Tutorial Answers

2B.1

2 C

2B.2

48 mΩ

2B.3

3.7 Ω

2B.5

10 V, −5 V

2B.6

$i_C = -6\text{ A}$, $i_E = -4\text{ A}$, $i_F = 4\text{ A}$, $i_G = 2\text{ A}$

3B.1

(a) $v_3 = 25\text{ V}$

(b) $I_S = 5/4\text{ A}$

(c) $I_3 = 5/12\text{ A}$

3B.2

$v_1 = 20/3\text{ V},\ v_2 = -10/3\text{ V},\ I_S = 10/3\text{ A}$

3B.3

$I_{20} = 2\text{ A} \rightarrow,\ I_{10} = 3\text{ A} \downarrow,\ I_{12} = 1\text{ A} \leftarrow,\ I_{14} = 2\text{ A} \rightarrow$

4A

(a) 2.52 V

(b) 50.0 mA

(c) 87.6 mW

(d) 2.0 V

(e) 43.8 mA

4B.1

$I_S = 10/3\,\text{A}$

4B.2

(a) $V_{Th} = 12\,\text{V}$, $I_N = 12/5\,\text{A}$, $R_{Th} = R_N = 5\,\Omega$

(b) $R_L = 5\,\Omega$

(c) 7.2 W

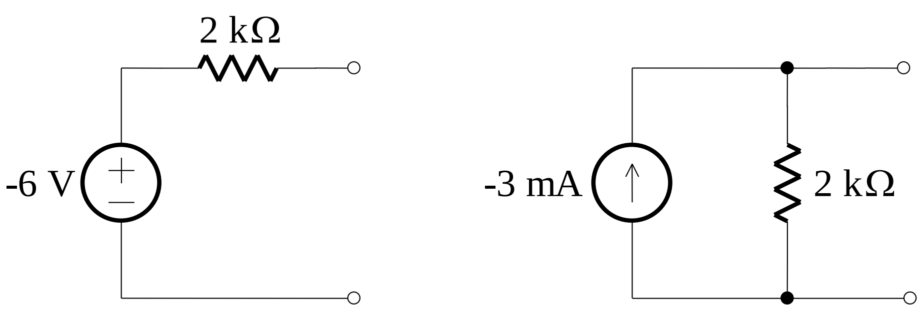
4B.3

(a) $R_{Th} = 2\,\text{k}\Omega$

(b) $V_{Th} = -6\,\text{V}$

(c) $I_N = -3\,\text{mA}$

(d)



(e) $I_L = -1\,\text{mA}$

(f) $R_L = 2\,\text{k}\Omega$

(g) $P_{L\max} = 9/2\,\text{mW}$

5A

(h) $R_{21} = 4\text{M}02$, $R_{22} = 16\text{M}0$

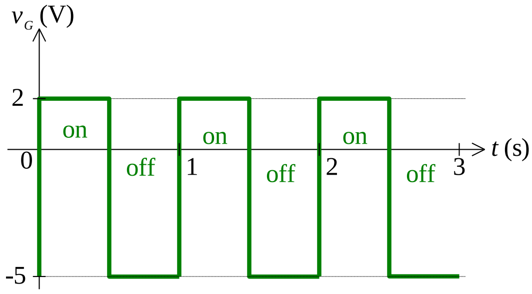
(i) $R_{23} = 5\text{M}49$, $R_{24} = 4\text{M}53$

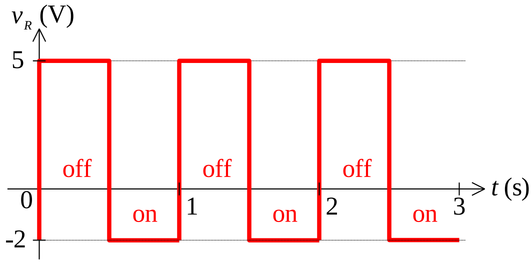
(j) $R_{25} = 5\text{M}49$, $R_{26} = 4\text{M}53$

