APPENDIX H Answers to Selected Problems

Chapter 1

1.1 3.93 MB

1.3 3.5 s

1.6 $362\,\mu\text{m}^2$

1.9 $4 \sin 5000t$ mC

1.12 a) 300 W, A to B

b) 500 W, B to A

c) 200 W, B to A

d) 400 W, A to B

1.17 a) 42.21 mW

b) $12.14\,\mu$J

c) $140.625\,\mu$J

1.24 a) 8.45 s

b) −15.40 W (15.40 W delivered)

c) 31.55 s

d) 15.40 W (15.40 W extracted)

e) $w(0) = 0$ J; $w(10) = 112.5$ J; $w(20) = 200$ J; $w(30) = 112.5$ J; $w(40) = 0$ J

1.26 1740 W

Chapter 2

2.2 $8\,\text{k}\Omega$

2.4 $20\,\Omega$

2.14 a) 0.4 A

b) 1.6 A

c) 120 V

d) $P_{40\Omega} = 160$ W; $P_{300\Omega} = 48$ W; $P_{75\Omega} = 192$ W

e) 400 W

2.16 a) $i_g = 6$ A; $i_o = 2$ A

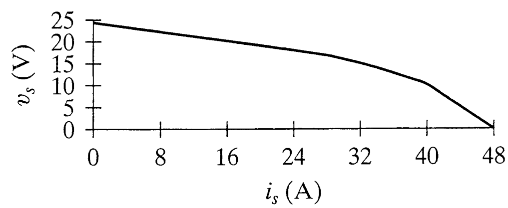
b) 240 V

c) $P_{\text{dev}} = P_{\text{abs}} = 1440$ W

2.21 a) −30 V source; $20\,\Omega$ resistor

b) 10 W

2.23 a)



b) 24 V source; $0.25\,\Omega$ resistor

c) 19.2 A

d) 96 A

e) 48 A

f) A linear model cannot predict the nonlinear behavior of the voltage source.

2.26 a) $P_{4\Omega} = 900$ W; $P_{20\Omega} = 1620$ W; $P_{5\Omega} = 180$ W; $P_{22.5\Omega} = 360$ W; $P_{15\Omega} = 1500$ W

b) 4560 W

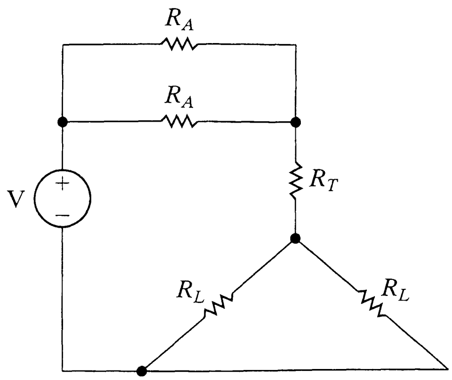
c) $P_{\text{supp}} = 4560\text{ W} = P_{\text{dis}}$

2.29 a) 5.55 V

b) $P_{\text{supp}} = 44.82\text{ mW} = P_{\text{dis}}$

2.34 $i = 385$ mA, so a warning sign should be posted and precautions taken.

2.35



2.36 a) $P_{\text{arm}} = 59.17$ W; $P_{\text{leg}} = 29.59$ W; $P_{\text{trunk}} = 7.40$ W

b) $t_{\text{arm}} = 1414.23$ s; $t_{\text{leg}} = 7071.13$ s; $t_{\text{trunk}} = 70{,}677.37$ s

c) All values are much greater than a few minutes.

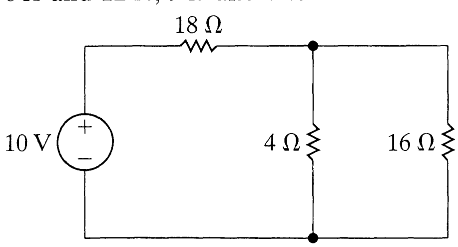
2.37 a) 40 V

b) No, 12 V/800 Ω = 15 mA will only cause a shock.

