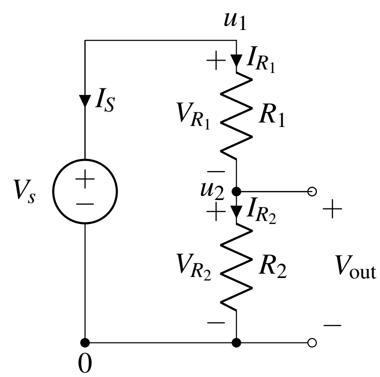
EECS 16A Designing Information Devices and Systems I
Spring 2022 Discussion 6B

1. Voltage Divider

For the circuit below, your goal will be to find the voltage V_{out} in terms of the resistances R_1, R_2, and V_s, using NVA (Node Voltage Analysis). The labeling steps (steps 1-4) have already been done for you.



Here is a reminder of the labeling steps followed to get the circuit diagram above:

- **Step 1:** Select a reference node and label it 0 (ground). Any node can be chosen for this purpose. We will measure all of the voltages in the rest of the circuit relative to this point.
- **Step 2:** Label all remaining nodes.
- **Step 3:** Label the current through every non-wire element in the circuit.
- **Step 4:** Label element voltages following **Passive Sign Convention**.

Our goal is to ***find*** V_{out}. In order to do this, we can use NVA to find equations describing our circuit, and solve the system of linear equations.

Step 5: Write KCL equations for all nodes with unknown voltages.

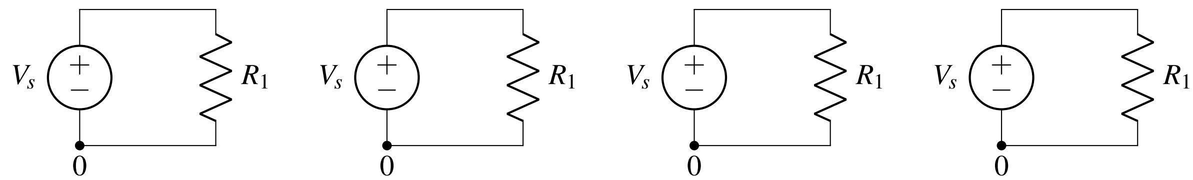
Step 6: Write down the IV relationships (Ohm's Law) of each of the non-wire elements.

Step 7: Use substitution to solve for $u_2 = V_{out}$.

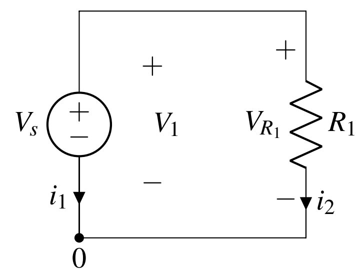
As an additional exercise, write out $\mathbf{A}\vec{x} = \vec{b}$ where $\vec{x}$ is a vector of your unknown currents and voltages. Fill in the rows of matrix $\mathbf{A}$ according to the equations you wrote.

2. Passive Sign Convention and Power

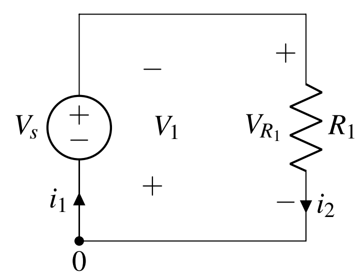
(a) Below are four copies of a the same single-resistor circuit. On each copy, provide a distinct choice of labels for each circuit's voltage polarities and current directions (there should be 4 possible choices in total!) while keeping with passive sign convention.



(b) Suppose we consider one of the possible labelings you have found above. Calculate the power dissipated or supplied by every element in the circuit. Let $V_s = 5\,\text{V}$ and let $R_1 = 5\,\Omega$. *Recall that the power dissipated is the rate of electric energy converted into other forms and is given by the equation $P = IV$. When the power dissipated by an element is a negative value, it signifies that element is actually supplying electrical power to the circuit.*



(c) Suppose we choose a second labeling of the circuit as shown below. Calculate the power dissipated or supplied by every element in the circuit. Let $V_s = 5\,\text{V}$ and let $R_1 = 5\,\Omega$.



(d) Did the values of the element voltages and element currents change with the different labeling? Did the power for each circuit element change? Did the node voltages change? If a quantity didn't change with a difference in labeling, discuss what would have to change for quantity to change.