CG1111: Engineering Principles and Practice I

Additional Practice Questions for Capacitors & Inductors in DC Circuits

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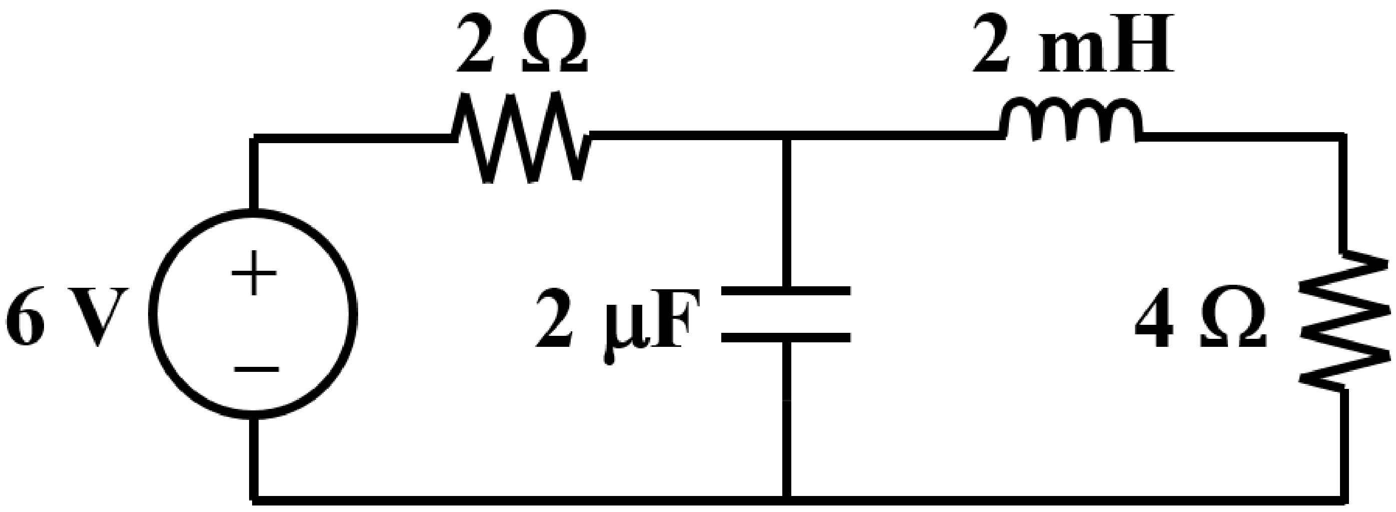
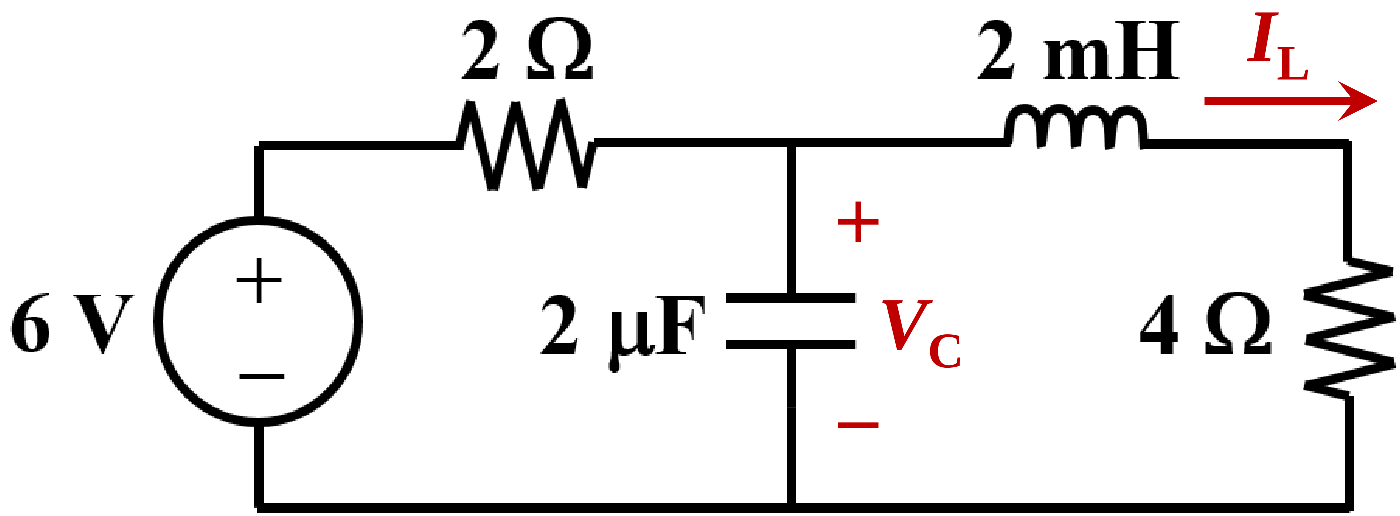
Question 1

