Boise State University
Electrical Engineering Department

EE 210: Circuits I

Solution 1

(a) $R_{Th} = 12 + 10 // 40 = 20\Omega, \quad \tau = \frac{L}{R_{Th}} = 5/20 = \underline{0.25s}$

(b) $R_{Th} = 40 // 160 + 8 = 40\Omega, \quad \tau = \frac{L}{R_{Th}} = (20x10^{-3})/40 = \underline{0.5\text{ ms}}$

Solution 2

$$i(t) = i(0)e^{-t/\tau}, \qquad \tau = \frac{L}{R_{eq}} = \frac{1/4}{4} = \frac{1}{16}$$

$$i(t) = 2e^{-16t}$$

$$v_o(t) = 3i + L\frac{di}{dt} = 6e^{-16t} + (1/4)(-16)2e^{-16t}$$

$$v_o(t) = \underline{-2e^{-16t}\ u(t)V}$$

Solution 3

Since the 2 Ω resistor, 1/3 H inductor, and the (3+1) Ω resistor are in parallel, they always have the same voltage.

$$-i = \frac{2}{2} + \frac{2}{3+1} = 1.5 \longrightarrow i(0) = -1.5$$

The Thevenin resistance R_{th} at the inductor's terminals is

$$R_{th} = 2 \,\|\, (3+1) = \frac{4}{3}, \qquad \tau = \frac{L}{R_{th}} = \frac{1/3}{4/3} = \frac{1}{4}$$

$$i(t) = i(0)e^{-t/\tau} = -1.5e^{-4t}, \quad t > 0$$

$$v_L = v_o = L\frac{di}{dt} = -1.5(-4)(1/3)e^{-4t}$$

$$v_o = \underline{\mathbf{2e^{-4t}\ V, \quad t > 0}}$$

$$v_x = \frac{1}{3+1}v_L = \underline{\mathbf{0.5e^{-4t}\ V, \quad t > 0}}$$

Solution 4

(a) Before t = 0,

$$v(t) = \frac{1}{4+1}(20) = \underline{\mathbf{4\ V}}$$

After t = 0,

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

$$\tau = RC = (4)(2) = 8, \quad v(0) = 4, \qquad v(\infty) = 20$$

$$v(t) = 20 + (4 - 20)\,e^{-t/8}$$

$$v(t) = \underline{20 - 16\,e^{-t/8}\ \text{V}}$$

(b) Before t = 0, $v = v_1 + v_2$, where v_1 is due to the 12-V source and v_2 is due to the 2-A source.

$$v_1 = 12\ \text{V}$$

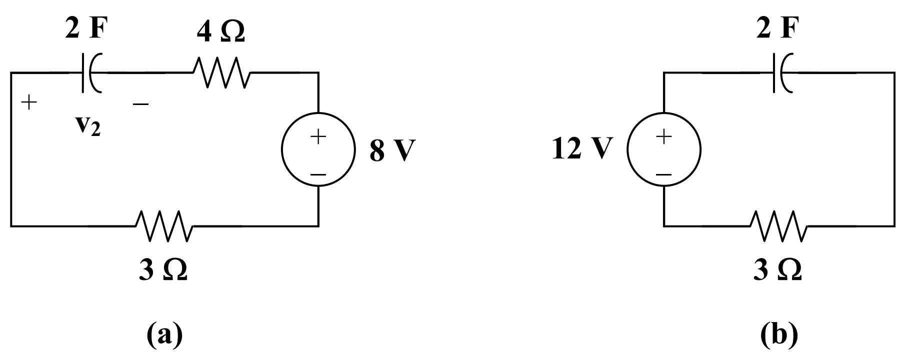
To get v_2, transform the current source as shown in Fig. (a).

$$v_2 = -8\ \text{V}$$

Thus,

$$v = 12 - 8 = \underline{\mathbf{4\ V}}$$

After t = 0, the circuit becomes that shown in Fig. (b).



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

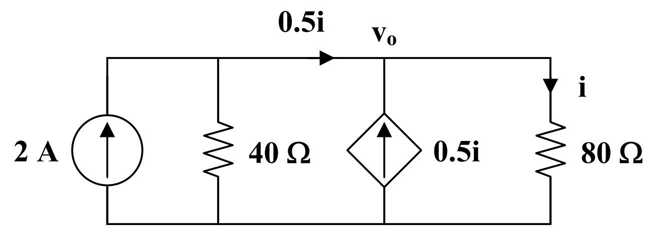
$$v(\infty) = 12, \qquad v(0) = 4, \qquad \tau = RC = (2)(3) = 6$$

$$v(t) = 12 + (4 - 12)\,e^{-t/6}$$

$$v(t) = \underline{\mathbf{12 - 8e^{-t/6}\ V}}$$

Solution 5

Before t = 0, the circuit has reached steady state so that the capacitor acts like an open circuit. The circuit is equivalent to that shown in Fig. (a) after transforming the voltage source.



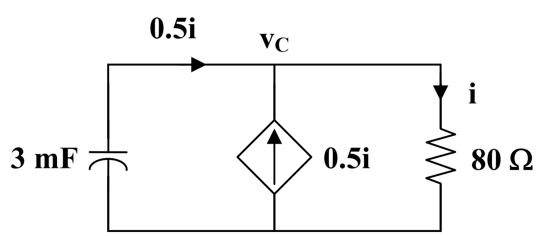
(a)

$$0.5i = 2 - \frac{v_o}{40}, \qquad i = \frac{v_o}{80}$$

Hence, $\frac{1}{2}\frac{v_o}{80} = 2 - \frac{v_o}{40} \longrightarrow v_o = \frac{320}{5} = 64$

$$i = \frac{v_o}{80} = \underline{\mathbf{0.8\ A}}$$

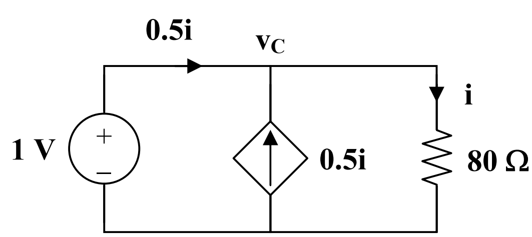
After t = 0, the circuit is as shown in Fig. (b).



(b)

$$v_C(t) = v_C(0)\, e^{-t/\tau}, \qquad \tau = R_{th}C$$

To find R_{th}, we replace the capacitor with a 1-V voltage source as shown in Fig. (c).



(c)