ECE 35, Fall 2017

Quiz 3 - Section A

Last name	
First + middle name(s)	
PID	

Instructions:

- Read each problem completely and thoroughly before beginning
- All calculations need to be done on these sheets
- Write your answers in the answer boxes for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit

(1) Consider the system below (it is repeated on the next page). For $t < 0$, the switch is closed. At $t = 0$, the switch is opened and it remains open. At time $t = 0^-$, just before the switch was opened, the system was not in steady state, but it is given that $\boldsymbol{v_C(0^-) = 1V}$ and $\boldsymbol{i_L(0^-) = 2A}$.

(a) What is the energy in the capacitor at time $\boldsymbol{t = 0^+}$, (right after the switch is opened)?

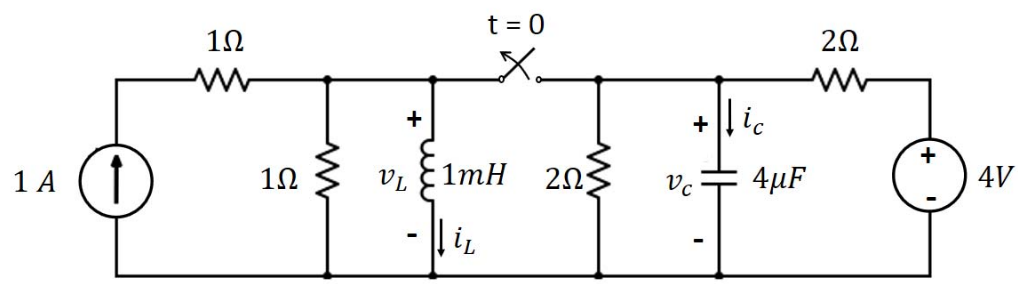
(b) Find the expression for the inductor voltage $\boldsymbol{v_L(t)}$, for $t > 0$.

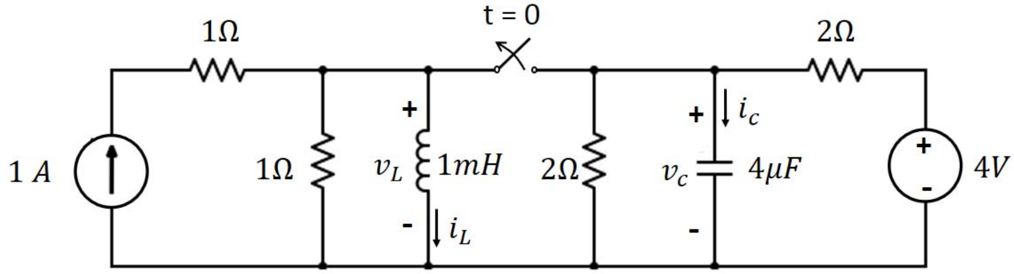
$v_L(t)$ in V =

(c) At time $t = 1000$, the switch is closed again. Find the capacitor voltage $\boldsymbol{v_C}$ and the inductor current $\boldsymbol{i_L}$ at time $\boldsymbol{t = \infty}$.

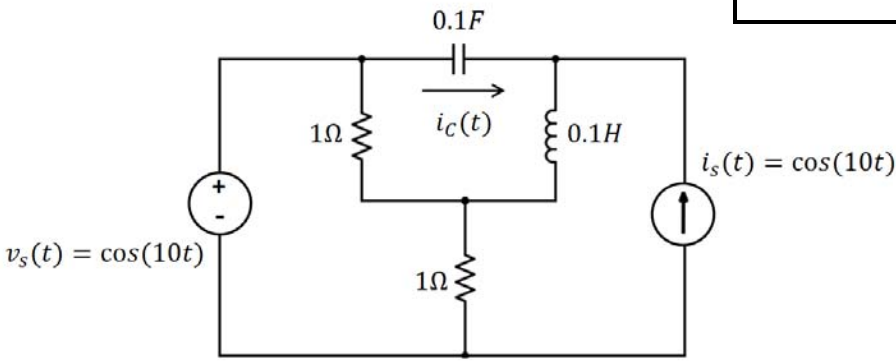
$\boldsymbol{v_C}$

$\boldsymbol{i_L}$




1Ω
t = 0
2Ω
1 A
1Ω
v_L
1mH
i_L
2Ω
v_c
i_c
4μF
4V

(2) Find *$i_C(t)$.* (Hint: you can use nodal analysis)



ECE 35, Fall 2017

Quiz 3 - Section B

Last name	
First + middle name(s)	
PID	

Instructions:

- Read each problem completely and thoroughly before beginning
- All calculations need to be done on these sheets
- Write your answers in the answer boxes for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit

(1) Consider the system below (it is repeated on the next page). For $t < 0$, the switch is closed. At $t = 0$, the switch is opened and it remains open. At time $t = 0^-$, just before the switch was opened, the system was not in steady state, but it is given that $\boldsymbol{v_C(0^-) = 8V}$ and $\boldsymbol{i_L(0^-) = -2A}$.

(a) What is the energy in the inductor at time $t = 0^+$, (right after the switch is opened)?

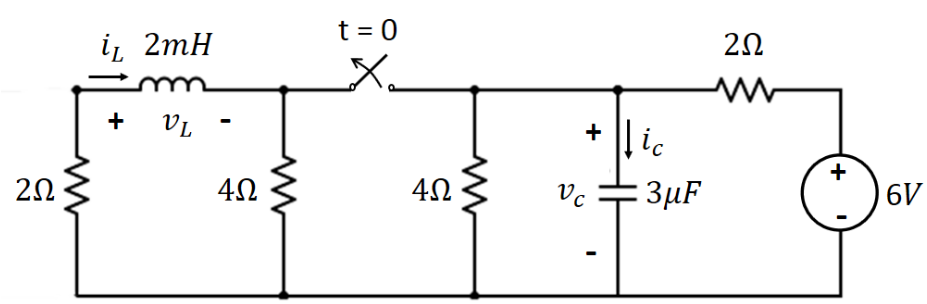
(b) Find the expression for the capacitor current $\boldsymbol{i_C(t)}$, for $t > 0$.

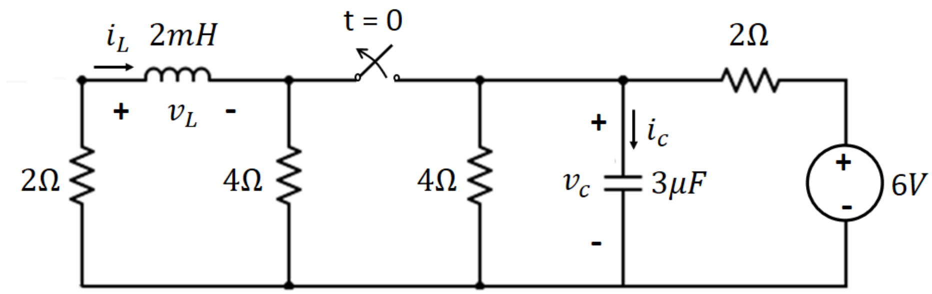
$i_C(t)$ in A =

(c) At time $t = 1000$, the switch is closed again. Find the capacitor voltage $\boldsymbol{v_C}$ and the inductor current $\boldsymbol{i_L}$ at time $\boldsymbol{t = \infty}$.

$\boldsymbol{v_C}$

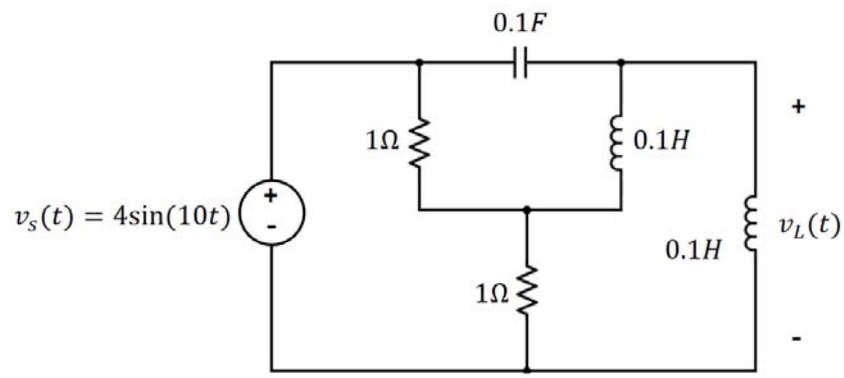
$\boldsymbol{i_L}$





i_L
$2mH$
t = 0
2Ω
+
v_L
-
+
i_c
2Ω
4Ω
4Ω
v_c
$3\mu F$
+
-
$6V$
-

(2) Find $v_L(t)$. (Hint: you can use nodal analysis)



ECE 35, Fall 2018
Quiz 3

Last name	
First + middle name(s)	
PID	

/ 20

Instructions:
- Read each problem completely and thoroughly before beginning
- All calculations need to be done on these sheets
- Write your answers in the answer boxes for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit

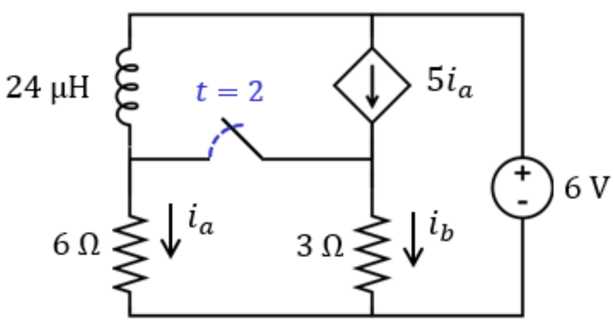
(1) For $t < 2$ s, the switch is closed and you may assume the system has reached steady state. The switch opens at time $t = 2$ s.

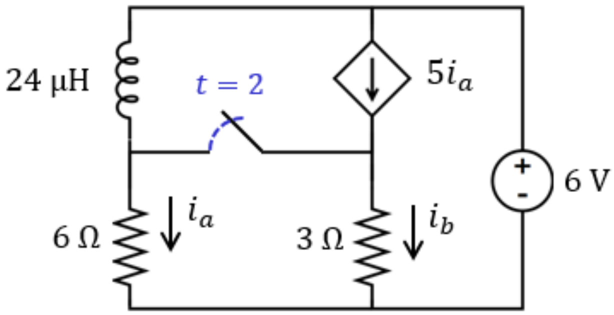
(a) Find $i_b(2^-)$. *(1 point)*

$i_b(2^-)$

(b) Find $i_b(t)$ for $t > 2$ s. *(6 points)*

$i_b(t)$

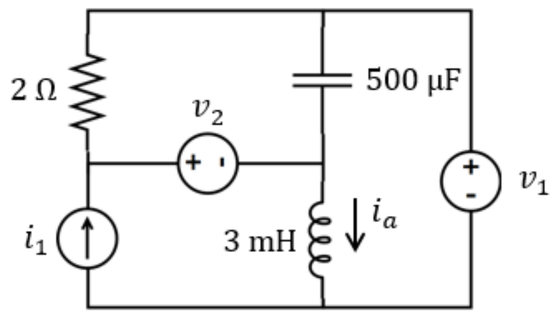




(2) For an RC system, we found $i_1(t) = -4 \cdot e^{-t/4\,s} + 1$ A. Draw this waveform. Indicate where you can find the time constant on the graph. *(2 points)*

(3) The system is in steady state. Find $i_a(t)$. (In your answer, combine cosines/sines with the same frequency. So for each frequency, there should be only one cosine wave.) *(6 points)*

$i_a(t)$



$i_1(t) = \sin(1000t)$ A

$v_1(t) = 2 \cdot \cos(1000t + \pi)$ V

$v_2(t) = 4$ V

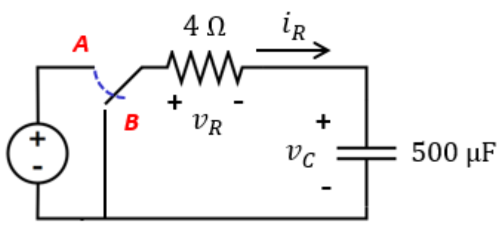
(4) In the circuit below, the switch moves from position A to position B at time t = 0 s. For *t* < 0 s (switch in position *A*), you may assume the system is in steady state. The voltage source is sinusoidal with $\omega = 1000$. The diagram shows two phasors, **A** and **B** (not to scale). One of them represents the capacitor voltage and the other the resistor voltage (but you are not told which one is which). *(5 points)*

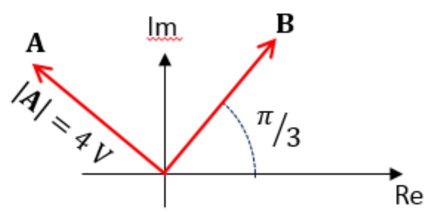
$i_R(0^-)$

$i_R(0^+)$

(a) Find i_R at time $t = 0^-$ (i.e. just before the switch moves to *B*).

(b) Find i_R at time $t = 0^+$ (i.e. immediately after the switch moves to *B*).





ECE 35, Fall 2019

Quiz 3 – Section A

Sequence number

Grade

/ 10

Last name

First + middle name(s)

PID

Instructions:

- Read each problem completely and thoroughly before beginning.
- All calculations need to be done on these sheets.
- Write your answers in the answer boxes for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit.

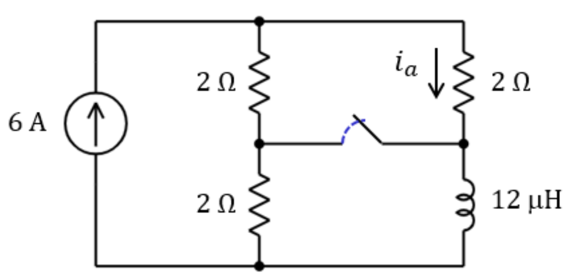
(1) *(5 points)* For $t < 2$ s, the switch is closed, and you may assume the system has reached steady state. The switch opens at time $t = 2$ s.

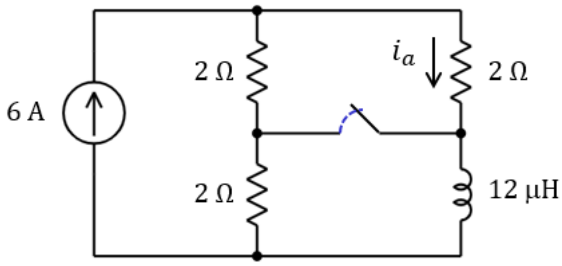
(a) Find $i_a(2^- \text{ s})$.

$i_a(2^- \text{ s})$

(b) Find $i_a(t)$ for $t > 2$ s. Write the equation.

