Basic Electrical Circuits
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Lecture – 58

We have defined the planer circuits and measures, now we will carry out mesh analysis.

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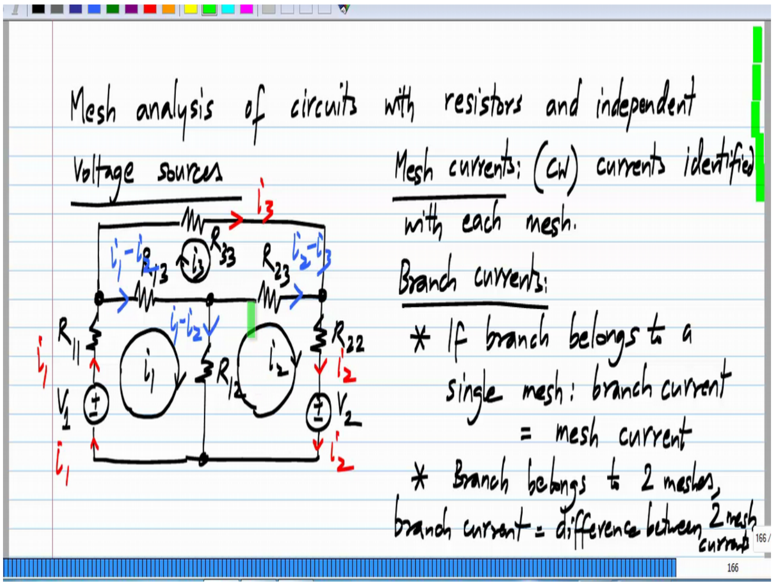

The first type of circuit will take, will be circuits with only resistors and independent voltage sources. You can see that this is out of the counter pat of nodal analysis, where we first look circuit with only resistors and independent current sources that happen to be the most convenient case for nodal analysis. Similarly, for mesh analysis the circuits with resistors and independent voltage sources are most convenient. Let me take a particular circuit and let me label these V 1, may be R 1 1, R 1 3, R 1 2, R 2 3 R 2 2 and R 3 3 and I will label that V 2.

We then clearly see that there are 3 measures, one is here, another is there and another is over there. So, the cleaner circuits identify these things is very easy. Now, what I will do is, I will define current variables, these are known as mesh currents and by convention, I will take this currents to be flowing in a positive direction. So, let me call this mesh current i 1, I will explain what they mean and this mesh current i 2 and this one as i 3.

Now, what does it really mean? So, I will take each mesh and in that mesh, I will identify a current. Now, what is this? The branch currents are related to these mesh currents. So, if a branch belongs to only a single mesh such as this R 1 1 and V 1, which belong only to this mesh number 1, then the current through these is equal to the mesh current. So, the mesh currents are clockwise currents identified with each mesh.

Now, the currents in the branches, if the branch belongs to a single mesh, then the branch current equals the mesh current, let me identify those. So, current through R 1 1 and this direction will be i 1. We have not the calculated value of i 1, mind you that will come later, but I am only relating the current in each branch to mesh currents. I have already identified the mesh currents, now I will write each branch current in terms of those mesh currents.

This is somewhat like a taking node voltages and then, relating voltages of each branch to the node voltages. So, that is also i 1 and here i 2 you take it in the proper direction, current through R 2 2 will be i 2 and current through V 2 will also be i 2. Similarly, current through R 3 3 will be i 3 in this direction, value of i 1 and i 2 and i 3 will be solved for later. Now, if a branch belongs to more than one mesh, we know that the branch can belong to at most two meshes, the branch belongs to two meshes, then the branch current equals the sum of individual mesh currents.

Because you take all mesh currents to be in the clockwise direction, basically in the same direction what happens is that a branch can belong to two meshes and the branch current will be the algebraic sum of i 1, which is flowing downwards in R 1 2 and i 2 which is flowing upwards. It will always be like this, one of them will be flowing in one direction, the other one will be flowing in the opposite direction. So, the branch which belongs to two meshes will have it is current to be the difference between two mesh currents.

