Basic Electrical Circuits
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Lecture – 48

As you seen solving nodal analysis equations involves matrix inversion, it is not just nodal analysis solving any system of linear equations involves matrix inversion. So, in this lesson we will look at matrix inversion methods very briefly. It is assumed that you know all of these things from high school algebra; otherwise, you can always refer to standard text book for this. I will go through it once just, so that for the small circuits such as a 2 node or a 3 node circuit, you can invert matrices quickly and find the complete solution.

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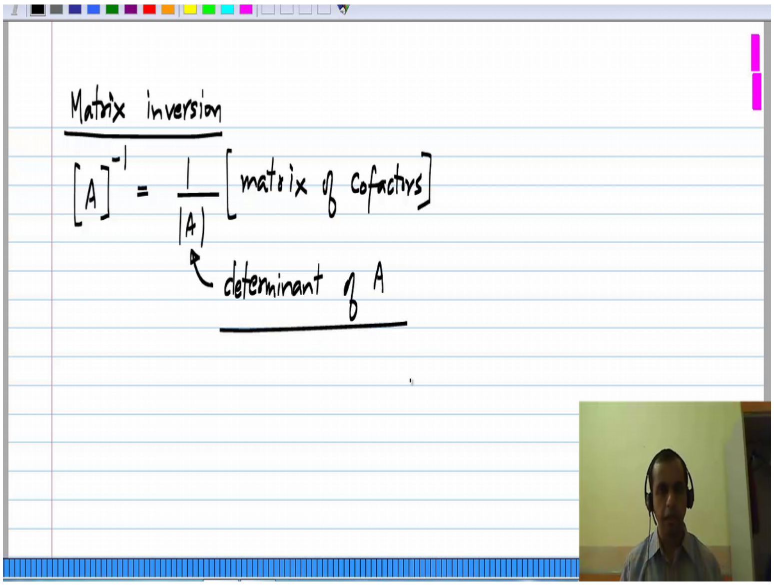

Now, in general you have a square metric A, the inverse of that is 1 over the determinant of A times the matrix of co factors. I will not go in to the definition of all of these things, I will just show the result for a 2 by 2 and 3 by 3 matrix. Now, this symbol of course, means the determinant of A.

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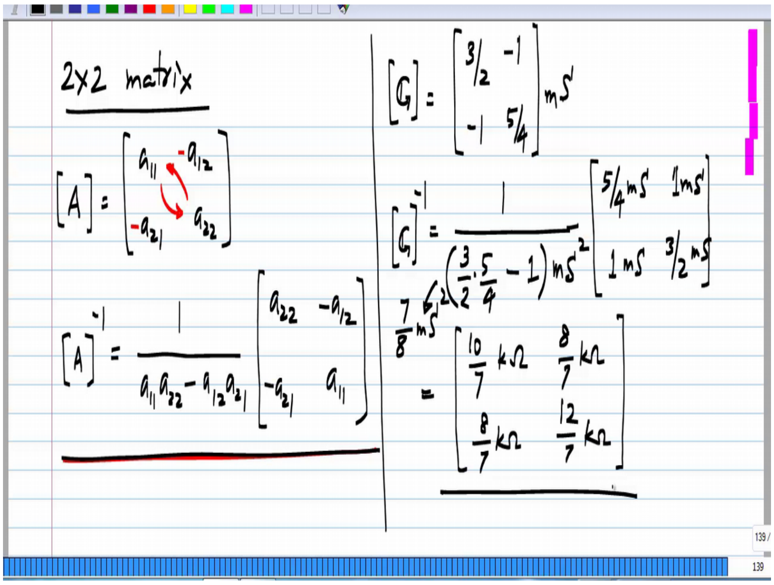

Now, let us take a 2 by 2 matrix, A equals a 1 1, a 1 2, a 2 1, a 2 2 and the invers of A is 1 over determinant of A, which I think you already know how to calculate. It is the product of the diagonal terms a 1 1 times a 2 2 minus the product of the off diagonal terms a 2 1 a 1 2 times matrix of co factors, which is very easy for a 2 by 2 matrix. So, all you have to do is swap the diagonal elements, that is a 2 2 comes over here and a 1 1 goes over there.

