Homework 5

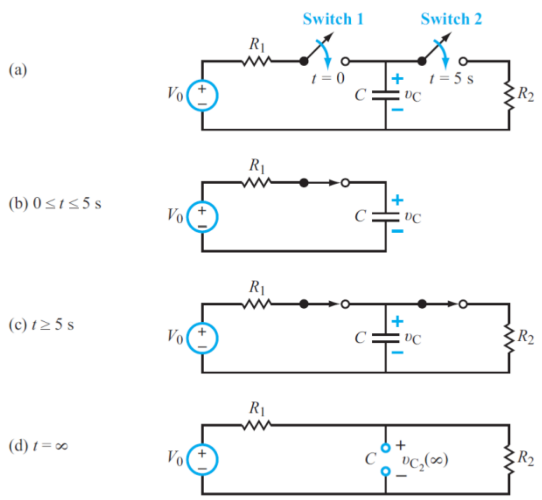
Due date:
Apr.16th, 2018
Turn in your homework in class

Rules:

- Please try to work on your own. Discussion is permissible, but identical submissions are unacceptable!
- Please show all intermediate steps: a correct solution without an explanation will get zero credit.
- Please submit on time. No late submission will be accepted.
- Please prepare your submission in English only. No Chinese submission will be accepted.

(本题满分6分)

1. The circuit contains two switches, both of which had been open for a long time before t = 0. Switch 1 closes at t = 0, and switch 2 follows suit at t = 5 s. Determine and plot $V_c(t)$ for t ≥ 0 given that $V_0 = 24$V, $R_1 = R_2 = 16$ kΩ, and C = 250μF. Assume $V_c(0) = 0$.



Solution:

Time Segment 1: $0 \leq t \leq 5$ s

(3分)

$$\tau_1 = R_1 C = 16 \times 10^3 \times 250 \times 10^{-6} = 4 \text{ s.} \quad (1分)$$

$$v_{C_1}(t) = v_{C_1}(\infty) + (v_{C_1}(t) - v_{C_1}(\infty))e^{-t/\tau_1} \quad (1分)$$

$$= V_0 + (0 - V_0)e^{-0.25t} \quad (1分)$$

$$= 24(1 - e^{-0.25t}), \quad \text{for } 0 \leq t \leq 5 \text{ s.}$$

Time Segment 2: $t \geq 5$ s (3分)

Through source transformation, it is easy to see that R_1 and R_2 should be combined in parallel. Hence:

① $$\tau_2 = \left(\frac{R_1 R_2}{R_1 + R_2}\right) C = 8 \times 10^3 \times 250 \times 10^{-6} = 2 \text{ s.}$$

$$v_{C_2}(t) = v_{C_2}(\infty) + [v_{C_2}(5 \text{ s}) - v_{C_2}(\infty)]e^{-(t-5)/\tau_2} \quad (1分)$$

② $$v_{C_2}(\infty) = \frac{V_0 R_2}{R_1 + R_2} = \frac{24 \times 16}{16 + 16} = 12 \text{ V.}$$

①与②与③相加1分

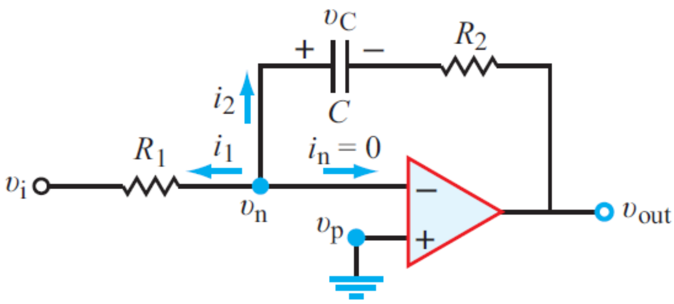
③ $$v_{C_2}(5 \text{ s}) = v_{C_1}(5 \text{ s}) = 24(1 - e^{-0.25 \times 5}) = 17.12 \text{ V}$$

$$v_{C_2}(t) = 12 + [17.12 - 12]e^{-0.5(t-5)}$$

$$= 12 + 5.12e^{-0.5(t-5)}, \quad \text{for } t \geq 5 \text{ s.}$$

(1分)

(本题满分6分) 2. Relate V_{out} to V_i in the circuit. Assume $V_c = 0$ at t = 0.



Solution:

Solution:

$$i_1 = \frac{v_n - v_i}{R_1}$$

$$V_c(0) = 0, i_2 = C\frac{dVc}{dt}$$ (2分)

By applying integration from out, we have:

$$\int_0^t i_2 dt = \int_0^t C\frac{dV_c}{dt}dt = C[V_c(t) - V_c(0)]$$ (2分)

$$\Rightarrow V_c(t) = V_c(0) + \frac{1}{C}\int_0^t i_2 dt = \frac{1}{C}\int_0^t i_2 dt$$

Therefore:

$$v_n - v_{out} = i_2 R_2 + \frac{1}{C}\int_0^t i_2\, dt$$

But $v_n = v_p = 0$, and

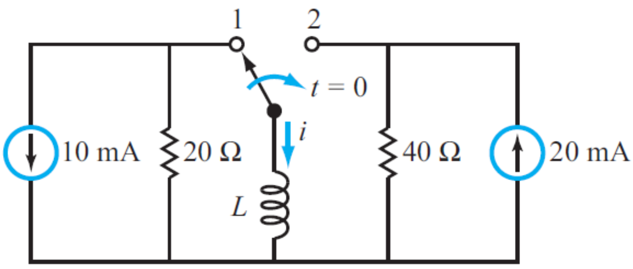
$$i_2 = -i_1 = \frac{v_i}{R_1},$$

which leads to

$$v_{out} = -\left(\frac{R_2}{R_1}v_i + \frac{1}{R_1 C}\int_0^t v_i\, dt\right).$$ (2分)

(本题满分6分)

3. The switch in the circuit was moved from position 1 to position 2 at t = 0, after it had been in position 1 for a long time. If L = 80 mH, determine i(t) for t ≥ 0.



