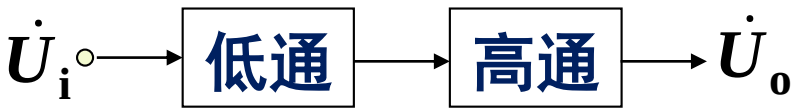
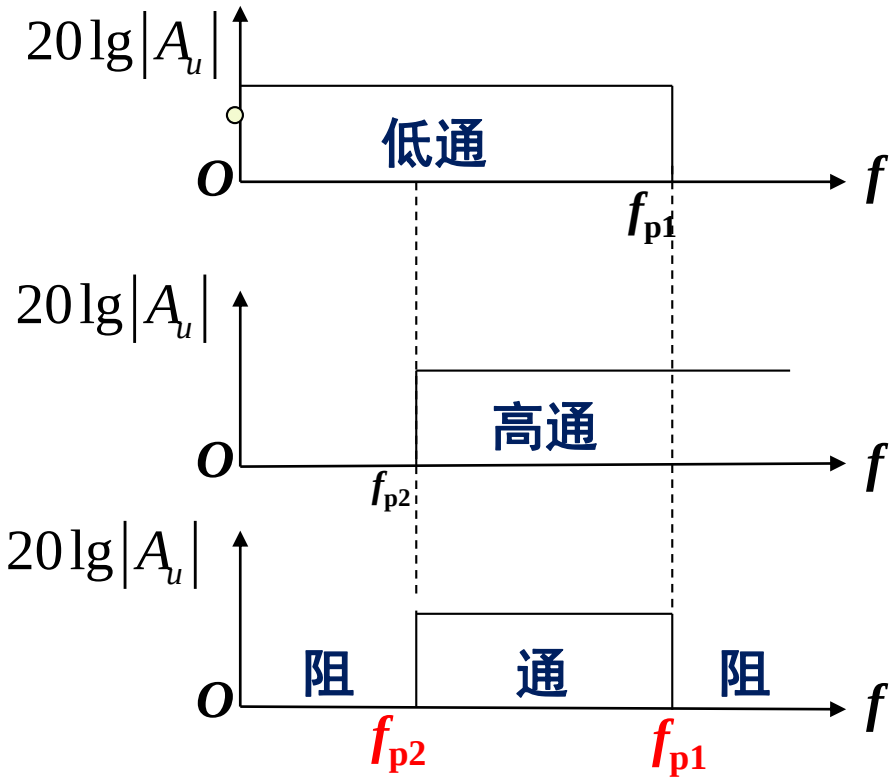
6.3 有源滤波电路

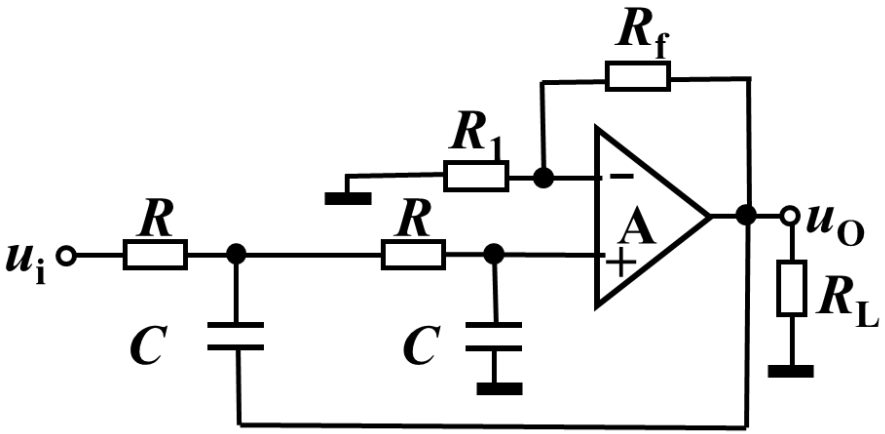
5.有源带通滤波器

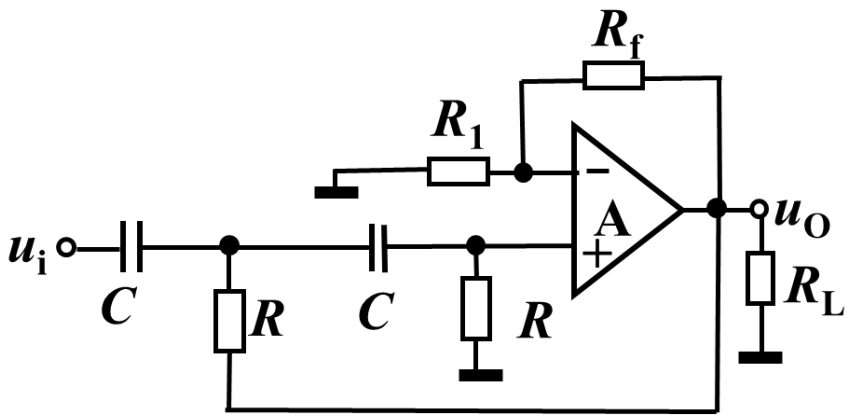
- 只允许某段频带内的信号通过，而抑制该频带以外的频率成分的有源滤波电路。将低通滤波器与高通滤波器串联，可以得到有源带通滤波器。

