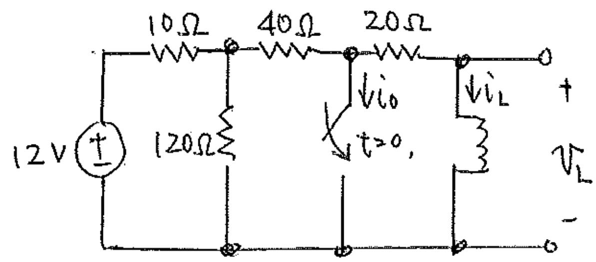
Example: 7.5



* Switch has been open for a long time.

(a) Find $i_o(0^-)$; $i_L(0^-)$;
$i_o(0^+)$; $i_L(0^+)$:
$i_o(\infty)$; $i_L(\infty)$:

(b). $i_{L(t)}$ for $t \geq 0$.

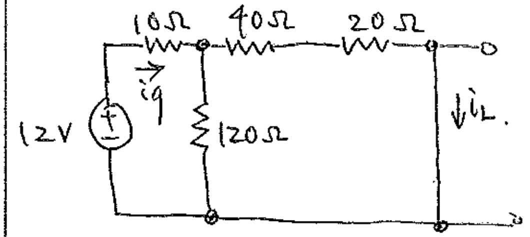
(c) Find. $V_L(0^-)$, $V_L(0^+)$, $V_L(\infty)$.

(d) $V_{L(t)}$ for $t \geq 0$.

(e) $i_o(t)$ for $t \geq 0$.

(a). $0^- = t$, open circuit for i_o. $\Rightarrow i_o(0^-) = 0$.

inductor $\Rightarrow$ short circuit.

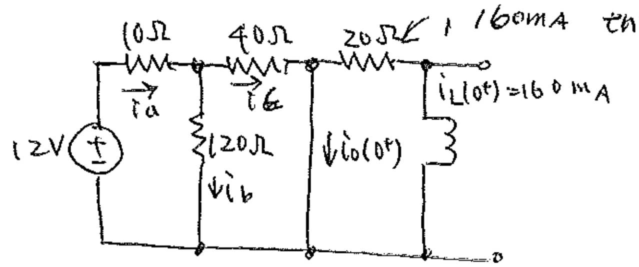


$120 \parallel 60 = 40\Omega$.

$i_g = \frac{12}{10+40} = 0.24\,A$.

$i_L(0^-) = i_g \times \frac{120}{120+60} = 160\,mA$.

$t=0^+$, $i_L(0^+) = 160\,mA$. (current cannot change instaneously).



$120 \parallel 40 = 30\Omega$.

$i_a = \frac{12}{10+30} = 0.30\,A = 300\,mA$.

$i_c = 300\,mA \times \frac{120}{120+40} = 225\,mA$

$i_o(0^+) = i_c - 160\,mA = 65\,mA$.

$t=\infty$; $i_o(\infty) = 225\,mA$ (all current through short circuit).

$i_L(\infty) = 0\,A$.

(b) $i_L(t)$. for $t \geq 0$, use the formula: $i_L(t) = i_L(\infty) + (i_L(0) - i_L(\infty))\, e^{-\frac{R}{L}t}$

$-\frac{R}{L} = \frac{20}{100 \times 10^{-3}} = 200$; $i_L(t) = 160 \cdot e^{-200t}\ mA$.

(c) $V(0^-) = 0V$. (inductor $V = L\frac{di}{dt}$, i = const).

$V(0^+)$: KVL: 20Ω + inductor: $20 \times (0.16) + V_L(0^+) = 0$. $V_L(0^+) = -3.2V$

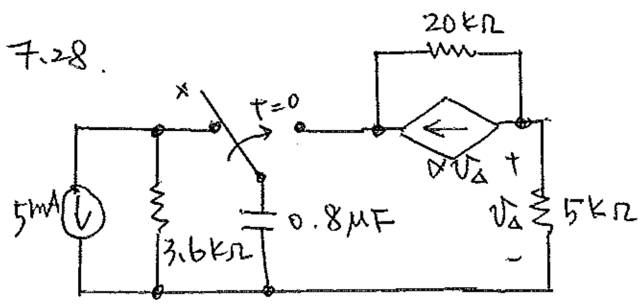
$v_L(\infty) = 0$, (short circuit).

(d) $v_L(t)$, for $t \ge 0$.

$$v_L(t) = v_L(\infty) + (v_L(0) - v_L(\infty))\, e^{-200t}$$
$$= 0 + (-3.2 - 0)\, e^{-200t} = -3.2\, e^{-200t} \text{ V}.$$

(e)
$$i_o(t) = i_c - i_L(t) = 225 - 160\, e^{-200t} \text{ mA}, \quad t \ge 0.$$

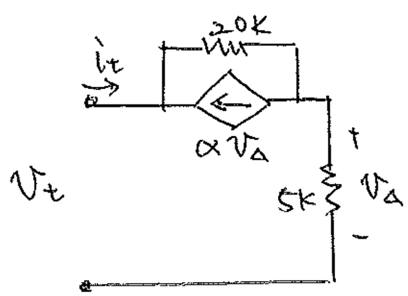
7.28.



Find: α so τ = 40ms

(b) v_Δ $t \ge 0$.

(a) The circuit is not the standard form of RC circuit we familiar with. Apply Thevenin ~~to~~ respect to the terminals of capacitor to simplify circuit:



Apply test voltage to solve for R_{th}...

Need R_{th} to solve $R_{th}C = \tau$.

Applying KVL:

$$v_t = (i_t + \alpha v_\Delta)\, 20k + v_\Delta$$

$\because$ $v_\Delta = 5000\, i_t$.

$$\Rightarrow \quad v_t = 25000\, i_t + 20\times10^3 \alpha (5000\, i_t)$$

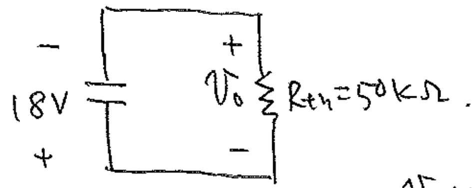
$$R_{th} = \frac{v_t}{i_t} = 25000 + 100\times10^6 \alpha$$

$$\tau = 40\times10^{-3} = R_{th}C = (25000 + 100\times10^6 \alpha) \times C$$

$$R_{th} = 50\text{ k}\Omega = 25000 + 100\times10^6 \alpha$$

$$\alpha = 2.5\times10^{-4} \text{ A/V}.$$

(b) therefore: $t \geq 0^+$

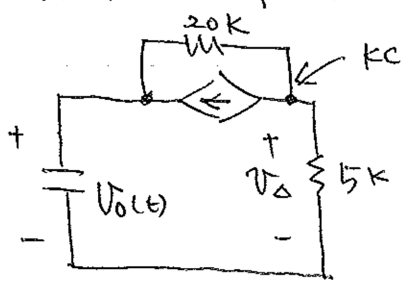


$V_c(0^+) = 18V$

$V_0(0^+) = -18V$.

$V_0(t) = -18e^{-25t}$ V ($t \geq 0$) simple RC.

apply to original circuit:



KCL: $\frac{V_\Delta}{5000} + \frac{V_\Delta - V_0}{20000} + 2.5 \times 10^{-4} V_\Delta = 0$.

$4V_\Delta + V_\Delta - V_0 + 5V_\Delta = 0$

$\therefore V_\Delta = \frac{V_0}{10} = -1.8 \times 10^{-25t}$ V ($t \geq 0$).