

Appendix H

ANSWERS TO SELECTED ODD-NUMBERED PROBLEMS

Chapter 1

5. 29.05 mph
11. 737.8 ft-lbs
13. (a) 10^4 (b) 10^6 (c) 10^3
(d) 10^{-3} (e) 10^0 (f) 10^{-1}
15. (a) 5.22×10^4 (b) 4.50×10^5
(c) 4.4×10^{-4} (d) 6.5×10^2
17. (a) 1.5×10^1 (b) 4.4
(c) 2.296×10^2 (d) 8.40×10^3
19. (a) 2.50×10^7 (b) 6.67×10^{-8}
(c) 4.4 (d) 1.95×10^{25}
21. (a) 1.6×10^5 (b) 2.16×10^{-7}
(c) 1.44×10^3 (d) 1.11×10^{11}
23. (a) 300 (b) 200.0×10^3
(c) 9.0×10^{12} (d) 150.0×10^{-9}
(e) 24.0×10^{12} (f) 800.0×10^{18}
(g) 56.4×10^3
25. (a) 50 ms (b) 2 ms (c) $40 \mu\text{s}$
(d) $0.0084 \mu\text{s}$ (e) 4000 mm
(f) 0.26 km
27. (a) 10^5 pF (b) 8 cm
(c) 60×10^{-5} km
(d) 11.52×10^6 ms (e) $16 \mu\text{m}$
(f) 60×10^{-4} m²
29. 5,280 ft, 1760 yds, 1609.35 m,
1.61 km
31. 3.40 s
33. 73.33 days
35. 3600 quarters
37. 345.6 m
39. 47.30 min/mi
41. (a) 4.74×10^{-3} Btu
(b) 7.1×10^{-4} m³
(c) 1.21×10^5 s
(d) 2113.38 pints
43. 13
45. 0.64
47. 2.95
49. 1.20×10^{12}

Chapter 2

3. (a) $1.11 \mu\text{N}$ (b) 0.31 N
(c) 1138.34 kN
5. 10 mm
7. 3 kV
9. 6 C
11. 4.29 mA
13. 1.92 C
15. 3 s
17. 2.25×10^{18} electrons
19. 22.43 mA
21. 6.67 V

23. 3.34 A
25. 60.0 Ah
35. 600 C

Chapter 3

1. (a) 500 mils (b) 20 mils
(c) 250 mils (d) 1000 mils
(e) 240 mils (f) 39.37 mils
3. (a) 0.04 in. (b) 0.029 in.
(c) 0.2 in. (d) 0.025 in.
(e) 0.0025 in. (f) 0.01 in.
5. 92.81 Ω
7. 3.58 ft
9. (a) silver (b) silver: 99 Ω ;
copper: 5.19 Ω ;
aluminum: 1.36 Ω
11. (a) 21.71 $\mu\Omega$ (b) 35.59 $\mu\Omega$
13. 942.28 m Ω
15. (a) #8: 1.13 Ω ; #18: 11.49 Ω
(b) #18: #8 = 10 : 1
(c) #18: #8 = 1 : 10
17. (a) 1.09 mA/CM
(b) 1.39 kA/in.² (c) 3.6 in.²
19. (a) 21.71 $\mu\Omega$ (b) 35.59 $\mu\Omega$
21. 0.15 in.
23. 2.57 Ω
25. 3.67 Ω
27. 46 m Ω
29. (a) 27.85°C (b) -210.65°C
31. (a) 0.00393 (b) 83.61°C
33. 1.751 Ω
35. 100.30 Ω
41. 6.5 k Ω
45. (a) Brown, red, brown, silver
(b) Gray, red, gold, silver
(c) Blue, gray, red, silver
(d) Orange, orange, green, silver
47. no overlap
49. (a) 8.33 mS (b) 0.25 mS
(c) 0.46 μS
51. 500 S
55. (a) -50°C: 10⁵ Ω -cm
50°C: 500 Ω -cm
200°C: 7 Ω -cm (b) negative
(c) No (d) 3.6 Ω -cm/^oC
57. (a) 0.5 mA: 195 V; 1 mA: 200 V;
5 mA: 215 V (b) 20 V
(c) 10 : 1 vs 1.08 : 1

Chapter 4

1. 117.5 V
3. 4 k Ω

5. 72 mV
7. 54.55 Ω
9. 28.57 Ω
11. 1.2 k Ω
13. (a) 12.63 Ω (b) 4.1×10^6 J
21. 16 s
23. 250 W
25. 4.8 W
27. 10.44 mA
29. 2.14 mA
31. 461.27 μA , no
33. 405 mW
35. 32 Ω , 120 V
37. 70.71 mA, 1.42 kV
39. 59.80 kWh
41. 0.65¢
43. 44.44 h
45. (a) 4.1 W (b) 19.78 Ω
(c) 88.56 kJ
47. 74.21¢
49. 94.43%
51. 84.77%
53. 16.06 A
55. 56.52 A
57. 65.25%
59. 80%
61. $\eta_1 = 40\%$, $\eta_2 = 80\%$

Chapter 5

1. (a) E and R_1 (b) R_1 and R_2
(c) E and R_1 (d) E and R_1 ,
 R_3 and R_4
3. (a) 7.7 k Ω (b) 17.5 k Ω
5. (a) 62 Ω (b) 1.8 k Ω
(c) 27 k Ω (d) $R_1 = 8$ k Ω ,
 $R_2 = 16$ k Ω
7. (a) 40 Ω (b) 3 A
(c) $V_1 = 30$ V; $V_2 = 36$ V;
 $V_3 = 54$ V
9. (a) 88 V (b) 20 V
11. (a) 8.18 mA, 18 V (b) 2.5 mA,
20 V (c) 9.94 μA , 99.35 V
13. (a) 82.0 Ω , 250 mA;
 $V_{R_1} = 5.50$ V; $V_{R_2} = 2.50$ V;
 $V_{R_3} = 11.75$ V; $V_{R_4} = 0.75$ V
(b) $P_{R_1} = 1.38$ W;
 $P_{R_2} = 625.00$ mW;
 $P_{R_3} = 2.94$ W;
 $P_{R_4} = 187.50$ mW (c) 5.13 W
(d) 5.13 W (e) same (f) 47 Ω
(g) dissipated (h) R_1 : 2 W;
 R_2 : $\frac{1}{2}$ W; R_3 : 5 W; R_4 : 1/2 W

15. (a) 0.53 A (b) 8 W (c) 15 V
(d) all out
17. (a) $V_{ab} = 0$ V (b) $V_{ab} = -6$ V
(c) $V_{ab} = 14$ V
19. (a) 10 V, 2 k Ω (b) 42 V, 1.5 k Ω
21. (a) 28 V (b) 4 V
23. (a) $V_1 = 9$ V; $V_2 = 8$ V
(b) $V_1 = 11$ V; $V_2 = 7$ V
25. (a) 8.2 k Ω (b) V_3 ; $V_2 = 8.2 : 1$
 V_3 ; $V_1 = 82 : 1$ (c) 52.90 V
(d) 59.35 V
27. (a) $V_1 = 60$ V; $V_2 = 40$ V;
 $E = 120$ V (b) $V_1 = 40$ V;
 $V_3 = 70$ V (c) $V_2 = 20$ V;
 $V_1 = 10$ V; $E = 1030$ V
(d) $V_1 = 10$ V; $V_2 = 3$ V
29. (a) 1.6 k Ω (b) 1.5 Ω
31. (a) $R_x = 80$ Ω (b) $\frac{1}{4}$ W
33. $V_{R_1} = 12$ V; $V_{R_2} = 42$ V;
 $V_{R_3} = 6$ V
35. (a) $V_a = 4$ V; $V_b = -8$ V;
 $V_{ab} = 12$ V (b) $V_a = 14$ V;
 $V_b = 4$ V; $V_{ab} = 10$ V
(c) $V_a = 13$ V; $V_b = 6$ V;
 $V_{ab} = 7$ V
37. (a) $V_a = 12$ V; $V_1 = 8$ V
(b) $V_a = 10$ V; $V_1 = 12$ V
39. $R_1 = 8$ Ω ; $R_3 = 4$ Ω
41. (a) $V_a = 44$ V; $V_b = 40$ V;
 $V_c = 32$ V; $V_d = 20$ V
(b) $V_{ab} = 4$ V; $V_{cb} = -8$ V;
 $V_{cd} = 12$ V (c) $V_{ad} = 24$ V;
 $V_{ca} = -12$ V
43. $V_0 = 0$ V; $V_{03} = 0$ V; $V_2 = 8$ V;
 $V_{23} = 8$ V; $V_{12} = 12$ V;
 $I_i = 17$ mA
45. (a) 11.82 V (b) 1.52%
(c) $P_s = 42.96$ W; $P_{\text{int}} = 0.64$ W
- (d) $I_{R_1} = 4.4$ mA; $I_{R_2} = 2$ mA;
 $I_{R_3} = 36.67$ mA; $I_{R_4} = 0.79$ mA
(e) $I_s = 43.87$ mA = I_T
(f) always greater
15. $V = 12$ V; $I' = 12$ A; $I'' = 8$ A
17. (a) $I_s = 7.5$ A; $I_1 = 1.5$ A
(b) $I_s = 9.6$ mA; $I_1 = 0.8$ mA
19. (a) $R_T = 867.86$ Ω ;
 $I_{R_1} = 100$ mA; $I_{R_2} = 3.03$ mA;
 $I_{R_3} = 12.2$ mA
(b) $P_{R_1} = 10$ W; $P_{R_2} = 0.30$ W;
 $P_{R_3} = 1.22$ W (c) 115.2 W
(d) $P_s = 11.52$ W = P_T
(e) R_1 —smallest resistor
21. 1.26 kW
23. (a) 14.67 A (b) 256 W
(c) 14.67 A
25. (a) $I_1 = 1$ A; $I_2 = 3$ A
(b) $I_1 = 4$ A; $I_2 = 9$ A; $I_3 = 6$ A;
 $I_4 = 13$ A
27. $R_1 = 3$ k Ω ; $R_3 = 6$ k Ω ;
 $R_T = 1.33$ k Ω ; $E = 12$ V
29. $I_2 = 2$ A; $I_3 = 12$ A; $I_4 = 0.6$ A;
 $I_T = 20.6$ A
31. (a) 9 A (b) 10, 0.9 A
(c) 1000, 9 mA
(d) 100,000, 90 μ A (e) little
effect (f) 9.1 A (g) 0.91 A
(h) 9.1 mA (i) 91 μ A
33. (a) 6 k Ω (b) $I_1 = 24$ mA;
 $I_2 = 8$ mA
35. (a) $I_1 = I_2 = 3$ A (b) 36 W
(c) 72 W (d) 6 A
37. 3 A, 2 Ω
39. (a) 6.13 V (b) 9 V (c) 9 V
41. (a) 16.48 V (b) 16.47 V
(c) 16.32 V (d) a : 13.33 V
 b : 13.25 V c : 11.43 V
43. No, 6 k Ω not connected
45. (a) 1 k Ω not connected
(b) Used +4 V source
5. (a) 4 Ω (b) $I_s = 9$ A; $I_1 = 6$ A;
 $I_2 = 3$ A (c) 6 V
7. (a) $I_s = 16$ mA; $I_2 = 2.33$ mA;
 $I_6 = 2$ mA (b) $V_1 = 28$ V;
 $V_3 = 7.2$ V (c) 261.33 mW
9. $I_1 = 4$ A; $I_2 = 0.72$ A
11. (a) $I_s = 5$ A; $I_1 = 1$ A; $I_3 = 4$ A;
 $I_4 = 0.5$ A (b) $V_a = 17$ V;
 $V_{bc} = 10$ V
13. (a) $I_E = 2$ mA = I_C (b) 24 μ A
(c) $V_B = 2.7$ V; $V_C = 3.6$ V
(d) $V_{CE} = 1.6$ V; $V_{BC} = -0.9$ V
15. (a) 174.12 Ω (b) 11.89 V
(c) 20.11 V (d) 11.89 V
(e) 20.54 mA
17. (a) $I_2 = 1.67$ A; $I_6 = 1.11$ A;
 $I_8 = 0$ A (b) $V_4 = 10$ V;
 $V_8 = 0$ V
19. (a) 1.88 Ω (b) $V_1 = V_4 = 32$ V
(c) $I_3 = 8$ A (d) 1.88 Ω
21. (a) 6.75 A (b) 32 V
23. 8.33 Ω
25. (a) 24 A (b) 8 A
(c) $V_3 = 48$ V; $V_5 = 24$ V;
 $V_7 = 16$ V (d) $P_{R_7} = 128$ W;
 $P_s = 5760$ W
27. 4.44 W
29. (a) 64 V
(b) $R_{L_2} = 4$ k Ω
 $R_{L_3} = 3$ k Ω
(c) $R_1 = 0.5$ k Ω
 $R_2 = 1.2$ k Ω
 $R_3 = 2$ k Ω
31. (a) yes (b) $R_1 = 750$ Ω ;
 $R_2 = 250$ Ω (c) $R_1 = 745$ Ω ;
 $R_2 = 255$ Ω
33. (a) 1 mA (b) $R_{\text{shunt}} = 5$ m Ω
35. (a) $R_s = 300$ k Ω
(b) 20,000 Ω /V
37. 0.05 μ A

