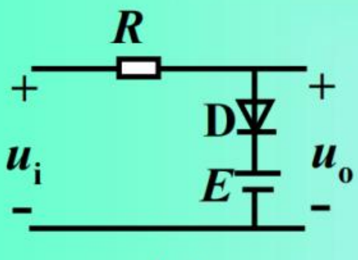
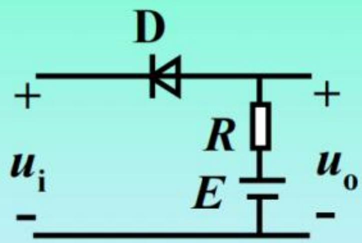
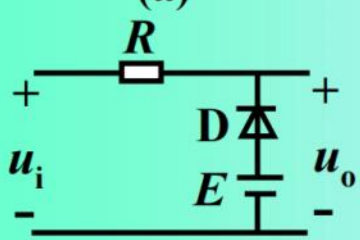
1.1 在图示各电路中，E=5V，二极管的正向压降可忽略不计，试分别画出输出电压u_o的波形。



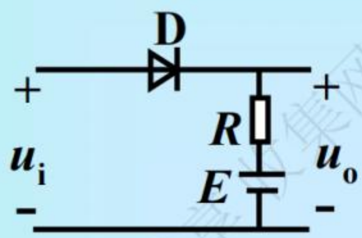
(a)



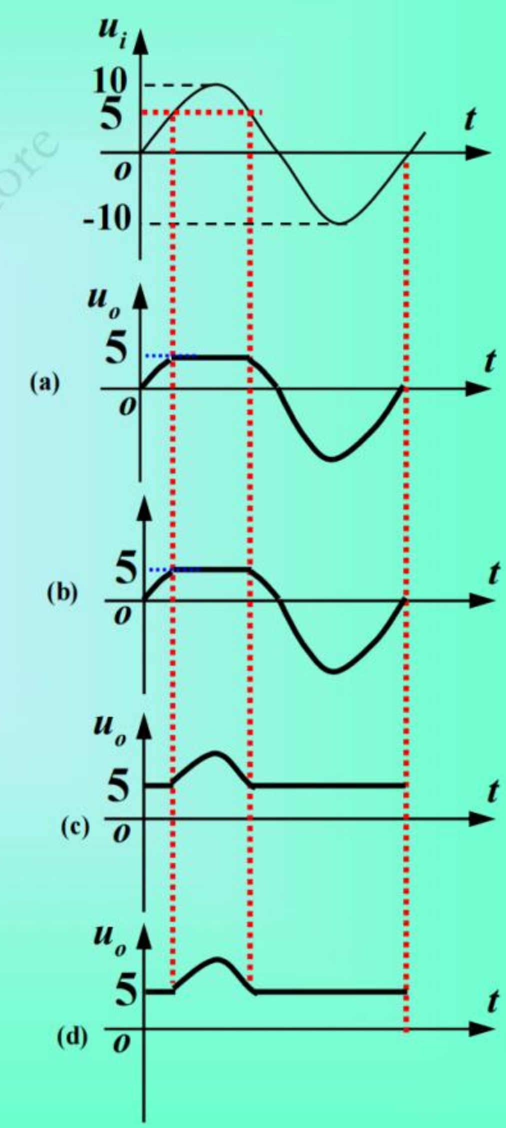
(b)



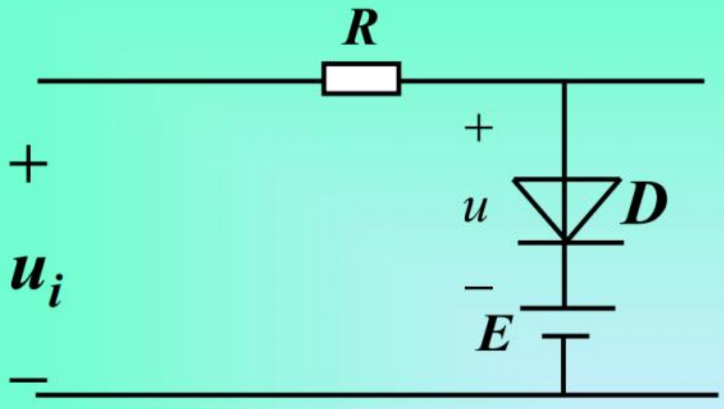
(c)



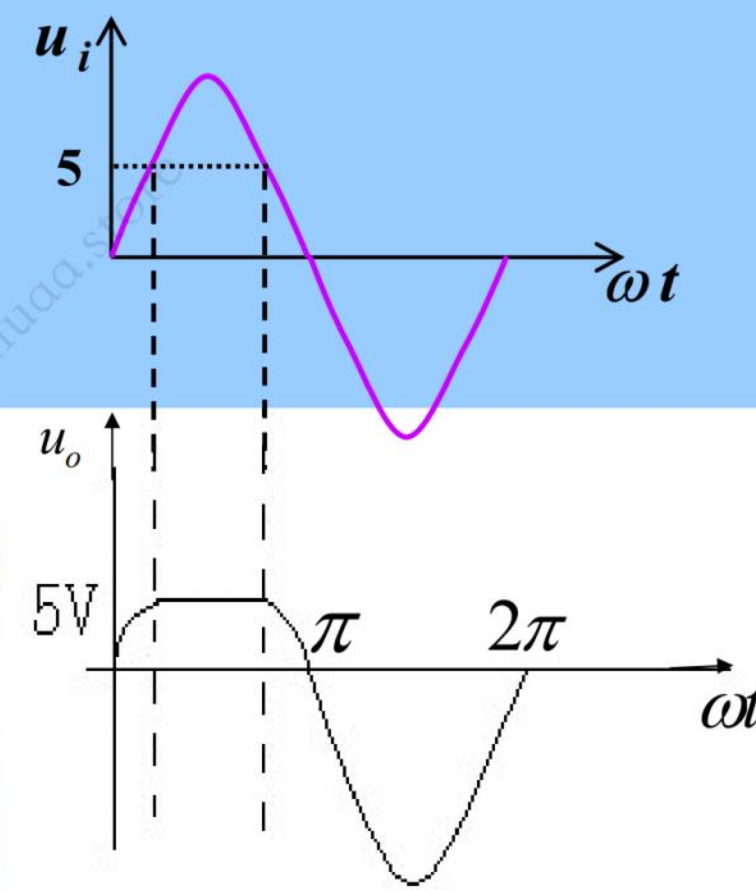
(d)



1.1:



(a)



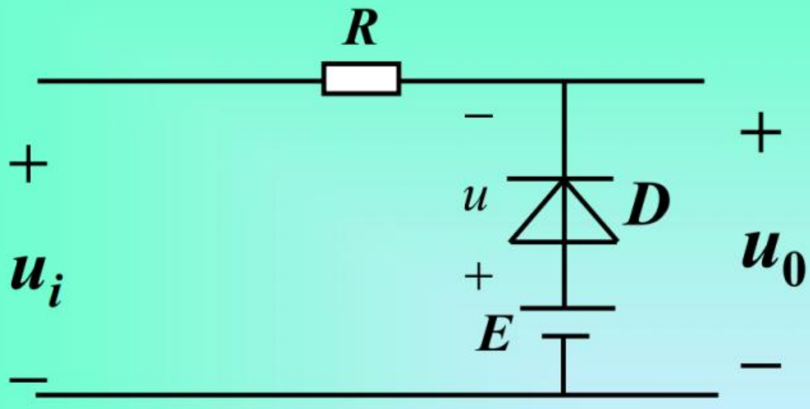
解:将D开路，求其阳、阴两极开路电压u，若u>0，则D导通；反之D截止。

$$u = u_i - 5$$

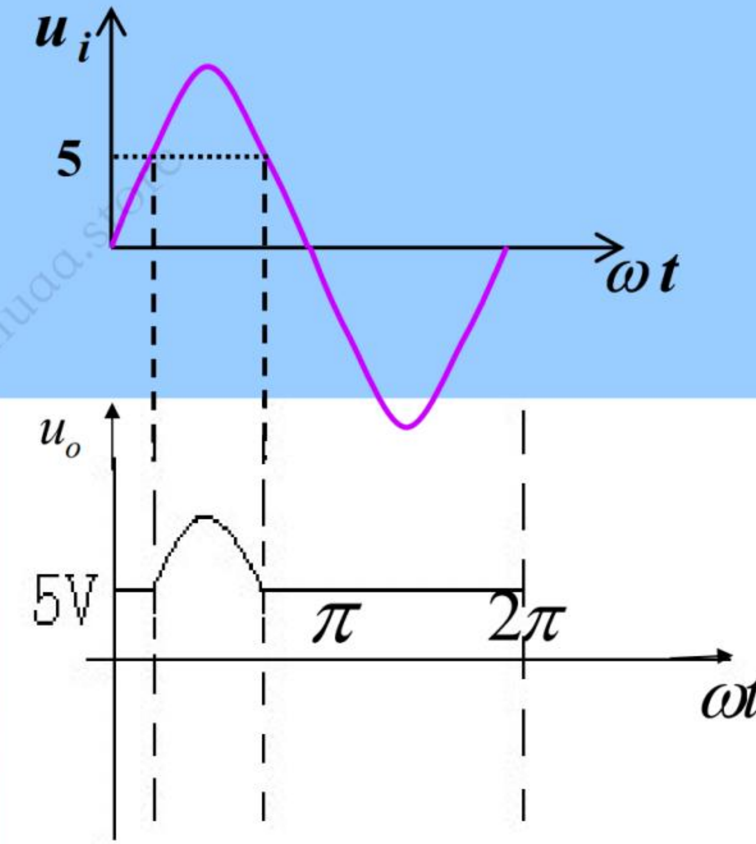
若$u_i < 5V, u < 0, D$截止，$u_0 = u_i$

若$u_i > 5V, u > 0, D$导通，$u_0 = 5V$

1.1:



(c)

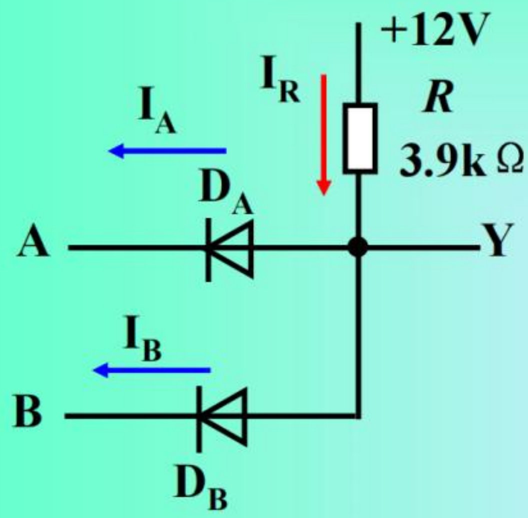


$$u = 5 - u_i$$

若$u_i < 5V, u > 0, D$导通，$u_0 = 5V$

若$u_i > 5V, u < 0, D$截止，$u_0 = u_i$

1.2 试求输出端*Y*的电位V_Y及各元件（*R*、D_A、D_B）中通过的电流：
（1）$V_A= V_B$ =0V；（2）V_A= +3V，V_B =0V；（3）$V_A= V_B$ =3V。



（1）D_A通，D_B通，V_Y =0V；

$$I_R=2I_A=2I_B=12/3.9=3.08\text{mA}$$

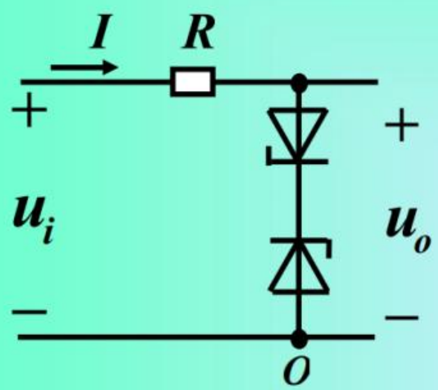
（2）D_B通，D_A止，V_Y =0V；

$$I_R=I_B=12/3.9=3.08\text{mA}$$

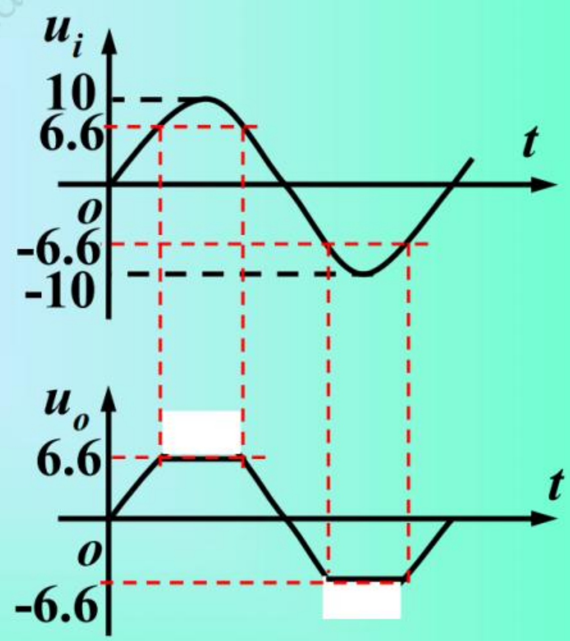
（3）D_A通，D_B通，V_Y =3V；

$$I_R=2I_A=2I_B=9/3.9=2.3\text{mA}$$

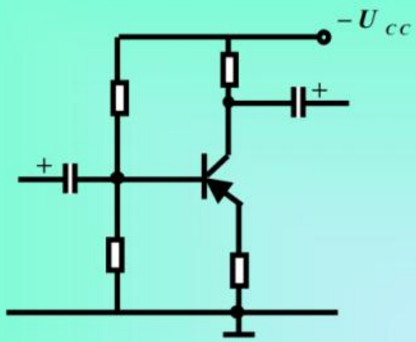
1.3 图示电路中，若稳压管的稳定电压U_Z都是6V，正向导通压降均为0.6V，试画出输出电压u_o的波形。



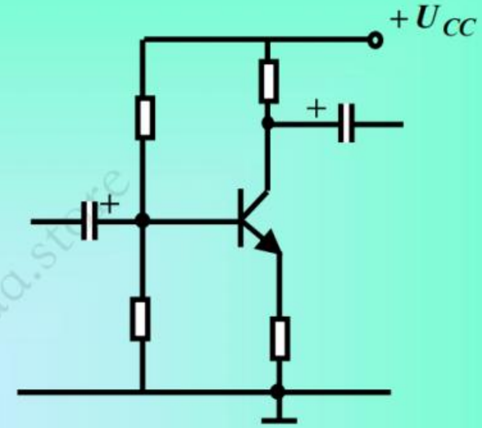
$$u_i = 10\sin\omega t\,\text{V}$$



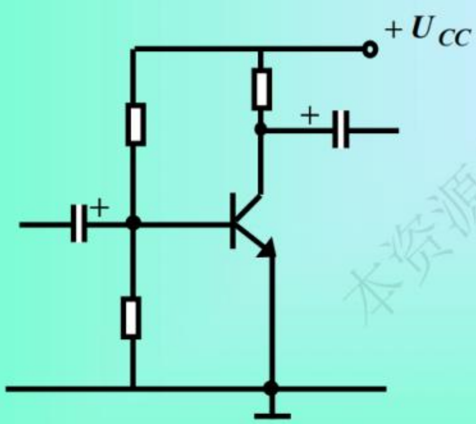
2.3 试判断图示各个电路能不能放大交流信号？为什么？



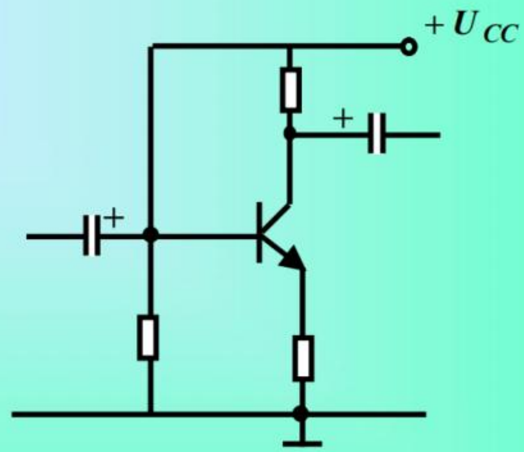
可以，偏置正确



可以，偏置正确

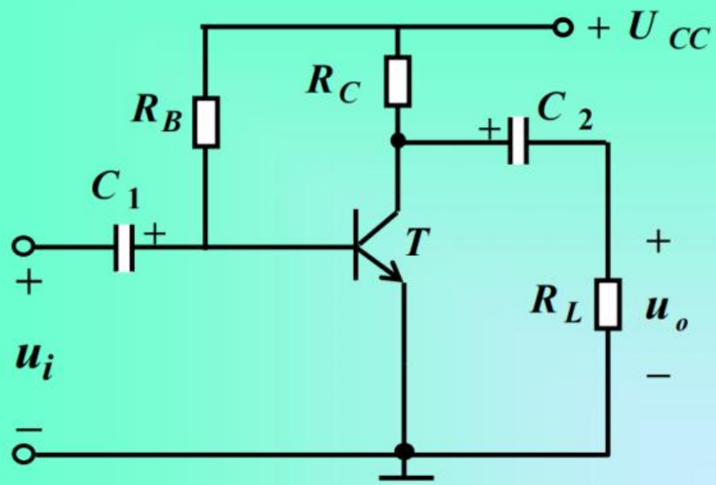


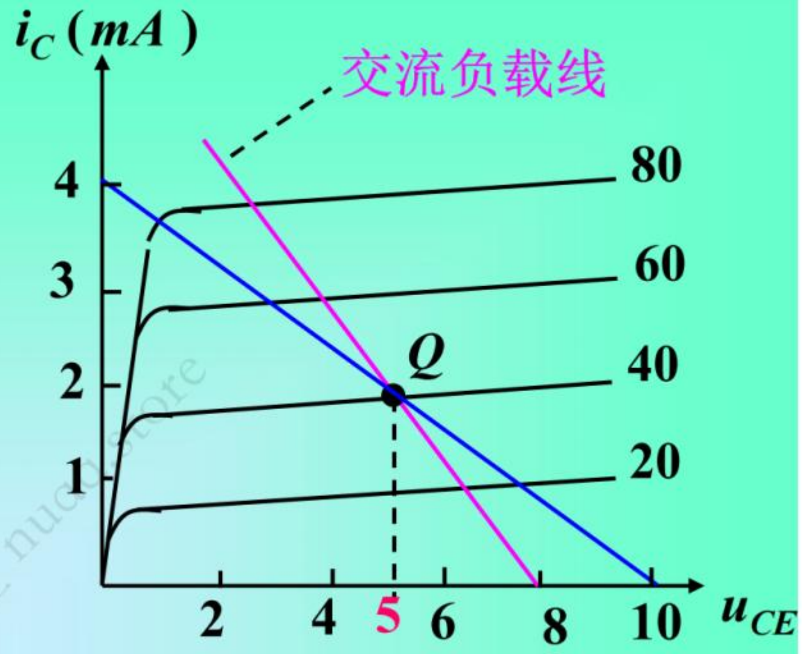
可以



不可以，输入端短路

2.4





（1） 从直流负载线可以看出，U_{CC}=10V

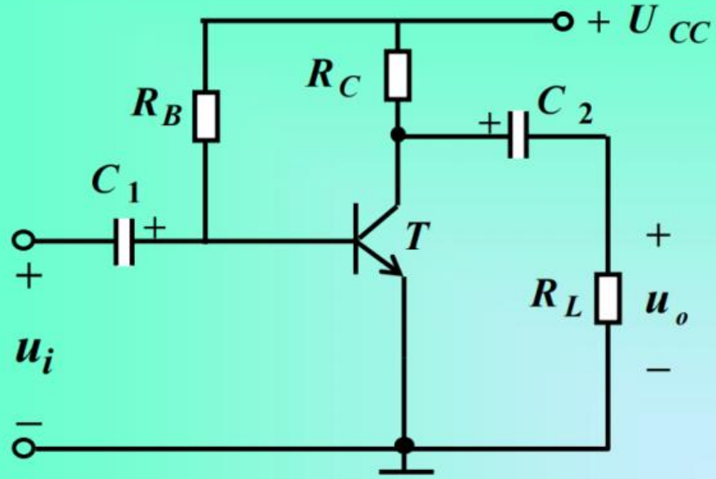
$$\tan\alpha = -\frac{1}{R_C} = -\frac{2}{5}$$ 因此R_C=2.5KΩ

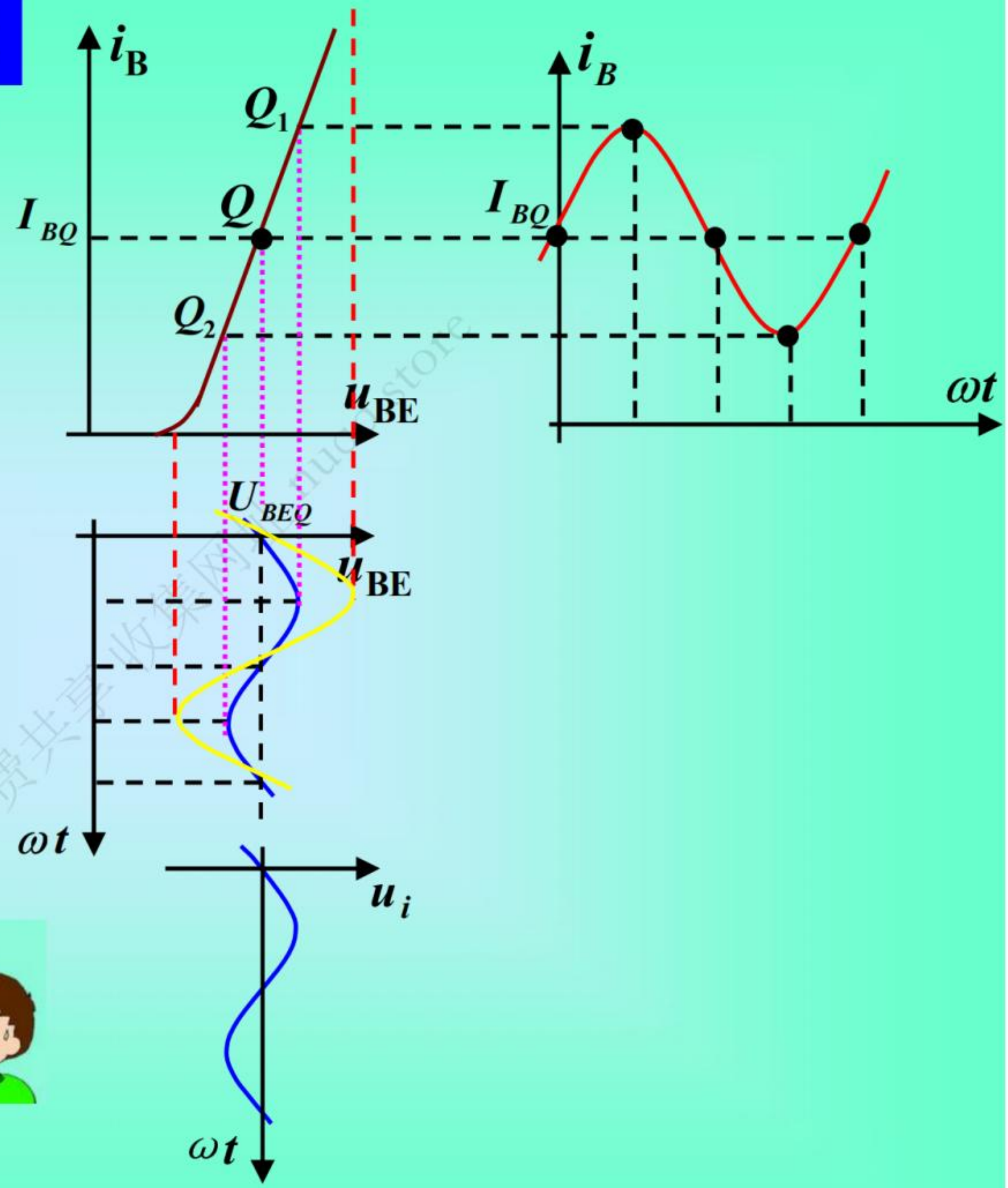
Q点对应的I_{CQ}=2mA, I_{BQ}=40μA， U_{CEQ}=5V

$$I_B = \frac{U_{CC} - U_{BE}}{R_B} \approx \frac{U_{CC}}{R_B} = \frac{10}{R_B} = 40\mu A \Rightarrow R_B = 250k\Omega$$

交流负载线斜率: $-\frac{1}{R_L // R_C} = -\frac{2}{8-5} = -\frac{2}{3} \Rightarrow R_L = 3.75k\Omega$

