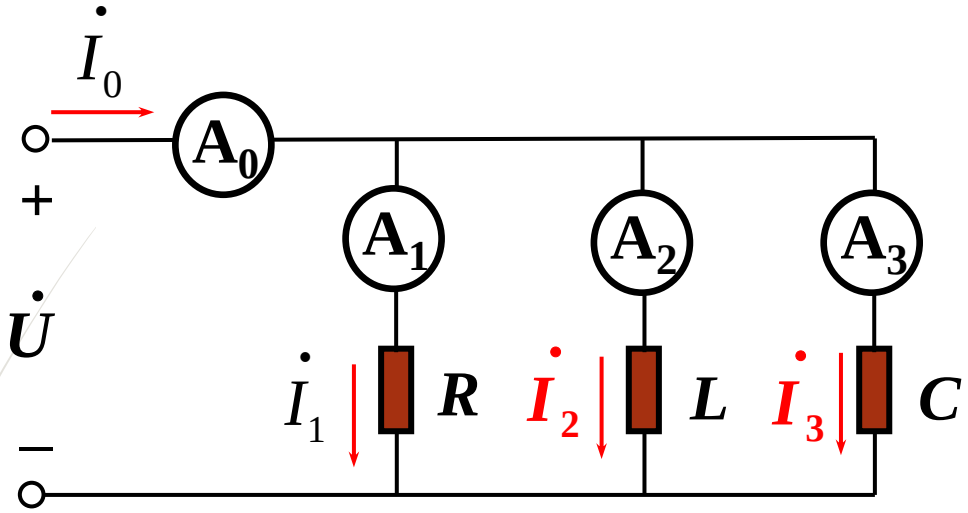
L19 总复习 –part2

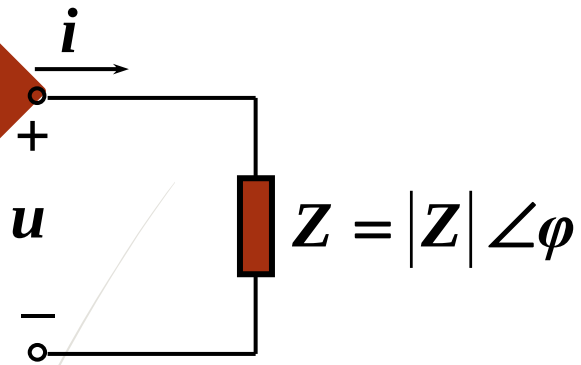
L19 Review – part2

15、



***f*=50Hz时，A_0 的读数是 5A, A_1 的读数是4A, A_2的读数是4A。若*U*不变，频率升为100Hz，请问此时 A_0读数是？**

16.



电路如图所示，已知电压和电流为

$$u(t)=10\sin(400\pi\, t+60^\circ)\ \mathrm{V}$$

$$i(t)=-\frac{1}{\sqrt{2}}\cos(400\pi\, t-150^\circ)\ \mathrm{A}$$

(a) ω = 400π rad/s, f = 200Hz, T = 0.005s .

(b) 有效值 U = 7.07V，有效值 I = 0.5A .

(c) u 和 i 的相位差 $\psi_u-\psi_i$ = -60° .

(d)负载是 容性，$|Z|$ = 14.14Ω，φ = -60° .

比较相位时，要将时域表达式转换成标准正弦形式

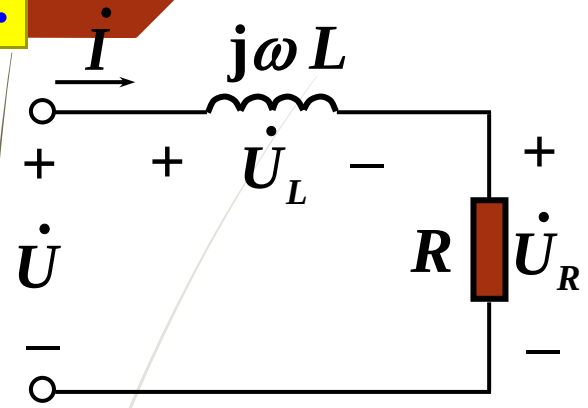
$$i(t)=\frac{1}{\sqrt{2}}\cos(400\pi t-150^\circ+180^\circ)=\frac{1}{\sqrt{2}}\cos(400\pi t+30^\circ)$$

$$=\frac{1}{\sqrt{2}}\sin(400\pi t+30^\circ+90^\circ)=\frac{1}{\sqrt{2}}\sin(400\pi t+120^\circ)A$$

$\varphi=\psi_u-\psi_i=60^o-120^o=-60^o$

17. 下列哪些表达式是正确的，哪些是错误的，并改正.

1).



(1) $\dot{I}=\dfrac{\dot{U}}{R+j\omega L}$ (2) $I=\dfrac{U}{\sqrt{R^2+(\omega L)^2}}$

✓(3) $u=u_R+u_L$ (4) $U^2=U_L^2+U_R^2$

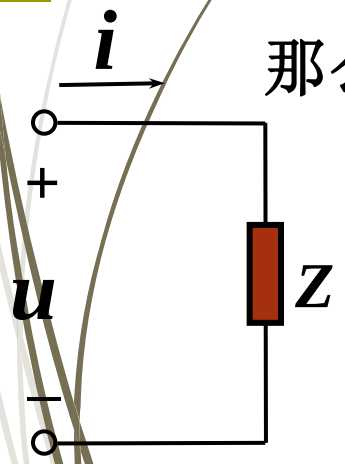
$\dot{U}=\dot{U}_R+\dot{U}_L$ (5) $P=\dfrac{U_R^2}{R}$

✓(6) $P=I^2R$ (7) $|Z|=\sqrt{R^2+(\omega L)^2}$

2).

如果 $u(t)=311\sin(\omega t+45°)\text{V}$, $Z=25\angle 60°\,\Omega$

那么 $i\neq\dfrac{u}{Z}\neq\dfrac{311\sin(\omega t+45°)}{25\angle 60°}\neq 12.44\sin(\omega t+45°-60°)\text{A}$



$$\dot{I}=\frac{\dot{U}}{Z}=\frac{\frac{311}{\sqrt{2}}\angle 45^{\circ}}{25\angle 60^{\circ}}=8.8\angle -15^{\circ}\ \text{A}$$

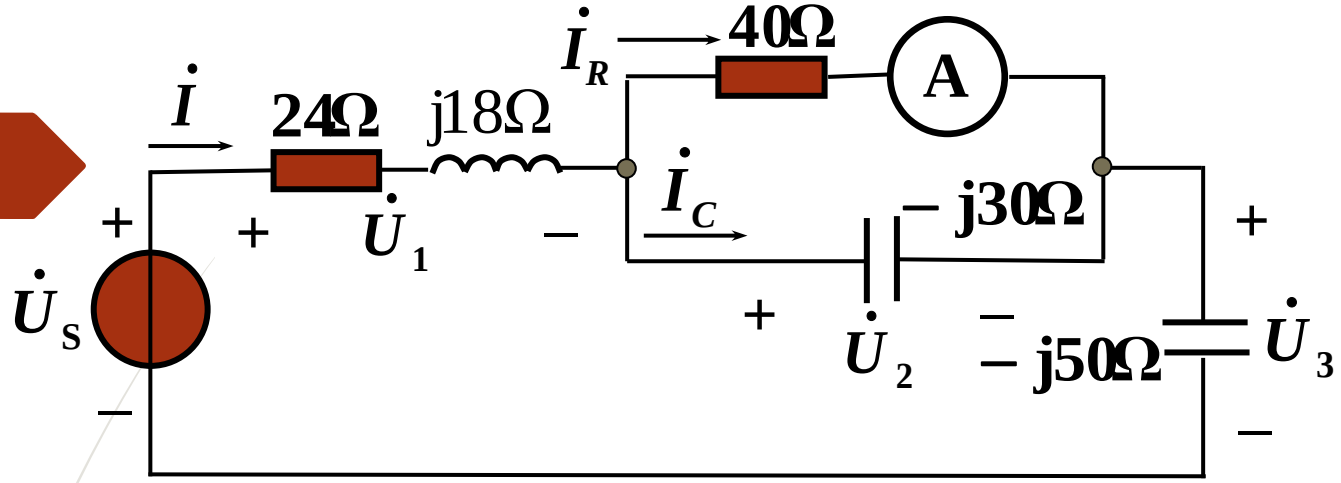
$i=8.8\sqrt{2}\sin(\omega t-15^{\circ})\ \text{A}$ 相量✕正弦量

正弦量	相量
时域 (t)	频域 (ω)
$u,\ i$	$\dot{U},\ \dot{I}$
$u_R = Ri_R$	$\dot{U}_R = R\dot{I}_R$
$u_L = L\dfrac{di_L}{dt}$	$\dot{U}_L = \mathrm{j}\omega L\dot{I}_L$
$i_C = C\dfrac{du_C}{dt}$	$\dot{I}_C = \mathrm{j}\omega C\dot{U}_C$
$\sum i = 0$	$\sum \dot{I} = 0$
$\sum u = 0$	$\sum \dot{U} = 0$

$\dot{U} = Z\dot{I}$

$\dot{I} = Y\dot{U}$

18.



