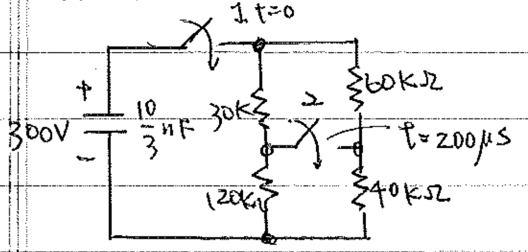
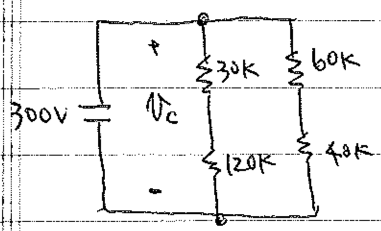
Example: 7.75.



Find the magnitude and direction of the current in the 2nd switch 300μs after switch 1 closes.

① $t \geq 0$ and $t \leq 200\mu s$. switch 1 closes, switch 2 opens.



⇒ Find the current at $t=200\mu s$ as the initial condition of $t > 200\mu s$...

capacitor starts to discharge...

Find: $v_c(t)$

$R_{eq} = 150k \| 100k = 60k\Omega$. (simple RC natural decay).

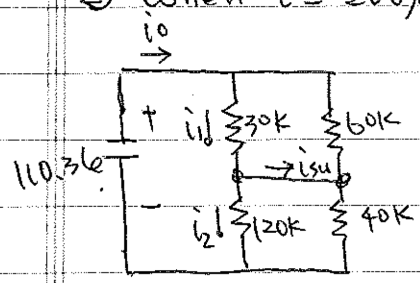
$\tau = RC = (\frac{10}{3} \times 10^{-9}) \times (60 \times 10^{3}) = 200\ \mu s$.

$v_c(t) = 300 \cdot e^{-5000t}\ V$. $(v_c(t) = A + Be^{-t/\tau})$ $\begin{cases} A = 0. \\ B = 300. \end{cases}$

at $t = 200\mu s$:

$v_c(200\mu s) = 300\, e^{-1} = 110.36\, V$.

② when $t \geq 200\mu s$.



Simplify the circuit to a standard RC circuit...

$R_{eq} = 30k \| 60k + 120k \| 40k = 50k\Omega$,

$\tau = (\frac{10}{3} \times 10^{-9})(50 \times 10^{3}) = 166.67\ \mu s$.

$\frac{1}{\tau} = 6000$.

$v_c(t) = 110.36 \times e^{-6000(t-200\mu s)}\ V$.

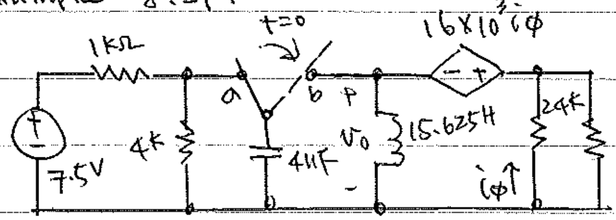
at $t = 300\mu s$; $v_c(300\mu s) = 110.36 \cdot e^{-6000 \times 100\mu s} = 60.57V$.

$i_0(300\mu s) = 60.57 / 50k = 1.21\ mA$.

$i_1(300\mu s) = i_0(300\mu s) \times 60/90 = 0.807\ mA$.

$i_2(300\mu s) = i_0(300\mu s) \times 40/160 = 0.303\ mA$

Example: 8.21.



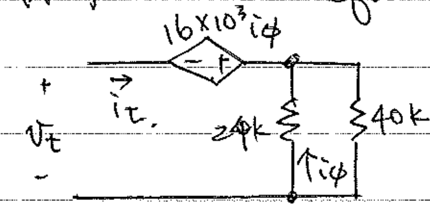
Find. $V_o(t)$ for $t\geq 0$.

(RLC natural response).

When $t>0$. we have non-standard RLC cirmit...

First, simplify the cirmit after $t>0$, to standard RLC...

⇒ apply Thevenin equivalent w.r.t. ~~capacitor~~ Inductor:



KVL:

$$V_t = -16000\, i_\phi + i_t \times (24K \| 40K)$$

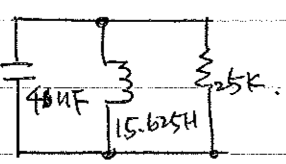
$$= -16000 i_\phi + i_t \times 15000$$

and $i_\phi = -i_t \times \frac{40}{64}$

$$\Rightarrow V_t = -16000 \times (-i_t \times 40/64) + 15000 i_t$$

$$\Rightarrow \frac{V_t}{i_t} = 10000 + 15000 = 25K\Omega.$$

Therefore the circuit after $t>0$:



Find initial condition:

$$V_0 = 7.5 \times \frac{4K}{1K+4K} = 6V. \quad I_0 = 0 \text{ Amp}.$$

① Characteristic equation for RLC in parallel:

$$s^2 + \frac{1}{RC}s + \frac{1}{LC} = 0. \quad S_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$$

$$\alpha = \frac{1}{2RC} = 5000 \text{ rad/s}. \quad \omega_0^2 = \frac{1}{LC} \Rightarrow \omega_0 = 4000 \text{ rad/s}$$

$$\alpha^2 - \omega_0^2 > 0. \text{ Overdamped.. } \quad S_{1,2} = -5000 \pm 3000 \text{ rad/s}$$

$$= -2000 \; ; \; -8000.$$

② Find $V_c(0^+)$ and $\frac{dV(0)}{dt}$:

$$V(0^+) = 6V. = A_1 + A_2$$

$$\frac{dV(0^+)}{dt} = \frac{i_c(0)}{C} = \frac{-i_R(0) - i_L(0)}{C} = \frac{-6/25K - 0}{4\times10^{-9}} = -60000$$

$$-60000 = A_1 S_1 + A_2 S_2$$

Therefore:

$A_1 = -2\ V. \quad A_2 = 8\ V.$

solution: $v_o(t) = 8e^{-8000t} - 2e^{-2000t}$ V.