Network Analysis

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Lecture – 77
Two Port Network - VII

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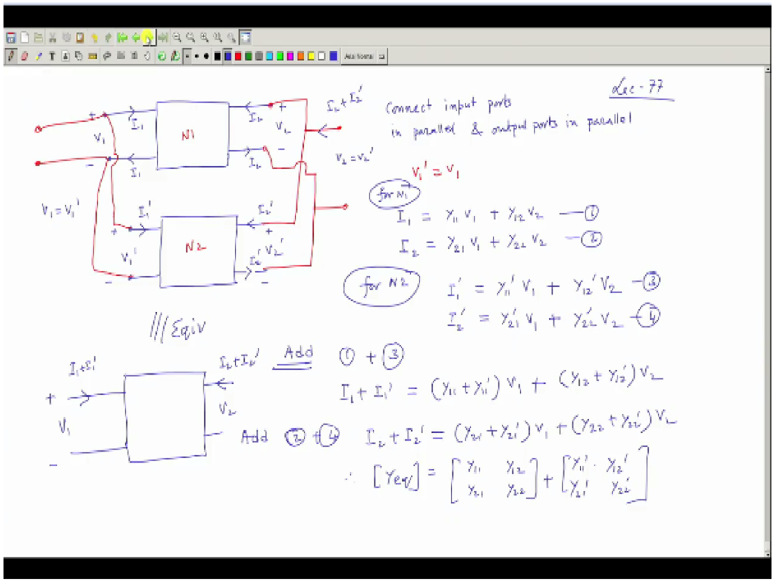

This is lecture 77. So we discussing about series connections. Similarly, if you can connect this one in parallel also. For example, if you have a two port network like this, this is suppose V1 and this is I1 and this suppose V2 and this is suppose I2 these are two port networks okay. Now here another network which are having things like this. This is plus, minus V1 dash, this is plus minus V2 dash and this I1 dash and this is I2 dash, this is the thing. Okay.

This two networks when we say connect them in parallel we mean that; of course two sources can be connected in parallel, for example this input ports should be connected in parallel plus with plus, minus with minus and that is connect input ports in parallel and output ports in parallel. So that means I take a piece of wire I connect this point with this and I connect this point with this and this, obviously I connect these two in parallel.

If I connect it in parallel V1 dash must be equal to V1, nothing doing. Similarly, the output ports I will connect the terminals in parallel that is this plus with plus and this minus with minus and this and this are the overall output terminals, this is input terminals. Now in this case as it will turn out to be; if you experience this network 1 and network 2 in terms of admittance parameters then the equivalent parameter values will be some of the admittances, that is the whole idea.

So first of all I will write down the equation as in terms of admittance parameters, that is suppose I1 for this two port network I1 = Y11 V1 + Y12 V2 and I2 = Y21 V1 + Y22 into V2. This basic equation for network 1. For network 2, this time I will straightaway write down, that is I1 dash in this case, I1 will be equal to Y11 dash for this network which; whose parameters I am marking with prime numbers, so Y11 dash into V1.

But V1 dash = V1, so I am straightaway writing this as V1 instead of skipping a step plus Y12 dash into V2 dash, but V2 dash 10 V2 are same, so I am writing it as V2 like this. Similarly, I2 dash; I am sorry; I2 this is I2 dash. Similarly, for this I2 dash for this concentrate on this, it will be equal to Y21 into V1, but V1 dash and V1 are same. So mind you, V1 = V1 dash. Similarly, V2 = V2 dash. Therefore, I2 dash = Y21 dash into V1 + Y22 into V2 prime. Okay.

Now what you do if you call 1, 2, 3, 4 then add 1 + 3, it will give you I1 + I1 dash that is this equation and this equation I am adding 1 + 3. So I1 + I1 dash is equal to, it will be equal to Y11 + Y11 dash into V1 + Y12 + Y12 dash into V2. And similarly add 2 + 4, equation 2 and 4 you add, if you add you will get I2 + I2 dash = Y21 + Y21 dash V1 + V22 + Y22 dash V2.