$i_a(t)$



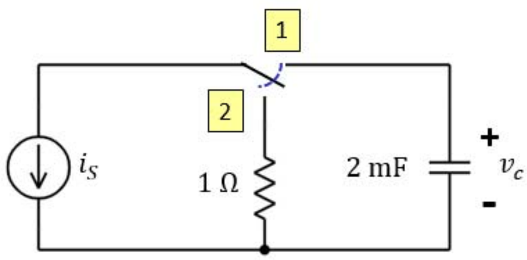


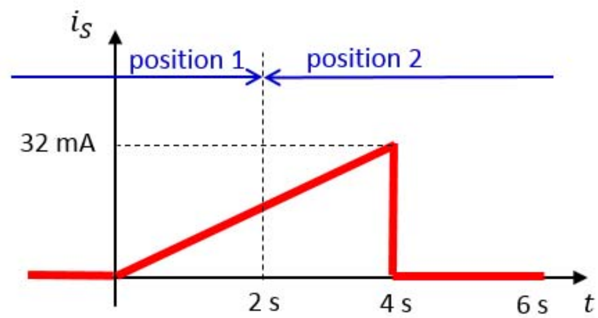
6 A
2 Ω
2 Ω
i_a
2 Ω
12 μH

(2) *(2 points)* The capacitor is fully discharged at *t* = 0 s. For *t* < 2 s, the switch is in position 1. <u>The switch moves from position 1 to position 2 at time *t* = 2 s</u>. You are given the curve of the current source i_S.

(a) Find v_c at time *t* = 1 s. $v_c(1)$ ☐

(b) Find v_c at time *t* = 6 s. $v_c(6)$ ☐





(3) *(3 points)* For $t < 0$ s, the switch is open, and you may assume the system has reached steady state. The switch closes at time $t = 0$ s. You are given the curve of the voltage v_c over the capacitor for $t > 0$ s.

(a) On the curve, we see that $v_c = 1.5$ V at time t_1. What is the current i_a at that same time t_1?

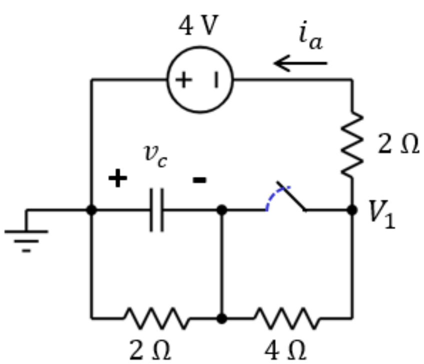
$i_a(t_1)$

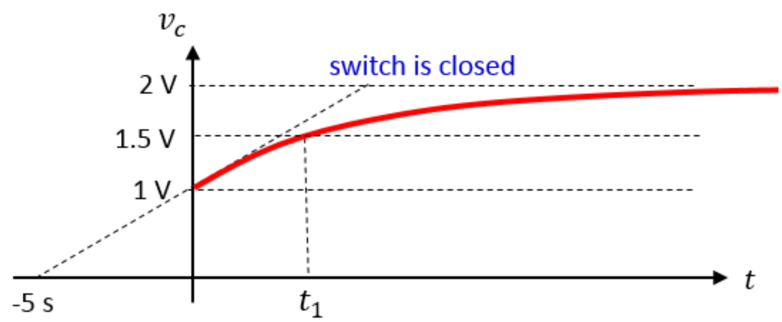
(b) What is the time constant τ of $v_c(t)$ for $t > 0$ s?

τ

(c) What is the time constant τ of the node voltage $V_1(t)$ for $t > 0$ s?

τ





ECE35 Equation Sheet

Basics: $i \triangleq \frac{dq}{dt}$ $\quad v_{ab} \triangleq \frac{dw}{dq}$ $\quad R = \rho \frac{l}{A}$

Capacitors: $C = \epsilon \cdot \frac{A}{d}$ $\quad Q = C \cdot v$ $\quad w_C = \frac{1}{2} C v^2$

Inductors: $L = \mu \cdot \frac{N^2 A}{l}$ $\quad B \sim i$ $\quad w_L = \frac{1}{2} L i^2$

AC power: $p(t) = \frac{1}{2} V_m I_m \cdot \cos(\theta_v - \theta_i) + \frac{1}{2} V_m I_m \cdot \cos(2\omega t + \theta_v + \theta_i)$

$P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i)$ $\quad Q = \frac{1}{2} V_m I_m \sin(\theta_v - \theta_i)$ $\quad X_{rms} = \sqrt{\frac{1}{T}\int_0^T x(t)^2 dt}$

Trigonometry:

$\sin(-\alpha) = -\sin(\alpha)$ $\quad \cos(-\alpha) = \cos(\alpha)$

$\sin(\pi - \alpha) = \sin(\alpha)$ $\quad \cos(\pi - \alpha) = -\cos(\alpha)$

$\sin\left(\frac{\pi}{2} - \alpha\right) = \cos(\alpha)$ $\quad \cos\left(\frac{\pi}{2} - \alpha\right) = \sin(\alpha)$

$\sin\left(\alpha - \frac{\pi}{2}\right) = -\cos(\alpha)$ $\quad \cos\left(\alpha - \frac{\pi}{2}\right) = \sin(\alpha)$

$\sin(2\alpha) = 2\sin(\alpha)\cos(\alpha)$ $\quad \cos(2\alpha) = \cos^2(\alpha) - \sin^2(\alpha)$

$\sin(\alpha \pm \beta) = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$

$\cos(\alpha \pm \beta) = \cos(\alpha)\cos(\beta) \mp \sin(\alpha)\sin(\beta)$

$\sin(\alpha)\sin(\beta) = 0.5 \cdot (\cos(\alpha - \beta) - \cos(\alpha + \beta))$

$\cos(\alpha)\cos(\beta) = 0.5 \cdot (\cos(\alpha - \beta) + \cos(\alpha + \beta))$

$\sin(\alpha)\cos(\beta) = 0.5 \cdot (\sin(\alpha - \beta) + \sin(\alpha + \beta))$

α:	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
sin(α):	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
tan(α):	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	∞

ECE 35, Fall 2019

Quiz 3 – Section B

Sequence number

Last name

First + middle name(s)

PID

Grade

/ 10

Instructions:

- Read each problem completely and thoroughly before beginning.
- All calculations need to be done on these sheets.
- Write your answers in the answer boxes for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit.

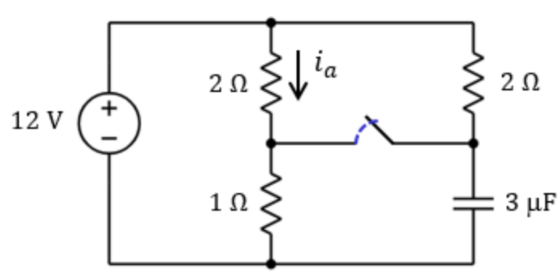
(1) *(5 points)* For $t < 2$ s, the switch is open, and you may assume the system has reached steady state. The switch closes at time $t = 2$ s.

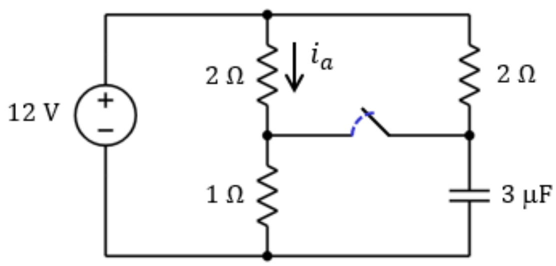
(a) Find $i_a(2^- \text{ s})$.

$i_a(2^- \text{ s})$

(b) Find $i_a(t)$ for $t > 2$ s. Write the equation.

$i_a(t)$



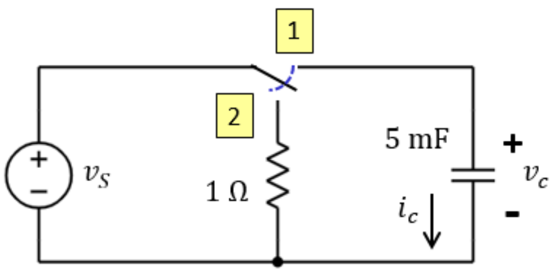


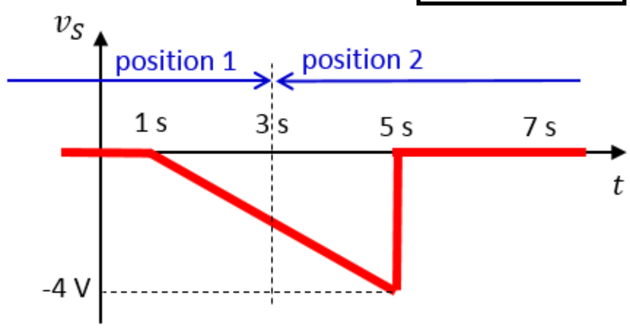
12 V
2 Ω
i_a
2 Ω
1 Ω
3 µF

(2) *(2 points)* The capacitor is fully discharged at t = 0 s. For t < 3 s, the switch is in position 1. <u>The switch moves from position 1 to position 2 at time t = 3 s</u>. You are given the curve of the voltage source v_S.

(a) Find v_c at time t = 4 s. $v_c(4)$ ☐

(b) Find i_c at time t = 2 s. $i_c(2)$ ☐





(3) *(3 points)* For $t < 0$ s, the switch is closed, and you may assume the system has reached steady state. The switch opens at time $t = 0$ s. You are given the curve of the current i_L through the inductor for $t > 0$ s.

(a) On the curve, we see that $i_L = 1.5\text{ A}$ at time t_1. What is the voltage v_a at that same time t_1?

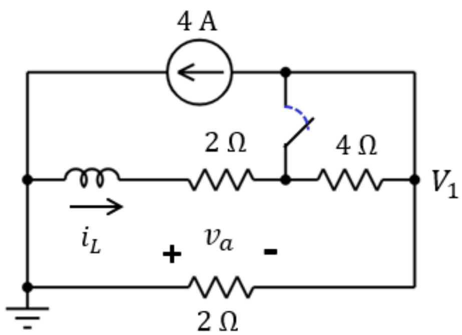
$v_a(t_1)$ $\boxed{}$

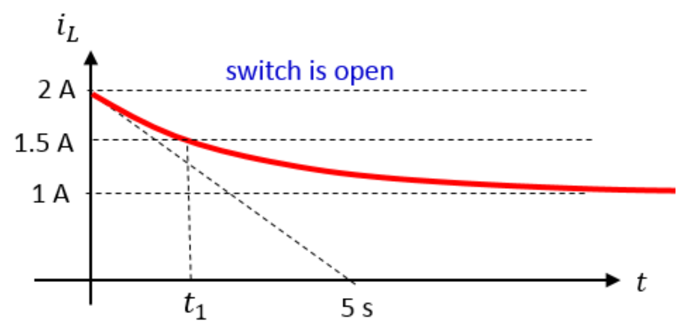
(b) What is the time constant τ of $i_L(t)$ for $t > 0$ s?

τ $\boxed{}$

(c) What is the time constant τ of the node voltage $V_1(t)$ for $t > 0$ s?

τ $\boxed{}$





ECE35 Equation Sheet

Basics: $i \triangleq \frac{dq}{dt}$ $\quad v_{ab} \triangleq \frac{dw}{dq}$ $\quad R = \rho\frac{l}{A}$

Capacitors: $C = \epsilon \cdot \frac{A}{d}$ $\quad Q = C \cdot v$ $\quad w_C = \frac{1}{2}Cv^2$

Inductors: $L = \mu \cdot \frac{N^2 A}{l}$ $\quad B \sim i$ $\quad w_L = \frac{1}{2}Li^2$

AC power: $p(t) = \frac{1}{2}V_m I_m \cdot \cos(\theta_v - \theta_i) + \frac{1}{2}V_m I_m \cdot \cos(2\omega t + \theta_v + \theta_i)$

$$P = \frac{1}{2}V_m I_m \cos(\theta_v - \theta_i) \qquad Q = \frac{1}{2}V_m I_m \sin(\theta_v - \theta_i) \qquad X_{rms} = \sqrt{\frac{1}{T}\int_0^T x(t)^2 dt}$$

Trigonometry:

$\sin(-\alpha) = -\sin(\alpha)$ $\qquad \cos(-\alpha) = \cos(\alpha)$

$\sin(\pi - \alpha) = \sin(\alpha)$ $\qquad \cos(\pi - \alpha) = -\cos(\alpha)$

$\sin\left(\frac{\pi}{2} - \alpha\right) = \cos(\alpha)$ $\qquad \cos\left(\frac{\pi}{2} - \alpha\right) = \sin(\alpha)$

$\sin\left(\alpha - \frac{\pi}{2}\right) = -\cos(\alpha)$ $\qquad \cos\left(\alpha - \frac{\pi}{2}\right) = \sin(\alpha)$

$\sin(2\alpha) = 2\sin(\alpha)\cos(\alpha)$ $\qquad \cos(2\alpha) = \cos^2(\alpha) - \sin^2(\alpha)$

$$\sin(\alpha \pm \beta) = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$$

$$\cos(\alpha \pm \beta) = \cos(\alpha)\cos(\beta) \mp \sin(\alpha)\sin(\beta)$$

$$\sin(\alpha)\sin(\beta) = 0.5 \cdot (\cos(\alpha - \beta) - \cos(\alpha + \beta))$$

$$\cos(\alpha)\cos(\beta) = 0.5 \cdot (\cos(\alpha - \beta) + \cos(\alpha + \beta))$$

$$\sin(\alpha)\cos(\beta) = 0.5 \cdot (\sin(\alpha - \beta) + \sin(\alpha + \beta))$$

α:	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
sin(α):	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
tan(α):	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	∞

ECE 35, Fall 2019

Quiz 4 – Section A

Sequence number

Last name

First + middle name(s)

PID

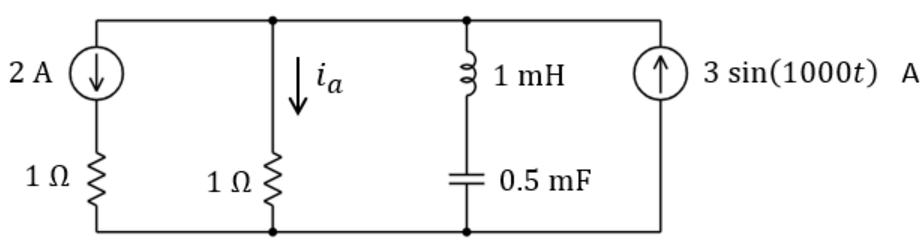
Grade

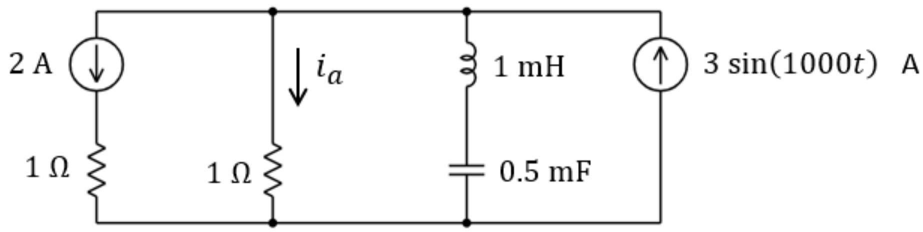
/ 10

Instructions:
- Read each problem completely and thoroughly before beginning.
- All calculations need to be done on these sheets.
- Write your answers in the answer boxes for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit.

