

Lecture S6 Muddiest Points

General Comments

In today's lecture, I finished up the loop method. based on the mud cards, there was not a lot of confusion about this approach. I then started on Thevenin equivalent circuits. I really only got started with that topic. Not surprisingly, there were quite a few questions about this material. We will pick this up again in Lecture S7.

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

(40 cards)

1. *Please explain the difference between linear and nonlinear. (6 students)* A circuit element is linear if the relationship between voltage and current for the element (the constitutive law) is linear. For static elements (i.e, for elements not described by differential equations) with only two terminals, that means the current can be plotted as a straight line vs. voltage, or that voltage can be plotted as a straight line against current. By this definition, resistors, voltage sources, and current sources are linear. Other circuit elements, such as diodes, fuses, etc., are explicitly nonlinear. For example, a diode is nonlinear because the constitutive law is
$$\begin{aligned}v &= 0, & i > 0 \\i &= 0, & v < 0\end{aligned}\tag{6}$$
2. *Do you mean to say that all analog circuits are linear? (1)* No, I said (and meant) that all digital circuits are nonlinear. There are certainly nonlinear analog circuits. For example, there are analog circuits that can multiply two signals together. This is a nonlinear operation.
3. *Unclear generally on the last 15 minutes of lecture. (5)* Yes, sorry about that. I clearly ran out of time. We will pick this up again at the end of the week, and in recitation, if we have time.
4. *Will we be needing 18.03 for circuits? (1)* You bet! 18.03 is central to much of what we do this year.
5. *Can we use calculators to solve systems of equations, or do we have to use Cramer's rule, i.e, do we have to solve by hand? (1)* On a quiz or homework, I will let you know if you have to solve by hand. In general, you should be prepared to solve low-order systems by hand.
6. *It's not clear how to choose nodes. For example, why did we need to solve for only one node on the last PRS question? (1)* In the last PRS question, there were four nodes. One node is defined to be ground. (I chose the bottom node.) Two of the other nodes are connected to ground through voltage sources, so the potentials of these nodes are known as well. That leaves just one node with unknown potential.

7. *A little confused on node and loop methods. (1)* Some practice will help, I'm sure. Please make sure that you do all the homework.
8. *Is one method (node method or loop method) in general easier for computers to solve? (1)* No, they are equally difficult (or easy). In fact, the methods are *dual* to each other. This implies that for every circuit with a given set of node equations found by the node method, there is a dual circuit, which has loop equations found by the loop method which are identical to the node equations of the first circuit. So neither one can be intrinsically easier or harder — if I can find a circuit where the node method is hard, I can find a circuit where the loop method is exactly as hard.
9. *Did not understand the result $a_1V_1 + a_2I_6$ that you obtained from Cramer's rule. What is the importance of this result? (3)* Here's the point: For every circuit with linear circuit elements (in our case, that means resistors, but it could also mean transformers, transistors in their linear range, etc.), the voltage or current in any circuit element is a linear combination of the source (voltage or current) strengths. This result follows immediately from the fact that the equations that come from the node method or the loop method are linear in the unknown currents and voltages, and also linear in the source strengths.
10. *I'm confused about characterizing the upstream circuit to design the downstream circuit. (1)* If I ask you to design, say, a speaker, you need to know what kind of signal you can expect to get from the amplifier before it. To design the amplifier, you need to know what kind of signal to expect from the tuner. To design the tuner, you need to know what kind of signal to expect from the antenna. What we are leading up to is understanding how to characterize circuits in terms of a few parameters.
11. *Please explain the graph of v vs. i . (2)* For static, linear circuits, the relationship between current into a terminal pair and the voltage across those terminals can be described by a straight line graph of v vs. i . The plot on the board was a generic straight line — that is, one with a slope and intercept. This will happen for every linear circuit.
12. *using the v you measured from the test current on the circuit, how do you go about solving the circuit, or what are you supposed to do with that voltage? (1)* If you know the circuit inside the boundaries, you can simply solve the circuit by the usual techniques, to obtain v vs. i . If you don't know the circuit, you would have to perform an experiment to determine v vs. i . In either case, that would lead to a linear v vs. i curve (if the circuit is linear), which can be described by two parameters — the slope and the intercept.
13. *Can we get solutions to the concept tests as well? (1)* I'm working on putting all those up.
14. *No mud. (14)* Good!