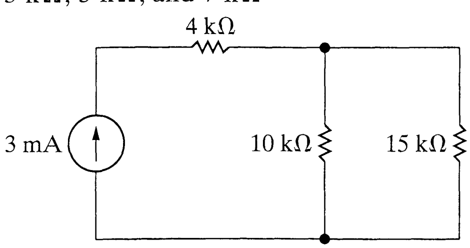
2.38 3000 V

Chapter 3

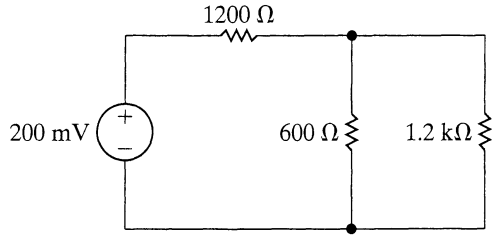
3.1 a) 6 Ω and 12 Ω; 9 Ω and 7 Ω



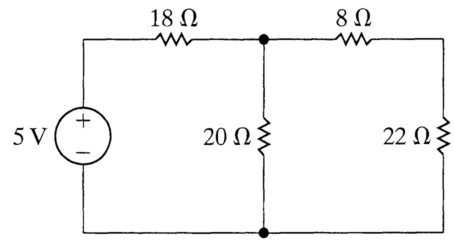
b) 3 kΩ, 5 kΩ, and 7 kΩ



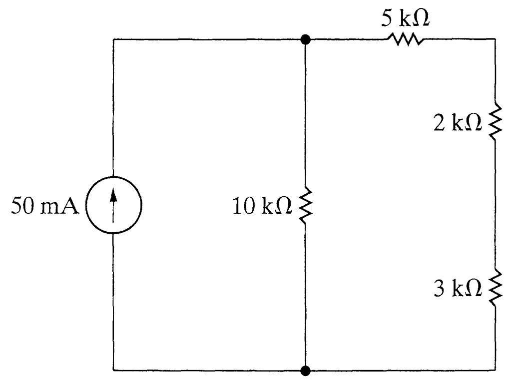
c) 300 Ω, 400 Ω, and 500 Ω



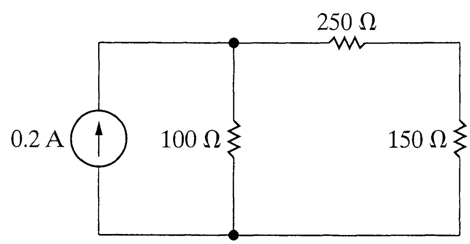
3.2 a) 10 Ω and 40 Ω; 100 Ω and 25 Ω



b) 9 kΩ, 18 kΩ, and 6 kΩ



c) 600 Ω, 200 Ω, and 300 Ω



3.5
a) $21.2\,\Omega$
b) $10\text{ k}\Omega$
c) $1600\,\Omega$

3.6
a) $30\,\Omega$
b) $5\text{ k}\Omega$
c) $80\,\Omega$

3.13
a) 10 V
b) $P_{R_1} = 800$ mW; $P_{R_2} = 200$ mW
c) $R_1 = 1600\,\Omega$; $R_2 = 400\,\Omega$ (minimum values)

3.14 $26.67\,\Omega$

3.21 $R_1 = 800\,\Omega$; $R_2 = 1.6\text{ k}\Omega$; $R_3 = 16\text{ k}\Omega$; $R_4 = 16\text{ k}\Omega$

3.22
a) 15 V, positive at the top
b) 20 mA, right to left
c) 1.5 mA, top to bottom
d) 18 V, positive at the top

3.23
a) 30 mV, positive on the left
b) 4.5 V, positive at the top
c) 0.4 A, bottom to top

3.31
a) $i_m = \dfrac{(10/99)}{10 + (10/99)} i_{\text{meas}} = \dfrac{1}{100} i_{\text{meas}}$
b) $\dfrac{1}{100{,}000}$
c) Yes

3.34
a) $49{,}980\,\Omega$
b) $4980\,\Omega$
c) $230\,\Omega$
d) $5\,\Omega$

3.49
a) $2000\,\Omega$
b) 8.4 mA
c) $800\,\Omega$; 28.8 mW
d) $500\,\Omega$; 2.88 mW

3.53 $v_1 = 23.2$ V; $v_2 = 21.0$ V

3.54
a) Equivalent wye is $5\,\Omega, 20\,\Omega, 4\,\Omega$; $R_{\text{ab}} = 33\,\Omega$.
b) Equivalent delta is $100\,\Omega, 80\,\Omega, 20\,\Omega$; $R_{\text{ab}} = 33\,\Omega$.
c) Convert R_4–R_5–R_6 delta to wye; convert R_3–R_4–R_6 wye to delta.

3.55 $90\,\Omega$

3.71 $R_1 = 1.0372\,\Omega,\ R_2 = 1.1435\,\Omega,\ R_3 = 1.2\,\Omega,$ $R_4 = 1.1435\,\Omega,\ R_5 = 1.0372\,\Omega,\ R_a = 0.0259\,\Omega,$ $R_b = 0.0068\,\Omega,\ R_c = 0.0068\,\Omega,\ R_d = 0.0259\,\Omega$

3.72 $P_{\text{diss}} = 624\text{ W} = P_{\text{del}}$

3.73
a) $R_1 = 0.4269\,\Omega,\ R_2 = 0.4617\,\Omega,\ R_3 = 0.48\,\Omega,$ $R_4 = 0.4617\,\Omega,\ R_5 = 0.4269\,\Omega,$ $R_a = 0.0085\,\Omega,\ R_b = 0.0022\,\Omega,$ $R_c = 0.0022\,\Omega,\ R_d = 0.0085\,\Omega$
b) $i_1 = 26.51$ A, $i_1^2 R_1 = 300$ W or 200 W/m; $i_2 = 25.49$ A, $i_2^2 R_2 = 300$ W or 200 W/m; $i_b = 52$ A, $i_b^2 R_b = 6$ W or 200 W/m; $P_{\text{del}} = 1548\text{ W} = P_{\text{diss}}$

Chapter 4

4.1
a) 11
b) 9
c) 9
d) 7
e) 6
f) 4
g) 6

4.2
a) 2
b) 5
c) 7
d) 1; 4; 7

4.3 a) 7

b) 3

c) 4

d) top mesh; leftmost mesh

4.4 a) 5

b) 3

c) $-i_g + i_{R_1} + i_{R_2} = 0; -i_{R_1} + i_{R_4} + i_{R_3} = 0;$
$i_{R_5} - i_{R_2} - i_{R_3} = 0$

d) 2

e) $R_1 i_{R_1} + R_3 i_{R_3} - R_2 i_{R_2} = 0;$
$R_3 i_{R_3} + R_5 i_{R_5} - R_4 i_{R_4} = 0$

4.6 −5 V

4.9 $v_1 = 120$ V, $v_2 = 96$ V

4.10 a) $i_a = 8$ A, $i_b = 2$ A, $i_c = 6$ A, $i_d = 2$ A,
$i_e = 4$ A

b) 360 W

4.19 750 W delivered

4.20 a) $P_{25A} = -8800$ W; $P_{dev} = 8800$ W

b) $P_{84i_\Delta} = 628.32$ W, $P_{40\Omega} = 3097.6$ W,
$P_{160\Omega} = 774.4$ W, $P_{10\Omega} = 1960$ W,
$P_{20\Omega} = 2247.2$ W, $P_{8\Omega} = 92.48$ W,
$P_{diss} = 8800$ W

