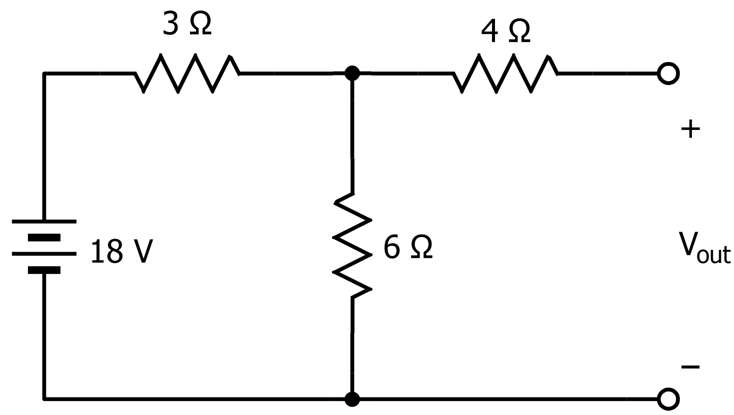
EE3 Fall 2021
Practice Problems 4

1. Find the Thévenin equivalent circuit for the given circuit, using all three methods discussed in lecture.



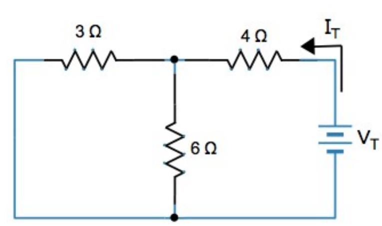
$$V_{OC} = 18\left(\frac{6}{6+3}\right) = 12 \text{ V}$$

R_{LOOK} Method:

$$R_{th} = 4+6\|3 = 6\ \Omega$$

$\dfrac{V_T}{I_T}$ Method:

$$I_T = \frac{V_T}{4+3\|6}$$



$$R_{th} = \frac{V_T}{I_T} = 6\ \Omega$$

$\dfrac{V_{OC}}{I_{SC}}$ Method:

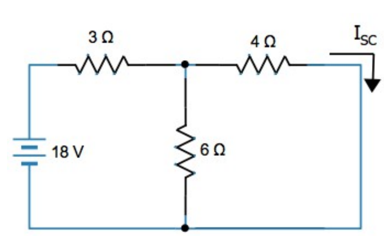
$$\frac{V_1-18}{3}+\frac{V_1}{6}+\frac{V_1}{4} = 0$$

$$9V_1 - 72 = 0$$

$$V_1 = 8 \text{ V}$$

$$I_{SC} = \frac{V_1}{4} = 2 \text{ A}$$

$$R_{th} = \frac{V_{OC}}{I_{SC}} = \frac{12}{2} = 6\ \Omega$$



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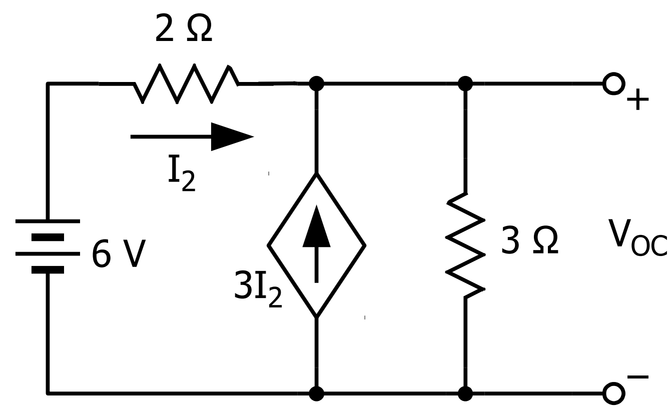
2a. Use Node Voltage Analysis to find V_{OC}.

Hint: find an expression for I_2.

2b. Use both allowable methods to find R_{th}.



$$\frac{V_{OC}-6}{2}-3I_2+\frac{V_{OC}}{3}=0$$

$$I_2=\frac{6-V_{OC}}{2}$$

$$\frac{V_{OC}-6}{2}-\frac{18-3V_{OC}}{2}+\frac{V_{OC}}{3}=0$$

$$3V_{OC}-18-54+9V_{OC}+2V_{OC}=0$$

$$V_{OC}=5.14\ \text{V}$$

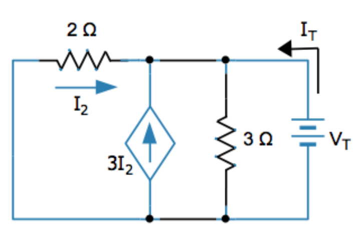
$\frac{V_T}{I_T}$ Method:

$$\frac{V_T}{2}+\frac{V_T}{3}-3I_2-I_T=0$$

$$I_2=\frac{0-V_T}{2}$$

$$\frac{5V_T}{6}+\frac{3V_T}{2}=I_T=V_T\left(\frac{14}{6}\right)$$

$$R_{th}=\frac{V_T}{I_T}=0.43\ \Omega$$



$\frac{V_{OC}}{I_{SC}}$ Method:

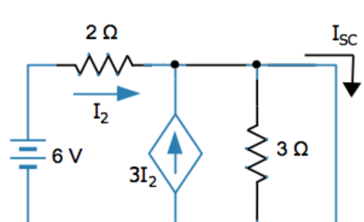
$$\frac{0-6}{2}-3I_2+\frac{0}{3}+I_{SC}=0$$

$$I_2=\frac{6-0}{2}=3$$

$$-3-3(3)+0=-I_{SC}$$

$$I_{SC}=12\ \text{A}$$

$$R_{th}=\frac{V_{OC}}{I_{SC}}=\frac{5.14}{12}=0.43\ \Omega$$



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3. The switch has been in position A for a LONG TIME before switching to position B at t = 0.

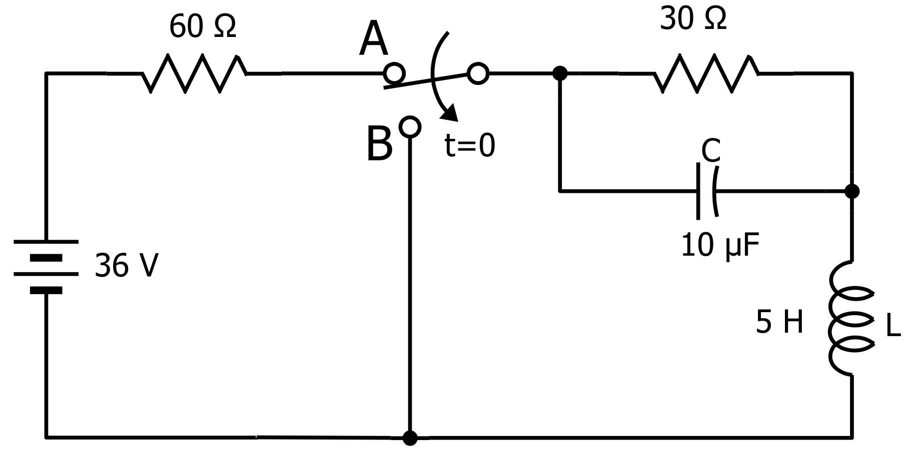
a. Find magnitude & direction of $i_L(0^-)$

b. Find magnitude and polarity of $v_C(0^-)$

c. Find magnitude and polarity of $v_L(0^+)$

d. Find magnitude and direction of $i_R(0^+)$

e. Find magnitude and direction of $i_C(0^+)$



$$i_L(0^-) = \frac{36}{60+30} = 0.4 \text{ A (down)}$$

$$v_C(0^-) = (0.4)(30) = 12 \text{ V (plus to left)}$$

$$v_L(0^+) = v_C(0^+) = v_C(0^-) = 12 \text{ V (+ to bottom)}$$

$$i_R(0^+) = \frac{12 \text{ V}}{30\ \Omega} = 0.4 \text{ A (left to right)}$$

Currents at top of inductor:

$$i_L(0^+) = +0.4 \text{ A}$$

$$i_R(0^+) = -0.4 \text{ A}$$

By KCL, $i_C(0^+) + 0.4 - 0.4 = 0$

$$\therefore \quad i_C(0^+) = 0$$

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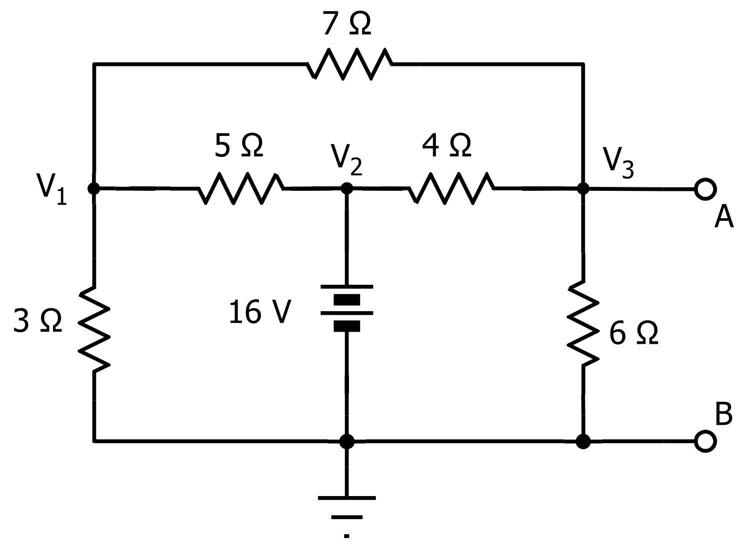
4.
a. Given the V_3 = 8.8 V, use the V_{OC}-I_{SC} method to find the Thévenin Equivalent circuit, looking in through Port A-B.

b. Compare your R_{th} to the answer in Problem 5.



From Practice Problems 3, $V_3 = 8.8\ \text{V}$

$V_{OC} = V_3 = 8.8\ \text{V}$

Shorting Terminals A and B,

$$\frac{V_1-16}{5}+\frac{V_1}{3}+\frac{V_1}{7}=0$$

$$\frac{0-16}{4}+\frac{0-V_1}{7}+I_{SC}=0$$

$$V_1=\frac{336}{71}=4.7324$$

$$I_{SC}=\frac{V_1+112}{28}=4.6761$$

$$R_{th}=\frac{V_{OC}}{I_{SC}}=\frac{8.8}{4.6761}=1.88\ \Omega$$

NOTE: This problem shows Method (a.) to finding the Thévenin Equivalent circuit.

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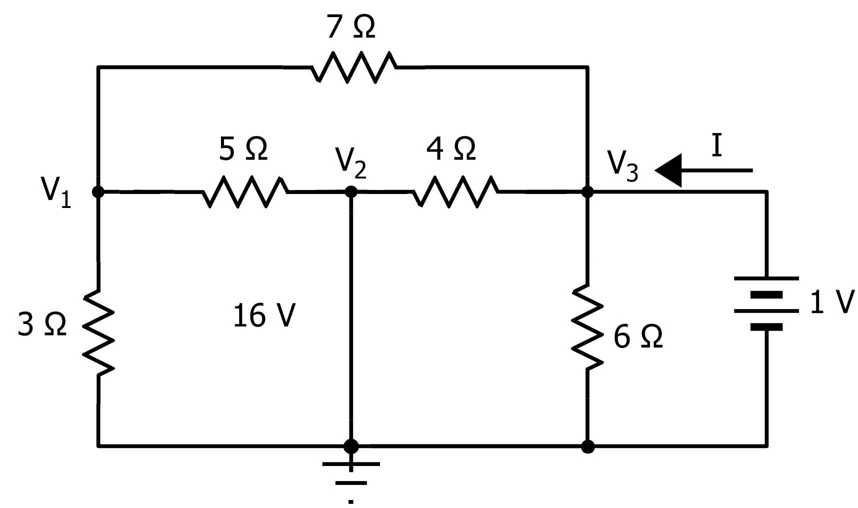
5. This is the circuit that we studied in Problem 4. This time, you will find the Thévenin Equivalent circuit by using Method (b.). V_{oc} does not change. For R_{th}, we replaced the 16 V battery with a short and attached a 1 V battery to the circuit as shown.
   a. Find the current I.
   b. Compute 1 V / I. Units are ohms.
   c. Compare your answer to Problem 4.



$$V_2 = 0\text{ V};\ V_3 = 1\text{ V}$$

$$\frac{V_1 - 0}{3} + \frac{V_1 - 0}{5} + \frac{V_1 - 1}{7} = 0$$

$$V_1 = \frac{15}{71} = 0.2113\text{ V}$$

$$-I + \frac{1-0\text{ V}}{4\ \Omega} + \frac{1\text{ V}}{6\ \Omega} + \frac{1-0.2113\text{ V}}{7\ \Omega} = 0$$