电流表的读数是 1.5A(有效值)，求：(1)U_S=? (2)电路吸收的有功功率 P 和无功功率 Q 。

解：　令 $\dot{I}_R = 1.5\angle 0^\circ \text{A}$

那么 $\dot{U}_2 = 40 \times 1.5\angle 0^\circ = 60\angle 0^\circ \text{V}$

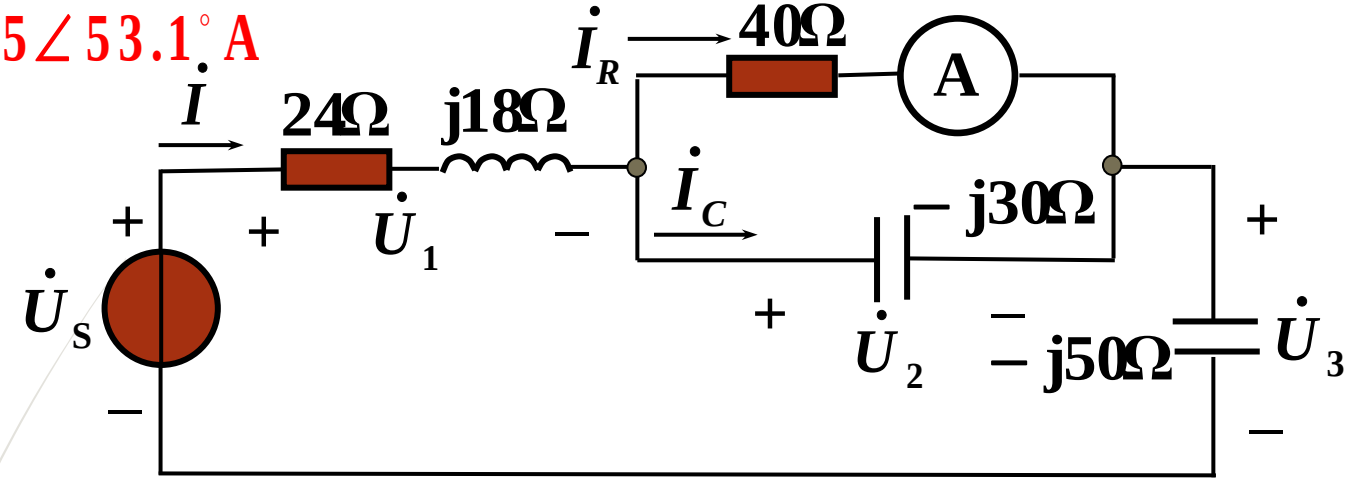
$$\dot{I}_C = \frac{\dot{U}_2}{-\text{j}30} = 2\angle 90^\circ = \text{j}2\text{A}$$

$$\dot{I} = \dot{I}_R + \dot{I}_C = 1.5 + \text{j}2 = 2.5\angle 53.1^\circ \text{A}$$

$$\dot{U}_1 = (24 + \text{j}18)\dot{I} = (24 + \text{j}18) \times 2.5\angle 53.1^\circ = 75\angle 90^\circ = \text{j}75\text{V}$$

$$\dot{U}_3 = (-\text{j}50)\dot{I} = (-\text{j}50) \times 2.5\angle 53.1^\circ = 125\angle -36.9^\circ = 100 - \text{j}75\text{V}$$

$\dot{I} = 2.5\angle 53.1^\circ \text{ A}$



$$\dot{U}_S = \dot{U}_1 + \dot{U}_2 + \dot{U}_3 = \text{j}75 + 60 + 100 - \text{j}75 = 160\angle 0^\circ \text{ V}$$

$$P_{吸} = U_S I\cos\varphi = 160\times 2.5\times 0.6 = 240 \text{ W}$$

$$P_{吸} = 24I^2 + 40I_R^2 = 24\times(2.5)^2 + 40\times(1.5)^2 = 240 \text{ W}$$

$$Q_{吸} = U_S I\sin\varphi = 160\times 2.5\times(-0.8) = -320 \text{ Var}$$

$$Q_{吸} = 18I^2 - 30I_C^2 - 50I^2$$

$$= 18\times(2.5)^2 - 30\times 2^2 - 50\times(2.5)^2 = -320 \text{ Var}$$

电源发出功率：　$\overline{S}_{发} = 160\times 2.5\angle -53.1^\circ = 240 - \text{j}320 \text{ VA}$

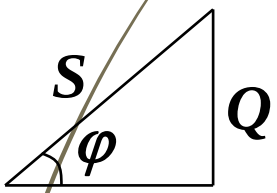
$$\overline{S} = \dot{U}\dot{I}^{*} = UI\angle\varphi = S\angle\varphi = P + \mathrm{j}Q$$

有功功率：$P=UI\cos\varphi$　　单位：W

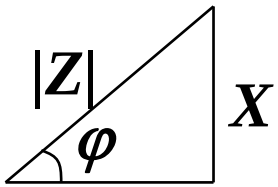
无功功率：$Q=UI\sin\varphi$　　单位：var

视在功率：$S=UI$　　单位：VA

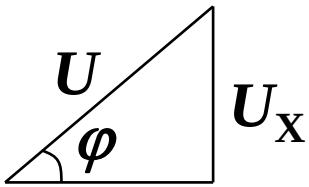
有功，无功，视在功率的关系：



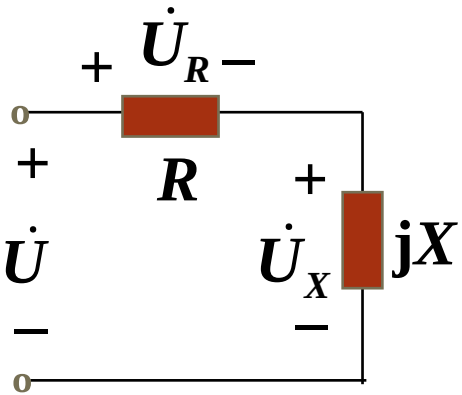
功率三角形



阻抗三角形



电压三角形



三个三角形相似

画相量图的步骤:

1. 设参考相量: { 电流 (串联电路) / 电压 (并联电路) }

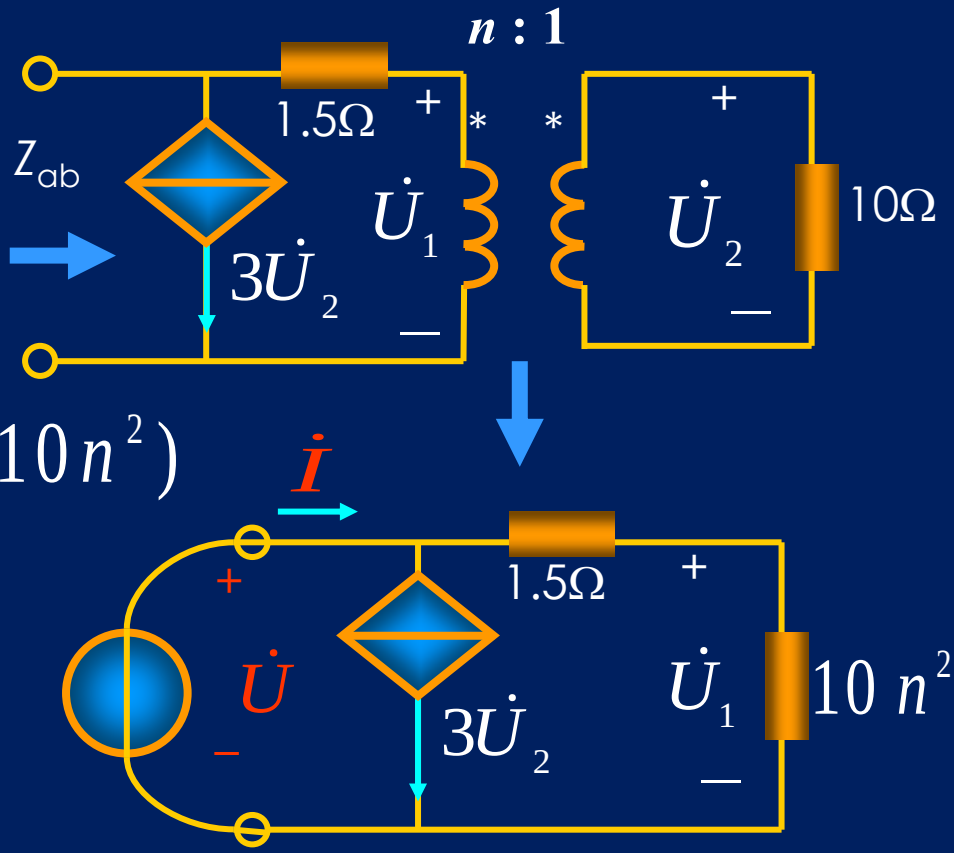
2. 根据元件特性，依次画出各支路的电压、电流相量。

3. 元件和支路的电压、电流相量间的关系:

元件 { R: $\dot{U}$ $\dot{I}$ 同相 / L: $\dot{U}$ 领先 $\dot{I}$ 90° / C: $\dot{U}$ 落后 $\dot{I}$ 90° }

支路 { RL: $\dot{U}$ 领先 $\dot{I}$ φ / RC: $\dot{U}$ 落后 $\dot{I}$ φ / $0^\circ < \varphi < 90^\circ$ }

19、已知图示电路的等效阻抗Z_{ab}= 0.25 Ω，求理想变压器的变比 n 。



解 应用阻抗变换

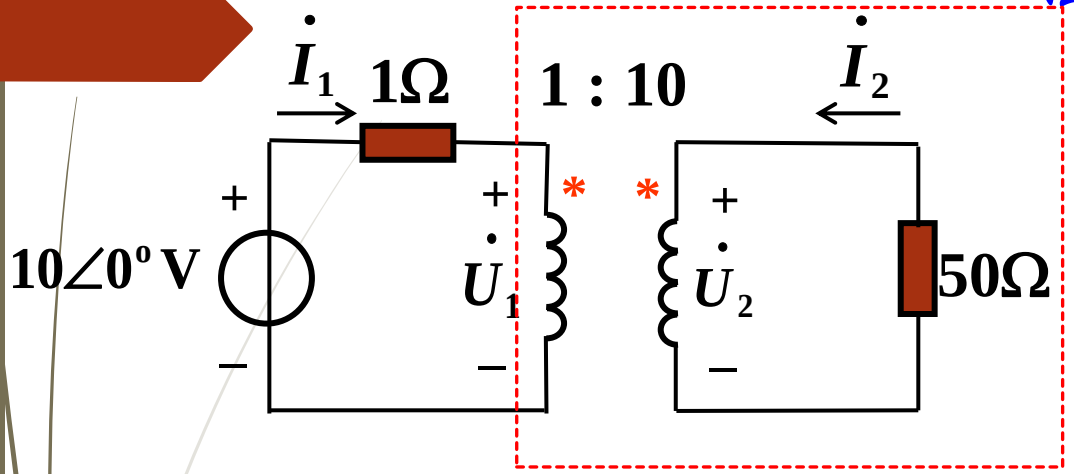
外加电源法得：

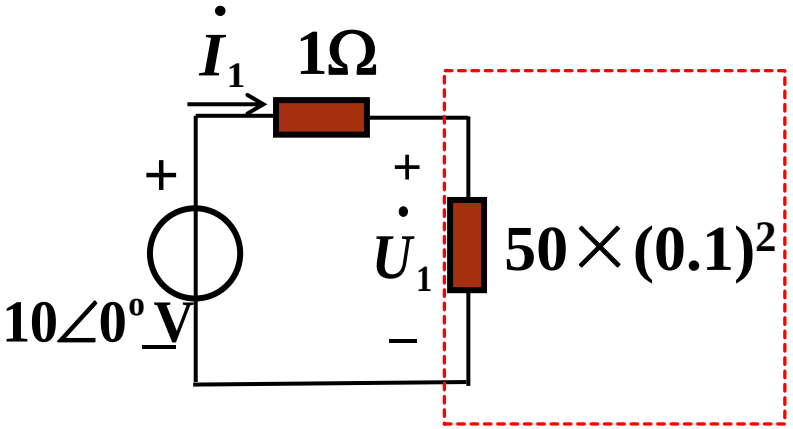
$$\begin{cases} \dot{U} = (\dot{I} - 3\dot{U}_2) \times (1.5 + 10n^2) \\ \dot{U}_1 = (\dot{I} - 3\dot{U}_2) \times 10n^2 \\ \dot{U}_1 = n\dot{U}_2 \end{cases}$$

$$Z_{ab} = 0.25 = \frac{\dot{U}}{\dot{I}} = \frac{1.5 + 10n^2}{30n + 1} \quad \rightarrow \quad \begin{cases} n = 0.5 \\ n = 0.25 \end{cases}$$

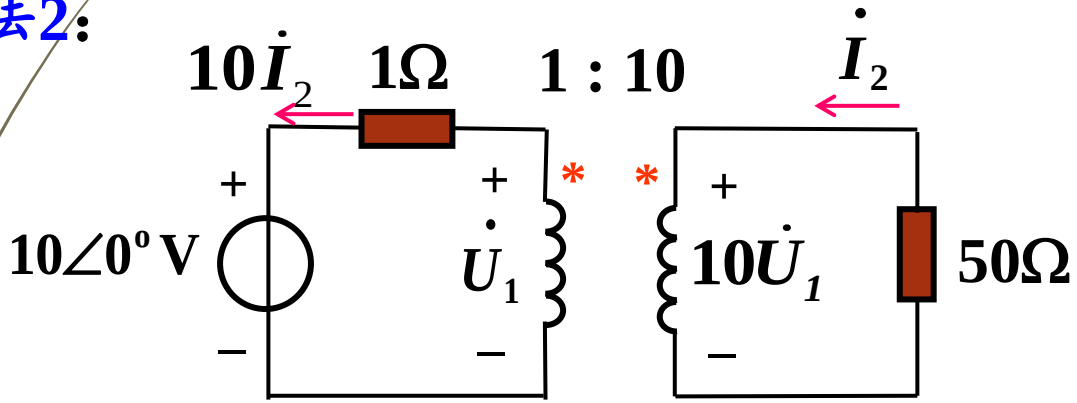
20、 已知如图所示，求电压 $\dot{U}_2$

法1：变阻抗特性（主级等效）



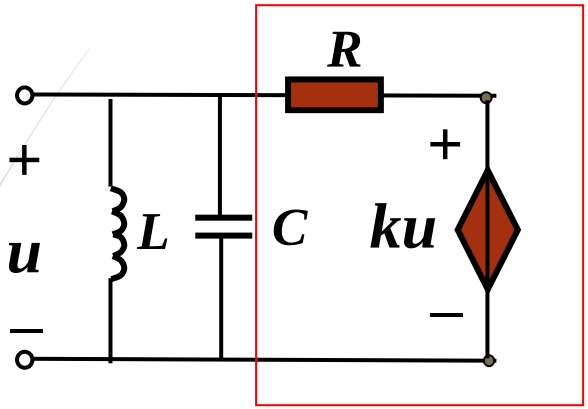


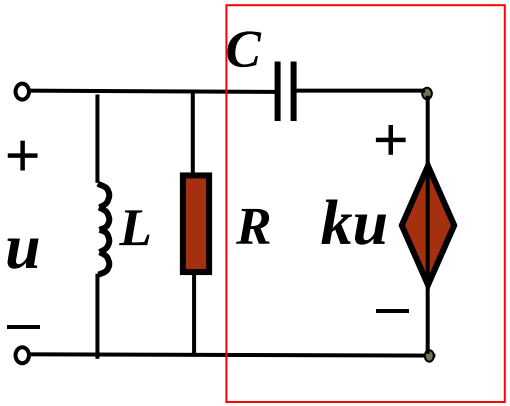
法2：



$$\begin{cases} 10\dot{U}_1 = -50\dot{I}_2 \\ 10\dot{I}_2 + 10 = \dot{U}_1 \end{cases} \Rightarrow \dot{U}_2 = 33.33\angle 0^o \text{ V}$$

