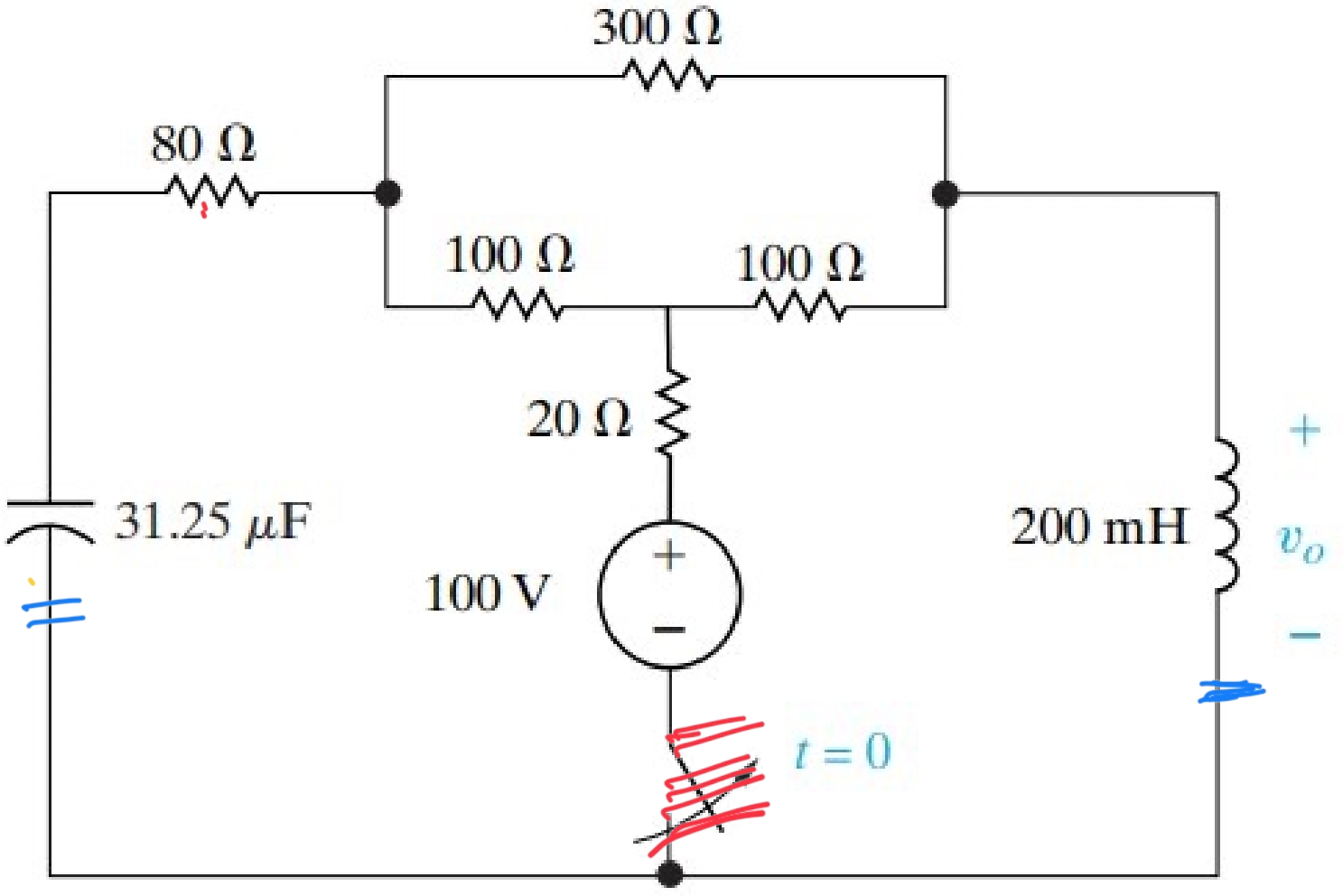
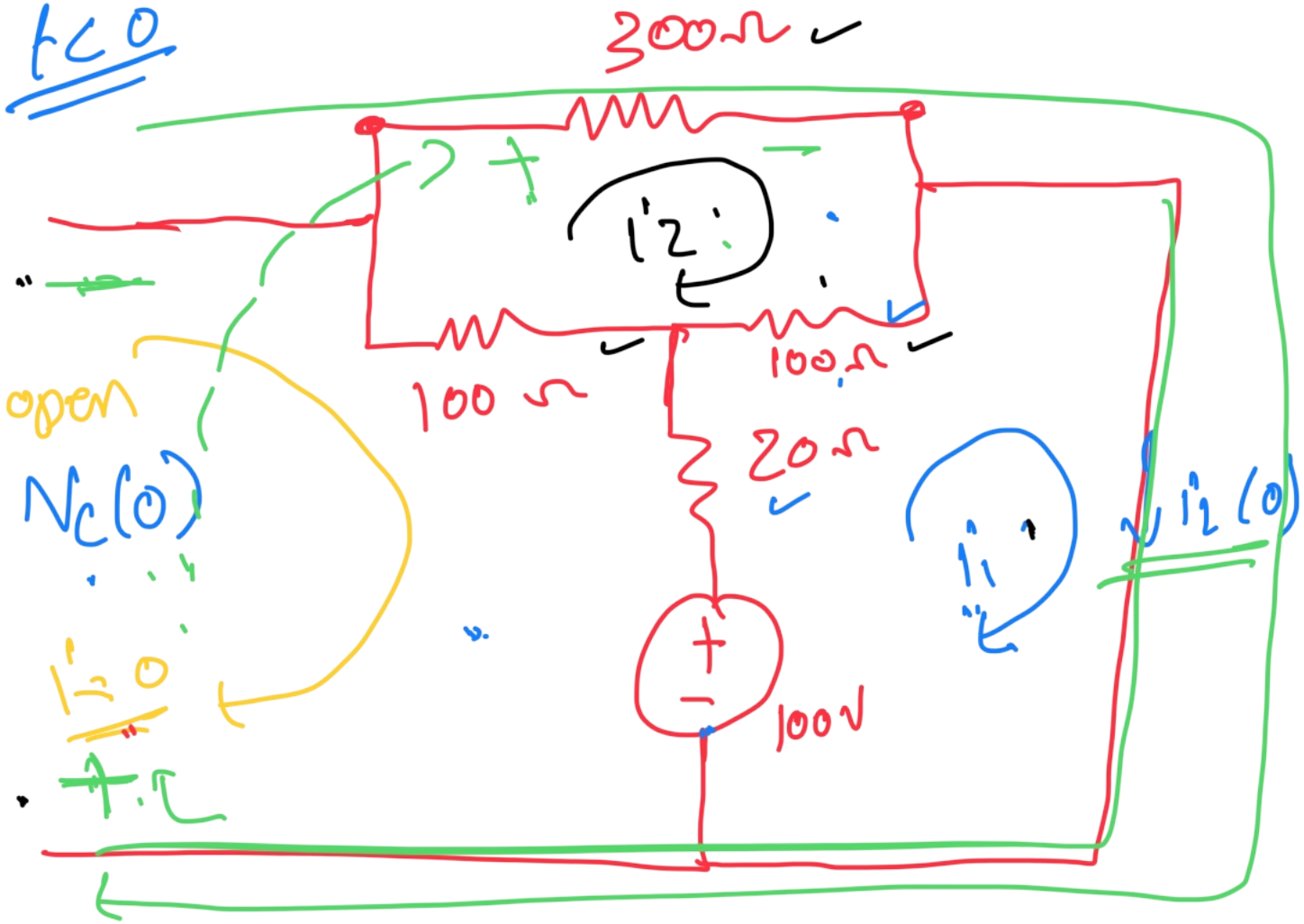
8.47 The switch in the circuit shown in Fig. P8.47 has been closed for a long time. The switch opens at $t = 0$. Find $v_o(t)$ for $t \geq 0^+$.

