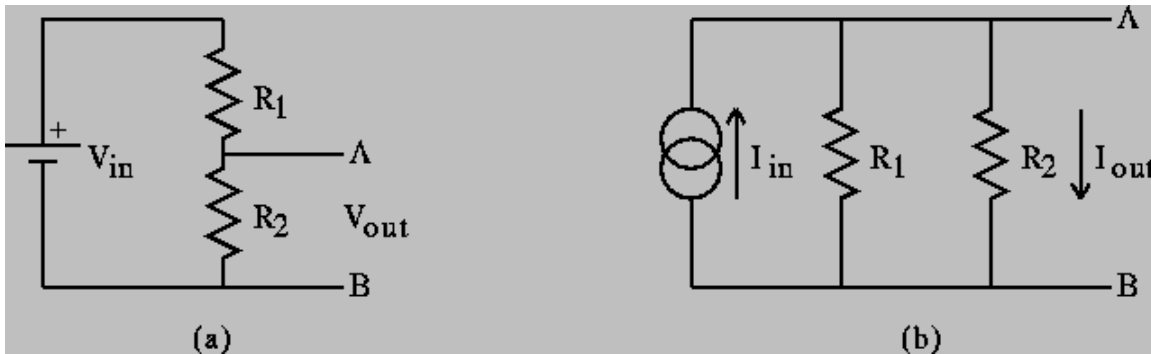


Homework #1
Thevenin and Norton Equivalent Circuits

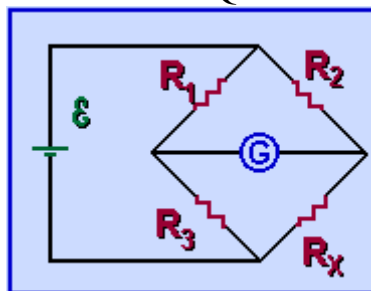
Due: 28 January

We will not be doing a great deal of pencil and paper circuit analysis in this course. We will be relying on PSpice to determine voltages and currents for most of the circuits we will study. However, there are a few basic configurations we will need to understand a little bit better. The only way to obtain this higher level of understanding is to do the analysis ourselves.

We have already seen voltage dividers under several different circumstances. There is also a circuit called a current divider, which we will also need to understand, but not right now. These two dividers are shown in the figure below, which is taken from page 10 of Gingrich. The voltage divider is also found on page 5 of the Engineer's Mini-Notebook on Formulas, Tables and Basic Circuits.

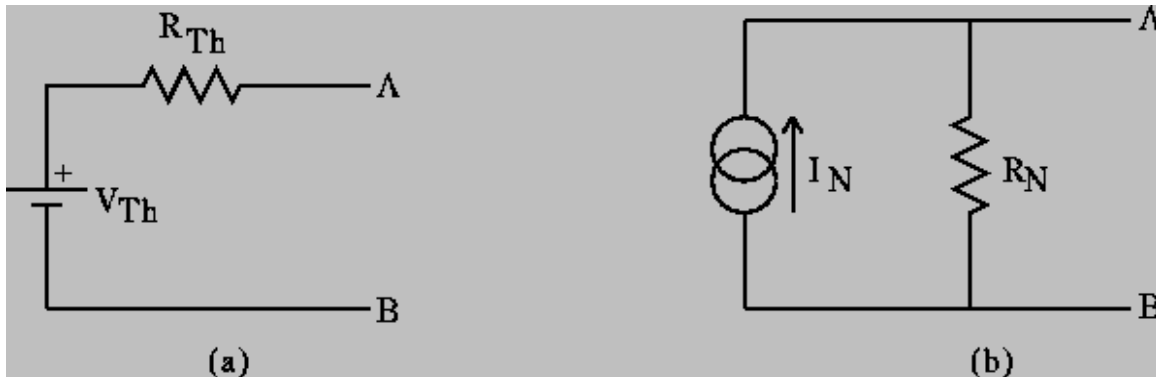


Another circuit we have seen in experiments 2 and 3 is a combination of two voltage dividers, which is called a bridge circuit. Actually it is called a Wheatstone Bridge, but we mostly forget about Mr. Wheatstone when we talk about it. There is some good basic info on circuits to be found on many, many different pages on the web. One of these sites is at the University of Guelph where you can find tutorials on such topics as DC circuits at <http://www.physics.uoguelph.ca/tutorials/ohm/Q.ohm.html>



In this figure, taken from the Guelph tutorial, the capital E represents the voltage source (this letter is used a lot, but not as much as the capital letter V), and G represents some kind of measurement device. This circuit has been set up to determine the unknown resistor R_x , just as we did in Experiment 2.

When we use such circuits as voltage dividers or bridges to produce a voltage of some kind, we will be using them like a voltage source. We have seen that voltage sources such as our function generator, a battery, etc. all have an internal resistance of some kind. We, therefore, can expect to require similar information about dividers or bridges when we use them as sources. It turns out that any combination of voltage or current sources and resistors can be simplified into one of the two following forms, called Thevenin and Norton Equivalents.



We will only be concerned with the Thevenin equivalent for now. Note that this simple combination is the model we have used for the practical sources we have seen in the studio.

Read section 1.4 of Gingrich, in which he discusses Equivalent Circuits. He does a relatively thorough example finding the Thevenin voltage and resistances for a bridge circuit. Generalize his result for resistors labeled R_1 , R_2 , R_3 , R_X as in the circuit from Guelph. That is, determine both V_{Th} and R_{Th} .

Find the Thevenin voltage and resistance for the voltage divider circuit on page 5 of the Mini-Notebook on Formulas, Tables and Basic Circuits.

You are to experimentally determine the voltage and internal resistance for a battery in Experiment 3 by placing two known loads across the battery ($R = 100$ ohms and an open circuit or at least very large R). The configuration used for this measurement is a voltage divider like the one you considered above. Using the formula you obtained for R_{Th} for a voltage divider and your measured value for the internal resistance of the battery, determine whether or not the Thevenin resistance for the battery changes significantly from its usual value when either of the loads is attached.

*Hint: This assignment **mostly** requires you to review what you have seen previously with respect to voltage dividers and bridges. However, you will need to understand the method by which the Thevenin resistance is determined. We will discuss this in class and you can read about it in Gingrich.*