21. 求图示电路的谐振频率以及在谐振时的入端阻抗 (0 < k < 1)





$$R_{等}=\frac{u}{(1-k)u/R}=\frac{R}{1-k}$$

$$\omega_0=\frac{1}{\sqrt{LC}}$$

$$Z(\omega_0)=\frac{R}{1-k}$$

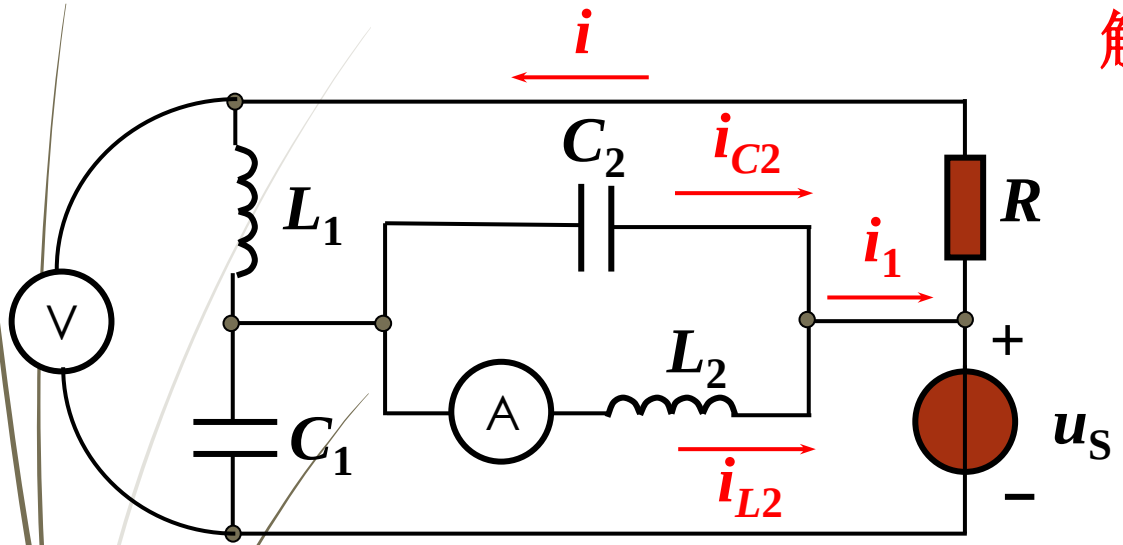
$$Z_{等}=\frac{\dot{U}}{(1-k)\dot{U}\mathrm{j}\omega C}$$

$$\omega_0=\frac{1}{\sqrt{LC(1-k)}}$$

$$Z(\omega_0)=R$$

22. 电路如图所示. $u_S(t)=\sin t$ V，$L_1=L_2=1$H，$C_1=C_2=1$F，$R=1\Omega$。

求电压表和电流表的读数 (RMS).



解：设 $\dot{U}_S=\dfrac{1}{\sqrt{2}}\angle 0^\circ$ V

$=0.707\angle 0^\circ$ V

$\omega L_2=\dfrac{1}{\omega C_2}=1\Omega$

(并联谐振)

$\dot{I}_1=0$

$\omega L_1=\dfrac{1}{\omega C_1}=1\Omega$ (串联谐振),

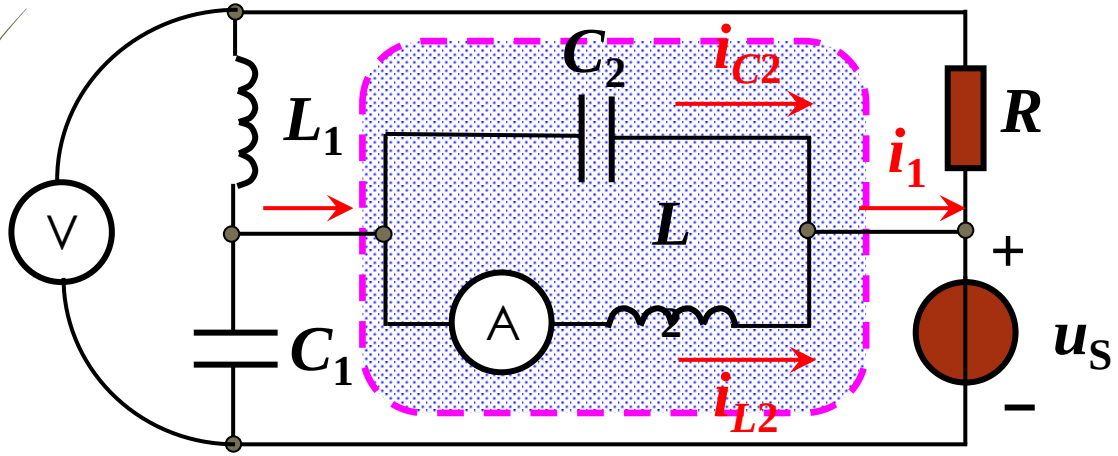
(V) =0

$\dot{I}=\dfrac{\dot{U}_S}{R}=\dfrac{0.707\angle 0^\circ}{1}=0.707\angle 0^\circ$ A

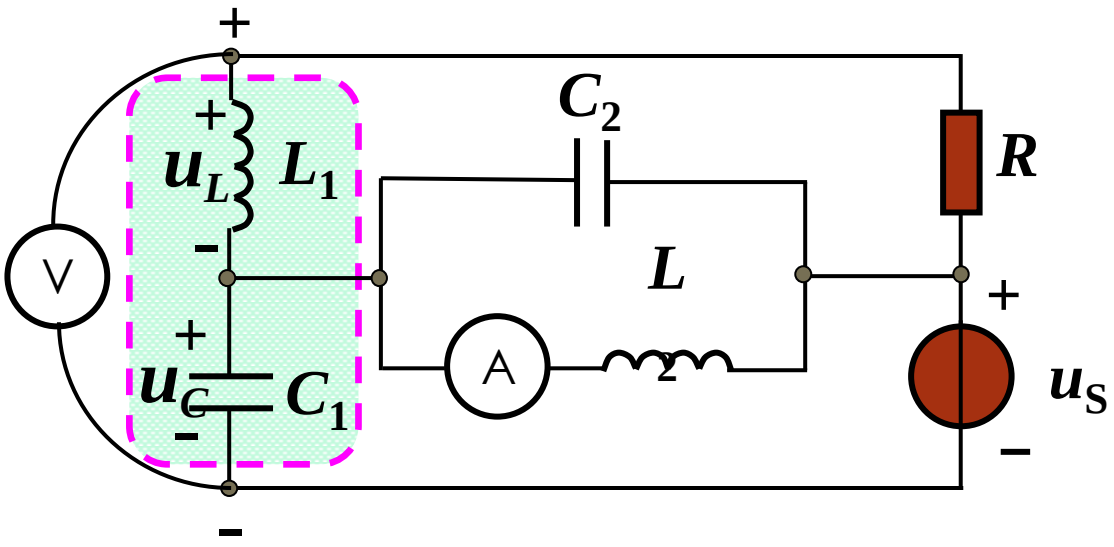
$\dot{I}_{L2}=\dfrac{\dfrac{1}{\mathrm{j}\omega C_1}\dot{I}-\dot{U}_S}{\mathrm{j}\omega L_2}=\dfrac{-\mathrm{j}0.707-0.707}{\mathrm{j}1}=-0.707+\mathrm{j}0.707=1.00\angle 135^\circ$ A

(A) =1A

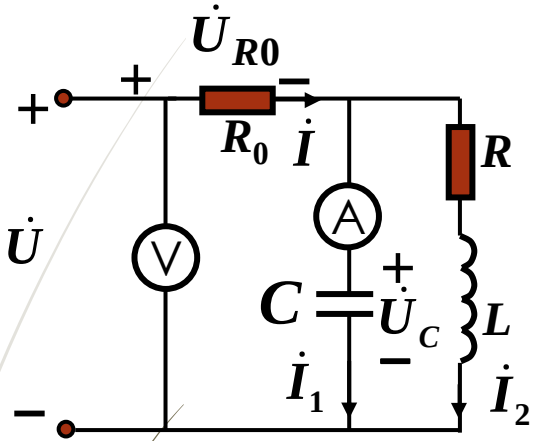
将发生并联谐振的电路看成一个二端网络 (或一条广义的支路)，则流进或流出端口的电流 (或通过该广义支路的电流)为零，但网络内部的各个支路的电流 并不一定为零，且Q越大，支路电流越大。



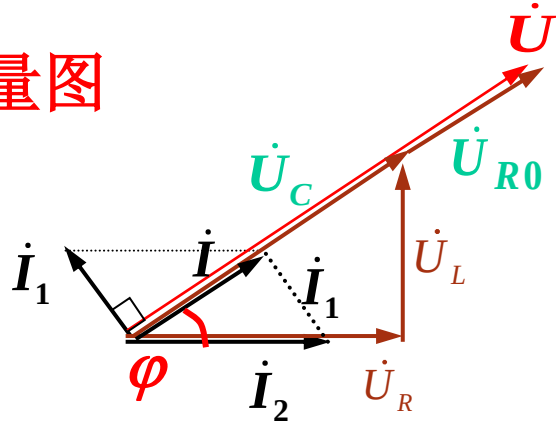
将发生串联谐振的电路看成一个二端网络 (或一条广义的支路)，则两个端钮之间的电压 (或广义支路两端的电压)为零，但网络内部的各个支路上的电压并不一定为零，且Q越大，支路电压越大。



23. ω=1000rad/s时, 电路发生谐振。 R_0=25Ω, C=16μF, 电压表的读数是 100V, 电流表的读数是 1.2A，求 R 和 L.



