Basic Electrical Circuits
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Lecture – 90

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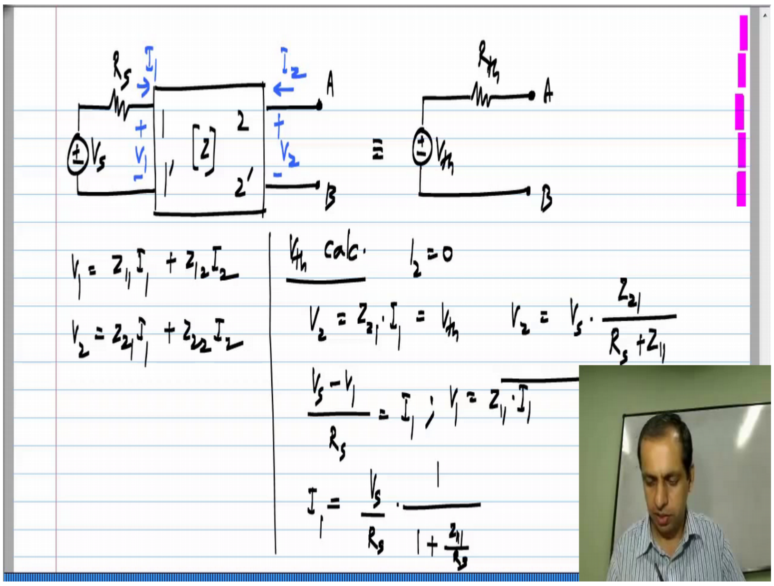

Now, I will show you another one, these cases could be lot more complicated, but for simplicity I will use something similar to what I had earlier. Let say you are given this whole circuit and you are asked to find the Thevenin equivalent between the terminals A B, that is we need to find the Thevenin voltage and the Thevenin resistance between A and B and that also can be done in terms of the two port parameters. So, in this case let me assume that, the two port is described by Z parameters instead of y parameters.

So, what will I have? I have this V 1, I 1, V 2, I 2 and I know that V 1 is Z 1 1 I 1 plus Z 1 2 I 2, V 2 is Z 2 1 I 1 plus Z 2 2 I 2. I need to find the Thevenin voltage, that is I do not connect anything between A and B, I have an open circuit and find V 2. In this particular circuit, if you have an open circuit between A and B, I 2 will be 0. Now, this is not necessarily always the case, this is the case in this particular example. So, for V t h calculation, in this circuit I 2 happens to be 0 that may not always be the case.

For instance we could have some load connector here, in which case I 2 will not be 0. So, V 2 will be simply Z 2 1 times I 1 and that is V t h, the open circuit voltage that appears here. Now, what is I 1, that we can find out from this side. We know that V s minus V 1 divided by R s is I 1 and also we know that V 1 is Z 1 1 I 1, because I 2 is 0. So, putting these two things together, we will get I 1 to be V s by R s times 1 by 1 plus Z 1 1 by R s. So, this is what comes out of the calculation and V 2 will be simply Z 2 1 times this value. So, it is V s times Z 2 1 divided by R s plus Z 1 1. In this particular case, it happens to be V s times Z 2 1 by R s plus Z 1 1.

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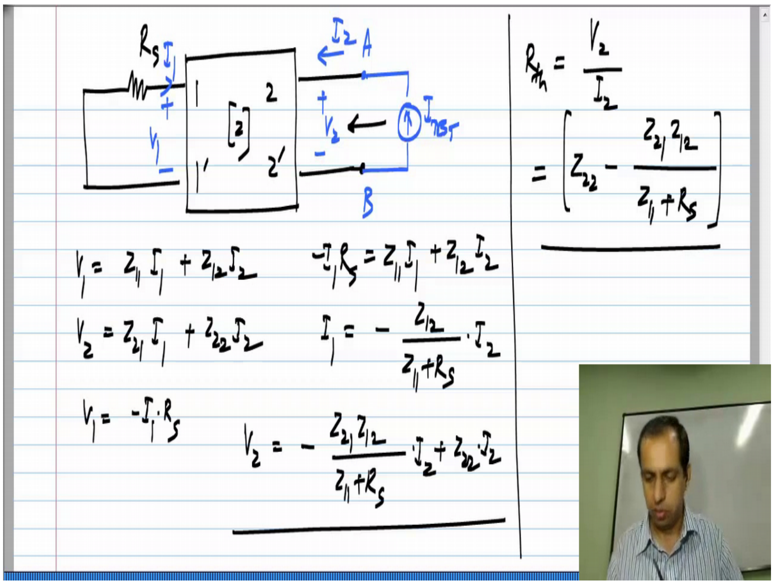

Now, we also have to find the Thevenin resistance, for that we set the independent source V s to 0. We have R s and we have to find the resistance looking back in to this one that is for instance this is v 2 and this is I 2. We can think of injecting either a voltage or a current source, this has nothing to do with what parameters set we choose. This is described by Z parameters, but I could apply a voltage source on this side.

