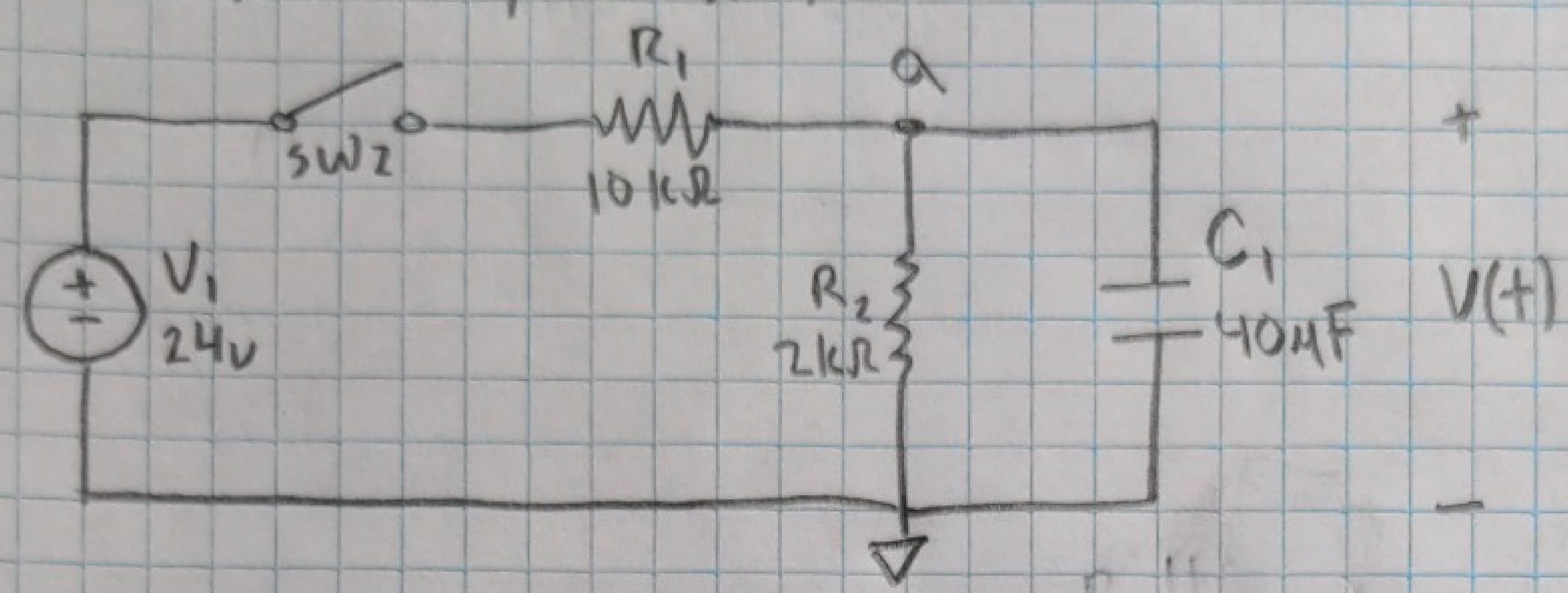
Chris Hunt HW1 ENGR 203

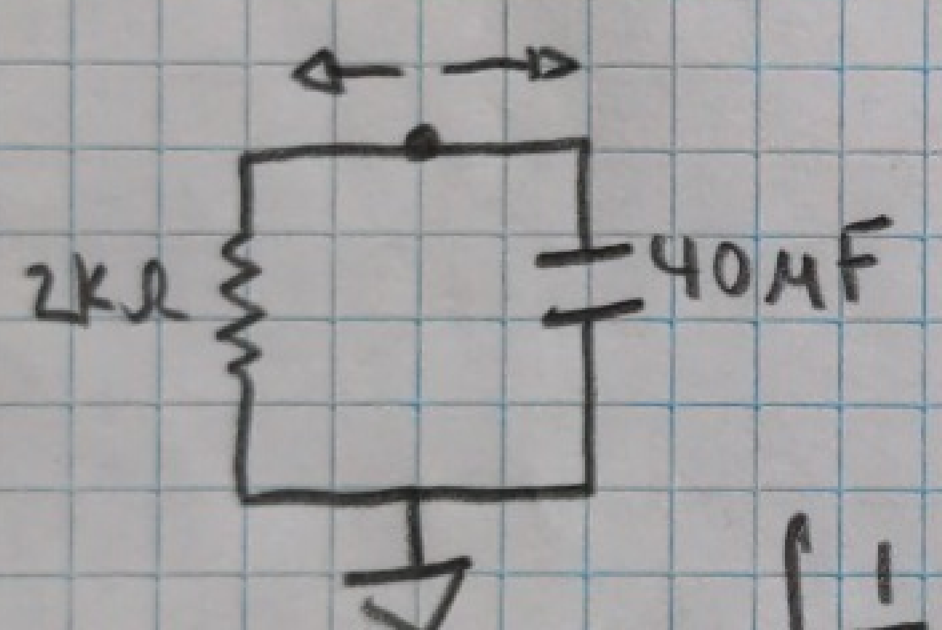
1.1) Find v(t) for $t \geq 0$. SW2 has been closed for a long time and opens at $t=0$



V_a at $t \leq 0$) In a DC circuit, capacitors act as an open circuit.

$$V_a = V_1\left(\frac{R_2}{R_1+R_2}\right) = 24v\left(\frac{2k\Omega}{12k\Omega}\right) = \frac{24V}{6} = 4v$$

At $t=0$ $V_c = V_a = 4v$, When SW2 opens effectively is:



$R = 2k\Omega$ $C = 40\mu F$ $\tau = RC = .08$

