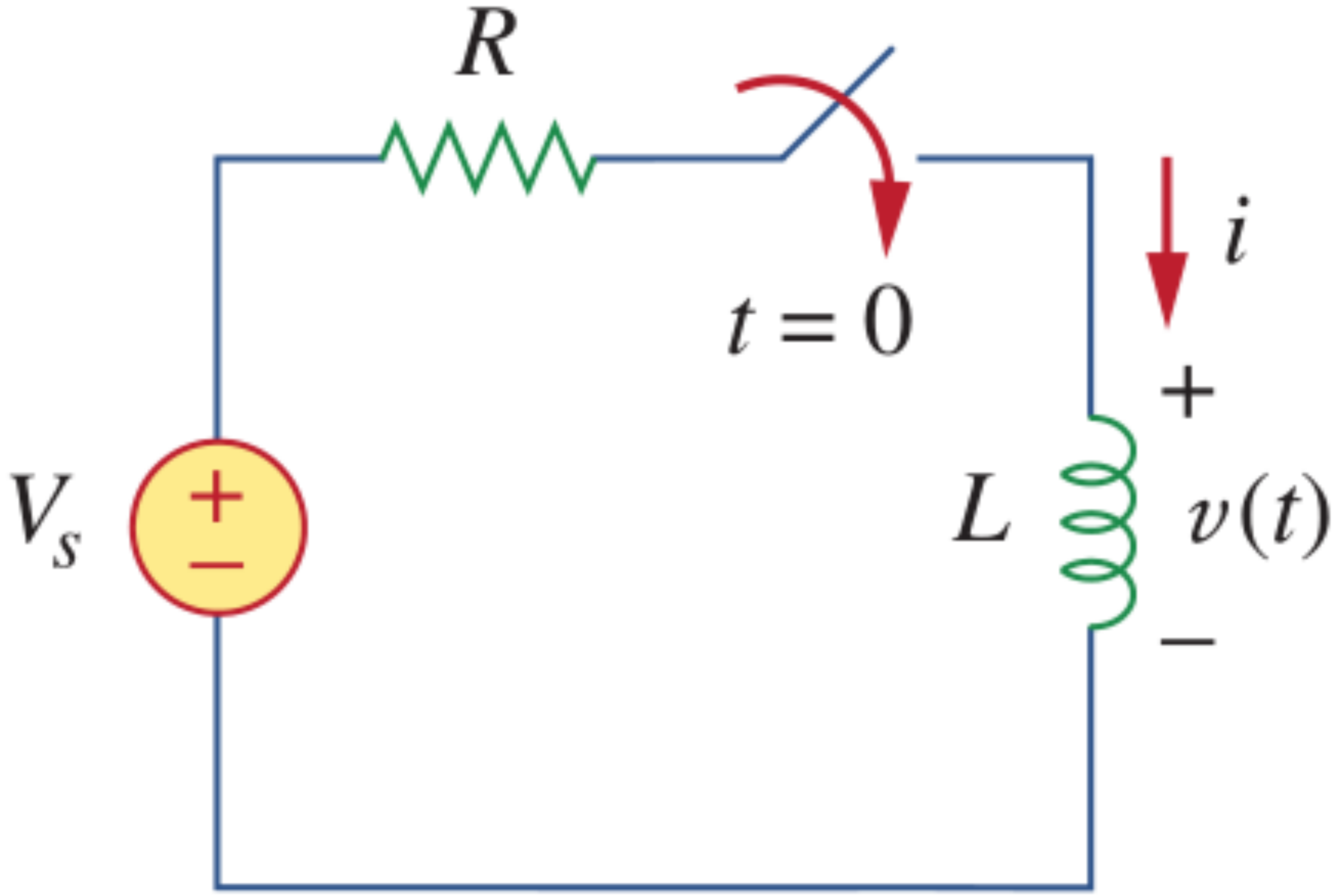
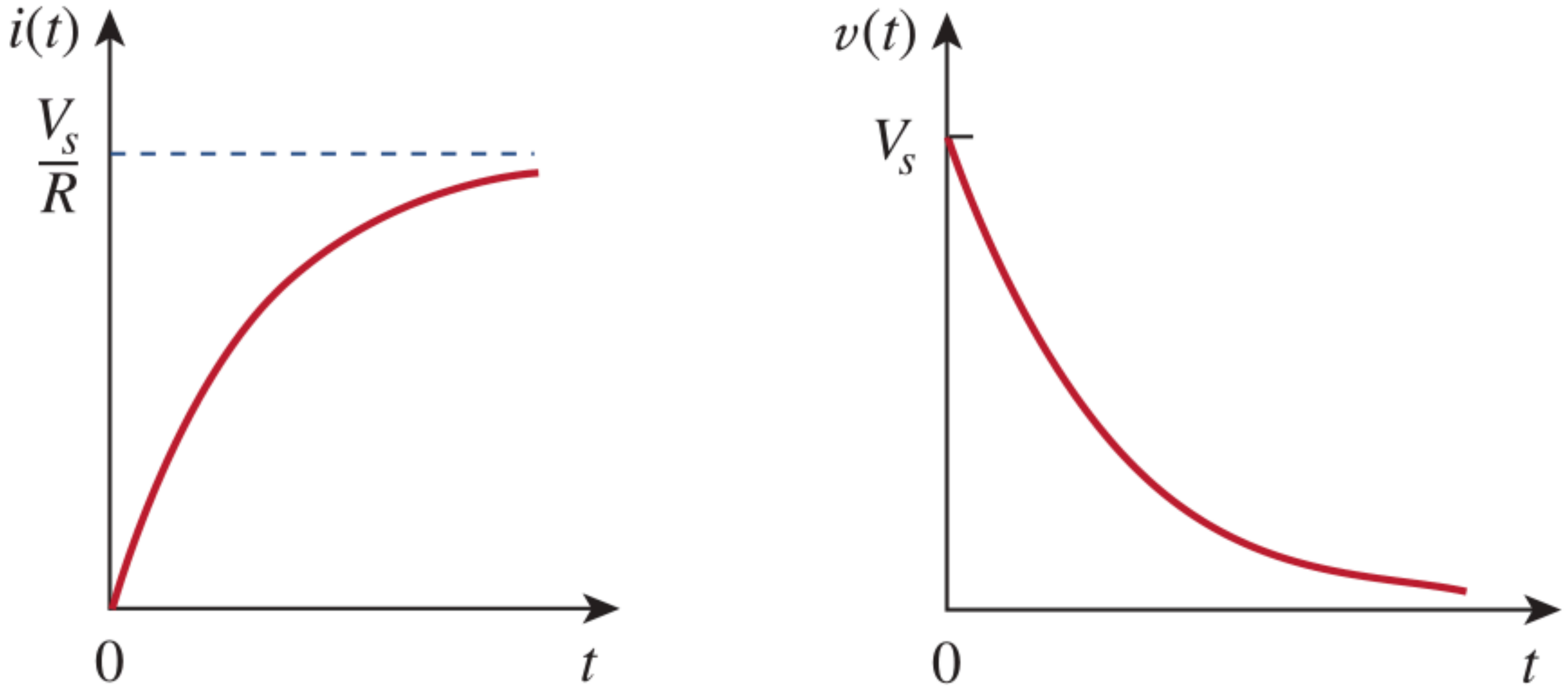
Step Response - RL Circuits

