Basic Electrical Circuits
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Lecture – 123

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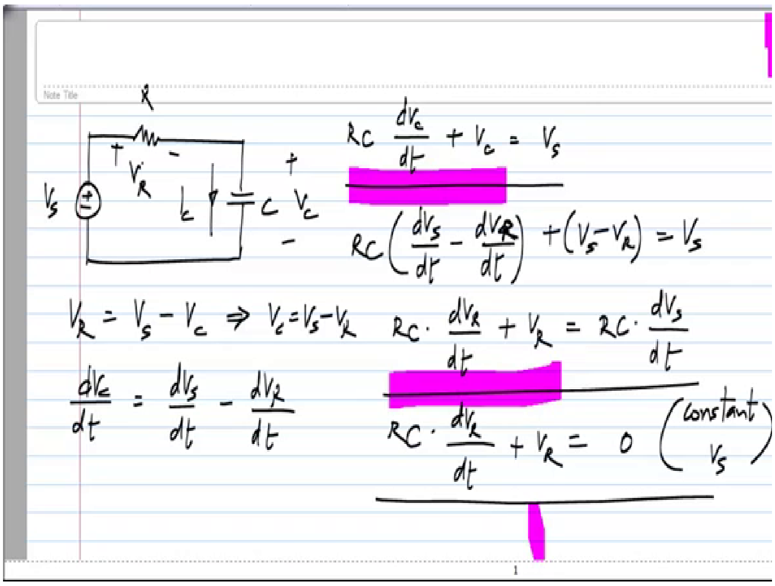

Let me get back to the original circuit what was the differential equation governing this in terms of this V c by the way I could have return the differential equation in terms of some other variable, let say the current I c or the voltage V R and so on. What you will get in that case please do that? Please derive the differential equation with I c or V R's variables and compare it to what I am going to work out by the way the differential equation for this V c was what was it. So, that is what it was this is the differential equation governing the circuit, then it is return in terms of V c the capacitor volts.

Now, let us right the differential equation for the circuit in terms of other possible variables such as the voltage across the register V R or in a current through the capacitor I c. So, we see that V R is nothing but, V s minus V c, so this comes from Kirchhoff's voltage law. So, then from this we see that V c is V s minus V R. So, now, differentiating both sides what we will get is that the derivative V c equals the derivative of V s minus the derivative of V R and substituting these two relationships into that one we get the following R C times that plus d v R by d t plus V s minus V R equals V s.

So, this if you rearrange the terms you will see that it is R C times d v R by d t plus V R equals R C times the time derivative of V s. And if we do know that V s is a constant we will get R C times d v R by d t plus V R equals 0. So, this is if you know that V s is a constant. So, the important thing to note is that the left hand side of that and the left side of that there in the same form. So, the coefficient of first derivative of is R c and coefficient of V R is 1.

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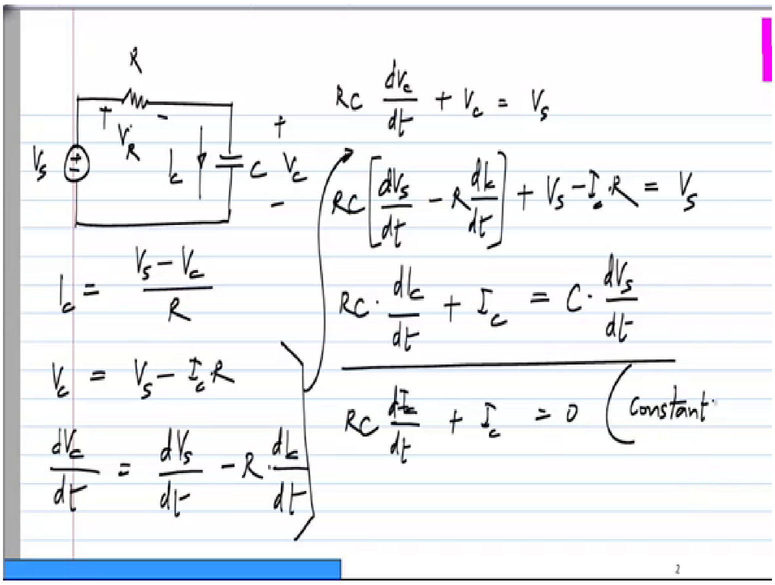