It is only for measuring the parameters that we apply a current source in case of Z parameters. So, let say I do apply a current source I test, clearly you see that I 2 is exactly equal to I test. So, what I need to find is the ratio v 2 by I 2, that is the resistance looking back between the terminals A and B, I also have this V 1 and I 1 over there. Now, again we have V 1 is Z 1 1 I 1 plus Z 1 2 I 2 and v 2 is Z 2 1 I 1 plus Z 2 2 I 2.

Now, because we have this resistance here, we have a relationship and force between V 1 and I 1 by ohms law. So, V 1 is minus I 1 times R s, this is because of the direction of variables chosen; I 1 is flowing out this, whereas V 1 is defined with this polarity. Remember, we need to find V 2 by I 2; that means, we have to eliminate V 1 and I 1 from these two equations. So, if I substitute this I will get minus I 1 R s is Z 1 1 I 1 plus Z 1 2 I 2 and from this, I get I 1 to be minus Z 1 2 divided by Z 1 1 plus R s times I 2 and

I will substituted in the other equation.

I will get V 2 to be Z 2 1 times I 1, which is minus Z 2 1 Z 1 2 by Z 1 1 plus R s times I 2 plus Z 2 2 times I 2 and the Thevenin resistance which is nothing but, V 2 by I 2. I 2 is the same as the I test and V 2 is the voltage developed, wherever you apply I test. This will come out to be Z 2 2 minus Z 2 1 Z 1 2 divided by Z 1 1 plus R s. So, that is what we are going to have.

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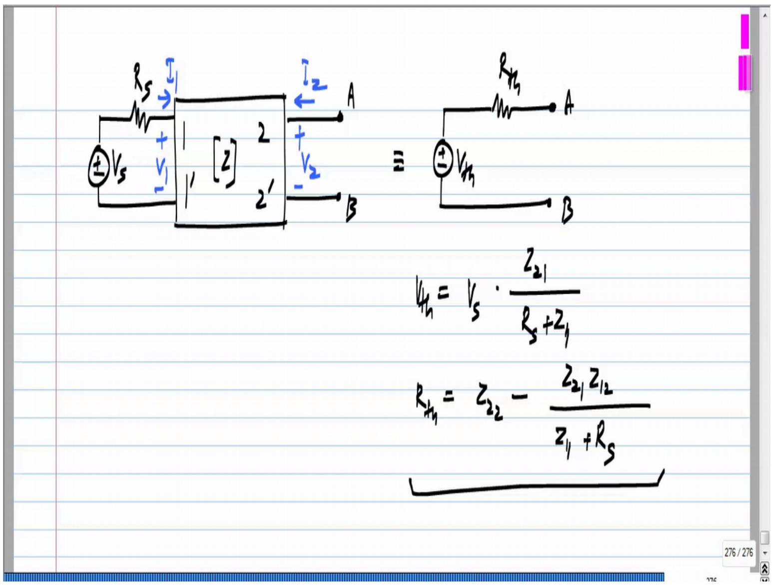

So, this whole thing, it could even be lot more complicated than this, it is equivalent to a Thevenin source and series with the Thevenin resistance, where the Thevenin voltage source is given by V s times Z 2 1 by R s plus Z 1 1. We see that it is depended on this network as well as the voltage source and resistance connected to it and R t h is Z 2 2 minus Z 2 1 Z 1 2 divided by Z 1 1 plus R s. So, we can have a two ports and some circuit using the two ports and the whole thing can be represented as by it is Thevenin equivalent circuit.

So, there are many more calculations you can do, the principle is always the same. You use the two port parameter and the relationship implied by them that is, you have the voltages and currents for the two port and you have some relationship between the voltages and currents. And also the circuitry that you connect outside of the two ports will impose some relationship between some of these variables by solving for all of these equations and eliminating some variables, you can find whatever you want.