

# Apéndice H

## RESPUESTAS A PROBLEMAS DE NUMERACIÓN IMPARES SELECCIONADOS

### Capítulo 1

5. 3 h  
7. CGS  
9. MKS = CGS = 20°C  
K = SI = 293.15  
11. 45.72 cm  
13. (a)  $15 \times 10^3$  (b)  $30 \times 10^{-3}$   
(c)  $7.4 \times 10^6$  (d)  $6.8 \times 10^{-6}$   
(e)  $402 \times 10^{-6}$  (f)  $200 \times 10^{-12}$   
15. (a)  $10^4$  (b) 10  
(c)  $10^9$  (d)  $10^{-2}$   
(e) 10 (f)  $10^{31}$   
17. (a)  $10^{-1}$  (b)  $10^{-4}$   
(c)  $10^9$  (d)  $10^{-9}$   
(e)  $10^{42}$  (f)  $10^3$   
19. (a)  $10^6$  (b)  $10^{-2}$   
(c)  $10^{12}$  (d)  $10^{-63}$   
21. (a)  $10^{-6}$  (b)  $10^{-3}$   
(c)  $10^{-8}$  (d)  $10^9$   
(e)  $10^{-16}$  (f)  $10^{-1}$   
23. (a) 0.006 (b) 400  
(c) 5000, 5, 0.005  
(d) 0.0003, 0.3, 300  
25. (a) 90 s (b) 144 s  
(c)  $50 \times 10^3$   $\mu$ s  
(d) 160 mm (e) 120 ns  
(f) 41,898 días (g) 1.02 m  
27. (a) 2.54 m (b) 1.219 m  
(c) 26.7 N (d) 0.1348 libras  
(e) 4921.26 pies  
(f) 3.2187 m (g) 8530.17 yardas  
29.  $670.62 \times 10^6$  mph  
31. 2.045 s  
33. 67.06 días  
35. \$900  
37. 345.6 m  
39. 47.29 min/milla  
41. (a)  $4.74 \times 10^{-3}$  Btu  
(b)  $7.098 \times 10^{-4}$  m<sup>3</sup>  
(c)  $1.2096 \times 10^5$  s  
(d) 2113.38 pintas  
43. 5.000  
45. 2.949

### Capítulo 2

3. (a) 18 mN (b) 2 mN  
(c) 180  $\mu$ N  
7. (a) 72 mN  
(b)  $Q_1 = 20 \mu$ C,  $Q_2 = 40 \mu$ C  
9. 3.1 A  
11. 90 C

13. 0.5 A  
15.  $1.194 \text{ A} > 1 \text{ A}$  (sí)  
17. (a) 1.248 millones  
(b) 0.936 millones, sol. = (a)  
19. 252 J  
21. 4 C  
23. 3.533 V  
25. 5 A  
27. 25 h  
29. 0.773 h  
31.  $60 \text{ Ah} : 40 \text{ Ah} = 1.5 : 1$ , 50% más con  
60 Ah  
33. 545.45 mA, 129.6 kJ  
43. 600 °C
- Capítulo 3**
1. (a) 500 mils (b) 10 mils  
(c) 4 mils (d) 1000 mils  
(e) 240 mils (f) 3.937 mils  
3. (a) 0.04 pulg (b) 0.03 pulg  
(c) 0.2 pulg (d) 0.025 pulg  
(e) 0.00278 pulg (f) 0.009 pulg  
5. 73.33  $\Omega$   
7. 3.581 pies  
9. (a)  $R_{\text{plata}} > R_{\text{cobre}} > R_{\text{aluminio}}$   
(b) plata 9.9  $\Omega$ ,  
cobre 1.037  $\Omega$ ,  
aluminio 0.34  $\Omega$   
11. (a)  $21.71 \mu\Omega$  (b)  $35.59 \mu\Omega$   
(c) se incrementa (d) disminuye  
13. 942.28 m $\Omega$   
15. (a) #8: 1.1308  $\Omega$ , #18: 11.493  $\Omega$   
(b) #18: #8 =  $10.164 : 1 \cong 10 : 1$   
#18: #8 =  $1 : 10.164 \cong 1 : 10$   
17. (a) 1.087 mA/CM  
(b) 1.384 kA/pulg<sup>2</sup>  
(c) 3.6127 pulg<sup>2</sup>  
19. (a)  $21.71 \mu\Omega$  (b)  $35.59 \mu\Omega$   
21. 0.15 pulg  
23. 2.409  $\Omega$   
25. 3.67  $\Omega$   
27. 0.046  $\Omega$   
29. (a)  $40.29^\circ\text{C}$  (b)  $-195.61^\circ\text{C}$   
31. (a)  $\alpha_{20} \cong 0.00393$   
(b)  $83.61^\circ\text{C}$   
33. 1.751  $\Omega$   
35. 142.86  
41.  $\sim 30^\circ\text{C}$ : 10.2 k $\Omega$   
 $100^\circ\text{C}$ : 10.15 k $\Omega$   
43. 6.5 k $\Omega$   
47. (a) Rojo Rojo Café Plata  
(b) Amarillo Violeta Rojo Plata

- (c) Azul Gris Naranja Plata  
(d) Blanco Café Verde Plata  
49. Sí  
51. (a) 0.1566 S (b) 0.0955 S  
(c) 0.0219 S  
57. (a)  $10 \text{ pc}$ : 3 k $\Omega$  100 pc: 0.4 k $\Omega$   
(b) negativo (c) escalas no  
logarítmicas  
(d)  $\sim 321.43 \Omega/\text{pc}$

### Capítulo 4

1. 15 V  
3. 4 k $\Omega$   
5. 72 mV  
7. 54.55  $\Omega$   
9. 28.571  $\Omega$   
11. 1.2 k $\Omega$   
13. (a) 12.632  $\Omega$  (b) 4.1 MJ  
17. 800 V  
19. 1 W  
21. (a) 57,600 J  
(b)  $16 \times 10^{-3}$  kWh  
23. 2 s  
25. 196  $\mu$ W  
27. 4 A  
29. 9.61 V  
31. 0.833 A, 144.06  $\Omega$   
33. (a) 0.133 mA (b) 66.5 mAh  
35. (c)  $\cong 70.7$  mA  
37. (a) 12 kW  
(b)  $10,130 \text{ W} < 12,000 \text{ W}$  (sí)  
39. 16.34 A  
41. (a) 238 W (b) 17.36%  
43. (a) 1657.78 W  
(b) 15.07 A  
(c) 19.38 A  
45. 65.25%  
47. 80%  
49. (a) 17.9%  
(b) 76.73%, incremento del 328.66%  
51. (a) 1350 J  
(b)  $P$  se duplica,  $P$  es el mismo  
53. 6.67 h  
55. (a) 50 kW (b) 240.38 A  
(c) 90 kWh  
57. \$2.19
- Capítulo 5**
1. (a)  $20 \Omega$ , 3 A  
(b)  $1.63 \text{ M}\Omega$ ,  $6.135 \mu$ A  
(c)  $110 \Omega$ , 318.2 mA  
(d) 10 k $\Omega$ , 12 mA

3. (a) 16 V (b) 4.2 V  
 5. (a) 0.388 A (CW)  
 (b) 2.087 A (CCW)  
 7. (a) 5 V (b) 70 V  
 9. 3.28 mA, 7.22 V  
 11. (a)  $70.6\ \Omega$ , 85 mA (CCW),  
 $V_1 = 2.8045$  V,  
 $V_2 = 0.4760$  V,  
 $V_3 = 0.850$  V,  
 $V_4 = 1.870$  V  
 (b)-(c)  $P_1 = 0.2384$  W,  
 $P_2 = 0.0405$  W,  
 $P_3 = 0.0723$  W,  
 $P_4 = 0.1590$  W  
 (d) Todos  $\frac{1}{2}$  W  
 13. (a)  $225\ \Omega$ , 0.533 A  
 (b) 8 W  
 (c) 15 V  
 15. Todos  $V_{ab}$   
 (a)  $66.67$  V (b)  $-8$  V  
 (c) 20 V (d) 0.18 V  
 17. (a) 12 V (b) 24 V  
 (c)  $60\ \Omega$  (d) 0.4 A  
 (e)  $60\ \Omega$   
 19. (a)  $R_s = 80\ \Omega$   
 (b)  $0.2\ W < \frac{1}{4}\ W$   
 21.  $R_1 = 3\ k\Omega$ ,  $R_2 = 15\ k\Omega$   
 23. (a)  $R_1 = 0.4\ k\Omega$ ,  $R_2 = 1.2\ k\Omega$ ,  
 $R_3 = 4.8\ k\Omega$   
 (b)  $R_1 = 0.4\ M\Omega$ ,  
 $R_2 = 1.2\ M\Omega$ ,  
 $R_3 = 4.8\ M\Omega$   
 25. (a)  $I$  (CW) = 6.667 A,  
 $V = 20$  V  
 (b)  $I$  (CW) = 1 A,  
 $V = 10$  V  
 27. (a) 20 V, 26 V, 35 V,  
 $-12$  V, 0 V  
 (b)  $-6$  V,  $-47$  V, 9 V  
 (c)  $-15$  V,  $-38$  V  
 29.  $V_0 = 0$  V,  $V_4 = 10$  V,  
 $V_7 = 4$  V,  $V_{10} = 20$  V,  
 $V_{23} = 6$  V,  $V_{30} = -8$  V,  
 $V_{67} = 0$  V,  $V_{56} = -6$  V,  
*I(arriba)* = 1.5 A  
 31.  $2\ \Omega$   
 33.  $100\ \Omega$   
 35. 1.52%
5. (a)  $18\ \Omega$  (b)  $R_1 = R_2 = 24\ \Omega$   
 7.  $120\ \Omega$   
 9. (a)  $0.8571\ \Omega$ , 1.1667 S  
 (b)  $I_1 = 1.05$  A,  $I_2 = 0.3$  A,  
 $I_3 = 0.15$  A,  $I_4 = 0.6$  A  
 (d)  $P_1 = 0.27$  W,  
 $P_2 = 0.135$  W,  
 $P_3 = 0.54$  W,  
 $P_{\text{entregada}} = 0.945$  W  
 (e)  $R_1, R_2 = \frac{1}{2}$  W,  $R_3 = 1$  W  
 11. (a) 66.67 mA (b)  $225\ \Omega$   
 (c) 8 W  
 13. (a)  $I_s = 7.5$  A,  $I_1 = 1.5$  A  
 (b)  $I_s = 9.6$  mA,  $I_1 = 0.8$  mA  
 15. 1260 W  
 17. (a) 4 mA (b) 24 V  
 (c) 18.4 mA  
 19. (a)  $I_1 = 3$  mA,  $I_2 = 1$  mA,  
 $I_3 = 1.5$  mA  
 (b)  $I_2 = 4\ \mu\text{A}$ ,  $I_3 = 1.5\ \mu\text{A}$ ,  
 $I_4 = 5.5\ \mu\text{A}$ ,  $I_1 = 6\ \mu\text{A}$   
 21. (a)  $R_1 = 5\ \Omega$ ,  $R_2 = 10\ \Omega$   
 (b)  $E = 12$  V,  $I_2 = 1.333$  A,  
 $I_3 = 1$  A,  $R_3 = 12\ \Omega$ ,  
 $I = 4.333$  A  
 (c)  $I_1 = 64$  mA,  $I_3 = 16$  mA,  
 $I_2 = 20$  mA,  $R = 3.2\ k\Omega$ ,  
 $I = 36$  mA  
 (d)  $E = 30$  V,  $I_1 = 1$  A,  
 $I_2 = I_3 = 0.5$  A,  
 $R_2 = R_3 = 60\ \Omega$ ,  
 $P_{R_2} = 15$  W  
 23. (a)  $I_1 = 4$  A,  $I_2 = 8$  A  
 (b)  $I_1 = 2$  A,  $I_2 = 4$  A,  
 $I_3 = 1$  A,  $I_4 = 1.333$  A  
 (c)  $I_1 = 272.73$  mA,  
 $I_2 = 227.27$  mA,  
 $I_3 = 90.91$  mA,  
 $I_4 = 500$  mA  
 (d)  $I_2 = 4.5$  A,  $I_3 = 8.5$  A,  
 $I_4 = 8.5$  A  
 25. (a)  $I = 4$  A,  $I_2 = 4$  A,  
 $I_1 = 3$  A  
 27.  $R_1 = 6\ k\Omega$ ,  $R_2 = 1.5\ k\Omega$ ,  
 $R_3 = 0.5\ k\Omega$   
 29.  $I = 3$  A,  $R = 2\ \Omega$   
 31. (a) 6.13 V  
 (b) 9 V  
 (c) 9 V  
 33. (a) 4 V (b) 3.997 V  
 (c) 3.871 V (d) 3 V  
 (e)  $R_m$  lo más grande posible  
 35. ¡No! Fuente de 4 V invertida
- (b) serie:  $E$  y  $R_1$ ,  
 paralelo:  $R_2$  y  $R_3$   
 (c) serie:  $E$ ,  $R_1$  y  $R_5$ ;  
 $R_3$  y  $R_4$   
 paralelo: ninguna  
 (d) serie:  $R_6$  y  $R_7$ ,  
 paralelo:  $E$ ,  $R_1$  y  $R_4$ ,  
 $R_2$  y  $R_5$
3. (a) sí (KCL) (b) 3 A  
 (c) sí (KCL) (d) 4 V  
 (e)  $2\ \Omega$  (f) 5 A  
 (g)  $P_1 = 12$  W,  $P_2 = 18$  W,  
 $P_{\text{entregada}} = 50$  W  
 5. (a)  $4\ \Omega$   
 (b)  $I_s = 9$  A,  $I_1 = 6$  A,  $I_2 = 3$  A  
 (c) 6 V  
 7.  $I_1 = 6$  A,  $I_2 = 16$  A,  $I_3 = 0.8$  A,  
 $I = 22$  A  
 9. (a) 4 A  
 (b)  $I_2 = 1.333$  A,  $I_3 = 0.6665$  A  
 (c)  $V_a = 8$  V,  $V_b = 4$  V  
 11. (a)  $5\ \Omega$ , 16 A  
 (b)  $I_{R_2} = 8$  A,  $I_3 = I_6 = 4$  A  
 (c)  $I_8 = 1$  A (d) 14 V  
 13. (a)  $V_G = 1.9$  V,  $V_s = 3.65$  V  
 (b)  $I_1 = I_2 = 7.05\ \mu\text{A}$ ,  
 $I_D = 2.433$  mA  
 (c) 6.268 V  
 (d) 8.02 V  
 15. (a) 0.6 A  
 (b) 28 V  
 17. (a)  $I_2 = 1.667$  A,  $I_6 = 1.111$  A,  
 $I_8 = 0$  A  
 19. (a)  $1.882\ \Omega$   
 (b)  $V_1 = V_4 = 32$  V  
 (c) 8 A  $\leftarrow$   
 (d)  $1.882\ \Omega$   
 21. (a) 6.75 A  
 (b) 32 V  
 23.  $8.333\ \Omega$   
 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,  
 $P(E) = 5760$  W  
 27. 4.44 W  
 29. (a) 64 V  
 (b)  $R_{L_2} = 4\ k\Omega$ ,  
 $R_{L_3} = 3\ k\Omega$   
 (c)  $R_1 = 0.5\ k\Omega$ ,  
 $R_2 = 1.2\ k\Omega$ ,  
 $R_3 = 2\ k\Omega$   
 31. (a) sí (b)  $R_1 = 750\ \Omega$ ,  
 $R_2 = 250\ \Omega$   
 (c)  $R_1 = 745\ \Omega$ ,  $R_2 = 255\ \Omega$   
 33. (a) 1 mA (b)  $R_{\text{desvío}} = 5\ m\Omega$   
 35. (a)  $R_r = 300\ k\Omega$   
 (b) 20.000  
 37. 0.05  $\mu\text{A}$

