《电路理论》复习&习题课

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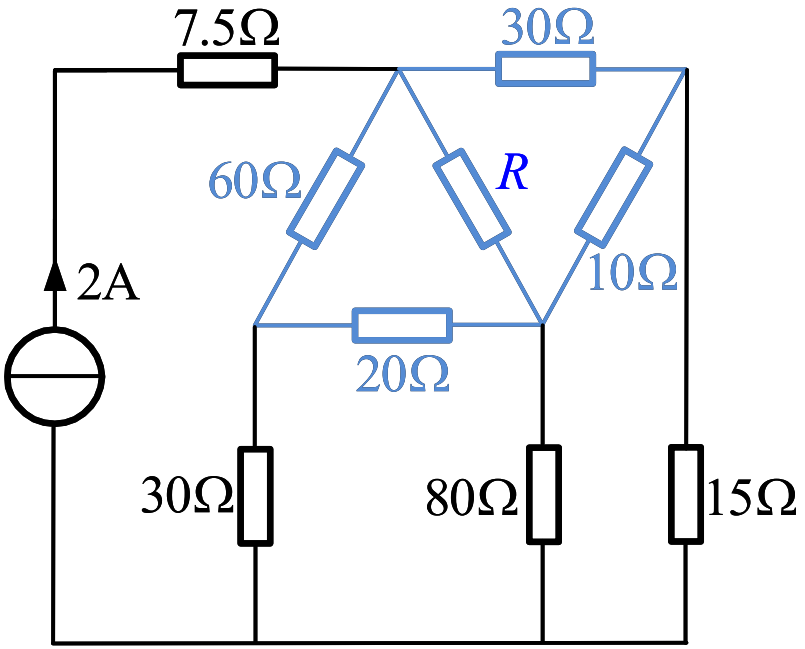
例 求电阻R=40Ω吸收的功率。



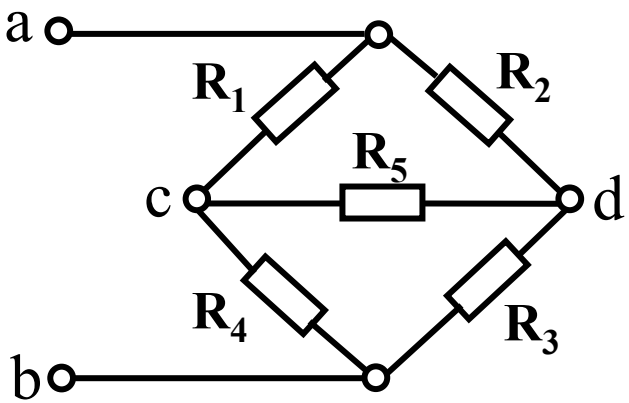
分析：1. 电阻串并联关系复杂

2. 不满足平衡电桥

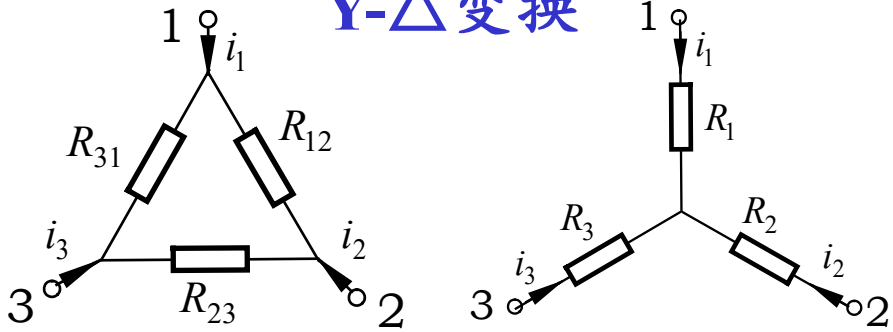
知识点回顾

电桥：一端口网络

$$\frac{R_1}{R_2}=\frac{R_3}{R_4} \Rightarrow i_5=0$$



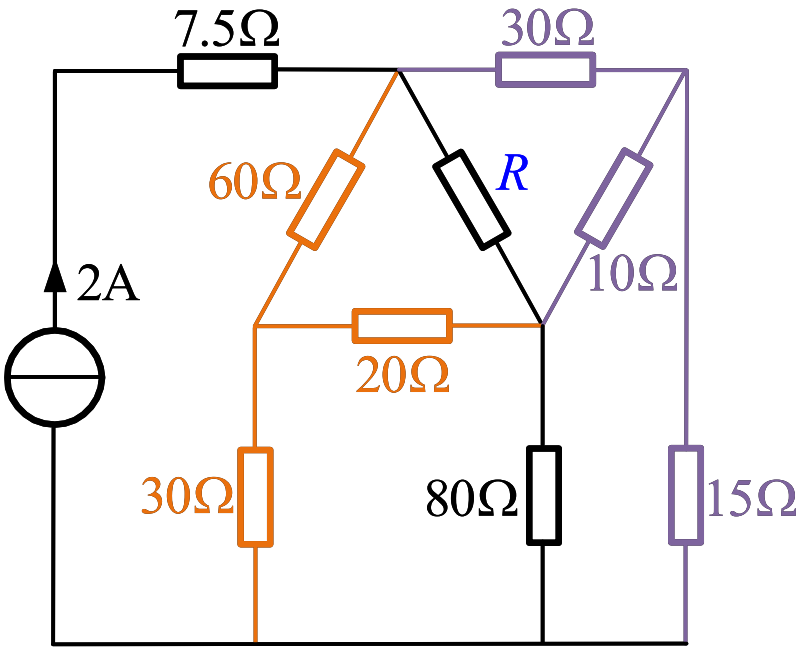
Y-△变换



$$\Delta \to \mathrm{Y}: R_1=\frac{R_{12}R_{31}}{R_{12}+R_{23}+R_{31}}$$

$$\mathrm{Y} \to \Delta: G_{12}=\frac{G_1G_2}{G_1+G_2+G_3}$$

例 求电阻R=40Ω吸收的功率。



解 **Y-△变换**

60Ω、20Ω、30Ω组成Y连接

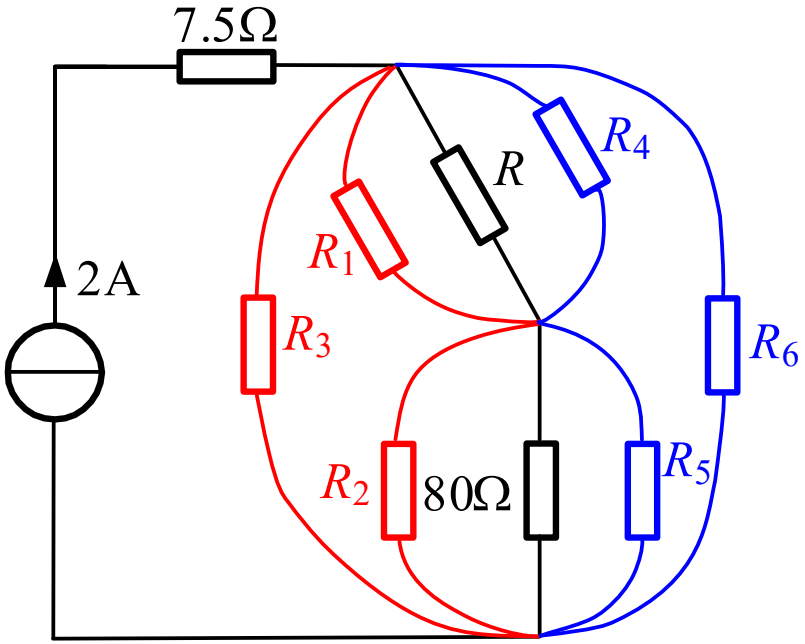
30Ω、10Ω、15Ω组成Y连接

$$\mathrm{Y}\rightarrow\Delta:\ G_{12}=\frac{G_1G_2}{G_1+G_2+G_3}$$

$R_1=120\ \Omega$　　$R_4=60\ \Omega$

$R_2=60\ \Omega$　　$R_5=30\ \Omega$

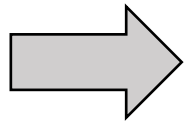
$R_3=180\ \Omega$　　$R_6=90\ \Omega$



$R_1 = 120\ \Omega \qquad R_4 = 60\ \Omega$

$R_2 = 60\ \Omega \qquad R_5 = 30\ \Omega$

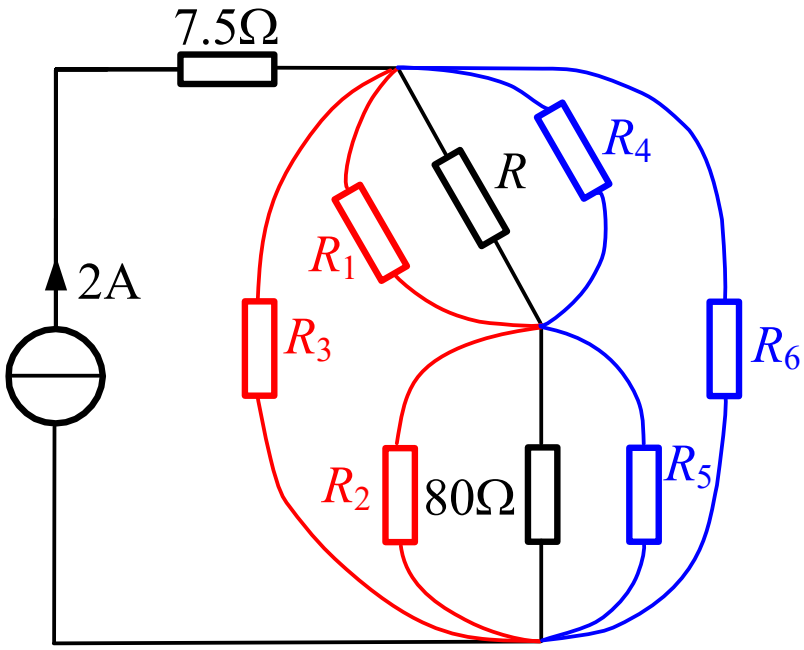
$R_3 = 180\ \Omega \qquad R_6 = 90\ \Omega$



$$R_1 \parallel R_4 = 40\ \Omega$$

$$R_2 \parallel R_5 \parallel 80 = 16\ \Omega$$

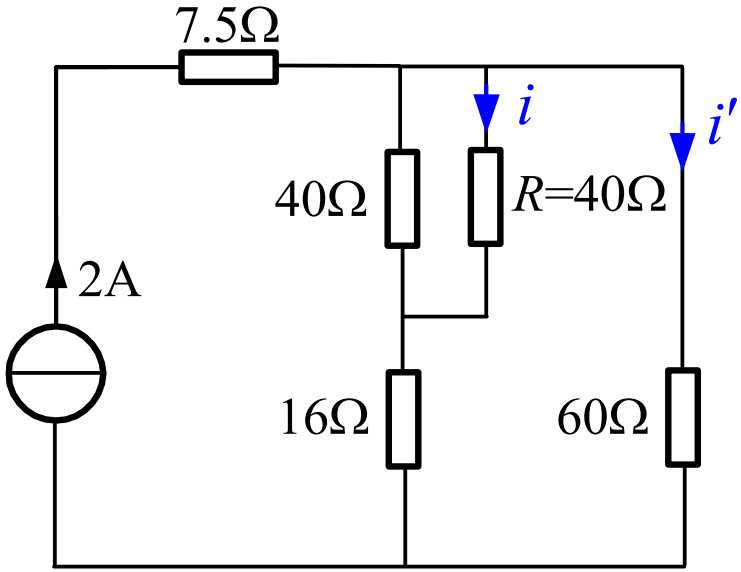
$$R_3 \parallel R_6 = 60\ \Omega$$



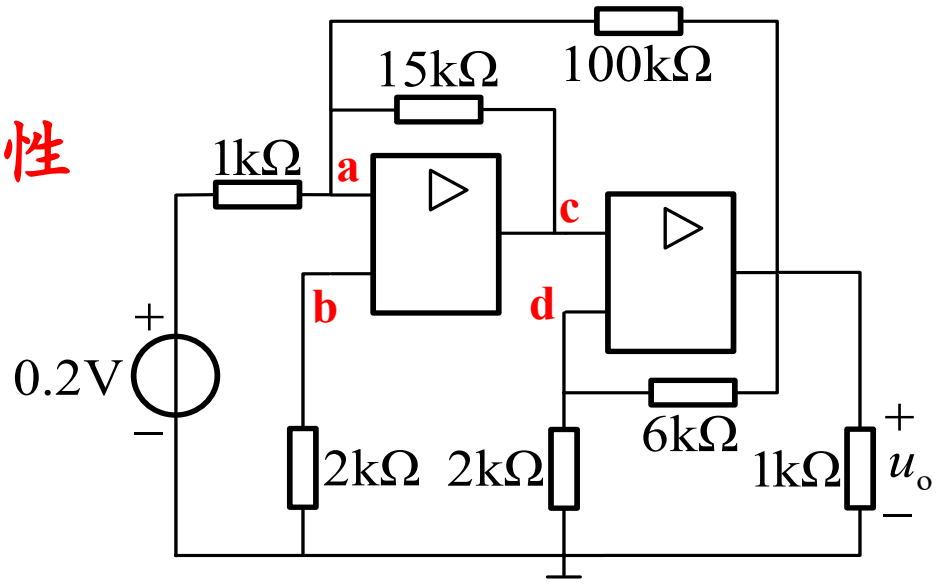
$$\begin{cases} 2i + i' = 2 \\ 40i + 16 \times 2i - 60i' = 0 \end{cases}$$