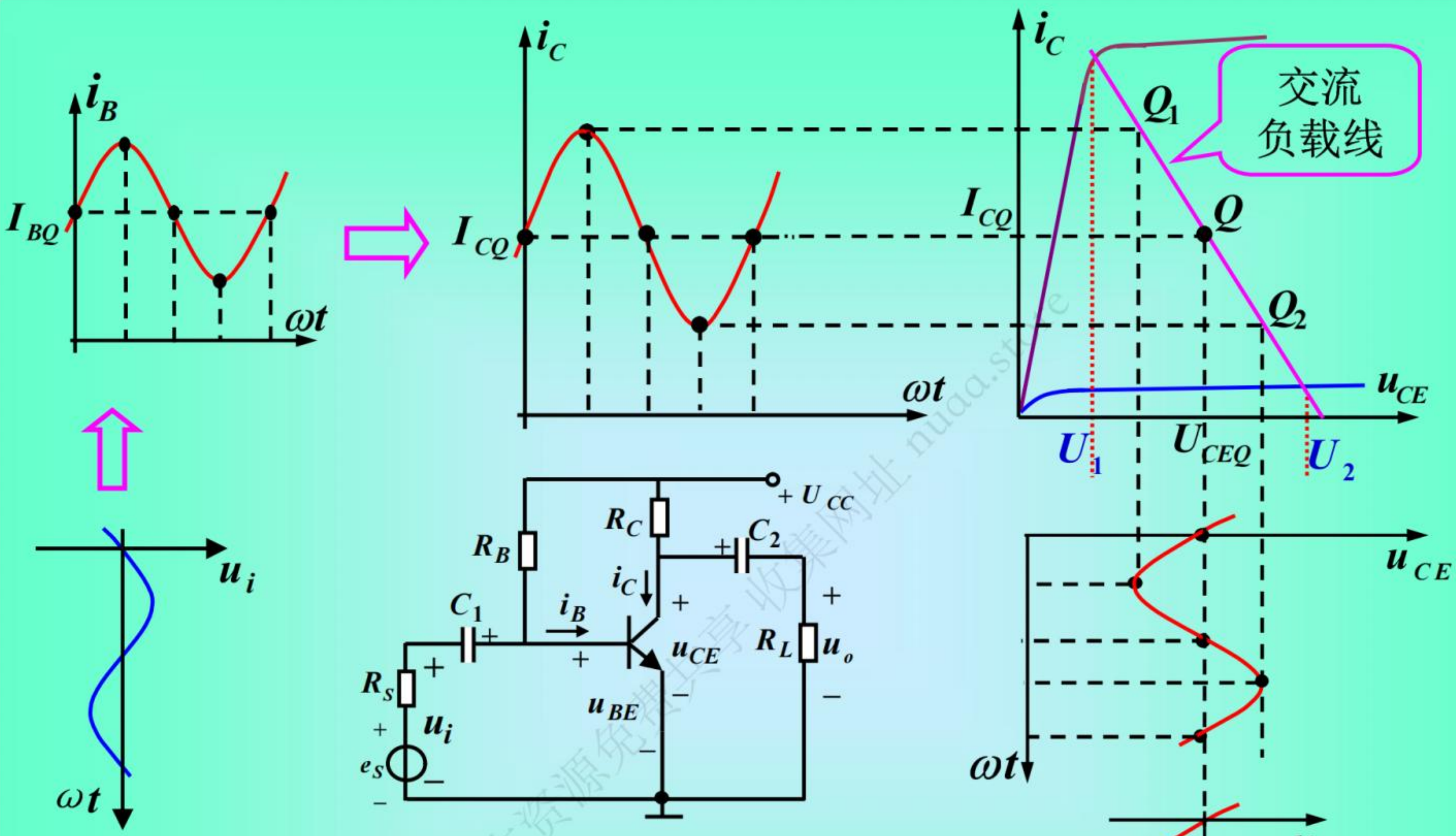
2）输入过大引起的失真

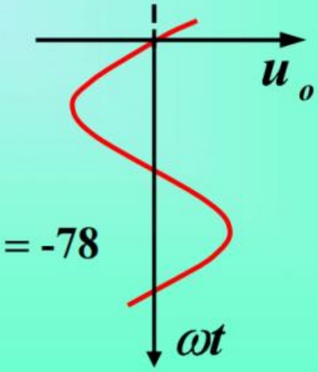




$$U_{im} = U_{BEQ} - U_T$$

输入曲线仅考虑截止失真，还要在输出曲线中考虑饱和失真



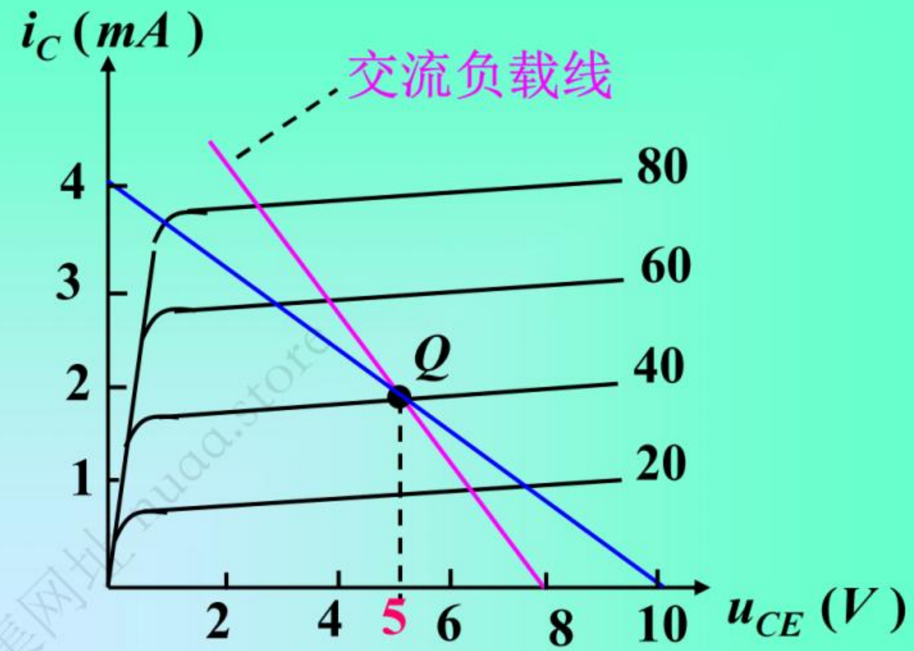


$$U_{om}=\min[U_{CEQ}-U_1, U_2-U_{CEQ}]$$

$$U_{im}=\frac{U_{om}}{|A_u|}$$

$$A_u=\frac{\dot{U}_o}{\dot{U}_i}=-\beta\frac{R_C//R_L}{r_{be}}=-50\times\frac{1.5}{0.96}=-78$$

$$U_{im}=\left|\frac{U_{om}}{A_u}\right|=\left|\frac{3}{A_u}\right|=38mV$$



(3) 输出首先出现什么失真？

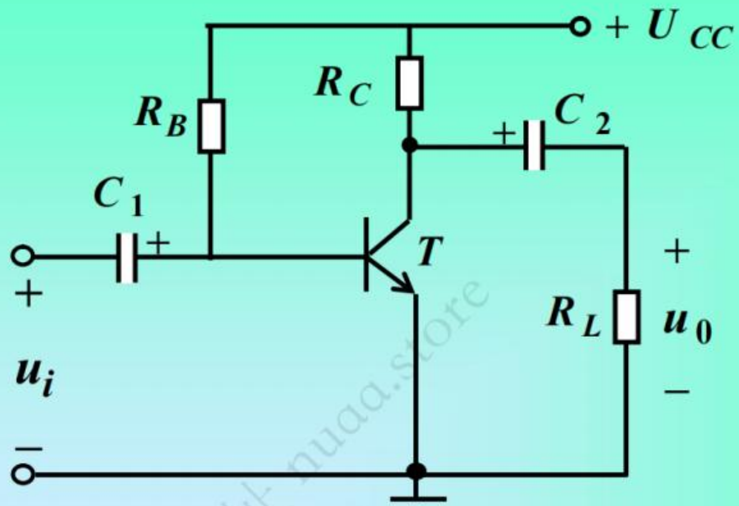
首先出现截止失真，减小R_B

(4)增大 R_L，对直流负载线无影响，

但使交流负载线的斜率绝对值减小，变的更平坦

交流负载线的 $tg\alpha' = -\dfrac{1}{R_L'}$

(5) β减小一半



$$I_B = \frac{U_C - U_{BE}}{R_B} \approx \frac{U_C}{R_B} = \frac{10}{R_B} = 40\mu A$$

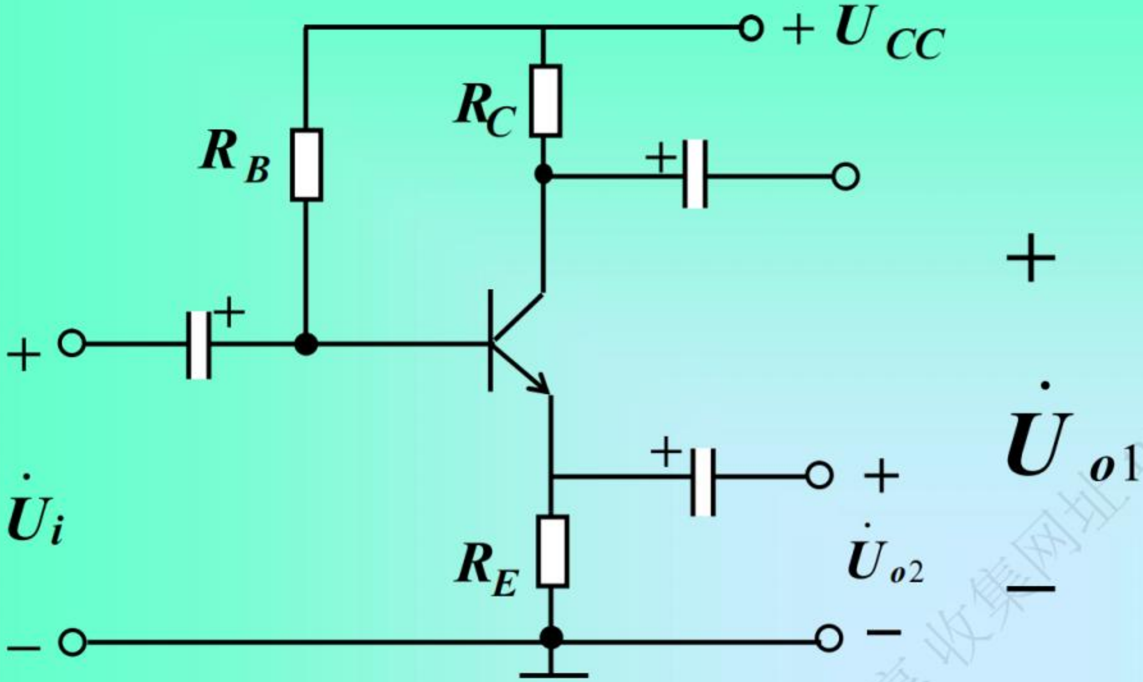
$I_C = \beta I_B$ I_C降为原来的一半 $U_{CE} = U_{CC} - I_C R_C$变大

$$r_{be} \approx 300 + (1+\beta)\frac{26(mV)}{I_E(mA)} = 300 + \frac{26(mV)}{I_B(mA)}$$

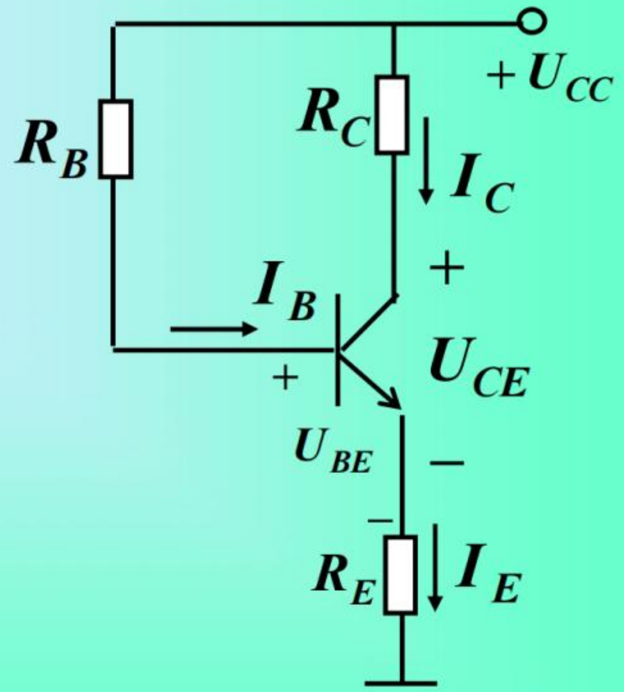
r_{be}不变

$$A_u = \frac{\dot{U}_o}{\dot{U}_i} = -\beta \frac{R_C // R_L}{r_{be}}$$ 减小一半

2.5



直流通路

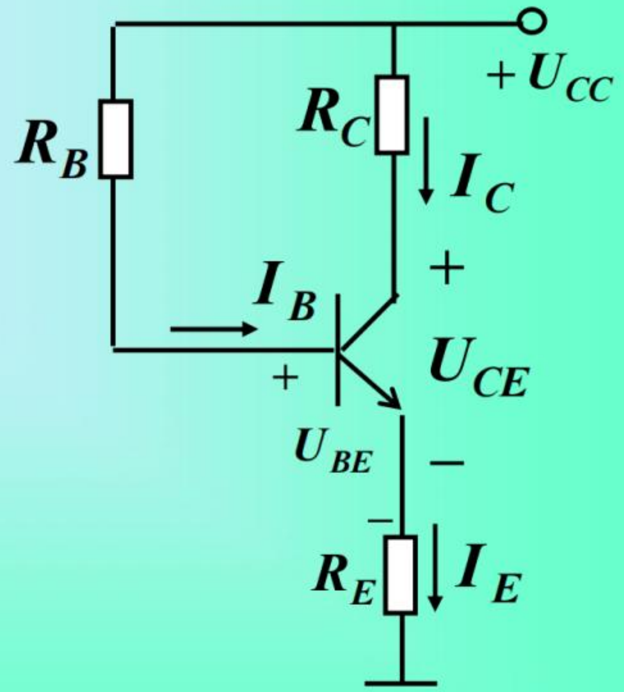


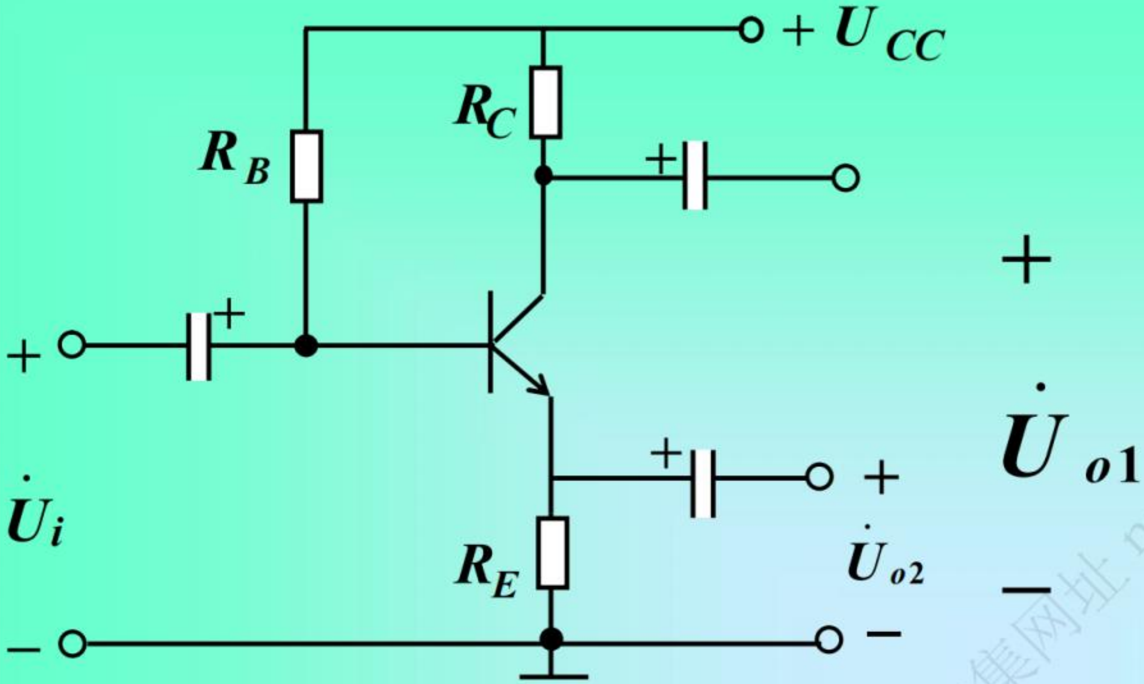
$$U_{CC} = R_B I_B + U_{BE} + (1+\beta) R_E I_B$$

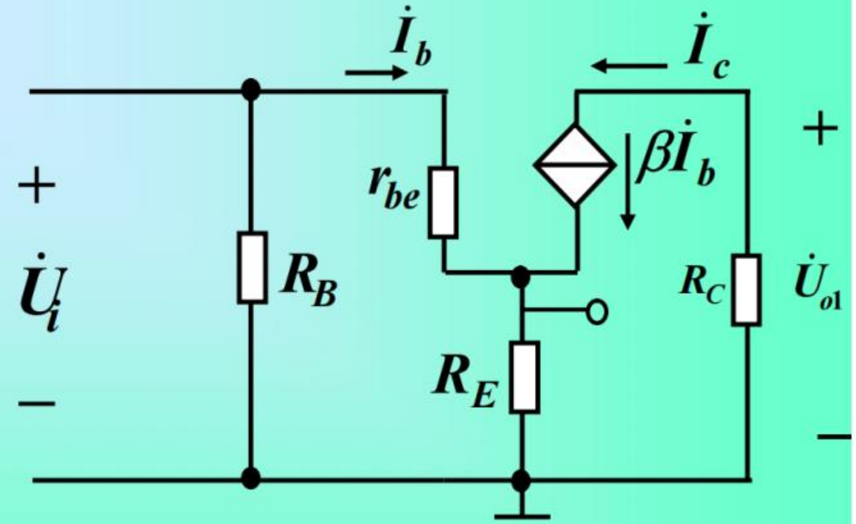
$$I_B = \frac{U_{CC} - U_{BE}}{R_B + (1+\beta) R_E} \approx 30\mu A$$

$$I_E = (1+\beta) I_B \approx 1.5mA$$

$$r_{be} \approx 300 + (1+\beta)\frac{26(mV)}{I_E(mA)} = 1.18k\Omega$$



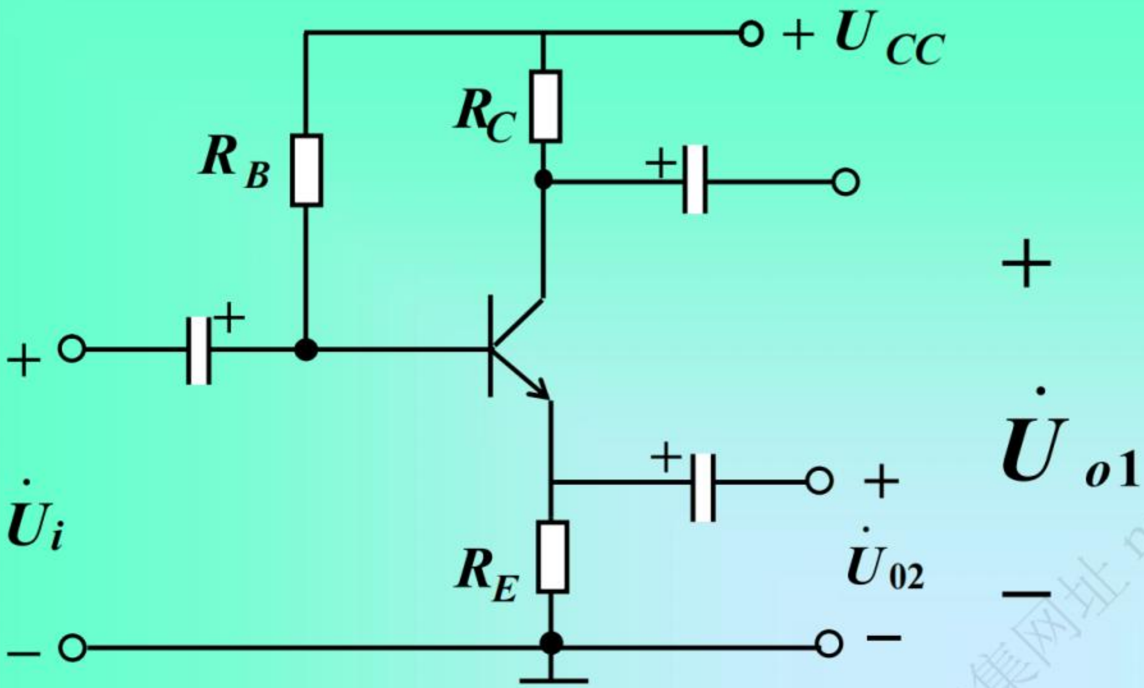




$$\dot{U}_{o1} = -\beta \dot{I}_b R_C$$

$$\dot{U}_i = \dot{I}_b r_{be} + (1+\beta)\dot{I}_b R_E$$

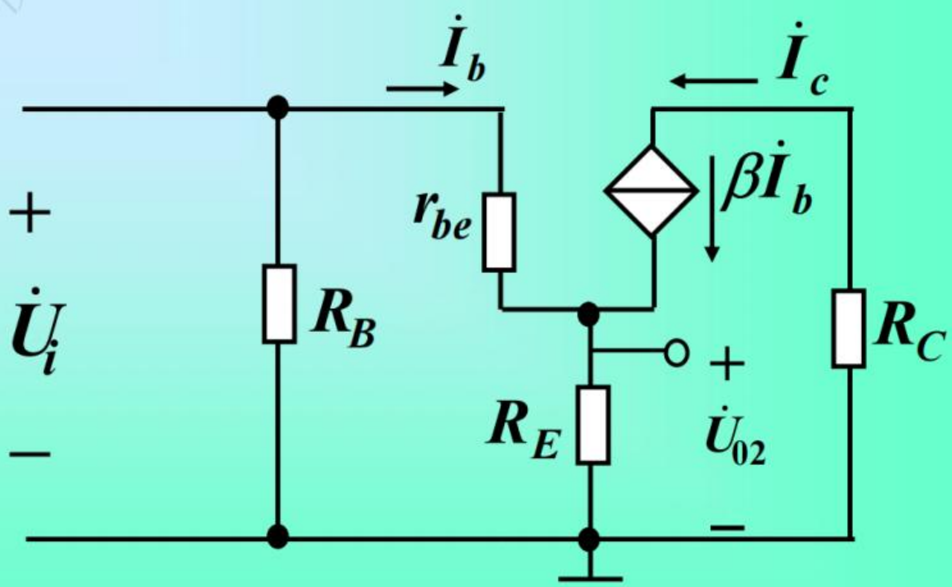
$$A_{u1} = \frac{\dot{U}_{o1}}{\dot{U}_i} = -\frac{\beta R_C}{r_{be} + (1+\beta) R_E} = -0.97$$



$$\dot{U}_{o2} = (1+\beta)\dot{I}_b R_E$$

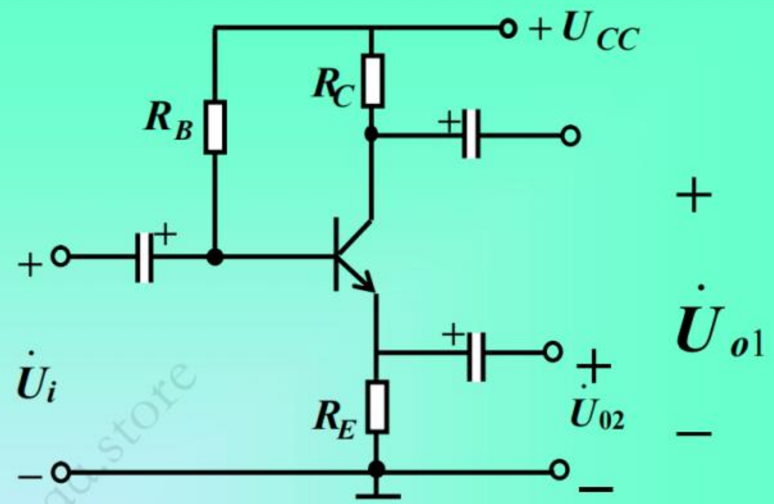
$$\dot{U}_i = \dot{I}_b r_{be} + (1+\beta)\dot{I}_b R_E$$

$$A_{u2} = \frac{\dot{U}_{o2}}{\dot{U}_i} = \frac{(1+\beta)R_E}{r_{be}+(1+\beta)R_E} = 0.99$$



