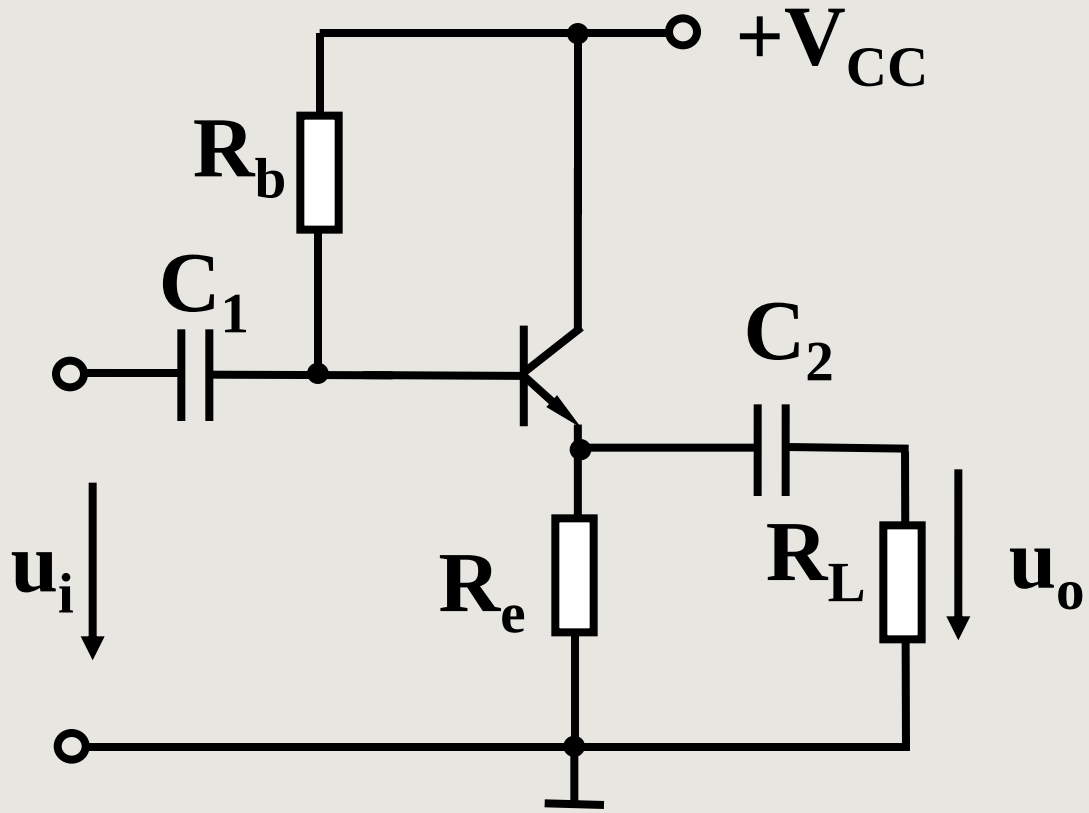
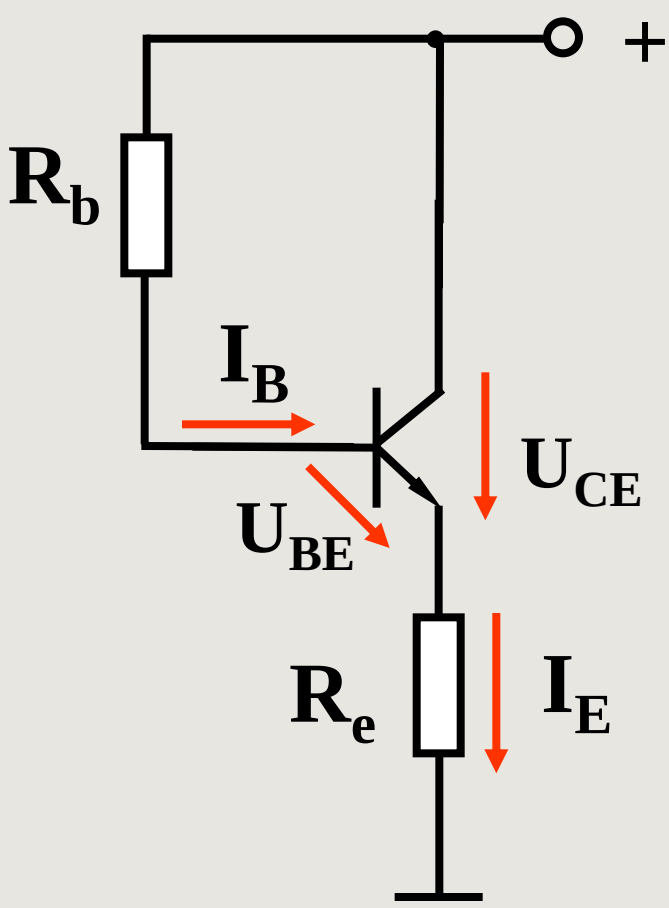
§11.1.5 共集放大电路