Solution:

Solution:

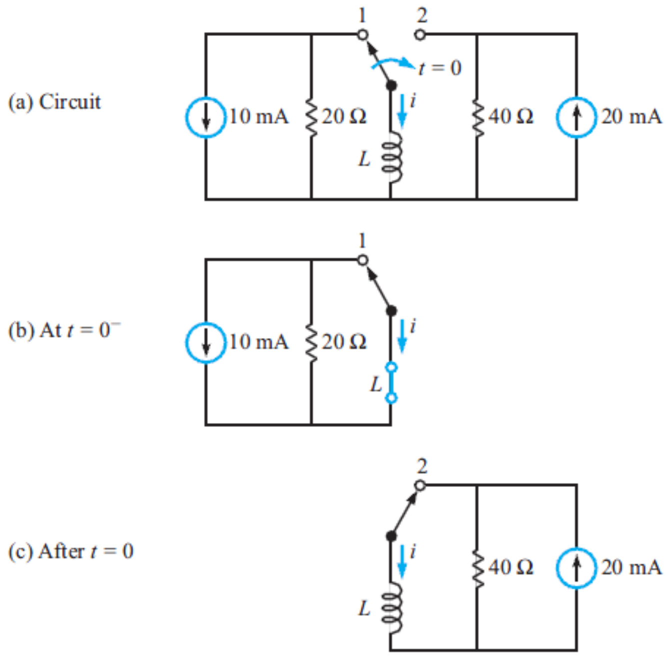


Figure P5.56

At $t = 0^-$ (Fig. P5.56(b)),

(2分) $i(0^-) = -10$ mA (current flows entirely through short circuit).

The circuit in Fig. P5.56(c) represents the circuit condition after $t = 0$.

$$i(\infty) = 20 \text{ mA.}$$ (1分)

$$\tau = \frac{L}{R} = \frac{80 \times 10^{-3}}{40} = 2 \times 10^{-3} \text{ s.}$$

$$\left.\begin{aligned} i(t) &= [i(\infty) + [i(0) - i(\infty)]e^{-t/\tau}] \\ &= [20 + (-10 - 20)e^{-500t}] \text{ mA} \\ &= [20 - 30e^{-500t}] \text{ mA.} \end{aligned}\right\}$$ => (3分)

(本题满分12分)

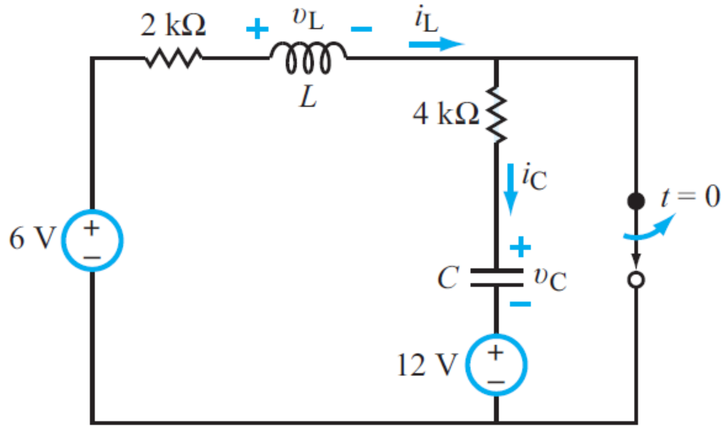
(每小题对应的那个值为2分)

4. The switch in the circuit opens at t = 0 after it has been closed for a long time. Find

(1) $V_C(0^+)$ and $i_L(0^+)$

(2) $i_C(0^+)$ and $V_L(0^+)$

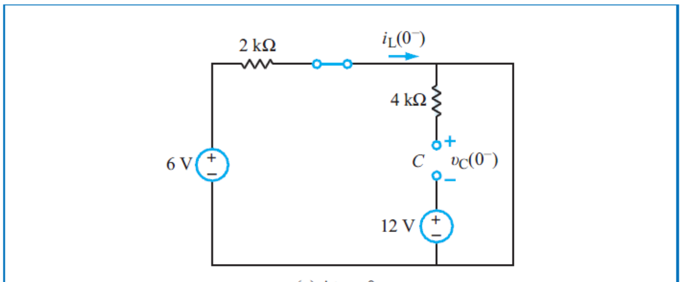
(3) $V_C(\infty)$ and $i_L(\infty)$.



Solution:

Solution:

(a)

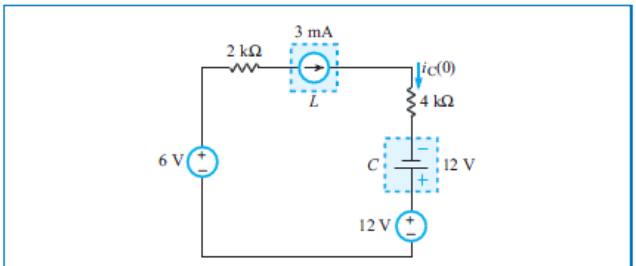


(a) At $t = 0^-$

$$v_C(0) = v_C(0^-) = -12\text{ V},$$

$$i_L(0) = i_L(0^-) = \frac{6}{2\text{k}} = 3\text{ mA}.$$

(b)



(b) At $t = 0$

At $t = 0$, L is replaced with 3-mA current source and C with -12 V voltage source.

$$i_C(0) = 3\text{ mA}.$$

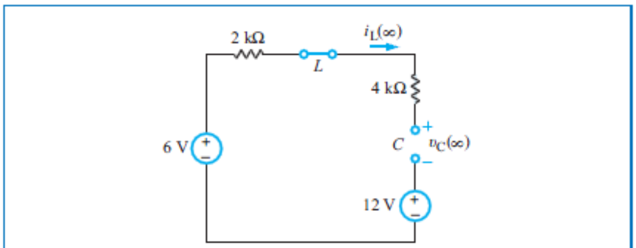
Application of KVL around the loop gives

$$-6 + 2\text{ k}\Omega \times 3\text{ mA} + v_L(0) + 3\text{ mA} \times 4\text{ k}\Omega - 12 + 12 = 0,$$

whose solution is

$$v_L(0) = -12\text{ V}.$$

(c)



(c) At $t = \infty$

Absence of a closed circuit at $t = \infty$ leads to

$$v_C(\infty) = 6 - 12 = -6\text{ V},$$

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

(本题满分 12分)

5. The voltage source in the circuit in the figure is generating the triangular waveform shown in figure. Assume that the energy stored in the capacity is zero at $t = 0$ and the Op-Amp is ideal.