(k) $R_{27} = 680\,\text{k}$, $R_{28} = 6\text{M}2$, $R_{29} = 3\text{M}3$

5B.1

(a)

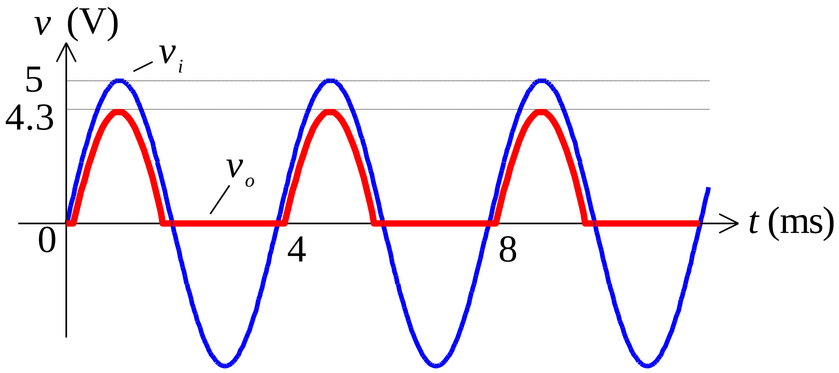




(b) The green and red LEDs would light alternately every second.

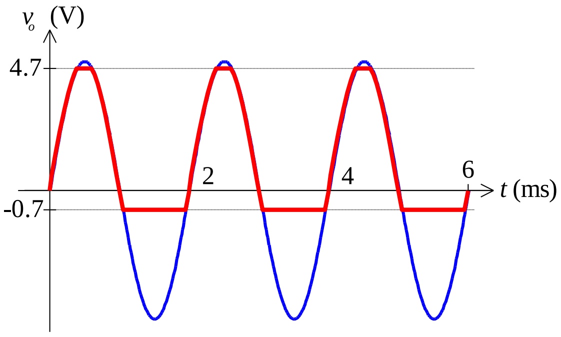
5B.2

(a)



(b) $\hat{I} = 4.3\,\text{mA}$

5B.3



5B.4

Input protection from overvoltage, undervoltage and electrostatic discharge (ESD) events.

6A

(a) (i) $R = 45\,\Omega$ (ii) $I_{\text{Dmin}} = 29\,\text{mA}$, $I_{D\max} = 11\,\text{mA}$ (iii) 60%

There is a large variation in output luminosity due to the variance of the LED characteristic.

(b) $R_{102} = 3\text{k}74$

This circuit sets a constant current, and therefore a constant luminosity of the LED.

6B.1

(a) $2.46\times10^{-7}\angle\text{-}18.1°$ N

(b) -18.1°

(c) $24.6\angle\text{-}18.1°$ Vm^{-1}

6B.2

(a) $\mathbf{E}=\dfrac{q}{4\pi\varepsilon_0 r^2}\hat{\mathbf{r}}$, $\hat{\mathbf{r}}$ points along a spherical radius

(b) $\mathbf{E}=\mathbf{0}$

(c) $\mathbf{E}=\dfrac{\lambda}{2\pi\varepsilon_0 r}\hat{\mathbf{r}}$, $\hat{\mathbf{r}}$ points along a cylindrical radius

(d) $\mathbf{E}=\dfrac{\sigma}{2\varepsilon_0}\hat{\mathbf{r}}$, $\hat{\mathbf{r}}$ points perpendicularly to the plane

