ECE 35, Winter 2022
Final

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.
- <u>Make sure you write your PID on EACH page.</u>
- <u>We will only look at the work that is within the dotted box on each page.</u> You can use pages that were part of earlier questions if there is still space. There are also two extra pages at the end that you can use as overflow for any of the questions. Always clearly mark where we can find the work for each question.
- You can use the backside of the pages as scratch paper, but we will not look at this for grading purposes.
- 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. 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.
- The last page of the exam is the equation sheet. You may detach this if you want.
- 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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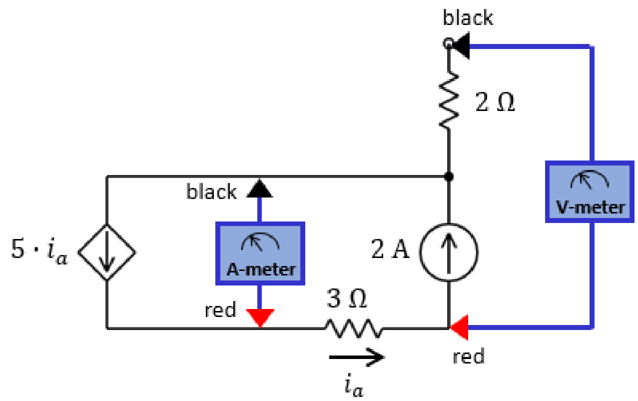
(1) *(5 points)* In the circuit below, the two meters are digital multimeters (DMMs), with one set to the ammeter setting and the other to the voltmeter setting. You can assume the DMMs act as ideal meters in either setting.

(a) What is the reading X_1 of the DMM in the ammeter setting? X_1

(b) What is the reading Y_1 of the DMM in the voltmeter setting? Y_1



Next, we change the settings of the DMMs, such that the one that was in the voltmeter setting is now in the ammeter setting and vice versa.

(c) What is the reading X_2 of the DMM that is now in the ammeter setting? X_2

(d) What is the reading Y_2 of the DMM that is now in the voltmeter setting? Y_2

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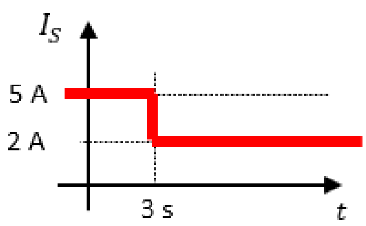
(2) *(5 points)* Consider the circuit below. The current source I_S changes as indicated in the graph. At time $t = 3^{-}$s (just before the current I_S changes), the system is not in steady state, but you are told that $i_a = 9$ A.

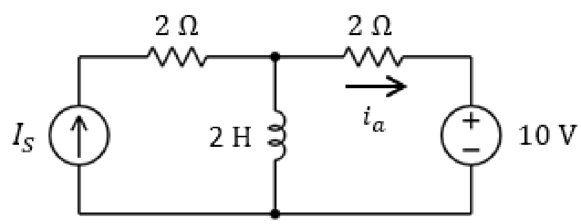
(a) Find the current i_a at time $t = 3^{+}$s (i.e., right after the current I_S changes)

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

(b) Find the current i_a at time $t = \infty$ s.

$i_a(\infty)$





PID

(3) *(8 points)* Consider the circuit below. You are told that $R_1 = 2\ \Omega$ and $k = 2\,\frac{V}{A}$.

(a) What is the power P_1 <u>received</u> by resistor R_1?

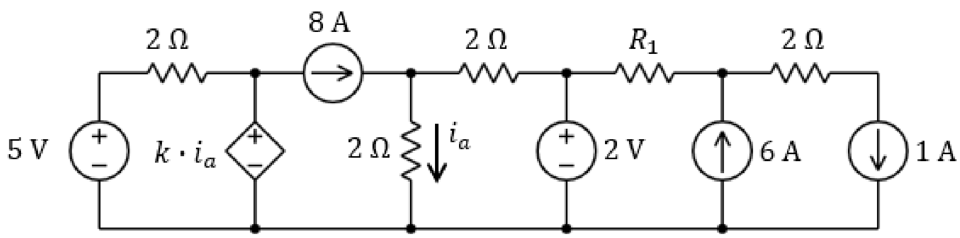
P_1

(b) What is the current i_a? (Hint: consider using superposition)

i_a

(c) What is the power P_2 <u>supplied</u> by the <u>dependent</u> voltage source?

P_2



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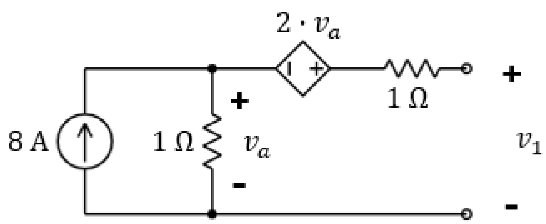
(4) *(7 points)*

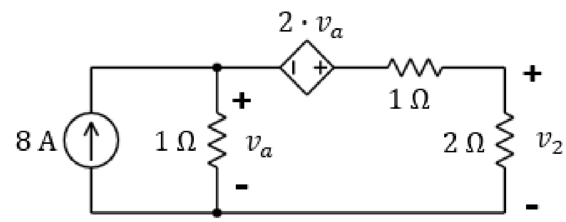
(a) For the circuit below on the left, find the voltage v_1.

v_1

(b) For the circuit below on the right, find the voltage v_2.

