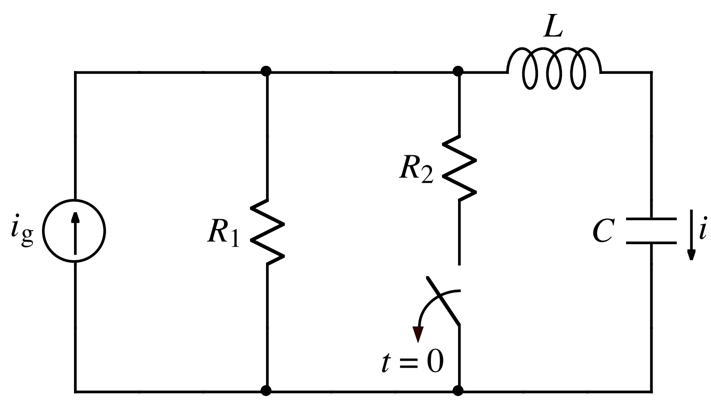
Ex:



After being closed for a long time, the switch opens at $t = 0$.

$L = 2.5$ nH $\quad C = 1.6$ nF $\quad R = 0.625\ \Omega$

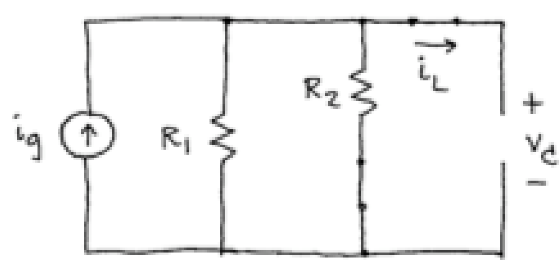
a) Give expressions for the following in terms of no more than i_g, R_1, R_2 L, and C:

$$i(t = 0^+) \quad \text{and} \quad \left.\frac{di(t)}{dt}\right|_{t=0^+}$$

b) Find the numerical values of L and C for the above circuit, given the following information:

$R_1 = 384$ mΩ $\quad R_2 = 192$ mΩ $\quad \alpha = 24$ kr/s $\quad \omega_d = 7$ kr/s

SOL'N: a) $t=0^-$ model: L = wire, C = open, find i_L, v_C
switch closed

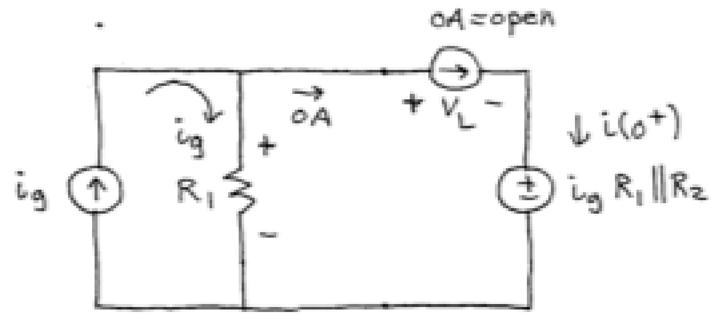


$i_L(0^-) = 0$ since C = open

$v_C(0^-) = i_g \cdot R_1 \| R_2$ since v_C across $R_1 \| R_2$

Use sources for i_L and v_C at $t=0^+$:
$i_L(0^+) = i_L(0^-)$ and $v_C(0^+) = v_C(0^-)$

$t=0^+$ model: $i_L = 0\,A$ = open, $v_c = i_g\, R_1 \| R_2$
switch open, R_2 disconnected



$$i(0^+) = 0A \quad \text{since} \quad i = i_L = 0A$$

For $\left.\dfrac{di}{dt}\right|_{t=0^+}$, we observe that $i = i_L$.

Thus, $\left.\dfrac{di}{dt}\right|_{t=0^+} = \left.\dfrac{di_L}{dt}\right|_{t=0^+} = \left.\dfrac{V_L}{L}\right|_{t=0^+}$

To find $v_L(0^+)$, we observe that i_g must flow thru R_1 since no current flows in L at $t=0^+$. It follows that the v-drop across R_1 is $i_g R_1$.

For v-loop on the right side, we have

$$i_g R_1 - V_L - i_g R_1 \| R_2 = 0V$$

or

$$V_L = i_g R_1 - i_g R_1 \| R_2$$

Thus $\left.\dfrac{di}{dt}\right|_{t=0^+} = \dfrac{V_L(0^+)}{L} = \dfrac{i_g R_1 - i_g R_1 \| R_2}{L}.$

b) We are given $\alpha = 24k$ r/s and $\omega_d = 7$ k r/s.

Thus, $s_{1,2} = -\alpha \pm j\omega_d = -24k \pm j7k$ r/s.

After $t=0$, only R_1 is in the circuit, and the circuit is a series RLC.

Thus $\alpha = \frac{R_1}{2L}$ and $\omega_d^2 = \frac{1}{LC} - \alpha^2$.

From α eq'n, $L = \frac{R_1}{2\alpha} = \frac{384\ m\Omega}{2 \cdot 24k\ r/s} = 8\mu H$.

From ω_d^2 eq'n, $\frac{1}{LC} = \omega_d^2 + \alpha^2 = 49M + (24k)^2\ r^2/s^2$

or $\frac{1}{LC} = 625\ M\ r^2/s^2$

or

$$C = \frac{1}{L \cdot 625M} F$$

or

$$C = \frac{1}{8\mu H \cdot 625\ M} F$$

or

$$C = \frac{1}{5k} F$$

or

$$C = 200\ \mu F$$