《Fundamentals of Electric Circuits》 homework CH.10&11

10.7 Use nodal analysis to find V in the circuit of Fig. 10.56. (10')

解:

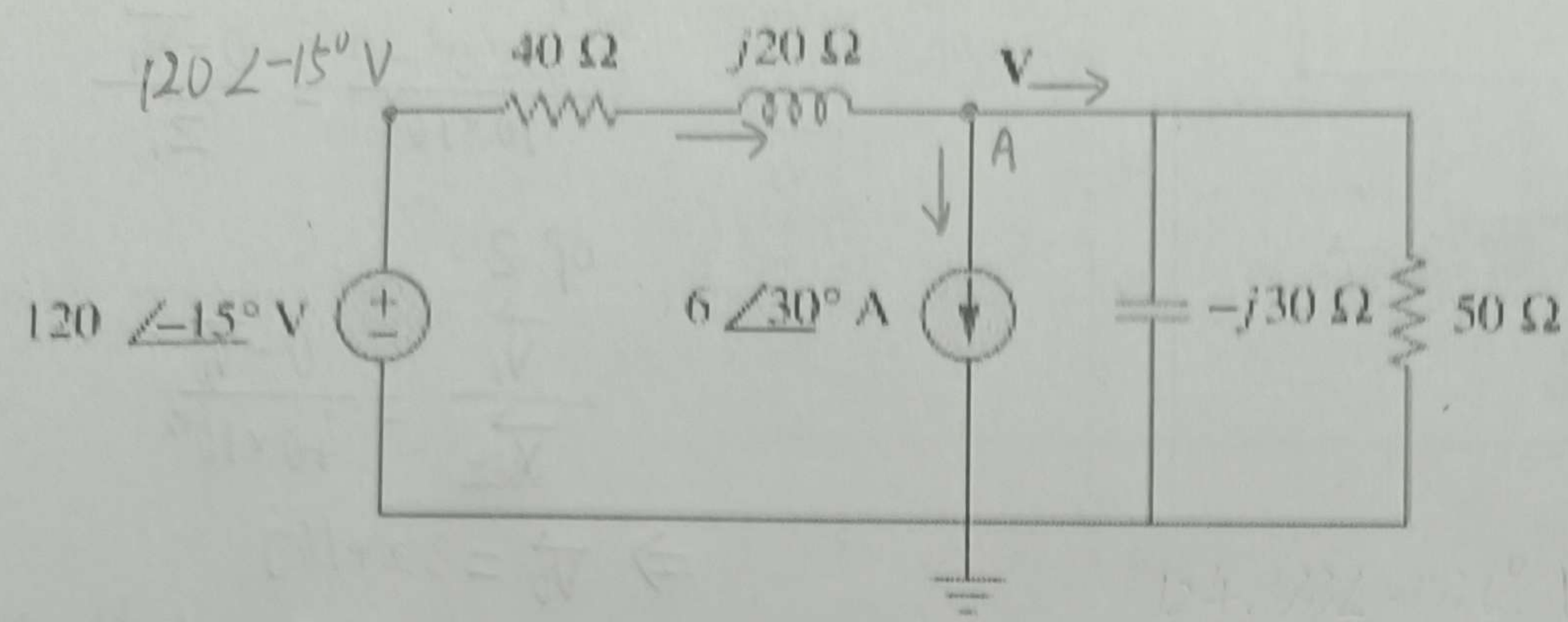


Figure 10.56

node A:

$$\frac{120\angle -15^\circ - \vec{V}}{40 + j20} = \frac{\vec{V}}{-j30} + \frac{\vec{V}}{50} + 6\angle 30^\circ$$

$$\Rightarrow \left(\frac{1}{50} - \frac{1}{30j} + \frac{1}{40+20j}\right)\vec{V} = 6\angle 30^\circ + \frac{120\angle -15^\circ}{40+20j}$$

$$\vec{V} = -111.5 - 54.47j = 124.1\angle 26.04^\circ \quad \boxed{\text{ANS}}$$

10.28 In the circuit of Fig.10.76, determine the mesh currents i_1 and i_2. Let $v_1 = 10 \cos 4t$ V and $v_2 = 20 \cos(4t - 30°)$ V. (10')