$v(t) = V_c e^{-t/\tau}$ → $\boxed{v(t) = 4e^{-t/.08} \text{ v For } t \geq 0}$

$$C\frac{dv}{dt} + \frac{v}{R} = 0$$

$$\frac{dv}{dt} + \frac{v}{RC} = 0$$

$$\frac{dv}{dt} = -\frac{v}{RC}$$

$$\frac{dv}{v} = -\frac{1}{RC}dt$$

$$\int \frac{1}{v}dv = -\frac{1}{RC}\int dt$$

$$\ln v + C_1 = -\frac{t}{RC} + C_2$$

$$\ln v = -\frac{t}{RC} + (C_2 - C_1); \quad C_2 - C_1 = \ln A$$

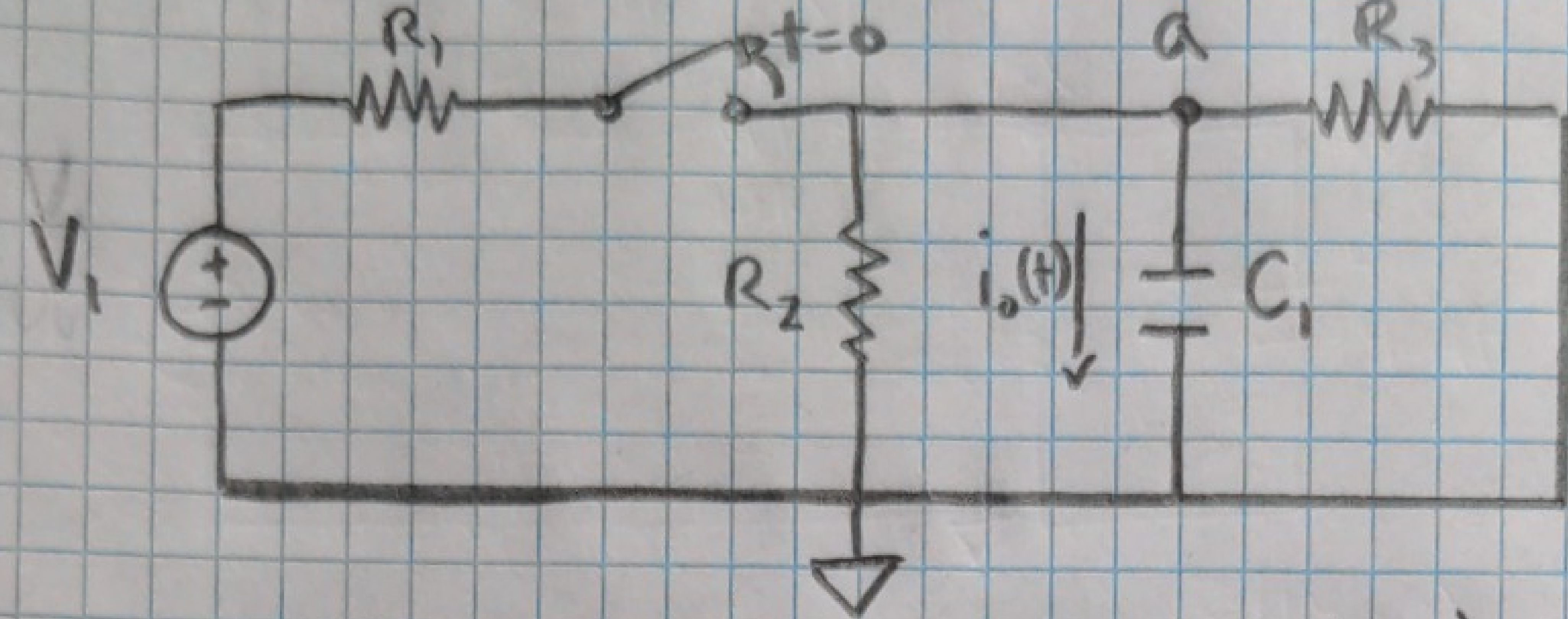
$$e^{\ln v} = e^{-\frac{t}{RC} + \ln A}$$

