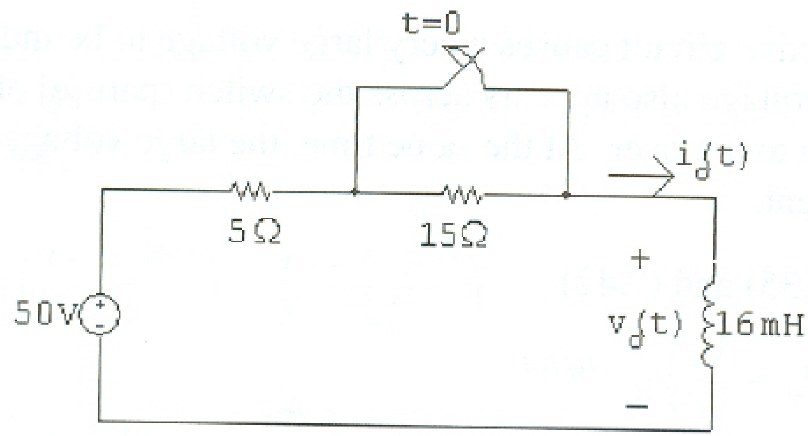
HW#11 Solutions

P 7.35 After making a Thévenin equivalent we have



For $t < 0$, the 15 Ω resistor is bypassed:

$$i_o(0^-) = i_o(0^+) = 50/5 = 10\,\text{A}$$

$$\tau = \frac{L}{R} = \frac{16 \times 10^{-3}}{5 + 15} = 8 \times 10^{-4}; \qquad \frac{1}{\tau} = 1250$$

$$i(\infty) = \frac{V}{R_{\text{eq}}} = \frac{50}{5 + 15} = 2.5\,\text{A}$$

$$i_o = i_o(\infty) + [i_o(0^+) - i_o(\infty)]e^{-t/\tau} = 2.5 + (10 - 2.5)e^{-1250t} = 2.5 + 7.5e^{-1250t}\,\text{A}, t \geq 0$$

$$v_o = L\frac{di_o}{dt} = 16 \times 10^{-3}(-1250)(7.5e^{-1250t}) = -150e^{-1250t}\,\text{V}, \quad t \geq 0^+$$

P 7.36 **[a]** $v_o(0^+) = -I_g R_2; \qquad \tau = \dfrac{L}{R_1 + R_2}$

$$v_o(\infty) = 0$$

$$v_o(t) = -I_g R_2 e^{-[(R_1+R_2)/L]t}\ \text{V}, \qquad t \ge 0^+$$

[b] $v_o = -(10)(15)e^{-\frac{(5+15)}{0.016}t} = -150e^{-1250t}\ \text{V}, \qquad t \ge 0^+$

[c] $v_o(0^+) \to \infty$, and the duration of $v_o(t) \to$ zero

[d] $v_{sw} = R_2 i_o; \qquad \tau = \dfrac{L}{R_1 + R_2}$

$$i_o(0^+) = I_g; \qquad i_o(\infty) = I_g \frac{R_1}{R_1 + R_2}$$

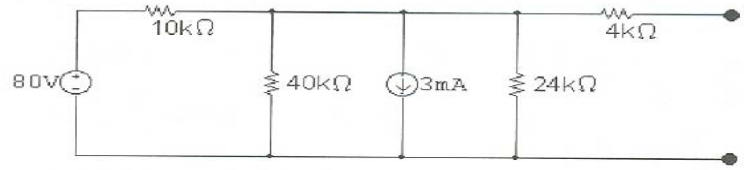
Therefore $\quad i_o(t) = \frac{I_g R_1}{R_1+R_2} + \left[I_g - \frac{I_g R_1}{R_1+R_2}\right] e^{-[(R_1+R_2)/L]t}$

$$i_o(t) = \frac{R_1 I_g}{(R_1+R_2)} + \frac{R_2 I_g}{(R_1+R_2)} e^{-[(R_1+R_2)/L]t}$$

Therefore $\quad v_{sw} = \frac{R_1 I_g}{(1+R_1/R_2)} + \frac{R_2 I_g}{(1+R_1/R_2)} e^{-[(R_1+R_2)/L]t}, \qquad t \ge 0^+$

[e] $|v_{sw}(0^+)| \to \infty; \qquad$ duration $\to 0$

P 7.47 For $t < 0$



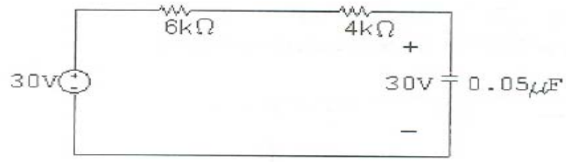
Simplify the circuit:

$80/10{,}000 = 8\,\text{mA}$, $\qquad 10\,\text{k}\Omega\|40\,\text{k}\Omega\|24\,\text{k}\Omega = 6\,\text{k}\Omega$

$8\,\text{mA} - 3\,\text{mA} = 5\,\text{mA}$

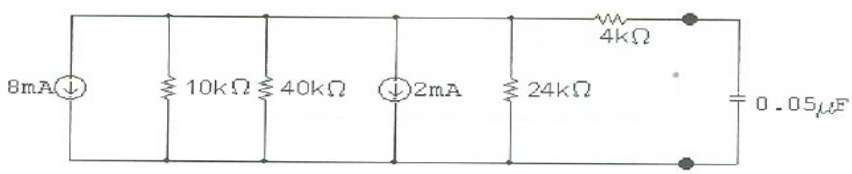
$5\,\text{mA} \times 6\,\text{k}\Omega = 30\,\text{V}$

Thus, for $t < 0$



$\therefore \quad v_o(0^-) = v_o(0^+) = 30\,\text{V}$

$t > 0$



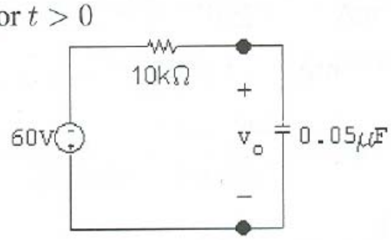
Simplify the circuit:

$8\,\text{mA} + 2\,\text{mA} = 10\,\text{mA}$

$10\,\text{k}\|40\,\text{k}\|24\,\text{k} = 6\,\text{k}\Omega$

$(10\,\text{mA})(6\,\text{k}\Omega) = 60\,\text{V}$

Thus, for $t > 0$



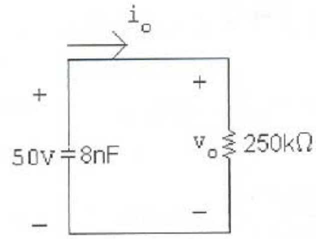
$v_o(\infty) = -60\,\text{V}$

$\tau = RC = (10\,\text{k})(0.05\,\mu) = 0.5\,\text{ms}; \qquad \dfrac{1}{\tau} = 2000$

$v_o = v_o(\infty) + [v_o(0^+) - v_o(\infty)]e^{-t/\tau} = -60 + [30 - (-60)]e^{-2000t}$

$= -60 + 90e^{-2000t}\,\text{V} \qquad t \geq 0$

P 7.50 **[a]** For $t > 0$:



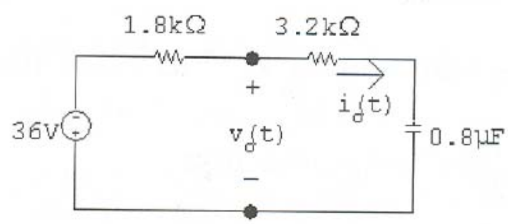
$$\tau = RC = 250 \times 10^3 \times 8 \times 10^{-9} = 2\,\text{ms}; \qquad \frac{1}{\tau} = 500$$

$$v_o = 50e^{-500t}\,\text{V}, \qquad t \geq 0^+$$

[b] $$i_o = \frac{v_o}{250{,}000} = \frac{50e^{-500t}}{250{,}000} = 200e^{-500t}\,\mu\text{A}$$

$$v_1 = \frac{-1}{40 \times 10^{-9}} \times 200 \times 10^{-6} \int_0^t e^{-500x}\,dx + 50 = 10e^{-500t} + 40\,\text{V}, \quad t \geq 0$$

P 7.53 **[a]**



$$i_o(0^+) = \frac{-36}{5000} = -7.2\,\text{mA}$$

[b] $i_o(\infty) = 0$

[c] $\tau = RC = (5000)(0.8 \times 10^{-6}) = 4\,\text{ms}$

[d] $i_o = 0 + (-7.2)e^{-250t} = -7.2e^{-250t}\,\text{mA}, \qquad t \geq 0^+$

[e] $v_o = -[36 + 1800(-7.2 \times 10^{-3}e^{-250t})] = -36 + 12.96e^{-250t}\,\text{V}, \qquad t \geq 0^+$