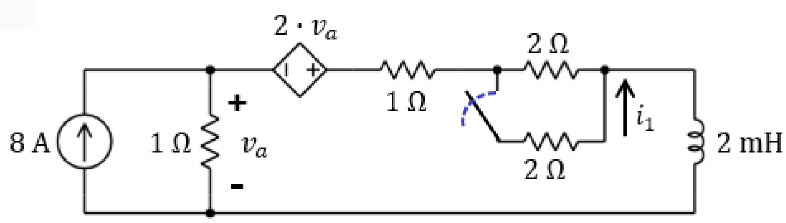
v_2





(c) Consider the circuit below. For $t < 4$ s, the switch is open, and the system has reached steady state. The switch closes at time $t = 4$ s. Find the time constant τ associated with $i_1(t)$ for $t > 4$ s.

τ



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(5) *(12 points)* Consider the circuit below. For $t < \frac{\pi}{40}$ s, both switches are in position 1 and the system has reached steady state. At time $t = \frac{\pi}{40}$ s, both switches move <u>from position 1 to position 2</u> simultaneously.

(a) Find the current i_a at time $t = \frac{\pi}{40}^-$ s (i.e., immediately before the switches move). $\quad i_a\left(\frac{\pi}{40}^- \text{ s}\right)$

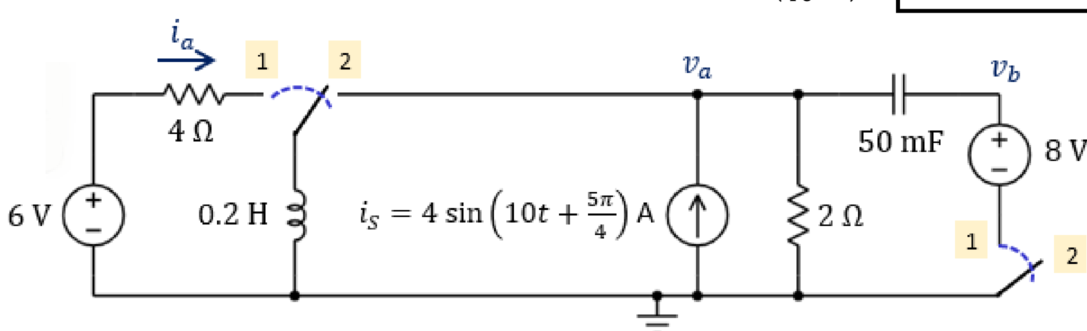
(b) Find the node voltage v_a at time $t = \frac{\pi}{40}^-$ s. $\quad v_a\left(\frac{\pi}{40}^- \text{ s}\right)$

(c) Find the node voltage v_b at time $t = \frac{\pi}{40}^-$ s. $\quad v_b\left(\frac{\pi}{40}^- \text{ s}\right)$

(d) Find the current i_a at time $t = \frac{\pi}{40}^+$ s (i.e., immediately after the switches move). $\quad i_a\left(\frac{\pi}{40}^+ \text{ s}\right)$

(e) Find the node voltage v_a at time $t = \frac{\pi}{40}^+$ s. $\quad v_a\left(\frac{\pi}{40}^+ \text{ s}\right)$

(f) Find the node voltage v_b at time $t = \frac{\pi}{40}^+$ s. $\quad v_b\left(\frac{\pi}{40}^+ \text{ s}\right)$



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(6) *(8 points)* The circuits below are in steady state.

(a) Find the complex power received by the capacitor, in the circuit on the left.

(b) What is the reading X of the voltmeter, in the circuit on the left?

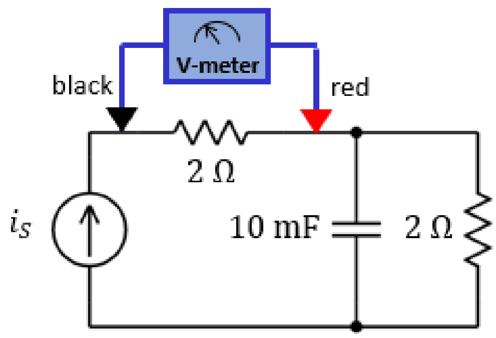
(c) I add a new circuit element in series with the current source as illustrated below on the right. As a result, the reactive power supplied by the current source is reduced to zero. What type of element should this new element be and what is its value (i.e., what is its resistance, capacitance or inductance)?

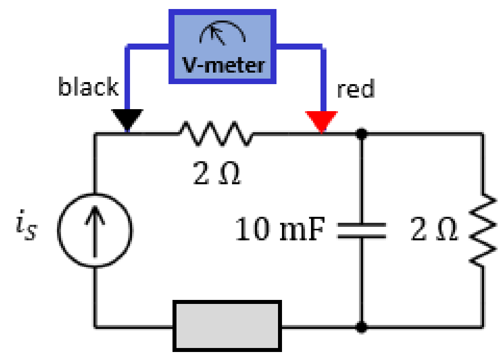
S_C

X

Type of element

value





$$i_S = 5\cos\left(100t + \frac{\pi}{3}\right)\text{ A}$$

PID

PID

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	$\sqrt{3}$	∞