4.21 10 V

4.26 $v_1 = -37.5$ V, $P_{25V} = 31.25$ W delivered

4.27 25 V

4.31 a) $i_a = 5.6$ A, $i_b = 3.2$ A, $i_c = -2.4$ A

b) $i_a = -8.8$ A, $i_b = -1.6$ A, $i_c = 7.2$ A

4.32 a) $P_{230V} = -1012$ W, $P_{460V} = -16{,}928$ W,
$P_{dev} = 17{,}940$ W

b) $P_{abs} = 17{,}940$ W

4.33 259.2 W

4.34 2016 W delivered

4.37 a) −312 W delivered (312 W absorbed)

b) 21,000 W

c) $P_{dev} = 21{,}000$ W $= P_{diss}$

4.38 a) 2 mA

b) 304 mW delivered

c) 0.9 mW delivered

4.43 740 W

4.46 a) $i_a = -4.2$ A, $i_b = 7.4$ A, $i_c = 4.68$ A,
$i_d = 11.6$ A, $i_e = 2.72$ A

b) $P_{dev} = 1329.632$ W $= P_{abs}$

4.52 a) Three unknown node voltages, but only two unknown mesh currents, so choose mesh current method.

b) 3.6 W

c) No, since it is straightforward to calculate the voltage drop across the current source from mesh currents.

d) 52.8 W delivered

4.54 a) Node-voltage method because constraint equations are easier to formulate.

b) 480 mW absorbed

4.55 a) −1 mA

b) −1 mA

4.58 a) -0.85 A
b) -0.85 A

4.59 $V_{Th} = 60$ V, $R_{Th} = 10\,\Omega$

4.62 $I_N = 1$ mA, top to bottom; $R_N = 3.75$ kΩ

4.63 a) 51.3 V
b) -5%

4.65 $v_{Th} = 160$ V, negative at the top; $R_{Th} = 56.4$ kΩ

4.72 1.43 μA

4.75 2.5 Ω and 22.5 Ω

4.76 a) 6 Ω
b) 24 W

4.87 a) 50 V
b) 250 W

4.88 30 V

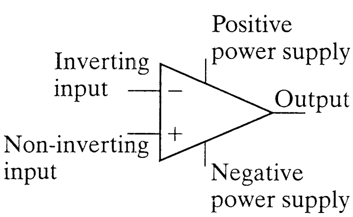
4.101 $v_1 = 39.583$ V, $v_2 = 102.5$ V

4.102 $v_1 = 37.5$ V, $v_2 = 105$ V

4.103 $v_1 = 52.083$ V, $v_2 = 117.5$ V

Chapter 5

5.1 a)



b) Input resistance is infinite, so $i_n = 0$ A
c) Gain in the linear region is infinite, so $v_p - v_n = 0$
d) -10 V

5.2 a) -15 V (saturated)
b) -10 V
c) -4 V
d) 7 V
e) $-1.08 \text{ V} \le v_a \le 4.92$ V

5.3 -1 mA

5.6 a) Use a single 20 kΩ resistor in the forward path and 6 series-connected 20 kΩ resistors in the feedback path, OR, use 6 parallel-connected 20 kΩ resistors in the forward path and a single 20 kΩ resistor in the feedback path.
b) ±18 V

5.7 a) Non-inverting amplifier
b) 9 V

5.16 a) Inverting summing amplifier
b) -4 V
c) $-2.5 \text{ V} \le v_b \le -1.3$ V

5.17 a) 14 V
b) $3.818 \text{ V} \le v_a \le 9.273$ V

5.19 $R_a = 24$ kΩ, $R_b = 12$ kΩ, $R_c = 8$ kΩ, $R_d = 6$ kΩ

5.22 a) Non-inverting amplifier
b) $2v_s$
c) $-6 \text{ V} \le v_s \le 4$ V

5.23 a) 10.54 V
b) $-4.554 \text{ V} \le v_g \le 4.554$ V
c) 181.76 kΩ

5.29 20 kΩ

5.30 a) 4.2 V
b) $-771 \text{ mV} \le v_c \le 1371$ mV

5.31 a) -1.53 V
b) 33.5 kΩ
c) 80 kΩ

5.37 a) 24.98
b) -0.04
c) 624.5

5.38 $19.93 \text{ k}\Omega \le R_x \le 20.07$ kΩ

5.39 a) -19.9915 V
b) 403.2 μV
c) 5002.02 Ω
d) -20; 0 V; 5000 Ω

5.48 a) 2 kΩ
b) 12 mΩ

Chapter 6

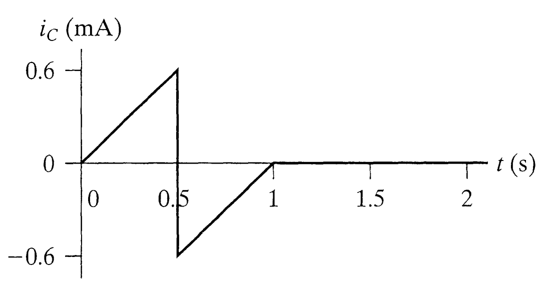
6.1 a)

$i = 0$	$t < 0$
$i = 50t$ A	$0 \le t \le 5$ ms
$i = 0.5 - 50t$ A	$5 \text{ ms} \le t \le 10$ ms
$i = 0$	$10 \text{ ms} \le t \le \infty$

b)

$v = 0$	$t < 0$
$v = 1$ V	$0 \le t \le 5$ ms
$v = -1$ V	$5 \text{ ms} \le t \le 10$ ms
$v = 0$	$10 \text{ ms} \le t \le \infty$
$p = 0$	$t < 0$
$p = 50t$ W	$0 \le t \le 5$ ms
$p = 50t - 0.5$ W	$5 \text{ ms} \le t \le 10$ ms
$p = 0$	$10 \text{ ms} \le t \le \infty$
$w = 0$	$t < 0$
$w = 25t^2$ J	$0 \le t \le 5$ ms
$w = 25t^2 - 0.5t + 0.0025$ J	$5 \text{ ms} \le t \le 10$ ms
$w = 0$	$10 \text{ ms} \le t \le \infty$

6.14



6.15 a) $8 \times 10^5 t + 12$ V

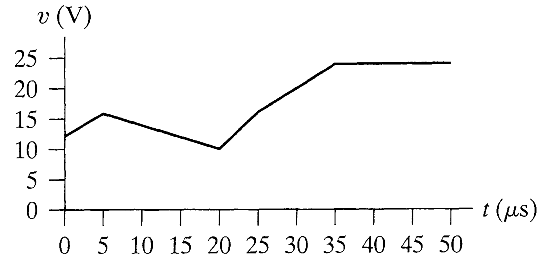
b) $-4 \times 10^5 t + 18$ V

c) $12 \times 10^5 t - 14$ V

d) $8 \times 10^5 t - 4$ V

e) 24 V

f)



