Problem 5.39  The switch in the circuit of Fig. P5.39 had been in position 1 for a long time until it was moved to position 2 at \( t = 0 \). Determine \( \nu(t) \) for \( t \geq 0 \), given that \( I_0 = 6 \, \text{mA} \), \( V_0 = 18 \, \text{V} \), \( R_1 = R_2 = 4 \, \text{kΩ} \), and \( C = 200 \, \mu \text{F} \).

Solution:

(a) 1 2
\[ V_1 = I_0 R_1 = 6 \times 10^{-3} \times 4 \times 10^3 = 24 \, \text{V}. \]
\[ \nu(0^-) = V_1 - V_0 = 24 - 18 = 6 \, \text{V}. \]

(b) At \( t = 0^- \)
\[ \nu(\infty) = -V_0 = -18 \, \text{V}. \]
\[ \tau = R_2 C = 4 \times 10^3 \times 2 \times 10^{-4} = 0.8 \, \text{s}. \]

Hence,
\[ \nu(t) = [\nu(\infty) + [\nu(0) - \nu(\infty)]e^{-t/\tau}] \]
\[ = [-18 + [6 + 18]e^{-1.25t}] \]
\[ = [-18 + 24e^{-1.25t}] \quad \text{(V), for } t \geq 0 \]
Problem 5.51  Derive an expression for $i_2(t)$ in the circuit of Fig. P5.51 in terms of the circuit variables, given that $I_s$ is a dc current source and the switch was closed at $t = 0$ after it had been open for a long time.

Figure P5.51: Circuit for Problem 5.51.

Solution: Before closing the switch, no current was flowing through $L$. Hence,

$$i_2(0^-) = 0.$$  

For $t \geq 0$, through source transformations, the circuit can be simplified into a parallel RL circuit:

Fig. P5.51 (a)
Hence,

\[ i_2(\infty) = I'_s = \frac{I_s R_s}{R_s + R_1}, \]

\[ i_2(t) = i_2(\infty) + [i_2(0) - i_2(\infty)]e^{-t/\tau} \]

\[ = \frac{I_s R_s}{R_s + R_1} (1 - e^{-t/\tau}) \text{ for } t \geq 0, \]

with

\[ \tau = \frac{L}{R_{eq}} = \frac{L(R_1 + R_2 + R_s)}{(R_s + R_1)R_2}. \]