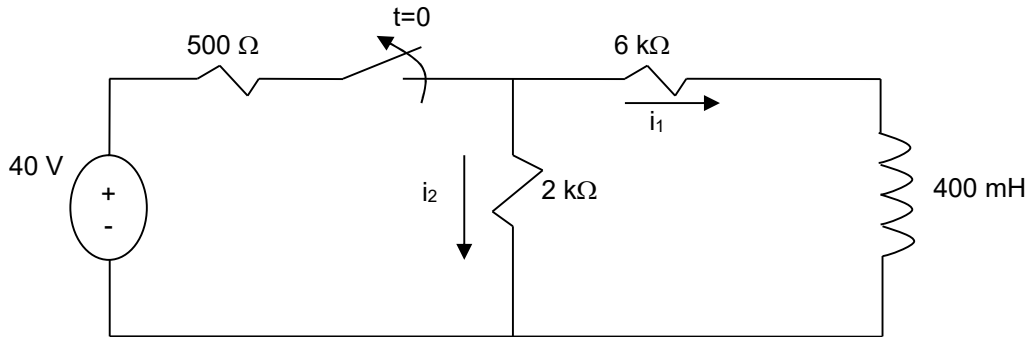


# Fundamentals of Electrical Circuits - Chapter 7

1S. In the following circuit, the switch is opened at  $t=0$ , after the switch being closed for a long time.

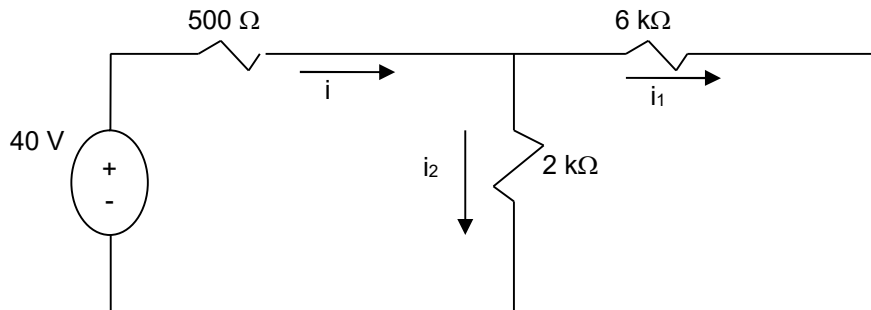


- Find  $i_1(0^-)$  and  $i_2(0^-)$ .
- Find  $i_1(0^+)$  and  $i_2(0^+)$ .
- Find  $i_1(t)$  for  $t \geq 0$ .
- Find  $i_2(t)$  for  $t \geq 0$ .
- Explain why  $i_2(0^-) \neq i_2(0^+)$ .

**Solution:**

- Find  $i_1(0^-)$  and  $i_2(0^-)$ .

At  $t=0^-$ , the switch has been closed for a long time. Therefore the inductor appears as a short..



Apply KVL  $\rightarrow$

$$-40 + 500i + 2000(i - i_1) = 0 \rightarrow 2500i - 2000i_1 = 40$$

$$6000i_1 + 2000(i_1 - i) = 0 \rightarrow -2000i + 8000i_1 = 0$$

Solve and we know  $i = i_1 + i_2$

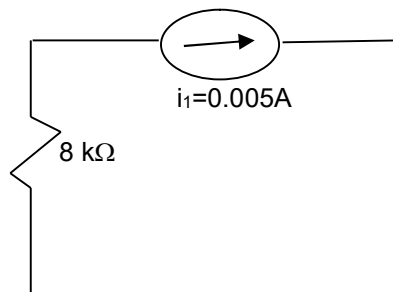
$$i(0^-) = 0.020 \text{ A}$$

$$i_1(0^-) = 0.005 \text{ A}$$

$$i_2(0^-) = 0.015 \text{ A}$$

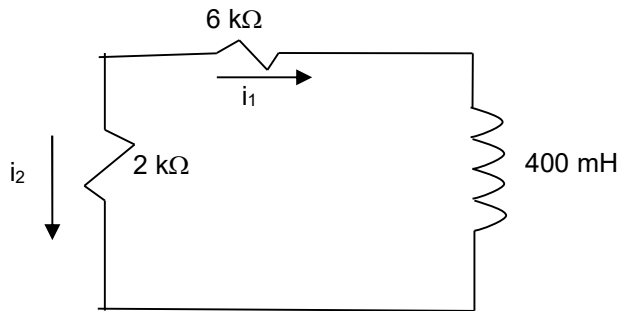
- Find  $i_1(0^+)$  and  $i_2(0^+)$ .

Immediately after switch is Opened at  $t=0^+$ , the inductor supplies  $i_1(0^+) = i_1(0^-) = 0.005 \text{ A}$  current.



$$i_2(0^+) = -i_1(0^+) = -0.005 \text{ A}$$

c) Find  $i_1(t)$  for  $t \geq 0$ .



Apply the Natural Response relationships  $\rightarrow i(t) = i(0)e^{-(R/L)t}$  for  $t \geq 0$

$$i_1(t) = i_1(0^+)e^{-(R/L)t} = 0.005e^{-(8000/0.4)t} \text{ for } t \geq 0$$

$$i_1(t) = 0.005e^{-20000t} \text{ A for } t \geq 0$$

d) Find  $i_2(t)$  for  $t \geq 0^+$ .

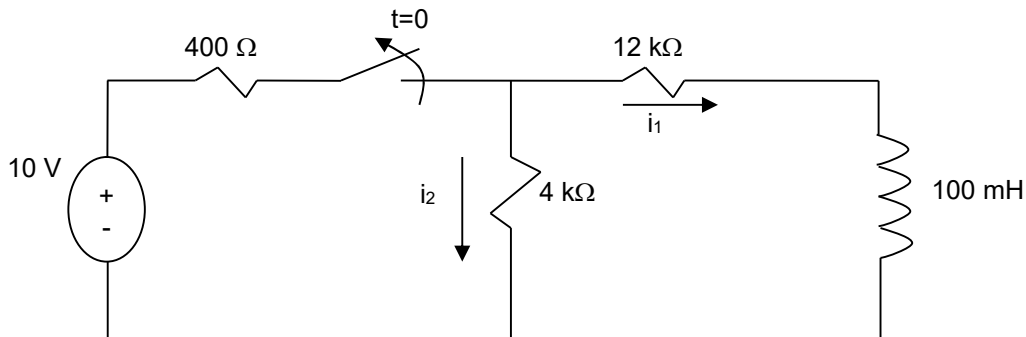
$$i_2(t) = -i_1(t) = -0.005e^{-20000t} \text{ for } t \geq 0^+$$

The only difference with part c is that  $t$  cannot be equal to 0.

e) Explain why  $i_2(0^-) \neq i_2(0^+)$ .

The current in resistor changes instantly. While the switching operation forces  $i_2(0^-)$  to be 0.015 A and  $i_2(0^+)$  to be -0.005 A

1U. In the following circuit, the switch is opened at  $t=0$ , after the switch being closed for a long time.



a) Find  $i_1(0^-)$  and  $i_2(0^-)$ .

b) Find  $i_1(0^+)$  and  $i_2(0^+)$ .

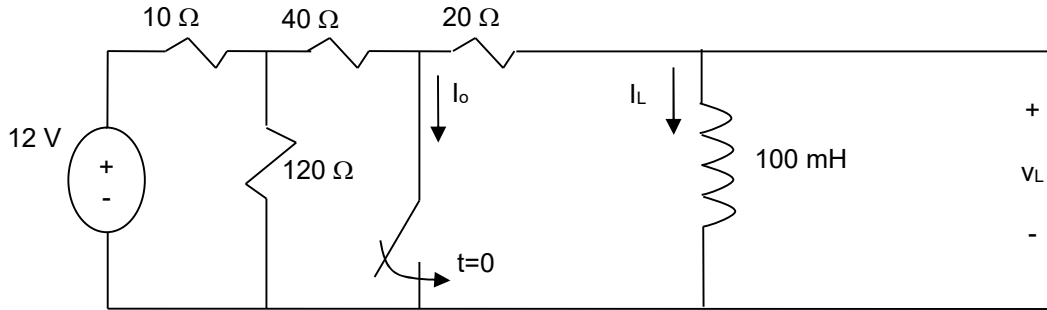
c) Find  $i_1(t)$  for  $t \geq 0$ .

d) Find  $i_2(t)$  for  $t \geq 0$ .

e) Explain why  $i_2(0^-) \neq i_2(0^+)$ .

**Solution:**

2S. The switch shown in the following figure has been open a long time before closing at  $t=0$ .

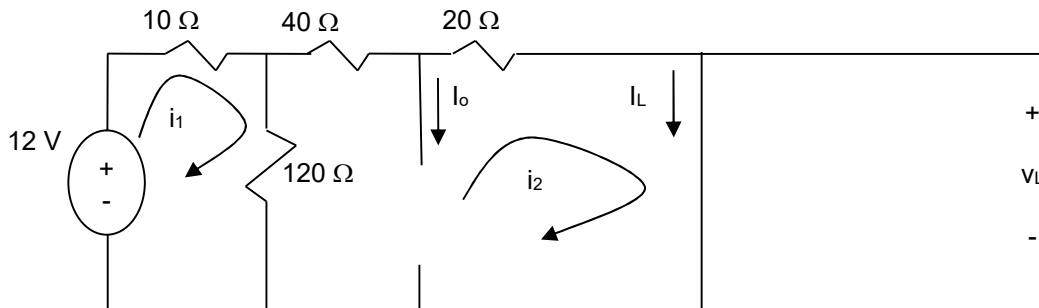


- Find  $i_o(0^-)$ .
- Find  $i_L(0^-)$ .
- Find  $i_o(0^+)$ .
- Find  $i_L(0^+)$ .
- Find  $i_o(\infty)$ .
- Find  $i_L(\infty)$ .
- Write the expression for  $i_L(t)$  for  $t \geq 0$ .
- Find  $V_L(0^-)$ .
- Find  $V_L(0^+)$ .
- Find  $V_L(\infty)$ .
- Write the expression for  $V_L(t)$  for  $t \geq 0^+$ .
- Write the expression for  $i_o(t)$  for  $t \geq 0^+$ .

