Network Analysis
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Lecture – 67
Numerical Examples of Network Analysis with Graph Theory

So, let us continue with the analysis of the circuit by using the concept of graph theory. Now today last time we found out the loop currents of a given network. Now today I will take another example to show you how to solve network problem by using say nodal method and graph theory.

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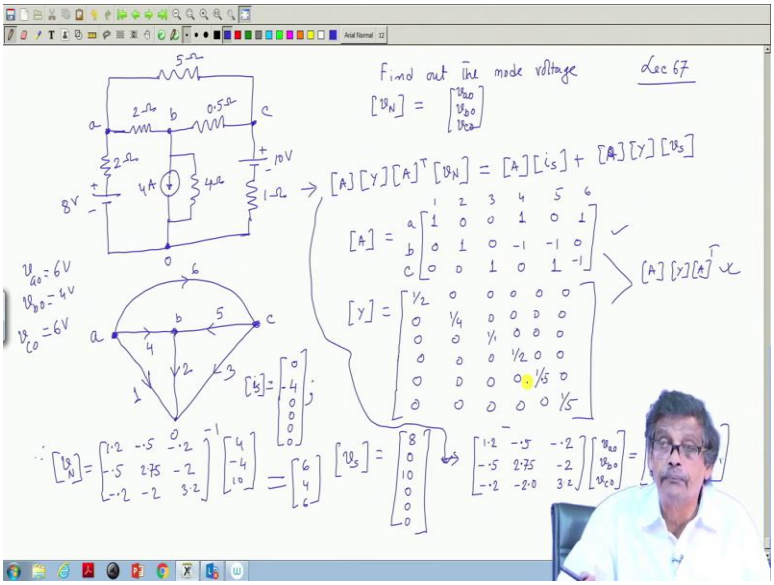

So let us draw the circuit first, so this circuit is suppose like this, like that and here is also a resistance and here it is 10 volt source here it is 1 ohm resistor it is connected. And this is a 5 ohm resistance connected. This is 2 ohm there and here is a resistance in series with source and suppose this is plus minus 8 volt and this is 2 and this is a 4 ohm resistance and this is a 4 ampere current source. So this is the network, how many nodes are there? 4 a b c choose this to be; so, what I want to do?

I want to find out find out the node voltages that is VN. What is this VN it is equal to va0 vb0 this is column vector you see, if you known the node voltage you can solve the circuit other parameters being known. So, I want to find out this node voltages using graph theory. So, first

thing is I have to draw a graph of these network which will be like this. This thing you see this is a branch voltage where the current voltage resistance?

So this I will show by a single line. This also I will show by single line. This is also a single line like this. And this 2 are joined this way and then you; this is the tree of the network, name them. This is a this is b, this is c this is O and I want to make a deducted graph. The assume deduction, deducted means the current deduction. So, assumed deduction of current is my choice so I will do it like this and I have to name also the branches, so let me do that.

So this is suppose I call 1 this I have put this way 2 this 5, this number is also arbitrary 4 and this is 6 elements 6 and this is suppose 3. So all deduction has been assumed and it has become a deducted graph ok. Now the first thing since by node voltage method show A matrix is to be known recall that to solve this node voltages what are the things we have to do? We have to adopt this method. So, nodal method means you have to do like this A y A transpose VN node voltages I want to find out.

So I must find out A matrix. A matrix formation is one of the simplest among A B and Q the total graph you go at each junctions this model. So A matrix for this one will be at node a and all the elements will participate so 1 2 3 4 5 6. Compute node A anything coming out of these will be assigned plus sign. So, one is plus 4 is also plus coming out and 6 is plus. So, these are the only three elements which participate in deciding the current which are coming out there so this is the thing others entries will be 0.

Similarly come to node B so this is at node A. At node B you come out so 2 is plus coming out from the node and 4 and 5 are involved but they will be coming in so negative. This will be this and finally at the node 3 it is reduced to incidence matrix. No point in trying to write down the KCL node. It will not give any new equation you know that and other entries will be given like this. At node C 3, 5 say 3 and 5 coming out so 3 is +1, 5 is +1 and 6 is -1 and all others are 0. So, A matrix is known therefore I can calculate A transpose etc.