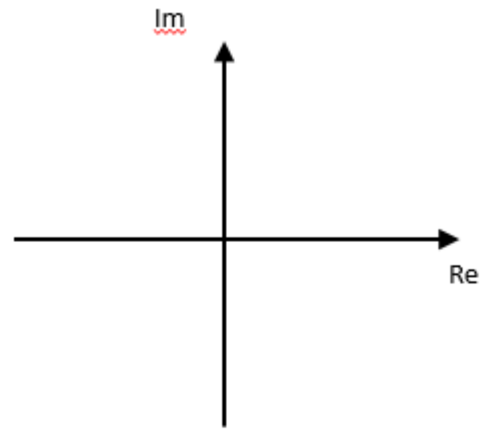
(1) *(5 points)* The system is in steady state. Find $i_a(t)$.

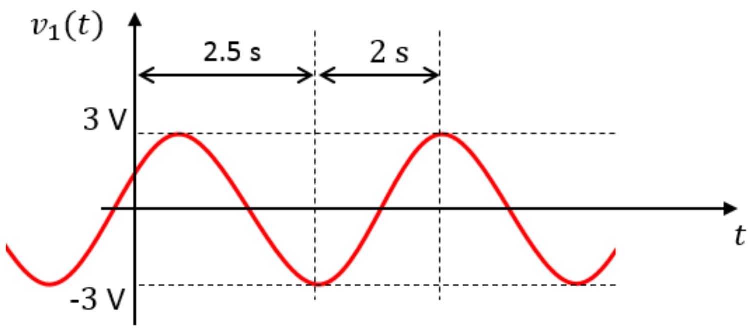
$i_a(t)$




2 A
i_a
1 mH
$3\sin(1000t)$ A
1 Ω
1 Ω
0.5 mF

(2) *(2 points)* Draw the phasor of $v_1(t)$ in the phasor diagram. Make sure it is fully defined (also list the frequency).



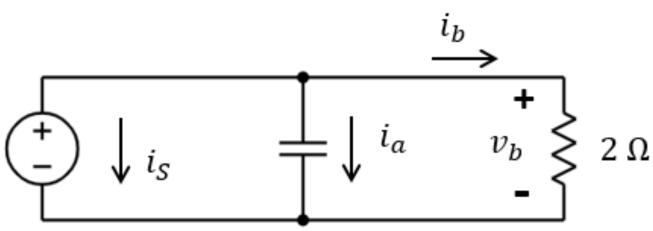


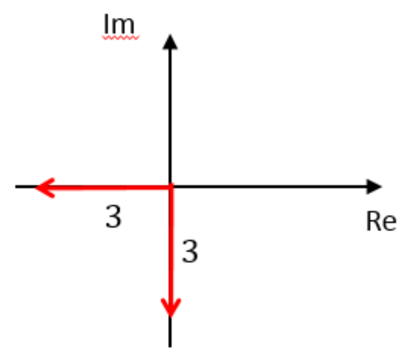
(3) *(3 points)* Consider the AC circuit below. The ω of the source is π rad/s and the system is in steady state. The phasor diagram shows the phasors of i_a and i_b, but you are not told which one is which.

(a) In the phasor diagram below, sketch the phasor of i_S.

(b) What is the value of v_b at t = 0.25 s?

$v_b(0.25\text{ s})$ $\boxed{}$





ECE35 Equation Sheet

Basics: $i \triangleq \frac{dq}{dt}$ $\quad v_{ab} \triangleq \frac{dw}{dq}$ $\quad R = \rho \frac{l}{A}$

Capacitors: $C = \epsilon \cdot \frac{A}{d}$ $\quad Q = C \cdot v$ $\quad w_C = \frac{1}{2} C v^2$

Inductors: $L = \mu \cdot \frac{N^2 A}{l}$ $\quad B \sim i$ $\quad w_L = \frac{1}{2} L i^2$

AC power: $p(t) = \frac{1}{2} V_m I_m \cdot \cos(\theta_v - \theta_i) + \frac{1}{2} V_m I_m \cdot \cos(2\omega t + \theta_v + \theta_i)$

$$P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i) \qquad Q = \frac{1}{2} V_m I_m \sin(\theta_v - \theta_i) \qquad X_{rms} = \sqrt{\frac{1}{T} \int_0^T x(t)^2 dt}$$

Trigonometry:

$\sin(-\alpha) = -\sin(\alpha)$ $\quad \cos(-\alpha) = \cos(\alpha)$

$\sin(\pi - \alpha) = \sin(\alpha)$ $\quad \cos(\pi - \alpha) = -\cos(\alpha)$

$\sin\left(\frac{\pi}{2} - \alpha\right) = \cos(\alpha)$ $\quad \cos\left(\frac{\pi}{2} - \alpha\right) = \sin(\alpha)$

$\sin\left(\alpha - \frac{\pi}{2}\right) = -\cos(\alpha)$ $\quad \cos\left(\alpha - \frac{\pi}{2}\right) = \sin(\alpha)$

$\sin(2\alpha) = 2\sin(\alpha)\cos(\alpha)$ $\quad \cos(2\alpha) = \cos^2(\alpha) - \sin^2(\alpha)$

$\sin(\alpha \pm \beta) = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$

$\cos(\alpha \pm \beta) = \cos(\alpha)\cos(\beta) \mp \sin(\alpha)\sin(\beta)$

$\sin(\alpha)\sin(\beta) = 0.5 \cdot (\cos(\alpha - \beta) - \cos(\alpha + \beta))$

$\cos(\alpha)\cos(\beta) = 0.5 \cdot (\cos(\alpha - \beta) + \cos(\alpha + \beta))$

$\sin(\alpha)\cos(\beta) = 0.5 \cdot (\sin(\alpha - \beta) + \sin(\alpha + \beta))$

α:	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
$\sin(\alpha)$:	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
$\tan(\alpha)$:	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	∞

ECE 35, Fall 2019
Quiz 4 – Section B

Sequence number

Grade

/ 10

Last name

First + middle name(s)

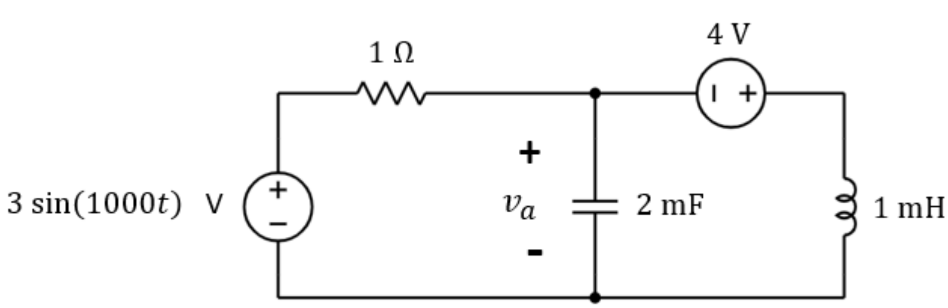
PID

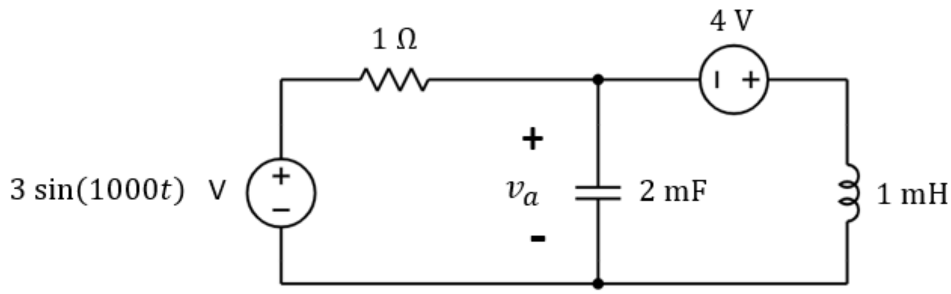
Instructions:

- Read each problem completely and thoroughly before beginning.
- All calculations need to be done on these sheets.
- Write your answers in the answer boxes for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit.

(1) *(5 points)* The system is in steady state. Find $v_a(t)$.

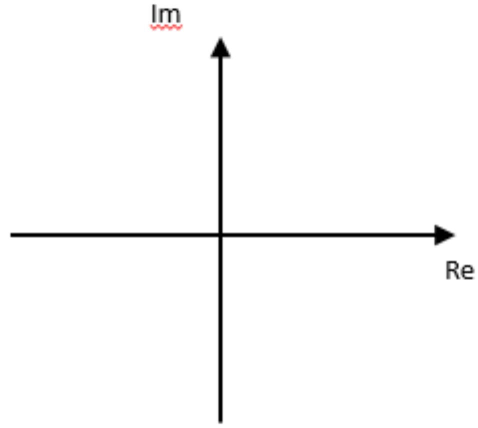
$v_a(t)$

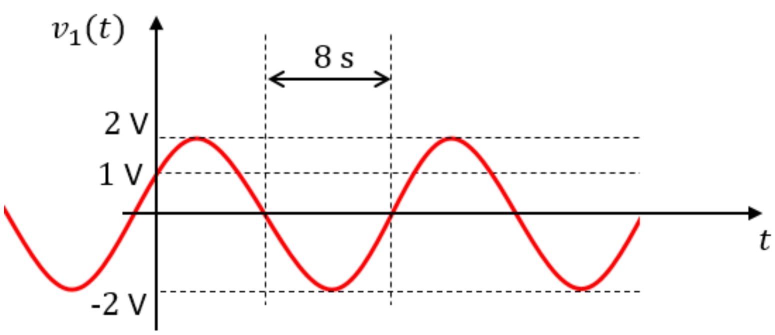




1 Ω
4 V
3 sin(1000t) V
+
v_a
-
2 mF
1 mH

(2) *(2 points)* Draw the phasor of $v_1(t)$ in the phasor diagram. Make sure it is fully defined (also list the frequency).



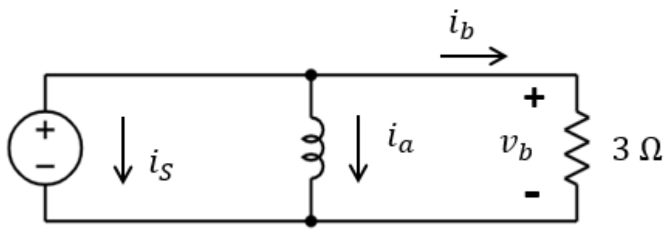


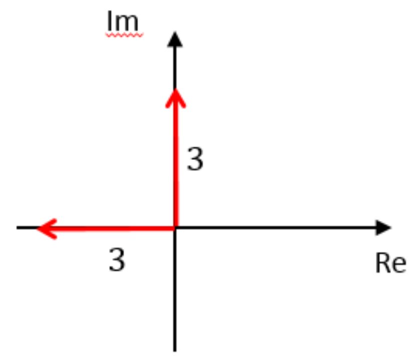
(3) *(3 points)* Consider the AC circuit below. The ω of the source is π rad/s and the system is in steady state. The phasor diagram shows the phasors of i_a and i_b, but you are not told which one is which.

(a) In the phasor diagram below, sketch the phasor of i_S.

(b) What is the value of v_b at t = 0.25 s?

$v_b(0.25\text{ s})$





ECE35 Equation Sheet

Basics: $i \triangleq \frac{dq}{dt}$ $v_{ab} \triangleq \frac{dw}{dq}$ $R = \rho \frac{l}{A}$

Capacitors: $C = \epsilon \cdot \frac{A}{d}$ $Q = C \cdot v$ $w_C = \frac{1}{2}Cv^2$

Inductors: $L = \mu \cdot \frac{N^2 A}{l}$ $B \sim i$ $w_L = \frac{1}{2}Li^2$

AC power: $p(t) = \frac{1}{2}V_m I_m \cdot \cos(\theta_v - \theta_i) + \frac{1}{2}V_m I_m \cdot \cos(2\omega t + \theta_v + \theta_i)$

$P = \frac{1}{2}V_m I_m \cos(\theta_v - \theta_i)$ $Q = \frac{1}{2}V_m I_m \sin(\theta_v - \theta_i)$ $X_{rms} = \sqrt{\frac{1}{T}\int_0^T x(t)^2 dt}$

Trigonometry:

$\sin(-\alpha) = -\sin(\alpha)$ $\cos(-\alpha) = \cos(\alpha)$

$\sin(\pi - \alpha) = \sin(\alpha)$ $\cos(\pi - \alpha) = -\cos(\alpha)$

$\sin\left(\frac{\pi}{2} - \alpha\right) = \cos(\alpha)$ $\cos\left(\frac{\pi}{2} - \alpha\right) = \sin(\alpha)$

$\sin\left(\alpha - \frac{\pi}{2}\right) = -\cos(\alpha)$ $\cos\left(\alpha - \frac{\pi}{2}\right) = \sin(\alpha)$

$\sin(2\alpha) = 2\sin(\alpha)\cos(\alpha)$ $\cos(2\alpha) = \cos^2(\alpha) - \sin^2(\alpha)$

$\sin(\alpha \pm \beta) = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$

$\cos(\alpha \pm \beta) = \cos(\alpha)\cos(\beta) \mp \sin(\alpha)\sin(\beta)$

$\sin(\alpha)\sin(\beta) = 0.5 \cdot (\cos(\alpha - \beta) - \cos(\alpha + \beta))$

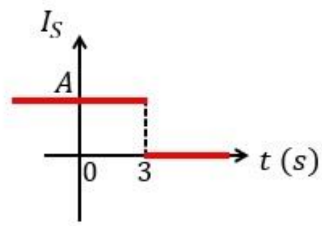
$\cos(\alpha)\cos(\beta) = 0.5 \cdot (\cos(\alpha - \beta) + \cos(\alpha + \beta))$

$\sin(\alpha)\cos(\beta) = 0.5 \cdot (\sin(\alpha - \beta) + \sin(\alpha + \beta))$

α:	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
sin(α):	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
tan(α):	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	∞

Q1

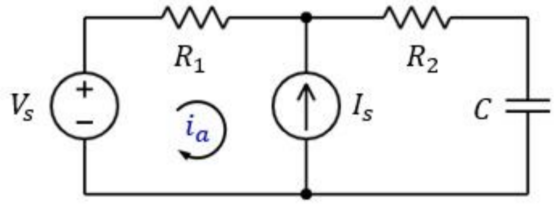
The current source I_s changes from A to 0 at t = 3 s, as shown on the right. For t < 3 s, you may assume the system has reached steady state. The current i_a is a mesh current.



