第八章 第九章

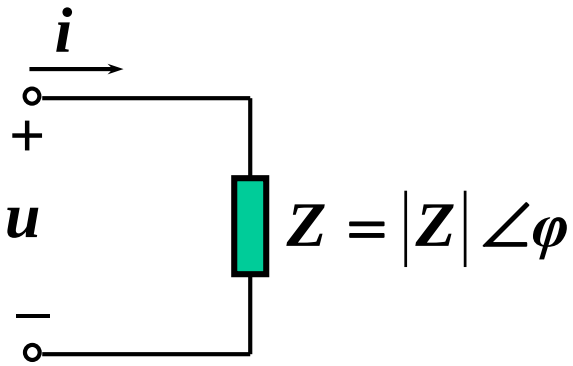
要点：1. 正弦量的基本概念：三要素、相位差、波形…

2. 定量计算：相量法　辅助工具：相量图

3.功率计算：有功、无功、视在功率、功率因数、复功率等

一. 正弦量、相量的基本概念

1、



左图电路中，已知：

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

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

(a)电源电压角频率ω = 400π rad/s, 频率 f= 200Hz, 周期 T= 0.005s .

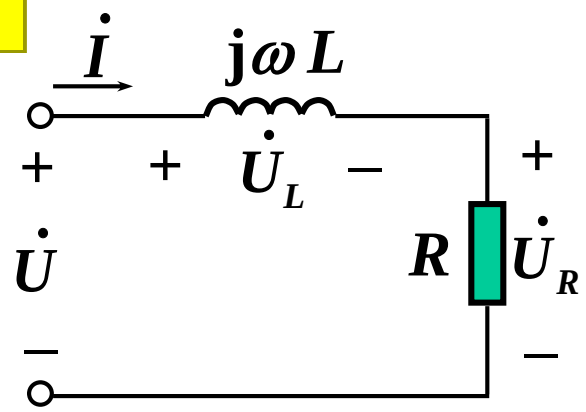
(b)电压有效值U= 7.07V ， 电流有效值 I= 0.5A .

(c)电压、电流间相位差$\Psi_u-\Psi_i$ = 120° .

(d)该负载是 感性 负载, $|Z|$= 14.14Ω ， φ = 120° .

2、指出下列结果是否正确,若有错,试将其改正。

a.



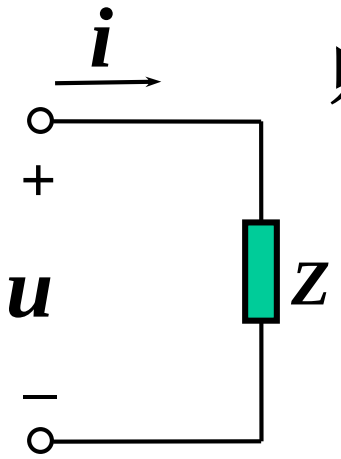
(1) $\dot{I}=\dfrac{\dot{U}}{R+j\omega L}$ (2) $I=\dfrac{U}{\sqrt{R^2+(\omega L)^2}}$

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

(5) $U_m^2=U_L^2+U_R^2$ (6) $P=\dfrac{U_R^2}{R}$

✓(7) $P=I^2R$ (8) $|Z|=\sqrt{R^2+(\omega L)^2}$

b.



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

则 $i=\dfrac{u}{Z}=\dfrac{311\cos(\omega t+45°)}{25\angle 60°}=\dfrac{311}{25}\cos(\omega t+45°-60°)\text{A}$

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

$$i=\frac{311}{25}\cos(\omega t-15^{o})\ \ \text{A}$$

用相量法分析正弦稳态电路的基本步骤：

(1) 时域电路--------〉相量模型

a：u,i 的相量形式

b：各元件的阻抗

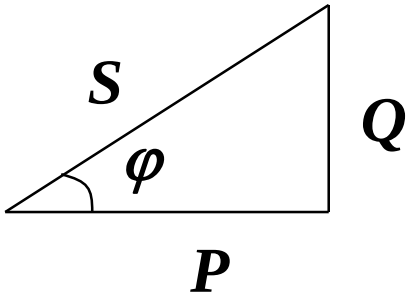
- **根据电路的结构特点，选用合适的分析方法，求出待求变量的相量**
- **根据求得的相量，写出其时域表达式**