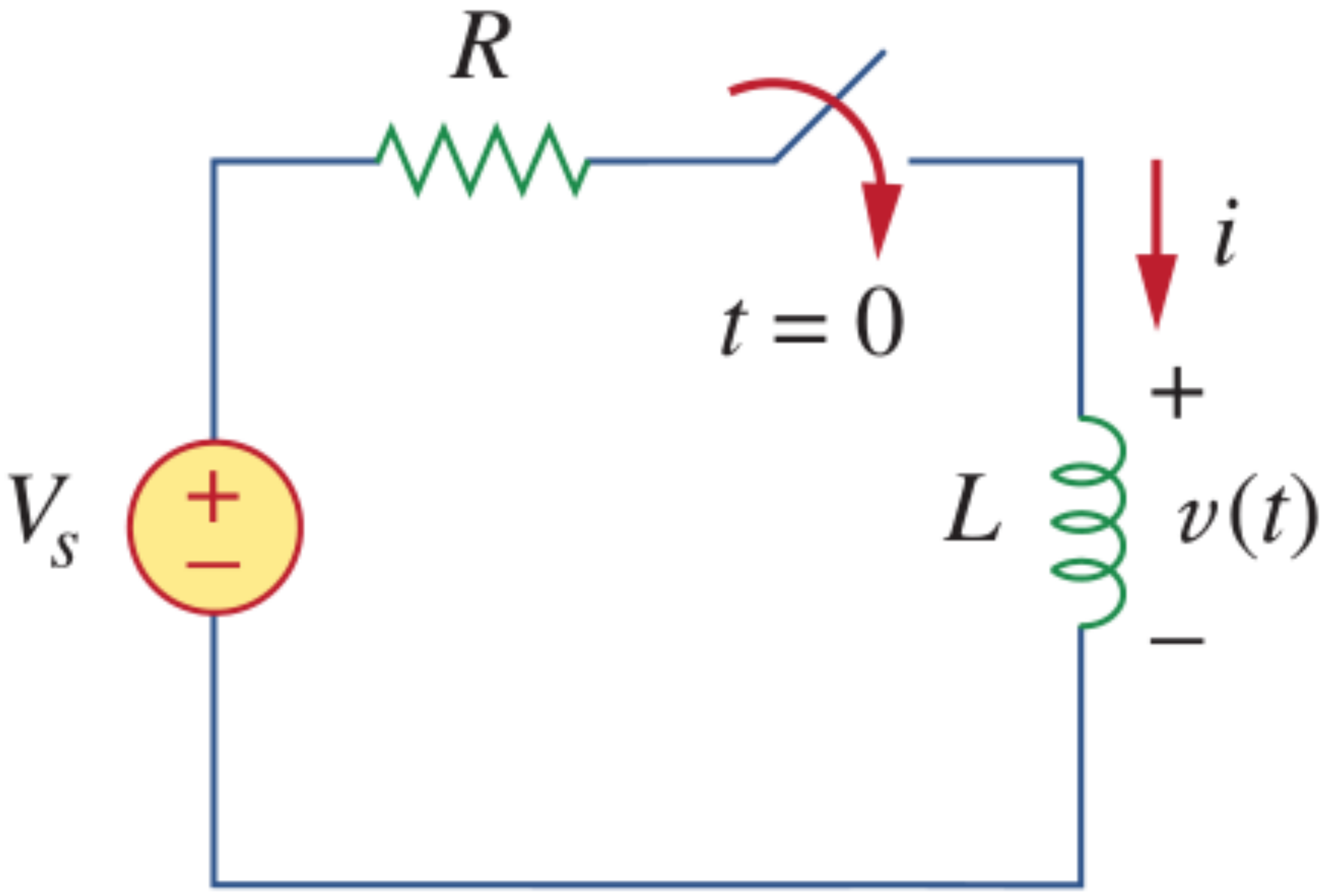
- Assume that at t=0, the inductor current is equal to 0A