1. 结构：



2. 直流通道及静态工作点分析：



$$U_{CC}=I_B R_b+U_{BE}+I_E R_e$$

$$=I_B R_b+U_{BE}+(1+\beta)I_B R_e$$

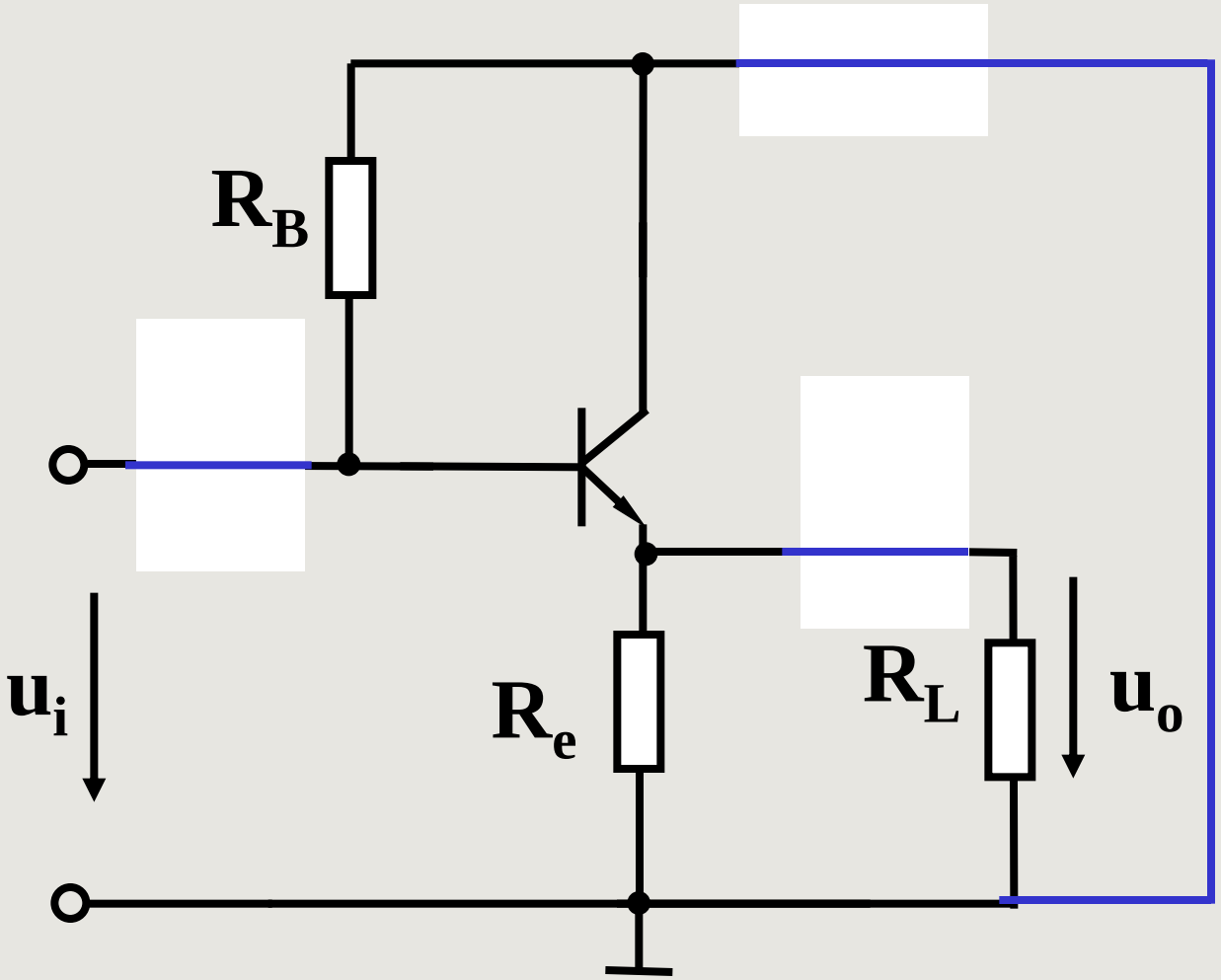
$$I_B=\frac{U_{CC}-U_{BE}}{R_b+(1+\beta)R_e}$$