Chapter 6

1. (a) R_2 and R_3 (b) E and R_3
(c) E and R_1 (d) R_2 , R_3 , and R_4
(e) E , R_1 , R_2 , R_3 , and R_4 (f) E ,
 R_1 , R_2 , and R_3 (g) R_2 and R_3
3. (a) 6.04 Ω (b) 545.55 Ω
(c) 90.09 Ω (d) 5.99 k Ω
(e) 2.62 Ω (f) 0.99 Ω
5. (a) 8 Ω (b) 18 k Ω (c) 20 k Ω
(d) 3.3 k Ω (e) $R_1 = R_2 =$
6.4 k Ω ; $R_3 = 3.2$ k Ω
7. (a) 1.6 Ω (b) ∞ Ω (c) ∞ Ω
(d) 1.18 Ω
9. 120 Ω
11. (a) 2.12 Ω (b) 18 V
(c) $I_s = 8.5$ A; $I_1 = 6$ A; $I_2 = 2$ A;
 $I_3 = 0.5$ A (d) $I_s = 8.5$ A = I_T
13. (a) 1 k Ω (b) 1.003 k Ω
(c) I_3 the most; I_4 the least

Chapter 7

1. (a) E and R_1 in series; R_2 , R_3 , and
 R_4 in parallel (b) E and R_1 in
series; R_2 , R_3 , and R_4 in parallel
(c) R_1 and R_2 in series; E , R_3 , and
 R_4 in parallel (d) E and R_1 in
series; R_4 and R_5 in series; R_2 and
 R_3 in parallel (e) E and R_1 in
series; R_2 and R_3 in parallel
(f) E , R_1 , and R_4 in parallel; R_6
and R_7 in series; R_2 and R_3 in
parallel.
3. (a) yes (b) 6 A (c) yes
(d) 6 V (e) 3.73 Ω (f) 1 A
(g) 20 W

Chapter 8

1. (a) $I_2 = I_3 = 10$ mA (b) 10 V
(c) 37.6 V
3. 28 V
5. 1.6 V, 0.1 A
7. (a) 3 A, 6 Ω
(b) 4.09 mA, 2.2 k Ω
9. (a) 11.76 A (b) 1.2 kV, 100 Ω
11. (a) 2 A (b) 8 V
13. (b) $V_{ab} = -6.44$ V (c) 1.07 A
15. (a) $I_{R_1} = -\frac{1}{7}$ A; $I_{R_2} = \frac{5}{7}$ A;
 $I_{R_3} = \frac{4}{7}$ A (b) $I_{R_1} = 3.06$ A;
 $I_{R_2} = 3.25$ A; $I_{R_3} = 0.19$ A
17. (I): 8.55 A, -22.75 V
(II): 1.27 A, -0.92 V
19. (a) $I_B = 63.02$ μ A; $I_C = 4.42$ mA;
 $I_E = 4.48$ mA (b) $V_B = 2.98$ V;

- $V_E = 2.28 \text{ V}; V_C = 10.28 \text{ V}$
 (c) 70.14
21. (I): $I_{R_1} = 1.45 \text{ mA};$
 $I_{R_2} = 8.51 \text{ mA}; I_{R_3} = 7.06 \text{ mA}$
 (II): $I_{R_1} = 2.03 \text{ mA};$
 $I_{R_2} = 0.80 \text{ mA};$
 $I_{R_3} = I_{R_4} = 1.23 \text{ mA}$
23. (a) 63.69 mA
25. (I): $I_1 = 1.21 \text{ mA};$
 $I_2 = -0.48 \text{ mA};$
 $I_3 = -0.62 \text{ mA}$ (all CW)
 (II): $I_1 = -0.24 \text{ A}; I_2 = -0.52 \text{ A};$
 $I_3 = -1.28 \text{ A}$ (all CW)
27. (a) $I_{24\text{V}} = I_{6\Omega} = I_{10\Omega} = I_{12\text{V}} =$
 3 A (CW); $I_{4\Omega} = 3 \text{ A}$ (CCW)
 (b) $I_{20\text{V}} = I_{4\Omega} = 5.53 \text{ A}, I_{6\Omega} =$
 $2.47 \text{ A}, I_{8\Omega} = 0.53 \text{ A}, I_{1\Omega} = 8.53 \text{ A}$
29. (I): (b) $I_1 = 1.45 \text{ mA};$
 $I_2 = -8.51 \text{ mA}$ (all CW)
 (c) $I_{R_1} = 1.45 \text{ mA};$
 $I_{R_2} = 8.51 \text{ mA}; I_{R_3} = 9.96 \text{ mA}$
 (II): (b) $I_1 = 2.03 \text{ mA};$
 $I_2 = 1.23 \text{ mA}$ (all CW)
 (c) $I_{R_1} = 2.03 \text{ mA};$
 $I_{R_2} = 0.80 \text{ mA};$
 $I_{R_3} = I_{R_4} = 1.23 \text{ mA}$
31. 63.69 mA
33. (I): $I_1 = 1.21 \text{ mA}; I_2 = -0.48 \text{ mA};$
 $I_3 = -0.62 \text{ mA}$ (all CW)
 (II): $I_1 = -0.24 \text{ A}; I_2 = -0.52 \text{ A};$
 $I_3 = -1.28 \text{ A}$ (all CW)
35. (a) $V_1 = 8.08 \text{ V}; V_2 = 9.39 \text{ V}$
 (b) $V_1 = 4.80 \text{ V}; V_2 = 6.40 \text{ V}$
37. (I): (b) $V_1 = -2.65 \text{ V};$
 $V_2 = 0.95 \text{ V}$
 (c) $V_{R_1} = 15.35 \text{ V};$
 $V_{R_2} = 2.05 \text{ V}; V_{R_3} = 2.65 \text{ V};$
 $V_{R_4} = 3.60 \text{ V}; V_{R_5} = 0.95 \text{ V}$
 (II): (b) $V_1 = 8.88 \text{ V}; V_2 = 9.83 \text{ V};$
 $V_3 = -3.01 \text{ V}$ (c) $V_{R_1} = 4.12 \text{ V};$
 $V_{R_2} = 0.84 \text{ V}; V_{R_3} = 5.17 \text{ V};$
 $V_{R_4} = 3.01 \text{ V}; V_{R_5} = 0.95 \text{ V}$
39. (I): $V_1 = -5.31 \text{ V}; V_2 = -0.62 \text{ V};$
 $V_3 = 3.75 \text{ V}$
 (II): $V_1 = -6.92 \text{ V}; V_2 = 12 \text{ V};$
 $V_3 = 2.3 \text{ V}$
41. (a) $V_1 = 8.08 \text{ V}; V_2 = 9.39 \text{ V}$
 (b) $V_1 = 4.8 \text{ V}; V_2 = 6.4 \text{ V}$
43. (I): (b) $V_1 = 7.24 \text{ V};$
 $V_2 = -2.45 \text{ V};$
 $V_3 = 1.41 \text{ V}$
 (c) $V_{R_1} = 7.76 \text{ V}; V_{R_2} = 2.45 \text{ V};$
 $V_{R_3} = 1.41 \text{ V}; V_{R_4} = 3.86 \text{ V};$
 $V_{R_5} = 9.69 \text{ V}; V_{R_6} = 5.83 \text{ V}$
 (II): (b) $V_1 = -6.64 \text{ V};$
 $V_2 = 1.29 \text{ V}; V_3 = 10.66 \text{ V}$
 (c) $V_{R_1} = 6.64 \text{ V}; V_{R_2} = 5.34 \text{ V};$
 $V_{R_3} = 1.29 \text{ V}; V_{R_4} = 7.93 \text{ V};$
 $V_{R_5} = 9.37 \text{ V}; V_{R_6} = 17.30 \text{ V}$

45. (b) 40 mA (c, d) no
 47. (b) 0 mA (c, d) yes
 51. (a) 7.36 A (b) 1.76 mA
 53. 2.14 A
 55. (a) $R_T = 1 \text{ k}\Omega$ (b) 5.71 mA

