Basic Electrical Circuits
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Lecture – 27

In units 3 and 4 we have looked at elements connected in series and parallel and also the use of controlled sources. I will talk about what example involve these aspects and this is the kind of problem that you expect in the assignment for these 2 units.

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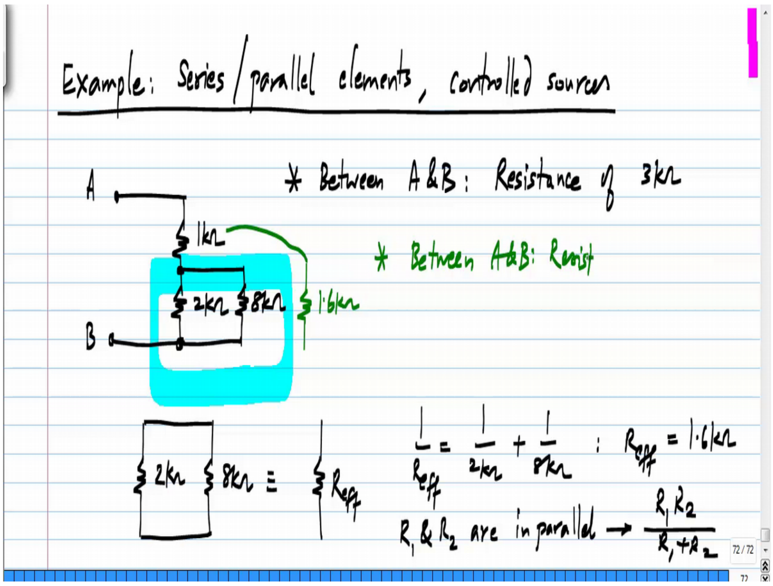

Now, let us take a very simple case, circuit like this with two resistors and series and any kind of question can be asked about this. For instance, one could ask you what the equivalent circuit is between the nodes A and B. It clearly looks like a resistance of 3 kilo ohm. Because, may I already discussed this, that the series combination of number of resistors essentially looks like the sum of all the individual resistors.

Now, we could complicate the circuit by having another resistance in parallel. So, again there are number of ways to solve this, but the easiest is you recognize that, we have a parallel combination here and that parallel combination looks like a single resistance. Now, if I call this the effective resistance 1 over R effective will be 1 by 2 kilo ohms plus 1 by 8 kilo ohms. By the way, for two resisters in parallel you are probably already familiar with the formula, if R 1 and R 2 are in parallel they result in a single resistance value R 1 R 2 by R 1 plus R 2.

This comes from the general relationship we evaluated earlier, that the reciprocal of the effective resistance is the sum of reciprocal of individual resistances. So, if you calculate this, in this case R effective turns out to be 1.3 kilo ohms. So, this entire combination equal 1.6 kilo ohms and in series with that, we have this 1 kilo ohm. So, in the new circuit when we have the 8 kilo ohms resistor also, we have an effective resistance of 1.6 plus 1 which is 2.6 kilo ohms, so it is quite simple.

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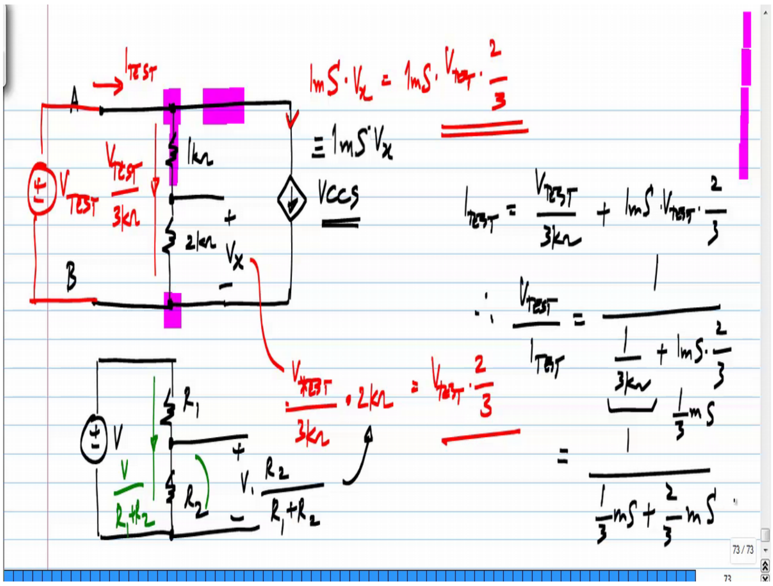

Now, I will show another simple example with control sources. Let say this is A and B and I will still ask the same question, what is the resistance between A and B, what the actual question could be something else. You could have a voltage source there and you could be asked to find some current and so on, all those can be carried out equally easily. Let me define this voltage as V x and I will defined a voltage controlled current source, which is 1 millisiemen times V x.