6.21 15 H

6.22 a) $6e^{-t}$ A

b) $4e^{-t} - 2$ A

c) $2e^{-t} + 2$ A

d) 36 J

e) 54 J

f) 18 J

g) 54 J − 36 J = 18 J (checks)

6.26 2 μF with 25 V positive at the top

6.27 a) $10e^{-t}$ V

b) $6.67e^{-t} - 2.67$ V

c) $3.33e^{-t} + 2.67$ V

d) 100 μJ

e) 132 μJ

f) 32 μJ

g) 100 μJ + 32 μJ = 132 μJ (checks)

6.34 a) $16\frac{di_2}{dt} + 32i_2 = 2\frac{di_g}{dt}$

b) $-16e^{-t} + 32e^{-2t} + 32e^{-t} - 32e^{-2t} = 16e^{-t}$

c) $34e^{-t} - 4e^{-2t}$ V, $\quad t \ge 0$

d) 30 V; yes

6.38 a) 50 mH; 2.4

b) 0.2×10^{-6} Wb/A

6.39 0.8 nWb/A; 1.2 nWb/A

6.47 a) 2721.6 mJ

b) 2721.6 mJ

c) 518.4 mJ

d) 518.4 mJ

6.48 a) -4.5 A
b) no

6.49 $v = \frac{1}{3}v_s(t) + v(0)$

6.51 The finger causes no change in the output voltage.

Chapter 7

7.1 a) $i_1(0^-) = 5$ mA, $i_2(0^-) = 15$ mA
b) $i_1(0^+) = 5$ mA, $i_2(0^+) = -5$ mA
c) $5e^{-20,000t}$ mA
d) $-5e^{-20,000t}$ mA
e) The current in a resistor can change instantaneously.

7.2 a) 4 A
b) 80 ms
c) $i = 4e^{-12.5t}$ A, $t \geq 0$; $v_1 = -180e^{-12.5t}$ V, $t \geq 0^+$; $v_2 = -200e^{-12.5t}$ V, $t \geq 0^+$
d) 56.89%

7.3 a) 0
b) 160 mA
c) 65 mA
d) 160 mA
e) 225 mA
f) 0
g) $160e^{-200t}$ mA, $t \geq 0$
h) 0
i) -3.2 V
j) 0
k) $-3.2e^{-200t}$ V, $t \geq 0^+$
l) $225 - 160e^{-200t}$ mA, $t \geq 0^+$

7.21 a) $i = 1.6e^{-50t}$ mA, $t \geq 0^+$, $v_1 = 32e^{-50t} + 8$ V, $t \geq 0$, $v_2 = -8e^{-50t} + 8$ V, $t \geq 0$
b) 800 μJ
c) $w_{\text{trapped}} = 160\ \mu$J, $w_{\text{diss}} = 640\ \mu$J

7.22 a) $9.9e^{-1000t}$ mA
b) 42.14%

7.33 a) $i_L(t) = -2 - 3e^{-5000t}$ A, $t \geq 0$; $v_o(t) = 48 - 48e^{-5000t}$ V, $t \geq 0$
b) $v_L(0^+) = 60$ V, $v_o(0^+) = 0$ V

7.34 a) $5 + 15e^{-1000t}$ A, $t \geq 0$
b) $50 - 450e^{-1000t}$ V, $t \geq 0^+$

7.35 $i_o(t) = 2.5 + 7.5e^{-1250t}$ A, $t \geq 0$; $v(t) = -150e^{-1250t}$ V, $t \geq 0$

7.47 $-60 + 90e^{-2000t}$ V, $t \geq 0$

7.48 a) $60 - 60e^{-100t}$ V, $t \geq 0$
b) $1 - 0.6e^{-100t}$ mA, $t \geq 0^+$
c) $1 + 2.4e^{-100t}$ mA, $t \geq 0^+$
d) $4 - 2.4e^{-100t}$ mA, $t \geq 0^+$
e) 3.4 mA

7.61 a) 50 V
b) -24 V
c) 0.1 μs
d) -18.5 A
e) $-24 + 74e^{-10^7 t}$ V, $t \geq 0$
f) $-18.5e^{-10^7 t}$ A, $t \geq 0^+$

7.62 a) 90 V
b) -60 V
c) 1000 μs
d) 916.3 μs

7.63 a) -13 mA
b) -12 mA
c) 80 μs
d) $-12 - e^{-12,500t}$ mA, $t \geq 0$

7.64 a) $6 - 6e^{-10t}$ A, $t \geq 0$
b) $100e^{-10t}$ V, $t \geq 0$
c) $7 - 7e^{-10t}$ A, $t \geq 0$
d) $-1 + e^{-10t}$ A, $t \geq 0$
e) Yes, check initial conditions and final values.

7.66 a) $4 - 4e^{-20t}$ A, $t \geq 0$
b) $80e^{-20t}$ V, $t \geq 0^+$
c) $2.4 - 2.4e^{-20t}$ A, $t \geq 0$
d) $1.6 - 1.6e^{-20t}$ A, $t \geq 0$
e) Yes, check initial conditions and final values.

