Basic Electrical Circuits
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Lecture - 61
Mesh Analysis with Current Controlled Voltage Sources

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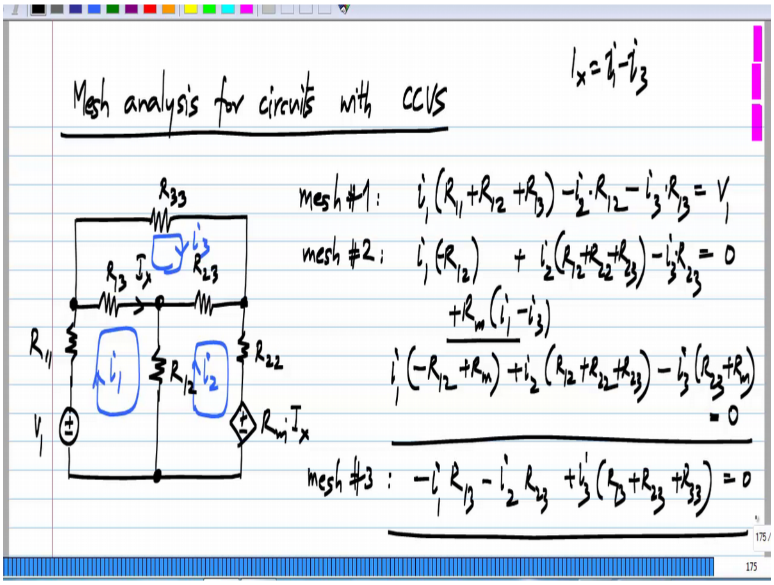

Now, we will see how to carry out mesh analysis for circuits which have a current controlled voltage source. What I have done is I have taken the same circuit as before, but replace the second voltage source by a current controlled voltage source - R m times I x, and I x is this current. Now clearly this control voltage source is in the second mesh and it is going to effect the equation only for the second mesh. So, for the first mesh equation is the same as what we had earlier that is I 1 times R 1 1 plus R 1 2 plus R 13 minus I 2 times R 1 2 minus I 3 times R 1 3 equal V 1. Now for the second mesh, the independent voltage source in the second mesh is zero, so in the right hand side will just I have a zero. The left hand side, if I ignore the control source, I will have I 2 times R 1 2 plus R 2 2 plus R 2 3 minus I 3 times R 2 3, these are the contributions from the resistors, and I will also have I 1 times minus R 1 2. So, these are the contribution from the resistors in the second mesh.

So, this is what I have but this is not complete because I have to also additionally take this voltage drop which is R m times I x. So, on the lefty hand side, I will have plus R m times I x. Now I x I do not want use another variable here, I know that this I x here in this branch equals I 1 minus I 3. So, instead of I x, we have I x to be I 1 minus I 3, so we will have plus R m times I 1 minus I 3. So, if I rearrange it, while grouping the current variables I have I 1 minus R 1 2 plus R m plus I 2 times R 1 2 plus R 2 2 plus R 2 3 minus I 3 times R 2 3 plus R m. So, this is what I will have, and you will see that this R m because I x is here, and I x equal I 1 minus I 3, R m adds to the coefficient of I 1 and subtraction from the co efficient of I 3. And for mesh number three nothing has changed I just have I 1 R 1 3 minus I 2 R 2 3 plus I 3 times R 1 3 plus R 2 3 plus R 3 3 to be equal to 0.

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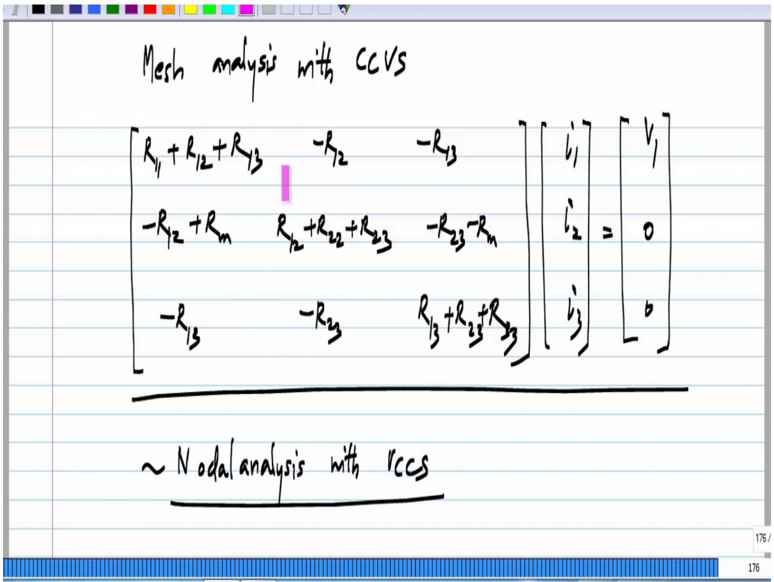

So, if I put this in matrix form, I will have R 1 1 plus R 1 2 plus R 1 3 minus R 1 2 minus R 1 3. Here I will have minus R 1 2 plus R m, which is the contribution of the current controlled voltage source, then R 1 2 plus R 2 2 plus R 2 3 and minus R 2 3 minus R m; and the third one is the same as before minus R 1 3 minus R 2 3 R 1 3 plus R 2 3 plus R 3 3 i 1 i 2 and i 3, and in this whole thing equals V 1 0 0. So, these are the mesh analysis equations, and this is analogous to the case of nodal analysis with a voltage controlled current source. What we have here is mesh analysis with a current controlled voltage source and that is analogous to nodal analysis with the voltage controlled voltage source. You can write the three node equations now the matrix becomes asymmetric, as you can see this element is not equal to that element.