$$I_C=\beta I_B$$

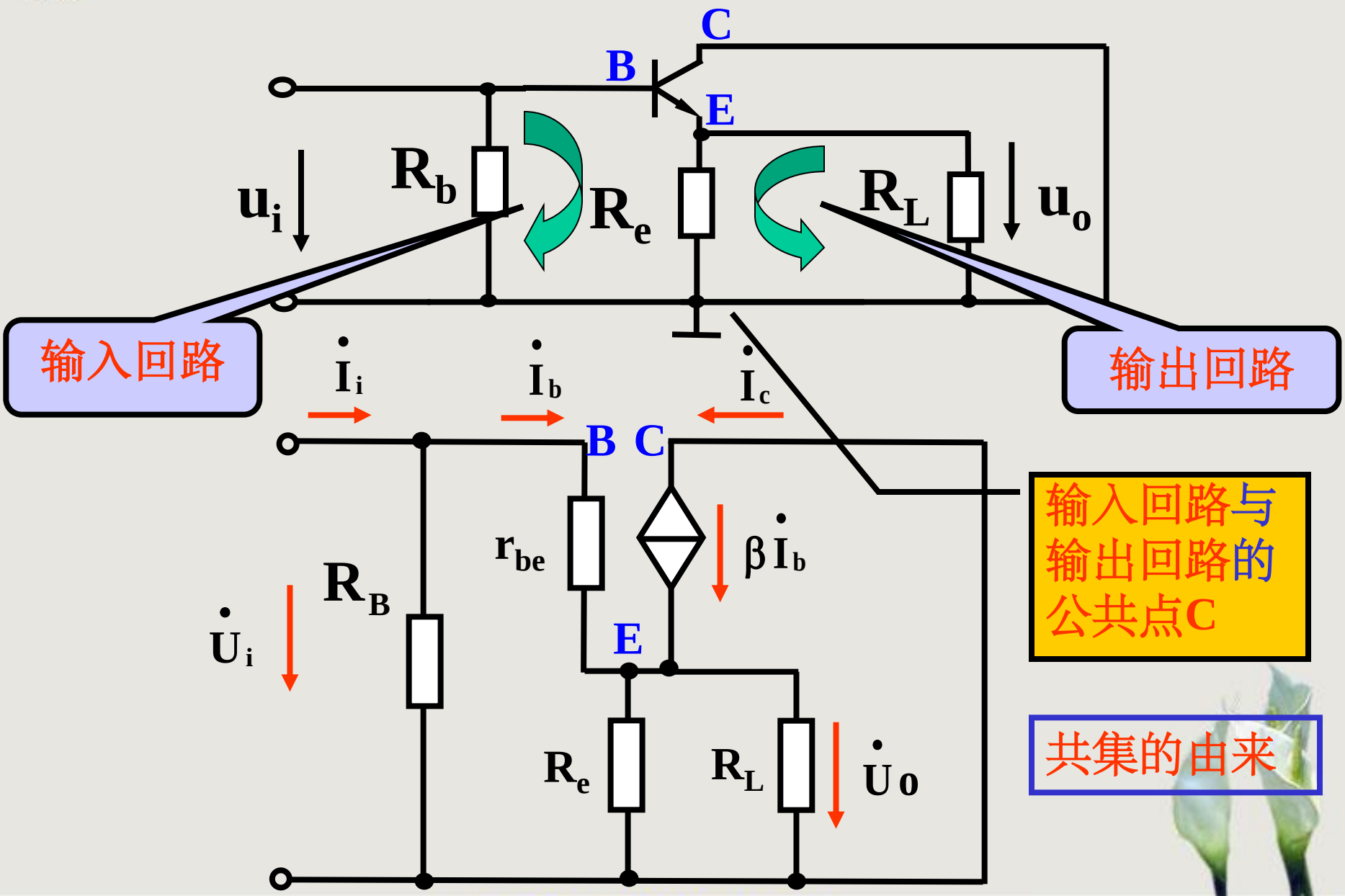
$$U_{CE}=U_{CC}-I_E R_E$$

3. 动态分析

交流通道及微变等效电路



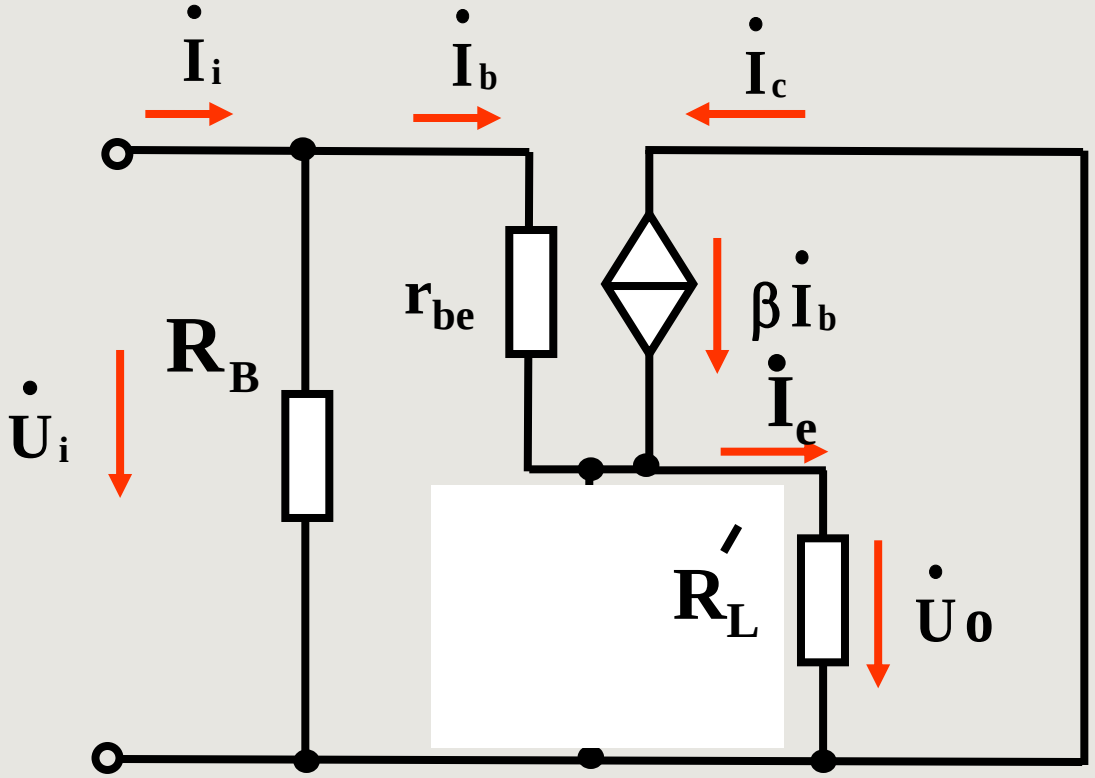
交流通道及微变等效电路



输入回路与输出回路的公共点C

共集的由来

(1)电压放大倍数



$$R'_L = R_e \,//\, R_L$$

$$\dot{U}_o = \dot{I}_e R'_L$$

$$= (1+\beta)\dot{I}_b R'_L$$

$$\dot{U}_i = \dot{I}_b r_{be} + \dot{I}_e R'_L$$

