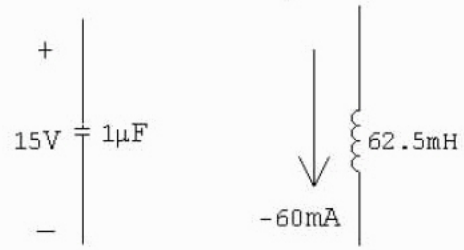
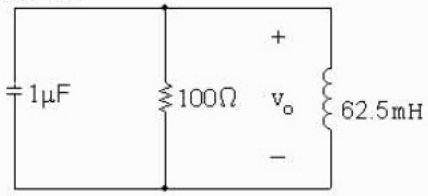
Q1

$t < 0:$ $\quad V_o = 15\,\text{V}, \quad I_o = -60\,\text{mA}$



$t > 0$:



$$i_R(0) = \frac{15}{100} = 150\,\text{mA}; \qquad i_\text{L}(0) = -60\,\text{mA}$$

$$i_\text{C}(0) = -150 - (-60) = -90\,\text{mA}$$

$$\omega_o^2 = \frac{1}{LC} = \frac{1}{(62.5 \times 10^{-3})(10^{-6})} = 16 \times 10^6$$

$$\alpha = \frac{1}{2RC} = \frac{1}{2(200)(10^{-6})} = 2500$$

$$s_{1,2} = -2500 \pm \sqrt{2500^2 - 16 \times 10^6} = -2500 \pm j3122.5\text{rad/s}$$

$$v_o(t) = B_1 e^{-2500t}\cos 3122.5t + B_2 e^{-2500t}\sin 3122.5t$$

$$v_o(0) = B_1 = 15\,\text{V}$$

$$i_R(0) = \frac{15}{200} = 75\,\text{mA}$$

$$i_\text{L}(0) = -60\,\text{mA}$$

$$i_\text{C}(0) = -i_R(0) - i_\text{L}(0) = -15\,\text{mA} \quad \therefore \quad \frac{i_\text{C}(0)}{C} = -15{,}000$$

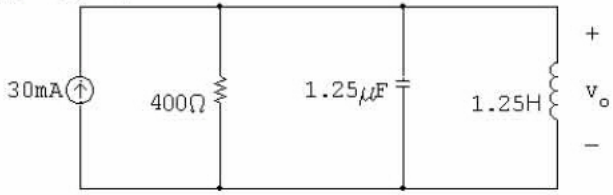
$$\frac{dv_o}{dt}(0) = -2500B_1 + 3122.5B_2 = -15{,}000$$

$$\therefore \quad B_2 = 7.21$$

$$v_o(t) = 15e^{-2500t}\cos 3122.5t + 7.21e^{-2500t}\sin 3122.5t\,\text{V}, \qquad t \geq 0$$

Q2

For $t > 0$



$$\alpha = \frac{1}{2RC} = 1000; \qquad \frac{1}{LC} = 64 \times 10^4$$

$$s_{1,2} = -1000 \pm 600 \text{ rad/s}$$

$$s_1 = -400\,\text{rad/s}; \qquad s_2 = -1600\,\text{rad/s}$$

$$v_o = V_f + A_1' e^{-400t} + A_2' e^{-1600t}$$

$$V_f = 0; \qquad v_o(0^+) = 0; \qquad i_C(0^+) = 30\,\text{mA}$$

$$\therefore \quad A_1' + A_2' = 0$$

$$\frac{dv_o(0^+)}{dt} = \frac{i_C(0^+)}{1.25 \times 10^{-6}} = 24{,}000\,\text{V/s}$$

