Capacitors Inductors 001

Problem has been graded.

You are given a capacitor with a capacitance C_1. At time $t = 0$, the voltage across this capacitor is V_o.

If a constant current I_1 flows through the capacitor, how long will the capacitor take to charge up to a charge of 10 nC?

Given Variables:

C1 : 8 nF

Vo : 1 V

I1 : 2 mA

Calculate the following:

t (us) :

You are given a capacitor with a capacitance C_1. At time $t = 0$, the voltage across this capacitor is V_o.

If a constant current I_1 flows through the capacitor, how long will the capacitor take to charge up to a charge of 10 nC?

C1 = 2 nF

Vo = 3 V

I1 = 2 mA

$$V_0 = 3V \qquad Q = C \cdot V$$

$$V_{END} = \frac{Q_{END}}{C_1} = \frac{10 \cdot 10^{-9}}{2 \cdot 10^{-9}} = 5V$$

$$i = C \frac{dv}{dt}$$

$$\Downarrow$$

$$V_{END} = V_0 + \frac{1}{C} \int_{t_0}^{t} I_1 \, dt = V_0 + \frac{I_1}{C} \cdot t$$

$$t = (V_{END} - V_0) \cdot \frac{C}{I_1} = (5-3) \cdot \frac{2 \cdot 10^{-9}}{2 \cdot 10^{-3}}$$

