模电第三章作业.

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2-1. 1. a;b; a; a 2. b 3. a;b 4. a;a;b 5. b

2-4. A管： ∵ $U_X > U_Y > U_Z$

∴ Y是基极b

∵ $U_Y - U_X = 11.7 - 12 = -0.3(V)$ ，$U_Y - U_Z = 11.7 - 6 = 5.7(V)$

∴ X是发射极e，Z是集电极c

∴ 这是一个PNP型的晶体管.

B管： ∵ $U_Y > U_X > U_Z$

∴ X是基极b

∵ $U_X - U_Y = -5.2 + 1 = -4.2(V)$

$U_X - U_Z = -5.2 + 5.5 = 0.3(V)$

∴ Y是集电极c，Z是发射极e

∴ 这是一个NPN型的晶体管.

2-7. (a). 不能。不应使用$+V_{CC}$，应将$+V_{CC}$替换成$-V_{CC}$，并将电容极性反接.

(b). 不能。发射极处于零偏置，应将R_B接V_{CC}

(c). 不能。基极直接与V_{CC}相连，动态时基极接地。应在基极与V_{CC}之间加一个电阻R_B

(d). 不能。无基极偏置电流。将R_B与发射极之间断开，将R_B接到V_{CC}

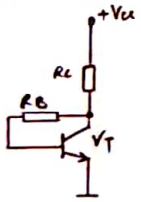
(e) 能

(f). 能

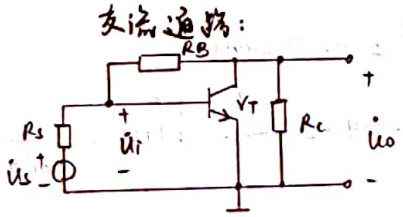
(g). 不能。输入交流信号时到出端的始终为0，应在集电极加R_C.

(h). 不能。输入交流信号时，C_B将R_B交流短路。应将C_B去掉

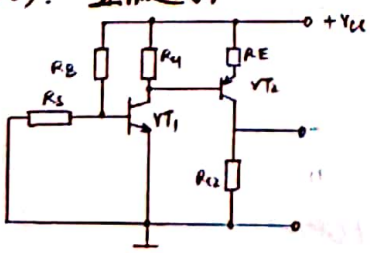
2-8. (a). 直流通路：



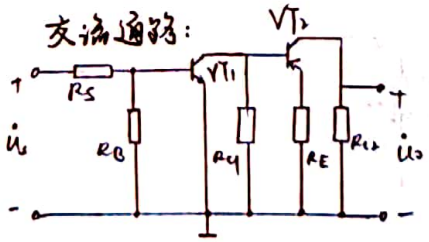
交流通路：



(b). 直流通路：



交流通路：



2-14. 1. ∵ $I_{BQ} = \frac{V_{CC} - U_{BE}}{R_B}$, $I_{CQ} = \beta I_{BQ}$

∴ $I_{CQ} = \beta \frac{V_{CC} - U_{BE}}{R_B}$

∴ $R_B = \beta \frac{V_{CC} - U_{BE}}{I_{CQ}} = 50 \times \frac{12 - 0.7}{0.5 \times 10^{-3}} = 1.13 \times 10^6 (\Omega) = 1.13 (M\Omega)$

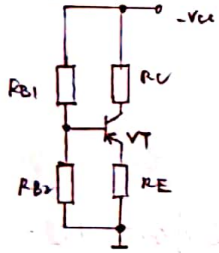
2. $A_u = \frac{\dot{U}_o}{\dot{U}_i} = -\frac{\beta R_L'}{r_{be}} = -\frac{50 \times \frac{80}{13} \times 10^3}{100 + \frac{26}{0.5}(1+50)} \approx -112.$

$A_{us} = \frac{\dot{U}_o}{\dot{U}_s} = \frac{\dot{U}_o}{\dot{U}_i} \cdot \frac{\dot{U}_i}{\dot{U}_s} = A_u \cdot \frac{R_i}{R_i + R_s} = A_u \cdot \frac{R_B // r_{be}}{R_B // r_{be} + R_s} = -112 \times \frac{2745}{2745 + 1000} \approx -83$

3. $R_i = R_B // r_{be} = \frac{1}{\frac{1}{1.13 \times 10^6} + \frac{1}{2745}} = 2745 (\Omega)$

$R_o = R_C = 16 k\Omega$

2-15. 1. 直流通路:



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

∴ $I_{CQ} = \frac{U_B - U_{BEon}}{R_E} = \frac{-4 + 0.7}{2 \times 10^3} = -1.65 (mA)$.

