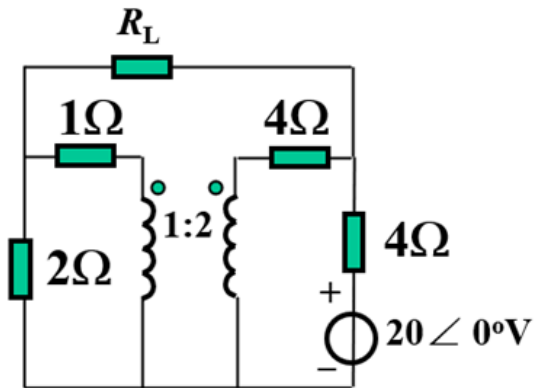


第7次习题课

- 互感
- 变压器
- 频率特性和滤波器
- 谐振

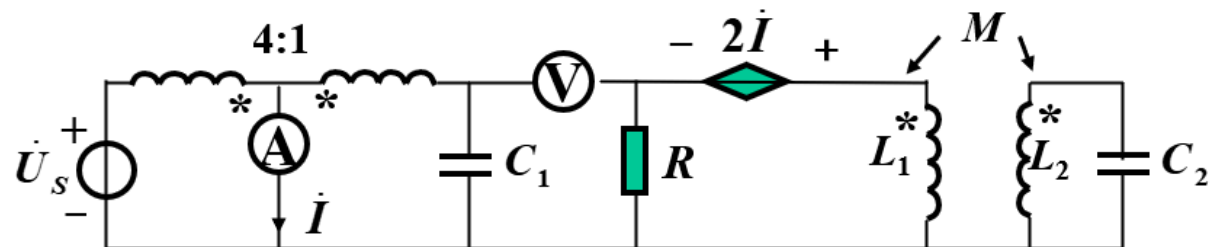
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1. R_L 取值为多大时获得最大功率？最大功率是多少？

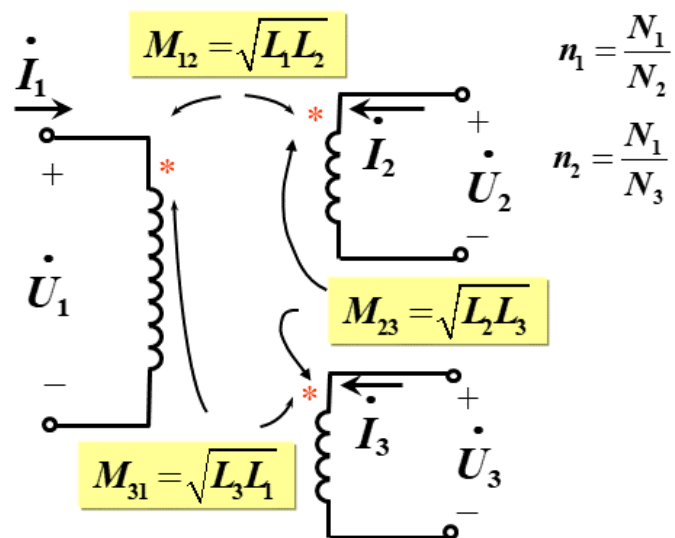


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2. $\dot{U}_s = 200\angle 0^\circ$, $\omega = 2 \text{ rad/s}$, $C_1 = 0.05 \text{ F}$, $R = 2\Omega$, $L_1 = 4 \text{ H}$
 $L_2 = 2 \text{ H}$, $M = 1 \text{ H}$, $C_2 = 0.25 \text{ F}$ 求电压表和电流表的读数。

