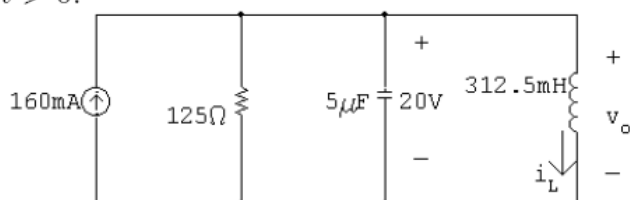


8.27**8.39****8.48****8.53**

P 8.27 $t < 0$:

$$v_o(0^-) = v_o(0^+) = \frac{625}{781.25}(25) = 20 \text{ V}$$

$$i_L(0^-) = i_L(0^+) = 0$$

 $t > 0$:

$$-160 \times 10^{-3} + \frac{20}{125} + i_C(0^+) + 0 = 0; \quad \therefore i_C(0^+) = 0$$

$$\frac{1}{2RC} = \frac{1}{2(125)(5 \times 10^{-6})} = 800 \text{ rad/s}$$

$$\omega_o^2 = \frac{1}{LC} = \frac{1}{(312.5 \times 10^{-3})(5 \times 10^{-6})} = 64 \times 10^4$$

$$\therefore \alpha^2 = \omega_o^2 \quad \text{critically damped}$$

$$[\text{a}] \quad v_o = V_f + D'_1 t e^{-800t} + D'_2 e^{-800t}$$

$$V_f = 0$$

$$\frac{dv_o(0)}{dt} = -800D'_2 + D'_1 = 0$$

$$v_o(0^+) = 20 = D'_2$$

$$D'_1 = 800D'_2 = 16,000 \text{ V/s}$$

$$\therefore v_o = 16,000t e^{-800t} + 20e^{-800t} \text{ V}, \quad t \geq 0^+$$

$$[\text{b}] \quad i_{\text{L}} = I_f + D_3' t e^{-800t} + D_4' e^{-800t}$$

$$i_{\text{L}}(0^+) = 0; \quad I_f = 160 \text{ mA}; \quad \frac{di_{\text{L}}(0^+)}{dt} = \frac{20}{312.5 \times 10^{-3}} = 64 \text{ A/s}$$

$$\therefore 0 = 160 + D_4'; \quad D_4' = -160 \text{ mA};$$

$$-800D_4' + D_3' = 64; \quad D_3' = -64 \text{ A/s}$$

$$\therefore i_{\text{L}} = 160 - 64,000te^{-800t} - 160e^{-800t} \text{ mA} \quad t \geq 0$$

$$\text{P 8.39 [a]} \quad -\alpha + \sqrt{\alpha^2 - \omega_0^2} = -4000; \quad -\alpha - \sqrt{\alpha^2 - \omega_0^2} = -16,000$$

$$\therefore \alpha = 10,000 \text{ rad/s}, \quad \omega_0^2 = 64 \times 10^6$$

$$\alpha = \frac{R}{2L} = 10,000; \quad R = 20,000 \Omega$$

$$\omega_0^2 = \frac{1}{LC} = 64 \times 10^6; \quad L = \frac{10^9}{64 \times 10^6 (31.25)} = 0.5 \text{ H}$$

$$R = 10,000 \Omega$$

$$\text{[b]} \quad i(0) = 0$$

$$L \frac{di(0)}{dt} = v_c(0); \quad \frac{1}{2} (31.25) \times 10^{-9} v_c^2(0) = 9 \times 10^{-6}$$

$$\therefore v_c^2(0) = 576; \quad v_c(0) = 24 \text{ V}$$

$$\frac{di(0)}{dt} = \frac{24}{0.5} = 48 \text{ A/s}$$

$$\text{[c]} \quad i(t) = A_1 e^{-4000t} + A_2 e^{-16,000t}$$

$$i(0) = A_1 + A_2 = 0$$

$$\frac{di(0)}{dt} = -4000A_1 - 16,000A_2 = 48$$

Solving,

$$\therefore A_1 = 4 \text{ mA}; \quad A_2 = -4 \text{ mA}$$

$$i(t) = 4e^{-4000t} - 4e^{-16,000t} \text{ mA}, \quad t \geq 0$$

$$\text{[d]} \quad \frac{di(t)}{dt} = -16e^{-4000t} + 64e^{-16,000t}$$

$$\frac{di}{dt} = 0 \text{ when } 64e^{-16,000t} = 16e^{-4000t}$$

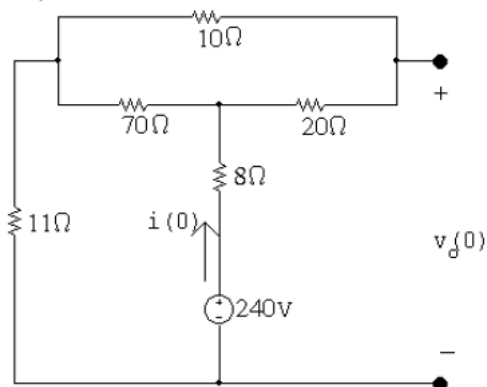
$$\text{or } e^{12,000t} = 4$$

$$\therefore t = \frac{\ln 4}{12,000} = 115.52 \mu\text{s}$$

$$\text{[e]} \quad i_{\max} = 4e^{-0.4621} - 4e^{-1.8484} = 1.89 \text{ mA}$$

$$\text{[f]} \quad v_L(t) = 0.5 \frac{di}{dt} = [-8e^{-1000t} + 32e^{-4000t}] \text{ V}, \quad t \geq 0^+$$