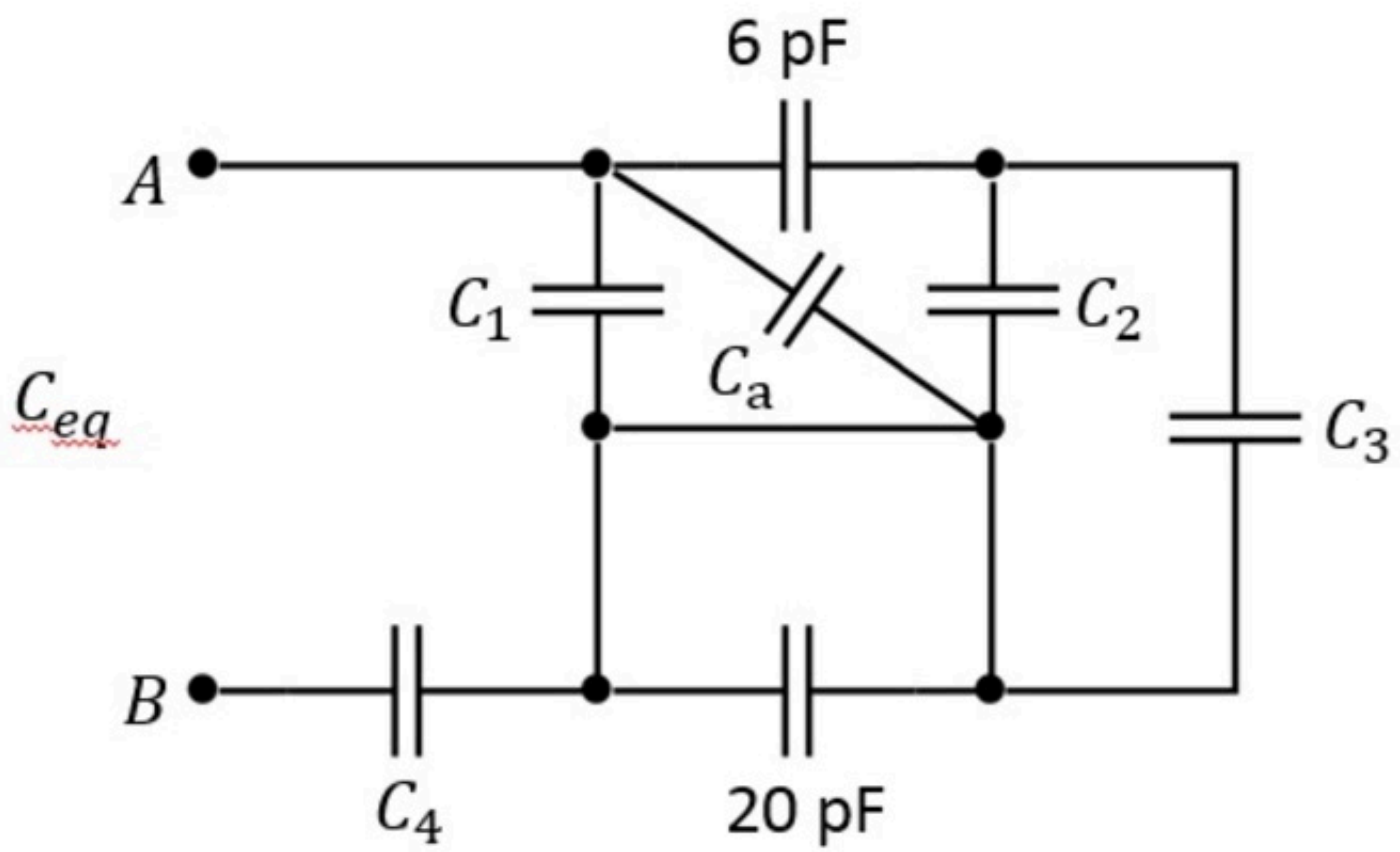
$$t = 2 \cdot 10^{-6} s$$

$$\boxed{t = 2 \mu s}$$

Capacitors Inductors 002

Problem has been graded.

Given C_{eq} between points A and B, what is C_a?



Given Variables:

C1 : 2 pF

C2 : 2 pF

C3 : 4 pF

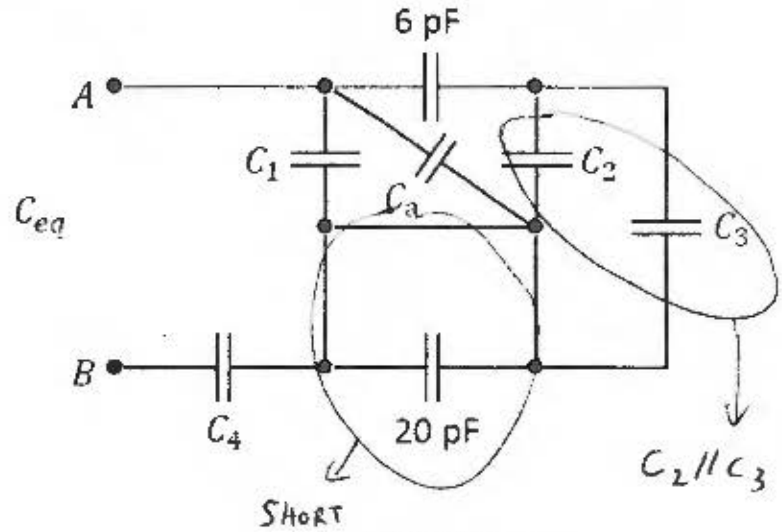
C4 : 6 pF

Ceq : 3 pF

Calculate the following:

Ca (pF) :

Given C_{eq} between points A and B, what is C_a?



C1 = 4 pF

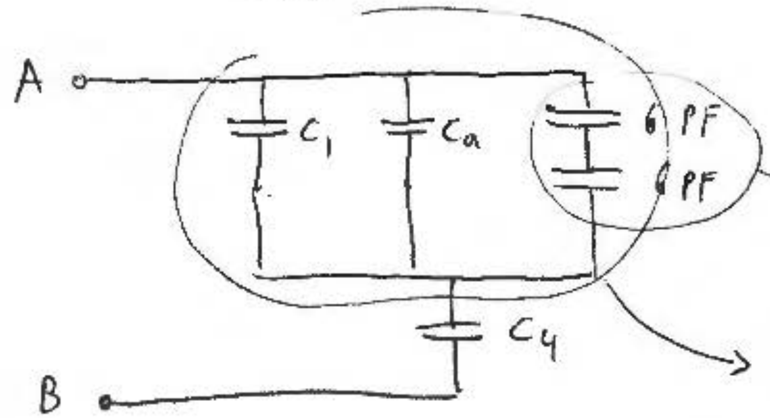
C2 = 5 pF

C3 = 1 pF

C4 = 10 pF

Ceq = 5 pF

$$C_2 // C_3 = C_2 + C_3 = 6\ pF$$



$$\frac{1}{\frac{1}{6}+\frac{1}{6}} = \frac{1}{\frac{1}{3}} = 3\ pF$$

C^*

$$\frac{1}{C_{eq}} = \frac{1}{C_4} + \frac{1}{C^*} \Rightarrow \frac{1}{C^*} = \frac{1}{5} - \frac{1}{10} = \frac{1}{10} \Rightarrow C^* = 10\ pF$$

