4.7 Connect a 5-Ω resistor in parallel with the inductor in the circuit shown in Fig. P4.6. Suppose that $v_s(t) = 13\cos(2t - 22.6°)$ V. Find the voltage $v_o(t)$ across the inductor by using voltage division. Draw a phasor diagram. Is this circuit a lag network or a lead network?

4.8 Connect a 5-Ω resistor in parallel with the inductor in the circuit shown in Fig. P4.6. Suppose that $v_s(t) = 13\cos(2t - 22.6°)$ V. Find the voltage $v_o(t)$ across the inductor by using nodal analysis. Draw a phasor diagram. Is this circuit a lag network or a lead network?

4.9 For the circuit given in Fig. P4.9, suppose that $i_s(t) = 5\cos 3t$ A. Find $v_o(t)$ and $v_s(t)$ by using current division.

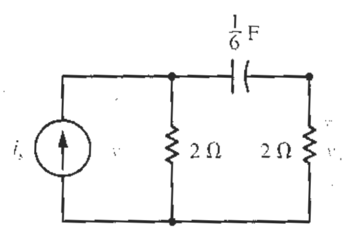

Fig. P4.9

4.10 For the circnit given in Fig. P4.9, suppose that $i_s(t) = 5\cos 3t$ A. Find $v_o(t)$ and $v_s(t)$ by using nodal analysis.

4.11 A voltage of $v_s(t) = 10\cos\omega t$ V is applied to a series *RLC* circuit. If $R = 5\ \Omega$, $L = \frac{1}{5}$ H, and $C = \frac{1}{5}$ F, by how many degrees does $v_C(t)$ lead or lag $v_s(t)$ when (a) $\omega = 1$ rad/s, (b) $\omega = 5$ rad/s, and (c) $\omega = 10$ rad/s?

4.12 A voltage of $v_s(t) = 10\cos\omega t$ V is applied to a series *RLC* circuit. If $R = 5\ \Omega$, $L = \frac{1}{5}$ H, and $C = \frac{1}{5}$ F, by how many degrees does $v_R(t)$ lead or lag $v_s(t)$ when (a) $\omega = 1$ rad/s, (b) $\omega = 5$ rad/s, and (c) $\omega = 10$ rad/s?

4.13 For the *RLC* connection given in Fig. P4.13, find the impedance **Z** when ω is (a) 2, (b) 4, and (c) 8 rad/s.

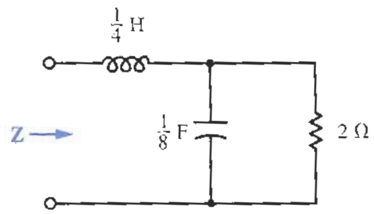

Fig. P4.13

4.14 For the *RLC* connection shown in Fig. P4.14, find the admittance **Y** when ω is: (a) 1, (b) 3, and (c) 7 rad/s.

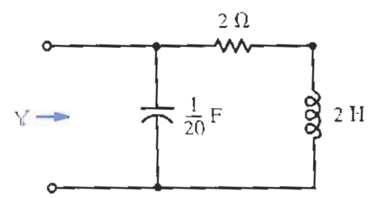

Fig. P4.14

4.15 Show that a general expression for the impedance **Z** depicted in Fig. P4.13 is

$$\mathbf{Z} = \frac{32}{\omega^2 + 16} + j\frac{\omega(\omega^2 - 16)}{4(\omega^2 + 16)}$$

4.16 Show that a general expression for the admittance **Y** depicted in Fig. P4.14 is

$$\mathbf{Y} = \frac{1}{2(\omega^2 + 1)} + j\frac{\omega(\omega^2 - 9)}{20(\omega^2 + 1)}$$

4.17 For the circuit shown in Fig. P4.17, find the Thévenin equivalent of the circuit in the shaded box when $v_s(t) = 4\cos(4t - 60°)$ V. Use this to determine $v_o(t)$.

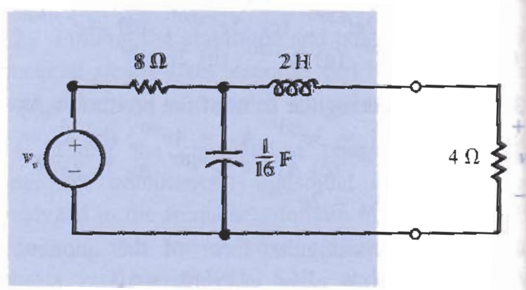

Fig. P4.17

4.18 For the circuit shown in Fig. P4.17, find the Thévenin equivalent of the circuit in the shaded box when $v_s(t) = 4\cos(2t - 60°)$ V. Use this to determine $v_o(t)$.