求输出电阻

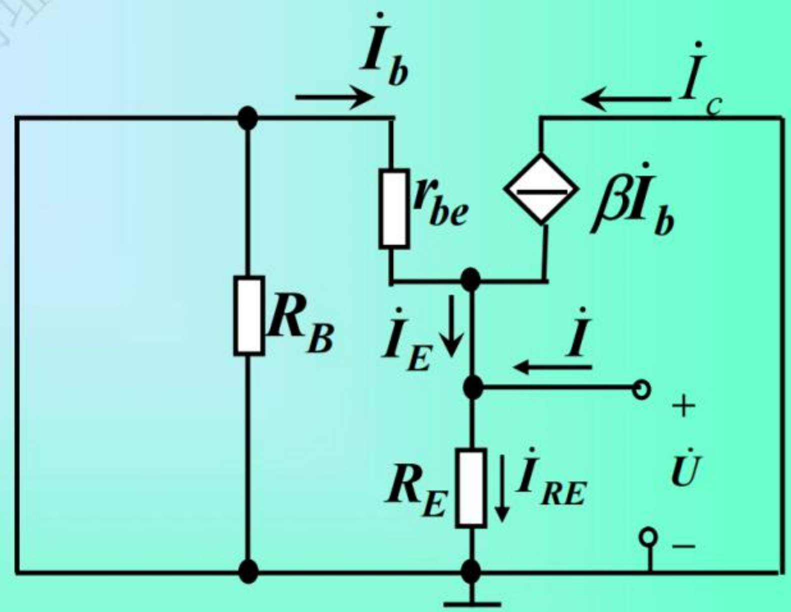
$$r_{o1} = R_C$$



$$r_{o2} = \frac{\dot{U}}{\dot{I}}$$

$$\dot{I} = \dot{I}_E + \dot{I}_{RE} = (1+\beta)\dot{I}_b + \dot{I}_{RE}$$

$$\dot{U} = -\dot{I}_b r_{be} \Rightarrow \dot{I}_b = -\frac{\dot{U}}{r_{be}}$$

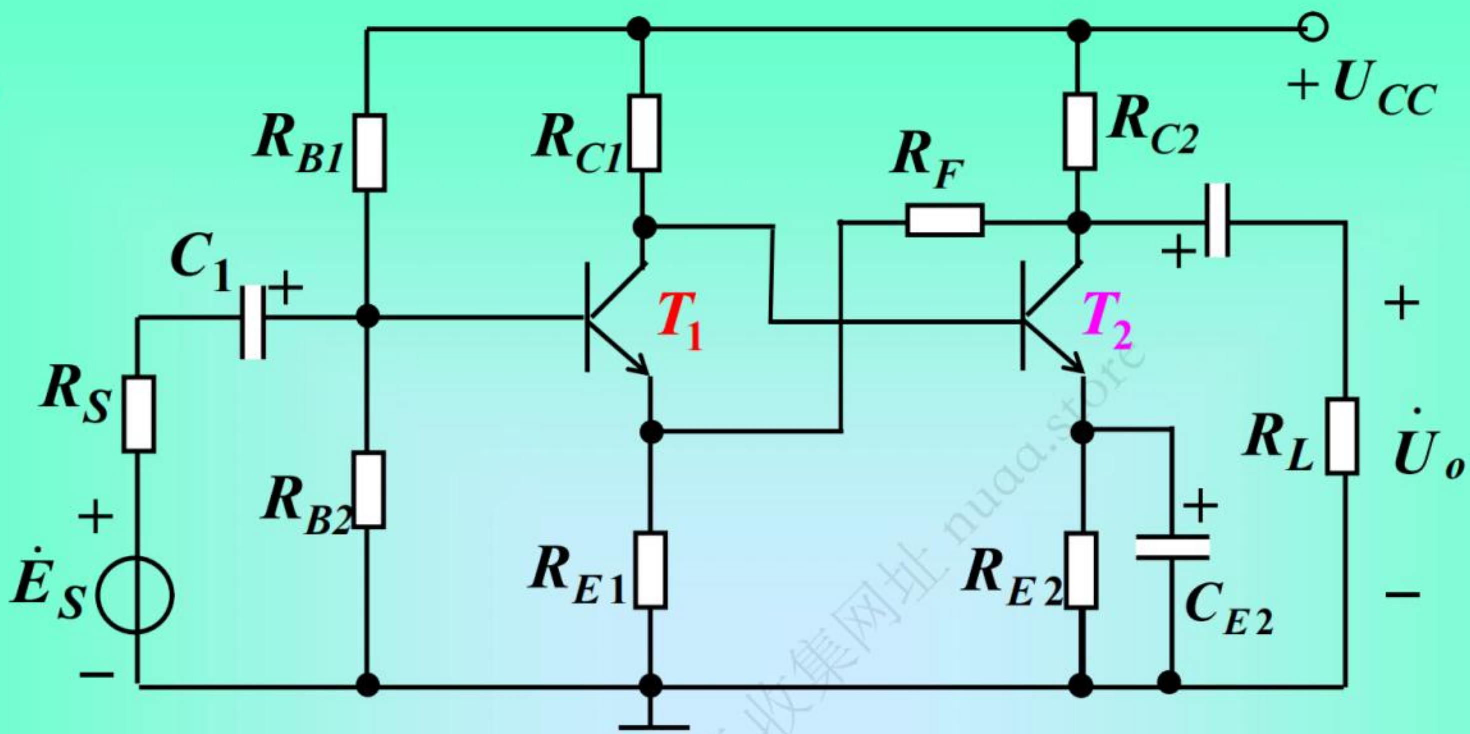


$$\dot{I}_{RE} = \frac{\dot{U}}{R_E}$$

$$\dot{I} = \frac{\dot{U}}{R_E} + (1+\beta)\frac{\dot{U}}{r_{be}}$$

$$r_{o2} = \frac{\dot{U}}{\dot{I}} \approx \frac{r_{be}}{1+\beta} = 23\Omega$$

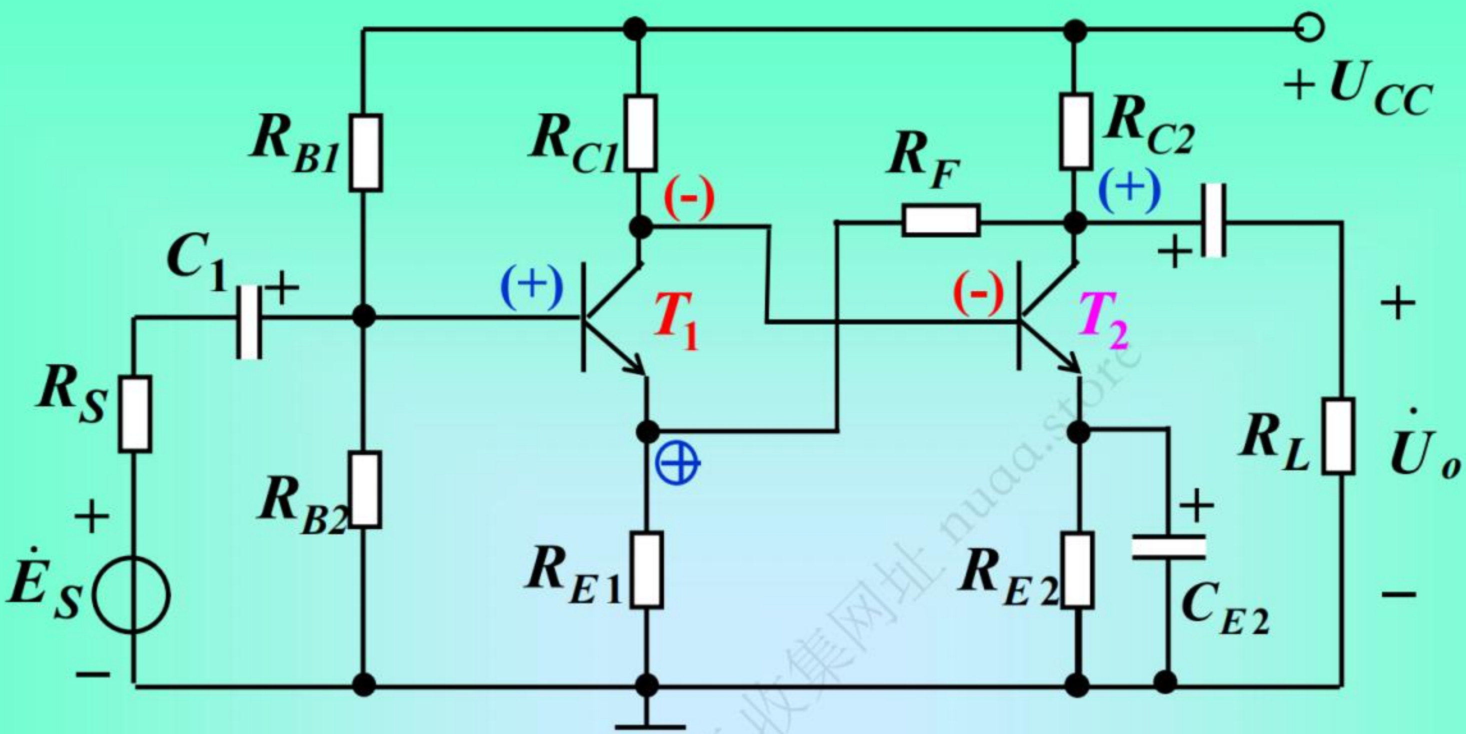
2.6



1、直流负反馈：R_{E1}、 R_{E2} R_F

温度↑ ⟶ I_{C2}↑ ⟶ V_{C2}↓ ⟶ V_{E1}↓ ⟶ U_{BE1}↑

I_{C2}↓ ⟵ I_{B2}↓ ⟵ V_{C1}↓ ⟵ I_{C1}↑ ⟵ I_{B1}↑



2、交流负反馈

R_{E1}：电流串联负反馈　　　R_F：电压串联负反馈

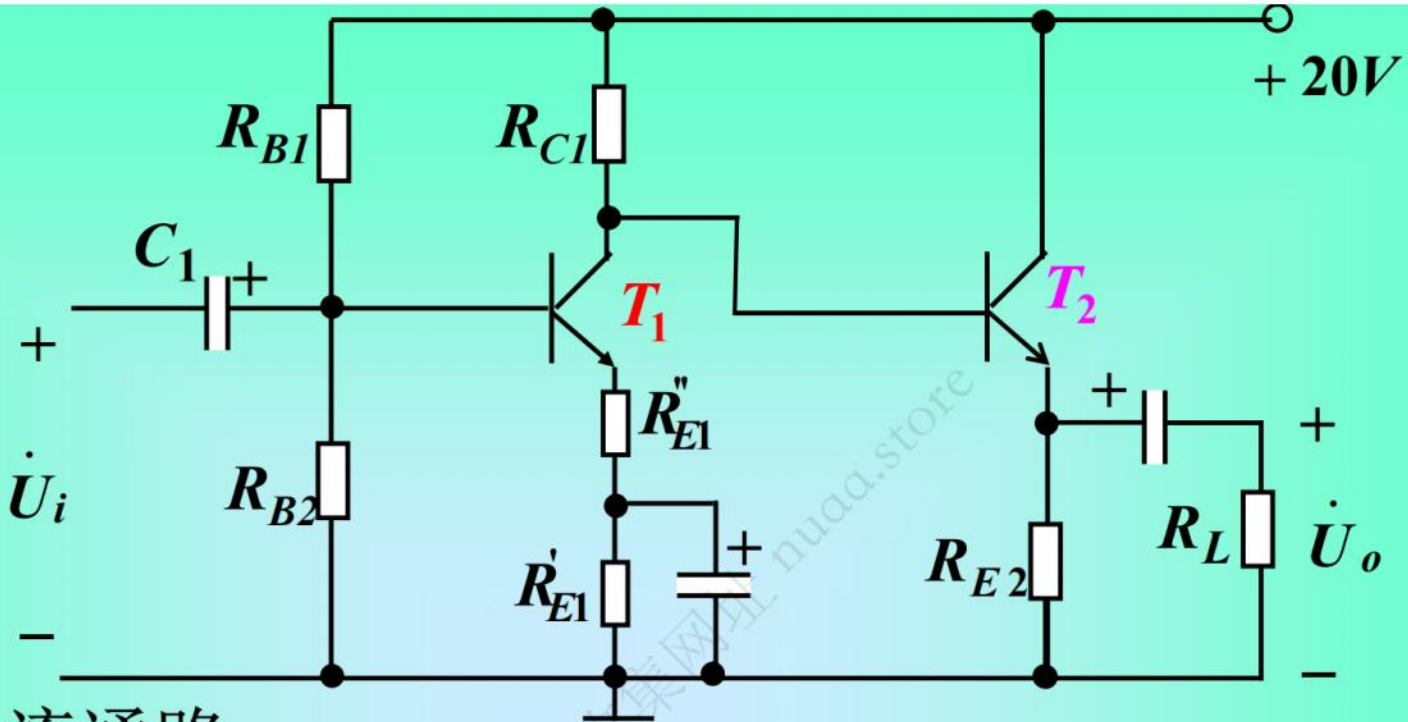
3、如R_F不接在T2的集电极，而接在C_2与R_L之间，两者有何不同？

将只有交流负反馈

4、如果R_F的另一端不是接在T_1的发射极，而是接在它的基极，则有何不同？是否会变成正反馈？

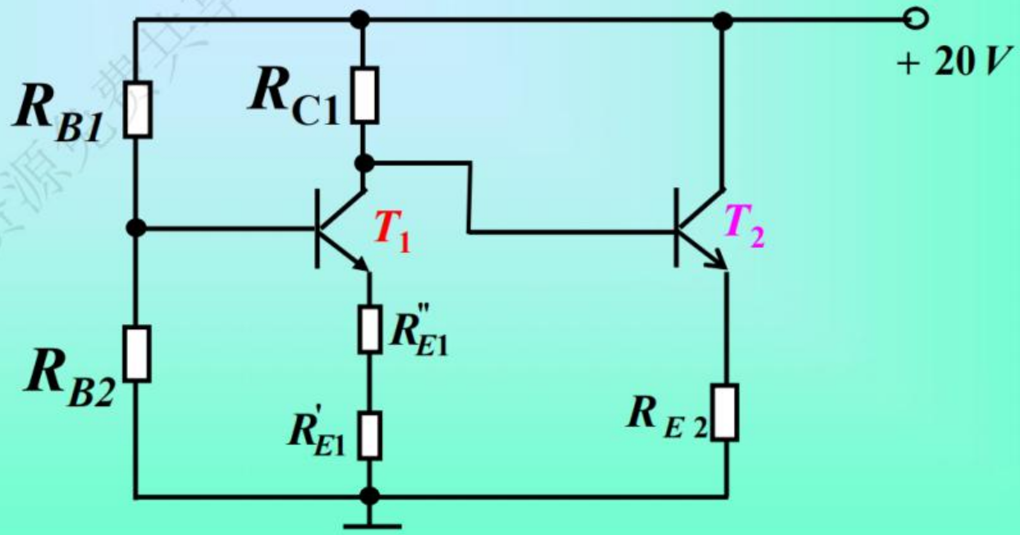
会变成电压并联正反馈

2.7



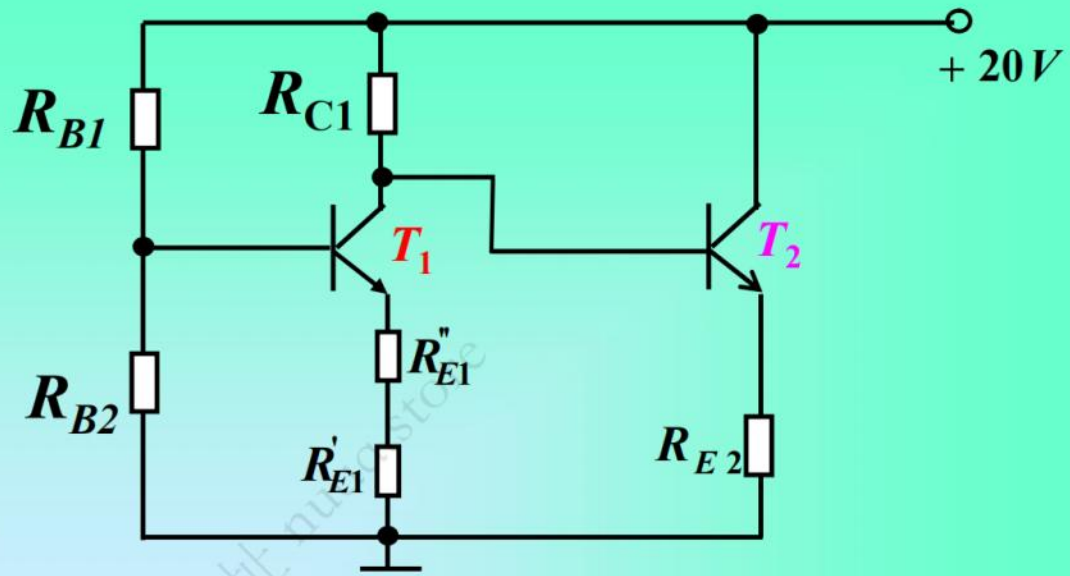
+20V
R_{B1}
R_{C1}
C_1
+
T_1
T_2
$\dot{U}_i$
R_{B2}
R''_{E1}
R'_{E1}
R_{E2}
R_L
$\dot{U}_o$

（1）画直流通路



+20V
R_{B1}
R_{C1}
T_1
T_2
R_{B2}
R''_{E1}
R'_{E1}
R_{E2}

第一级：



$$V_{B1} \approx \frac{R_{B2}}{R_{B1}+R_{B2}} \times 20 = 4V$$

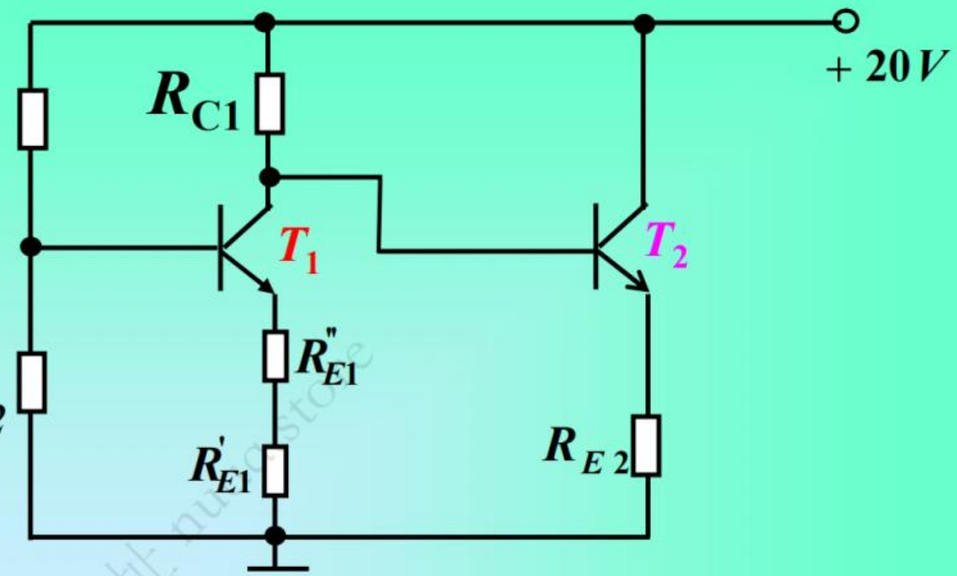
$$I_{C1} \approx I_{E1} = \frac{V_{B1}-U_{BE1}}{R_{E1}} = \frac{4-0.6}{3.39} = 1mA$$

$$I_{B1} = \frac{I_{C1}}{\beta_1} = 25\mu A$$

$$U_{CE1} \approx U_{CC} - I_{C1}(R_{C1}+R'_{E1}+R''_{E1}) = 20-13.4 = 6.6V$$

$$r_{be1} = 300 + (1+\beta_1)\frac{26}{I_{E1}} = 1.34k\Omega$$

第二级：

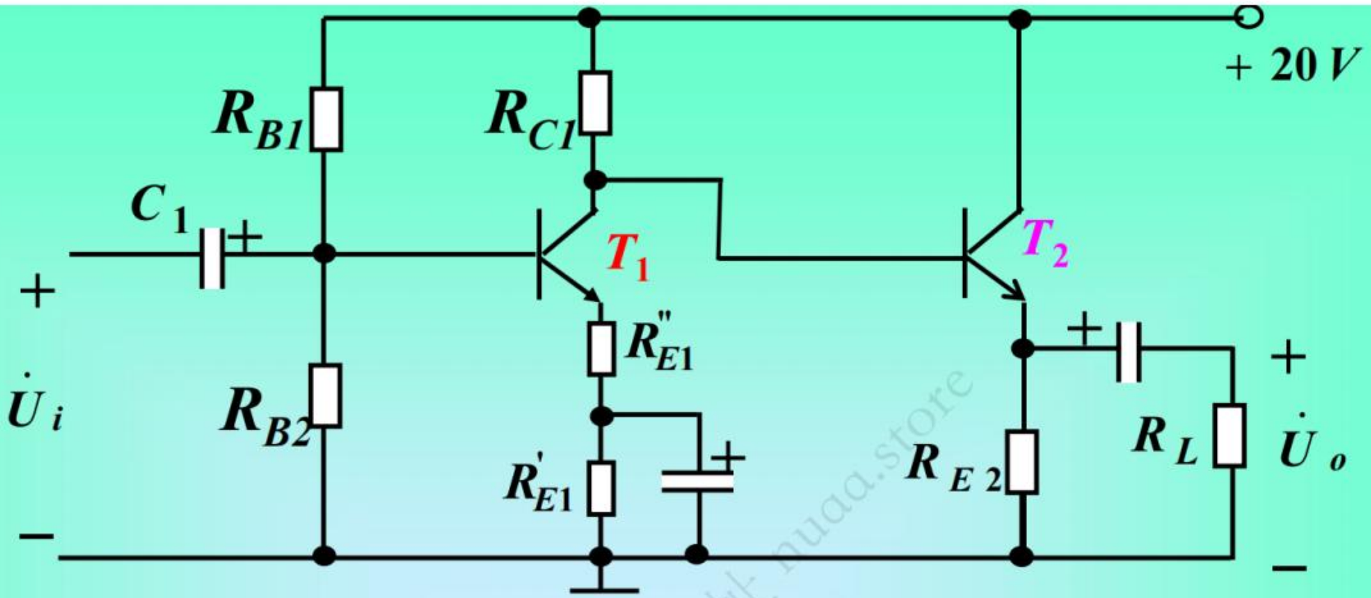


$$V_{B2}=V_{C1}=20-I_C R_{C1}=10V$$

$$I_{C2}\approx I_{E2}=\frac{V_{B2}-U_{BE2}}{R_{E2}}=\frac{10-0.6}{5.1}=1.84mA \qquad I_{B2}=\frac{I_{C2}}{\beta_2}=46\mu A$$

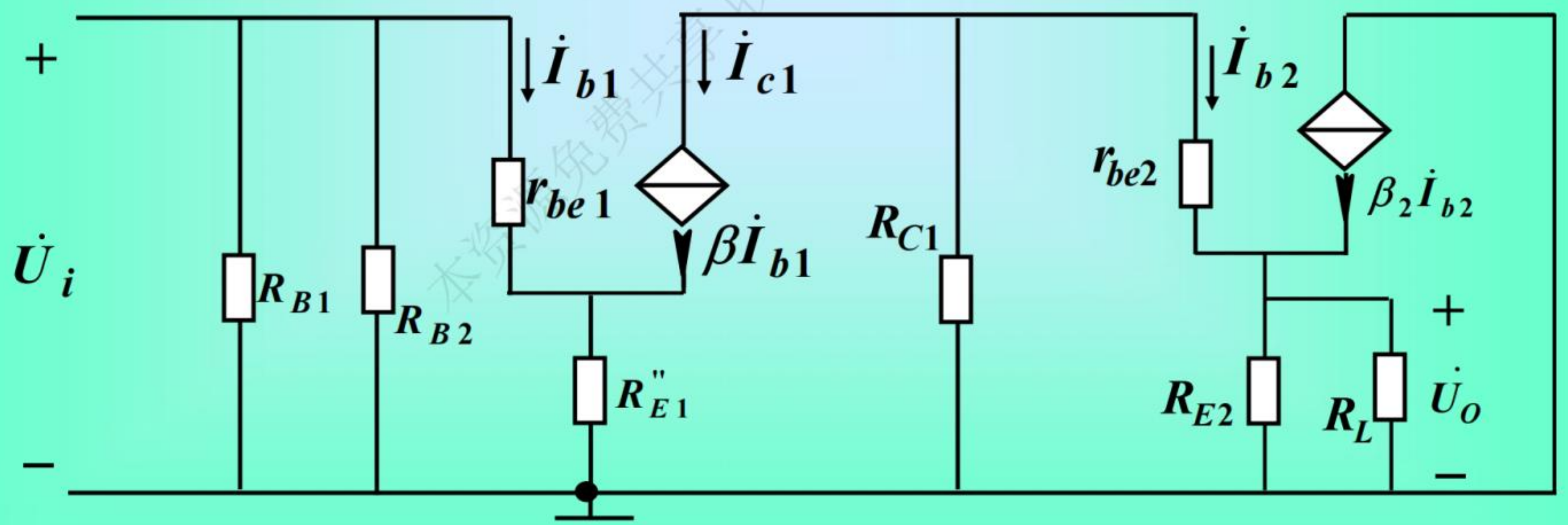
$$U_{CE2}=U_{CC}-I_{C2}R_{E2}=10.6V$$

$$r_{be2}=300+(1+\beta_2)\frac{26}{I_{E2}}=0.879k\Omega$$

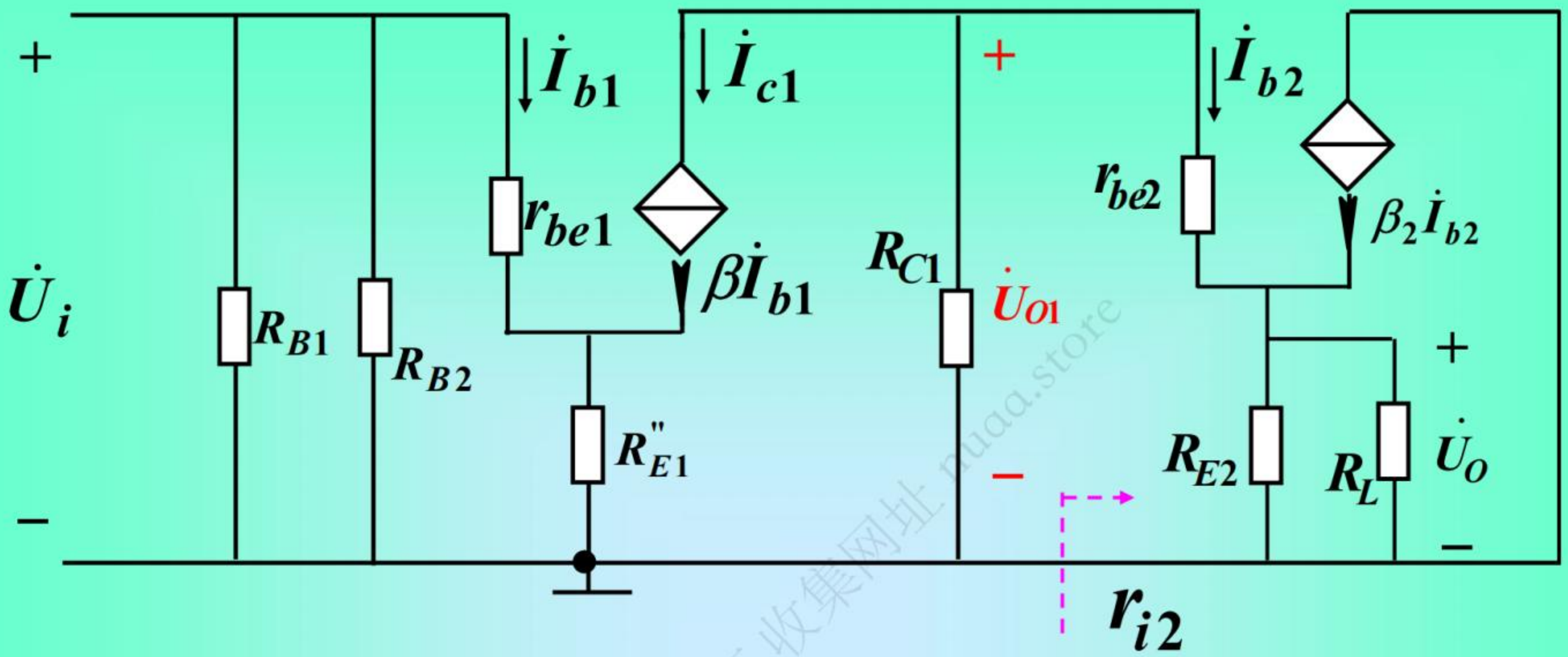


+ 20 V
R_B1
R_C1
C_1
T_1
T_2
+
U̇_i
R_B2
R″_E1
R′_E1
R_E2
R_L
U̇_o
−

（2）求交流参数



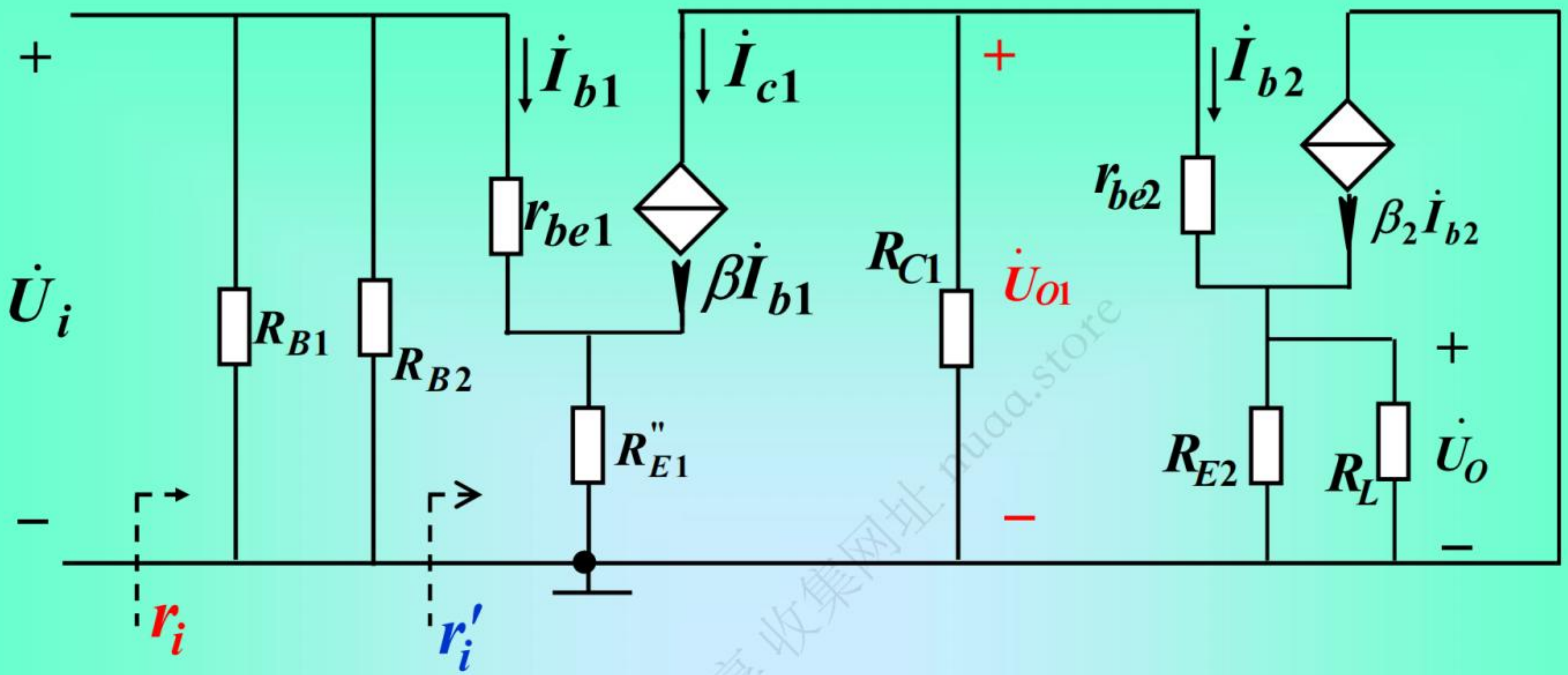
+
U̇_i
−
R_B1
R_B2
İ_b1
İ_c1
r_be1
βİ_b1
R″_E1
R_C1
İ_b2
r_be2
β_2 İ_b2
R_E2
R_L
U̇_o



$$A_{u1} = \frac{\dot{U}_{o1}}{\dot{U}_i} = -\beta_1 \frac{R_{C1} // r_{i2}}{r_{be1} + (1+\beta_1)R_E''} = -\beta_1 \frac{R_{C1} //[r_{be2} + (1+\beta_2)R_{E2} // R_L]}{r_{be1} + (1+\beta_1)R_E''} = -21$$

$$A_{u2} = \frac{\dot{U}_o}{\dot{U}_{O1}} = \frac{(1+\beta_2)R_{E2} // R_L}{r_{be2} + (1+\beta_2)R_{E2} // R_L} = 0.99$$

