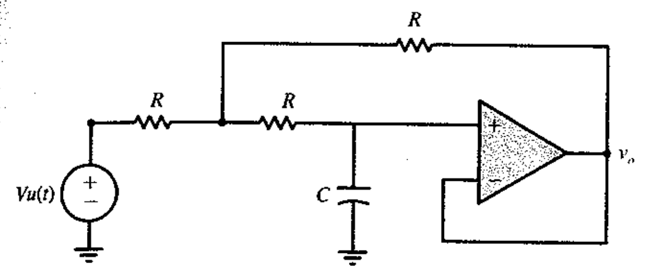

Fig. P3.50

3.50 Find the step response $v_o(t)$ for the op-amp circuit shown in Fig. P3.50.

3.51 For the series RC circuit given in Fig. P3.7a, suppose that $v_s(t) = 12e^{-t/2}u(t)$ V. Find the responses $v(t)$ and $i(t)$.

3.52 For the series RC circuit given in Fig. P3.7a, suppose that $v_s(t) = 12e^{-t/4}u(t)$ V. Find the responses $v(t)$ and $i(t)$.

3.53 For the series RL circuit given in Fig. P3.1a, suppose that $v_s(t) = 12e^{-2t}u(t)$ V. Find the responses $i(t)$ and $v(t)$.

3.54 For the series RL circuit given in Fig. P3.1a, suppose that $v_s(t) = 12e^{-t}u(t)$ V. Find the responses $i(t)$ and $v(t)$.

3.55 For the circuit shown in Fig. P3.30, when $i_s(t) = 10u(t)$ A, then $i(t) = 4(1 - e^{-t})u(t)$ A and $v(t) = 20e^{-t}u(t)$ V. Find $i(t)$ and $v(t)$ when $i_s(t) = 5u(t) - 5u(t-1)$ A.

3.56 For the circuit shown in Fig. P3.34, when $v_s(t) = 12u(t)$ V, then $v(t) = 18(1 - e^{-4t})u(t)$ V and $i(t) = 3e^{-4t}u(t)$ A. Find $v(t)$ and $i(t)$ when $v_s(t) = 4u(t) - 4u(t-2)$ V.

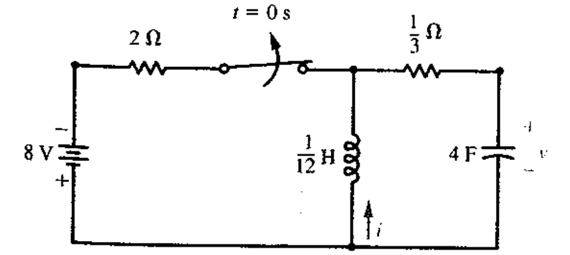

Fig. P3.57

3.57 For the circuit shown in Fig. P3.57, the switch opens at time $t = 0$ s. Find $v(t)$ and $i(t)$ for all time.

3.58 For the circuit shown in Fig. P3.57, change the value of the capacitor to $\frac{3}{5}$ F. For the resulting circuit, the switch opens at time $t = 0$ s. Find $v(t)$ and $i(t)$ for all time.

3.59 For the circuit shown in Fig. P3.57, change the value of the capacitor to 3 F. For the resulting circuit, the switch opens at time $t = 0$ s. Find $v(t)$ and $i(t)$ for all time.

3.60 For the circuit shown in Fig. P3.60, the switch opens at time $t = 0$ s. Find $i(t)$ and $v(t)$ for all time. (See p. 184.)

3.61 For the circuit shown in Fig. P3.60, change the value of the resistor to $\frac{1}{2}$ Ω. For the resulting circuit, the switch opens at time $t = 0$ s. Find $i(t)$ and $v(t)$ for all time. (See p. 184.)

3.62 For the circuit shown in Fig. P3.60, change the value of the inductor to $\frac{2}{9}$ H. For the resulting circuit, the switch opens at time $t = 0$ s. Find $v(t)$ and $i(t)$ for all time. (See p. 184.)