Chapter 9

1. (a) $I_{R_1} = 4 \text{ A}; I_{R_2} = 3 \text{ A};$
 $I_{R_3} = 7 \text{ A}$ (b) $E_1: 48 \text{ W};$
 $E_2: 48 \text{ W}$ (c) 192 W (d) no
3. 3.17 A
5. 10.66 V
7. (a) $R_{Th} = 6 \Omega; E_{Th} = 6 \text{ V}$
 (b) $2 \Omega: 0.75 \text{ A};$
 $30 \Omega: 166.67 \text{ mA};$
 $100 \Omega: 56.60 \text{ mA}$
9. (a) $R_{Th} = 7.5 \Omega; E_{Th} = 10 \text{ V}$
 (b) $2 \Omega: 2.22 \text{ W}; 100 \Omega: 0.87 \text{ W}$
11. $R_{Th} = 1.58 \text{ k}\Omega; E_{Th} = -1.15 \text{ V}$
13. (I): $R_{Th} = 45 \Omega; E_{Th} = -5 \text{ V}$
 (II): $R_{Th} = 2.06 \text{ k}\Omega; E_{Th} = 16.77 \text{ V}$
15. $R_{Th} = 4.04 \text{ k}\Omega; E_{Th} = 9.74 \text{ V}$
17. (a) $R_{Th} = 12.5 \text{ k}\Omega; E_{Th} = 20 \text{ V}$
 (b) $R_{Th} = 2.72 \text{ k}\Omega; E_{Th} = 60 \text{ mV}$
 (c) $R_{Th} = 2.2 \text{ k}\Omega; E_{Th} = 16 \text{ V}$
19. (a) $R_N = 7.5 \Omega; I_N = 1.34 \text{ A}$
21. (I): (a) $R_N = 9.76 \Omega; I_N = 0.95 \text{ A}$
 (II): (b) $R_N = 2 \Omega; I_N = 30 \text{ A}$
23. (a) $R_N = 3 \Omega; I_N = 5 \text{ A}$
 (b) $R_N = 2 \Omega; I_N = 0.75 \text{ A}$
25. (I): (a) 10 Ω
 (b) 100 mW
 (II): (a) 4.03 k Ω
 (b) 8.93 mW
27. (a) 2 Ω (b) 60.5 W
29. (a) $\infty \Omega$ (b) no
31. 6.12 A, 18.37 V
33. 0.38 A, 76.52 V
35. 2.32 mA, 15.78 V
39. (a) 0.5 mA (b) 0.5 mA
 (c) yes
41. (a) 4 V (b) 4 V (c) yes

Chapter 10

1. (a) $9 \times 10^3 \text{ N/C}$
 (b) $36 \times 10^9 \text{ N/C}$
3. 120 μF
5. 50 V/m
7. $8 \times 10^3 \text{ V/m}$
9. 1.11 nF
11. mica
13. (a) 10^6 V/m (b) 4.96 μC
 (c) 24.80 nF
15. 29.04 kV
17. 0.35 μF
19. 176 $\mu\text{F} \rightarrow 264 \mu\text{F}$
21. (a) 0.51 s
 (b) $v_C = 20 \text{ V} (1 - e^{-t/0.51 \text{ s}})$

- (c) $1\tau: 12.64 \text{ V}; 3\tau: 19 \text{ V};$
 $5\tau: 19.87 \text{ V}$
 (d) $i_C = 0.2 \text{ mA } e^{-t/0.51 \text{ s}},$
 $v_R = 20 \text{ V } e^{-t/0.51 \text{ s}}$
23. (a) 5.5 ms
 (b) $v_C = 100 \text{ V} (1 - e^{-t/5.5 \text{ ms}})$
 (c) $1\tau: 63.21 \text{ V};$
 $3\tau: 95.02 \text{ V}; 5\tau: 99.33 \text{ V}$
 (d) $i_C = 18.18 \text{ mA } e^{-t/5.5 \text{ ms}},$
 $v_R = 60 \text{ V } e^{-t/5.5 \text{ ms}}$
25. (a) 5 ms (b) 19.8 mV
 (c) 60 mV
27. (a) 200 ms
 (b) $v_C = 8 \text{ V} (1 - e^{-t/200 \text{ ms}});$
 $i_C = 4 \text{ mA } e^{-t/200 \text{ ms}}$
 (c) $v_C = 7.95 \text{ V}; i_C = 26.95 \mu\text{A}$
 (d) $v_C = 7.95 \text{ V } e^{-t/200 \text{ ms}};$
 $i_C = 3.98 \text{ mA } e^{-t/200 \text{ ms}}$
29. (a) $v_C = 50 \text{ V} (1 - e^{-t/100 \text{ ms}});$
 $i_C = 10 \text{ mA } e^{-t/100 \text{ ms}};$
 $v_{R_1} = 30 \text{ V } e^{-t/100 \text{ ms}}$
 (b) $v_C = 31.6 \text{ V}; i_C = 3.68 \text{ mA};$
 $v_{R_1} = 11.04 \text{ V}$
 (c) $v_C = 31.6 \text{ V } e^{-t/40 \text{ ms}};$
 $i_C = -15.8 \text{ mA } e^{-t/40 \text{ ms}};$
 $v_{R_2} = -31.6 \text{ V } e^{-t/40 \text{ ms}}$
31. (a) 10 μs (b) 3 kA
 (c) yes
33. $v_C = 40 \text{ V } e^{-t/4.4 \text{ s}};$
 $i_C = 18.18 \text{ mA } e^{-t/4.4 \text{ s}};$
 $v_R = 40 \text{ V } e^{-t/4.4 \text{ s}}$
35. (a) $v_C = 52 \text{ V} - 40 \text{ V } e^{-t/123.8 \text{ ms}};$
 $i_C = 2.20 \text{ mA } e^{-t/123.8 \text{ ms}}$
 37. 0.73 s
39. (a) 166.80 ms (b) 1 mA
 (c) 43.20 mW
41. (a) 22.07 V (b) 0.81 μA
 (c) 3.58 s
43. (a) $v_C = 27.2 \text{ V} - 25.2 \text{ V } e^{-t/18.26 \text{ ms}};$
 $i_C = 3.04 \text{ mA } e^{-t/18.26 \text{ ms}}$
45. (a) $v_C = 3.27 \text{ V} (1 - e^{-t/53.80 \text{ ms}});$
 $i_C = 1.22 \text{ mA } e^{-t/53.80 \text{ ms}}$
47. (a) 19.63 V (b) 2.32 s
 (c) 1.15 s
49. $0 \rightarrow 20 \mu\text{s}: i_C = -1.18 \text{ A}; 20 \rightarrow$
 $30 \mu\text{s}: i_C = 0 \text{ A}; 30 \rightarrow 50 \mu\text{s}: i_C =$
 $2.35 \text{ A}; 50 \rightarrow 80 \mu\text{s}: i_C =$
 $-2.35 \text{ A}; 80 \rightarrow 90 \mu\text{s}: i_C =$
 $4.7 \text{ A}; 90 \rightarrow 100 \mu\text{s}: i_C = 0 \text{ A}$
51. 12 μF
53. $V_1 = 10 \text{ V}; Q_1 = 60 \mu\text{C};$
 $V_2 = 6.67 \text{ V}; Q_2 = 40 \mu\text{C};$
 $V_3 = 3.33 \text{ V}; Q_3 = 40 \mu\text{C}$
55. $V_1 = 16 \text{ V}; Q_1 = 144 \mu\text{C};$
 $V_2 = 8 \text{ V}; Q_2 = 80 \mu\text{C};$
 $V_3 = 7.11 \text{ V}; Q_3 = 64 \mu\text{C};$
 $V_4 = 0.89 \text{ V}; Q_4 = 64 \mu\text{C}$
57. 8,640 pJ
59. (a) $W_{6\mu\text{F}} = 1.19 \text{ mJ};$
 $W_{12\mu\text{F}} = 0.38 \text{ mJ}$

- (b) $W_{6\ \mu\text{F}} = 85.23\ \mu\text{J}$;
 $W_{12\ \mu\text{F}} = 42.77\ \mu\text{J}$

Chapter 11

- (a) $0.04\ \text{Wb/m}^2$ (b) $0.04\ \text{T}$
(c) $88\ \text{At}$ (d) $0.4 \times 10^3\ \text{gauss}$
- $12.54\ \text{mH}$
- (a) $45\ \text{mH}$ (b) $1.67\ \text{mH}$
(c) $80\ \text{mH}$ (d) $1875\ \text{mH}$
- $6.0\ \text{V}$
- $14\ \text{turns}$
- $5\ \text{V}$
- (a) $2.27\ \mu\text{s}$ (b) $i_L = 5.45\ \text{mA} (1 - e^{-t/2.27\ \mu\text{s}})$
(c) $v_L = 12\ \text{V} e^{-t/2.27\ \mu\text{s}}$;
 $v_R = 12\ \text{V} (1 - e^{-t/2.27\ \mu\text{s}})$
(d) $i_L: 1\tau = 3.45\ \text{mA}$;
 $3\tau = 5.18\ \text{mA}$; $5\tau = 5.41\ \text{mA}$
 $v_L: 1\tau = 4.42\ \text{V}$; $3\tau = 0.60\ \text{V}$;
 $5\tau = 0.08\ \text{V}$
- (a) $i_L = 9.23\ \text{mA} - 1.23\ \text{mA} e^{-t/30.77\ \mu\text{s}}$
 $v_L = 4.8\ \text{V} e^{-t/30.77\ \mu\text{s}}$
- (a) $i_L = 1.76\ \text{mA} - 4.76\ \text{mA} e^{-t/588.2\ \mu\text{s}}$
 $v_L = 16.2\ \text{V} e^{-t/588.2\ \mu\text{s}}$
- (a) $i_L = 2\ \text{mA} (1 - e^{-t/1\ \mu\text{s}})$; $v_L = 20\ \text{V} e^{-t/1\ \mu\text{s}}$ (b) $i_L = 2\ \text{mA} e^{-t/1\ \mu\text{s}}$;
 $v_L = -40\ \text{V} e^{-t/1\ \mu\text{s}}$
- (a) $i_L = 0.88\ \text{mA} (1 - e^{-t/0.74\ \mu\text{s}})$;
 $v_L = 6\ \text{V} e^{-t/0.74\ \mu\text{s}}$ (b) $i_L = 0.88\ \text{mA} e^{-t/0.33\ \mu\text{s}}$;
 $v_L = -13.23\ \text{V} e^{-t/0.33\ \mu\text{s}}$
- (a) $i_L = 1.33\ \text{mA} (1 - e^{-t/55.56\ \text{ns}})$;
 $v_L = 48\ \text{V} e^{-t/55.56\ \text{ns}}$ (b) $i_L = 1.11\ \text{mA}$; $v_L = 7.93\ \text{V}$
- (a) $0.24\ \text{V}$ (b) $29.47\ \text{V}$
(c) $18.96\ \text{V}$ (d) $2.03\ \text{ms}$
- (a) $i_L = 3\ \text{mA} (1 - e^{-t/6.67\ \mu\text{s}})$;
 $v_L = 2.25\ \text{V} e^{-t/6.67\ \mu\text{s}}$
(b) $i_L = 2.60\ \text{mA}$; $v_L = 0.30\ \text{V}$
(c) $i_L = 2.60\ \text{mA} e^{-t/3.33\ \mu\text{s}}$;
 $v_L = -3.90\ \text{V} e^{-t/3.33\ \mu\text{s}}$
- (a) $i_L = -3.48\ \text{mA} - 7.43\ \text{mA} e^{-t/173.9\ \mu\text{s}}$
 $v_L = 51.28\ \text{V} e^{-t/173.9\ \mu\text{s}}$
- (a) $20\ \text{V}$ (b) $12\ \mu\text{A}$
(c) $5.38\ \mu\text{s}$ (d) $0.37\ \text{V}$
- $0 \rightarrow 2\ \text{ms}: -50\ \text{mV}$;
 $2 \rightarrow 5\ \text{ms}: 0\ \text{V}$; $5 \rightarrow 11\ \text{ms}: 25\ \text{mV}$;
 $11 \rightarrow 18\ \text{ms}: -7.14\ \text{V}$;
 $18\ \text{ms} \rightarrow: 0\ \text{V}$
- (a) $10\ \text{H}$ (b) $2.4\ \text{H}$
- (a) $16\ \text{mH}$ in series with $18\ \mu\text{F}$
- (a) $i_L = 3.56\ \text{mA} (1 - e^{-t/8.33\ \mu\text{s}})$;
 $v_L = 12.8\ \text{V} e^{-t/8.33\ \mu\text{s}}$
- $I_1 = 7\ \text{A}$; $I_2 = 2\ \text{A}$
- $I_1 = 3\ \text{A}$; $I_2 = 0\ \text{A}$; $V_1 = 12\ \text{V}$;
 $V_2 = 0\ \text{V}$