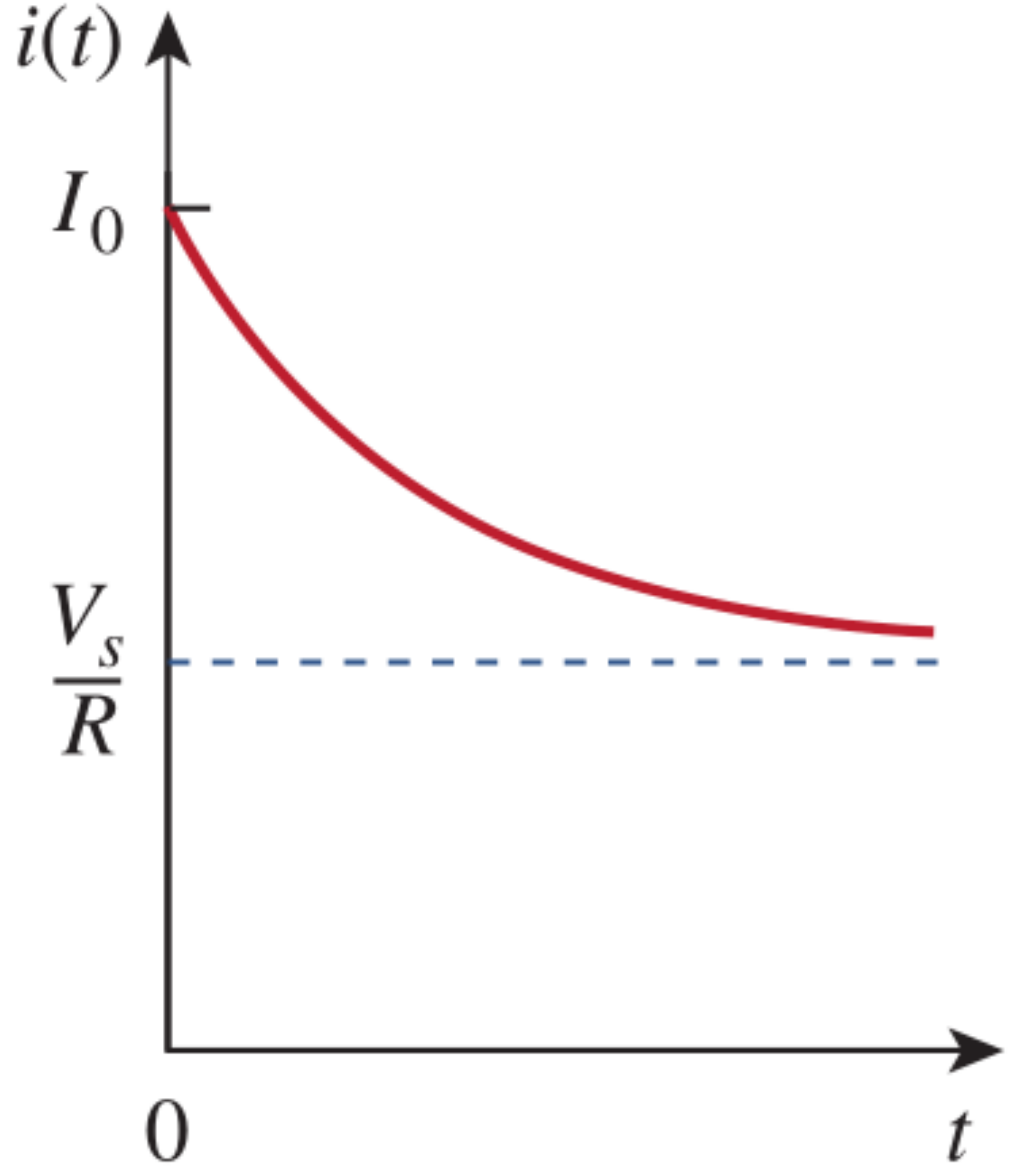


$$
\begin{aligned}
I_L(t) &= I_\infty \left(1 - e^{-t/\tau}\right) \\
&= \frac{V_s}{R}\left(1 - e^{-t\frac{R}{L}}\right)
\end{aligned}
$$