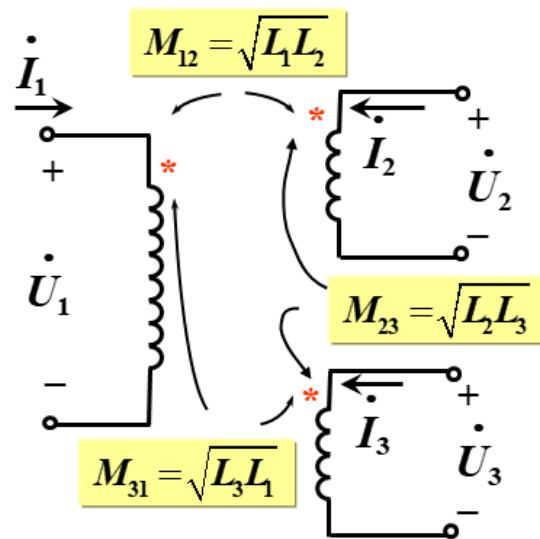


3-1 仿造2线圈全耦合变压器关系，推导3线圈全耦合变压器的电压电流关系



3-2 仿造2线圈理想变压器关系，基于3-1推导3线圈理想变压器的电压电流关系

拓展：3绕组全耦合变压器的性质



$$\begin{cases} \dot{U}_1 = j\omega L_1 \dot{I}_1 + j\omega \sqrt{L_1 L_2} \dot{I}_2 + j\omega \sqrt{L_1 L_3} \dot{I}_3 \\ \dot{U}_2 = j\omega \sqrt{L_1 L_2} \dot{I}_1 + j\omega L_2 \dot{I}_2 + j\omega \sqrt{L_2 L_3} \dot{I}_3 \\ \dot{U}_3 = j\omega \sqrt{L_1 L_3} \dot{I}_1 + j\omega \sqrt{L_2 L_3} \dot{I}_2 + j\omega L_3 \dot{I}_3 \end{cases}$$

$$\begin{cases} \dot{U}_1 = \sqrt{\frac{L_1}{L_2}} \dot{U}_2 = \frac{N_1}{N_2} \dot{U}_2 \\ \dot{U}_1 = \sqrt{\frac{L_1}{L_3}} \dot{U}_3 = \frac{N_1}{N_3} \dot{U}_3 \\ \dot{I}_1 = \frac{\dot{U}_1}{j\omega L_1} - \sqrt{\frac{L_2}{L_1}} \dot{I}_2 - \sqrt{\frac{L_3}{L_1}} \dot{I}_3 \end{cases}$$

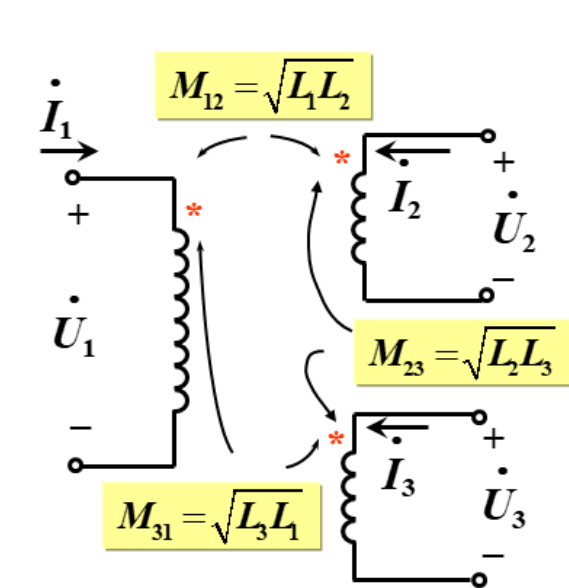
$$n_1 = \frac{N_1}{N_2}$$

$$n_2 = \frac{N_1}{N_3}$$

$$\begin{cases} \dot{U}_1 = n_1 \dot{U}_2 \\ \dot{U}_1 = n_2 \dot{U}_3 \\ \dot{I}_1 = \frac{\dot{U}_1}{j\omega L_1} - \frac{1}{n_1} \dot{I}_2 - \frac{1}{n_2} \dot{I}_3 \end{cases}$$

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3绕组全耦合变压器的性质



$$n_1 = \frac{N_1}{N_2}$$

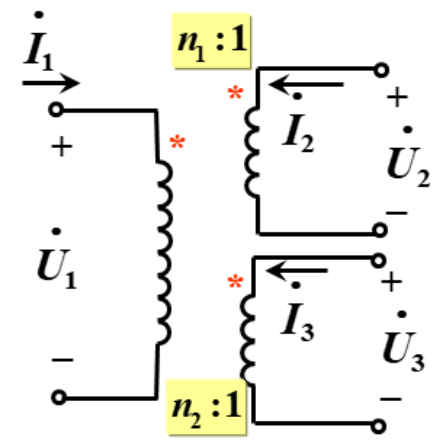
$$n_2 = \frac{N_1}{N_3}$$



$$\begin{cases} \dot{U}_1 = n_1 \dot{U}_2 \\ \dot{U}_1 = n_2 \dot{U}_3 \\ \dot{I}_1 = \frac{\dot{U}_1}{j\omega L_1} - \frac{1}{n_1} \dot{I}_2 - \frac{1}{n_2} \dot{I}_3 \end{cases}$$