Chapter 12

- (Φ) CGS: 5×10^4 Maxwells;
English: 5×10^4 lines
(B) CGS: $8\ \text{Gauss}$; English:
 $51.62\ \text{lines/in.}^2$
- (a) $0.04\ \text{T}$
- $952.4 \times 10^3\ \text{At/Wb}$
- $2,624.67\ \text{At/m}$
- $2.13\ \text{A}$
- (a) $60\ \text{t}$
(b) $13.34 \times 10^{-4}\ \text{Wb/Am}$
- $2.70\ \text{A}$
- $1.35\ \text{N}$
- (a) $2.02\ \text{A}$ (b) $2\ \text{N}$
- $6.12\ \text{mWb}$
- (a) $B = 1.5\ \text{T} (1 - e^{-H/700\ \text{At/m}})$
(b) $900\ \text{At/m}: 1.09\ \text{T}$;
 $1800\ \text{At/m}: 1.39\ \text{T}$;
 $2700\ \text{At/m}: 1.47\ \text{T}$
(c) $H = -700 \log_e \left[1 - \frac{B}{1.5} \right]$
(d) $1\ \text{T}: 769.03\ \text{At/m}$;
 $1.4\ \text{T}: 1895\ \text{At/m}$ (e) $40.1\ \text{mA}$

Chapter 13

- (a) $20\ \text{mA}$ (b) $15\ \text{ms}: -20\ \text{mA}$,
 $20\ \text{ms}: 0\ \text{mA}$ (c) $40\ \text{mA}$
(d) $20\ \text{ms}$ (e) $2.5\ \text{cycles}$
- (a) $8\ \text{mV}$ (b) $3\ \mu\text{s}: -8\ \text{mV}$,
 $9\ \mu\text{s}: 0\ \text{mV}$ (c) $16\ \text{mV}$
(d) $4.5\ \mu\text{s}$ (e) $2.22\ \text{cycles}$
- (a) $60\ \text{Hz}$ (b) $100\ \text{Hz}$
(c) $25\ \text{Hz}$ (d) $40\ \text{kHz}$
- $0.3\ \text{ms}$
- (a) $150\ \text{mV}$ (b) $40\ \mu\text{s}$
(c) $25\ \text{kHz}$
- (a) 45° (b) 30° (c) 18°
(d) 108°
- (a) $314.16\ \text{rad/s}$
(b) $3769.91\ \text{rad/s}$
(c) $12.56 \times 10^3\ \text{rad/s}$
(d) $25.13 \times 10^3\ \text{rad/s}$
- $2.08\ \text{ms}$
- (a) $20, 60\ \text{Hz}$ (b) $5, 120\ \text{Hz}$
(c) $10^6, 1591.55\ \text{Hz}$ (d) $-6.4,$
 $149.92\ \text{Hz}$
- $0.48\ \text{A}$
- $11.54^\circ, 168.46^\circ$
- (a) $v = 25 \sin(\omega t + 30^\circ)$
(b) $i = 3 \times 10^{-3} \sin(6.28 \times 10^3 t - 60^\circ)$
- v leads i by 10°
- i leads v by 80°
- i leads v by 190°
- $13.95\ \mu\text{s}$
- $2\ \text{V}$
- $3.87\ \text{mA}$
- (a) $40\ \mu\text{s}$ (b) $25\ \text{kHz}$
(c) $17.13\ \text{mV}$

- (a) $v = 14.14 \sin 377t$
(b) $i = 70.7 \times 10^{-3} \sin 377t$
(c) $v = 2.83 \times 10^3 \sin 377t$
- $2.16\ \text{V}$
- (a) $T = 40\ \mu\text{s}, f = 25\ \text{kHz}$,
Average = $20\ \text{mV}$, Peak = $40\ \text{mV}$,
rms = $34.64\ \text{mV}$ (b) $T = 100\ \mu\text{s}$,
 $f = 10\ \text{kHz}$, Average = $-0.3\ \text{V}$,
Peak = $0.3\ \text{mV}$, rms = $367.42\ \text{mV}$

Chapter 14

- (a) $3770 \cos 377t$
(b) $452.4 \cos(754t + 20^\circ)$
(c) $4440.63 \cos(157t - 20^\circ)$
(d) $200 \cos t$
- (a) $v = 700 \sin 1000t$
(b) $v = 14.8 \sin(400t - 120^\circ)$
(c) $v = 42 \times 10^{-3} \sin(\omega t + 88^\circ)$
(d) $v = 28 \sin \omega t$
- (a) $1.59\ \text{H}$ (b) $2.65\ \text{H}$
(c) $1.68\ \text{H}$
- (a) $v = 100 \sin(\omega t + 90^\circ)$
(b) $v = 0.8 \sin(\omega t + 150^\circ)$
(c) $v = 120 \sin(\omega t - 120^\circ)$
(d) $v = 60 \sin(\omega t + 190^\circ)$
- (a) $i = 2.4 \sin(\omega t - 90^\circ)$
(b) $i = 0.6 \sin(\omega t - 70^\circ)$
(c) $i = 0.8 \sin(\omega t + 10^\circ)$
(d) $i = 1.6 \sin(377t + 130^\circ)$
- (a) $\infty\ \Omega$ (b) $530.79\ \Omega$
(c) $265.39\ \Omega$ (d) $15.92\ \Omega$
(e) $62.83\ \Omega$
- (a) $31.83\ \text{Hz}$ (b) $4.66\ \text{Hz}$
(c) $9.31\ \text{Hz}$ (d) $1.59\ \text{Hz}$
- (a) $i = 6 \times 10^{-3} \sin(200t + 90^\circ)$
(b) $i = 22.64 \times 10^{-6} \sin(377t + 90^\circ)$ (c) $i = 44.94 \times 10^{-3} \sin(374t + 300^\circ)$
(d) $i = 56 \times 10^{-3} \sin(\omega t + 160^\circ)$
- (a) $v = 1334 \sin(300t - 90^\circ)$
(b) $v = 42.48 \sin(377t - 90^\circ)$
(c) $v = 159 \sin 754t$
(d) $v = 100 \sin(1600t - 170^\circ)$
- (a) C (b) $L = 254.78\ \text{mH}$
(c) $R = 5\ \Omega$
- $318.47\ \text{mH}$
- $5.07\ \text{nF}$
- $0\ \text{W}$
- $192\ \text{W}$
- $i = 40 \sin(\omega t - 50^\circ)$
- (a) $i = 4 \sin(314t - 30^\circ)$
(b) $79.62\ \text{mH}$ (c) $0\ \text{W}$
- (a) $i_1 = 3.39 \sin(10^4 t + 150^\circ)$,
 $i_2 = 16.97 \sin(10^4 t + 150^\circ)$
(b) $i_s = 20.36 \sin(10^4 t + 150^\circ)$
- (a) $5.0 \angle 36.87^\circ$ (b) $2.83 \angle 45^\circ$
(c) $17.09 \angle 69.44^\circ$ (d) $1.0 \times 10^3 \angle 84.29^\circ$ (e) $1077.03 \angle 21.80^\circ$
(f) $6.58 \times 10^{-3} \angle 81.25^\circ$
(g) $11.78 \angle -49.82^\circ$

- (h) $8.94 \angle -153.43^\circ$
- (i) $61.85 \angle -104.04^\circ$
- (j) $101.73 \angle -39.94^\circ$
- (k) $4,326.66 \angle 123.69^\circ$
- (l) $25.5 \times 10^{-3} \angle -78.69^\circ$
- 41. (a) $15.03 \angle 86.19^\circ$
- (b) $60.21 \angle 4.76^\circ$
- (c) $0.30 \angle 88.09^\circ$
- (d) $223.61 \angle -63.43^\circ$
- (e) $86.18 \angle 93.73^\circ$
- (f) $38.69 \angle -94.0^\circ$
- 43. (a) $11.8 + j 7.0$
- (b) $151.90 + j 49.90$
- (c) $4.72 \times 10^{-6} + j 71$
- (d) $5.20 + j 1.60$
- (e) $209.30 + j 311.0$
- (f) $-21.20 + j 12.0$
- (g) $7.03 + j 9.93$
- (h) $95.7 + j 22.77$
- 45. (a) $6.0 \angle -50^\circ$
- (b) $200 \times 10^{-6} \angle 60^\circ$
- (c) $109 \angle -170^\circ$
- (d) $76.47 \angle -80^\circ$ (e) $4 \angle 0^\circ$
- (f) $5.93 \angle -134.47^\circ$
- (g) $4.21 \times 10^{-3} \angle 161.10^\circ$
- (h) $9.30 \angle -43.99^\circ$
- 47. (a) $x = 4, y = 3$ (b) 4
- (c) $x = 3, y = 6$ or $x = 6, y = 3$
- (d) 30°
- 49. (a) $56.57 \sin(377t + 20^\circ)$
- (b) $169.68 \sin(377t + 10^\circ)$
- (c) $11.31 \times 10^{-3} \sin(377t + 120^\circ)$
- (d) $7.07 \sin(377t + 90^\circ)$
- (e) $1696.8 \sin(377t - 50^\circ)$
- (f) $6000 \sin(377t - 180^\circ)$
- 51. $i_1 = 20.88 \times 10^{-6} \sin(\omega t + 76.70^\circ)$
- 53. $i_s = -21.21 \times 10^{-3} \sin 377t$