4.19 Find the frequency-domain Thévenin equivalent (to the left of terminals a and b) of the circuit shown in Fig. 4.20 on p. 211. (*Hint:* Use the fact that $\mathbf{Z}_o = \mathbf{V}_{oc}/\mathbf{I}_{sc}$.)

4.20 The frequency-domain Thévenin equivalent of a circuit having $\omega = 5$ rad/s has $\mathbf{V}_{oc} = 171\underline{/-15.9°}$ V and $\mathbf{Z}_o = 2.38 - j0.667\ \Omega$. Determine a corresponding time-domain Thévenin-equivalent circuit.

4.21 For the op-amp circuit shown in Fig. P4.21, find $v_o(t)$ when $v_s(t) = 6\sin 2t$ V.

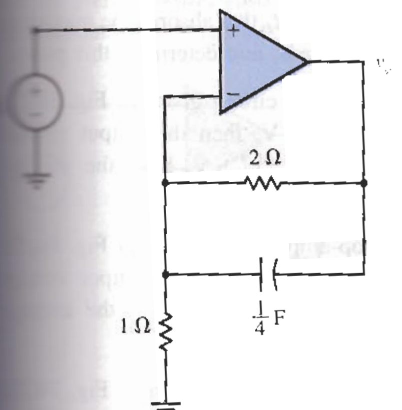

Fig. P4.21

4.22 For the op-amp circuit given in Fig. P4.22, find $v_o(t)$ when $v_s(t) = 3\cos 2t$ V.

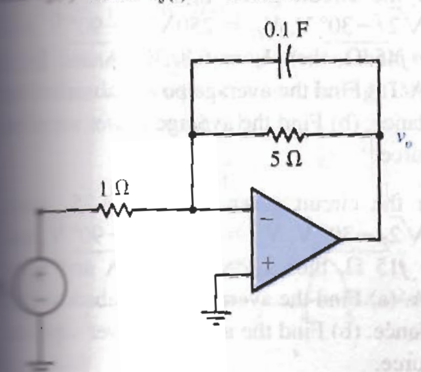

Fig. P4.22

4.23 For the op-amp circuit shown in Fig. P4.23, find $v_o(t)$ when $v_s(t) = 4\cos(2t - 30°)$ V. (See p. 258.)

4.24 For the circuit shown in Fig. P4.24, find the currents $\mathbf{I}_1$ and $\mathbf{I}_2$ when $\mathbf{V}_{s1} = 250\sqrt{2}\underline{/-30°}$ V, $\mathbf{V}_{s2} = 250\sqrt{2}\underline{/-90°}$ V, and $\mathbf{Z} = 78 - j45\ \Omega$.

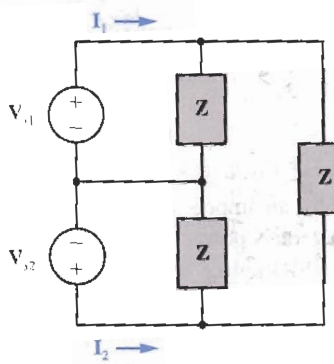

Fig. P4.24

4.25 Use mesh analysis to find $\mathbf{I}_1$ and $\mathbf{I}_2$ for the circuit given in Fig. P4.25 when $\mathbf{V}_{s1} = 250\sqrt{2}\underline{/-30°}$ V, $\mathbf{V}_{s2} = 250\sqrt{2}\underline{/-90°}$ V, and $\mathbf{Z} = 26 - j15\ \Omega$.

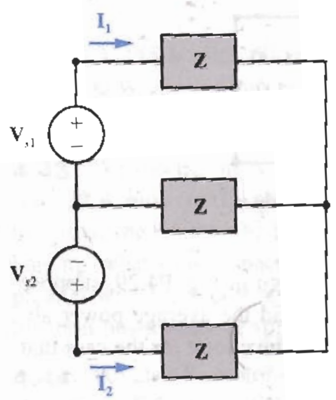

Fig. P4.25

4.26 For the circuit shown in Fig. P4.9, when $i_s(t) = 5\cos 3t$ A then $v_o(t) = 4.47\cos(3t + 26.6°)$ V. Find the average power absorbed by each element in the circuit.

