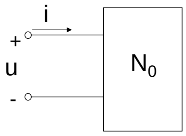
例9-1

已知：$u=100\cos 2t$ V

$i=10\cos(2t+60°)$ A

求：最简串联组合及并联组合元件值



解：

$\dot{U}_m=100\angle 0^\circ \text{V}$

$\dot{I}_m=10\angle 60^\circ \text{A}$

$$Z=\frac{\dot{U}_m}{\dot{I}_m}=\frac{100\angle 0^\circ}{10\angle 60^\circ}=10\angle -60^\circ=5-j8.66\Omega$$

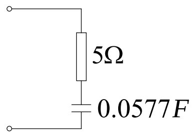
1

$$Z=\frac{\dot{U}_m}{\dot{I}_m}=\frac{100\angle 0^\circ}{10\angle 60^\circ}=10\angle -60^\circ=5-j8.66\Omega$$

串联组合 $R=5\Omega$

$$\frac{1}{\omega C}=8.66$$

$$C=\frac{1}{8.66\times 2}=0.0577\text{F}$$



2

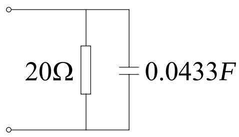
$$Y=\frac{1}{Z}=\frac{1}{10\angle -60^\circ}=0.1\angle 60^\circ=0.05+j0.0866\text{S}$$

并联组合 $G=0.05\text{S}$

$\omega C=0.0866$

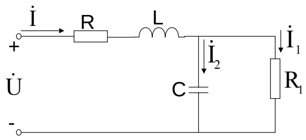
$$R=\frac{1}{G}=\frac{1}{0.05}=20\Omega$$

$$C=\frac{0.0866}{2}=0.0433\text{F}$$



3

例9-2



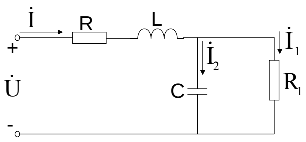
已知：$R=10\,\Omega$ $R_1=50\,\Omega$ $L=20\text{mH}$ $C=10\,\mu\text{F}$

$U=100\text{V}$ $\omega=1000\text{rad/s}$

求：各支路电流

4

解：

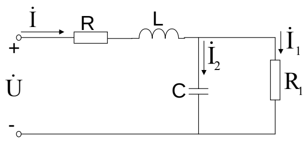


设 $\dot{U}=100\angle 0^\circ \text{V}$

$$Z=R+j\omega L+\frac{R_1(-j\frac{1}{\omega C})}{R_1-j\frac{1}{\omega C}}=50\angle 0^\circ\Omega$$

$$\dot{I}=\frac{\dot{U}}{Z}=\frac{100\angle 0^\circ}{50\angle 0^\circ}=2\angle 0^\circ \text{A}$$

5



$$\dot{I}_1=\frac{-j\frac{1}{\omega C}}{R_1-j\frac{1}{\omega C}}\dot{I}=1.79\angle -26.6^\circ \text{A}$$

$$\dot{I}_2=\frac{R_1}{R_1-j\frac{1}{\omega C}}\dot{I}=0.894\angle 63.4^\circ \text{A}$$

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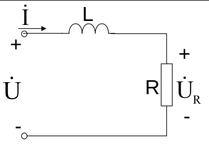
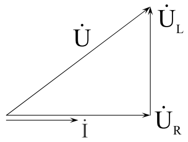
例9-3

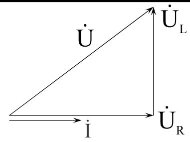


已知：R=800Ω　U=220V　f=50Hz　若使U_R=110V

求：　L值

解：





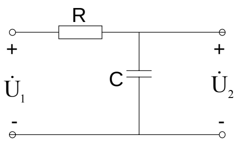
$$U_L=\sqrt{U^2-U_R^2}=\sqrt{220^2-110^2}=190.5V$$

$$I=\frac{U_R}{R}=\frac{110}{800}=0.1375A$$

$$X_L=\omega L=\frac{U_L}{I}=\frac{190.5}{0.1375}=1385.45\,\Omega$$

$$L=\frac{X_L}{\omega}=\frac{X_L}{2\pi f}=\frac{1385.45}{2\pi\times 50}=4.4H$$

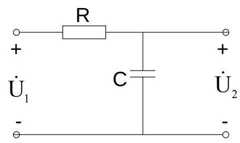
例9-4



已知：R=1KΩ　f=5kHz

若使$\dot U_2$滞后于$\dot U_1$ 30° 应取C为何值。

解：法1



$$\dot U_2=\frac{-j\frac{1}{\omega C}}{R-j\frac{1}{\omega C}}\dot U_1$$

$$=\frac{-j\frac{1}{\omega C}(R+j\frac{1}{\omega C})}{R^2+(\frac{1}{\omega C})^2}\dot U_1$$

$$=\frac{\frac{1}{\omega C}}{R^2+(\frac{1}{\omega C})^2}(\frac{1}{\omega C}-jR)\dot U_1$$