∴ $I_{BQ} = \frac{I_{CQ}}{\beta} = \frac{-1.65}{60} = 2.75 \times 10^{-5} (A) = 27.5 (\mu A)$.

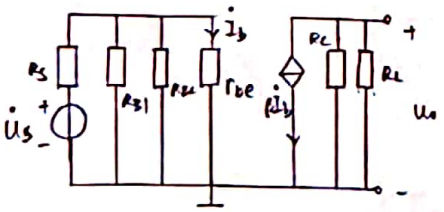
∴ $U_{CEQ} = -V_{CC} + I_{CQ}(R_C + R_E) = -16 + 1.65 \times (3 + 2) = -8.75 (V)$

2. ∵ $I_{CQ}' = \frac{-V_{CC} - U_{CEQ}'}{R_C + R_E} = \frac{-16 + 4}{2 + 3} = -2.4 (mA)$.

∴ $U_B' = I_{CQ}' R_E + U_{BEon} = -2.4 \times 2 + 0.7 = -5.5 (V) = \frac{R_{B2}}{R_{B1}' + R_{B2}}(-V_{CC})$

∴ $R_{B1}' \approx 38 k\Omega$.

3. 微变等效电路:



∵ $r_{be} = r_{bb'} + (1+\beta)\frac{26mV}{I_{EQ}} = 0 + (1+60)\frac{26}{1.65 + 2.75 \times 10^{-2}} = 962.7 (\Omega)$

∴ $A_{us} = \frac{\dot{U}_o}{\dot{U}_s} = -\frac{R_i}{R_i + R_s} \frac{\beta(R_C // R_L)}{r_{be}} = -\frac{R_{B1} // R_{B2} // r_{be}}{R_{B1} // R_{B2} // r_{be} + R_s} \cdot \frac{\beta(R_C // R_L)}{r_{be}} = -60$

$R_o = R_C = 3 k\Omega$.

2-16. (1) 由 2-15 得 $A_u = \frac{u_o}{u_i} = \frac{-\beta R_L'}{r_{be}} = \frac{-\beta R_L'}{(1+\beta)\frac{26mV}{I_{EQ}}}$

∵ 当 β 增大，I_{EQ} 基本不变，

∴ A_u 减小，r_{be} 增大

∴ $R_i = R_{B1} // R_{B2} // r_{be}$ 增大.

(2) ∵ R_E 增大

∴ I_{EQ} 减小

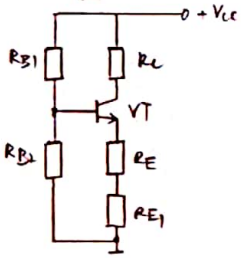
∴ A_u 增大，r_{be} 增大

∴ $R_i = R_{B1} // R_{B2} // r_{be}$ 增大.

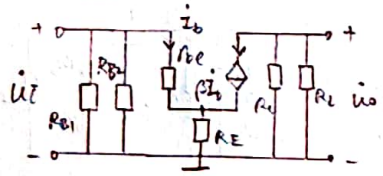
2-17.

~~① 当 R_E=0 时~~

~~$A_u = \frac{u_o}{u_i}$~~ 直流通路：



等效微变电路：



① 当 R_E=0 时

∵ $U_B = \frac{R_{B2}}{R_{B2}+R_{B1}} V_{cc} = \frac{10}{10+75} \times 18 = 2.12(V)$

∴ $I_E = \frac{U_B - U_{BEQ}}{R_{E1}} = \frac{2.12-0.7}{1} = 1.42(mA)$

∵ $r_{be} = r_{bb'} + (1+\beta)\frac{26mV}{I_E} = 100 + (100+1)\frac{26}{1.42} = 1.95(k\Omega)$

∴ $R_i = R_{B1} // R_{B2} // [r_{be} + (1+\beta) R_E] = 1.6\ k\Omega$

∴ $A_u = \frac{u_o}{u_i} = -\frac{\beta(R_C // R_L)}{r_{be} + (1+\beta) R_E} = -\frac{100 \times 3.53}{1.95 + 101 \times 0} = -181$

∴ $R_o = R_C = 8.2k\Omega$.

② 当 R_E = 200Ω，用到上公式可得

∵ $I_E' = \frac{U_B - U_{BEQ}}{R_{E1} + R_E'} = \frac{2.12-0.7}{1+0.2} = 1.18(mA)$

∴ $r_{be}' = r_{bb'} + (1+\beta)\frac{26mV}{I_E'} = 100 + 101 \times \frac{26}{1.18} = 2.33(k\Omega)$

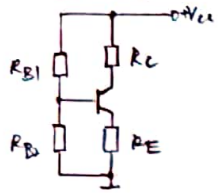
~~$R_i' = R_{B1} // R_{B2} // [r_{be}' + (1+\beta) R_E']$~~ ∴ $R_i' = R_{B1} // R_{B2} // [r_{be}' + (1+\beta) R_E'] = 6.34\ k\Omega$

∴ $A_u' = \frac{u_o}{u_i} = \frac{-\beta(R_C // R_L)}{r_{be}' + (1+\beta) R_E'} = \frac{-100 \times 3.53}{2.33 + 101 \times 200 \times 10^{-3}} = -15.7$

∴ $R_o' = R_C = 8.2k\Omega$

∴ R_E 增大，R_i 增大，$|A_u|$ 减小.