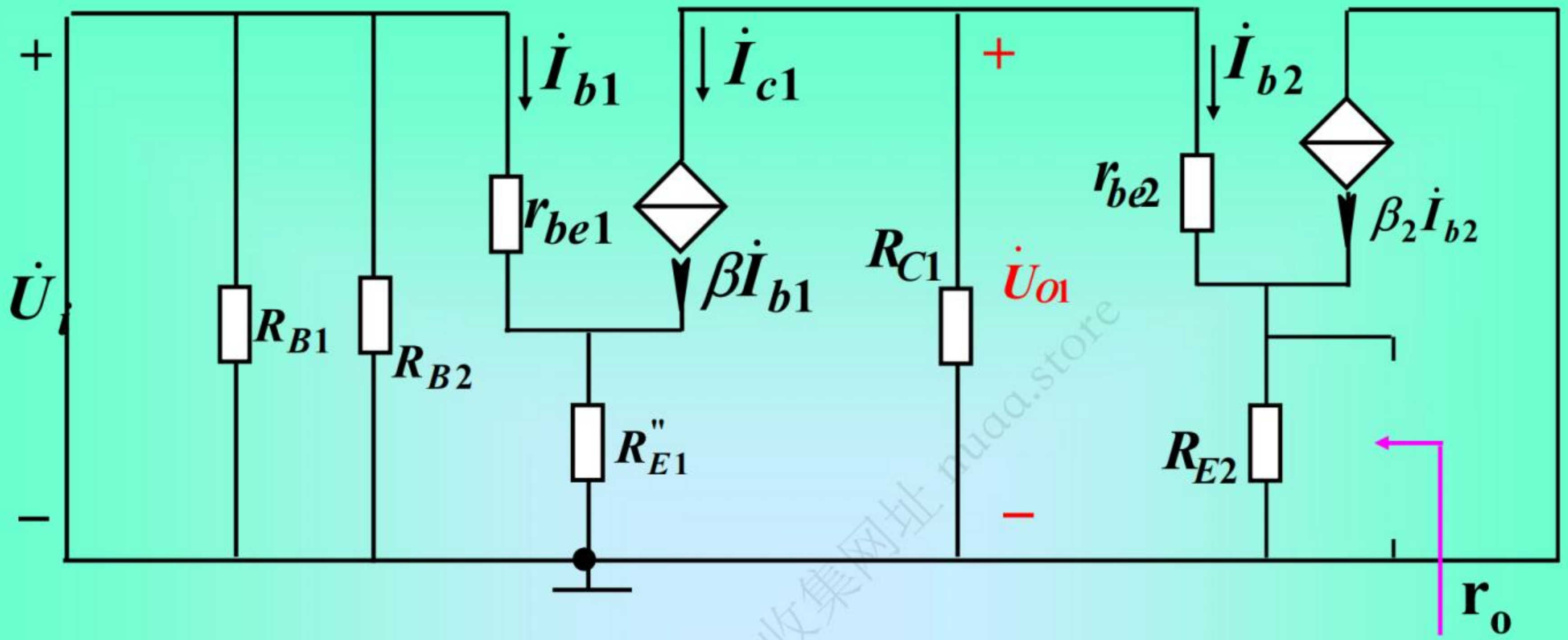
$$A_u = \frac{\dot{U}_o}{\dot{U}_i} = A_{u1}A_{u2} = -21$$



求输入电阻

$$r_i = \frac{\dot{U}_i}{\dot{I}_i} = R_{B1} // R_{B2} // r_i'$$

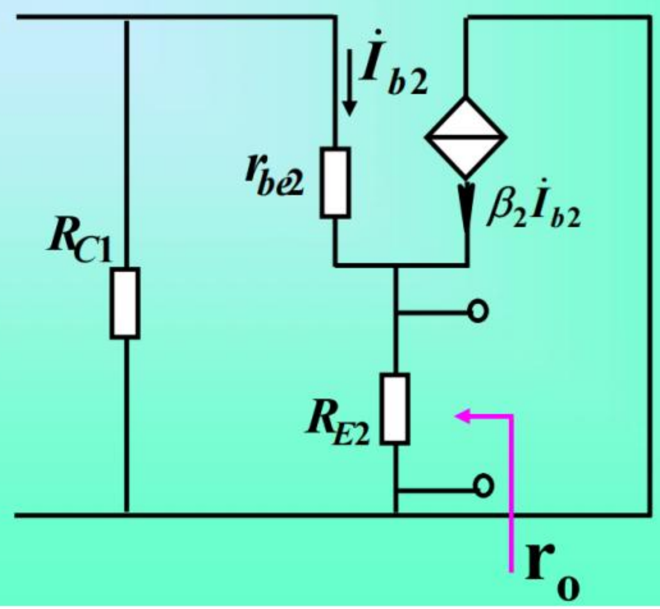
$$\text{而} r_i' = \frac{\dot{U}_i}{\dot{I}_b} = r_{be1} + (1+\beta_1)R''_{\text{E}}$$



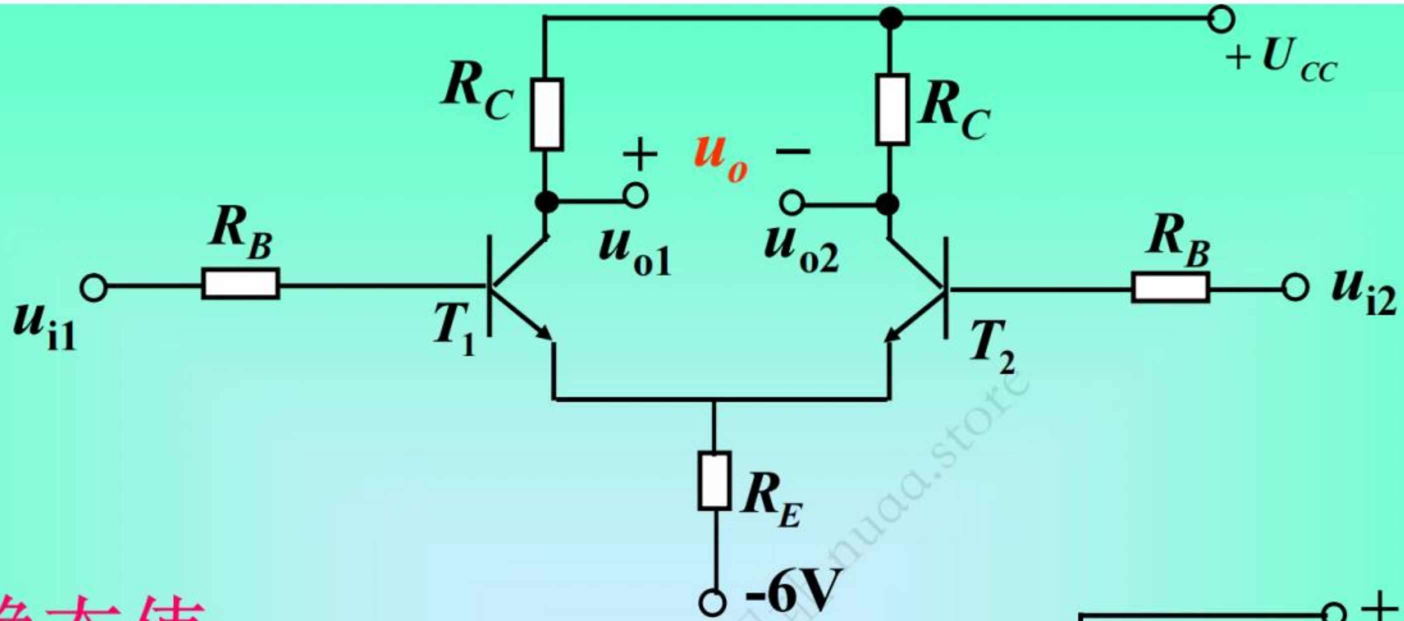
求输出电阻

$$r_o = \frac{R_{E2}(R_{C1} + r_{be2})}{(1+\beta)R_{E2} + R_{C1} + r_{be2}}$$

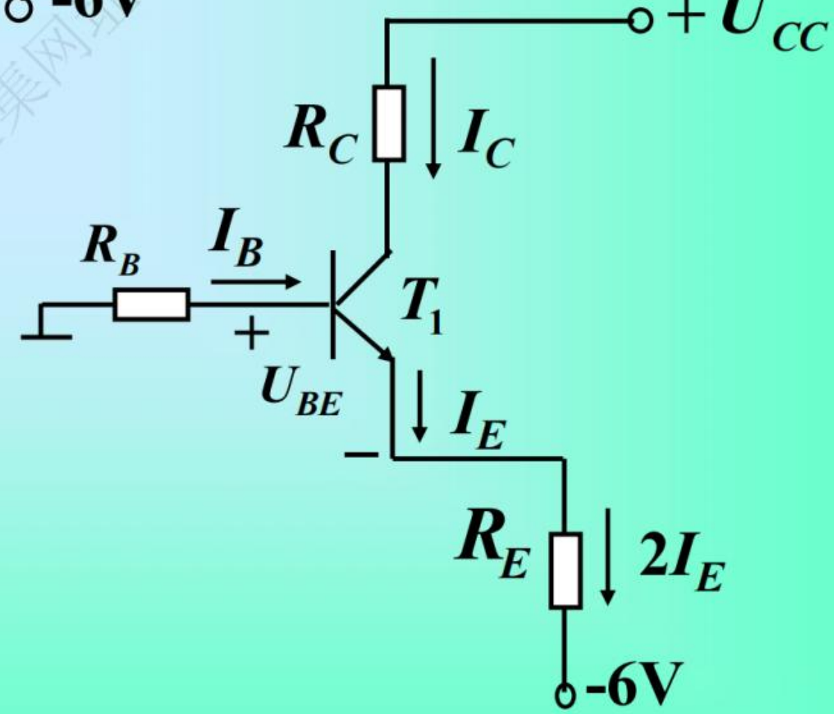
$$\approx \frac{R_{C1} + r_{be2}}{(1+\beta)}$$



2.9



(1) 求静态值



$$I_B \cdot R_B + U_{BE} + 2I_E \cdot R_E = 6$$

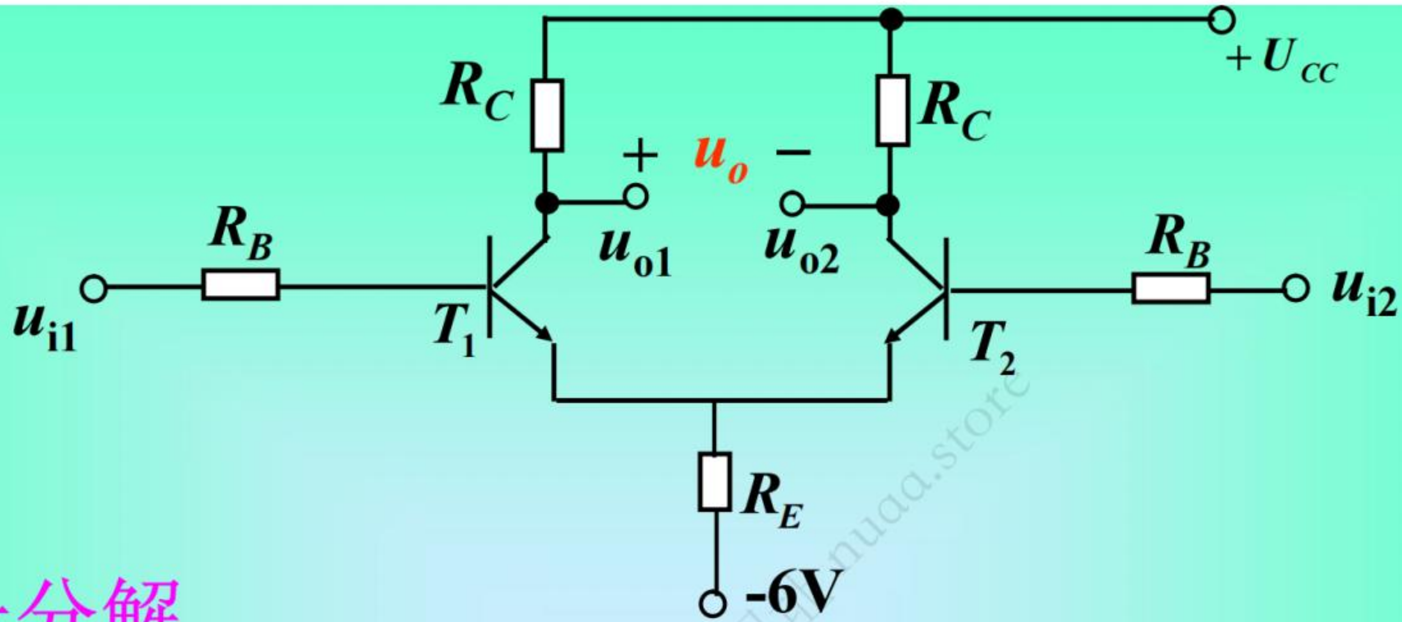
$$I_B = \frac{E_E - U_{BE}}{R_B + 2(1+\beta)R_E} = 0.01mA$$

$$I_C = \beta I_B = 0.5mA \approx I_E$$

$$V_B = -I_B R_B = -0.1V$$

$$V_C = 6 - I_C R_C = 3.45V$$

$$V_E = V_B - U_{BE} = -0.7V$$



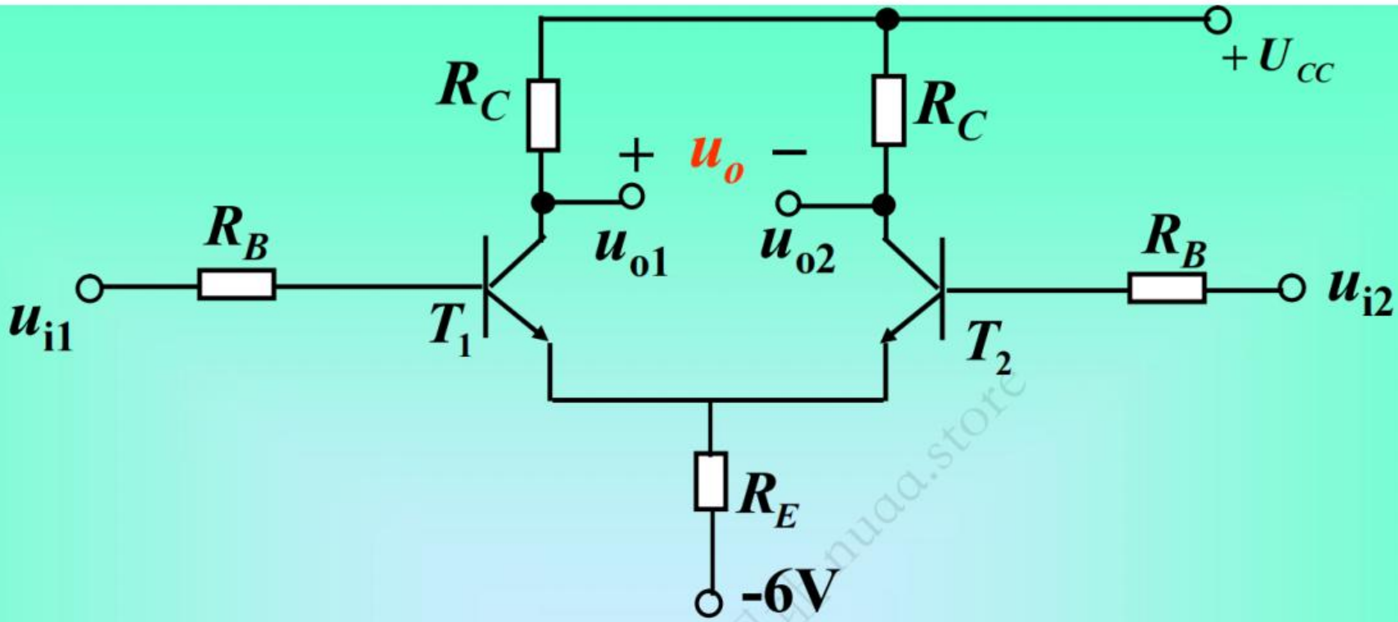
(2) 信号分解

$$u_{ic1} = u_{ic2} = \frac{u_{i1} + u_{i2}}{2} = 5\text{mV}$$

$$u_{id1} = -u_{id2} = \frac{u_{i1} - u_{i2}}{2} = 2\text{mV}$$

u_{i1}=5+2 mV

u_{i2}=5-2 mV

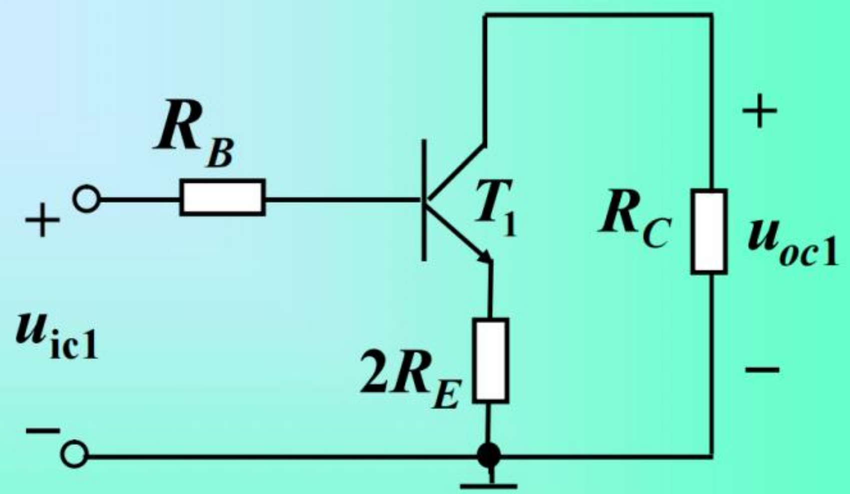


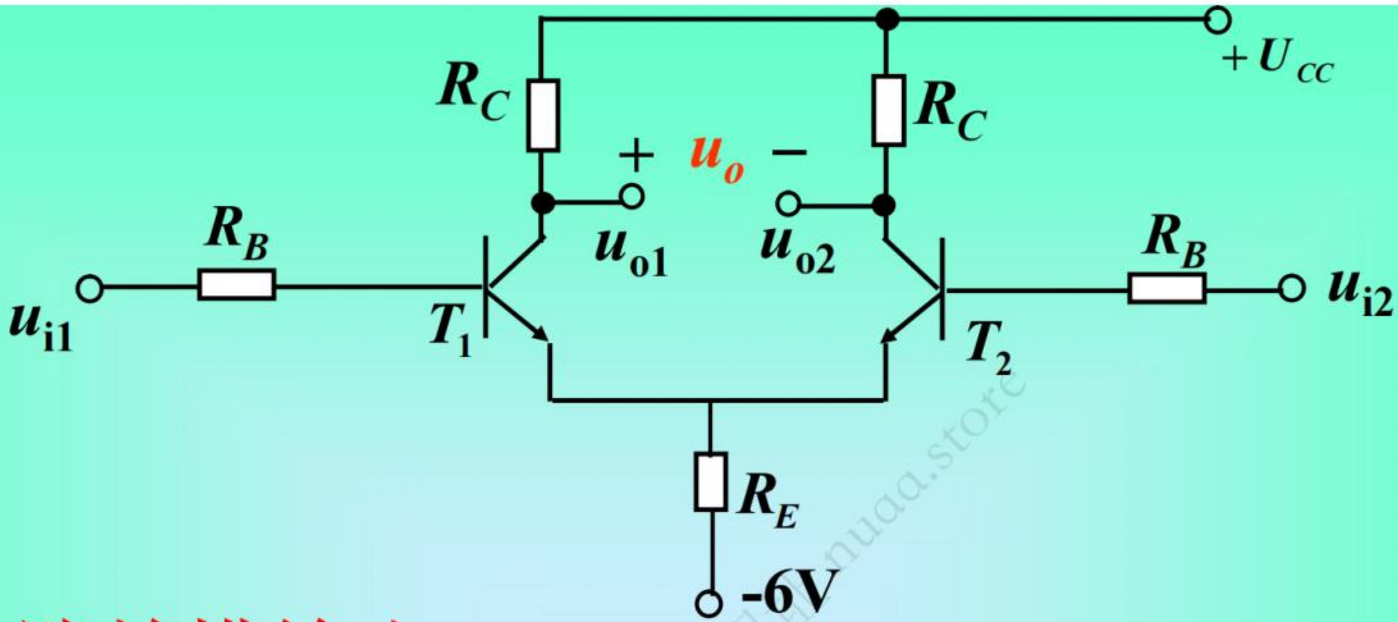
(3) 求单端共模输出

$$A_c = -\beta \frac{R_C}{R_B + r_{be} + 2(1+\beta)R_E}$$

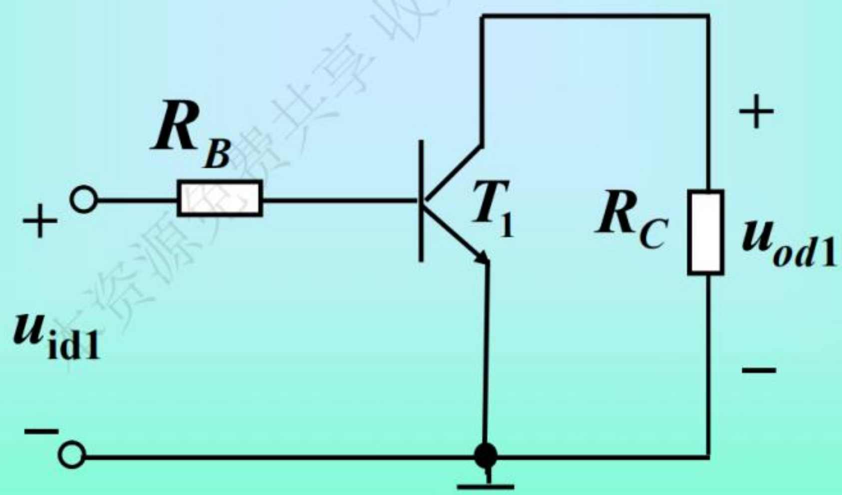
$$u_{oc1} = A_c u_{ic1} \approx -2.5mV$$

$$u_{oc2} = u_{oc1} = -2.5mV$$

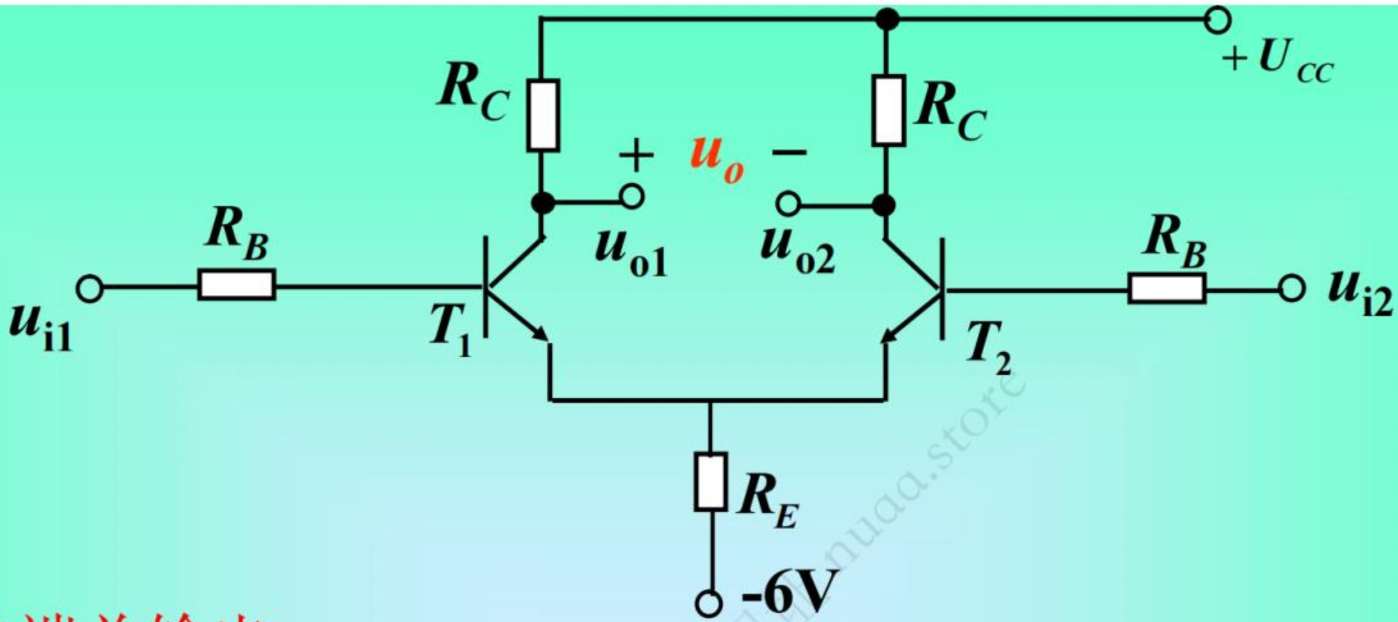




(4) 求单端差模输出



$$u_{od1} = A_{d1} u_{id1} = -\beta \frac{R_C}{R_B + r_{be}} u_{id1} = -40mV \qquad u_{od2} = -u_{od1} = 40mV$$



(5) 求单端总输出

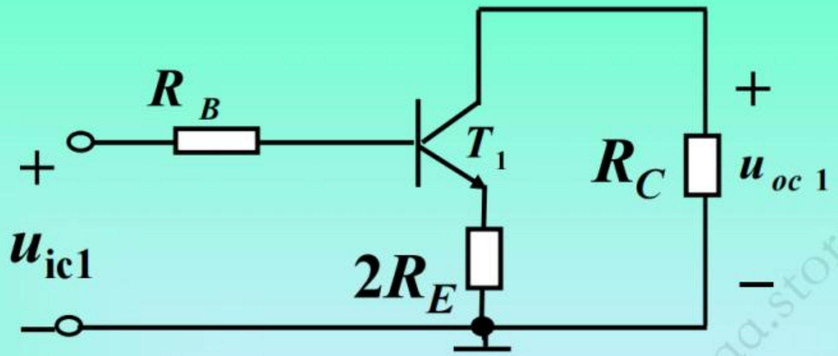
$$u_{o1} = u_{oc1} + u_{od1} = -2.5 - 40 = -42.5mV$$

$$u_{o2} = u_{oc2} + u_{od2} = -2.5 + 40 = -37.5mV$$

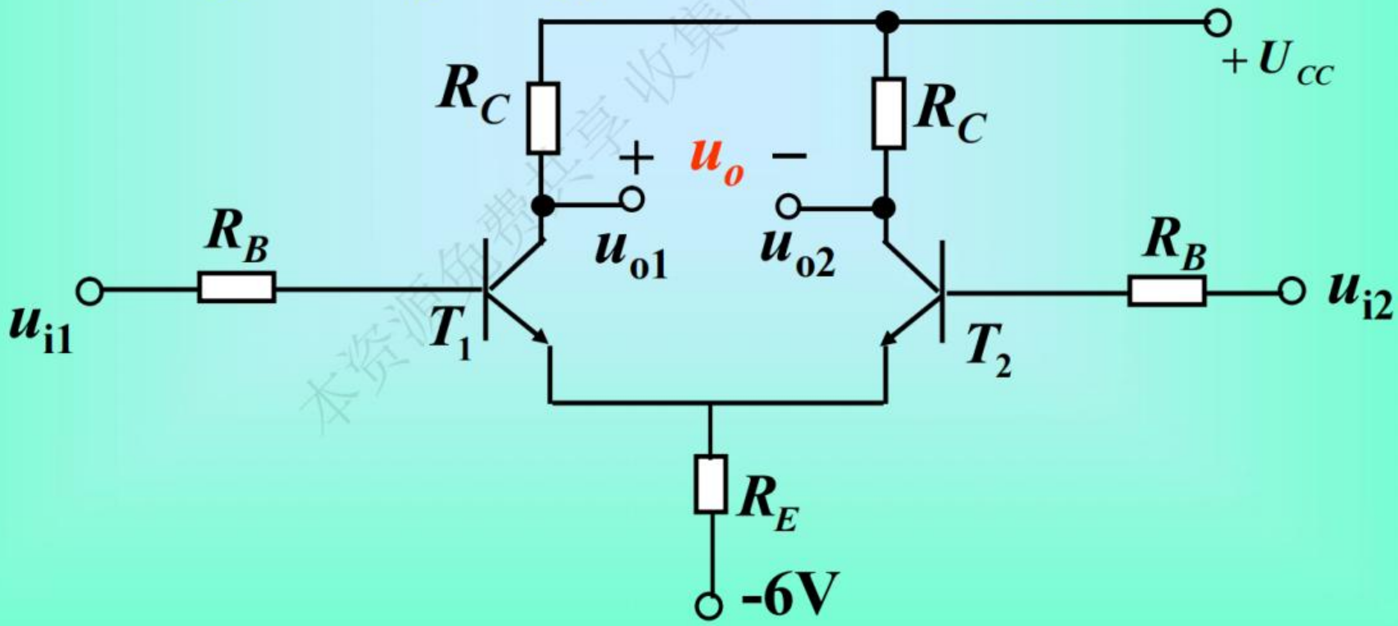
(6) 求双端总输出

$$u_o = u_{o1} - u_{o2} = -80mV$$

(7) 求共模输入电阻及差模输入电阻



$$r_{ic} = R_B + r_{be} + 2(1+\beta)R_E$$



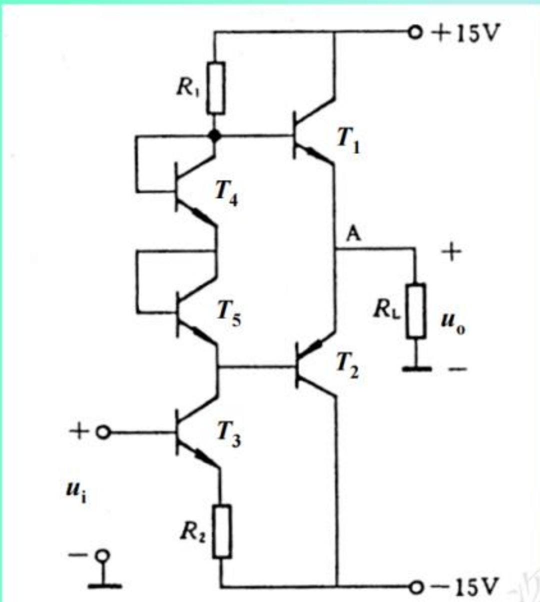
$$r_{id} = 2(R_B + r_{be})$$

2.9

（1）图示是什么电路？ T_4和T_5是如何联接的，起什么作用？

（2）在静态时，V_A=0，这时T_3的集电极电位V_{C3}应调到多少？设各管的发射结电压为0.6V。

（3）忽略U_{CES}，求最大输出功率P_o



1、T_4和T_5接成二极管，消除交越失真

2、$V_{C3} = -0.6\text{V}$

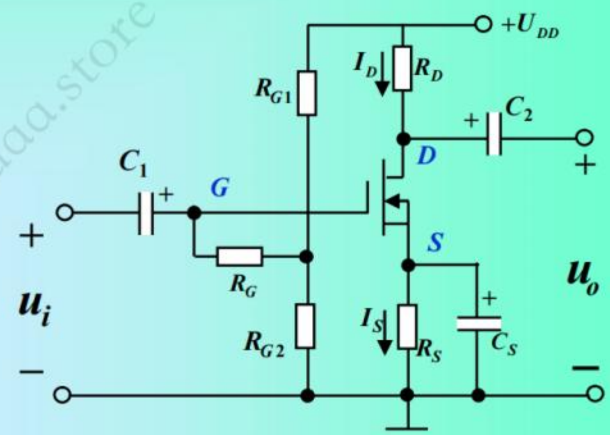
$$P_{o\max} = \frac{U_{o\max}^2}{R_L} = \frac{\left(\frac{15 - U_{CES}}{\sqrt{2}}\right)^2}{R_L} \approx \frac{225/2}{9} = 12.5$$

