Lecture S1 Muddiest Points

General Comments

In this lecture, I began by explaining why active learning is important, and expectations for the year. I then began a review of resistive circuits. The most difficult part of the lecture was probably the discussion of the passive sign convention. This was reflected in the muddy card questions. Please don't worry about this too much — we will talk about this a lot in the coming days.

I ended the lecture with a discussion of the difference between a battery and a voltage source. This also caused some confusion, which I hope will be cleared up in the next lecture.

A few students commented that the pace was too slow, although others commented that it was a good review at a good pace. The pace will pick up, but I like to start the first lecture making sure everyone is on the same page.

Responses to Muddiest-Part-of-the-Lecture Cards

(69 cards)

1. ***General confusion about voltage, current, and power sign conventions. (12 students)*** We will cover this more in class. For now, it's important to understand that a *convention* is "general agreement on or acceptance of certain practices or attitudes." (See http://dictionary.reference.com/.) The Passive Sign Convention (PCS) allows experts to talk to one another without ambiguity as to the meaning of "the current through the resistor" or "the current through the voltage source." The convention is probably the best possible one (of several possibilities), because it simplifies the discussion of power. When using the PCS, the power dissipated (or in the case of an energy storage element, absorbed) is given by $\mathbb{P} = iv$. When $\mathbb{P}$ is negative, power is supplied by the element.

2. ***What is the relevance to thermodynamics? (1)*** The First Law requires that energy be conserved, *always*. That means that the sum of the power supplied by any sources in a circuit must equal the sum of the power dissipated by the resistors. Said another way, the power dissipated by passive elements in a circuit *minus* the power supplied by sources in the circuit equals zero. Since power dissipated is iv, and power supplied is $-iv$ (when we use the PCS), the net result is that
$$\sum_n i_n v_n = 0 \tag{1}$$
where the sum is over all circuit elements, whether resistors, batteries, or any other type of element, *so long as we use the passive sign convention*. Equation (1) is essentially the statement of the First Law for circuits.

3. ***Why would adding the resistor make the current flow up in the battery? (1)*** Putting the resistor in the circuit allows current to flow down through the resistor, since the top terminal is at a higher potential than the bottom. Kirchhoff's current law then requires that current flows up through the battery. More on this next time.

4. ***Are we going to deal at all with mechanical systems, or just circuits? (1)*** Just circuits this term, but generic systems next term.

5. ***How do you know that the current flows away from the + terminal in a battery? (1)*** It doesn't always, but it usually does! Current in a conductor or a resistor flow from high potential to low potential, so whenever you connect a single resistor to a battery, you know that the current will flow from + to − outside the battery. However, in a battery charger, current flows the other way.

6. ***General confusion about the PRS question. Some students want it explained, others found it ambiguous. (3)*** We will cover this more in class next time. Here's the point, though: Sometimes, the current draw from a battery is so low that modeling the battery as a voltage source is perfectly appropriate. For example, the current draw in my watch is so low that the battery will last for a year or more, and the voltage of the battery is nearly constant, at least until the battery is mostly discharged. However, when I start my car in the morning, the battery voltage drops from about 12 V to probably close to 6 V. I can tell that the voltage drops, because the headlights dim when I crank the car. So in this case, the battery is not well modeled as a voltage source. So the answer is, it depends on the situation. I think that this will be clearer after we do modeling next time. If not, ask the question again next time.

7. ***Modelling, but I guess that will be explained next time. (1)*** Yup.

8. ***Is a voltage source a rectified alternating current source [a power supply], or just some theoretical, ideal component? (1) How does one physically come by a voltage source? (1) What does a voltage source look like? (1) Difference between a voltage source and a battery? (1)*** Batteries and power supplies are physical components. They are sometimes modeled as a current source, which is an ideal circuit element. Sometimes they are *not* well modeled by a voltage source.

9. ***What's the difference between V and v, and I and i? (3).***

10. ***Is a voltage source like a plug in a wall? (1)*** The receptacle in a wall might be modeled as a voltage source, or might not, depending on the situation. For now, uppercase V means the strength of a battery or a voltage source. Lowercase v means the voltage across any circuit element (including a voltage source). Later, we will use lowercase letters to denote signals (functions of time), and uppercase letters to denote amplitudes of sinusoidal signals, or the transform of signals. ***Constitutive vs. other types of laws. (1)*** I'm not quite sure what the question is. "Constitutive law" is just how we describe the equations that define a resistor, capacitor, or other circuit element. Prof. Spearing will use the same terminology for equations that describe material behavior.

11. ***Why is the flow electrons different than the flow of the current. (1)*** Current flow is defined as the net charge flow. When positive charge carriers move to the right, that's a (positive) current to the right. When electrons, which are negative charge carriers, flow to the right, that's a negative current flow to the right, or a negative current flow to the left. By the way, there really are positive charge carriers — the charge carriers inside a lithium battery are lithium ions, Li^+, which are positively charged. ***I'm taking 6.002. Is there anything that I'm going to see that is new here? (1)*** Frankly, probably not much. There is a very large overlap, and they have a lot more lectures. ***Does this set of lectures***

deal only with analog systems. (1) Yes. We won't talk about digital systems, or even nonlinear analog systems. We just don't have enough time to teach everything.

12. ***If the current through the resistor is positive, them the current through voltage source is negative?*** For the example in class, yes, but a different labeling of the resistor would have given a different result.

13. ***(Paraphrasing) Doesn't the resistor have to be labeled with its – terminal on top, so that the current i through the resistor is the same as the current i through the battery? (1)*** No! The current through the voltage source is i_1; the current through the resistor is i_2. Your labeling would give

$$i_1 = i_2 \tag{2}$$

My labeling would give

$$i_1 = -i_2 \tag{3}$$

which is not a problem.

14. ***What were the 3 symbols we won't be covering? (1)*** Among others we won't be covering are the transformer, transistor, and the diode. I'm not sure that I drew exactly those three.

15. ***General comments: I'm horrible at circuits (with little sad face drawn).*** Cheer up — my job is to teach you circuits, and I hope to succeed where others have failed! ***People learn in different ways, and interactive learning may not always be the end all be all solution.*** I agree to a point — different people do have different learning styles. There might be a few students who do worse with active learning, but the vast majority of students will do better. That's not just my opinion — it's backed up by data on thousands of students, at many different schools. Fortunately, you have access to multiple learning activities — the reading, homework, the lecture part of class, the active learning part of class, etc. ***The slides on the effectiveness of [Peer Instruction] were very interesting.*** Great! MIT is a data-driven place, so I hope that you found the data convincing.

16. ***No mud. (36)*** Good! As I said above, the pace was a little slow, so be prepared for a little faster pace next time.