ECE 35, Fall 2021

Your sequence number

Last name

Quiz 4

First + middle name(s)

/ 12

PID

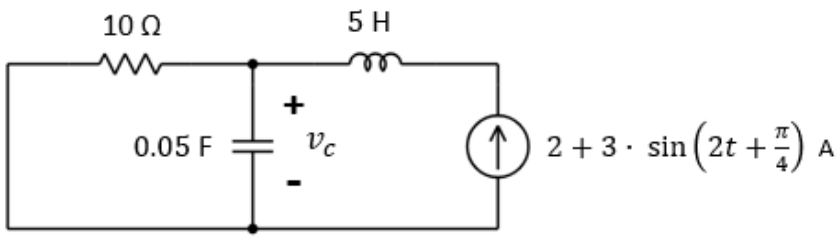
Instructions:

- 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 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 $\boldsymbol{i_a}$.

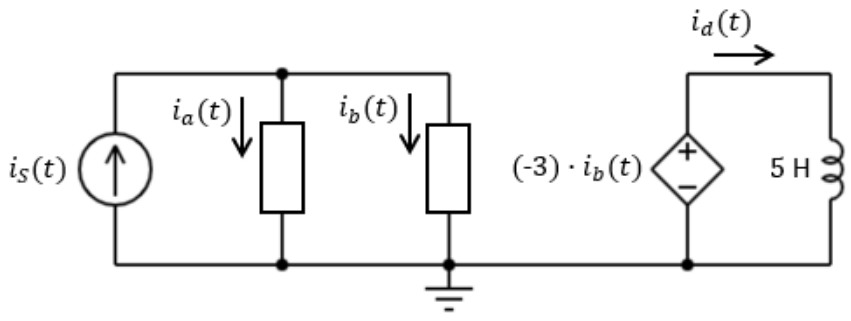
The rectangular boxes represent two circuit elements. You are told that one of them is an inductor of **1 mH** (but you don't know if this one corresponds to i_a and i_b). The other one can be a resistor of 2 Ω, a capacitor of 2 mF or an inductor of 2 mH.

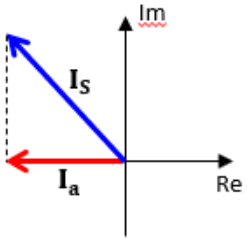
Finally, you are also told that the maximum value of the $i_S(t)$ waveform is **4 A** and the maximum value of the $i_a(t)$ waveform is **3 A**. *(6 points)*

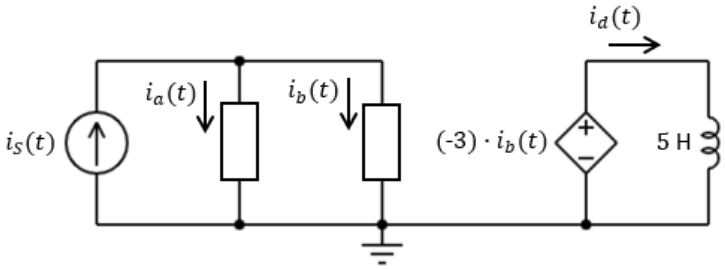
(a) What is the maximum value of the $i_b(t)$ waveform? i_b^{max} [ ]

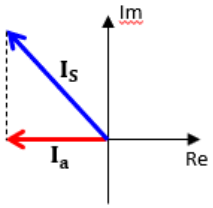
(b) With $i_d(t)$ expressed as $A \cdot \cos(\omega t + \theta)$, and $A > 0$, what is the value of θ ? θ [ ]

(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) · $i_b(t)$
5 H


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

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	$\sqrt{3}$	∞