ECE 35, Fall 2024

Quiz 3

/ 12

Your sequence number

Last name

First + middle name(s)

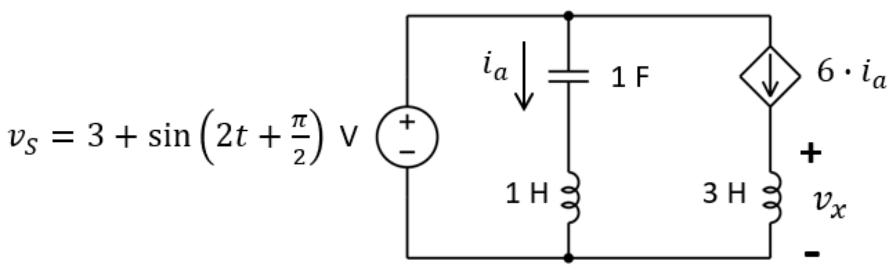
PID

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.

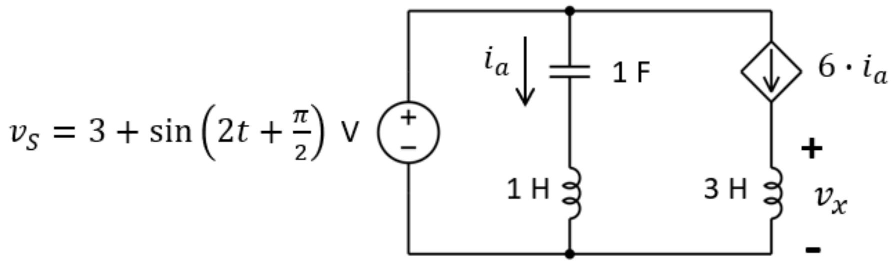
(1) *(6 points)* The circuit below is in steady state.

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

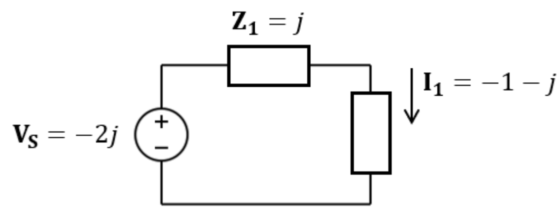
$v_x\left(\frac{\pi}{8}\ \text{s}\right)$



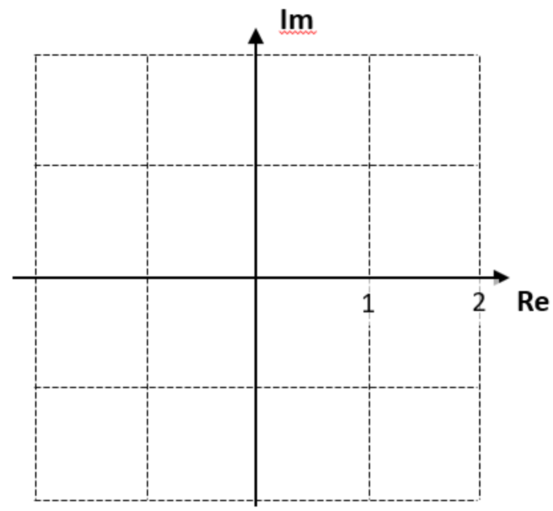
Repeated from the previous page …



(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).



Phasor diagram

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

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

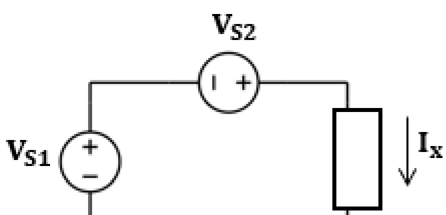
(3) *(3 points)* The circuit below represents an AC circuit in steady state in the phasor domain (for the complex numbers, you may assume units are V, A, Ω, etc. as appropriate). Both voltage sources have the same ω = 10 rad/s.

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



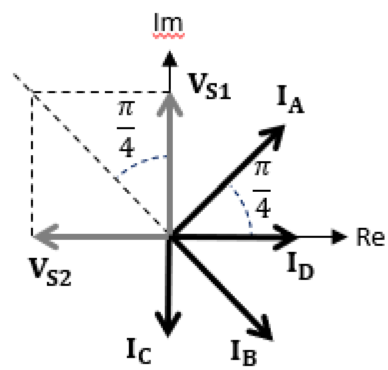
$|\mathbf{V_{S1}}| = |\mathbf{V_{S2}}| = 20$ V

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

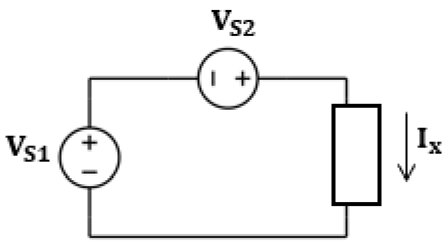
$|\mathbf{I_B}| = 4$ A

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

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



Repeated from the previous page …



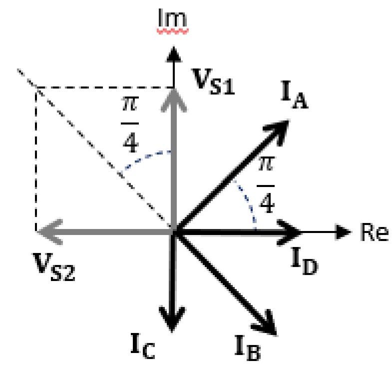
$|\mathbf{V_{S1}}| = |\mathbf{V_{S2}}| = 20\ \text{V}$

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

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

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

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



ECE35 Equation Sheet

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	$\sqrt{3}$	∞