-V_{CC}$

b) ∵ NPN型管发射结正偏

∴ 不能正常放大

改正：R_B 接地 → R_B 接 V_{CC}

c) ∵ 基极b处电位为 V_{CC}，晶体管饱和

∴ 不能正常放大

改正：在基极b与 V_{CC} 间接电阻 R_B

d) ∵ NPN型管无基极偏置电流

∴ 不能正常放大

改正：将 R_B 改为由b极接 V_{CC}

e) 能正常放大

f) 能正常放大

g) ∵ NPN型管缺少集电极电阻，交流信号 i_C 无法转变为 u_{CE} 变化

∴ 不能正常放大

改正：在集电极c与 V_{CC} 间加上集电极电阻 R_C

h) ∵ 交流信号时 C_B 使得b极短路

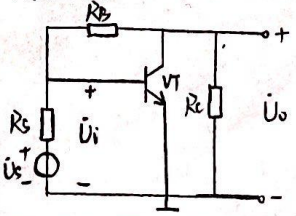
∴ 不能正常放大

改正：删去 C_B

2-8 解：

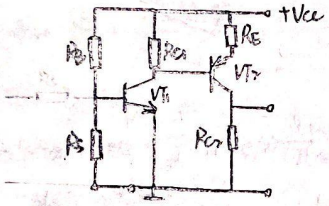
a) 直流通路：

交流通路：

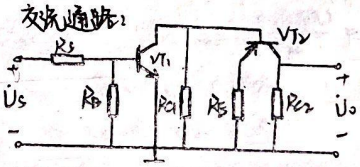


联系方式：

b) 直流通路：



交流通路：

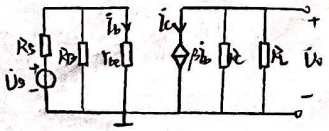


2-14 解：

1. $I_{CQ}=\beta I_{BQ} \rightarrow I_{BQ}=\frac{I_{CQ}}{\beta}=\frac{0.5mA}{50}=0.01mA=10\mu A$

$R_B=\frac{V_{CC}-U_{BEQ}}{I_{BQ}}=\frac{12V-0.7V}{10\mu A}=1.13M\Omega$

2. $A_u=\frac{\dot U_o}{\dot U_i}=\frac{-I_{CQ}R_C//R_L}{I_{BQ}r_{be}}=\frac{-\beta(R_C//R_L)}{r_{be}}$



$r_{be}=r_{bb'}+(1+\beta)\frac{26mV}{I_{EQ}}\approx 700\Omega$

$R_C//R_L=\frac{R_CR_L}{R_C+R_L}=\frac{10k\Omega\cdot 10k\Omega}{10k\Omega+10k\Omega}=5k\Omega$

代入得 $A_u=\frac{-50\times 5}{2.7}\approx -114$

$R_i=\frac{\dot U_i}{I_i}=R_B//r_{be}=\frac{R_Br_{be}}{R_B+r_{be}}\approx 2.7k\Omega$

$A_{us}=\frac{\dot U_o}{\dot U_s}=\frac{\dot U_o}{\dot U_i}\cdot\frac{R_i}{R_i+R_S}=\frac{R_i}{R_i+R_S}A_u=-83$

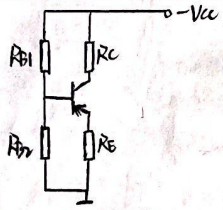
3. $R_i=2.7k\Omega$ (由2得)

$R_o=R_C=10k\Omega$

联系方式：_____

2-15 解：

1. 直流通路



$U_B=\frac{R_{B2}}{R_{B1}+R_{B2}}\cdot(-V_{CC})=\frac{20k\Omega}{60k\Omega+20k\Omega}\times(-16V)=-4V$