**Capítulo 6**

1. (a) 2, 3, 4 (b) 2, 3 (c) 1, 4  
 3. (a)  $6\ \Omega$ , 0.1667 S  
 (b)  $1\ k\Omega$ , 1 mA  
 (c)  $2.076\ k\Omega$ , 0.4817 mA  
 (d)  $1.333\ \Omega$ , 0.75 S  
 (e)  $9.948\ \Omega$ , 100.525 mA  
 (f)  $0.6889\ \Omega$ , 1.4516 S

**Capítulo 7**

1. (a) serie:  $E$ ,  $R_1$  y  $R_4$ ,  
 paralelo:  $R_2$  y  $R_3$

**Capítulo 8**

1. 28 V  
 3. (a)  $I_1 = 12 \text{ A}$ ,  $I_2 = 11 \text{ A}$   
     (b)  $V_x = 24 \text{ V}$ ,  $V_3 = 6 \text{ V}$   
 5. (a) 3 A, 6  $\Omega$  (b) 4.091 mA,  
     2.2 k $\Omega$   
 7. (a) 8 A (b) 8 A  
 9. 9.6 V, 2.4 A  
 11. (a) 5.4545 mA, 2.2 k $\Omega$   
     (b) 17.375 V (c) 5.375 V  
     (d) 2.443 mA  
 13. (I) CW:  $I_{R_1} = 1.445 \text{ mA}$ ,  
     abajo:  $I_{R_3} = 9.958 \text{ mA}$ ,  
     CCW:  $I_{R_2} = 8.513 \text{ mA}$   
 (II) CW:  $I_{R_1} = 2.0316 \text{ mA}$ ,  
     izquierda:  $I_{R_2} = 0.8 \text{ mA}$ ,  
     CW:  $I_{R_3} = I_{R_4} = 1.2316 \text{ mA}$   
 15. (d) izquierda: 63.694 mA  
 17. (a) CW:  $I_{R_1} = -\frac{1}{3} \text{ A}$ ,  
     CW:  $I_{R_2} = -\frac{5}{6} \text{ A}$ ,  
      $I_{R_3} = \frac{4}{3} \text{ A}$  (abajo)  
 (b) CW:  $I_{R_1} = -3.0625 \text{ A}$ ,  
     CW:  $I_{R_3} = 0.1875 \text{ A}$ ,  
      $I_{R_2} = 3.25 \text{ A}$  (arriba)  
 19. (I) CW:  $I_1 = 1.8701 \text{ A}$ ,  
     CW:  $I_2 = -8.5484 \text{ A}$ ,  
      $V_{ab} = -22.74 \text{ V}$   
 (II) CW:  $I_2 = 1.274 \text{ A}$ ,  
     CW:  $I_3 = 0.26 \text{ A}$ ,  
      $V_{ab} = -0.904 \text{ V}$   
 21. (a) 72.16 mA, -4.433 V  
     (b) 1.953 A, -7.257 V  
 23. (a) Todos CW  
      $I_1 = 0.0321 \text{ mA}$ ,  
      $I_2 = -0.8838 \text{ mA}$ ,  
      $I_3 = -0.968 \text{ mA}$ ,  
      $I_4 = -0.639 \text{ mA}$   
 (b) Todos CW  
      $I_1 = -3.8 \text{ A}$ ,  
      $I_2 = -4.2 \text{ A}$ ,  
      $I_3 = 0.2 \text{ A}$   
 25. (a) CW,  
      $I_1 = -\frac{1}{3} \text{ A}$ ,  $I_2 = -\frac{5}{6} \text{ A}$   
 (b) CW,  
      $I_1 = -3.0625 \text{ A}$ ,  
      $I_2 = 0.1875 \text{ A}$   
 27. (I) (a) CW  
     (b)  $I_1 = 1.871 \text{ A}$ ,  
          $I_2 = -8.548 \text{ A}$   
 (c)  $I_{R_1} = 1.871 \text{ A}$ ,  
      $I_{R_2} = -8.548 \text{ A}$ ,  
      $I_{R_3} = 10.419 \text{ A}$   
 29.  $I_{531}$  (CW) = 1.9535 A,  
      $V_a = -7.26 \text{ V}$   
 31. (a) Todos CW,  
      $I_1 = 0.0321 \text{ mA}$ ,  
      $I_2 = -0.8838 \text{ mA}$ ,  
      $I_3 = -0.968 \text{ mA}$ ,  
      $I_4 = -0.639 \text{ mA}$

- (b) Todos CW,  
      $I_1 = 3.8 \text{ A}$ ,  $I_2 = -4.2 \text{ A}$ ,  
      $I_3 = 0.2 \text{ A}$   
 33. (I) (b)  $V_1 = -14.86 \text{ V}$ ,  
      $V_2 = -12.57 \text{ V}$   
 (c)  $V_{R_1} = V_{R_4} =$   
      $V_1 = -14.86 \text{ V}$ ,  
      $V_{R_2} = V_2 = -12.57 \text{ V}$ ,  
      $V_{R_3} = 9.71 \text{ V}$  (+ -)  
 (II) (b)  $V_1 = -2.556 \text{ V}$ ,  
      $V_2 = 4.03 \text{ V}$   
 (c)  $V_{R_1} = V_1 = -2.556 \text{ V}$ ,  
      $V_{R_2} = V_{R_5} =$   
      $V_2 = 4.03 \text{ V}$ ,  
      $V_{R_4} = V_{R_3} = V_2 - V_1$   
     = 6.586 V  
 35. (I)  $V_1 = 7.238 \text{ V}$ ,  
      $V_2 = -2.453 \text{ V}$ ,  
      $V_3 = 1.405 \text{ V}$   
 (II)  $V_1 = -6.64 \text{ V}$ ,  
      $V_2 = 1.288 \text{ V}$ ,  
      $V_3 = 10.676 \text{ V}$   
 37. (a)  $V_1 = 10.083 \text{ V}$ ,  
      $V_2 = 6.944 \text{ V}$ ,  
      $V_3 = -17.056 \text{ V}$   
 (b)  $V_1 = 48 \text{ V}$ ,  $V_2 = 64 \text{ V}$   
 39. (b) (I)  $V_1 = -14.86 \text{ V}$ ,  
      $V_2 = -12.57 \text{ V}$   
 (II)  $V_1 = -2.556 \text{ V}$ ,  
      $V_2 = 4.03 \text{ V}$   
 (c) (I)  $V_{R_1} = V_{R_4} = -14.86 \text{ V}$ ,  
      $V_{R_2} = -12.57 \text{ V}$ ,  
      $V_{R_3} = V_1 + 12 - V_2$   
     = 9.71 V  
 (II)  $V_{R_1} = -2.556 \text{ V}$ ,  
      $V_{R_2} = V_{R_5} = 4.03 \text{ V}$ ,  
      $V_{R_3} = V_{R_4} = V_2 - V_1$   
     = 6.586 V  
 41. (I)  $V_1 = -5.311 \text{ V}$ ,  
      $V_2 = -0.6219 \text{ V}$ ,  
      $V_3 = 3.751 \text{ V}$ ,  
      $V_{SA} = -5.311 \text{ V}$   
 (II)  $V_1 = -6.917 \text{ V}$ ,  
      $V_2 = 12 \text{ V}$ ,  
      $V_3 = 2.3 \text{ V}$ ,  
      $V_{SA} = V_2 - V_1 = 18.917 \text{ V}$ ,  
      $V_{2A} = V_3 - V_2 = -9.7 \text{ V}$   
 43. (b)  $V_{R_5} = 0.1967 \text{ V}$   
 (c) no  
 (d) no  
 45. (b)  $I_{R_5} = 0 \text{ A}$   
 (c) no  
 (d) no  
 47. (a) 3.33 mA  
 (b) 1.177 A  
 49. (a) 133.33 mA  
 (b) 7 A  
 51. (b) 0.833 mA  
 53. 4.2  $\Omega$