$$= \dot{I}_b r_{be} + (1+\beta)\dot{I}_b R'_L$$

$$A_u = \frac{\dot{U}_o}{\dot{U}_i} = \frac{(1+\beta)\dot{I}_b R'_L}{\dot{I}_b r_{be} + (1+\beta)\dot{I}_b R'_L} = \frac{(1+\beta) R'_L}{r_{be} + (1+\beta)R'_L}$$

讨论

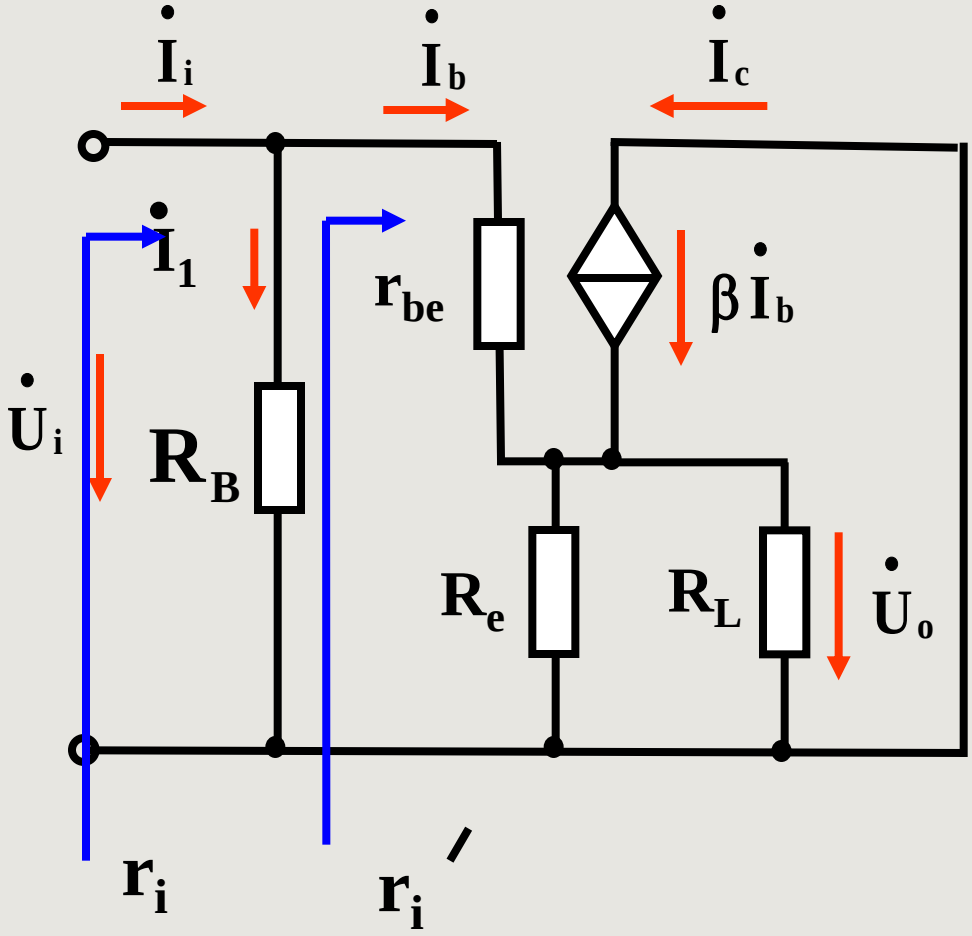
$$A_u = \frac{(1+\beta)\,R'_L}{r_{be} + (1+\beta)R'_L}$$