$$v(t) = Ae^{-\frac{t}{RC}} \qquad A = V_c \quad RC = \tau$$

$$v(t) = V_c e^{-\frac{t}{\tau}}$$

Chris Hunt HW 1 ENGR 203

1.2) The switch has been closed for a long time, and it opens at $t=0$. Find $i_o(t)$ for $t \geq 0$.



$V_1 = 10\,v$
$R_1 = 4\,k\Omega$
$R_2 = 6\,k\Omega$
$R_3 = 12\,k\Omega$
$C_1 = 125\,\mu F$

Find V_a at $t \leq 0$) $V_a = V_1\left(\frac{R_2 \| R_3}{R_1 + R_2 \| R_3}\right)$

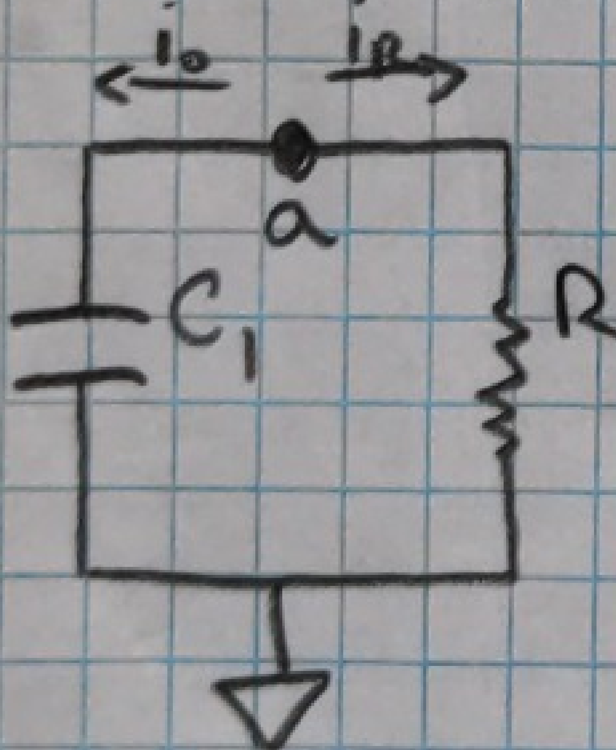
$R_2 \| R_3 = \frac{(6k\Omega)(12k\Omega)}{18k\Omega} = 4k\Omega$

$V_a = 10v\left(\frac{4k\Omega}{8k\Omega}\right) = 5v = V_c$

Find $V_c(t)$) $V_c(t) = V_c e^{-t/\tau}$ $R = R_2 \| R_3 = 4k\Omega$ $C = 125\,\mu F$

$V_c(t) = 5e^{-2t}$ $\tau = RC = .5$

Find $i_o(t)$) We can redraw the open switched circuit.