$$\Rightarrow i = 0.625\ \text{A}$$

$$\Rightarrow P_{\text{R}} = 0.625^2 \times 40 = 15.625\ \text{W}$$



例 图示电路中，运算放大器视为理想的，且工作在线性区。（1）计算输出电压u_o；（2）将100kΩ电阻断开，再计算u_o。



解 **考察“虚短、虚断”特性**

$$u_a = u_b = 0 \qquad u_c = u_d$$

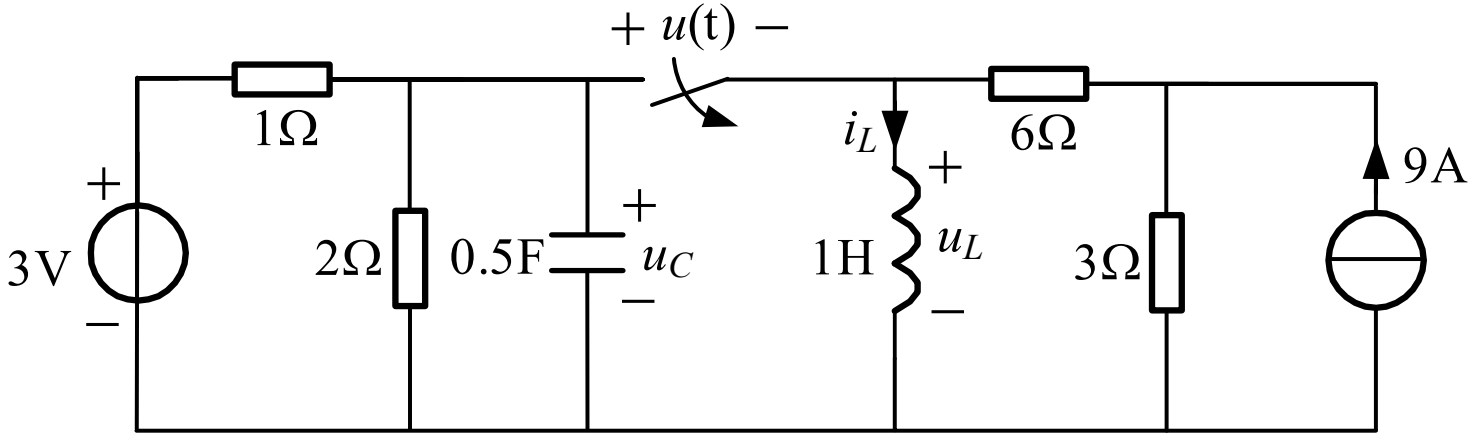
（1）
$$\frac{0.2}{1} + \frac{u_c}{15} + \frac{u_o}{100} = 0$$

$$\frac{u_d}{2} = \frac{u_o - u_d}{6} \quad \Rightarrow u_o = -7.5\text{V}$$

（2）放大电路的级联

$$\frac{u_c}{15} = -\frac{0.2}{1} \quad \Rightarrow u_c = -3\text{V} \qquad \frac{u_o - u_d}{6} = \frac{u_d}{2} \quad \Rightarrow u_o = -12\text{V}$$

例 图示电路中各参数已给定，开关S打开前电路为稳态，$t=0$时开关S打开，求开关打开后电压u(t)。



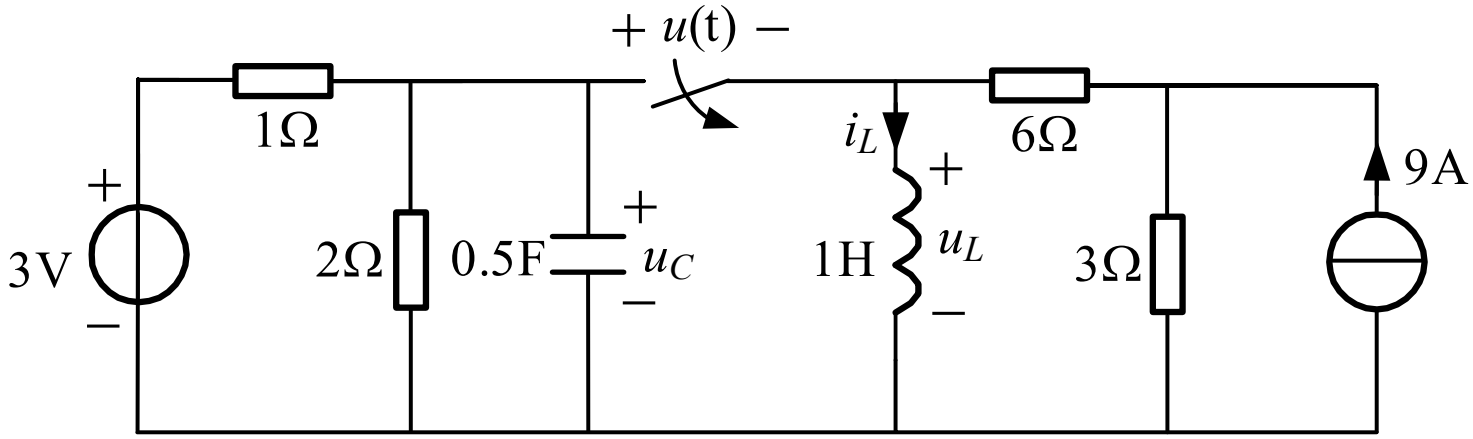
知识点回顾 **暂态电路求解→“三要素”法**

三要素： $y(0_+)$ $y(\infty)$ τ

RC电路 $\tau = R_{eq}C$ $\Rightarrow y(t) = y(\infty) + \left[y(0_+) - y(\infty)\right]e^{-\frac{t}{\tau}}$

RL电路 $\tau = L/R_{eq}$ $= y(0_+)e^{-\frac{t}{\tau}} + y(\infty)\left(1 - e^{-\frac{t}{\tau}}\right)$

例 图示电路中各参数已给定，开关S打开前电路为稳态，$t=0$时开关S打开，求开关打开后电压u(t)。

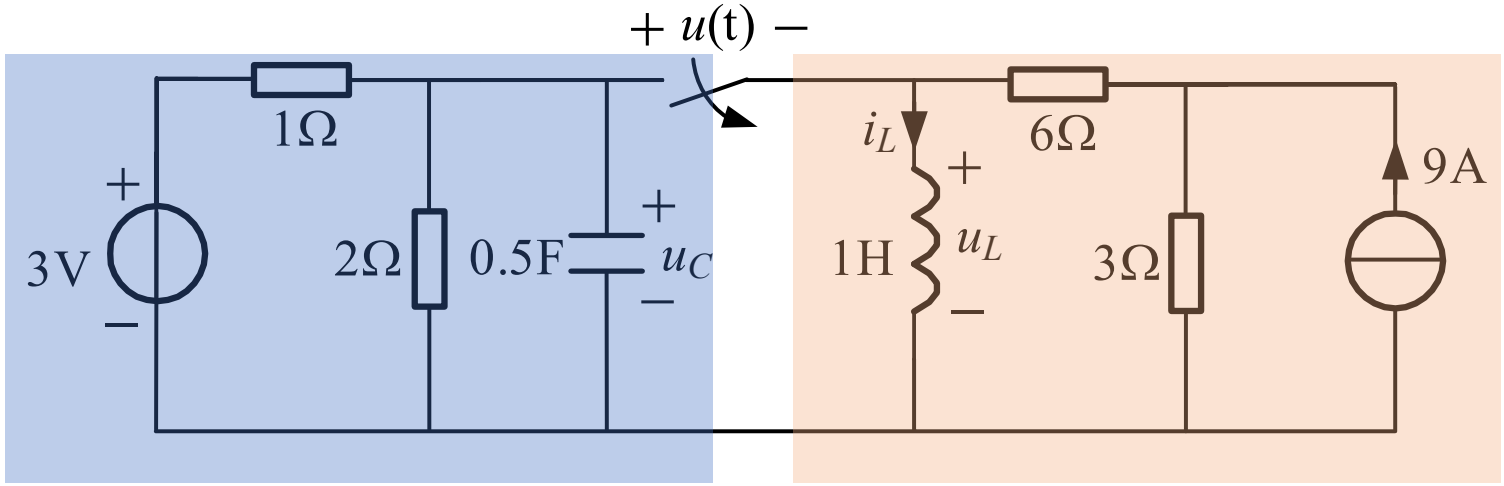


解 **解题思路：“三要素”法**

开关打开前：C开路、L短路

$$u_C(0_-)=0$$

$$i_L(0_-)=\frac{3}{1}+9\times\frac{3}{6+3}=6\ \text{A}$$



零状态响应　　全响应

开关打开后：

$$u_C(0_+)=u_C(0_-)=0$$

$$u_C(\infty)=\frac{3}{1+2}\times 2=2\ \text{V}$$

$$\tau=R_{\text{eq}}C=\frac{1\times 2}{1+2}0.5=\frac{1}{3}\ \text{s}$$

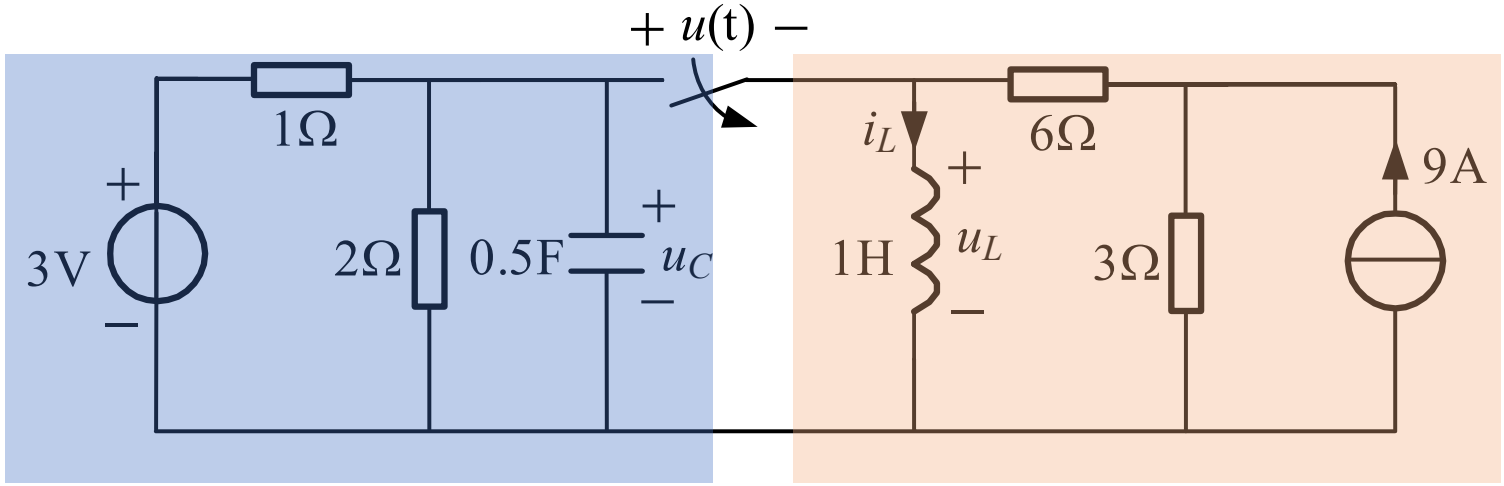
$$\Rightarrow u_C(t)=2\left(1-e^{-3t}\right)\ \text{V}$$

