ECE 35, Fall 2021
Final – Section A

Your sequence number

Grade

/ 45

Last name

First + middle name(s)

PID

Instructions:

- Do not look at the questions or start writing until it is announced you can do so.
- Make sure you write your PID on EACH page.
- Read each problem completely and thoroughly before beginning.
- Answers without supporting calculations will receive zero credit. If you are using intuition, write a short explanation.
- All calculations must be done on these pages. It should be clear which question they belong to. Use the front for your actual work and the back as scratch paper.
- Write clearly and make sure your answer is structured properly. We will not hunt for your work or answers.
- Write your final answers in the answer boxes. Make sure you list units.
- You must follow the Final Exam Procedures that were posted on Canvas. If you are unsure of anything, ask. As a reminder:
    - Your phone should be turned off and put inside your bag
    - Calculators are not allowed.
    - This is a closed book exam.
    - Follow the Academic Integrity standards.

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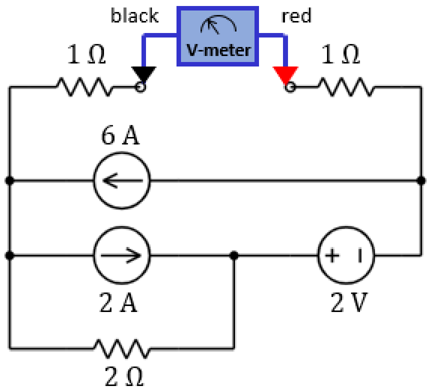
(1) *(4 points)* Consider the circuit below.
What is the reading ***X*** of the voltmeter?

X



PID

(2) *(7 points)* Consider the circuit below.

(a) Find the current i_b.

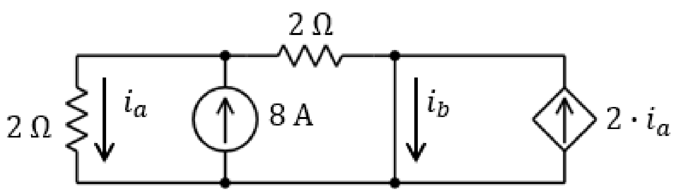
(b) Find the power P_1 received by the independent source.

(c) Find the power P_2 supplied by the dependent source.

i_b

P_1

P_2

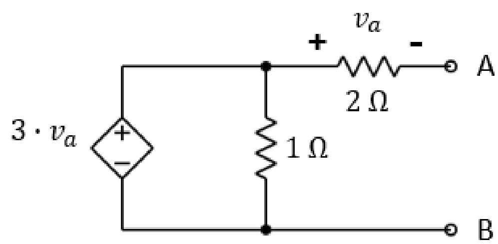


PID

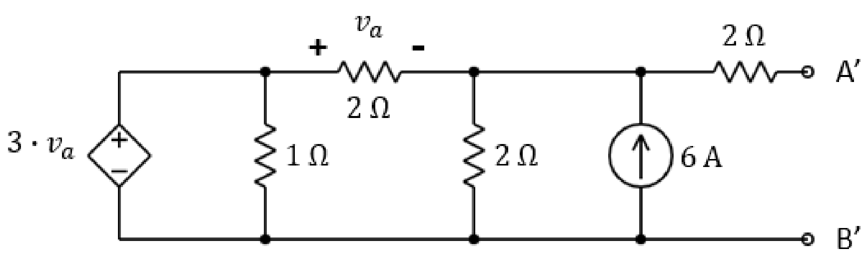
(3) *(7 points)*

(a) Consider the circuit below. What is the Thevenin equivalent resistance between A and B?

R_{TH}



(b) Consider the circuit below (which contains the circuit above). Draw the Norton equivalent model between A' and B' (make sure you label A' and B').



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(4) *(10 points)* Consider the circuit below. For *t* < 2 s, the switch is in position 1 and you may assume the system has reached steady state. The switch moves from position 1 to position 2 at *t* = 2 s and remains in position 2.

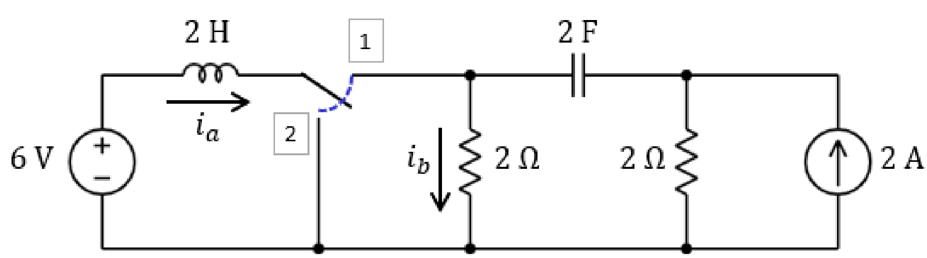
Note: make sure you don't mix up i_a and i_b in the questions below.