Again I ask, what is the equivalent between the nodes A and B and this is the standard way for finding the equivalent for any circuit, apply a voltage and find the current. Of course, you could apply current source and find the voltage, in this case I will consider applying a voltage. Now, clearly if I have a V test, it is applied across this series combination of two resistors.

So, the current that flows here is given by V test divided by the total resistance between these two, I am only looking at this series branch which consist of these two resistors. So, that will be V test divided by 3 kilo ohms and this V x would be the current flowing through that times the voltage, which is V x V test divided by 3 kilo ohms times 2 kilo ohms, which is V test times 2 by 3. This is nothing but, the voltage divided formula which you are most likely familiar with.

If I have V and R 1 and R 2, across this I will have V times R 2 by R 1 plus R 2. So, that is exactly what I get and the way to derive this formula is to realize that current through this is V divided by R 1 plus R 2 and that current times this resistance is the voltage across R 2. Then, this control current source draws a current which is basically 1 Millisiemens times V x, which is 1 Millisiemens times V test times 2 by 3. So, all I did was substitute the value of V x in this place.

So, now, the total current I test is equal to the current flowing here plus the current flowing there. So, I test will be equal to V test divided by 3 kilo ohm plus 1 Millisiemens times V test times 2 by 3. Therefore, V test by I test while turn out to be 1 by 3 kilo ohms plus 1 Millisiemens times 2 by 3, which this part you realize is 1 by 3 Millisiemens. So, this is 1 by 1 by 3 Millisiemens plus 2 by 3 Millisiemens.

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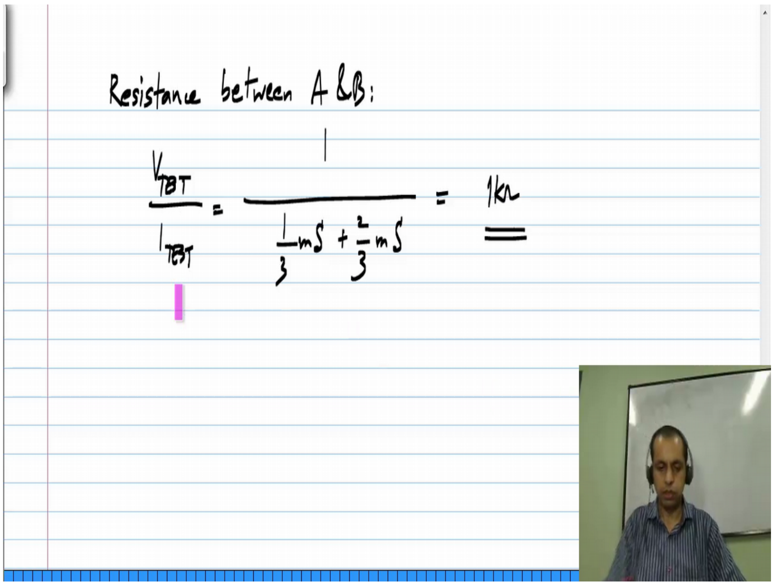

So, the effective resistance between A and B is V test by I test, which is 1 by 1 by 3 Millisiemens plus 2 by 3 Millisiemens which is basically 1 kilo ohm. So, now, you could be asked number of other questions, for instance ((Refer Time: 09:09)) you could be asked the current flowing through this branch or this branch, or the circuit could be a little more complicated and you could be asked for currents and voltages elsewhere in the circuit.

But, once you are able to apply the voltage source and carry out these calculations, you should be able to find any of those quantities. So, in this particular example the effective resistance turns out to be 1 kilo ohm.