$L_1 \rightarrow \infty$
同时确保 L_1/L_2 和 L_1/L_3 比值不变
且全耦合

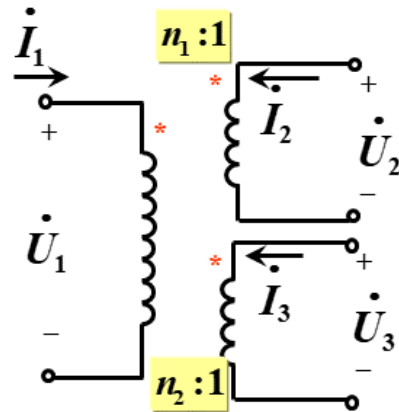
3绕组理想变压器的性质



$$\begin{cases} \dot{U}_1 = n_1 \dot{U}_2 \\ \dot{U}_1 = n_2 \dot{U}_3 \\ \dot{I}_1 = -\frac{1}{n_1} \dot{I}_2 - \frac{1}{n_2} \dot{I}_3 \end{cases}$$

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3 绕组理想变压器的性质



$$n_1 = \frac{N_1}{N_2}$$

$$n_2 = \frac{N_1}{N_3}$$

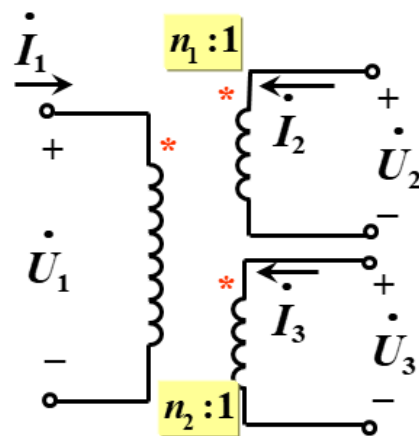
$$\begin{cases} \dot{U}_1 = n_1 \dot{U}_2 \\ \dot{U}_1 = n_2 \dot{U}_3 \\ \dot{I}_1 = -\frac{1}{n_1} \dot{I}_2 - \frac{1}{n_2} \dot{I}_3 \end{cases}$$