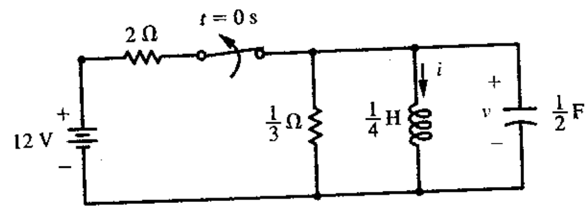

Fig. P3.60

3.63 For the series *RLC* circuit shown in Fig. P3.63, suppose that $R = 7\ \Omega$, $L = 1$ H, $C = 0.1$ F, $v_s(t) = 12$ V for $t < 0$ s and $v_s(t) = 0$ V for $t \geq 0$ s. Find $v(t)$ and $i(t)$ for all time.

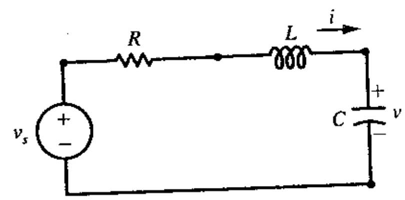

Fig. P3.63

3.64 For the series *RLC* circuit shown in Fig. P3.63, suppose that $R = 2\ \Omega$, $L = 0.25$ H, $C = 0.2$ F, $v_s(t) = 10$ V for $t < 0$ s and $v_s(t) = 0$ V for $t \geq 0$ s. Find $v(t)$ and $i(t)$ for all time.

3.65 For the series *RLC* circuit shown in Fig. P3.63, suppose that $R = 2\ \Omega$, L = 1 H, $C = 1$ F, $v_s(t) = 6$ V for $t < 0$ s and $v_s(t) = 0$ V for $t \geq 0$ s. Find $v(t)$ and $i(t)$ for all time.

3.66 For the circuit shown in Fig. P3.66, suppose that $v_s(t) = 6$ V for $t < 0$ s and $v_s(t) = 0$ V for $t \geq 0$ s. Find $v_2(t)$ and $v_1(t)$ for all time.

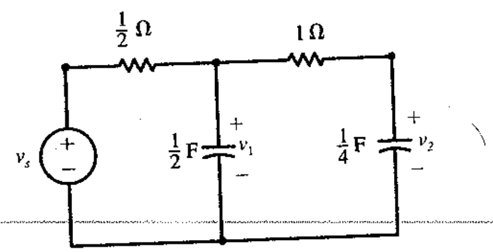

Fig. P3.66

3.67 For the circuit shown in Fig. P3.67, suppose that $v_s(t) = 6$ V for $t < 0$ s and $v_s(t) = 0$ V for $t \geq 0$ s. Find $i(t)$ and $v(t)$ for all time.

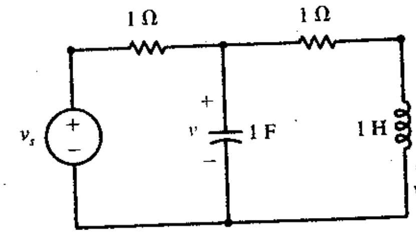

Fig. P3.67

3.68 For the circuit shown in Fig. P3.67, interchange the inductor and the capacitor. Suppose that $v_s(t) = 6$ V for $t < 0$ s and $v_s(t) = 0$ V for $t \geq 0$ s. Find the capacitor voltage $v(t)$ and the inductor current $i(t)$ for all time.

3.69 For the parallel RLC circuit shown in Fig. P3.69, suppose that $R = 0.5\ \Omega$, $L = 0.2$ H, $C = 0.25$ F, and $i_s(t) = 2u(t)$ A. Find the step responses $i(t)$ and $v(t)$.

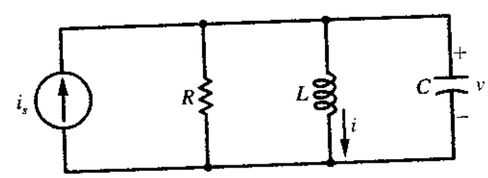

Fig. P3.69

3.70 For the parallel *RLC* circuit shown in Fig. P3.69, suppose that $R = 3\ \Omega$, L = 3 H, $C = \frac{1}{12}$ F, and $i_s(t) = 4u(t)$ A. Find the step responses $i(t)$ and $v(t)$.