Chapter 15

- 1. (a) $6.8 \Omega \angle 0^\circ = 6.8$
- (b) $452.4 \Omega \angle 90^\circ = j 452.4 \Omega$
- (c) $15.7 \Omega \angle 90^\circ = j 15.7 \Omega$
- (d) $1 \text{ k}\Omega \angle -90^\circ = -j 1 \text{ k}\Omega$
- (e) $318.47 \Omega \angle -90^\circ = -j 318.47 \Omega$ (f) $220 \Omega \angle 0^\circ = 220 \Omega$
- 3. (a) $v = 88 \times 10^{-3} \sin \omega t$
- (b) $v = 16.98 \sin(1000t + 150^\circ)$
- (c) $v = 254.7 \sin(157t - 50^\circ)$
- 5. (a) $Z_T = 3 \Omega - j 1 \Omega = 3.16 \Omega \angle -18.43^\circ$ (b) $Z_T = 1 \text{ k}\Omega + j 4 \text{ k}\Omega = 4.12 \text{ k}\Omega \angle 75.96^\circ$
- (c) $Z_T = 470 \Omega - j 80 \Omega = 476.76 \Omega \angle -9.66^\circ$
- 7. (a) $10 \Omega \angle 36.87^\circ$
- (c) $I = 10 \text{ A} \angle -36.87^\circ, V_R = 80 \text{ V} \angle -36.87^\circ, V_L = 60 \text{ V} \angle 53.13^\circ$
- (f) 800 W (g) 0.8 lagging
- (h) $v_R = 113.12 \sin(\omega t - 36.87^\circ)$

- $v_L = 84.84 \sin(\omega t + 53.13^\circ)$
- $i = 14.14 \sin(\omega t - 36.87^\circ)$
- 9. (a) $2.34 \text{ k}\Omega \angle -19.89^\circ$
- (b) $6.04 \text{ mA} \angle 19.89^\circ$
- (c) $V_R = 13.29 \text{ V} \angle 19.89^\circ, V_C = 4.81 \text{ V} \angle -70.11^\circ$
- (d) $80.26 \text{ mW}, 0.94$ leading
- 11. (a) $2.16 \text{ k}\Omega \angle 33.69^\circ$ (c) $5.31 \mu\text{F}, 6.37 \text{ H}$
- (d) $I = 1.96 \text{ mA} \angle 26.31^\circ, V_R = 3.53 \text{ V} \angle 26.31^\circ, V_L = 2.68 \text{ V} \angle 116.31^\circ, V_C = 1.18 \text{ V} \angle -63.69^\circ$
- (g) 6.91 mW (h) 0.832 lagging
- (i) $i = 2.77 \times 10^{-3} \sin(\omega t + 26.31^\circ)$
- $v_R = 4.99 \sin(\omega t + 26.31^\circ)$
- $v_L = 3.79 \sin(\omega t + 116.31^\circ)$
- $v_C = 1.67 \sin(\omega t - 63.69^\circ)$
- 13. (a) 40 mH (b) 220Ω
- 15. (a) $V_1 = 29.09 \text{ V} \angle -15.96^\circ, V_2 = 116.36 \text{ V} \angle 74.04^\circ$
- (b) $V_1 = 48.69 \text{ V} \angle 40.75^\circ, V_2 = 26.78 \text{ V} \angle -49.25^\circ$
- 17. (a) $I = 39 \text{ mA} \angle 126.65^\circ, V_R = 1.17 \text{ V} \angle 126.65^\circ, V_C = 25.86 \text{ V} \angle 36.65^\circ$
- (b) 0.058 leading (c) 45.63 mW
- (f) $V_R = 1.17 \text{ V} \angle 126.65^\circ, V_C = 25.84 \text{ V} \angle 36.65^\circ$
- (g) $Z_T = 30 \Omega - j 512.2 \Omega$
- 19. $3.2 \Omega + j 2.4 \Omega$
- 25. (a) $Z_T = 91 \Omega \angle 0^\circ, Y_T = 10.99 \text{ mS} \angle 0^\circ$
- (b) $Z_T = 200 \Omega \angle 90^\circ, Y_T = 5 \text{ mS} \angle -90^\circ$ (c) $Z_T = 0.2 \text{ k}\Omega \angle -90^\circ, Y_T = 5 \text{ mS} \angle 90^\circ$
- (d) $Z_T = 9.86 \Omega \angle 9.46^\circ, Y_T = 0.10 \text{ S} \angle -9.46^\circ$
- (e) $Z_T = 1.90 \Omega \angle -18.43^\circ, Y_T = 0.53 \text{ S} \angle 18.43^\circ$
- (f) $Z_T = 2.94 \text{ k}\Omega \angle 9.55^\circ, Y_T = 0.34 \text{ mS} \angle -9.55^\circ$
- 27. (a) $R = 5.85 \Omega, X_C = 2.13 \Omega$
- (b) $R = 23.26 \text{ k}\Omega, X_C = 4.07 \text{ k}\Omega$
- (c) $R = 80 \text{ k}\Omega, X_L = 46.19 \text{ k}\Omega$
- 29. (a) $Y_T = 0.112 \text{ mS} \angle 26.57^\circ$
- (c) $E = 17.89 \text{ V} \angle -6.57^\circ, I_R = 1.79 \text{ mA} \angle -6.57^\circ, I_C = 0.90 \text{ mA} \angle 83.44^\circ$ (f) 32.04 mW
- (g) 0.894 leading (h) $i_s = 2.83 \times 10^{-3} \sin(\omega t + 20^\circ)$
- $i_R = 2.53 \times 10^{-3} \sin(\omega t - 6.57^\circ)$
- $i_C = 1.27 \times 10^{-3} \sin(\omega t + 83.44^\circ)$
- $e = 25.3 \sin(\omega t - 6.57^\circ)$
- 31. (a) $Y_T = 0.89 \text{ S} \angle -19.81^\circ, Z_T = 1.12 \Omega \angle 19.81^\circ$
- (c) $531 \mu\text{F}, 5.31 \text{ mH}$
- (d) $E = 2.40 \text{ V} \angle 79.81^\circ, I_R = 2.00 \text{ A} \angle 79.81^\circ, I_L = 1.20 \text{ A} \angle -10.19^\circ, I_C = 0.48 \text{ A} \angle 169.81^\circ$ (g) 4.8 W

- (h) 0.941 lagging
- (i) $e = 3.39 \sin(377t + 79.81^\circ)$
- $i_R = 2.83 \sin(377t + 79.81^\circ)$
- $i_L = 1.70 \sin(377t - 10.19^\circ)$
- $i_C = 0.68 \sin(377t + 169.81^\circ)$
- 33. (a) $Y_T = 0.11 \text{ S} \angle 65.77^\circ, Z_T = 9.09 \Omega \angle -65.77^\circ$
- (c) $636.9 \mu\text{F}, 31.8 \text{ mH}$
- (d) $E = 25.03 \text{ V} \angle 60^\circ, I_s = 2.75 \text{ A} \angle 125.77^\circ, I_C = 5 \text{ A} \angle 150^\circ, I_R = 1.14 \text{ A} \angle 60^\circ, I_L = 2.50 \text{ A} \angle -30^\circ$
- (g) 28.59 W (h) 0.409 leading
- (i) $e = 35.4 \sin(314t + 60^\circ)$
- $i_s = 3.89 \sin(314t + 125.77^\circ)$
- $i_C = 7.07 \sin(314t + 150^\circ)$
- $i_R = 1.61 \sin(314t + 60^\circ)$
- $i_L = 3.54 \sin(314t - 30^\circ)$
- 41. (a) $7.02 \text{ k}\Omega - j 2.88 \text{ k}\Omega$
- (b) $17.48 \Omega + j 29.72 \Omega$
- 43. (a) $E = 75.6 \text{ V} \angle -70.11^\circ, I_R = 0.34 \text{ A} \angle -70.11^\circ, I_L = 12.04 \text{ mA} \angle -160.11^\circ$
- (b) 0.340 leading (c) 25.97 W
- (f) $0.47 \text{ A} \angle 19.63^\circ$
- (g) $25.72 \Omega - j 71.08 \Omega$
- 47. (I): (a) v_1 leads v_2 by 72°
- (b) v_1 : p-p = 2.5 V , rms = 0.88 V
- v_2 : p-p = 1.2 V , rms = 0.42 V
- (c) 1.25 kHz
- (II): (a) v_1 leads v_2 by 132°
- (b) v_1 : p-p = 5.6 V , rms = 1.98 V
- v_2 : p-p = 8 V , rms = 2.83 V
- (c) 16.67 kHz

Chapter 16

- 1. (a) $2.33 \Omega \angle 30.96^\circ$
- (b) $5.15 \text{ A} \angle -30.96^\circ$
- (c) $5.15 \text{ A} \angle -30.96^\circ$
- (d) $I_2 = 3.09 \text{ A} \angle -30.96^\circ, I_3 = 2.06 \text{ A} \angle -30.96^\circ$
- (e) $30.9 \text{ V} \angle 59.04^\circ$
- 3. (a) $Z_T = 19.86 \Omega \angle 37.17^\circ, Y_T = 50.35 \text{ mS} \angle -37.17^\circ$
- (b) $3.02 \text{ A} \angle -7.17^\circ$
- (c) $3.98 \text{ A} \angle 82.83^\circ$
- (d) $47.81 \text{ V} \angle -7.17^\circ$
- (e) 167.07 W
- 5. (a) $0.25 \text{ A} \angle -6.34^\circ$
- (b) $70.71 \text{ V} \angle -45^\circ$
- (c) 24.85 W
- 7. (a) $1.42 \text{ A} \angle 18.26^\circ$
- (b) $26.57 \text{ V} \angle 4.76^\circ$
- (c) 54.07 W
- 9. (a) $82.51 \text{ mS} \angle -8.11^\circ$
- (b) $V_1 = 20.4 \text{ V} \angle 30^\circ, V_2 = 10.89 \text{ V} \angle 58.13^\circ$
- (c) $1.93 \text{ A} \angle 11.11^\circ$