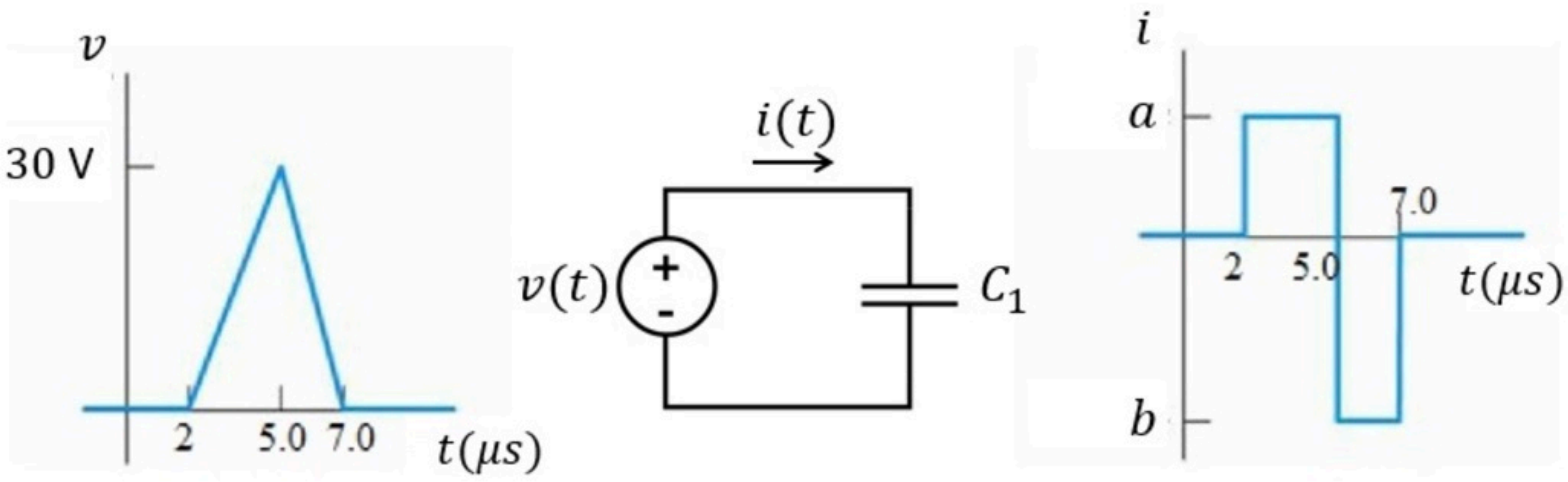
$$C^* = C_1 + C_a + 3 \Rightarrow C_a = 10 - 4 - 3 = 3\ pF$$

$$\boxed{C_a = 3\ pF}$$

Capacitors Inductors 003

Problem has been graded.

Given the two plots of the voltage and current of the capacitor.
Find the values of a and b labeled on the graph.



Given Variables:

C1 : 8 nF

Calculate the following:

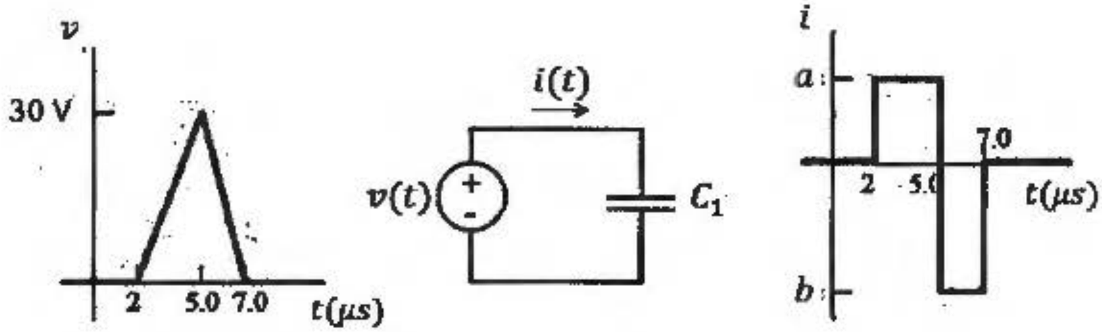
a (A) :

0.08

b (A) :

-0.12

Given the two plots of the voltage and current of the capacitor. C1 = 1 nF
Find the values of a and b labeled on the graph.