A.10

7A

(a) No

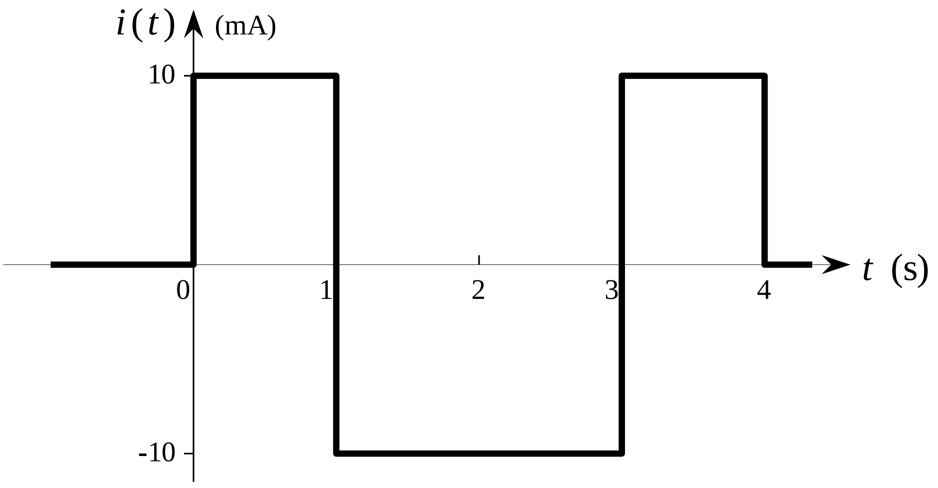
(b) $1/C_{\text{ser}} = 1/C_{\text{small}} + 1/C_{\text{large}} \approx 1/C_{\text{small}} \quad \therefore C_{\text{ser}} \approx C_{\text{small}}$

(c) 2.556 pF

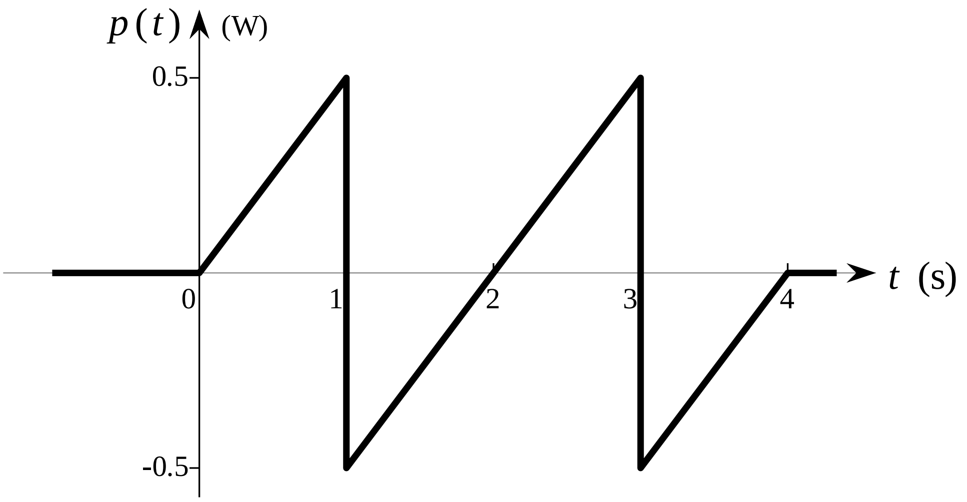
(d) 10.89 pF

7B.1

(e)



(f)



(g) 0.25 J

8A

(a) $L21 = 22\ \mu\text{H}$

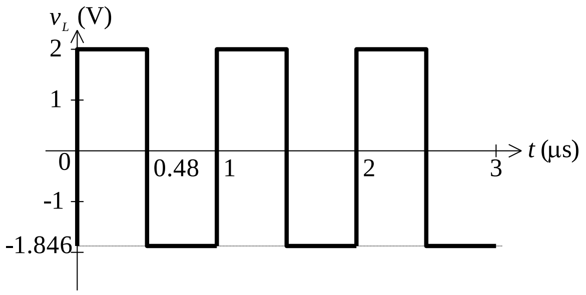
(b) $T = 1\ \mu\text{s}$

(c) $I_p = 43.64\ \text{mA}$

(d) $I_o = 21.82\ \text{mA}$

(e) 20.95 mW

(f)



