Problem 8–16. Find the equivalent impedance Z in Figure P8–16. If $\omega = 10$ krad/s, what two elements (R, L, and/or C) could be used to replace the phasor circuit?

Combine the individual impedances and then determine an equivalent circuit.

$$Z = 25 - j25 + [(20 + j50) \parallel -j100] = 25 - j25 + 68.97 + j72.41$$

$$Z = 93.97 + j47.41 = 105.25\angle 26.77^\circ\ \Omega$$

$$R = 93.97\ \Omega$$

$$X = 47.41\ \Omega = \omega L$$

$$L = \frac{X}{\omega} = \frac{47.41}{10000} = 4.74\ \text{mH}$$

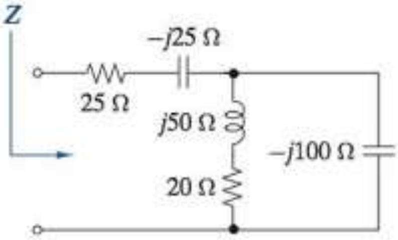

FIGURE P8–16

We could use a 93.97-Ω resistor in series with a 4.74-mH inductor to replace the circuit when $\omega = 10$ krad/s.

Problem 8–60. Use mesh-current analysis to find the phasor currents $\mathbf{I}_A$ and $\mathbf{I}_B$ in Figure P8–60.

Write the mesh-current equations and solve.

$$(10 + j30)\mathbf{I}_A + (20 + j10)(\mathbf{I}_A - \mathbf{I}_B) + 120 = 0$$

$$-120 + (20 + j10)(\mathbf{I}_B - \mathbf{I}_A) + (30 + j20)\mathbf{I}_B = 0$$

$$(30 + j40)\mathbf{I}_A - (20 + j10)\mathbf{I}_B = -120$$

$$-(20 + j10)\mathbf{I}_A + (50 + j30)\mathbf{I}_B = 120$$

$$\mathbf{I}_A = -0.96 + j1.44 = 1.731\angle 123.69^\circ\ \text{A}$$

$$\mathbf{I}_B = 1.44 - j0.48 = 1.518\angle -18.43^\circ\ \text{A}$$

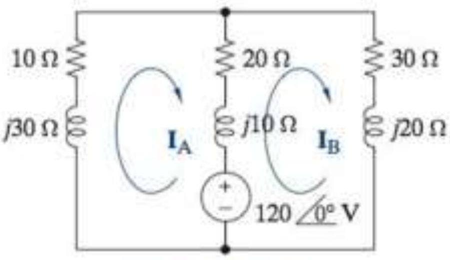

FIGURE P8–60

Problem 8–76. You have a task of designing a load that ensure maximum power is delivered to it. The load needs to be connected to a source circuit that is not readily observable, but that you can make measurements at its output terminals. You measure the open circuit voltage and read $120\angle 0^\circ$ V. You then connect a known load of $50 - j50\ \Omega$ and you measure $47.1\angle 11.3^\circ$ V across it.

(a). Design your load for maximum power transfer.

Find the Thévenin equivalent circuit. The Thévenin voltage is the open-circuit voltage, $\mathbf{V}_\mathrm{T} = 120\angle 0^\circ$ V. Compute the Thévenin impedance as follows:

$$\mathbf{I}_\mathrm{L} = \frac{\mathbf{V}_\mathrm{L}}{Z_\mathrm{L}} = \frac{47.1\angle 11.3^\circ}{50 - j50} = 0.3696 + j0.5542 \text{ A}$$

$$\mathbf{V}_1 = \mathbf{V}_\mathrm{T} - \mathbf{V}_\mathrm{L} = 120 - 47.1\angle 11.3^\circ = 73.81 - j9.23 \text{ V}$$

$$Z_\mathrm{T} = \frac{\mathbf{V}_1}{\mathbf{I}_\mathrm{L}} = \frac{73.81 - j9.23}{0.3696 + j0.5542} = 50 - j100\ \Omega$$

For maximum power transfer, we need $Z_\mathrm{L} = Z_\mathrm{T}^* = 50 + j100\ \Omega$.

(b). Find the maximum average power delivered to your load.

Compute the maximum average power transfer.

$$P_\mathrm{MAX} = \frac{|\mathbf{V}_\mathrm{T}|^2}{8R_\mathrm{T}} = \frac{(120)^2}{(8)(50)} = 36 \text{ W}$$

Problem 16–12. A load made up of a 50-Ω resistor in parallel with a 10-μF capacitor is connected across a 400-Hz source that delivers 110 V (rms). Find the complex power delivered to the load and the load power factor. State whether the power factor is lagging or leading.

We have the following calculations and results:

$$\omega = 2\pi f = 2513.3 \text{ rad/s}$$

$$Z_\mathrm{C} = \frac{1}{j\omega C} = -j39.79\ \Omega$$

$$Z_\mathrm{L} = R \parallel Z_\mathrm{C} = 50 \parallel -j39.79 = 19.386 - j24.362\ \Omega$$

$$|\mathbf{I}| = \frac{|\mathbf{V}|}{|Z_\mathrm{L}|} = \frac{110}{|19.386 - j24.362|} = 3.5331 \text{ A(rms)}$$

$$S_\mathrm{L} = Z_\mathrm{L}|\mathbf{I}|^2 = (19.386 - j24.362)(3.5331)^2 = 242 - j304.1 \text{ VA}$$

$$\mathrm{pf} = \frac{P_\mathrm{L}}{|S_\mathrm{L}|} = \frac{242}{|242 - j304.1|} = 0.6227$$

The reactive power is negative, so the power factor is leading.