Using KCL, the current at (a) can be written as: $i_o + i_R = 0$

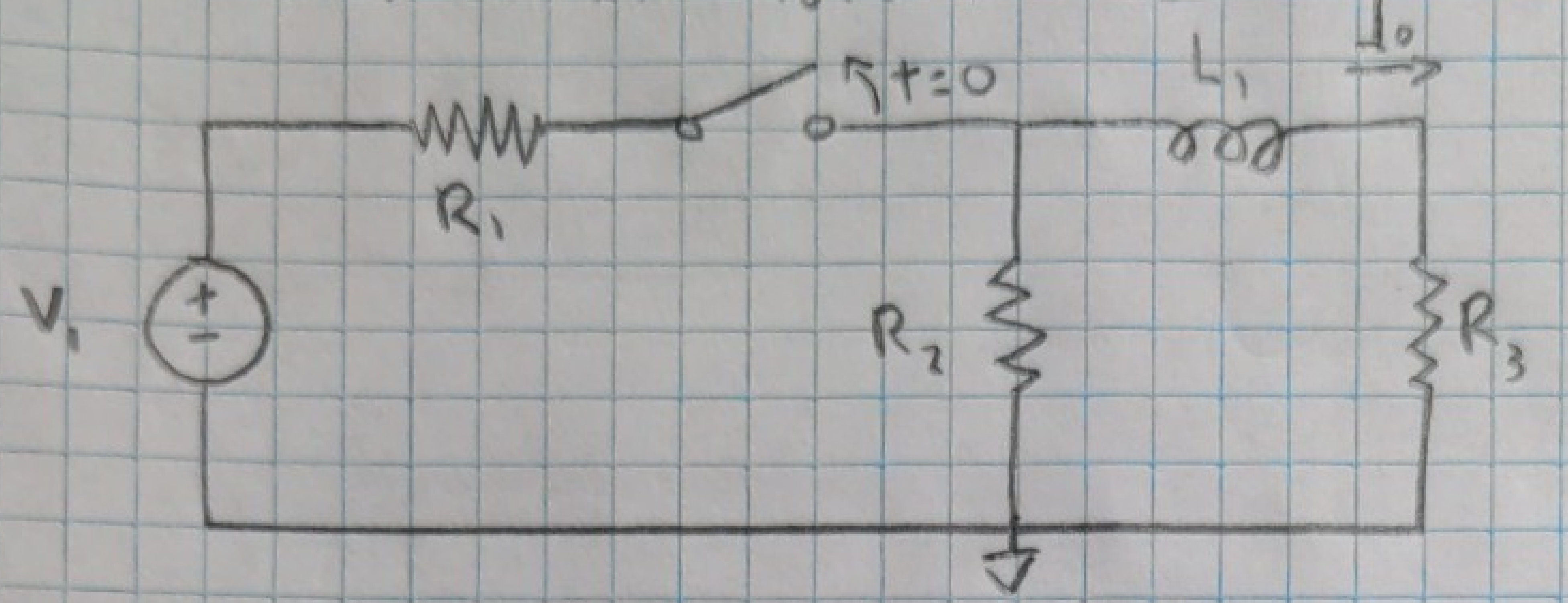
So $\rightarrow$ $i_o(t) = -i_R(t)$

$i_R(t) = \frac{V_c(t)}{R} \rightarrow \frac{5e^{-2t}\,v}{4k\Omega} = 1.25e^{-2t}\,mA$

$$\boxed{i_o(t) = -1.25e^{-2t}\,mA}$$

Chris Hunt HW1 ENGR 203

1.3) The switch has been closed for a long time and opens at $t=0$. Find $i_o(t)$ for $t \geq 0$