正弦稳态电路的功率分析：

有功功率：$P=UI\cos\varphi$　　单位：W

视在功率：$S=UI$　　单位：VA

无功功率：$Q=UI\sin\varphi$　　单位：var



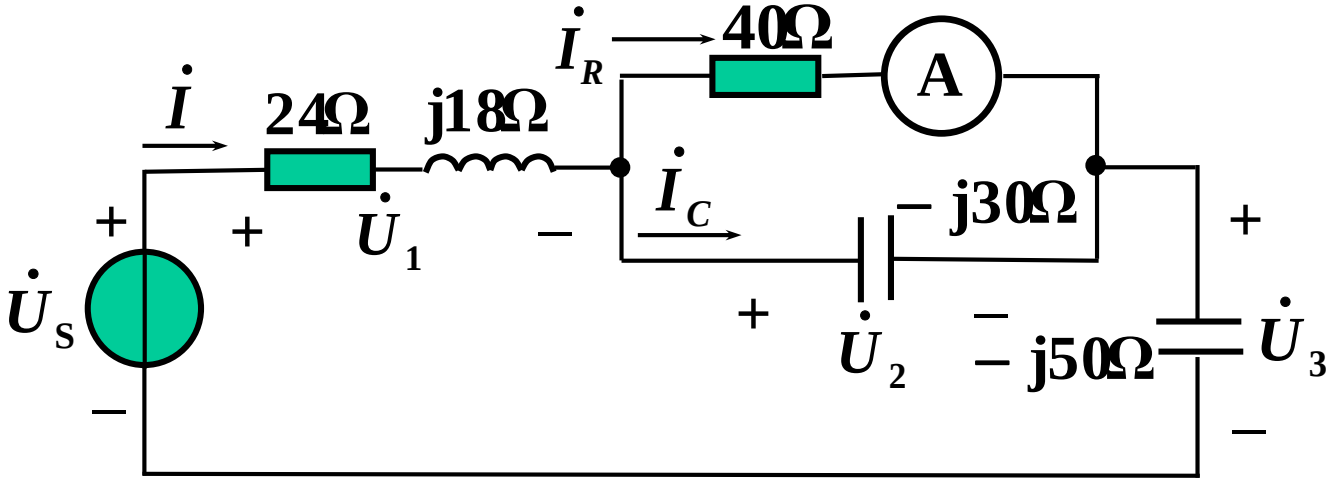
功率三角形

$$P = S\cos\varphi, \quad Q = S\sin\varphi$$

$$S = \sqrt{P^2 + Q^2}, \ \varphi = \arctan(\frac{Q}{P})$$

已知：已知电流表读数为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：　设　$\dot{I}_R = 1.5\angle 0^\circ \text{ A}$