$$i = C\frac{dv}{dt}$$

⊛ FOR $2\ \mu s < t < 5\ \mu s$. $\frac{dv}{dt} = \frac{\Delta v}{\Delta t} = \frac{30\ V}{3\cdot 10^{-6}\ s}$

$$i = 10^{-9} \cdot \frac{30}{3\cdot 10^{-6}} = 10 \cdot 10^{-3} = 0.01 \qquad \boxed{a = 0.01\ A}$$

⊛ FOR $5\mu s < t < 7\mu s$. $\frac{dv}{dt} = \frac{\Delta v}{\Delta t} = \frac{-30\ V}{2\cdot 10^{-6}\ s}$

$$i = 10^{-9}\,\frac{(-30)}{2\cdot 10^{-6}} = -15\cdot 10^{-3} = -0.015$$

$$\boxed{b = -0.015\ A}$$

Capacitors Inductors 004

Problem has been graded.

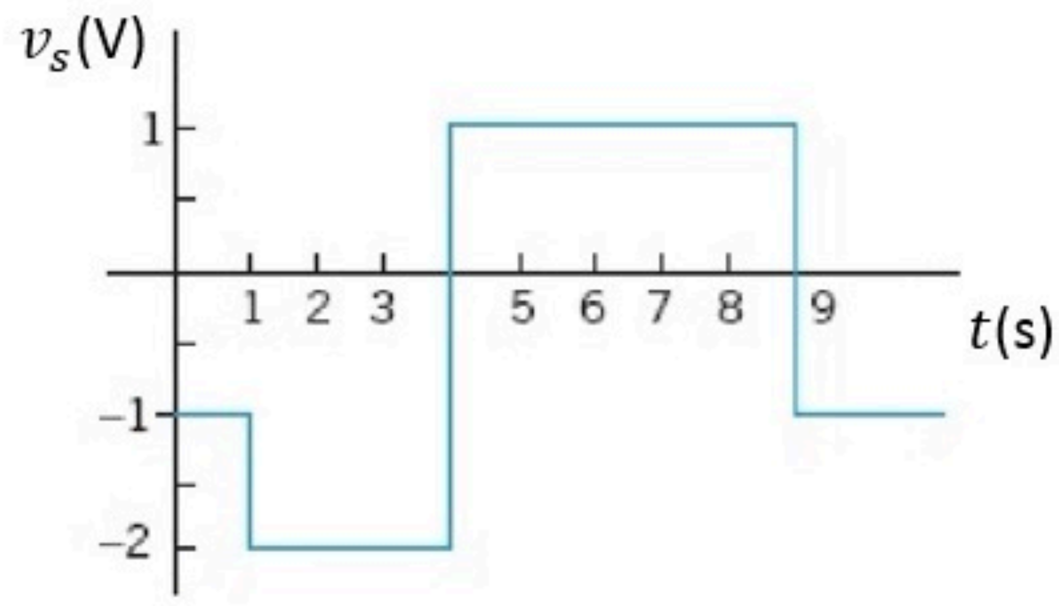
Find the current $i(t)$ in the circuit, when $i(0) = 1$ A and the voltage is as shown in the graph.

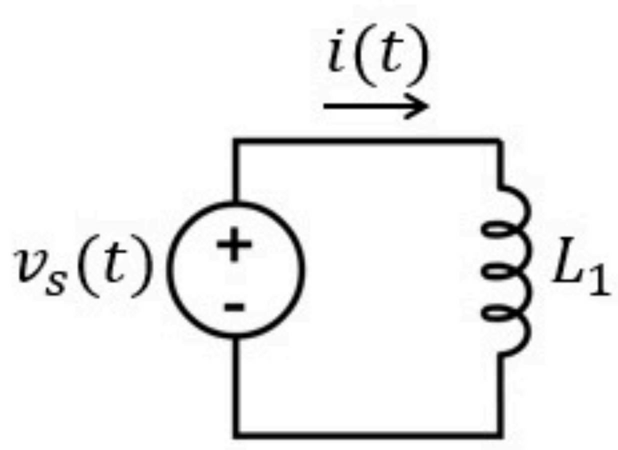
$i(t) = a_1 t + a_2$ for $0\text{ s} < t < 1\text{ s}$

$i(t) = a_3 t + a_4$ for $1\text{ s} < t < 4\text{ s}$

$i(t) = a_5 t + a_6$ for $4\text{ s} < t < 9\text{ s}$

$i(t) = a_7 t + a_8$ for $9\text{ s} < t$





Given Variables:

L1 : 0.2 H

Calculate the following:

a1 (A/s) :

-5

a2 (A) :

1

a3 (A/s) :

-10

a4 (A) :

6

a5 (A/s) :

5

a6 (A) :

-54

a7 (A/s) :

-5

a8 (A) :

36

Hint: Make sure your offsets of the line segments are correct

Find the current $i(t)$ in the circuit, when $i(0) = 1$ A and the voltage is as shown in the graph.