(a) Find $i_a(3^-\ \text{s})$.

(b) Find $i_a(t)$ for t > 3 s. Write the equation.

R1:	1 Ω
R2:	2 Ω
Vs:	2 V
A:	6 A
C:	2 pF



Q2

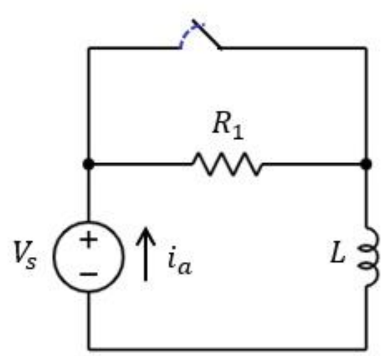
For t < 0 s, the switch is open, and you may assume the system has reached steady state. <u>The switch closes at time t = 0 s and opens again at time t = 4 s.</u>

(You can leave your answer written as a function of e)

(a) Find $i_a(2\ \text{s})$.

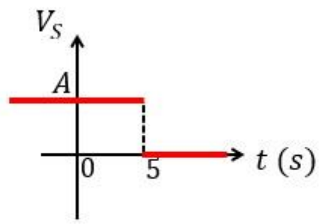
(b) Find $i_a(7\ \text{s})$.

Vs:	4 V
R1:	2 Ω
L:	4 H



Q1

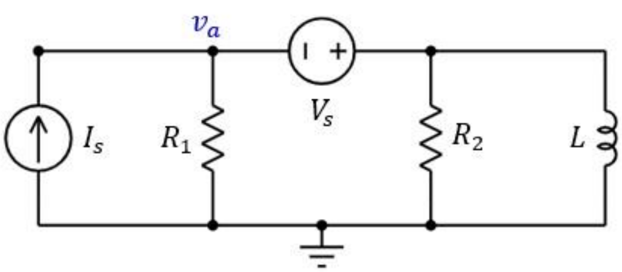
The voltage source V_s changes from A to 0 at t = 5 s, as shown on the right. For t < 5 s, you may assume the system has reached steady state. The voltage v_a is a node voltage.



(a) Find $v_a(5^-\ \mathrm{s})$.

(b) Find $v_a(t)$ for t > 5 s. Write the equation.

R1:	1 Ω
R2:	2 Ω
Is:	2 A
A:	6 V
L:	2 nH



Q2

For t < 0 s, the switch has been opening and closing (and the capacitor may not have reached steady state).

<u>The switch closes at time t = 0 s.</u>

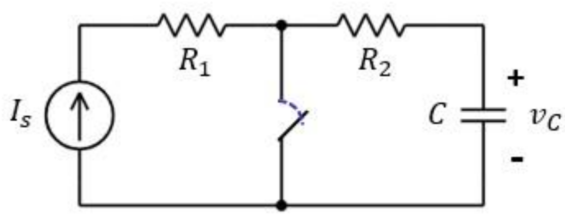
You are given the capacitor voltage at time t = 4$^-$ s:

$$v_C(4^-) = \mathrm{X}$$

(a) Find $v_C(0^+\mathrm{s})$. (You can leave your answer written as a function of e)

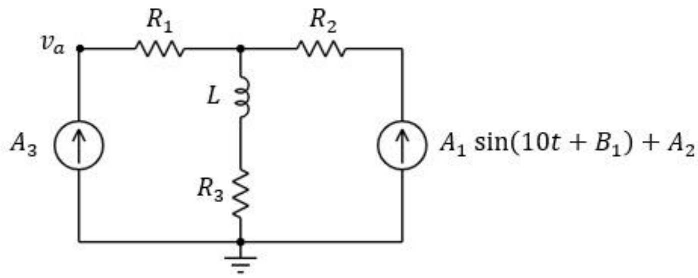
(b) The switch opens again at time t = 4 s. Find $v_C(6\ \mathrm{s})$.

R1:	1 Ω
R2:	4 Ω
X:	3 V
Is:	1 A
C:	2 F



Q1

Find steady state node voltage $v_a(t)$.



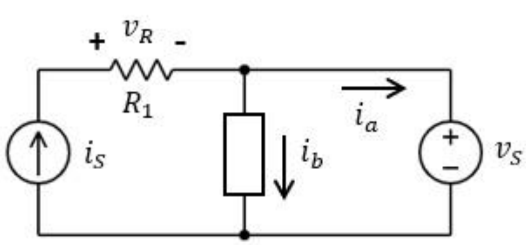
R1: 3 Ω
R2: 2 Ω
R3: 2 Ω
L: 200 mH
A1: 2 A
B1: -20 degrees
A2: 2A
A3: 1 A

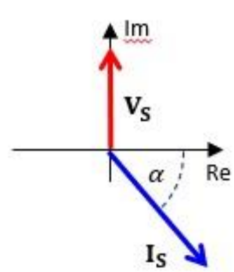
Q2

The AC circuit below has ω = 10 rad/s and is in steady state. The phasor diagram shows the phasors of v_S and i_S. You are given the angle α, $|\mathbf{I_S}|$ and $|\mathbf{V_S}|$. The diagram is not necessarily drawn to scale (but V_S is along the imaginary axis).
The element in the center (rectangular box) is either an inductor or a capacitor but you are not told which.

(a) At what time t_0 does the waveform of v_R reach its maximum value? (if there are multiple such times, giving one of them is sufficient).

(b) We select the mystery element such that $|\mathbf{I_a}|$ is minimized (not $|\mathbf{I_b}|$). What is the mystery element (capacitor or inductor) and what is its value?

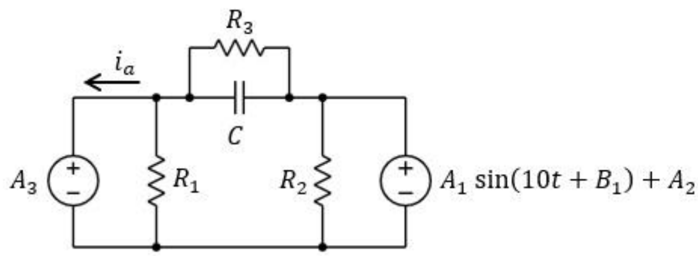




|Is|: 2 A
alpha: -30 degrees
|Vs|: 3 V
R1: 3 Ω

Q1

Find steady state current $i_a(t)$.



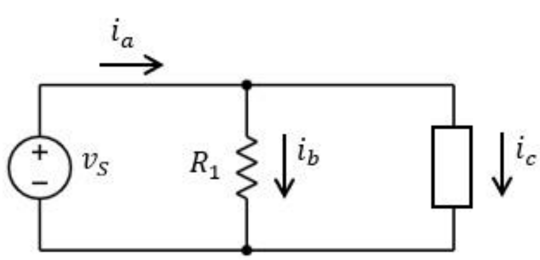
R1: 3 Ω
R2: 2 Ω
R3: 2 Ω
C: 50 mF
A1: 2 V
B1: -20 degrees
A2: 3 V
A3: 3 V

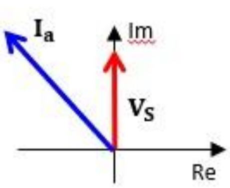
Q2

The AC circuit below has ω = 10 rad/s and is in steady state. The phasor diagram shows the phasors of v_S and i_a. You are given $|\mathbf{I_a}|$ and $|\mathbf{V_S}|$. The diagram is not necessarily drawn to scale (but V_S is along the imaginary axis and I_a is in the quadrant it is depicted).
The element on right (rectangular box) is either an inductor or a capacitor but you are not told which.

(a) At what time t_0 does the waveform of i_b reach its maximum value? (if there are multiple such times, giving one of them is sufficient).

(b) What is the mystery element (capacitor or inductor) and what is its value?





|Ia|: 5 A
|Vs|: 8 V
R1: 2 Ω

ECE 35, Fall 2021

Quiz 3

/ 12

Your sequence number

Last name

First + middle name(s)

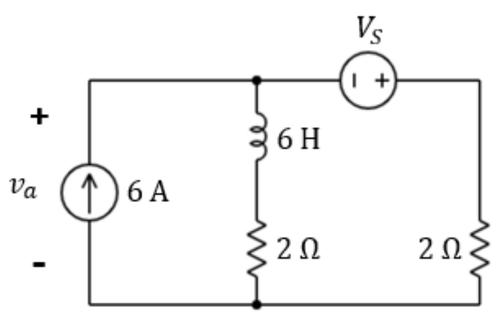
PID

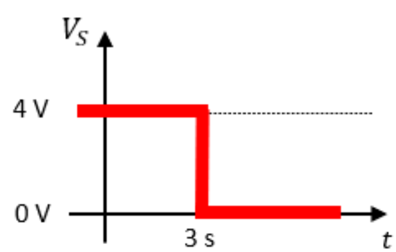
Instructions:
- Read each problem completely and thoroughly before beginning
- All calculations need to be done on these sheets
- Write your answers in the answer boxes for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit

(1) The voltage source V_S changes as shown in the figure. For $t < 3$ s, you may assume the system has reached steady state. *(7 points)*

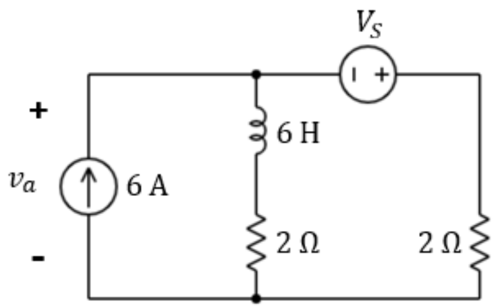
(a) Find $v_a(3^-\ \mathrm{s})$ (just before V_S changes) $v_a(3^-\ \mathrm{s})$

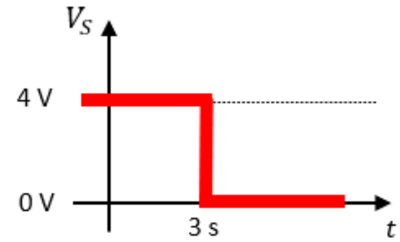
(b) Find $v_a(t)$ for $t > 3$ s.
Write the equation. $v_a(t)$





The circuit is copied on the next page for your convenience.


V_S
+
v_a
-
6 A
6 H
2 Ω
2 Ω


V_S
4 V
0 V
3 s
t

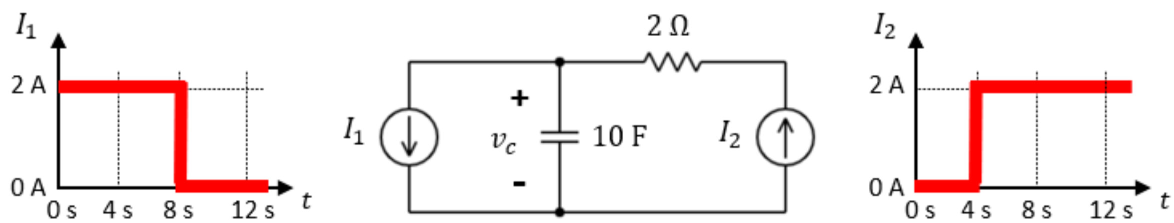
(2) The capacitor is fully discharged at t = 0 s. The two current sources change as indicated in the figures. *(5 points)*

(a) Find $v_c(4^- \text{ s})$ (just before I_2 changes)

$v_c(4^- \text{ s})$

(b) Find $v_c(9 \text{ s})$ (at time t = 9 s)

$v_c(9 \text{ s})$



ECE35 Equation Sheet

Basics: $i \triangleq \frac{dq}{dt}$ $\quad v_{ab} \triangleq \frac{dw}{dq}$ $\quad R = \rho \frac{l}{A}$

Capacitors: $C = \epsilon \cdot \frac{A}{d}$ $\quad Q = C \cdot v$ $\quad w_C = \frac{1}{2} C v^2$

Inductors: $L = \mu \cdot \frac{N^2 A}{l}$ $\quad B \sim i$ $\quad w_L = \frac{1}{2} L i^2$

AC power: $p(t) = \frac{1}{2} V_m I_m \cdot \cos(\theta_v - \theta_i) + \frac{1}{2} V_m I_m \cdot \cos(2\omega t + \theta_v + \theta_i)$

$$P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i) \qquad Q = \frac{1}{2} V_m I_m \sin(\theta_v - \theta_i) \qquad X_{rms} = \sqrt{\frac{1}{T}\int_0^T x(t)^2 dt}$$

Trigonometry:

$\sin(-\alpha) = -\sin(\alpha)$ $\qquad \cos(-\alpha) = \cos(\alpha)$

$\sin(\pi - \alpha) = \sin(\alpha)$ $\qquad \cos(\pi - \alpha) = -\cos(\alpha)$

$\sin\left(\frac{\pi}{2} - \alpha\right) = \cos(\alpha)$ $\qquad \cos\left(\frac{\pi}{2} - \alpha\right) = \sin(\alpha)$

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$\sin(2\alpha) = 2\sin(\alpha)\cos(\alpha)$ $\qquad \cos(2\alpha) = \cos^2(\alpha) - \sin^2(\alpha)$

$\sin(\alpha \pm \beta) = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$

$\cos(\alpha \pm \beta) = \cos(\alpha)\cos(\beta) \mp \sin(\alpha)\sin(\beta)$

$\sin(\alpha)\sin(\beta) = 0.5 \cdot (\cos(\alpha - \beta) - \cos(\alpha + \beta))$

$\cos(\alpha)\cos(\beta) = 0.5 \cdot (\cos(\alpha - \beta) + \cos(\alpha + \beta))$

$\sin(\alpha)\cos(\beta) = 0.5 \cdot (\sin(\alpha - \beta) + \sin(\alpha + \beta))$

α:	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
sin(α):	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
tan(α):	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	∞

ECE 35, Fall 2021

Quiz 4

/ 12

Your sequence number

Last name

First + middle name(s)

PID

Instructions:

- Read each problem completely and thoroughly before beginning
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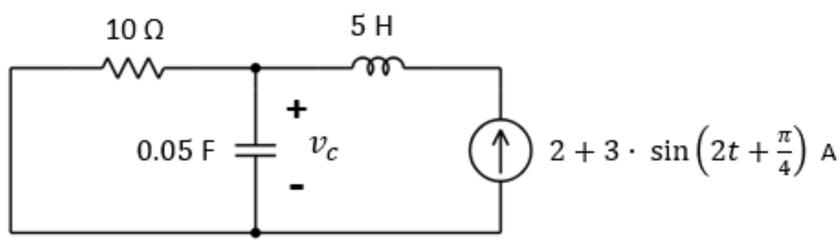
- Answers without supporting calculations will receive zero credit

(1) The system is in steady state.
Find $v_c\left(-\frac{\pi}{4}\text{ s}\right)$., i.e., v_c at time $t = -\frac{\pi}{4}$ s. *(6 points)*

$v_c\left(-\frac{\pi}{4}\text{ s}\right)$



(2) The AC circuit below is in steady-state, and you are not told what the ω of the source is. The phasor diagram shows the phasors of $\boldsymbol{i_S}$ and $\boldsymbol{i_a}$.