So this is the thing. Therefore, this whole network can be considered to be an equivalent; and equivalently you can think of this network to be a single to port network whose input voltage is either of this voltage is V1 + -. But in input currents of this is I1 + I1 dash is what, is this input current, I1 + I1 dash. Similarly, this side it will be equal to V2. And you can see this current is I2 + I2 dash. I2 is going, I2 dash is going here so I2 + I2 dash.

Therefore; so output port current is this one I2 + I2 dash. And the equivalent the admittance parameter of this network will simply with the sum of the y parameters. Therefore, if several two port networks are connected in parallel you simply go on adding the parameter values of each one them therefore equivalent Y metrics will be equal to obviously Y11 Y12, Y21 Y22 + Y11 dash Y12 dash Y21 dash and Y22 dash, that is what we have seen. Now there is another interesting connection which is called cascade connection.

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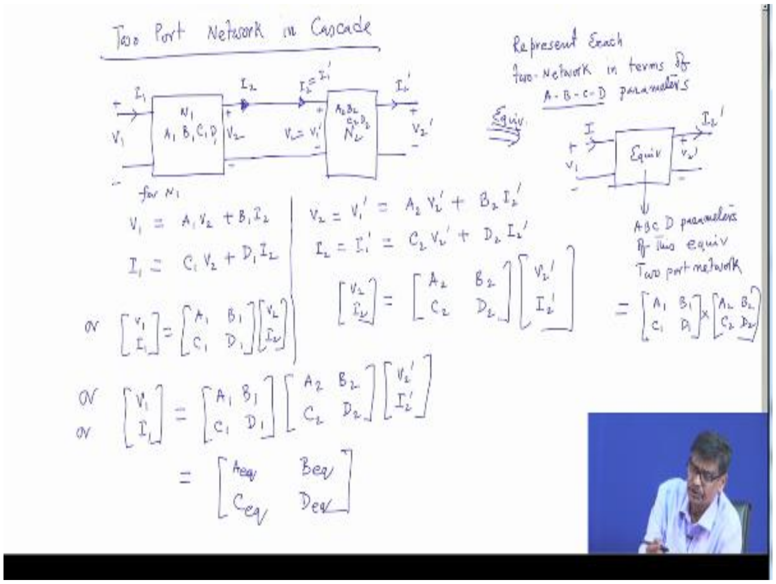

Two port networks in cascade. In cascade means the output of one port is the input; the output whatever you get from the first port is connected, suppose this network 1 it is plus minus V1, this is I1 you connect it and here another network into whose input you connect to this port, get the point. This is plus minus; this is V2. And say, so V1 it will have its terminal and you consider this to be your V1 dash.

And it will be shown here, if this two networks are connected in cascade the representing each of this two port network in terms of its ABCD parameters is beneficial. Then the product I think it will come of this two metrics will give you the overall two port network thing. For example, let us try to do that. What; let us show that. This is I1. For ABCD parameters representation I will do represent each two port network in terms of ABCD parameters.

That is network 1 is suppose its ABCD parameters are A1, B1, C1, D1. Similarly, for this network ABCD parameters are A2, B2, C2, D2 like that we will represent. Now so far as the first network is concerned we know that for ABCD parameters we have V1 = V1 input parameter V1 I1. And since I will be writing ABCD representation so I2 deduction I have reversed it is like this as we have been doing all the time.

So V1 = A1 into V2 + B1 into I2 for this network. This is V2, this is I2 and I1 = B1 C1 into V2 + D1 into I2, this will be the thing. Now for this second; this is for N1, this will be the thing. For this second network this is the input current of the second network which is suppose prime I2, I1 dash is the input current. And input voltage is V1 dash and output voltage is I will it has V2 dash and output current as I2 dash. This is what I will do.

Therefore, for this network the relationship will be V1 dash equal to A2 into V2 dash + B2 into I2 dash that is what I will do for this. And in the second equation that is I1 dash is equal to what, C2 V2 dash + D2 I2 dash, that is what I will do. Is not? But you see that V1 dash and V2 are same, this V2. So this is nothing but V2 itself. Similarly, I1 dash is nothing but I2 itself. So here first I write it is V1 I1 = A1 B1 C1 D1 and here we write V2 I2 this is the thing.

