Basic Electrical Circuits
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Lecture - 57
Planar Circuits

We had looked at nodal analysis which is the way of analyzing circuits in general, and it can be scale to any size of circuits. It is a way of systematic writing down the equation for the circuit, so that it can be solved by matrix inversion. Now instead of starting from KCL at nodes of the circuit, you can also start from KVL around loops. Now unlike nodes loops are ambiguous that is you can take the same circuits and come up with two different sets of loops or multiple different sets of loops, which are all independent, but different from one another. So, what will be looking at is a particular variant of loop analysis which applies to only a subset of circuits; it is not universally applicable to all circuits and that is known as mesh analysis.

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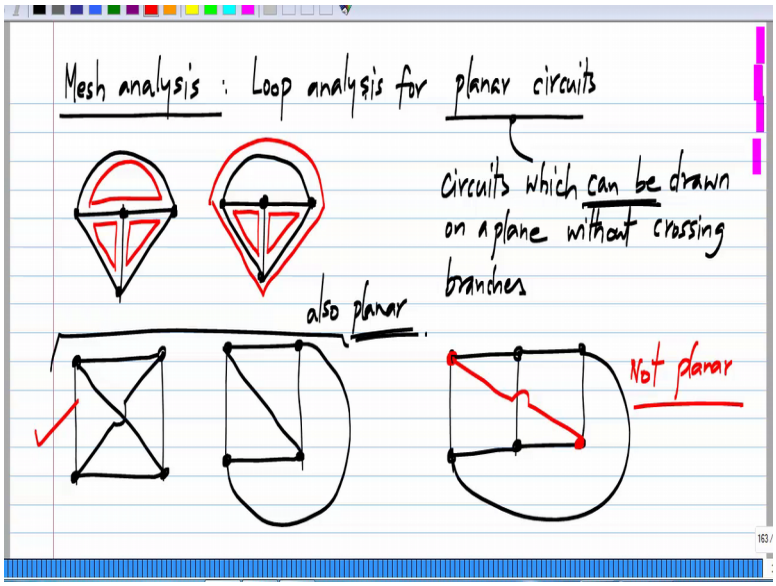

It is basically variants of loop analysis for what are known as planer circuits. Like I said earlier let me take the graph of a circuit and show you how one can choose multiple different loops around which to write Kirchhoff voltage law. So, let say this is the graph of a circuit this means that each of these four points is a node, and these branch contain some two terminal element. So, now, let say I could choose this loop that loop, and this

loop. Alternatively, we could also choose this loop, this loop and this entire thing. So, we need to write three loop equation for this circuit. These are two possible way of doing it; there are more ways as well; given this there is certain ambiguity. Now this mesh analysis eliminates that ambiguity; this is only for convenient, we can do loop analysis in general for any circuits. But for a couple of reasons, firstly, that nodal analysis is more preferred one and with all this ambiguity loop analysis looks complicated I will not deal with that I will only talk about mesh analysis.

Now, what are planar circuits, where we simply put their circuits which can be drawn on a plane like a piece of paper or this clean that I am drawing on without crossing branches. For instance, this particular graph, you see that node two branches are crossing each other. So, this is defiantly a planar circuit. Now the key word here is that circuits which can be drawn in this way not how you choose to draw the circuit for instance, the classic example is this looks like these two branches here are crossing each other, but I do not have to draw at like that. I could have drawn it that way, so this also a planar circuit. But take this circuit for instance now so far this is planar let say connect a branch from this node to this node. You can easily see that however, I will draw it, it will have to cross another branch, so this is defiantly not planar. So, the mesh analysis I am going to describe will apply only to this type of circuit.

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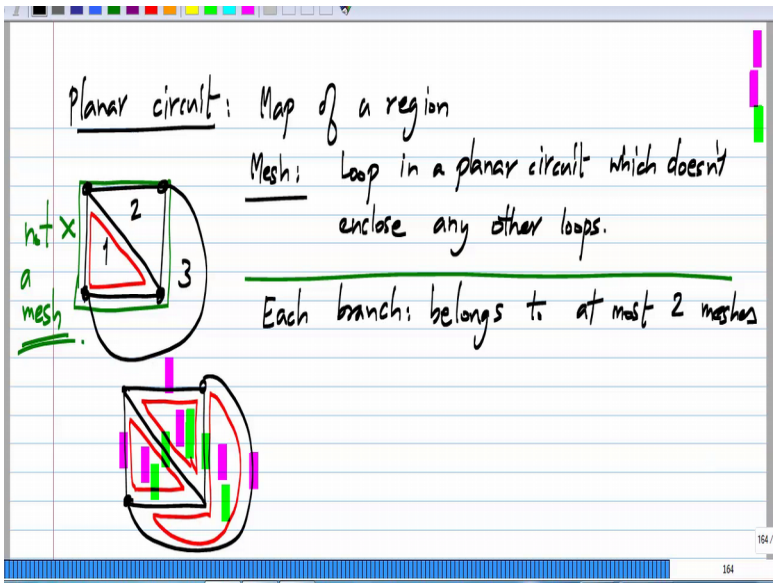

