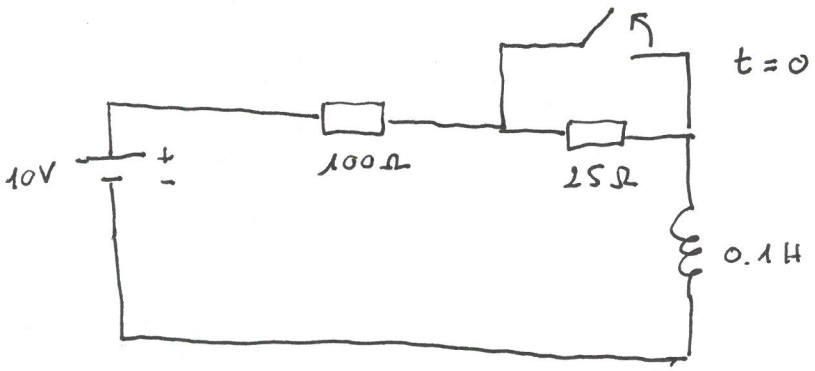
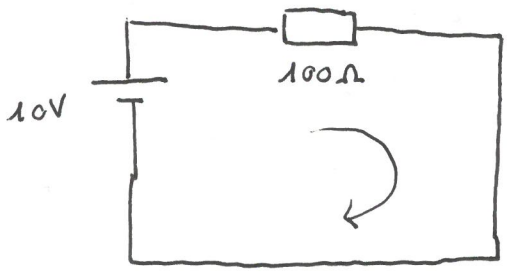
EXAMPLE 1 :

Find voltage across the inductor after the switch opens.



- $t < 0$

with closed switch the circuit is :



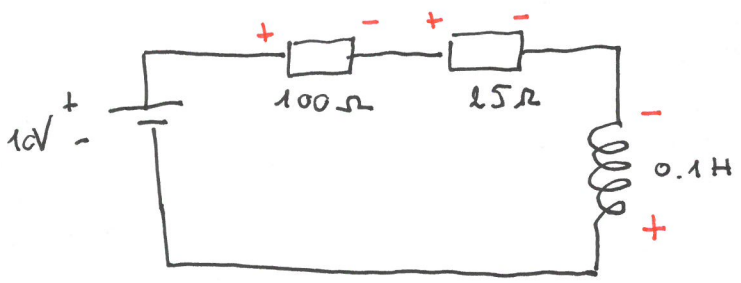
1) the 25Ω resistance is short-circuited with the closed switch

2) the long-time response of the inductor is that of a S/C

$$\begin{cases} V_L = 0\,V \\ i \equiv i_L = \dfrac{V}{R_1} = \dfrac{10\,V}{100\,\Omega} = 0.1\,A \end{cases}$$

- $t \geq 0$ $\qquad V_L(t) = V_{fin} + (V_{in} - V_{fin})\, e^{-\frac{t}{\tau}}$

the circuit now is :



We would need to find:

V_{in}, V_{fin}, τ

V_{in} The current through an inducta cannot chaye istantaneasly

so $i \equiv i_L = 0.1\,A$ (calculated above)

Using KVL: $10V - i \cdot 100\Omega - i \cdot 25\Omega + V_L = 0$

→ Lenz law

the induced e.m.f. opposes to the change

→ • R increases
• current decreases

V_L "helps" the current supply to maintain the higher current.

So: $V_L \equiv V_{in} = 0.1A \cdot (125\Omega) - 10V = 2.5V$

V_{fin} in the steady state the inducta will behave again as a S/C

$V_{fin} = 0V$

τ $\tau = \frac{L}{R} = \frac{0.1H}{125\Omega}$

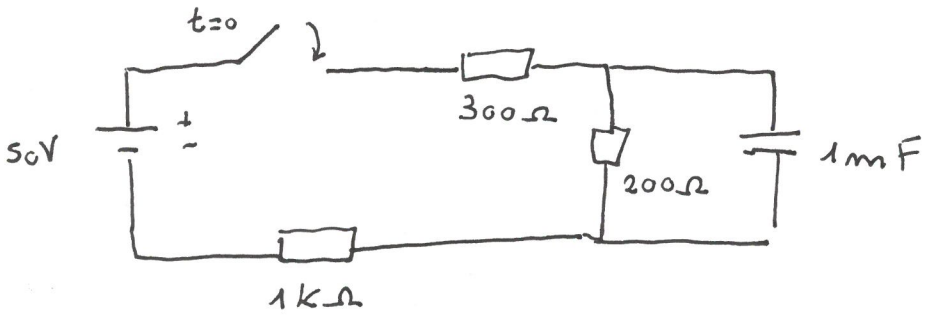
Finally: $V_L(t) = 0V + (2.5V - 0V)\, e^{-t \cdot \frac{125\Omega}{0.1H}}$

$= 2.5V\, e^{-\frac{t}{0.8ms}}$

EXAMPLE 2 :

In the circuit below the switch has been open for a long time, so C is fully discharged.