So A matrix is the first thing we do then what I have to do is this I have to get the y matrix admittance matrix, what it is? Very simple, y it will be a diagonal matrix. So, the first element will be which one I have called the 1 where there is 2 ohm is present, so it will be half of y matrix so y matrix this elements will be half and others are 0 1 2 3 4 5 6 there are 6 elements. Similarly element 2 this one here resistance is present 4, 1 by 4. Third that is this element is third that is one present, so this 001 3rd no 1 by 1 and then 000.

Then the 4th element here, it is 2 ohms so 0 0 0 1/2 this is the element 4. Fifth element is this one? What is the value? I did not write I am giving you the value here, if I forget to write it is 0.5 ohm. So, 1 2 3 4 then 5 2 3 4 fifth element is 1 by 0.5 and finally the element 6 which is 5 so 0 0 0 0 0 1 by 0.5 so this is the y matrix only diagonal elements will appear. So, it is there, therefore the left hand side this equation if you go I am in a position to compute A y A transpose A is known and y is known. So, using this 2 you calculate Ay into A transpose that is all. Then I have to know so Ay are known and is and vs are to be known now.

First let me write this is it will be a column vector. In node 1 is there any current? No, in element 1 no current source, element 2 yes, there is a current source 4 ampere so that will be 4 elements. Should it be plus or minus that you have to decide, so it will be minus consistency so +4 you write and then in no other elements there is any current source or other entries will be simply 0. So this will be your is. Then I will write what will be vs, it will be also a column vector. And vs will be equal, to go to each element c voltage source is present.

See element 1 there is a voltage 8 volt and 8 is connected to note A it will be +8. So, in element 2 no voltage source that will be 0, so, element 3 there is a voltage source which should be +10 it is not +10 element 4 4 5 and 6 have got no sources. So, other 3 will be 0. So this is the vs matrix, therefore I now know everything of this equation. I will calculate A Y A transpose. I will just give you the final result. So, this equation I am putting the numbers if you put here I am writing A y A transpose you can verify if I have made any mistake.

That is you check that it will look like 1.2 -0.5 -0.2 then this one -0.5 2.75 and -2 and this is -0.2 -2 2.0 3.2 these equation this into VN what is VN, va0 vb0 vc0. And hand right hand side will be

A into is if you do that it will translate into 0 -4 6, 6 or 0? I think 0. A into is and then A into y into vs comes out to be finally 4 -4 10 got the point A into y into vs. Therefore these 2 can be added not just adding this it will give you; so right hand side is a column vector 4 - 8 +10.

Therefore VN this node voltages that is this column vector va0 vb0 vc0 will be this matrix inverse that is this matrix so anyway, let me write so that you understand very quickly -0.5 -0.2 then -0.5 2.75 -2 -0.2 - 2 3.2 the inverse of this into your 4 –8 10 and if you do this calculation, it will come out to be 6 4 6. So, I will say look here va0 of this network is 6 volt. Vb0 will be equal to 4 volt. And vc0 will be equal to also 6 volt.

Let means in this network, there will be no current in this branch. S0, after we have got that I can easily calculate the louder; so these are the step by step one has to go to find out the current. This is 4 this one this should be 0 there is a sub correction is 4 0 and 10, so it will be 4 then -4 here. Please make this correction and 10 so here it will be 4 - 4 -4 and 10. So, you see you have to take the inverse of a matrix. That is not very easy I mean people often make mistake particularly if it goes behind the 2 by 2 matrix.

But computer will do very easily. And only thing we are demanding is make these simple matrices that should you should do correctly then give it to a computer it will calculate and give you finally the node voltages and the loop currents and from node voltages and currents. It can be easily you can calculate the every branch currents as I told you is. So, that this is the second problem where I will. Of course you should not be under the impression that I could also apply the fundamental loop method to do this.

This I gave it to you same for this network adopted the nodal method if I ask you find out the fundamental loop currents. I think you will be able to do draw tree then you have to draw and solve as I have explained in the first example. Now finally and other network I will for the same network for the same network. We will try to find out the twig voltages. Let us see so the same network so let me copy this copy new page and here I paste.