So, it simply interchange the position of these two and for the other two you retain the positions, but negate the values. So, here and here you have minus and minus that is all. So, now, you can go back to the example we had earlier, which was we had a G matrix which was 3 by 2, minus 1, minus 1, 5 by 4 Millisiemens. So, the inverse of this is 1 by the product of these two which is 3 by 2 times 5 by 4 and each of them is Millisiemens.

So, the unit of this is Millisiemens square minus the product of these two, which is just 1 Millisiemens square and I have to swap the diagonal elements. So, I get 5 by 4 Millisiemens over there, 3 by 2 Millisiemens over there and this minus 1 will become 1 millisiemen and the other minus 1 also becomes 1 millisiemen and this whole thing will be equal to, if I simplify this I get 7 by 8 Millisiemens square. So, I have 8 by 7 and 8 by 7 Millisiemens square times all of these entries which will give me 10 by 7 kilo ohms.

I get these kilo ohms, because I have Millisiemens divided by millisiemen square, 8 by 7 kilo ohm 8 by 7 kilo ohm and 12 by 7 kilo ohms and this is what I used. I multiplied the current source vector with this to get the node voltages. So, for a 3 by 3 matrix you can similarly calculate the inverse by calculating the determinant of the matrix and various of matrices, you can look at any stander text book for this.

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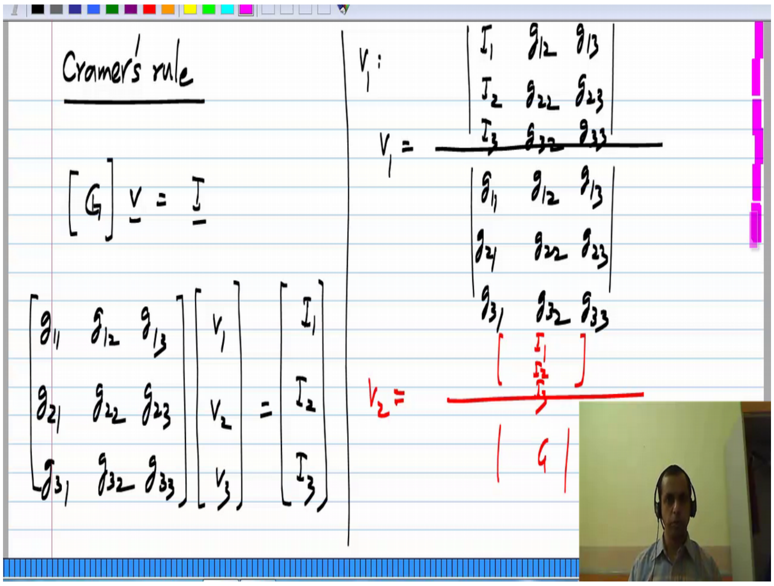

The only other thing I will mention is what is known as Cramer's rule. Let me take my nodal analysis equation G times V is I and I will assume that V. So, I will assume a 3 by 3 matrix which corresponds to a 4 node circuit, which is described by 3 KCL equations. And in general, there will be three non zero elements I 1, I 2 and I 3 which consist of total currents pushed into each of the nodes, they may not correspond to the values of single current sources, but they correspond to the total currents being pushed into nodes 1, 2 and 3.

Now, this Cramer's rule is convenient when you are not looking to solve for the vector completely. So, let say you want one of them, let say V 1. What you do is, V 1 turns out to be the ratio of two determinants and in the denominator we have the G matrix itself g 1 1, g 1 2, g 1 3, g 2 1, g 2 2, g 2 3 and g 3 1, g 3 2, g 3 3 and the numerator that matrix is basically this G matrix, but with one of the column replaced by the right hand side.

In this case we want V 1, so the first column is replaced by the right hand side vector and the remaining two are the same as before. Similarly, if you wanted V 2, you would have G here and in this, the second column would be I; I 1, I 2, I 3. So, similarly for V 3 you would take this right hand side vector, put it in the third column, take the ratio of that determinant to the determinant of the G matrix. So, this is also sometimes useful, again this is hand analysis 3 by 3 is the most complicated that we would consider, for all other cases if you have to solve for larger circuits with dimensions more than 3 by 3, you use a computer.