2.10 在图示的场效应管放大电路中，已知R_{G1}=2MΩ，R_{G2}=47kΩ，R_G=10 MΩ，R_D=30kΩ, R_S=2kΩ，U_{DD}=18V，C_1=C_2=0.01μF，C_S=10μF，管子为3DO1。

试计算：（1）静态值I_D和U_{DS}；（2）r_i，r_o和A_u；

（3）如将旁路电容C_S除去，计算A_{uf}。

设静态值U_{GS}=-0.2V，gm=1.2mA/V，rds>>RD。



$$V_G = \frac{R_{G2}}{R_{G1} + R_{G2}} U_{DD} = 0.4\text{V}$$

$$U_{GS} = V_G - V_S = 0.4 - R_S I_D$$

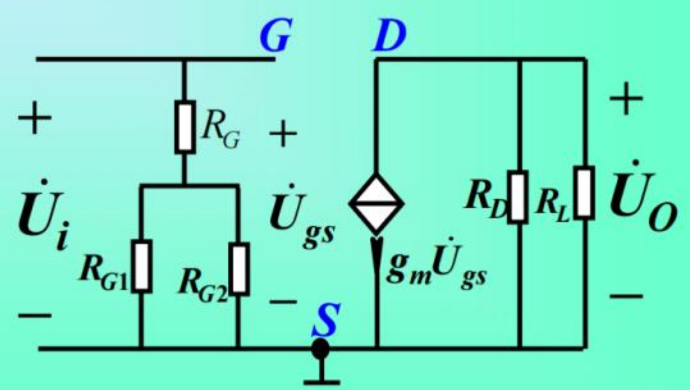
$$\Rightarrow I_D = 0.3\text{mA}$$

$$U_{DS} = U_{DD} - (R_D + R_S) I_D = 8.2V$$

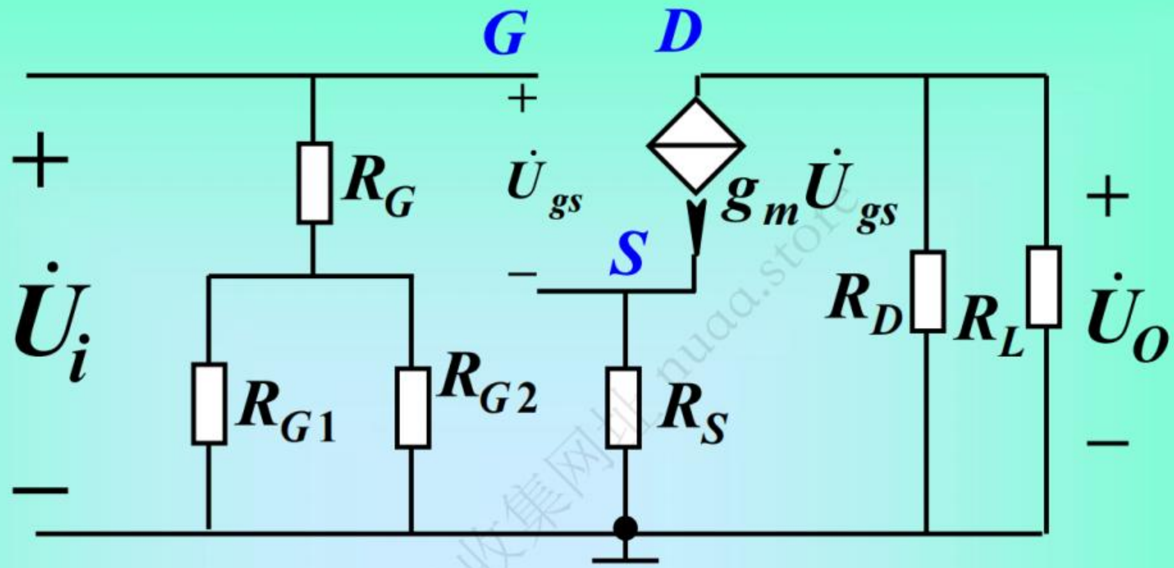
$$A_u = \frac{\dot{U}_o}{\dot{U}_i} = -\frac{g_m \dot{U}_{gs}(R_D // R_L)}{\dot{U}_{gs}} = -g_m R'_L = -36$$

$$r_i = \frac{\dot{U}_i}{\dot{I}_i} = R_G + R_{G1} // R_{G2}$$

$$r_o = R_D$$



（3）如将旁路电容C_S除去，计算A_u。

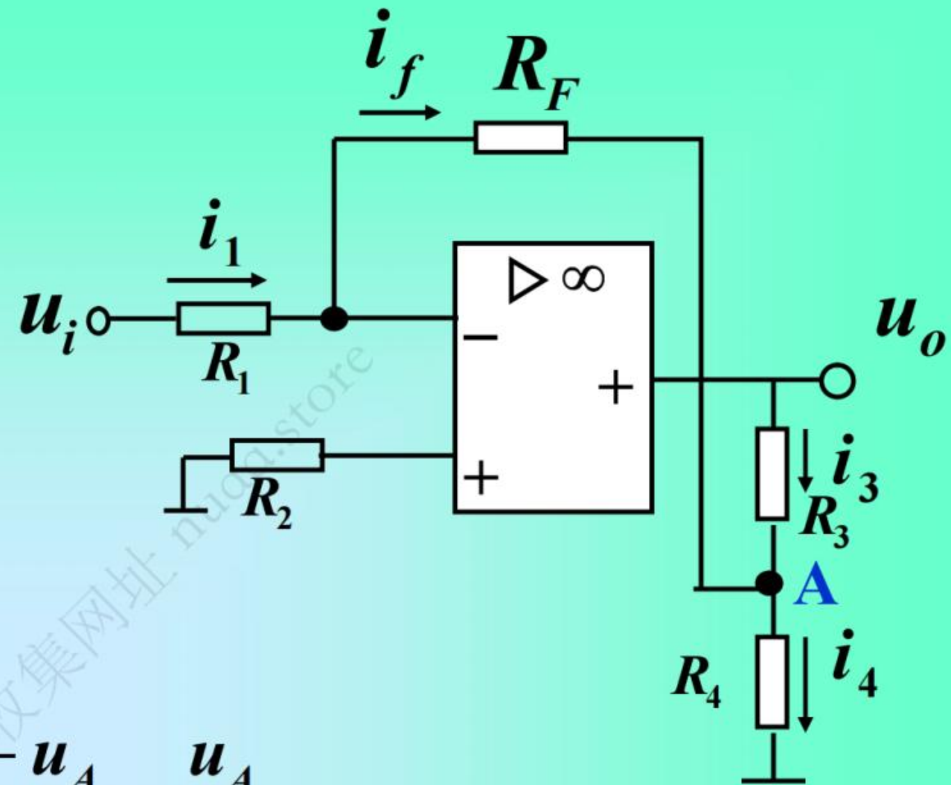


$$\dot{U}_i = \dot{U}_{gs} + g_m \dot{U}_{gs} R_S$$

$$\dot{U}_o = -g_m \dot{U}_{gs} (R_D // R_L)$$

$$A_u = \frac{\dot{U}_o}{\dot{U}_i} = -\frac{g_m R'_L}{1 + g_m R_S} = -10.6$$

3.1

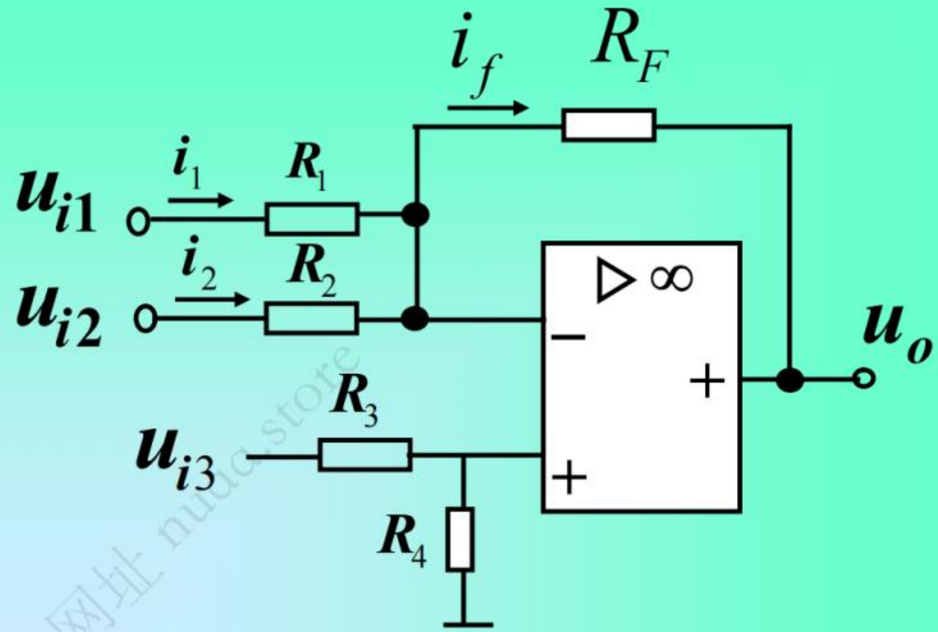


$$i_1 = i_f \Rightarrow u_A = -\frac{R_F}{R_1} u_i$$

$$i_f + i_3 = i_4 \Rightarrow \frac{u_i}{R_1} + \frac{u_o - u_A}{R_3} = \frac{u_A}{R_4}$$

$$u_o = -5.06 u_i$$

3.2



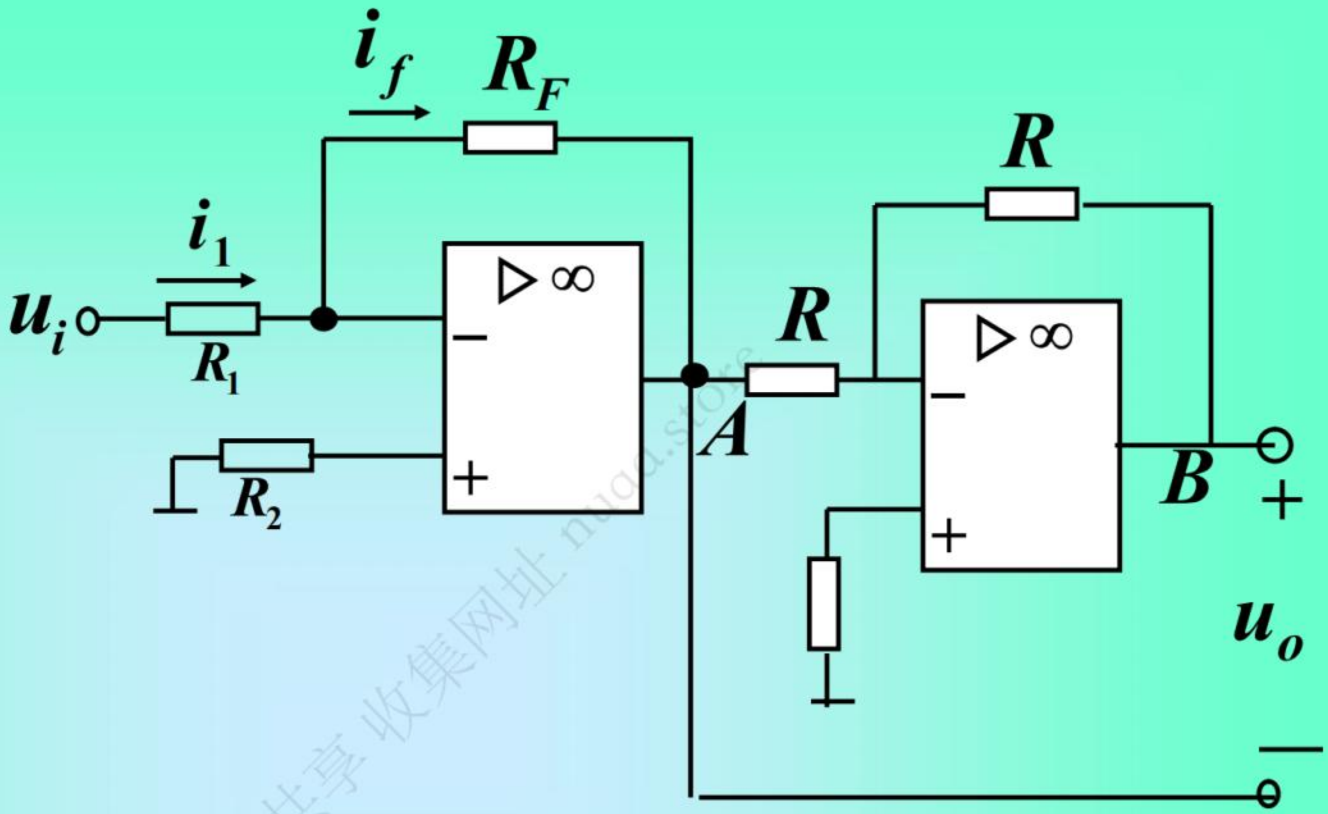
$$u_- = u_+ = \frac{R_4}{R_4 + R_3} u_{i3}$$

$$i_1 + i_2 = i_f$$

$$\frac{u_{i1} - u_-}{R_1} + \frac{u_{i2} - u_-}{R_2} = \frac{u_- - u_o}{R_f}$$

$$u_o = 0$$

3.3

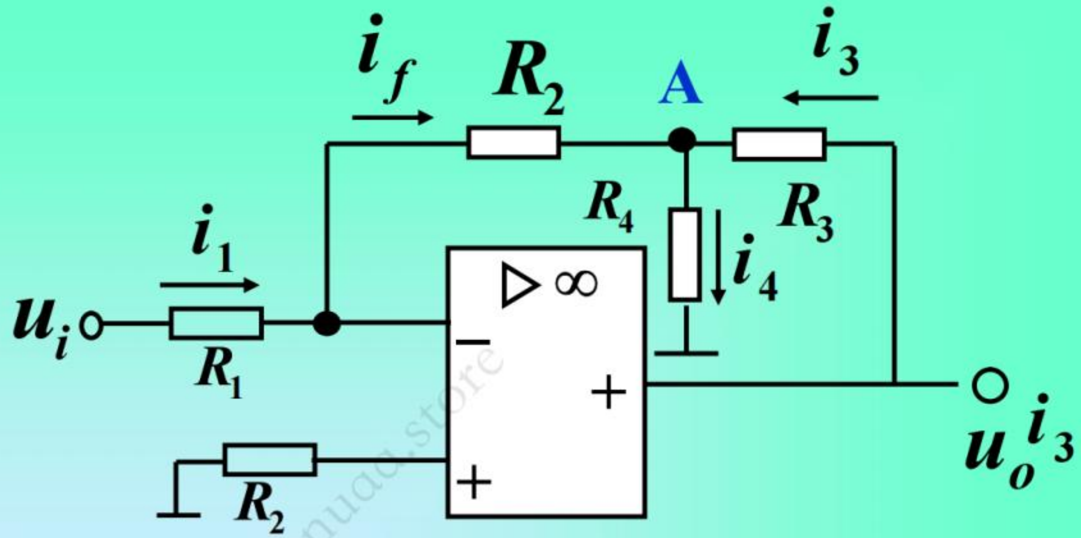


$$u_A = -\frac{R_F}{R_1} u_i$$

$$u_B = -u_A$$

$$\Rightarrow u_o = u_B - u_A = 2\frac{R_F}{R_1} u_i$$

3.4



$$i_1 = \frac{u_i}{R_1} = i_f$$

$$u_A = -\frac{R_2}{R_1} u_i$$

$$i_f + i_3 = i_4 \quad \Rightarrow \quad \frac{u_i}{R_1} + \frac{u_o - u_A}{R_3} = \frac{u_A}{R_4}$$

3.5

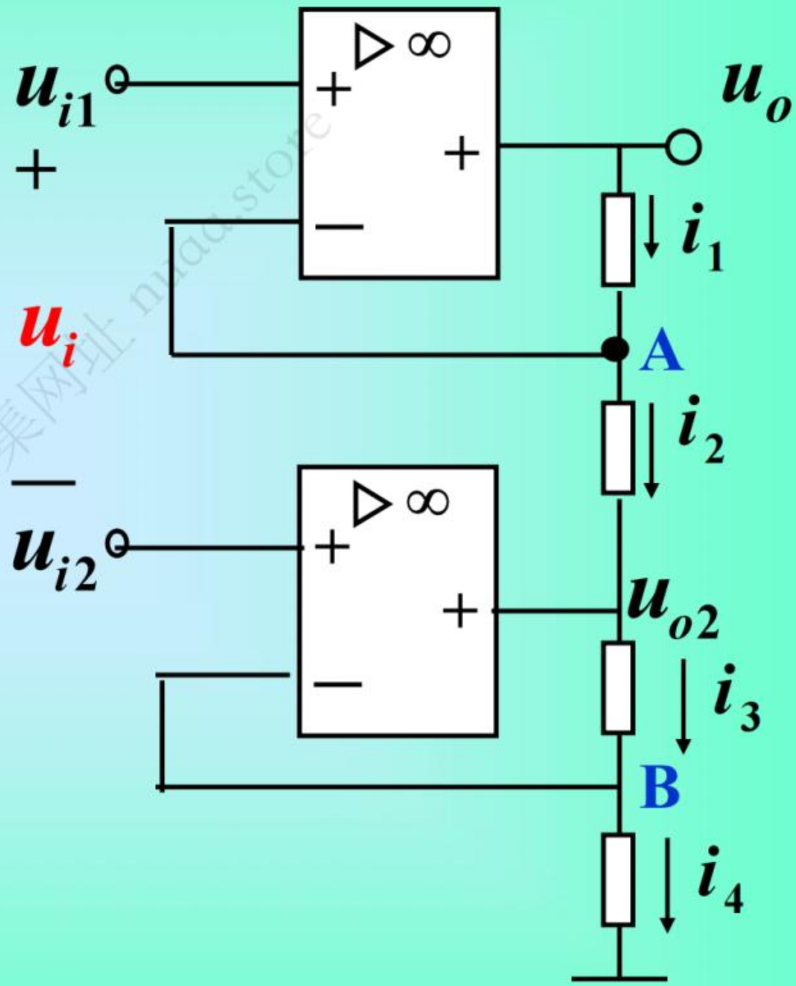
$$u_A = u_{i1}$$

$$u_B = u_{i2}$$

$$u_{o2} = (1 + \frac{R}{R})u_{i2} = 2u_{i2}$$

$$i_1 = i_2$$

$$\frac{u_o - u_A}{R} = \frac{u_A - u_{o2}}{R}$$



$$\Rightarrow u_o = 2u_A - u_{O2} = 2(u_{i1} - u_{i2}) = 2u_i$$

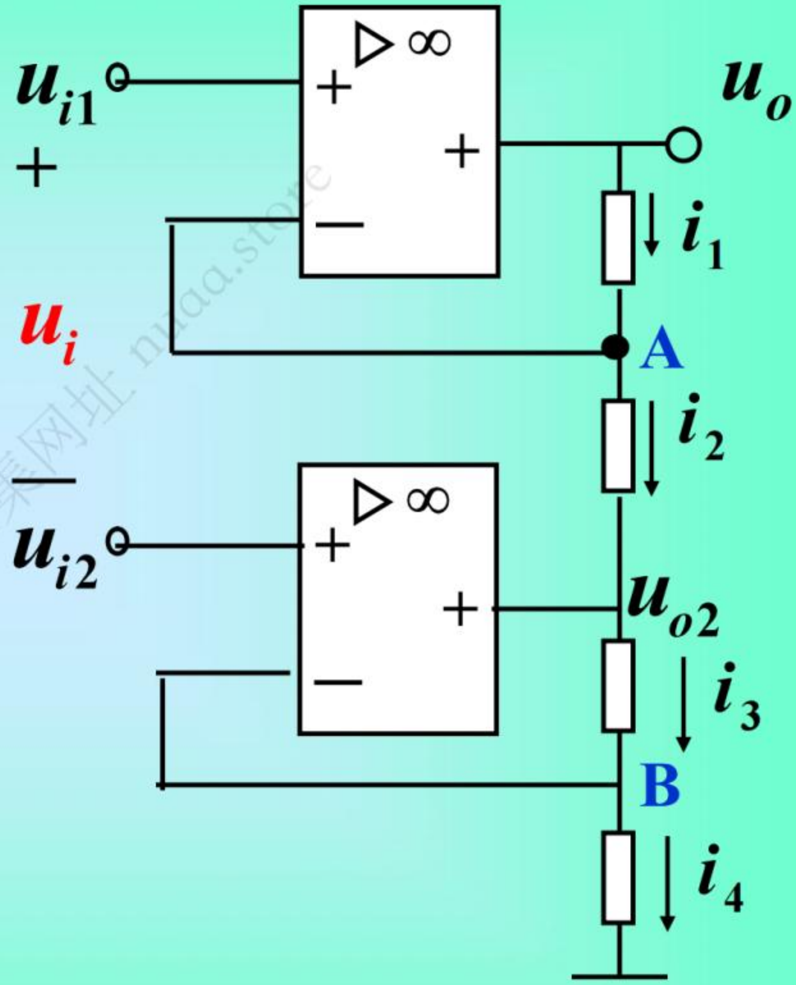
$$i_1 = i_2$$

$$i_3 = i_4$$

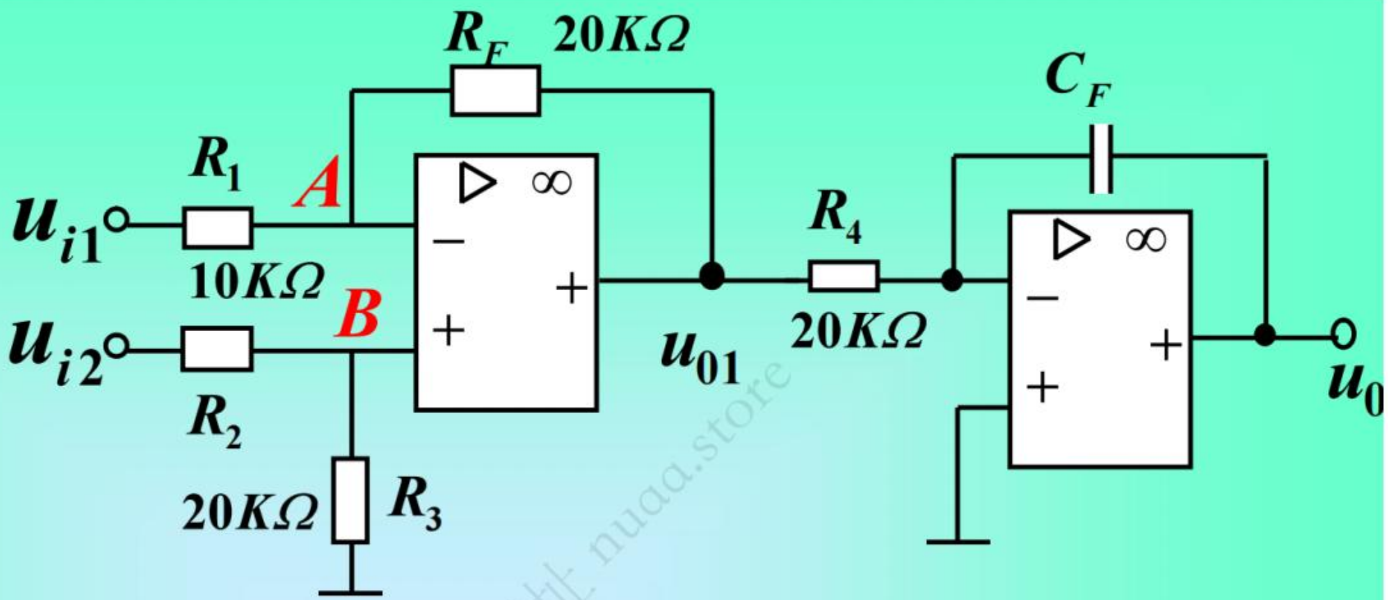
~~$$i_1 = i_2 = i_3 = i_4$$~~

$$\frac{u_o}{4R} = \frac{u_A - u_B}{2R} = \frac{u_{i1} - u_{i2}}{2R}$$

⇨ $u_o = 2u_i$



3.6

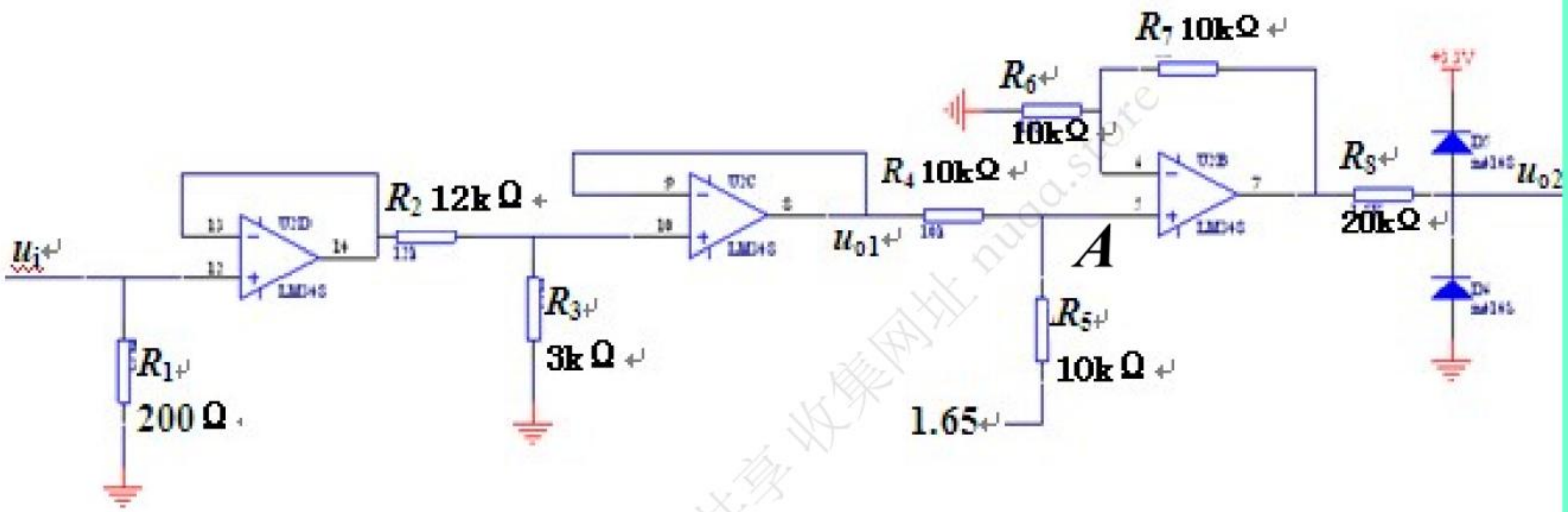


$$u_A = u_B = \frac{R_3}{R_2 + R_3} u_{i2} = \frac{2}{3} V$$

$$\frac{u_{i1} - u_A}{R_1} = \frac{u_A - u_{o1}}{R_F} \Rightarrow u_{o1} = -0.2V$$

$$u_o = -\frac{1}{R_4 C_F} \int_0^t u_{o1} dt = 10t \qquad t = 1s$$

3.7 下图是一个实际应用的信号调理电路，其最终的输出接入到 CPU 芯片的数据端口，该端口对信号幅值的要求是 0~3.3V, u_i是一个正弦交流信号，请写出 u_{o1}、u_{o2} 的表达式，并说明 D1, D2 的作用，以及为何要设计一个 1.65V 的直流输入。



