Basic Electrical Circuits
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Lecture - 52
Nodal Analysis with VCVS

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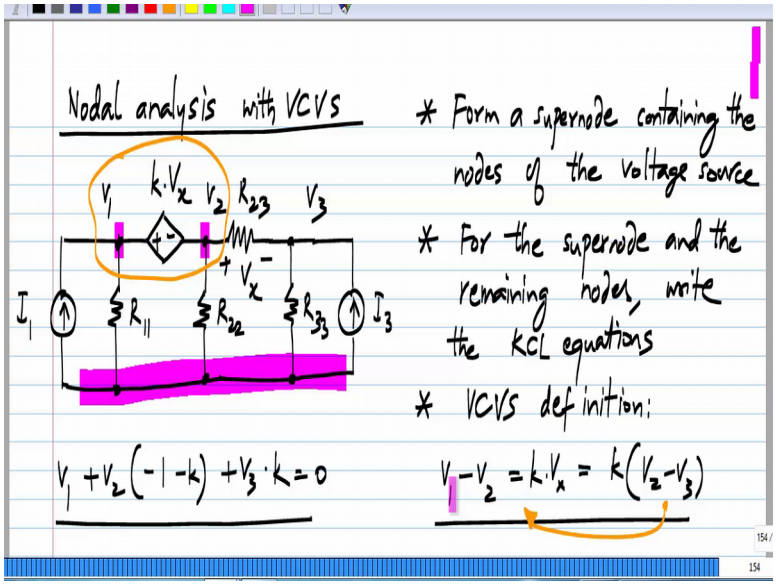

Now we will consider circuits containing voltage control voltage sources. It turns out that this is similar to the case where we had independent voltage sources. Let me take this circuit. Again for simplicity, I have taken three node circuit, and modified it slightly to contain a voltage control voltage source, the bottom node is references node. Now this case as I said is very similar to when we had an independent voltage source. Let me define the node voltage as V 1, V 2 and V 3. The problem as with the case of independent voltage source is that we do not know what current is flowing through this control source. In this case, the control sources is connected between in nodes 1 and 2, and it is dependent on voltage between node 2 and 3 V x is defined over here. Of course, in general, it could be anywhere in the circuit, we do not know what current is flowing through this.

So, as before we form a super node, what is my super node containing the nodes of the voltage source, and for the entire super node, you write the equation KCL equation as usual; and also for remaining node, you write the KCL equation as usual. For combining two nodes into the super node, we have lost one equation, but we can get an equation from the definition of the voltage control voltage source. The control voltage source is

connected between V 1, V 2; it is defining V 1 minus V 2. So, it says V 1 minus V 2 equals k times V x which itself is an unknown. So, you have to write this as k times V 2 minus V 3, following the definition of V x. Now remember in case of the independent voltage source on the right hand side, we would have the independent voltage source value; in this case on right hand side also, we have the unknown node voltages. So, we just take the entries to the left hand side, and have V plus V 2 times minus 1 minus k plus V 3 times k equal 0. All I have done is to shift this two that one.

Now in this particular case V 2 appears here and there as well, but that is not necessarily true in general, you can have that controlling node is to be completely separate from the controlled nodes. So, this is the equation that we have and the other two equations are from the super node and node 3. So, I am not going to write that down here, but you can from these three equations solve for all the variables in the circuit. I have already written on the equations in the case of the independent voltage source, this controlled voltage source is connecting in the same way as that independent voltage source. So, all you have to do is replaces the definition of independent voltage source with the definition of control source which is given here.