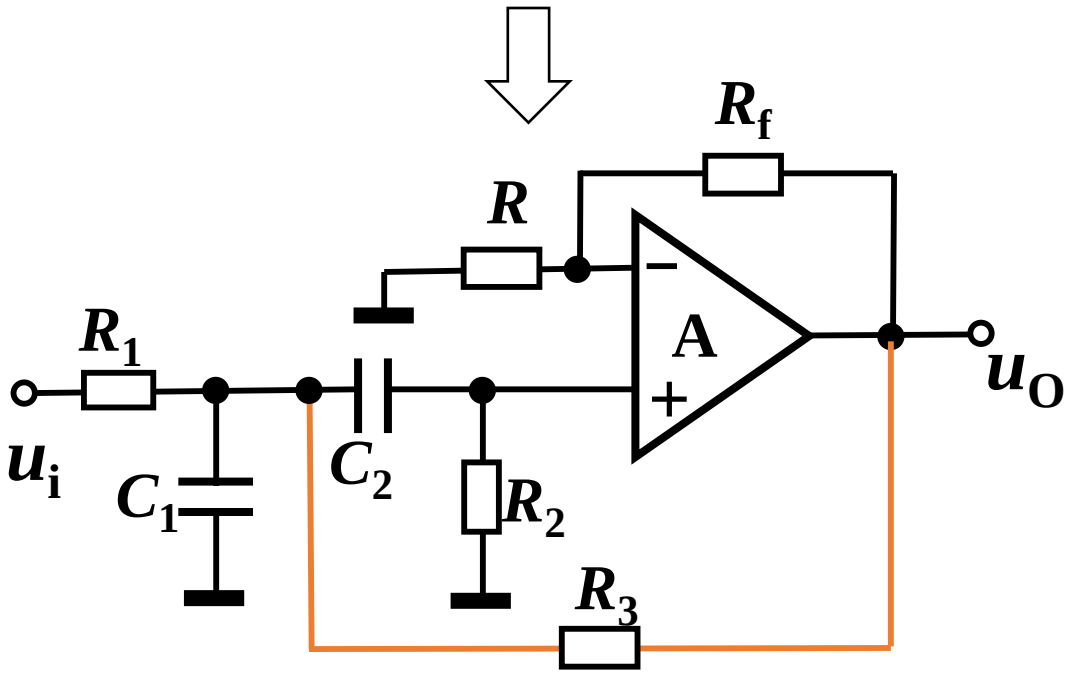




6.3 有源滤波电路



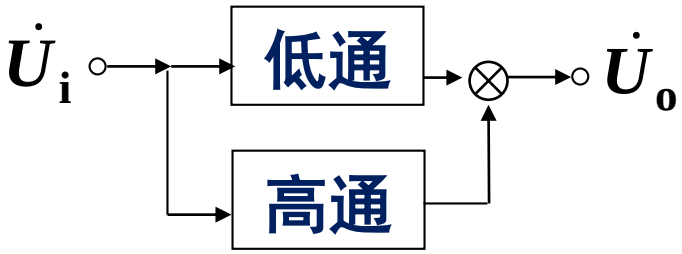


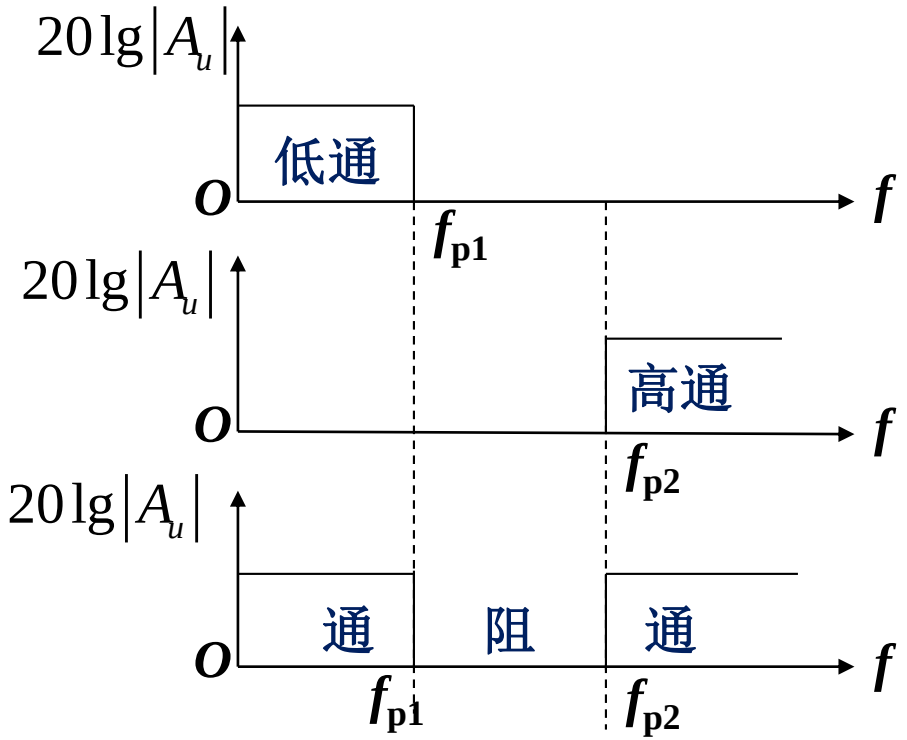


6.3 有源滤波电路

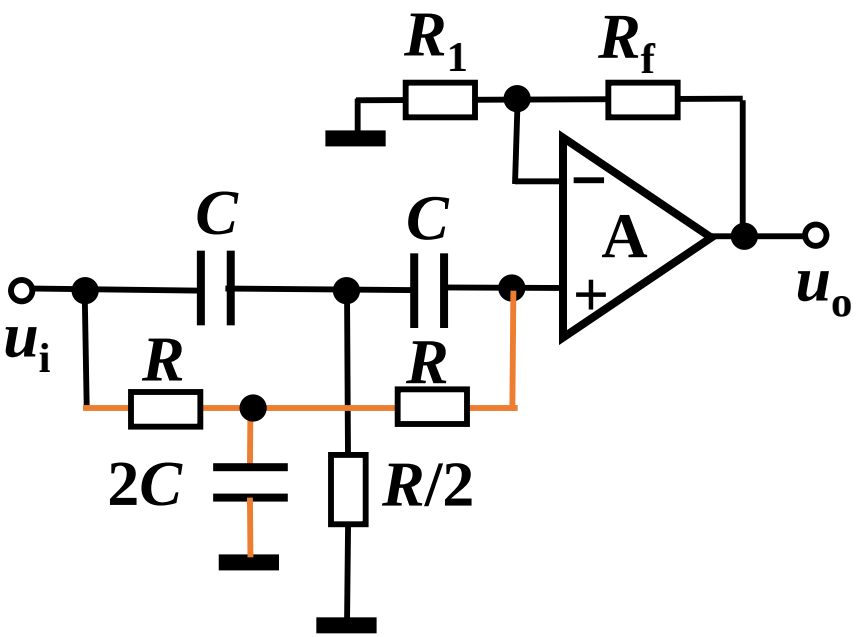
6.有源带阻滤波器

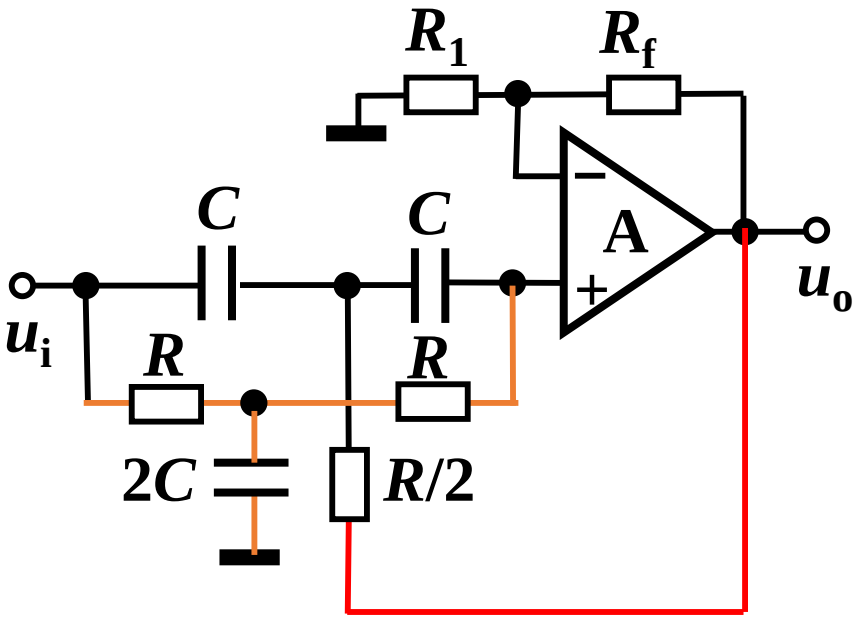
- 在特定的频带内频率成分被抑制，而该频带以外的频率成分能顺利通过的有源滤波电路；将低通滤波器与高通滤波器并联，可以得到有源带通滤波器。





