

Chapter 7, Solution 59.

Determine the step response $v_o(t)$ to $v_s = 18 u(t)$ in the circuit of Fig. 7.124.

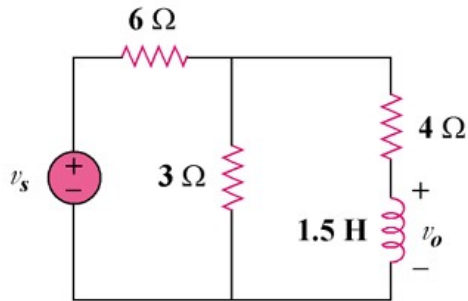


Figure 7.124
For Prob. 7.59.

Solution

Let $i(t)$ be the current through the inductor.

$$\text{For } t < 0, \quad v_s = 0, \quad i(0) = 0$$

$$\text{For } t > 0, \quad R_{\text{eq}} = 4 + (6 \parallel 3) = 6\ \Omega \text{ and } \tau = \frac{L}{R_{\text{eq}}} = \frac{1.5}{6} = 0.25 \text{ sec.}$$

At $t = \infty$, the inductor becomes a short and the current delivered by the 18 volts source is $I_s = 18/[6 + (3 \parallel 4)] = 18/7.714 = 2.333$ amps. The voltage across the 4-ohm resistor is equal to $18 - 6(2.333) = 18 - 14 = 4$ volts. Therefore the current through the inductor is equal to $i(\infty) = 4/4 = 1$ amp.

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

$$i(t) = 1(1 - e^{-4t}) \text{ amps.}$$

$$v_o(t) = L \frac{di}{dt} = (1.5)(1)(-4)(-e^{-4t})$$

$$v_o(t) = [6e^{-4t}]u(t) \text{ volts.}$$