$$\frac{\dot{U}_1}{N_1} = \frac{\dot{U}_2}{N_2} = \frac{\dot{U}_3}{N_3}$$

$$N_1 \dot{I}_1 + N_2 \dot{I}_2 + N_3 \dot{I}_3 = 0$$

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三绕组理想变压器的另一种观点



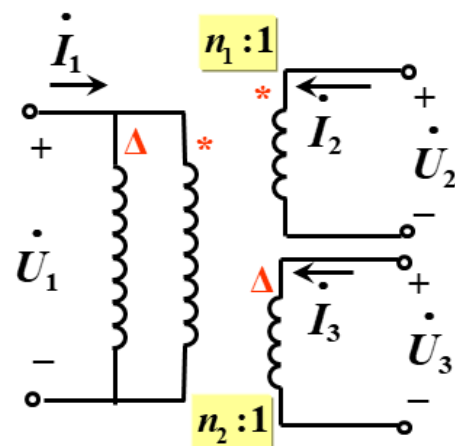
$$\dot{U}_1 = n_1 \dot{U}_2$$

$$\left\{ \begin{array}{l} \dot{U}_1 = n_2 \dot{U}_3 \end{array} \right.$$

$$\dot{I}_1 = -\frac{1}{n_1} \dot{I}_2 - \frac{1}{n_2} \dot{I}_3$$

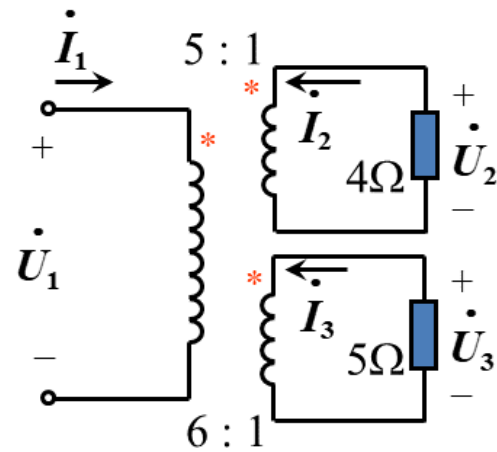
$$n_1 = \frac{N_1}{N_2}$$

$$n_2 = \frac{N_1}{N_3}$$



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3-拓展，理想变压器副边有两个线圈，变比分别为5:1和6:1。
求原边等效电阻 R 。

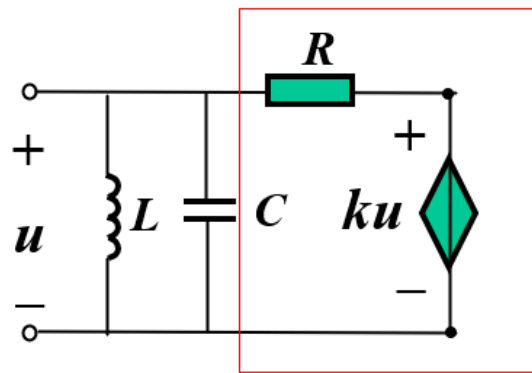


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回顾 LC 串/并联谐振的电抗频率特性

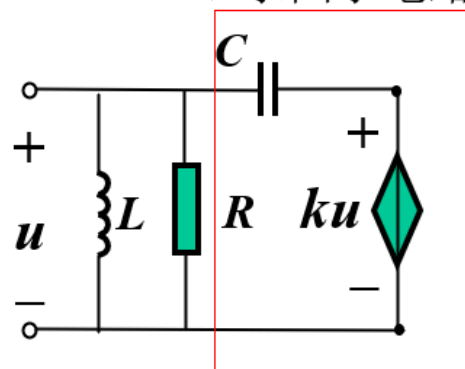
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4. 求图示电路的谐振频率以及在谐振时的入端阻抗 ($0 < k < 1$)



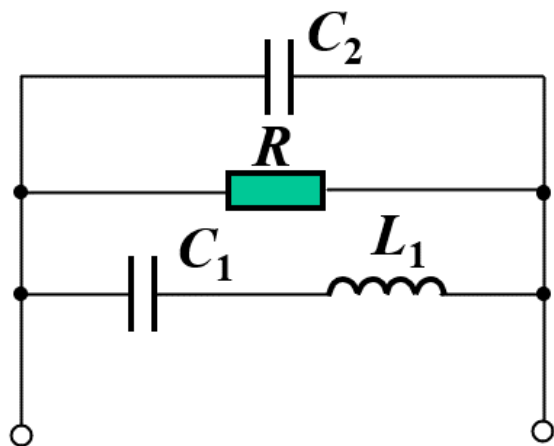
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4. 求图示电路的谐振频率以及在谐振时的入端阻抗 ($0 < k < 1$)



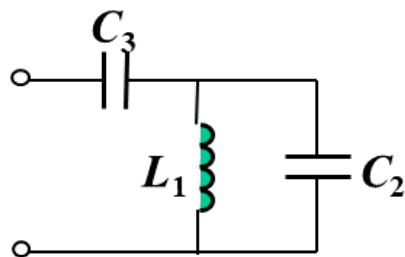
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4. 求图示电路的谐振频率以及在谐振时的入端阻抗 ($0 < k < 1$)



