Problem 5.47  Determine $i(t)$ for $t \geq 0$ given that the circuit in Fig. P5.47 had been in steady state for a long time prior to $t = 0$. Also, $I_0 = 5 \text{ A}$, $R_1 = 2 \Omega$, $R_2 = 10 \Omega$, $R_3 = 3 \Omega$, $R_4 = 7 \Omega$, and $L = 0.15 \text{ H}$.

Solution:

At $t = 0^-$, current division in the circuit of Fig. P5.47(b) gives

$$i(0^-) = \frac{I_0 R_1}{R_1 + R_3} = \frac{5 \times 2}{2 + 3} = 2 \text{ A}.$$  

Hence,

$$i(0) = i(0^-) = 2 \text{ A}. $$

At $t = \infty$,

$$i(\infty) = 0 \quad \text{(no active sources)}. $$

At $t \geq 0$,

$$\tau = \frac{L}{R_{eq}}$$

$$R_{eq} = \frac{R_2(R_3 + R_4)}{R_2 + R_3 + R_4} = \frac{10 \times (3 + 7)}{10 + 3 + 7} = 5.$$
\[ \tau = \frac{0.15}{5} = 0.03 \text{ s.} \]

\[ i_L(t) = [i(\infty) + [i(0) - i(\infty)]e^{-t/\tau}] \]

\[ = 2e^{-100t/3} \quad \text{(A).} \]