**Solution:**

- Find  $i_o(0^-)$ .

at  $t=0^- \rightarrow$  circuit before the switch is closed and the inductor appear as a short.



$i_o(0^-)=0$  since the switch is open.

- Find  $i_L(0^-)$ .

$$\text{KVL} \rightarrow -12 + 10i_1 + 120(i_1 - i_2) = 0 \rightarrow 130i_1 - 120i_2 = 12$$

$$\text{KVL} \rightarrow 20i_2 + 40i_2 + 120(i_2 - i_1) = 0 \rightarrow -120i_1 + 180i_2 = 0$$

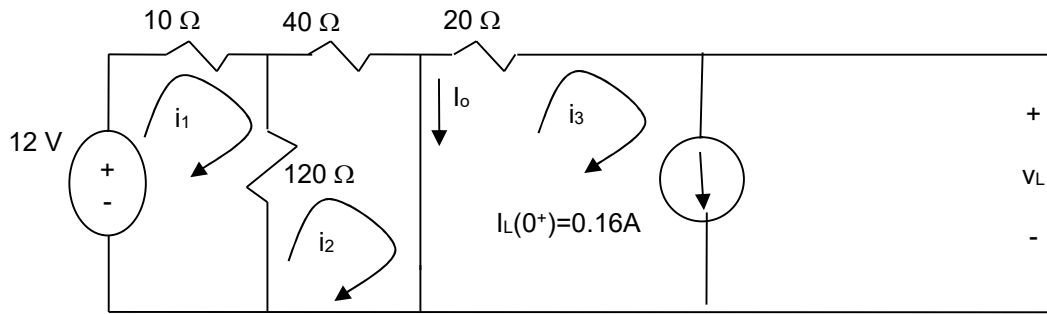
Solve

$$i_1 = 0.24 \text{ A}; i_2 = 0.16 \text{ A};$$

$$\rightarrow i_L(0^-) = i_2 = 0.16 \text{ A}$$

- Find  $i_o(0^+)$ .

at  $t=0^+ \rightarrow$  circuit after the switch is closed and the inductor appear as a current source.



KVL @  $i_1 \rightarrow -12 + 10 i_1 + 120 (i_1 - i_2) = 0 \rightarrow 130i_1 - 120i_2 = 12 \rightarrow 520i_2/3 - 120i_2 = 12 \rightarrow i_2 = 0.225 \text{ A}$   
 KVL @  $i_2 \rightarrow 120(i_2 - i_1) + 40 i_2 = 0 \rightarrow -120i_1 + 160i_2 = 0 \rightarrow i_1 = 4i_2/3$   
 KVL @  $i_3 \rightarrow i_3 = 0.16$

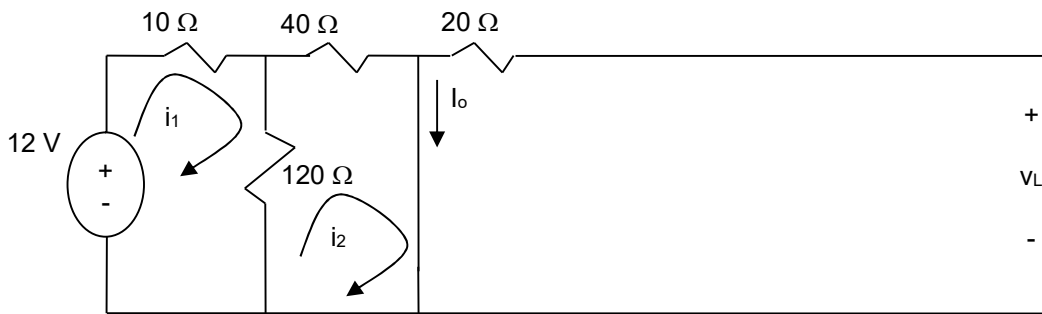
$i_o = i_o(0^+) = i_2 - i_3 = 0.065 \text{ A}$

d) Find  $i_L(0^+)$ .

$i_L(0^+) = i_L(0^-) = 0.16 \text{ A}$

e) Find  $i_o(\infty)$ .

Inductor will have current of 0 (open) after long period of switch being closed

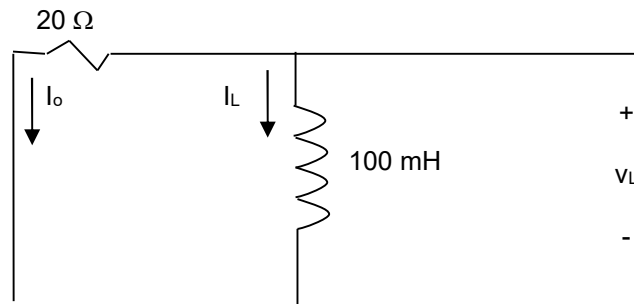


Same as part c  $\rightarrow i_o(\infty) = i_2 = 0.225 \text{ A}$

f) Find  $i_L(\infty)$ .

$i_L(\infty) = 0$ ;

g) Write the expression for  $i_L(t)$  for  $t \geq 0$ .



Apply the Natural Response relationships  $\rightarrow i(t) = i(0)e^{-(R/L)t}$  for  $t \geq 0$

$i_L(t) = 0.16e^{-(20/.1)t}$  for  $t \geq 0$

$i_L(t) = 0.16e^{-200t}$

h) Find  $V_L(0^-)$ .  
 $V_L(0^-) = 0$

i) Find  $V_L(0^+)$ .  
 refer to circuit in part c and write KVL around the most right loop  $\rightarrow$   
 $20 \cdot (0.16) + V_L(0^+) = 0 \rightarrow V_L(0^+) = -3.2 \text{ V}$

j) Find  $V_L(\infty)$ .  
 $V_L(\infty) = 0$

k) Write the expression for  $V_L(t)$  for  $t \geq 0^+$ .

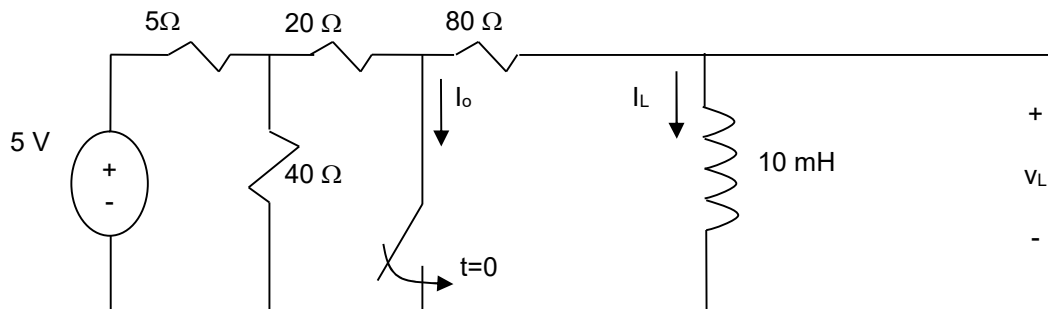
$$v_L(t) = L \frac{di_L}{dt} = (0.1) \frac{di_L}{dt} = 0.1 \cdot 0.16 \cdot (-200) e^{-(20/0.1)t} \text{ for } t \geq 0$$

$$v_L(t) = -3.2 e^{-200t}$$

l) Write the expression for  $i_o(t)$  for  $t \geq 0^+$ .

$$i_o(t) = i_2(t) - i_L(t) = 0.225 - 0.16 e^{-200t} \text{ A}$$

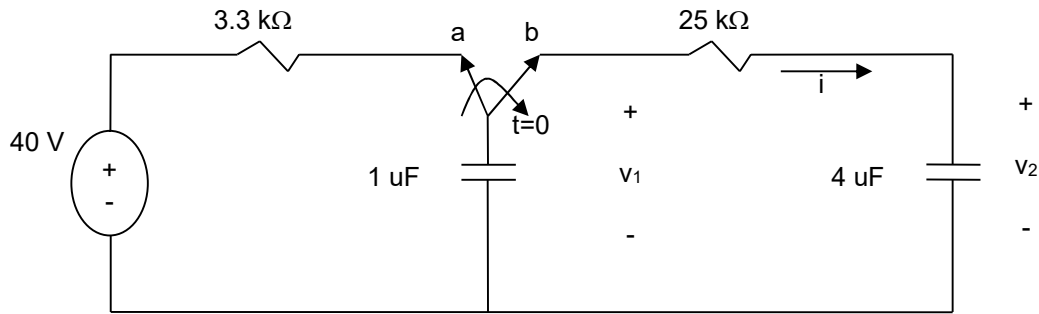
2U. The switch shown in the following figure has been open a long time before closing at  $t=0$ .



- Find  $i_o(0^-)$ .
- Find  $i_L(0^-)$ .
- Find  $i_o(0^+)$ .
- Find  $i_L(0^+)$ .
- Find  $i_o(\infty)$ .
- Find  $i_L(\infty)$ .
- Write the expression for  $i_L(t)$  for  $t \geq 0$ .
- Find  $V_L(0^-)$ .
- Find  $V_L(0^+)$ .
- Find  $V_L(\infty)$ .
- Write the expression for  $V_L(t)$  for  $t \geq 0^+$ .
- Write the expression for  $i_o(t)$  for  $t \geq 0^+$ .

**Solution:**

3S. The switch in the following circuit has been in position for a long time. At  $t=0$ , the switch is thrown to position b.



Calculate:

- $i$ ,  $v_1$  and  $v_2$  for  $t \geq 0^+$ .
- energy stored in the capacitors at  $t = 0$ .
- energy trapped in the circuit and the total energy dissipated in the  $25 \text{ k}\Omega$  resistor if the switch remains in position b indefinitely.

**Solution:**

- $i$ ,  $v_1$  and  $v_2$  for  $t \geq 0^+$ .