11. 32.89 A $\angle 38.89^\circ$
 13. 139.71 mW

Chapter 17

3. (a) $Z = 21.93 \Omega \angle -46.85^\circ$,
 $E = 10.97 \text{ V} \angle 13.15^\circ$
 (b) $Z = 5.15 \Omega \angle 59.04^\circ$,
 $E = 10.30 \text{ V} \angle 179.04^\circ$
 5. (a) 5.15 A $\angle -24.5^\circ$
 (b) 0.44 A $\angle 143.48^\circ$
 7. (a) 13.07 A $\angle -33.71^\circ$
 (b) 48.33 A $\angle -77.57^\circ$
 9. $I_L = -3.17 \times 10^{-3} \text{ V} \angle 137.29^\circ$
 11. $I_{1\text{k}\Omega} = 10 \text{ mA} \angle 0^\circ$,
 $I_{2\text{k}\Omega} = 1.67 \text{ mA} \angle 0^\circ$
 13. 1.38 mA $\angle -56.31^\circ$
 15. (a) $V_1 = 19.86 \text{ V} \angle 43.8^\circ$,
 $V_2 = 8.94 \text{ V} \angle 106.9^\circ$
 (b) $V_1 = 19.78 \text{ V} \angle 132.48^\circ$,
 $V_2 = 13.37 \text{ V} \angle 98.78^\circ$
 17. $V_1 = 100 \text{ V} \angle 90^\circ$, $V_2 =$
 $96.66 \text{ V} \angle -12.43^\circ$, $V_3 = 0 \text{ V} \angle 0^\circ$
 19. $V_1 = 14.62 \text{ V} \angle -5.86^\circ$,
 $V_2 = 35.03 \text{ V} \angle -37.69^\circ$
 $V_3 = 32.4 \text{ V} \angle -73.34^\circ$,
 $V_4 = 5.67 \text{ V} \angle 23.53^\circ$
 21. $V_{1\text{k}\Omega} = 2.25 \text{ V} \angle 17.63^\circ$
 23. $V_{2\text{k}\Omega} = 10.67 \text{ V} \angle 180^\circ$
 25. $V_L = -2451.92 E_i$
 27. (a) no (b) 1.76 mA $\angle -71.54^\circ$
 (c) 7.03 V $\angle -18.46^\circ$
 29. yes
 31. $L_x = R_2 L_3 / R_1$
 33. (a) 11.57 A $\angle -67.13^\circ$
 (b) 36.9 A $\angle 23.87^\circ$

Chapter 18

1. (a) 6.09 A $\angle -32.12^\circ$
 (b) 3.77 A $\angle -93.8^\circ$
 3. $0.5 + 1.58 \sin(\omega t - 26.57^\circ)$
 5. 6.26 mA $\angle -63.43^\circ$
 7. $-22.09 \text{ V} \angle 6.34^\circ$
 9. 19.62 V $\angle 53^\circ$
 11. 10 V $\angle 0^\circ$
 13. (a) $E_{Th} = 2.13 \text{ V} \angle 32.2^\circ$,
 $Z_{Th} = 21.31 \Omega \angle 32.2^\circ$
 (b) $E_{Th} = 57.95 \text{ V} \angle 11.10^\circ$,
 $Z_{Th} = 6.81 \Omega \angle -54.23^\circ$
 15. (a) $E_{Th} = 4 \text{ V} + 10 \text{ V} \angle 0^\circ$,
 $Z_{Th} = 4 \Omega \angle 90^\circ$
 (b) $0.5 + 1.58 \sin(\omega t - 26.57^\circ)$
 17. (a) $E_{Th} = 31.31 \text{ V} \angle -26.57^\circ$,
 $Z_{Th} = 4.47 \text{ k}\Omega \angle -26.57^\circ$
 (b) 6.26 mA $\angle 63.44^\circ$
 19. $E_{Th} = -444.45 \times 10^3 \text{ I} \angle 0.26^\circ$,
 $Z_{Th} = 4.44 \text{ k}\Omega \angle -0.03^\circ$
 21. $E_{Th} = -50 \text{ V} \angle 0^\circ$,
 $Z_{Th} = 5.10 \text{ k}\Omega \angle -11.31^\circ$
 23. $E_{Th} = 20 \text{ V} \angle 53^\circ$,
 $Z_{Th} = -39.22 \Omega \angle 0^\circ$

25. $E_{Th} = 1.62 \text{ V} \angle 0^\circ$,
 $Z_{Th} = 607.42 \Omega \angle 0^\circ$
 27. (a) $I_N = 0.1 \text{ A} \angle 0^\circ$,
 $Z_N = 21.31 \Omega \angle 32.2^\circ$
 (b) $I_N = 8.51 \text{ A} \angle 65.32^\circ$,
 $Z_N = 6.81 \Omega \angle -54.23^\circ$
 29. (a) $I_N = 2.15 \text{ A} \angle -42.87^\circ$,
 $Z_N = 9.66 \Omega \angle 14.93^\circ$
 (b) $I_N = 22.83 \text{ A} \angle -34.65^\circ$,
 $Z_N = 4.37 \Omega \angle 55.67^\circ$
 31. (a) $I_N = 1.33 \text{ A} + 2.67 \text{ A} \angle 0^\circ$,
 $Z_N = 9 \Omega \angle 0^\circ$
 (b) 12 V + 2.65 V $\angle -83.66^\circ$
 33. $I_N = -1.96 \times 10^{-3} \text{ V} \angle 11.31^\circ$,
 $Z_N = 5.1 \text{ k}\Omega \angle -11.31^\circ$
 35. $I_N = 9.81 \text{ mA} \angle 11.31^\circ$,
 $Z_N = 5.1 \text{ k}\Omega \angle -11.31^\circ$
 37. $I_N = 0.79 \text{ mA} \angle 0^\circ$,
 $Z_N = 6.63 \text{ k}\Omega \angle 0^\circ$
 39. (a) $Z_L = 8.32 \Omega \angle 3.18^\circ$,
 1198.2 W (b) $Z_L =$
 $1.56 \Omega \angle 14.47^\circ$, 1.61 W
 41. 40 k Ω , 25 W
 43. (a) 9 Ω (b) 20 W
 45. (a) 1.41 k Ω (b) 516.53 mW
 49. 25.77 mA $\angle 104.4^\circ$

Chapter 19

1. (a) 120 W (b) $Q_T = 0 \text{ VAR}$,
 $S_T = 120 \text{ VA}$ (c) 0.5 A
 (d) 20 W: 720 Ω , 40 W: 360 Ω
 (e) $I_1 = 0.17 \text{ A}$, $I_2 = 0.33 \text{ A}$
 3. (a) $P_T = 400 \text{ W}$, $Q_T =$
 -400 VAR (C), $S_T = 565.69 \text{ VA}$,
 $F_p = 0.707$ leading
 (c) 5.66 A $\angle 135^\circ$
 5. (a) $P_T = 500 \text{ W}$, $Q_T =$
 -200 VAR (C), $S_T = 538.52 \text{ VA}$
 (b) $F_p = 0.928$ leading
 (d) 10.78 A $\angle 21.88^\circ$
 7. (a) R: 200 W, L: 0 W, C: 0 W
 (b) R: 0 VAR, L: 100 VAR, C:
 80 VAR (c) R: 200 VA, L: 100
 VAR, C: 80 VA (d) $P_T = 200 \text{ W}$,
 $Q_T = 20 \text{ VAR}$ (L), $S_T = 200 \text{ VA}$,
 $F_p = 0.995$ lagging
 (f) 10.05 A $\angle -5.73^\circ$
 9. (a-c) L: 0 W, 126.74 VAR,
 126.74 VA, C: 0 W, 46.92 VAR,
 46.92 VA, R: 38.99 W, 0 VAR,
 38.99 VA (d) $P_T = 38.99 \text{ W}$,
 $Q_T = 79.82 \text{ VAR}$ (L),
 $S_T = 88.83 \text{ VA}$, $F_p = 0.439$
 lagging (f) $W_R = 0.31 \text{ J}$
 (g) $W_L = 0.32 \text{ J}$, $W_C = 0.12 \text{ J}$
 11. (a) $Z = 2.30 \Omega + j 1.73 \Omega$
 (b) 4000 W
 13. (a) $P_T = 900 \text{ W}$, $Q_T = 0 \text{ VAR}$,
 $S_T = 900 \text{ VA}$, $F_p = 1$
 (b) 9 A $\angle 0^\circ$ (d) Z_1 : $X_C = 20 \Omega$,

- Z_2 : $R = 2.83 \Omega$, Z_3 : $R = 5.66 \Omega$,
 $X_L = 4.72 \Omega$
 15. (a) $P_T = 1100 \text{ W}$, $Q_T =$
 2366.26 VAR , $S_T = 2609.44 \text{ VA}$,
 $F_p = 0.422$ leading
 (b) 521.89 V $\angle -65.07^\circ$
 (c) Z_1 : $R = 1743.38 \Omega$,
 $X_C = 1307.53 \Omega$, Z_2 : $R = 43.59 \Omega$,
 $X_C = 99.88 \Omega$
 17. (a) 7.81 kVA (b) 0.640 lagging
 (c) 65.08 A (d) 1105 μF
 (e) 41.67 A
 19. (a) 128.14 W (b) a-b: 42.69 W,
 b-c: 64.03 W, a-c: 106.72 W,
 a-d: 106.72 W, c-d: 0 W,
 d-e: 0 W, f-e: 21.34 W
 21. (a) $R = 5 \Omega$, 132.03 mH
 (b) 10 Ω (c) 15 Ω , 262.39 mH