$I_{CQ}\approx I_{EQ}=\frac{U_B+0.3V}{R_E}=\frac{-4V+0.3V}{2k\Omega}=-1.85mA$

$U_{CEQ}=-V_{CC}-I_{CQ}(R_C+R_E)=-6.75V$

2. $U_{CEQ}=-4V$

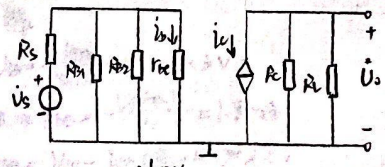
$I_{CQ}=\frac{-V_{CC}-U_{CEQ}}{R_C+R_E}=\frac{[-16-(-4)]V}{3k\Omega+2k\Omega}=-2.4mA$

$U_B\approx I_{CQ}R_E-0.3V=-2.4mA\times 2k\Omega-0.3V=-5.1V$

$U_B=\frac{R_{B2}}{R_{B1}+R_{B2}}(-V_{CC})$

$R_{B1}=42.75\ k\Omega$

3.



$r_{be}=r_{bb'}+(1+\beta)\frac{26mV}{I_{EQ}}\approx 1.3k\Omega$

$R_i=R_{B1}//R_{B2}//r_{be}=60k\Omega//20k\Omega//1.3k\Omega\approx 1.2k\Omega$

$A_{us}=\frac{\dot U_o}{\dot U_s}=\frac{R_i}{R_i+R_S}\cdot\frac{\dot U_o}{\dot U_i}=\frac{R_i}{R_i+R_S}\cdot\frac{-\beta(R_C//R_L)}{r_{be}}=-45$

$R_o=R_C=3k\Omega$

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2.16 解：

1. $A_u = \frac{\dot{U}_o}{\dot{U}_i} = \frac{-\dot{I}_c(R_C \| R_L)}{\dot{I}_b r_{be}} = \frac{-\beta(R_C \| R_L)}{r_{be}}$

$R_i = R_{B1} \| R_{B2} \| r_{be}$

$r_{be} = r_{bb'} + (1+\beta)\frac{26mV}{I_{EQ}} \approx (1+\beta)\frac{26mV}{I_{EQ}}$

$I_{EQ} = \frac{U_B - U_{BE}}{R_E}$

若增大 β，I_E 不变，$A_u = \frac{-\beta(R_C \| R_L)}{r_{be}} = \frac{-I_{EQ}(R_C \| R_L)}{26mV}$ 不变

$r_{be} = (1+\beta)\frac{26mV}{I_{EQ}}$ 增大

∴ $R_i = R_{B1} \| R_{B2} \| r_{be}$ 增大

2. 若增大 R_E，$I_E = \frac{U_B - U_{BE}}{R_E}$ 减小

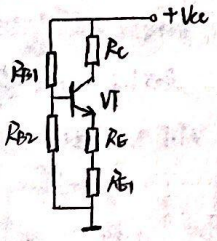
$A_u = \frac{-I_{EQ}(R_C \| R_L)}{26mV}$ 减小

$r_{be} = (1+\beta)\frac{26mV}{I_{EQ}}$ 增大

∴ $R_i = R_{B1} \| R_{B2} \| r_{be}$ 增大

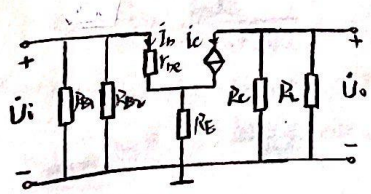
2.17 解：

直流通路：



$U_B = \frac{R_{B2}}{R_{B1}+R_{B2}} V_{CC} = \frac{10}{75+10} \times 18V = 2.12V$

当 $R_E = 0$ 时，$I_E = \frac{U_B - 0.7V}{R_E + R_{E1}} = 1.42mA$



$r_{be} = r_{bb'} + (1+\beta)\frac{26mV}{I_E} = 1.217\,k\Omega$

$A_u = \frac{\dot{U}_o}{\dot{U}_i} = \frac{-\dot{I}_c(R_L \| R_C)}{\dot{I}_b[r_{be}+(1+\beta)R_E]} = \frac{-\beta(R_L \| R_C)}{r_{be}+(1+\beta)R_E} = -1.74$

$R_i = \frac{\dot{U}_i}{\dot{I}_i} = R_{B1} \| R_{B2} \| [r_{be}+(1+\beta)R_E] = 1.63k\Omega$