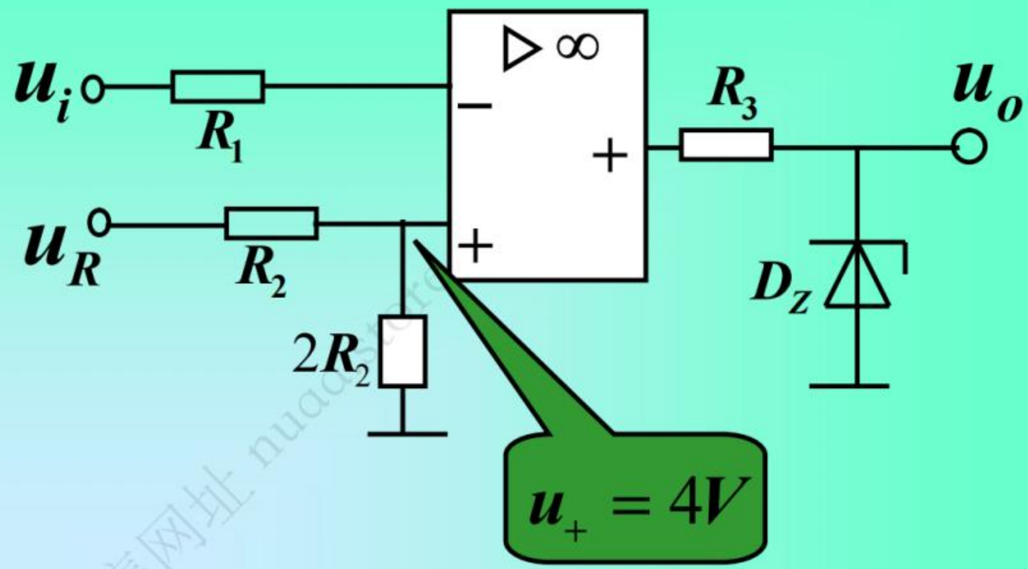
$$u_{o1}=\frac{1}{5}u_i \qquad u_A=\frac{u_{o1}+1.65}{2}$$

$$u_{o2}=(1+\frac{R_7}{R_6})u_A=2u_A=u_{o1}+1.65$$

D1、D2的作用是为了对端口信号的幅值进行限幅

设计一个**1.65**的直流输入是为了提高交流信号的输入范围

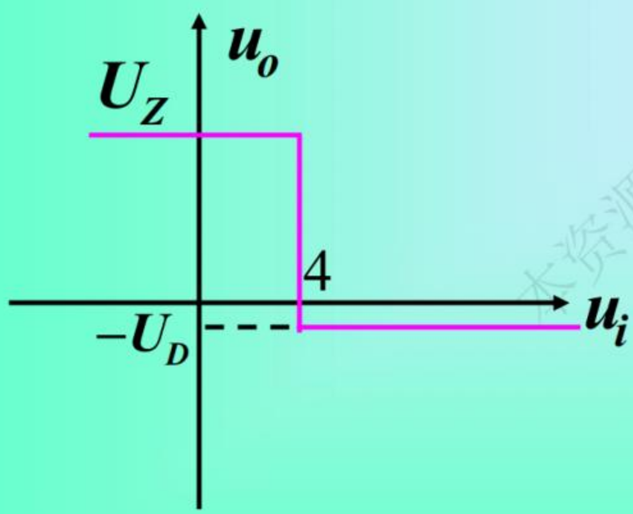
3.8

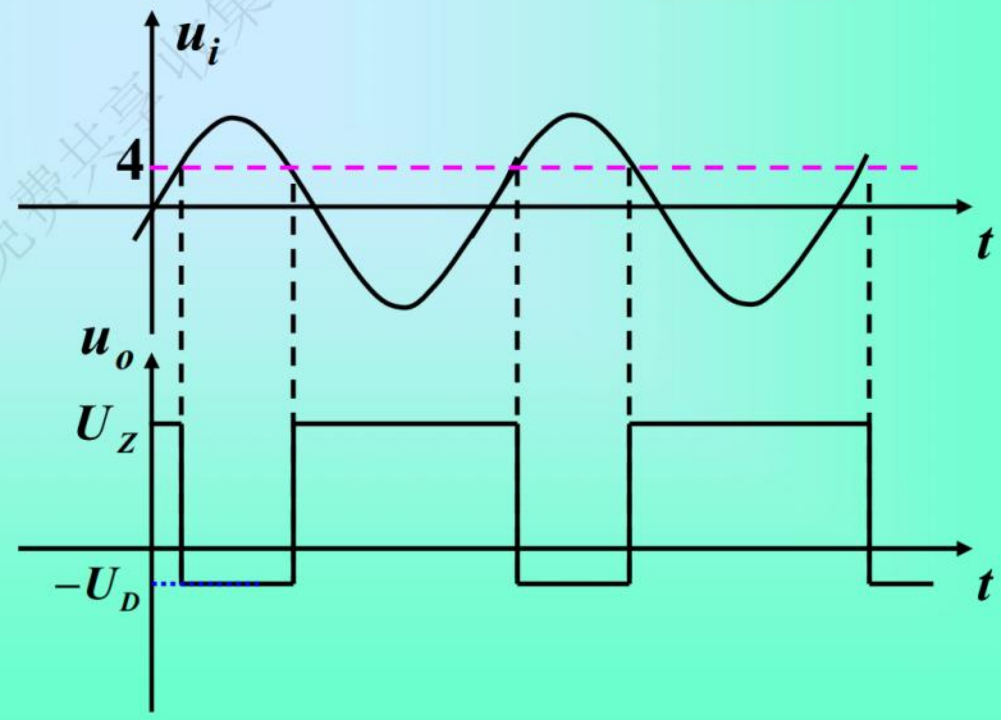


$$u_i > u_+ \Rightarrow u_o = -U_D = -0.7V$$

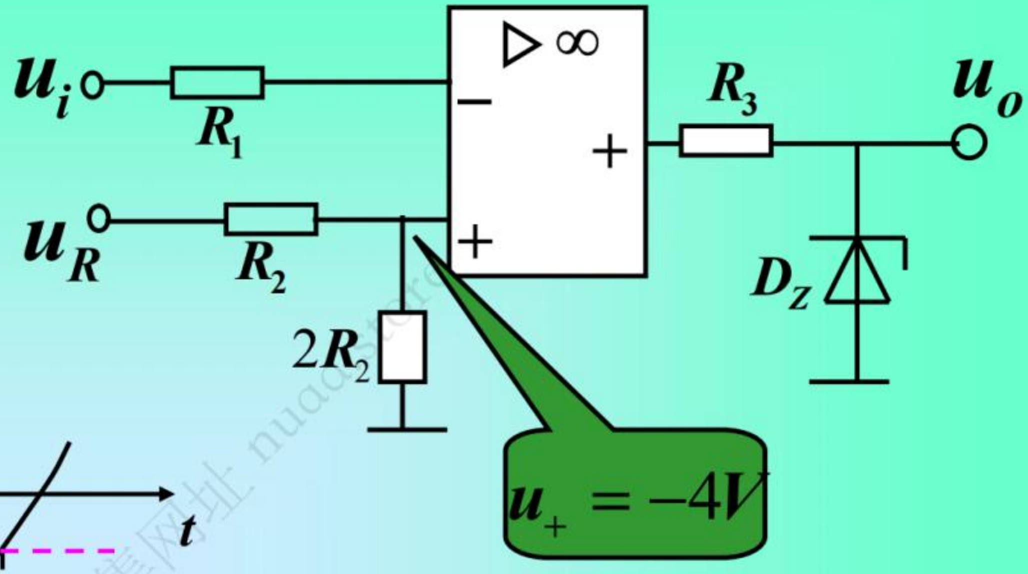
$$u_i < u_+ \Rightarrow u_o = U_Z = 6V$$

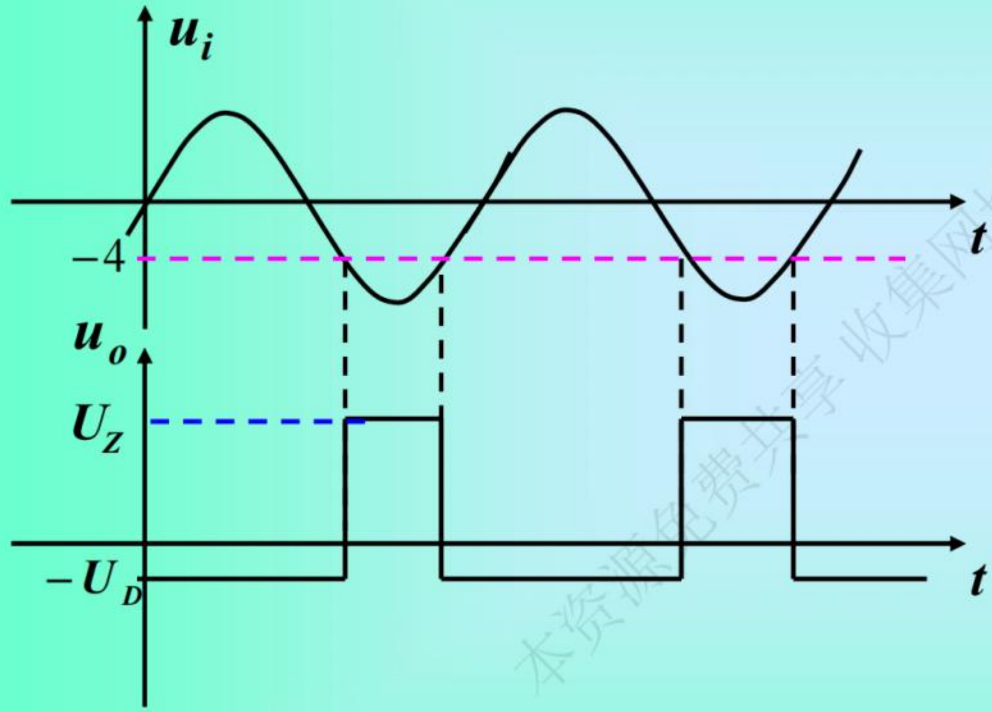
1、$u_R = 6V$

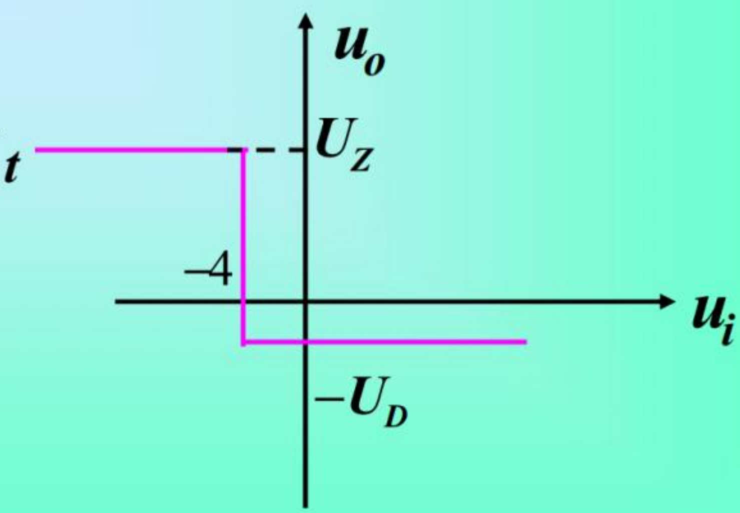




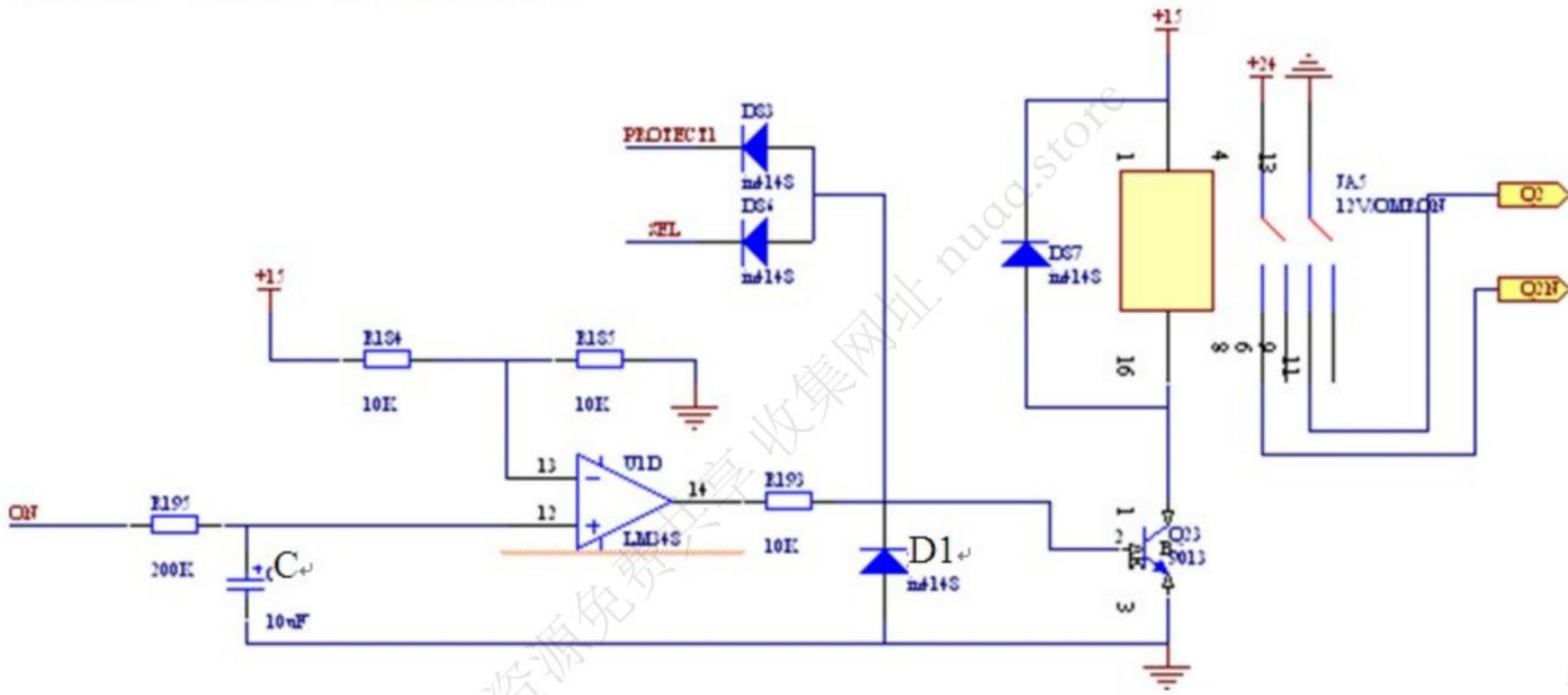
2、$u_R = -6V$







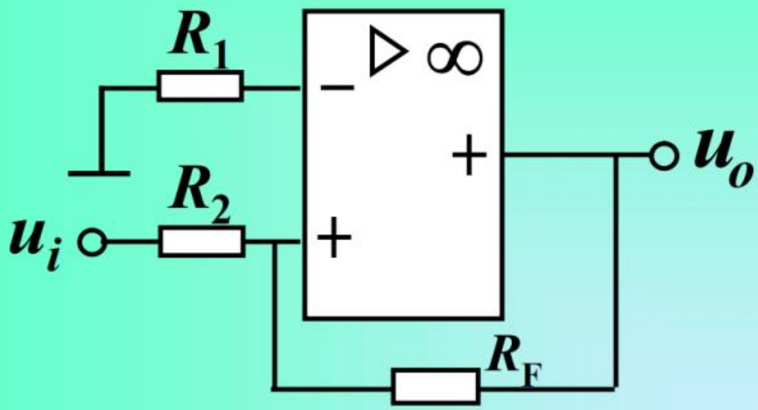
3.10 下图是一个实用的控制电路，ON, PROTECT1,SEL 均为输入信号，其幅值或者是 0V, 或者是 15V, 请分析在什么情况下 Q2, Q2N 这两个端子能获得 24V 的电压(该电压用于控制接触器)，并说明 C 和 D1 的作用。

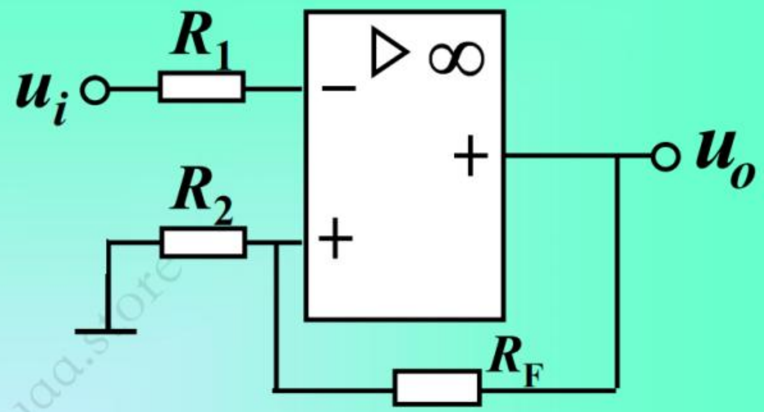


在三个输入信号均为15V的时候Q2、Q2N能获得24V的电压

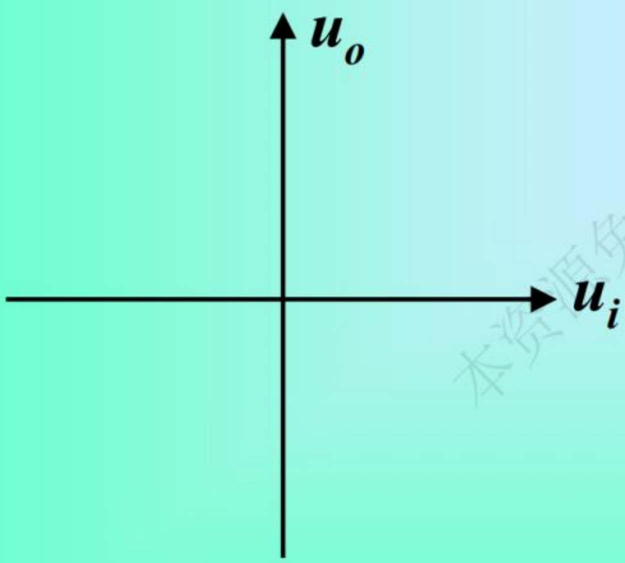
C与200kΩ的电阻组成延时电路。D1防止T发射结被反向击穿。

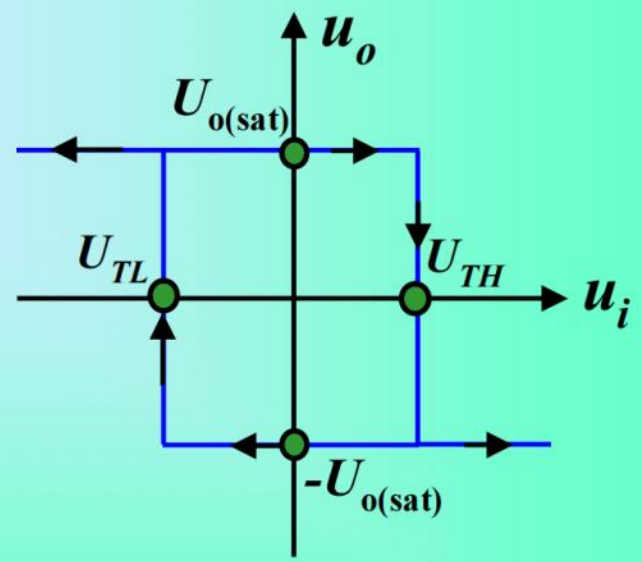
课后作业

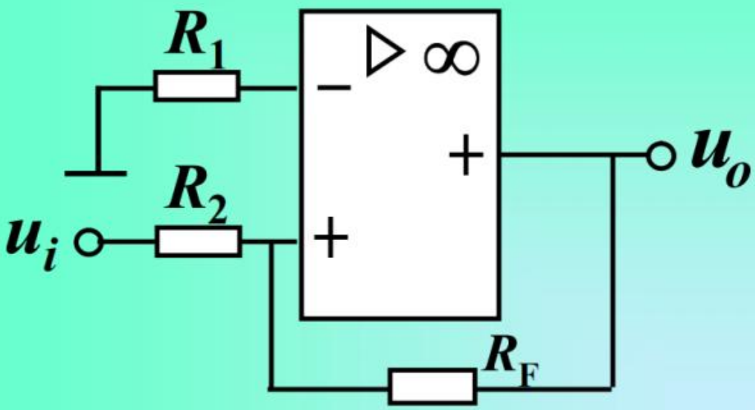




滞回比较器



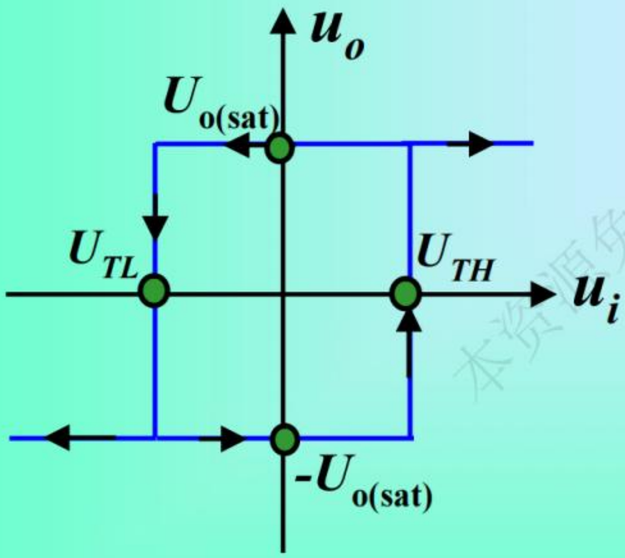




设加电源瞬间，$u_{\mathrm{i}} < 0$

$$u_o = -U_{\mathrm{o(sat)}} \Rightarrow u_+ = -\frac{R_2}{R_2 + R_F} U_{o(sat)} + \frac{R_F}{R_2 + R_F} u_i$$

$$u_i \uparrow \Rightarrow 只有 u_+ > 0，\quad u_o = U_{o(sat)}$$

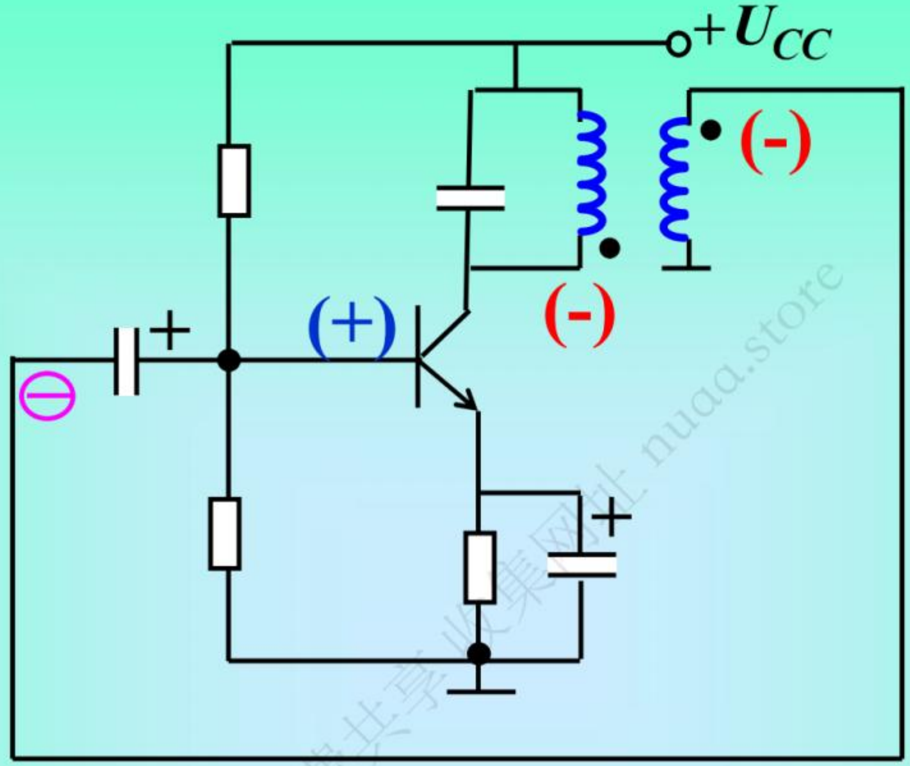


$$u_i 继续\uparrow \ \Rightarrow u_o = U_{o(sat)}$$

$$若 u_i \downarrow$$

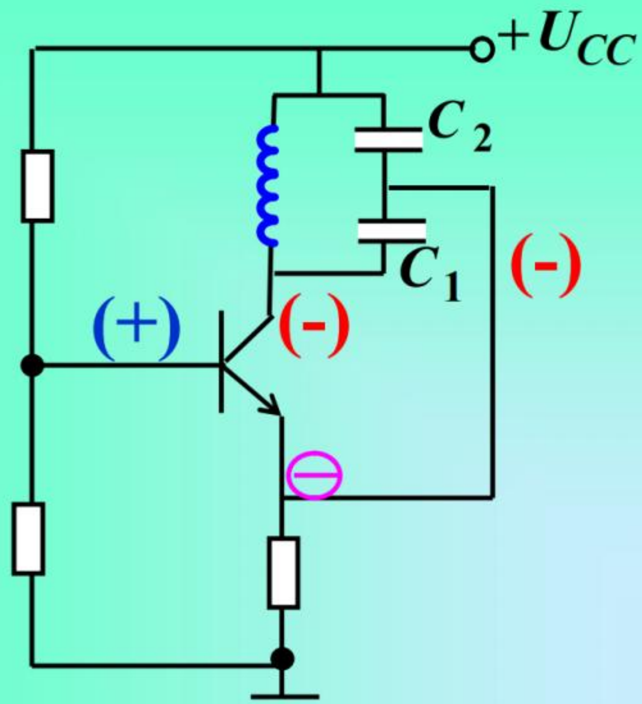
$$\Rightarrow u_i = -\frac{R_2}{R_F} U_{o(sat)} \Rightarrow u_o = -U_{o(sat)}$$