3.71 For the series *RLC* circuit shown in Fig. P3.63, suppose that $R = 7\ \Omega$, $L = 1$ H, $C = 0.1$ F, and $v_s(t) = 12u(t)$ V. Find the step responses $v(t)$ and $i(t)$.

3.72 For the series *RLC* circuit shown in Fig. P3.63, suppose that $R = 2\ \Omega$, $L = 1$ H, $C = 1$ F, and $v_s(t) = 12u(t)$ V. Find the step responses $v(t)$ and $i(t)$.

3.73 For the *RLC* circuit shown in Fig. 3.43 on p. 172, suppose that $R = \frac{1}{2}\ \Omega$, $L = \frac{1}{3}$ H, $C = \frac{1}{4}$ F, and $V = 1$ V. Find the unit step responses $i(t)$ and $v(t)$.

3.74 For the *RLC* circuit shown in Fig. 3.43 on p. 172, suppose that $R = \frac{1}{2}\ \Omega$, $L = \frac{1}{4}$ H, $C = \frac{1}{2}$ F, and $V = 1$ V. Find the unit step responses $i(t)$ and $v(t)$.

3.75 For the circuit shown in Fig. P3.66, suppose that $v_s(t) = 9u(t)$ V. Find the step response $v_2(t)$.

3.76 For the circuit shown in Fig. P3.67, suppose that $v_s(t) = 6u(t)$ V. Find the step responses $i(t)$ and $v(t)$.

3.77 Find the step response $v_o(t)$ for the op-amp circuit shown in Fig. P3.77 when $C = \frac{1}{3}$ F and $v_s(t) = 4u(t)$ V.

3.78 Find the step response $v_o(t)$ for the op-amp circuit shown in Fig. P3.77 when $C = \frac{1}{8}$ F and $v_s(t) = 8u(t)$ V.

3.79 Find the step response $v_o(t)$ for the op-amp circuit shown in Fig. P3.77 when $C = \frac{1}{4}$ F and $v_s(t) = 6u(t)$ V.

3.80 Find the step response $v_o(t)$ for the op-amp circuit shown in Fig. P3.80 when $C = \frac{4}{3}$ F and $v_s(t) = 4u(t)$ V.

3.81 Find the step response $v_o(t)$ for the op-amp circuit shown in Fig. P3.80 when $C = 1$ F and $v_s(t) = 3u(t)$ V.

3.82 Find the step response $v_o(t)$ for the op-amp circuit shown in Fig. P3.80 when $C = \frac{1}{5}$ F and $v_s(t) = 2u(t)$ V.

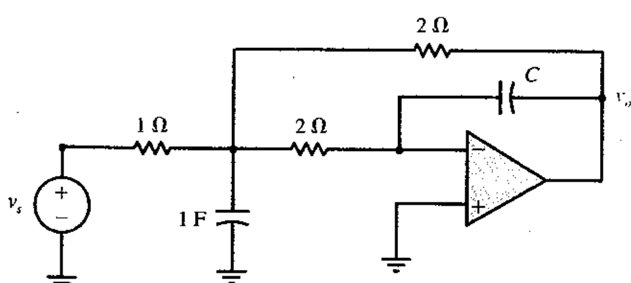

Fig. P3.77

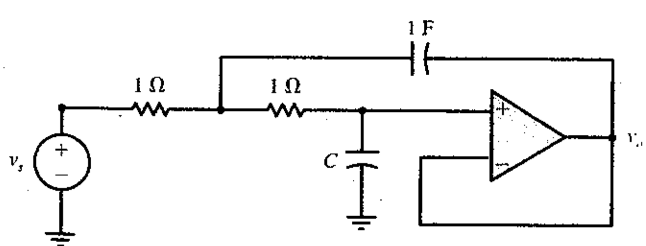

Fig. P3.80

5. Important circuit concepts such as the principle of superposition and Thévenin's theorem are also applicable in the frequency domain.