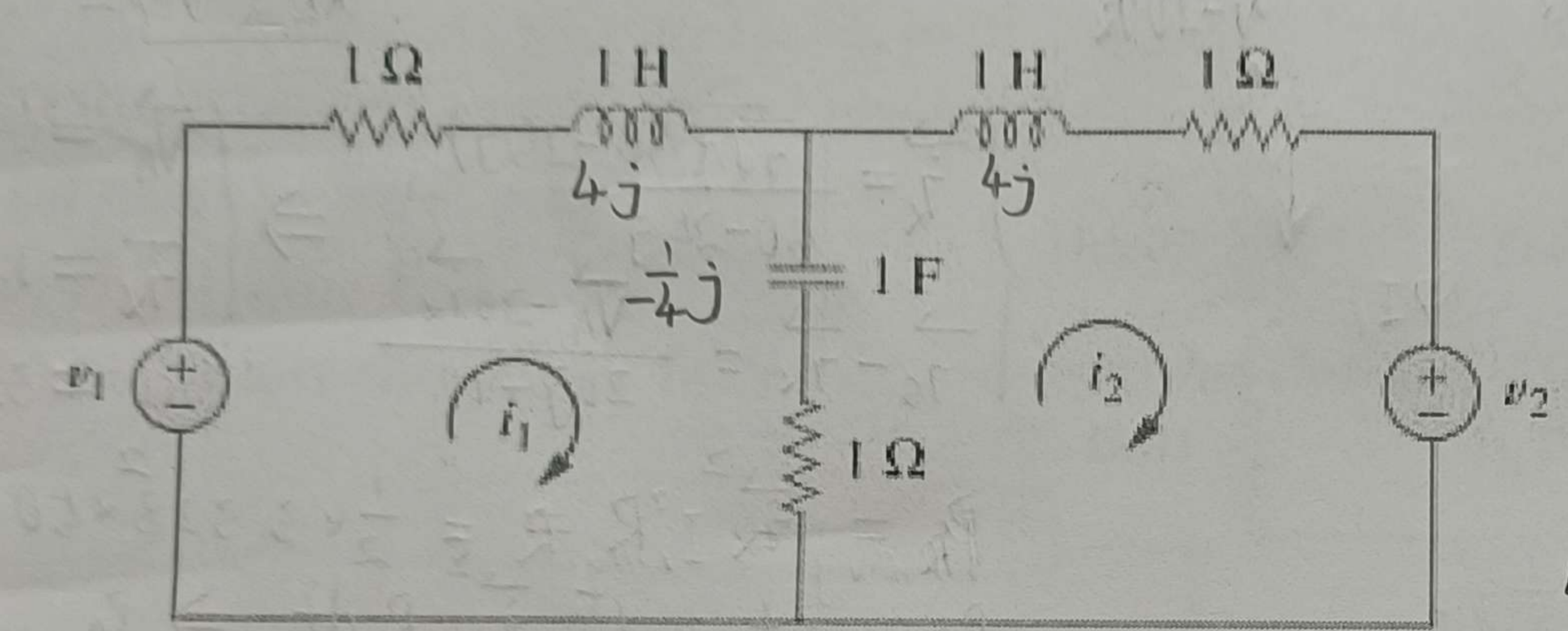


Figure 10.76

解: $w = 4$

$\vec{V}_1 = 10\angle 0^\circ$ V, $\vec{V}_2 = 20\angle -30^\circ$ V

$$\frac{1}{jwC} = \frac{1}{j4\times 1} = -\frac{1}{4}j$$

$$jwL = j4\cdot 1 = 4j$$

mesh ①: $-10\angle 0^\circ + \vec{i}_1(1+4j) + (-\frac{1}{4}j+1)(\vec{i}_1 - \vec{i}_2) = 0$

mesh ②: $20\angle -30^\circ + (1-\frac{1}{4}j)(\vec{i}_2 - \vec{i}_1) + \vec{i}_2(4j+1) = 0$

$\Rightarrow \vec{i}_1 = 2.067 - 1.800j \quad \vec{i}_2 = -0.1438 + 4.112j$

$i_1(t) = 2.741\cos(4t - 41.05^\circ)$ $\boxed{\text{ANS}}$

$i_2(t) = 4.115\cos(4t - 88.00^\circ)$

10.45 Use superposition to find $i(t)$ in the circuit of Fig. 10.90. (10')

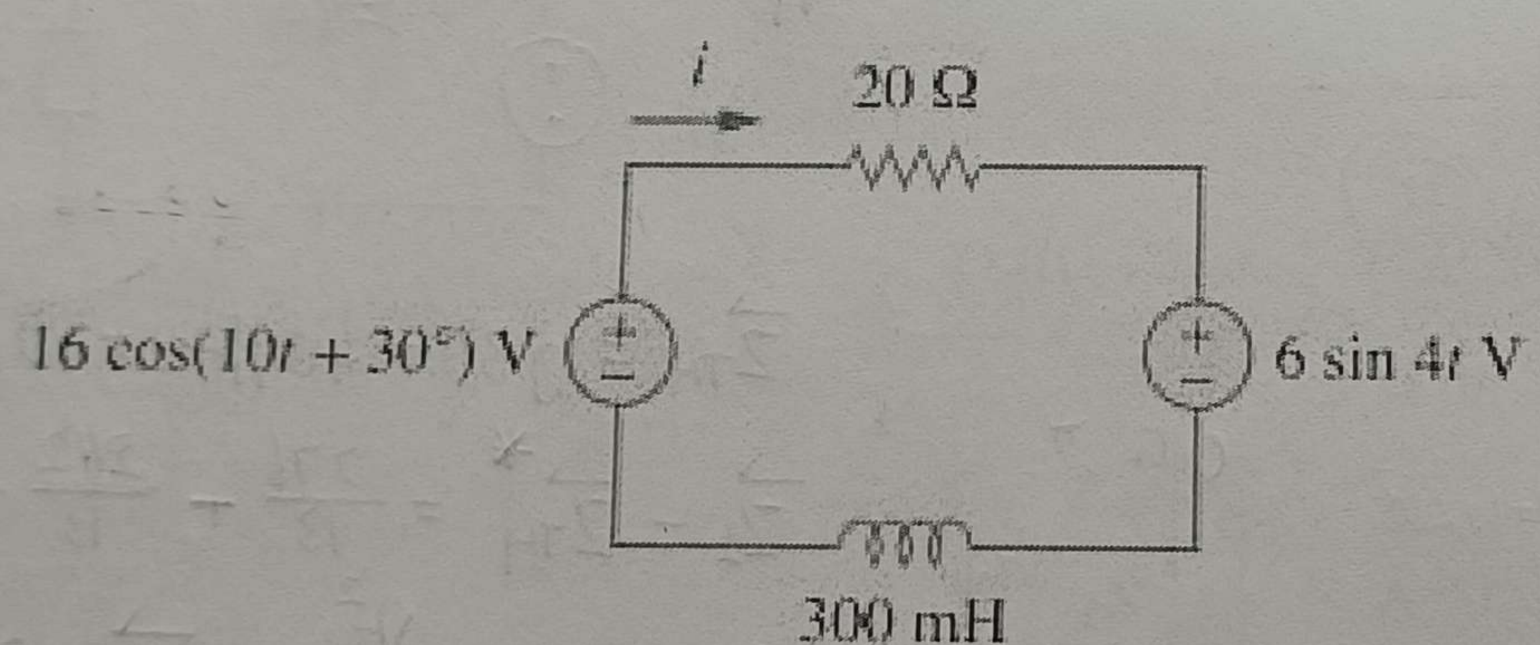
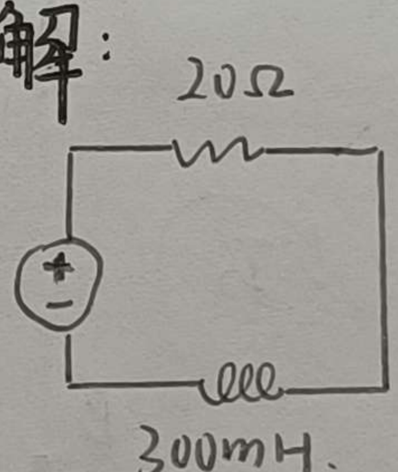


