Questions and Answers

ECE 2300 – January 28, 2014 – Dr. Dave Shattuck

Question (Q): I am unclear about counting nodes and about resistance. Can we spend some time to discuss about examples for those concepts.

Related Comment: Please give example problems after each concept. I think it will help us understand better.  
Answer (A): Most definitely, we will do examples about these topics. Doing problems in class will be an important part of what we will do. It may not seem like it, since our first class had no examples, the second class was taught by Dr. Trombetta, and the third class again had no examples. However, this is not typical of how the class will be conducted.

Since the topic has been raised, let me note that this is a continuing question, every semester: why don’t we do more examples in class? First, there is always a balance to be struck here. Some time must be spent on introducing new concepts, and some time spent showing examples of how those concepts are used to solve problems. I try to balance these two things. Second, our time is limited, and we can only do so much in class. Third, there is a sense, conveyed to you by earlier classes, that it is possible to do an example of all possible problems you might be asked. That sense is in error. The nature of engineering, where we solve new problems not solved before, is that we cannot do an example of all possible problems. Rather, we need you to move to where you are comfortable taking on unfamiliar problems. While it is important to show you some examples so that you can get the feel for the process, you need to do enough problems yourself so that you develop this comfort level. Fourth, I will always begin the class by asking if there are questions. If you have a problem you want me to solve, and it is not a homework problem for future submission, I will at least lay out the solution approach in class. You just need to raise your hand, and offer the problem.

Related Reply: Sometimes, it helps to get a couple of concepts out before useful problems can be solved. I will try to get the examples in as soon as possible.

Q: What causes KCL to become untrue?

A: When the objects we are working with become large in comparison with the wavelengths involved, then KCL starts to break down. So, as long as we work at relatively low frequencies, and with relatively small objects, then KCL is such a good approximation that we call it a law. In antennas, for example, to be effective the antenna must be close to the size of the wavelength, and KCL will no longer hold. We will assume that KCL holds for all cases we look at, in ECE 2300.

Q: Does a device with negative resistance deliver power?

A: Not necessarily. But a negative resistance itself will always deliver positive power, unless the power is zero.

Let me explain. A device is often modeled with more than one element. If it is, then parts of the model for the device could deliver positive power, and other parts could absorb positive power. Then, the device as a whole would be the sum of those parts, which could go either way.

However, if we are modeling the device with just a resistance, then positive resistance will always absorb positive power, and negative resistance will always deliver positive power. You can prove this to yourself, by combining the power rules and Ohm’s Law.

Comment: My comment is… “Hi! I think I’m going to like this class.”

Reply: My reply is… “I love this class! I hope you will, too!”

Q: What does a negative resistance do to devices in relation to conductance?

A: I am not sure I understand this question. Resistance and conductance are inverses of each other. A negative resistance means that you will have a negative conductance, because when you take the inverse of a negative number, you get a negative number.

Q: What are examples of current sources?

A: One example you may be aware of is an electric fence. They are usually set up so that they will not kill the animals that touch the fence, but shock them. Such fences can be modeled accurately with a current source. In addition, we often build current sources with op amps or transistors for particular purposes, such as in electo-plating.

I will say it again in a different way. Later, we will see that all practical sources have some resistance as a part of their model. However, often that resistance can be ignored. If it is so small that it can be ignored, we will call that thing a voltage source. If it is so large it can be ignored, we will call that thing a current source.

This will all become more clear when we get to Thevenin’s and Norton’s Theorems.

Comment: I love you.

Reply: Thank you. I love my wife. However, I am sure that I will come to like you, as I get to know you better. Also, I love teaching this course.

Comment: Dr. Dave’s voice sounds like Wallace Shawn.

Reply: I am not sure whether that is a compliment or an insult.

Q: Does negative resistance compose the function of a capacitor?

A: No. Let me say that again. NO! In a capacitor, the current is proportional to the time-rate-of-change of the voltage (a derivative). In a resistance, the current is proportional to the voltage. These two things are very different.

Comment: I am unclear about nodes. My understanding of nodes is wrong, and it is hard for me to understand how many nodes are in a circuit and pointing them out.