$$\frac{dv_o(0^+)}{dt} = -400A_1' - 1600A_2' = 24{,}000$$

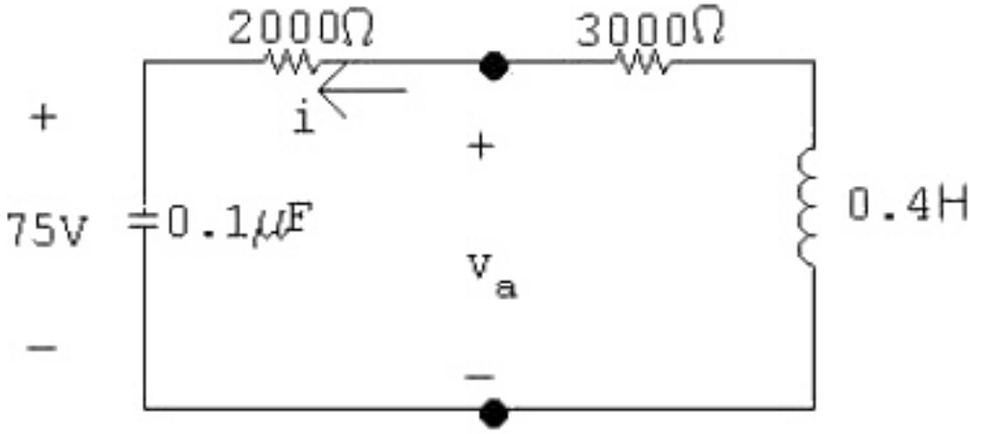
Solving,

$$A_1' = 20\,\text{V}; \qquad A_2' = -20\,\text{V}$$

$$v_o = 20e^{-400t} - 20e^{-1600t}\,\text{V}, \qquad t \geq 0$$

Q3

[a] For $t > 0$:



Since $i(0^-) = i(0^+) = 0$

$v_o(0^+) = 75\,\text{V}$

[b] $v_o = 2000i + 10^7 \int_0^t i\,dx + 75$

$$\frac{dv_o}{dt} = 2000\frac{di}{dt} + 10^7 i$$

$$\frac{dv_o(0^+)}{dt} = 2000\frac{di(0^+)}{dt} + 10^7 i(0^+) = 2000\frac{di(0^+)}{dt}$$

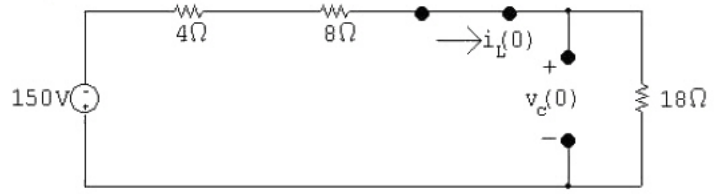
$$-L\frac{di(0^+)}{dt} = 75$$

$$\frac{di(0^+)}{dt} = -2.5(75) = -187.5\,\text{A/s}$$

$$\therefore \quad \frac{dv_o(0^+)}{dt} = -375{,}000\,\text{V/s}$$

Q4

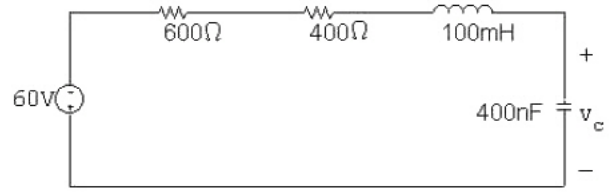
$t < 0$:



$$i_{\mathrm{L}}(0) = \frac{-150}{30} = -5\,\mathrm{A}$$

$$v_{\mathrm{C}}(0) = 18 i_{\mathrm{L}}(0) = -90\,\mathrm{V}$$

$t > 0$:



$$\alpha = \frac{R}{2L} = \frac{10}{2(0.1)} = 50\ \mathrm{rad/s}$$

$$\omega_o^2 = \frac{1}{LC} = \frac{1}{(0.1)(2\times 10^{-3})} = 5000$$

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

$$s_{1,2} = -50 \pm \sqrt{50^2 - 5000} = -50 \pm j50$$

$$v_c = 60 + B_1' e^{-50t}\cos 50t + B_2' e^{-50t}\sin 50t$$

$$v_c(0) = -90 = 60 + B_1' \quad \therefore \quad B_1' = -150$$

$$C\frac{dv_c}{dt}(0) = -5; \qquad \frac{dv_c}{dt}(0) = \frac{-5}{2\times 10^{-3}} = -2500$$

$$\frac{dv_c}{dt}(0) = -50B_1' + 50B_2 = -2500 \quad \therefore \quad B_2' = -200$$

$$v_c = 60 - 150e^{-50t}\cos 50t - 200e^{-50t}\sin 50t\,\mathrm{V}, \quad t \geq 0$$