解: 相量图



$$I_1 = 1.2\text{A}$$

$$U_C = 1.2 \Big/ (1000 \times 1.6 \times 10^{-6}) = 75\text{V}$$

谐振时:

$$U_{R0} = 25\text{V} \qquad I = 1\text{A}$$

$$I_2 = \sqrt{I_1^{\,2} + I^2} = 1.562\text{A}$$

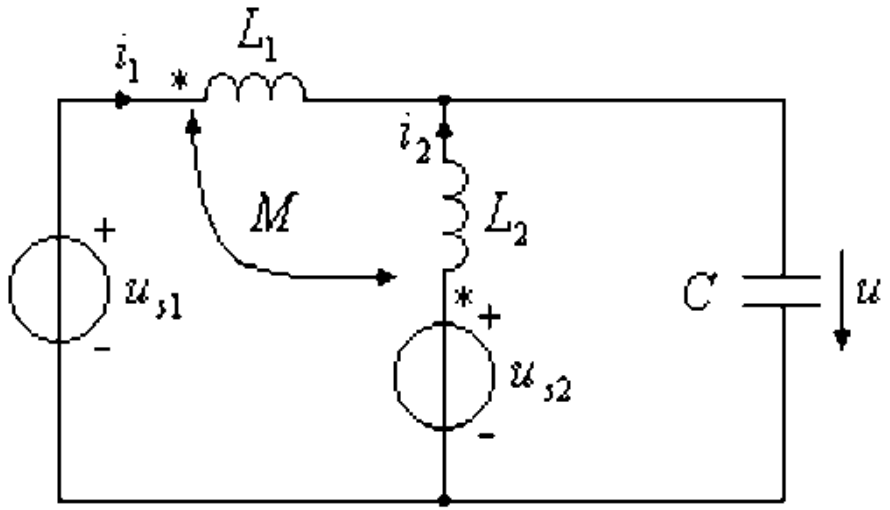
$$\varphi = \arctan(I_1 / I) = 50.2^{\circ}$$

$$|Z| = U_C \Big/ I_2 = 75 \Big/ 1.562 = 48.01\Omega$$

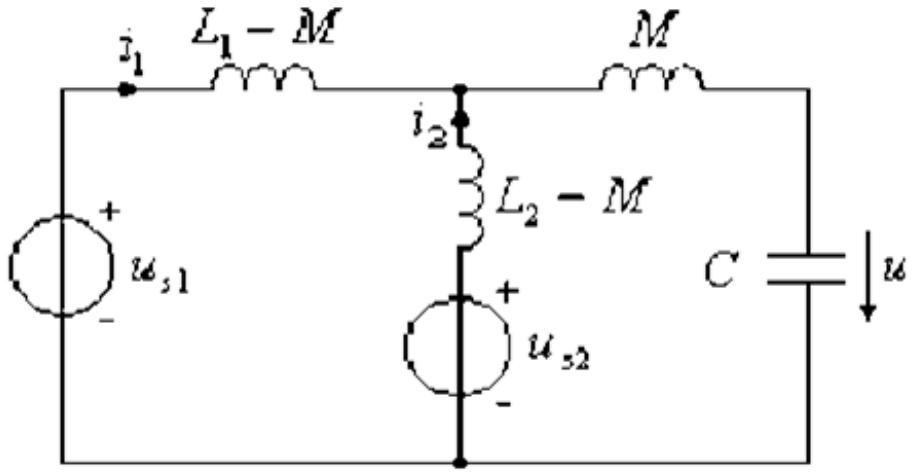
$$R = 48.01\cos 50.2^{\circ} = 30.7\Omega$$

$$L = 48.01\sin 50.2^{\circ} \Big/ 1000 = 36.9\text{mH}$$

24. 图 12—11 所示电路中，$u_{s1}=60\sqrt{2}\cos(2\omega t+45^0)\text{V}$，$u_{s2}=30\sqrt{2}\cos(\omega t)\text{V}$，$\omega L_1=20\Omega$，$\omega L_2=7.5\Omega$，$\omega M=5\Omega$，$\dfrac{1}{\omega C}=20\Omega$。求$i_1$，$i_2$及$u$。



解：将图 12—11 所示的电路去耦后的等效电路如图 12—11（a）。



基波分量和二次谐波分量作用的等效电路分别如图 12—11（b）和 12—11（c）。在图 12—11（b）中电路发生了并联谐振，因此

$$\dot{I}_{2(1)}=0,\quad \dot{U}_{(1)}=\frac{-\mathrm{j}20}{\mathrm{j}5-\mathrm{j}20}\times 30\underline{/0^{0}}=40\underline{/0^{0}}\ \mathrm{V},\quad \dot{I}_{1(1)}=-\frac{30\underline{/0^{0}}}{\mathrm{j}15}=2\underline{/90^{0}}\ \mathrm{A}$$

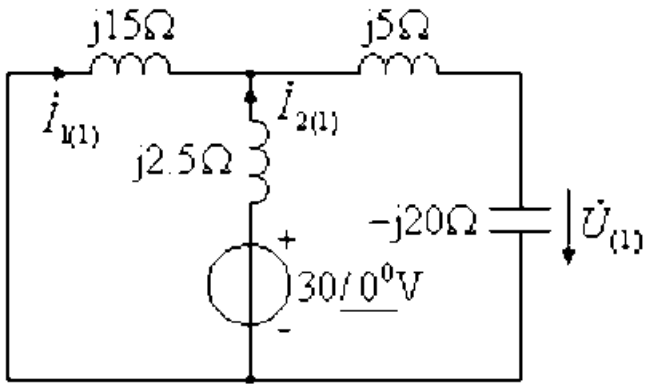


图12—11(b)

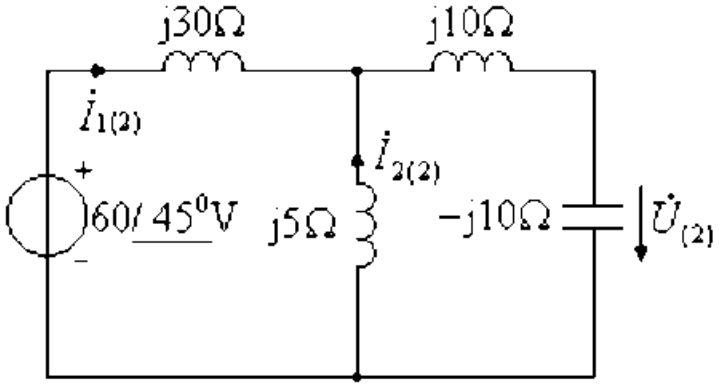


图12—11(c)

在图 12—11（c）中电路发生了串联谐振，因此

$$\dot{I}_{2(2)}=0,\quad \dot{I}_{1(2)}=\frac{60\underline{/45^{0}}}{\mathrm{j}30}=2\underline{/-45^{0}}\ \mathrm{A},\quad \dot{U}_{(2)}=2\underline{/-45^{0}}\times(-\mathrm{j}10)=20\underline{/-135^{0}}\ \mathrm{V}$$

于是：$i_1=[2\sqrt{2}\cos(\omega t+90^{0})+2\sqrt{2}\cos(2\omega t-45^{0})]\mathrm{A}$；