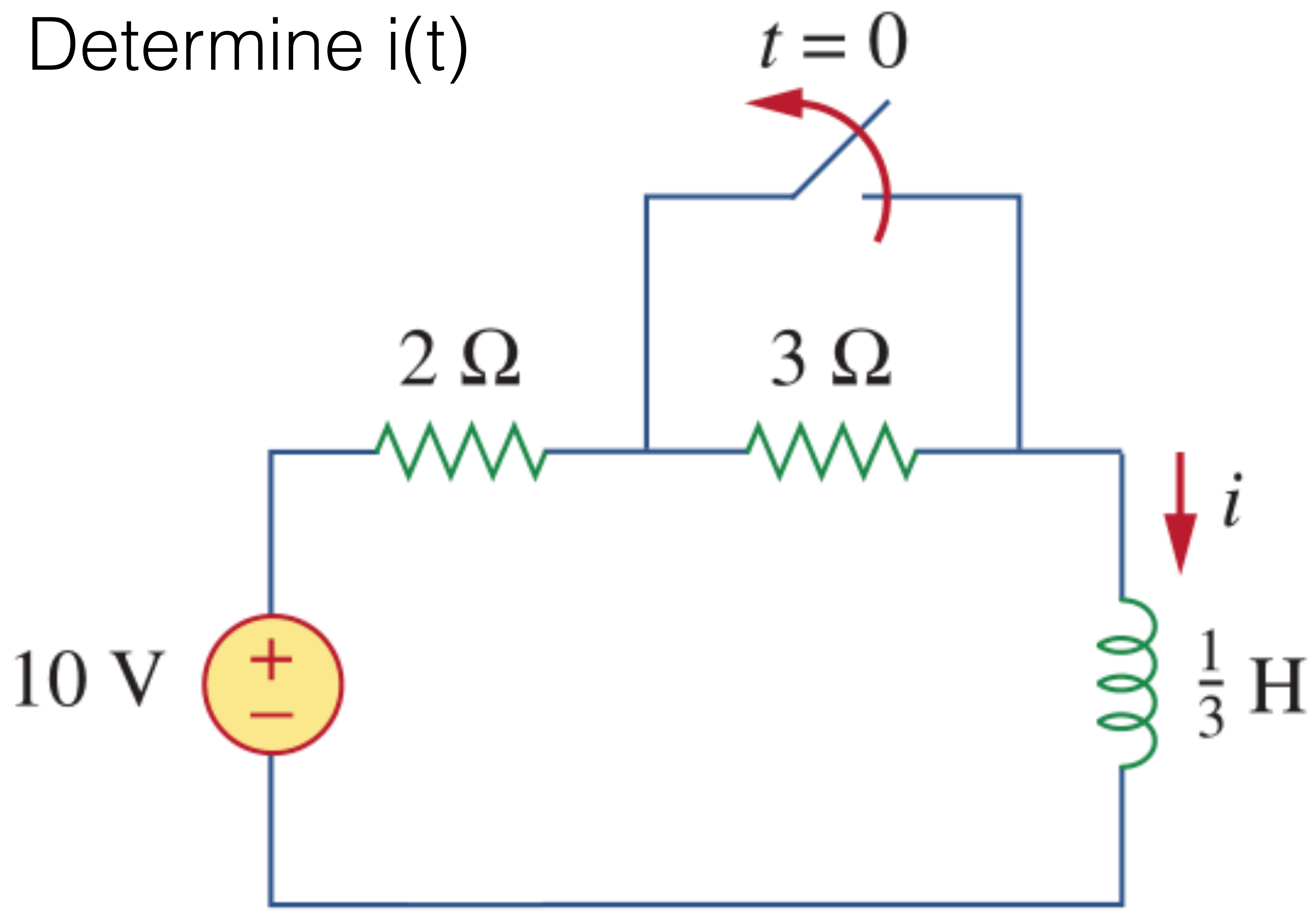
- Assume that at t=0, the inductor current is equal to I_0