6. The instantaneous power absorbed by an element is equal to the product of the voltage across it and the current through it.

7. The average power absorbed by a resistance R having a sinusoidal current of amplitude I and voltage of amplitude V is

$$P_R = \tfrac{1}{2}VI = \tfrac{1}{2}RI^2 = \tfrac{1}{2}\frac{V^2}{R}$$

8. The average power absorbed by a capacitance or an inductance is zero.

9. A circuit whose Thévenin-equivalent (output) impedance is $\mathbf{Z}_o$ transfers maximum power to a load $\mathbf{Z}_L$ when $\mathbf{Z}_L$ is equal to the complex conjugate of $\mathbf{Z}_o$.

10. For the case in which $\mathbf{Z}_L$ is restricted to be purely resistive, maximum power is transferred when $\mathbf{Z}_L$ equals the magnitude of $\mathbf{Z}_o$.

11. The effective or rms value of a sinusoid of amplitude A is $A/\sqrt{2}$.

12. The average power absorbed by a resistance R having a current whose effective value is I_e and a voltage whose effective value is V_e is

$$P_R = V_eI_e = RI_e^2 = \frac{V_e^2}{R}$$

13. The power factor (pf) is the ratio of average power to apparent power.

14. If current lags voltage, the pf is lagging. If current leads voltage, the pf is leading.

15. Average or real power can be generalized with the notion of complex power.

16. The ordinary household uses a single-phase, three-wire electrical system.

17. The most common polyphase electrical system is the balanced three-phase system.

18. Three-phase sources are generally Y connected, and three-phase loads are generally Δ connected.

19. The device commonly used to measure power is the wattmeter.

20. Three-phase load power measurements can be taken with the two-wattmeter method.

Problems

4.1 Find the exponential form of the following complex numbers given in rectangular form: (a) $4 + j7$, (b) $3 - j5$, (c) $-2 + j3$, (d) $-1 - j6$, (e) 4, (f) -5, (g) $j7$, (h) $-j2$.

4.2 Find the rectangular form of the following complex numbers given in exponential form: (a) $3e^{j70°}$, (b) $2e^{j120°}$, (c) $5e^{-j60°}$, (d) $4e^{-j150°}$, (e) $6e^{j90°}$, (f) $e^{-j90°}$, (g) $2e^{j180°}$, (h) $2e^{-j180°}$.

4.3 Find the rectangular form of the product $\mathbf{A}_1\mathbf{A}_2$ given that: (a) $\mathbf{A}_1 = 3e^{j30°}$, $\mathbf{A}_2 = 4e^{j60°}$; (b) $\mathbf{A}_1 = 3e^{j30°}$, $\mathbf{A}_2 = 4e^{-j30°}$; (c) $\mathbf{A}_1 = 5e^{-j60°}$, $\mathbf{A}_2 = 2e^{j120°}$; (d) $\mathbf{A}_1 = 4e^{j45°}$, $\mathbf{A}_2 = 2e^{-j90°}$.

4.4 Find the rectangular form of the quotient $\mathbf{A}_1/\mathbf{A}_2$ for $\mathbf{A}_1$ and $\mathbf{A}_2$ given in Problem 4.3.

4.5 Find the rectangular form of the sum $\mathbf{A}_1 + \mathbf{A}_2$ for $\mathbf{A}_1$ and $\mathbf{A}_2$ given in Problem 4.3.

4.6 For the ac circuit shown in Fig. P4.6, suppose that $v_s(t) = 13\cos(2t - 22.6°)$ V. Find $v_o(t)$ by using voltage division. Draw a phasor diagram. Is this circuit a lag network or a lead network?

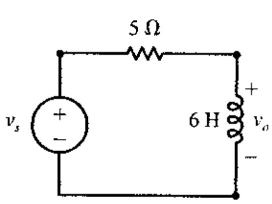

Fig. P4.6