INTERACTIVE COMPUTER DEMONSTRATIONS FOR ELECTRICAL ENGINEERING

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ABSTRACT - There are a number of relationships in electrical engineering that students have trouble understanding ranging all the way from how the signs of voltages and currents depend on their reference directions to how a signal's shape is related to its Fourier Transform. The objective of this paper is to describe some Interactive Demonstrations I have put on the WEB at http://emapf.ent.csupomona.edu to help students understand these relationships.

INTRODUCTION - Lectures are great for presentation of material. Group and class discussions are great for getting students actively involved. And labs are great for giving students the experience of building and troubleshooting real circuits and for giving them first hand experience in how circuits behave. But many students still need extra help learning the basic conventions and relationships they need before they can go on to more general analysis, synthesis and system evaluation (Bloom, 1984). The goal of the interactive multimedia demonstrations described in this paper is to give students the added experience that will help them accomplish this goal (Kolb, 1984).

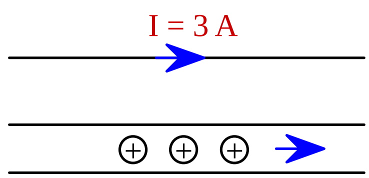
The multimedia demonstrations described in this paper help students gain experience in circuit behavior by showing them what happens when they click on circuit diagrams to change things like reference directions and circuit element values. The main advantages of these demonstrations, besides being free, are that they are easy to use and give students immediate feedback. Students do not need to build and troubleshoot hardware or learn any specialized programs. All a student needs is a computer with a browser. Another nice feature of these demonstrations is that they can simultaneously show how more than one variable is changing at the same time. It is straightforward, for example, to put together an interactive demonstration that shows how changes in the value of the capacitor of a first order RC circuit affects both its transient and frequency responses. Such demonstrations are typically much more difficult to do in the lab.

I originally put together a collection of interactive demonstrations about six years ago using Supercard and Hypercard for Macintosh computers. But their usefulness was limited by the fact that virtually all our students have PCs. The present demonstrations are written in HTML and so are accessible on the internet to all students. I also give my students a disk of my demonstrations so they can run them without having to be connected to the internet.

EXAMPLES OF INTERACTIVE DEMONSTRATIONS - The following interactive demonstrations, together with other material for my class, are available from my home page at http://emapf.ent.csupomona.edu. They are written in such a way that when students click on the blue "things" - things like current reference arrows, meters and so on - the browser will link to a new page showing what changes in red. The things in black do not change - they are not affected by the changes initiated by the student.

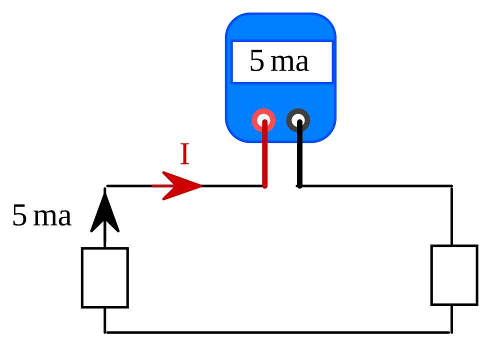
Current Reference Directions - Demo 1

Click on the blue arrows to see how the sign of I depends on both the direction the equivalent positive charge is flowing and your choice of reference direction. Note that each ⊕ represents the flow of one coulomb/sec of equivalent positive charge.



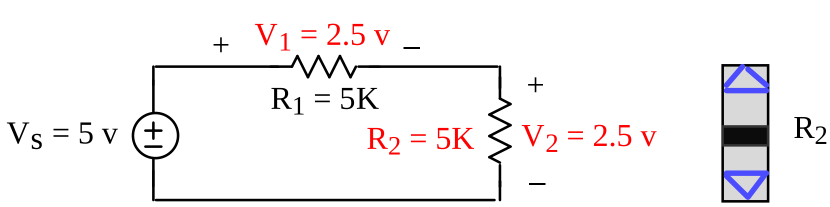
Current Measurements

Click on the current meter to see how reversing its leads affects the value of the measured current I. Note that the boxes contain circuit elements like batteries and light bulbs.



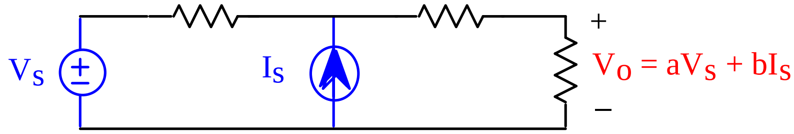
Voltage Division In Series Resistor Circuits

Click on the blue arrows to see what happens to the current I and the voltages V_1 and V_2 as the resistor R_2 is increased and decreased.



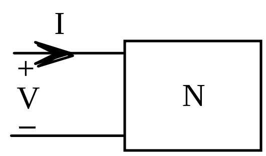
Superposition In Resistor Circuits

Click on the sources in the following circuit to see what happens to V_O when the voltage source is set to zero (replaced by a short) and the current source is set to zero (replaced by an open). Click on the resulting open and short circuits to bring back the original sources.

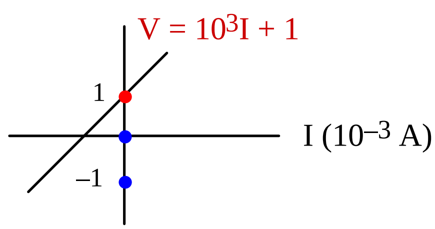


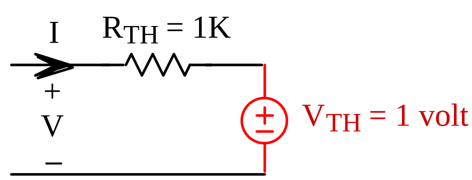
Equivalent Resistor Circuits

Given the following circuit



Click on the dots on the vertical axis of the following graph to see how the open circuit voltage of N is related to its equivalent circuit.





ASSESSMENT - My students not only seem to like but also benefit from interactive demonstrations like those above. But I am doing so many interrelated things in my classes including group discussions and peer instruction (Mazur, 1997) that it would be very hard to isolate the affect of any one of them. I have, however, received messages from other instructors telling me they are recommending that their students use these demonstrations.

FUTURE PLANS - My future plans are to continue writing more interactive demonstrations. There are opportunities in virtually all areas from analog to digital. The challenge, of course, is to identify what important results the students are not understanding and then come up with examples that clearly focus on the points you are trying to make.

REFERENCES

1. Bloom, B (1956). *Taxonomy of Educational Objectives*. New York and London: Longman.

2. Kolb, D (1984). *Experiential Learning - Experience as The Source of Learning and Development.* Englewood Cliffs, New Jersey: Prentice-Hall.

3. Mazur, E (1997). *Peer Instruction.* Englewood Cliffs, New Jersey: Prentice-Hall.