ECE 35, Fall 2024

Your sequence number

Last name

First + middle name(s)

PID

Quiz 2

/ 12

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)* Consider the circuit below. At time *t* = 1 s, the current source changes as shown in the figure, and will not change after that. Immediately before the current source changes, the system is not guaranteed to have reached steady-state.

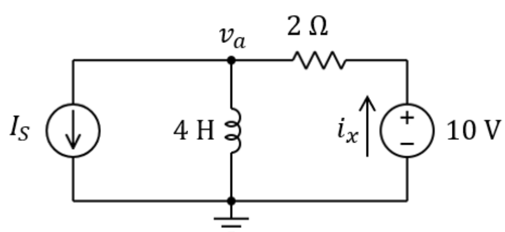
However, you are told that immediately after the change, i.e., at time $t = 1^+$, the node voltage v_a = 2 V. In other words: $v_a(1^+\text{ s})$ = 2 V.

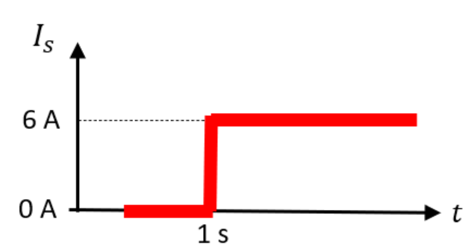
(a) Find $i_x(1^+\text{ s})$. (i.e., the current just after the current source changes) $i_x(1^+\text{ s})$

(b) Find $v_a(1^-\text{ s})$. (i.e., the node voltage just before the current source changes) $v_a(1^-\text{ s})$

(c) Find $i_x(\infty)$. $i_x(\infty)$

(d) Find $i_x(6\text{ s})$. (i.e., the current at time *t* = 6 s). You can leave your answer as a function of e. $i_x(6\text{ s})$





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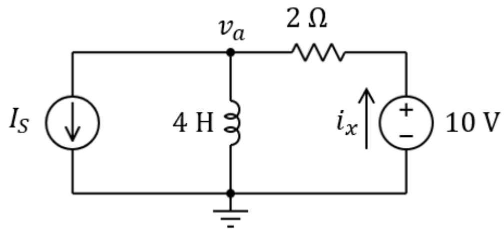

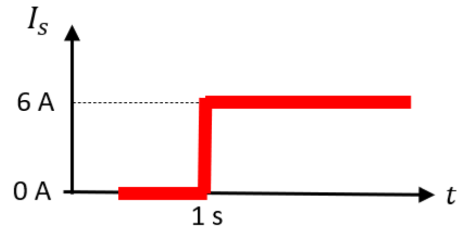

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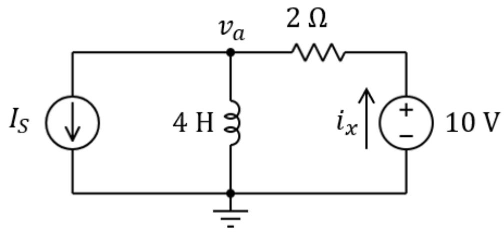

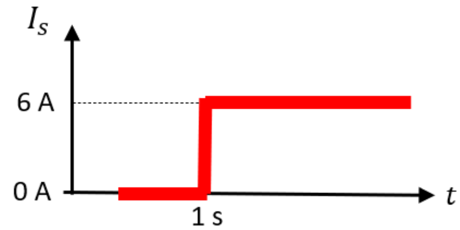

(2) *(6 points)* Consider the circuit below in Figure 1. You are not told the values of I_1 and V_1. However, you are told that if you attach the circuit from Figure 2 to the one from Figure 1 (with A' connected to A and B' connected to B), the value of $i_a = 3$ A.

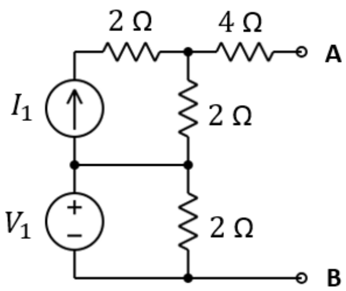

Figure 1

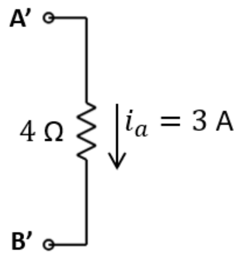

Figure 2

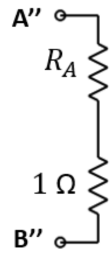

Figure 3

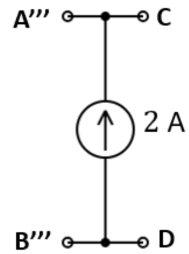

Figure 4

(a) <u>Draw</u> the <u>Thevenin</u> model between A and B for the circuit in Figure 1 (make sure you label A and B in your drawing).

(b) The circuit from Figure 3 is attached to the one from Figure 1 (with A'' connected to A and B'' connected to B). What should be the value of R_A to maximize the power received by R_A?

R_A

(c) The circuit from Figure 4 is attached to the one from Figure 1 (with A''' connected to A and B''' connected to B). For this new combined circuit, <u>draw</u> the <u>Norton</u> model between C and D (make sure you label C and D in your drawing).

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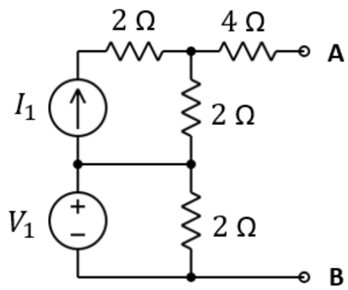

Figure 1

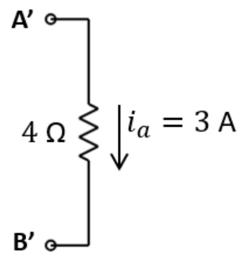

Figure 2

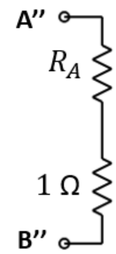

Figure 3

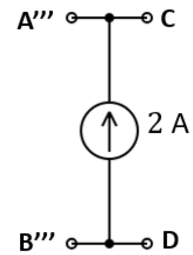

Figure 4

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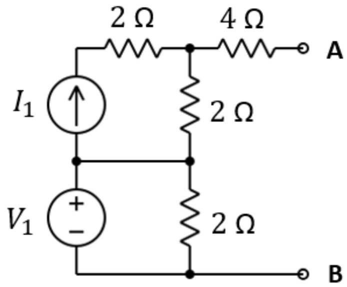

Figure 1

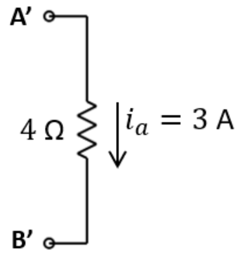

Figure 2

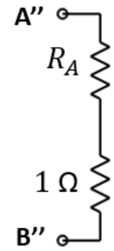

Figure 3

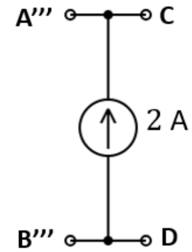

Figure 4

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	$\sqrt{3}$	∞