(本小题满分 8分，对应分值下面有)

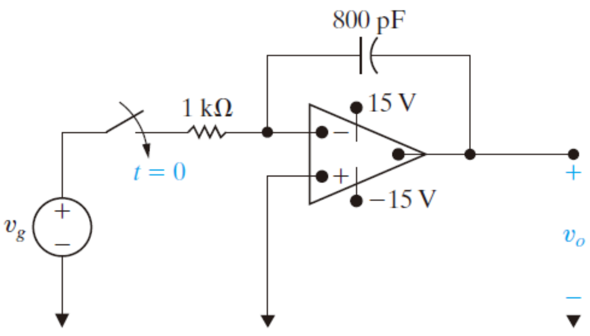
(1) Derive the numerical expressions for $V_0(t)$ for the following time in the following time intervals: $0 \le t \le 1\mu s$; $1 \le t \le 3\mu s$; $3 \le t \le 4\mu s$.

(图 2分，曲线，坐标)

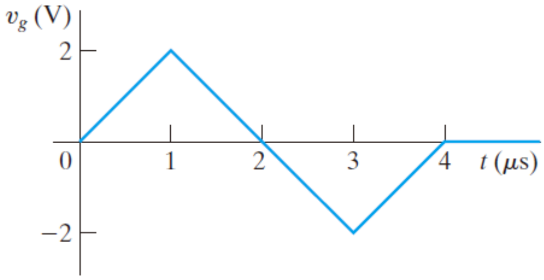
(2) Sketch the output waveform between 0 and 4μs.

(理由 1分。其中看到电压一样 1分，解释理由重新开始过程 1分)

(3) If the triangular input voltage continues to repeat itself for $t > 4\mu s$, what would you expect the output voltage to be? Explain.



(a)



(b)

Solution:

[a] $RC = (1000)(800 \times 10^{-12}) = 800 \times 10^{-9}$; $\quad \dfrac{1}{RC} = 1{,}250{,}000$

$0 \le t \le 1\,\mu s$:

$v_g = 2 \times 10^6 t$

$v_o = -1.25 \times 10^6 \int_0^t 2 \times 10^6 x\,dx + 0$ (式子 1分)

$= -2.5 \times 10^{12} \frac{x^2}{2}\Big|_0^t = -125 \times 10^{10} t^2\,\text{V}, \quad 0 \le t \le 1\,\mu s$ (答案 1分)

$v_o(1\,\mu s) = -125 \times 10^{10}(1 \times 10^{-6})^2 = -1.25\,\text{V}$ (初状态 1分)

$1\,\mu s \le t \le 3\,\mu s$:

$v_g = 4 - 2 \times 10^6 t$

$v_o = -125 \times 10^4 \int_{1\times10^{-6}}^t (4 - 2 \times 10^6 x)\,dx - 1.25$ (式子 1分)

$= -125 \times 10^4 \left[4x\Big|_{1\times10^{-6}}^t - 2 \times 10^6 \frac{x^2}{2}\Big|_{1\times10^{-6}}^t \right] - 1.25$

$= -5 \times 10^6 t + 5 + 125 \times 10^{10} t^2 - 1.25 - 1.25$

$= 125 \times 10^{10} t^2 - 5 \times 10^6 t + 2.5\,\text{V}, \quad 1\,\mu s \le t \le 3\,\mu s$ (答案 1分)

$v_o(3\,\mu s) = 125 \times 10^{10}(3 \times 10^{-6})^2 - 5 \times 10^6 (3 \times 10^{-6}) + 2.5$

$= -1.25$ (初状态 1分)

$3\,\mu s \le t \le 4\,\mu s$:

$v_g = -8 + 2 \times 10^6 t$

$v_o = -125 \times 10^4 \int_{3\times10^{-6}}^t (-8 + 2 \times 10^6 x)\,dx - 1.25$ (式子 1分)

$= -125 \times 10^4 \left[-8x\Big|_{3\times10^{-6}}^t + 2 \times 10^6 \frac{x^2}{2}\Big|_{3\times10^{-6}}^t \right] - 1.25$

$= 10^7 t - 30 - 125 \times 10^{10} t^2 + 11.25 - 1.25$

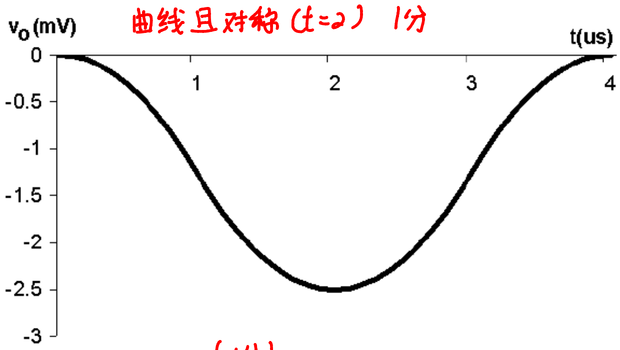
$= -125 \times 10^{10} t^2 + 10^7 t - 20\,\text{V}, \quad 3\,\mu s \le t \le 4\,\mu s$ (答案 1分)

$v_o(4\,\mu s) = -125 \times 10^{10}(4 \times 10^{-6})^2 + 10^7(4 \times 10^{-6}) - 20 = 0$

[b]

横纵坐标正确 1分

曲线且对称 (t=2) 1分



(1分)

