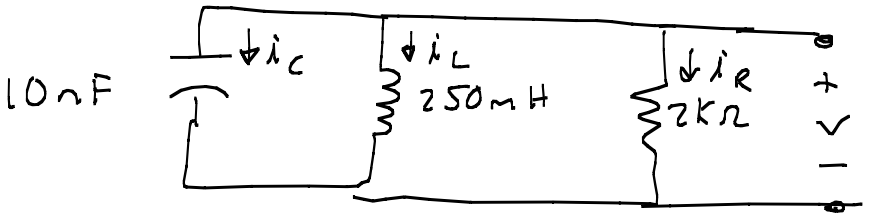
Problem 1

$I_0 = -30\,mA$

$V_0 = 90\,V$



Determine

- $v(t)$
- $i_L(t)$

$$\alpha = \frac{1}{2RC} = \frac{1}{(2)(2000\Omega)(10\times10^{-9}F)} = 25{,}000\ rad/s$$

$$\omega_0^2 = \frac{1}{LC} = \frac{1}{(0.25H)(10\times10^{-9}F)} = 4\times10^8\ rad/s^2$$

$$\alpha^2 = 6.25\times10^8\ rad/s^2 > \omega_0^2 \Rightarrow \text{overdamped}$$

$$s_1 = -25{,}000 + \sqrt{6.25\times10^8 - 4\times10^8} = -10{,}000\ rad/s$$

$$s_2 = -25{,}000 - \sqrt{6.25\times10^8 - 4\times10^8} = -40{,}000\ rad/s$$

$$v(t) = A_1 e^{-10{,}000t} + A_2 e^{-40{,}000t}$$

$$v(0) = 90\,V \Rightarrow \boxed{A_1 + A_2 = 90}$$

$$i_R(0^+) + i_L(0^+) + i_C(0^+) = 0$$

$$\frac{90\,V}{2000\,\Omega} + (-30\,mA) + i_C(0^+) = 0 \qquad i_C(0^+) = -15\,mA = C\frac{dv(0^+)}{dt}$$

$$\frac{dv(0^+)}{dt} = \frac{-15\,mA}{10\times10^{-9}\,F} = -1{,}500{,}000\ V/s$$

$$\frac{dv}{dt} = -10{,}000A_1e^{-10{,}000t} - 40{,}000A_2e^{-40{,}000t}$$

$$\boxed{-1{,}500{,}000 = -10{,}000A_1 - 40{,}000A_2}$$

$$A_1 = 70,\ A_2 = 20$$

$$\boxed{v(t) = 70e^{-10{,}000t} + 20e^{-40{,}000t}\ V}$$

$$i_R(t) = \frac{v(t)}{2000} = \underline{\left(35e^{-10{,}000t} + 10e^{-40{,}000t}\right)\,mA}$$

$$i_C(t) = C\frac{dv}{dt} = (10\times10^{-9}\,F)\left(-10{,}000(70)e^{-10{,}000t} - 40{,}000(20)e^{-40{,}000t}\right)$$

$$= \left(-7e^{-10{,}000t} - 8e^{-40{,}000t}\right)\ mA$$

$$i_L(t) = -i_R(t) - i_C(t)$$

$$i_L(t) = \left(-28e^{-10{,}000t} - 2e^{-40{,}000t}\right)\ mA$$