Networks and Systems
Prof. V.G.K. Murti
Department of Electronics & Communication Engineering
Indian Institute of Technology – Madras

Lecture-63A
Mutual Inductance Continued

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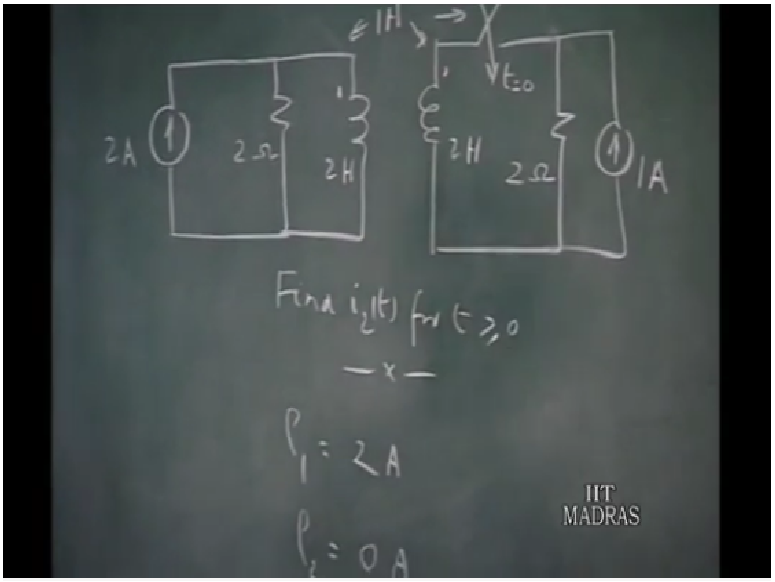

In this example we have a circuit with a pair of couple coils, having this arrangement 2 henries, and let this also be of 2 henries self inductance, and let the mutual inductance i in these 2 coils be 1 henry. Let the elements value is as mark here. These 2 are current sources, this is the current sources; 1 ampere and 2 ampere, and the switch is kept open for a long time and close the t equals 0.

You are asked to find i 2 of t, find i 2 of t for t greater than 0; greater than or equal to 0. So, let us see, as for as this inductor is concerned it does not carry any initial current t equal 0, because the switch is open. Therefore, if you call the rho to be the current here it is 0.

As for as the first induct is concerned, this 2 ampere current source dc current source close entirely to the inductance, because for steady state the voltage here is 0. Therefore, this 2 ohms is short circuited; therefore, rho 1 2 henries. So from the statement of the problem we know, that rho 1 is 2 amperes that is the current in that inductor equals 0 minus, the current in the second inductor is 0, so that is what we are having.

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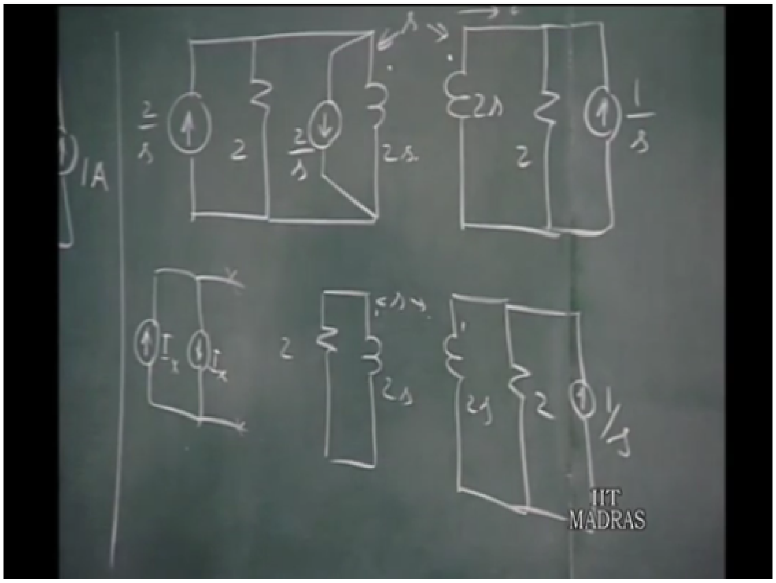

So, if you set up the transform diagram for this, you have corresponding to the 2 amperes dc source, you have 2 by s; that is the current source in the transform domain, and you are having 2 the generalized impedance of the resistance, and you having self inductance 2 s. And since the initial current here, is 2 amperes, I can replace this by an equivalent current source of 2 by s, in the second representation which we have just now discussed.

And these two inductors, have the same self inductance and mutual inductance, which is equal to s in the transform domain, and once the switch is closed here, you have this 2 ohms and then the current source here. You should not put the current source as 1 here, but 1 by s, because the dc source, and we are talking about the transform domain, all the variables have the transform domain.