$R_o = R_C = 8.2k\Omega$

当 $R_E = 200\Omega$ 时，$I_E = \frac{U_B - 0.7V}{R_E + R_{E1}} = 1.18mA$

$r_{be} = r_{bb'} + (1+\beta)\frac{26mV}{I_E} = 1.4k\Omega$

$A_u = \frac{\dot{U}_o}{\dot{U}_i} = \frac{-\dot{I}_c(R_L \| R_C)}{\dot{I}_b[r_{be}+(1+\beta)R_E]} = \frac{-(\beta(R_L \| R_C)}{r_{be}+(1+\beta)R_E} = -15.5$

$R_i = \frac{\dot{U}_i}{\dot{I}_i} = R_{B1} \| R_{B2} \| [r_{be}+(1+\beta)R_E] = 6.3k\Omega$

$R_o = R_C = 8.2k\Omega$

R_E 增大时，$|A_u|$ 减小，R_i 增大，R_o 不变

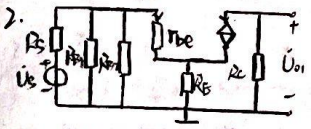
2.18 解：

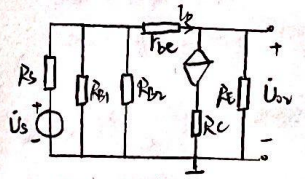
1. $U_B = \frac{R_{B2}}{R_{B1}+R_{B2}} V_{CC} = 4.3V$

$I_{EQ} \approx I_{EQ} = \frac{U_B - 0.7V}{R_E} = 1.8mA$

$U_{CEQ} = V_{CC} - I_{EQ}(R_C + R_E) = 2.8V$

2.





联系方式：_____

$r_{be}=r_{bb'}+(1+\beta)\frac{26mV}{I_E}=1.2k\Omega$

$R_i=\frac{\dot{U}_i}{\dot{I}_i}=R_{B1}\|R_{B2}\|[r_{be}+(1+\beta)R_E]=8.2k\Omega$

$A_{us1}=\frac{\dot{U}_{o1}}{\dot{U}_s}=\frac{-\beta R_c}{r_{be}+(1+\beta)R_E}\cdot\frac{R_i}{R_i+R_s}=-0.79$

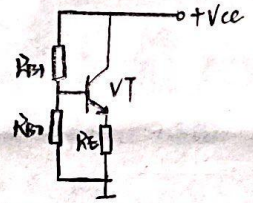
$A_{us2}=\frac{\dot{U}_{o2}}{\dot{U}_s}=\frac{(1+\beta)R_E}{r_{be}+(1+\beta)R_E}\cdot\frac{R_i}{R_i+R_s}=0.797$

3. $R_{o1}=R_c=2k\Omega$

$R_{o2}=R_E\|\frac{r_{be}+R_s\|R_{B1}\|R_{B2}}{1+\beta}=33\Omega$

2-19 解：

1. 直流通路：



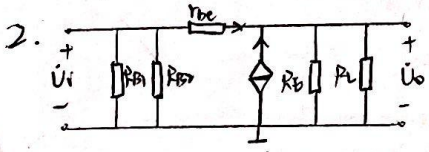
$U_{BQ}=\frac{R_{B2}}{R_{B1}+R_{B2}}V_{CC}=5V$

$I_{EQ}=\frac{U_{BQ}-0.7V}{R_E}=2.15mA$

$I_{CQ}=\frac{\beta}{1+\beta}I_{EQ}=2.1mA$

$U_{CEQ}=V_{CC}-R_EI_{EQ}=7.7V$

2.