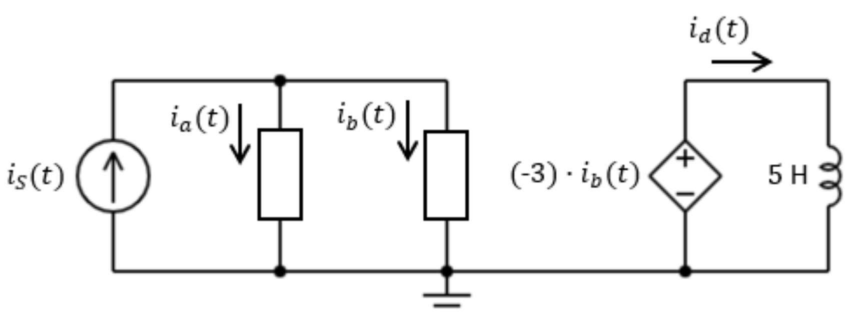
The rectangular boxes represent two circuit elements. You are told that one of them is an inductor of **1 mH** (but you don't know if this one corresponds to i_a and i_b). The other one can be a resistor of 2 Ω, a capacitor of 2 mF or an inductor of 2 mH.

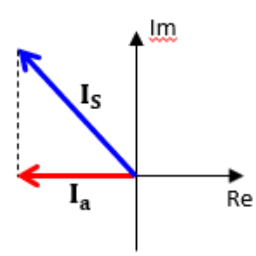
Finally, you are also told that the maximum value of the $i_S(t)$ waveform is **4 A** and the maximum value of the $i_a(t)$ waveform is **3 A**. *(6 points)*

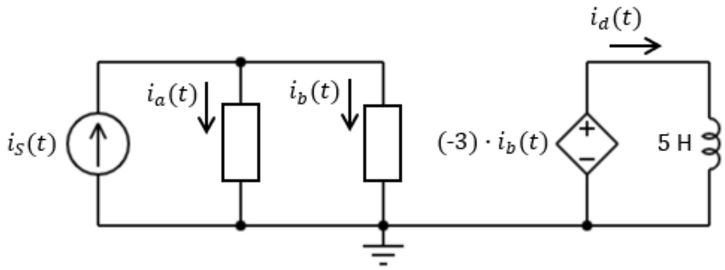
(a) What is the maximum value of the $i_b(t)$ waveform? i_b^{max} [ ]

(b) With $i_d(t)$ expressed as $A \cdot \cos(\omega t + \theta)$, and $A > 0$, what is the value of θ ? θ [ ]

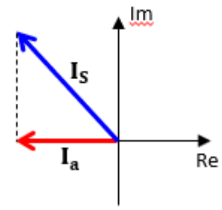
(c) What is the value of ω? (Note: if you eliminate an option for what the mystery element could be, make sure it is clear why) ω [ ]







$i_d(t)$
$i_a(t)$
$i_b(t)$
$i_S(t)$
$(-3) \cdot i_b(t)$
5 H



Im
$\mathbf{I_S}$
$\mathbf{I_a}$
Re

ECE35 Equation Sheet

Basics: $i \triangleq \frac{dq}{dt}$ $\quad v_{ab} \triangleq \frac{dw}{dq}$ $\quad R = \rho \frac{l}{A}$

Capacitors: $C = \epsilon \cdot \frac{A}{d}$ $\quad Q = C \cdot v$ $\quad w_C = \frac{1}{2} C v^2$

Inductors: $L = \mu \cdot \frac{N^2 A}{l}$ $\quad B \sim i$ $\quad w_L = \frac{1}{2} L i^2$

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$$P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i) \qquad Q = \frac{1}{2} V_m I_m \sin(\theta_v - \theta_i) \qquad X_{rms} = \sqrt{\frac{1}{T}\int_0^T x(t)^2 dt}$$

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$\sin(\alpha \pm \beta) = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$

$\cos(\alpha \pm \beta) = \cos(\alpha)\cos(\beta) \mp \sin(\alpha)\sin(\beta)$

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$\cos(\alpha)\cos(\beta) = 0.5 \cdot (\cos(\alpha - \beta) + \cos(\alpha + \beta))$

$\sin(\alpha)\cos(\beta) = 0.5 \cdot (\sin(\alpha - \beta) + \sin(\alpha + \beta))$

α:	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
$\sin(\alpha)$:	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
$\tan(\alpha)$:	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	∞

ECE 35, Fall 2022

Quiz 3

/ 12

Your sequence number

Last name

First + middle name(s)

PID

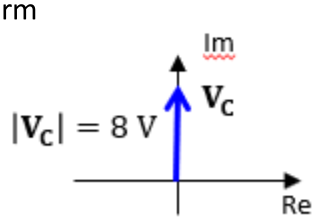
Instructions:

- Read each problem completely and thoroughly before beginning
- All calculations need to be done on these sheets
- Write your answers in the answer boxes for each question. <u>Make sure you list units!</u>
- Answers without supporting calculations will receive zero credit

(1) *(6 points)*

(a) Consider the circuit in Figure 1. It is in steady-state. The current source i_S is an AC source with $\omega = 5$ rad/s. In the diagram, we give you the phasor of $\boldsymbol{v_c}$. Find the current waveform $i_S(t)$.

$i_S(t)$



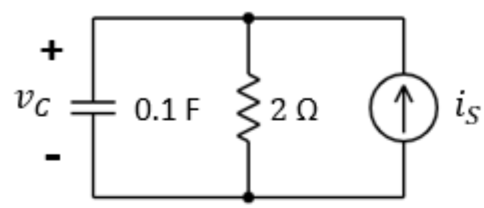


Figure 1

(b) Consider the circuit in Figure 2. It has the exact same components as the circuit in Figure 1 (including the same AC current source i_S). The only difference is that it contains two additional DC voltage sources. The circuit is in steady state. What is the value of v_x at time $t = \frac{\pi}{20}$ s?

$v_x(\frac{\pi}{20}\ \text{s})$

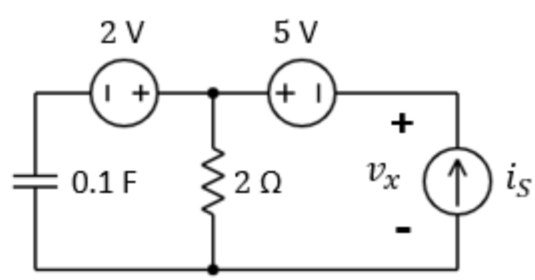
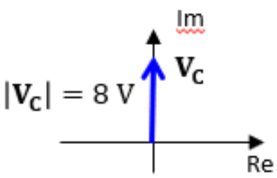


Figure 2

Copy of the circuits from the previous page …



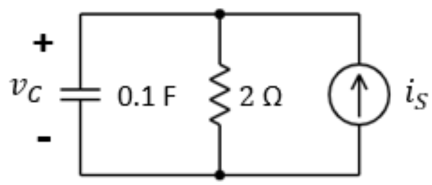


Figure 1

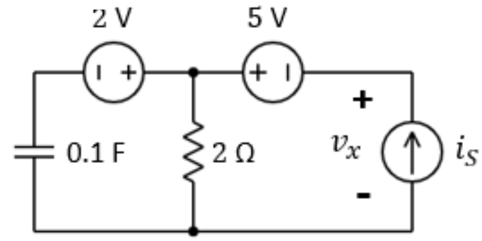


Figure 2

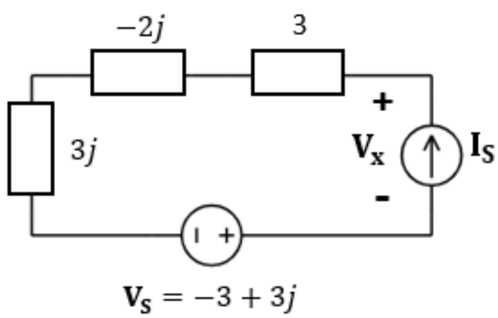
(2) *(6 points)* The circuit below represents an AC circuit in steady-state in the phasor domain (for the complex numbers, you may assume units are V, A, Ω, etc. as appropriate). Both sources in the circuit have the same ω, but you are not told the value of ω. Each box represents the impedance of a single circuit element (a resistor, capacitor or inductor).

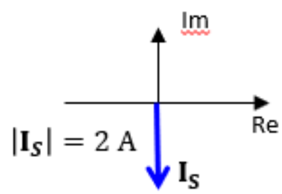
(a) Find the phasor $\mathbf{V_x}$. Your answer should be a complex number (can be in cartesian or polar form).

V_x

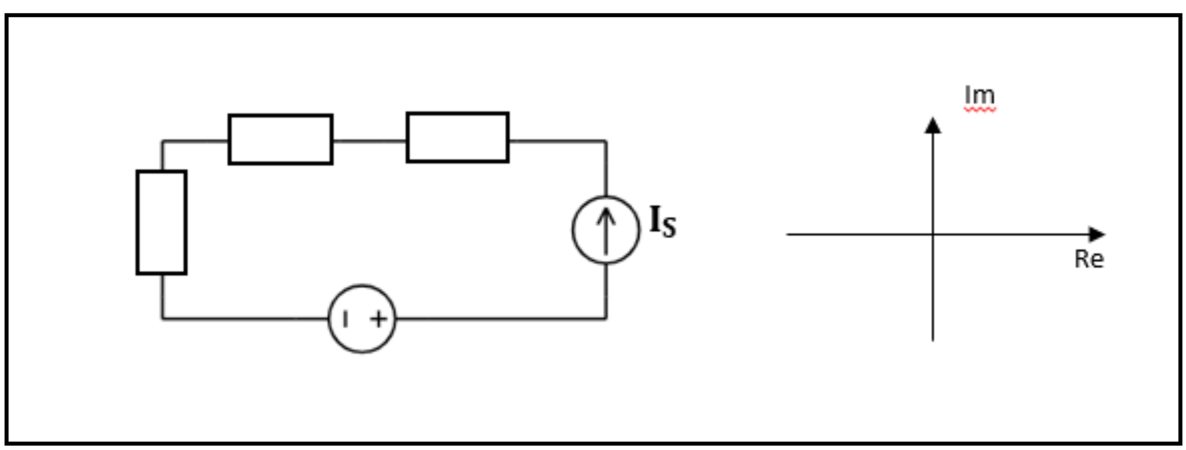
(b) What is the maximum value of the voltage waveform v_S(t)?

$v_{s\,max}$

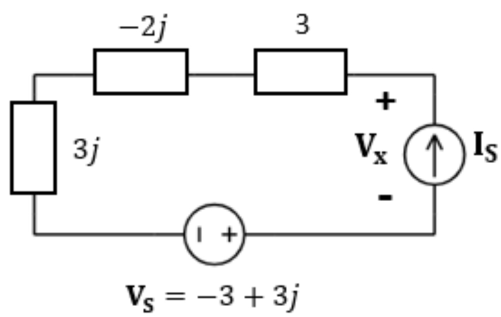


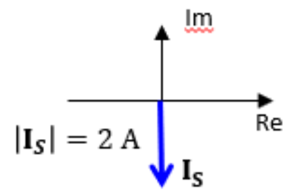


(c) We now double ω of both sources but keep everything else the same (such as the capacitor, inductor and resistor values; the amplitude and phase of the sources, etc.). In the drawing below, complete the circuit diagram for this new situation. I.e., add the new values of all the complex numbers and draw the new $\mathbf{I_S}$ vector (also label the angle and magnitude).



Copy of the circuit from the previous page …





ECE35 Equation Sheet

Basics: $i \triangleq \frac{dq}{dt}$ $v_{ab} \triangleq \frac{dw}{dq}$ R l

Capacitors: $C = \epsilon \cdot \frac{A}{d}$ $Q = C \cdot v$ $w_C = \frac{1}{2} C v^2$

Inductors: $L = \mu \cdot \frac{N^2 A}{l}$ $B \sim i$ $w_L = \frac{1}{2} L i^2$

AC power: $p(t) = \frac{1}{2} V_m I_m \cdot \cos(\theta_v - \theta_i) + \frac{1}{2} V_m I_m$

$P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i)$ $Q = \frac{1}{2} V_m I_m \sin(\theta_v - \theta_i)$ $X_{rms} = \sqrt{\frac{1}{T} \int_0^T x(t)^2 dt}$

Trigonometry:

$\sin(-\alpha) = -\sin(\alpha)$ $\cos(-\alpha) = \cos(\alpha)$

$\sin(\pi - \alpha) = \sin(\alpha)$ $\cos(\pi - \alpha) = -\cos(\alpha)$

$\sin\left(\frac{\pi}{2} - \alpha\right) = \cos(\alpha)$ $\cos\left(\frac{\pi}{2} - \alpha\right) = \sin(\alpha)$

$\sin\left(\alpha - \frac{\pi}{2}\right) = -\cos(\alpha)$ $\cos\left(\alpha - \frac{\pi}{2}\right) = \sin(\alpha)$

$\sin(2\alpha) = 2\sin(\alpha)\cos(\alpha)$ $\cos(2\alpha) = \cos^2(\alpha) - \sin^2(\alpha)$

$\sin(\alpha \pm \beta) = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$

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$\sin(\alpha)\sin(\beta) = 0.5 \cdot (\cos(\alpha - \beta) - \cos(\alpha + \beta))$

$\cos(\alpha)\cos(\beta) = 0.5 \cdot (\cos(\alpha - \beta) + \cos(\alpha + \beta))$

$\sin(\alpha)\cos(\beta) = 0.5 \cdot (\sin(\alpha - \beta) + \sin(\alpha + \beta))$

α:	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
$\sin(\alpha)$:	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
$\tan(\alpha)$:	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	∞

ECE 35, Fall 2024

Quiz 3

/ 12

Your sequence number

Last name

First + middle name(s)

PID

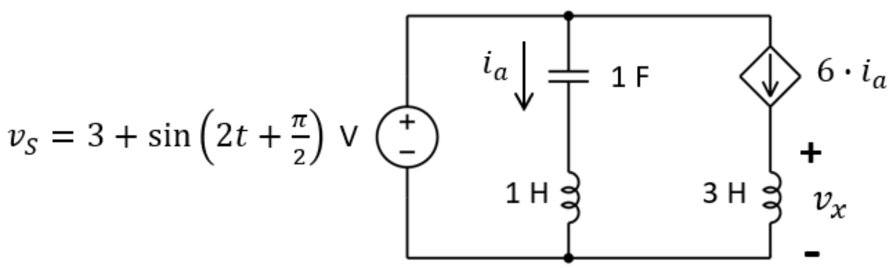
Instructions:

- Read each problem completely and thoroughly before beginning.
- All calculations need to be done on these sheets.
- Write your answers in the answer boxes for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit.