L1 = 0.1 H

(a) $i(t) = a_1 t + a_2$ for $0\,s < t < 1\,s$

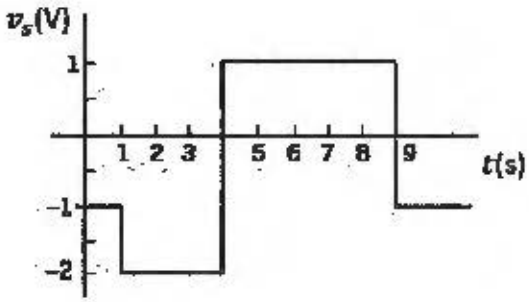
(b) $i(t) = a_3 t + a_4$ for $1\,s < t < 4\,s$

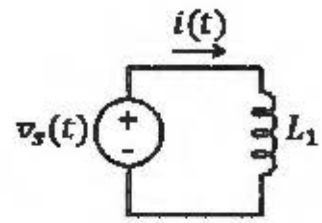
(c) $i(t) = a_5 t + a_6$ for $4\,s < t < 9\,s$

(d) $i(t) = a_7 t + a_8$ for $9\,s < t$

$$v_s = L \frac{di}{dt}$$

$$i(t) = i(t_0) + \frac{1}{L} \int_{t_0}^{t} v_s(u)\,du$$





(a) $t_0 = 0\,s$: $i(t) = 1 + \frac{1}{0.1} \int_0^t (-1)\,du = 1 - 10t$

$\boxed{a_1 = -10\ A/s \quad a_2 = 1A}$

at $t = 1\,s$: $i(1) = 1 - 10 \cdot 1 = -9$ A

(b) $t_0 = 1\,s$ $\quad i(t) = -9 + \frac{1}{0.1} \int_1^t (-2)\,du = -9 - 20(t-1) = 11 - 20t$

at $t = 4\,s$. $i(4) = 11 - 20 \cdot 4 = -69$ A $\quad \boxed{a_3 = -20\ A/s} \quad \boxed{a_4 = 11\ A}$

(c) $t_0 = 4\,s$. $\quad i(t) = -69 + \frac{1}{0.1} \int_4^t 1\,du = -69 + 10(t-4) = -109 + 10t$

at $t = 9\,s$. $i(9) = -109 + 10 \cdot 9 = -19$A $\quad \boxed{a_5 = 10\ A/s} \quad \boxed{a_6 = -109\ A}$

(d) $t_0 = 9\,s$. $\quad i(t) = -19 + \frac{1}{0.1} \int_9^t (-1)\,du = -19 - 10(t-9) = 71 - 10t$

$\boxed{a_7 = -10\ A/s} \quad \boxed{a_8 = 71\ A}$

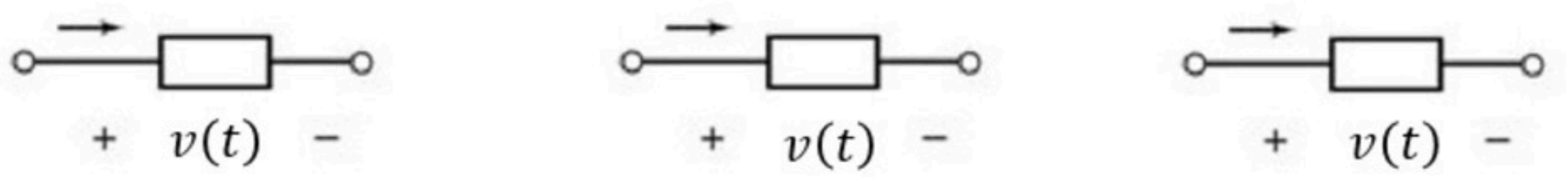
Capacitors Inductors 005

Problem has been graded.