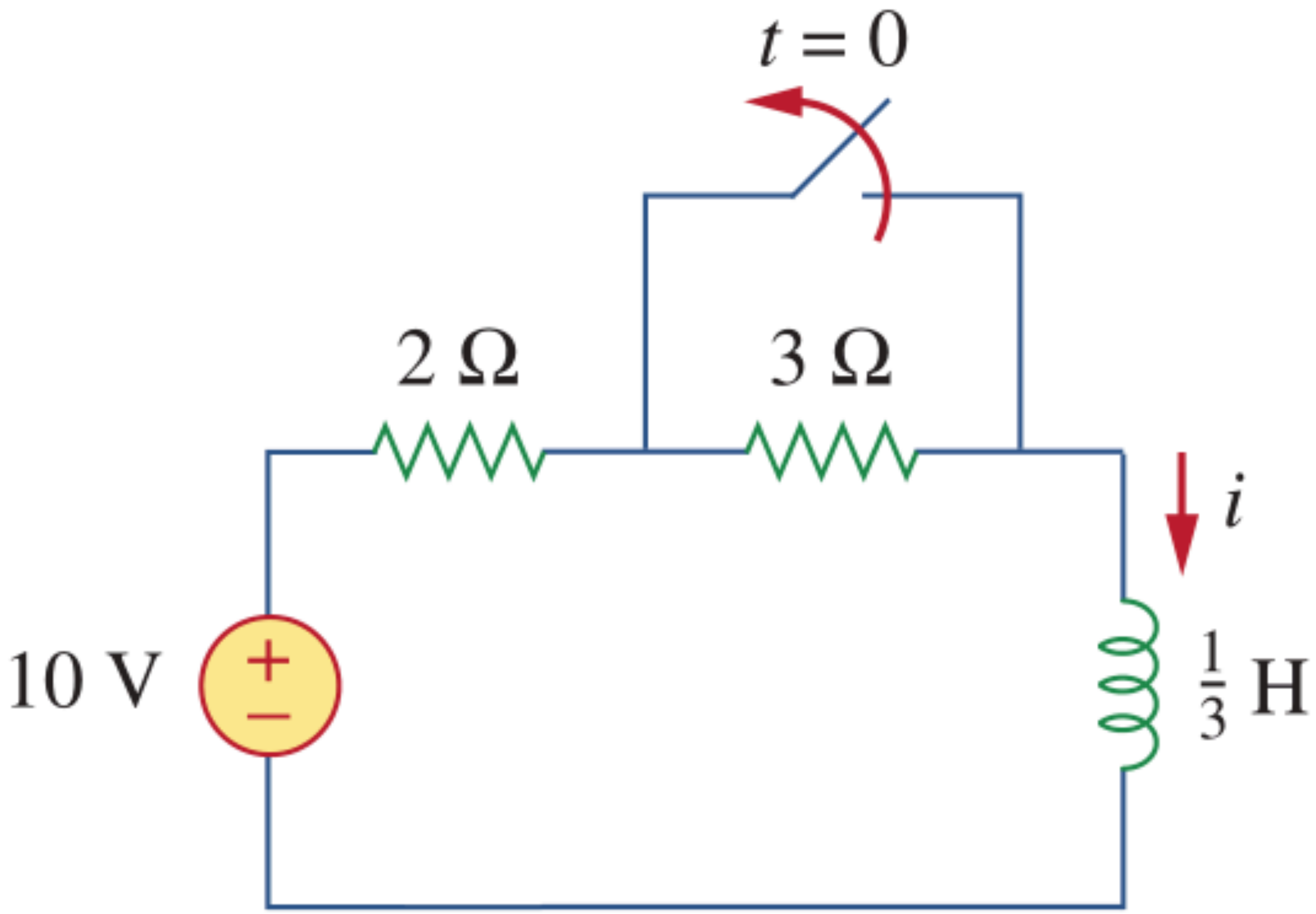




$$I_L(t) = I_\infty + (I_0 - I_\infty)e^{-t/\tau}$$
$$= \frac{V_s}{R} + \left(I_0 - \frac{V_s}{R}\right)e^{-t\frac{R}{L}}$$

- Determine i(t)

