Introduction to Time – Varying Electrical Networks
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Lecture 15
MNA Stamp of an Ideal opamp

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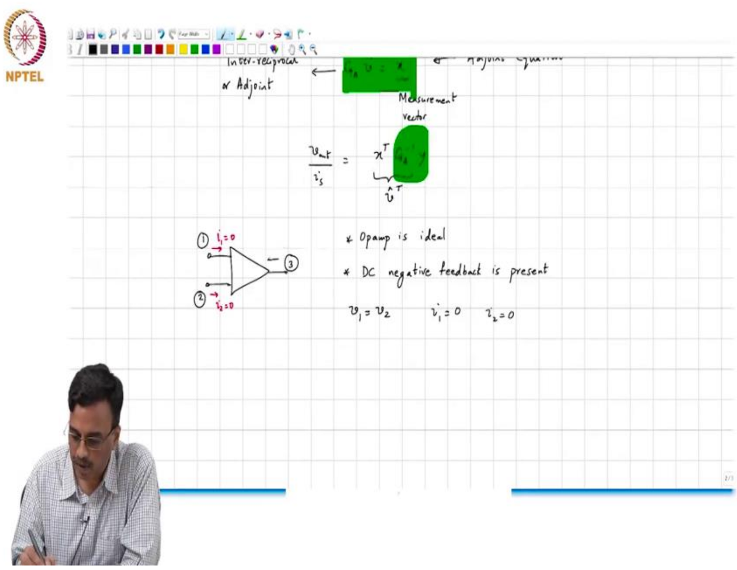

The next, small thing that I would like to mention is the following; is the MNA stamp of an opamp, did we discuss this before? Not in the context of MNA. So, let us say that you have an opamp and we know that it is in negative feedback. If the opamp is in negative feedback, so opamp is ideal and DC negative feedback is present.

Under these circumstances what comment can we make about the properties of an opamp? There is an opamp embedded inside a network, there is we know that the opamp is ideal in the sense that GM is infinite or the voltage gain is infinite and we know that there is DC negative feedback around the opamp. So what does it mean as far as the network equations are concerned?

Student: (())(01:36)

Professor: V1, the virtual shot. So, v1 equal to v2 and what about, is that all?

Student: (())(01:46)

Professor: And i1 is 0 and i1 is 0 and likewise i2 is 0. And what about i3? It can be anything and that is dictated by the rest of the network.

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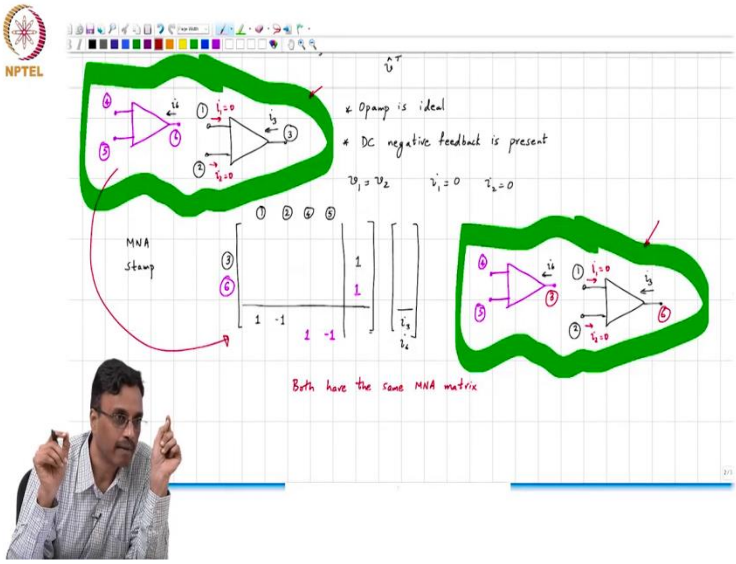

So, therefore what would be the MNA stamp of an ideal opamp? I mean, how many unknowns will be? Do we need to have an extra unknown?

Student: (())(02:38)

Professor: Well, remember that the current flowing through the output of an opamp is an unknown. So, we will need an extra unknown. And now, can you tell me what the structure of the MNA stamp of the opamp, ideal opamp should be?

Student: (())(03:05)

Professor: Yes, what do we have in the last row?

Student: 1 and minus 1.

Professor: 1 and minus 1 in which columns?

Student: (())(03:11)

Professor: Yes, so let me, yes ok. 1 and 2 and you basically have 1 and minus 1. What else?

Student: Third row last column

Professor: The row corresponding to node 3 in the last column, plus 1 or minus 1?

Student: (())(03:39)

Professor: It is going outside, so it must be, yes Arshit?

Student: plus 1.

Professor: Plus 1. Very good. Now, we come to something interesting. So, let us say we had a circuit with 2 opamps in it. So, we had a network with 2 opamps. So, let me call this 1, 2, 3. Let me call that 4, 5, 6 and again I am going to assume that there is, these are ideal opamps and that there is negative feedback around. DC negative feedback around all the opamps. So, to make things clearer I am going to basically call this, I am going to make this opamp in magenta. Now, can we, how will the MNA matrix be when we have both these opamps in?

Student: (())(05:12)

Professor: We will have one more row. Let us call that i6 is another unknown. So, we need another row and so, what do we do with that row? Sorry, 4 and 5. 4 and 5, what do we do?

Student: (())(05:46)

Professor: 1, I am going to put that in magenta again. It is 1 and minus 1. And then what else? The sixth row?

Student: plus 1

Professor: Plus 1. Now, I am going to do; I am going to draw your attention to something interesting. If I showed you this matrix, I did not show you the picture of the opamps. Of course you already know what the MNA stamp of the opamp is. Now if I say, draw the circuit, what would you do? You understand the question? So, far what we have done is, gone from the circuit to the MNA matrix. Now, I am asking you, here is the MNA matrix, what is the circuit? Is the magenta nodes were not there…

Student: (())(07:05)

Professor: 4 and 5 are, if the black entries were not there, I am sorry. What would you say?

Student: 4, 5.

Professor: 4, 5 are the inputs

Student: 6 is the output.

Professor: 6 is the output. Now, when both are there?

Student: (())(7:23)

Professor: Exactly, so basically when you have both present, one obvious solution is, I mean because we came up with it, one obvious solution is to say, well that is the network but it is entirely legitimate to say, well what do I do? It is perfectly to say, this is 3 and this is 6. Both these circuits have the same MNA matrix. So, what is the morol of the story?

Student: (())(08:33)

Professor: Yes, if both have the same MNA matrix, what comment can we make about the outputs at node 6 and node 3. Do you understand the question? So these are 2, I mean these are parts of a circuit. In one of them, the opamp, the ideal opamp is connected between 4, 5 and 6 and the other one is between 1, 2 and 3. In the other circuit all I have done is cut-off the output from 6 for the opamp in magenta and connected it to 3 and vice versa. Both networks evidently have the…

Student: Same MNA

Professor: Same MNA matrix. So therefore, as far as voltages at node 3 and node 6 are concerned they will remain the…

Student: (())(09:34)

Professor: They will remain the same because the MNA matrices are the same. So therefore, when you have, so what is the design implication of this? If you have a network with multiple identical, I mean ideal opamps you can actually cut-off there outputs and switch them any which way you want and nothing will change. Do you understand this? Do you understand the implication? Let me prove that to you an example.