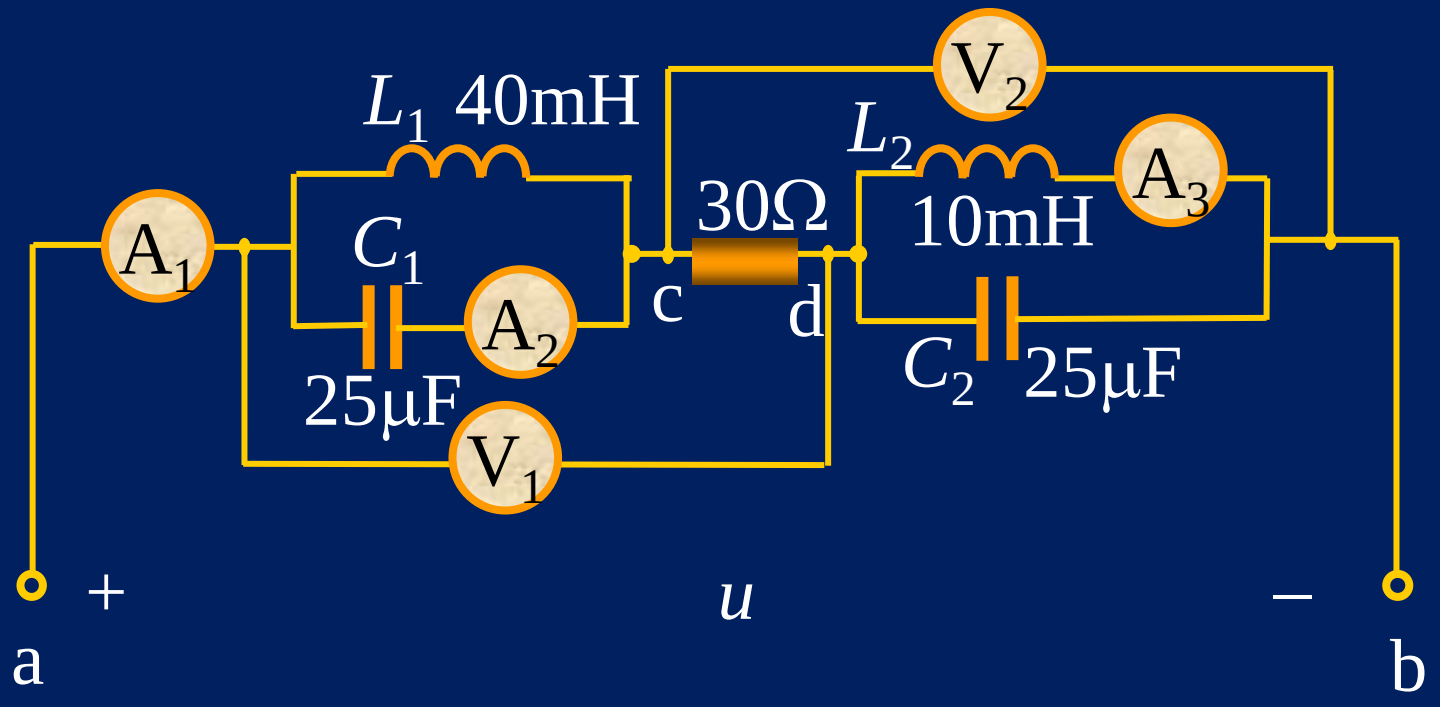
$i_2=0$；

$u=40\sqrt{2}\cos(\omega t)+20\sqrt{2}\cos(2\omega t-135^{0})\mathrm{V}$

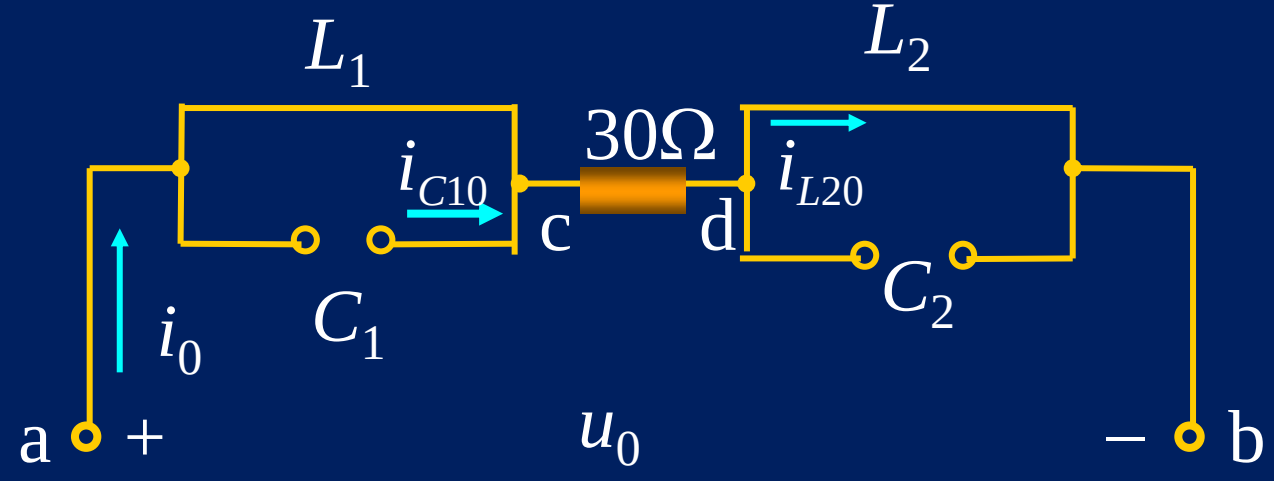
I_1？ U？ P_U？

25、 $u_1=30+120\sin 1000t+60\sin(2000t+\pi/4)$ V

求电路中各表读数(有效值)。



解



(1)u_0=30V作用于电路，L_1、L_2短路，C_1、C_2开路。

$$i_0 = i_{L20} = u_0/R = 30/30 = 1\text{A},$$

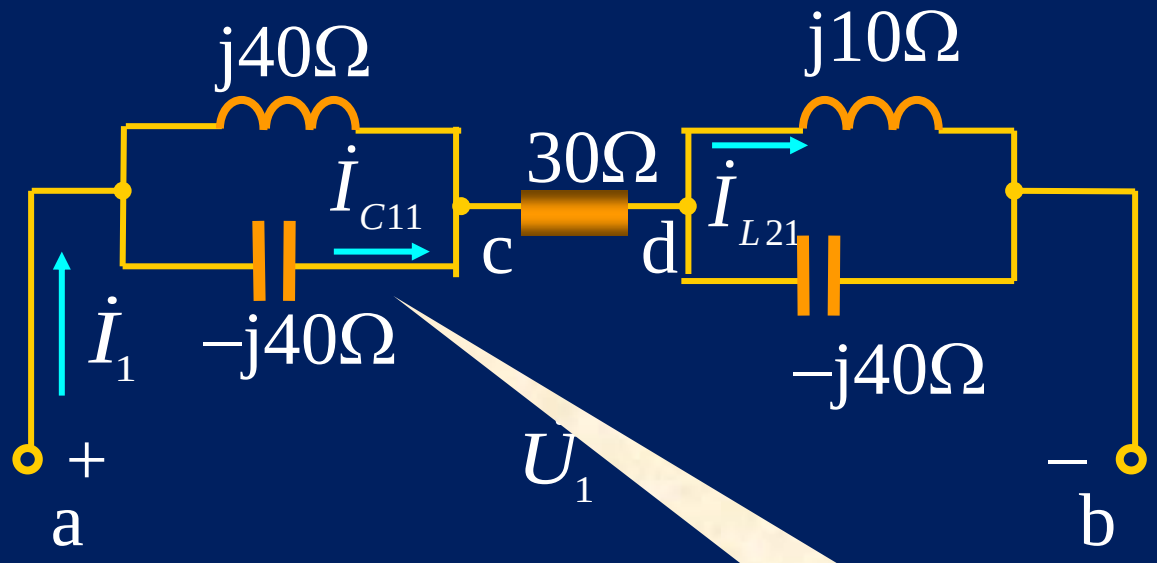
$$i_{C10} = 0,$$

$$u_{ad0} = u_{cb0} = u_0 = 30\text{V}$$

(2) u_1=120sin1000t V 作用

$$\omega L_1 = 1000\times 40\times 10^{-3} = 40\Omega \qquad \omega L_2 = 1000\times 10\times 10^{-3} = 10\Omega$$

$$-\frac{1}{\omega C_1} = -\frac{1}{\omega C_2} = -\frac{1}{1000\times 25\times 10^{-6}} = -40\Omega$$