**Capítulo 9**

1. (a) CW:  $I_{R_1} = \frac{5}{6} \text{ A}$ ,  $I_{R_2} = 0 \text{ A}$ ,  
     CW:  $I_{R_3} = \frac{5}{6} \text{ A}$   
 (b)  $E_1$ : 5.33 W,  $E_2$ : 0.333 W  
 (c) 8.333 W (d) no  
 3. (a) abajo: 4.4545 mA  
 (b) abajo: 3.11 A  
 5. (a) 6  $\Omega$ , 6 V  
 (b) 2  $\Omega$ : 0.75 A,  
     30  $\Omega$ : 0.1667 A,  
     100  $\Omega$ : 0.0566 A  
 7. (I) 2  $\Omega$ , 84 V (II) 1.579 k $\Omega$ ,  
     -1.149 V  
 9. (I) 45  $\Omega$ , -5 V (II) 2.055 k $\Omega$ ,  
     16.772 V  
 11. 4.041 k $\Omega$ , 9.733 V  
 13. (I): 14  $\Omega$ , 2.571 A,  
     (II): 7.5  $\Omega$ , 1.333 A  
 15. (a) 9.756  $\Omega$ , 0.95 A  
 (b) 2  $\Omega$ , 30 A  
 17. (a) 10  $\Omega$ , 0.2 A  
 (b) 4.033 k $\Omega$ , 2.9758 mA  
 19. (I) (a) 14  $\Omega$   
     (b) 23.14 W  
 (II) (a) 7.5  $\Omega$   
     (b) 3.33 W  
 21. (a) 9.756  $\Omega$ , 2.2 W  
 (b) 2  $\Omega$ , 450 W  
 23. 0  $\Omega$   
 25. 500  $\Omega$   
 27. 39.3  $\mu\text{A}$ , 220 mV  
 29. 2.25 A, 6.075 V  
 35. (a) 0.357 mA (b) 0.357 mA  
 (c) sí

**Capítulo 10**

1.  $9 \times 10^3 \text{ N/C}$   
 3.  $70 \mu\text{F}$   
 5. 50 V/m  
 7.  $8 \times 10^3 \text{ V/m}$   
 9. 937.5 pF  
 11. mica  
 13. (a)  $10^6 \text{ V/m}$  (b)  $4.96 \mu\text{C}$   
     (c)  $0.0248 \mu\text{F}$   
 15. 29.035 V  
 17. (a) 0.5 s (b)  $20(1 - e^{-t/0.5})$   
     (c)  $1\tau: 12.64 \text{ V}$ ,  $3\tau: 19 \text{ V}$ ,  
          $5\tau: 19.87 \text{ V}$   
     (d)  $i_C = 0.2 \times 10^{-3} e^{-t/0.5}$   
          $v_R = 20e^{-t/0.5}$   
 19. (a) 5.5 ms  
     (b)  $100(1 - e^{-t/(5.5 \times 10^{-3})})$   
     (c)  $1\tau: 63.21 \text{ V}$ ,  $3\tau: 95.02 \text{ V}$ ,  
          $5\tau: 99.33 \text{ V}$   
     (d)  
          $i_C = 18.18 \times 10^{-3} e^{-t/(5.5 \times 10^{-3})}$   
          $v_R = 60e^{-t/(5.5 \times 10^{-3})}$   
 21. (a) 10 ms

- (b)  $50(1 - e^{-\mu(10 \times 10^{-3})})$   
 (c)  $10 \times 10^{-3} e^{-\mu(10 \times 10^{-3})}$   
 (d)  $v_C \approx 50 \text{ V}, i_C = 0 \text{ A}$   
 (e)  $v_C = 50e^{-\mu(4 \times 10^{-3})},$   
 $i_C = -25 \times 10^{-3} e^{-\mu(4 \times 10^{-3})}$
23. (a)  $80(1 - e^{-\mu(1 \times 10^{-6})})$   
 (b)  $0.8 \times 10^{-3} e^{-\mu(1 \times 10^{-6})}$   
 (c)  $v_C = 80e^{-\mu(4.9 \times 10^{-6})},$   
 $i_C = 0.163 \times 10^{-3} e^{-\mu(4.9 \times 10^{-6})}$
25. (a)  $10 \mu\text{s}$  (b)  $3 \text{kA}$  (c) sí  
 27. (a)  $v_C = 52 \text{ V} - 40 \text{ V } e^{-\mu(123.8 \mu\text{s})},$   
 $i_C = 2.198 \text{ mA } e^{-\mu(123.8 \mu\text{s})}$
29.  $1.386 \mu\text{s}$   
 31.  $R = 54.567 \text{ k}\Omega$   
 33. (a)  $v_C = 60(1 - e^{-\mu(0.25)})$ ,  
 $0.5 \text{ s: } 55.07 \text{ V}, 1 \text{ s: } 59.596 \text{ V},$   
 $i_C = 60 \times 10^{-3} e^{-\mu(0.25)},$   
 $0.5 \text{ s: } 4.93 \text{ mA},$   
 $1 \text{ s: } 0.404 \text{ mA},$   
 $v_{R_1} = 60 e^{-\mu(0.25)},$   
 $0.5 \text{ s: } 4.93 \text{ V}, 1 \text{ s: } 0.404 \text{ V}$   
 (b)  $t = 0.405 \text{ s}, 1.387 \text{ s largo}$
35. (a)  $19.634 \text{ V}$   
 (b)  $2.31 \text{ s}$   
 (c)  $1.155 \text{ s}$
37. (a)  $v_C = 3.275(1 - e^{-\mu(52.68 \mu\text{s})}),$   
 $i_L = 1.216 \times 10^{-3} e^{-\mu(52.68 \mu\text{s})}$
39. (a)  $v_C = 27.2 - 25.2 e^{-\mu(18.26 \mu\text{s})},$   
 $i_C = 3.04 \text{ mA } e^{-\mu(18.26 \mu\text{s})}$
41. 0–4 ms: 0.3 mA,  
 4–6 ms: 0.9 mA,  
 6–7 ms: 3 mA,  
 7–10 ms: 0 mA,  
 10–13 ms: –3.2 mA,  
 13–15 ms: 1.8 mA
43. 0–4 ms: 0 V,  
 4–6 ms: –8 V,  
 6–16 ms: 20 V,  
 16–18 ms: 0 V,  
 18–20 ms: –12 V,  
 20–25 ms: 0 V
45.  $V_1 = 10 \text{ V}, Q_1 = 60 \mu\text{C},$   
 $V_2 = 6.67 \text{ V}, Q_2 = 40 \mu\text{C},$   
 $V_3 = 3.33 \text{ V}, Q_3 = 40 \mu\text{C}$
47. (a)  $56.54 \text{ V}$   
 (b)  $42.405 \text{ V}$   
 (c)  $14.135 \text{ V}$   
 (d)  $43.46 \text{ V}$   
 (e)  $433.44 \text{ ms}$
49. 8640 pJ
51. (a)  $5 \text{ J}$   
 (b)  $0.1 \text{ C}$   
 (c)  $200 \text{ A}$   
 (d)  $10 \text{ kW}$   
 (e)  $10 \text{ s}$

## Capítulo 11

1.  $\Phi: 5 \times 10^4 \text{ maxwells},$   
 $5 \times 10^4 \text{ líneas}, B: 8 \text{ gauss},$   
 $51.616 \text{ líneas}$
3. (a)  $0.04 \text{ T}$   
 5.  $952.4 \times 10^3 \text{ At/Wb}$   
 7.  $2624.67 \text{ At/m}$   
 9.  $2.133 \text{ A}$
11. (a)  $N_1 = 60$  (i)  
 (b)  $13.34 \times 10^{-4} \text{ Wb/Am}$
13.  $2.687 \text{ A}$
15.  $1.35 \text{ N}$
17. (a)  $2.028 \text{ A}$  (b)  $\approx 2 \text{ N}$
19.  $6.1 \times 10^{-3} \text{ Wh}$
21. (a)  $B = 1.5(1 - e^{-H/700 \text{ At/m}})$   
 (c)  $H = -700 \log_e(1 - B/1.5 \text{ T})$   
 (e) Ecuación:  $40.1 \text{ mA}$

## Capítulo 12

1.  $4.25 \text{ V}$
3. 14 vueltas
5.  $15.65 \mu\text{H}$
7. (a)  $2.5 \text{ V}$  (b)  $0.3 \text{ V}$   
 (c)  $200 \text{ V}$
9. 0–3 ms: 0 V, 3–8 ms: 1.6 V,  
 8–13 ms: –1.6 V,  
 13–14 ms: 0 V,  
 14–15 ms: 8 V,  
 15–16 ms: –8 V,  
 16–17 ms: 0 V
11. 0–5  $\mu\text{s}$ : 4 mA, 10  $\mu\text{s}$ : –8 mA,  
 12  $\mu\text{s}$ : 4 mA, 12–16  $\mu\text{s}$ : 4 mA,  
 24  $\mu\text{s}$ : 0 mA
13. (a)  $2.27 \mu\text{s}$   
 (b)  $5.45 \times 10^{-3}(1 - e^{-\mu(2.27 \mu\text{s})})$   
 (c)  $v_I = 12e^{-\mu(2.27 \mu\text{s})},$   
 $v_R = 12(1 - e^{-\mu(2.27 \mu\text{s})})$   
 (d)  $i_L; 1\tau = 3.45 \text{ mA},$   
 $3\tau = 5.179 \text{ mA},$   
 $5\tau = 5.413 \text{ mA},$   
 $v_I; 1\tau = 4.415 \text{ V},$   
 $3\tau = 0.598 \text{ V},$   
 $5\tau = 0.081 \text{ V}$

15. (a)  $i_L = 4.186 \text{ mA} -$   
 $3.814 \text{ mA } e^{-\mu(13.95 \mu\text{s})},$   
 $v_L = -32.8 \text{ V } e^{-\mu(13.95 \mu\text{s})}$
17. (a)  $v_I = 20 \text{ V } e^{-\mu(1 \mu\text{s})},$   
 $i_L = 2 \text{ mA}(1 - e^{-\mu(1 \mu\text{s})})$   
 (b)  $i_L = 2 \text{ mA } e^{-\mu(0.5 \mu\text{s})},$   
 $v_I = -40 \text{ V } e^{-\mu(0.5 \mu\text{s})}$
19. (a)  $i_L = 6 \text{ mA}(1 - e^{-\mu(0.5 \mu\text{s})}),$   
 $v_L = 12 \text{ V } e^{-\mu(0.5 \mu\text{s})}$   
 (b)  $i_L = 5.188 \text{ mA } e^{-\mu(83.3 \mu\text{s})},$   
 $v_L = -62.256 \text{ V } e^{-\mu(83.3 \mu\text{s})}$
21.  $25.68 \mu\text{s}$
23. (a)  $i_L = 3.638 \times$   
 $10^{-3}(1 - e^{-\mu(6.676 \mu\text{s})}),$   
 $v_I = 5.45 e^{-\mu(6.676 \mu\text{s})}$

- (b)  $2.825 \text{ mA}, 1.2186 \text{ V}$   
 (c)  $i_L = 2.825 \times$   
 $10^{-3} e^{-\mu(2.128 \mu\text{s})},$   
 $v_L = -13.27 e^{-\mu(2.128 \mu\text{s})}$