Figure 10.90

解:

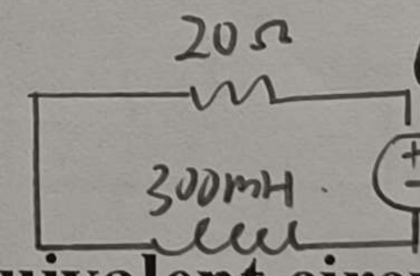


① $\vec{V}_1 = 16\angle 30^\circ$ V, $w_1 = 10$

$$jwL = j\,10\times 300\times 10^{-3} = 3j$$

$$\vec{i}_1 = \frac{16\angle 30^\circ}{3j + 20} = 0.7363 + 0.2896j$$

$i_1(t) = 0.7912\cos(10t + 21.47^\circ)$



② $\vec{V}_2 = 6\angle -90^\circ$ V, $w_2 = 4$

$$jwL = j\,4\times 300\times 10^{-3} = 1.2j$$

$$\vec{i}_2 = \frac{6\angle -90^\circ}{1.2j + 20} = -0.01794 - 0.2989j$$

$i_2(t) = 0.2994\cos(10t + 86.57^\circ)$

$\therefore i(t) = i_1(t) + i_2(t) = 0.7912\cos(10t + 21.47^\circ) + 0.2994\cos(10t + 86.57^\circ)$ $\boxed{\text{ANS}}$

10.66 At terminals *a-b*, obtain Thevenin and Norton equivalent circuits for the network depicted in Fig.10.109. Take w = 10 rad/s. (10')