Chapter 20

1. (a) $\omega_s = 250 \text{ rad/s}$, $f_s = 39.79 \text{ Hz}$
 (b) $\omega_s = 3535.53 \text{ rad/s}$,
 $f_s = 562.7 \text{ Hz}$
 (c) $\omega_s = 21,880 \text{ rad/s}$,
 $f_s = 3482.31 \text{ Hz}$
 3. (a) 40 Ω (b) 10 mA
 (c) $V_R = 20 \text{ mV}$, $V_L = 400 \text{ mV}$,
 $V_C = 400 \text{ mV}$ (d) 20 (high)
 (e) 1.27 mH, 795.77 nF
 (f) 250 Hz
 (g) 4.88 kHz, 5.13 kHz
 5. (a) 400 Hz (b) 5800 Hz,
 6200 Hz (c) 45 Ω
 (d) 375 mW
 7. (a) 10 (b) 20 Ω (c) 1.59 mH,
 3.98 μF (d) 1900 Hz, 2100 Hz
 9. $R = 10 \Omega$, $L = 13.26 \text{ mH}$,
 $C = 27.07 \text{ nF}$, 8340 Hz, 8460 Hz
 11. (a) 1 MHz (b) 160 kHz
 (c) $R = 720 \Omega$, $L = 0.716 \text{ mH}$,
 $C = 35.37 \text{ pF}$ (d) 56.25 Ω
 13. (a) 159.16 kHz (b) 4 V
 (c) 40 mA (d) 20
 15. (a) 11,253.95 Hz (b) 1.77 (no)
 (c) $f_p = 9,280.24 \text{ Hz}$,
 $f_m = 10,794.41 \text{ Hz}$
 (d) $X_L = 5.83 \Omega$, $X_C = 8.57 \Omega$,
 $X_C > X_L$ (e) 12.5 Ω (f) 25 mV
 (g) $Q_p = 1.46$, $BW = 6.36 \text{ kHz}$
 (h) $I_C = 2.92 \text{ mA}$, $I_L = 3.54 \text{ mA}$
 17. (a) 30 Ω (b) 225 Ω
 (c) $I_C = 0.6 \text{ A} \angle 90^\circ$, $I_L \cong$
 $0.6 \text{ A} \angle -86.19^\circ$ (d) $L =$
 0.239 mH , $C = 265.26 \text{ nF}$
 (e) $Q_p = 7.5$, $BW = 2.67 \text{ kHz}$
 19. (a) $f_s = 7.12 \text{ kHz}$, $f_p = 6.65 \text{ kHz}$,
 $f_m = 7 \text{ kHz}$, low Q_p
 (b) $X_L = 20.88 \Omega$, $X_C = 23.94 \Omega$
 (c) 55.56 Ω (d) $Q_p = 2.32$,
 $BW = 2.87 \text{ kHz}$

- (e) $I_C = 92.73 \text{ mA}$, $I_L = 99.28 \text{ mA}$
 (f) 2.22 V
21. (a) 3558.81 Hz (b) 138.2 V
 (c) 691 mW (d) 575.86 Hz
23. (a) 98.54 Ω (b) 8.21
 (c) 8.05 kHz (d) 4.83 V
 (e) $f_1 = 7.55 \text{ kHz}$, $f_2 = 8.55 \text{ kHz}$
25. $R_s = 3.24 \text{ k}\Omega$, $C = 31.66 \text{ nF}$
27. (a) 251.65 kHz, (b) 4.44 k Ω
 (c) 14.05, (d) 17.91 kHz
 (e) **a:** 251.65 kHz, **b:** 49.94 Ω ,
c: 2.04, **d:** 95.55 kHz
 (f) **a:** 251.65 kHz, **b:** 13.33 k Ω ,
c: 21.08, **d:** 11.94 kHz
 (g) Network: 100×10^3 , **part (e):**
 1×10^3 , **part (f):** 400×10^3
 (h) As L/C increased, BW
 decreased

Chapter 21

1. (a) 1.54 kHz, 5.62 kHz
 (b) 0.22 V, 0.52 V
3. (a) 1000 (b) 10^{12} (c) 1.59
 (d) 1.1 (e) 10^{10} (f) 1513.56
 (g) 10.02 (h) 1,258,925.41
5. 1.68
 7. -0.30
9. (a) 1.85 bels (b) 18.45 bels
11. 13.01 dB
13. 38.49 dB_v
15. 24.08 dB_v
19. (a) $f_c: 0.707$, $0.1f_c: 0.995$, $0.5f_c:$
 0.894 , $2f_c: 0.447$, $10f_c: 0.0995$
 (b) $f_c: -45^\circ$, $0.1f_c: -5.71^\circ$,
 $0.5f_c: -26.57^\circ$, $2f_c: -63.43^\circ$,
 $10f_c: -84.29^\circ$
21. $C = 0.265 \mu\text{F}$
23. (a) $f_c: 0.707$, $2f_c: 0.894$, $0.5f_c:$
 0.447 , $10f_c: 0.995$, $0.1f_c: 0.0995$
 (b) $f_c: 45^\circ$, $2f_c: 26.57^\circ$, $0.5f_c:$
 63.43° , $10f_c: 5.71^\circ$, $0.1f_c: 84.29^\circ$
25. $R = 797 \Omega$
27. (a) low-pass: $f_{c1} = 795.77 \text{ Hz}$,
 high-pass: $f_{c2} = 1989.44 \text{ Hz}$
 (b) $f_c = 1940 \text{ Hz}$, $BW \cong 2.9 \text{ kHz}$
29. (a) 100.66 kHz (b) $Q_s = 18.39$,
 $BW = 5.473.52 \text{ Hz}$ (d) $f_s: 0.93 \text{ V}$,
 $f_1: 0.66 \text{ V}$, $f_2: 0.66 \text{ V}$
31. (a) 12.2 (b) $BW = 409.84 \text{ Hz}$,
 $f_1 = 4.80 \text{ kHz}$, $f_2 = 5.20 \text{ kHz}$
 (d) little change
33. (a) $f_p = 726.44 \text{ kHz}$ (band-stop),
 $f = 2.01 \text{ MHz}$ (pass-band)
35. (a-b) $f_c = 772.55 \text{ Hz}$
 (c) $f_c: -3 \text{ dB}$, $0.5f_c: -7 \text{ dB}$,
 $2f_c: -0.969 \text{ dB}$, $0.1f_c: -20.04 \text{ dB}$,
 $10f_c: -0.043 \text{ dB}$ (d) $f_c: 0.707$,
 $0.5f_c: 0.447$, $2f_c: 0.894$ (e) $f_c: 45^\circ$,
 $0.5f_c: 63.43^\circ$, $2f_c: 26.57^\circ$

37. (a-b) $f_c = 13.26 \text{ kHz}$
 (c) $f_c: -3 \text{ dB}$, $0.5f_c: -0.97 \text{ dB}$,
 $2f_c: -6.99 \text{ dB}$, $0.1f_c: -0.04 \text{ dB}$,
 $10f_c: -20.04 \text{ dB}$ (d) $f_c: 0.707$,
 $0.5f_c: 0.894$, $2f_c: 0.447$
 (e) $f_c: -45^\circ$, $0.5f_c: -26.57^\circ$,
 $2f_c: -63.43^\circ$
39. (a) $f_1 = 663.15 \text{ Hz}$, $f_c = 468.1 \text{ Hz}$
 (b) $f_1: 45^\circ$, $f_c: 54.78^\circ$, $2f_1: 26.57^\circ$,
 $10f_1: 5.71^\circ$
41. (a) $f_1 = 19,894.37 \text{ Hz}$,
 $f_c = 1,989.44 \text{ Hz}$
 (b) $f_1: -39.29^\circ$, $f_c: -39.29^\circ$,
 $10 \text{ kHz}: -52.06^\circ$
43. (a) $f_1 = 964.58 \text{ Hz}$,
 $f_c = 7,334.33 \text{ Hz}$ (b) $f_1: 37.51^\circ$,
 $f_c: 37.51^\circ$, $1.3 \text{ kHz}: 43.38^\circ$
45. (a) $f = 180 \text{ Hz}: A_{v_{dB}} \cong -3 \text{ dB}$,
 $f = 18 \text{ kHz}: A_{v_{dB}} = -3.105 \text{ dB}$
 (b) $f = 180 \text{ Hz}: \cong 90^\circ$,
 $f = 1.8 \text{ kHz}: \cong 0^\circ$,
 $f = 18 \text{ kHz}: \cong -90^\circ$
47. $A_v = \frac{-120}{[1 - j\frac{50}{f}][1 - j\frac{200}{f}][1 + j\frac{f}{36\text{kHz}}]}$
49. $f_c = 2 \text{ kHz}$
51. $f_1 = 1 \text{ kHz}: A_{v_{dB}} = 3.06 \text{ dB}$,
 $f_2 = 2 \text{ kHz}: A_{v_{dB}} = 6.81 \text{ dB}$,
 $f_3 = 3 \text{ kHz}: A_{v_{dB}} = 9.1 \text{ dB}$
53. (a) Woofer: 400 Hz: $A_v = 0.673$
 Tweeter: 5 kHz: $A_v = 0.678$
 (b) Woofer: 3 kHz: $A_v = 0.015$
 Tweeter: 3 kHz: $A_v = 0.337$
 (c) mid-range: 3 kHz: $A_v = 0.998$

Chapter 22

1. (a) 0.2 H (b) $e_p = 1.6 \text{ V}$,
 $e_s = 5.12 \text{ V}$ (c) $e_p = 15 \text{ V}$,
 $e_s = 24 \text{ V}$
3. (a) 158.02 mH (b) $e_p = 24 \text{ V}$,
 $e_s = 1.8 \text{ V}$ (c) $e_p = 15 \text{ V}$,
 $e_s = 24 \text{ V}$
5. (a) 3.13 V (b) 391.02 μWb
7. 56.31 Hz
9. 400 Ω
11. 12,000 turns
13. (a) 3 (b) 2.78 W
15. (a) 360.56 $\Omega \angle 86.82^\circ$
 (b) 332.82 mA $\angle -86.82^\circ$
 (c) $V_{R_e} = 6.66 \text{ V} \angle -36.82^\circ$,
 $V_{X_c} = 13.31 \text{ V} \angle 3.18^\circ$,
 $V_{X_L} = 106.50 \text{ V} \angle 3.18^\circ$
19. 1.35 H
21. $\mathbf{I}_1(\mathbf{Z}_{R_1} + \mathbf{Z}_{L_1}) + \mathbf{I}_2(\mathbf{Z}_m) = \mathbf{E}_1$
 $\mathbf{I}_1(\mathbf{Z}_m) + \mathbf{I}_2(\mathbf{Z}_{L_2} + \mathbf{Z}_{R_1}) = 0$
 $\mathbf{X}_m = -\omega M \angle 90^\circ$

23. (a) 20 (b) 83.33 A (c) 4.17 A
 (d) **a:** 0.05, **b:** 4.17 A, **c:** 83.33 A
25. (a) $V_L = 25 \text{ V} \angle 0^\circ$, $\mathbf{I}_s = 5 \text{ A} \angle 0^\circ$
 (b) 80 $\Omega \angle 0^\circ$ (c) 20 $\Omega \angle 0^\circ$
27. (a) $\mathbf{E}_2 = 40 \text{ V} \angle 60^\circ$, $\mathbf{I}_2 =$
 $3.33 \text{ A} \angle 60^\circ$, $\mathbf{E}_3 = 30 \text{ V} \angle 60^\circ$,
 $\mathbf{I}_3 = 3 \text{ A} \angle 60^\circ$ (b) 64.52 Ω