And here we write; we will also get this as V2 I2 its input quantity V1 dash V2 because of this parallel connection. And V2 I2 = A2; sorry A2 B2 C2 D2 and V2 dash and I2 dash. This way I will write it. This is the thing. So if you want to get the overall structure, suppose I want to replace this whole thing by a simple two port network with this thing that is; this is I2 dash, this is + -V2 dash and here you have applied V1 and this is current. This is the equivalent.

That is, I can represent this two cascaded; two port networks as a single two port network equivalent. Now what you can see from this equation V1 I1 or, this equal to A1 B1 C1 D1 is this thing into V2 I2. But this column vector V2 I2 is nothing but this; so substitute this column vector in terms of the product of A2 B2 C2 D2 and V2 dash I2 dash. So this can be written as A2 B2 C2 and D2. And this will be V2 dash and I2 dash.

So the overall, the ABCD parameters of this; ABCD parameters of this equivalent two port network will be product of the, this two metrics because this is product. So this is equivalent to; it will be also a 2/2 metrics whatever it will be that is A1 A2 + B1 C2 etc. So this will be A equivalent from whatever you get you say B equivalent, C equivalent and D equivalent. So this equivalent ABCD metrics will be just product of this two A1 B1, C1 D1 into A2 B2 and C2 D2.

So very easy. Therefore, if several two port networks are connect; cascade connection means what then, the input voltage of this second network is the output voltage of the first and so on you can connect several in cascade. So the product of the ABCD parameters will give you the equivalent representation ABCD parameters of the network that is what I want to tell you. Is that clear? Therefore, see it therefore depends.

If it is transmission lane parameter and there will be several network connected one after another that is in cascade, it is better you deal with ABCD parameters equivalent ABCD parameters will be simply multiplication of this 2 / 2 metrics. As many stages are there, so many, multiplication you have to do. Similarly, if the networks are in series connected mode and by series connection I mean the way it was connected input ports are series connected, output ports are series connected.

In that case if each one of these ports are represented in Z parameters equivalent Z parameters can be easily calculated. It does not mean that this cannot be represented in ABCD parameters, it can be. But then the equivalent Z will come in a complex way. And we already know that if you have represented the network in any form either H or Y or Z parameters terms then you can find out the parameter values for other representation.

We have to do a little bit of work algebra there that is all. So this is how things will go around. Anyway so these are the three connections I told you. And you go through it and if you find any further conditions should be put you think about that. But I have assumed here that the networks each one of them are two ports and I1 I1 dash etc., or same and so on. Now I will tell you some about one two port; so far I was telling that two port networks maybe; anyway let us start without much talking.

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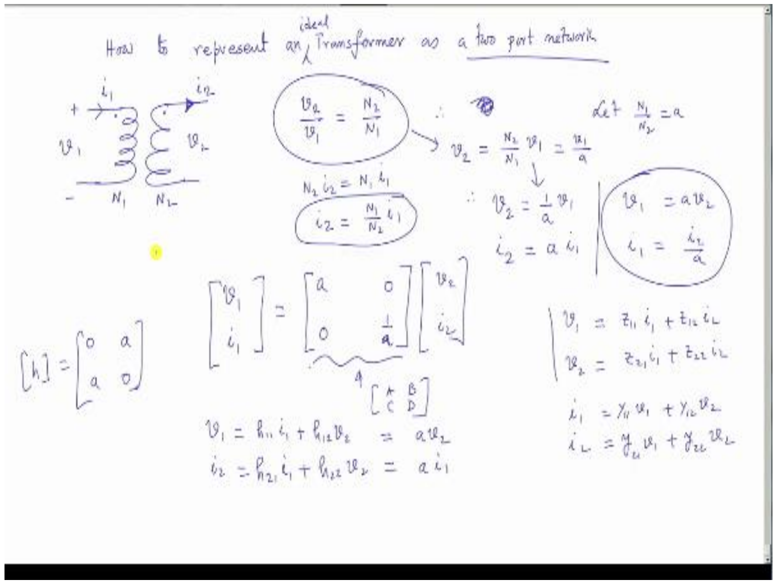

Suppose, how to represent a transformer and ideal transformer as a two port network. We know what a transformer is. Suppose we have a ideal transformer here. These are the dot terminals of the transformer. Ideal transformer means no resistance, no linkage flux etcetera. And if you apply a voltage here we will get some induced voltage there, this is number of trans N1, this is number of trans N2, and if it delivers a current I2 in this direction.