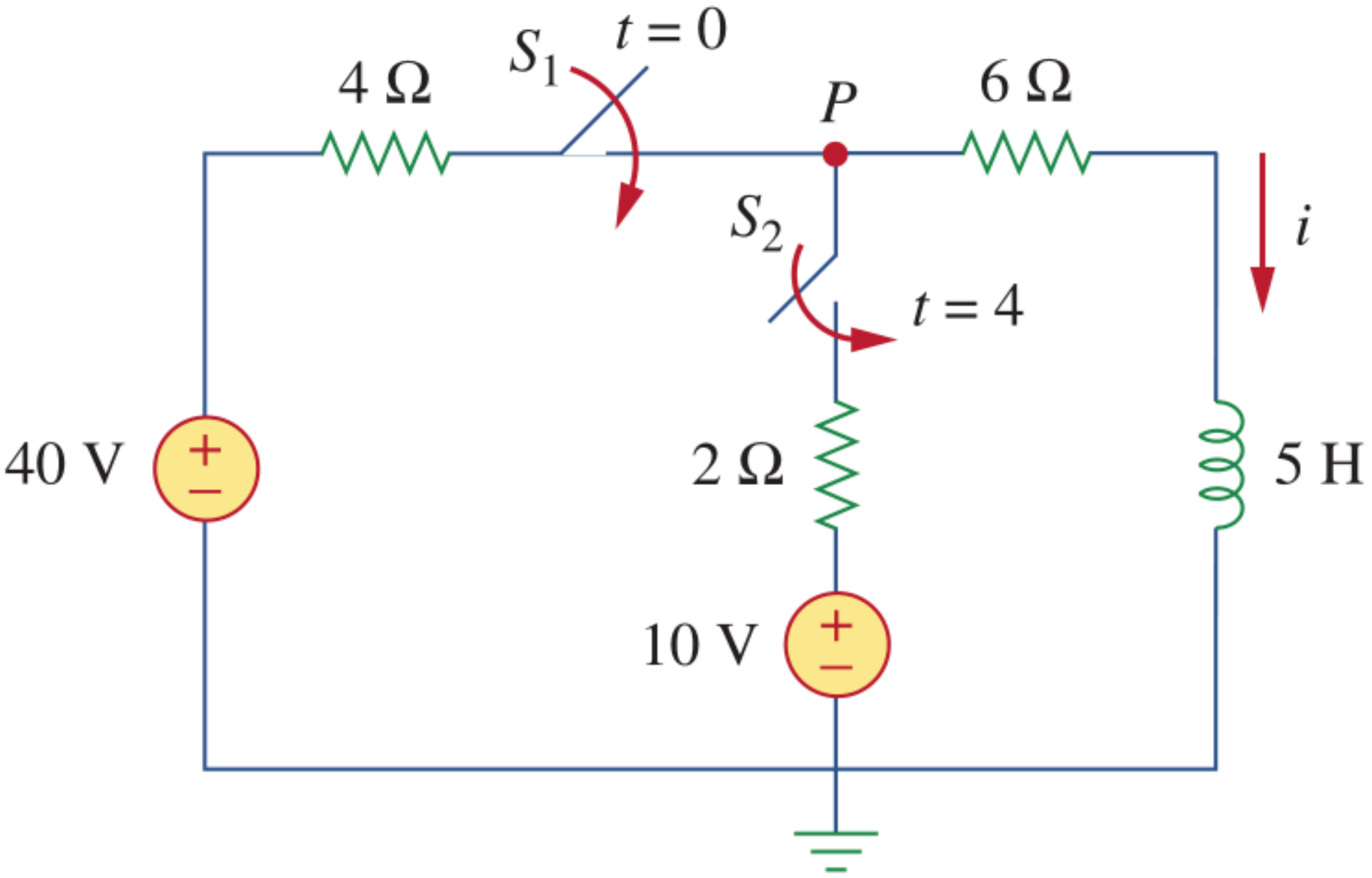




$$I_0 = 5A$$
$$\tau = 1/15s$$
$$V_\infty = 2A$$

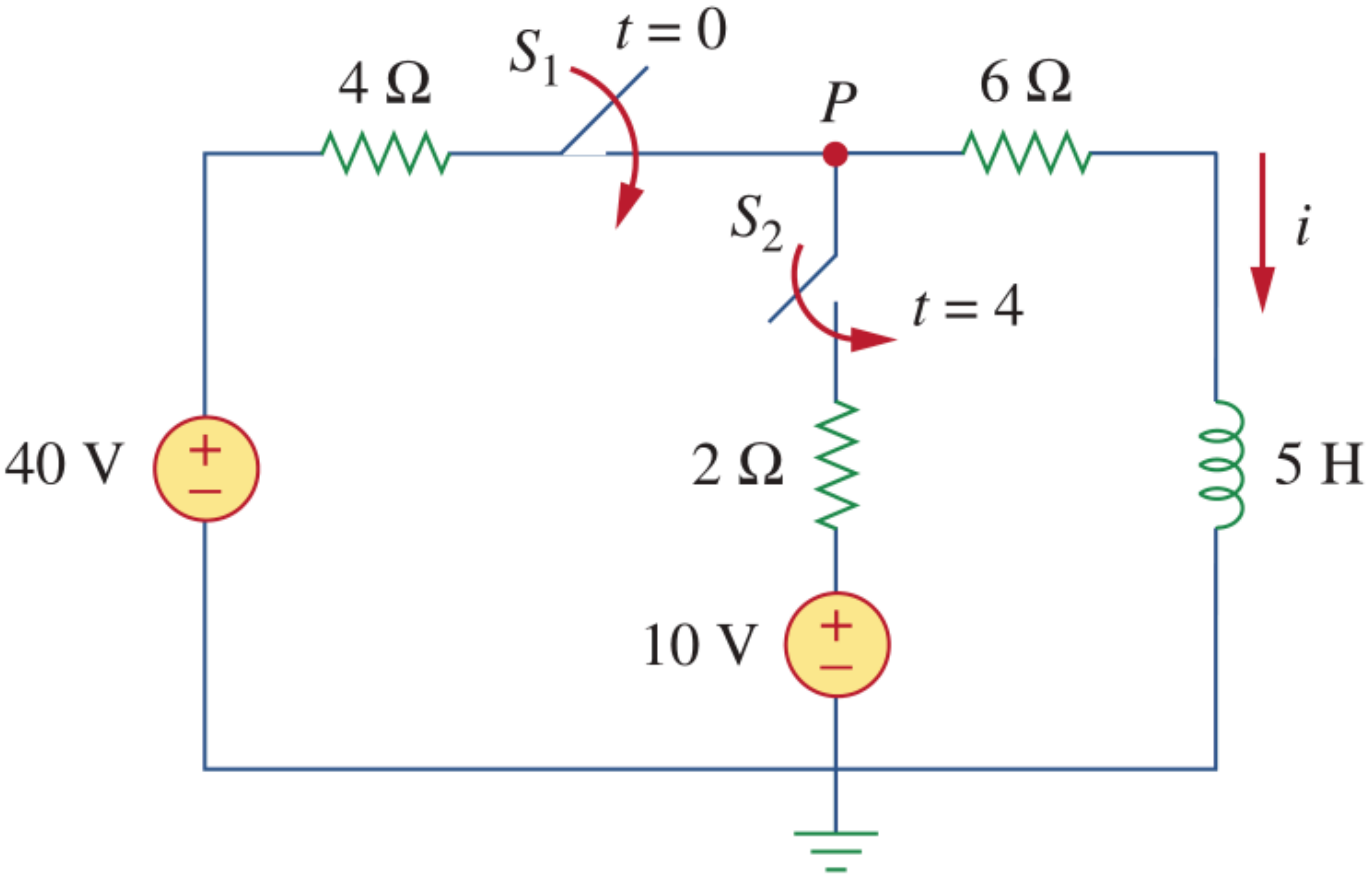
$$I_L(t) = I_\infty + (I_0 - I_\infty)e^{-t/\tau}$$