After a long time with switch in position a results in capacitor appear as opening

$$\rightarrow v_1(0^-) = v_1(0^+) = 40 \text{ V}; \quad v_2(0^-) = 0 \text{ V};$$

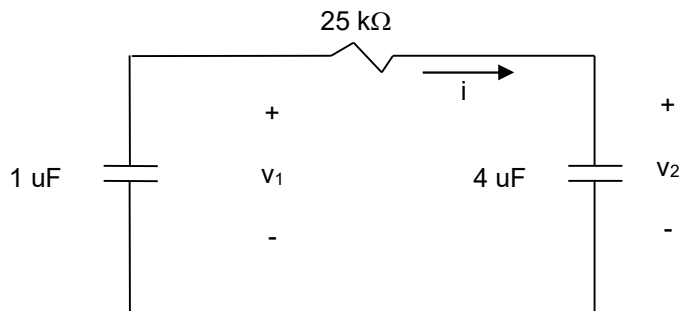
When switch is put to position b, voltage is applied to  $4\mu\text{F}$  which would appear open at  $t=0^+$

$$\rightarrow v_1(0^+) = v_1(0^-) = 40 \text{ V}$$

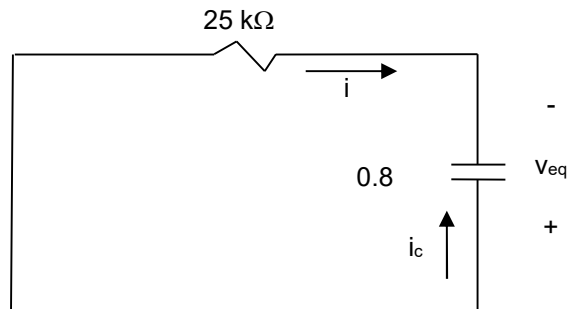
$$\rightarrow V_1 \text{ is supplying and } V_2 \text{ is short at } t=0^+ \rightarrow i(0^+) = (v_1(0^+) - v_2(0^+))/25000 = 1.6 \text{ mA}$$

$$\rightarrow v_2(0^+) = v_2(0^-) = 0 \text{ V}$$

After Switch is changes from a to b



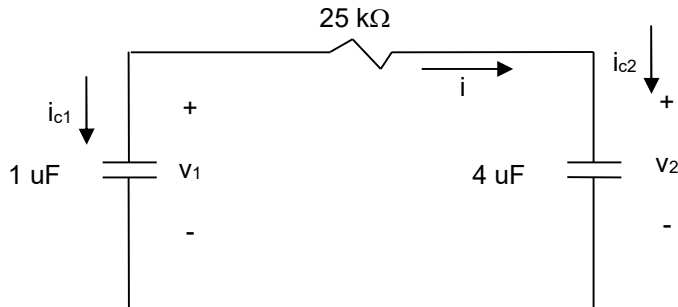
$$C_{eq} = 1/(1/1 + 1/4) = 0.8 \text{ }\mu\text{F} \text{ with } V_{eq}(0^-) = 40 \text{ V}$$



Apply the Natural Response relationships  $v(t) = v(0)e^{-t/RC}$  for  $t \geq 0$

$$i_c = C \frac{dv}{dt} = -C \frac{v(0)}{RC} e^{-t/RC} = -\frac{v(0)}{R} e^{-t/RC} \quad \text{for } t \geq 0$$

$$i(t) = -i_c(t) = \frac{40}{25000} e^{-t/(25 \times 10^3 \times 0.8 \times 10^{-6})} = 1.6 e^{-50t} \text{ mA} \quad \text{for } t \geq 0$$



$$v_1 = \frac{1}{C} \int_0^t i(\tau) d\tau + v(0^-) = \frac{1}{1 \times 10^{-6}} \int_0^t -1.6 \times 10^{-3} e^{-50\tau} d\tau + 40 = 32e^{-50t} + 8 \text{ V} \quad \text{for } t \geq 0$$

$$v_2 = \frac{1}{C} \int_0^t i(\tau) d\tau + v(0^-) = \frac{1}{4 \times 10^{-6}} \int_0^t 1.6 \times 10^{-3} e^{-50\tau} d\tau + 0 = -8e^{-50t} + 8 \text{ V} \quad \text{for } t \geq 0$$

b) Energy stored in the capacitors at  $t = 0$ .

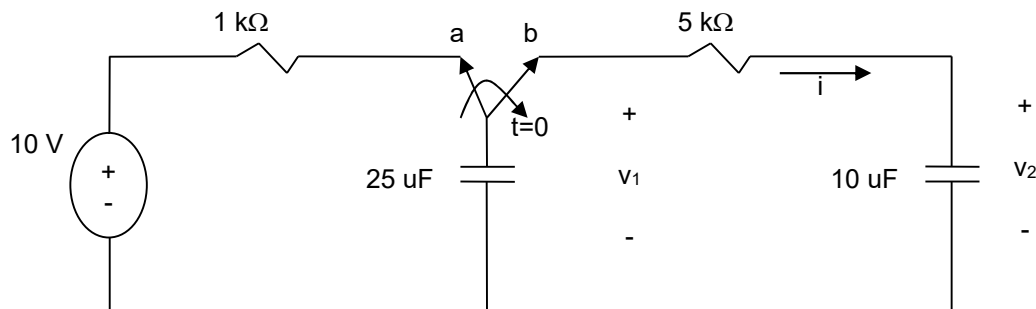
The only capacitor with energy is equivalent capacitor  $\{1/(1 + 1/4)\} = 0.8 \mu\text{F}$

$$w_{C_{eq}}(0) = 1/2 C_{eq} V_{eq}(0)^2 = 0.5 \times 0.8 \times 10^{-6} \times (40)^2 = 640 \mu\text{J}$$

c) The energy that R dissipates is equal to the amount of energy that was in the equivalent C at  $t=0^+$  since after a long-time the stored energy in the combined capacitor will be zero:

$$w_{C_{eq}}(0) = 1/2 C_{eq} V_{eq}(0)^2 = 0.5 \times 0.8 \times 10^{-6} \times (40)^2 = 640 \mu\text{J}$$

3U. The switch in the following circuit has been in position for a long time. At  $t=0$ , the switch is thrown to position b.



**Calculate**

a)  $i$ ,  $v_1$  and  $v_2$  for  $t \geq 0^+$ .

b) energy stored in the capacitor at  $t = 0$ .

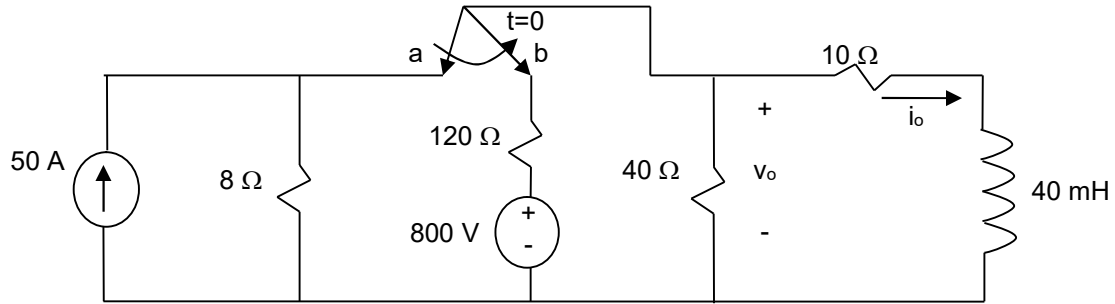
c) energy trapped in the circuit and the total energy dissipated in the  $5 \text{ k}\Omega$  resistor if the switch remains in position b indefinitely.

**Solution:**

4S. The switch in the following circuit has been in position a for a long time. At  $t=0$ , the switch moves instantaneously to position b.

a) Find the numerical expression for  $i_o(t)$  where  $t \geq 0$ .

b) Find the numerical expression for  $v_o(t)$  where  $t \geq 0^+$ .



**Solution:**

a) Find the numerical expression for  $i_o(t)$  where  $t \geq 0$ .

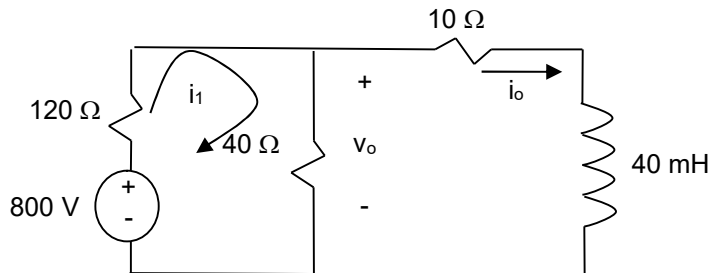
When the switch has been in position a for a long-time  $\rightarrow$  Inductor will appear as a short



Simplified circuit  $\rightarrow V(\infty) = 50 \cdot 4 = 200\text{V}$

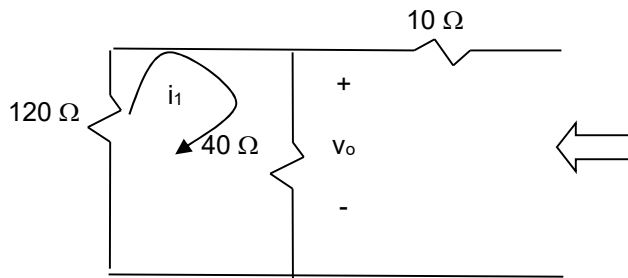
Original circuit  $\rightarrow i_o(\infty) = 200 / 10 = 20\text{ A}$

After the switch is change to position b , circuit is redrawn and find the Thevenin equivalent with respect to Inductor terminals:



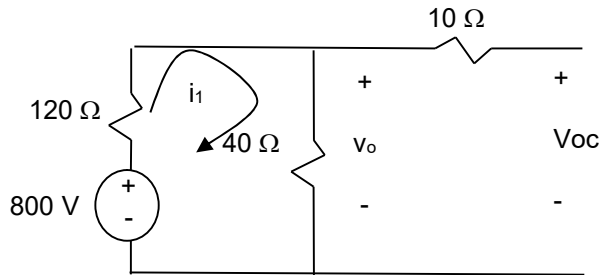
To Find  $R_{th}$  disable Voltage source (short)