Oh, two port networks, so I will; okay I2 and this as I1. Let us write. The deduction it is my thing. Okay, if you write like this then I will say we know that V1; V2 / V1 = N2 / N1. This is one equation and second equation is N2 i2, it is called MMF balance equation is equal N1 into i1. So from this say that, this is the thing and i2 = N1/N2 into i1. This way I can write. Similarly, I can write from this as V2 = N2/N1 into V1.

So N1/N2 is the ratio. Let N1/N2 be a some number. Therefore, I will say V2 = a V1. This is one equation from this; “Professor - student conversation starts” 1 / a. 1 / a. 1 / a. V2 = 1/a. “Professor - student conversation ends”. So this is equal to V1 / a. Is not, if I define like this. So N2 / N1 is 1/a. So this is one thing and second thing is i2 = a i1. Or I can write it down suppose V1 = a V2 etc., in same equations I am; and it is i2 / a.

Now the way I have assumed the deduction of the current i1 and i2 like this. This one, this equation I am writing in metrics form V1 i1 that is input voltage and current in terms of the output voltage and current and the deduction of i2 I have assumed like this. So what will be this one? V1 = a V2. So a here it will be V2, no i2 and i1 = i2 / a so this is 0. This is 1 / a. So it is also a two port network but for terminal two port network, not that this two (()) (27:45) when if it is join you can. But what I am telling this is a. What do you think these parameters? Is it Z, is it ABCD? Is it H parameters?

It is ABCD parameters, because I have assumed like i2 like this and input voltage and current is represented in terms of this. So this one can be termed as an ABCD parameters of the network. So this is nothing but ABCD parameter of the transformer. So a transformer can be considered to be a what is called a two port network whose ABCD metrics is this. Can this be represented as an impedance metrics?

To represent in terms of impedance metrics this transformer what you have to do is this, V1 and V2 you have to write in terms of i1 and i2. Is not? This is what Z11 i1 + Z12 i2 + Z21 i1 + Z22 i2. This is how you have to write it. Question is can it be written like this? So V1 cannot be expressed in terms of i1 i2. Similarly, V2 cannot be expressed in terms of that. That is it looks like impedance metrics does not exists there.

I will ask you to see carefully that whether ABCD parameters if there known how they are related Z parameters. And whether it is possible to obtain the impedance parameters or admittance, similarly admittance parameters, is it possible that is i1 i2 = y1 V1 + y12 V2 and i2 = y21 V1 + y22 V2. Can I write i1 in terms of V? No. i2 in terms of V? No. I cannot write. Can I write it in H parameters known?

For example, is it possible to write it V1 i2 you are writing. V1 is equal to what, h11 into i1 + h12 into V2. Is not? And this is equal to h21 i1 + h22 into V2. The question is V1 = a V2. So this one looks like; there is no i1 term so this one is a into V2, is not? V1 = a V2. And i2 = a into i1. So it looks like it can be written. Is not? There is no H parameters exits. What will be h11? 0. So this same transformer as a two port network has a H parameter it looks like.

What its value will be? h_{11} that is 0 into i_1, so 0. h_{12} into V_2 that is a. Is not? Then $i_2 = h_{21} i_1$ that is a; and of course there is no contribution for V_2. 0. So you please; behind all these representation slight manipulation of the equation in most of the cases, you will be able to conclude several things whether can I represent it in H parameters or Y parameters or Z parameters things like that. We will continue with this idea and tell you about another two port network which is an interesting network called Gyrator in my next class.