8B.1

(a) 20.6 ms (b) 177.7 ms

8B.2

(a) $60\cos 10t$ V (b) $5+2\sin 10t$ A

9A

(a) A = battery present, B = button working, C = energy harvester working
G = green LED on, R = red LED on

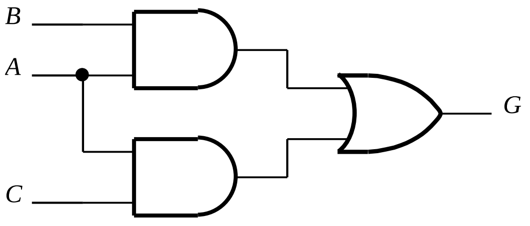
(b)

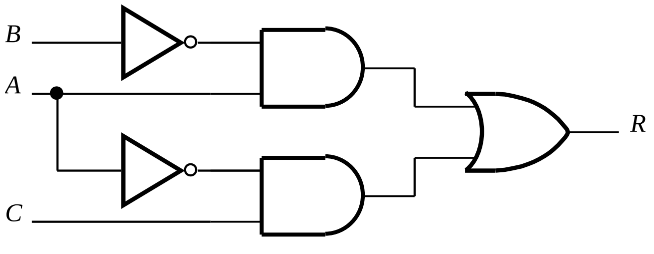
A	*B*	*C*	*G*	*R*
0	0	0	0	0
0	0	1	0	1
0	1	0	0	0
0	1	1	0	1
1	0	0	0	1
1	0	1	1	1
1	1	0	1	0
1	1	1	1	0

(c) $G = A\overline{B}C + AB\overline{C} + ABC$, $R = \overline{A}\,\overline{B}C + \overline{A}BC + A\overline{B}\,\overline{C} + A\overline{B}C$

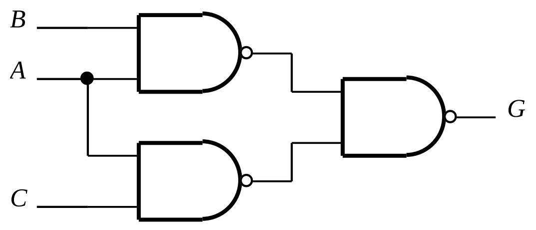
(d) $G = A(B + C)$, $R = A\overline{B} + \overline{A}C$

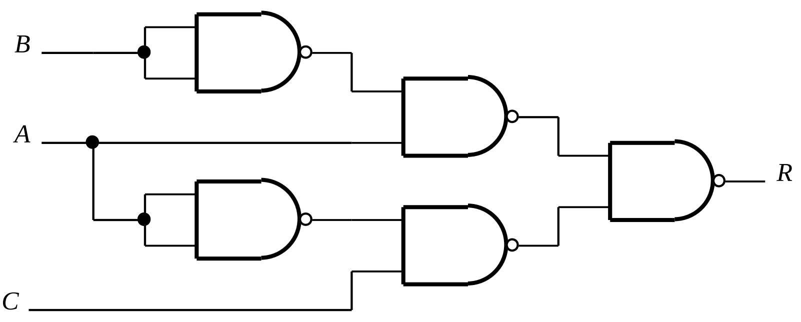
(e)





(f)