$$i_L(0_+)=i_L(0_-)=6\ \text{A}$$

$$i_L(\infty)=\frac{3}{3+6}\times 9=3\ \text{A}$$

$$\tau=\frac{L}{R_{\text{eq}}}=\frac{1}{6+3}=\frac{1}{9}\ \text{s}$$

$$\Rightarrow i_L(t)=\left[3+(6-3)e^{-9t}\right]\ \text{A}$$



零状态响应

全响应

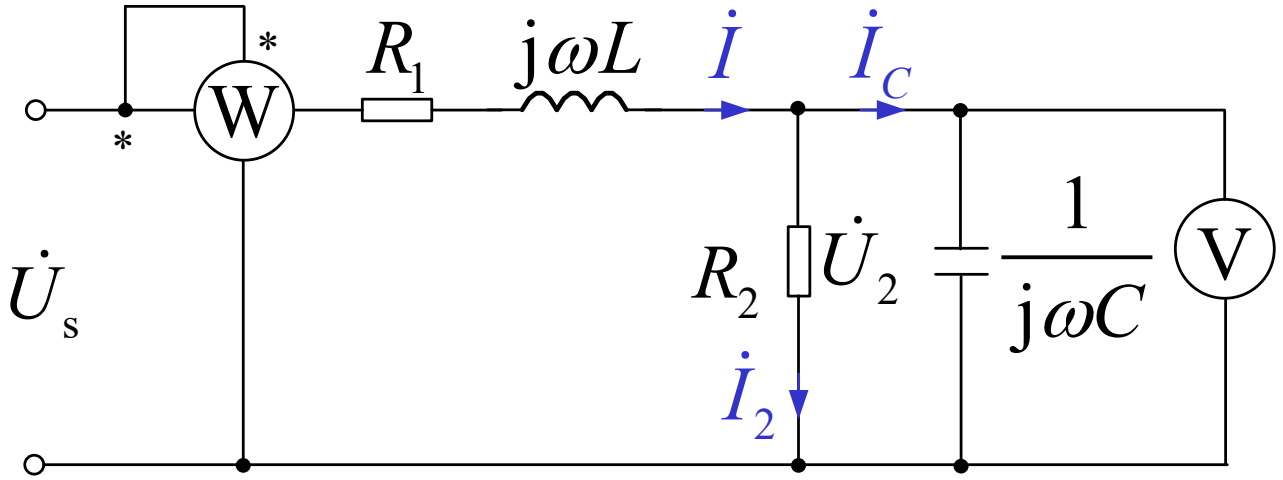
$$\Rightarrow u_C(t)=2\left(1-e^{-3t}\right)\ \text{V} \qquad \Rightarrow i_L(t)=\left[3+(6-3)e^{-3t}\right]\ \text{A}$$

$$\Rightarrow u(t)=u_C(t)-u_L(t)$$

$$=u_C(t)-L\frac{\mathrm{d}i_L(t)}{\mathrm{d}t}$$

$$=2\left(1-e^{-3t}\right)+27e^{-9t}\ \text{V}$$

例 图示电路中$R_1=R_2=10\Omega$，L=0.25H，C=1mF。电压表读数为20V，功率表的读数为120W。试求$\dot{U}_2/\dot{U}_S$和电源发出的复功率$\overline{S}$。



正弦稳态电路分析　　正弦稳态电路的功率

知识点回顾

正弦稳态电路分析 < 相量法 / 相量图法

$$u=\sqrt{2}U\cos(\omega t+\phi) \quad \Leftrightarrow \quad \dot{U}=U\angle\phi$$

引入阻抗：$\dot{U}=Z\dot{I}$　$Z=R$　$Z=\mathrm{j}\omega L$　$Z=\dfrac{1}{\mathrm{j}\omega C}$

- 电阻电路中所有网络定理和分析方法都推广应用于正弦稳态的相量分析中

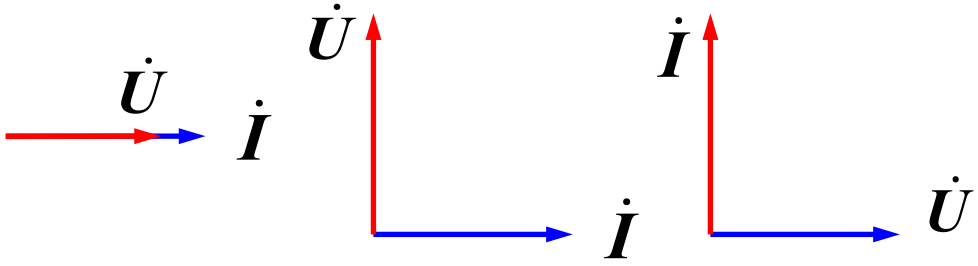
A.画相量模型 ⇒ B.列代数方程 ⇒ C.解代数方程 ⇒ D.变换正弦量

相量图法

$\dot{U}=R\dot{I}$　$\dot{U},\dot{I}$ 同相

$\dot{U}=\mathrm{j}\omega L\dot{I}$　$\dot{U}$ 超前 $\dot{I}$ 90°

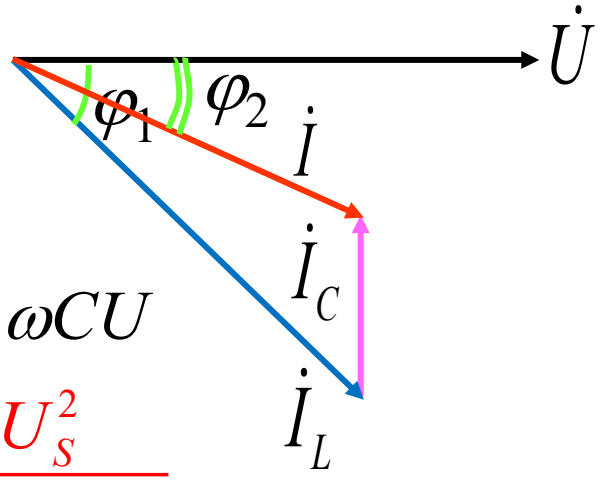
$\dot{U}=\dfrac{1}{\mathrm{j}\omega C}\dot{I}$　$\dot{U}$ 滞后 $\dot{I}$ 90°



知识点回顾　正弦稳态电路的功率分析

- 瞬时功率：元件或一端口网络某一时刻的功率　$p(t)=ui$
- 有功功率：$P=UI\cos\varphi$　　单位：[W]　　守恒
- 无功功率：$Q=UI\sin\varphi$　　单位：[var]　　守恒
- 视在功率：$S=UI$　　单位：[V·A]　　不守恒
- 复功率：　$\overline{S}=\dot{U}\dot{I}^{*}=UI\angle\varphi$　　单位：[V·A]　　守恒

功率因数提高：并联电容

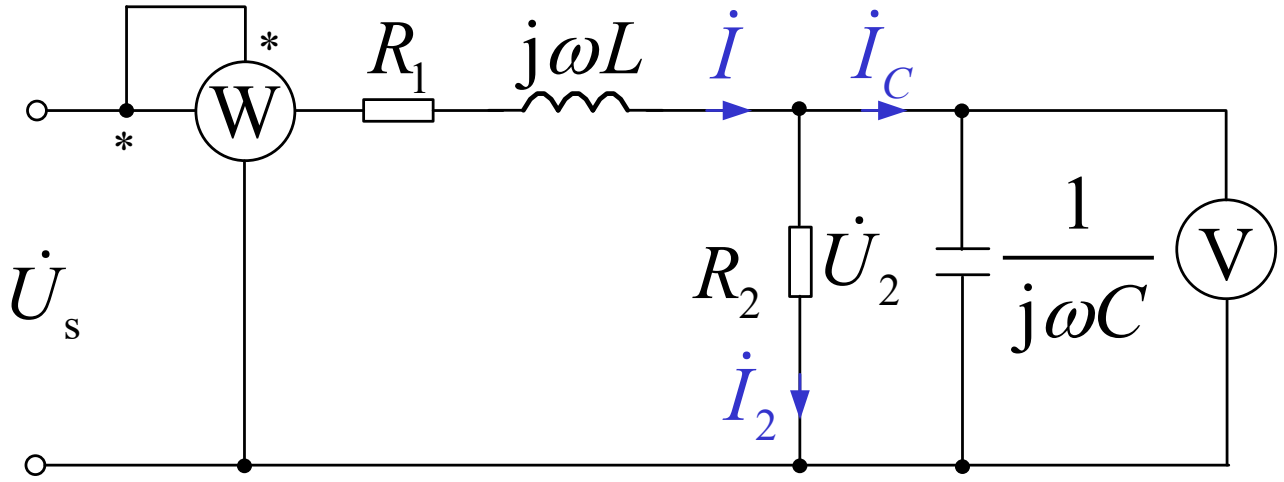


$$I_C=I_L\sin\varphi_1-I\sin\varphi_2$$

$$=\frac{P}{U\cos\varphi_1}\sin\varphi_1-\frac{P}{U\cos\varphi_2}\sin\varphi_2=\omega CU$$

最大有功功率：　$Z_L=Z_i^{*}$　$P_{\max}=\dfrac{U_S^2}{4\,\mathrm{Re}[Z_L]}$

例 图示电路中R_1=R_2=10Ω，L=0.25H，C=1mF。电压表读数为20V，功率表的读数为120W。试求$\dot{U}_2/\dot{U}_S$和电源发出的复功率$\overline{S}$。



解 表W读数是R_1、R_2吸收功率和，表V读数是U_2有效值

$$I_2 = U_2/R_2 = 2\text{A} \quad P_{R2} = U_2^2/R_2 = 40\text{W} \quad \Rightarrow P_{R1} = 80\text{W}$$

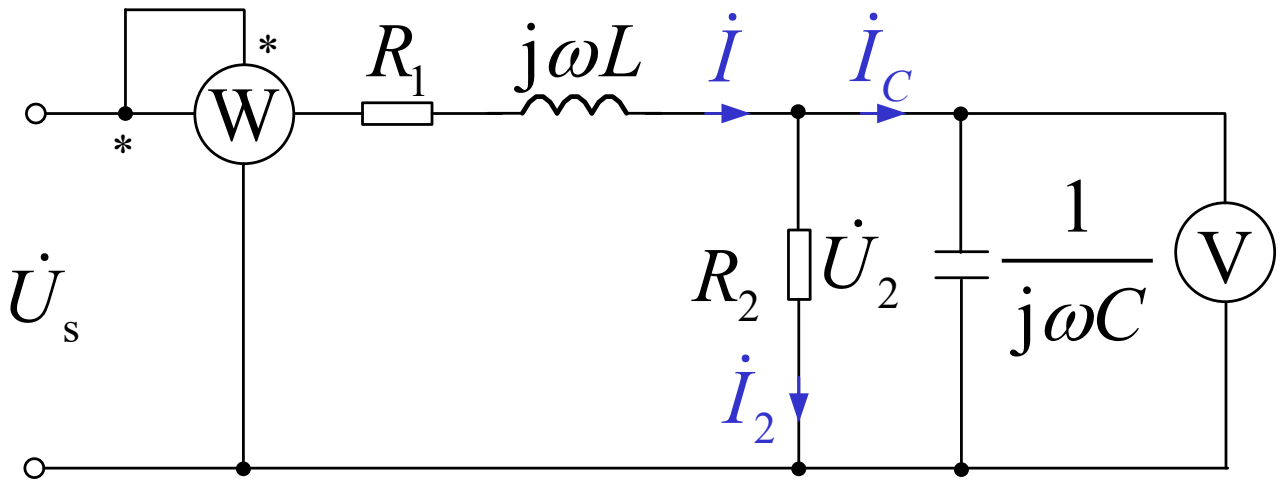
$$I = \sqrt{\frac{P_{R1}}{R_1}} = 2\sqrt{2}\text{A} \quad \Rightarrow I_C = \sqrt{I^2 - I_2^2} = 2\text{A}$$

$$\frac{U_2}{I_C}=\frac{1}{\omega C}=10$$

$$\Rightarrow \omega = 100 \text{ rad/s}$$

$$\Rightarrow \mathrm{j}\omega L = \mathrm{j}25\ \Omega$$

$$\Rightarrow \frac{1}{\mathrm{j}\omega C}=-\mathrm{j}10\ \Omega$$



取 $I_2 = 2\angle 0°\text{A} \quad \Rightarrow I_C = 2\angle 90°\text{A} \quad I = 2\sqrt{2}\angle 45°\text{A}$

