Lecture S4 Muddiest Points

General Comments

In today's lecture, we finished talking about the node method. From the muddy cards, it's clear that the lecture cleared up much of the confusion about the node method, which is good.

At the end of the lecture, I gave a little Concept Test (due to Eric Mazur at Harvard), asking how the brightness of two bulbs in a circuit changes when a switch is thrown, adding a new battery to the circuit. The surprising answer is that nothing happens! There were a lot of cards on this topic. Rather than answer those cards, I'm going to do three things: (1) Post the Concept Test and solution on the web; (2) talk about the CT in recitation Tuesday; and (3) Do another CT in class on Wednesday. If there are still muddies, please ask again at that point!

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

(54 cards)

1. ***General confusion about the light bulb concept test. (19 students)*** See the general comments above.
2. ***What exactly is a node? (3)*** A node (or junction) is the point where two or more circuit elements meet. Physically, a node can be spread out — it's really all the points that are known to be at the same potential, because they are connected. So if two resistors have leads soldered together, and also soldered to a wire that is connected to one terminal of a battery, the battery terminal, wire, and resistor leads all form a single node.
3. ***How do you find out what the current is going into the voltage source? (1)*** You break the circuit, and put a current measuring device, called an *ammeter*, in series with the battery.
4. ***What is the purpose of the node variables (e's). (1)*** By working with the absolute potentials (e's) instead of the individual potential differences (v's), we reduce the number of variables in the problem significantly. At the same time, Kirchhoff's voltage law is automatically satisfied, so there is no need to apply KVL.
5. ***What is the point of a ground node? (1)*** The electric potential is only defined up to an additive constant. That means that we always have to talk about the potential at a point *relative to* the potential at some reference point. The reference point is called ground (whether it is physically the ground or not), and by definition, the potential at ground is zero.
6. ***Why do you refer to the diagram as a network rather than a circuit? (1)*** A *circuit* is "a configuration of electrically or electromagnetically connected components or devices." A *network* is "a group or system of electric components and connecting circuitry designed to function in a specific manner." The definitions are only subtly different from each other, but *circuit* is probably preferred, given the increasing importance of

communication *networks*. But I learned circuit theory from a book called *Introductory Network Theory* by Amar Bose and Kenneth Stevens. Go figure.

7. ***Need more practice with or examples of the node method. (3)*** There is plenty of practice on the problem set. See me during office hours if you still have trouble.

8. ***How do you choose the nodes in the node method? (1)*** There really isn't much choosing to be done. Every circuit has a specific number of nodes. Any one of them can be ground — choose whichever one you want. It's usually best to make ground be the negative terminal of a voltage source, if there is one. The ground node has zero potential. All the other nodes are labelled with known voltages (e.g., the positive terminal of a 12 V voltage source is at 12 V, if its negative terminal is at ground), or unknown potentials (e_1, e_2, etc.).

9. ***Don't understand signs of G/R. (1)*** The signs result from application of KCL at each node. You might try working through the example in the notes. The general pattern is always the same, though. The node potential where KCL is applied is multiplied by the sum of all conductances (resistors) it touches; the potential of nodes touched by those resistors is multiplied by the negative of the conductance that connects it to the node under consideration.

10. ***What is conductance? (1)*** It's the inverse of resistance. For any resistor with resistance R, its conductance is $G = 1/R$. Big resistance implies that the resistor "resists" the current flow. Big conductance means the opposite — the resistor conducts current well.

11. ***(Paraphrasing) You showed that at a node connected by resistors, the node voltage is the weighted average of the nodes connected to it. What can we take away from imagining it like this? (1)*** It's just one more way to gain some intuition about what's going on in the circuit.

12. ***How do we determine the sign of voltage or current sources in KCL? (1)*** I assume that you mean when we apply KCL in the node method, and move sources to the right. The point is that we always (in this class) sum the voltages *out* of a node. If a current source flows into the node, it contributes to the sum with a minus sign. When it moves to the right, it then has a positive sign. Similar arguments apply to the voltage source.

13. ***Can you go over the voltage divider again? (1)*** See the notes, where this is worked out in detail.

14. There was one question I didn't understand – I think it was a sentence fragment: ***How do you use the constitutive laws and e_1, e_2 (known) to find? (1)*** Please ask again, and I'll try to answer.

15. ***No mud. (20)*** There were some nice comments: ***"Great lecture."*** Thanks. We all appreciate positive feedback from time to time. ***"I am definitely seeing the benefits of the PRS, and you take good advantage of it."*** . Good! For many students, it's nice just to break up the lecture, but I hope it forces you to confront misunderstandings now, rather than later during a quiz. And there was this: ***"Why is Gaussian reduction the biggest pain in the tushie ever?"*** Really? It's not fun, but I can't think of a lot of things worse than Gaussian reduction.