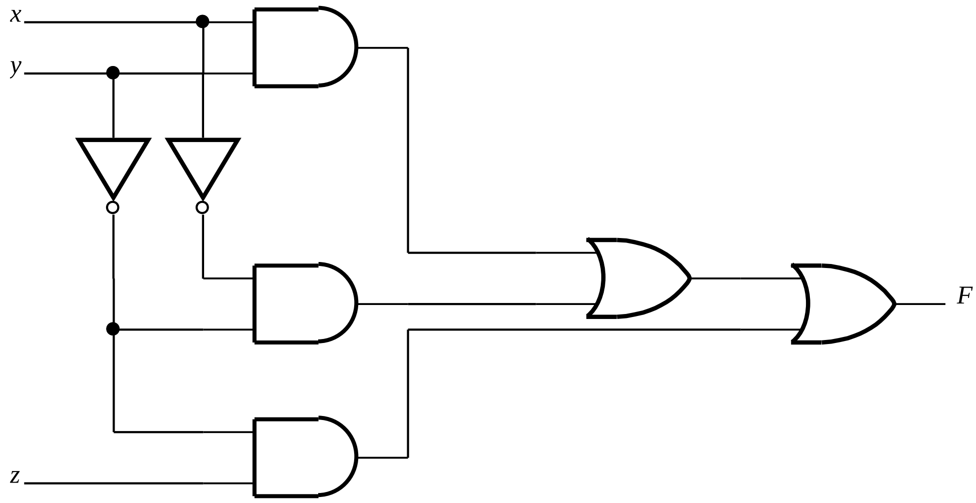


9B.1

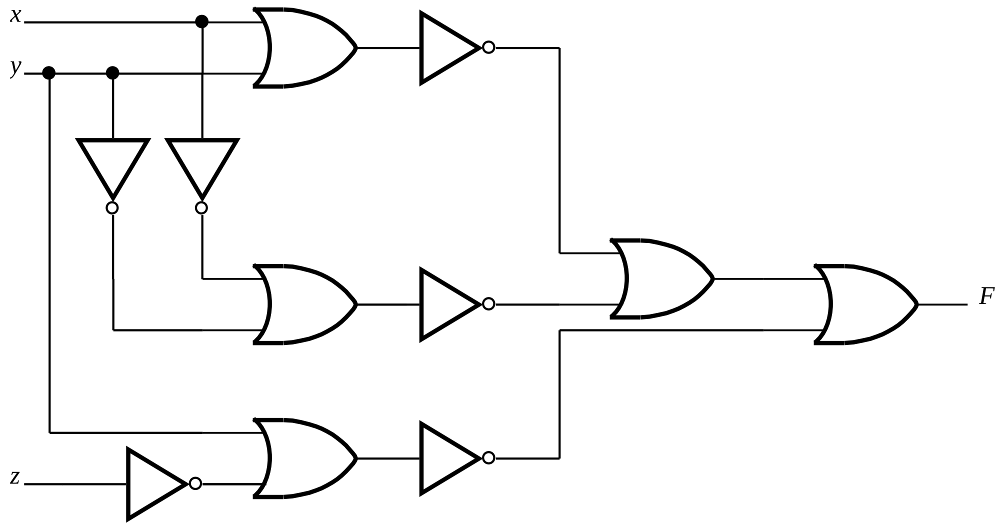
$L = (A + B)C$

9B.2

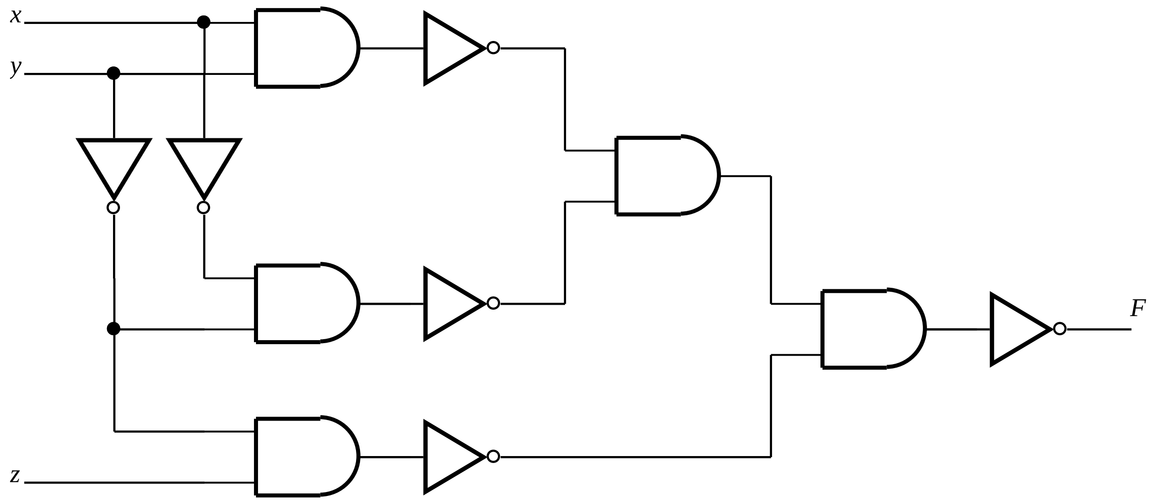
(a)



