APPENDIX C

PC.1 Because the capacitor voltage is zero at $t = 0$, the charge on the capacitor is zero at $t = 0$. Then using Equation 3.5 in the text, we have

$$q(t) = \int_0^t i(t)dx + 0$$

$$= \int_0^t 3dx = 3t$$

For $t = 2\ \mu\text{s}$, we have

$$q(3) = 3 \times 2 \times 10^{-6} = 6\ \mu\text{C}$$

PC.2 Refer to Figure PC.2 in the book. Combining the 10-Ω resistance and the 20-Ω resistance we obtain a resistance of 6.667 Ω, which is in series with the 5-Ω resistance. Thus, the total resistance seen by the 15-V source is 5 + 6.667 = 11.667 Ω. The source current is 15/11.667 = 1.286 A. The current divides between the 10-Ω resistance and the 20-Ω resistance. Using Equation 2.27, the current through the 10-Ω resistance is

$$i_{10} = \frac{20}{20+10} \times 1.286 = 0.8572\ \text{A}$$

Finally, the power dissipated in the 10-Ω resistance is

$$P_{10} = 10 i_{10}^2 = 7.346\ \text{W}$$

PC.3 The equivalent capacitance of the two capacitors in series is given by

$$C_{eq} = \frac{1}{1/C_1 + 1/C_2} = 4\mu\text{F}$$

The charge supplied by the source is

$$q = C_{eq}V = 200 \times 4 \times 10^{-6} = 800\mu\text{C}$$

PC.4 The input power to the motor is the output power divided by efficiency

$$P_{in} = \frac{P_{out}}{\eta} = \frac{2 \times 746}{0.80} = 1865 \text{ W}$$

However the input power is also given by

$$P_{in} = V_{rms} I_{rms} \cos(\theta)$$

in which $\cos(\theta)$ is the power factor. Solving for the current, we have

$$I_{rms} = \frac{P_{in}}{V_{rms}\cos(\theta)} = \frac{1865}{220 \times 0.75} = 11.30 \text{ A}$$

PC.5 $Z = R + j\omega L - \dfrac{j}{\omega C} = 30 + j40 - j80 = 30 - j40 = 50\angle -53.1^\circ$

Thus the impedance magnitude is 50 Ω.

PC.6 We have

$$\text{Apparent power} = V_{rms} I_{rms}$$

Also, the power factor is $\cos(\theta) = 0.6$ from which we find that $\theta = 53.13^\circ$. (We selected the positive angle because the power factor is stated to be lagging.) Then we have

$$Q = V_{rms} I_{rms} \sin(\theta) = (\text{Apparent power}) \times \sin(\theta) = 2000 \times 0.8 = 1600 \text{ VAR}$$

PC.7 For practical purposes, the capacitor is totally discharged after twenty time constants and all of the initial energy stored in the capacitor has been delivered to the resistor. The initial stored energy is

$$W = \tfrac{1}{2} C V^2 = \tfrac{1}{2} \times 150 \times 10^{-6} \times 100^2 = 0.75 \text{ J}$$

PC.8 $\omega = 2\pi f = 120\pi$

$$Z = R + j\omega L - \frac{j}{\omega C} = 50 + j56.55 - j106.10 = 50 - j49.55 = 70.39\angle -44.74^\circ$$

$$I_{rms} = \frac{V_{rms}}{|Z|} = \frac{110}{70.39} = 1.563 \text{ A}$$

PC.9 See Example 4.2 in the book. In this case, we have $K_2 = K_1 = V_S / R = 1$ A and $\tau = L/R = 0.5$ s. Then the current is given by

$$i(t) = 1 - \exp(-t / \tau) = 1 - \exp(-2t)$$

PC.10 We have $V_{BC} = -V_{CB} = -50 \text{ V}$ and $V_{AB} = V_{AC} - V_{BC} = 200 - (-50) = 250$. The energy needed to move the charge from point *B* to point *A* is $W = QV_{AB} = 0.2(250) = 50 \text{ J}$.