1、 $r_{be} << (1+\beta)R'_L$，所以 $A_u \approx 1$，

输出电压与输入电压近似相等，电压未被放大，但是电流放大了，即输出功率被放大了。

2、输入输出同相，输出电压跟随输入电压，故称电压跟随器。

(2)输入电阻



$$\dot{U}_i = \dot{I}_b r_{be} + \dot{I}_e R'_L$$

$$= \dot{I}_b r_{be} + (1+\beta)\dot{I}_b R'_L$$

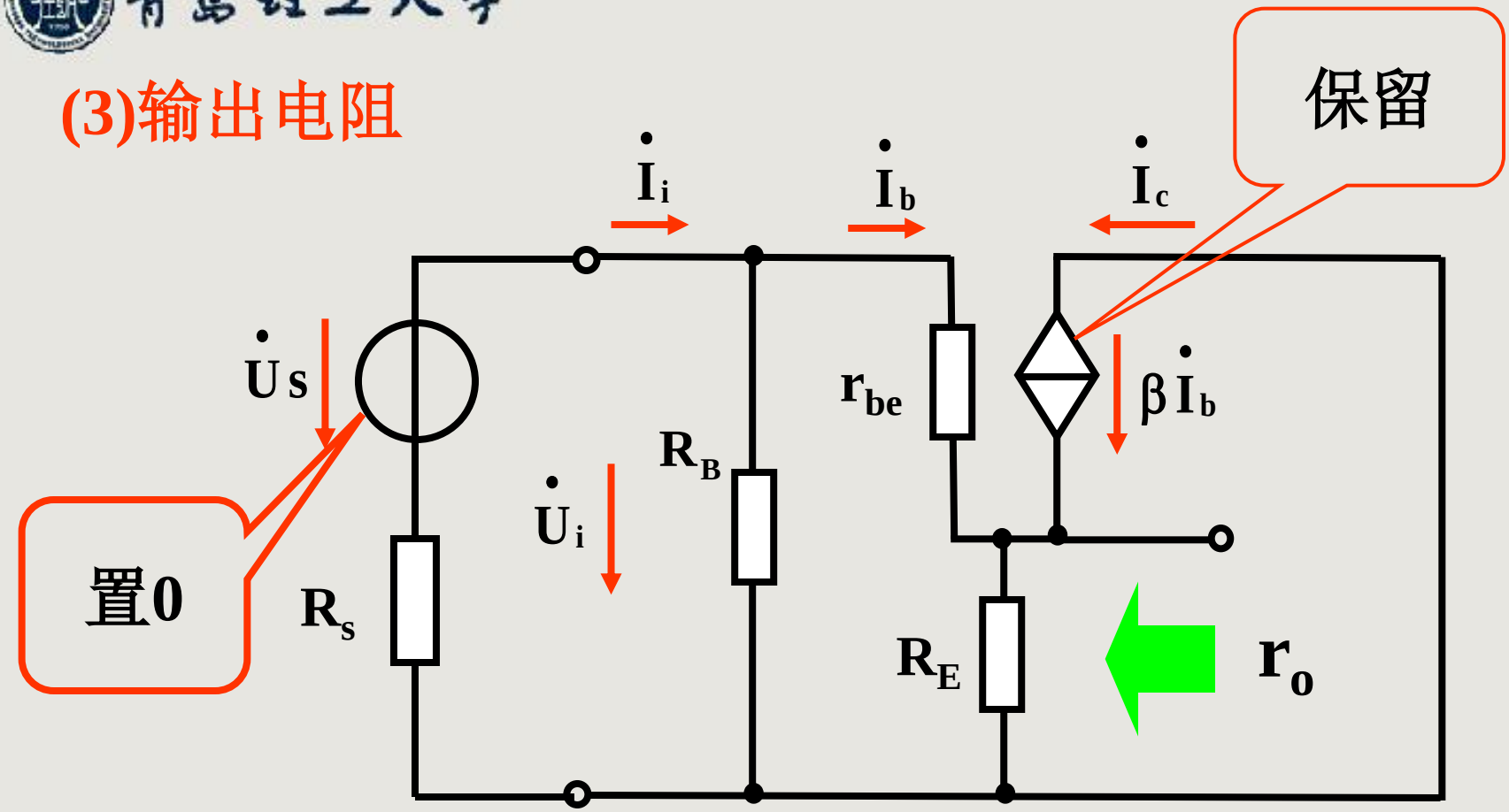
$$r_i' = \frac{U_i}{I_b}$$

$$= r_{be} + (1+\beta)R_L'$$

$$r_i = R_B // r_i'$$

$$= R_B // [r_{be} + (1+\beta)R_L']$$

(3)输出电阻



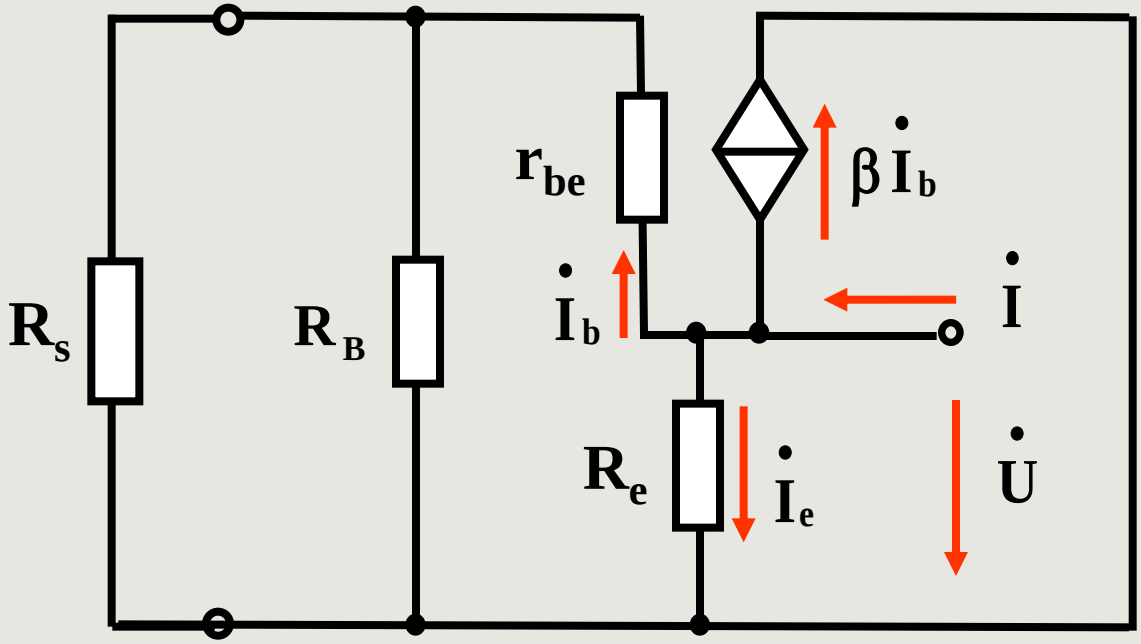
用外加电压法求输出电阻。

(3)输出电阻

$$R'_s = R_s \,//\, R_B$$

$$r_o = R_e \,//\, \frac{r_{be}}{1+\beta}$$

当R_S=0时