4.1

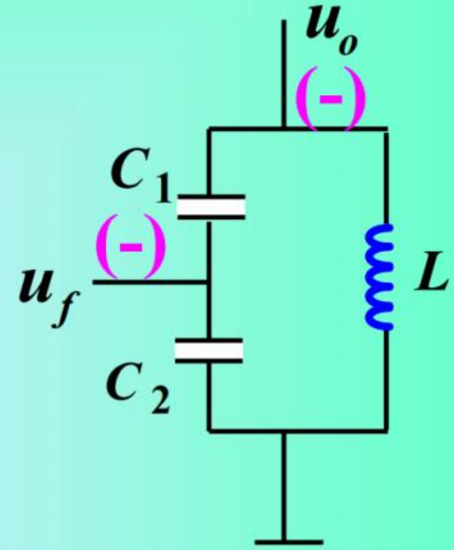


(a)

负反馈，无法振荡



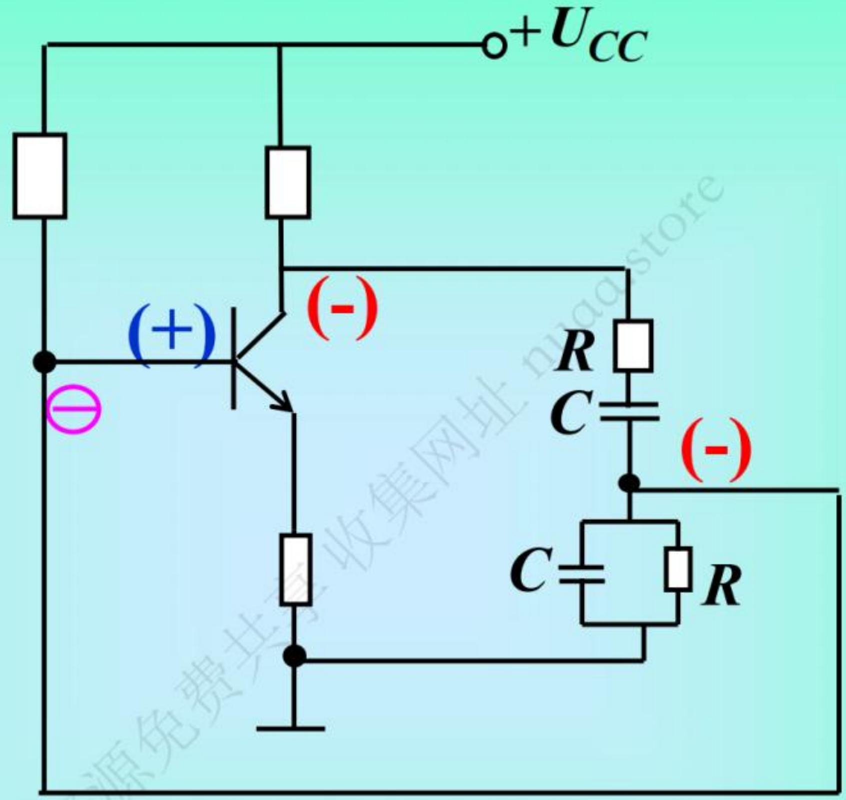
(b)



$$\frac{\dot{U}_f}{\dot{U}_o}=\frac{\frac{1}{j\omega C_2}}{\frac{1}{j\omega C_1}+\frac{1}{j\omega C_2}}=\frac{\frac{1}{C_2}}{\frac{1}{C_1}+\frac{1}{C_2}}>0$$

正反馈，可以振荡

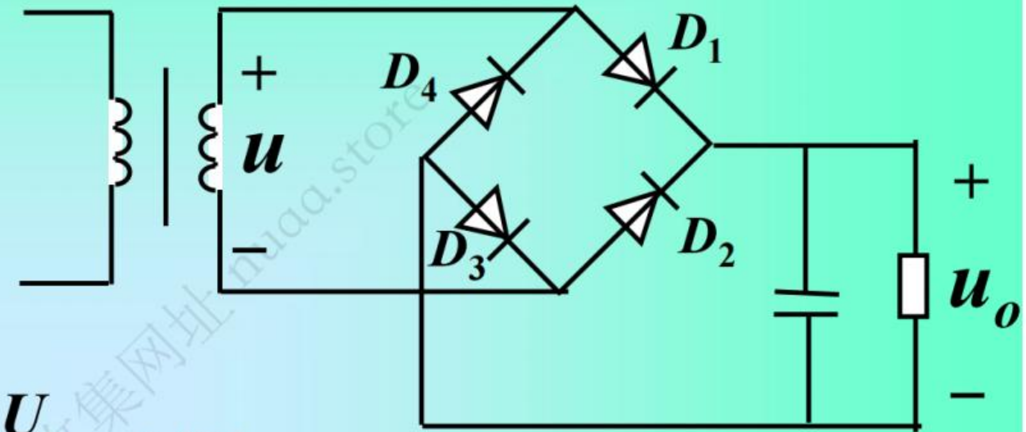
4.2



(a)

负反馈

5.1已知负载电阻R_L=20Ω，采用单相桥式整流滤波电路供电，要求负载电压U_O=12V，请给出二极管及滤波电容器件的选型依据。如果采用二极管半波整流滤波电路呢？



（1）桥式整流滤波

$$I_o=\frac{U_o}{R_L}=0.6\text{A}\qquad I_D=\frac{1}{2}I_o=0.3\text{A}$$

$$U_o=1.2U\qquad U_{DRM}=\sqrt{2}U=\sqrt{2}\frac{U_o}{1.2}=14\text{V}$$

$$U_{CM}=\sqrt{2}U=14\qquad R_LC=5T\Rightarrow C=2500\mu F$$

（2）半波整流滤波

$$U_o=U\qquad I_o=\frac{U_o}{R_L}=0.6$$

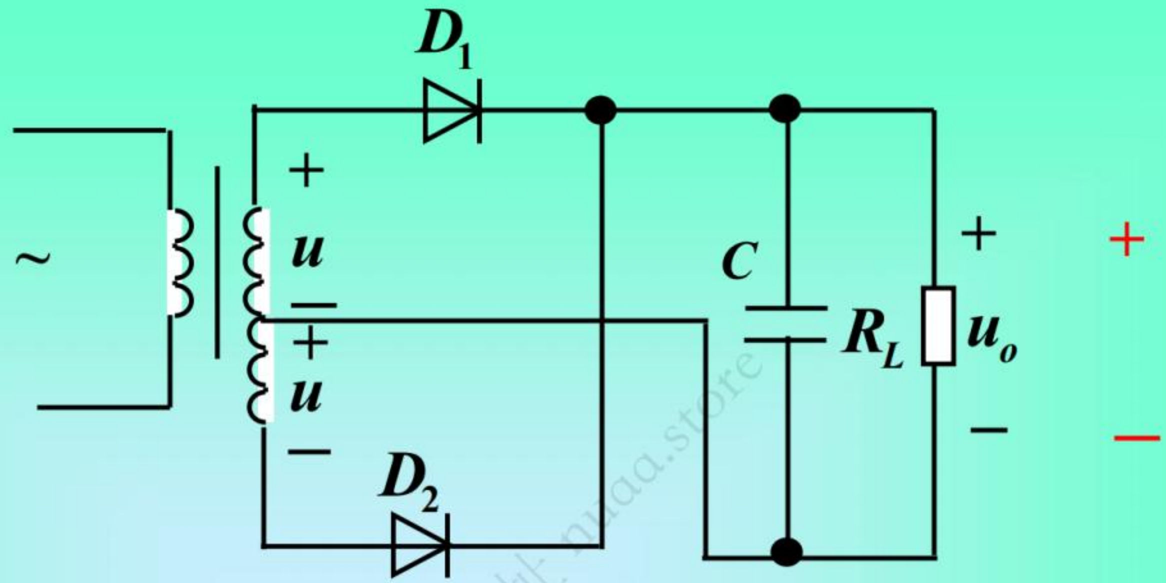
$$I_D=I_o=0.6$$

$$U_{DRM}=2\sqrt{2}U=2\sqrt{2}U_o=34$$

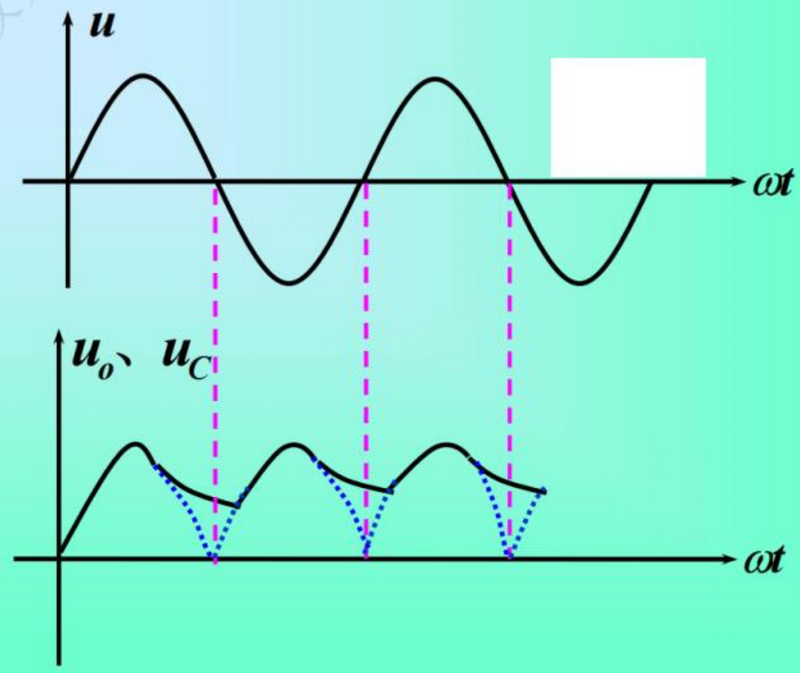
$$U_{CM}=\sqrt{2}U=17$$

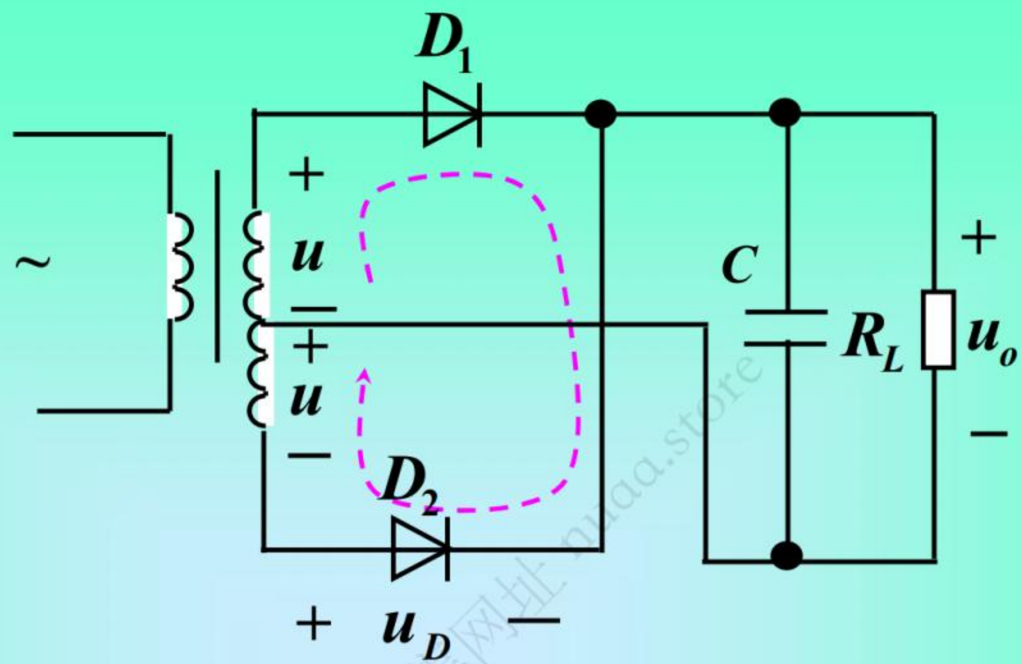
$$R_LC=5T\Rightarrow C=2500\mu F$$

5.2



（2） 全波整流

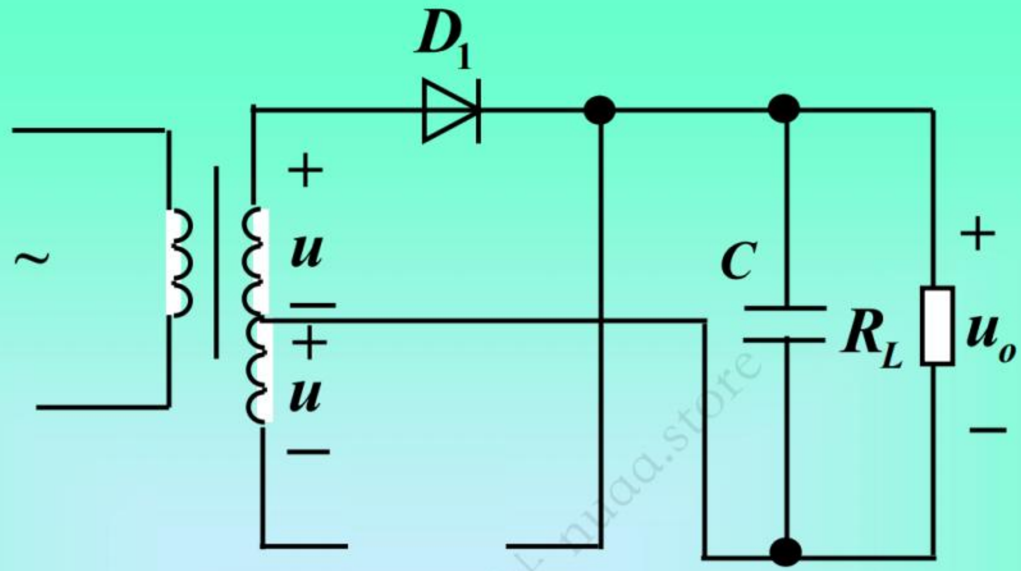




(3)无 C 则 $U_O = 0.9U$，有 C 则 $U_O = 1.2U$

(4)$U_{DRM} = 2\sqrt{2}U$

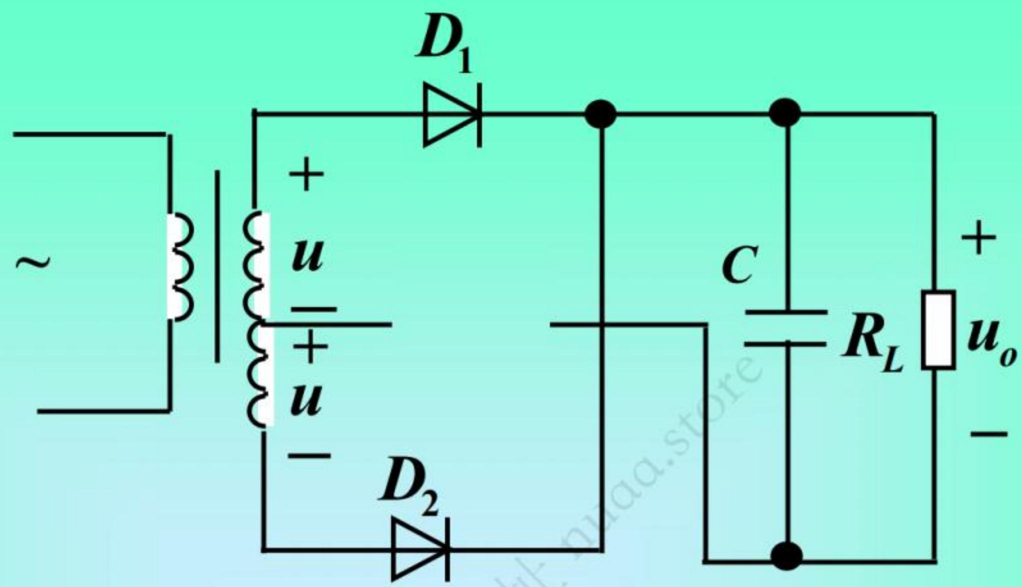
$$u_D = -2u$$



（5）

如果**D2**虚焊，

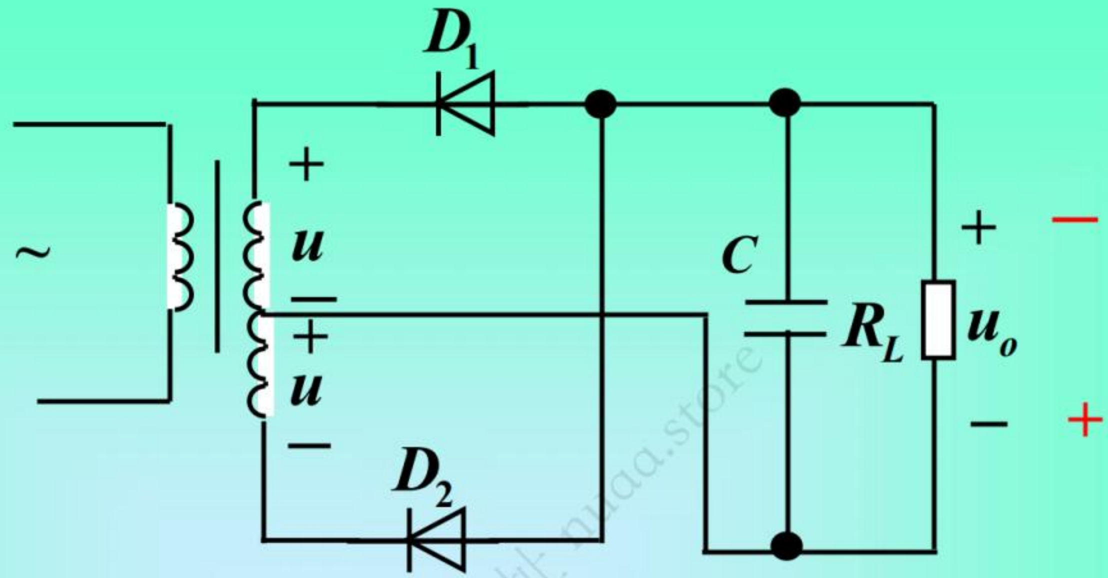
$$U_O = U \neq \frac{1}{2} \cdot 1.2U$$



（5）

如果变压器副边中心抽头虚焊，

输出电压= 0



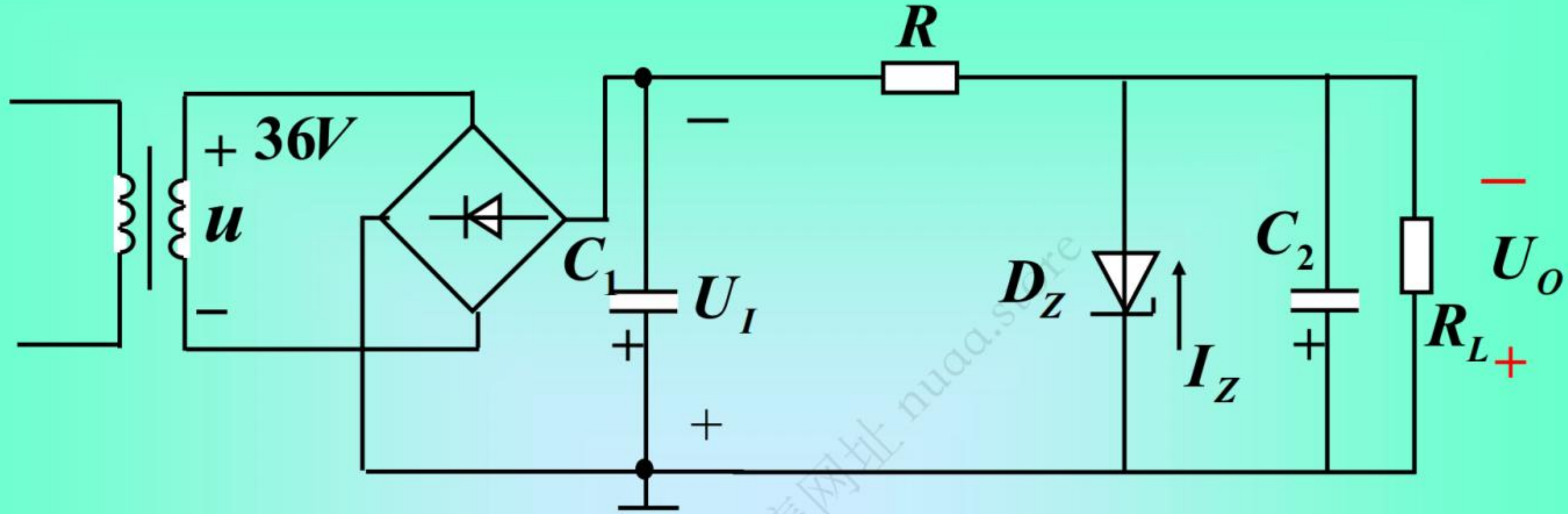
（6）如果把**D2**的极性接反

变压器副边短路

（7）如果把图中的**D1**和**D2**都反接

仍有整流滤波作用，输出电压极性相反，滤波电容极性也相反

5.3



(1) $U_O = U_Z = 15V$

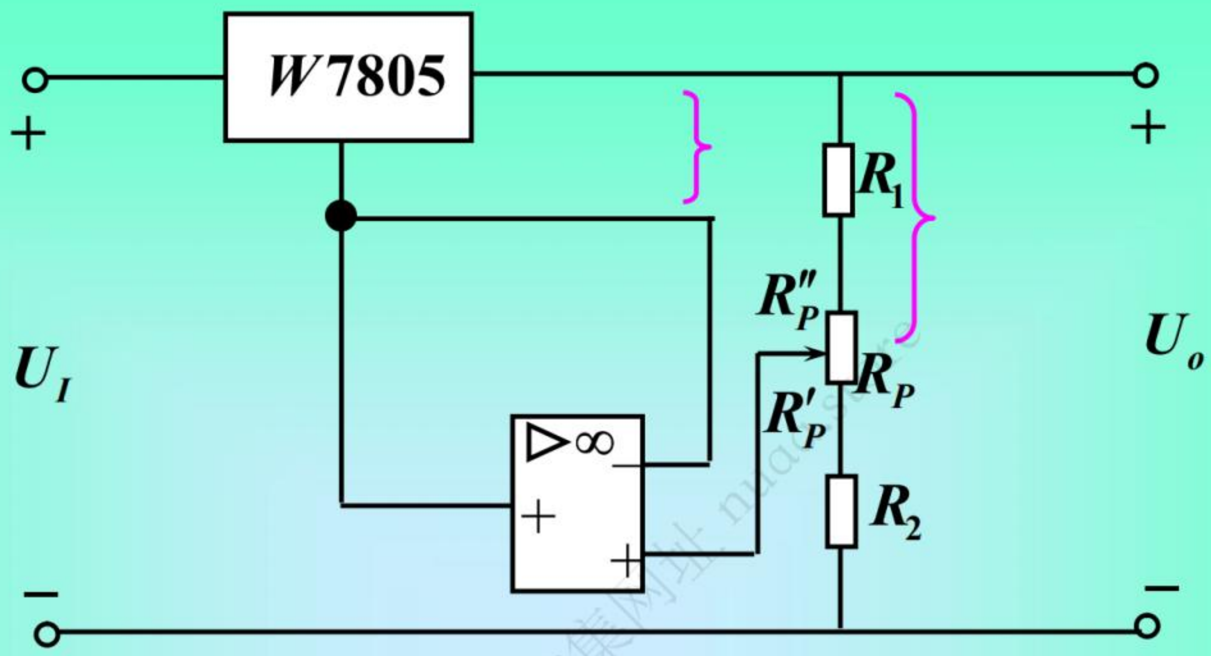
(2) $U_{C1(\max)} = \sqrt{2}U = 50.9V, U_{C2} = U_Z = 15V$

(3) $I_{Z\min} \le \frac{U_I - U_Z}{R} - \frac{U_Z}{R_L} \le I_{Z\max} \Rightarrow 5 \le \frac{43.2-15}{2.4} - \frac{15}{R_L} \le I_{Z\max} \quad \Rightarrow 2.22k\Omega < R_L$

（4）D_Z接反　则D_Z正向导通，　U_O =0.7V

（5）R=0　稳压效果差，D_Z可能被烧毁

5.4

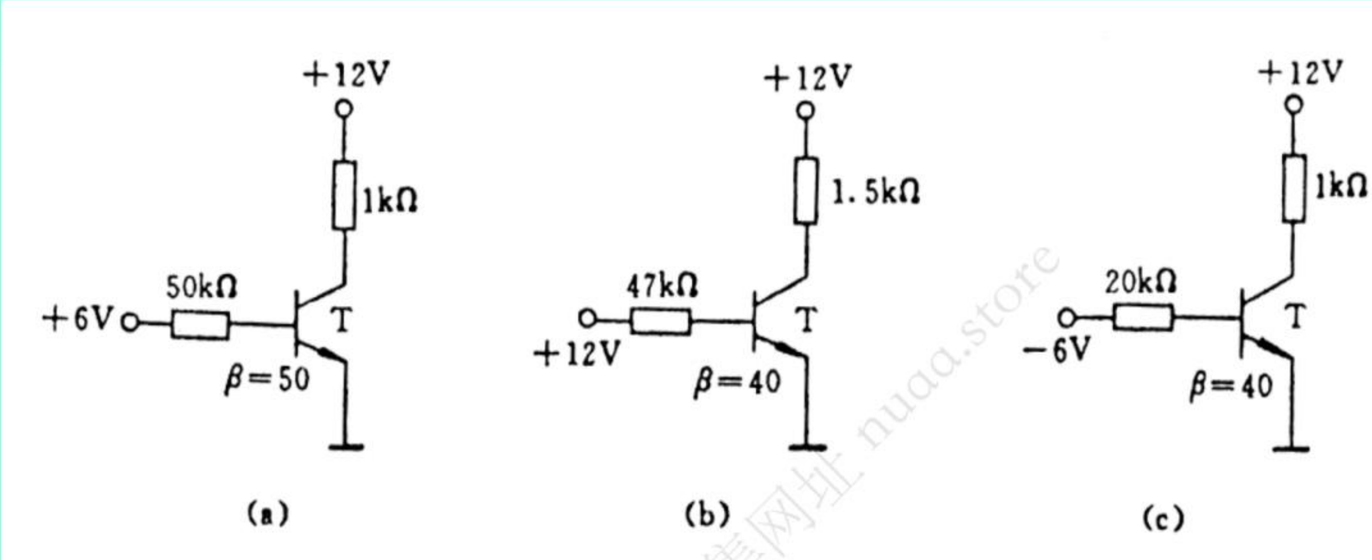


$$\frac{R_1 + R_P''}{R_1 + R_2 + R_P} U_o = 5$$

$$\therefore U_o = \frac{R_1 + R_2 + R_P}{R_1 + R_P''} U_{\times\times} \qquad R_P'' \in [0, R_P]$$

$$\Rightarrow U_o \in [7, 17.3]\text{V}$$

6.1在图示的各个电路中，试问晶体管工作于何种状态？



$$I_B=\frac{6\text{-}0.7}{50}=0.1\text{mA}$$

$$I_{BS}=\frac{12}{1\cdot 50}=0.24\text{mA}$$

$$I_B<I_{BS}$$

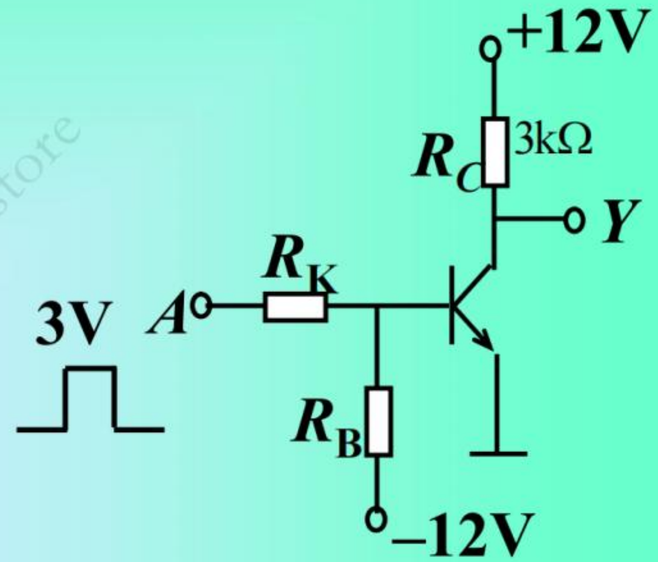
放大

$$I_B \geq I_{BS}$$

饱和

截止

6.2 在图示的晶体管"非"门电路中，（1）设R_K=3 kΩ，R_B=30 kΩ，试问晶体管的 β 值最小应该是多少才能满足饱和的条件？
（2）设 β=30，R_B=30 kΩ，试问R_K的阻值最大应该是多少才能满足饱和的条件？



$$I_B \geq I_{BS}$$

$$I_{BS} = \frac{I_{CS}}{\beta} \approx \frac{4}{\beta} mA$$

$$I_B = \frac{V_A - V_B}{R_K} - \frac{V_B - (-12)}{R_B} = \frac{3-0.7}{3} - \frac{12.7}{30} = 0.34 mA$$

$$\Rightarrow \beta \geq 12$$

$$I_B = \frac{V_A - V_B}{R_K} - \frac{V_B - (-12)}{R_B} = \frac{3-0.7}{R_K} - \frac{12.7}{30} = \frac{4}{30} mA$$

$$\Rightarrow R_K \leq 4.14\text{k}\Omega$$

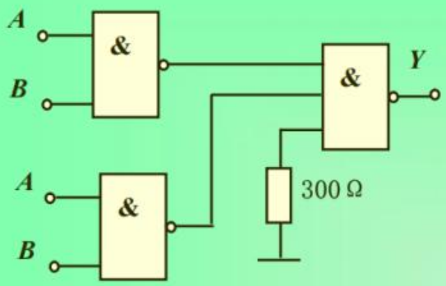
6.4 应用逻辑代数运算法则化简下列各式：

$$Y = \overline{\overline{A}B + A\overline{B}} = AB + \overline{A}\,\overline{B}$$