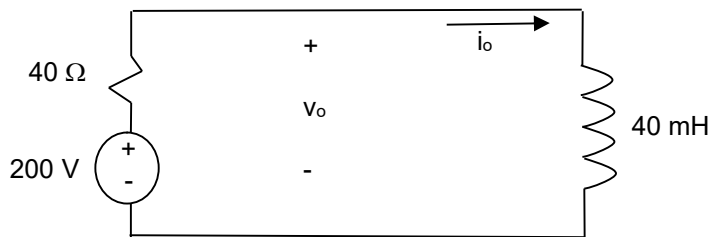
$$R_{th} = (120 \parallel 40) + 10 = 40 \Omega$$

To Find  $V_{th}$  or  $V_{oc}$  disable Voltage source (short)



$$\text{KVL} \rightarrow -800 + 120 i_1 + 40 i_1 = 0 \rightarrow 160 i_1 = 800 \rightarrow i_1 = 5 \text{ A} \rightarrow V_{oc} = 40 * 5 = 200 \text{ V}$$

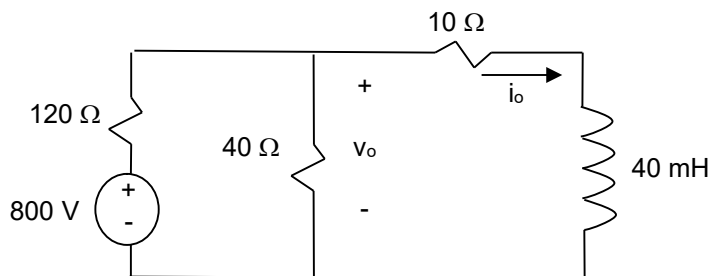
Place the Thevenin Equivalent back into the circuit:



$$\text{Apply the step response relationships } i(t) = \frac{V_s}{R} + \left( I_0 - \frac{V_s}{R} \right) e^{-(R/L)t} \text{ for } t \geq 0$$

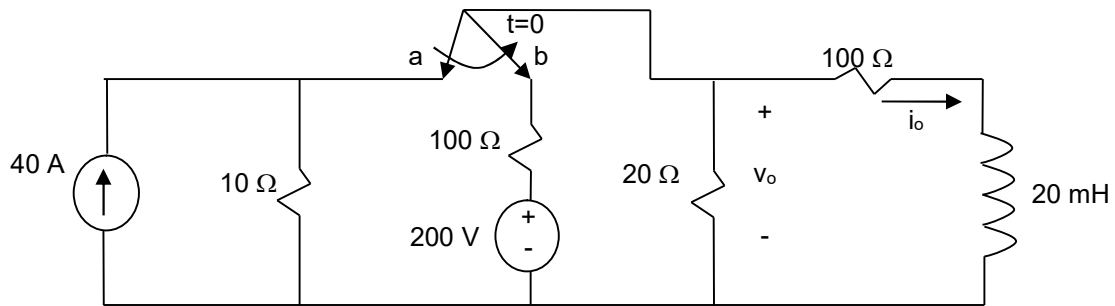
$$\rightarrow i_o(t) = \frac{200}{40} + \left( 20 - \frac{200}{40} \right) e^{-(40/0.04)t} = 5 + 15e^{-1000t} \text{ A for } t \geq 0$$

b) Find the numerical expression for  $v_o(t)$  where  $t \geq 0^+$ .



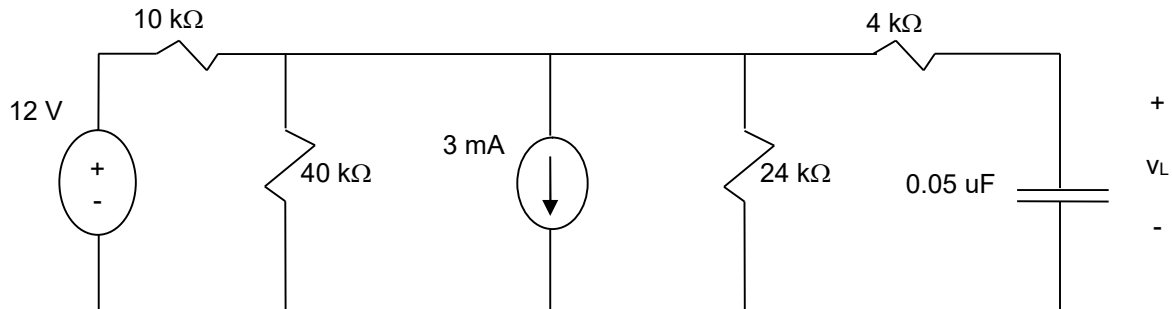
$$v_o(t) = 10i_o + L \frac{di}{dt} = 10(5 + 15e^{-1000t}) + 0.04(-1000)(15e^{-1000t}) = 50 - 450e^{-1000t} \text{ for } t \geq 0$$

- 4U. The switch in the following circuit has been in position a for a long time. At  $t=0$ , the switch moves instantaneously to position b.
- Find the numerical expression for  $i_o(t)$  where  $t \geq 0$ .
  - Find the numerical expression for  $v_o(t)$  where  $t \geq 0^+$ .



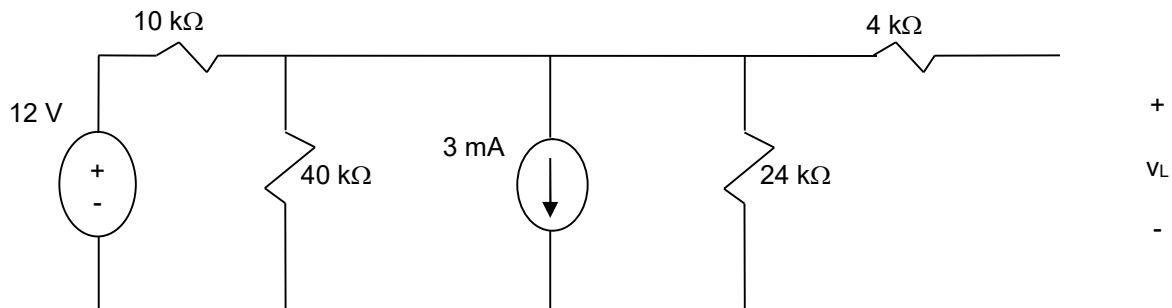
**Solution:**

- 5S. The following circuit has been in operation for a long time. At  $t=0$ , the voltage source reverses polarity and the current source drops from 3 mA to 2 mA. Find  $v_L(t)$  for  $t \geq 0$ .

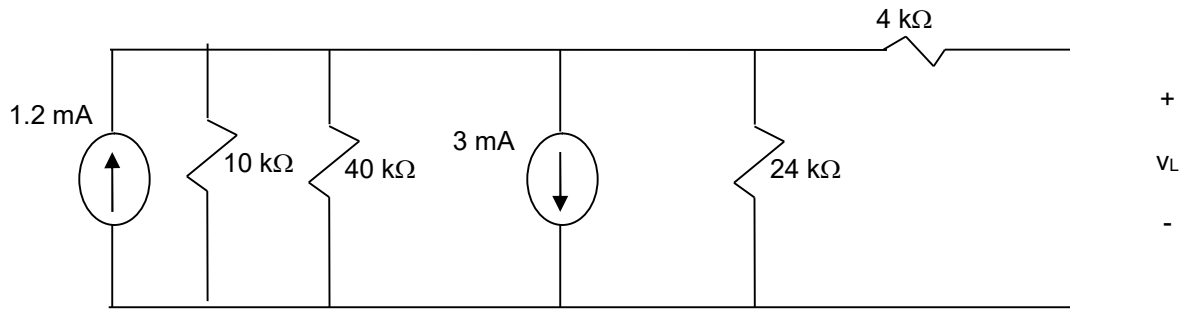


**Solution:**

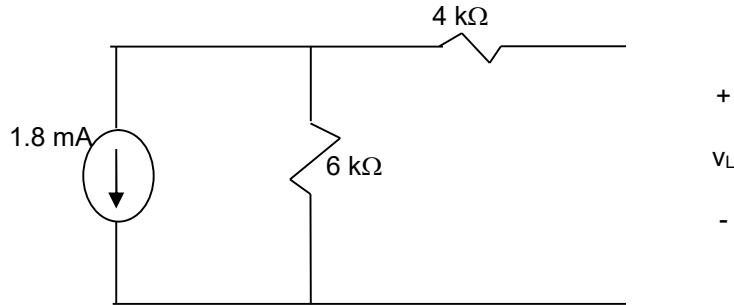
After circuit has been in current state for a long-time ( $t=0^-$ ), Capacitor will appear as an open