2-18. 直流通路：



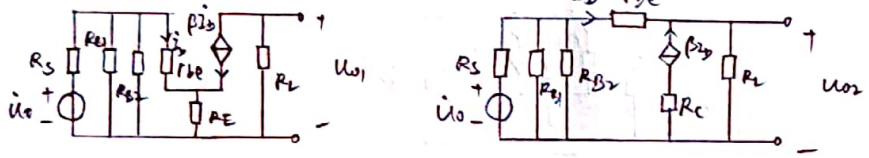
(1) $\because U_B = \frac{R_{B2}}{R_{B1}+R_{B2}} V_{cc} = \frac{15}{20+15} \times 10 = 4.3(V)$

$\therefore I_{EQ} = \frac{U_B - U_{BEon}}{R_E} = \frac{4.3-0.7}{2} = 1.8(mA)$

$\therefore I_{CQ} \approx I_{EQ} = 1.8mA$

$\therefore U_{CEQ} = V_{cc} - I_{CQ}(R_E+R_c) = 10 - 1.8 \times 4 = 2.8(V)$

(4). 微变等效电路：



$\because r_{be} = r_{bb'} + (1+\beta)\frac{26mV}{I_{EQ}} = 300 + (1+60)\frac{26}{1.8} = 1.2(k\Omega)$

$\therefore R_i = \frac{u_i}{i_i} = R_{B1} // R_{B2} // [r_{be} + (1+\beta) R_E] = \frac{1}{\frac{1}{20}+\frac{1}{15}+\frac{1}{1.2+61\times2}} = 8.2(k\Omega)$

$\therefore A_{uS1} = \frac{u_{o1}}{u_s} = \frac{-\beta R_c}{r_{be}+(1+\beta)R_E} \frac{R_i}{R_s+R_s} = \frac{-60\times2}{1.2+61\times2} \frac{8.2}{8.2+2} = -0.79$

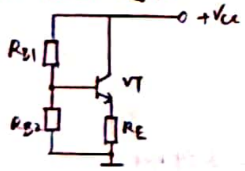
$A_{uS2} = \frac{u_{o2}}{u_s} = \frac{(1+\beta)R_E}{r_{be}+(1+\beta)R_E} \frac{R_i}{R_i+R_s} = \frac{61\times2}{1.2+61\times2} \times \frac{8.2}{8.2+2} = 0.797$

(5). 用(4)得 $R_i = 8.2k\Omega$

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

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

2-19. (1). 直流通路：



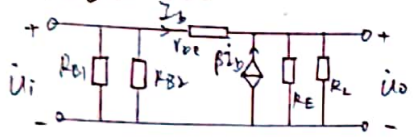
$\because U_{BQ} = \frac{R_{B2}}{R_{B1}+R_{B2}} V_{cc} = \frac{47}{47+68} \times 12 \approx 4.9(V)$.

$\therefore I_{EQ} = \frac{U_{BQ} - U_{BEon}}{R_E} = \frac{4.9-0.7}{2} = 2.1(mA)$.

$\therefore I_{CQ} \approx \frac{V_B}{R_B} \approx I_{EQ} = 2.1mA$

$\therefore U_{CEQ} = V_{cc} - I_{EQ} R_E = 12 - 2.1 \times 2 = 7.8(V)$

(2). 微变等效电路：



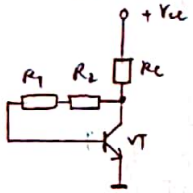
$\because r_{be} = r_{bb'} + (1+\beta)\frac{26mV}{I_{EQ}} = 100 + 101 \times \frac{26}{2.1} = 1.35\,(k\Omega)$

$\therefore A_u = \frac{\dot{U}_o}{\dot{U}_i} = \frac{\dot{I}_e R_L'}{\dot{I}_b r_{be} + \dot{I}_e R_L'} = \frac{(1+\beta)R_L'}{r_{be} + (1+\beta)R_L'} = \frac{101 \times 1}{1.35 + 101} = 0.987$