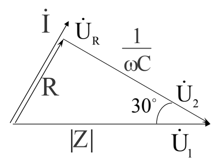
$$\dot U_2=\frac{\frac{1}{\omega C}}{R^2+(\frac{1}{\omega C})^2}(\frac{1}{\omega C}-jR)\dot U_1$$

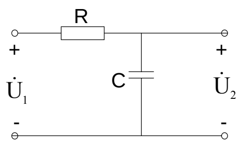
$$=\frac{\frac{1}{\omega C}\sqrt{R^2+(\frac{1}{\omega C})^2}}{R^2+(\frac{1}{\omega C})^2}\angle \mathrm{arctg}\frac{-R}{\frac{1}{\omega C}}\dot U_1$$

$$\mathrm{arctg}(-\omega CR)=-30^\circ$$

$$\mathrm{tg}(-30^\circ)=-\omega CR=-\frac{\sqrt3}{3}\qquad C=-\frac{\frac{\sqrt3}{3}}{2\pi fR}=0.0184\mu f$$

法2

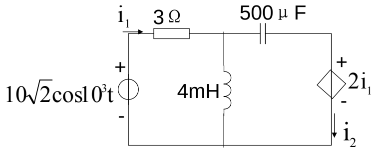




$$\mathrm{tg}30^\circ=\frac{R}{\frac{1}{\omega C}}=\omega CR=2\pi fCR$$

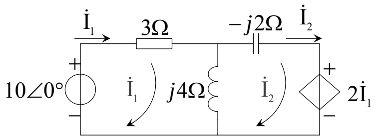
$$C=\frac{\mathrm{tg}30^\circ}{2\pi fR}=\frac{\frac{\sqrt3}{3}}{2\pi\times5\times10^3\times10^3}=0.0184\mu f$$

例9−5



求：i_1 i_2

解：



相量模型

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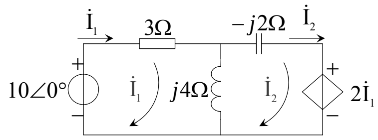

相量模型

$$(3+j4)\dot{I}_1-j4\dot{I}_2=10\angle 0°$$

$$(j4-j2)\dot{I}_2-j4\dot{I}_1=-2\dot{I}_1$$

解得 $\dot{I}_1=1.24\angle 29.8°\text{A}$

$\dot{I}_2=2.77\angle 56.3°\text{A}$

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$$\dot{I}_1=1.24\angle 29.8°\text{A}$$

$$\dot{I}_2=2.77\angle 56.3°\text{A}$$

$$i_1=1.24\sqrt{2}\cos(10^3t+29.8°)\text{A}$$

$$i_2=2.77\sqrt{2}\cos(10^3t+56.3°)\text{A}$$

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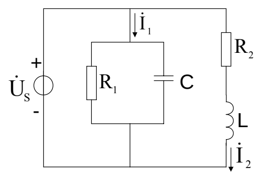
例9−6



求：$\dot{I}_1$ 超前于 $\dot{I}_2$ $\frac{\pi}{2}$ 的条件

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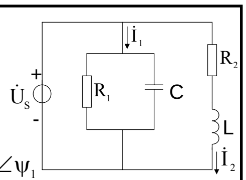
解：

设 $\dot{U}_S=U_S\angle 0°$



$$\dot{I}_1=\dot{U}_S(\frac{1}{R_1}+j\omega C)=U_S\angle 0°(\frac{1}{R_1}+j\omega C)=I_1\angle\psi_1$$

$$\dot{I}_2=\frac{\dot{U}_S}{R_2+j\omega L}=\frac{U_S\angle 0°}{R_2+j\omega L}=I_2\angle\psi_2$$

$$\psi_1=\text{arctg}\frac{\omega C}{\frac{1}{R_1}}=\text{arctg}\,\omega CR_1$$

$$\psi_2=-\text{arctg}\frac{\omega L}{R_2}$$

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$$\psi_1=\psi_2+\frac{\pi}{2}$$

$$\text{tg}\psi_1=-\text{ctg}\psi_2$$

$$\omega CR_1=\frac{R_2}{\omega L}$$

$$\frac{R_2}{R_1}=\omega^2 LC$$

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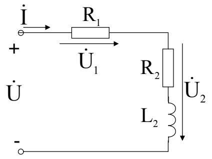
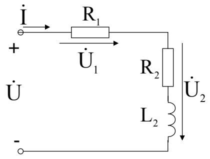
例9-7