7.69 $-100 + 130e^{-200t}$ V, $t \geq 0$

7.70 a) 7.5 A
b) 6.14 A
c) 226.48 mA
d) −220.73 V
e) −110.4 V

7.84 a) 2.25
b) 272.1 μs

7.85 83.09 ms

7.89 80 ms

7.90 $v_o = 8 - 1600t$ V, $0 \leq t \leq t_{sat}$;
$v_2 = 11e^{-200t} - 15$ V, $0 \leq t \leq t_{sat}$;
$v_f = 23 - 1600t - 11e^{-200t}$ V, $0 \leq t \leq t_{sat}$

7.103 a) 1.091 MΩ
b) 0.29 s

7.104 a) 8.55 flashes/min
b) 559.3 kΩ

7.105 a) 24.3 flashes/min
b) 99.06 mA
c) $43.39 per year

Chapter 8

8.1 a) −100 rad/s, −400 rad/s
b) overdamped
c) 1562.5 Ω
d) $-160 + j120$ rad/s, $-160 - j120$ rad/s
e) 1250 Ω

8.2 a) $R = 8$ kΩ, $L = 40$ H, $\alpha = 625$ rad/s, $\omega_0 = 500$ rad/s
b) $i_R(t) = 4e^{-1000t} - e^{-250t}$ mA, $t \geq 0^+$;
$i_C(t) = 0.2e^{-250t} - 3.2e^{-1000t}$ mA, $t \geq 0^+$;
$i_L(t) = 0.8e^{-250t} - 0.8e^{-1000t}$ mA, $t \geq 0^+$

8.7 a) 40 mH
b) 625 Ω
c) 100 V
d) 40 mA
e) $e^{-20,000t}(40 \cos 15,000t + 220 \sin 15,000t)$ mA, $t \geq 0$

8.8 a) $\alpha = 500$ rad/s, $\omega_0 = 400$ rad/s, $L = 1.5625$ H, $C = 4\ \mu$F, $A_1 = -31$ mA, $A_2 = 76$ mA
b) $38.75e^{-200t} - 23.75e^{-800t}$ V, $t \geq 0$
c) $155e^{-200t} - 95e^{-800t}$ mA, $t \geq 0^+$
d) $-124e^{-200t} + 19e^{-800t}$ mA, $t \geq 0$

8.9 a) $R = 1$ kΩ, $C = 1\ \mu$F, $D_1 = 6000$ V/s, $D_2 = 8$ V
b) $(-3000t + 2)e^{-500t}$ mA, $t \geq 0^+$

8.16 $5e^{-2000t} + 10e^{-8000t}$ V, $t \geq 0$

8.17 $15e^{-2000t} \cos 3122.5t + 4.8e^{-2000t} \sin 3122.5t$ V, $t \geq 0$

8.18 $15e^{-4000t}$ V, $t \geq 0$

8.24 $60 - 120e^{-5000t} + 15e^{-20,000t}$ mA, $t \geq 0$

8.25 $60 - 105e^{-8000t} \cos 6000t - 90e^{-8000t} \sin 6000t$ mA, $t \geq 0$

8.26 $60 - 750,000te^{-10,000t} - 105e^{-10,000t}$ mA, $t \geq 0$

8.40 $-2.4e^{-4t} \cos 3t - 3.2e^{-4t} \sin 3t$ A, $t \geq 0^+$

8.42 a) $10,000te^{-10^5 t} + 0.1e^{-10^5 t}$ A, $t \geq 0$
b) $25 \times 10^5 te^{-10^5 t} + 50e^{-10^5 t}$ V, $t \geq 0$

8.46 a) 24 V
b) −53,248 V/s
c) $-40 - 25.6e^{-160t} + 89.6e^{-640t}$ V, $t \geq 0^+$

8.51 a) $v_o = 10t^2$ V, $0 \leq t \leq 0.5^-$ s;
$v_o = -5t^2 + 15t - 3.75$ V, $0.5^+\text{ s} \leq t \leq t_{sat}$;
$v_{o1} = -1.6t$ V, $0 \leq t \leq 0.5^-$ s;
$v_{o1} = 0.8t - 1.2$ V, $0.5^+\text{ s} \leq t \leq t_{sat}$
b) 3.5 s

8.52 $v_o = 10 - 20e^{-t} + 10e^{-2t}$ V, $0 \le t \le 0.5$ s; $v_o = -5 + 19.42e^{-(t-0.5)} - 12.87e^{-2(t-0.5)}$ V, $0.5 \le t \le \infty$; $v_{o1} = -0.8 + 0.8e^{-2t}$ V, $0 \le t \le 0.5$ s; $v_{o1} = 0.4 - 0.91e^{-2(t-0.5)}$ V, $0.5 \le t \le \infty$

8.60 a) $55.23\,\mu$s

b) 262.42 V

c) $t_{max} = 53.63\,\mu$s, $v(t_{max}) = 262.15$ V

8.61 a) 40 mJ

b) −27,808.04 V

c) 568.15 V

Chapter 9

9.1 a) 600 Hz

b) 1.67 ms

c) 10 V

d) 6 V

e) −53.13° or −0.9273 rad

f) $662.64\,\mu$s

g) $245.97\,\mu$s

9.2 $\frac{V_m}{2}$

9.3 a) 40 V

b) 50 Hz

c) 314.159 rad/s

d) 1.05 rad

e) 60°

f) 20 ms

g) 6.67 ms

h) $40\cos 100\pi t$ V

i) 8.33 ms

j) 16.67 ms

9.9 a) $-195.72e^{-1066.67t} + 200\cos(800t - 11.87°)$ mA

b) $-195.72e^{-1066.67t}$ mA, $200\cos(800t - 11.87°)$ mA

c) 28.39 mA

d) 0.2 A, 800 rad/s, −11.87°

e) 36.87°

9.12 a) 1000 Hz

b) 0°

c) −90°

d) 8 Ω

e) 1.27 mH

f) $j8\,\Omega$

9.13 a) 314,159.27 rad/s

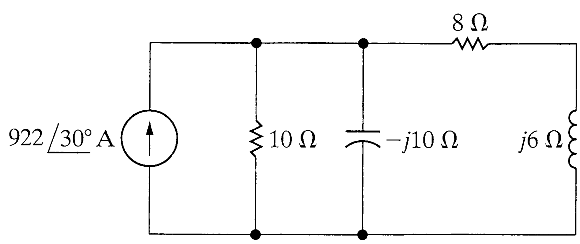
b) 90°

c) −15.92 Ω

d) $0.2\,\mu$F

e) $-j15.92\,\Omega$

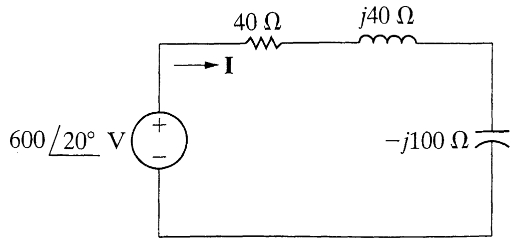
9.14 a)



