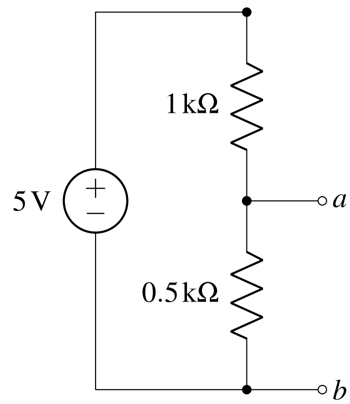
EECS 16A Designing Information Devices and Systems I
Fall 2019 Discussion 8B

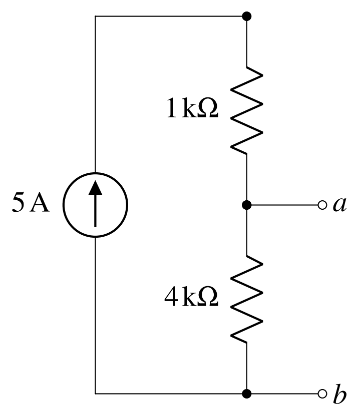
1. Equivalence

Find the Thévenin and Norton equivalents across terminals a and b for the circuits given below.

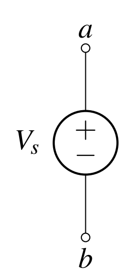
(a)



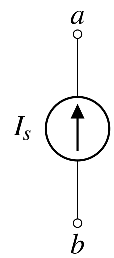
(b)



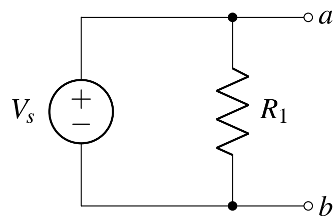
(c)



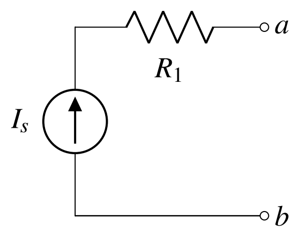
(d)



(e) (Practice)

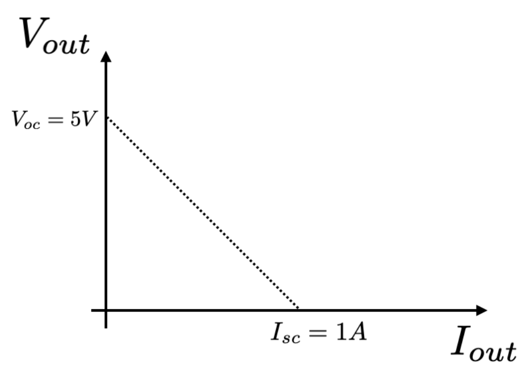


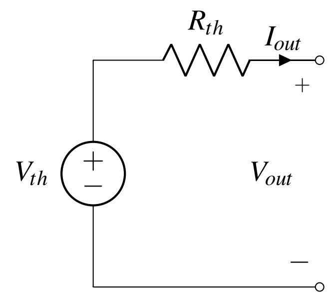
(f) (Practice)



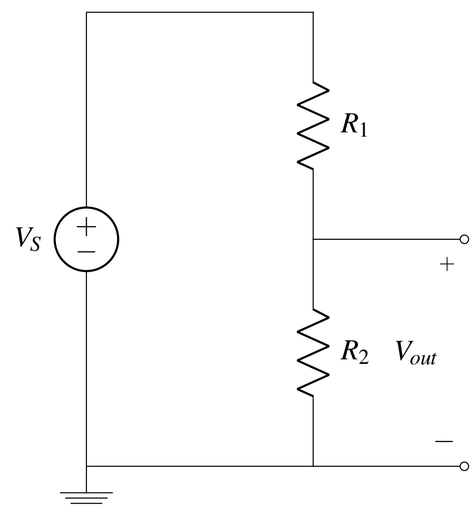
2. Thevenin equivalence

(a) You are given the following $I_{out} - V_{out}$ characteristic of the Thevenin model of a circuit. Find the Thevenin voltage and the Thevenin resistance.