$V_1 = 24\,v$

$R_1 = 3\,\Omega$ $R_2 = 4\,\Omega$

$R_3 = 8\,\Omega$ $L_1 = 4\,H$

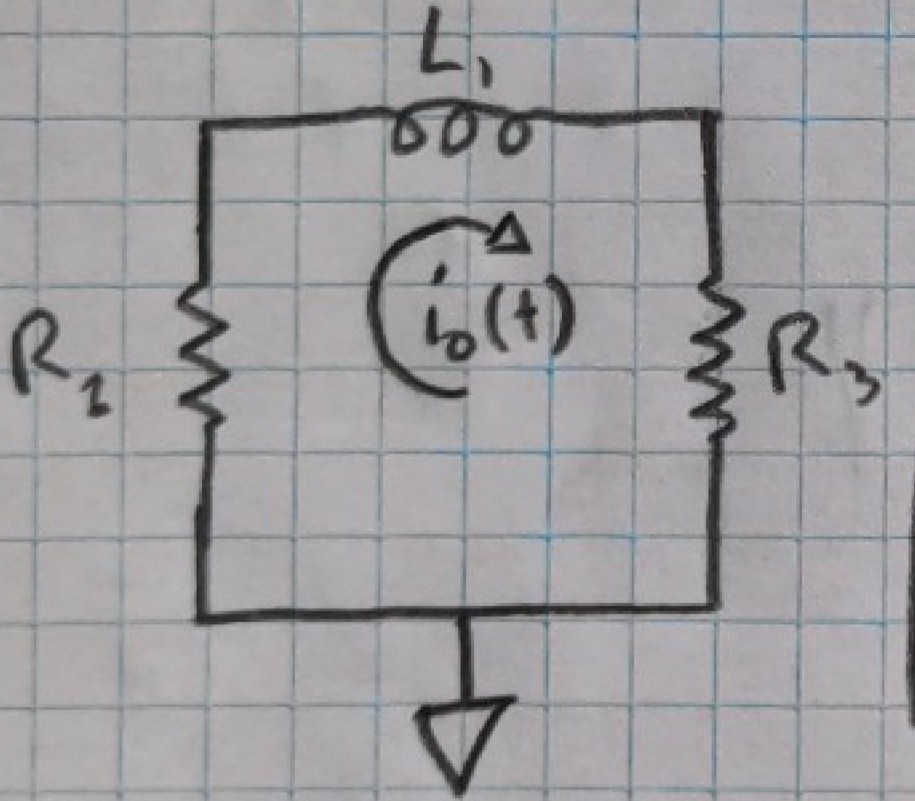
Find I_o when $t<0$) L_1 acts as a short circuit.

$I_o = I_{tot}\left(\frac{R_2}{R_2+R_3}\right)$ $I_{tot} = \frac{V_1}{R_{tot}}$ $R_{tot} = R_1 + R_2 || R_3$

$I_o = \frac{72}{17}A\left(\frac{4\,\Omega}{12\,\Omega}\right)$ $I_{tot} = \frac{24\,v}{17/3\,\Omega}$ $R_{tot} = 3\,\Omega + \frac{8}{3}\,\Omega = \frac{17}{3}\,\Omega$