b) 5000.25 /17.47° V

c) $5000.25\cos(2 \times 10^4 t + 17.47°)$ V

9.15 a)



b) $8.32 \angle 76.31^\circ$ A

c) $8.32 \cos(8000t + 76.31^\circ)$ A

9.16 $17.68 \cos(50t - 135^\circ)$ mA

9.17 a) $200 \angle 36.87^\circ$ mS

b) 160 mS

c) 120 mS

d) 10 A

9.18 $42.43 \cos(2000t + 45^\circ)$ V

9.19 a) $50 \angle 45^\circ\ \Omega$

b) $50\ \mu$s

9.20 $42.43 \cos(50{,}000t + 45^\circ)$ V

9.35 $0.667\ \Omega$

9.39 $10 \cos 200t$ mV

9.42 $227.68 \angle -18.43^\circ$ V, positive at the top; $3.6 + j10.8\ \Omega$

9.43 $2.2 \angle 0^\circ$ A, flowing top to bottom; $30 - j40\ \Omega$

9.51 $188.43 \angle -42.88^\circ$ V

9.54 $36 \cos 2000t$ V

9.56 $j80$ V $= 80 \angle 90^\circ$ V

9.59 $4 - j2$ A $= 4.47 \angle -26.57^\circ$ A

9.66 a) $i_g = 5 \cos(5000t - 36.87^\circ)$ A, $i_L = \cos(5000t - 180^\circ)$ A

b) 0.5

c) 9.0 mJ, 12 mJ

9.67 $850 + j850$ V, positive at the top; $85 + j85\ \Omega$

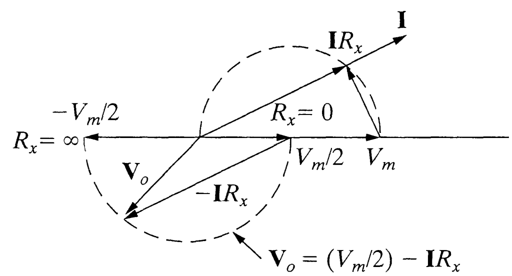
9.71 $512 \angle 60^\circ$ kΩ

9.75 a) $247.11 \angle 1.68^\circ$ V

b) $-32\ \Omega$, $241.13 \angle 1.90^\circ$ V

c) $-26.90\ \Omega$

9.76 As R_x varies from 0 to ∞, the amplitude of v_o remains constant and its phase angle changes from 0 to -180°.



9.85 a) $\mathbf{I}_1 = 24 \angle 0^\circ$ A, $\mathbf{I}_2 = 2.04 \angle 0^\circ$ A, $\mathbf{I}_3 = 21.96 \angle 0^\circ$ A, $\mathbf{I}_4 = 19.40 \angle 0^\circ$ A, $\mathbf{I}_5 = 4.6 \angle 0^\circ$ A, $\mathbf{I}_6 = 2.55 \angle 0^\circ$ A

b) $0.42 \angle 0^\circ$ A

9.86 a) 0 A

b) 0.436 A

c) When the two loads are equal, more current is drawn from the primary.

Chapter 10

10.1 a) $P = 409.58$ W (abs); $Q = 286.79$ VAR (abs)

b) $P = 103.53$ W (abs); $Q = -386.37$ VAR (del)

c) $P = -1000$ W (del); $Q = -1732.05$ VAR (del)

d) $P = -250$ W (del); $Q = 433.01$ VAR (abs)

13.49 a) $\dfrac{200}{s+200}$ pole at -200 rad/s

b) $\dfrac{s}{s+200}$ zero at 0, pole at -200 rad/s

c) $\dfrac{s}{s+8000}$ zero at 0, pole at -8000 rad/s

d) $\dfrac{8000}{s+8000}$ pole at -8000 rad/s

e) $\dfrac{100}{s+500}$ pole at -500 rad/s

13.57 $1-e^{-t}$ V, $0 \le t \le 1$; $(e-1)e^{-t}$ V, $1 \le t \le \infty$

13.58 e^{-t} V, $0 \le t \le 1$; $(1-e)e^{-t}$ V, $1 \le t \le \infty$

13.76 $16.97\cos(3t+8.13^\circ)$ V

13.77 a) $\dfrac{-10^4 s}{(s+400)(s+1000)}$

b) $13.13\cos(400t-156.8^\circ)$ V

13.83 a) 80 V

b) 20 V

c) 0 V

d) $32\delta(t)\ \mu$A

e) 16 V

f) 4 V

g) 20 V

13.84 a) 0.8 A

b) 0.6 A

c) 0.2 A

d) -0.6 A

e) $0.6e^{-2\times10^6 t}u(t)$ A

f) $-0.6e^{-2\times10^6 t}u(t)$ A

g) $-1.6\times10^{-3}\delta(t) - 7200e^{-2\times10^6 t}u(t)$ V

13.89 a) $i_2(0^-) = i_2(0^+) = 0$ A;
$i_L(0^-) = i_L(0^+) = 35.36$ A

b) $V_0 =$

$$\frac{1440\pi(122.92\sqrt{2}s - 3000\pi\sqrt{2})}{(s+1475\pi)(s^2+14{,}400\pi^2)} + \frac{300\sqrt{2}}{s+1475\pi};$$