25. (a)  $0.243 \text{ V}$   
 (b)  $29.47 \text{ V}$   
 (c)  $18.96 \text{ V}$   
 (d)  $2.025 \text{ ms}$
27. (a)  $20 \text{ V}$   
 (b)  $12 \mu\text{A}$   
 (c)  $5.376 \mu\text{s}$   
 (d)  $0.366 \text{ V}$
29.  $i_L = -3.478 \text{ mA} -$   
 $7.432 \text{ mA } e^{-\mu(173.9 \mu\text{s})}$   
 $v_L = 51.28 \text{ V } e^{-\mu(173.9 \mu\text{s})}$
31. (a)  $8 \text{ H}$   
 (b)  $4 \text{ H}$
33.  $L: 4 \text{ H}, 2 \text{ H}$   
 $R: 5.7 \text{ k}\Omega, 9.1 \text{ k}\Omega$
35.  $V_1 = 16 \text{ V}, V_2 = 0 \text{ V},$   
 $I_1 = 4 \text{ mA}$
37.  $V_1 = 10 \text{ V},$   
 $I_1 = 2 \text{ A},$   
 $I_2 = 1.33 \text{ A}$
39.  $W_C = 360 \mu\text{J},$   
 $W_L = 12 \text{ J}$

## Capítulo 13

1. (a)  $10 \text{ ms}$  (b)  $2$  (c)  $100 \text{ Hz}$   
 (d) amplitud =  $5 \text{ V},$   
 $V_{pp} = 6.67 \text{ V}$
3.  $10 \text{ ms}, 100 \text{ Hz}$
5. (a)  $60 \text{ Hz}$  (b)  $100 \text{ Hz}$   
 (c)  $29.41 \text{ Hz}$  (d)  $40 \text{ kHz}$
7.  $0.25 \text{ s}$
9.  $T = 50 \mu\text{s}$
11. (a)  $\pi/4$  (b)  $\pi/3$  (c)  $\frac{2}{3}\pi$   
 (d)  $\frac{2}{3}\pi$  (e)  $0.989\pi$  (f)  $1.228\pi$
13. (a)  $3.14 \text{ rad/s}$   
 (b)  $20.94 \times 10^3 \text{ rad/s}$   
 (c)  $1.57 \times 10^6 \text{ rad/s}$   
 (d)  $157.1 \text{ rad/s}$
15. (a)  $120 \text{ Hz}, 8.33 \text{ ms}$   
 (b)  $1.34 \text{ Hz}, 746.27 \text{ ms}$   
 (c)  $954.93 \text{ Hz}, 1.05 \text{ ms}$   
 (d)  $9.95 \times 10^{-3} \text{ Hz}, 100.5 \text{ s}$
17.  $104.7 \text{ rad/s}$
23.  $0.4755 \text{ A}$
25.  $11.537^\circ, 168.463^\circ$
29. (a)  $v$  adelanta a  $i$  por  $10^\circ$   
 (b)  $i$  adelanta a  $v$  por  $70^\circ$   
 (c)  $i$  adelanta a  $v$  por  $80^\circ$   
 (d)  $i$  adelanta a  $v$  por  $150^\circ$
31. (a)  $v = 25 \text{ sen}(\omega t + 30^\circ)$   
 (b)  
 $i = 3 \times 10^{-3} \text{ sen}(6.28 \times 10^3 t - 60^\circ)$
33.  $\frac{1}{2} \text{ ms}$
35.  $0.388 \text{ ms}$
37. (a)  $0.4 \text{ ms}$

- (b) 2.5 kHz  
(c) -25 mV  
39. (a) 1.875 V (b) -4.778 mA  
41. (a) 40  $\mu$ s  
(b) 25 kHz  
(c) 17.13 mV  
43. (a)  $2 \operatorname{sen} 377t$   
(b)  $100 \operatorname{sen} 377t$   
(c)  $84.87 \times 10^{-3} \operatorname{sen} 377t$   
(d)  $33.95 \times 10^{-6} \operatorname{sen} 377t$   
45. 2.16 V  
47. 0 V  
49. (a)  $T = 40 \mu$ s,  $f = 25$  kHz,  
 $V_{\text{promedio}} = 20$  mV,  
 $V_{\text{rms}} = 34.6$  mV  
(b)  $T = 100 \mu$ s,  $f = 10$  kHz,  
 $V_{\text{promedio}} = -0.3$  V,  
 $V_{\text{rms}} = 367$  mV

## Capítulo 14

3. (a)  $3770 \operatorname{cos} 377t$   
(b)  $452.4 \operatorname{cos}(754t + 20^\circ)$   
(c)  $4440.63 \operatorname{cos}(157t - 20^\circ)$   
(d)  $200 \operatorname{cos} t$   
5. (a)  $210 \operatorname{sen} 754t$   
(b)  $14.8 \operatorname{sen}(400t - 120^\circ)$   
(c)  $42 \times 10^{-3} \operatorname{sen}(\omega t + 88^\circ)$   
(d)  $28 \operatorname{sen}(\omega t + 180^\circ)$   
7. (a) 1.592 H (b) 2.654 H  
(c) 0.8414 H  
9. (a)  $100 \operatorname{sen}(\omega t + 90^\circ)$   
(b)  $8 \operatorname{sen}(\omega t + 150^\circ)$   
(c)  $120 \operatorname{sen}(\omega t - 120^\circ)$   
(d)  $60 \operatorname{sen}(\omega t + 190^\circ)$   
11. (a)  $1 \operatorname{sen}(\omega t - 90^\circ)$   
(b)  $0.6 \operatorname{sen}(\omega t - 70^\circ)$   
(c)  $0.8 \operatorname{sen}(\omega t + 10^\circ)$   
(d)  $1.6 \operatorname{sen}(377t + 130^\circ)$   
13. (a)  $\approx \Omega$  (b) 530.79  $\Omega$   
(c) 265.39  $\Omega$  (d) 17.693  $\Omega$   
(e) 1.327  $\Omega$   
15. (a) 9.31 Hz (b) 4.66 Hz  
(c) 18.62 Hz (d) 1.59 Hz  
17. (a)  $6 \times 10^{-3} \operatorname{sen}(200t + 90^\circ)$   
(b)  $33.96 \times 10^{-3} \operatorname{sen}(377t + 90^\circ)$   
(c)  $44.94 \times 10^{-3} \operatorname{sen}(374t + 300^\circ)$   
(d)  $56 \times 10^{-3} \operatorname{sen}(\omega t + 160^\circ)$   
19. (a)  $1334 \operatorname{sen}(300t - 90^\circ)$   
(b)  $37.17 \operatorname{sen}(377t - 90^\circ)$   
(c)  $127.2 \operatorname{sen} 754t$   
(d)  $100 \operatorname{sen}(1600t - 170^\circ)$   
21. (a)  $C$  (b)  $L = 254.78$  mH  
(c)  $R = 5$   $\Omega$   
25. 318.47 mH  
27. 5.067 nF  
29. (a) 0 W (b) 0 W  
(c) 122.5 W  
31. 192 W

33.  $40 \operatorname{sen}(\omega t - 50^\circ)$   
35. (a)  $2 \operatorname{sen}(157t - 60^\circ)$   
(b) 318.47 mH (c) 0 W  
37. (a)  $i_1 = 2.828 \operatorname{sen}(10^4t + 150^\circ)$   
 $i_2 = 11.312 \operatorname{sen}(10^4t + 150^\circ)$   
(b)  $i = 14.14 \operatorname{sen}(10^4t + 150^\circ)$   
39. (a)  $5 \angle 36.87^\circ$   
(b)  $2.83 \angle 45^\circ$   
(c)  $16.38 \angle 77.66^\circ$   
(d)  $806.23 \angle 82.87^\circ$   
(e)  $1077.03 \angle 21.80^\circ$   
(f)  $0.00658 \angle 81.25^\circ$   
(g)  $11.78 \angle -49.82^\circ$   
(h)  $8.94 \angle 153.43^\circ$   
(i)  $61.85 \angle -104.04^\circ$   
(j)  $101.53 \angle -39.81^\circ$   
(k)  $4326.66 \angle 123.69^\circ$   
(l)  $25.495 \times 10^{-3} \angle -78.69^\circ$   
41. (a)  $15.033 \angle 86.19^\circ$   
(b)  $60.208 \angle 4.76^\circ$   
(c)  $0.30 \angle 88.09^\circ$   
(d)  $2002.5 \angle -87.14^\circ$   
(e)  $86.182 \angle 93.73^\circ$   
(f)  $38.694 \angle -94^\circ$   
43. (a)  $11.8 + j 7$   
(b)  $151.9 + j 49.9$   
(c)  $4.72 \times 10^{-6} + j 71$   
(d)  $5.2 + j 1.6$   
(e)  $209.3 + j 311$   
(f)  $-21.2 + j 12$   
(g)  $7.03 + j 9.93$   
(h)  $95.698 + j 22.768$   
45. (a)  $6 \angle -50^\circ$   
(b)  $0.2 \times 10^{-3} \angle 140^\circ$   
(c)  $109 \angle -230^\circ$   
(d)  $76.471 \angle -80^\circ$   
(e)  $4 \angle 0^\circ$   
(f)  $0.71 \angle -16.49^\circ$   
(g)  $4.21 \times 10^{-3} \angle 161.1^\circ$   
(h)  $18.191 \angle -50.91^\circ$   
47. (a)  $x = 4, y = 3$   
(b)  $x = 4$   
(c)  $x = 3, y = 6$  o  
 $x = 6, y = 3$   
(d)  $30^\circ$   
49. (a)  $56.569 \operatorname{sen}(377t + 20^\circ)$   
(b)  $169.68 \operatorname{sen} 377t$   
(c)  
 $11.314 \times 10^{-3} \operatorname{sen}(377t + 120^\circ)$   
(d)  $7.07 \operatorname{sen}(377t + 90^\circ)$   
(e)  $1696.8 \operatorname{sen}(377t - 120^\circ)$   
(f)  $6000 \operatorname{sen}(377t - 180^\circ)$   
51.  
 $i_1 = 2.537 \times 10^{-5} \operatorname{sen}(\omega t + 96.79^\circ)$   
53.  $i_T = 18 \times 10^{-3} \operatorname{sen} 377t$
- Capítulo 15
1. (a)  $6.8 \Omega \angle 0^\circ$   
(b)  $754 \Omega \angle 90^\circ$
- (c)  $15.7 \Omega \angle 90^\circ$   
(d)  $265.25 \Omega \angle -90^\circ$   
(e)  $318.47 \Omega \angle -90^\circ$   
(f)  $200 \Omega \angle 0^\circ$   
3. (a)  $88 \times 10^{-3} \operatorname{sen} \omega t$   
(b)  $9.045 \operatorname{sen}(377t + 150^\circ)$   
(c)  $2547.02 \operatorname{sen}(157t - 50^\circ)$   
5. (a)  $4.24 \Omega \angle -45^\circ$   
(b)  $3.04 \text{ k}\Omega \angle 80.54^\circ$   
(c)  $1617.56 \Omega \angle 88.33^\circ$   
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 atrasado
9. (a)  $1660.27 \Omega \angle -73.56^\circ$   
(b)  $8.517 \text{ mA} \angle 73.56^\circ$   
(c)  $\text{V}_R = 4.003 \text{ V} \angle 73.56^\circ$ ,  
 $\text{V}_L = 13.562 \text{ V} \angle -16.44^\circ$   
(d)  $34.09 \text{ mW}$ , 0.283 adelantado
11. (a)  $3.16 \text{ k}\Omega \angle 18.43^\circ$   
(c)  $3.18 \mu\text{F}, 6.37 \text{ H}$   
(d)  $I = 1.3424 \text{ mA} \angle 41.57^\circ$ ,  
 $\text{V}_R = 4.027 \text{ V} \angle 41.57^\circ$ ,  
 $\text{V}_L = 2.6848 \text{ V} \angle 131.57^\circ$ ,  
 $\text{V}_C = 1.3424 \text{ V} \angle -48.43^\circ$   
(g) 5.406 mW  
(h) 0.9487 atrasado
13. (a)  $40 \text{ mH}$  (b)  $220 \Omega$   
15. (a)  $\text{V}_1 = 37.97 \text{ V} \angle -51.57^\circ$ ,  
 $\text{V}_2 = 113.92 \text{ V} \angle 38.43^\circ$   
(b)  $\text{V}_1 = 55.80 \text{ V} \angle 26.55^\circ$ ,  
 $\text{V}_2 = 12.56 \text{ V} \angle -63.45^\circ$   
17. (a)  $I = 39 \text{ mA} \angle 126.65^\circ$ ,  
 $\text{V}_R = 1.17 \text{ V} \angle 126.65^\circ$ ,  
 $\text{V}_C = 25.86 \text{ V} \angle 36.65^\circ$   
(b) 0.058 adelantado  
(c) 45.63 mW  
(g)  $Z_T = 30 \Omega - j 512.2 \Omega$   
19.  $Z_T = 3.2 \Omega + j 2.4 \Omega$   
25. (a)  $Z_T = 3 \Omega + j 8 \Omega$ ,  
 $\text{Y}_T = 41.1 \text{ mS} - j 109.5 \text{ mS}$   
(b)  $Z_T = 60 \Omega - j 70 \Omega$ ,  
 $\text{Y}_T = 7.1 \text{ mS} + j 8.3 \text{ mS}$   
(c)  $Z_T = 200 \Omega - j 100 \Omega$ ,  
 $\text{Y}_T = 4 \text{ mS} + j 2 \text{ mS}$   
27. (a)  $\text{Y}_T = 538.52 \text{ mS} \angle -21.8^\circ$   
(c)  $E = 3.71 \text{ V} \angle 21.8^\circ$ ,  
 $I_R = 1.855 \text{ A} \angle 21.8^\circ$ ,  
 $I_L = 0.742 \text{ A} \angle -68.2^\circ$   
(f) 6.88 W  
(g) 0.928 atrasado  
(h)  $e = 5.25 \operatorname{sen}(377t + 21.8^\circ)$ ,  
 $i_R = 2.62 \operatorname{sen}(377t + 21.8^\circ)$ ,  
 $i_L = 1.049 \operatorname{sen}(377t - 68.2^\circ)$ ,  
 $i_s = 2.828 \operatorname{sen} 377t$
29. (a)  $\text{Y}_T = 129.96 \text{ mS} \angle -50.31^\circ$   
(c)  $I_s = 7.8 \text{ A} \angle -50.31^\circ$ ,  
 $I_R = 5 \text{ A} \angle 0^\circ$ ,  
 $I_L = 6 \text{ A} \angle -90^\circ$