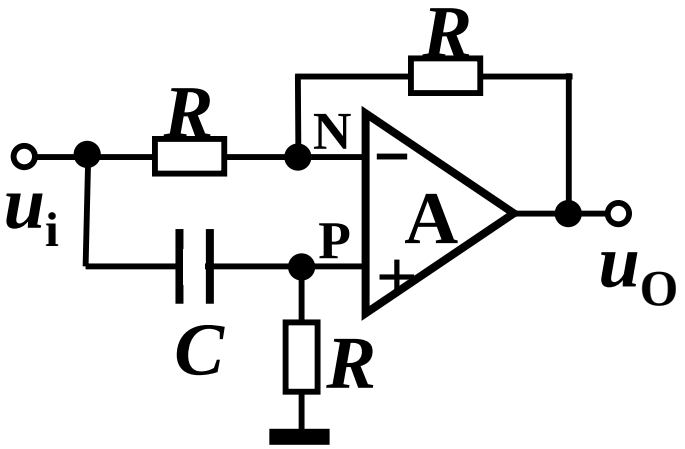
6.3 有源滤波电路





6.3 有源滤波电路

7. 全通滤波器

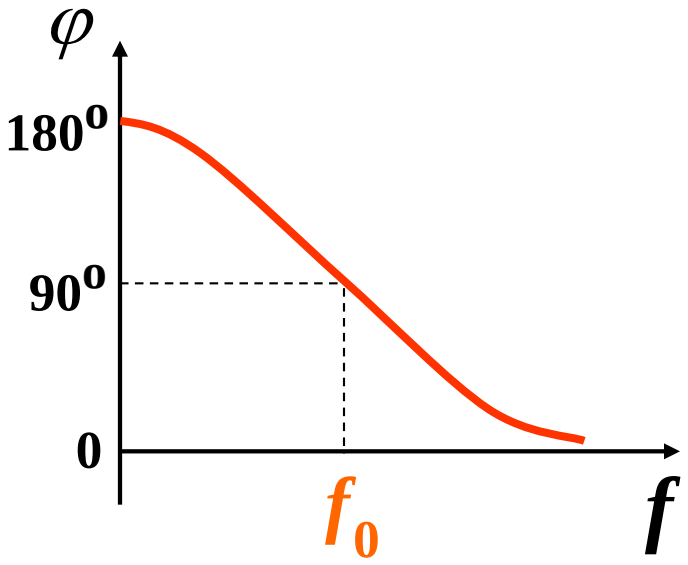


$|A_u(f)| = 1.0$,

与 f 无关——全通

相频特性如图

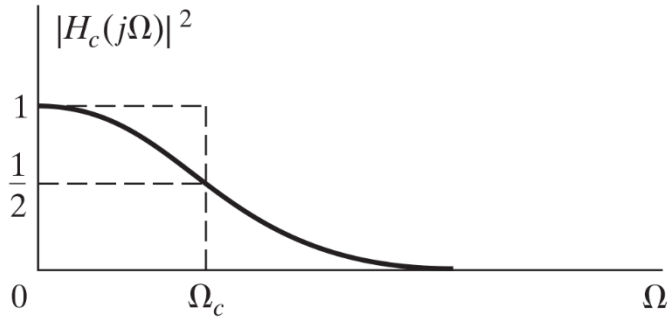
电路功能——仅改变相位



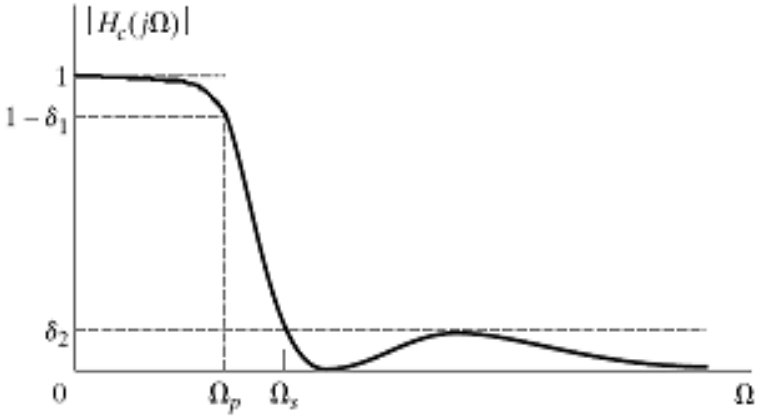
6.3 有源滤波电路

高阶有源滤波器—特性

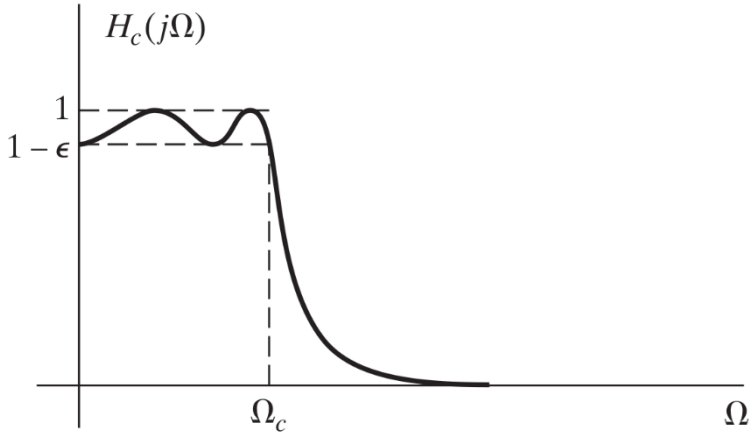
巴特沃斯



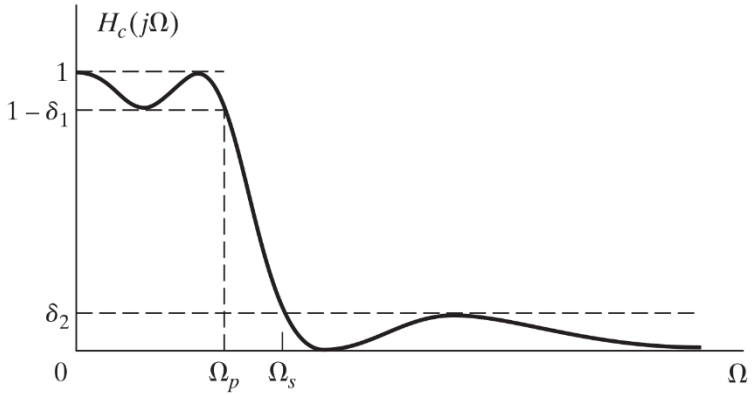
切比雪夫II型



切比雪夫I型

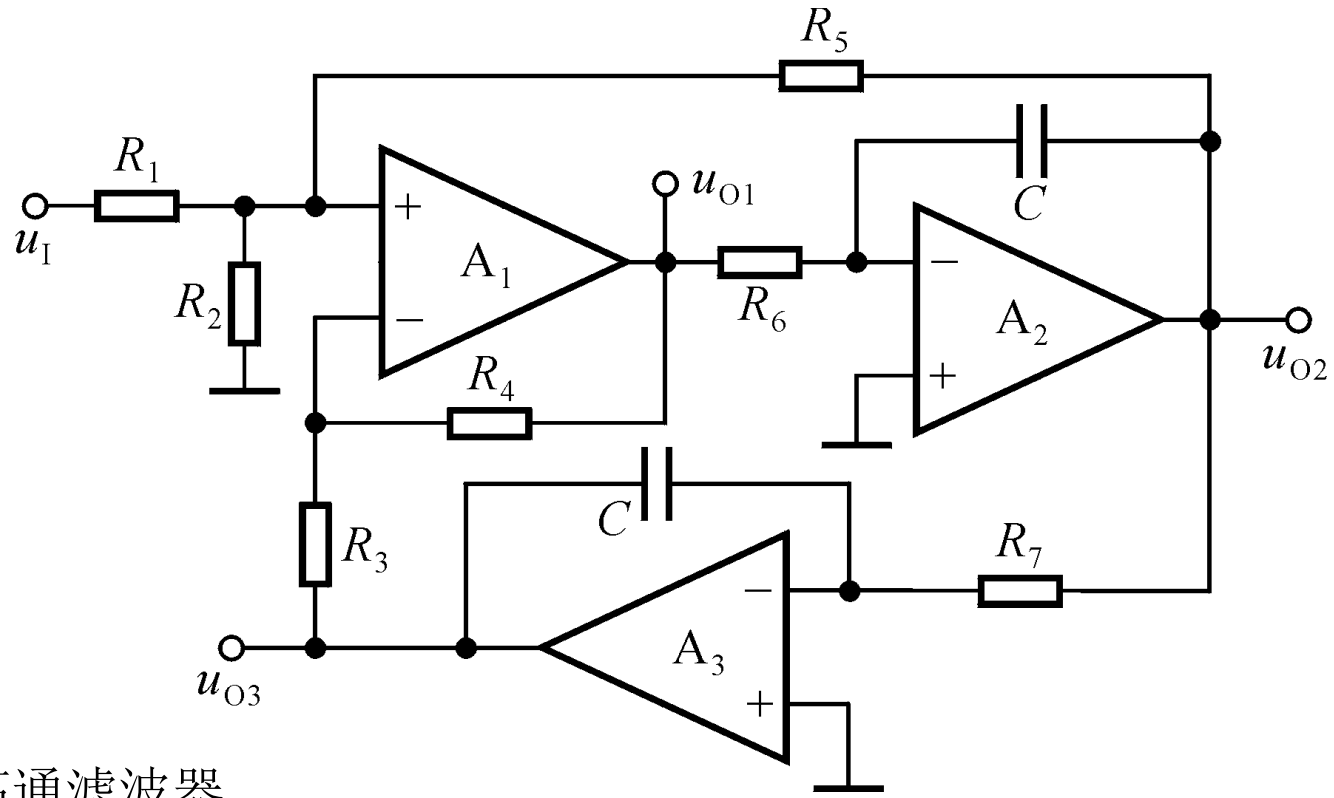


椭圆滤波器



6.3 有源滤波电路

例：试分析电路的输出u_{o1}、u_{o2}和u_{o3}分别具有哪种滤波特性（LPF、HPF、BPF、BEF）？



u_{o1}:高通滤波器

u_{o2}：带通滤波器

u_{o3}：低通滤波器

作业
6.20

第7章 波形的发生和信号的转换

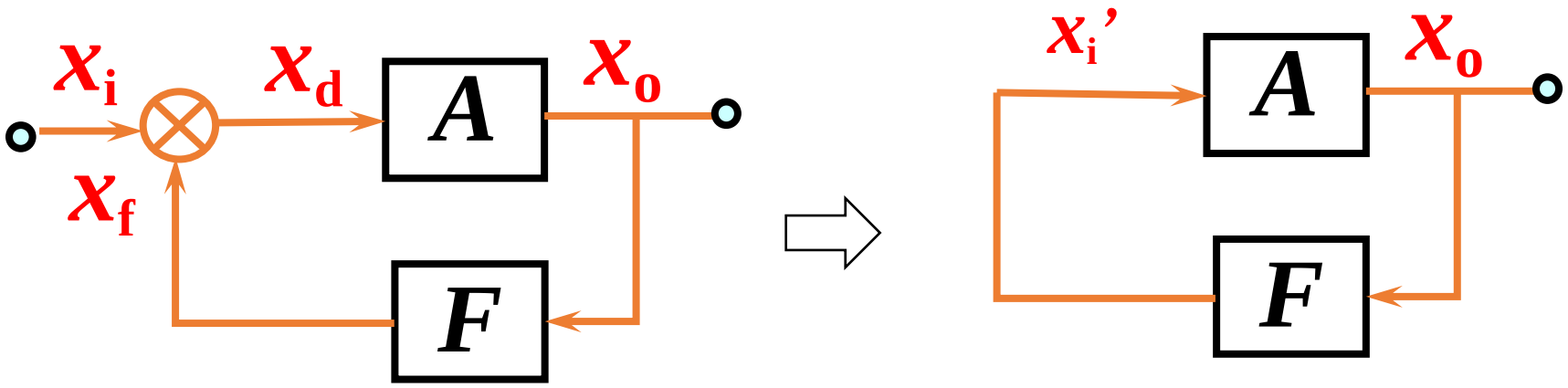
7.1 正弦波振荡电路

7.2 电压比较器

7.3 非正弦波发生电路

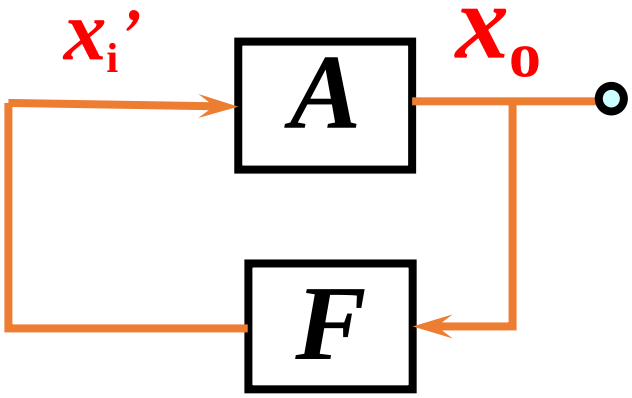
7.1.1 概述

正弦波振荡电路：在没有外加输入信号的情况下，依靠电路自激振荡而产生正弦波输出电压的电路，广泛用于测量、通信、控制等科研与实践领域。



7.1.1 概述

正弦波振荡电路组成



- 放大电路：实现能量的控制

  运算放大器/三极管等

- 选频网络：产生单一频率振荡

  RC/LC/石英晶振电路等

- 正反馈网络：使输入信号为反馈信号

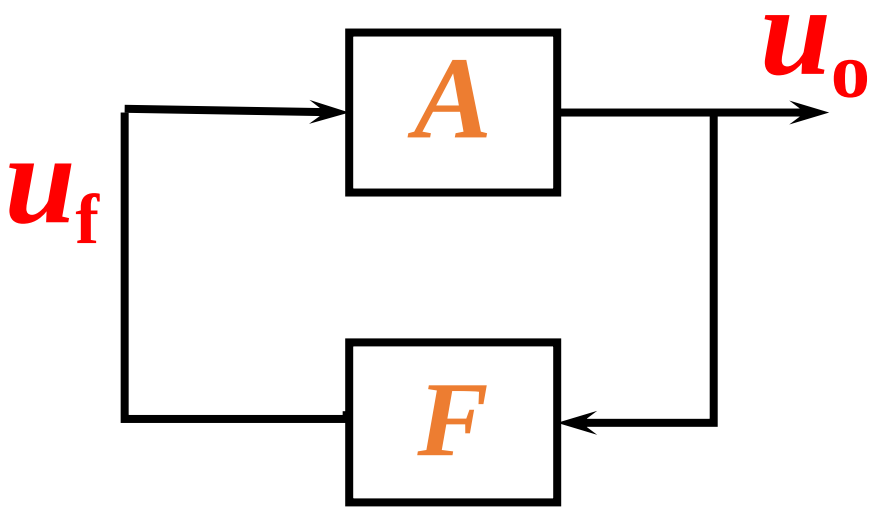
  通常与选频网络合二为一

- 稳幅电路：非线性环节，稳定输出

  晶体管和运放的非线性

7.1.1 概述

自激振荡的条件:



$$\dot{A}\dot{F} = \frac{\dot{U}_o}{\dot{U}_d}\frac{\dot{U}_f}{\dot{U}_o} = 1$$

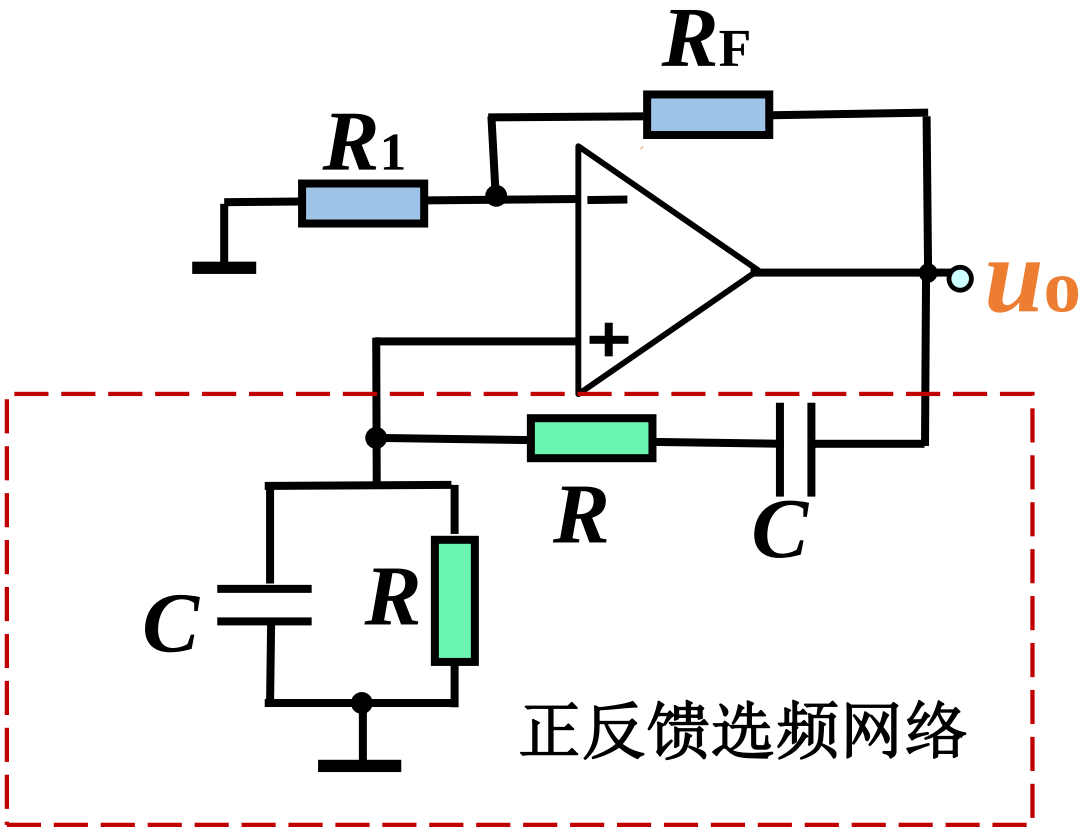
(1) 相位条件:

$$\varphi = \varphi_A + \varphi_F = 2n\pi \qquad (n=0,1,2\ \ldots)$$

(2) 幅度条件: $|AF| = 1$

起振条件: $|AF| > 1$

7.1.2 RC正弦波振荡电路



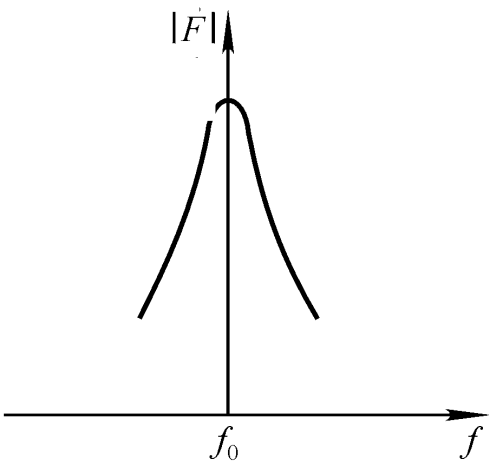
7.1.2 RC正弦波振荡电路

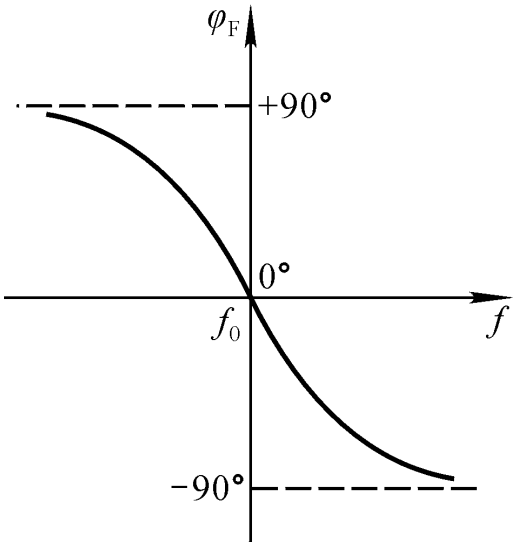
低频段

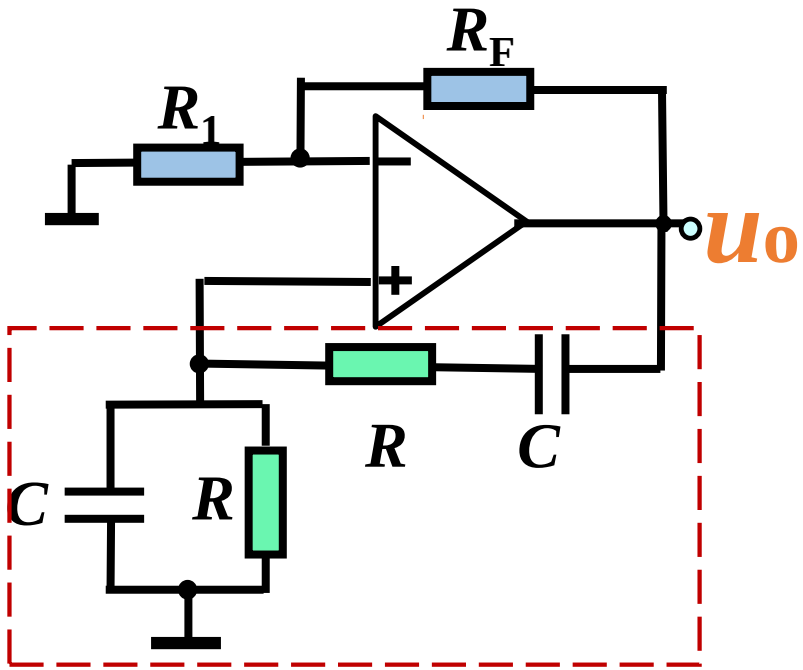
$$f \to 0, \quad \left|\dot{U}_{\mathrm{f}}\right| \to 0, \quad \phi_{\mathrm{F}} \to +90^{\circ}$$

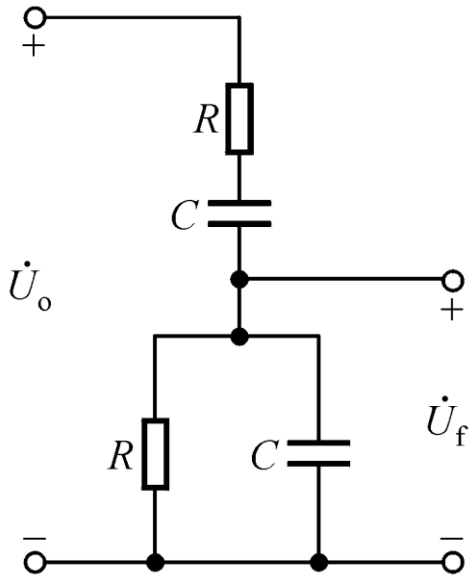
高频段

$$f \to \infty, \left|\dot{U}_{\mathrm{f}}\right| \to 0, \quad \varphi_{\mathrm{F}} \to -90^{\circ}$$