$$\dot{U}_1 = 120\angle 0^\circ \text{ V}$$

$$\dot{I}_1 = \dot{I}_{L21} = 0$$

$$\dot{U}_{cb1} = 0$$

$$\dot{U}_{ad1} = \dot{U}_1 = 120\angle 0^\circ \text{ V}$$

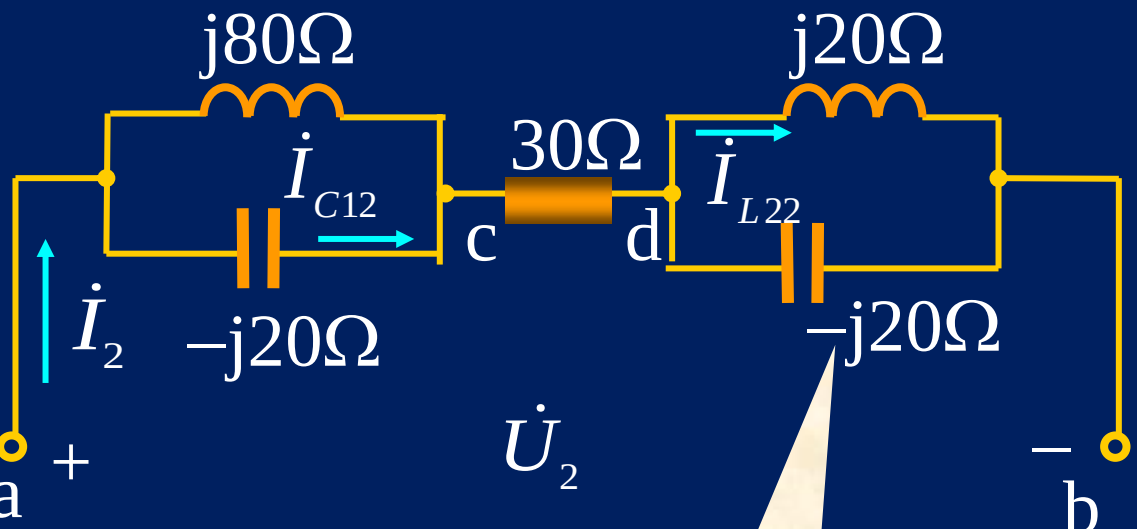
并联谐振

$$\dot{I}_{C11} = \text{j}\omega C_1 \dot{U}_1 = \frac{120\angle 0^\circ}{-\text{j}40} = 3\angle 90^\circ \text{ A}$$

(3) $u_2=60\sin(2000t+\pi/4)$V 作用

$$2\omega L_1 = 2000\times 40\times 10^{-3} = 80\Omega, \quad 2\omega L_2 = 2000\times 10\times 10^{-3} = 20\Omega$$

$$-\frac{1}{2\omega C_1} = -\frac{1}{2\omega C_2} = -\frac{1}{2000\times 25\times 10^{-6}} = -20\Omega$$



$$\dot{U}_2 = 60\angle 45^\circ \text{V}$$

$$\dot{I}_2 = \dot{I}_{C12} = 0$$

$$\dot{U}_{ad2} = 0$$

$$\dot{U}_{cb2} = \dot{U}_2 = 60\angle 45^\circ \text{V}$$

$$\dot{I}_{L22} = \frac{\dot{U}_2}{\text{j}2\omega_1 L_2} = \frac{60\angle 45^\circ}{\text{j}20} = 3\angle -45^\circ \text{A}$$

并联谐振

所求电压、电流的瞬时值为：

$i=i_0+i_1+i_2=1\text{A}$

$i_{C1}=i_{C10}+i_{C11}+i_{C12}=3\sin(1000t+90°)\text{ A}$

$i_{L2}=i_{L20}+i_{L21}+i_{L22}=1+3\sin(2000t-45°)\text{ A}$

$u_{ad}=u_{ad0}+u_{ad1}+u_{ad2}=30+120\sin 1000t\text{ V}$

$u_{cb}=u_{cb0}+u_{cb1}+u_{cb2}=30+60\sin(2000t+45°)\text{ V}$

表A_1的读数：$I=1\text{ A}$　　表A_2的读数：$3/\sqrt{2}=2.12\text{A}$

表A_3的读数：$\sqrt{1^2+(3/\sqrt{2})^2}=2.35\text{A}$

表V_1的读数：$\sqrt{30^2+(120/\sqrt{2})^2}=90\text{V}$

表V_2的读数：$\sqrt{30^2+(60/\sqrt{2})^2}=52.0\text{V}$

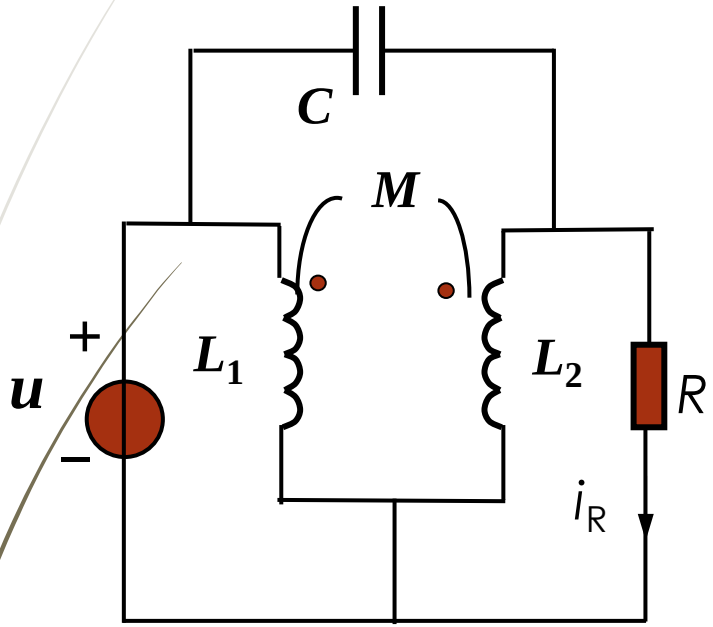
电阻R的功率

$P_R=30\times 1$

$=30\text{W}$

26. $u = \sqrt{2}\sin 2000\pi t\ \mathrm{V}$, $R = 50\pi\ \Omega$, $C = 25/\pi^2\ \mu\mathrm{F}$

M=10mH, L_1=30mH, L_2=20mH. 用戴维南定理求 i_R 。



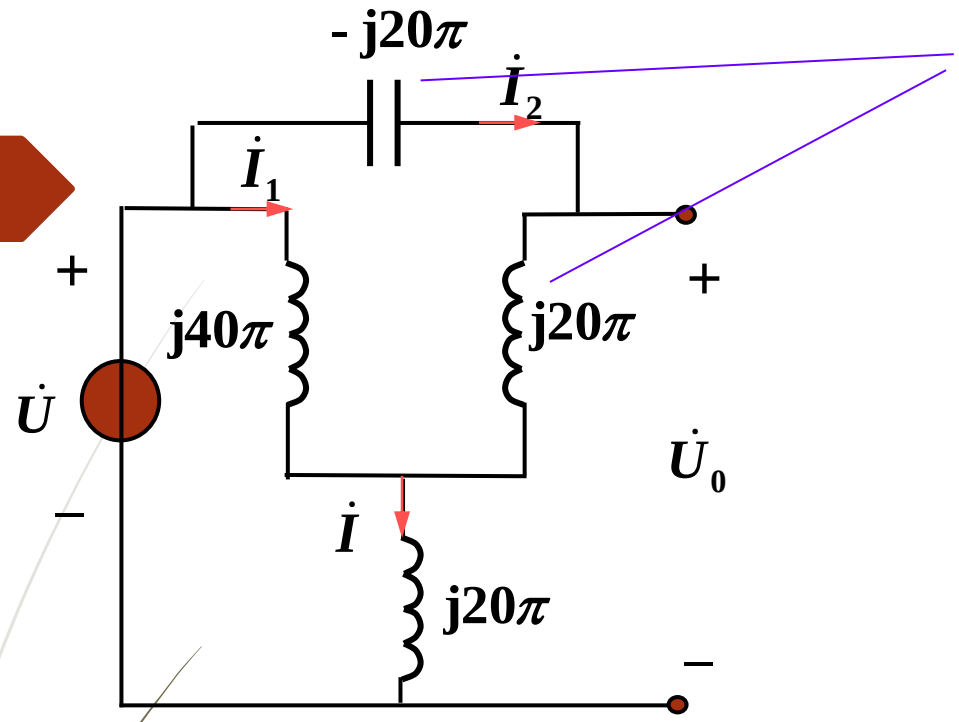
首先计算各元件的阻抗:

$$\mathrm{j}\omega M = \mathrm{j}20\pi$$

$$\mathrm{j}\omega L_1 = \mathrm{j}60\pi$$

$$\mathrm{j}\omega L_2 = \mathrm{j}40\pi$$

$$\frac{1}{\mathrm{j}\omega C} = -\mathrm{j}20\pi$$



串联谐振

$$\dot{I}_1 = 0$$

but $\dot{I}_2 \neq 0$

$$\dot{I}_2 = \dot{I} = \frac{\dot{U}}{j20\pi}$$

$$\dot{U}_0 = \text{j}20\pi\dot{I}_2 + \text{j}20\pi\dot{I} = \text{j}20\pi\frac{1\angle 0^\circ}{\text{j}20\pi} + 1\angle 0^\circ = 2\angle 0^\circ\,\text{V}$$

$$Z_{入} = -\text{j}20\pi/(\text{j}20\pi + (\text{j}40\pi/\text{j}20\pi)) = -\text{j}50\pi\Omega$$