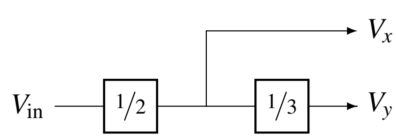


(b) You are given a voltage divider as shown below. Find R_1 and R_2 such that the Thevenin equivalent model is the same as that of (a). You are given that $V_S = 10V$.



3. Modular Circuits

In this problem, we will explore the design of circuits that perform a set of (arbitrary) mathematical operations. (Note that the so-called analog signal processing – where these kinds of mathematical operations are performed on continuously-valued voltages by analog circuits – is extremely common in real-world applications; without this capability, essentially none of our radios or sensors would actually work.) Specifically, let's assume that we want to implement the block diagram shown below:



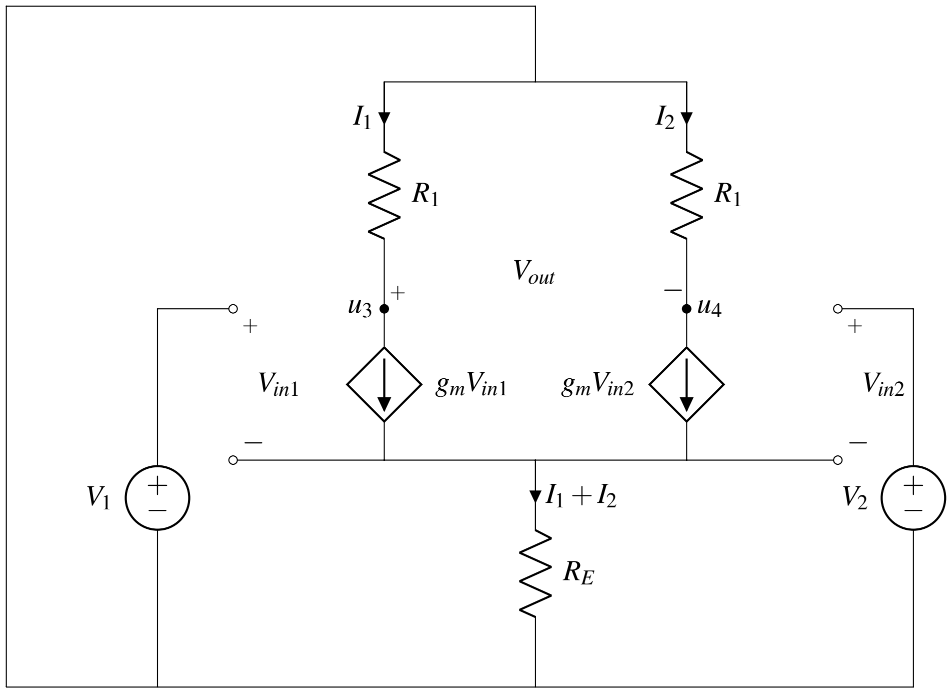
In other words, we want to implement a circuit with two outputs V_x and V_y, where $V_x = \frac{1}{2}V_{\text{in}}$ and $V_y = \frac{1}{3}V_x$.

(a) Design two voltage divider circuits that each independently would implement the two multiplications shown in the block diagram above (i.e., multiply by 1/2 and multiply by 1/3). Note that you do not need to include the input voltage sources in your design – you can simply define the input to each block as being at the appropriate potential (e.g., V_{in} or V_x).

(b) Assuming that V_{in} is created by an ideal voltage source, implement the original block diagram as a circuit by directly replacing each block with the designs you came up with in part (a).

(c) For the circuit from part (b), find V_x and V_y. Do you get the desired relationship between V_y and V_x? How about between V_x and V_{in}? Be sure to explain why or why not each block retains its desired functionality.

4. Superposition (Optional)



(a) Calculate V_{out} with only V_1 on. Repeat this with only V_2 on.

(b) Let's now turn on both V_1 and V_2. What is the output V_{out}? What does this circuit do to arbitrary input voltages?