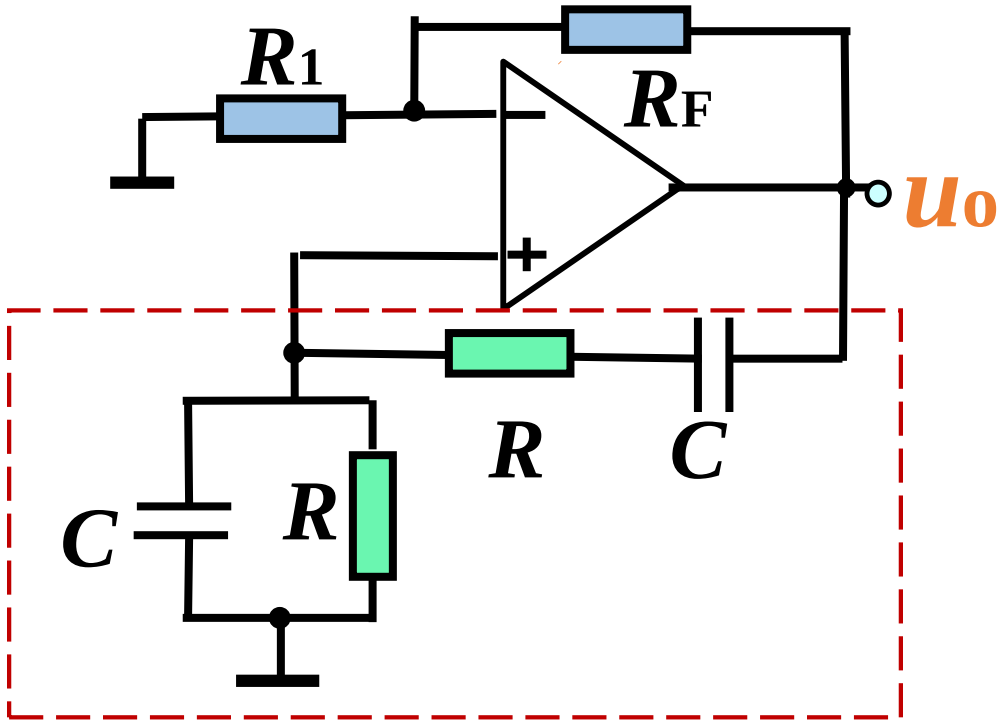
7.1.2 RC正弦波振荡电路

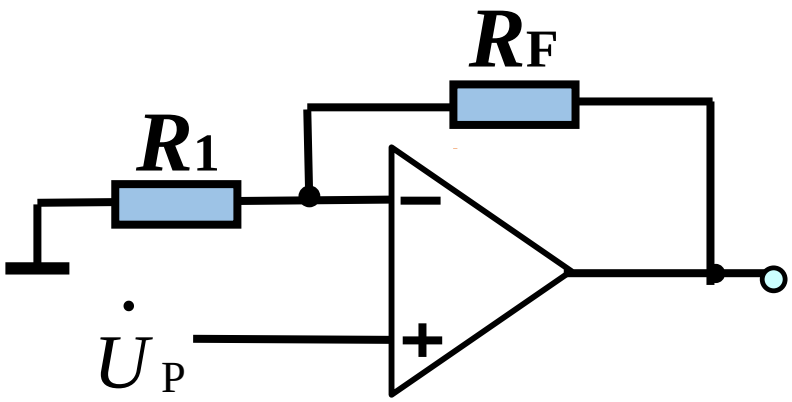
$$Z_1 = R + \frac{1}{j\omega C} \qquad Z_2 = \frac{R \bullet \frac{1}{j\omega C}}{R + \frac{1}{j\omega C}}$$

$$\dot{U}_P = \dot{U}_O \frac{Z_2}{Z_1 + Z_2}$$

$$F = \frac{\dot{U}_P}{\dot{U}_O} = \frac{1}{3 + j(\omega RC - \frac{1}{\omega RC})}$$

$$\omega_0 = \frac{1}{RC} \qquad f_0 = \frac{1}{2\pi RC}$$





7.1.2 RC正弦波振荡电路

$$\omega_0 = \frac{1}{RC} \qquad f_0 = \frac{1}{2\pi RC}$$

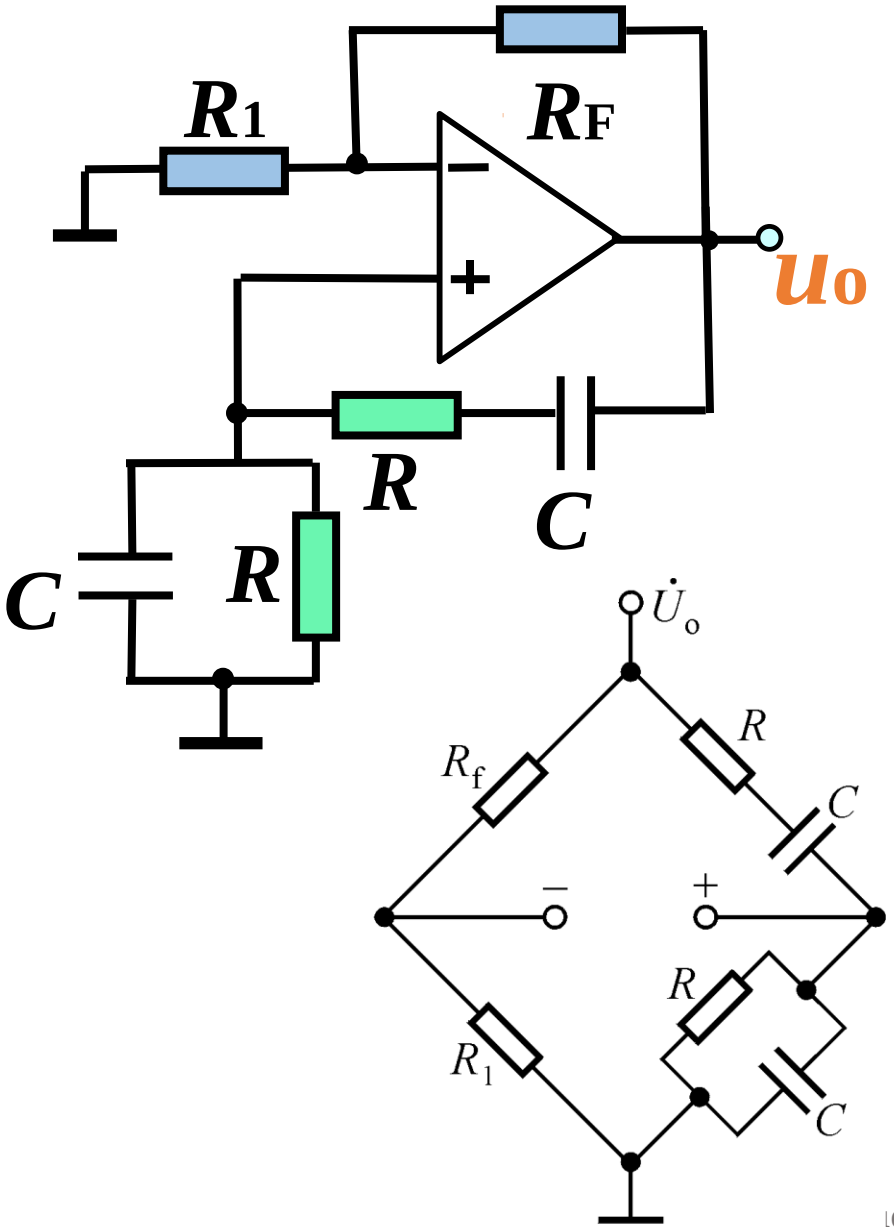
$$F = \frac{\dot{U}_P}{\dot{U}_O} = \frac{1}{3 + j(\omega RC - \frac{1}{\omega RC})} = \frac{1}{3}$$

$$A = 1 + \frac{R_F}{R_1} \qquad \boldsymbol{AF = 1}$$

$$1 + \frac{R_F}{R_1} = 3 \qquad \frac{R_F}{R_1} = 2$$

起振时应满足 $\boldsymbol{R_F > 2R_1}$

文氏振荡桥



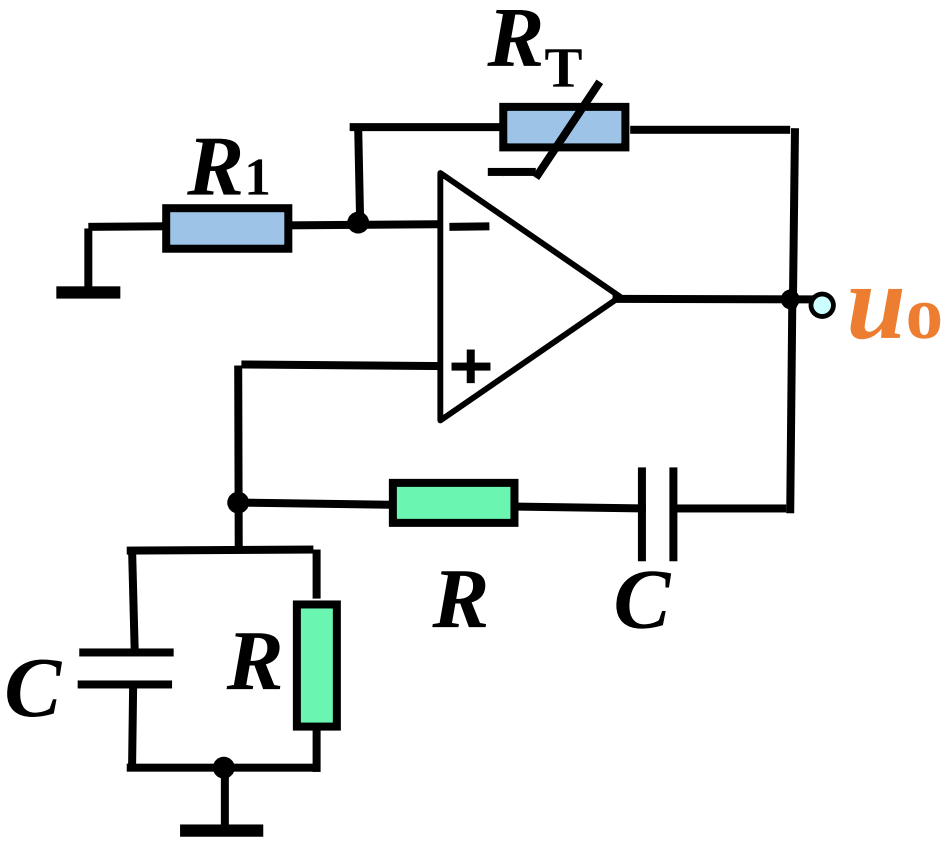
7.1.2 RC正弦波振荡电路

稳幅措施：

用热敏电阻稳幅

用具有负温度系数的热敏电阻R_T代替R_F。

$$u_O \uparrow \longrightarrow i_{R_T} \uparrow \longrightarrow R_T \downarrow \longrightarrow A \downarrow$$