(1) *(6 points)* The circuit below is in steady state.

Find the voltage v_x at time $t = \frac{\pi}{8}$ s.

$v_x\left(\frac{\pi}{8}\text{ s}\right)$



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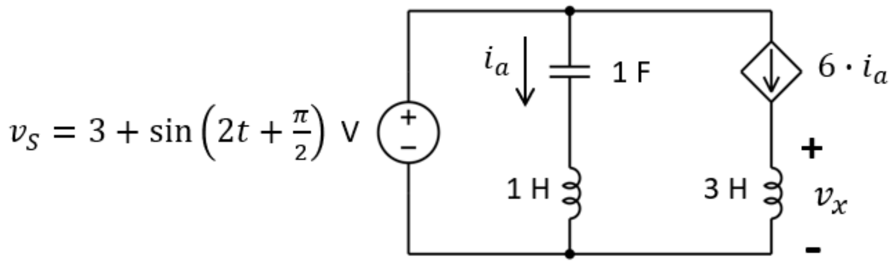
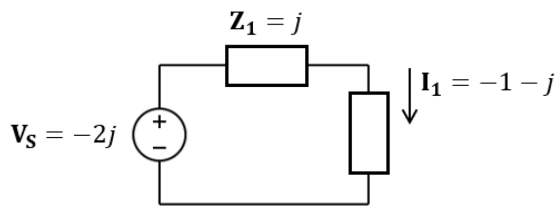


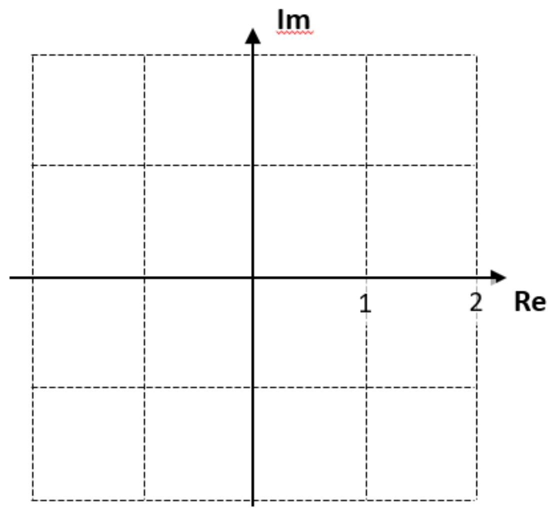
(2) *(3 points)* The circuit represents an AC circuit in steady state in the phasor domain (for the complex numbers, you may assume units are V, A, Ω, etc. as appropriate). The voltage source $v_S(t)$ (phasor V_S) has ω = 2 rad/s.



(a) On the diagram on the right, sketch <u>all the phasors</u> that we labeled in the circuit above (you do not need to calculate/find any additional ones).

(b) In the same diagram, sketch the phasor of $x(t)$:

$$x(t) = v_S(t - t_0) \text{ with } t_0 = \frac{\pi}{4} s$$



Phasor diagram

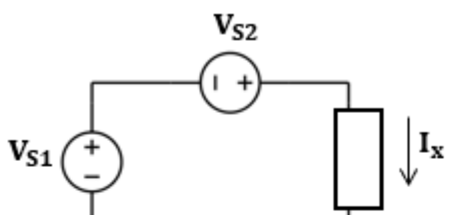
(3) *(3 points)* The circuit below represents an AC circuit in steady state in the phasor domain (for the complex numbers, you may assume units are V, A, Ω, etc. as appropriate). Both voltage sources have the same ω = 10 rad/s.

The box represents the impedance of a single circuit element (a resistor, capacitor or inductor). The current through this element, $\mathbf{I_x}$, is represented by one of the phasors $\mathbf{I_A}$, $\mathbf{I_B}$, $\mathbf{I_C}$ or $\mathbf{I_D}$ in the phasor diagram. However, you are not told which one (the other phasors do not represent anything in the circuit; they are merely included so that you need to select the correct phasor out of the four possible options).

What is the value of the circuit element represented by the box (i.e., the resistance, capacitance or inductance, with the appropriate units)?

(When mapping $\boldsymbol{I_x}$ to a phasor in the diagram, make sure to include the motivation for your choice).

Element value



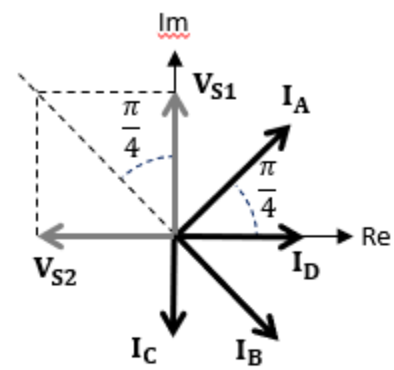
$|\mathbf{V_{S1}}| = |\mathbf{V_{S2}}| = 20$ V

$|\mathbf{I_A}| = 5$ A

$|\mathbf{I_B}| = 4$ A

$|\mathbf{I_C}| = 2$ A

$|\mathbf{I_D}| = 1$ A



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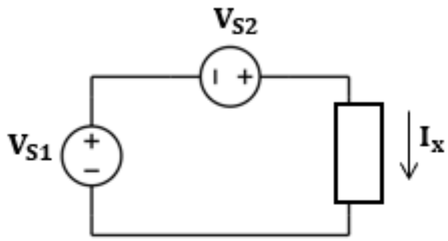


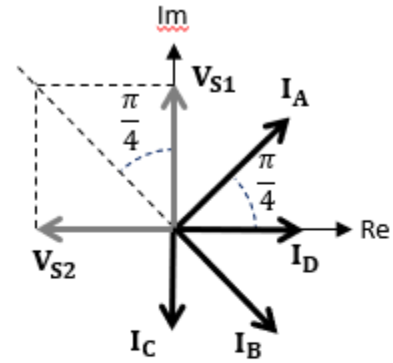
$|\mathbf{V_{S1}}| = |\mathbf{V_{S2}}| = 20\ \mathrm{V}$

$|\mathbf{I_A}| = 5\ \mathrm{A}$

$|\mathbf{I_B}| = 4\ \mathrm{A}$

$|\mathbf{I_C}| = 2\ \mathrm{A}$

$|\mathbf{I_D}| = 1\ \mathrm{A}$



ECE35 Equation Sheet

Basics: $i \triangleq \frac{dq}{dt}$ $\quad v_{ab} \triangleq \frac{dw}{dq}$ $\quad R = \rho \frac{l}{A}$

Capacitors: $C = \epsilon \cdot \frac{A}{d}$ $\quad Q = C \cdot v$ $\quad w_C = \frac{1}{2} C v^2$

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AC power: $p(t) = \frac{1}{2} V_m I_m \cdot \cos(\theta_v - \theta_i) + \frac{1}{2} V_m I_m \cdot \cos(2\omega t + \theta_v + \theta_i)$

$$P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i) \qquad Q = \frac{1}{2} V_m I_m \sin(\theta_v - \theta_i) \qquad X_{rms} = \sqrt{\frac{1}{T}\int_0^T x(t)^2 dt}$$

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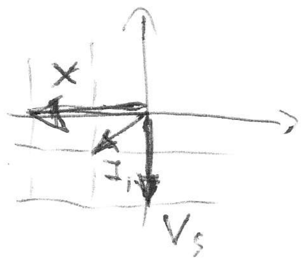
α:	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
$\sin(\alpha)$:	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
$\tan(\alpha)$:	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	∞

▽

(1) $12\sqrt{2}$ V

(2)

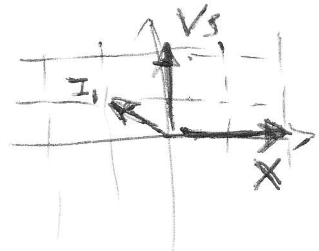


(3) $\frac{2\sqrt{2}}{5}$ H

△

(1) $8\sqrt{2}$ V

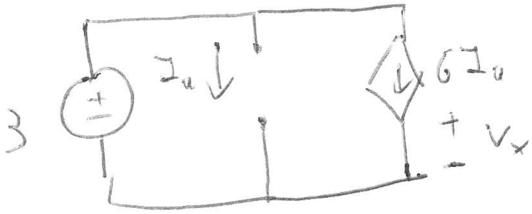
(2)



(3) $\frac{\sqrt{2}}{5}$ H

① SUPERPOSITION

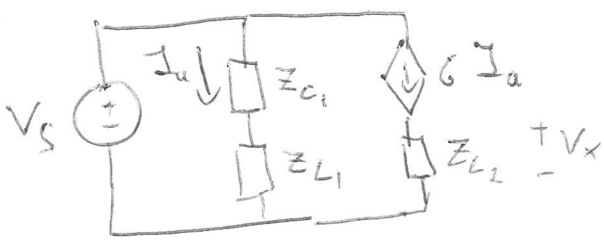
$\underline{\omega = 0:}$



$I_a = 0$

$V_x = 0 \implies v_x = 0$

$\underline{\omega = 2:}$



$$v_s(t) = \sin\left(2t + \frac{\pi}{2}\right) = \cos\left(2t + \frac{\pi}{2} - \frac{\pi}{2}\right) = \cos(2t)$$

$$V_s = 1$$

$$Z_{C_1} = \frac{1}{j \cdot 2 \cdot 1} = -\frac{j}{2}$$

$$Z_{L_1} = j \cdot 2 \cdot 1 = 2j$$

$$Z_{L_2} = j \cdot 2 \cdot 3 = 6j$$

$$I_a = \frac{V_s}{Z_{C_1} + Z_{L_1}} = \frac{1}{-\frac{j}{2} + 2j} = \frac{1}{\frac{3}{2} j} \implies V_x = (6 I_a) \cdot Z_{L_2} = 6 \cdot \frac{1}{\frac{3}{2}\cancel{j}} \cdot \overset{2}{\cancel{6}}\cancel{j} = 24$$

$$v_x(t) = 24 \cos(2t)$$

$$v_x\left(\frac{\pi}{8}\right) = 24 \cos\left(\frac{\pi}{4}\right) = 24 \cdot \frac{\sqrt{2}}{2} = 12\sqrt{2}$$

$$\boxed{v_x\left(\frac{\pi}{8}\text{ s}\right) = 12\sqrt{2} \text{ V}}$$

(2) (a) PHASORS: V_s & I_1 ⟶ only draw these

IMPEDANCES: Z_1 ⟶ do NOT draw this (it is NOT a phasor)

(b) $V_s = -2j = 2e^{-j\frac{\pi}{2}}$

$v_s(t) = 2\cos\left(2t - \frac{\pi}{2}\right)$

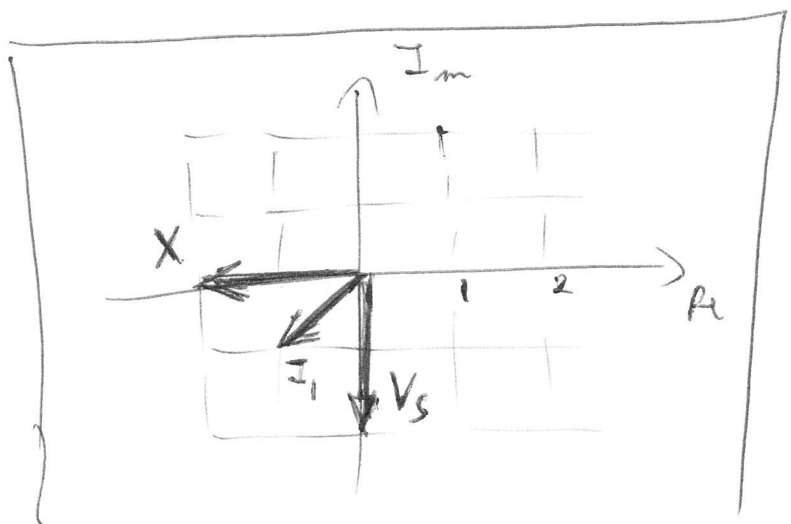
$v_s(t-t_0) = 2\cos\left(2(t-t_0) - \frac{\pi}{2}\right) = 2\cos\left(2t - 2t_0 - \frac{\pi}{2}\right)$

$= 2\cos\left(2t - 2\cdot\frac{\pi}{4} - \frac{\pi}{2}\right)$

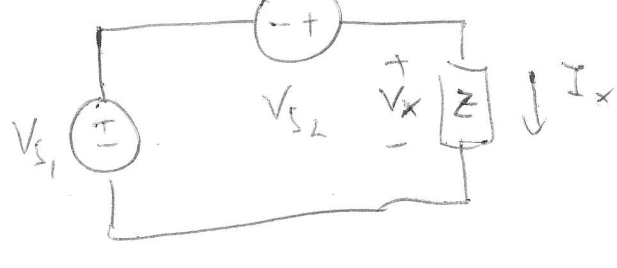
$= 2\cos(2t - \pi)$

$= x(t)$

$X = 2e^{-j\pi}$



(3)



$$V_x = V_{s_1} + V_{s_2}$$
$$= 20\sqrt{2}\, e^{j\frac{3\pi}{4}}$$

FOR ANY OF THE POSSIBLE ELEMENTS:

I_x either is in phase with V_x (same sign)
or leads or lags ~~V_x~~ V_x by $\frac{\pi}{2}$

$\Rightarrow$ only option is I_A

$$I_A = |I_A| e^{j\frac{\pi}{4}}$$

$$Z = \frac{V_x}{I_A} = \frac{20\sqrt{2}\, e^{j\frac{3\pi}{4}}}{5\, e^{j\frac{\pi}{4}}} = 4\sqrt{2}\, e^{j\frac{\pi}{2}} = \underbrace{4\sqrt{2} j}_{\hookrightarrow \text{ inductor}}$$

$$Z_L = j\omega L = 4\sqrt{2} j \Rightarrow \omega L = 4\sqrt{2}$$
$$L = \frac{4\sqrt{2}}{\omega} = \frac{4\sqrt{2}}{10}$$

$$\boxed{L = \frac{2\sqrt{2}}{5} \text{ H}}$$

ECE 35, Fall 2024

Quiz 3

/ 12

Your sequence number

Last name

First + middle name(s)

PID

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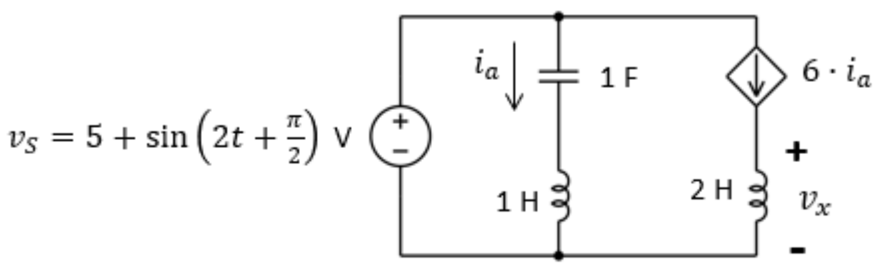
(1) *(6 points)* The circuit below is in steady state.