$I_o = \frac{24}{17}A$ $I_{tot} = \frac{72}{17}A$

Find $i_o(t)$ when $t \geq 0$) $i_o(t) = I_o e^{-t/\tau}$



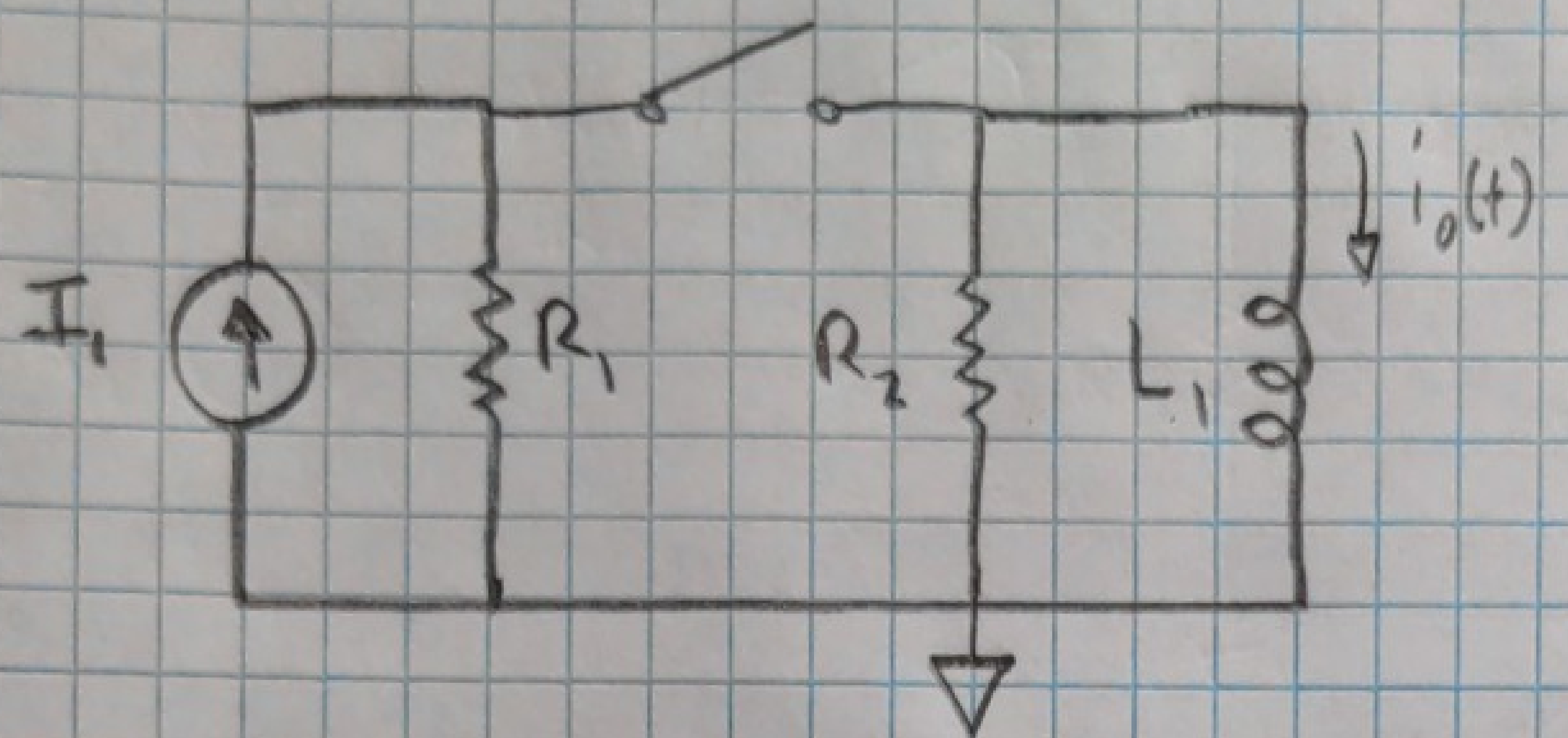
$R = R_2 + R_3 = 12\,\Omega$ $L_1 = 4\,H$

$\tau = \frac{L}{R} = \frac{4}{12} = \frac{1}{3}$

$$\boxed{i_o(t) = \frac{24}{17} e^{-3t}\ A}$$

Chris Hunt HW1 ENGR203

1.4) Find the inductor current $i_o(t)$ for $t \geq 0$. The switch has been closed for $t<0$ and opens at $t=0$.



$I_1 = 6\ A$ $R_1 = 4\Omega$

$R_2 = 2\Omega$ $L_1 = 3H$

At $t<0$, the inductor acts as a short circuit, therefore the current when $t<0$ through L_1 is $6A$

$I_o = 6\ A$

Find $i_o(t)$) $i_o(t) = I_o e^{-t/\tau}$ $\tau = \frac{L}{R} = \frac{3H}{2\Omega}$

$$\boxed{i_o(t) = 6e^{-\frac{2}{3}t}\ A}$$