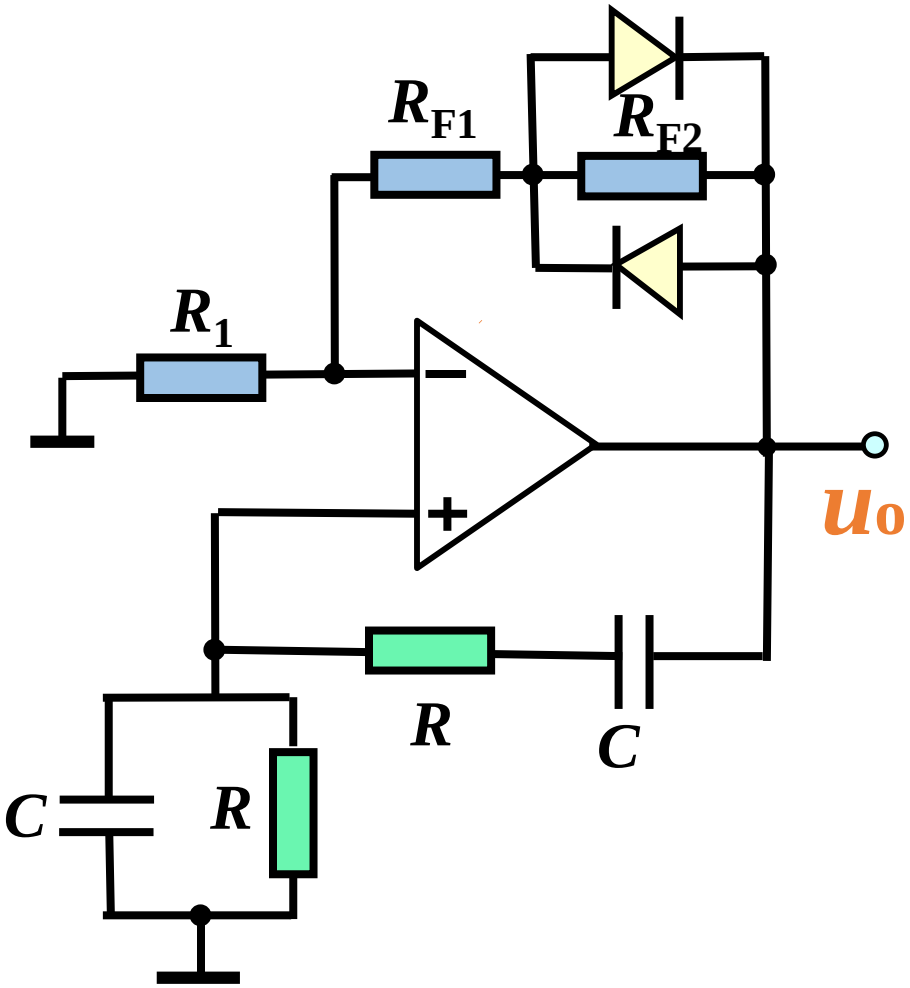


思考：如果R_T具有正温度系数，应接在何处？

7.1.2 RC正弦波振荡电路

用二极管稳幅

电流增大时二极管的动态电阻减小，电流减小时二极管动态电阻增大特点，即加入非线性环节来稳定输出电压。



作业

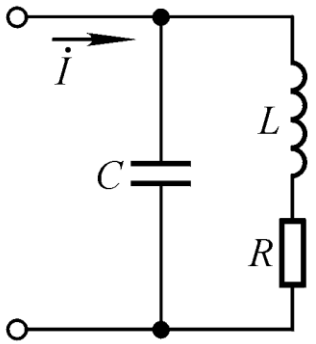
7.6

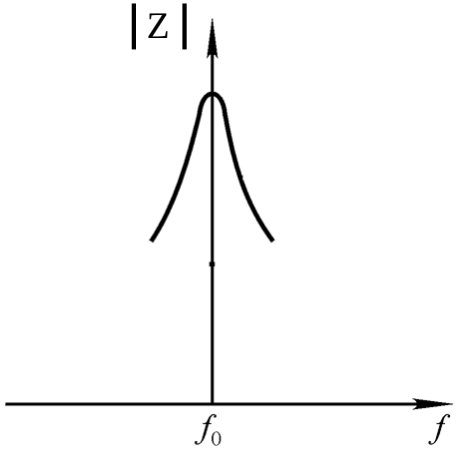
7.8

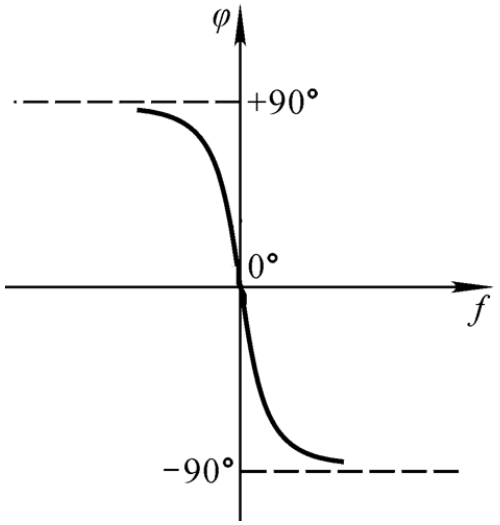
7.1.3 *LC*正弦波振荡电路

选频网络

- 电路形式：LC正弦波振荡电路的选频网络采用LC的并联网络；通常振荡频率较高，放大电路多用分立元件电路。





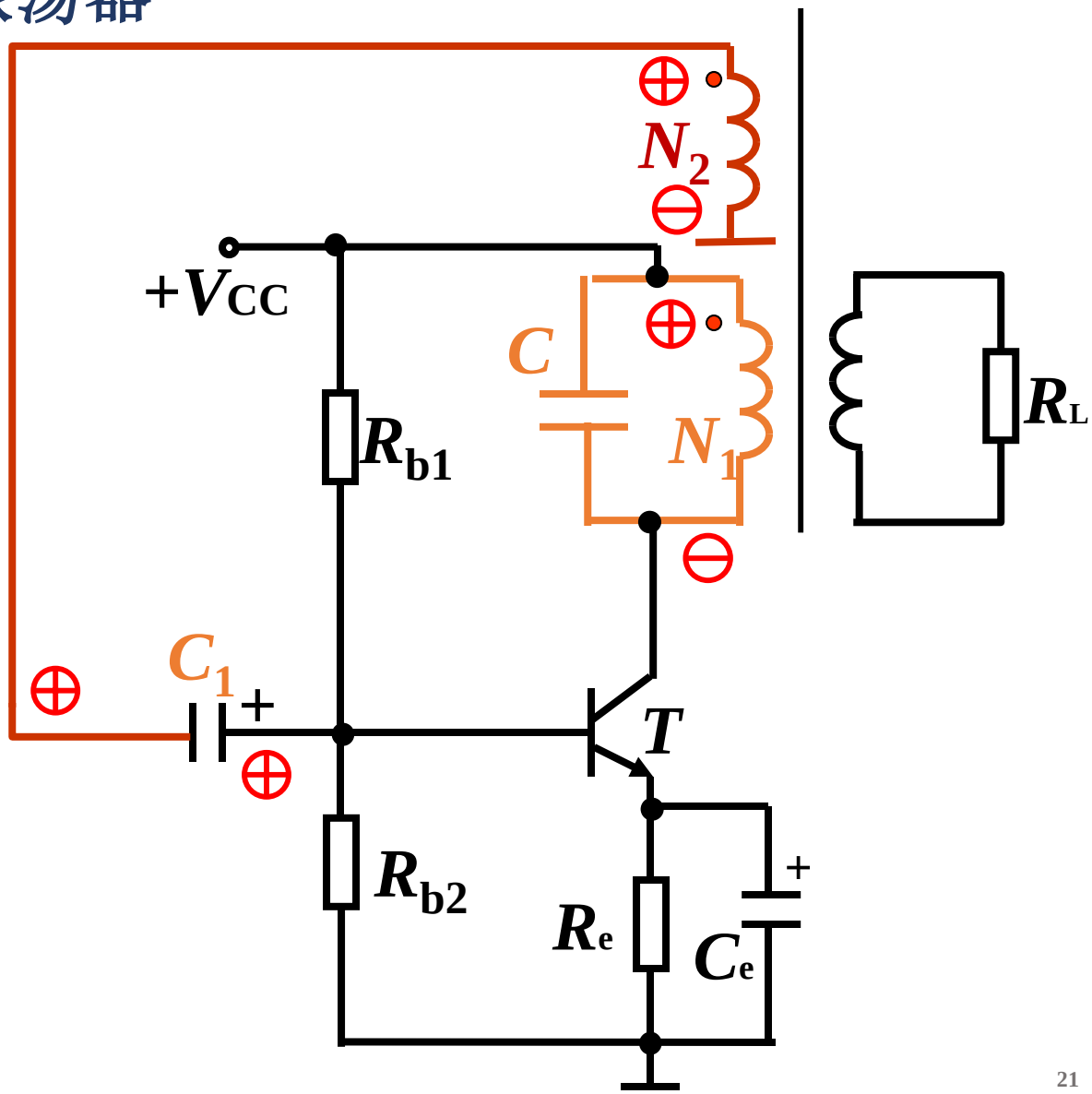


$$\omega_0 \approx \frac{1}{\sqrt{LC}}, \quad f_0 \approx \frac{1}{2\pi\sqrt{LC}}, \quad Q \approx \frac{1}{R}\sqrt{\frac{L}{C}}$$

