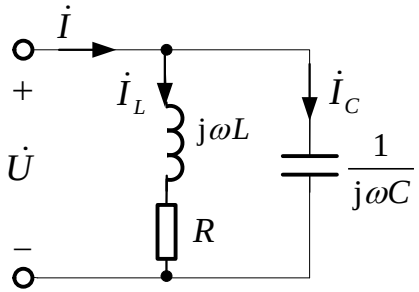
实际并联谐振电路

由于实际的电感线圈都有电阻，故有如下的实际并联电路



端口阻抗 $Z=\dfrac{(R+j\omega L)\times(-j/\omega C)}{R+j\omega L-j/\omega C}\overset{\omega_0 L>>R}{\underset{\text{谐振}}{\approx}}$

$$\frac{j\omega L(-j/\omega C)}{R+j\omega L-j/\omega C}=\frac{L/C}{R+j(\omega L-1/\omega C)}$$

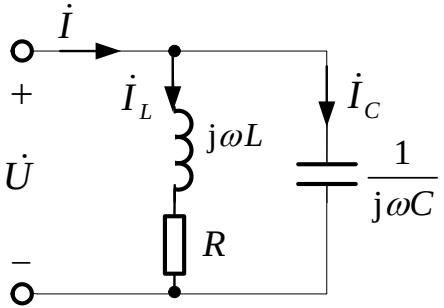
谐振条件 $\omega L=1/\omega C$

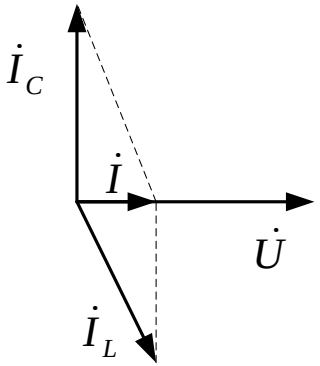
谐振方法 $\omega=\omega_0=1/\sqrt{LC}$ →谐振角频率

谐振时其等效阻抗为一个电阻 $R_0=\dfrac{L}{RC}$

当 $R=0$ $R_0\to\infty$ 理想电感与电容并联谐振

谐振时各支路电流





$$\dot{I}_L = \frac{\dot{U}}{R + \mathrm{j}\omega L} \approx \frac{\dot{U}}{\mathrm{j}\omega L} \qquad (\omega L >> R)$$

$$\dot{I}_C = \mathrm{j}\omega C\dot{U}$$

$$I_L = \frac{U}{\sqrt{R^2 + (\omega_0 L)^2}} \approx \frac{U}{\omega_0 L} \quad ; I_C = \omega_0 CU$$

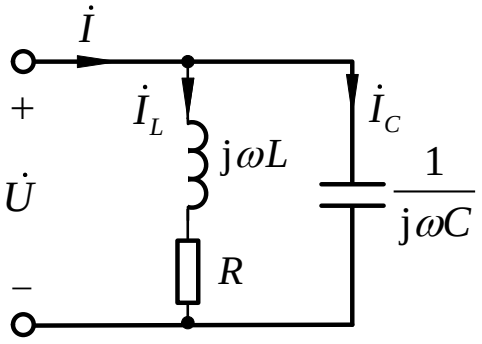
$$Q_L = \omega_0 L / R \qquad I_L \approx I_C = QI >> I$$

实际并联谐振电路

端口导纳 $Y=\dfrac{1}{R+\mathrm{j}\omega L}+\mathrm{j}\omega C$

$$=\frac{R}{R^2+(\omega L)^2}+\mathrm{j}\left[\omega C-\frac{\omega L}{R^2+(\omega L)^2}\right]$$

谐振条件 $\omega C-\dfrac{\omega L}{R^2+(\omega L)^2}=0$



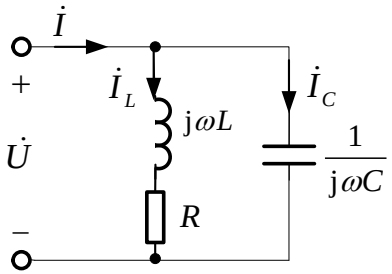
线圈与电容器并联电路

谐振角频率 ⇨ $\omega_0=\sqrt{\dfrac{1}{LC}-\dfrac{R^2}{L^2}}$ （当 $R<\sqrt{\dfrac{L}{C}}$ 时存在）

谐振时阻抗 $Z=R_0=\dfrac{R^2+(\omega_0 L)^2}{R}=\dfrac{L}{RC}$

并联谐振电路-例题

例2 已知图示电路$R=25\Omega$，$L=0.25\text{mH}$，$C=85\text{pF}$。试求该并联电路的谐振频率和谐振时的品质因数及阻抗。



解：$$\omega_0 \approx \sqrt{\frac{1}{LC}} = \sqrt{\frac{1}{0.25\times10^{-3}\,\text{H}\times85\times10^{-12}\,\text{F}}} = 6.86\times10^{6}\,\text{rad/s}$$

$$f_0 = \frac{\omega_0}{2\pi} = \frac{(6.86\times10^{6})\text{s}^{-1}}{2\pi} \approx 1092\text{kHz}$$

$$Q = \frac{\omega_0 L}{R} = \frac{6.86\times10^{6}\times0.25\times10^{-3}\Omega}{25\Omega} = 68.6$$

$$Z = R_0 = \frac{L}{RC} = \frac{0.25\times10^{-3}\,\text{H}}{25\Omega\times85\times10^{-12}\,\text{F}} = 118\text{k}\Omega$$