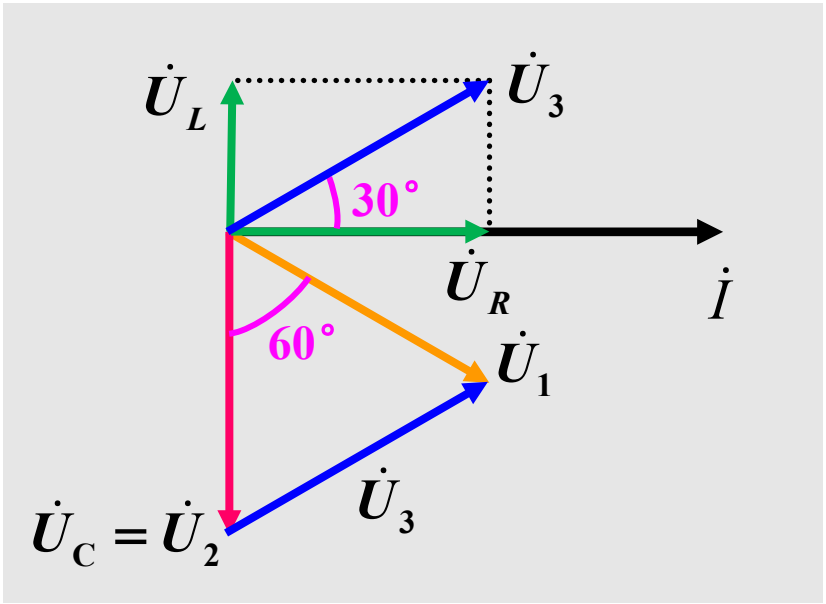
由KVL，得：$\dot{U}_S = (10+\mathrm{j}25)\dot{I}+\dot{U}_2$

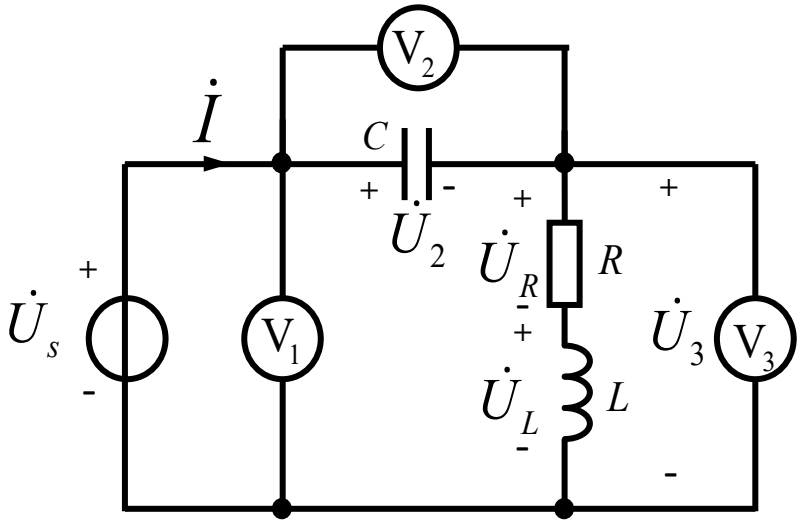
$$\Rightarrow \overline{S} = \dot{U}_S\dot{I}^* = (10+\mathrm{j}25)I^2 + \dot{U}_2\dot{I}^* = (120+\mathrm{j}160)\ \text{V}\cdot\text{A}$$

$$\frac{\dot{U}_2}{\dot{U}_S}=\frac{\dot{U}_2}{(10+\mathrm{j}25)\dot{I}+\dot{U}_2}=0.283\angle -98.13° \quad \Rightarrow \frac{U_2}{U_S}=0.283$$

例 图示电路中，已知电源频率为50Hz，负载的有功功率为3630W，3个电压表的读数均为220V，求R、L、C的值。

解 **相量图法**





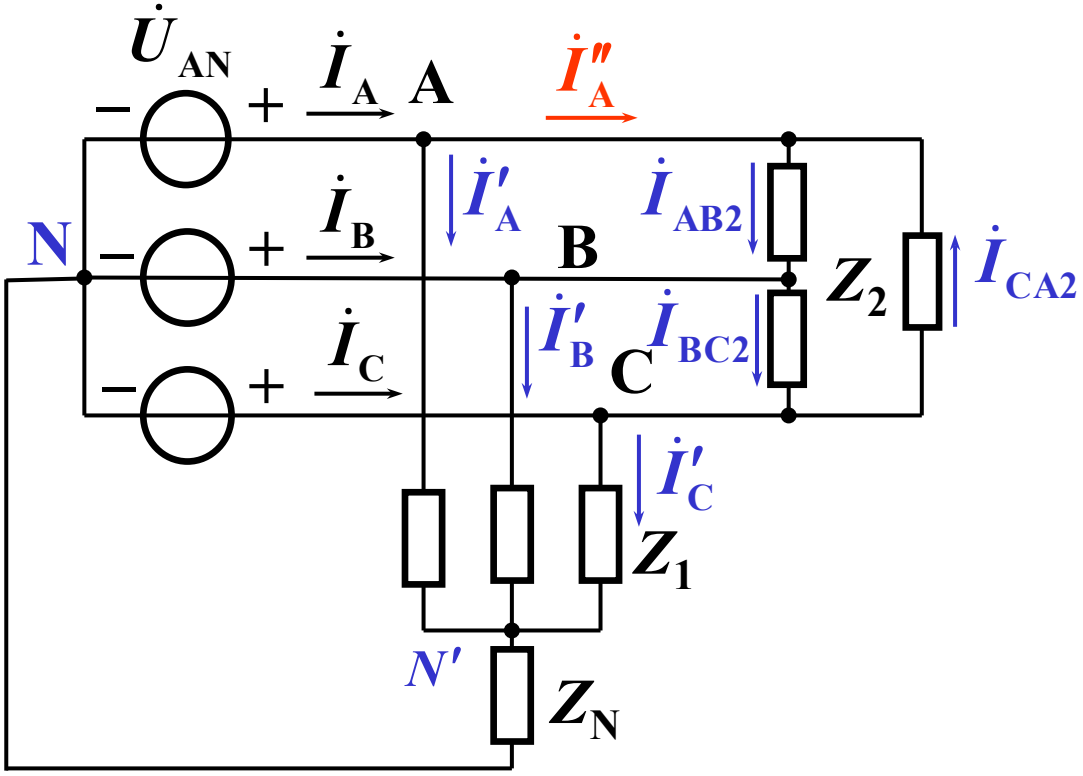
$$R = 10\ \Omega$$

$$L = 0.018\ \mathrm{H}$$

$$C = 275.7\,\mu\mathrm{F}$$

例 如图对称三相电路，电源线电压为380V，$|Z_1|=10\Omega$，$\cos\varphi_1=0.6$(滞后)，$Z_2=-j50\Omega$，$Z_N=1+j2\Omega$。求：线电流、相电流。

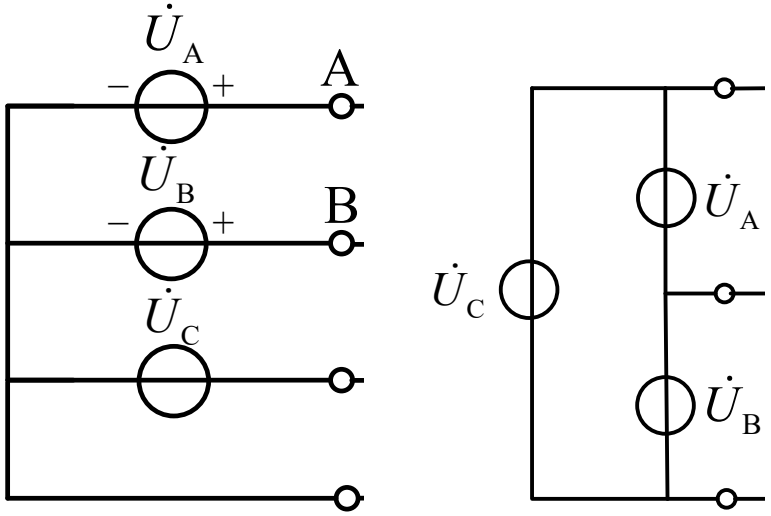
三相正弦稳态电路



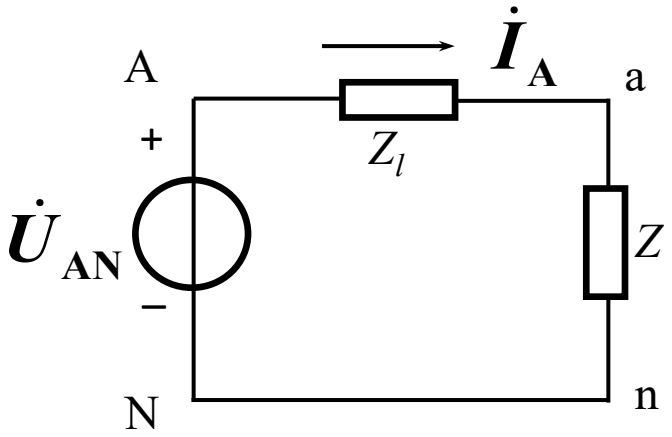
知识点回顾　三相正弦稳态电路

Y-接：$\dot{I}_{al}=\dot{I}_{ap}$　$\dot{U}_{AB}=\sqrt{3}\dot{U}_{AN}\angle 30^{\circ}$

Δ-接：$\dot{U}_{AB}=\dot{U}_{AN}$　$\dot{I}_{al}=\sqrt{3}\dot{I}_{ap}\angle -30^{\circ}$



