Basic Electrical Circuits
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Lecture – 62

Now, I will say how to carry out mesh analysis, when we have a current controlled current source.

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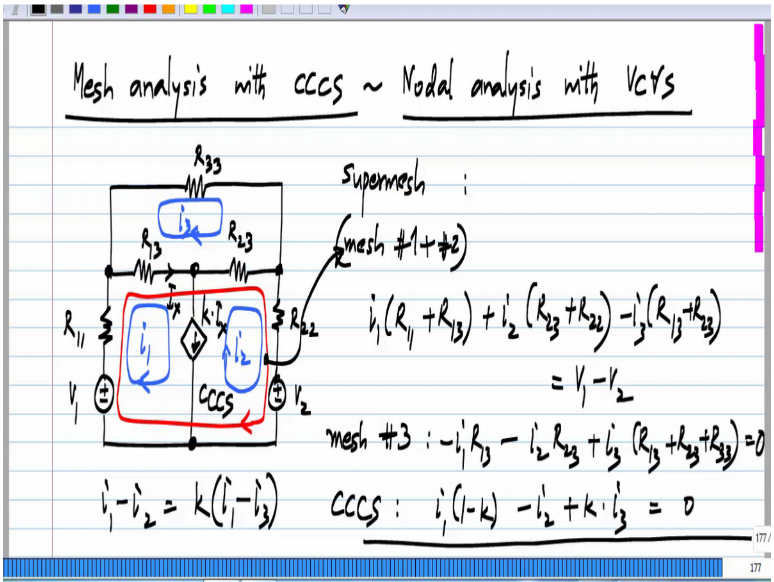

Again the circuit I have taken is similar to what I had before and earlier I had shown you, how to carry out the analysis and I had an independent current source in this branch. Now, instead of an independent current source I have a current controlled current source of value K times I x, where I x is the current and R 1 3. Now, as you can guess, this is analogous to nodal analysis with a voltage controlled voltage source. Now, because we have studied nodal analysis extensively, by making this analysis you can see the correspondence as well as reinforce your knowledge of both mesh analysis and nodal analysis.

Now, what is the problem with having a current source, whether it is independent or controlled? You do not know what the voltage across that is, when we write the equation around this mesh, we do not know what this voltage is. Without introducing an auxiliary variable for the voltage drop across the current source, it is not possible to write KVL around this. So, as with the independent current source we form a super mesh, which consists of all the meshes which share this current controlled current source and then we write the equation for the super mesh.

Now, what do we have there? We have to take the voltage drops here R 1 1, R 1 3, R 2 3, R 2 2 and equate that to the total voltage rise in the loop. So, I will have I 1 times R 1 1 plus R 1 3 that will correct I 1 is flowing through R 1 1, R 1 3 and I will have plus I 2 times R 2 3 plus R 2 2. I 2 is flowing through R 2 2 plus R 2 3, the actual current through R 2 3 is I 2 minus I 3. What I am pointing out is that, I 2 flows through R 2 3, there is an additional mesh current in the other direction through R 2 3 as well. And I 3 goes through R 2 3 and R 1 3 in the opposite direction. So, will have minus I 3 times R 1 3 plus R 2 3 and this whole thing equals the voltage rise which is V 1 minus V 2, so this is the equation for the super mesh and the third mesh is not affected by this. So, for mesh number 3 we have the same equation that we had before, this equals 0. Now, a current controlled current source itself introduces another constraint, we know that the current in this minus the current in that equals this current.

So, by combining I 1 and I 2 in this branch, we know that this current K times I x is I 1 minus I 2. So, I 1 minus I 2 is K times I x and I x itself is the current through this branch R 1 3, so it is K times I 1 minus I 3. So, if I take all the unknowns from the left side, I will get the equation for the current controlled source, which is that I 1 times 1 minus K minus I 2 plus K times I 3 equals 0. So, this is what I will have and I can of course, write that in matrix form.

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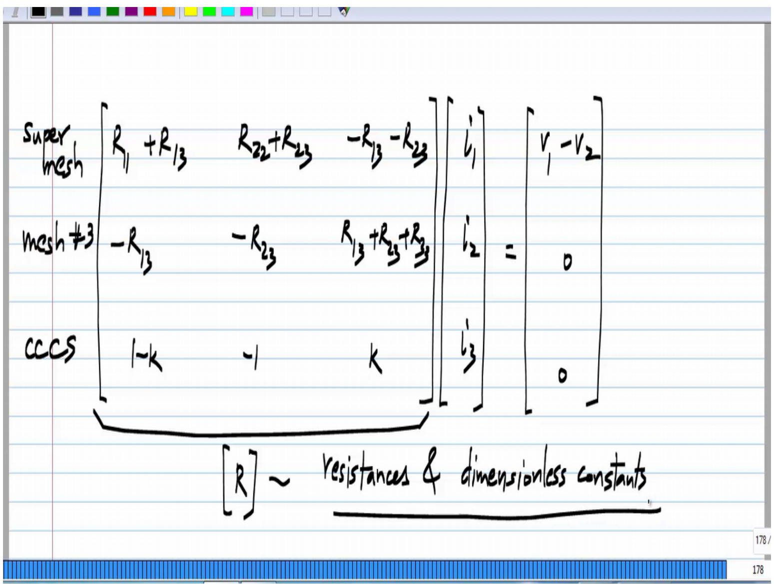

So, the first row is for the super mesh, the second row is for mesh number 3 and the third row is the constraint coming from the current controlled current source. And I will continue to call this R or Resistant matrix, but you realized that this has both resistances and dimensionless constants. So, these entries are all resistances and these entries are dimensionless constants. So, as I mention earlier, this is analogous to the case of nodal analysis with a voltage controlled voltage source. So, please go back and look at that case and understand the similarities between these two.