已知:R_1=32Ω　U=115V　f=50Hz　U_1=55.4V　U_2=80V

求：R_2　L_2

解：法1



设 $\dot{I}=I\angle 0°$

$$Z_2=R_2+j\omega L_2$$

$$Z_2=\frac{\dot{U}_2}{\dot{I}}=\frac{U_2}{I}\angle\varphi_2$$

$$I=\frac{U_1}{R_1}=\frac{55.4}{32}=1.73A$$

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

$$115\angle\varphi=55.4\angle 0°+80\angle\varphi_2$$

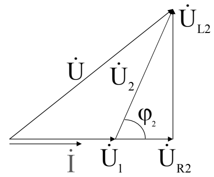
$$\varphi_2=64.9°$$

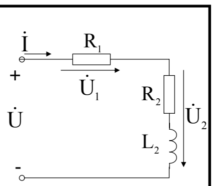
$$Z_2=\frac{\dot{U}_2}{\dot{I}}=\frac{80\angle 64.9°}{1.73\angle 0°}=46.24\angle 64.9°=19.6+j41.88\Omega$$

$$R_2=19.6\Omega$$

$$L_2=\frac{41.88}{2\pi\times 50}=133.4mH$$

法2





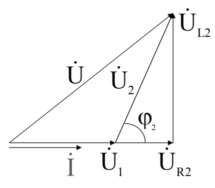
由余弦定理 $U^2=U_1^2+U_2^2-2U_1U_2\cos(\pi-\varphi_2)$

$$\cos\varphi_2=\frac{U^2-U_1^2-U_2^2}{2U_1U_2}\quad\Rightarrow\varphi_2$$

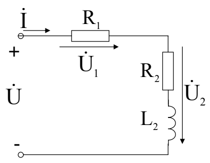
$$I=\frac{U_1}{R_1}$$

$$\frac{U_2\cos\varphi_2}{I}=R_2\quad\Rightarrow R_2$$

$$\frac{U_2\sin\varphi_2}{I}=\omega L_2\quad\Rightarrow L_2$$

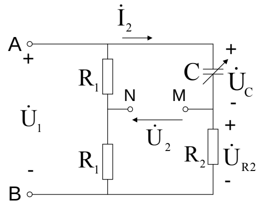


法3



$$\begin{cases}\dfrac{U_2}{I}=\sqrt{R_2^2+(\omega L_2)^2}\\ \dfrac{U}{I}=\sqrt{(R_1+R_2)^2+(\omega L_2)^2}\\ I=\dfrac{U_1}{R_1}\end{cases}$$

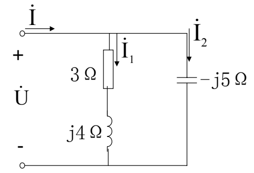
例9-8



已知：R_1　R_2

讨论：C在0→∞范围内变化时，$\dot{U}_2$的变化情况

例9-9



已知：$\dot{U}=100\angle 0°V$

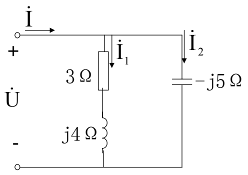
$\dot{I}=12.65\angle 18.5°A$

$\dot{I}_1=20\angle -53.1°A$

$\dot{I}_2=20\angle 90°A$

求：二端网络的P, S, $\cos\varphi$

解：求有功功率



法1 $P=UI\cos(\varphi_u-\varphi_i)$

$=100\times 12.65\cos(-18.5°)$

$=1200\,W$

法2 $P=I_1^2R=20^2\times 3=1200W$

法3 $P=UI_1\cos(\varphi_u-\varphi_{i1})$

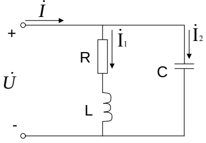
$=100\times 20\cos 53.1°$

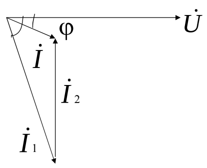
$=1200W$

$S=UI=100\times 12.65=1265VA$

$\cos\varphi=\frac{P}{S}=\frac{1200}{1265}=0.949$

例9-10　在f=50Hz, U=380V的电路中，一感性负载吸收的功率P=20KW，功率因数cosΦ₁=0.6 若要使功率因数提高到0.9，求并联电容值。





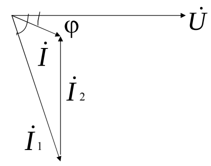
$I_1=\frac{P}{U\cos\varphi_1}=\frac{20\times 10^3}{380\times 0.6}=87.72A$

