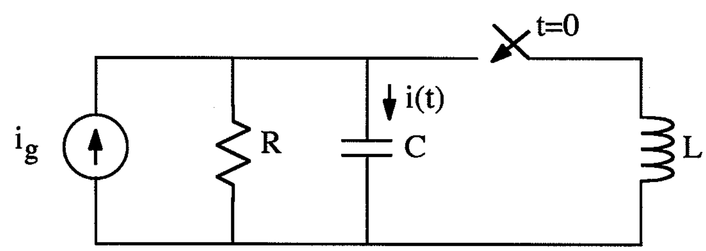
Ex:



After being open for a long time, the switch closes at t = 0.

The inductor carries no current at time $t = 0^-$.

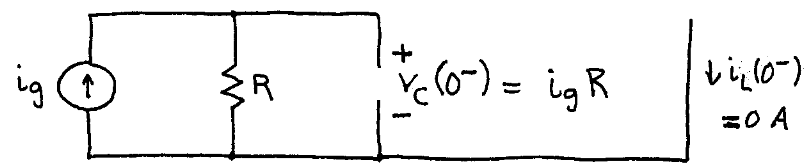
a) Give expressions for the following in terms of i_g, R, L, and C:

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

b) Find the numerical values of L and R given the following information:

$$C = 5\ \mu\text{F} \qquad s_1 = -10\text{k rad/s} \qquad s_2 = -40\text{k rad/s}$$

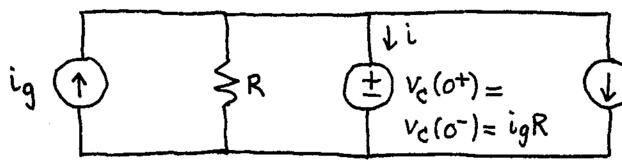
sol'n: a) We find initial conditions by starting at $t=0^-$: (L acts like wire, C acts like open)



$i_L(0^-) = 0$ A since prob says so

We only find the values of these energy variables at $t=0^-$ because they will not change instantly when we close the switch.

At $t=0^+$: (model L as i src, C as v src)



Since $i_L(0^+) = 0\,A$, the L acts like it is not there still.

The current thru R is $v_c(0^+)/R = i_g$. Thus, no current is left to flow thru C, and $\boxed{i(0^+) = 0\,A}$.

To find $\left.\frac{di}{dt}\right|_{t=0^+}$, we start by writing i in terms of i_L and v_c. (Don't plug in $t=0^+$ or take d/dt yet.)

Summing current out of the top wire:

$$-i_g + i_R + i + i_L = 0\,A$$

Replacing i_R with v_c/R, we have

$$i = i_g - \left(\frac{v_c}{R} + i_L\right).$$

Taking $\frac{d}{dt}$ of both sides:

$$\frac{di}{dt} = -\frac{1}{R}\frac{dv_c}{dt} - \frac{di_L}{dt}$$

We use $\frac{dv_c}{dt} = \frac{i_c}{C}$ and $\frac{di_L}{dt} = \frac{v_L}{L}$:

$$\frac{di}{dt} = -\frac{1}{R}\frac{i_C}{C} - \frac{v_L}{L}$$

$$\therefore \left.\frac{di}{dt}\right|_{t=0^+} = -\frac{1}{RC} i_C(0^+) - \frac{v_L(0^+)}{L}$$

Returning to our circuit for $t = 0^+$, we have $i_C(0^+) = i(0^+) = 0A$.

Also, $v_L(0^+) = v_C(0^+) = i_g R$.

$$\boxed{\left.\frac{di}{dt}\right|_{t=0^+} = -\frac{i_g R}{L}}$$

b) We always have $s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$.

We have a parallel RLC with $\alpha = \frac{1}{2RC}$.

For any simple RLC, $\omega_0^2 = \frac{1}{LC}$.

From the above, we use

$$s_1 + s_2 = -2\alpha = \frac{-1}{2RC} \cdot 2$$

$$\text{or } -10k\ r/s - 40k\ r/s = \frac{-1}{R \cdot 5\mu F}$$

$$\text{or } R = \frac{-1 \quad \Omega}{-50k \cdot 5\mu} = \frac{1\ \Omega}{250m} = 4\Omega$$

$\boxed{R = 4\Omega}$ (and $\alpha = 25k/s$)

To find L, we use

$$s_1 \cdot s_2 = \left(-\alpha + \sqrt{\alpha^2 - \omega_0^2}\right)\left(-\alpha - \sqrt{\alpha^2 - \omega_0^2}\right)$$

$$= (-\alpha)^2 - \sqrt{\alpha^2 - \omega_0^2}^{\,2}$$

$$= \alpha^2 - (\alpha^2 - \omega_0^2)$$

$$= \omega_0^2$$

$$= \frac{1}{LC}$$

$$\therefore L = \frac{1}{s_1 s_2 C}$$

$$L = \frac{1}{(-10k)(-40k)\,5\mu} \text{ H}$$

$$L = \frac{1}{2000} \text{ H}$$

$$\boxed{L = 500\,\mu\text{H}}$$