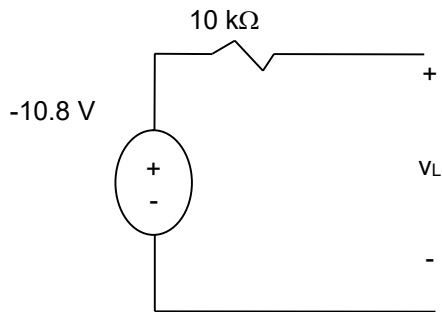
Use source transformation to simplify the circuit:  
 $12\text{v} \ \& \ \text{series } 10 \text{ k}\Omega \rightarrow 1.2 \text{ mA} \ \& \ \text{parallel } 10 \text{ k}\Omega$



$$R = (10 \parallel 40 \parallel 24) = 6 \text{ k}\Omega$$

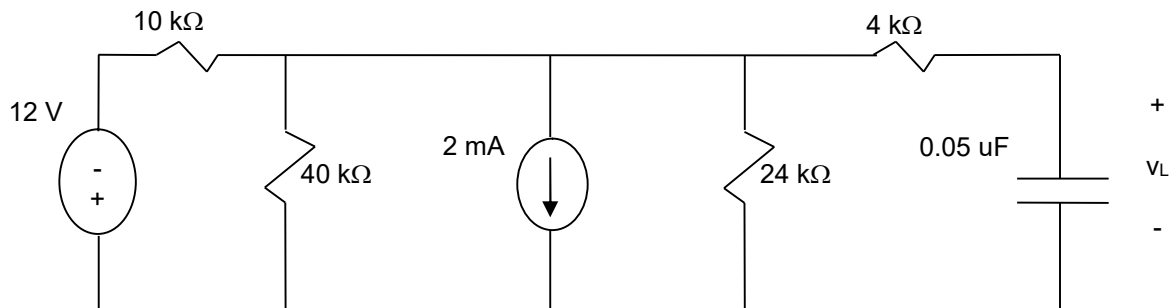


1.8 mA & parallel 6 kΩ → 10.8 V and series 6 kΩ



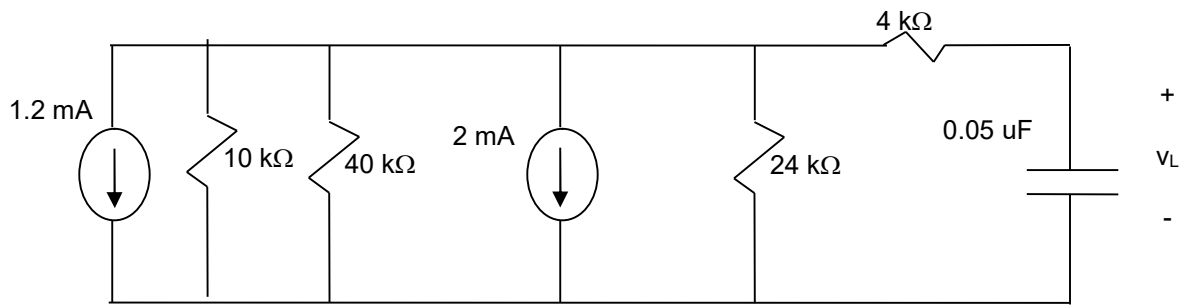
$$V_{L(0^-)} = 1.8 \text{ mA} * 6 \text{ k}\Omega = -10.8 \text{ V}$$

at  $t=0$  ( $t > 0$ ): circuit changes to

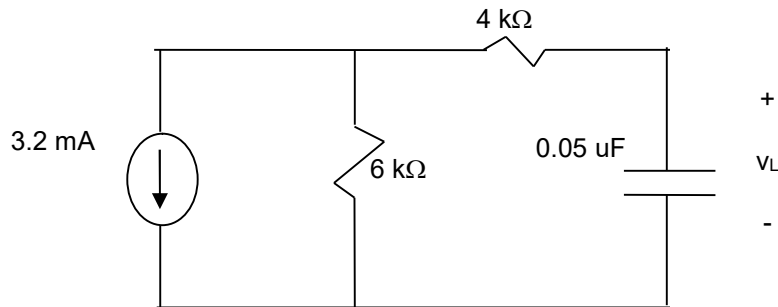


Use similar source transformation technique as used earlier will simplify the circuit into Norton equivalent.

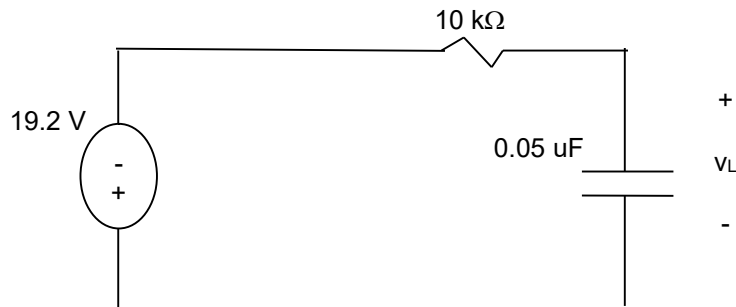
12v & series 10 kΩ → 1.2 mA and parallel 10 kΩ



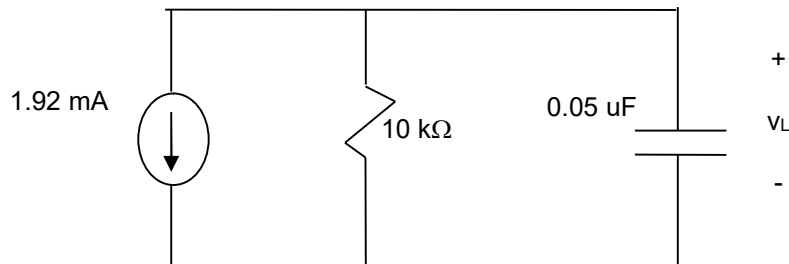
$$R = (10 \parallel 40 \parallel 24) = 6 \text{ k}\Omega$$



3.2 mA & parallel 6 kΩ → 19.2 V and series 6 kΩ  
 Another source transformation reduces the circuit to:



Another transformation get us back to the standard form:  
 19.2v & series 10 kΩ → 1.92 mA and parallel 10 kΩ



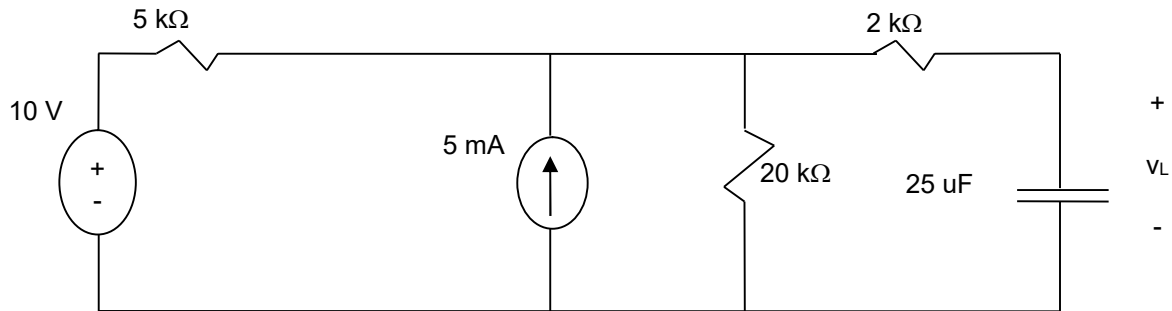
Apply the step response for RC circuit  $v(t) = I_s R + (V_0 - I_s R)e^{-t/RC}$  for  $t \geq 0$

$$v_L(t) = -(0.00192) * (10,000) - (-10.8 - (-0.00192 * 10,000))e^{-t/0.0005}$$

$$v_L(t) = -19.2 + (+10.8 - 19.2)e^{-2000t}$$

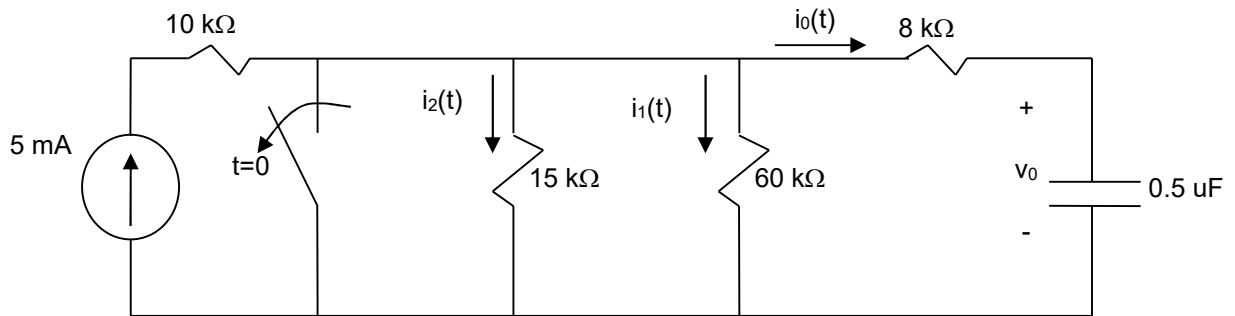
$$v_L(t) = -19.2 - 8.4e^{-2000t}$$

5U. The following circuit has been in operation for a long time. At  $t=0$ , the voltage source reverses polarity and the current source drops from 5 mA to 3 mA. Find  $v_L(t)$  for  $t \geq 0$ .



**Solution:**

6S. The switch in the following circuit has been closed a long time before opening at  $t = 0$ .



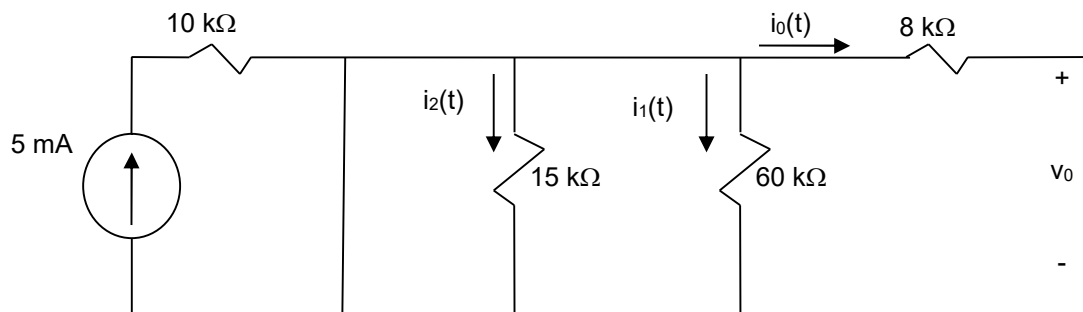
For  $t \geq 0^+$ , find:

- a)  $v_o(t)$ .      b)  $i_o(t)$ .      c)  $i_1(t)$ .      d)  $i_2(t)$ .      e)  $i_1(0^+)$ .

**Solution:**

a)  $v_o(t)$

After a long time at  $t=0^-$ , capacitor appears as open...