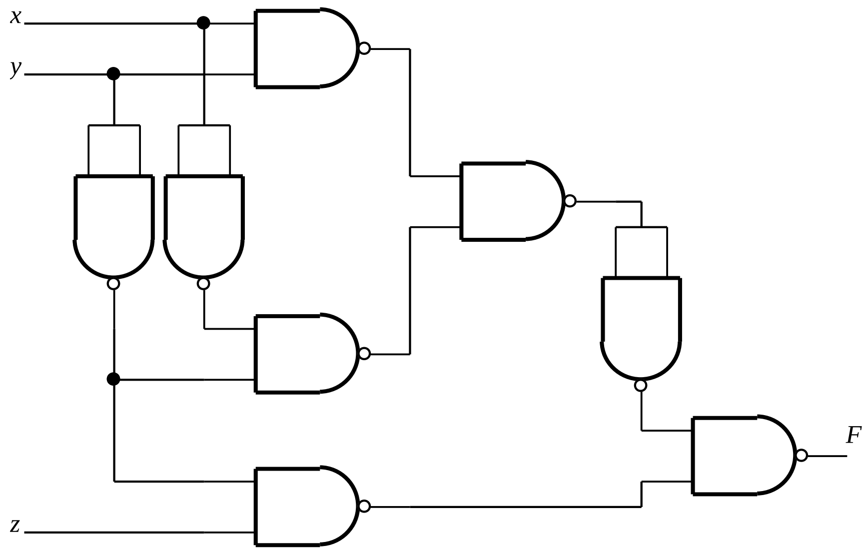
(b)



(c)

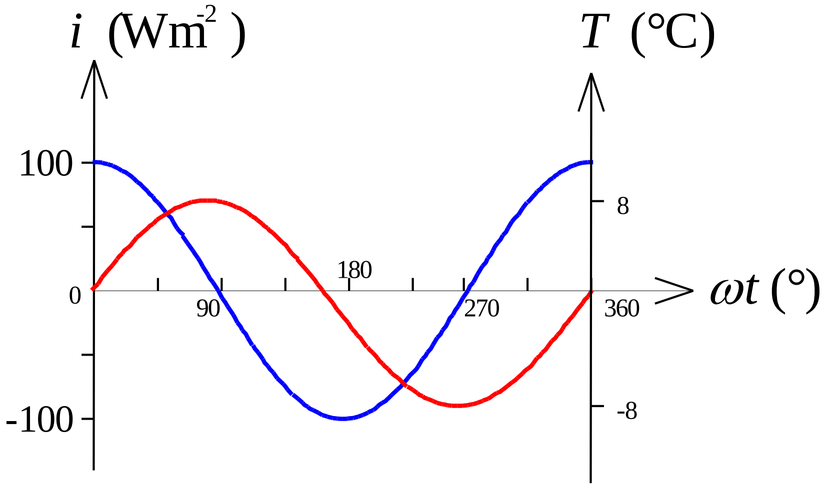


(d)



10A

(a)



(b) $T = 52$ weeks, $\omega = \dfrac{2\pi}{52}$ rad/week, $f = 31.80$ nHz

(c) Temperature deviation lags solar intensity deviation because its peak occurs later in time.