- 对称：分相计算法



- 非对称：复杂电路分析

- 三相电路功率　$p=3UI\cos\varphi$

$$P=3U_pI_p\cos\varphi=\sqrt{3}U_lI_l\cos\varphi$$

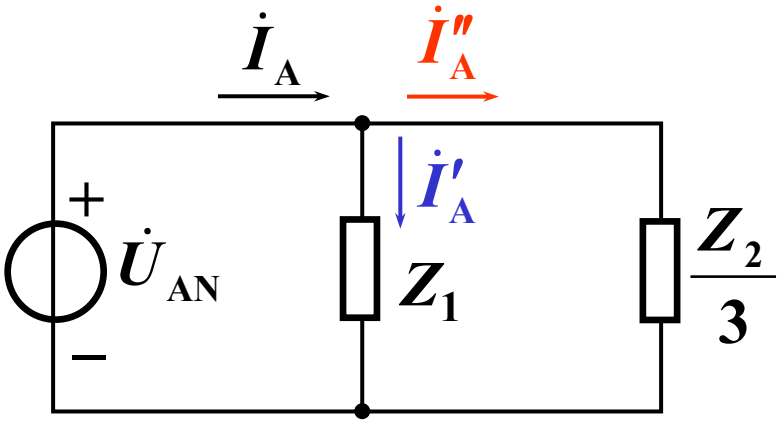
三表法和二表法

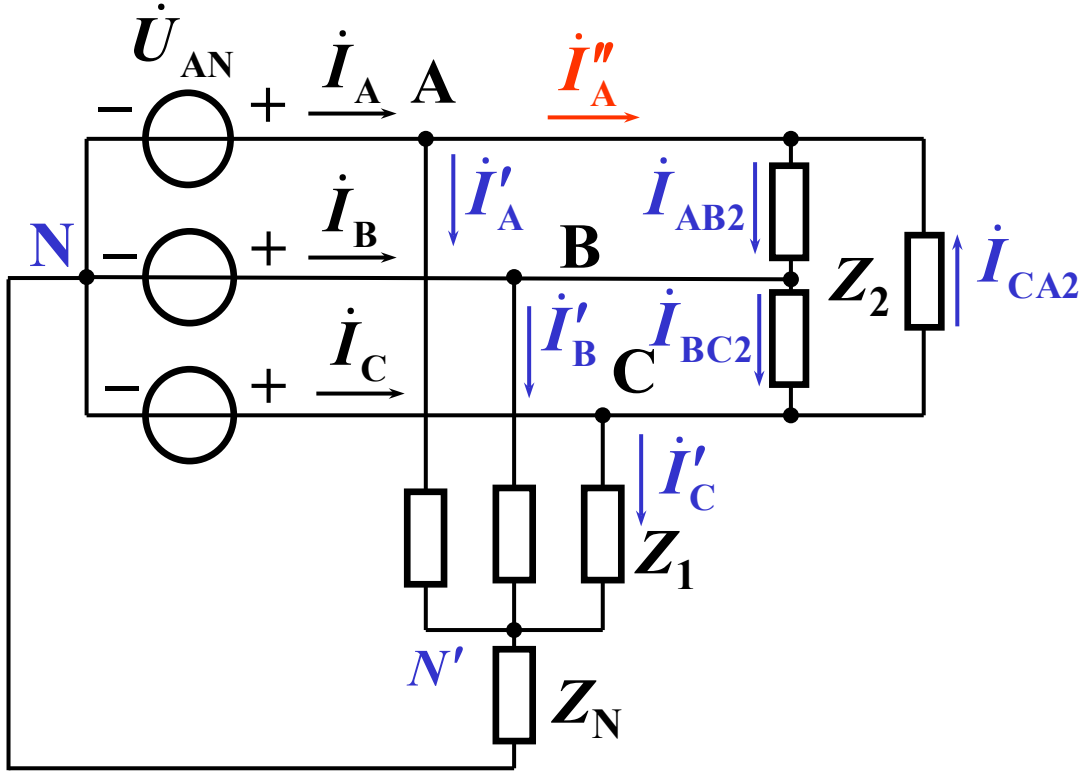
例 如图对称三相电路，电源线电压为380V，$|Z_1|=10\Omega$，$\cos\varphi_1=0.6$(滞后)，$Z_2=-j50\Omega$，$Z_N=1+j2\Omega$。求：线电流、相电流。

解 设 $\dot{U}_{AB}=380\angle 30^\circ$ V

$\dot{U}_{AN}=220\angle 0^\circ$V

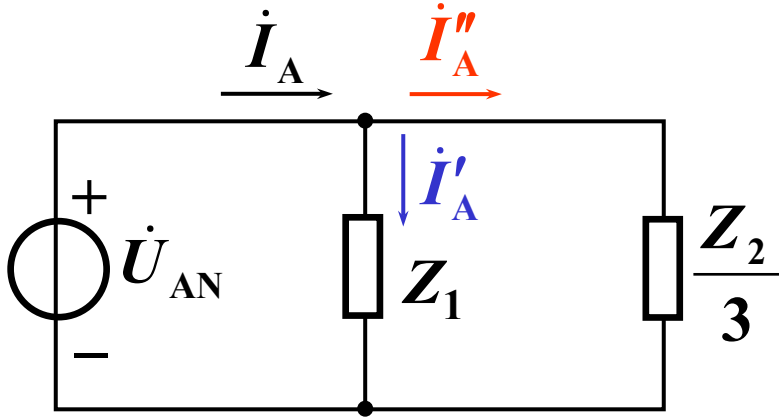
取A相计算电路





$$Z_1 = 10\angle\varphi_1 = 6 + \mathrm{j}8\,\Omega$$

$$Z_2' = \frac{1}{3}Z_2 = -\mathrm{j}\frac{50}{3}\,\Omega$$



$$\dot{I}'_A = \frac{\dot{U}_{AN}}{Z_1} = \frac{220\angle 0^\circ}{10\angle 53.13^\circ} = 22\angle -53.13^\circ\,\mathrm{A} = 13.2 - \mathrm{j}17.6\,\mathrm{A}$$

$$\dot{I}''_A = \frac{\dot{U}_{AN}}{Z_2'} = \frac{220\angle 0^\circ}{-\mathrm{j}50/3} = \mathrm{j}13.2\,\mathrm{A}$$

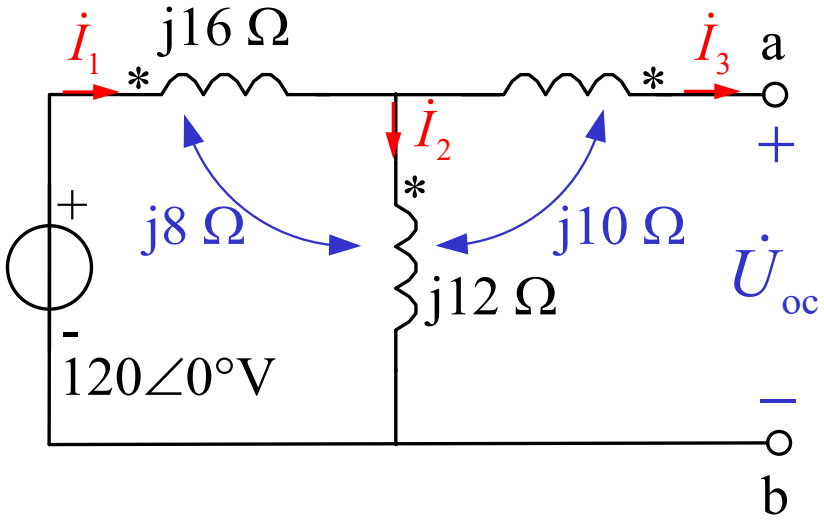
$$\dot{I}_A = \dot{I}'_A + \dot{I}''_A = 13.9\angle -18.4^\circ\,\mathrm{A}$$

根据对称性，得B、C相的线电流、相电流

$$\dot{I}_B = 13.9\angle -138.4^\circ\,\mathrm{A}$$

$$\dot{I}_C = 13.9\angle 101.6^\circ\,\mathrm{A}$$

例 求ab端口的戴维南等效电路。

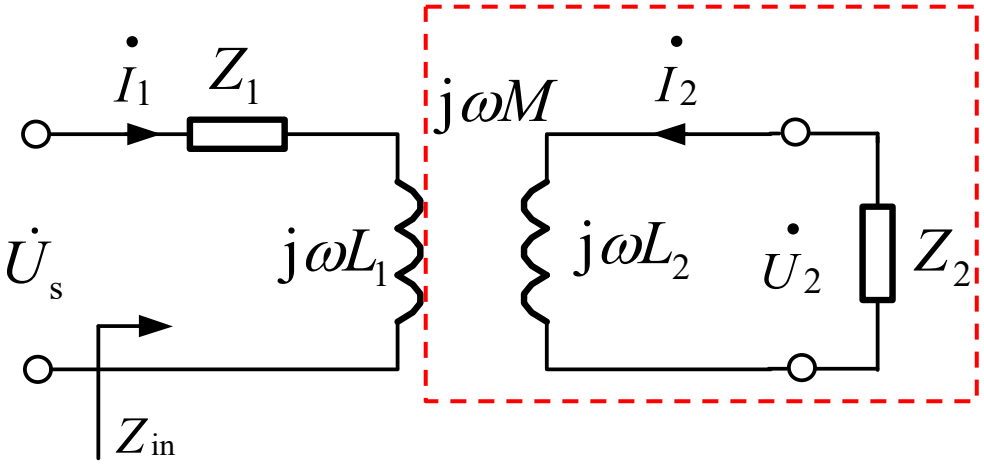


含磁耦合的电路

知识点回顾　含磁耦合的电路

- 网孔分析法　$\dot{U}_1 = \mathrm{j}\omega L_1 \dot{I}_1 \pm \mathrm{j}\omega M \dot{I}_2$
- 去耦等效法　同、异名端接在公共端－、＋
- 映射阻抗法

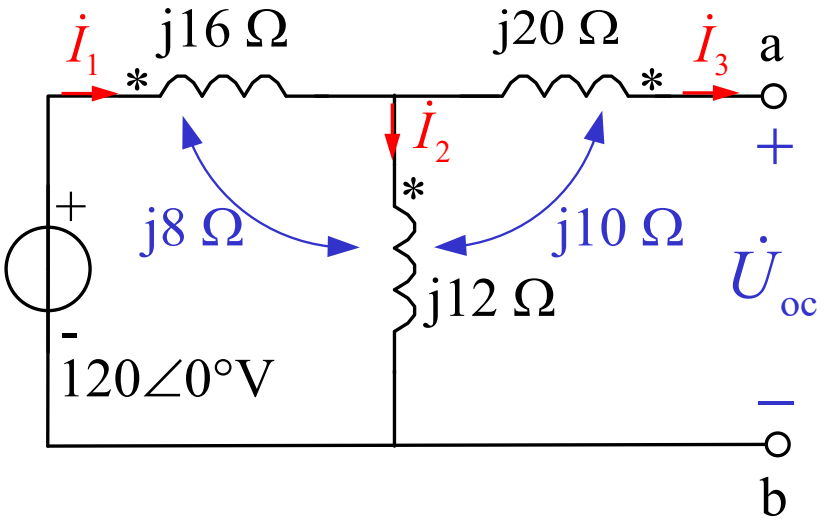
$$Z_{\text{ref}} = \frac{(\omega M)^2}{Z_{22}}$$

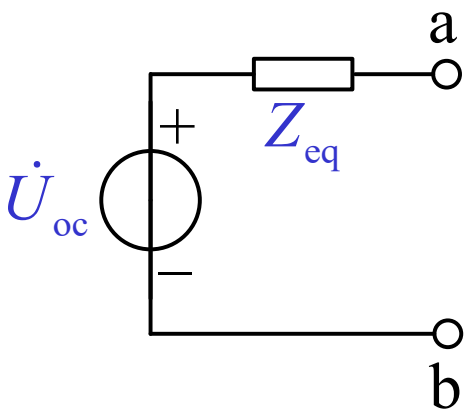


理想变压器

$$\frac{u_1}{u_2} = \frac{N_1}{N_2} = n \qquad \frac{i_1}{i_2} = -\frac{N_2}{N_1} = -\frac{1}{n}$$