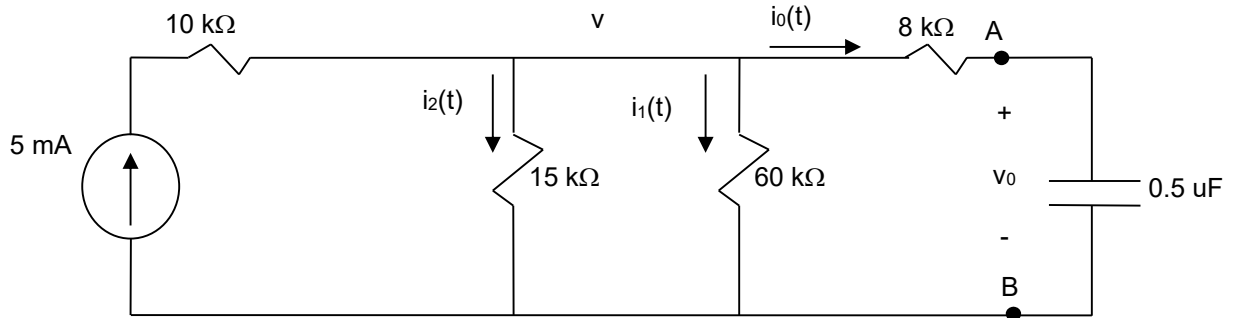


Short across the source then no power is delivered to the rest of the circuit  $\rightarrow$

$$v_o(0^-) = 0 \text{ V}$$

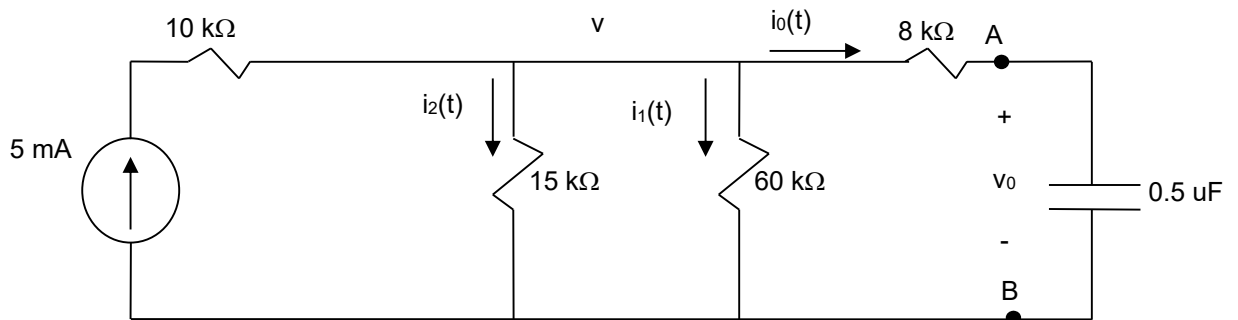
$$i_o(0^-) = i_1(0^-) = i_2(0^-) = 0 \text{ A}$$

After  $t=0$  ( $t>0$ ), circuit is redrawn as:



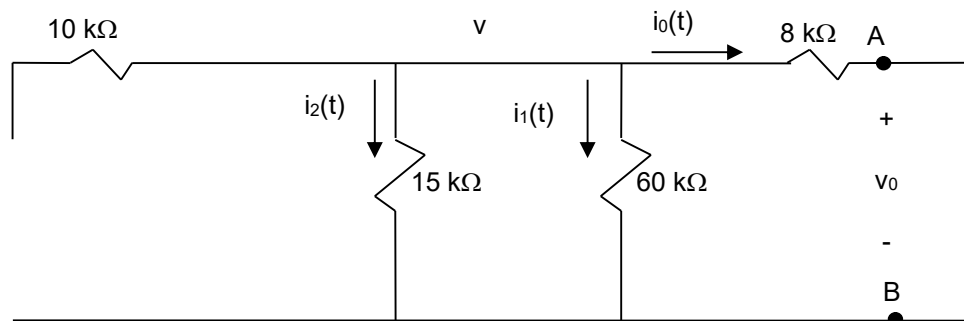
At  $t=0^+$ , Capacitor appears as a short  $\rightarrow V_0(0^+)=0$  V.

$$\text{KCL} \rightarrow -5 + v/15 + v/60 + v/8 = 0 \rightarrow 25v = 5 \cdot 120 \rightarrow v(0^+) = 24 \text{ V} \rightarrow i_0(0^+) = 3 \text{ mA}$$



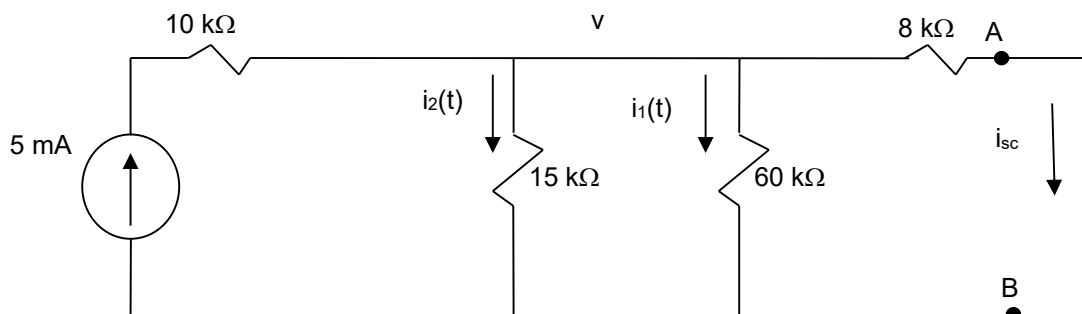
Find the Norton Equivalent at terminal AB  $\rightarrow$

Disable current source (open) to find  $R_{th}$ :

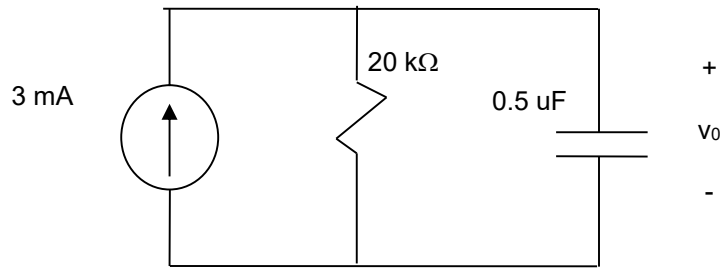


$$R_{th} = (15 \parallel 60) + 8 = 20 \text{ k}\Omega$$

Find  $I_{sc}$ :



$$\text{KCL} \rightarrow -5 + v/15 + v/60 + v/8 = 0 \rightarrow 25v = 5 \cdot 120 \rightarrow v(0^+) = 24 \text{ V} \rightarrow i_{sc} = 3 \text{ mA}$$



Apply the step response for RC circuit  $\rightarrow v(t) = I_s R + (V_0 - I_s R)e^{-t/RC}$  for  $t \geq 0$

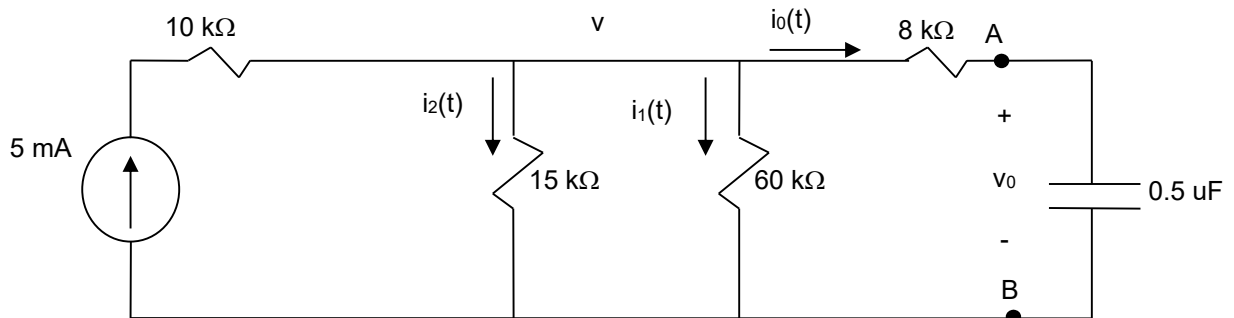
$$v_0(t) = 0.003 * 20,000 + (0 - 0.003 * 20,000)e^{-t/(20,000 * 0.5 * 10^{-6})}$$
 for  $t \geq 0$

$$v_0(t) = 60 - 60e^{-100t} \text{ V} \text{ for } t \geq 0$$

b)  $i_0(t)$

$$i_0(t) = C \frac{dv}{dt} = 0.5 * 10^{-6} * (-60) * (-100)e^{-100t} = 3e^{-100t} \text{ mA} \text{ for } t \geq 0$$

c)  $i_1(t)$



$$v(t) = 8,000 * i_0(t) + v_0(t) = 8 * 3e^{-100t} + 60 - 60e^{-100t} = 60 - 36e^{-100t} \text{ for } t \geq 0$$

$$i_1(t) = \frac{v(t)}{60,000} = 1 - 0.6e^{-100t} \text{ mA} \text{ for } t \geq 0$$

d)  $i_2(t)$

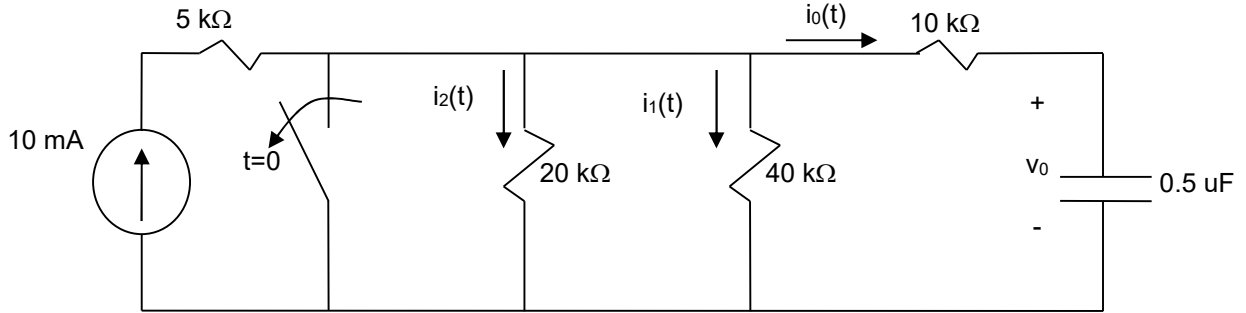
$$i_2(t) = \frac{v(t)}{15,000} = 4 - 2.4e^{-100t} \text{ mA} \text{ for } t \geq 0$$

e)  $i_1(0^+)$

$$v(0^+) = 24 \text{ V} \text{ from earlier part.}$$

$$i_1(0^+) = v(0^+)/60,000 = 0.4 \text{ mA}$$

6U. The switch in the following circuit has been closed a long time before opening at  $t = 0$ .