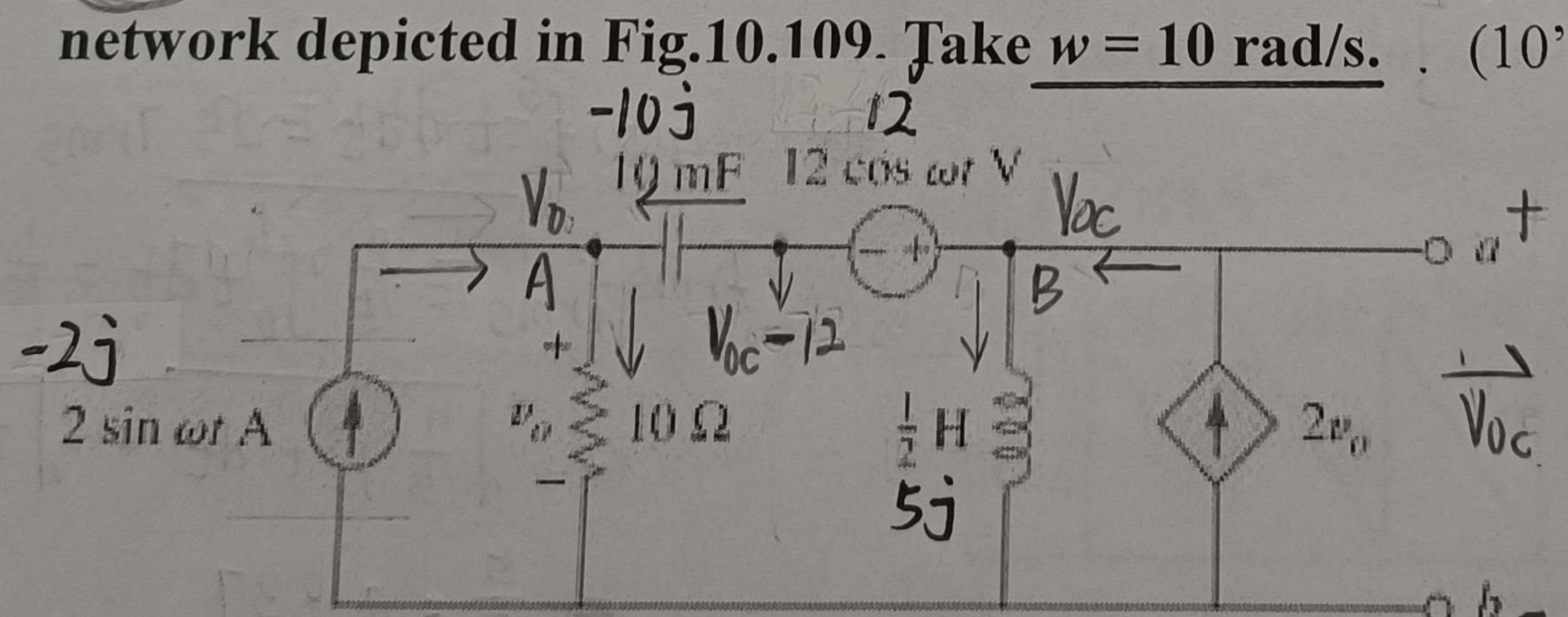


Figure 10.109

解: $\frac{1}{jwC} = \frac{1}{j\times 10\times 10\times 10^{-3}} = -10j$

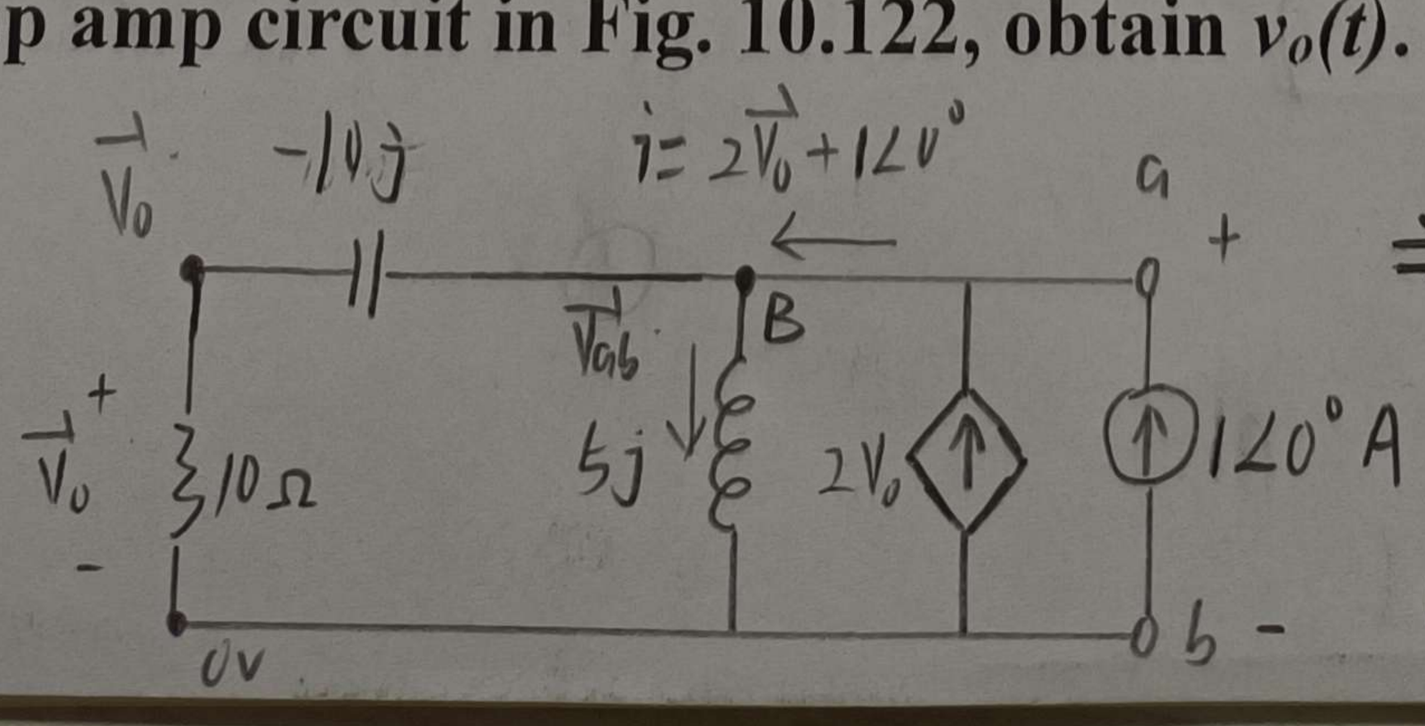
$$jwL = j\times 10\times \tfrac{1}{2} = 5j$$

node A: $-2j + \frac{\vec{V}_{oc} - 12 - \vec{V}_0}{-10j} = \frac{\vec{V}_0}{10}$

(super) node B: $+2\vec{V}_0 = \frac{\vec{V}_{oc} - 12 - \vec{V}_0}{-10j} + \frac{\vec{V}_{oc}}{5j}$

$\Rightarrow \vec{V}_{oc} = -29.90 - 2.095j$ $\boxed{\text{ANS}}$

10.79 For the op amp circuit in Fig. 10.122, obtain $v_o(t)$.



node B: $+2\vec{V}_0 + 12\angle 0^\circ = \frac{\vec{V}_{ab} - \vec{V}_0}{-10j} + \frac{\vec{V}_{ab}}{5j}$ 后接.