$$I = 0.53\text{ A}$$

$$R_{th} = \frac{1\text{ V}}{I} = \frac{1}{0.53} = 1.89\ \Omega$$

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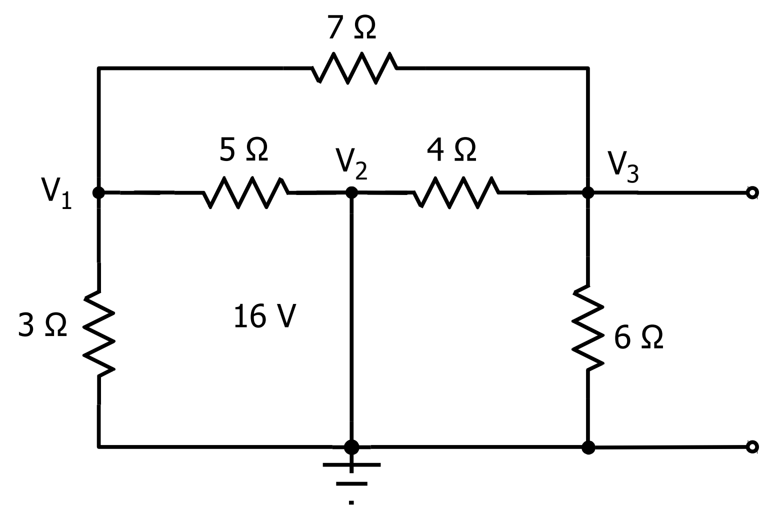
6. This is the circuit that we studied in Problem 1. This time, you will find the Thévenin Equivalent circuit by using Method (c.). We replaced the 16 V battery with a short.
   a. Using your knowledge of series and parallel circuits, find the resistance of the circuit when looking in through the port.
   b. Compare your answer to Problem 4.



$$R_{th} = (7+5\|3) \;\|\; (4\|6) = 1.89\ \Omega$$

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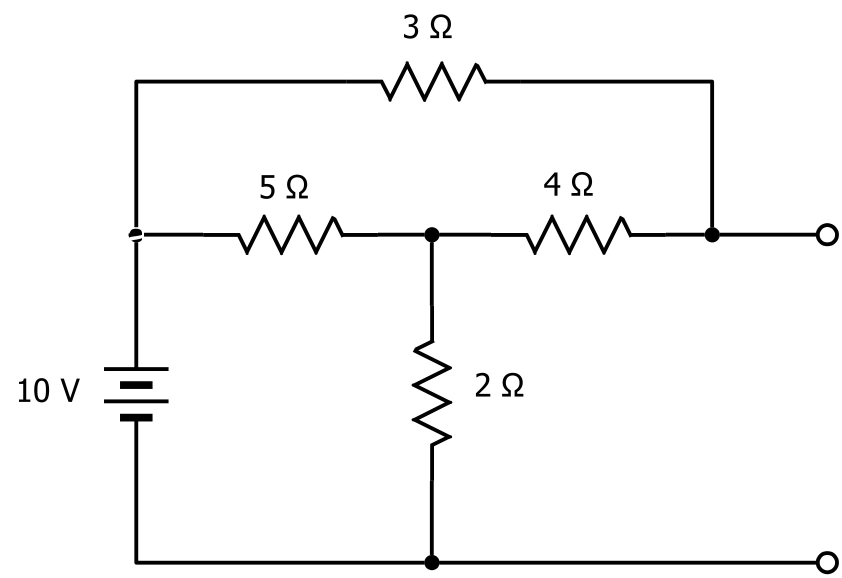
7. Find the Thévenin Equivalent circuit, using Method a.



Finding V_OC:let V_1 be the voltage at the top of the 2_Ω resistor.

$$\frac{V_1-10}{5}+\frac{V_1}{2}+\frac{V_1-V_{OC}}{4}=0$$

$$\frac{V_{OC}-10}{3}+\frac{V_{OC}-V_1}{4}=0$$

$$4V_1+10V_1+5V_1-5V_{OC}=40$$
$$-3V_1+3V_{OC}+4V_{OC}=40$$

$$V_{OC}=7.46\ \text{V}$$

Finding I_{SC}:

$$\frac{V_1-10}{5}+\frac{V_1}{2}+\frac{V_1}{4}=0$$

$$\frac{0-10}{3}+\frac{0-V_1}{4}+I_{SC}=0$$

$$4V_1+10V_1+5V_1=40$$
$$-3V_1+12I_{SC}=40$$

$$I_{SC}=3.86\ \text{A}$$

$$R_{th}=\frac{V_{OC}}{I_{SC}}=1.93\,\Omega$$

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8. Find the Thévenin Equivalent circuit, using Method c.