4.27 For the circuit shown in Fig. P4.17, when $v_s(t) = 10\cos 4t$ V, then the Thévenin equivalent of the portion of the circuit in the shaded box is $\mathbf{V}_{oc} =$

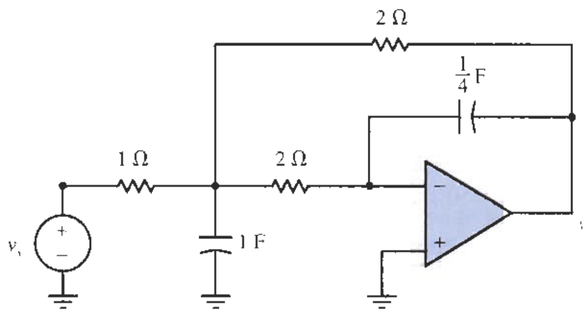

Fig. P4.23

$4.47\underline{/-63.4^\circ}$ V and $\mathbf{Z}_o = 1.6 + j4.8\ \Omega$. (a) Replace the 4-Ω load resistor by an impedance $\mathbf{Z}_L$ that absorbs the maximum average power, and determine this maximum power. (b) Replace the 4-Ω load resistor with a resistance R_L that absorbs the maximum power for resistive loads, and determine this power.

4.28 For the *RLC* circuit shown in Fig. P4.28, suppose that $v_s(t) = 10 \cos 3t$ V. Find the average power absorbed by the 4-Ω resistor for the case that (a) $C = \frac{1}{6}$ F; (b) $C = \frac{1}{18}$ F; (c) $C = \frac{1}{30}$ F.

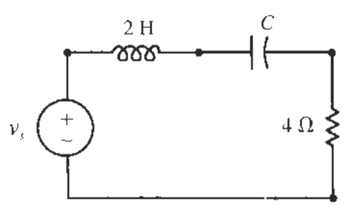

Fig. P4.28

4.29 For the circuit shown in Fig. P4.29, suppose that $v_s(t) = 8 \cos 2t$ V. Find the average power absorbed by each element in the circuit for the case that $\mathbf{Z}_L = 1\ \Omega$.

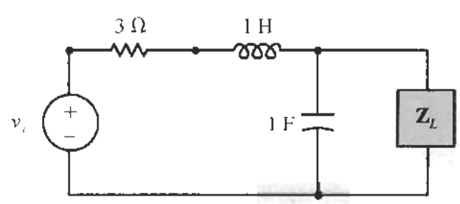

Fig. P4.29

4.30 For the circuit shown in Fig. P4.29, change the value of the resistor to 2 Ω and the value of the capacitor to $\frac{1}{4}$ F. Suppose that $v_s(t) = 8 \cos 2t$ V. (a) Find the load impedance $\mathbf{Z}_L$ that absorbs the maximum average power, and determine this power. (b) Find the load resistance R_L that absorbs the maximum power for resistive loads, and determine this power.

4.31 For the op-amp circuit given in Fig. P4.21, when $v_s(t) = 6 \sin 2t$ V, then the output voltage $v_o(t) = 13.4 \cos(2t - 117^\circ)$ V. Find the average power absorbed by each element.

4.32 For the op-amp circuit given in Fig. P4.22, when $v_s(t) = 3 \cos 2t$ V, then the output voltage $v_o(t) = 10.6 \cos(2t + 135^\circ)$ V. Find the average power absorbed by each element.

4.33 For the op-amp circuit given in Fig. P4.23, when $v_s(t) = 4 \cos(2t - 30^\circ)$ V, then $v_1(t) = 1.6\cos(2t - 66.9^\circ)$ V and $v_o(t) = 1.6\cos(2t + 23.1^\circ)$ V. Find the average power absorbed by each element.

4.34 For the circuit given in Fig. P4.24, when $\mathbf{V}_{s1} = 250\sqrt{2}\underline{/-30^\circ}$ V, $\mathbf{V}_{s2} = 250\sqrt{2}\underline{/-90^\circ}$ V, and $\mathbf{Z} = 78 - j45\ \Omega$, then $\mathbf{I}_1 = 6.8\underline{/30^\circ}$ A and $\mathbf{I}_2 = 6.8\underline{/-90^\circ}$ A. (a) Find the average power absorbed by each impedance. (b) Find the average power supplied by each source.

4.35 For the circuit given in Fig. P4.25, when $\mathbf{V}_{s1} = 250\sqrt{2}\underline{/-30^\circ}$ V, $\mathbf{V}_{s2} = 250\sqrt{2}\underline{/-90^\circ}$ V, and $\mathbf{Z} = 26 - j15\ \Omega$, then $\mathbf{I}_1 = 6.8\underline{/30^\circ}$ A and $\mathbf{I}_2 = 6.8\underline{/-90^\circ}$ A. (a) Find the average power absorbed by each impedance. (b) Find the average power supplied by each source.