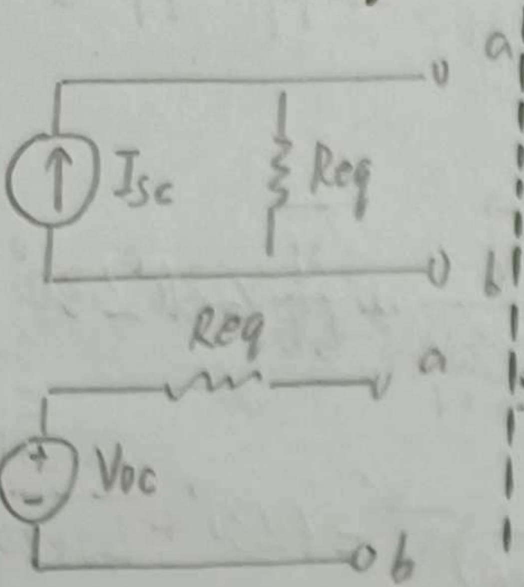
续10.66

$$+\ \frac{\vec{V}_{ab}-\vec{V}_o}{-10j}=\frac{\vec{V}_o}{10}$$

$$\Rightarrow \vec{V}_{ab}=-0.4270+0.5169j$$

$$\therefore \vec{Z}_{eq}=-0.4270+0.5169j,\quad \vec{V}_{oc}=29.90-2.095j$$

$$I_{sc}=\frac{V_{oc}}{Z_{eq}}=-30.81-32.39j$$



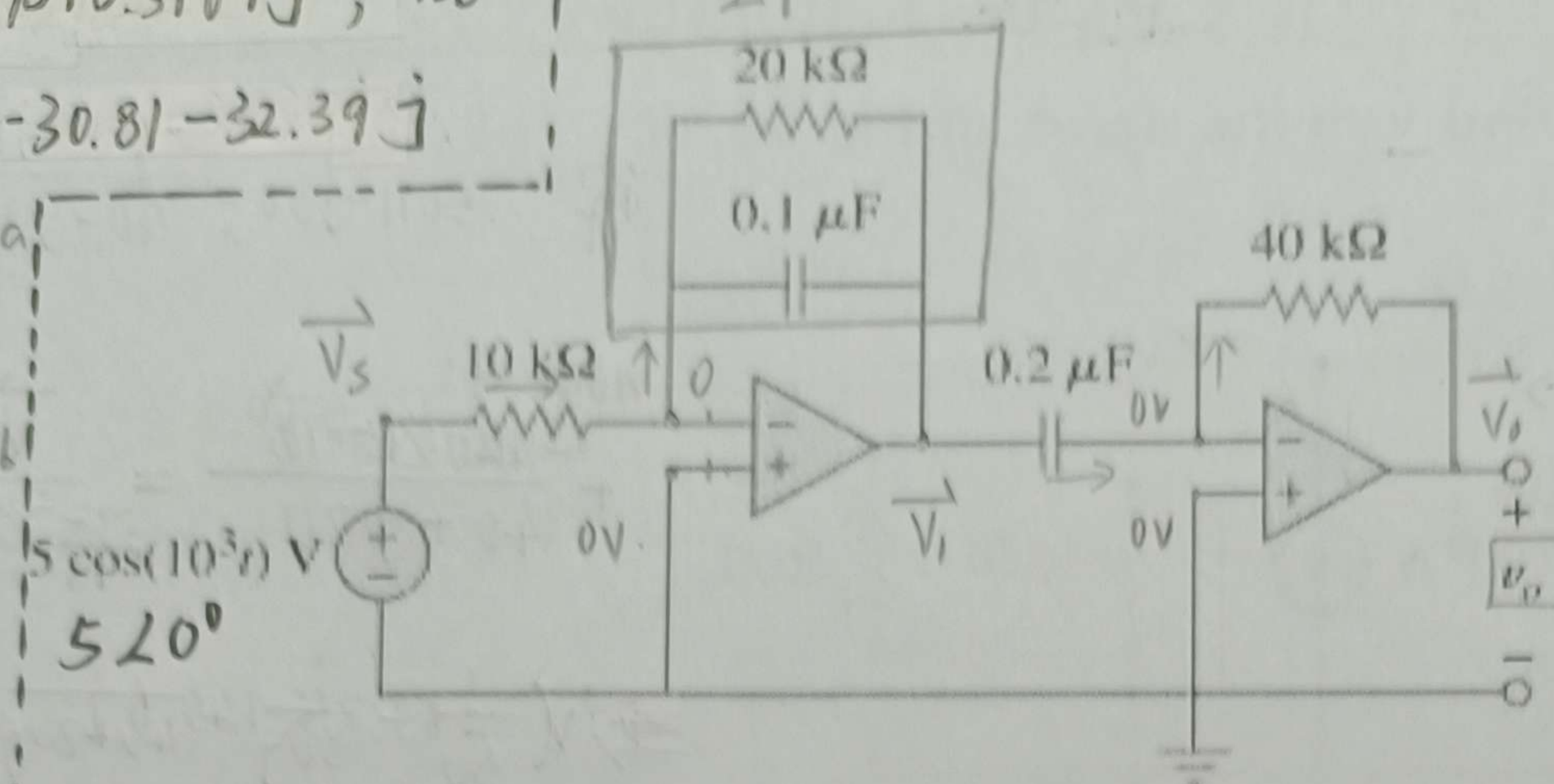


Figure 10.122

10.79解：$w=10^3$

$$\vec{X}_{C_1}=\frac{1}{jwC_1}=\frac{1}{j\times10^3\times0.1\times10^{-6}}=-10^4j$$

$$\vec{X}_{C_2}=\frac{1}{jwC_2}=\frac{1}{j\times10^3\times0.2\times10^{-6}}=-5\times10^3j$$

$$\vec{Z}_1=20\times10^3\,||-10^4j=\frac{-2\times10^8j}{2\times10^4-10^4j}=4000-8000j$$

op 1：

$$\frac{5\angle0^\circ-0}{10\times10^3}=\frac{0-\vec{V}_1}{\vec{Z}_1}$$

op 2：

$$\frac{\vec{V}_1}{\vec{X}_{C2}}=\frac{0-\vec{V}_o}{40\times10^3}$$

$$\Rightarrow \vec{V}_o=32+16j$$

$$V_o(t)=35.78\cos(10^3t+26.57^\circ)\ \text{V}$$

11.6 For the circuit in Fig.11.38 [$i_s = 6\cos 10^3t$ A] Find the average power absorbed by the $50\ \Omega$ resistor. (10')