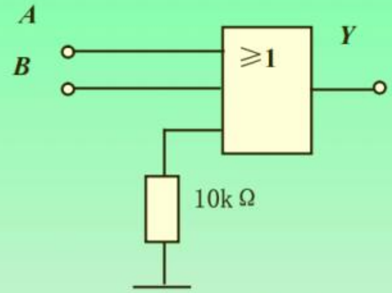
$$Y = AB + BCD + \overline{A}C + \overline{B}C = AB + BCD + \overline{AB}C = AB + C$$

$$Y = (AB + \overline{A}B + A\overline{B})(A + B + C + AB\overline{C}) = (A+B)(A+B+C+AB\overline{C}) = A + B$$

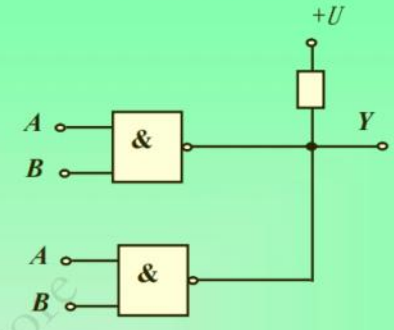
6.5 图示均为TTL门电路，试问各电路能否正常工作？并简述理由。



（a）



（b）



（c）

关门电阻R_{OFF}及开门电阻R_{ON}　$R_{OFF}\approx 0.7k\Omega$　$R_{ON}\approx 2k\Omega$

6.6 应用卡诺图化简下列各式。

$$Y = AB + \overline{C}\,\overline{D} + CD + ABD$$

$$= AB + \overline{C}\,\overline{D} + CD$$

$$Y = AB + \overline{A}BC + \overline{A}B\overline{C} = B$$

A \ BC	00	01	11	10
0	1	1		
1	×	×	1	×

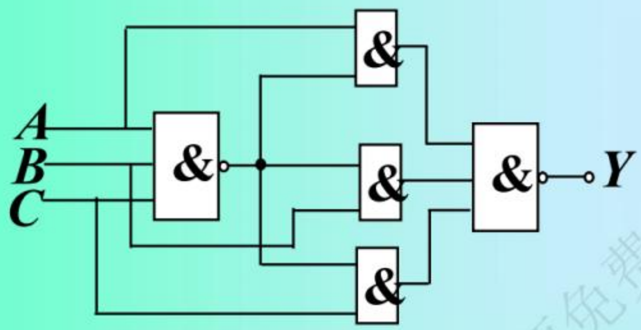
$$Y = ABC + \overline{ABC} + \overline{AB}C \quad \text{约束条件：} A\overline{B} + A\overline{C} = 0$$

$$Y = A + \overline{B}$$

6.7（1）根据逻辑式 $Y=AB+\overline{A}\,\overline{B}$ 列出逻辑状态表，说明其逻辑功能，并画出其用“与非”门组成的逻辑图。

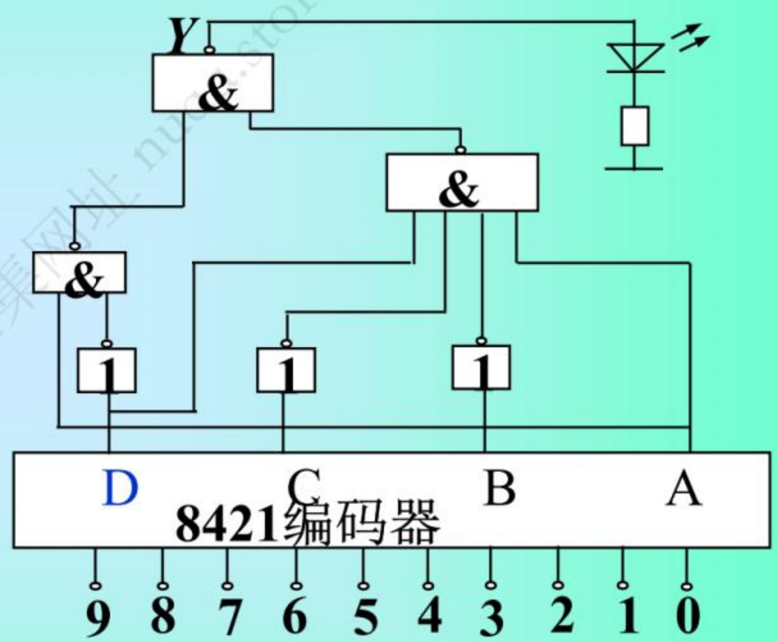
（2）将上式求反后得出的逻辑式具有何种逻辑功能？

6.8 分析图示电路的逻辑功能。



（a）

Y恒为1



（b）

$$Y = I_1 + I_3 + I_5 + I_7 + I_9 = \overline{\overline{I_1} \cdot \overline{I_3} \cdot \overline{I_5} \cdot \overline{I_7} \cdot \overline{I_9}}$$

输入奇数时亮灯

6.9 在题**3.10**中，输出量（**Q2, Q2N**两个端子获得**24V**电压与否）与输入信号**ON, PROTECT1, SEL**之间是什么样的逻辑关系，用表达式及逻辑门电路表示。

$$Y = \mathbf{ON} \cdot \mathbf{PROTECT1} \cdot \mathbf{SEL}$$

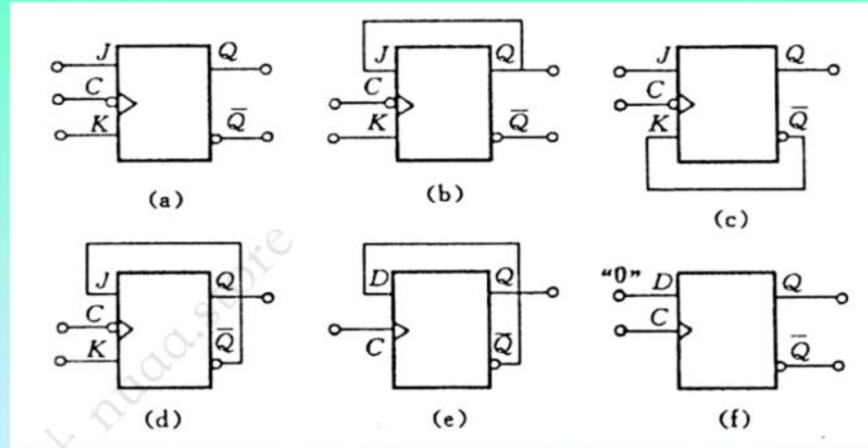
6.10 用与非门实现一个三地控制一盏灯的电路：在A、B、C共3个地方安装3个双掷开关，在任何一处拨动一次开关，灯L就会改变其亮灭状态。开关的两种位置状态分别用“0”和“1”表示，假设初始状态为：当A,B,C均为 “0”时灯灭。

A	*B*	*C*	*L*
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

6.11仿照全加器设计一个一位二进制数的全减器：输入被减数为*A*，减数为*B*，低位来的借位数为*C*，全减差为*D*，向高位的借位数为*C*1。

A	*B*	*C*	*D*	C_1
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

7.3已知时钟脉冲*C*的波形如图所示。试分别画出图中各触发器输出端*Q*的波形。设它们的初始状态均为“0”。指出哪个具有计数功能。



$$Q^{n+1} = J\overline{Q^n} + \overline{K}Q^n$$

$$Q_a^{n+1} = 1\overline{Q^n} + \bar{1}Q^n = \overline{Q^n}$$

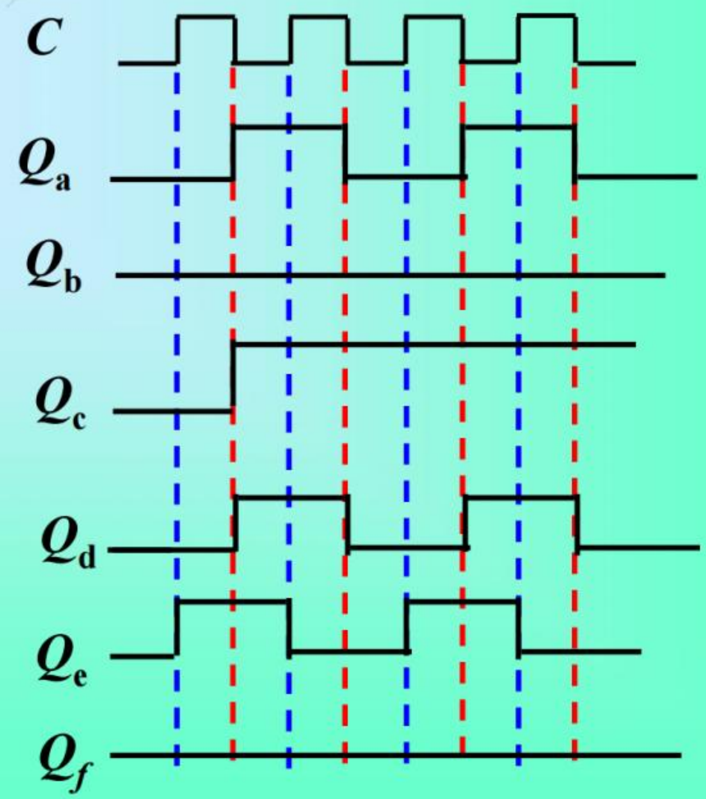
$$Q_b^{n+1} = Q^n\overline{Q^n} + \bar{1}Q^n = 0$$

$$Q_c^{n+1} = 1\overline{Q^n} + \overline{\overline{Q^n}}Q^n = 1$$

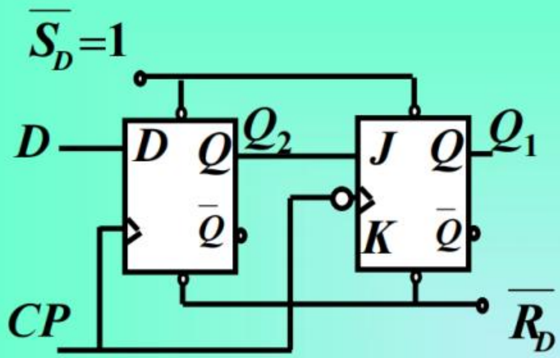
$$Q_d^{n+1} = \overline{Q^n}\,\overline{Q^n} + \bar{1}Q^n = \overline{Q^n}$$

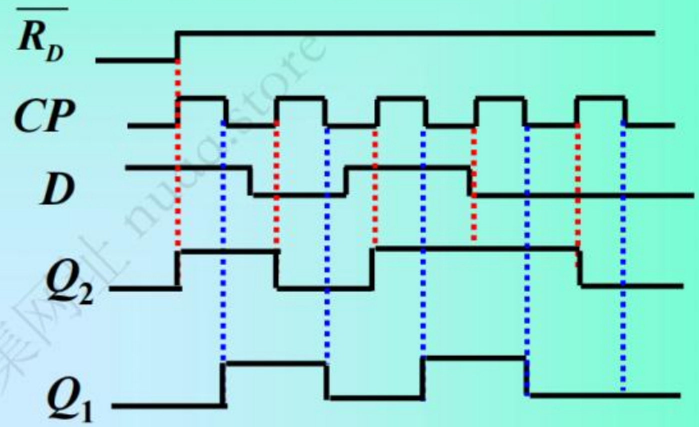
$$Q_e^{n+1} = D = \overline{Q^n}$$

$$Q_f^{n+1} = D = 0$$



7.4 电路及信号波形如图，请画出Q_2、Q_1的波形

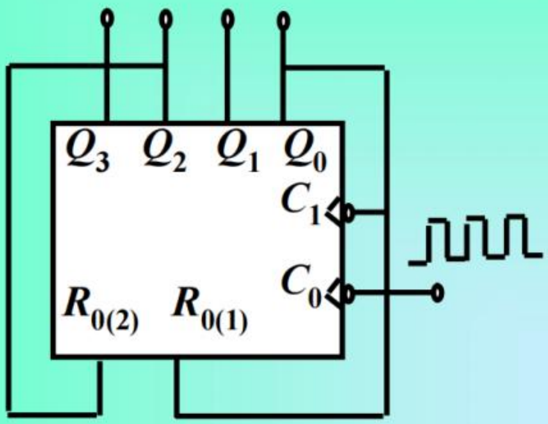




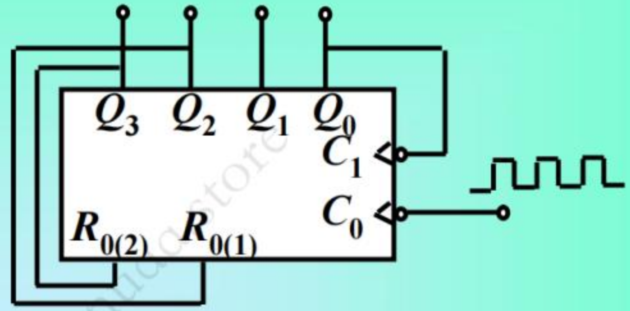
$$Q_2^{n+1} = D$$

$$Q_1^{n+1} = Q_2^n \overline{Q_1^n}$$

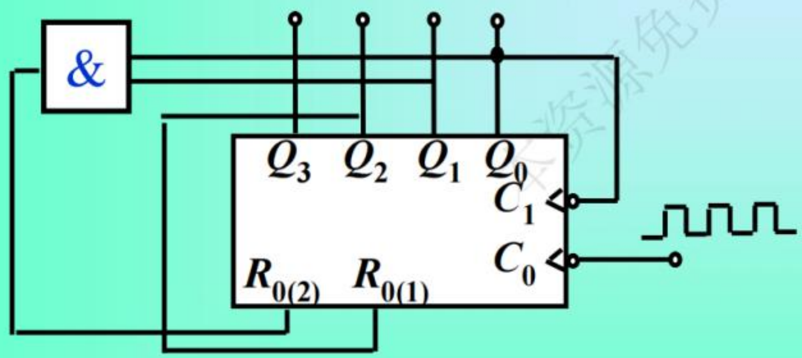
7.5 将二-八-十六进制计数器**CT74LS293**接成图示的两个电路时，各为几进制计数器？能否把它接成七进制或十一进制计数器。



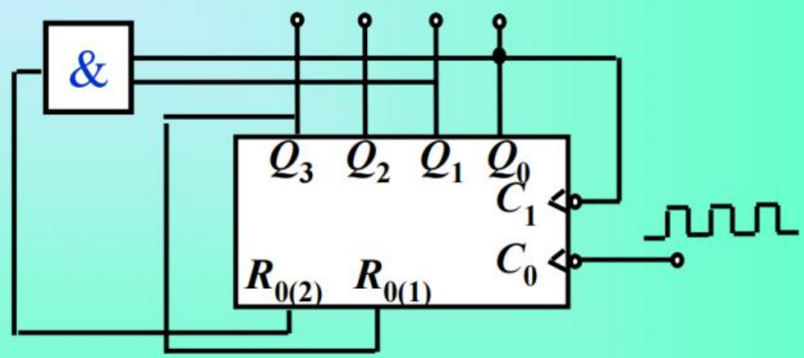
5进制



12进制

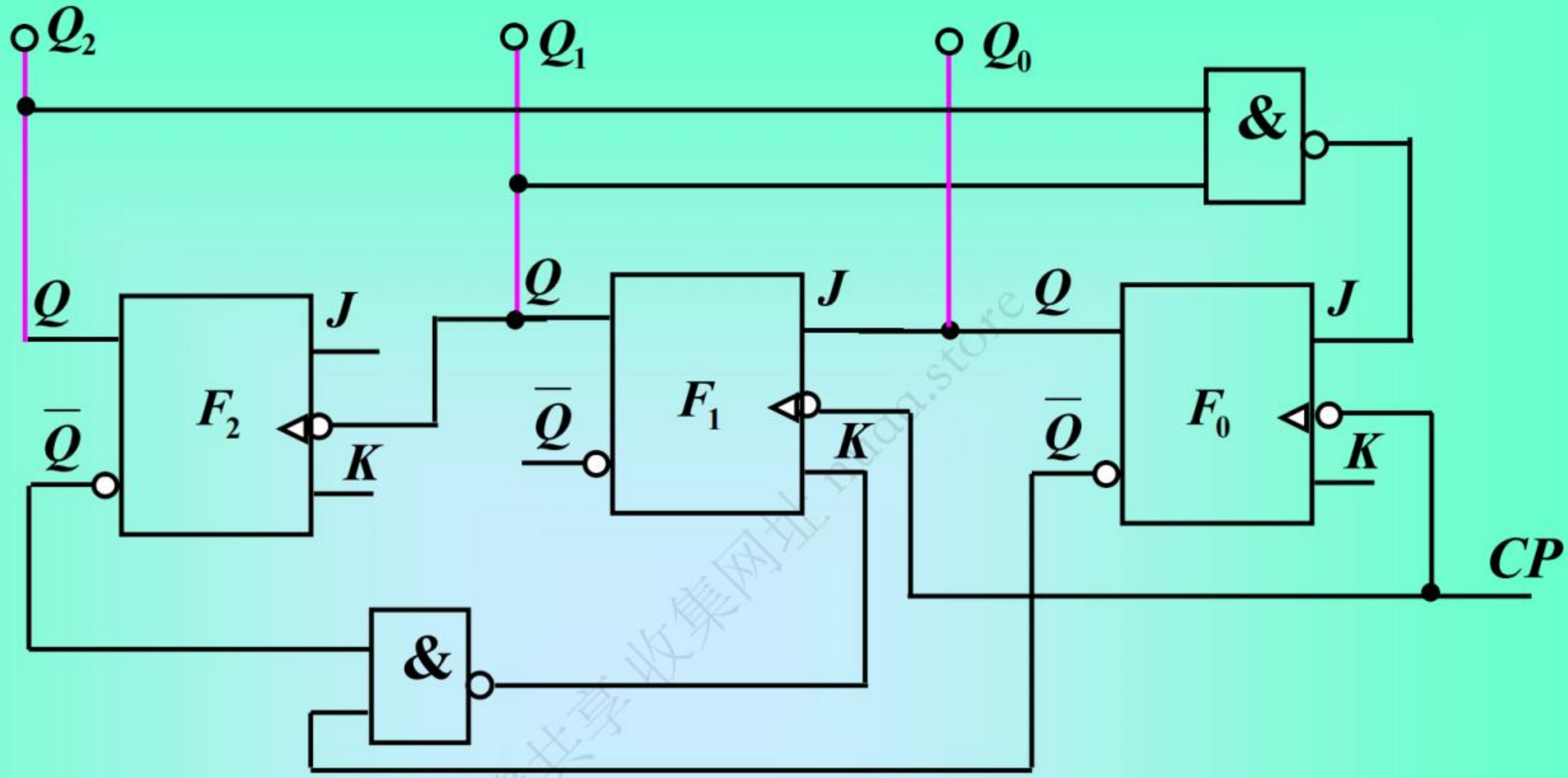


7进制



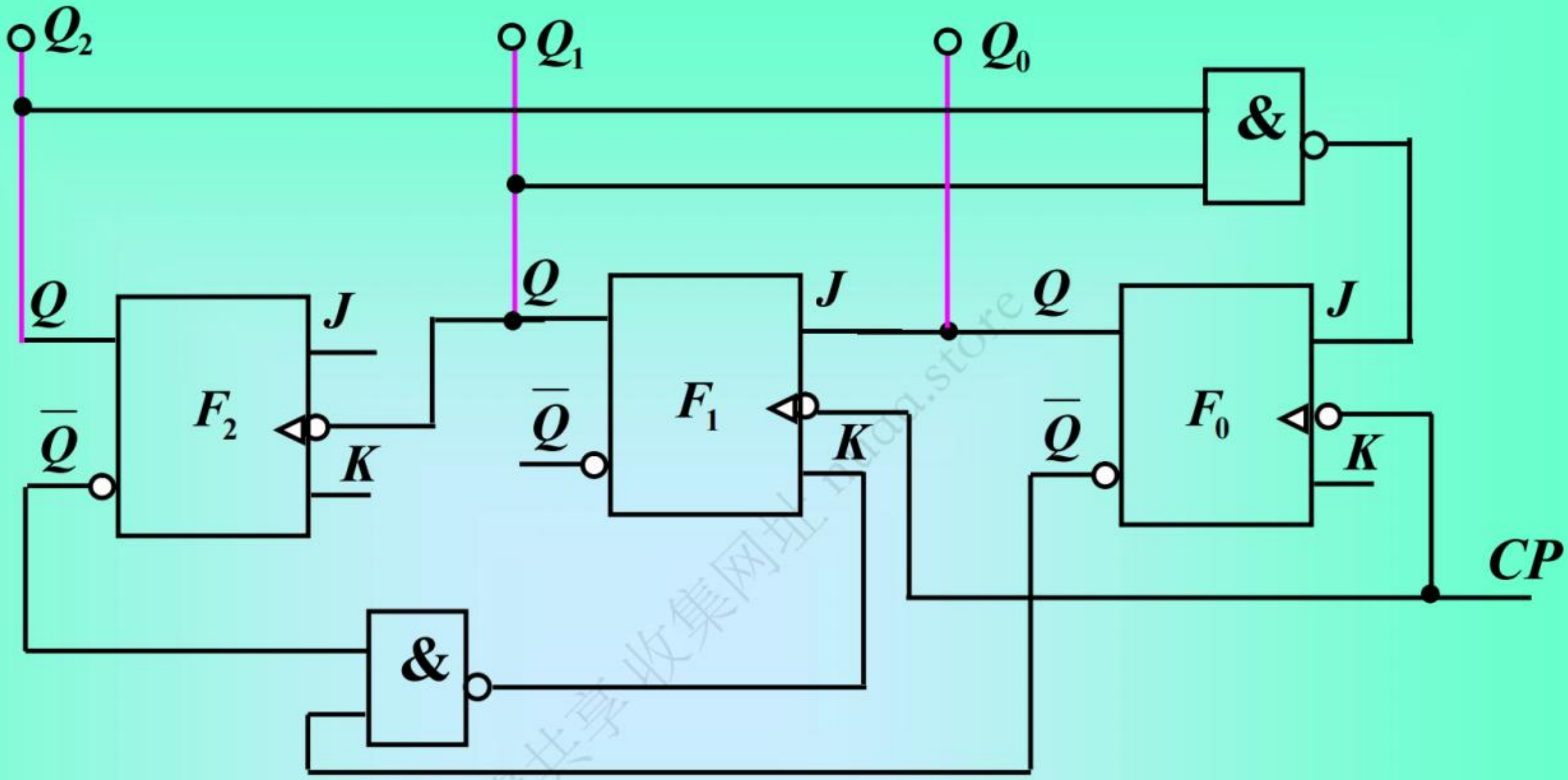
11进制

7.5



$J_0 = \overline{Q_2^{\ n} Q_1^{\ n}}$ $\quad$ $J_1 = Q_0^{\ n}$ $\quad$ $J_2 = 1$

$K_0 = 1$ $\quad$ $K_1 = \overline{\overline{Q_2^{\ n}}\,\overline{Q_0^{\ n}}}$ $\quad$ $K_2 = 1$



$$J_0 = \overline{Q_2^n Q_1^n},\quad K_0 = 1 \Rightarrow Q_0^{n+1} = \overline{Q_2^n Q_1^n} \cdot \overline{Q_0^n}$$ CP ↓

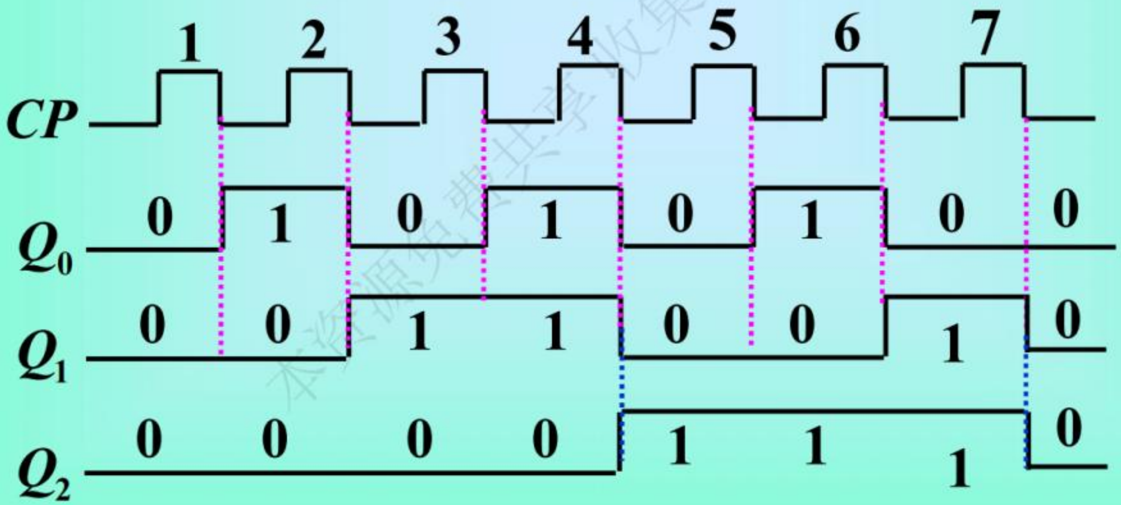
$$J_1 = Q_0^n,\quad K_1 = \overline{\overline{Q_2^n}\,\overline{Q_0^n}} \Rightarrow Q_1^{n+1} = Q_0^n \overline{Q_1^n} + \overline{Q_2^n}\,\overline{Q_0^n} Q_1^n$$ CP ↓

$$J_2 = 1,\quad K_2 = 1 \Rightarrow Q_2^{n+1} = \overline{Q_2^n}$$ Q_1 ↓

$$Q_0^{n+1} = \overline{Q_2^n Q_1^n} \cdot \overline{Q_0^n} \qquad CP \downarrow$$

$$Q_1^{n+1} = Q_0^n \overline{Q_1^n} + \overline{Q_2^n}\,\overline{Q_0^n} Q_1^n \qquad CP \downarrow$$

$$Q_2^{n+1} = \overline{Q_2^n} \qquad Q_1 \downarrow$$



七进制加法计数器

$$Q_0^{n+1} = \overline{Q_2^n Q_1^n} \cdot \overline{Q_0^n} \qquad CP \downarrow$$

$$Q_1^{n+1} = Q_0^n \overline{Q_1^n} + \overline{Q_2^n}\,\overline{Q_0^n} Q_1^n \qquad CP \downarrow$$

$$Q_2^{n+1} = \overline{Q_2^n} \qquad Q_1 \downarrow$$

CP	Q_2	Q_1	Q_0
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	0	0	0

七进制加法计数器