例 求ab端口的戴维南等效电路。





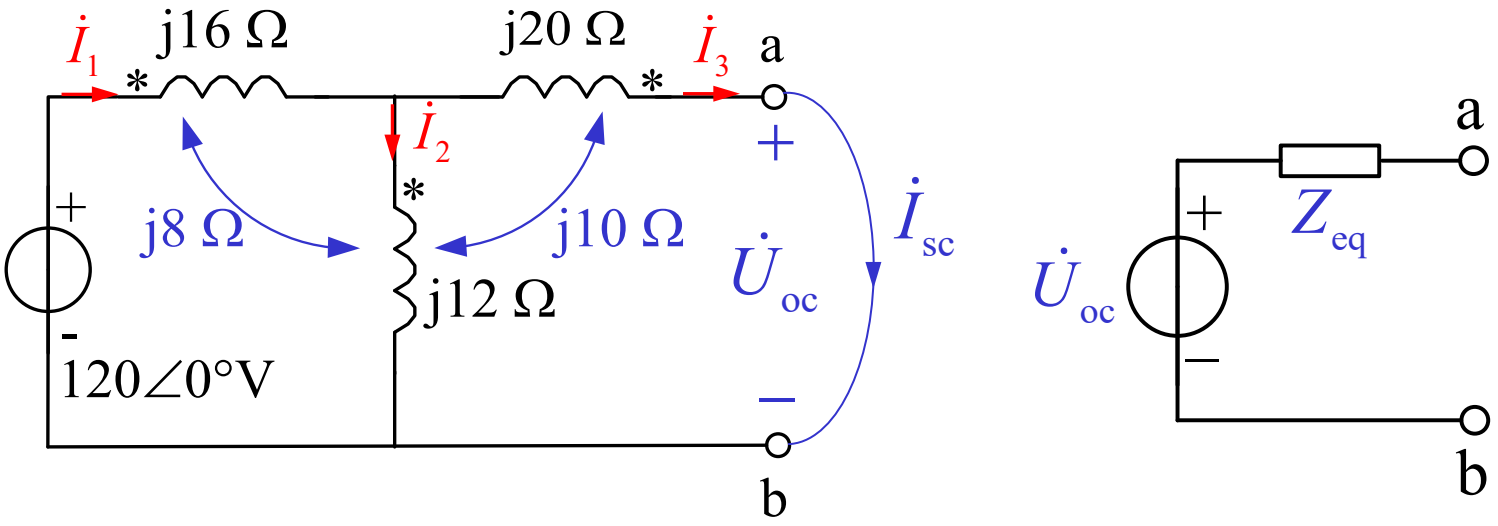
解 1）计算开路电压

$$\dot{I}_3=0 \quad \dot{I}_1=\dot{I}_2$$

$$\dot{U}_{oc}=-\left(\mathrm{j}20\dot{I}_3-\mathrm{j}10\dot{I}_2\right)+\left(\mathrm{j}12\dot{I}_2+\mathrm{j}8\dot{I}_1-\mathrm{j}10\dot{I}_3\right)$$

$$120\angle 0^\circ=\left(\mathrm{j}16\dot{I}_1+\mathrm{j}8\dot{I}_2\right)+\left(\mathrm{j}12\dot{I}_2+\mathrm{j}8\dot{I}_1-\mathrm{j}10\dot{I}_3\right)$$

$$\Rightarrow \dot{U}_{oc}=\frac{900}{11}\angle 0^\circ\ \mathrm{V}$$



2）计算短路电流

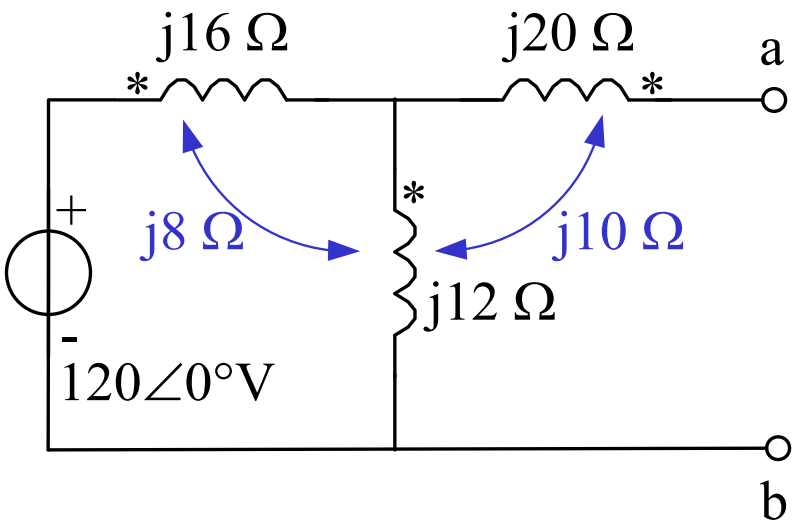
$$\mathrm{j}12\dot{I}_2+\mathrm{j}8\dot{I}_1-\mathrm{j}10\dot{I}_3=\mathrm{j}20\dot{I}_3-\mathrm{j}10\dot{I}_2$$

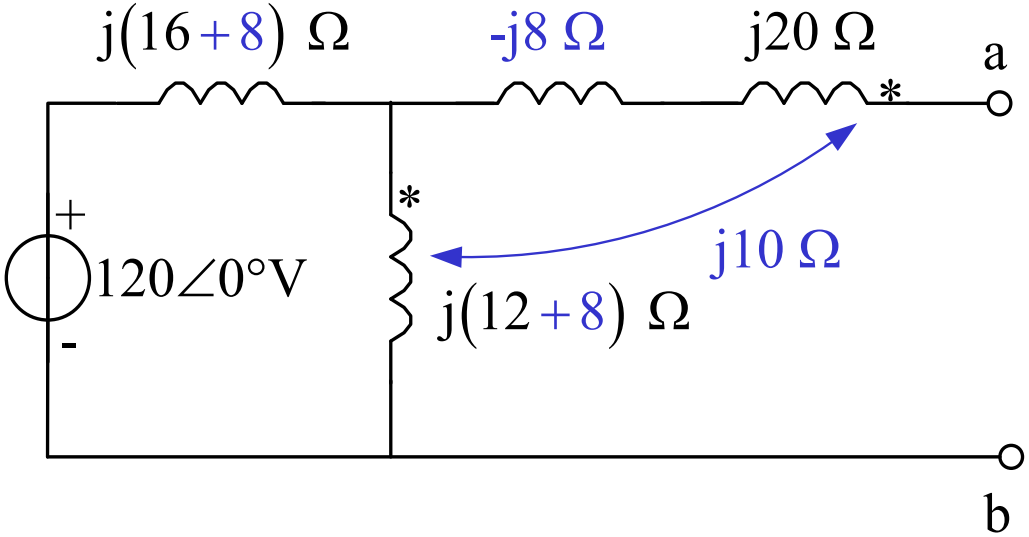
$$120\angle 0^\circ=\left(\mathrm{j}16\dot{I}_1+\mathrm{j}8\dot{I}_2\right)+\left(\mathrm{j}12\dot{I}_2+\mathrm{j}8\dot{I}_1-\mathrm{j}10\dot{I}_3\right)$$

$$\dot{I}_1=\dot{I}_2+\dot{I}_3 \qquad \dot{I}_{sc}=\dot{I}_3=-\mathrm{j}\frac{900}{347}\ \mathrm{A}$$

3）计算等效阻抗

$$Z_{eq}=\frac{\dot{U}_{oc}}{\dot{I}_{sc}}=\mathrm{j}\frac{347}{11}\ \Omega$$



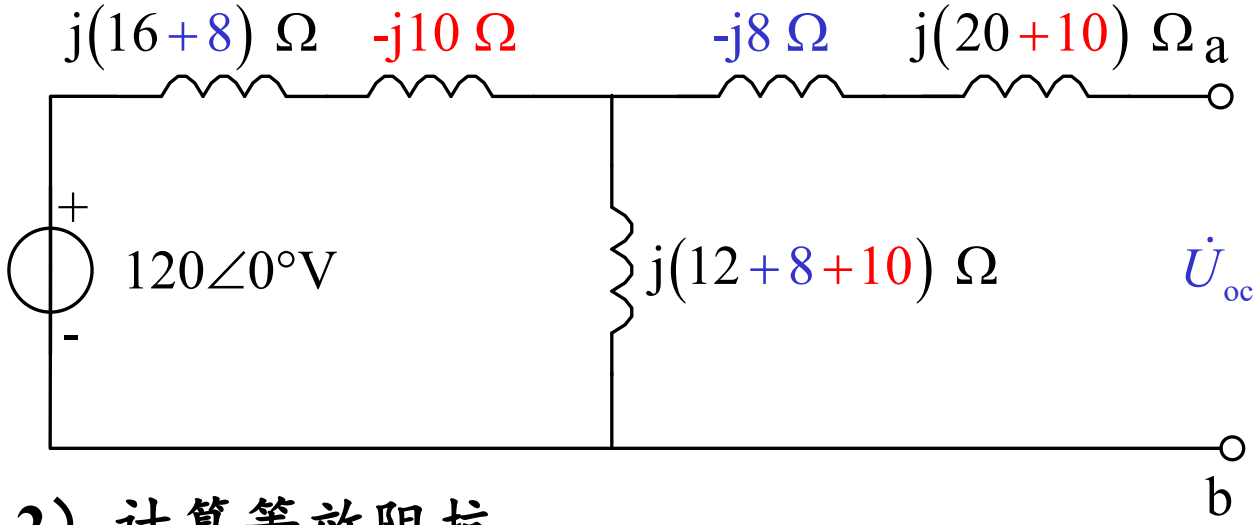


解 去耦等效法

1）计算开路电压

$$\dot{U}_{oc}=\frac{\mathrm{j}30}{\mathrm{j}14+\mathrm{j}30}\cdot 120$$

$$=\frac{900}{11}\angle 0^{\circ}\ \mathrm{V}$$



2）计算等效阻抗

$$Z_{eq}=\left[\mathrm{j}22+\left(\mathrm{j}30\ /\!/\ \mathrm{j}14\right)\right]=\mathrm{j}\frac{347}{11}\ \Omega$$