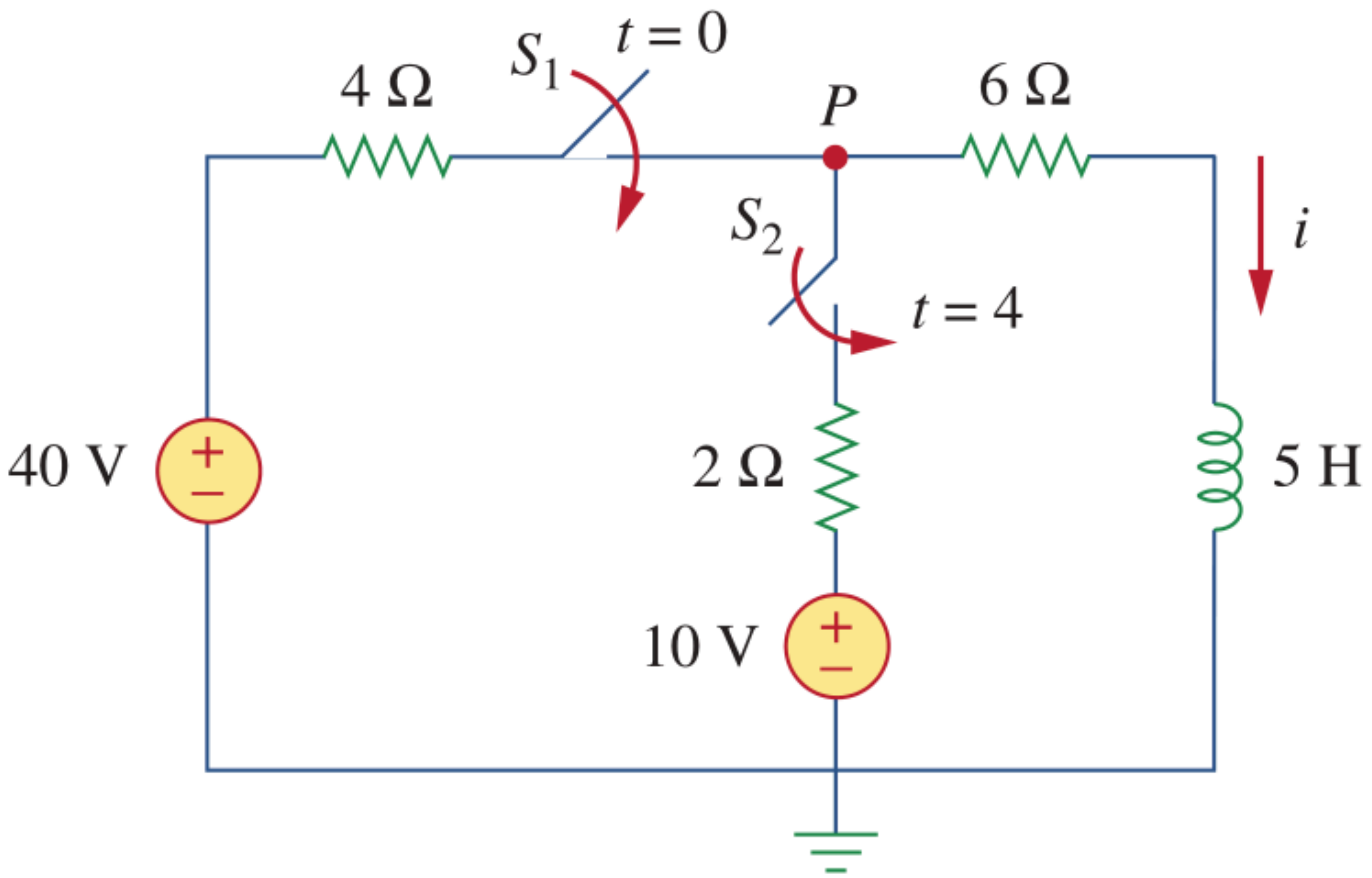
- Determine i(t) given that $i_0=0$



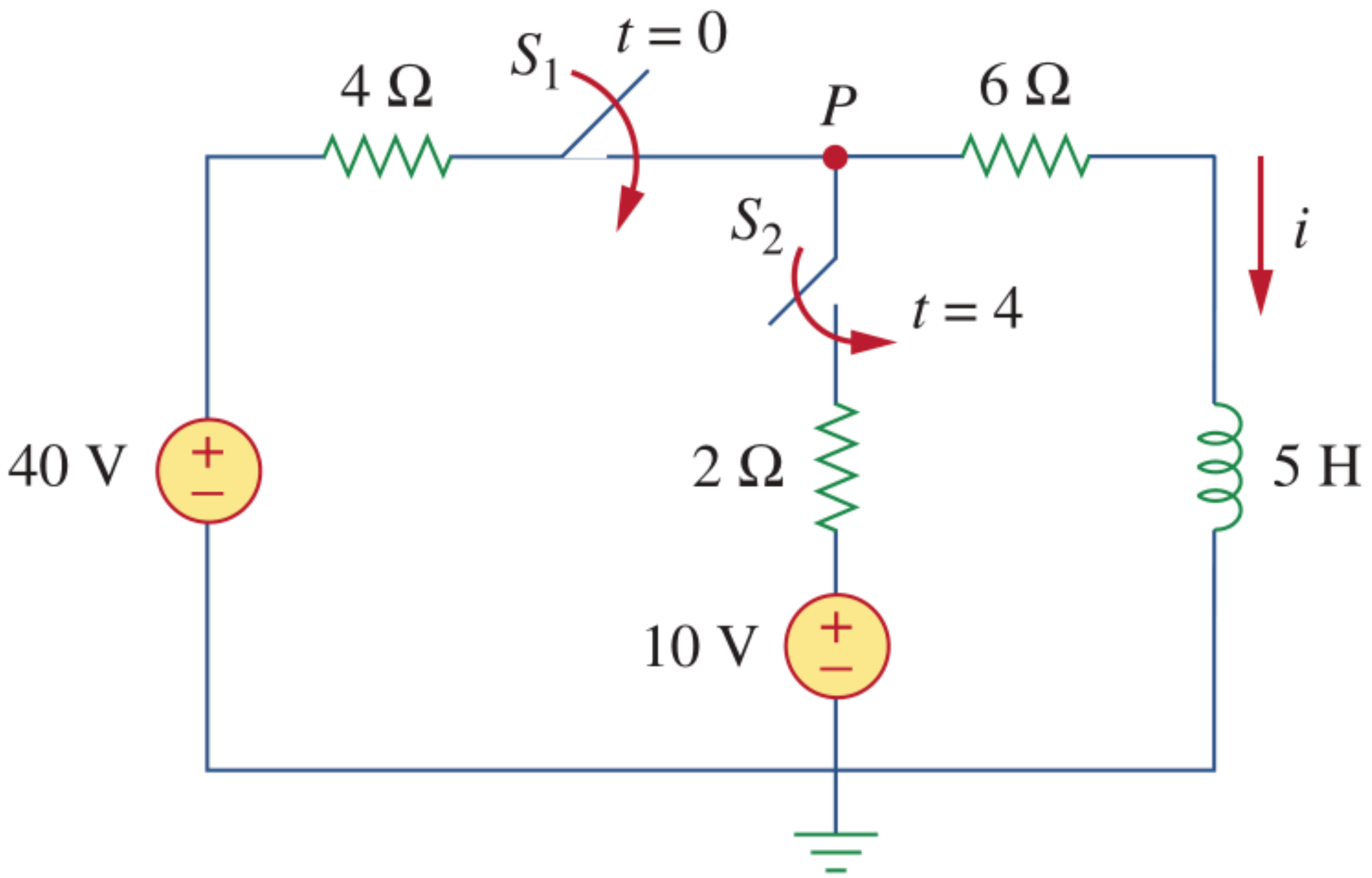
- Determine i(t) given that i_0=0

$$i(t) = I_\infty\left(1 - e^{-t/\tau}\right)$$





$$i(t) = 4A(1 - e^{-2t}) \text{ for } 4 > t > 0$$

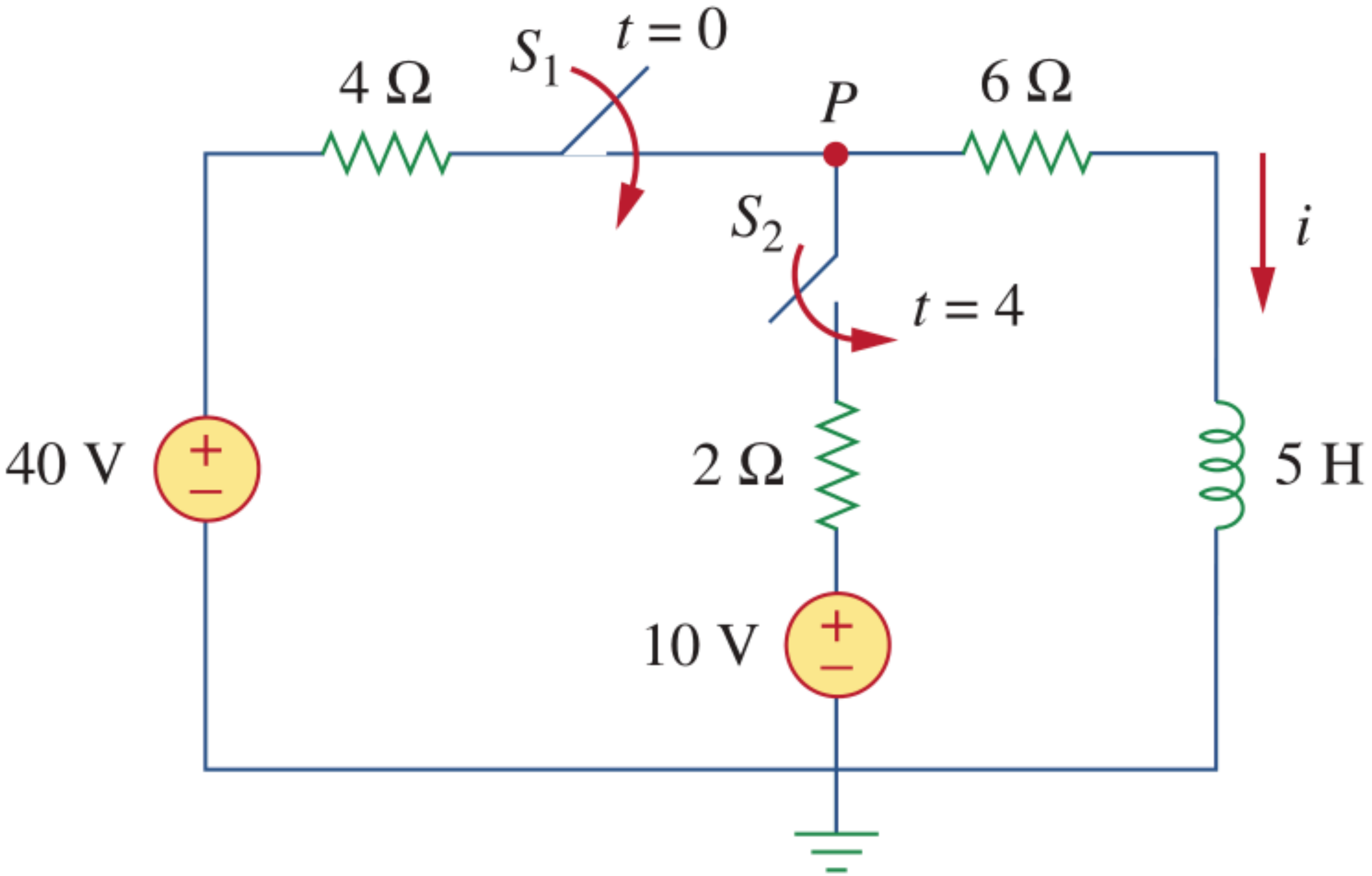


$$i(t) = 4A(1 - e^{-2t}) \text{ for } 4 > t > 0$$

$$\hat{t} = t - 4$$

$$t \geq 4 \iff \hat{t} \geq 0$$

$$i(\hat{t}) = I_\infty + \left(I_{\hat{t}=0} - I_\infty\right) e^{-\hat{t}/\tau}$$



$$i(t) = 4(1 - e^{-2t})A \text{ for } t \in [0,4)$$

$$i(t) = \left(2.73 + 1.72e^{-1.5(t-4)}\right) A \text{ for } t \in [4,\infty)$$