Another way to think about it is that a planar circuit is like a map of the region map of the country, which can be drawn on a plane and you would not have boundaries crossing each other that is we have this, this is like a map. Let say this is a country and you think of it as having three different states, and any branch will be common to utmost two of these regions or two of these states. So, a mesh is a loop in planar circuit, which does not enclose any other loops that is for instance, this is a mesh consistence of these three branches this one, this one and that one. Whereas this is not a mesh, because inside this loop you have another loop, so that is not a mesh. Basically it is a loop bounded by branches, but inside that there should not other branches no other loops. So, you can think of the planer circuit as a map of a country and each mesh has one of the state of a country.

Now, with these definitions, you see that each branch it belongs to utmost two meshes. Again redrawing the circuit, let us identify the meshes first when you have meshes there is no ambiguity at all there is only one way to identify of meshes that is the advantages of this. I mean that is the simplicity of it that is why I am going to deal with that. Now as I said loop analysis can be carried out in general, but I would not do that in this course. So, there are three meshes here and you can see that for instance, this outside branches they belong to only one mesh; for instance, this branch belong only to that mesh this one belong only to that one this one belong only to that one. Now you have this branch which is common to this particular branch is common to this mesh and that mesh. Similarly this one is common to this one and that one.

So, each branch is belongs to either a single mesh, if it on the periphery or it can belong to two meshes, if it is boundary between two meshes. Now by the way once you have drawn the circuit, identifying the meshes is an ambiguous you see each region enclose by loop of branches and that is a mesh and of course, you just make sure that there are no further loops inside this loop, but the same circuit can be drawn in different ways. So, that still that gives you some ambiguity, but once you have drawn the circuit, there is no ambiguity about the meshes.

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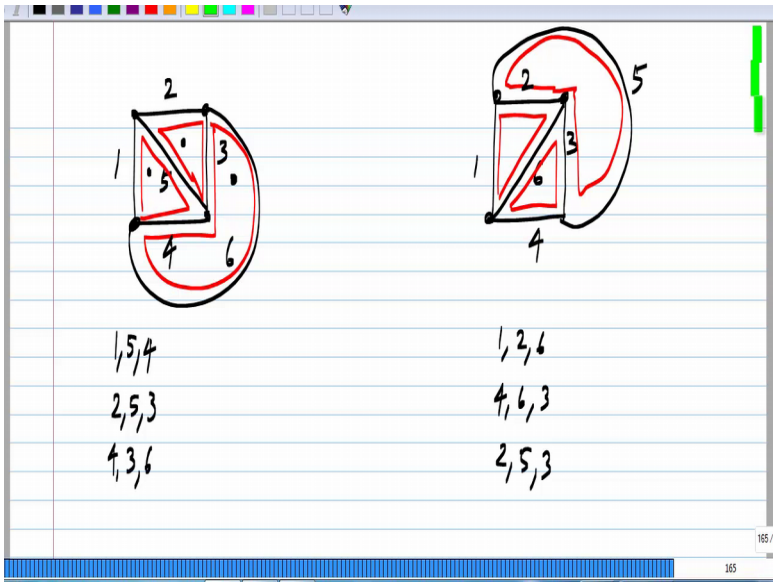

What I mean is let me redraw the same circuit in two different ways and also identify the branches. Let me name this 1, 2, 3, 4, 5 and also 6. And you see that the exact same circuits can be written as that well number them the same now this is 5 and that is 6. The meshes here are these regions, this node contain any other loops. So, there are three measures consistence of branches 1, 5 and 4 that is this 1 then 2, 5 and 3 that is that one and 4, 3 and 6 that is and in this if identify the meshes this is how it is going to be and now this meshes will be consisting of branches 1, 2 and 6, 4, 6 and 3, and 2, 5and 3. So, there are different measures of course, you analysis it using these measures or those measures, you will get exactly the same answers, but the intermediate variables that you have used in the circuit will be different.

So, you have to assume that the circuit is given to you in some way already drawn properly as a plainer circuit and from that you identify the meshes without changing anything that is the definition of planar circuit and meshes. So, using mesh currents as variables; with nodal analysis which was node voltage as variables and solve for them. In mesh analysis we will use mesh current as variables and solve for those variables; from that we able to get all other current and the branches. We will be able to get the current in all branches and from that voltage in all branches using element relationships.