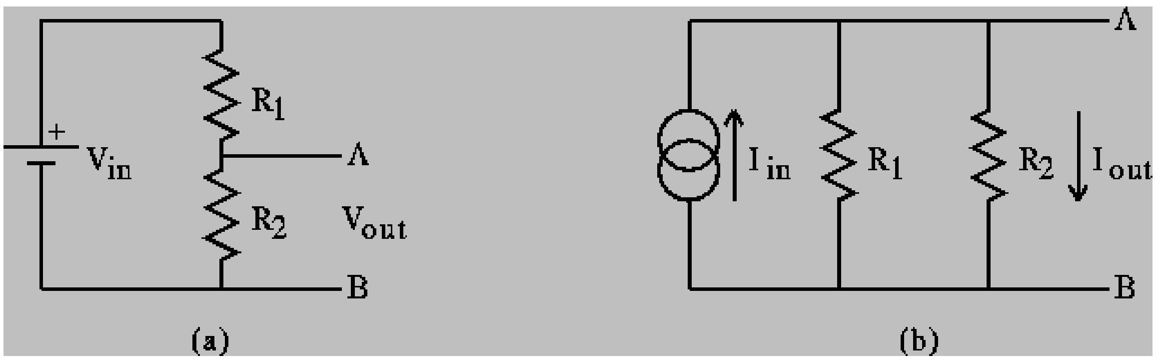
**Electronic Instrumentation**

**Name _______________ ENGR-4300 Fall 2001 Section ____________**

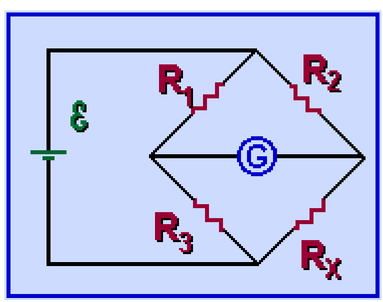
# Homework #1
## Thevenin and Norton Equivalent Circuits
*Due: Monday, September 17th*

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.

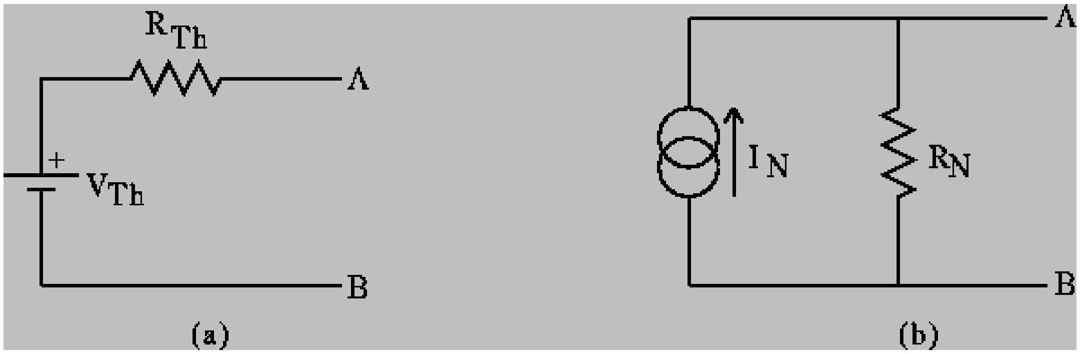



Another circuit we have seen in experiments 2 and 3 is a combination of two voltage dividers, which is called a bridge circuit. Actually it is called a Wheatstone Bridge, but we mostly forget about Mr. Wheatstone when we talk about it. There is some good basic info on circuits to be found on many, many 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