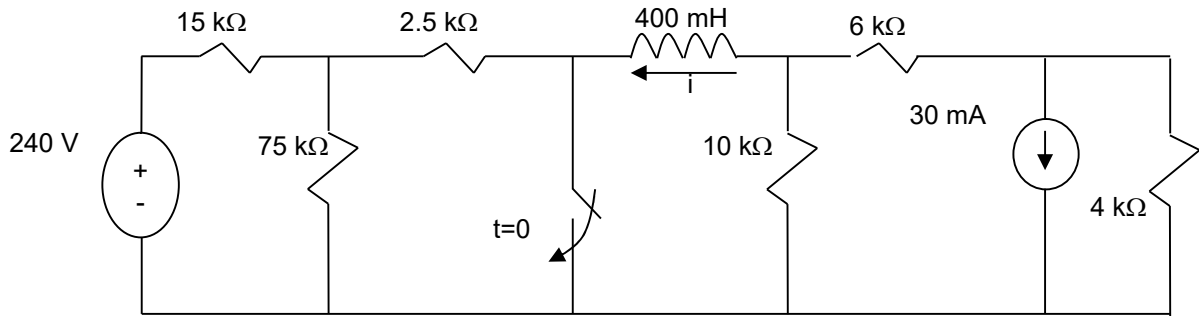


For  $t \geq 0^+$ , find:

- a)  $v_0(t)$ .      b)  $i_0(t)$ .      c)  $i_1(t)$ .      d)  $i_2(t)$ .      e)  $i_1(0^+)$ .

**Solution:**

7S. At  $t=0$  the switch is closed in the following circuit after the switch being open for a long time.



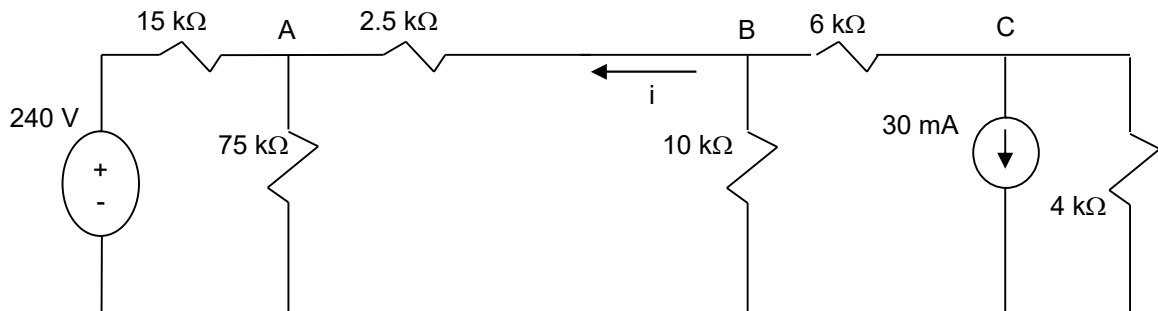
Calculate:

- a) the initial value of  $i$   
 b) the final value of  $i$   
 c) the time constant for  $t \geq 0$   
 d) the numerical expression for  $i(t)$  when  $t \geq 0$ .

**Solution:**

- a) the initial value of  $i$

At  $t=0^-$ , the inductor appears as a short since the circuit has been stabilized for a long time. The circuit can be redrawn as:



$$\text{KCL Node A} \rightarrow (V_A - 240)/15 + V_A/75 + (V_A - V_B)/2.5 = 0 \rightarrow 36V_A - 30V_B = 1200$$

$$\text{KCL Node B} \rightarrow (V_B - V_A)/2.5 + V_B/10 + (V_B - V_C)/6 = 0 \rightarrow -12V_A + 20V_B - 5V_C = 0$$

$$\text{KCL Node C} \rightarrow (V_C - V_B)/6 + 30 + V_C/4 = 0 \rightarrow -2V_B + 5V_C = -360$$

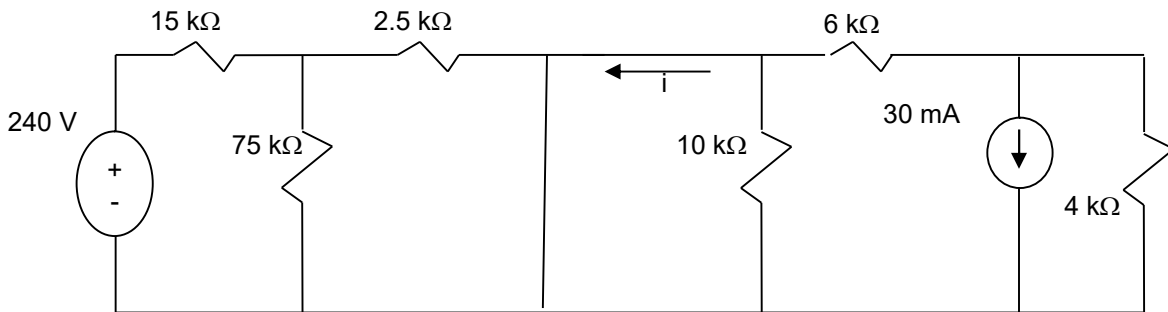
$$\text{Solve} \rightarrow V_A = 37.5\text{V}; V_B = 5\text{V}; V_C = -70\text{V}$$

$$i(0^-) = (V_B - V_A)/2.5 = (5 - 37.5)/2.5 = -13 \text{ mA} \text{ Initial value of } i$$

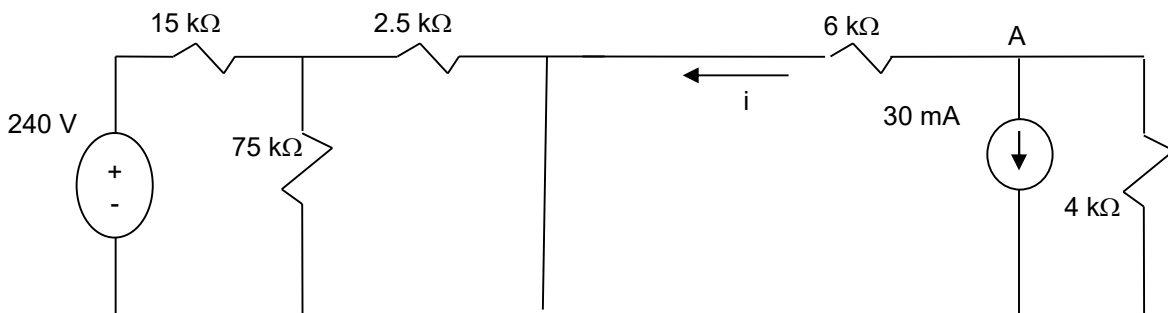


b) Final value of  $i$

At  $t = \infty$ , the inductor appears as a short and the circuit can be redrawn as:



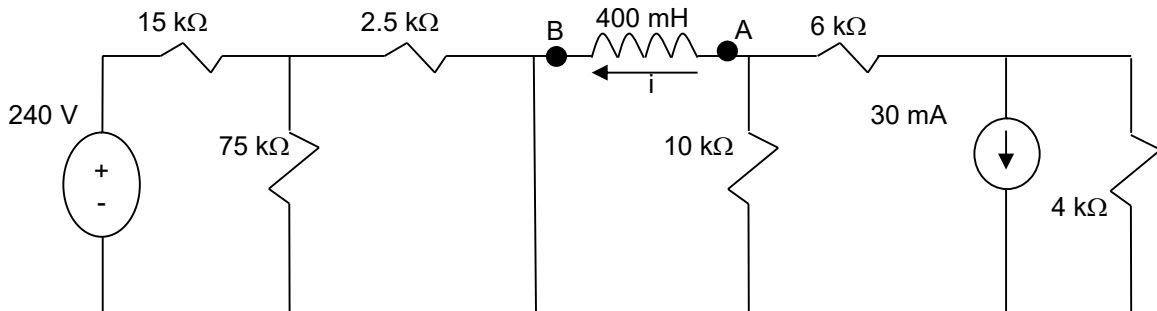
Or can be redrawn as:



KCL  $\rightarrow V_A / 6 + 30 + V_A / 4 = 0 \rightarrow V_A = -72$   
 $i(\infty) = -72 / 6 = -12 \text{ mA}$

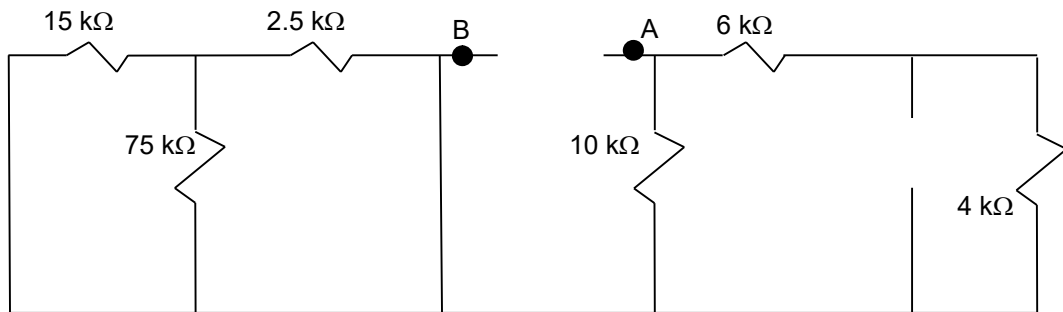
c) Time constant for  $t \geq 0$

After  $t=0$ , the circuit may be redrawn as:

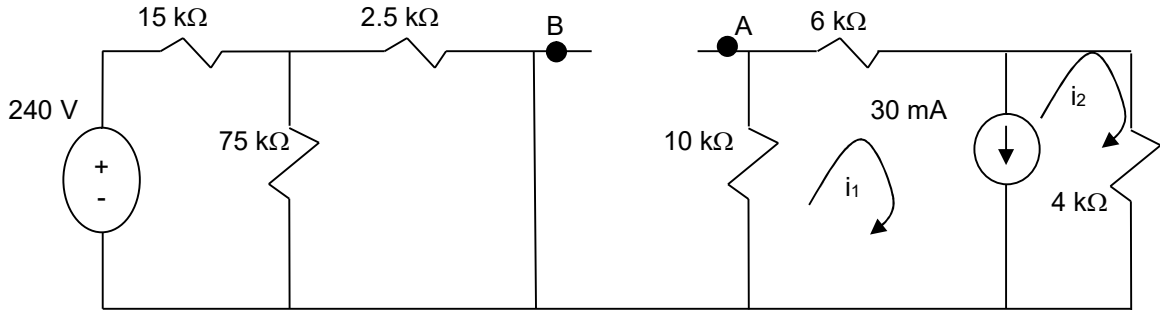


Find the Thevenin equivalent...