Reply: I told you that this course was hard. I encourage you to draw the “blobs” on your circuits. It helps me to count nodes accurately.

Q: Components meet at several places. Why are they not nodes?

A: When we are counting nodes, we assume that it does not matter how you wire the components together, so long as they are connected. The angles and positions of components do not matter to us, only how they are connected. It is a different way of looking at things, but this new way of looking will help us.

Q: If for a resistance, voltage/current needs to be constant, does that mean that it cannot be a function of time?

A: I am not sure what you meant by “it” in that question. For us, in this course, resistances will be constant, and not a function of time. Allowing resistance to change with time makes the circuit non-linear, and much harder to solve. On the other hand, voltage and current can change with time, and will change with time in this course. For resistances, the ratio of them will be a constant.

Q: Does anyone ever get an A in this class?

A: Sure! It happens every semester, at least in my experience. That is not a guarantee, but I have not had a semester yet where it did not happen at least a couple of times. In addition, if you all get an average over 90, then every one of you will get an A. I promise.

Comment: You should go over the harder problems in the homework.

Reply: As I mentioned earlier, there is a problem with limited time, and I make judgments about how to use that time. There will be homework problems that I will go over in class without your prompting. However, as I also mentioned earlier, if there is a homework problem you have submitted and want me to go over, all you need to do is ask for me to do so.

Comment: I liked your homework. I felt like I struggled just enough to learn.

Reply: Great! I am glad that it worked for you.

Q: What is the purpose of nodes?

A: They are places where we connect components together. If we do not connect our components together, they do not work as well.

OK. You probably meant, why do we need to count them? Having a count of the nodes will help us set up equations to solve circuits, and to know how many of those equations we will need.

Q: I just want to be clear. The direction of the current arrow doesn’t matter in relation to the voltage, correct?

A: Good, I want you to be clear, also. The direction of a reference current arrow is arbitrary. It does not depend on voltage reference polarities. It does not depend on resistance values, nor on the sign of the resistance values. It does not depend on the phase of the moon. It is arbitrary.

Comment: I am glad I’m taking you for this class!

Reply: In that case, I am glad I am teaching the class you are in!

Q: Do we get back our homework?

A: Yes, and it will be graded. However, we are off to a lousy start getting the TAs assigned, so there may be a longer delay at the beginning. After things stabilize, you should get it back in about a week.

Comment: I am unclear about negative resistors.

Reply: Good. There are no negative resistors. When we have positive resistances, we will call them resistors. Thus, resistors are by definition resistances with positive values.

Q: What is the example of a dependent current source?

A: A dependent current source is an amplifier where the resistance part of the model for the amplifier is enough larger than the other resistances in the circuit, that we can ignore the resistance part of the model for the amplifier.

Q: Will the sign conventions get complicated in KCL and KVL?

A: No. On the contrary, sign conventions have nothing to do with KCL and KVL. We use sign conventions in power equations, and in Ohm’s Law. Now, if you try to combine Ohm’s Law and KCL’s or KVL’s, there may be complications. However, the sign conventions only are a part of Ohm’s Law.

Q: Was there anything wrong with Question 10 on Homework 1? I got a different answer from the solution.

A: There is no nice way to say this. You must have done something wrong.

This is not to say that I never make mistakes. I do, I have, and I will. But these homework problems have been used for so long, I have come to believe that we have the correct solutions. This is a clue that you have made an error. I can tell you that a large number of people try to do those kinds of problems by assuming that the integral of a product is equal to the product of the integrals. This assumption is wrong. The integral of a sum is equal to the sum of the integrals. But it does not work with multiplication.

Comment: I am unclear about why the guy two seats to my right refuses to shut up.

Reply: I will admit that I am unclear as well. If I notice it, I will ask him to raise his hand before he speaks. You may ask me to ask him to do so in class, if you want. Or, perhaps he will read this note. Only one person should speak at one time in class. That is a class rule.

Q: Conductivity? How can we think of it? Could it be how easily charges flow through the element?

A: First, let us not talk about “elements” that way. The term you want here, is “device”.

Second, we will deal with conductance in this course, not conductivity. Similarly, we will deal with resistance, and not with resistivity. Resistivity and conductivity are useful concepts for materials, but we will consider what we called lumped parameters, or devices.