(a) Find the current $i_a(2^-\text{ s})$. (i.e., just before the switch moves). $i_a(2^-\text{ s})$

(b) Find the current $i_b(2^+\text{ s})$. (i.e., just after the switch moves). $i_b(2^+\text{ s})$

(c) Find the current $i_a(7\text{ s})$. $i_a(7\text{ s})$

(d) Find the current $i_b(\infty)$. $i_b(\infty)$



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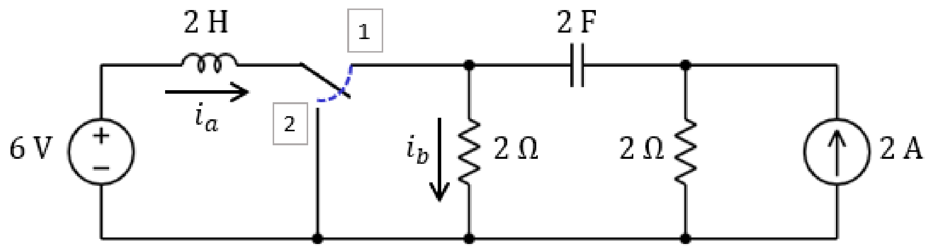
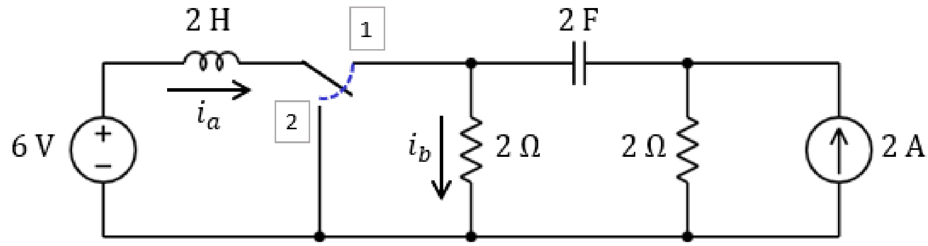



2 H
1
2 F
i_a
2
6 V
+
−
i_b
2 Ω
2 Ω
2 A

PID

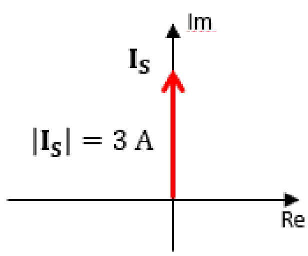
(5) *(9 points)* Consider the circuit below. For $t < \frac{\pi}{4}$ ms, the switch is closed and you may assume the system has reached steady state. The source i_S is an AC source with $\omega = 4000$ rad/s. Its phasor diagram is shown on the left. The switch opens at $t = \frac{\pi}{4}$ ms and remains open.

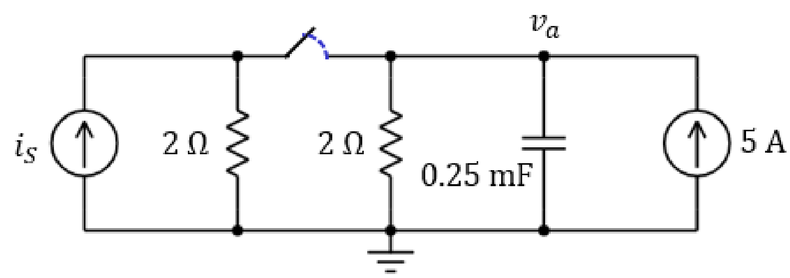
(a) Find the node voltage $v_a\left(\frac{\pi^-}{4}\ ms\right)$. (i.e., just before the switch opens).

$v_a\left(\frac{\pi^-}{4}\ ms\right)$

(b) Find the node voltage $v_a(\pi\ ms)$.

$v_a(\pi\ ms)$





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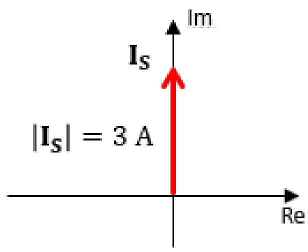

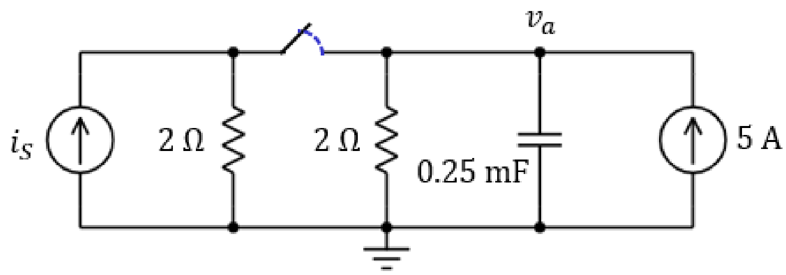

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(6) *(8 points)* The circuit below is in steady state.

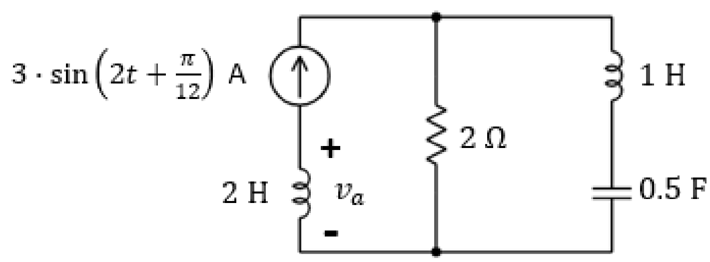
(a) Sketch the phasor of v_a (make sure the magnitude and phase are labeled).

(b) Find average power P_R received by the resistor.

P_R

(c) If the reactive power received by all capacitors and inductors combined is **21.6 VAR**, what is the complex power S supplied by the independent source?

S



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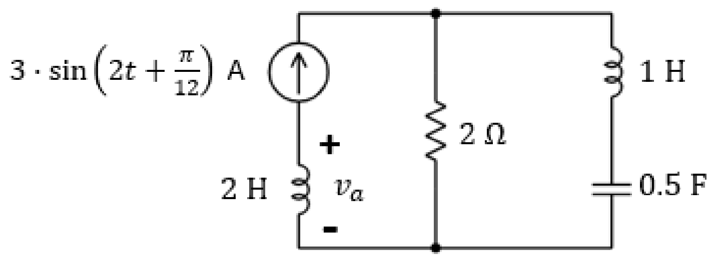

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ECE35 Equation Sheet

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

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

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

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

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

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	$\sqrt{3}$	∞