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L18



$$\omega_1 = \frac{1}{\sqrt{L_1(C_2 + C_3)}}$$

发生串联谐振

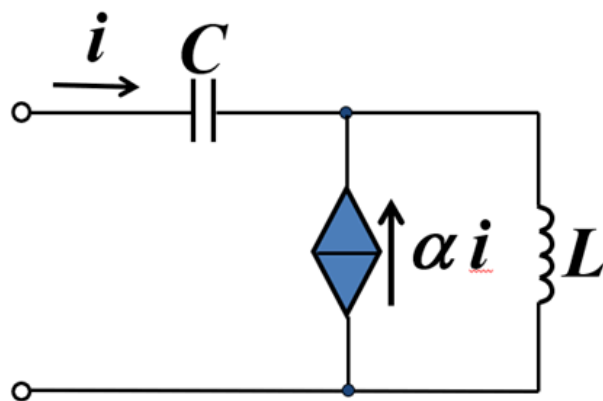
$$\omega_2 = \frac{1}{\sqrt{L_1 C_2}}$$

发生并联谐振

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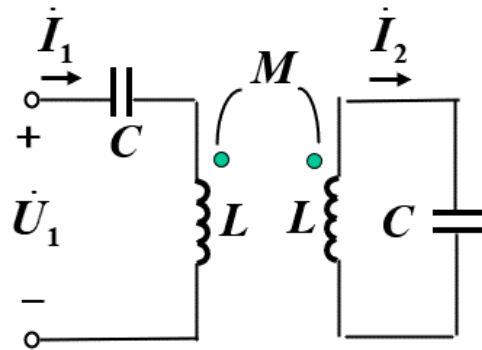
求图示电路的谐振频率

投稿



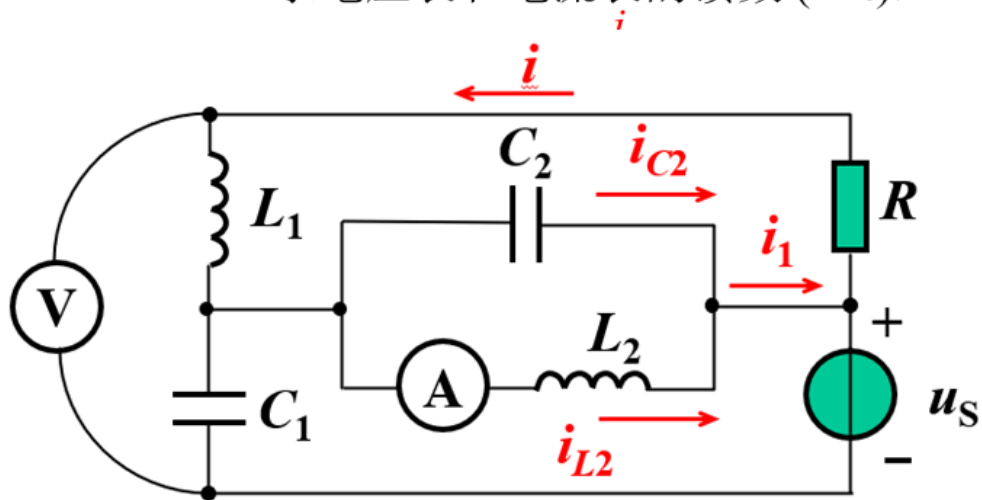
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5. 求谐振频率.



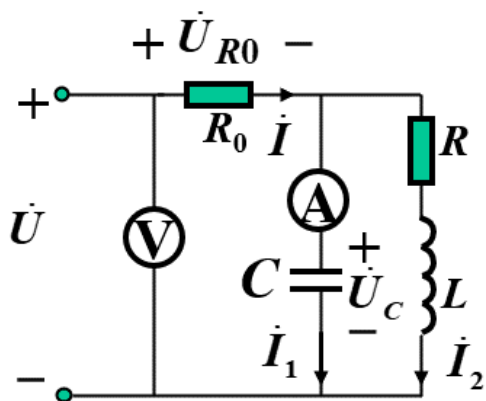
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6. 电路如图所示. $u_s(t)=\sin t$ V,
 $L_1=L_2=1\text{H}$, $C_1=C_2=1\text{F}$, $R=1\Omega$.
 求电压表和电流表的读数 (rms).



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7. $\omega=1000\text{rad/s}$ 时, 电路发生谐振。 $R_0=25\Omega$, $C=16\mu\text{F}$, 电压表的读数是 100V , 电流表的读数是 1.2A , 求 R 和 L .



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