[c] The output voltage will also repeat. This follows from the observation that at $t = 4\,\mu s$ the output voltage is zero, hence there is no energy stored in the capacitor. This means the circuit is in the same state at $t = 4\,\mu s$ as it was at $t = 0$, thus as v_g repeats itself, so will v_o. (1分)

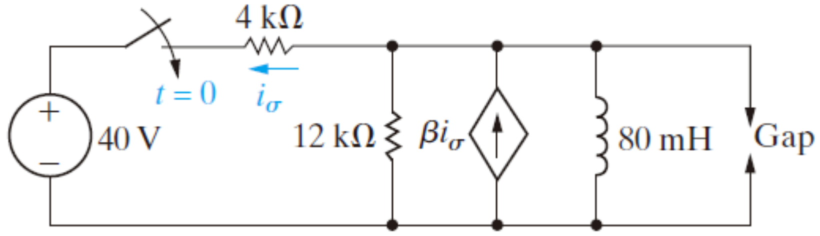
(本题满分12分)

6. The gap in the circuit seen in figure will arc over whenever the voltage across the gap reaches 30 kV. The initial current in the inductor is zero. The value of β is adjusted so the Thevenin resistance with respect to the terminals of the inductor when the switch is closed is -4 kΩ.

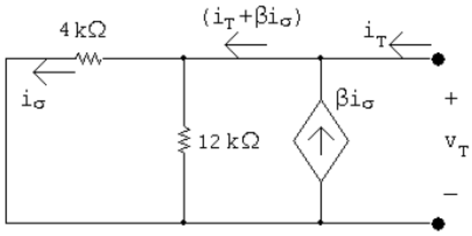
(第1题 6分)
(第2题 6分)

(1) What is the value of β?

(2) How many microseconds after the switch has been closed will the gap arc over?



[a]



Using Ohm's law,

$v_T = 4000 i_\sigma$ → (Vth得1分)

Using current division,

$$i_\sigma = \frac{12{,}000}{12{,}000+4000}(i_T+\beta i_\sigma) = 0.75 i_T + 0.75\beta i_\sigma$$

求得 i_σ 关系得1分

Solve for i_σ:

$$i_\sigma(1-0.75\beta) = 0.75 i_T$$

→ 求得 i_T 得2分

$$i_\sigma = \frac{0.75 i_T}{1-0.75\beta}; \qquad v_T = 4000 i_\sigma = \frac{3000 i_T}{(1-0.75\beta)}$$

Find β such that $R_{Th} = -4\,\text{k}\Omega$:

$$R_{Th} = \frac{v_T}{i_T} = \frac{3000}{1-0.75\beta} = -4000$$

$$1-0.75\beta = -0.75 \qquad \therefore\ \beta = 2.33$$

求得β得2分

$$\frac{V_{TH}-40}{4k} = i_\sigma$$

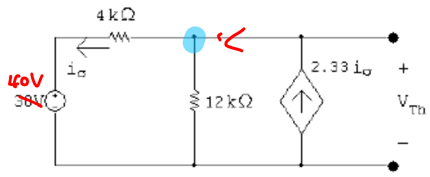
$$1.33 i_\sigma = \frac{V_{TH}}{12k}.$$

$$\frac{4}{3}(V_{TH}-40)\times 3 = V_{TH}$$

$$4V_{TH} - 160 = V_{TH}$$

$$V_{TH} = \frac{160}{3}\ \text{V}.$$

[b] Find V_{Th}; $2.33 i_\sigma$.



Write a KCL equation at the top node:

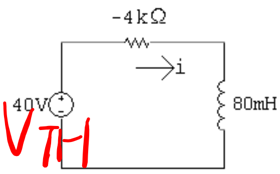
$$\frac{V_{Th}-\cancel{30}\,40}{4000} + \frac{V_{Th}}{12{,}000} - 2.33 i_\sigma = 0 \quad (1分)$$

The constraint equation is:

$$i_\sigma = \frac{(V_{Th}-\cancel{30}\,40)}{4000} = 0$$

Solving,

$V_{Th} = 40\ \text{V}$ 32 V (1分)



Write a KVL equation around the loop:

$$40 = -4000 i + 0.08\frac{di}{dt} \quad (1分)$$

Rearranging:

$$\frac{di}{dt} = 500 + 50{,}000 i = 25{,}000(i+0.01)$$

Separate the variables and integrate to find i;

$$\frac{di}{i+0.01} = 50{,}000\,dt$$

$$\int_0^i \frac{dx}{x+0.01} = \int_0^t 50{,}000\,dx$$

$$\therefore\ i = -10 + 10e^{50{,}000t}\ \text{mA} \quad (1分)$$

$$\frac{di}{dt} = (10\times10^{-3})(50{,}000)e^{50{,}000t} = 500e^{50{,}000t}$$

Solve for the arc time: (1分)

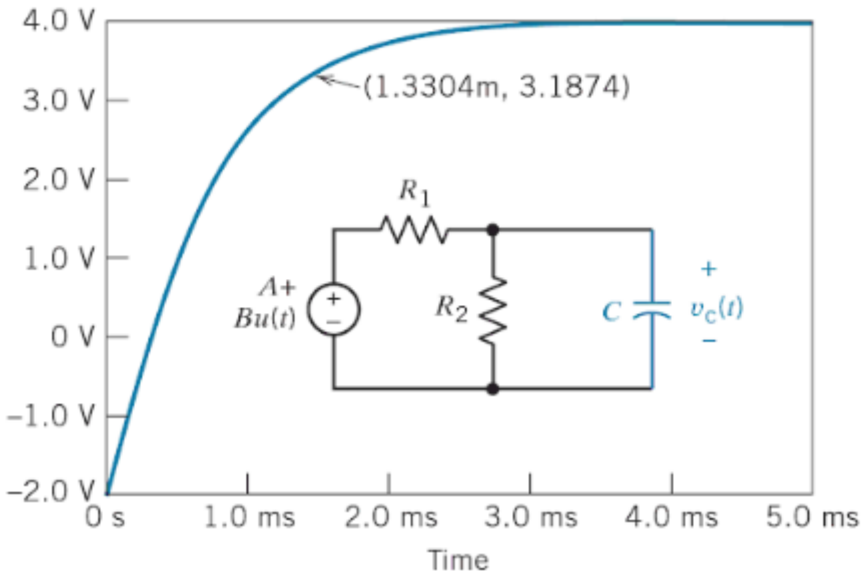
$$v = 0.08\frac{di}{dt} = 40e^{50{,}000t} = 30{,}000; \qquad e^{50{,}000t} = 750$$

$$\therefore\ t = \frac{\ln 750}{50{,}000} = 132.4\,\mu\text{s} \quad (1分)$$

(本题满分10分)