At $t=0$ the switch is closed for 10 ms and then opened again.



What is V across the 200Ω resistance for $t > 10$ ms ?

Note that $V_{200\Omega} \equiv V_C$

- $t < 0$

Circuit open for long time, C fully discharged.

$i = 0$ A

$V_{200\Omega} = V_C = 0$ V

- $0 \leq t < 10$ ms

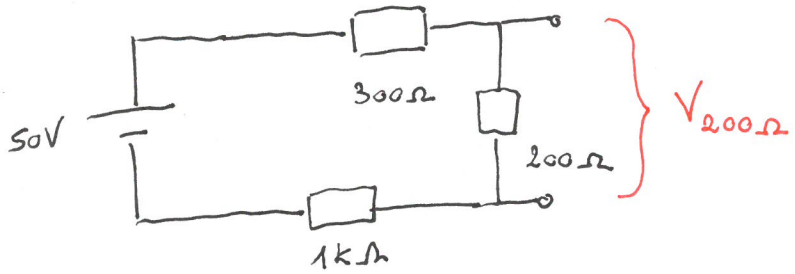
$$V_c = V_{fin} + (V_{in} - V_{fin})\, e^{-\frac{t}{\tau}}$$

V_{in} the voltage across a capacita cannot change istantaneously

$V_{cin} = 0$ V

V_{fin} with circuit closed for long time, capacitor behaves like an o/c

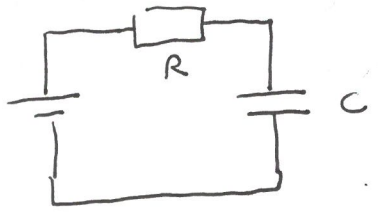
So we have :



$$i = \frac{50\,V}{(300 + 200 + 1000)\,\Omega} = \frac{50\,V}{1500\,\Omega} = \frac{1}{30}\,A$$

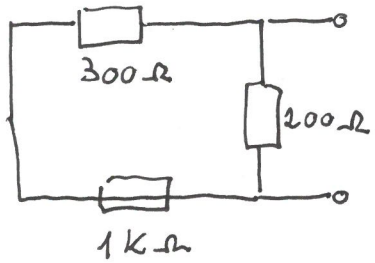
$$V_{200\Omega} = V_C = \frac{1}{30}\,A \cdot 200\,\Omega = \frac{20}{3}\,A\Omega = 6.67\,V$$

τ We are looking for something which is like



So we have to calculate the R (equivalent) using procedure used for Thevenin

$\tau = RC$ where R is the equivalent of



$$\frac{1}{R} = \frac{1}{1300\,\Omega} + \frac{1}{200\,\Omega} \quad ; \quad R = 173\,\Omega$$

$\tau = 1\,mF \cdot 173\,\Omega = 173\,ms >> 10\,ms$

in 10ms the system has not reached the steady state

$$V_{200\Omega}(t = 10ms) = V_C(t = 10ms)$$

$$= 6.67\left(1 - e^{-\frac{10ms}{173ms}}\right)V$$

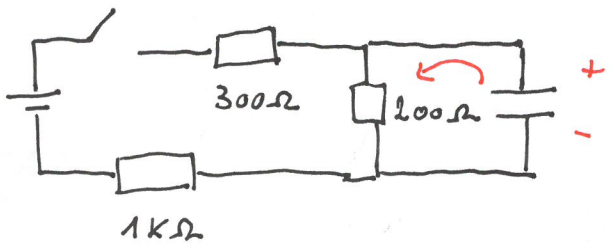
$$= 0.38V$$

$t \geq 10ms$

V across the capacitor won't change abruptly

Vin $v_{in} = 0.38V$

Vfin after opening the switch the circuit will be



C will discharge onto the resistance 200Ω, as only this branch of the circuits forms a closed loop.

For long times after opening the switch, C will be fully discharged. $\longrightarrow V_{fin} = 0V$

τ $\tau = R \cdot C = 200\Omega \cdot 1mF = 200ms$

Finally $V_{200\Omega}(t \geq 10ms) = 0V + (0.38V - 0V)\, e^{-\frac{(t-10ms)}{200ms}}$

$$= 0.38V\, e^{-\frac{(t-10ms)}{200ms}}$$

be careful at time = 0 s is now set to 10ms