Chapter 23

1. (a) 120.1 V (b) 120.1 V
 (c) 12.01 A (d) 12.01 A
3. (a) 120.1 V (b) 120.1 V
 (c) 16.98 A (d) 16.98 A
5. (a) $\theta_2 = -120^\circ$, $\theta_3 = +120^\circ$
 (b) $\mathbf{V}_{an} = 120 \text{ V} \angle 0^\circ$, $\mathbf{V}_{bn} =$
 $120 \text{ V} \angle -120^\circ$, $\mathbf{V}_{cn} =$
 $120 \text{ V} \angle 120^\circ$
 (c) $\mathbf{I}_{an} = 8 \text{ A} \angle -53.13^\circ$,
 $\mathbf{I}_{bn} = 8 \text{ A} \angle -173.13^\circ$,
 $\mathbf{I}_{cn} = 8 \text{ A} \angle 66.87^\circ$ (e) 8 A
 (f) 207.85 V
7. $V_\phi = 127.0 \text{ V}$, $\mathbf{I}_\phi = 8.98 \text{ A}$,
 $\mathbf{I}_L = 8.98 \text{ A}$
9. (a) $\mathbf{E}_{AN} = 12.7 \text{ kV} \angle -30^\circ$,
 $\mathbf{E}_{BN} = 12.7 \text{ kV} \angle -150^\circ$,
 $\mathbf{E}_{CN} = 12.7 \text{ kV} \angle 90^\circ$
 (b-c) $\mathbf{I}_{an} = \mathbf{I}_{Aa} =$
 $11.29 \text{ A} \angle -97.54^\circ$, $\mathbf{I}_{bn} = \mathbf{I}_{Bb} =$
 $11.29 \text{ A} \angle -217.54^\circ$, $\mathbf{I}_{cn} = \mathbf{I}_{Cc} =$
 $11.29 \text{ A} \angle 22.46^\circ$ (d) $\mathbf{V}_{an} =$
 $12.16 \text{ kV} \angle -29.34^\circ$, $\mathbf{V}_{bn} =$
 $12.16 \text{ kV} \angle -149.34^\circ$, $\mathbf{V}_{cn} =$
 $12.16 \text{ kV} \angle 90.66^\circ$
11. (a) 120.1 V (b) 208 V
 (c) 13.36 A (d) 23.15 A
13. (a) $\theta_2 = -120^\circ$, $\theta_3 = +120^\circ$
 (b) $\mathbf{V}_{ab} = 208 \text{ V} \angle 0^\circ$,
 $\mathbf{V}_{bc} = 208 \text{ V} \angle -120^\circ$,
 $\mathbf{V}_{ca} = 208 \text{ V} \angle 120^\circ$
 (d) $\mathbf{I}_{ab} = 9.46 \text{ A} \angle 0^\circ$,
 $\mathbf{I}_{bc} = 9.46 \text{ A} \angle -120^\circ$,
 $\mathbf{I}_{ca} = 9.46 \text{ A} \angle 120^\circ$
 (e) 16.38 A (f) 120.1 V
15. (a) $\theta_2 = -120^\circ$, $\theta_3 = +120^\circ$
 (b) $\mathbf{V}_{ab} = 208 \text{ V} \angle 0^\circ$, $\mathbf{V}_{bc} =$
 $208 \text{ V} \angle -120^\circ$,
 $\mathbf{V}_{ca} = 208 \text{ V} \angle 120^\circ$
 (d) $\mathbf{I}_{ab} = 86.67 \text{ A} \angle -36.87^\circ$,
 $\mathbf{I}_{bc} = 16.67 \text{ A} \angle -156.87^\circ$
 $\mathbf{I}_{ca} = 86.67 \text{ A} \angle 83.13^\circ$
 (e) 150.11 A (f) 120.1 V
17. (a) $\mathbf{I}_{ab} = 15.33 \text{ A} \angle -73.30^\circ$,
 $\mathbf{I}_{bc} = 15.33 \text{ A} \angle -193.30^\circ$,
 $\mathbf{I}_{ca} = 15.33 \text{ A} \angle 46.7^\circ$
 (b) $\mathbf{I}_{Aa} = 26.55 \text{ A} \angle -103.30^\circ$,
 $\mathbf{I}_{Bb} = 26.55 \text{ A} \angle 136.70^\circ$,
 $\mathbf{I}_{Cc} = 26.55 \text{ A} \angle 16.70^\circ$
 (c) $\mathbf{E}_{AB} = 17.01 \text{ kV} \angle -0.59^\circ$,
 $\mathbf{E}_{BC} = 17.01 \text{ kV} \angle -120.59^\circ$,
 $\mathbf{E}_{CA} = 17.01 \text{ kV} \angle 119.41^\circ$

19. (a) 208 V (b) 120.09 V
(c) 7.08 A (d) 7.08 A
21. $V_\phi = 69.28$ V, $I_\phi = 2.89$ A,
 $I_L = 2.89$ A
23. $V_\phi = 69.28$ V, $I_\phi = 5.77$ A,
 $I_L = 5.77$ A
25. (a) 440 V (b) 440 V
(c) 29.33 A (d) 50.8 A
27. (a) $\theta_2 = -120^\circ$, $\theta_3 = +120^\circ$
(b) $V_{ab} = 100$ V $\angle 0^\circ$, $V_{bc} = 100$ V $\angle -120^\circ$, $V_{ca} = 100$ V $\angle 120^\circ$
(d) $I_{ab} = 5$ A $\angle 0^\circ$, $I_{bc} = 5$ A $\angle -120^\circ$, $I_{ca} = 5$ A $\angle 120^\circ$
(e) 8.66 A
29. (a) $\theta_2 = -120^\circ$, $\theta_3 = +120^\circ$
(b) $V_{ab} = 100$ V $\angle 0^\circ$, $V_{bc} = 100$ V $\angle -120^\circ$, $V_{ca} = 100$ V $\angle 120^\circ$
(d) $I_{ab} = 7.07$ A $\angle 45^\circ$,
 $I_{bc} = 7.07$ A $\angle -75^\circ$, $I_{ca} = 7.07$ A $\angle 165^\circ$ (e) 12.25 A
31. $P_T = 2160$ W, $Q_T = 0$ VAR,
 $S_T = 2160$ VA, $F_p = 1$
33. $P_T = 7210.67$ W,
 $Q_T = 7210.67$ VAR (C),
 $S_T = 10,197.42$ VA, $F_p = 0.707$ (leading)
35. $P_T = 7.26$ kW, $Q_T = 7.26$ kVAR
(L), $S_T = 10.27$ kVA, $F_p = 0.707$ (lagging)
37. $P_T = 287.93$ W, $Q_T = 575.86$ VAR (L), $S_T = 643.83$ VA,
 $F_p = 0.447$ (lagging)
39. $P_T = 900$ W, $Q_T = 1200$ VAR (L),
 $S_T = 1500$ VA, $F_p = 0.6$ (lagging)
41. $12.98 \Omega -j 7.31 \Omega$
43. (a) 9,237.6 V (b) 80 A
(c) 1276.8 kW (d) 0.576 lagging

- (e) $I_{Aa} = 80$ A $\angle -54.83^\circ$
(f) $V_{an} = 7773.45$ V $\angle -4.87^\circ$
(g) $62.52 \Omega + j 74.38 \Omega$
(h) System: 0.576 lagging; Load: 0.643 lagging (i) 93.98%
45. (b) $P_T = 5899.64$ W,
 $P_{\text{meter}} = 1966.55$ W
49. (a) 120.09 V (b) $I_{an} = 8.49$ A,
 $I_{bn} = 7.08$ A, $I_{cn} = 42.47$ A
(c) $P_T = 4.93$ kW, $Q_T = 4.93$ kVAR (L), $S_T = 6.97$ kVA,
 $F_p = 0.707$ (lagging)
(d) $I_{an} = 8.49$ A $\angle -75^\circ$,
 $I_{bn} = 7.08$ A $\angle -195^\circ$,
 $I_{cn} = 42.47$ A $\angle 45^\circ$
(e) 35.09 A $\angle -43.00^\circ$

Chapter 24

1. (a) positive-going (b) 2 V
(c) 0.2 ms (d) 6 V (e) 6.5%
3. (a) positive-going (b) 10 mV
(c) 3.2 ms (d) 20 mV
(e) 6.9%
5. $V_2 = 13.58$ mV
7. (a) $120 \mu\text{s}$ (b) 8.33 kHz
(c) maximum: 440 mV
minimum: 80 mV
9. prf = 125 kHz
Duty cycle = 62.5%
11. (a) $8 \mu\text{s}$ (b) $2 \mu\text{s}$ (c) 125 kHz
(d) 0 V (e) 3.46 mV
13. 18.88 mV
15. 117 mV
17. $v_C = 4$ V $(1 - e^{-t/20\text{ms}})$
19. $i_C = -8$ mA e^{-t}
21. $i_C = 4$ mA $e^{-t/0.2\text{ms}}$

23. $0 \rightarrow \frac{1}{2}T: v_C = 20$ V,
 $\frac{1}{2}T \rightarrow T: v_C = 20$ V $e^{-t/0.2\text{ms}}$,
 $T \rightarrow \frac{3}{2}T: v_C = 20$ V $(1 - e^{-t/0.2\text{ms}})$
 $\frac{3}{2}T \rightarrow 2T: v_C = 20$ V $e^{-t/0.2\text{ms}}$,
25. $V_{\text{scope}} = 10$ V $\angle 0^\circ$,
 $\theta_{z_S} = \theta_{z_P} = -59.5^\circ$

Chapter 25

1. (I): (a) no (b) no (c) yes
(d) no (e) yes
(II): (a) yes (b) yes (c) yes
(d) yes (e) no
(III): (a) yes (b) yes (c) no
(d) yes (e) yes
(IV): (a) no (b) no (c) yes
(d) yes (e) yes
7. (a) 19.04 V (b) 4.53 A
9. 71.87 W
11. (a) $2 + 2.08 \sin(400t - 33.69^\circ) + 0.5 \sin(800t - 53.13^\circ)$
(b) 2.51 A (c) 24 +
 $24.96 \sin(400t - 33.69^\circ) + 6 \sin(800t - 53.13^\circ)$ (d) 30.09 V
(e) $16.64 \sin(400t + 56.31^\circ) + 8 \sin(800t + 36.87^\circ)$ (f) 13.06 V
(g) 75.48 W
13. (a) $1.2 \sin(400t + 53.13^\circ)$
(b) 0.85 A (c) $18 \sin(400t + 53.13^\circ)$ (d) 12.73 V
(e) $18 + 23.98 \sin(400t - 36.87^\circ)$
(f) 24.73 V (g) 10.79 W
15. $2.26 \times 10^{-3} \sin(377t + 93.66^\circ) + 1.92 \times 10^{-3} \sin(754t + 1.64^\circ)$
17. $30 + 30.27 \sin(20t + 7.59^\circ) + 0.5 \sin(40t - 30^\circ)$

