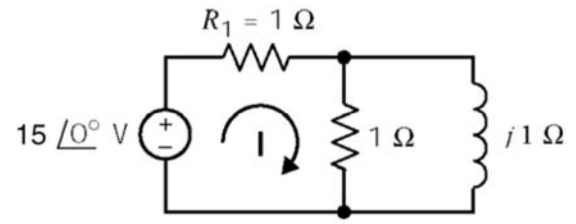
P 11.3-8

Solution:



The equivalent impedance of the parallel resistor and inductor is

$$\mathbf{Z} = \frac{(1)(j)}{1+j} = \frac{1}{2}(1+j)\ \Omega. \text{ Then}$$

$$\mathbf{I} = \frac{15\angle 0°}{1+\frac{1}{2}(1+j)} = \frac{30}{3+j} = \frac{30}{\sqrt{10}}\angle -18.4°\ \text{A}$$

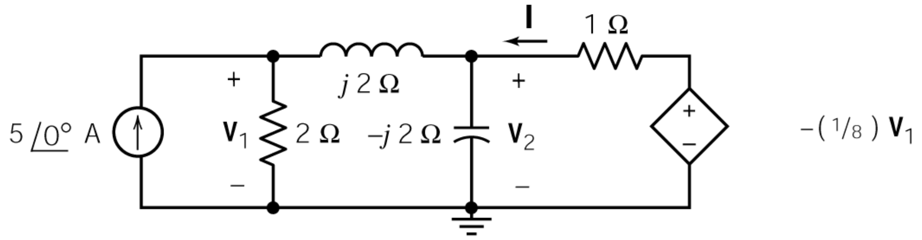
(a) $P_{\text{source}} = \dfrac{|\mathbf{I}||\mathbf{V}|}{2}\cos\theta = \dfrac{(15)\left(\dfrac{30}{\sqrt{10}}\right)}{2}\cos(-18.4°) = 67.5\ \text{W}$

(b) $P_{R_1} = \dfrac{|\mathbf{I}|^2 R_1}{2} = \dfrac{\left(\dfrac{30}{\sqrt{10}}\right)^2 (1)}{2} = 45\ \text{W}$

P 11.5-3

Solution:

Represent the circuit in the frequency domain and label the node voltages:



The node equations are:

$$5\angle 0 = \frac{\mathbf{V}_1}{2} + \frac{\mathbf{V}_1 - \mathbf{V}_2}{j2} \quad \Rightarrow \quad \mathbf{V}_1(1-j) + j\,\mathbf{V}_2 = 10$$

$$\frac{\mathbf{V}_2 - \mathbf{V}_1}{j2} + \frac{\mathbf{V}_2}{-j2} + \frac{\mathbf{V}_2 - \left(-\frac{1}{8}\mathbf{V}_1\right)}{1} = 0 \quad \Rightarrow \quad \mathbf{V}_1(0.25+j) + \mathbf{V}_2(2) = 0$$

Using MATLAB:

$$\begin{bmatrix} 1-j & j \\ 0.25+j & 2 \end{bmatrix}\begin{bmatrix} \mathbf{V}_1 \\ \mathbf{V}_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \end{bmatrix} \quad \Rightarrow \quad \begin{array}{l} \mathbf{V}_1 = 5.33\angle 36.9°\ \text{V} \\ \mathbf{V}_2 = 2.75\angle -67.2°\ \text{V} \end{array}$$

then

$$\mathbf{I} = \frac{-\frac{1}{8}\mathbf{V}_1 - \mathbf{V}_2}{1} = 2.66\angle 126.9°\ \text{A}$$

Now the complex power can be calculated as

$$\mathbf{S} = \frac{\mathbf{I}^*\left(-\left(\frac{1}{8}\right)\mathbf{V}_1\right)}{2} = \frac{\left(2.667\angle 126.9^\circ\right)^*\left(-\frac{5.33}{8}\angle 36.9^\circ\right)}{2} = j\,0.8889 = j\frac{8}{9} \text{ VA}$$

Finally

$$\mathbf{S} = P + jQ = j\frac{8}{9} \quad \Rightarrow \quad P = 0,\ \ Q = \frac{8}{9} \text{ VAR}$$

(Checked using MATLAB and LNAP)

P 11.6-10
Solution:

(a) $\mathbf{S} = \dfrac{\left(48\angle 0^\circ\right)\left(1.076\angle -8.3^\circ\right)^*}{2} = 25.82\angle 8.3^\circ = 25.6 + j\,3.7 \text{ VA}$

(b) $\mathbf{V}_1 = \dfrac{2\,\mathbf{S}_1}{\mathbf{I}^*} = \dfrac{2\left(6.945 + j\,13.89\right)}{\left(1.076\angle -8.3^\circ\right)^*} = \dfrac{2\left(15.53\angle 63.4^\circ\right)}{\left(1.076\angle 8.3^\circ\right)} = 28.87\angle 55.1^\circ \text{ V}$

$$\mathbf{Z}_1 = \frac{\mathbf{V}_1}{\mathbf{I}} = \frac{28.87\angle 55.1^\circ}{1.076\angle -8.3^\circ} = 26.83\angle 63.4^\circ = 12 + j\,24 = 12 + j\,6\left(4\right) \ \Omega$$

$R_1 =$ 12 Ω and $L_1 = 4$ H.