7. About one months ago, Wang Xiaoming went into the lab to find the principle of Thevenin circuit. Today, Keyi Yuan, who is an SIST student, is also interested in the principle of the circuit. He wanted to find how RL circuit works. With the help of Wang Xiaoming, he built a circuit like the one in figure.

In the figure shows the transient response of a first-order circuit. A point on this transient response has been labeled. The label indicates a time and the capacitor voltage at that time. Assume that this circuit has reached steady state before the time t=0. Placing the circuit diagram on the plot suggests that the plot corresponds to the circuit. Suppose $R_1 = 1k\Omega, R_2 = 2k\Omega$. Specify values of A, B and C that cause the voltage across the capacitor in this circuit to be accurately represented by this plot.



Step 1

$$u(t) = \begin{cases} 0 & for\ t<0 \\ 1 & for\ t>0 \end{cases}$$

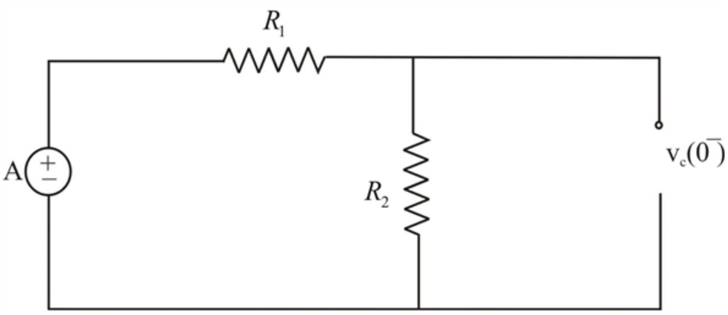
$$A + Bu(t) = \begin{cases} A & for\ t<0 \\ A+B & for\ t>0 \end{cases}$$

Comment

Step 2 of 8

For $t<0$ circuit reached to steady state and capacitor becomes open circuited

$\therefore$ For $t<0$ circuit is



By voltage division rule

$$v_c(0^-) = A \times \frac{R_2}{R_1+R_2}$$ (1分)

In capacitor voltage can't change instantaneously

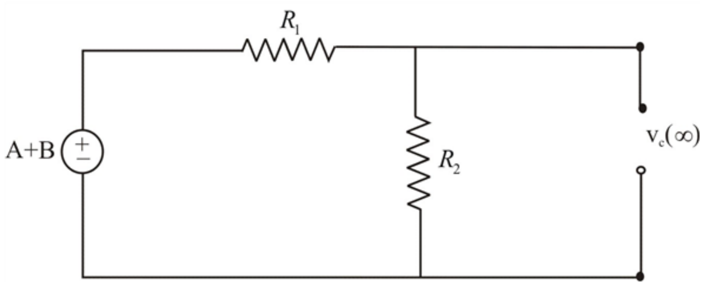
$$v_c(0^-) = v_c(0^+)$$ → (1分)

$$v_c(0^-) = \frac{AR_2}{R_1+R_2} \quad ----(1)$$

Comment

Step 4 of 8

For $t>>0$ i.e. at $t=\infty$ again circuit reached to steady state and capacitor becomes open circuited. For $t>>0$ circuit is



Step 5 of 8

By voltage division rule

$$v_c(\infty)=\frac{(A+B)R_2}{R_1+R_2}\ ------(2)$$ (1分)

From the graph

$v_c(0)=-2\text{V}$ and $v_c(\infty)=4\text{V}$

$\therefore$ Capacitor voltage equation is

$$v_c(t)=v_c(\infty)-[v_c(\infty)-v_c(0)]e^{\frac{-t}{\tau}}$$ (1分)

$$v_c(t)=4-(4+2)e^{\frac{-t}{\tau}}$$

$$v_c(t)=4-6e^{\frac{-t}{\tau}}\ \ for\ t>0$$ (1分)

Step 6 of 8

From the plot it is given that point is $(1.3304\text{m},3.1874)$

$$3.1874=4-6e^{\frac{-1.3304\times10^{-3}}{\tau}}$$

$$0.1355=e^{\frac{-1.3304\times10^{-3}}{\tau}}$$

$$-1.99=\frac{-1.3304\times10^{-3}}{\tau}$$

$$\boxed{\tau=0.669\text{ms}}$$ (1分)

From the circuit time constant $\tau=RC$

$$\tau=R_{eq}C$$

$$R_{eq}=R_1\parallel R_2$$

$$R_{eq}=\frac{R_1R_2}{R_1+R_2}$$

$$\tau=\frac{R_1R_2}{R_1+R_2}C$$

Step 7 of 8

$$0.669\times10^{-3}=\frac{R_1R_2}{R_1+R_2}C$$

From (1) and (2)

$$\left.\begin{aligned}-2&=\frac{AR_2}{R_1+R_2}\\4&=\frac{(A+B)R_2}{R_1+R_2}\end{aligned}\right\}\Rightarrow 1分$$

Step 8 of 8

Let $R_1=1\text{k}$ and $R_2=2\text{k}$

$$\left.\begin{aligned}&\therefore A=-3\\&A+B=6\\&\therefore B=9\\&\text{And }0.669\times10^{-3}=0.667\times10^{3}\times C\\&C=1\mu\text{F}\end{aligned}\right\}\Rightarrow \text{计值答案各 1分}$$