- (f) 300 W  
 (g) 0.638 atrasado  
 (h)  $e = 84.84 \text{ sen}(377t)$ ,  
 $i_R = 7.07 \text{ sen}(377t)$ ,  
 $i_L = 8.484 \text{ sen}(377t - 90^\circ)$ ,  
 $i_C = 11.03 \text{ sen}(377t - 50.31^\circ)$
31. (a)  $\mathbf{Y}_T = 0.416 \text{ mS} \angle 36.897^\circ$   
 (c)  $L = 10.61 \text{ H}$ ,  $C = 1.326 \mu\text{F}$   
 (d)  $\mathbf{E} = 8.498 \text{ V} \angle -56.897^\circ$ ,  
 $\mathbf{I}_R = 2.833 \text{ mA} \angle -56.897^\circ$ ,  
 $\mathbf{I}_L = 2.125 \text{ mA} \angle -146.897^\circ$ ,  
 $\mathbf{I}_C = 4.249 \text{ mA} \angle 33.103^\circ$   
 (g) 24.078 mW  
 (h) 0.8 adelantado  
 (i)  
 $e = 12.016 \text{ sen}(377t - 56.897^\circ)$ ,  
 $i_R = 4 \text{ sen}(377t - 56.897^\circ)$ ,  
 $i_L = 3 \text{ sen}(377t - 146.897^\circ)$ ,  
 $i_C = 6 \text{ sen}(377t + 33.103^\circ)$
33. (a)  $\mathbf{I}_1 = 18.09 \text{ A} \angle 65.241^\circ$ ,  
 $\mathbf{I}_2 = 8.528 \text{ A} \angle -24.759^\circ$   
 (b)  $\mathbf{I}_1 = 11.161 \text{ A} \angle 0.255^\circ$ ,  
 $\mathbf{I}_2 = 6.656 \text{ A} \angle 153.690^\circ$
39. (a)  $R_p = 94.73 \Omega$ ,  
 $X_p = 52.1 \Omega (C)$   
 (b)  $R_p = 4 \text{ k}\Omega$ ,  
 $X_p = 4 \text{ k}\Omega (C)$
41. (a)  $\mathbf{E} = 176.68 \text{ V} \angle 36.44^\circ$ ,  
 $\mathbf{I}_R = 0.803 \text{ A} \angle 36.44^\circ$ ,  
 $\mathbf{I}_L = 2.813 \text{ A} \angle -53.56^\circ$   
 (b) 0.804 atrasado  
 (c) 141.86 W  
 (f)  $\mathbf{I}_C = 1.11 \text{ A} \angle 126.43^\circ$   
 (g)  $\mathbf{Z}_T = 142.15 \Omega + j 104.96 \Omega$
43.  $R = 4 \Omega$ ,  $X_L = 3.774 \Omega$

## Capítulo 16

1. (a)  $1.2 \Omega \angle 90^\circ$   
 (b)  $10 \text{ A} \angle -90^\circ$   
 (c)  $10 \text{ A} \angle -90^\circ$   
 (d)  $\mathbf{I}_2 = 6 \text{ A} \angle -90^\circ$ ,  
 $\mathbf{I}_3 = 4 \text{ A} \angle -90^\circ$   
 (e)  $60 \text{ V} \angle 0^\circ$
3. (a)  $\mathbf{Z}_T = 3.87 \Omega \angle -11.817^\circ$ ,  
 $\mathbf{Y}_T = 0.258 \text{ S} \angle 11.817^\circ$   
 (b)  $15.504 \text{ A} \angle 41.817^\circ$   
 (c)  $3.985 \text{ A} \angle 82.826^\circ$   
 (d)  $47.809 \text{ V} \angle -7.174^\circ$   
 (e) 910.71 W
5. (a)  $0.375 \text{ A} \angle 25.346^\circ$   
 (b)  $70.711 \text{ V} \angle -45^\circ$   
 (c) 33.9 W
7. (a)  $1.423 \text{ A} \angle 18.259^\circ$   
 (b)  $26.574 \text{ V} \angle 4.763^\circ$   
 (c) 54.074 W
9. (a)  $\mathbf{Y}_T = 0.099 \text{ S} \angle -9.709^\circ$   
 (b)  $\mathbf{V}_1 = 20.4 \text{ V} \angle 30^\circ$ ,  
 $\mathbf{V}_2 = 10.887 \text{ V} \angle 58.124^\circ$   
 (c)  $1.933 \text{ A} \angle 11.109^\circ$

11.  $33.201 \text{ A} \angle 38.89^\circ$   
 13. 139.71 mW

## Capítulo 17

3. (a)  $\mathbf{Z} = 21.93 \Omega \angle -46.85^\circ$ ,  
 $\mathbf{E} = 10.97 \text{ V} \angle 13.15^\circ$   
 (b)  $\mathbf{Z} = 5.15 \Omega \angle 59.04^\circ$ ,  
 $\mathbf{E} = 10.3 \text{ V} \angle 179.04^\circ$
5. (a)  $5.15 \text{ A} \angle -24.5^\circ$   
 (b)  $0.442 \text{ A} \angle 143.48^\circ$
7. (a)  $13.07 \text{ A} \angle -33.71^\circ$   
 (b)  $48.33 \text{ A} \angle -77.57^\circ$
9.  $-3.165 \times 10^{-3} \text{ V} \angle 137.29^\circ$
11.  $\mathbf{I}_{RN} = 10 \text{ mA} \angle 0^\circ$ ,  
 $\mathbf{I}_{2RN} = 1.667 \text{ mA} \angle 0^\circ$
13.  $\mathbf{I}_L = 1.378 \text{ mA} \angle -56.31^\circ$
15. (a)  $\mathbf{V}_1 = 19.86 \text{ V} \angle 43.8^\circ$ ,  
 $\mathbf{V}_2 = 8.94 \text{ V} \angle 106.9^\circ$   
 (b)  $\mathbf{V}_1 = 19.78 \text{ V} \angle 132.48^\circ$ ,  
 $\mathbf{V}_2 = 13.37 \text{ V} \angle 98.78^\circ$
17.  $\mathbf{V}_1 = 220 \text{ V} \angle 0^\circ$ ,  
 $\mathbf{V}_2 = 96.664 \text{ V} \angle -12.426^\circ$ ,  
 $\mathbf{V}_3 = 100 \text{ V} \angle 90^\circ$
19. (izquierda)  $\mathbf{V}_1 = 14.62 \text{ V} \angle -5.86^\circ$ ,  
 (superior)  $\mathbf{V}_2 = 35.03 \text{ V} \angle -37.69^\circ$ ,  
 (derecha)  $\mathbf{V}_3 = 32.4 \text{ V} \angle -73.34^\circ$ ,  
 (en medio)  $\mathbf{V}_4 = 5.677 \text{ V} \angle 23.53^\circ$
21.  $\mathbf{V}_L = 4.372 \text{ V} \angle -128.66^\circ$ ,  
 $\mathbf{V}_2 = 2.253 \text{ V} \angle 17.628^\circ$
23.  $\mathbf{V}_1 = -10.667 \text{ V} \angle 0^\circ$ ,  
 $\mathbf{V}_2 = -6 \text{ V} \angle 0^\circ$
25.  $-2451.92 \text{ E}$
27. (a) No  
 (b)  $1.76 \text{ mA} \angle -71.54^\circ$   
 (c)  $7.03 \text{ V} \angle -18.46^\circ$
29. Balanceado
31.  $R_s = R_2 R_3 / R_1$ ,  
 $L_s = R_2 L_3 / R_1$
33. (a)  $11.57 \text{ A} \angle -67.13^\circ$   
 (b)  $36.9 \text{ A} \angle 23.87^\circ$

## Capítulo 18

1. (a)  $6.095 \text{ A} \angle -32.115^\circ$   
 (b)  $3.77 \text{ A} \angle -93.8^\circ$
3.  $i = 0.5 \text{ A} + 1.581 \text{ sen}(\omega t - 26.565^\circ)$
5.  $6.261 \text{ mA} \angle -63.43^\circ$
7.  $-22.09 \text{ V} \angle 6.34^\circ$
9.  $19.62 \text{ V} \angle 53^\circ$
11.  $\mathbf{V}_s = 10 \text{ V} \angle 0^\circ$
13. (a)  $\mathbf{Z}_{Th} = 21.312 \Omega \angle 32.196^\circ$ ,  
 $\mathbf{E}_{Th} = 2.131 \text{ V} \angle 32.196^\circ$   
 (b)  $\mathbf{Z}_{Th} = 6.813 \Omega \angle -54.228^\circ$ ,  
 $\mathbf{E}_{Th} = 57.954 \text{ V} \angle 11.099^\circ$
15. (a)  $\mathbf{Z}_{Th} = 4 \Omega \angle 90^\circ$ ,  
 $\mathbf{E}_{Th} = 4 \text{ V} + 10 \text{ V} \angle 0^\circ$   
 (b)  $\mathbf{I} = 0.5 \text{ A} +$   
 $1.11 \text{ A} \angle -26.565^\circ$

17. (a)  $\mathbf{Z}_{Th} = 4.472 \text{ k}\Omega \angle -26.565^\circ$ ,  
 $\mathbf{E}_{Th} = 31.31 \text{ V} \angle -26.565^\circ$   
 (b)  $\mathbf{I} = 6.26 \text{ mA} \angle 63.435^\circ$