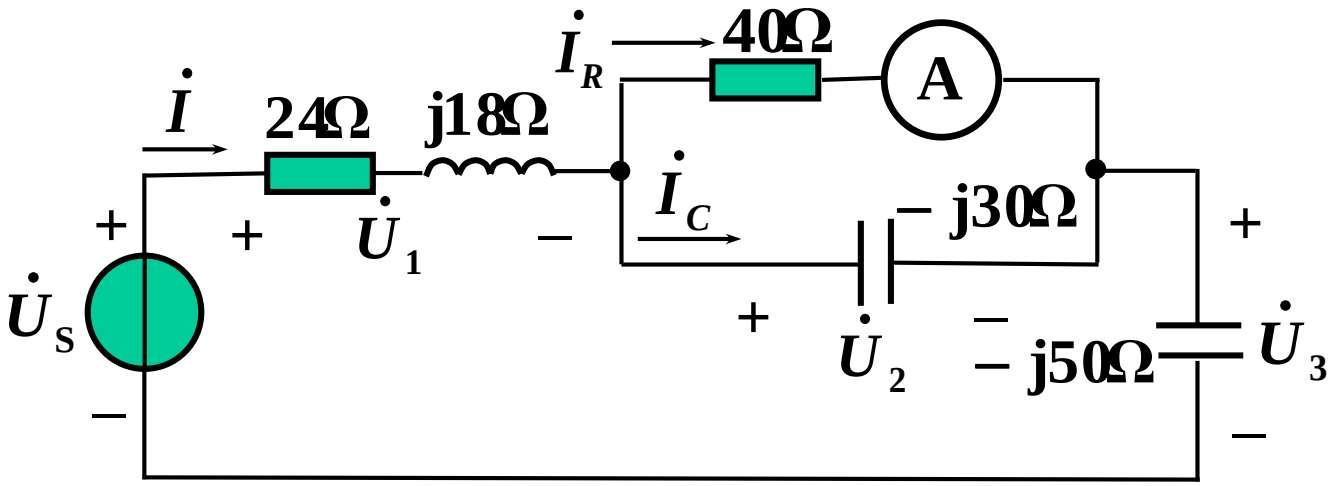
则　$\dot{U}_2 = 40 \times 1.5\angle 0^\circ = 60\angle 0^\circ \text{ V}$

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

$$\dot{I} = \dot{I}_R + \dot{I}_C = 1.5 + j2 = 2.5\angle 53.1^\circ \text{ A}$$

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

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



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

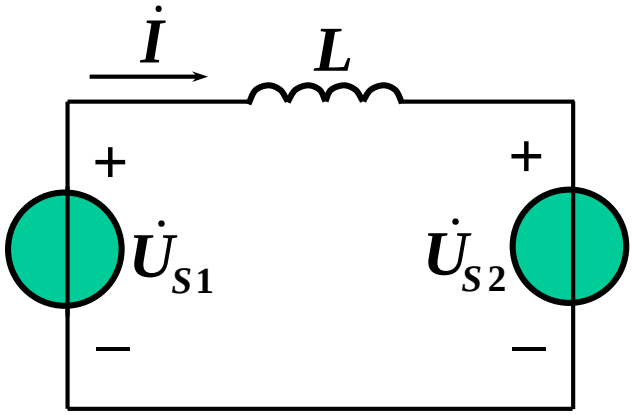
$$P_x = U_S I \cos\varphi = 160 \times 2.5 \times 0.6 = 240 \text{ W}$$

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

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

$$Q_x = 18I^2 - 30I_C^2 - 50I^2$$

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



已知：$\dot{U}_{S1}=110\angle-30^\circ\,\text{V}$，$\dot{U}_{S2}=110\angle30^\circ\,\text{V}$，

$L=1.5\text{H}$，$f=50\text{Hz}$.

试求：两个电源各自发出的有功功率和无功功率。

解：

$$\dot{I}=\frac{\dot{U}_{S1}-\dot{U}_{S2}}{\text{j}\omega L_1}=\frac{110\angle-30^\circ-110\angle30^\circ}{\text{j}314\times1.5}=\frac{-\text{j}110}{\text{j}471}=-0.234\,\text{A}$$

$$P_1=U_{S1}I\cos(-30^\circ-180^\circ)=110\times0.234\times(-0.866)=-22.3\,\text{W}$$

$$Q_1=U_{S1}I\sin(-30^\circ-180^\circ)=110\times0.234\times0.5=12.9\,\text{Var}$$

$$P_2=-U_{S2}I\cos(30^\circ-180^\circ)=-110\times0.234\times(-0.866)=22.3\,\text{W}$$

$$Q_2=-U_{S2}I\sin(30^\circ-180^\circ)=-110\times0.234\times(-0.5)=12.9\,\text{Var}$$

两个电源发出的有功功率互相抵消，而无功功率不抵消，因为电路中的电感吸收无功。