$\boxed{R_1=1\text{k}}$

$\boxed{R_2=2\text{k}}$

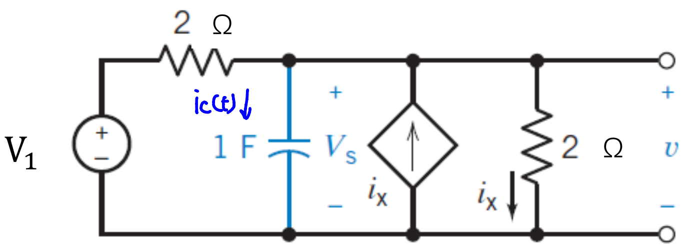
$\boxed{A=-3}$

$\boxed{B=9}$

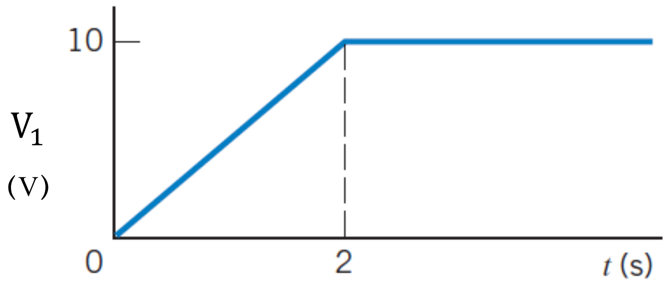
$\boxed{C=1\mu\text{F}}$

(本题满分 12分)

8. Determine v(t) for the circuit shown in figure a when the voltage source V_1 varies as shown in figure. The initial capacitor voltage is $V_s(0)=0$.



(a)



(b)

Sol: $V_1 = \begin{cases} 5t, & 0 \le t \le 2s \\ 10V, & t \ge 2s \end{cases}$, $i_C(t) = C\frac{dV_s(t)}{dt}$

First, for $0 \le t \le 2s$:

Using KCL on the top node, we can get that:

$$\begin{cases} \frac{V_s(t)-V_1}{2} + i_C(t) - i_x + i_x = 0 \\ V_1 = 5t \end{cases} \Rightarrow 1分$$

Therefore, $\frac{dV_s(t)}{dt} + \frac{V_s(t)}{2} = \frac{5}{2}t$

Solving the equation, we can get that:

$$\left.\begin{aligned} V_s(t) &= e^{-\int \frac{1}{2}dt}\left(\int \tfrac{5}{2}t e^{\int \frac{1}{2}dt} dt + c\right) \\ &= Ce^{-\frac{1}{2}t} + \tfrac{5}{2}e^{-\frac{1}{2}t}\int t\cdot e^{\frac{1}{2}t}dt \\ &= Ce^{-\frac{1}{2}t} + 5t - 10 \end{aligned}\right\} \Rightarrow (2分)$$

For the initial condition that $V_s(0)=0$

Therefore $C = 10$ (1分)

So $V_s(t) = 10e^{-\frac{1}{2}t} + 5t - 10$ (1分)

Second, for $t > 2s$:

$V_s(2) = 3.679V$, $V_1 = 10V$ (1分)

Using KCL, we can get that:

$$\begin{cases} \frac{V_s(t)-V_1}{2} + i_C(t) + i_x - i_x = 0 \\ V_1 = 10 \end{cases} \Rightarrow (1分)$$

Therefore, $\frac{dV_s(t)}{dt} + \frac{V_s(t)}{2} = 5$

Solving the equation, we can get that:

$$\left.\begin{aligned} V_s(t) &= e^{-\int \frac{1}{2}dt}\left(\int 5 e^{\int \frac{1}{2}dt} dt + c\right) \\ &= Ce^{-\frac{1}{2}t} + 10 \end{aligned}\right\} \Rightarrow (2分)$$

此2分还包括之后 t-2 的式子

But because we change it at t=2s, thus it has 2s delay.

We need to replace t with t-2 to make that it will change at the time $\boxed{t-2=0}$.

$\therefore V_s(t') = Ce^{-\frac{1}{2}(t'-2)} + 10$ (1分)

Because $V_s(2) = 3.679V$, thus:

$C = -6.321$ (1分)

$\therefore V_s(t) = 10 - 6.321e^{-\frac{1}{2}(t-2)}$

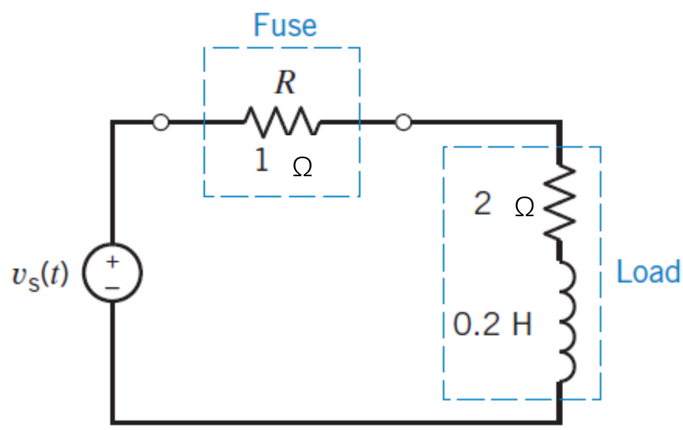
$$\therefore V_s(t) = \begin{cases} 10e^{-\frac{1}{2}t} + 5t - 10, & t \in [0,2] \\ -6.321e^{-\frac{1}{2}(t-2)} + 10, & t \in [2,+\infty) \end{cases}$$

(1分)

注意范围

(本题满分12分)

9. Fuses are used to open a circuit when excessive current flows. This circuit was designed by Wright in 1990. One fuse is designed to open when the power absorbed by R exceeds 10W for 0.5s. Consider the circuit shown in figure. The input is given by $V_s = A[u(t) - u(t-0.75)]$. Assume that $i_L(0^-) = 0$. Determine the largest value of A that will not cause the fuse to open.