One of these three elements is a resistor, one is an inductor, and one is a capacitor, but you are not told in advance which one is which. You are given the voltages across and the currents through each one of the elements.

$$v(t) = 12\cos(4000t)\ \text{V}$$

$i_1(t) = A_1\sin(4000t)$ $i_2(t) = A_2\cos(4000t)$ $i_3(t) = A_3\sin(4000t)$



Find the value of the resistor *R*, the inductor *L* and the capacitor *C* (all three are positive values).

(For this problem, ignore the initial conditions. As we will see later in this course, this means we assume the system is in what is called "steady state".)

Given Variables:

A1 : -48 mA

A2 : 6 mA

A3 : 3 mA

Calculate the following:

R (kohm) :

2

L (H) :

1

C (uF) :

1

Hint: The elements may not be in the order R, L, C.

One of these three elements is a resistor, one is an inductor, and one is a capacitor, but you are not told in advance which one is which. You are given the voltages across and the currents through each one of the elements.

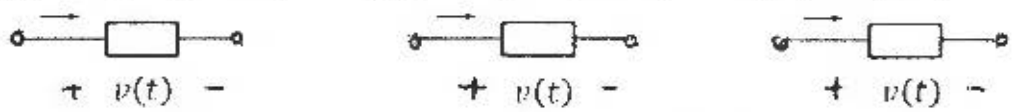
A1 = -96 mA

A2 = 12 mA

A3 = 3 mA

$$v(t) = 12\cos(4000t)\ \text{V}$$

$i_1(t) = A_1\sin(4000t)$ $\quad$ $i_2(t) = A_2\cos(4000t)$ $\quad$ $i_3(t) = A_3\sin(4000t)$



Find the value of the resistor *R*, the inductor *L* and the capacitor *C* (all three are positive values).

(For this problem, ignore the initial conditions. As we will see later in this course, this means we assume the system is in what is called "steady state".)

⊛ CAPACITOR: $i = C\frac{dv}{dt} = -C\cdot 12\cdot 4000\sin(4000t)$ (1)

⊛ INDUCTOR: $v = L\frac{di}{dt} \Rightarrow i = \frac{1}{L}\int v\,dt = \frac{12}{L}\cdot\frac{\sin(4000t)}{4000}$ (2)

⊛ RESISTOR: $v = iR \Rightarrow i = \frac{12}{R}\cos(4000t)$ (3)

⊛ ONLY i_2 IS $\cos(4000t) \Rightarrow$ FROM (3). $\frac{12}{R} = A_2 = 12\cdot 10^{-3}$