Calculate  $R_{th}$  by disable the sources (short for voltage source and open for current source):



$R_{th} = (10 \parallel (6+4)) = 5 \text{ k}\Omega$



Choose B as the reference ( $v=0$ ) and write the super mesh current equation:

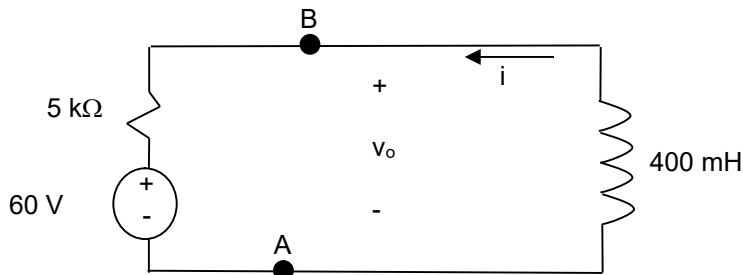
$$10i_1 + 6i_1 + 4i_2 = 0$$

$$i_1 - i_2 = 30 \text{ mA}$$

$$\text{Solve} \rightarrow i_1 = 6 \text{ mA}$$

$$V_{th} = V_{oc} = V_{BA} = - (10,000)(0.006) = -60 \text{ V}$$

Place the Thevenin Equivalent back into the circuit:



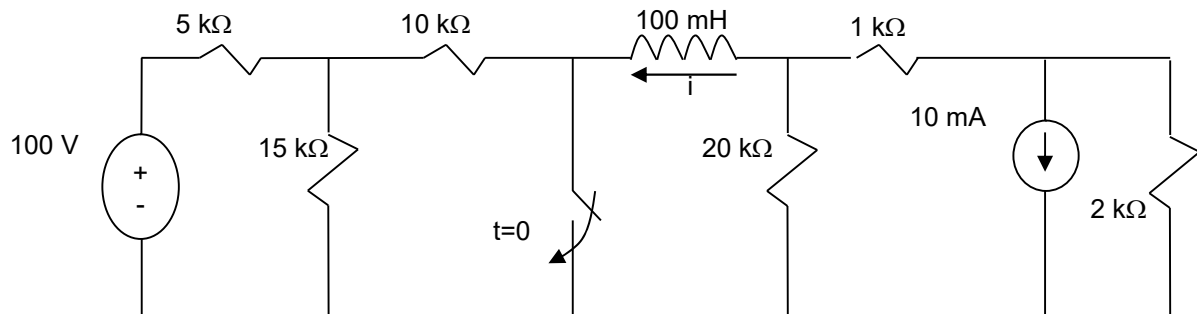
$$\text{Time Constant} = L/R = 0.4/5000 = 80 \text{ uSec}$$

d) The numerical expression for  $i(t)$  when  $t \geq 0$ .

$$\text{Apply Step response for RL Circuit} \rightarrow i(t) = \frac{V_s}{R} + \left( I_0 - \frac{V_s}{R} \right) e^{-(R/L)t} \text{ for } t \geq 0$$

$$i(t) = -\frac{60}{5000} + \left( -0.013 - \frac{-60}{5000} \right) e^{-12,500t} = -0.012 - .001e^{-12,500t} \text{ A for } t \geq 0$$

7U. At  $t=0$  the switch is closed in the following circuit after the switch being open for a long time.



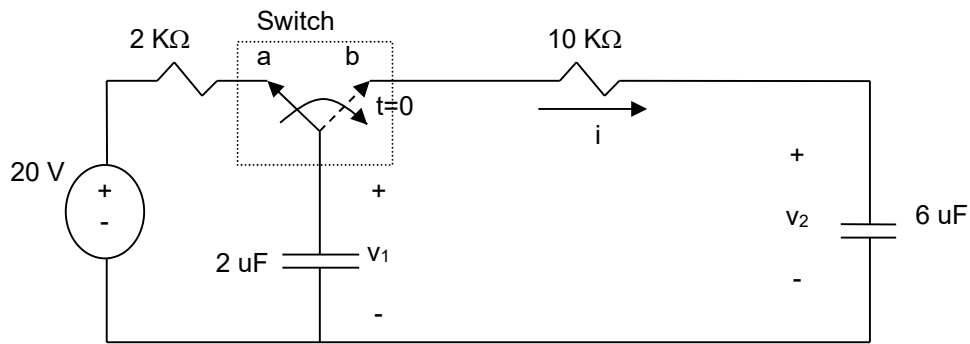
Calculate:

- the initial value of  $i$
- the final value of  $i$
- the time constant for  $t \geq 0$

d) the numerical expression for  $i(t)$  when  $t \geq 0$ .

**Solution:**

8S. In the following circuit, switch has been in the “a” position for a long time. At  $t=0$ , the switch is moved to position “b”:



For the above circuit:

- a) Calculate  $i(t)$  for  $t > 0$
- b) Find the values of  $i(0^+)$ ,  $v_1(0^+)$  and  $v_2(0^+)$ .

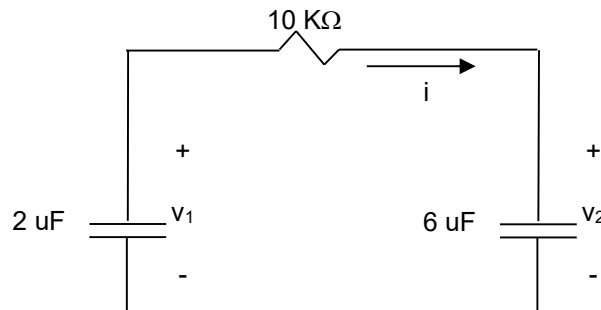
**Solution:**

a) RC Natural Response

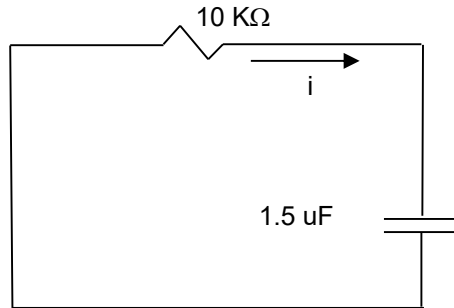
Before change ( $t < 0$ ) Initial condition where capacitors are open  
 $v_1(0^-) = 20\text{ V}$  and  $v_2(0^-) = 0\text{ V}$

After change ( $t > 0$ )

Redraw Circuit with the new switch position



$$C_{eq} = 1/(1/2 + 1/6) = 1.5 \text{ uF}, V_c = 20 \text{ V}$$



Natural Response  $\rightarrow v(t) = v(0)e^{-t/RC} = 20e^{-66.67t}$  for  $t \geq 0$

$$i(t) = -\frac{V}{R} = -2e^{-66.67t} \text{ mA}$$

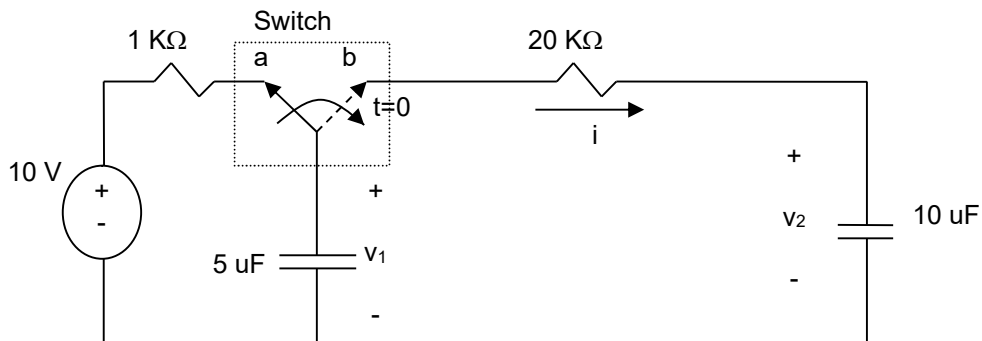
b)

$$i(0^+) = -2 \text{ mA}$$

$$v_1(t) = \frac{1}{2 \times 10^{-6}} \int_0^t 2e^{-66.7t} dt + 20 \rightarrow v_1(0^+) = 20$$

$$v_2(t) = \frac{1}{6 \times 10^{-6}} \int_0^t -2e^{-66.7t} dt + 0 \rightarrow v_2(0^+) = 0$$

8U. In the following circuit, switch has been in the “a” position for a long time. At  $t=0$ , the switch is moved to position “b”:



For the above circuit:

- Calculate  $i(t)$  for  $t > 0$
- Find the values of  $i(0^+)$ ,  $v_1(0^+)$  and  $v_2(0^+)$ .

**Solution:**