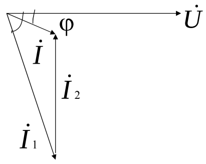
$I\cos\varphi=I_1\cos\varphi_1$

$I=\frac{I_1\cos\varphi_1}{\cos\varphi}=\frac{87.72\times 0.6}{0.9}=58.48A$

$\cos\varphi_1=0.6 \Rightarrow \varphi_1=53.13°$

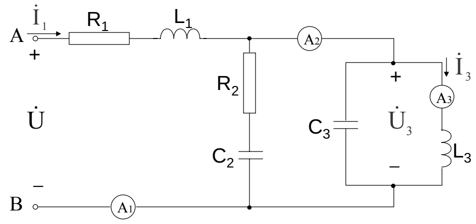
$\cos\varphi=0.9 \Rightarrow \varphi=25.84°$





$$I_2=I_1\sin\varphi_1-I\sin\varphi$$
$$=87.72\sin53.13°-58.48\sin25.84°$$
$$=44.69\text{A}$$
$$C=\frac{I_2}{\omega U}=\frac{I_2}{2\pi fU}=\frac{44.69}{2\pi\times50\times380}=375\mu\text{F}$$

例9-11

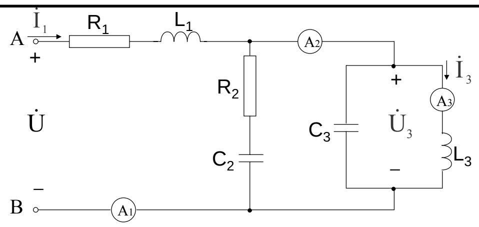


已知：$R_1=50\Omega$ $R_2=50\Omega$ $L_1=200\text{mH}$ $C_2=5\mu\text{f}$
$L_3=100\text{mH}$ $C_3=10\mu\text{f}$ $U=200\text{V}$
电流表A_2指示为零，所有电流表内阻忽略不计

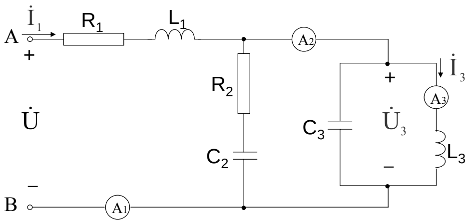
求：（1）A_1，A_2的读数
（2）输入AB端的功率和功率因数

解(1)

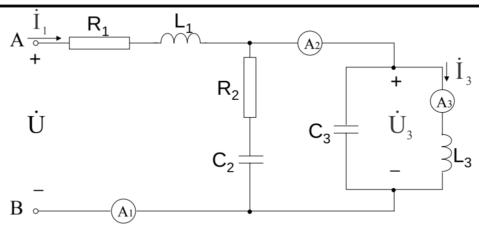
$$\omega C_3=\frac{1}{\omega L_3}$$
$$\omega=\frac{1}{\sqrt{L_3C_3}}=\frac{1}{\sqrt{100\times10^{-3}\times10\times10^{-6}}}=10^3\text{rad/s}$$



$$Z=(R_1+R_2)+j\left(\omega L_1-\frac{1}{\omega C_2}\right)$$
$$=50+50+j\left(10^3\times200\times10^{-3}-\frac{1}{10^3\times5\times10^{-6}}\right)$$
$$=100\angle0^0\Omega$$
$$I_1=\frac{U}{|Z|}=\frac{200}{100}=2\text{A}$$



$$U_3=I_1|Z_2|=I_1\sqrt{R_2^{\ 2}+\left(\frac{1}{\omega C_2}\right)^2}=412.3\text{V}$$
$$I_3=\frac{U_3}{\omega L_3}=\frac{412.3}{10^3\times100\times10^{-3}}=4.12\text{A}$$



(2) $\varphi=0°$
$\cos\varphi=1$

$P=UI_1\cos\varphi=200\times2=400\text{w}$
或：$P=I_1^{\ 2}(R_1+R_2)=2^2\times(50+50)=400\text{w}$