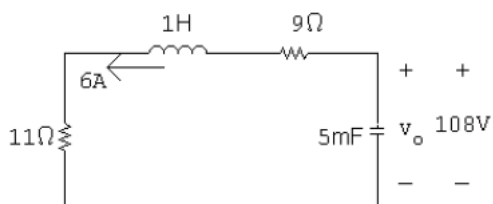
P 8.48 $t < 0$:



$$i(0) = \frac{240}{8 + 30 \parallel 70 + 11} = \frac{240}{40} = 6 \text{ A}$$

$$v_o(0) = 240 - 8(6) - \frac{70}{100}(6)(20) = 108 \text{ V}$$

$t > 0$:



$$\alpha = \frac{R}{2L} = \frac{20}{2(1)} = 10, \quad \alpha^2 = 100$$

$$\omega_o^2 = \frac{1}{LC} = \frac{1}{(1)(5 \times 10^{-3})} = 200$$

$$\omega_o^2 > \alpha^2 \quad \text{underdamped}$$

$$s_{1,2} = -100 \pm \sqrt{100 - 200} = -10 \pm j10 \text{ rad/s}$$

$$v_o = B_1 e^{-10t} \cos 10t + B_2 e^{-10t} \sin 10t$$

$$v_o(0) = B_1 = 108 \text{ V}$$

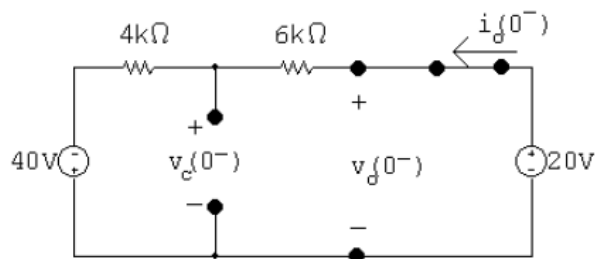
$$C \frac{dv_o}{dt}(0) = -6, \quad \frac{dv_o}{dt} = \frac{-6}{5 \times 10^{-3}} = -1200 \text{ V/s}$$

$$\frac{dv_o}{dt}(0) = -10B_1 + 10B_2 = -1200$$

$$10B_2 = -1200 + 10B_1 = -1200 + 1080; \quad B_2 = -120/10 = -12 \text{ V}$$

$$\therefore v_o = 108e^{-10t} \cos 10t - 12e^{-10t} \sin 10t \text{ V}, \quad t \geq 0$$

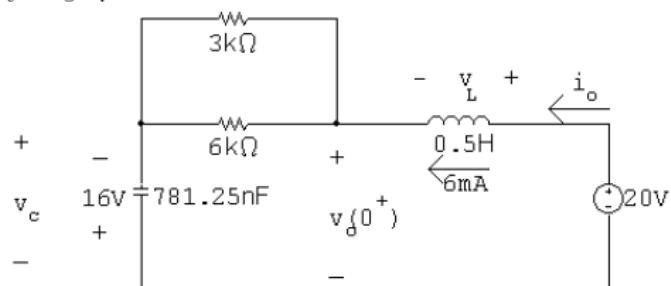
P 8.53 [a] $t < 0$:



$$i_o(0^-) = \frac{60}{10,000} = 6 \text{ mA}$$

$$v_c(0^-) = 20 - (6000)(0.006) = -16 \text{ V}$$

$t = 0^+$:



$$3 \text{ k}\Omega \parallel 6 \text{ k}\Omega = 2 \text{ k}\Omega$$

$$\therefore v_o(0^+) = (0.006)(2000) - 16 = 12 - 16 = -4 \text{ V}$$

$$\text{and } v_L(0^+) = 20 - (-4) = 24 \text{ V}$$

$$[\mathbf{b}] \quad v_o(t) = 2000i_o + v_C$$

$$\frac{dv_o}{dt}(t) = 2000\frac{di_o}{dt} + \frac{dv_C}{dt}$$

$$\frac{dv_o}{dt}(0^+) = 2000\frac{di_o}{dt}(0^+) + \frac{dv_C}{dt}(0^+)$$

$$v_L(0^+) = L\frac{di_o}{dt}(0^+)$$

$$\frac{di_o}{dt}(0^+) = \frac{v_L(0^+)}{L} = \frac{24}{0.5} = 48 \text{ A/s}$$

$$C\frac{dv_C}{dt}(0^+) = i_o(0^+)$$

$$\therefore \frac{dv_C}{dt}(0^+) = \frac{6 \times 10^{-3}}{781.25 \times 10^{-9}} = 7680$$

$$\therefore \frac{dv_o}{dt}(0^+) = 2000(48) + 7680 = 103,680 \text{ V/s}$$

$$[\mathbf{c}] \quad \omega_o^2 = \frac{1}{LC} = 2.56 \times 10^6; \quad \omega_o = 1600 \text{ rad/s}$$

$$\alpha = \frac{R}{2L} = 2000 \text{ rad/s}$$

$$\alpha^2 > \omega_o^2 \quad \text{overdamped}$$

$$s_{1,2} = -2000 \pm j1200 \text{ rad/s}$$

$$v_o(t) = V_f + A'_1 e^{-800t} + A'_2 e^{-3200t}$$

$$V_f = v_o(\infty) = 20 \text{ V}$$

$$20 + A'_1 + A'_2 = -4; \quad -800A'_1 - 3200A'_2 = 103,680$$

$$\text{Solving} \quad A'_1 = 11.2; \quad A'_2 = -35.2$$

$$\therefore v_o(t) = 20 + 11.2e^{-800t} - 35.2e^{-3200t} \text{ V}, \quad t \geq 0^+$$