- Find the energy stored in the capacitor and the inductor



Concepts tested:
Capacitor and Inductor in DC steady-state

Solution to Q1



At steady state:

- Capacitor behaves like an open-circuit
- Inductor behaves like a short-circuit

Therefore,

$$I_L = \frac{6\ \mathrm{V}}{2\ \Omega + 4\ \Omega} = 1\ \mathrm{A}, \qquad V_C = I_L \times 4\ \Omega = 4\ \mathrm{V}$$

Solution to Q1

- Energy stored in capacitor:

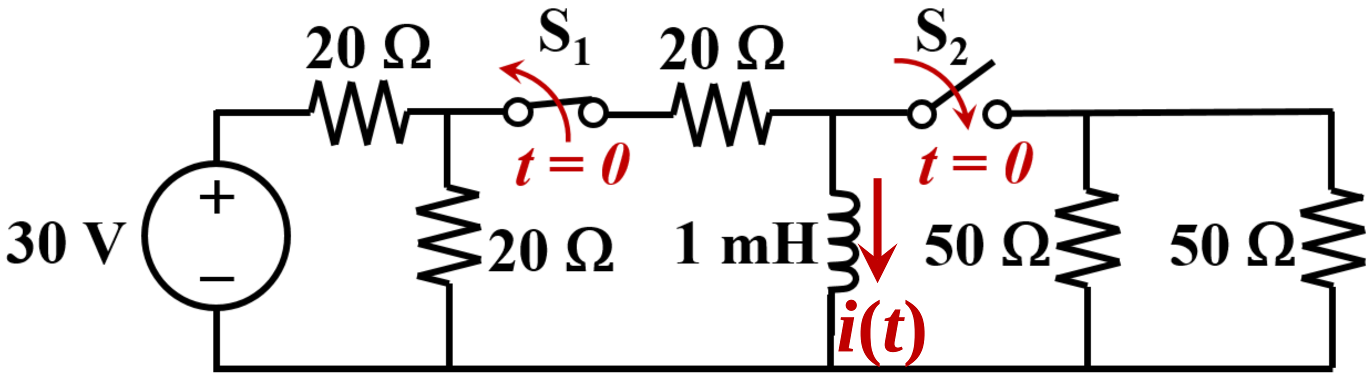
$$E_{\text{cap}} = \frac{1}{2}CV^2 = \frac{1}{2} \times 2 \times 10^{-6} \times 4^2 = 16\ \mu\text{J}$$

- Energy stored in inductor:

$$E_{\text{ind}} = \frac{1}{2}LI^2 = \frac{1}{2} \times 2 \times 10^{-3} \times 1^2 = 1\ \text{mJ}$$