Step 2 of 10

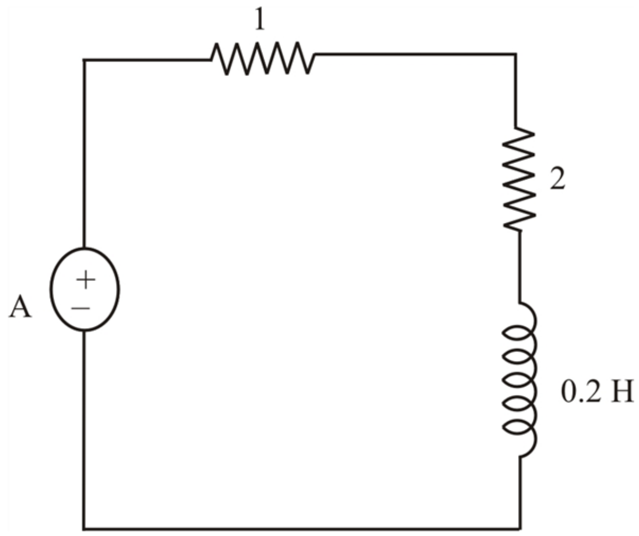
Given

$$v_s(t) = A[u(t) - u(t-0.75)]\text{V}$$

$$\therefore v_s(t) = \begin{cases} A & \text{for } 0 < t < 0.75 \\ 0 & \text{for } t > 0.75 \end{cases}$$

Step 3 of 10

For $0 < t < 0.75$ circuit is



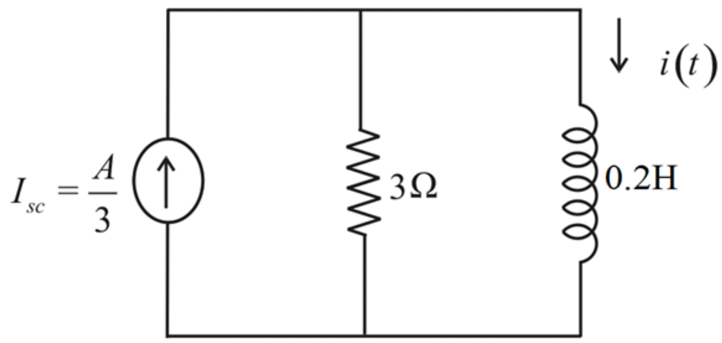
Step 4 of 10

$\therefore$ Generalized expression for inductor current is

$$i(t) = I_{sc} + (i(0) - I_{sc})e^{\frac{-t}{\tau}}$$

Step 5 of 10

By source transformation



Step 6 of 10

Given $i_L(0^-) = 0$

$i_L(0^-) = i_L(0^+)$ ⇒ (1分)

$i_L(0) = 0$

$$\therefore i(t) = \frac{A}{3} + \left(0 - \frac{A}{3}\right)e^{\frac{-t}{\tau}}$$

$$i(t) = \frac{A}{3}\left(1 - e^{\frac{-t}{\tau}}\right)$$ (2分)

Step 7 of 10

$$\tau = \frac{L}{R_{eq}}$$

$$R_{eq} = 3\Omega$$

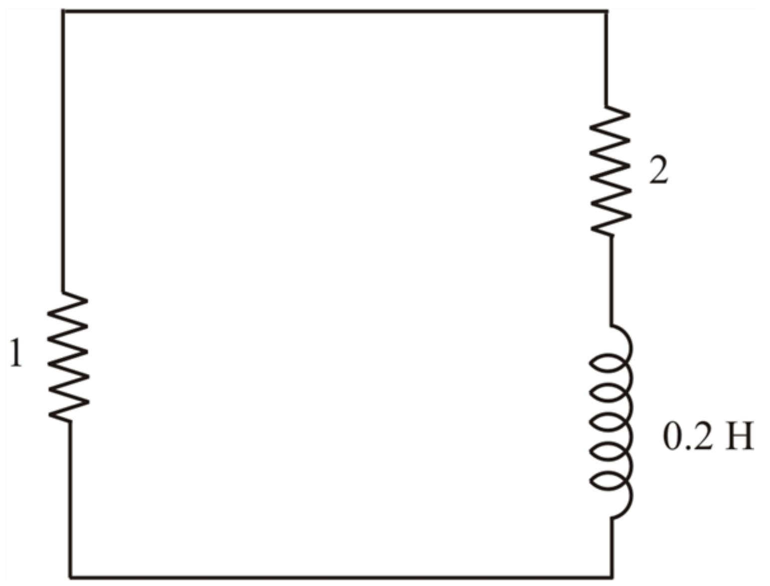
$$\therefore \tau = \frac{0.2}{3}$$ (1分)

$$\tau = 0.0667\,\text{sec}$$

$$i(t) = \frac{A}{3}\left(1 - e^{-15t}\right)\text{A} \qquad 0 < t < 0.75$$ (1分)

Step 8 of 10

For $t > 0.75$ circuit is



Step 9 of 10

$$I_{sc} = 0$$

$$i(0.75) = \frac{A}{3}\left(1 - e^{-15\times 0.75}\right)$$

$$i(0.75) = 0.333\text{A}$$ (1分)

$$\therefore i(t) = 0 + (0.333A - 0)e^{-\frac{(t-0.75)}{\tau}} \qquad t > 0.75$$ (2分)

$$i(t) = 0.333Ae^{-15(t-0.75)} \qquad t > 0.75$$

Step 10 of 10

We need to find the value of *A* such that maximum power through 1Ω should not exceed 10W for 0.5 sec

