CSM 16A   Designing Information Devices and Systems I
## Spring 2021   Week 5

1. Passive Sign Convention

Learning Goal: This question practices labeling for passive sign convention.
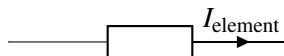
Relevant Notes: **Note 11A Section 11.3** introduces the standard circuit elements that are used in this question.

For the following components, label all the missing V_{element}, I_{element}, and +/- signs. *Hint: The value of the voltage and current sources shouldn't affect passive sign convention—remember that voltage and current can be negative!*
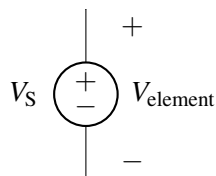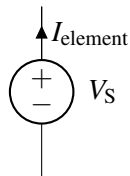
(a) .
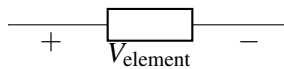
(b) .

(c) .

If $V_S = 1$V, what is V_{element}?

If $V_S = -1$V, what is V_{element}? Would this change the $+/-$ labels of V_{element}?

(d) .

If $V_S = 3$V, what is V_{element}?

If $V_S = -3$V, what is V_{element}?

(e) .
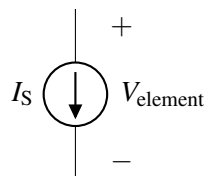
If $I_S = 5$A, what is I_{element}?

If $I_S = -5$A, what is I_{element}? Would this change the direction of the I_{element} label?
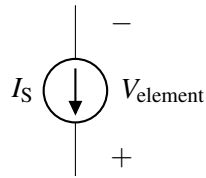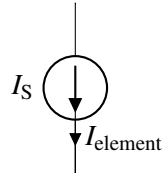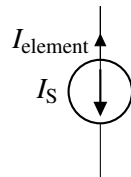
(f) .

If $I_S = 1A$, what is $I_{element}$?

If $I_S = -1A$, what is $I_{element}$? Would this change the direction of the $I_{element}$ label?

(g) **(PRACTICE)**

(h) **(PRACTICE)**

(i) **(PRACTICE)**

I_{element}

(j) **(PRACTICE)**

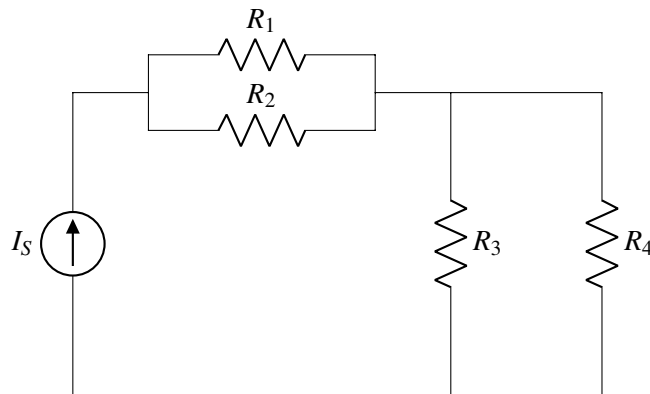$-\quad V_{\text{element}}\quad +$

2. **Nodes and Branches**

   Learning Goal: The goal of this problem is to introduce nodal analysis, KVL, and KCL.
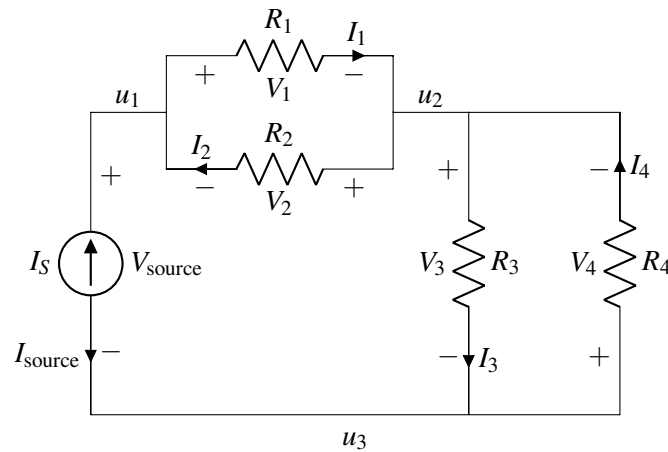
   Relevant Notes: **Note 11A Section 11.4** introduces KVL and KCL.

   (a) Label all the elements in the following circuit according to passive sign convention.

   R_1

   R_2

   I_S

   R_3

   R_4

(b) Find and label all the distinct nodes in the circuit from part (a).

(c) Some current and voltage labels are added to the circuit in part (a):

(i) If $I_S = 5\text{mA}$ and $I_1 = 2\text{mA}$, find I_{source} and I_2. Start by writing the KCL equation at node u_1.

(ii) If $I_3 = 4\text{mA}$ and $I_4 = -1\text{mA}$, find I_{source} and I_S. Start by writing the KCL equation at node u_3.

(iii) (PRACTICE) Solve the two problems above by labeling the circuit using different passive sign convention. What do you notice about the values of the currents?

(d) Consider the labeled circuit from part (c).

(i) If $V_{\text{source}} = 10\text{V}$ and $V_4 = -4\text{V}$, find V_1, V_2 and V_3. Start by writing the KVL equations for different loops.

(ii) Assume $R_1 = 3\text{k}\Omega$, $R_2 = 2\text{k}\Omega$, $R_3 = 1\text{k}\Omega$ and $R_4 = 4\text{k}\Omega$. Calculate I_1, I_2, I_3 and I_4 using the results from subpart (i).

3. **Intro to Circuit Solving**

   Learning Goal: The goal of this problem is to practice going through the main steps to solve circuits.

   Relevant Notes: Note 11B introduces the circuit analysis procedure.

   Solve the following circuit for all the branch currents and voltage differences across elements. Find the power dissipated in all elements. Follow the steps listed below to step through the problem. Use the following values for this problem: $V_S = 5\text{V}$, $R_1 = 2\text{k}\Omega$, $R_2 = 2\text{k}\Omega$, $R_3 = 4\text{k}\Omega$, and $I_S = 2\text{mA}$.

   Solve the following circuit for all the branch currents and voltage differences across elements. Find the power dissipated in all elements. Follow the steps listed below to step through the problem.
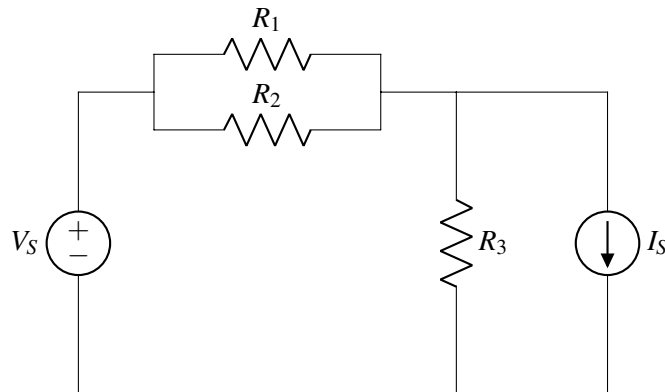
   (a) Select a reference node.

   (b) Label nodes with voltage set by sources and the remaining nodes.

   (c) Label element voltages and currents.

(d) Write the KCL equations for all the nodes without a voltage source.

(e) Write expressions for the element currents for resistors and current sources. Also write expressions for node voltages for the nodes connected to the voltage sources.

(f) Substitute element current expressions into the KCL equations.

(g) Solve for the unknown node voltages (use Gaussian Elimination if necessary).

(h) Find each elemental current and voltage.

(i) Find the power dissipated by each element. Show that the power is conserved.