15.10: Alternating-Current Circuits (Answers)

Check Your Understanding

15.1. 10 ms

15.2. a. $(20V)sin200\pi t, (0.20A)sin200\pi t$

b. $(20V)sin200\pi t, (0.13A)sin(200\pi t+\pi/2)$

c. $(20V)sin200\pi t, (2.1A)sin(200\pi t-\pi/2)$

15.3. $v_R=(V_0R/Z)sin(\omega t-\phi); v_C=(V_0X_C/Z)sin(\omega t-\phi+\pi/2)=-(V_0X_C/Z)cos(\omega t-\phi); v_L$
$=(V_0X_L/Z)sin(\omega t-\phi-\pi/2)=(V_0X_L/Z)cos(\omega t-\phi)$

15.4. $v(t)=(10.0V)sin90\pi t$

15.5. 2.00 V; 10.01 V; 8.01 V

15.6. a. 160 Hz;

b. 40Ω;

c. $(0.25A)sin10^3t$;

d. 0.023 rad

15.7. a. halved;

b. halved;

c. same

15.8. $v(t)=(0.14V)sin(4.0\times10^2t)$

15.9. a. 12:1;

b. 0.042 A;

c. $2.6\times10^3\Omega$

Conceptual Questions

1. Angular frequency is 2π times frequency.

3. yes for both

5. The instantaneous power is the power at a given instant. The average power is the power averaged over a cycle or number of cycles.

7. The instantaneous power can be negative, but the power output can't be negative.

9. There is less thermal loss if the transmission lines operate at low currents and high voltages.

11. The adapter has a step-down transformer to have a lower voltage and possibly higher current at which the device can operate.

13. so each loop can experience the same changing magnetic flux

Problems

15. a. 530Ω;

b. 53Ω;

c. 5.3Ω

17. a. 1.9Ω;

b. 19Ω;

c. 190Ω

19. 360 Hz

21. $i(t) = (3.2A)sin(120\pi t)$

23. a. 38Ω;

b. $i(t) = (4.24A)sin(120\pi t - \pi/2)$

25. a. 770Ω;

b. 0.16 A;

c. $I = (0.16A)cos(120\pi t)$;

d. $v_R = 120cos(120\pi t); v_C = 120cos(120\pi t - \pi/2)$

27. a. 690Ω;

b. 0.15 A;

c. $I = (0.15A)sin(1000\pi t - 0.753)$;

d. 1100Ω, 0.092 A, $I = (0.092A)sin(1000\pi t + 1.09)$

29. a. 5.7Ω;

b. 29°;

c. $I = (30.A)cos(120\pi t)$

31. a. 0.89 A;

b. 5.6A;

c. 1.4 A

33. a. 5.3 W;

b. 2.1 W

35. a. inductor;

b. $X_L = 52\Omega$

37. $1.3 \times 10^{-7} F$

39. a. 820 Hz;

b. 7.8

41. a. 50 Hz;

b. 50 W;

c. 13;

d. 25 rad/s

43. The reactance of the capacitor is larger than the reactance of the inductor because the current leads the voltage. The power usage is 30 W.

45. a. 45:1;

b. 0.68 A, 0.015 A;

c. 160Ω

47. a. 41 turns;

b. 40.9 mA

Additional Problems

49. a. $i(t) = (1.26A)sin(200\pi t + \pi/2)$;

b. $i(t) = (12.6A)sin(200\pi t - \pi/2)$;

c. $i(t) = (2A)sin(200\pi t)$

51. a. $2.5 \times 10^3 \Omega, 3.6 \times 10^{-3} A$;

b. $7.5\Omega, 1.2A$

53. a. 19 A;

b. inductor leads by 90°

55. 11.7Ω

57. 36 W

59. a. $5.9 \times 10^4 W$;

b. $1.64 \times 10^{11} W$

Challenge Problems

61. a. 335 MV;

b. the result is way too high, well beyond the breakdown voltage of air over reasonable distances;

c. the input voltage is too high

63. a. 20Ω;

b. 0.5 A;

c. 5.4°, lagging;

d.
$V_R = (9.96V)cos(250\pi t + 5.4^\circ), V_C = (12.7V)cos(250\pi t + 5.4^\circ - 90^\circ), V_L = (11.8V)cos(250\pi t + 5.4^\circ + 90^\circ)$,
$V_{source} = (10.0\,V)cos(250\pi t)$;
;

e. 0.995;

f. 6.25 J

65. a. 0.75Ω;

b. 7.5Ω;

c. 0.75Ω;

d. 7.5Ω;

e. 1.3Ω;

f. 0.13Ω

67. The units as written for inductive reactance Equation 15.8 are $\frac{rad}{s}$H. Radians can be ignored in unit analysis. The Henry can be defined as $H = \frac{V \cdot s}{A} = \Omega \cdot s$. Combining these together results in a unit of Ω for reactance.

69. a. 156 V;

b. 42 V;

c. 154 V

71. a. $\frac{v_{out}}{v_{in}} = \frac{1}{\sqrt{1 + 1/\omega^2 R^2 C^2}}$ and \(\displaystyle \frac{v_{out}}{v_{in}}=\frac{ωL}{\sqrt{R^2+ω^2L^2}};

b. $v_{out} \approx v_{in}$ and $v_{out} \approx 0$