$\therefore R_i = R_{B1} // R_{B2} // [r_{be} + (1+\beta)R_L'] = 21.9\ k\Omega.$

$R_o = R_E // \frac{r_{be} + R_{B1} // R_{B2} // R_S}{1+\beta} = 23\ \Omega.$

2-24. (1). 直流通路：



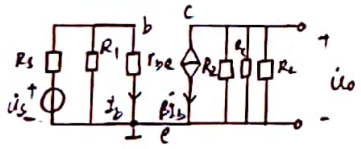
$\because I_{RC} = I_{BQ} + I_{CQ} = I_{BQ} + \beta I_{BQ} = \frac{V_{cc} - U_{CEQ}}{R_c} = \frac{15-4}{8.2} = 1.34\,(mA)$

$\therefore I_{BQ} = \frac{U_{CEQ} - U_{BEQ}}{R_1 + R_2} = \frac{U_{CEQ} - U_{BEQ}}{2R_1} = \frac{I_{BQ}}{1+\beta}$

$\therefore R_1 = \frac{U_{CEQ} - U_{BEQ}}{2I_{BQ}}(1+\beta) = 51 \times \frac{4-0.7}{2 \times 1.34 \times 10^{-3}} = 63\,(k\Omega)$

$\therefore R_2 = R_1 = 63\,k\Omega.$

(2). 微变等效电路：



$\because r_{be} = r_{bb'} + (1+\beta)\frac{26mV}{I_{EQ}} = 300 + 51 \times \frac{26}{1.34} = 1.3\,(k\Omega)$

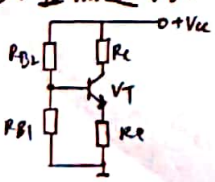
$\therefore A_u = \frac{\dot{U}_o}{\dot{U}_i} = \frac{-\beta\dot{I}_b(R_2 // R_c // R_L)}{\dot{I}_b r_{be}} = \frac{-\beta(R_2 // R_c // R_L)}{r_{be}} = \frac{-50 \times 3.85}{1.3} = -148$

$A_{us} = \frac{\dot{U}_o}{\dot{U}_s} = \frac{\dot{U}_o}{\dot{U}_i} \cdot \frac{\dot{U}_i}{\dot{U}_s} = A_u \frac{\dot{I}_b r_{be}}{U_s} = \frac{r_{be} // R_1}{r_{be} // R_1 + R_S} A_u = \frac{1.27}{1.27+1} \times (-148) = -83.$

(3). $R_i = r_{be} // R_1 = 1.27\,k\Omega$

$R_o = R_2 // R_c = 7.3\,k\Omega.$

2-25. (1). 直流通路：



$\because U_{BQ} = \frac{R_{B1}}{R_{B1} + R_{B2}} V_{cc}$ 且 $\approx 5\,U_{BEQ} = 5 \times 0.7 = 3.5\,(V).$

$\therefore \frac{R_{B1}}{R_{B1} + R_{B2}} = \frac{3.5}{12} = \frac{7}{24}$

$\because U_{CEQ} = \frac{1}{2}V_{cc} - I_{CQ}(R_c + R_E)$

$\therefore R_c + R_E = \frac{V_{cc} - U_{CEQ}}{I_{CQ}} = \frac{12-4}{1} = 8\,(k\Omega).$

$\because I_{EQ} = \frac{U_{BQ} - U_{BEQ}}{R_E} \approx 1mA$

$\therefore R_E = \frac{U_{BQ} - U_{BEQ}}{I_{EQ}} = \frac{3.5-0.7}{1} = 2.8\,(k\Omega)$

∴ $R_c = 8 - 2.8 = 5.2\,(k\Omega)$

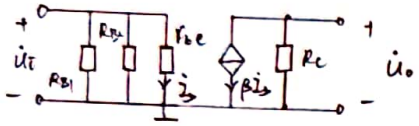
∵ $I_{BQ} = \frac{I_{CQ}}{\beta} = \frac{1}{100} = 0.01\,(mA) = 10\,\mu A$.

∴ $I_1 = 10 I_{BQ} = 0.1\,mA$

∴ $R_{B1} = \frac{U_B}{I_1} = \frac{3.5}{0.1} = 35\,(k\Omega)$

∴ $R_{B2} = 85\,k\Omega$.

(2). 微变等效电路：



∵ $r_{be} = r_{bb'} + (1+\beta)\frac{26mV}{I_{EQ}} = 2.7\,k\Omega$

∴ $A_u = \frac{\dot{U}_o}{\dot{U}_i} = \frac{-\beta \dot{I}_b R_c}{\dot{I}_b r_{be}} = \frac{-\beta R_c}{r_{be}} = \frac{-100 \times 5.2}{2.7} = -193$

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

$R_o = R_c = 5.2\,k\Omega$.