

**PROFESSOR:** Today I'd like to talk to you about a new method for solving circuits. Last time, we reviewed using KVL, KCL, and Ohm's Law in order to solve circuits in a general sense. This produced a lot of equations, in particular, a lot of redundant equations or a lot of dependent equations, that we don't necessarily need for solving our circuit.

Today I'm going to review the Node Voltage Component Current method, which is very similar to node analysis. So if you hear one versus the other, know that you're talking about approximately the same thing. And I'll review the difference in a second.

Once we know how to use the NVCC method for solving circuits, we can express the relationships between components in our circuit more concisely and more effectively, and possibly solve our equations faster, which is relevant when we're working on a mid-term or in the general sense, just trying to save time. Let's take a look at NVCC.

As I said before NVCC, stands for Node Voltage Component Current. And what that means is if you have a very simple circuit-- let's say just a voltage source and a couple of resistors. Previously, with KVL, we were interested in the voltage drop around the loop being equivalent to 0. In this case, we're actually going to look at the voltages associated with particular nodes.

To do that we're going to label our nodes, which are anywhere our components connect. We're also going to go after the component current. When we're doing KCL, we typically look at the flow in and out of a particular node. At this point, we're going to look at the flow through a given component. So we're also going to label all of the currents associated with our circuit.

But when we approach NVCC method, we're going to think about the currents flowing through a particular component as opposed to and out of a particular node. NVCC is sort of the opposite of KVL and KCL in that sense, even though you're still

going to end up using the same relationships. So at this point, I've labeled the currents going through-- I labeled one individual current for every component in my circuit.

The next step would be to identify what I'm going to call ground, or in particular, one of my nodes -- I'm going to assign to ground or relative voltage 0. At that point, I'm going to write out the relationships between the voltage drop across particular components, the current flowing through that particular component, and whatever relationship the component requires the voltage and the current to have to one another.

That's a whirlwind review of NVCC method. Node analysis is very similar. The main difference between node analysis and NVCC method is when your component is a voltage source. And there are multiple currents flowing into that voltage source.

You can treat this as a single voltage. You can treat this as a single voltage node, where this voltage it has value 0. And actually write your KCL equations as though this point were collapsed. So current flowing in and current flowing out, or vice versa, have to sum to 0. That's the major difference.

Let's look at an example. You can find this example repeated in 6.4.3 of the reading. And I'm going to walk through these directions.

So the first thing I'm going to do is label my nodes and my currents. People interchangeably use  $e$  or  $n$ . It doesn't really matter. I guess  $n$  in particular could refer to the node, while  $e$  in particular could refer to the voltage associated with that node.

Now I'm going to specify the voltage drop across a particular component in terms of the node voltages. I'm also going to assign  $n_0$  to 0 as my ground. As a consequence, I know that  $n_1$  is going to be 15 Volts.

My voltage drop is typically specified in the same direction as the current - that I've also decided. So this convention is arbitrary. But if you want to be consistent in your work, and make it easier to get partial credit or get help in office hours, et cetera,

then assume that the voltage drop occurs in the same direction as the current.

That's it for our relationship associated with voltage drop. Now I'm going to go over KCL for the relevant nodes. And in the last step I'm going to combine the two into the equation that you're certainly allowed to use to express your work on midterms. Or if you can skip to the third step immediately, then that's OK. Just check your signs.

Here's the second step. Flowing into  $n_1$  is  $i_0$  and flowing out is  $i_1$ . So  $i_0$  is going to be equal to  $i_1$ . Flowing into  $n_2$  is  $i_1$  and  $i_3$ . And flowing out of  $n_2$  is  $i_2$ . Flowing into  $n_0$  is  $i_2$ , and flowing out of  $n_0$  is  $i_0$  and  $i_3$ . We're almost certainly not going to end up using that equation. Because it's the last of our KCL equations and is dependent upon the other equations that we've already written out for KCL.

$i_3$  is equal to 10 Amperes. So we can go ahead and make that substitution. I still have to work with  $i_1$  and  $i_2$  though. And I can go after expressions for them in terms of my node voltages and components by using the equations for voltage drop I made earlier.

This is the equation that you can jump straight to, if you understand where this expression comes from, as a consequence, of our KCL and also our component voltages. I'm going to substitute in 15 Volts for  $n_1$  here. And now I have an expression that only contains  $n_2$  and known values. So I can solve for  $n_2$ . and I'll do that real quickly right now.

So first I'm just going to copy this over. I'm going to multiply through by 6 Ohms. And I solved for the voltage associated with  $n_2$ .

At this point, I can solve for  $i_2$  and  $i_1$ . Sorry about that. What do I have left?  $i_3$  I know is 10 Amperes.  $i_0$  is equal to  $i_1$ , which is negative 1 Amperes.

There's a voltage drop associated with the 3 Ohm resistor, which is 15 minus 18, negative 3 Volts. And the voltage drop associated with the 2 Ohm resistor is 18 Volts, since  $n_0$  is ground. This concludes my introduction to node voltage

component current method or node analysis without the ability to collapse voltage sources for KCL.