$$\dot{I} = \dot{I}_b + \beta \dot{I}_b + \dot{I}_e = \frac{\dot{U}}{r_{be} + R'_s} + \beta \bullet \frac{\dot{U}}{r_{be} + R'_s} + \frac{\dot{U}}{R_E}$$

$$r_o = \frac{\dot{U}}{\dot{I}} = \frac{1}{\frac{1+\beta}{r_{be} + R'_s} + \frac{1}{R_E}} = R_E \,//\, \frac{r_{be} + R'_s}{1+\beta}$$

射极输出器的特点：电压放大倍数=1，
输入阻抗高，输出阻抗小。

射极输出器的使用

1. 将射极输出器放在电路的首级，可以提高输入电阻。

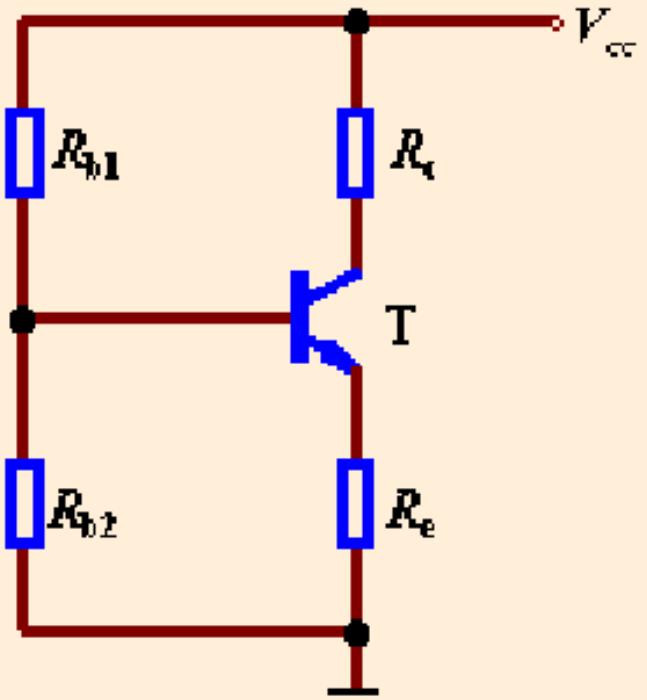
2. 将射极输出器放在电路的末级，可以降低输出电阻，提高带负载能。

3. 将射极输出器放在电路的两级之间，可以起到电路的匹配作用。

共基放大电路（课堂练习）

1. 静态工作点

直流通路与射极偏置电路相同



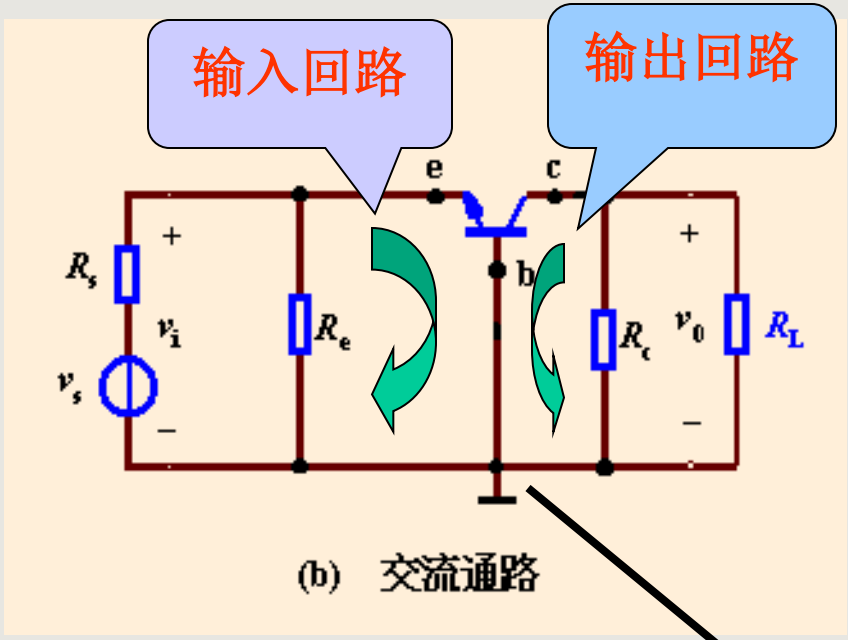
$$U_B \approx \frac{R_{b2}}{R_{b1}+R_{b2}} \cdot U_{CC}$$