Third, yes, if the resistance is low, and the conductance is high, then the charges flow more “easily”, in the sense that you have more current for the same amount of voltage.

Comment: The cheerful readiness with which you expel, loudly and suddenly, the word “cockroach” during lectures is steadily becoming a challenge to my mental stability…

Reply: That does not sound good. Is there some other animal that you would prefer that I talk about passing current through?

Q: I am kind of confused. I think I was writing when you described what a node was. So wait, when I count nodes do I count the grouping of connecting branches?

A: Be careful. Soon we will have a formal definition for “branches”, so you do not want to be throwing that word around casually. I will stick with my definition in my notes. A node is a place where components are connected together with wires, without regard to how many wires are used to make that connection, nor of their position.

Q: How can a power plug maintain constant voltage with a sinusoidal voltage source?

A: Either I misspoke, or you misheard me. A wall plug does not have a constant voltage. It has a determined voltage. In this case, it is determined to be sinusoidal, changing with time. I may have used the word “fixed”. In this context, this does not mean constant. It means that the voltage is set by the wall plug, or determined by the wall plug.

Q: If I charge three capacitors of capacitance C1, C2, and C3, in parallel, to voltage V and reconnect them in series, what energy will I have available at the end terminals? Please express the answer in terms of energy, voltage, and capacitance.

A: First, let me note that we will not get to these topics for weeks yet, so if this question is not important to you now, you may skip this.

Second, there is more than one answer, depending on what polarity you connect the three capacitors in series. The voltage can be either V or 3V across the series combination of capacitors, with positive or negative polarity. As such, the energy which can be taken from these three capacitors by a device connected to the series combination will be either (½)CEQ(V)2 or (½)CEQ(3V)2 , where CEQ is the inverse of the sum of the inverses of the three capacitances.

Third, what made you think of this question at this point in the course?

Q: How does KCL works only at nodes? Or can it go in a closed loop?

A: KCL does not only work at nodes. It does work for nodes, but it also works for any closed surface. KCL is unrelated to closed loops. We will use closed loops for KVL. A closed loop and a closed surface are related, but completely different. My mother and I are related, but we are completely different.

Q: Can Ohm’s Law be a function of time?

A: It depends on what you mean by this. The voltage can change with time, but the current will change in time the same way. Resistance will not change with time, at least, not in this course. In this course we will restrict ourselves to resistances that do not change with time.

Comment: After covering the material needed to complete our homework, we only had 48 hours to study the material given and complete Homework 1. I believe this to be a bit to (sic) soon of a due date. Thank you.

Reply: You are welcome. I disagree, but we are allowed to disagree. I would say that you should not wait until everything is covered to look at the homework. I encourage you to look through it, and do what you can do, as soon as you can. Still, I should remind you that this course will be difficult and time consuming. We will be pushing you, hard, all semester long, and will still have trouble finishing on time.

Q: What type of questions are we allowed to ask, when you ask if we have any questions at the beginning of class?

A: It is hard to answer this. I suggest that you go ahead and ask, and if I cannot or will not answer the question, I will not answer it.

Q: Will we be able to see the solution steps to the homework after it is turned in? If not, can we ask you for explanation in office hours after class?

A: The answer to both questions is yes. I would encourage you to ask in class, if you believe that the whole class wants to see the solution. If not, I would encourage you to come to my office, and we can solve it there. However, we will not publish or hand out the solutions, because such solutions get used in future semesters, to the detriment of the those students.

Comment: In Ex.3 of the Homework the current is carrier of electrons, but it contradicts the definition in the notes. I was not understanding it contradicted the answers in the back.

Reply: No. By identifying the nature of the charge carriers, we do not contradict the definition in the notes. The definition stands, regardless of the charge carriers. Current is the **net** flow of positive charge carriers. When the charge carriers are electrons, and the current value is positive, it means that the electrons are moving in the opposite direction from the direction of the reference polarity for the current.

Again, we will not change the definition of current. Sometimes we will identify the nature of the charge carriers, and sometimes we will not. This never changes the definition of current.

I am confident that the answers at the back of the homework assignment were correct, and they did not contradict the definition of current.