For instance, the current through R 1 2 will be a 1 minus i 2, the current through R 2 3 will be i 2 minus i 3, the current through R 1 3 will be i 1 minus i 2. So, these are the branches which are common to more than one mesh and their currents will be the difference between two mesh currents. Now, you see also the analogy between nodal analysis and mesh analysis. In nodal analysis, the voltage across any branch will be either one of the node voltages, if the branches connected between some node and the reference node, then the voltage across the branch will be one of the node voltages that you solved for.

If the branch is connected between two nodes neither of which is the reference node, then the branch voltage will be difference between two node voltages. Similarly, in mesh analysis if the branch is on the periphery of the circuit; that is if it belongs to only a single mesh then it is current will be equal to the mesh current and if the branch belongs to two meshes, then it is current will be equal to difference between two mesh currents.

Now, one difference though is that, unlike node voltages the mesh currents may not represent a current flowing anywhere in the circuit. What I mean by that is, node voltages you can always measure with a multi meter; that is, let say you have a voltage between some node x and the reference node, you take a voltmeter and place it between node x in the reference node and you will measure that voltage. Now, if you have a mesh current, then that may not be any of the branch currents; that is that current may not be flowing anywhere in the circuit.

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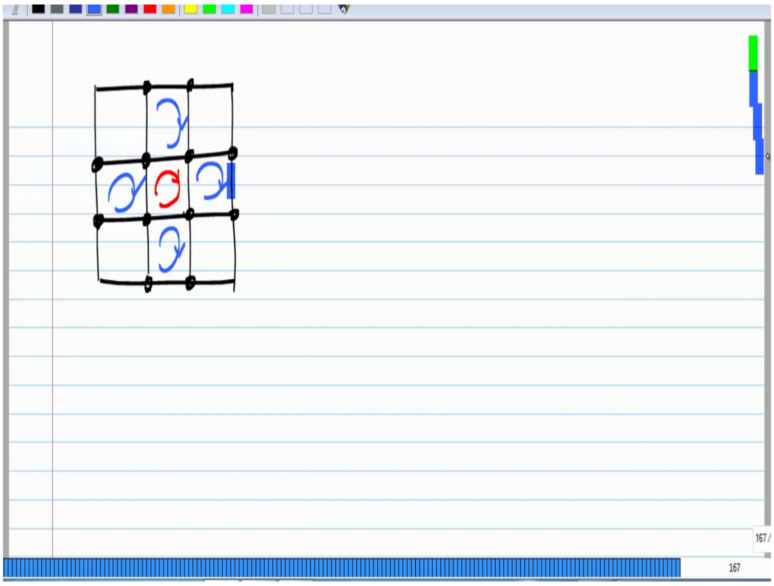

For instance, let say I have a circuit like this, where I have a circuit whose graph looks like this. These are all nodes, but of course, here I am concern with currents. So, let say you take the current in the inner most mesh and if you look at these four branches, which enclose the mesh, their currents will not be equal to this mesh current. Their current will be this mesh current minus some other mesh currents, like this one or this one or this one or that one.

So, this mesh current if you see you cannot measure this particular mesh current in any branch of the circuit. So, in a way it is like an auxiliary variable, which may or may not be found in the circuit. If you have a mesh current belonging to an outside mesh; that is a mesh on the outside something like this, then this mesh current can be measured by measuring that branch current, whereas for the red one that is not possible.

But, as far as finding the solution to the circuit is concerned, these variables will work just fine and we can go ahead with mesh analysis just like we did with nodal analysis. So, I hope you have understood the definition of mesh currents. You of course, take them always in the same direction and by convention, I will take them in the clockwise direction and from that, you understand that every branch current is either equal to a mesh current or difference between two mesh currents.