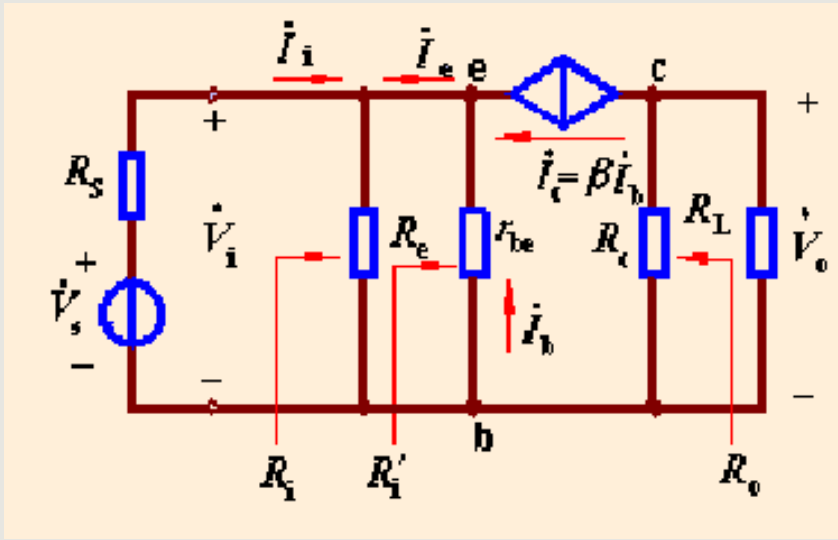
$$I_C \approx I_E = \frac{U_B - U_{BE}}{R_e}$$

$$U_{CE} = U_{CC} - I_C R_c - I_E R_e \approx U_{CC} - I_C (R_c + R_e)$$

$$I_B = \frac{I_C}{\beta}$$

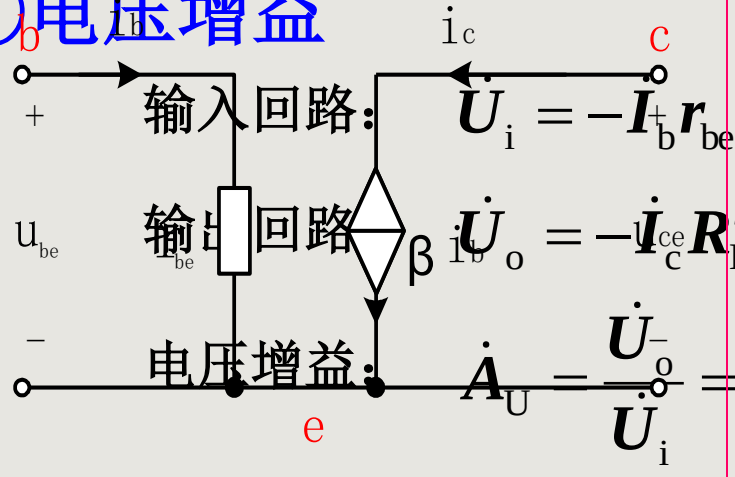
2. 动态指标





输入回路与输出回路公共点B

①电压增益



输入回路：$\dot{U}_i = -\dot{I}_b r_{be}$

输出回路：$\dot{U}_o = -\dot{I}_c R_L' = -\beta \dot{I}_b R_L'$　　$R_L' = R_c // R_L$

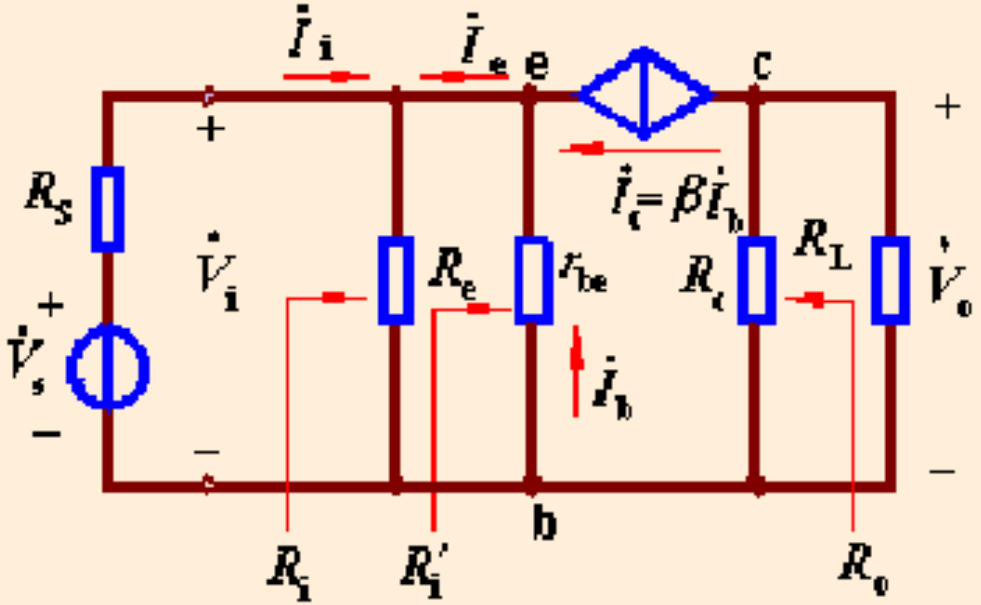
电压增益：$\dot{A}_U = \dfrac{\dot{U}_o}{\dot{U}_i} = \dfrac{-\beta \dot{I}_b R_L'}{-\dot{I}_b r_{be}} = \dfrac{\beta R_L'}{r_{be}}$

