**Basic Electrical Circuits**
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**Lecture – 70**
**Substituting a Voltage or Current Source with a Resistor**

We have seen the substitution theorem where an element can be replaced by a voltage source or current source. And the value of the voltage source or current source should be exactly same as the voltage or current that was present in the element that is the voltage source value should be equal to the voltage across the element or the current source value should be equal to the current through the element, so that is the substitution theorem. Now it always works this way, you can substitute any element with the voltage source, whose value equals the voltage across the element and similarly with the current source.

Now the back substitution is the also sometimes is possible that is you can take voltage source substitute that with the resistor for instance that is very much possible. Now the only condition is that for this to happen, you should have the voltage source to be dissipating power. So, if the voltage sources generating power and you replace that by resistor first of all the resistance will have to be negative and it does not always work. But if you have a voltage source which is dissipating power or a current source which is dissipating power substituting that with the resistor, it will always work.

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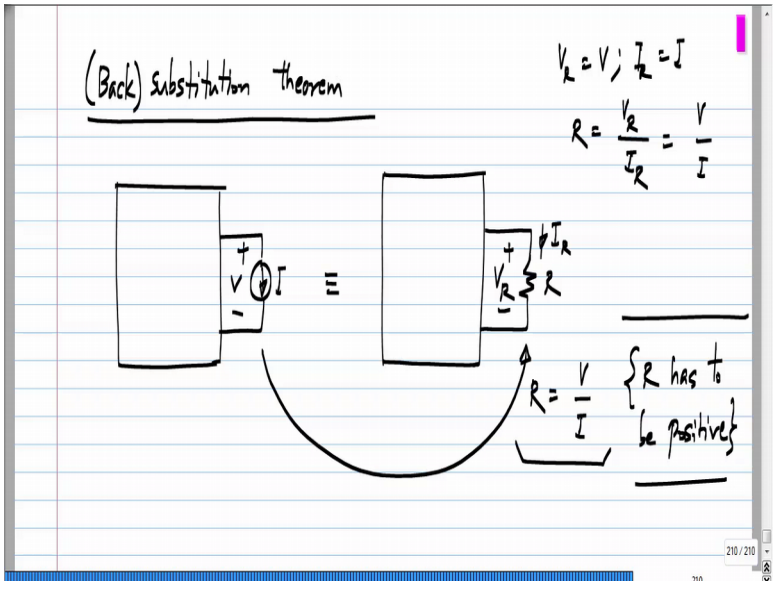


Let us see what that substitution should be, this is also substitution theorem, but we can

call it the back substitution theorem. And let say I have a current source I with a certain V across it then what I am saying is that this can be replaced by a resistor. Now what should be the value of the resistor, let say the voltage across the resistor is V R and the current through the resistor is I R. And we want V R and I R to be exactly the same is V and I. So, we want to substitute this current source with the resistor without altering any voltage or current in the circuit. So, V R must be V and I R must be I. We also know that the resistance R is V R divided by I R which has to be equal to V by I. So, if I have a current source with the voltage V across it, I can replace that with a resistor where the resistance value equals V divided by I. So, this is how you can find the value of the resistance, but the one condition is that this resistance has to be positive.

So, this is the sufficient condition, it turns out that if you substitute current sources which are dissipating power with positive resistors, the substitution always was meaning none of the voltages and currents in the circuits will be altered. Now the other way around, when the current source generating power, which corresponds to an equivalent negative resistances that is sometimes is works, but for now we will just restrict that. So, if you go and replace the every independent source in the circuit with positive or negative resistors, it will not work because of some other conditions, we would not go into that here.

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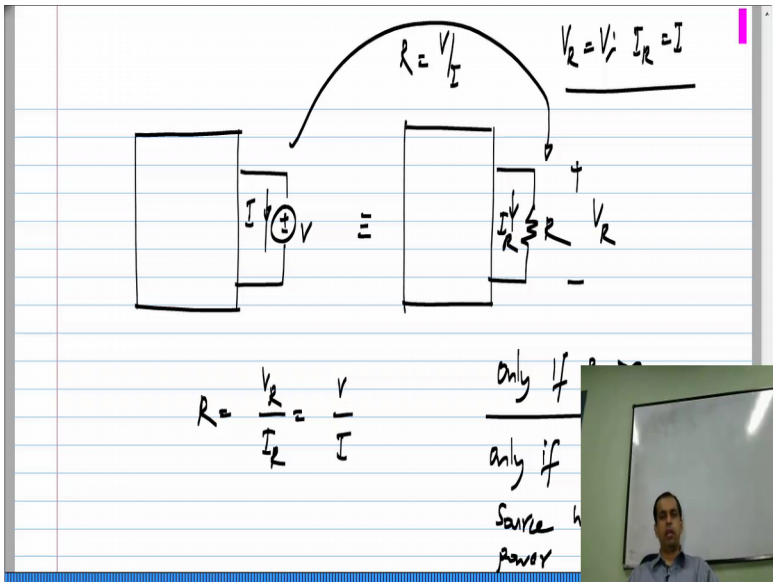


Now, quickly we can deal with other case as well where I have a circuit with some voltage source V and let say this voltage source V happens to have a current I through it. I say that the voltage source V can be substituted by a resistor. Now what should this

resistor be again we want the voltage across the resistor V R to be exactly the same as V, and the current through the resistor I R to be exactly the same as I. So, V R equals V, and I R equals I. So, the resistance value which is V R by I R has to be equal to V by I. So, when I substitute a voltage source with the resistor, I have to substitute with the resistance, whose value is V by I. where V is the value of the voltage source and I is the currents through the voltage source with the appropriate sign convention the passive sign convention. Again we will say that this has to be done only if R is greater than 0 so that means, that only if the original voltage source was dissipating power so that is how the variant of a substitution theorem and sometimes this is useful to come up with circuits where if you end up of a too many current sources, you can replace the some of them with resistors.