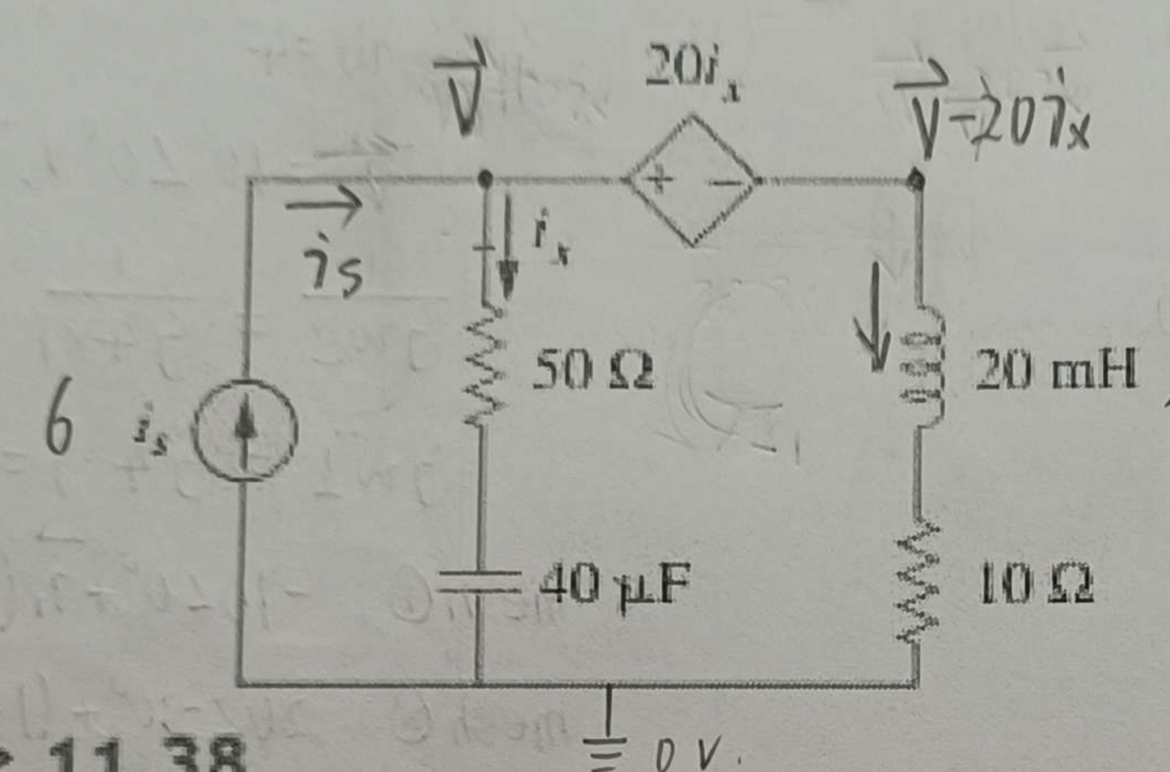


Figure 11.38

解：$w=10^3$，$\vec{X}_C=\frac{1}{jwC}=\frac{1}{j\times10^3\times40\times10^{-6}}=-25j$

$\vec{i}_s=6\angle0^\circ$，$\vec{X}_L=jwL=j\times10^3\times20\times10^{-3}=20j$

$$\begin{cases}\vec{i}_x=\dfrac{\vec{V}}{50-25j}\\[2mm] \vec{i}_s-\vec{i}_x=\dfrac{\vec{V}-20\vec{i}_x}{20j+10}\end{cases}\Rightarrow \vec{i}_x=1.108+3.138j=3.328\cos(10^3t+70.55^\circ)$$

$$P_{R.avg}=I_{rms}^2R=\frac{1}{2}\times3.328^2\times50=276.9\ \text{W}$$

11.18 Find the value of Z_L in the circuit of Fig.11.49 for maximum power transfer. (10')

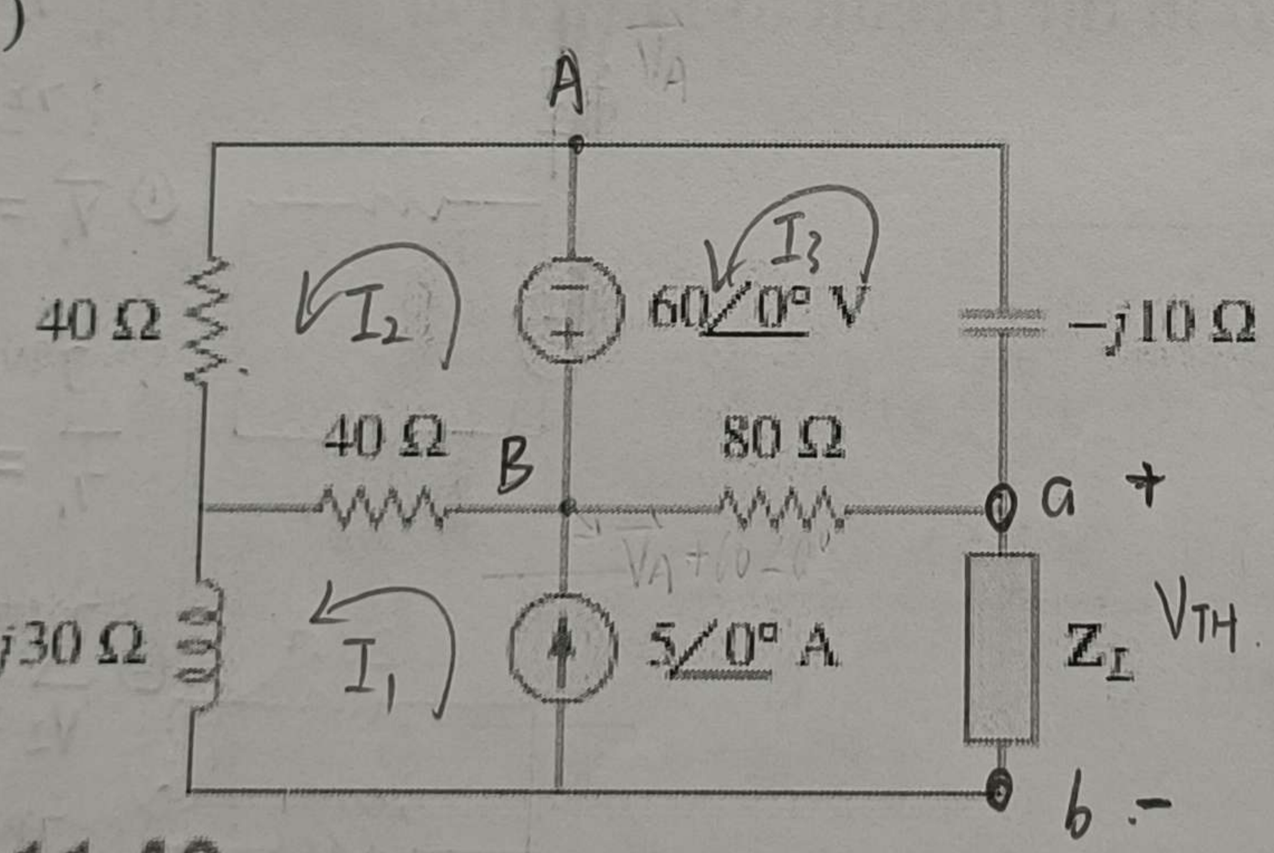
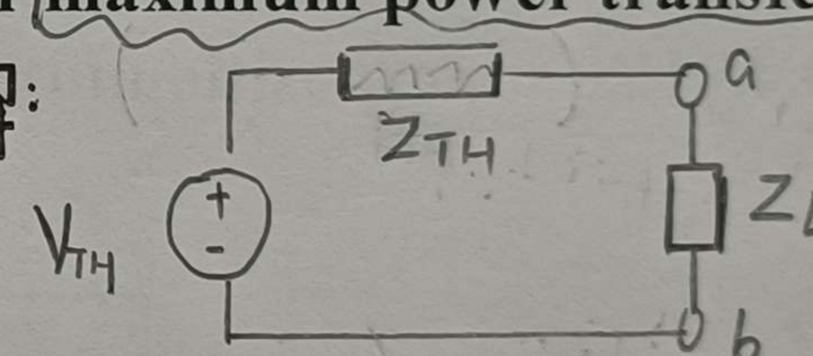


