EXAMPLE 4.7 Energy Storage in an Ignition Coil

Problem

Determine the energy stored in an automotive ignition coil.

Solution

Known Quantities: Inductor current initial condition (current at $t = 0$); inductance value.

Find: Energy stored in inductor.

Schematics, Diagrams, Circuits, and Given Data: $L = 10$ mH; $i_L = I_0 = 8$ A.

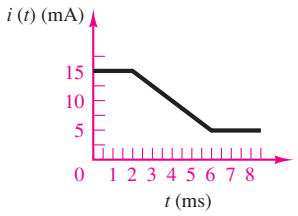
Analysis:

$$W_L = \frac{1}{2}Li_L^2 = \frac{1}{2} \times 10^{-2} \times 64 = 32 \times 10^{-2} = 320 \text{ mJ}$$

Comments: A more detailed analysis of an automotive ignition coil is presented in Chapter 5 to accompany the discussion of transient voltages and currents.

CHECK YOUR UNDERSTANDING

Calculate and plot the inductor energy and power for a 50-mH inductor subject to the current waveform shown below. What is the energy stored at $t = 3$ ms? Assume $i(-\infty) = 0$.



Answer:

$$w(t) = \begin{cases} 5.625 \times 10^{-6} \text{ J} & 0 \le t < 2 \text{ ms} \\ 0.156t^2 - (2.5 \times 10^{-3})t + 10^{-6} & 2 \le t < 6 \text{ ms} \\ 0.625 \times 10^{-6} & t \ge 6 \text{ ms} \end{cases}$$

$$p(t) = \begin{cases} (20 \times 10^{-3} - 2.5t)(-0.125 \text{ W}) & 2 \le t < 6 \text{ ms} \\ 0 & \text{otherwise} \end{cases}$$

$$w(t = 3 \text{ ms}) = 3.9 \ \mu\text{J}$$

$w(t) = 0.156t^2 - \left(2.5 \times 10^{-3}\right)t + 10^{-6}$ $2 \le t < 6$ ms should be changed to $w(t) = 0.156t^2 - \left(2.5 \times 10^{-3}\right)t + 10^{-5}$ $2 \le t < 6$ ms

4.2 TIME-DEPENDENT SIGNAL SOURCES

In Chapter 2, the general concept of an ideal energy source was introduced. In this chapter, it will be useful to specifically consider sources that generate time-varying