7.1.3 *LC*正弦波振荡电路

1.变压器反馈式 *LC*振荡器

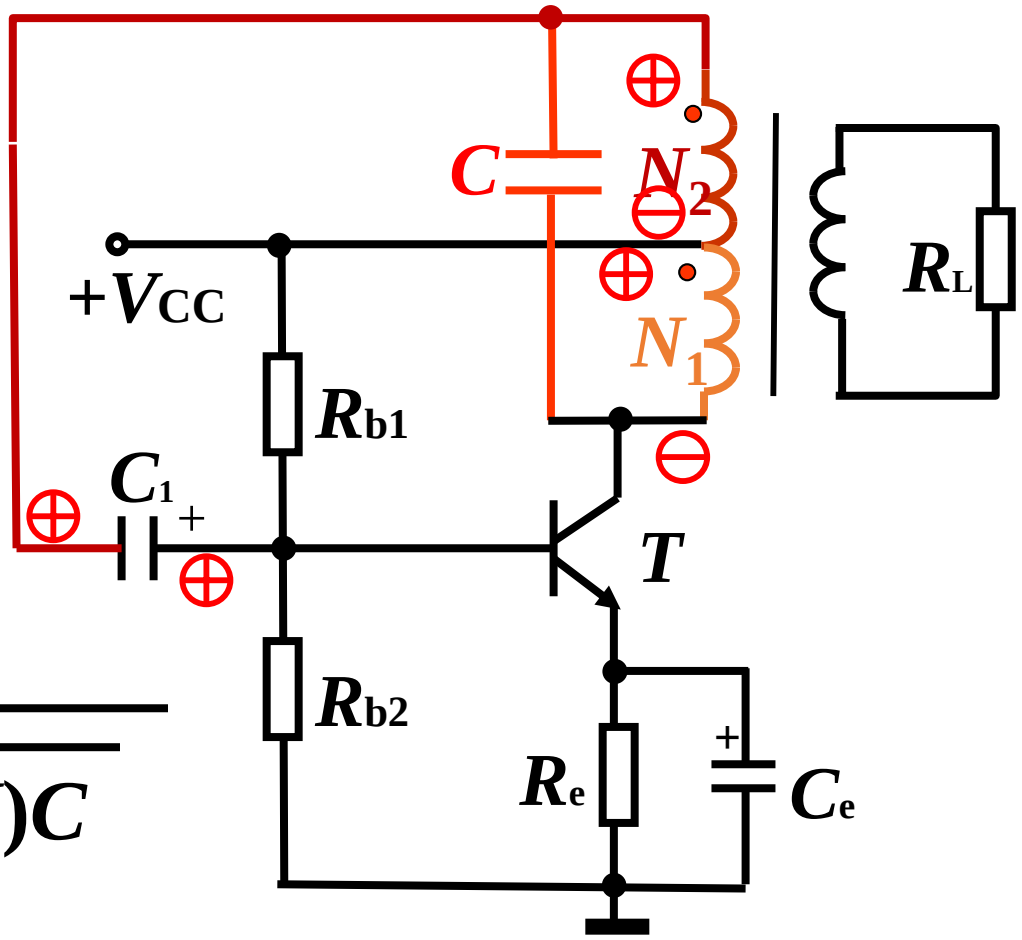
$$f_0 \approx \frac{1}{2\pi\sqrt{LC}}$$



7.1.3 *LC* 正弦波振荡电路

2. 电感反馈式振荡电路

$$f_0 \approx \frac{1}{2\pi\sqrt{LC}}$$



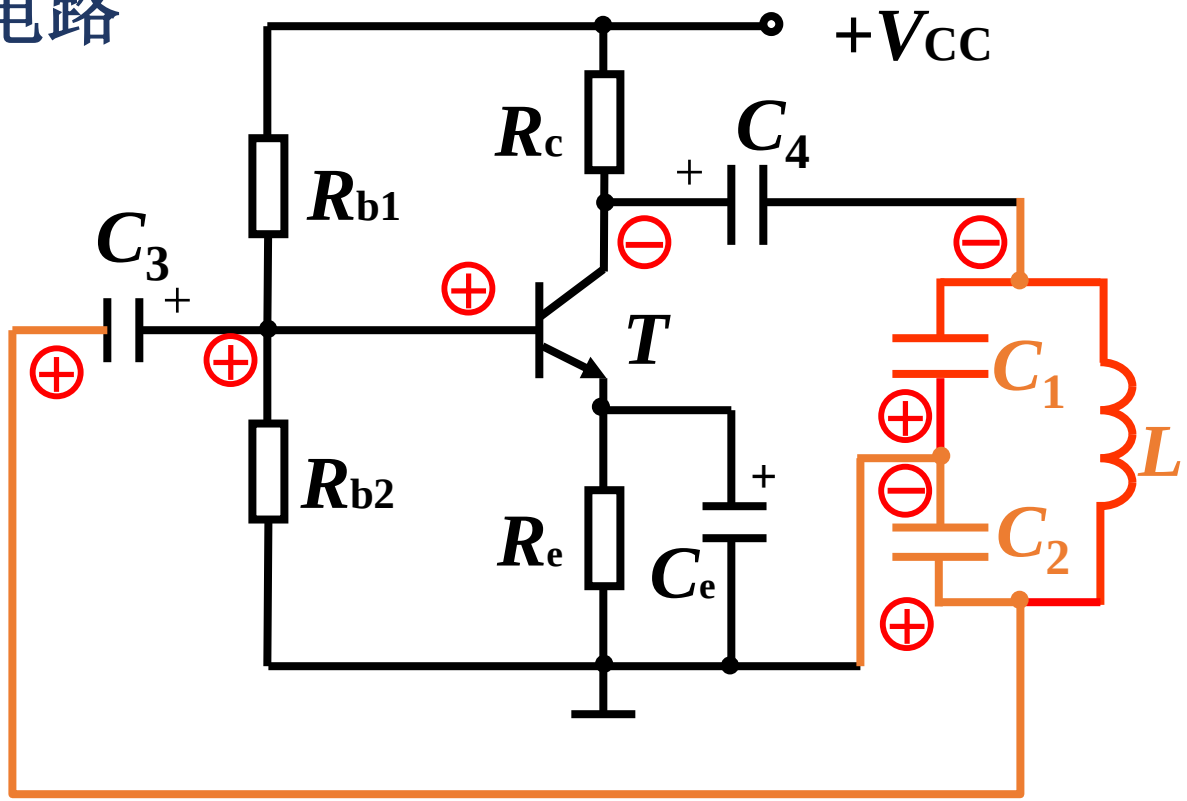
$$f_0 \approx \frac{1}{2\pi\sqrt{(L_1 + L_2 + 2M)C}}$$

电感三点式振荡电路　(Hartley)

7.1.3 *LC* 正弦波振荡电路

3.电容反馈式振荡电路

$$f_0 \approx \frac{1}{2\pi\sqrt{LC}}$$

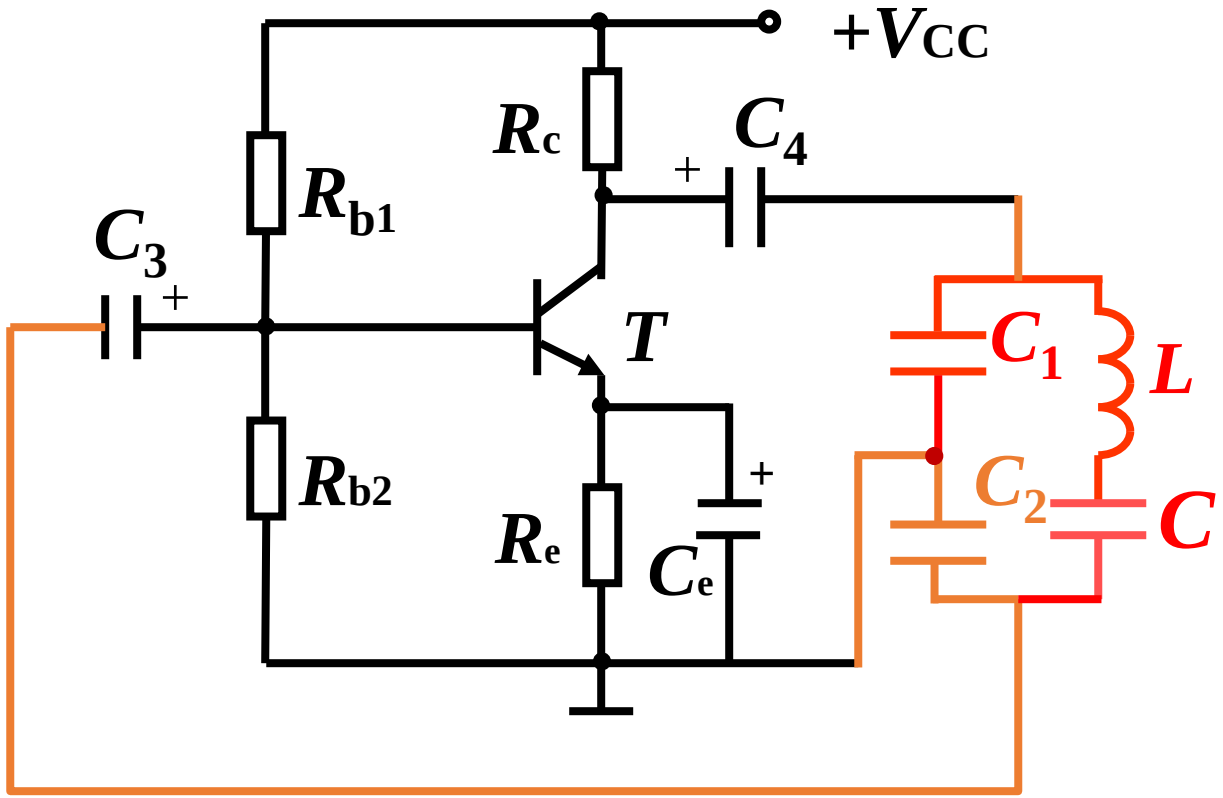


$$f_0 \approx \frac{1}{2\pi\sqrt{L\dfrac{C_1 C_2}{C_1 + C_2}}}$$

电容 三点式振荡电路
(Colpitts)