(c) $\theta = \cos^{-1}\left(0.56\right) = 56^\circ, \quad \left|\mathbf{S}\right| = \dfrac{P}{pf} = \dfrac{4.63}{0.56} = 8.268 \text{ VA}$

$$\mathbf{V}_3 = \frac{2\left(8.268\angle 56^\circ\right)}{\left(1.076\angle -8.3^\circ\right)^*} = 15.37\angle 47.7^\circ \text{ V}$$

$$\mathbf{Z}_3 = \frac{\mathbf{V}_3}{\mathbf{I}} = \frac{15.37\angle 47.7^\circ}{1.076\angle -8.3^\circ} = 14.28\angle 56^\circ = 8 + j\,11.83 = 8 + j\,6\left(1.97\right) \ \Omega$$

$R_3 =$ 8 Ω and $L_3 = 2$ H.

P 11.8-3
Solution:

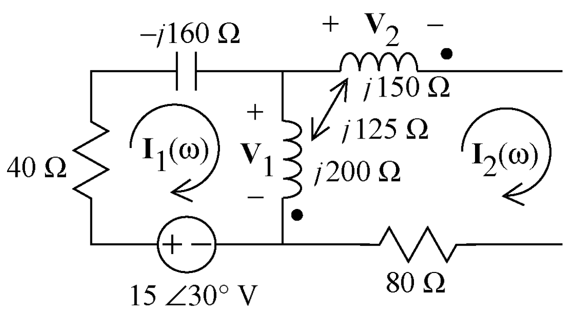
$$\mathbf{Z}_\mathrm{t} = 800 + j1600\ \Omega \ \text{ and } \ \mathbf{Z}_\mathrm{L} = \frac{R\left(\frac{-j}{\omega C}\right)}{R - \frac{j}{\omega C}} = \frac{R - j\omega R^2 C}{1 + (\omega RC)^2}$$

$$\mathbf{Z}_\mathrm{L} = \mathbf{Z}_\mathrm{t}^* \quad \Rightarrow \quad \frac{R\left(\frac{-j}{\omega C}\right)}{R - \frac{j}{\omega C}} = \frac{R - j\omega R^2 C}{1 + (\omega RC)^2} = 800 - j1600\ \Omega$$

Equating the real parts gives

$$800 = \frac{R}{1 + (\omega RC)^2} = \frac{4000}{1 + [(5000)(4000)C]^2} \quad \Rightarrow \quad C = 0.1\ \mu\text{F}$$

P 11.9-8
Solution:



The equations describing the coupled coils give:

$$\mathbf{V}_1 = j200(\mathbf{I}_1 - \mathbf{I}_2) + j125\,\mathbf{I}_2 = j200\mathbf{I}_1 - j75\,\mathbf{I}_2$$
$$\mathbf{V}_2 = j150\,\mathbf{I}_2 + j125(\mathbf{I}_1 - \mathbf{I}_2) = j125\,\mathbf{I}_1 + j25\,\mathbf{I}_2$$

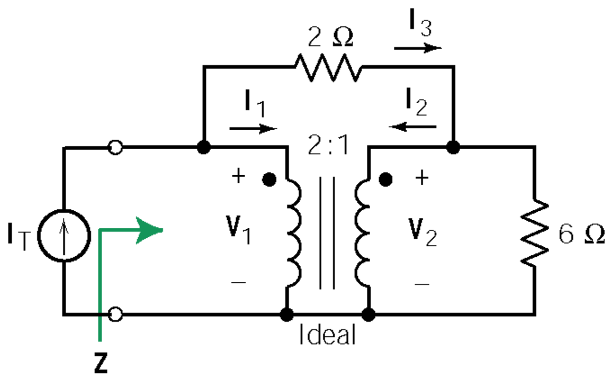
The mesh equation for the left mesh is

$$-j\,160\,\mathbf{I}_1 + \mathbf{V}_1 - 15\angle 30° + 40\,\mathbf{I}_1 = 0$$
$$-j\,160\,\mathbf{I}_1 + j200\mathbf{I}_1 - j75\,\mathbf{I}_2 - 15\angle 30° + 40\,\mathbf{I}_1 = 0$$
$$(40 + j40)\,\mathbf{I}_1 - j75\,\mathbf{I}_2 = 15\angle 30°$$

The mesh equation for the right mesh is

$$\mathbf{V}_2 + 80\,\mathbf{I}_2 - \mathbf{V}_1 = 0$$
$$j125\,\mathbf{I}_1 + j25\,\mathbf{I}_2 + 80\,\mathbf{I}_2 - (j200\mathbf{I}_1 - j75\,\mathbf{I}_2) = 0$$
$$-j75\,\mathbf{I}_1 + (80 + j100)\,\mathbf{I}_2 = 0$$

P 11.10-6
Solution:



$$\mathbf{V}_2 = \frac{1}{2}\mathbf{V}_1$$
$$\mathbf{I}_3 = \frac{\mathbf{V}_1 - \mathbf{V}_2}{2} = \frac{\mathbf{V}_1}{4}$$
$$\mathbf{I}_2 = \mathbf{I}_3 - \frac{\mathbf{V}_2}{6} = \frac{\mathbf{V}_1}{6}$$
$$\mathbf{I}_1 = -\frac{1}{2}\mathbf{I}_2 = -\frac{\mathbf{V}_1}{12}$$
$$\mathbf{I}_T = \mathbf{I}_3 + \mathbf{I}_1 = \frac{\mathbf{V}_1}{6}$$
$$\mathbf{Z} = \frac{\mathbf{V}_1}{\mathbf{I}_T} = 6$$