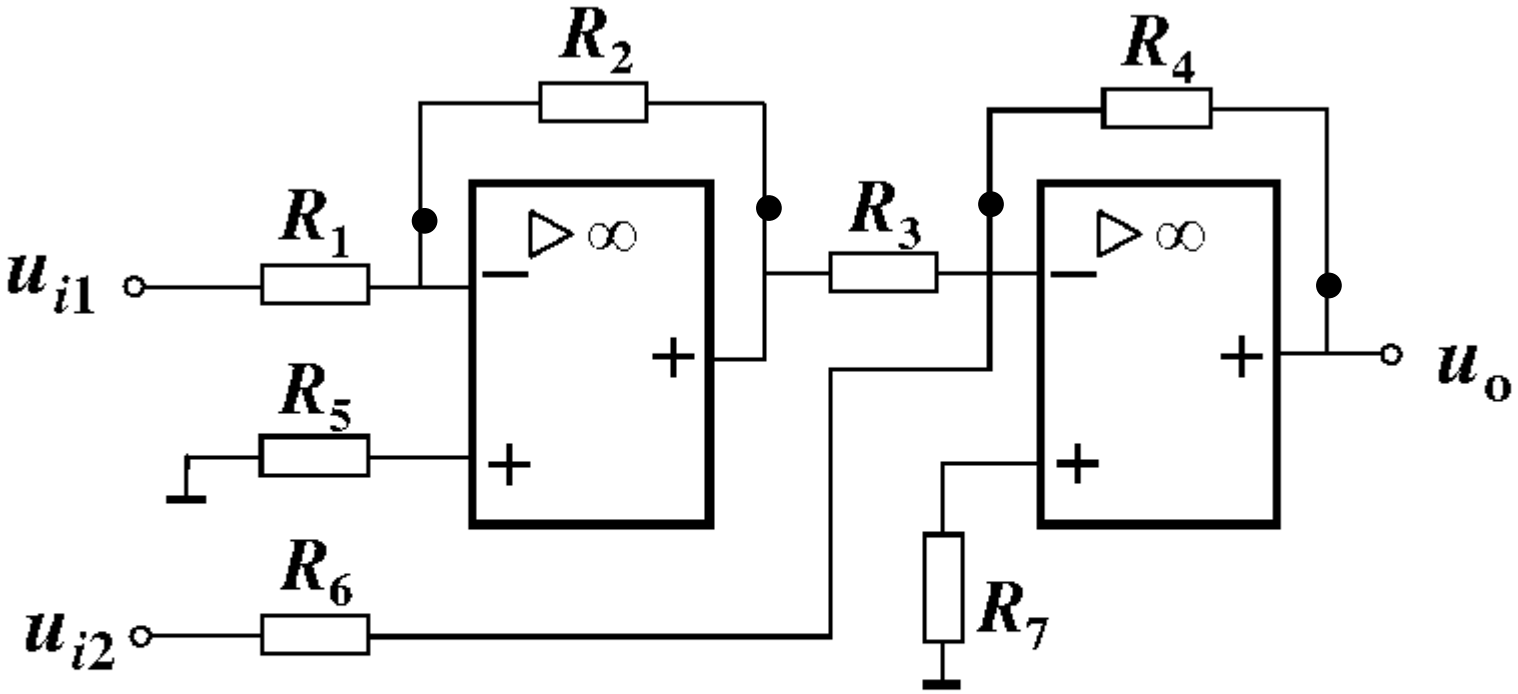
$$\therefore \quad \dot{I}_R = \frac{2\angle 0^\circ}{50\pi - j50\pi} = 9\times10^{-3}\angle 45^\circ\,\text{A}$$

$$i_R = \sqrt{2}9\times10^{-3}\sin(2000\pi t + 45^\circ)\text{A}$$

主观题 0.5分

设置

27. 试计算图示电路中的输出电压u_0的表达式。



解：

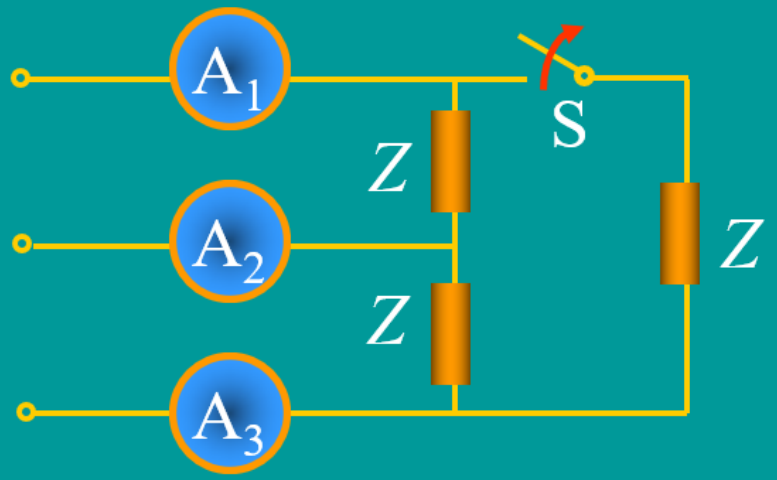
$$u_{01}=-\frac{R_2}{R_1}u_{i1} \qquad u'_0=-\frac{R_4}{R_3}u_{01}=\frac{R_2R_4}{R_1R_3}u_{i1} \qquad u''_0=-\frac{R_4}{R_6}u_{i2}$$

$$u_0=u'_0+u''_0=\frac{R_2R_4}{R_1R_3}u_{i1}-\frac{R_4}{R_6}u_{i2}$$

作答

28. 如图电路中，电源三相对称。当开关S闭合时，电流表的读数均为5A。

求：开关S打开后各电流表的读数。

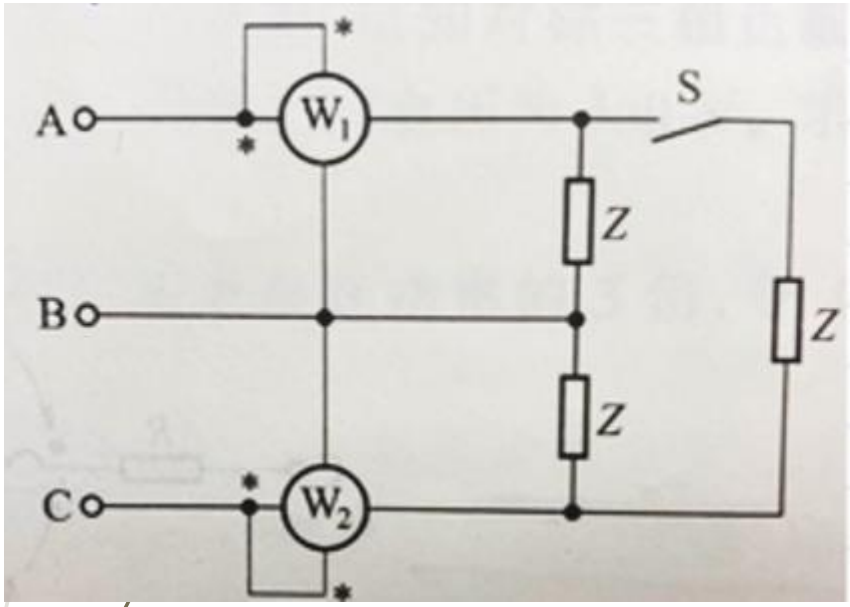


解

开关S打开后，表A_2的电流数与负载对称时相同。而表A_1和表A_3的电流数等于负载对称时的相电流。

$A_2 = 5\text{A}$　　$A_1 = A_3 = 5/\sqrt{3} = 2.89\text{A}$

29.



$U_{AB}=380V$. S闭合时功率表读数分别为 782，1976.44

求：

(1) 负载的复功率 S 和阻抗 Z

(2) 开关打开后，功率表读数

https://www.bilibili.com/video/BV1cA4y1D7Uf/

30. 图示对称三相电路中，U_l =380V，Z_1=－j110 Ω，电动机 P=1320W，$\cos\varphi$=0.5(滞后)。

求：(1) 线电流和电源发出总功率；

(2) 用两表法测电动机负载的功率，画接线图。求两块表的读数。