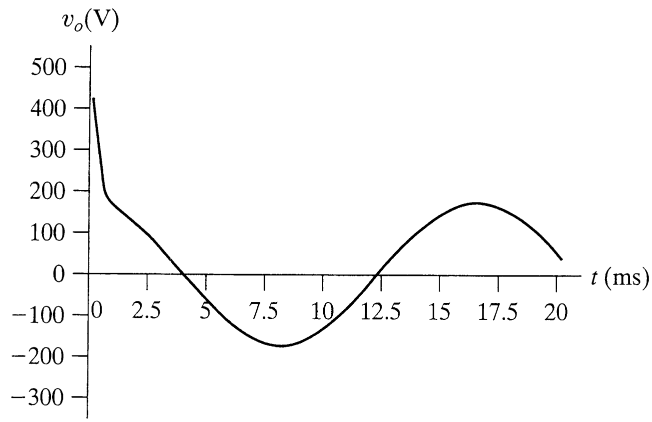
$v_0(t) =$

$252.89e^{-1475\pi t} + 172.62\cos(120\pi t + 6.85^\circ)$ V;

$v_0(0^+) = 424.26$ V

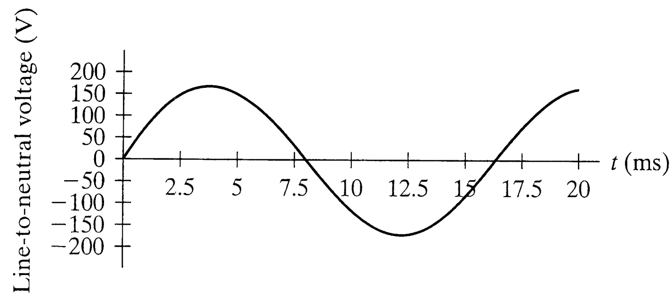
c) $\mathbf{V}_0 = 122.06\ \angle 6.85^\circ$ V (rms)

d)



13.90 a) $-20.58e^{-1475\pi t} + 172.62\cos(120\pi t - 83.15^\circ)$ V

b)



c) Voltage spikes in Problem 13.89 but not here

Chapter 14

14.1 a) 2021.27 Hz

b) $H(j\omega_c) = 0.71\ \angle -45^\circ$;
$H(j0.2\omega_c) = 0.98\ \angle -11.31^\circ$;
$H(j5\omega_c) = 0.2\ \angle -78.69^\circ$

c) $v_o(\omega_c) = 7.07\cos(12{,}700t - 45^\circ)$ V;
$v_o(0.2\omega_c) = 9.81\cos(2540t - 11.31^\circ)$ V;
$v_o(5\omega_c) = 1.96\cos(63{,}500t - 78.69^\circ)$ V

14.2 a) $31.42\ \Omega$

b) 895.77 Hz

14.9 a) $5.31\ \text{k}\Omega$

b) 333.86 Hz

14.10 a) $125\ \Omega$

b) $3\ \text{k}\Omega$

14.15 a) 100 krad/s

b) 15.92 kHz

c) 8

d) 93.95 krad/s

e) 14.96 kHz

f) 106.45 krad/s

g) 16.94 kHz

h) 12.5 krad/s or 1.99 kHz

14.16 a) $R = 5\ \text{k}\Omega,\ L = 50\ \text{mH}$

b) $f_{c1} = 2.88\ \text{kHz},\ f_{c2} = 3.52\ \text{kHz}$

c) 636.62 Hz

14.24 a) 1 Mrad/s

b) 159.15 kHz

c) 15

d) 967.22 krad/s

e) 153.94 kHz

f) 1.03 Mrad/s

g) 164.55 kHz

h) 10.61 kHz

14.25 a) $R = 397.89\ \Omega,\ L = 3.17\ \text{mH}$

b) $f_{c1} = 3.62\ \text{kHz},\ f_{c2} = 4.42\ \text{kHz}$

c) 800 Hz

14.31 a) $L = 0.39\ \text{H},\ C = 0.1\ \mu\text{F}$

b) $0.948|V_{\text{peak}}|$

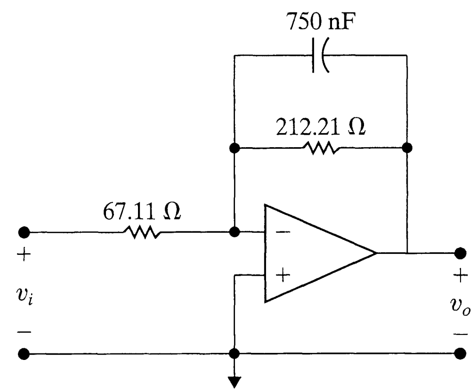
c) $0.344|V_{\text{peak}}|$

14.32 $L = 0.225\ \text{H},\ C = 0.057\ \mu\text{F},\ 0.344|V_{\text{peak}}|$

Chapter 15

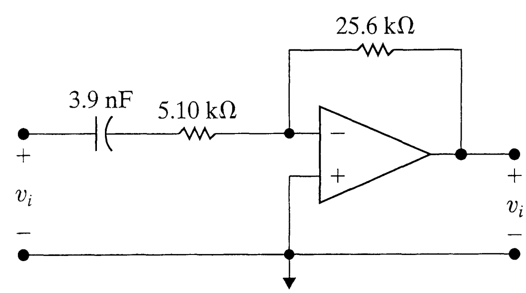
15.4 a) $R_1 = 67.11\ \Omega, \quad R_2 = 212.21\ \Omega$

b)



15.5 a) $R_1 = 5.10\ \text{k}\Omega, \quad R_2 = 25.6\ \text{k}\Omega$

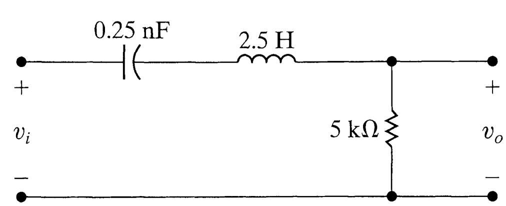
b)



15.9 a) $R = 0.05\ \Omega, \quad L = 1\ \text{H} \quad C = 1\ \text{F}$

b) $R = 5\ \text{k}\Omega, \quad L = 2.5\ \text{H} \quad C = 0.25\ \text{nF}$

c)