例 求图示电路中各支路电流。 **串联谐振、并联谐振**

解 先去耦。

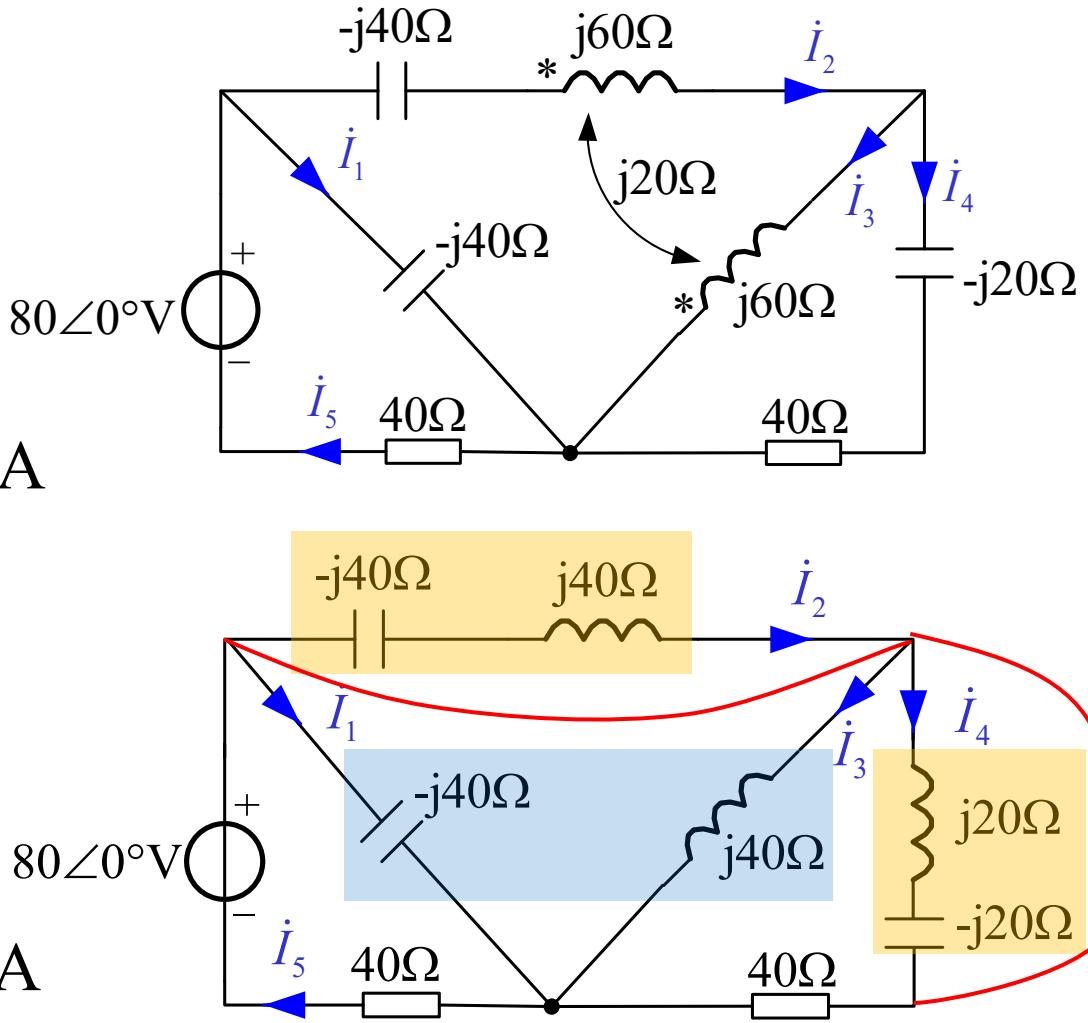
$$\dot{I}_1+\dot{I}_3=0$$

$$\dot{I}_4=\dot{I}_5=\frac{80\angle 0^\circ}{40+40}=1\angle 0^\circ\text{A}$$

$$\dot{I}_3=\frac{40\dot{I}_4}{\text{j}40}=1\angle -90^\circ\text{A}$$

$$\dot{I}_1=-\dot{I}_3=1\angle 90^\circ\text{A}$$

$$\dot{I}_2=\dot{I}_3+\dot{I}_4=\sqrt{2}\angle -45^\circ\text{A}$$



知识点回顾

RLC 串联谐振　　*GCL* 并联谐振

谐振频率

$$\omega_0 = \frac{1}{\sqrt{LC}} = \sqrt{\omega_{c1}\omega_{c2}}$$

品质因数	$Q = \dfrac{\omega_0 L}{R} = \dfrac{1}{\omega_0 CR} = \dfrac{\omega_0}{B}$	$Q = \dfrac{1}{\omega_0 LG} = \dfrac{\omega_0 C}{G} = \dfrac{\omega_0}{B}$
截止频率	$\omega_{c1,c2} = \mp\dfrac{\omega_0}{2Q} + \omega_0\sqrt{1+\left(\dfrac{1}{2Q}\right)^2}$ $\omega_{c1,c2} \approx \omega_0 \mp \dfrac{B}{2}\ (Q \geq 10)$	
带宽	$B = \omega_{c2} - \omega_{c1} = \dfrac{\omega_0}{Q}$	

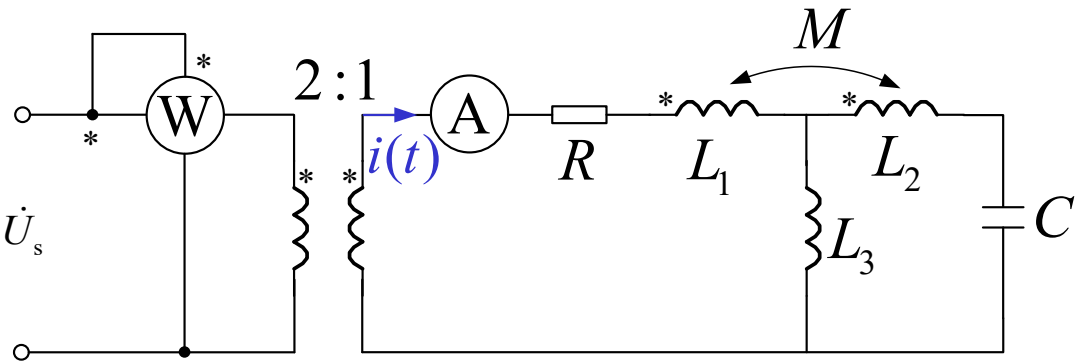
例 在图示电路中，$u_s(t)=(300\sqrt{2}\sin\omega t+200\sqrt{2}\sin 3\omega t)$，$R=50\Omega$，$\omega L_1=60\Omega$，$\omega L_2=50\Omega$，$\omega M=40\Omega$，$\omega L_3=20\Omega$，且电感$L_3$的电流不含基波。计算电流$i(t)$、各表的读数。

正弦稳态电路及功率测量

磁耦合及变压器

正弦稳态电路的频率响应

周期性非正弦稳态电路



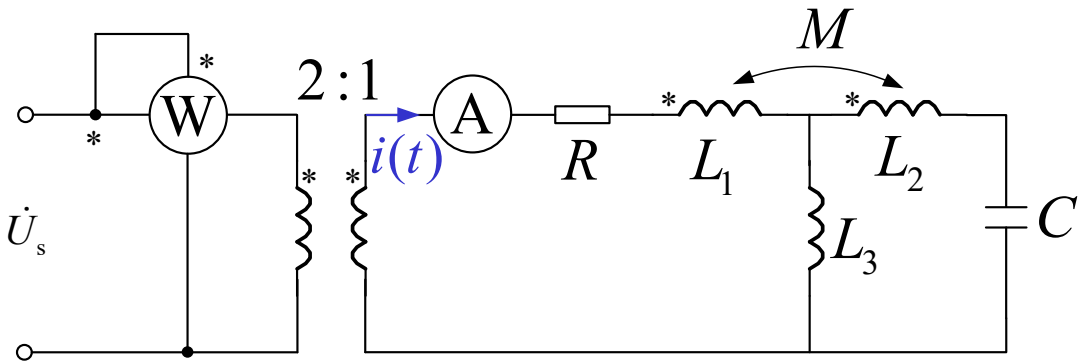
知识点回顾

A. 将周期性非正弦电源分解为傅里叶级数

B. 根据叠加定理，分别计算直流分量和各次谐波激励单独作用时产生的响应；**注意电感和电容的阻抗值！**

C. 将计算结果以瞬时值形式相加（**各次谐波激励所产生的相量形式响应不能进行相加**，因其频率不同）

例 在图示电路中，$u_s(t)=(300\sqrt{2}\sin\omega t+200\sqrt{2}\sin 3\omega t)$，$R=50\Omega$，$\omega L_1=60\Omega$，$\omega L_2=50\Omega$，$\omega M=40\Omega$，$\omega L_3=20\Omega$，且电感$L_3$的电流不含基波。计算电流$i(t)$、各表的读数。



解 （1）基波单独作用：

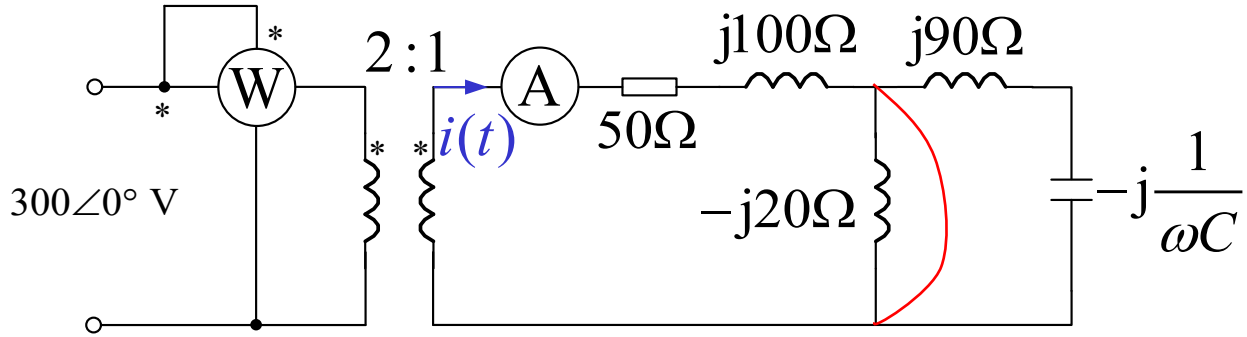
先去耦

电感L_3的电流不含基波

$\rightarrow \dot{I}_{L3(1)}=0$

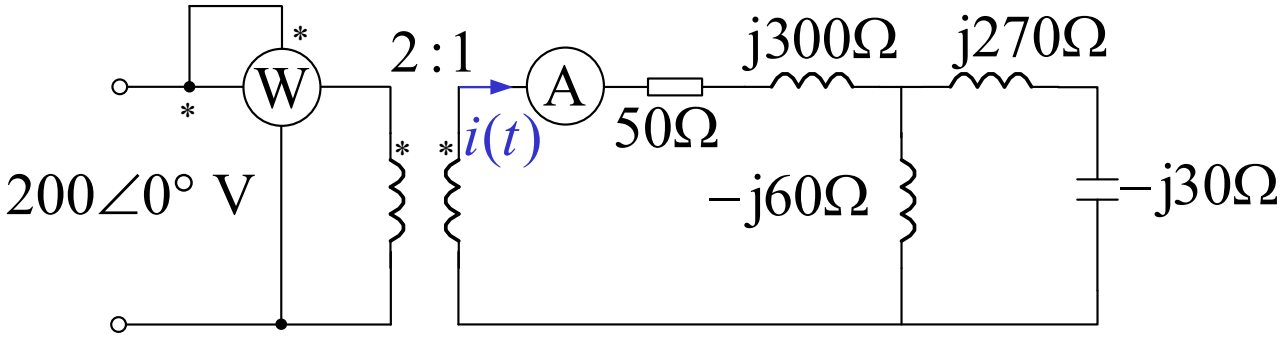
$\rightarrow \mathrm{j}90-\mathrm{j}\dfrac{1}{\omega C}=0$

$\dfrac{1}{\omega C}=90\Omega$



$$\dot{I}_{(1)}=\frac{150}{50+\mathrm{j}100}=1.34\angle -63.4^\circ\ \mathrm{A}$$

（2）3次谐波单独作用：



$$Z_{(3)} = 50 + \mathrm{j}300 + \frac{-\mathrm{j}240 \times \mathrm{j}60}{\mathrm{j}240 - \mathrm{j}60} = 50 + \mathrm{j}220\ \Omega$$

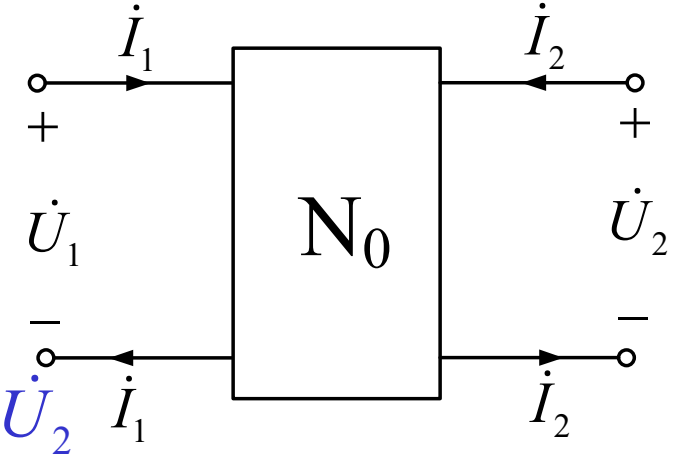
$$\dot{I}_{(3)} = \frac{100\angle 0^\circ}{50 + \mathrm{j}220} = 0.44\angle -77.2^\circ\ \mathrm{A}$$

$$i(t) = 1.34\sqrt{2}\sin(\omega t - 63.4^\circ) + 0.44\sqrt{2}\sin(3\omega t - 77.2^\circ)\ \mathrm{A}$$

电流表读数：$I = \sqrt{1.34^2 + 0.44^2} = 1.41\ \mathrm{A}$

功率表读数：$P = 50I^2 = 50 \times 1.41^2 = 99.5\ \mathrm{W}$

例 已知：端口2开路时，U_1=10mV，I_1=10μA，U_2=-40V；端口2短路时，U_1=24mV，I_1=20μA，I_2=1mA。计算网络*H*参数。



知识点回顾 二端口网络

- 六组参数方程

$$\begin{cases}\dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2\end{cases} \qquad \begin{cases}\dot{I}_1 = Y_{11}\dot{U}_1 + Y_{12}\dot{U}_2 \\ \dot{I}_2 = Y_{21}\dot{U}_1 + Y_{22}\dot{U}_2\end{cases}$$