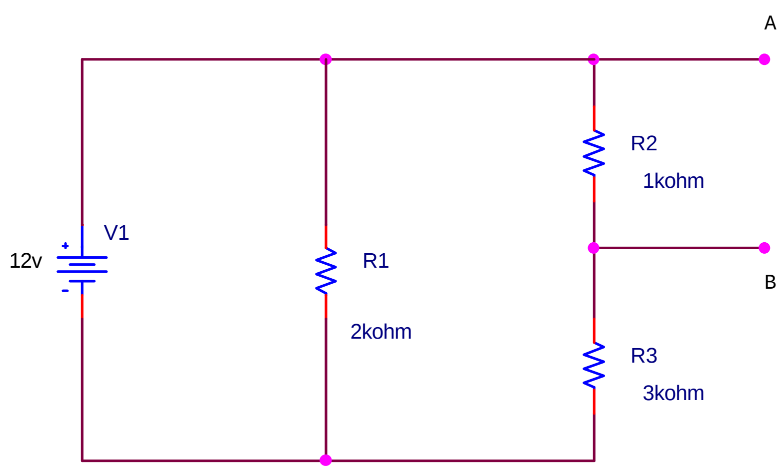

In this figure, taken from the Guelph tutorial, the capital E represents the voltage source (this letter is used a lot, but not as much as the capital letter V), and G represents some kind of measurement device. This circuit has been set up to determine the unknown resistor $R_x$, just as we did in Experiment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

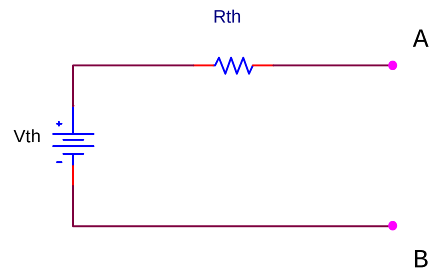



We will only be concerned with the Thevenin equivalent for now. Note that this simple combination is the model we have used for the practical sources we have seen in the studio.

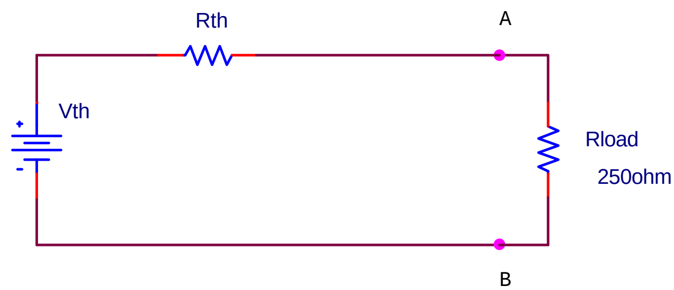
Read section 2.1 of Lunn, in which he discusses Equivalent Circuits. He does a relatively thorough example finding the Thevenin voltage and resistances for a bridge circuit. We can generalize his result for resistors labeled $R_1$, $R_2$, $R_3$, $R_X$ as in the circuit from Guelph. That is, we can determine both $V_{Th}$ and $R_{Th}$.
Once you have looked over Lunn, determine $V_{Th}$ and $R_{Th}$ for the following circuit. Assume that the output is taken across the points labeled A and B.




Now you can simplify this circuit to look like the following:




Then use your Thevenin equivalent source to find the voltage that would appear across a 250 ohm resistor connected between points A and B. Once you connect this additional resistor to the circuit, it will look like the following:




*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 Lunn. To find Thevenin equivalent circuits, you must also be able to readily analyze series and parallel combinations of resistors and, ultimately, other kinds of impedances. To check to be sure that you have developed your skills adequately, you should visit the **Precision Teaching – Electromagnetics** site at Georgia Tech and download Unit 5 (Resistors in Series/Parallel, RC Circuits, Kirchoff's Laws). You can download all of the units if you wish, but this is the only one we will need for this course. Once you think you understand series/parallel combination of resistors and Kirchoff's Laws, give yourself the tests, but address only the questions involving resistors and voltage sources, not capacitors. The capacitor problems should be tried after we introduce them. It is very important that you go through the relevant tests in this unit before Quiz 1, since mastering these skills will make taking this quiz a lot easier. Note – if you do not have a computer of your own, please use the available open shop time to do these tests using the studio computers.*