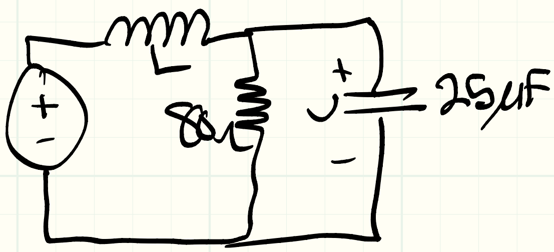
$L = 1H$, $V_s = 0$ for $t > 0$

$v(0) = 6V$ $\quad \frac{dv(0)}{dt} = -3000\ V/s$



Parallel RLC

$$\Rightarrow \alpha = \frac{1}{2RC} \quad \omega_0^2 = \frac{1}{LC}$$

$$\alpha = \frac{1}{2*80*25\times10^{-6}} = 250\ rad/sec$$

$$\omega_0^2 = \frac{1}{LC} = \frac{1}{1*25\times10^{-6}} = 40{,}000\ rad^2/sec^2$$

$$\alpha^2 > \omega_0^2 \Rightarrow \text{overdamped circuit}$$

$$v_n = A_1 e^{s_1 t} + A_2 e^{s_2 t}$$

$$s_1 = -\alpha + \sqrt{\alpha^2 - \omega_0^2} \qquad s_2 = -\alpha - \sqrt{\alpha^2 - \omega_0^2}$$

$$s_1 = -100 \qquad s_2 = -400$$

$$v(0) = A_1 + A_2 \Rightarrow 6 = A_1 + A_2$$

$$s_1 A_1 + s_2 A_2 = \frac{dv(0)}{dt} \Rightarrow -100A_1 - 400A_2 = -3000$$

or $A_1 + 4A_2 = 30$

$$A_1 = 6 - A_2$$

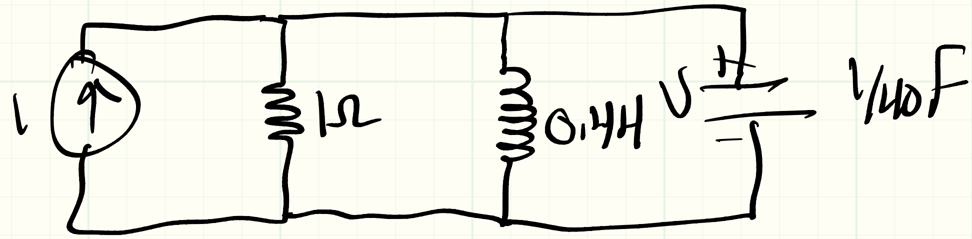
$$6 - A_2 + 4A_2 = 30$$

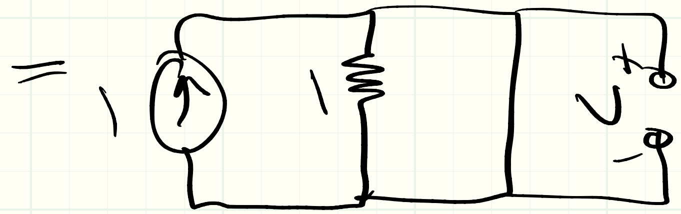
$$\Rightarrow 3A_2 = 24 \Rightarrow A_2 = 8$$

$$A_1 = 6 - 8 = -2$$

$$\therefore \boxed{v_n(t) = -2e^{-100t} + 8e^{-400t}\ V}$$

for $t<0$





$v(0) = 0\,V$
$i(0) = 1\,A$

for $t>0$)

parallel RLC

$$\alpha = \frac{1}{2RC} = \frac{1}{2(1)(1/40)} = 20 \text{ rad/sec}$$

$$\omega_0^2 = \frac{1}{LC} = \frac{1}{0.4 * 1/40} = 100 \text{ rad}^2/\text{sec}^2$$

$$\alpha^2 > \omega_0^2 \Rightarrow \text{overdamped}$$

$$v_n(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$$

$$s_1 = -\alpha + \sqrt{\alpha^2 - \omega_0^2} \qquad s_2 = -\alpha - \sqrt{\alpha^2 - \omega_0^2}$$