2. 动态指标

② 输入电阻

$$R_i' = r_{eb} = \frac{\dot{U}_i}{-\dot{I}_e}$$

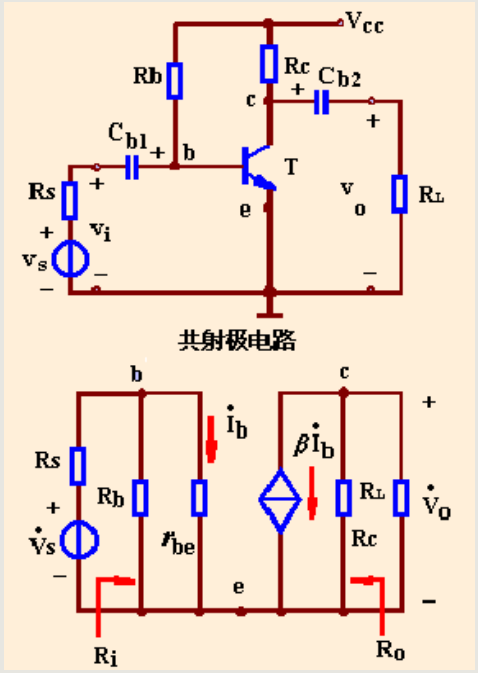
$$= \frac{-\dot{I}_b r_{be}}{-(1+\beta)\dot{I}_b} = \frac{r_{be}}{1+\beta}$$

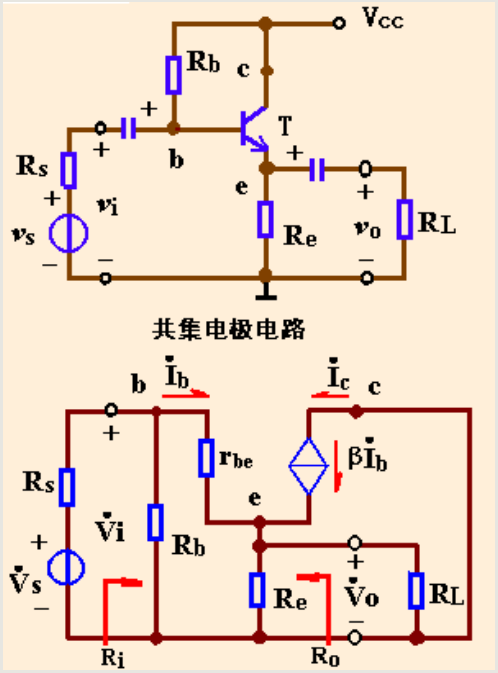


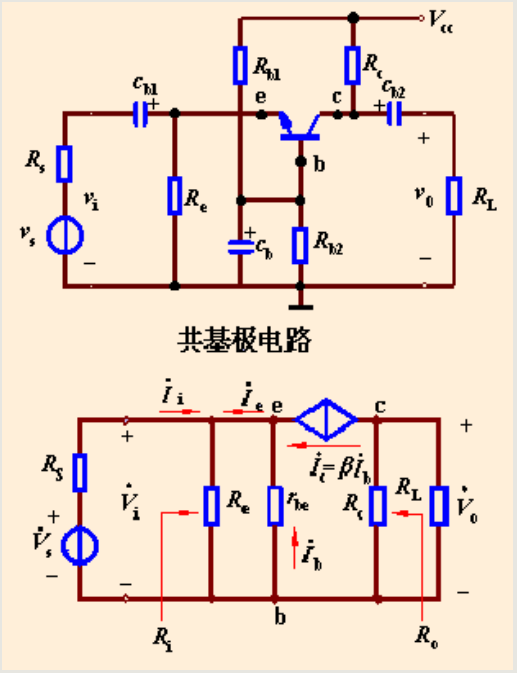
$$R_i = \frac{\dot{U}_i}{\dot{I}_i} = R_e // r_{eb} = R_e // \frac{r_{be}}{1+\beta} \approx \frac{r_{be}}{1+\beta}$$

③ 输出电阻 $R_o \approx R_c$

3. 三种组态的比较







	共射极电路	共集电极电路	共基极电路
电压增益：	$-\dfrac{\beta\cdot(R_c /\!/ R_L)}{r_{be}}$	$\dfrac{(1+\beta)\cdot(R_e /\!/ R_L)}{r_{be}+(1+\beta)(R_e /\!/ R_L)}$	$\dfrac{\beta\cdot(R_c /\!/ R_L)}{r_{be}}$
输入电阻：	$R_b /\!/ r_{be}$	$R_b /\!/ [r_{be}+(1+\beta)(R_e /\!/ R_L)]$	$R_e /\!/ \dfrac{r_{be}}{1+\beta}$
输出电阻：	R_c	$R_e /\!/ \dfrac{(R_s /\!/ R_b)+r_{be}}{1+\beta}$	R_c