$R = 10^3\ \Omega$ $\quad \boxed{R = 1\ k\Omega}$

⊛ CAPACITOR HAS − SIGN FOR CURRENT

$\Rightarrow$ FROM (1). $-C\cdot 12\cdot 4000 = A_1 = -96\ 10^{-3}$

$C = 2\cdot 10^{-6}$ $\quad \boxed{C = 2\ \mu F}$

⊛ INDUCTOR HAS + SIGN FOR CURRENT

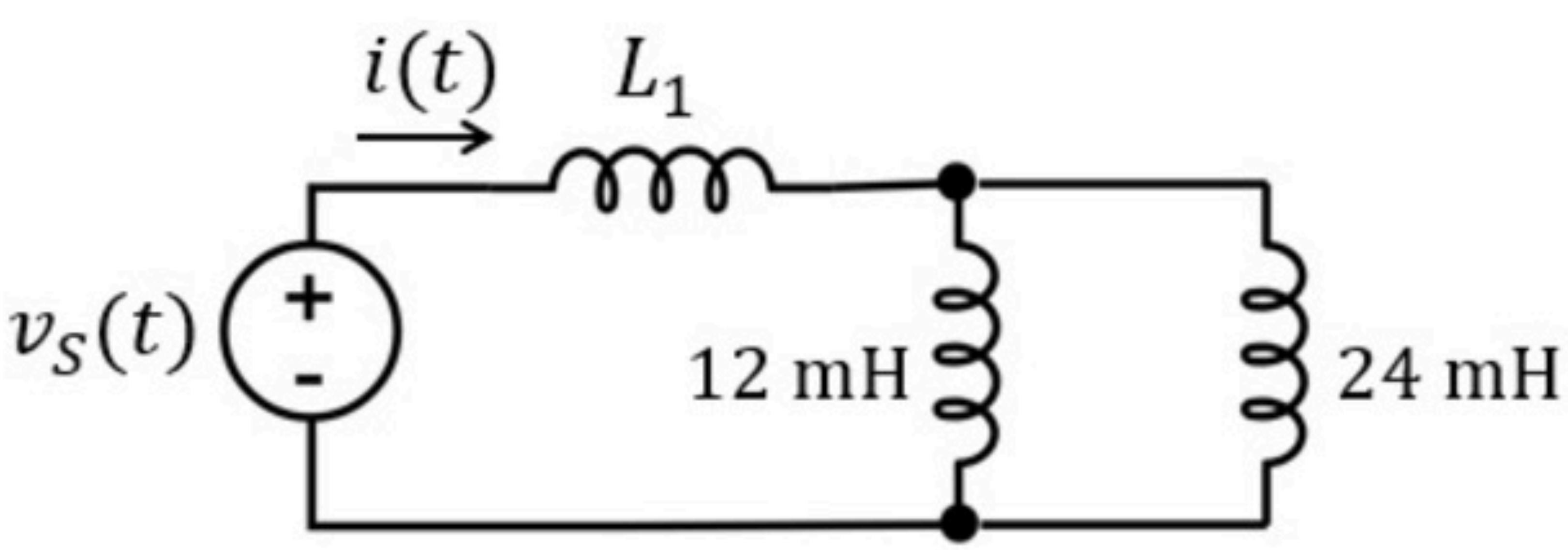
$\Rightarrow$ FROM (2): $\frac{12}{4000L} = A_3 = 3\cdot 10^{-3} \Rightarrow \boxed{L = 1\ H}$

Capacitors Inductors 006

Unlimited Attempts.

Find the current i (i.e., the constant B).

(For this problem, ignore the initial conditions. As we will see later in this course, this means we assume the system is in what is called "steady state".)



$$v_S(t) = \mathrm{A} \cdot \cos(2000\mathrm{t})$$

$$i(t) = \mathrm{B} \cdot \sin(2000\mathrm{t})$$

Given Variables:

A : 8 V

L1 : 2 mH

Calculate the following:

B (mA) :

400

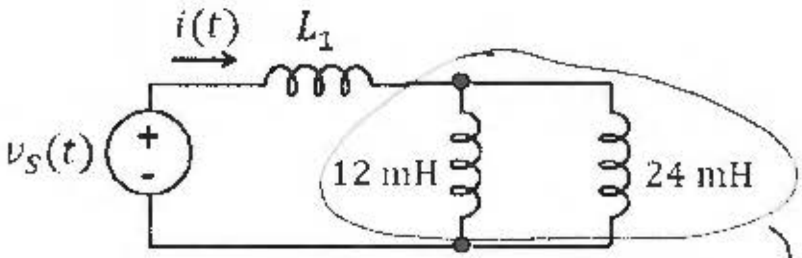
Hint: Mind the units

Find the current i (i.e., the constant B).

(For this problem, ignore the initial conditions. As we will see later in this course, this means we assume the system is in what is called "steady state".)

A = 4.8 V

L1 = 4 mH

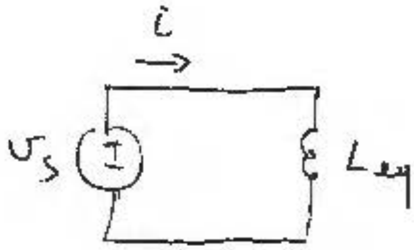


$$v_S(t) = \mathrm{A} \cdot \cos(2000\mathrm{t})$$

$$i(t) = \mathrm{B} \cdot \sin(2000\mathrm{t})$$

PARALLEL

$$\frac{1}{\frac{1}{12} + \frac{1}{24}} = \frac{1}{3/24} = 8 \text{ mH}$$



$$L_{eq} = L_1 + 8 = 12 \text{ mH}$$

$$v = L \frac{di}{dt} \Rightarrow 4.8 \cos(2000t) = L_{eq} \cdot B\ 2000 \cos(2000t)$$

$$\Rightarrow B = \frac{4.8}{2000 \cdot 12 \cdot 10^{-3}} = \frac{4.8}{24} = 0.2 \text{ A}$$

$$\boxed{B = 200 \text{ mA}}$$