Find the voltage v_x at time $t = \frac{\pi}{8}$ s.

$v_x\left(\frac{\pi}{8}\ \text{s}\right)$



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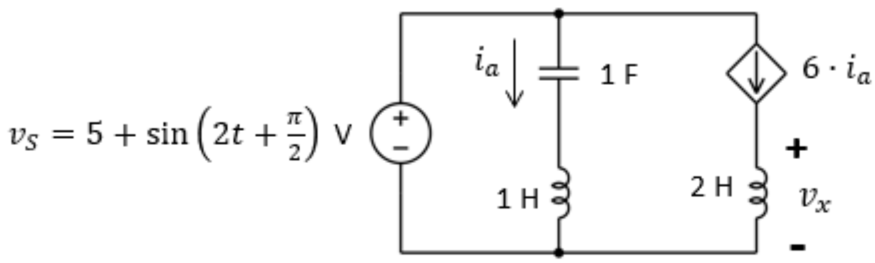
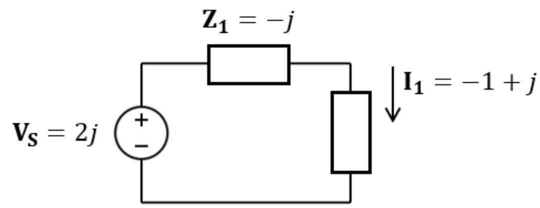


(2) *(3 points)* The circuit represents an AC circuit in steady state in the phasor domain (for the complex numbers, you may assume units are V, A, Ω, etc. as appropriate). The voltage source $v_S(t)$ (phasor $\mathrm{V_S}$) has ω = 2 rad/s.



(a) On the diagram on the right, sketch all the phasors that we labeled in the circuit above (you do not need to calculate/find any additional ones).

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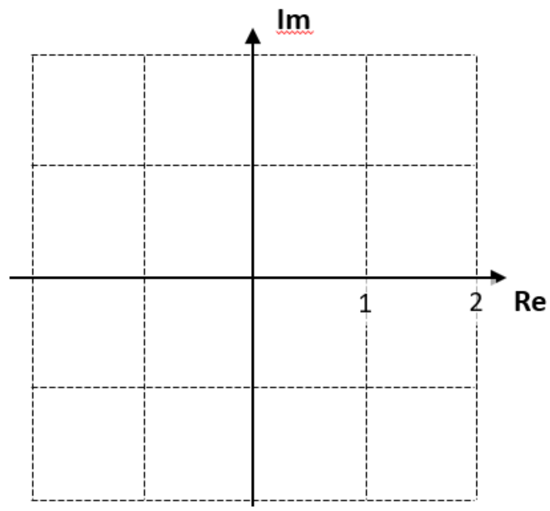
$$x(t) = v_S(t - t_0) \text{ with } t_0 = \frac{\pi}{4} s$$



Phasor diagram

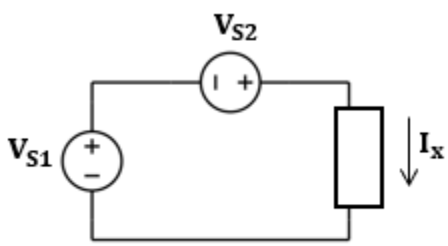
(3) *(3 points)* The circuit below represents an AC circuit in steady state in the phasor domain (for the complex numbers, you may assume units are V, A, Ω, etc. as appropriate). Both voltage sources have the same ω = 10 rad/s.

The box represents the impedance of a single circuit element (a resistor, capacitor or inductor). The current through this element, $\mathbf{I_x}$, is represented by one of the phasors $\mathbf{I_A}$, $\mathbf{I_B}$, $\mathbf{I_C}$ or $\mathbf{I_D}$ in the phasor diagram. However, you are not told which one (the other phasors do not represent anything in the circuit; they are merely included so that you need to select the correct phasor out of the four possible options).

What is the value of the circuit element represented by the box (i.e., the resistance, capacitance or inductance, with the appropriate units)?

(When mapping $\boldsymbol{I_x}$ to a phasor in the diagram, make sure to include the motivation for your choice).

Element value



$|\mathbf{V_{S1}}| = |\mathbf{V_{S2}}| = 10$ V

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$|\mathbf{I_B}| = 4$ A

$|\mathbf{I_C}| = 2$ A

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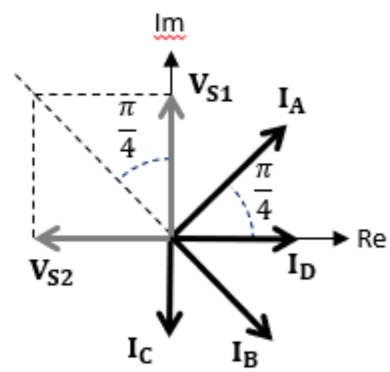

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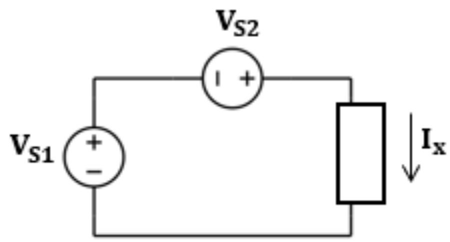


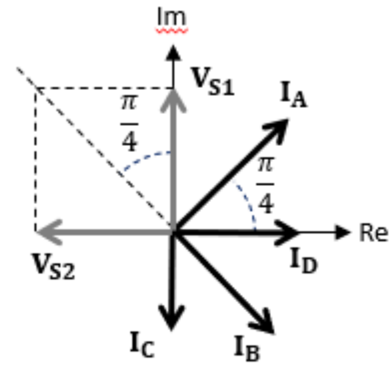
$|\mathbf{V_{S1}}| = |\mathbf{V_{S2}}| = 10\ \text{V}$

$|\mathbf{I_A}| = 5\ \text{A}$

$|\mathbf{I_B}| = 4\ \text{A}$

$|\mathbf{I_C}| = 2\ \text{A}$

$|\mathbf{I_D}| = 1\ \text{A}$



ECE35 Equation Sheet

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Inductors: $L = \mu \cdot \frac{N^2 A}{l}$ $\quad B \sim i$ $\quad w_L = \frac{1}{2} L i^2$

AC power: $p(t) = \frac{1}{2} V_m I_m \cdot \cos(\theta_v - \theta_i) + \frac{1}{2} V_m I_m \cdot \cos(2\omega t + \theta_v + \theta_i)$

$$P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i) \qquad Q = \frac{1}{2} V_m I_m \sin(\theta_v - \theta_i) \qquad X_{rms} = \sqrt{\frac{1}{T}\int_0^T x(t)^2 dt}$$

Trigonometry:

$\sin(-\alpha) = -\sin(\alpha)$ $\quad \cos(-\alpha) = \cos(\alpha)$

$\sin(\pi - \alpha) = \sin(\alpha)$ $\quad \cos(\pi - \alpha) = -\cos(\alpha)$

$\sin\left(\frac{\pi}{2} - \alpha\right) = \cos(\alpha)$ $\quad \cos\left(\frac{\pi}{2} - \alpha\right) = \sin(\alpha)$

$\sin\left(\alpha - \frac{\pi}{2}\right) = -\cos(\alpha)$ $\quad \cos\left(\alpha - \frac{\pi}{2}\right) = \sin(\alpha)$

$\sin(2\alpha) = 2\sin(\alpha)\cos(\alpha)$ $\quad \cos(2\alpha) = \cos^2(\alpha) - \sin^2(\alpha)$

$\sin(\alpha \pm \beta) = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$

$\cos(\alpha \pm \beta) = \cos(\alpha)\cos(\beta) \mp \sin(\alpha)\sin(\beta)$

$\sin(\alpha)\sin(\beta) = 0.5 \cdot (\cos(\alpha - \beta) - \cos(\alpha + \beta))$

$\cos(\alpha)\cos(\beta) = 0.5 \cdot (\cos(\alpha - \beta) + \cos(\alpha + \beta))$

$\sin(\alpha)\cos(\beta) = 0.5 \cdot (\sin(\alpha - \beta) + \sin(\alpha + \beta))$

α:	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
sin(α):	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
tan(α):	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	∞

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Quiz 3

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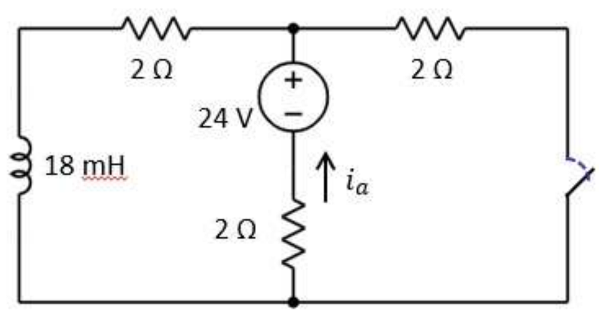
(1) *(5 points)*

For $t < 5$ s, the switch is open, and you may assume the system has reached steady state. The switch closes at time $t = 5$ s.

(a) Find $i_a(5^-\ \text{s})$.

(b) Find $i_a(t)$ for $t > 5$ s. Write the equation.

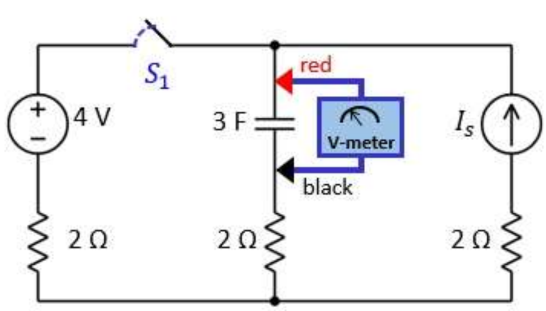


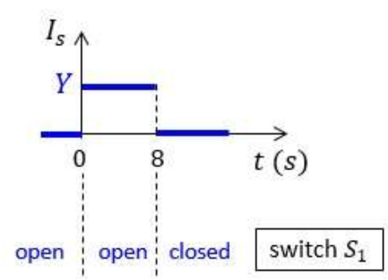
(2) *(5 points)*

- For time $t < 0$s, switch S1 is open and current source I_s is zero. The voltmeter reading is 1V.
- At time $t = 0$s, switch S1 remains open and the current source I_s jumps to Y (an unknown DC value).
- The moment the voltmeter reading becomes 9V, which happens at time $t = 8$s, switch S1 closes and the current source I_s becomes zero again.

(a) Find the voltmeter reading X at time $t = 5$s.

(b) Find the voltmeter reading X at time $t = 11$s.





ECE 35, Spring 2020

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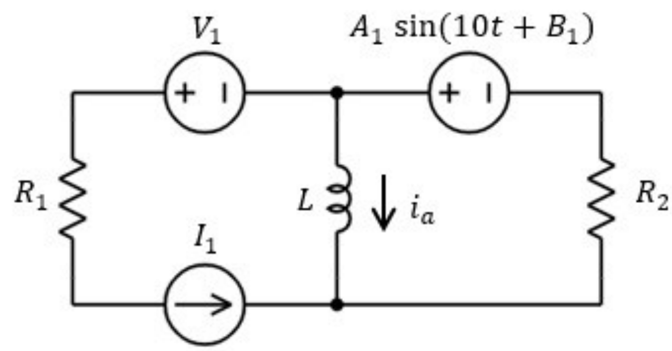
(1) *(5 points)*

Find steady state current $i_a(t)$.

V_1 = 2 V
I_1 = 1 A
R_1 = 1 Ω
R_2 = 1 Ω
L = 100 mH
A_1 = 3 V
B_1 = -45 degrees



(2) *(5 points)*

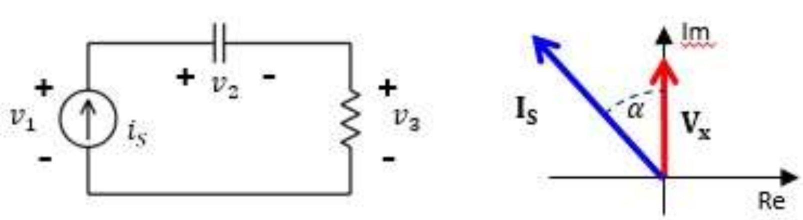
The AC circuit below is in steady state. The phasor diagram shows the phasor of i_S. It also shows the phasor $\mathbf{V_x}$, which is of one of the voltages v_1, v_2, or v_3 but you are not told which one. You are given that $\alpha = \frac{\pi}{3}$ and $|\mathbf{V_x}|$ = 8 V.

(a) Copy the phasor diagram with the given phasors and on that same diagram draw the phasors of v_1, v_2, and v_3.

(b) What is the capacitor voltage v_2 at time $t = T/_3$ where T is the period of the AC current source i_S?

(c) What is the amplitude of the voltage v_1 across the current source if the frequency of i_S is <u>multiplied</u> by 2 (everything else in the systems stays the same)?

(d) Sketch the waveform v_1 from part (c). The phase does not need to be exact.



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Quiz 3

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Last name

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PID

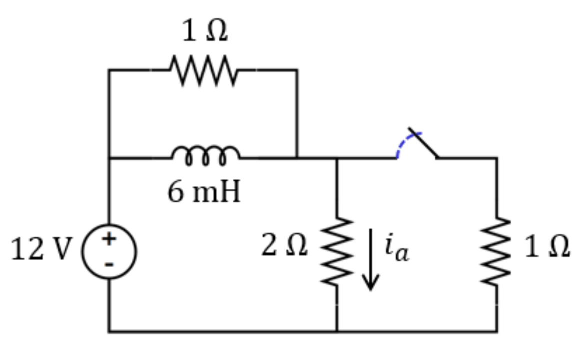
Instructions:

- Read each problem completely and thoroughly before beginning
- All calculations need to be done on these sheets
- Write your answers in the answer boxes for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit

(1) For $t < 2$ s, the switch is closed, and you may assume the system has reached steady state. The switch opens at time $t = 2$ s.