Figure 11.49

解：



$$\vec{Z}_{TH}=j30+40||40+80||-j10=\frac{276}{13}+\frac{262}{13}j$$

$$\vec{Z}_L=\vec{Z}_{TH}^{*}=\frac{276}{13}-\frac{262}{13}j\ 时$$

$$P_{L.max}=\frac{V_{TH}^2}{8R_{TH}},\quad \vec{Z}_L=21.23-20.15j$$

11.27 Calculate the rms value of the current waveform of Fig. 11.58. (10')

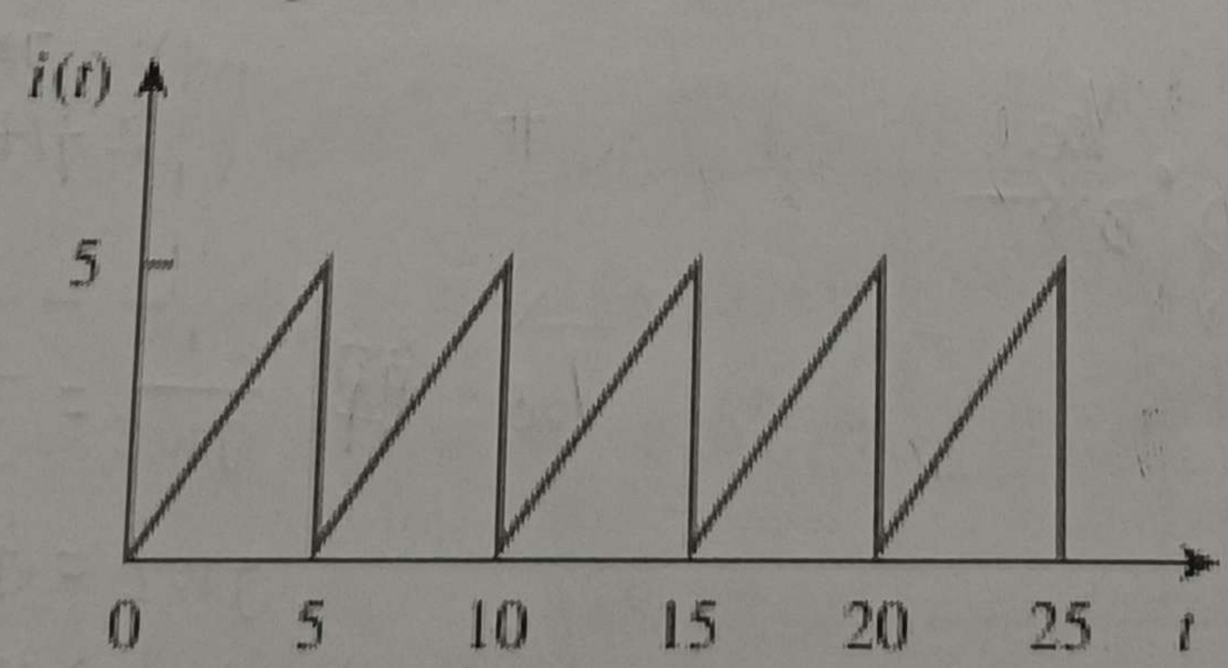


Figure 11.58

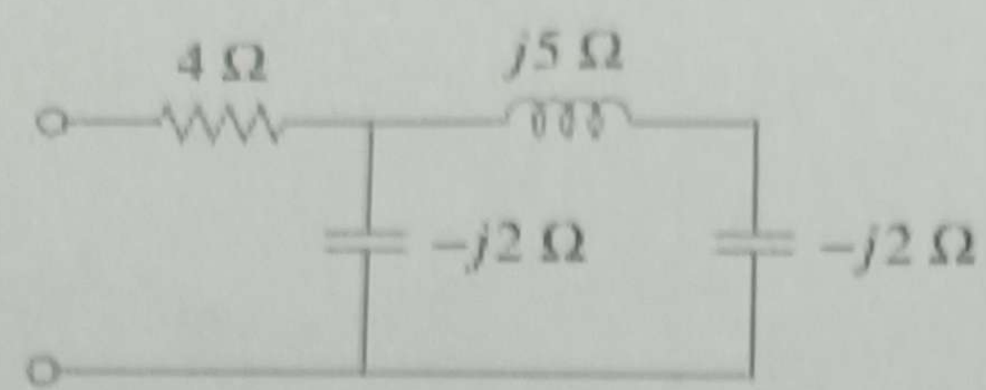
解：$i(t)=t\quad 0<t<5$

$$I_{rms}=\sqrt{\frac{1}{5}\int_0^5 i^2(t)\,dt}=\sqrt{\frac{1}{5}\int_0^5 t^2dt}=\sqrt{\frac{1}{5}\times\frac{1}{3}\times5^3}=\frac{5}{\sqrt{3}}=2.887$$