Figure P8.47



$t < 0$



$$120 i_1 - 100 i_2 = 100$$

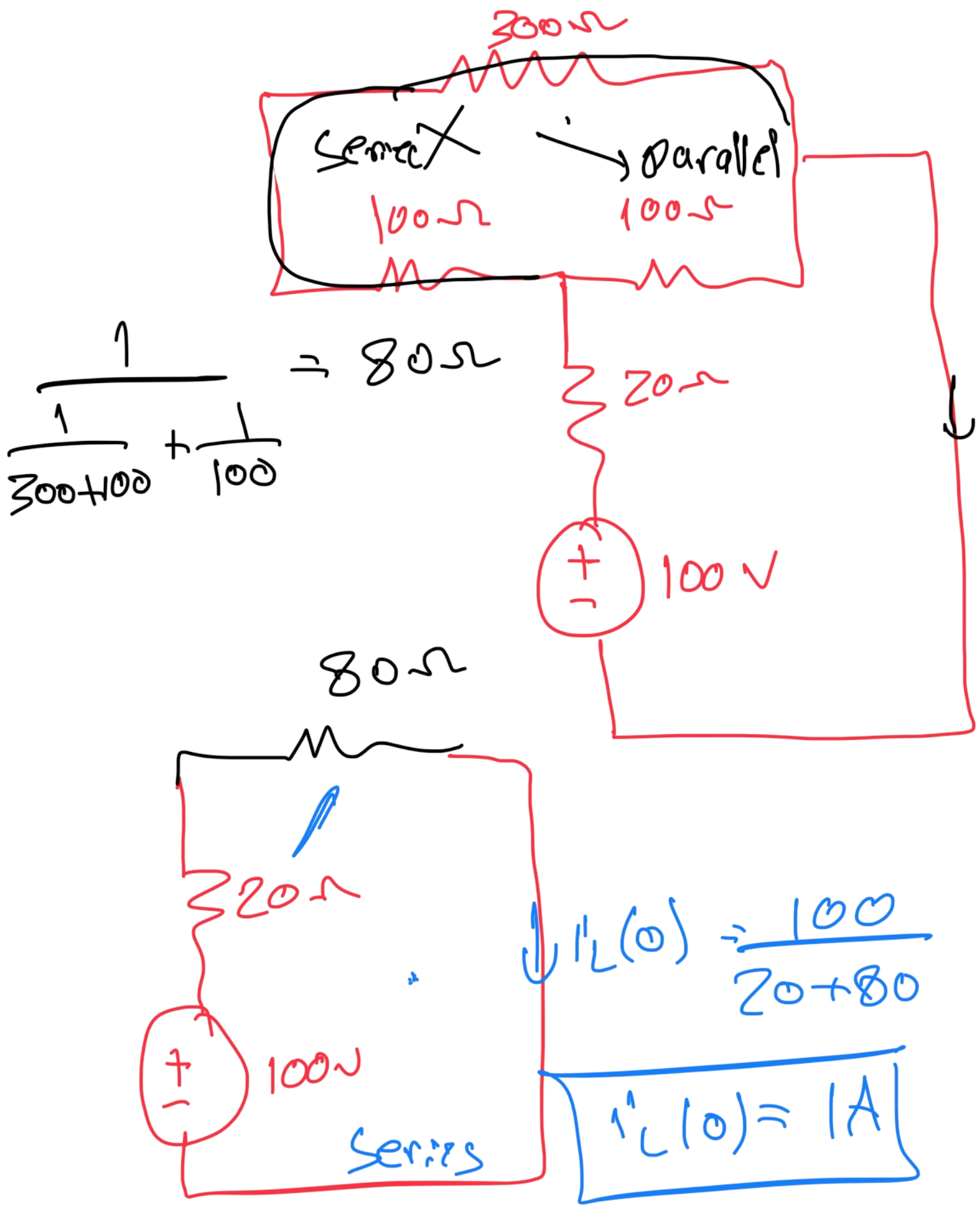
$$-100 i_1 + 500 i_2 = 0$$

$$i_1 = 1A \qquad i_2 = 0,2A$$

$$\Longrightarrow \boxed{i_L(0) = i_1 = 1A}$$

$$V_C(0) + 300 i_2 = 0$$

$$\Longrightarrow V_C(0) = -300 \times 0,2 = \boxed{-60V}$$


300Ω
series
parallel
100Ω
100Ω
$\frac{1}{\frac{1}{300+100}+\frac{1}{100}} = 80\Omega$
20Ω
100 V
80Ω
20Ω
100V
series
$i_L(0) = \frac{100}{20+80}$
$i_L(0) = 1A$