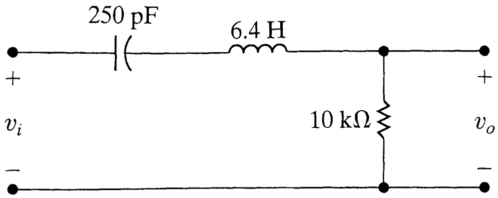


15.10 a) $1/Q$

b) $\dfrac{s/Q}{s^2 + s/Q + 1}$

c) $R = 10\ \text{k}\Omega, \quad L = 6.4\ \text{H}, \quad C = 250\ \text{pF}$

d)



e) $\dfrac{1562.5s}{s^2 + 1562.5s + 625 \times 10^6}$

15.25 $f_{c1} = 38.52$ Hz, $f_{c2} = 1038.52$ Hz, $R_{\text{L}} = 30.65\ \Omega$, $R_{\text{H}} = 826.43\ \Omega$

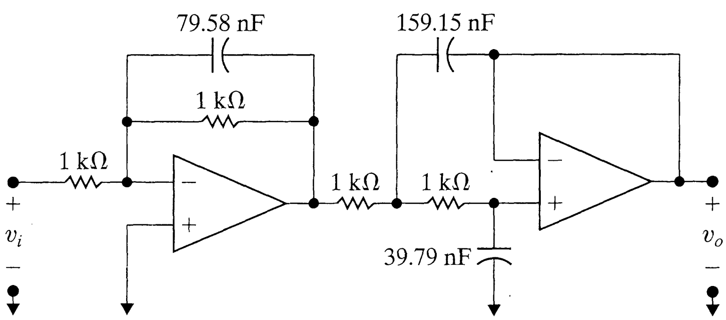
15.26 $R_{\text{L}} = 21.18\ \text{k}\Omega$, $R_{\text{H}} = 1.18\ \text{k}\Omega$, $\dfrac{R_f}{R_i} = 6$

15.28 a) 3

b) −32.65 dB

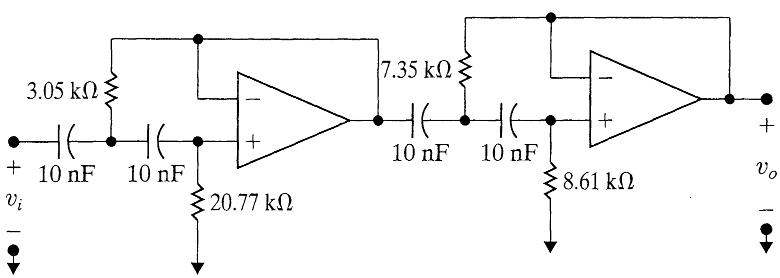
15.31 a) First-order circuit: $R = 1\ \text{k}\Omega$, $C = 79.58$ nF
Second-order circuit: $R = 1\ \text{k}\Omega$,
$C_1 = 159.15$ nF, $C_2 = 39.79$ nF

b)



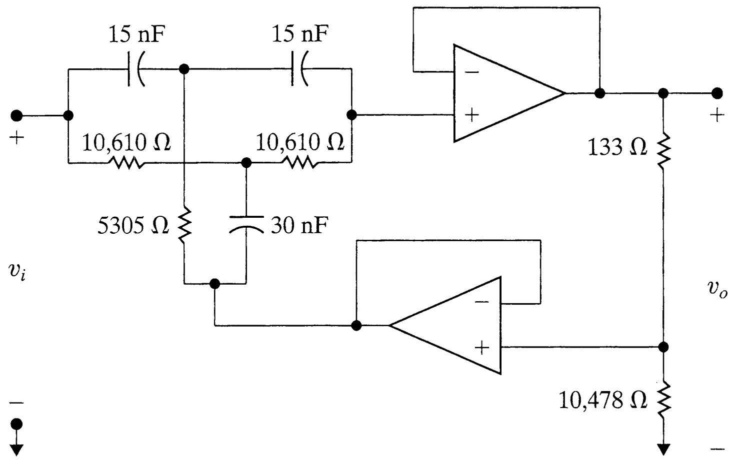
15.32 a) First section: $R_1 = 3.05\ \text{k}\Omega$, $R_2 = 20.77\ \text{k}\Omega$
Second section: $R_1 = 7.35\ \text{k}\Omega$, $R_2 = 8.61\ \text{k}\Omega$

b)



15.53 a) $R = 10{,}610\,\Omega$; $\sigma R = 10{,}478\,\Omega$;
$(1-\sigma)R = 133\,\Omega$

b)



c) $$\frac{s^2 + 4 \times 10^6\pi^2}{s^2 + 100\pi s + 4 \times 10^6\pi^2}$$

15.54 $C = 39.79$ nF, $|H(j\omega)|_{\max} = 20.01$ dB,
$|H(j/R_2C_1)| = 17.04$ dB

15.55 Choose $R_1 = 100\ \text{k}\Omega$, then $R_2 = 400\ \text{k}\Omega$,
$C_1 = 7.96$ nF.

Chapter 16

16.1 a) $\omega_{oa} = 31{,}415.93$ rad/s, $\omega_{ob} = 3978.87$ rad/s

b) $f_{oa} = 5$ kHz, $f_{ob} = 25$ kHz

c) $a_{va} = 0$, $a_{vb} = 25$ V

d) $a_{va} = 0$; $a_{ka} = 0$ for k even;

$a_{ka} = \frac{-80}{\pi k}\sin\frac{\pi k}{2}$ for k odd;

$b_{ka} = 0$ for k even; $b_{ka} = \frac{240}{\pi k}$ for k odd;

$a_{ab} = 25$; $a_{kb} = \frac{200}{\pi k}\sin\frac{\pi k}{4}$ for all k;

$b_{kb} = 0$ for all k

e) $$v_a(t) = \frac{80}{\pi}\sum_{n=1,3,5,\ldots}^{\infty} -\frac{1}{n}\sin\frac{\pi n}{2}\cos n\omega_o t + \frac{3}{n}\sin n\omega_o t \ \text{V};$$

$$v_b(t) = 25 + \frac{200}{\pi}\sum_{n=1}^{\infty}\frac{1}{n}\sin\frac{n\pi}{4}\cos n\omega_o t \ \text{V}$$