$r_{be}=r_{bb'}+(1+\beta)\frac{26mV}{I_{EQ}}=1.35k\Omega$

$A_u=\frac{\dot{U}_o}{\dot{U}_i}=\frac{\dot{I}_oR_L'}{\dot{I}_br_{be}+\dot{I}_oR_L'}=\frac{(1+\beta)R_L'}{r_{be}+(1+\beta)R_L'}=0.987$

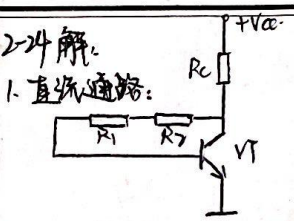
$R_i=R_{B1}\|R_{B2}\|[r_{be}+(1+\beta)R_L']=21.8k\Omega$

$R_o=R_E\|\frac{r_{be}+R_s\|R_{B1}\|R_{B2}}{1+\beta}=23\Omega$

联系方式：_____

2-24 解：

1. 直流通路：

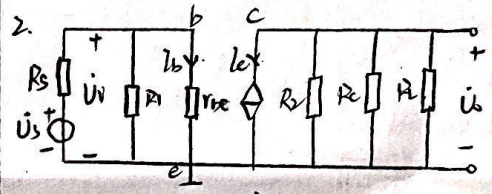


$I_{RC}=\frac{V_{CC}-U_{CEQ}}{R_C}=I_{BQ}+I_{CQ}=(1+\beta)I_{BQ}$

$I_{BQ}=\frac{U_{CEQ}-U_{BEQ}}{R_1+R_2}=\frac{U_{CEQ}-U_{BEQ}}{2R_1}$

解得 $R_1=R_2=62k\Omega$

2.



$r_{be}=r_{bb'}+(1+\beta)\frac{26mV}{I_{CQ}}=1.3k\Omega$

$A_u=\frac{\dot{U}_o}{\dot{U}_i}=\frac{-\dot{I}_{c1}(R_c\|R_L\|R_2)}{\dot{I}_br_{be}}=\frac{-\beta(R_c\|R_L\|R_2)}{r_{be}}=-149$

3. $R_i=r_{be}\|R_1=1.3k\Omega$

$R_o=R_c\|R_2=7.3k\Omega$

$A_{us}=\frac{\dot{U}_o}{\dot{U}_s}=\frac{R_i}{R_i+R_s}A_u=-83$

2-25 解：

1. $I_{BQ}=\frac{I_{CQ}}{\beta}=0.01mA=10\mu A$

$I_{EQ}\approx I_{CQ}=1mA$

$U_{BQ}=\frac{R_{B1}}{R_{B1}+R_{B2}}V_{CC}=5U_{BEQ}=5\times0.7V=3.5V$

$I_{EQ}=\frac{U_{BQ}-U_{BEQ}}{R_E}=\frac{3.5V-0.7V}{R_E}=1mA$

$\therefore R_E=2.8k\Omega$

$R_C=\frac{V_{CC}-U_{CEQ}-(U_{BQ}-U_{BEQ})}{I_{CQ}}=5.2k\Omega$

∵ $I_1 = 0.1mA$

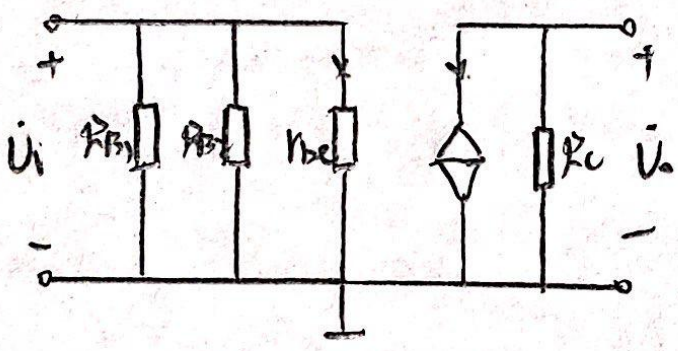
$V_{CE} = I_C(R_{B1} + R_{B2})$

$U_{B1} = I_1 R_{B1}$

∴ 解得 $R_{B1} = 35k\Omega$

$R_{B2} = 85k\Omega$

2.



$$A_u = \frac{-I_C R_C}{I_B r_{be}} = \frac{-\beta R_C}{r_{be}} = -193$$

$R_i = R_{B1} // R_{B2} // r_{be} = 2.4k\Omega$

$R_o = R_C = 5.2k\Omega$