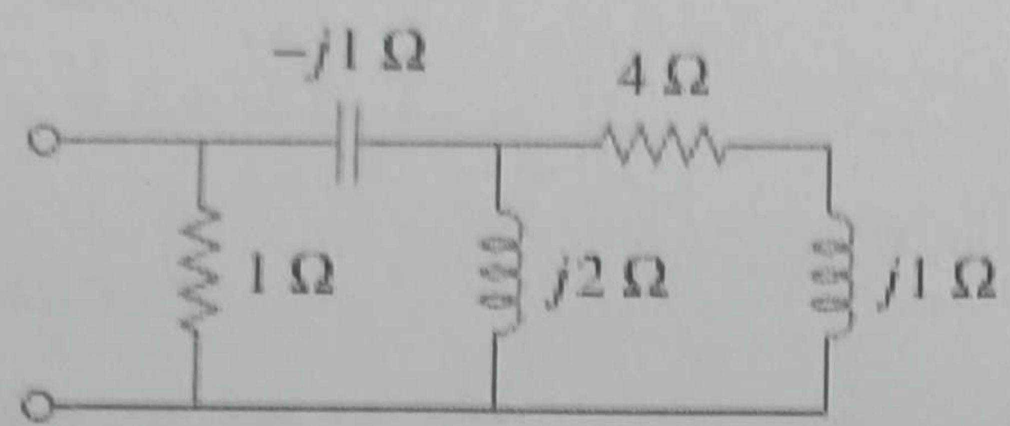
11.41 Obtain the power factor for each of the circuits in Fig.11.68. Specify each power

解: a) $\vec{Z} = 4+(5j-2j)\,||\,-2j$
$= 4-6j$
$= \sqrt{16+36}\ \angle -56.31^\circ$
$Pf = \cos(-56.31^\circ) = 0.5547$, leading pf

factor as leading or lagging. (10')



(a)



(b)

b) $\vec{Z} = [(4+j)\,||\,2j - j]\,||\,1$
$= \frac{33}{74} + \frac{13}{74}j$
$= \sqrt{(\frac{33}{74})^2+(\frac{13}{74})^2}\ \angle 21.50^\circ$
$Pf = \cos(21.50^\circ) = 0.9304$, laging pf

Figure 11.68

11.53 In the circuit of Fig. 11.72, load A receives 4 kVA at 0.8 pf leading. Load *B* receives 2.4 kVA at 0.6 pf lagging. Box *C* is an inductive load that consumes 1 kW and receives 500 VAR.

$\vec{S_C} = 1000 + 500j = \frac{1}{2}\vec{V_C}\cdot\vec{I_C}^*$

(a) Determine I.

(b) Calculate the power factor of the combination. (10')

$\vec{S} = P + Qj$

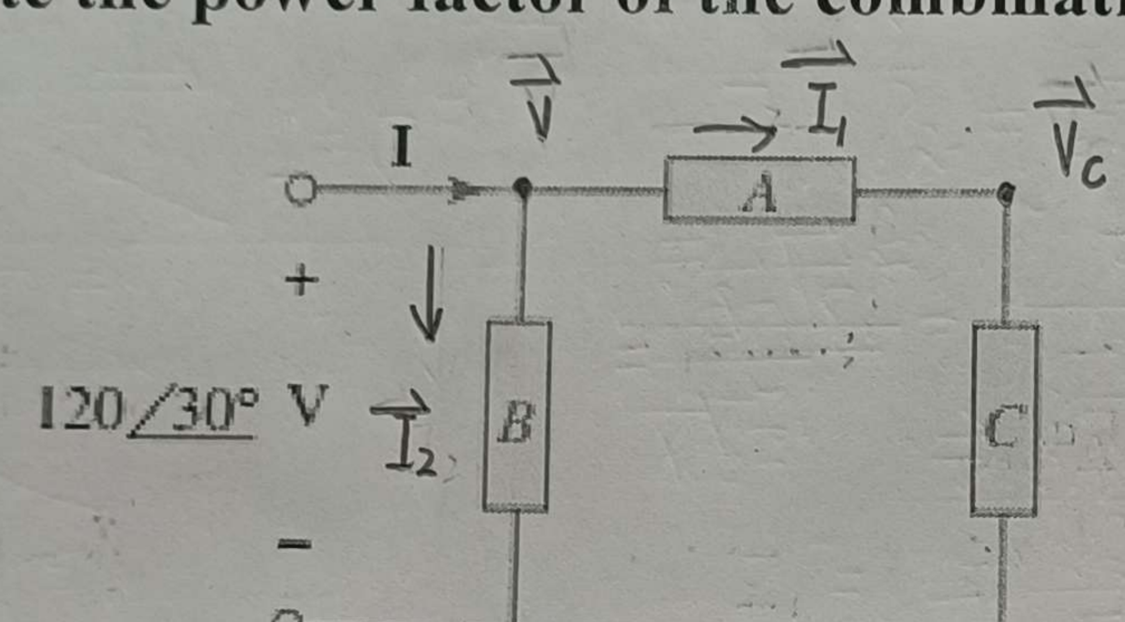


Figure 11.72

解: a) $\vec{S_A} = \frac{1}{2}(\vec{V}-\vec{V_C})\,\vec{I_1}^* = \frac{1}{2}120 I_1 \angle 30^\circ-\phi_1 - (1000+500j) = 4000\angle -\cos^{-1}0.8 = 3200-2400j$

$\vec{S_B} = \frac{1}{2}\vec{V}\cdot\vec{I_2}^* = \frac{1}{2}120 I_2 \angle 30^\circ-\phi_2 = 60 I_2 \angle 30^\circ-\phi_2 = 2400\angle \cos^{-1}0.6 = 1440+1920j$

$\vec{S_C} = \frac{1}{2}\vec{V_C}\,\vec{I_1}^* = 1000+500j$

$\Rightarrow I_2 = 40 \qquad I_1 = 76.83$

$\phi_2 = -23.13^\circ \qquad \phi_1 = +54.34^\circ$

$\vec{I_2} = 40\angle -23.13^\circ \qquad \vec{I_1} = 76.83\angle +54.34^\circ$

$\vec{I} = 40\cos(23.13^\circ) - 40\sin 23.13^\circ j + 76.83\cos 54.34^\circ + 76.83\sin 54.34^\circ j$
$= 81.57+46.71j = 94.00\angle 29.80^\circ$ A

b) $\vec{Z} = \frac{\vec{V}}{\vec{I}} = \frac{V_m}{I_m}\angle 30^\circ - 29.80^\circ$

$Pf = \cos 0.2^\circ = 1$ lagging Pf