7.1.3 *LC*正弦波振荡电路

4.改进型电容 三点式振荡电路

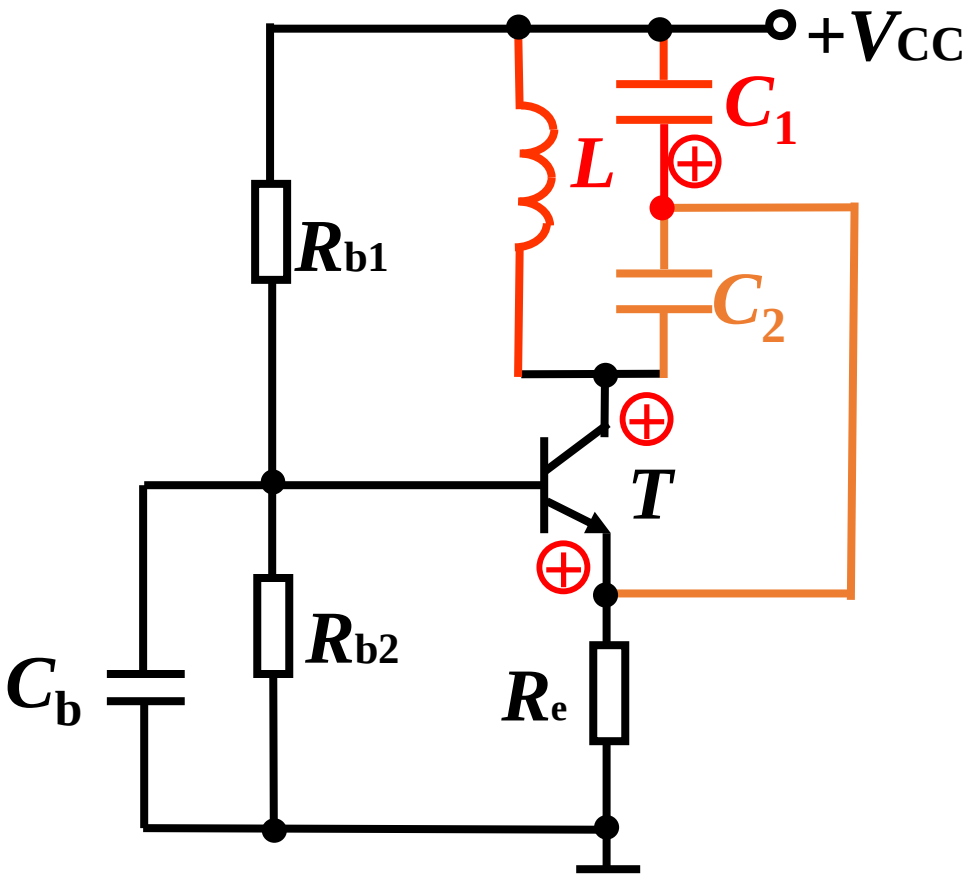


$C<<C_1$，$C<<C_2$

$$f_0 \approx \frac{1}{2\pi\sqrt{LC}}$$

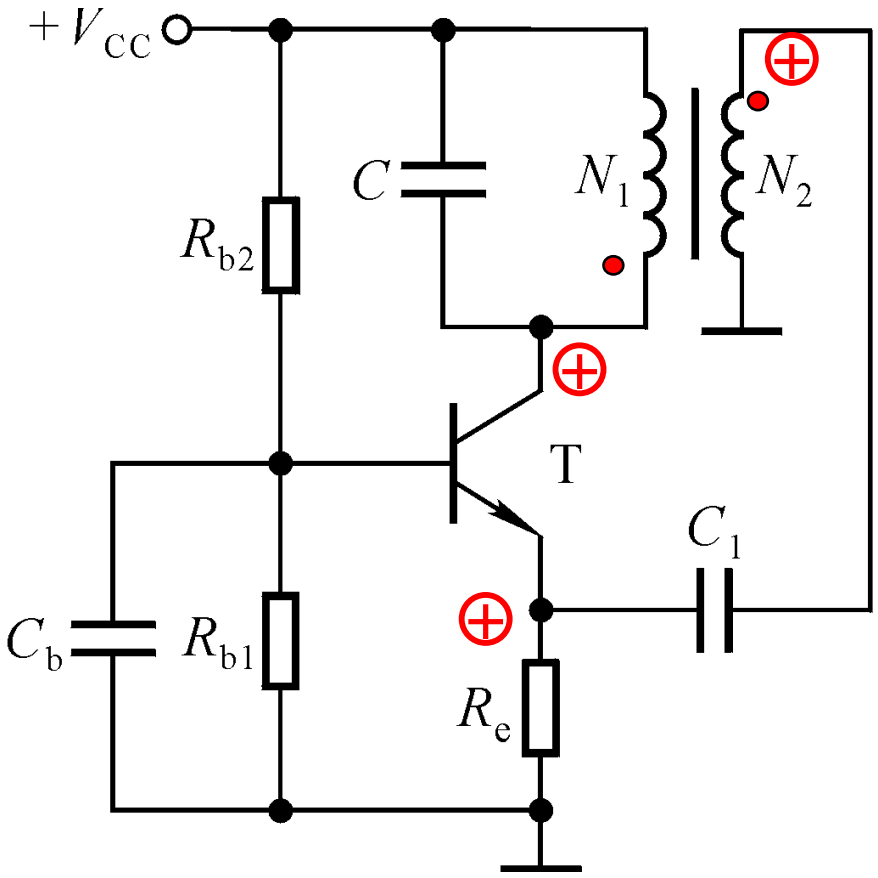
7.1.3 *LC*正弦波振荡电路

5.采用共基放大电路的电容三点式振荡电路



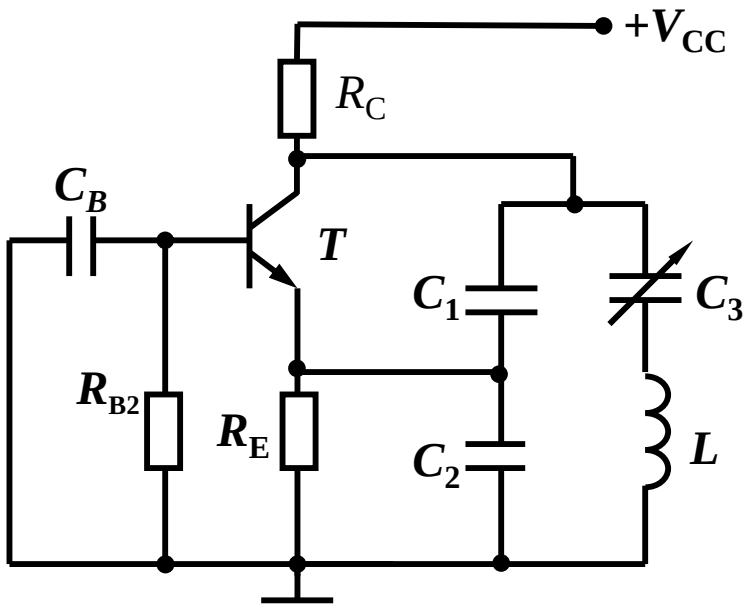
7.1.3 *LC*正弦波振荡电路

例：C_b为旁路电容，C_1为耦合电容，对交流信号均可视为短路。为使电路可能产生正弦波振荡，说明变压器一次线圈和二次线圈的同名端



7.1.3 *LC*正弦波振荡电路

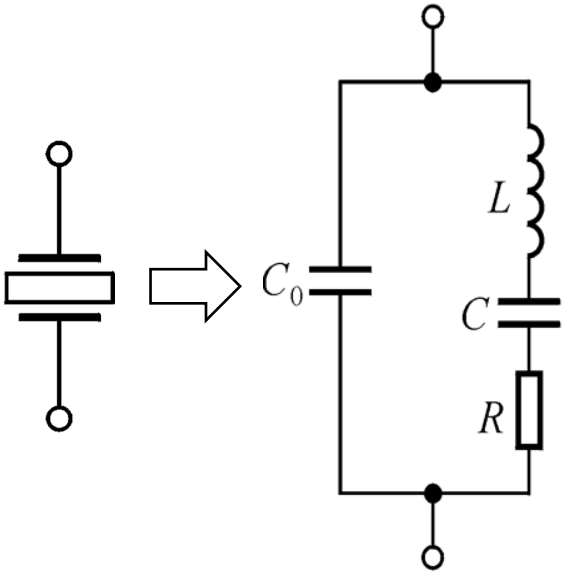
例：判断电路可否振荡



无合适的静态工作点，三极管未处在放大状态，不满足构成振荡器的基本条件。

7.1.4石英晶体正弦波振荡电路

将二氧化硅结晶体按特定方向切割成很薄的品片， 再将晶片两个对应的表面抛光和涂敷银层，作为两个极引出引脚并封装。



作业
7.10