实验测量法

$$\begin{cases}\dot{U}_1 = h_{11}\dot{I}_1 + h_{12}\dot{U}_2 \\ \dot{I}_2 = h_{21}\dot{I}_1 + h_{22}\dot{U}_2\end{cases} \qquad \begin{cases}\dot{I}_1 = g_{11}\dot{U}_1 + g_{12}\dot{I}_2 \\ \dot{U}_2 = g_{21}\dot{U}_1 + g_{22}\dot{I}_2\end{cases}$$

互易、对称条件

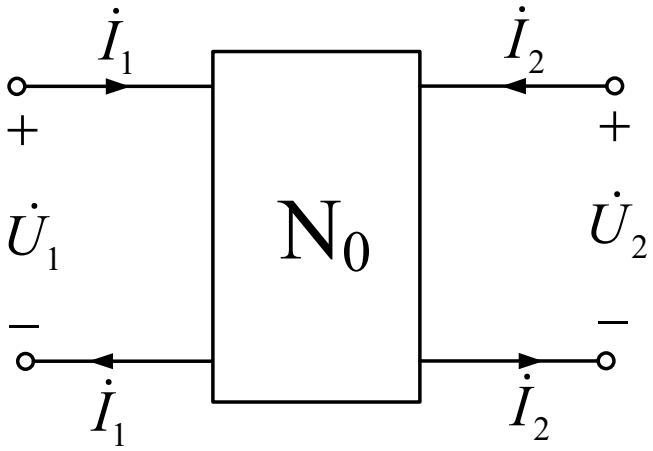
$$\begin{cases}\dot{U}_1 = A\dot{U}_2 + B(-\dot{I}_2) \\ \dot{I}_1 = C\dot{U}_2 + D(-\dot{I}_2)\end{cases} \qquad \begin{cases}\dot{U}_2 = A'\dot{U}_1 + B'(-\dot{I}_1) \\ \dot{I}_2 = C'\dot{U}_1 + D'(-\dot{I}_1)\end{cases}$$

- 等效电路模型

T形电路

π形电路

例 已知：端口2开路时，U_1=10mV，I_1=10μA，U_2=-40V；端口2短路时，U_1=24mV，I_1=20μA，I_2=1mA。计算网络*H*参数。



解 端口2开路 ⇒ $\dot{I}_2 = 0$

端口2短路 ⇒ $\dot{U}_2 = 0$

T参数方程
$$\begin{cases} \dot{U}_1 = A\dot{U}_2 + B\left(-\dot{I}_2\right) \\ \dot{I}_1 = C\dot{U}_2 + D\left(-\dot{I}_2\right) \end{cases}$$

$$A = \frac{\dot{U}_1}{\dot{U}_2} = \frac{10\text{mV}}{-40\text{V}} = -2.5\times10^4 \qquad B = \frac{\dot{U}_1}{-\dot{I}_2} = \frac{24\text{mV}}{-1\text{mA}} = -24\ \Omega$$

$$C = \frac{\dot{I}_1}{\dot{U}_2} = \frac{10\mu\text{A}}{-40\text{V}} = -2.5\times10^7\ \text{S} \qquad D = \frac{\dot{I}_1}{-\dot{I}_2} = \frac{20\mu\text{A}}{-1\text{mA}} = -0.02$$

$$A=-2.5\times10^{4} \qquad C=-2.5\times10^{7}\ \text{S}$$

$$B=-24\ \Omega \qquad D=-0.02$$

T参数方程

$$\begin{cases}\dot{U}_1=A\dot{U}_2+B\left(-\dot{I}_2\right)\\ \dot{I}_1=C\dot{U}_2+D\left(-\dot{I}_2\right)\end{cases}$$

H参数方程

$$\begin{cases}\dot{U}_1=h_{11}\dot{I}_1+h_{12}\dot{U}_2\\ \dot{I}_2=h_{21}\dot{I}_1+h_{22}\dot{U}_2\end{cases}$$

$$\dot{I}_1=C\dot{U}_2+D\left(-\dot{I}_2\right) \Rightarrow \dot{I}_2=-\frac{1}{D}\dot{I}_1+\frac{C}{D}\dot{U}_2$$

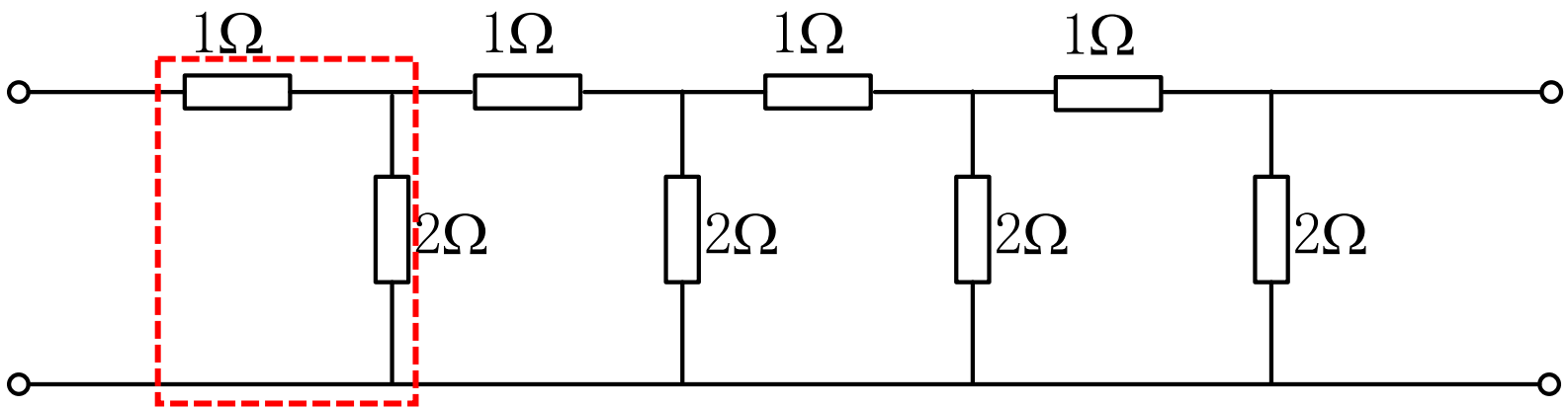
$$h_{21}=-\frac{1}{D}=50 \qquad h_{22}=\frac{C}{D}=12.5\ \mu\text{S}$$

$$\dot{U}_1=A\dot{U}_2+B\left(\frac{1}{D}\dot{I}_1-\frac{C}{D}\dot{U}_2\right) \Rightarrow$$

$$h_{11}=\frac{B}{D}=1.2\ \text{k}\Omega$$

$$h_{12}=\frac{AD-BC}{D}=5\times10^{-5}$$

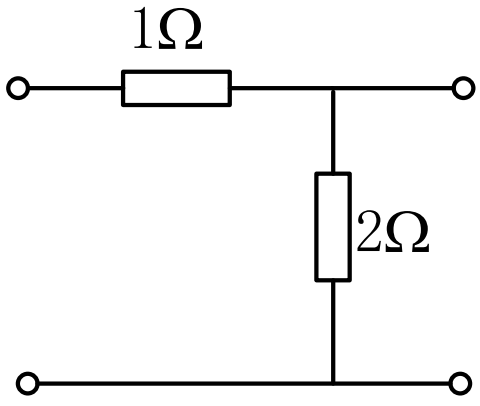
例 求T参数矩阵。



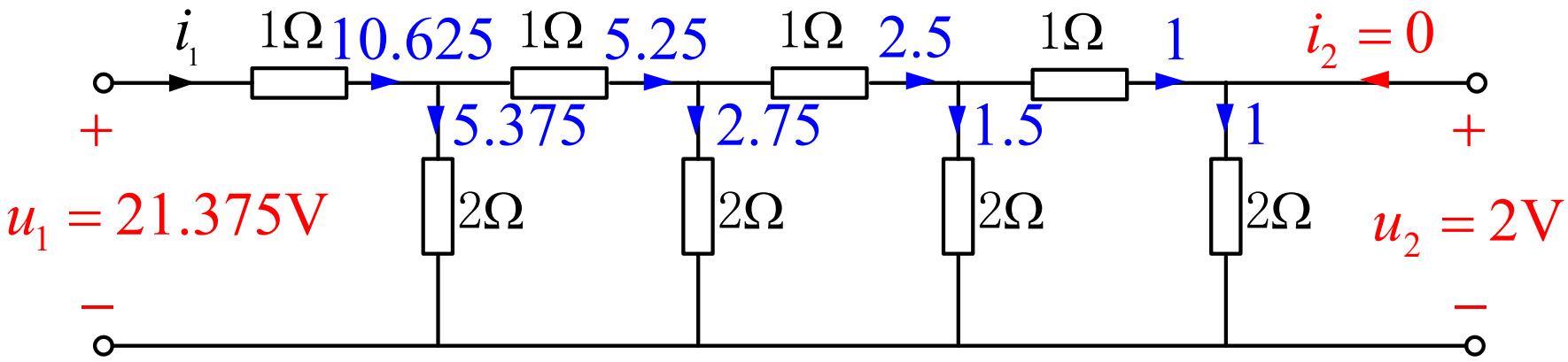
解

$$T_1=\begin{bmatrix}1.5 & 1\\ 0.5 & 1\end{bmatrix}$$

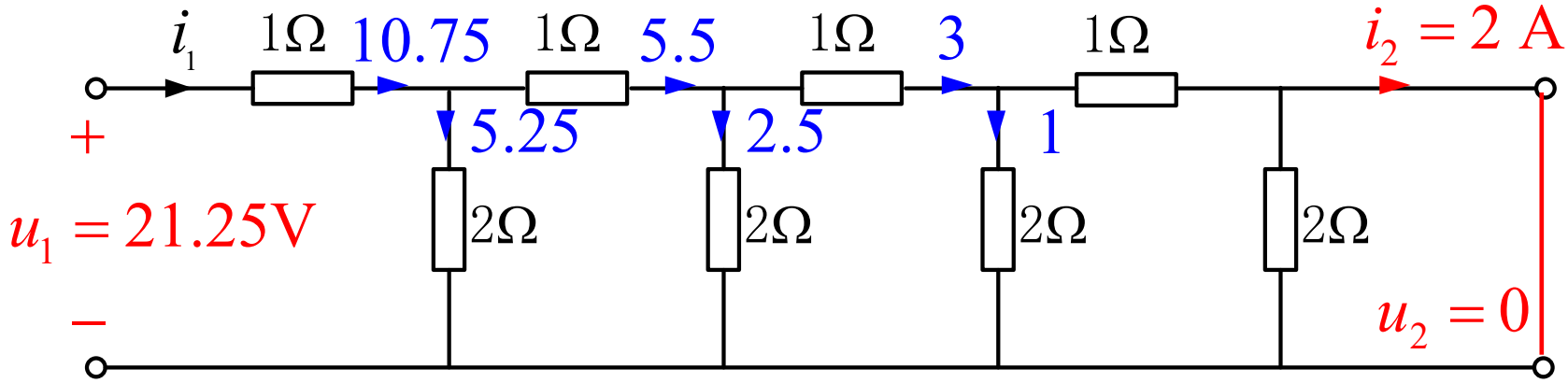
$$\begin{cases}\dot{U}_1=A\dot{U}_2+B\left(-\dot{I}_2\right)\\ \dot{I}_1=C\dot{U}_2+D\left(-\dot{I}_2\right)\end{cases}$$



$$T=T_1^4=(T_1^2)^2=\begin{bmatrix}10.6875 & 10.625\\ 5.3125 & 5.375\end{bmatrix}$$



$$A = \left.\frac{u_1}{u_2}\right|_{i_2=0} = \frac{21.375}{2} = 10.6875 \qquad C = \left.\frac{i_1}{u_2}\right|_{i_2=0} = \frac{10.625}{2} = 5.3125\ \text{S}$$



$$B = \left.\frac{u_1}{i_2}\right|_{u_2=0} = \frac{21.25}{2} = 10.625\ \Omega \qquad D = \left.\frac{i_1}{i_2}\right|_{u_2=0} = \frac{10.75}{2} = 5.375$$

作业

- 16.2节：16-2
- 16.3节：16-11，16-16
- 16.4节：16-26
- 16.5节：16-30
- 综合：16-38

谢 谢！