Ex:

\[ + \quad - \quad v_s \]

\[ R_1 \]

\[ t = 0 \]

\[ L \quad i(t) \quad R_3 \]

\[ R_2 \]

After being open for a long time, the switch closes at \( t = 0 \). Write an expression for \( i_L(t > 0) \) in terms of no circuit quantities other than \( R_1, R_2, R_3, v_s, \) and \( L \).

**soln:** Since \( R_1 \) is directly across \( v_s \), it is a 2nd circuit in parallel with the 1st circuit consisting of all components below it that is directly across \( v_s \). Consequently, we can solve the circuits separately, as though each had its own \( v_s \) source.

\[ i_L(t) = \frac{v_s}{R_2 + R_3} \]

We also combine \( R_2 \) and \( R_3 \), yielding a simple circuit:
$t=0^-$ model: L = wire, find $i_L(0^-)$

No current flows, owing to the open circuit.

$t=0^+$ model: $i_L(0^+) = i_L(0^-)$, L = i source

$= 0 \text{ A} = \text{open circuit}$

We have $i(t^+) = i_L(0^+) = i_L(0^-) = 0 \text{A}$

$t \to \infty$ model: L = wire, find $i(t \to \infty)$
By Ohm's law, \( i(t \to \infty) = \frac{V_3}{R_2 + R_3} \)

\[ t = \frac{L}{R_{Th}} : \text{We find } R_{Th} \text{ by turning off independent source } V_3 \text{ and looking into circuit from terminals where } L \text{ is attached.} \]

![Diagram](image)

Clearly, \( R_{Th} = R_2 + R_3 \).

Now we use the general form of solution:

\[ i(t) = i(t \to \infty) + \left[ i(0^+) - i(t \to \infty) \right] e^{-t/\tau}, \quad t > 0 \]

or \[ i(t) = \frac{V_3}{R_2 + R_3} + \left[ 0 - \frac{V_3}{R_2 + R_3} \right] e^{-t/L/(R_2 + R_3)}, \quad t > 0 \]

or \[ i(t) = \frac{V_3}{R_2 + R_3} \left[ 1 - e^{-t(L/(R_2 + R_3))} \right], \quad t > 0 \]