$t \geq 0$

300 Ω

Parallel

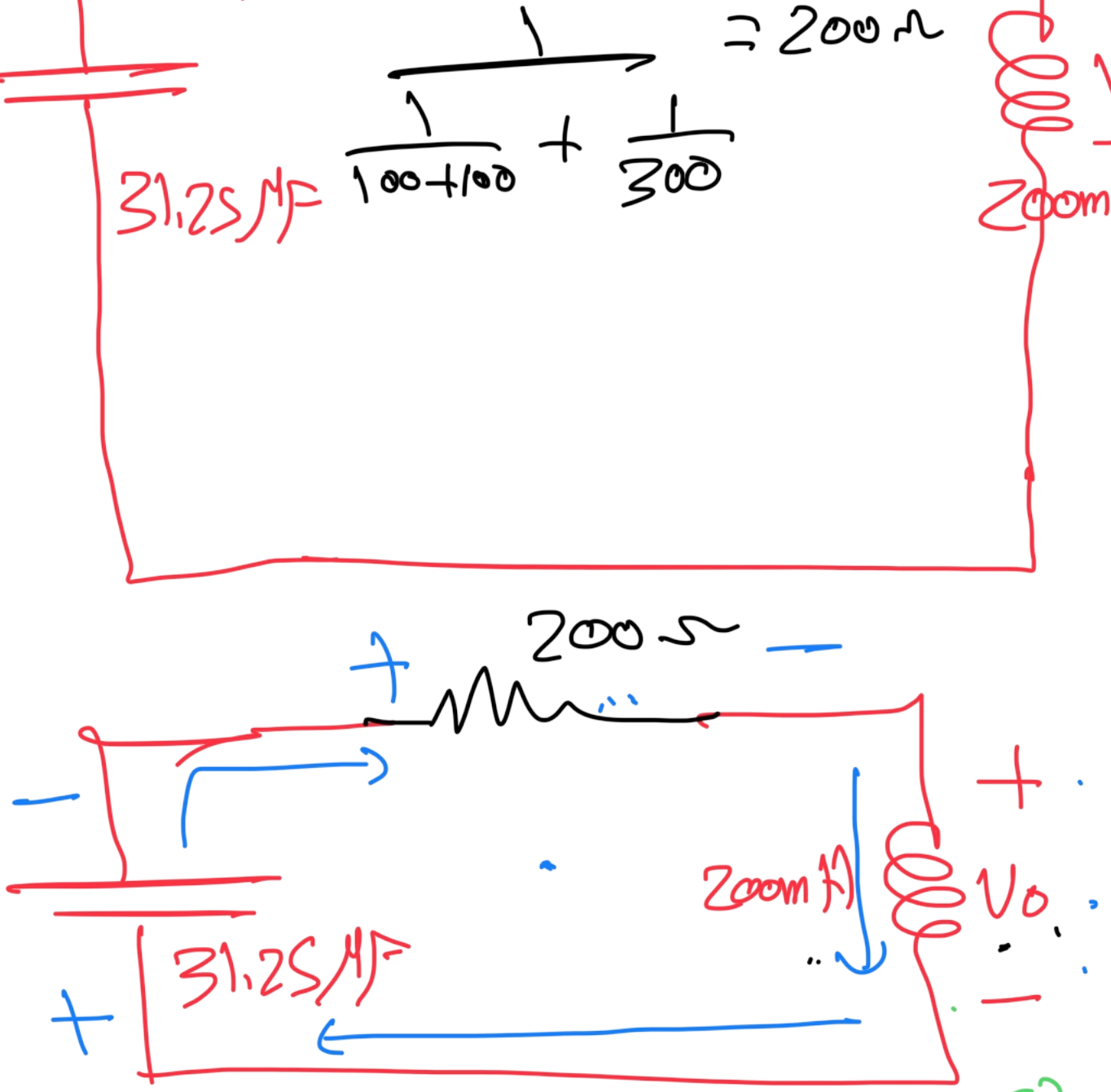
100 Ω + 100 Ω

$$\frac{1}{\frac{1}{100+100} + \frac{1}{300}} = 200\ \Omega$$

31.25 μF

200 mH

$V_0(t)$



$$\sum V = 0 \Rightarrow V_L + V_R + V_C = 0$$

Series / Second order / Natural

$\Longrightarrow$ free source

$$\alpha = \frac{R}{2L} = \frac{200}{2 \times 200 \times 10^{-3}} = 500 \text{ rad/s}$$

$$w_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{31.25 \times 10^{-6} \times 200 \times 10^{-3}}} = 400 \text{ rad/s}$$

$\alpha > w_0 \Longrightarrow$ overdamped

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

$$s_{1,2} = -\alpha \mp \sqrt{\alpha^2 - w_0^2}$$

$$s_{1,2} = -500 \mp \sqrt{500^2 - 400^2}$$

$s_1 = -200$ rad/s +

$s_2 = -800$ rad/s -

$e^0 = 1$

$$\therefore V_0(0) = A_1 + A_2$$

$$V_0'(0) = s_1 A_1 + s_2 A_2$$

$$V_L = L \frac{di}{dt} \quad \therefore$$

$$i_C = C \frac{dv_C}{dt}$$

$$i_2(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t} \quad \therefore$$

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

$$i_L'(0) = s_1 A_1 + s_2 A_2$$

$$i_L(0) = 1A \rightarrow$$

$$i_L'(0) = \frac{V_L(0)}{L} =$$

$$V_L(0) = -\left(V_C(0) + V_R(0)\right)$$

$$V_L(0) = -\left[-60 + 1 \times 200\right]$$

$$\Rightarrow \boxed{V_L(0) = -140\,V}$$

$$i_L'(0) = \frac{-140}{200 \times 10^{-3}} = -700\ A/s$$

$$A_1 + A_2 = 1$$

$$-200A_1 - 800A_2 = -700$$

$$A_1 = \frac{1}{6} A \qquad A_2 = \frac{5}{6} A$$

$$i_2(t) = \frac{1}{6} e^{-200t} + \frac{5}{6} e^{-800t} \quad A$$

$$V_2(t) = L \frac{\partial i_2(t)}{\partial t}$$

$$V_2 = 200 \times 10^{-3} \left[\frac{1}{6} * -200 e^{-200t} + \frac{5}{6} * -800 e^{-800t} \right]$$

$$V_2(t) = -\frac{20}{3} e^{-200t} + -\frac{400}{3} e^{-800t} \quad V$$

$t \geq 0$