Current through 1Ω resistor $= i(t)$

$$i(t) = \frac{A}{3}\left(1 - e^{-15t}\right)$$

Now we have to find *A* so that power through the resistor is greater than 10W during $0.25 < t < 0.75\,\text{sec}$

$$\therefore i^2(0.25)R_{fuse} = 10\text{W}$$

$$\left(\frac{A}{3}\left(1 - e^{-15\times 0.25}\right)\right)^2 1 = 10$$ (2分)

$$\left(\frac{A}{3}0.97648\right)^2 = 10$$

$$0.1059A^2 = 10$$

$$A^2 = 94.428$$

$$\boxed{A = 9.715}$$ (2分)

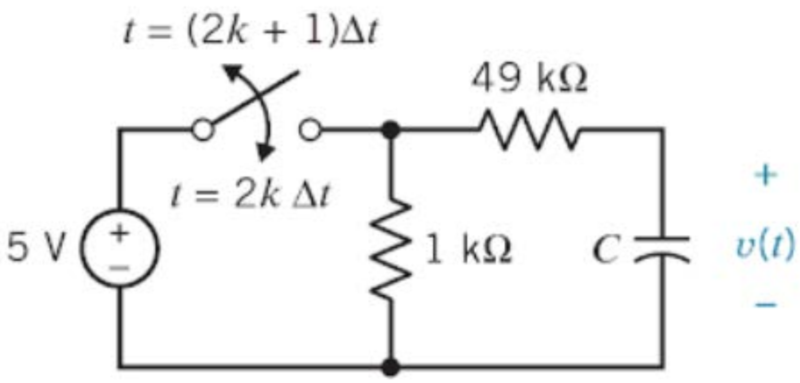
(本题满分 12 分)

(主体分 7分)

10. The switch in Figure closes at time 0, $2\Delta t, 4\Delta t, \cdots, 2k\Delta t$ and opens at times $\Delta t, 3\Delta t, 5\Delta t, \cdots, (2k+1)\Delta t$. When the switch closes, $v(t)$ makes the transition from $v(t)=0$ to $v(t)=5V$. Conversely, when switch opens, $v(t)$ makes the transition from $v(t)=5V$ to $v(t)=0$. Suppose we require that one transition be 95 percent complete before the next one begins.

(1) Determine the value of C required so that $\Delta t = 1\mu s$.

(2) How large must Δt be when $C = 2\mu F$?



Step 1 of 7

Generalized expression for capacitor voltage is

$$v(t) = v(\infty) + (v(0) - v(\infty))e^{\frac{-t}{\tau}}$$

When the switch closes $v(t)$ makes transition from $v(t)=0$ to 5V in Δt sec

$$\therefore v(0) = 0$$

$$v(\infty) = 5$$

(1分)

$$v(t) = 5 + (0-5)e^{\frac{-\Delta t}{\tau}}$$

$$v(t) = 5\left(1 - e^{\frac{-\Delta t}{\tau}}\right)$$

(1分)

Step 2 of 7

It is given that one transition is 95 percentage complete before the next one begins.

$$v(t) = 0.95v(\infty)$$

$$v(t) = 0.95 \times 5$$

$$v(t) = 4.75$$

⇒ (1分)

$$4.75 = 5\left(1 - e^{\frac{-\Delta t}{\tau}}\right)$$

(2分)

$$0.95 = 1 - e^{\frac{-\Delta t}{\tau}}$$

$$0.05 = e^{\frac{-\Delta t}{\tau}}$$

$$2.995 = \frac{\Delta t}{\tau}$$

(1分)

Step 3 of 7

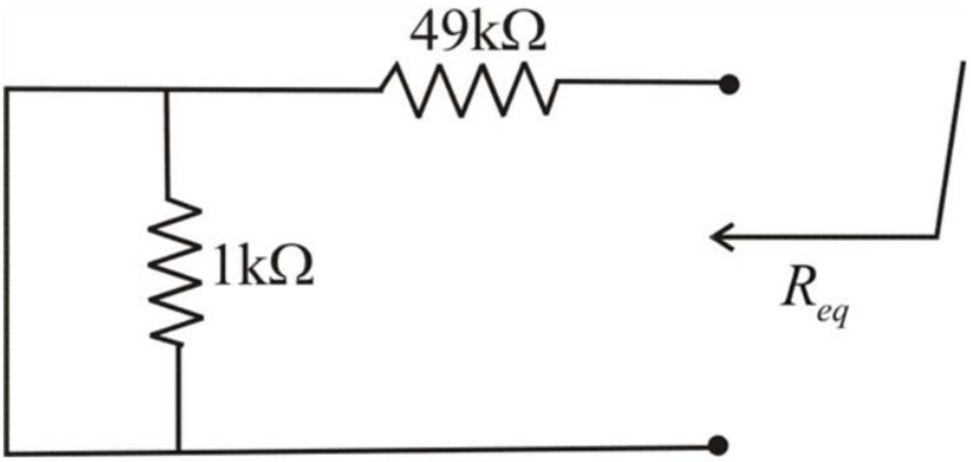
When the switch is opened the equivalent resistance is,

$$R_{eq} = 50\text{k}\Omega$$

When the switch closes time constant $\tau = R_{eq}C$

Step 4 of 7

R_{eq} can be calculated by short circuiting the voltage source



Step 5 of 7

$R_{eq} = 49\text{k}\Omega$

R_{eq} □ $50\text{k}\Omega$ (1分)

$\tau = 49 \times 10^3 \times C$

Step 6 of 7

(a) Given $\Delta t = 1\mu\text{sec}$

$\therefore 2.995 = \dfrac{1 \times 10^{-6}}{50 \times 10^3 \times C}$

$\boxed{C = 6.67\text{PF}}$

⇒ 2分

Step 7 of 7

(b) Given $C = 2\mu\text{F}$

$2.995 = \dfrac{\Delta t}{\tau}$

$\Delta t = 2.995 \times \tau$

$\Delta t = 2.995 \times R_{eq} C$

$\Delta t = 2.995 \times 50 \times 10^3 \times 2 \times 10^{-6}$

$\Delta t = 0.2995$

$\boxed{\Delta t = 0.3\text{s}}$

⇒ (3分)