Question 2

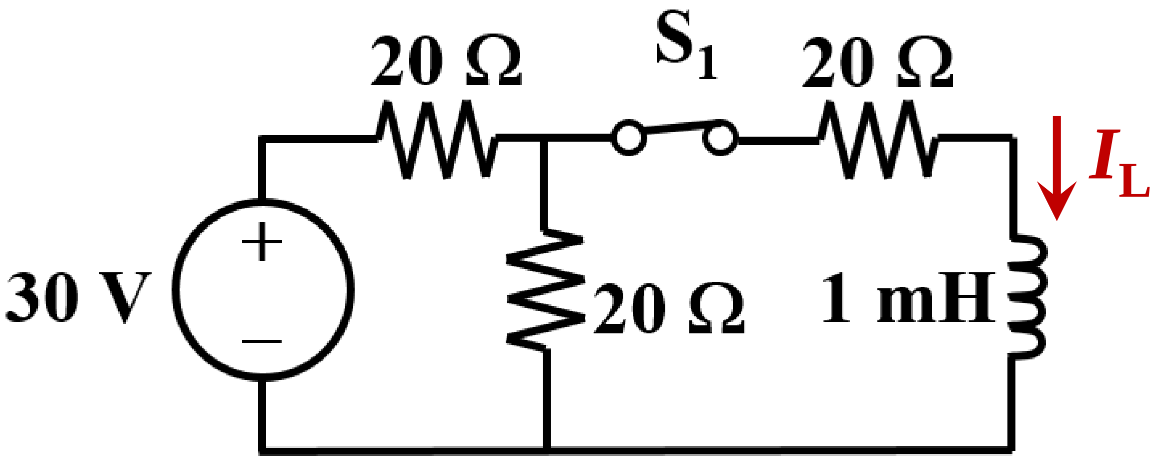
- Before t = 0, S_1 was closed and S_2 was opened, both for a long time. At t = 0, both switches were flipped. Find the current $i(t)$ after t = 0.



Concepts tested:

- Inductor in DC steady-state
- Inductor in DC transient

Solution to Q2



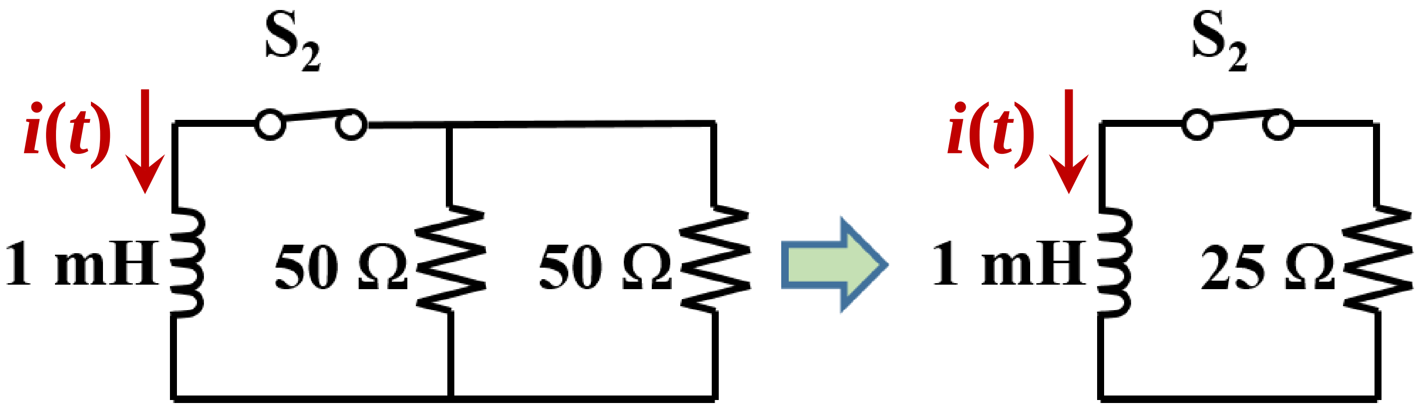
At steady state:

- Inductor behaves like a short-circuit

At t = 0$^-$,

$$I_L = \frac{30\,V}{(20 + 20||20)\,\Omega} \times \frac{20\,\Omega}{(20 + 20)\,\Omega} = 0.5\,A$$

Solution to Q2



- $i(t=0^{+}) = 0.5\text{ A}$ (cannot change instantaneously)
- $i(t=\infty) = 0\text{ A}$

To apply the transient equation formula, we need to get the equivalent series RL circuit. There is no Thevenin voltage, only Thevenin resistance (50||50 = 25 Ω).

Hence, $\tau = \frac{L}{R} = \frac{0.001}{25} = 40\ \mu s$

$$i(t) = i(0)e^{-\frac{t}{\tau}} + i(\infty)[1 - e^{-\frac{t}{\tau}}] = 0.5e^{-\frac{t}{\tau}}, \tau = 40\ \mu s$$