19.  $\mathbf{Z}_{Th} = 4.44 \text{ k}\Omega \angle -0.031^\circ$ ,  
 $\mathbf{E}_{Th} = -444.45 \times 10^3 \text{ I} \angle 0.255^\circ$
21.  $\mathbf{Z}_{Th} = 5.099 \text{ k}\Omega \angle -11.31^\circ$ ,  
 $\mathbf{E}_{Th} = -50 \text{ V} \angle 0^\circ$
23.  $\mathbf{Z}_{Th} = -39.215 \Omega \angle 0^\circ$ ,  
 $\mathbf{E}_{Th} = 20 \text{ V} \angle 53^\circ$
25.  $\mathbf{Z}_{Th} = 607.42 \Omega \angle 0^\circ$ ,  
 $\mathbf{E}_{Th} = 1.62 \text{ V} \angle 0^\circ$
27. (a)  $\mathbf{Z}_N = 21.312 \Omega \angle 32.196^\circ$ ,  
 $\mathbf{I}_N = 0.1 \text{ A} \angle 0^\circ$   
 (b)  $\mathbf{Z}_N = 6.813 \Omega \angle -54.228^\circ$ ,  
 $\mathbf{I}_N = 8.506 \text{ A} \angle 65.324^\circ$
29. (a)  $\mathbf{Z}_N = 9.66 \Omega \angle 14.93^\circ$ ,  
 $\mathbf{I}_N = 2.15 \text{ A} \angle -42.87^\circ$   
 (b)  $\mathbf{Z}_N = 4.37 \Omega \angle 55.67^\circ$ ,  
 $\mathbf{I}_N = 22.83 \text{ A} \angle -34.65^\circ$
31. (a)  $\mathbf{Z}_N = 9 \Omega \angle 0^\circ$ ,  
 $\mathbf{I}_N = 1.333 \text{ A} + 2.667 \text{ A} \angle 0^\circ$   
 (b)  $12 \text{ V} + 2.65 \text{ V} \angle -83.66^\circ$
33.  $\mathbf{Z}_N = 5.1 \text{ k}\Omega \angle -11.31^\circ$ ,  
 $\mathbf{I}_N = -1.961 \times 10^{-3} \text{ V} \angle 11.31^\circ$
35.  $\mathbf{Z}_N = 5.1 \text{ k}\Omega \angle -11.31^\circ$ ,  
 $\mathbf{I}_N = 9.81 \text{ mA} \angle 11.31^\circ$
37.  $\mathbf{Z}_N = 6.63 \text{ k}\Omega \angle 0^\circ$ ,  
 $\mathbf{I}_N = 0.792 \text{ mA} \angle 0^\circ$
39. (a)  $\mathbf{Z}_L = 8.32 \Omega \angle 3.18^\circ$ ,  
 $1198.2 \text{ W}$   
 (b)  $\mathbf{Z}_L = 1.562 \Omega \angle -14.47^\circ$ ,  
 $1.614 \text{ W}$
41. 40 kΩ, 25 W
43. (a) 9 Ω (b) 20 W
45. (a) 1.414 kΩ (b) 0.518 W
49. 25.77 mA ∠104.4°

## Capítulo 19

1. (a) 120 W  
 (b)  $Q_f = 0 \text{ VAR}$ ,  $S_f = 120 \text{ VA}$   
 (c) 0.5 A  
 (d)  $I_1 = \frac{1}{6} \text{ A}$ ,  $I_2 = \frac{1}{3} \text{ A}$
3. (a) 400 W, -400 VAR (C),  
 $565.69 \text{ VA}, 0.7071$  adelantado  
 (c) 5.66 A ∠135°
5. (a) 500 W, -200 VAR (C),  
 $538.52 \text{ VA}$   
 (b) 0.928 adelantado  
 (d) 10.776 A ∠21.875°
7. (a)  $R: 200 \text{ W}$ ,  $L, C: 0 \text{ W}$   
 (b)  $R: 0 \text{ VAR}$ ,  $C: 80 \text{ VAR}$ ,  
 $L: 100 \text{ VAR}$   
 (c)  $R: 200 \text{ VA}$ ,  $C: 80 \text{ VA}$ ,  
 $L: 100 \text{ VA}$   
 (d) 200 W, 20 VAR (L),  
 $200.998 \text{ VA}, 0.995$  (atrasado)  
 (f) 10.05 A ∠-5.73°

9. (a)  $R: 38.99 \text{ W}, L: 0 \text{ W}, C: 0 \text{ W}$   
 (b)  $R: 0 \text{ VAR}, L: 126.74 \text{ VAR}, C: 46.92 \text{ VAR}$   
 (c)  $R: 38.99 \text{ VA}, L: 126.74 \text{ VA}, C: 46.92 \text{ VA}$   
 (d)  $38.99 \text{ W}, 79.82 \text{ VAR} (L), 88.83 \text{ VA}, 0.439 \text{ (atrasado)}$   
 (f)  $0.31 \text{ J}$   
 (g)  $W_L = 0.32 \text{ J}, W_C = 0.12 \text{ J}$
11. (a)  $Z = 2.30 \Omega + j 1.73 \Omega$   
 (b)  $4000 \text{ W}$
13. (a)  $900 \text{ W}, 0 \text{ VAR}, 900 \text{ VA}, 1 \angle 0^\circ$   
 (d)  $Z_1: R = 0 \Omega, X_C = 20 \Omega, Z_2: R = 2.83 \Omega, X = 0 \Omega, Z_3: R = 5.66 \Omega, X_L = 4.717 \Omega$
15. (a)  $1100 \text{ W}, 2366.26 \text{ VAR}, 2609.44 \text{ VA}, 0.4215 \text{ (adelantado)}$   
 (b)  $521.89 \text{ V} \angle -65.07^\circ$   
 (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)  $7.81 \text{ kVA}$   
 (b)  $0.640 \text{ (atrasado)}$   
 (c)  $65.08 \text{ A}$   
 (d)  $1105 \mu\text{F}$   
 (e)  $41.67 \text{ A}$
19. (a)  $128.14 \text{ W}$   
 (b)  $a-b: 42.69 \text{ W}, b-c: 64.03 \text{ W}, a-c: 106.72 \text{ W}, a-d: 106.72 \text{ W}, c-d: 0 \text{ W}, d-e: 0 \text{ W}, f-e: 21.34 \text{ W}$
21. (a)  $5 \Omega, 132.03 \text{ mH}$   
 (b)  $10 \Omega$   
 (c)  $15 \Omega, 262.39 \text{ mH}$

## Capítulo 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)  $X_L = 40 \Omega$   
 (b)  $I = 10 \text{ mA}$   
 (c)  $V_R = 20 \text{ mV}, V_L = 400 \text{ mV}, V_C = 400 \text{ mV}$   
 (d)  $Q_s = 20 \text{ (alto)}$   
 (e)  $L = 1.27 \text{ mH}, C = 0.796 \mu\text{F}$   
 (f)  $BW = 250 \text{ Hz}$   
 (g)  $f_2 = 5.125 \text{ kHz}, f_1 = 4.875 \text{ kHz}$
5. (a)  $BW = 400 \text{ Hz}$   
 (b)  $f_2 = 6200 \text{ Hz}, f_1 = 5800 \text{ Hz}$   
 (c)  $X_L = X_C = 45 \Omega$   
 (d)  $P_{\text{HPF}} = 375 \text{ mW}$

7. (a)  $Q_s = 10$   
 (b)  $X_L = 20 \Omega$   
 (c)  $L = 1.59 \text{ mH}, C = 3.98 \mu\text{F}$   
 (d)  $f_2 = 2100 \text{ Hz}, f_1 = 1900 \text{ Hz}$
9.  $L = 13.26 \text{ mH}, C = 27.07 \text{ nF}, f_2 = 8460 \text{ Hz}, f_1 = 8340 \text{ Hz}$
11. (a)  $f_s = 1 \text{ MHz}$   
 (b)  $BW = 160 \text{ kHz}$   
 (c)  $R = 720 \Omega, L = 0.7162 \text{ mH}, C = 35.37 \text{ pF}$   
 (d)  $R_t = 56.25 \Omega$
13. (a)  $f_p = 159.155 \text{ kHz}$   
 (b)  $V_C = 4 \text{ V}$   
 (c)  $I_L = I_C = 40 \text{ mA}$   
 (d)  $Q_p = 20$
15. (a)  $f_s = 11,253.95 \text{ Hz}$   
 (b)  $Q_t = 1.77 \text{ (no)}$   
 (c)  $f_p = 9,280.24 \text{ Hz}, f_m = 10,794.41 \text{ Hz}$   
 (d)  $X_L = 5.83 \Omega, X_C = 8.57 \Omega$   
 (e)  $Z_{T_p} = 12.5 \Omega$   
 (f)  $V_C = 25 \text{ mV}$   
 (g)  $Q_p = 1.46, BW = 6.356 \text{ kHz}$   
 (h)  $I_C = 2.92 \text{ mA}, I_t = 3.54 \text{ mA}$
17. (a)  $X_C = 30 \Omega$   
 (b)  $Z_{T_p} = 225 \Omega$   
 (c)  $I_C = 0.6 \text{ A} \angle 90^\circ, I_t \approx 0.6 \text{ A} \angle -86.19^\circ$   
 (d)  $L = 0.239 \text{ mH}, C = 265.26 \text{ nF}$   
 (e)  $Q_p = 7.5, BW = 2.67 \text{ kHz}$
19. (a)  $f_s = 7.118 \text{ kHz}, f_p = 6.647 \text{ kHz}, f_m = 7 \text{ kHz}$   
 (b)  $X_L = 20.88 \Omega, X_C = 23.94 \Omega$   
 (c)  $Z_{T_p} = 55.56 \Omega$   
 (d)  $Q_p = 2.32, BW = 2.865 \text{ kHz}$   
 (e)  $I_t = 99.28 \text{ mA}, I_C = 92.73 \text{ mA}$   
 (f)  $V_C = 2.22 \text{ V}$
21. (a)  $f_p = 3558.81 \text{ Hz}$   
 (b)  $V_C = 138.2 \text{ V}$   
 (c)  $P = 691 \text{ mW}$   
 (d)  $BW = 575.86 \text{ Hz}$
23. (a)  $X_L = 98.54 \Omega$   
 (b)  $Q_t = 8.21$   
 (c)  $f_p = 8.05 \text{ kHz}$   
 (d)  $V_C = 4.83 \text{ V}$   
 (e)  $f_2 = 8.55 \text{ kHz}, f_1 = 7.55 \text{ kHz}$
25.  $R_s = 3.244 \text{ k}\Omega, C = 31.66 \text{ nF}$
27. (a)  $f_p = 251.65 \text{ kHz}$   
 (b)  $Z_{T_p} = 4.444 \text{ k}\Omega$   
 (c)  $Q_p = 14.05$   
 (d)  $BW = 17.91 \text{ kHz}$   
 (e)  $20 \text{ nF}: f_p = 194.93 \text{ kHz}, Z_{T_p} = 49.94 \Omega, Q_p = 2.04$   
 (f)  $1 \text{ nF}: f_p = 251.65 \text{ kHz}, Z_{T_p} = 13.33 \text{ k}\Omega, Q_p = 21.08, BW = 11.94 \text{ kHz}$

- (g) Red:  $L/C = 100 \times 10^3$ , inciso (e):  $L/C = 1 \times 10^3$ , inciso (f):  $L/C = 400 \times 10^3$   
 (h) sí,  $L/C \uparrow, BW \downarrow$

## Capítulo 21

1. (a)  $0.2 \text{ H}$   
 (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)  $158.02 \text{ mH}$   
 (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)  $3.125 \text{ V}$  (b)  $391.02 \mu\text{Wb}$
7.  $56.31 \text{ Hz}$
9.  $400 \Omega$
11.  $12,000t$
13. (a) 3  
 (b)  $2.78 \text{ W}$
15. (a)  $360.56 \Omega \angle 86.82^\circ$   
 (b)  $332.82 \text{ mA} \angle -86.82^\circ$   
 (c)  $V_{R_c} = 6.656 \text{ V} \angle -86.82^\circ, V_{X_c} = 13.313 \text{ V} \angle 3.18^\circ, V_{Y_L} = 106.50 \text{ V} \angle 3.18^\circ$