Now, we can also now we can tried in terms of I c and it will be similar I c is nothing but, V s minus V c divided by R and if I write V c as see that it is V s minus I c times R. So, time derivative of V c is time derivative of V s minus R time derivative of I c and if I substitute these two in there what will I get R C times d v s by d t minus R d i c by d t plus V c which is V s minus I c times R and the right hand side we have V s and if you rearrange this we will end up with R C d i c by d t plus I c equals C times d v s by d t and again if V s is known to be a constant we have R C d v s by d t plus I c equals 0.

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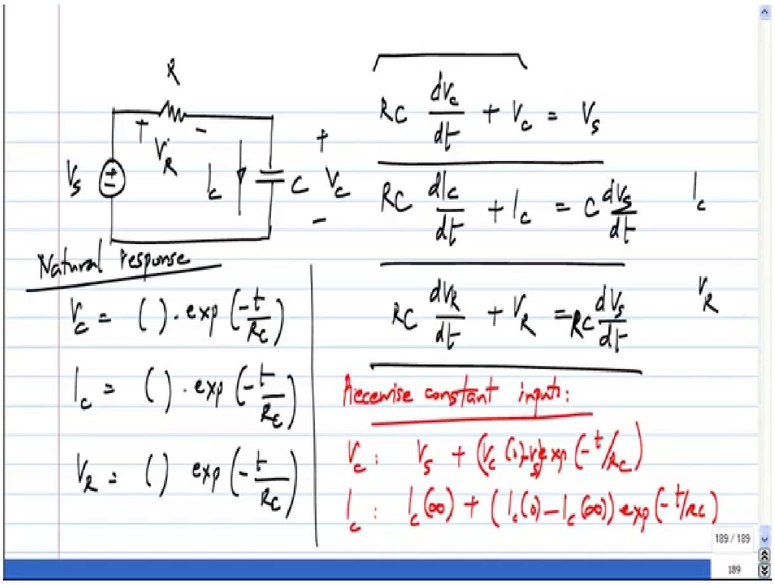

Fine, I have written all three with to variables on the left side and the source on the right side. So, what you notice what these three differential equations anything or no.

Student: ((Refer time: 05:13)).

Left hand side is the exactly the same the homogeneous parts of the differential equation are the same and this is a general property of any circuit. Now, it is not that earlier we found the solution for the capacitor voltage as V s plus V c l 0 minus V s explanation minus t by R C. Now, if you look at this left hand side is exactly the same so; that means, that the homogeneous parts of everything is the same. So, all of them whether V c will be something times exponential minus t by R C that is the homogeneous solution to V c.

Similarly, I c will also be the same way and we are will also be the same way, these are the natural responses or ((Refer Time: 06:17)) response or the homogeneous solution. Now, this is a general property of any circuit and this is nothing to do with the first order differential equation either. So, if you have it turns out that for higher orders you will get combination of exponentials. So, this just like we have one time constant here for higher order equations you will have multiple time constants and multiple experiential.

So, the natural response of any variable in the circuit whether it is any current or voltage will be exactly the same. So, you do not have to if I had ask you for the current in this loop or the voltage across the register you do not have to solve for the circuit again the solution will an exactly the same form. And also now for piece wise constant inputs everything will also have the same form V c we already know we will elaborate on this little V c of 0 minus V s and I c will be basically the final value which I will write as I c of infinity plus I c of 0 minus I c of infinity, this is the general form, the initial minus final value decking of whether time constant R C.

Finally, the V R also will be the same V R of infinity which is the final value plus the difference between initial and final values times experiential minus t by R C the ((Refer Time: 07:54)) same time processor. So, it should be able to work out the solution for any variable in the circuit in any complicated circuit.