Now in this we are interest in finding out i 2 of s, this is the what we are after. Observe here the 2 by s and minus this 2 by s coming together the same node, cancel each other out; that is if you have the current source here of some i x and another current source of i x here. So, both of them cancel each other out, and therefore that current in the, whatever which is corrected is 0.

So, using this principle here; after all, this current source and this current source are parallel to each other, and equal and oppositely headed. So, the effect of rest of the circuit is negligible is 0; therefore, I can write this simply as 2 this is 2 s, and the coupling of s between this 2, and you have 2 of s and you have 1 by s of the current source. This is 2. This is 2 s. So, that is what here i having.

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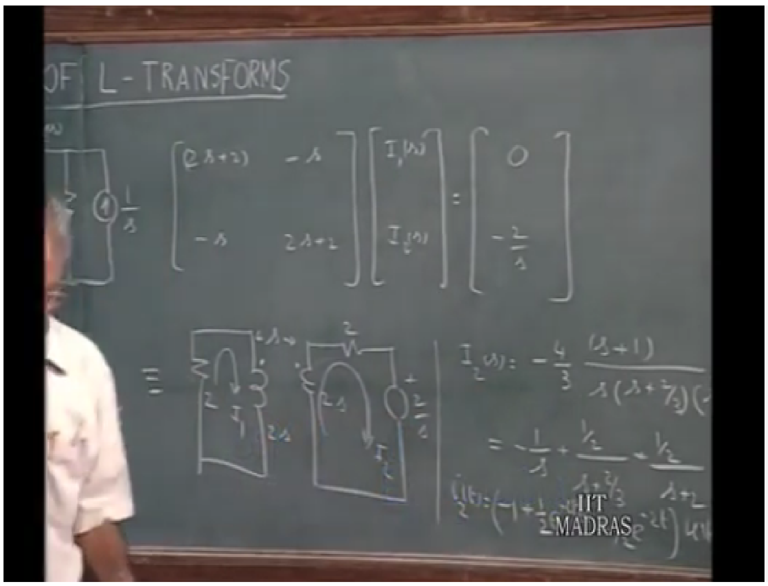

So, suppose I like to use loop current method analysis. They can convert the current source, in parallel with the resistance, as a voltage source in with the resistance. So, this equivalent to 2 ohms 2 s. This is 2 again, generalized impedance 2 ohms 2 s coupling to s.

Now, a current source in parallel with resistance can be replaced by an equivalent voltage source, in series with assistance, and the strength of the voltage source assisters we use as equivalent that is in dc circuits, the multiplication of this 2 is becomes 2 by s. So, you have a voltage source 2 by s in series with a generalized impedance 2. So, if I write the 2 loop equations as; loop currents as i 1 and i 2.

The current here is what we are interested in that is same as write 2 the current in this coil. Therefore, the identical the current is retained, and you write the loop equations for this. So, I can write this as 2 s plus 2. I write these loop equations in matrix form, because this is quite simple and easy to visualize. So, I write this i 1 of s and i 2 of s, and the other side I write the forcing function; therefore, the first loop equation is 2 s plus 2 times i 1 of s.

The mutually induced voltage i 1 is the entering the dot point and i 2 is leading the dot point. therefore, the sign of the mutually induced voltage is negative, and the multiplication factor is s, because this si the mutual impedance; s times i 2 is the magnitude the mutual induced voltage, but you have to have a negative sign therefore, minus s times i 2 of s, and the total driving voltage in this loop is 0.

Now, for the second loop the self impedance of the loop is 2 s plus 2, and the mutually induced voltage, again i 2 is leaving the dot point and i 1 is the entering the dot point; therefore, the side of the mutual induced voltage is negative. The mutual induced voltage is the Laplace transform s times i 1, but the sign is negative.

Therefore, minus s times i 1 2 s times i 2 of s, that must be the net voltage in this loop, trying to drive a current in the direction of i 2, but the total e m f in the circuit is 2 by s in the opposite direction; therefore, I must write the minus 2 by s. So, these are the equations which describe the behavior of the circuit and the loop current basis.

You can solve for the, and you get equation for i 2 of s solution of this 2 equations will give you i 2 of s equal minus 4 up on 3 s plus 1 over s times s plus 2 by 3 times s plus 2, which the partial fraction expansion will yield minus 1 by s plus half divided by s plus 2 by 3 plus half s plus 2.

So, that is the partial fraction expansion of i 2 of s, and therefore, you can write i 2 of t as minus 1 plus half e to the power of minus 2 t by 3 plus half e to the power of minus 2 t, and the entire quantities of course, multiplied by u, that is the expression for i 2 of t. So, you can see the solution for the transient problem of the start once again, can easily be handled with transform diagram approach.

You do not have to write a differential equation. And once you have the transform diagram, you write the equations up on forms in s domain, in the same way as you do for dc circuits. And once you get the solution for the required quantity in terms of transforms, you have to find the inverse transform, to find the quantity in time domain.