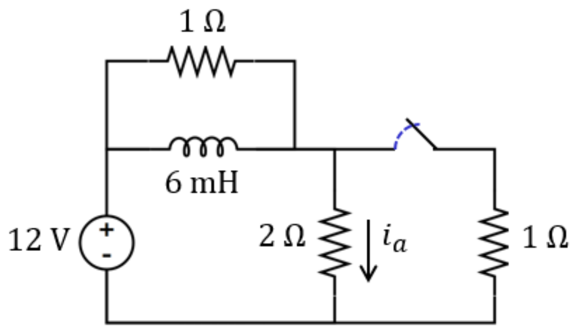
$i_a(2^- \text{ s})$

(a) Find $i_a(2^- \text{ s})$. *(1 point)*



(b) Find $i_a(t)$ for $t > 2$ s.
Write the equation.
(6 points)

$i_a(t)$



(2) For $t < 3$ s, the switch is open. <u>The switch closes at time t = **3 s**</u>. <u>The switch opens again at time t = 5 s.</u>
At $t = 0$, the capacitor is charged to **1 V**.

(a) Find $v_a(2\text{ s})$. *(2 points)*

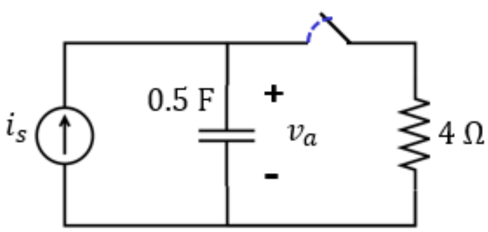
(b) Find $v_a(3^+\text{ s})$. *(1 point)*

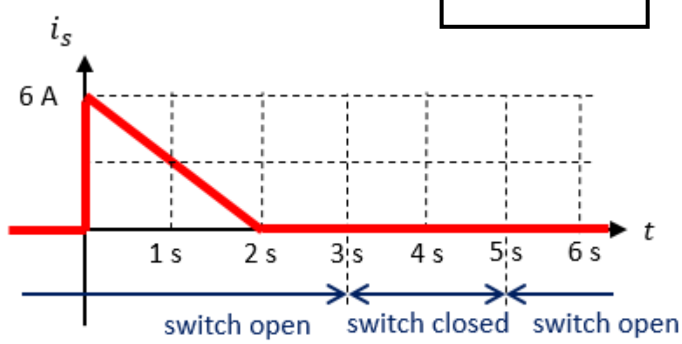
(c) Find $v_a(\infty)$. *(2 points)*

$v_a(2\text{ s})$

$v_a(3^+\text{ s})$

$v_a(\infty)$





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Quiz 4

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Last name

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PID

Instructions:

- Read each problem completely and thoroughly before beginning
- All calculations need to be done on these sheets
- Write your answers in the answer boxes for each question. <u>Make sure you list units!</u>
- Answers without supporting calculations will receive zero credit

(1) The system is in steady state. The phasor diagram shows the voltages $\mathbf{V_a}$ and $\mathbf{V_b}$ (but you are not told which one is which). The current source is a sine wave with $\omega = 1$ rad/s.

(a) Find $v_i\left(\frac{3\pi}{4}\text{s}\right)$, i.e., v_i at time $t = \frac{3\pi}{4}$ seconds. *(2 points)*

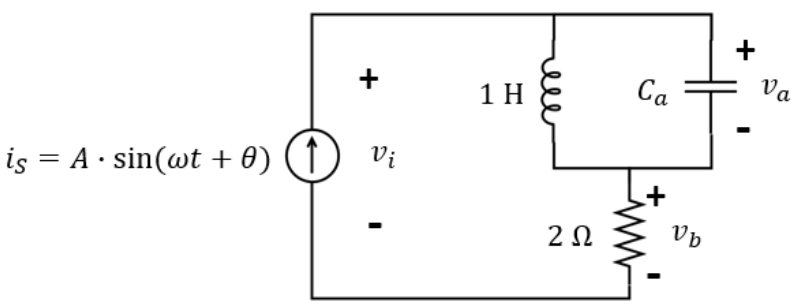
$v_i\left(\frac{3\pi}{4}\text{ s}\right)$

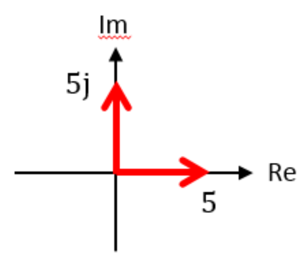
(b) What is the value of A? *(2 points)*

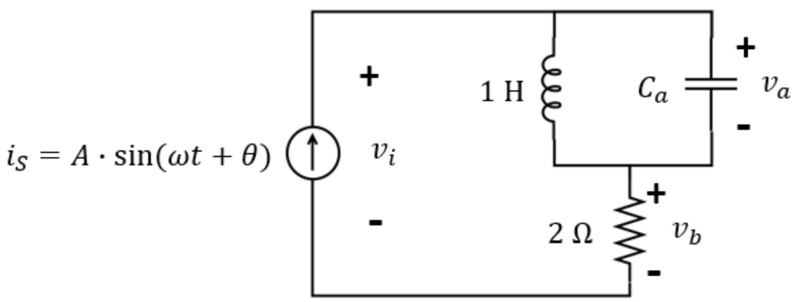
A

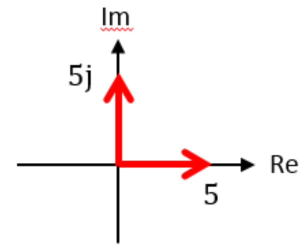
(c) What is the value of capacitor C_a? *(3 points)*

C_a



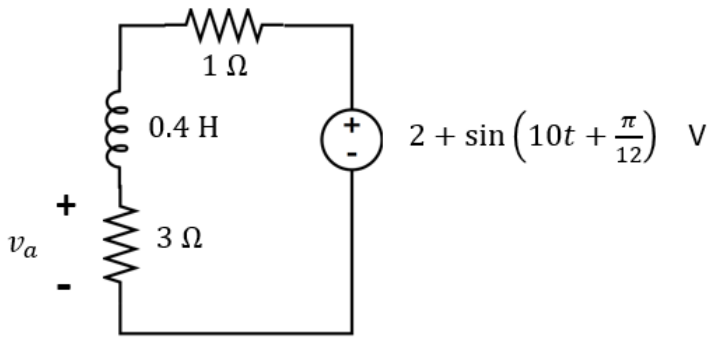



$i_S = A \cdot \sin(\omega t + \theta)$
+
v_i
-
1 H
C_a
+
v_a
-
+
2 Ω
v_b
-


Im
5j
Re
5

(2) The system is in steady state. Find $v_a\left(\frac{\pi}{10}\,\mathrm{s}\right)$, i.e., v_a at time $t = \frac{\pi}{10}$ seconds. *(5 points)*

$v_a\left(\frac{\pi}{10}\,\mathrm{s}\right)$ $\boxed{}$



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Quiz 3

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Your sequence number

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Instructions:

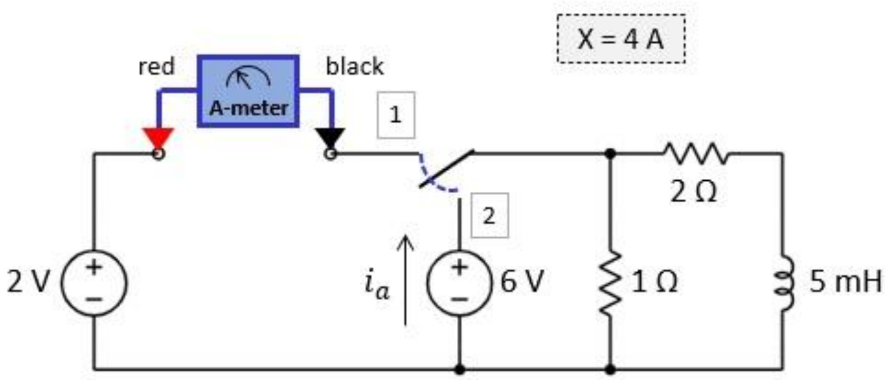
- Read each problem completely and thoroughly before beginning
- All calculations need to be done on these sheets
- Put a box around your answer for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit

(1) *(6 points)*

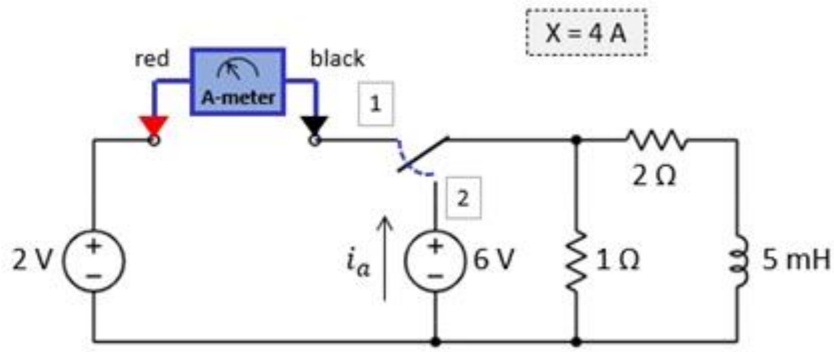
Consider the circuit below. For $t < 2$ s, the switch is in position 1 and it is possible that the system has not yet reached steady state.

When the ideal ammeter reading has a value of X, we move the switch from position 1 to position 2. This happens at time $t = 2$ s. The switch then remains in position 2.

Find $i_a(t)$ for $t > 2$ s. Write the equation.



The circuit is also copied on the next page for your convenience.



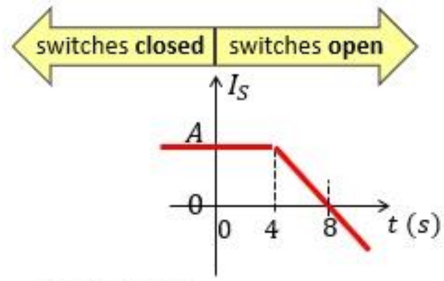
X = 4 A
red
black
A-meter
1
2
2 Ω
2 V
i_a
6 V
1 Ω
5 mH

(2) *(6 points)*

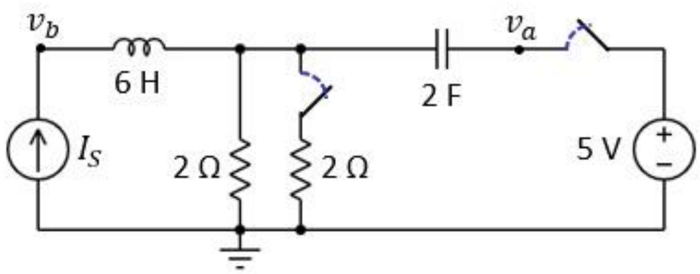
Consider the circuit below.

For $t < 0$ s, both switches are closed, and the system has reached steady state.
At time $t = 0$ s, both switches open and remain open.
The current I_S varies as shown in the graph.

a. Find the node voltage v_a at time $t = 0^+$ s (i.e., immediately after the switches open).
b. Find the node voltage v_b at time $t = 0^+$ s.
c. Find the node voltage v_a at time $t = 6$ s.
d. Find the node voltage v_b at time $t = 6$ s.



$A = 6$ A



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Your sequence number

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Quiz 4

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Instructions:

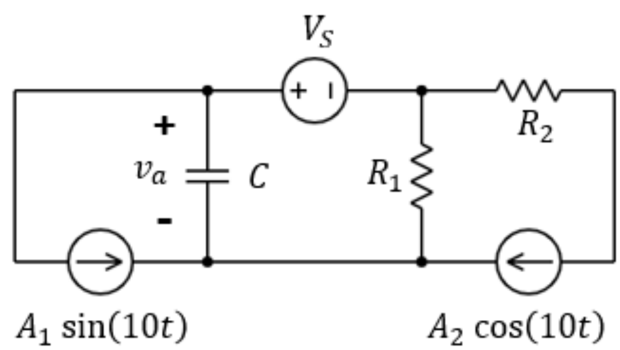
- Read each problem completely and thoroughly before beginning
- All calculations need to be done on these sheets
- Put a box around your answer for each question. Make sure you list units!
- Answers without supporting calculations will receive zero credit

(1) *(6 points)*

Consider the circuit below. You may assume it is in steady state.

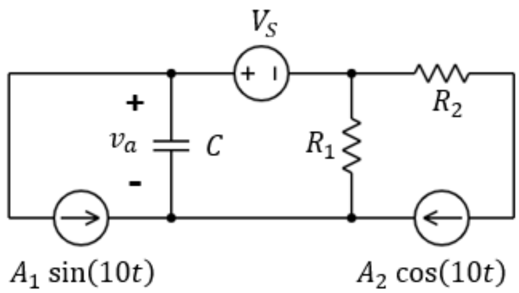
a. Find the voltage v_a at time $t = \frac{\pi}{40}$.

b. Find a time t_0 where the voltage v_a reaches its maximum value. If there are multiple possible answers, giving only one is sufficient.



A1:	2 A
A2:	2 A
Vs:	1 V
R1:	2 Ω
R2:	2 Ω
C:	50 mF

The circuit is also copied on the next page for your convenience.



A1:	2 A
A2:	2 A
Vs:	1 V
R1:	2 Ω
R2:	2 Ω
C:	50 mF

(2) *(6 points)*

Consider the circuit below. You may assume it has reached steady state. The phasor diagram shows the phasors of i_1 and i_2 (the angles are as shown; the magnitudes are not drawn to scale).

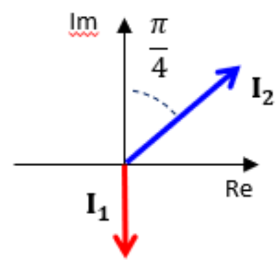
Each rectangular box represents a connection of mystery elements in series/parallel. The impedances of the two boxes are $\boldsymbol{Z_a} = \boldsymbol{aj}$ and $\boldsymbol{Z_b} = \boldsymbol{b}(\mathbf{1} + \boldsymbol{j})$ but you are not told which one is which.

Note: you are given the values for a, b and $|\mathrm{V}|$.

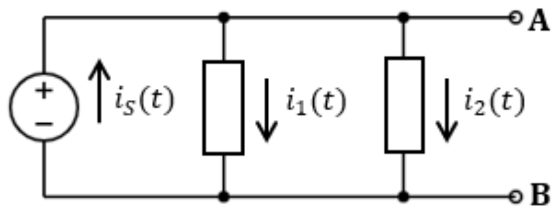
(a) We want to build the impedance Z_b using two elements in series. What elements would you use and what are their values?

(b) Consider the source $v_S(t)$. Find the value of X.

(c) Between A and B, we add a third impedance Z_3, such that the current $i_S(t)$ through the voltage source becomes equal to $i_1(t)$. What is the value of this impedance Z_3?



$v_S(t) = |\mathrm{V}| \cdot \cos(10t + X)$



a:	-2
b:	3
|V|:	2 V