19.  $1.354 \text{ H}$
21.  $I_1(R_1 + j X_{L_1}) + I_2(j X_m) = E_1, I_1(j X_m) + I_2(j X_{L_2} + R_L) = 0$
23. (a) 20 (b)  $83.33 \text{ A}$  (c)  $4.167 \text{ A}$   
 (d)  $a = \frac{1}{20}, I_s = 4.167 \text{ A}, I_p = 83.33 \text{ A}$
25. (a)  $25 \text{ V} \angle 0^\circ, 5 \text{ A} \angle 0^\circ$   
 (b)  $80 \Omega \angle 0^\circ$  (c)  $20 \Omega \angle 0^\circ$
27. (a)  $E_2 = 40 \text{ V} \angle 60^\circ, I_2 = 3.33 \text{ A} \angle 60^\circ, E_3 = 30 \text{ V} \angle 60^\circ, I_3 = 3 \text{ A} \angle 60^\circ$   
 (b)  $R_1 = 64.52 \Omega$
29.  $[Z_1 + X_{L_1}]I_1 - Z_{M_{12}}I_2 + Z_{M_{13}}I_3 = E_1, Z_{M_{12}}I_1 - [Z_2 + Z_3 + X_{L_2}]I_2 + Z_{21}I_3 = 0, Z_{M_{13}}I_1 - Z_2I_2 + [Z_2 + Z_3 + X_{L_3}]I_3 = 0$

## Capítulo 22

1. (a)  $120.1 \text{ V}$  (b)  $120.1 \text{ V}$   
 (c)  $12.01 \text{ A}$  (d)  $12.01 \text{ A}$
3. (a)  $120.1 \text{ V}$  (b)  $120.1 \text{ V}$   
 (c)  $16.98 \text{ A}$  (d)  $16.98 \text{ A}$
5. (a)  $\theta_2 = -120^\circ, \theta_3 = 120^\circ$   
 (b)  $V_{an} = 120 \text{ V} \angle 0^\circ, V_{bn} = 120 \text{ V} \angle -120^\circ, V_{cn} = 120 \text{ V} \angle 120^\circ$   
 (c)  $I_{an} = 8 \text{ A} \angle -53.13^\circ, I_{bn} = 8 \text{ A} \angle -173.13^\circ, I_{cn} = 8 \text{ A} \angle 66.87^\circ$   
 (e)  $8 \text{ A}$  (f)  $207.85 \text{ V}$
7.  $V_\phi = 127 \text{ V}, I_\phi = 8.98 \text{ A}, I_t = 8.98 \text{ A}$

- 9.** (a)  $E_{AN} = 12.7 \text{ kV} \angle -30^\circ$ ,  
 $E_{BN} = 12.7 \text{ kV} \angle -150^\circ$ ,  
 $E_{CN} = 12.7 \text{ kV} \angle 90^\circ$   
(b)  $I_{an} = 11.285 \text{ A} \angle -97.54^\circ$ ,  
 $I_{bn} = 11.285 \text{ A} \angle -217.54^\circ$ ,  
 $I_{cn} = 11.285 \text{ A} \angle 22.46^\circ$   
(c)  $I_t = I_o$   
(d)  $V_{an} = 12,154.28 \text{ V} \angle -29.34^\circ$ ,  
 $V_{bn} = 12,154.28 \text{ V} \angle -149.34^\circ$ ,  
 $V_{cn} = 12,154.28 \text{ V} \angle 90.66^\circ$
- 11.** (a) 120.1 V (b) 208 V  
(c) 13.364 A (d) 23.15 A
- 13.** (a)  $\theta_2 = -120^\circ$ ,  $\theta_3 = +120^\circ$   
(b)  $V_{ab} = 208 \text{ V} \angle 0^\circ$ ,  
 $V_{bc} = 208 \text{ V} \angle -120^\circ$ ,  
 $V_{ca} = 208 \text{ V} \angle 120^\circ$   
(d)  $I_{ab} = 9.455 \text{ A} \angle 0^\circ$ ,  
 $I_{bc} = 9.455 \text{ A} \angle -120^\circ$ ,  
 $I_{ca} = 9.455 \text{ A} \angle 120^\circ$   
(e) 16.376 A (f) 120.1 V
- 15.** (a)  $\theta_2 = -120^\circ$ ,  $\theta_3 = 120^\circ$   
(b)  $V_{ab} = 208 \text{ V} \angle 0^\circ$ ,  
 $V_{bc} = 208 \text{ V} \angle -120^\circ$ ,  
 $V_{ca} = 208 \text{ V} \angle 120^\circ$   
(d)  $I_{ab} = 86.67 \text{ A} \angle -36.87^\circ$ ,  
 $I_{bc} = 86.67 \text{ A} \angle -156.87^\circ$ ,  
 $I_{ca} = 86.67 \text{ A} \angle 83.13^\circ$   
(e) 150.11 A (f) 120.1 V
- 17.** (a)  $I_{ab} = 15.325 \text{ A} \angle -73.30^\circ$ ,  
 $I_{bc} = 15.325 \text{ A} \angle -193.30^\circ$ ,  
 $I_{ca} = 15.325 \text{ A} \angle 46.7^\circ$   
(b)  $I_{An} = 26.54 \text{ A} \angle -103.31^\circ$ ,  
 $I_{Bn} = 26.54 \text{ A} \angle 136.68^\circ$ ,  
 $I_{Cn} = 26.54 \text{ A} \angle 16.69^\circ$   
(c)  $E_{AN} = 17,013.6 \text{ V} \angle -0.59^\circ$ ,  
 $E_{BN} = 17,013.77 \text{ V} \angle -120.59^\circ$ ,  
 $E_{CN} = 17,013.87 \text{ V} \angle 119.41^\circ$
- 19.** (a) 208 V (b) 120.09 V  
(c) 7.076 A (d) 7.076 A
- 21.**  $V_\phi = 69.28 \text{ V}$ ,  $I_\phi = 2.89 \text{ A}$ ,  
 $I_t = 2.89 \text{ A}$
- 23.**  $V_\phi = 69.28 \text{ V}$ ,  $I_\phi = 5.77 \text{ A}$ ,  
 $I_t = 5.77 \text{ A}$
- 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)  $V_{ab} = 100 \text{ V} \angle 0^\circ$ ,  
 $V_{bc} = 100 \text{ V} \angle -120^\circ$ ,  
 $V_{ca} = 100 \text{ V} \angle 120^\circ$   
(d)  $I_{ab} = 5 \text{ A} \angle 0^\circ$ ,  
 $I_{bc} = 5 \text{ A} \angle -120^\circ$ ,  
 $I_{ca} = 5 \text{ A} \angle 120^\circ$   
(e) 8.66 A
- 29.** (a)  $\theta_2 = -120^\circ$ ,  $\theta_3 = 120^\circ$   
(b)  $V_{ab} = 100 \text{ V} \angle 0^\circ$ ,  
 $V_{bc} = 100 \text{ V} \angle -120^\circ$ ,  
 $V_{ca} = 100 \text{ V} \angle 120^\circ$
- (d)  $I_{ab} = 7.072 \text{ A} \angle 45^\circ$ ,  
 $I_{bc} = 7.072 \text{ A} \angle -75^\circ$ ,  
 $I_{ca} = 7.072 \text{ A} \angle 165^\circ$   
(e) 12.25 A
- 31.** 2160 W, 0 VAR, 2160 VA,  
 $F_p = 1$
- 33.** 7210.67 W, 7210.67 VAR (C),  
10,197.42 VA, 0.707 adelantado
- 35.** 7.263 kW, 7.263 kVAR,  
10,272 kVA, 0.707 atrasado
- 37.** 287.93 W, 575.86 VAR (L),  
643.83 VA, 0.4472 atrasado
- 39.** 900 W, 1200 VAR (L), 1500 VA,  
0.6 atrasado
- 41.**  $Z_\phi = 12.98 \Omega - j 17.31 \Omega$
- 43.** (a) 9237.6 V (b) 80 A  
(c) 1276.8 kW  
(d) 0.576 atrasado  
(e)  $I_{4a} = 80 \text{ A} \angle -54.83^\circ$   
(f)  $V_{an} = 7773.45 \text{ V} \angle -4.87^\circ$   
(g)  $Z_\phi = 62.52 \Omega + j 74.38 \Omega$   
(h)  $F_p$  (sistema completo) = 0.576,  
 $F_p$  (carga) = 0.643 (ambos  
atrasados)  
(i) 93.98%
- 45.** (b)  $P_T = 5899.64 \text{ W}$ ,  
 $P_{medidor} = 1966.55 \text{ W}$
- 49.** (a) 120.09 V  
(b)  $I_{an} = 8.492 \text{ A}$ ,  $I_{bn} = 7.076 \text{ A}$ ,  
 $I_{cn} = 42.465 \text{ A}$   
(c) 4928.5 W, 4928.53 VAR (L),  
6969.99 VA, 0.7071 atrasado  
(d)  $I_{an} = 8.492 \text{ A} \angle -75^\circ$ ,  
 $I_{bn} = 7.076 \text{ A} \angle -195^\circ$ ,  
 $I_{cn} = 42.465 \text{ A} \angle 45^\circ$   
(e)  $I_N = 34.712 \text{ A} \angle -42.972^\circ$
- Capítulo 23**
- 1.** (a) izquierda: 1.54 kHz,  
derecha: 5.623 kHz  
(b) abajo: 0.2153 V,  
arriba: 0.5248 V
- 3.** (a) 1000 (b)  $10^{12}$   
(c) 1.585 (d) 1.096  
(e)  $10^{10}$  (f) 1513.56  
(g) 10.023 (h) 1,258,925.41
- 5.** 1.681
- 7.** -0.301
- 9.** (a) 1.845  
(b) 18.45
- 11.** 13.01
- 13.** 38.49
- 15.** 24.08 dB<sub>s</sub>
- 19.** (a)  $0.1f_c: 0.995$ ,  $0.5f_c: 0.894$ ,  
 $f_c: 0.707$ ,  $2f_c: 0.447$ ,  
 $10f_c: 0.0995$   
(b)  $0.1f_c: -5.71^\circ$ ,  $0.5f_c: -26.57^\circ$ ,  
 $f_c: -45^\circ$ ,  $2f_c: -63.43^\circ$ ,  
 $10f_c: -84.29^\circ$
- 21.**  $C = 0.265 \mu\text{F}$ ,  
250 Hz:  $A_v = 0.895$ ,  
 $\theta = -26.54^\circ$ ,  
1000 Hz:  $A_v = 0.4475$ ,  
 $\theta = -63.41^\circ$
- 23.** (a)  $f_c = 3.617 \text{ kHz}$ ,  
 $f_c: A_v = 0.707$ ,  $\theta = 45^\circ$ ,  
 $2f_c: A_v = 0.894$ ,  $\theta = 26.57^\circ$ ,  
 $0.5f_c: A_v = 0.447$ ,  $\theta = 63.43^\circ$ ,  
 $10f_c: A_v = 0.995$ ,  $\theta = 5.71^\circ$ ,  
 $\frac{1}{10}f_c: A_v = 0.0995$ ,  
 $\theta = 84.29^\circ$
- 25.**  $R = 795.77 \Omega \rightarrow 797 \Omega$ ,  
 $f_c: A_v = 0.707$ ,  $\theta = 45^\circ$ ,  
1 kHz:  $A_v = 0.458$ ,  $\theta = 63.4^\circ$ ,  
4 kHz:  $A_v = 0.9$ ,  $\theta = 26.53^\circ$
- 27.** (a)  $f_{c1} = 795.77 \text{ Hz}$ ,  
 $f_{c2} = 1989.44 \text{ Hz}$ ,  
 $f_{c1}: V_o = 0.656V_o$ ,  
 $f_{c2}: V_o = 0.656V_o$ ,  
 $f_{centro} = 1392.60 \text{ Hz}$ ,  
 $V_o = 0.711V_o$ ,  
500 Hz:  $V_o = 0.516V_o$ ,  
4 kHz:  $V_o = 0.437V_o$ ,  
(b)  $BW \cong 2.9 \text{ kHz}$ ,  
 $f_{centro} = 1.94 \text{ kHz}$
- 29.** (a)  $f_s = 100.658 \text{ kHz}$   
(b)  $Q_s = 18.39$ ,  $BW = 5473.52 \text{ Hz}$   
(c)  $f_s: A_v = 0.93$ ,  
 $f_1 = 97,921.24 \text{ Hz}$ ,  
 $f_2 = 103,394.76 \text{ Hz}$ ,  
 $f = 95 \text{ kHz}$ :  $A_v = 0.392$ ,  
 $f = 105 \text{ kHz}$ :  $A_v = 0.5$   
(d)  $f = f_s$ ,  $V_o = 0.93 \text{ V}$ ,  
 $f = f_1 = f_2$ ,  $V_o = 0.658 \text{ V}$
- 31.** (a)  $Q_s = 12.195$   
(b)  $BW = 410 \text{ Hz}$ ,  
 $f_2 = 5205 \text{ Hz}$ ,  
 $f_1 = 4795 \text{ Hz}$   
(c)  $f_s: V_o = 0.024V_o$ ,  
(d)  $f_s: V_o$  sigue 0.024V<sub>s</sub>
- 33.** (a)  $f_p = 726.44 \text{ kHz}$  (banda de  
atenuación)  
 $f = 2.013 \text{ MHz}$  (pasa-banda)
- 35.** (a-b)  $f_c = 6772.55 \text{ Hz}$   
(c)  $f_c: -3 \text{ dB}, \frac{1}{2}f_c: -6.7 \text{ dB}$ ,  
 $2f_c: -0.969 \text{ dB}$ ,  
 $\frac{1}{10}f_c: -20.04 \text{ dB}$ ,  
 $10f_c: -0.043 \text{ dB}$   
(d)  $f_c: 0.707$ ,  $\frac{1}{2}f_c: 0.4472$ ,  
 $2f_c: 0.894$   
(e)  $f_c: 45^\circ$ ,  $\frac{1}{2}f_c: 63.43^\circ$ ,  $2f_c: 26.57^\circ$
- 37.** (a-b)  $f_c = 13.26 \text{ kHz}$   
(c)  $f_c: -3 \text{ dB}, \frac{1}{2}f_c: -0.97 \text{ dB}$ ,  
 $2f_c: -6.99 \text{ dB}$