$$s_1 = -2.7 \qquad s_2 = -37.3$$

$$v(0) = A_1 + A_2 \Rightarrow A_1 + A_2 = 0 \text{ or } A_1 = -A_2$$

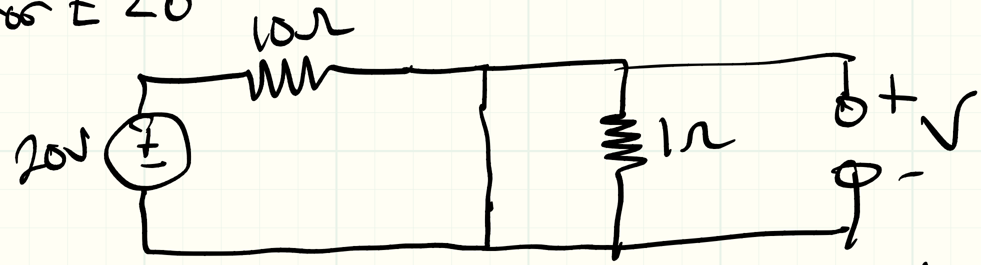
$$s_1 A_1 + s_2 A_2 = -\frac{v(0)}{RC} - \frac{i(0)}{C}$$

$$-2.7A_1 - 37.3A_2 = -40 \text{ or } A_1 + 13.8A_2 = 14.8$$

$$\Rightarrow 12.8A_2 = 14.8 \Rightarrow A_2 = 1.16,\ A_1 = -1.16$$

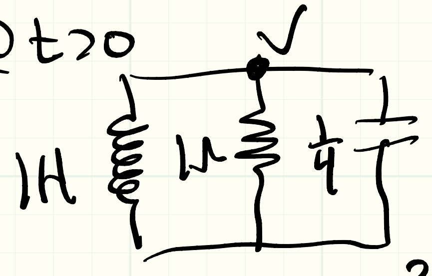
$$\boxed{v_n(t) = -1.16e^{-2.7t} + 1.16e^{-37.3t}} \checkmark$$

For $t < 0$



$V_c(0) = 0V \quad i(0) = \frac{20}{10} = 2A$

@ $t > 0$



$\alpha = \frac{1}{2RC} = \frac{1}{2\times1\times\frac{1}{4}} = 2$

$\omega_0^2 = \frac{1}{LC} = \frac{1}{1\times\frac{1}{4}} = 4\left(\frac{rad}{sec}\right)^2$

$\alpha^2 = \omega_0^2 \therefore$ critically damped

$S_{1,2} = -\alpha = -2$

$V_n = (A_1 t + A_2)e^{s_1 t}$

$\Rightarrow V_n = (A_1 t + A_2)e^{-2t}$

$V_n(0) = 0 = A_2 \Rightarrow A_2 = 0$

$\frac{V(0)}{R} + i(0) + C\frac{dv(0)}{dt} = 0 \Rightarrow C\frac{dv(0)}{dt} = -i(0) - \frac{V(0)}{R}$

$\Rightarrow \frac{1}{4}\frac{dv(0)}{dt} = -2 - 0 \Rightarrow \frac{dv(0)}{dt} = -8$

Finding $\frac{dv}{dt}$ from V_n

$\frac{dV_n}{dt} = (-2)A_1 t e^{-2t} + e^{-2t}(A_1) - 2A_2 e^{-2t}$

$\frac{dV_n(0)}{dt} = A_1 \Rightarrow A_1 = -8$

$\boxed{V_n = -8te^{-2t}\ V}$

Solving for current through L

$$\frac{v}{R} + i + C\frac{dv}{dt} = 0 \quad \text{also} \quad V = L\frac{di}{dt}$$

$$\frac{L}{R}\frac{di}{dt} + i + LC\frac{d^2i}{dt^2} = 0$$

$$\Rightarrow \frac{d^2i}{dt^2} + \frac{1}{RC}\frac{di}{dt} + \frac{1}{LC}i = 0$$

From Q3

$\alpha = 2$

$\omega_0^2 = 4$

$s = -2$

$i(0) = 2$

$v(0) = 0$

$$i_n = (A_1 t + A_2)e^{-2t}$$

$$i_n(0) = A_2 = 2$$

$$v(0) = L\frac{di(0)}{dt} \Rightarrow \frac{di(0)}{dt} = 0$$

$$\frac{di_n}{dt} = -2(A_1 t + A_2)e^{-2t} + e^{-2t}(A_1)$$

$$\frac{di_n(0)}{dt} = -2A_2 + A_1 \Rightarrow -2(2) + A_1 = 0$$

$$\Rightarrow A_1 = 4$$

$$\boxed{i_N = (4t + 2)e^{-2t}\ A}$$