(d) $-90°$

(e) 7.494 °C

(f) $\mathbf{I} = 100\angle 0°$, $\mathbf{T} = 80\angle -90°$

10B.1

(a) $i(t) = 5.51\cos(314t - 33.8°)\text{ A}$

(b) $i(5\text{m}) = 5.029 - 4.32 + 2.37 = 3.08\text{ A}$

10B.2

(a) $-1.5 \pm j1.323$, $2\angle \pm 138.6°$, $2e^{\pm j138.6°}$

(b) $4.088\angle 95.73°$

(c) $3.768 - j10.53$

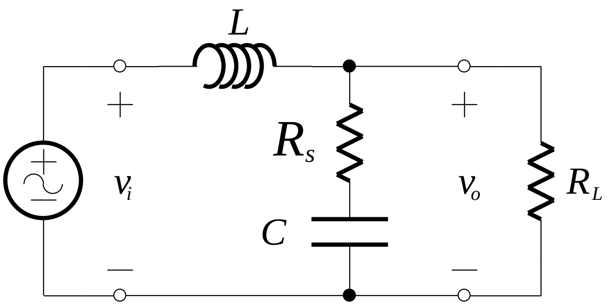
(d) $3.125\angle 85.65°$

(e) $2.236\angle 63.43°$, $2.236\angle -116.6°$

(f) $14.72\angle -50.93°$

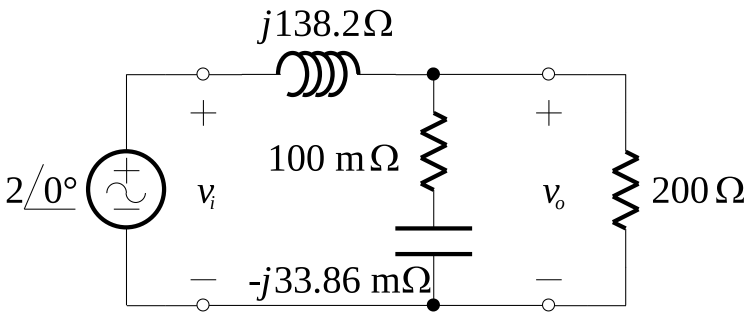
11A

(a)



(b) 4 V

(c)



(d) 7.662×10^{-4}

(e) -62.37 dB

11B.1

(a) $\mathbf{Z}_T = 3 - j4 = 5\angle -53.13°\ \Omega$

(b) $i(t) = 14.14\cos(10^4 t - 36.87°)$ A

(c) $v_R(t) = 42.42\cos(10^4 t - 36.87°)$ V

$v_L(t) = 84.84\cos(10^4 t + 53.13°)$ V

$v_C(t) = 141.4\cos(10^4 t - 126.87°)$ V

(d) $L = 0.8$ mH

(e) The impedance magnitude increases, consequently the peak value of current decreases. The phase angle changes to 66.88°, indicating that the current is *lagging* the voltage. The circuit has gone from being predominantly capacitive to predominantly inductive.

11B.2

(a) $395\angle -1.5°$ mA

(b) 0 V

(c) 90°

(d) $R = 12\ \Omega$ in series with $C = 50\ \mu\text{F}$

11B.3

(a)

$$\begin{aligned}(5+j4)I_1-(3+j4)I_2&=18\angle 80^\circ\\-(3+j4)I_1+(7+j)I_2&=(4-j3)I_3\\I_3&=-6\end{aligned}$$

(b)

$$\begin{aligned}(5+j4)I_1-(3+j4)I_2&=18\angle 80^\circ\\-(3+j4)I_1+(7+j)I_2&=-24+j18\end{aligned}$$

(c) $\mathbf{I}_1=4.194\angle 135.3^\circ\text{ A}$, $\mathbf{I}_2=6.669\angle 153.4^\circ\text{ A}$

(d) $\mathbf{I}_A=2.982\angle -0.6917^\circ\text{ A}$

(e) $i_1(t)=4.194\cos(314t+135.3^\circ)\text{ A}$, $i_2(t)=6.669\cos(314t+153.4^\circ)\text{ A}$

(f) $i_b(t)=6.669\cos(314t-26.6^\circ)\text{ A}$