- $\frac{1}{m}f_c = -0.043$  dB,  
 $10f_c = -20.04$  dB  
 (d)  $f_c = 0.707$ ,  $\frac{1}{2}f_c = 0.894$ ,  
 $2f_c = 0.447$   
 (e)  $f_c = -45^\circ$ ,  $\frac{1}{2}f_c = -26.57^\circ$ ,  
 $2f_c = -63.43^\circ$
39. (a)  $f_1 = 663.15$  Hz,  $f_c = 468.1$  Hz  
 $0 < f < f_c: +6$  dB/octava,  
 $f > f_c: -3.03$  dB  
 (b)  $f_c = 45^\circ$ ,  $f_1 = 54.78^\circ$ ,  $\frac{1}{2}f_1 = 63.43^\circ$ ,  
 $2f_1 = 84.29^\circ$
41. (a)  $f_1 = 19,894.37$  Hz  
 $f_c = 1,989.44$  Hz  
 $0 < f < f_c: 0$  dB,  
 $f_c < f < f_1: -6$  dB/octava,  
 $f > f_1: -20$  dB  
 (b)  $f_c = -39.29^\circ$ ,  
 $10$  kHz:  $-52.06^\circ$ ,  
 $f_1 = -39.29^\circ$
43. (a)  $f_1 = 964.58$  Hz,  
 $f_c = 7,334.33$  Hz,  
 $0 < f < f_1: -17.62$  dB,  
 $f_1 < f < f_c: +6$  dB/octava,  
 $f > f_c: 0$  dB  
 (b)  $f_c = 39.35^\circ$ ,  $1.3$  kHz:  $43.38^\circ$ ,  
 $f_1 = 39.35^\circ$
45. (a)  $f = 180$  Hz  $\approx -3$  dB,  
 $f = 18$  kHz:  $-3.105$  dB  
 (b)  $100$  Hz:  $97^\circ$ ,  
 $1.8$  kHz:  $0.12^\circ \approx 0^\circ$ ,  
 $18$  kHz:  $-61.8^\circ$
47.  $A_v = -120/[1 - j(50/f)(1 - j(200/f)(1 - j/f/36\text{ kHz})]$
49.  $f_c = 2$  kHz,  $0 < f < f_c: 0$  dB,  
 $f > f_c: -6$  dB/octava
51.  $f_1 = 1$  kHz,  $f_2 = 2$  kHz,  
 $f_3 = 3$  kHz,  
 $0 < f < f_1: 0$  dB,  
 $f_1 < f < f_2: +6$  dB/octava,  
 $f_2 < f < f_3: +12$  dB/octava,  
 $f > f_3: 13.06$  dB
53. (a) woofer: 0.673, tweeter: 0.678  
 (b) woofer: 0.015, tweeter: 0.337  
 (c) intervalo medio: 0.998  $\approx 1$

## Capítulo 24

1. (a) tendencia positiva (b) 2 V  
 (c) 0.2 ms (d) 6 V (e) 6.5%
3. (a) tendencia positiva  
 (b) 10 mV  
 (c) 3.2 ms (d) 20 mV  
 (e) 3.4%
5.  $V_2$  de  $(V_1 - V_2)/V = 0.1$  es  
 $13.571$  mV
7. (a)  $120$   $\mu$ s (b)  $8.333$  kHz  
 (c) máximo =  $440$  mV,  
 mínimo =  $80$  mV

9.  $\text{prf} = 125$  kHz,  
 ciclo de trabajo = 62.5%
11. (a)  $8$   $\mu$ s  
 (b)  $2$   $\mu$ s  
 (c) 125 kHz  
 (d) 0 V  
 (e) 3.464 mV
13. 18.88 mV
15. 117 mV
17.  $v_o = 4(1 + e^{-t/20ms})$
19.  $i_C = -8 \times 10^{-3} e^{-t}$
21.  $i_C = 4 \times 10^{-3} e^{-(t/2)2ms}$   
 (a)  $5\tau = T/2$  (b)  $5\tau = \frac{1}{2}(T/2)$   
 (c)  $5\tau = 10(T/2)$
23.  $0 = T/2$ ;  $v_C = 20$  V,  
 $T/2 = T$ ;  $v_C = 20e^{-t/T}$ ,  
 $T = \frac{3}{2}T$ ;  $v_C = 20(1 - e^{-t/T})$ ,  
 $\frac{3}{2}T = T$ ;  $v_C = 20e^{-t/T}$
25.  $Z_p = 4.573$  M $\Omega$   $\angle -59.5^\circ$ ,  
 $Z_s = 0.507$  M $\Omega$   $\angle -59.5^\circ$
- ## Capítulo 25
1. (I) a. no b. no c. sí d. no  
 e. sí  
 (II) a. sí b. sí c. sí d. sí  
 e. no  
 (III) a. sí b. sí c. no d. sí  
 e. sí  
 (IV) a. no b. no c. sí d. sí  
 e. sí
7. (a) 19.04 V (b) 4.53 A
9. 71.872 W
11. (a)  $i = 2 + 2.08 \text{ sen}(400t - 33.69) + 0.5 \text{ sen}(800t - 53.13^\circ)$   
 (b) 2.508 A  
 (c)  $v_R = 24 + 24.96 \text{ sen}(400t + 33.69^\circ) + 6 \text{ sen}(800t - 53.13^\circ)$   
 (d) 30.092 A  
 (e)  $v_I = 16.64 \text{ sen}(400t + 56.31^\circ) + 8 \text{ sen}(800t + 36.87^\circ)$   
 (f) 13.055 V (g) 75.481 W
13. (a)  $i = 1.2 \text{ sen}(400t + 53.13^\circ)$   
 (b) 0.848 A  
 (c)  $v_R = 18 \text{ sen}(400t + 53.13^\circ)$   
 (d) 12.73 V  
 (e)  $v_C = 18 + 23.98 \text{ sen}(400t - 36.87^\circ)$   
 (f) 24.73 V (g) 10.79 W
15.  $v_o = 2.257 \times 10^{-3} \text{ sen}(377t + 93.66^\circ) + 1.923 \times 10^{-3} \text{ sen}(754t + 1.64^\circ)$
17.  $i_t = 30 + 30.27 \text{ sen}(20t + 7.59^\circ) + 0.5 \text{ sen}(40t - 30^\circ)$
- ## Capítulo 26
1.  $Z_i = 986.84$   $\Omega$
3. (a)  $I_{ij} = 10$   $\mu$ A  
 (b)  $Z_{ij} = 4.5$  k $\Omega$   
 (c)  $E_{ij} = 6.9$  V
5.  $Z_o = 44.59$  k $\Omega$
7.  $Z_o = 10$  k $\Omega$
9. (a)  $A_v = -392.98$   
 (b)  $A_{v_T} = -320.21$
11. (a)  $A_{v_{NL}} = -2398.8$   
 (b)  $E_i = 50$  mV  
 (c)  $Z_i = 1$  k $\Omega$
13. (a)  $A_G = 6.067 \times 10^4$   
 (b)  $A_{G_f} = 4.94 \times 10^4$
15. (a)  $A_{v_T} = 1500$   
 (b)  $A_{ij} = 187.5$   
 (c)  $A_{i_1} = 15$ ,  $A_{i_2} = 12.5$   
 (d)  $A_{v_T} = 187.5$
17. (a)  $z_{11} = (Z_1 Z_2 + Z_1 Z_3)/(Z_1 + Z_2 + Z_3)$ ,  
 $z_{12} = Z_1 Z_3/(Z_1 + Z_2 + Z_3)$ ,  
 $z_{21} = z_{12}$ ,  
 $z_{22} = (Z_1 Z_3 + Z_2 Z_3)/(Z_1 + Z_2 + Z_3)$
19. (a)  $y_{11} = (Y_1 Y_2 + Y_1 Y_3)/(Y_1 + Y_2 + Y_3)$ ,  
 $y_{12} = -Y_1 Y_2/(Y_1 + Y_2 + Y_3)$ ,  
 $y_{21} = y_{12}$ ,  
 $y_{22} = (Y_1 Y_2 + Y_2 Y_3)/(Y_1 + Y_2 + Y_3)$
21.  $h_{11} = Z_1 Z_2/(Z_1 + Z_2)$ ,  
 $h_{21} = -Z_1/(Z_1 + Z_2)$ ,  
 $h_{12} = Z_1/(Z_1 + Z_2)$ ,  
 $h_{22} = (Z_1 + Z_2 + Z_3)/(Z_1 Z_2 + Z_2 Z_3)$
23.  $h_{11} = (Y_1 + Y_2 + Y_3)/(Y_1 Y_2 + Y_1 Y_3)$ ,  
 $h_{21} = -Y_2/(Y_2 + Y_3)$ ,  
 $h_{12} = Y_3/(Y_2 + Y_3)$ ,  
 $h_{22} = Y_2 Y_3/(Y_2 + Y_3)$
25. (a) 47.62 (b) -99
27.  $Z_i = 9,219.5$   $\Omega$   $\angle -139.4^\circ$ ,  
 $Z_o = 29.07$  k $\Omega$   $\angle -86.05^\circ$
29.  $h_{11} = 2.5$  k $\Omega$ ,  $h_{12} = 0.5$ ,  
 $h_{21} = -0.75$ ,  $h_{22} = 0.25$  mS