Basic Electrical Circuits
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Lecture - 54
Nodal analysis with CCCS

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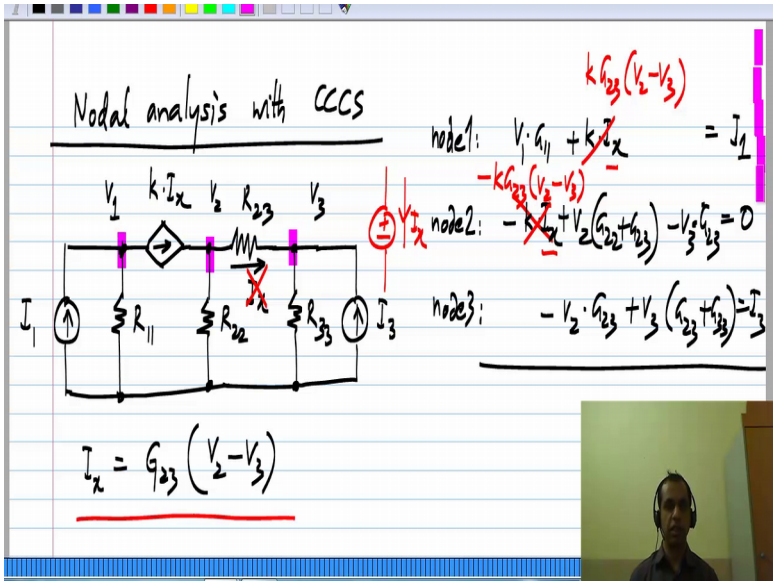

We will now consider nodal analysis with current controlled current sources. Here is the circuit, and we have a current controlled current sources k times I x connected between nodes 1 and 2. And this is I x happens to be dependent on the current through R 2 3. So, first of all, you realize that this current source appears in the equations for node 1 and node 2, because it is connected between nodes 1 and 1. So, if I write for node 1, the currents flowing away from the node, I will have V 1 times G 1 1 through this resistor plus k times I x through the controlled source to be equal to I 1, the independent source injected into node 1.

Similarly for node 2, I have to take the current flowing away from the node. So, I have the usual terms corresponding to resistors, which are V 2 times G 2 2 plus G 2 3 minus V 3 times G 2 3 to be equal to zero, because there is no independent current source pumping current into this node. And we also have this term k times I x and that pushing into the node current flowing out of the node will be minus k times I x. And for node 3, nothing has changed; it is the same equation that it always was. So, we will have minus V 2 G 2 3 plus V 3 times G 2 3 plus G 3 3 to be equal to I 3. So, we do have three equations, but we have this extra unknown here which is I x; and the primary variables, I

would like to use in nodal analysis are the node voltages. This I x is defined to be the current through is resistor. So, it can be rewritten as I x is G 2 3 the conductance corresponding of R 2 3 times V 2 minus V 3. So, in both of these, I will replace this with minus k G 2 3 V 2 minus V 3, and here also will have plus k G 2 3 V 2 minus V 3. I have three equations in three unknown, the unknown node voltages and I can solve this to get the node voltages, and after that everything else in the circuit.

You also see that this case a similar to that of a voltage controlled current source except that you have to go an extra step to eliminate the unknown current I x. As with the current controlled voltage source, one complication I have not considered is when the controlling current instead of being here, if it for through some voltage source, you would not be able to do this, you would not be able to write an equation like that, because the current through a voltage source is determined by other things in the circuit not by the voltage source itself. To analyze it properly, we have do considered auxiliary variables and that is done in what is known as modified nodal analysis, but we will not be considering that in this course. So, as far as this course is concerned when we have current controlled sources, we will be considering controlling current to be only those through resistors, not through voltage sources. Now this does not mean that such circuits cannot be analyzed, they can be of course analyzed, but we would not be dealing with them here.