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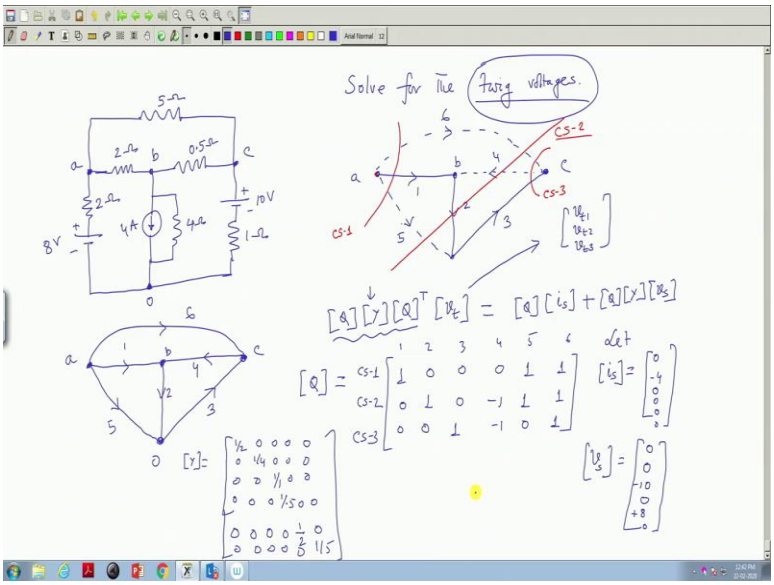

So, this is the network earlier given and we want to solve it. So this is the network this is the graph all the values are given deduction I have a assumed the same deductions you are keeping. Suppose this is the same network. We have to solve it by what is known as solve this, get solve for twig voltages. Twig voltages the moment I ask you to solve for twig voltages. You must understand that I may I may choose one thing you may choose another thing.

So the element twig voltages I am talking about whatever tree you draw from that whatever twig voltages those I am asking to solve. So here in this network, what will be doing his first step is you draw the graph of the network. And this you have to do very peaceful so suppose we say that; I name the elements 1 2 3 and this is suppose 4, element 4 and this is element 5 and this is element 6. Element names are also different from that.

So arbitrarily once again graph has been drawn I name the elements arbitrarily do not worry. So 1 2 3 4 5 6 when I have to make a deducted graph in effect assuming the deduction of the current which I am allowed to do so. So, this is the opposite direction this way I assume now this is 6 and this is 4 and this is 3 node name I do not change a b c and this is all. So if you know why I want to calculate twig voltages.

If I know the twig voltages then all other branch voltages can be found out. So, we say that if you know the twig voltages you have almost solve the circuit that is the whole idea. In this case I

have to choose a tree because twig voltage involved, so I have to choose this as the tree. So, all the notes should be present and it should be connected. So this is the thing I choose. That is this is 1 this is 2 this arrow I forgot to give you 2 and this is 3 this is a, b and c. So, these are the twig 3. So, if you know ve1 ve2 and ve3 that is the target, I want to get that.

And you know the links these links; also do not play with the directions. Once deductions has been assigned to keep them as it is fine but at the beginning you are free to choose that is the whole idea so 6. So, all the deductions as shown in things like that. Now here I have to first form the Q matrix now what is the equation I will be using first. Let me write it down equation that I will be using is this one involving Q that is equation.

So, I copy this equation and paste it here. So, since I have to calculate the twig voltages this equation is a concern. you know vt is the twig voltages in this case it will be ve1, ve2 and ve3 this twig voltages is there will be this column vector vt1, vt2, vt3 and if you know this you know everything almost. So, this is the thing I have to calculate, so before that I have to form the Q matrix. So Q matrix; how to form, you have to basically write down KCL at different cut sets.

So what are the cut sets? Cut set will be wherever you cut this network there should be only one twig present that is it first thing. So, first cut set is this one involving one this is cut set 1. Involving 1 there are several cut set also there could be a cut set, but no there will be two twigs involved I will not do only one twig will be present you make a cut set and then you have to apply KCL at this cut set. So, here the thing will be at cut set 1 I am writing down the KCL.

So, deduction and so here all the elements can participate so 1 2 3 4 5 6 you write and then you see the direction of 1 this twig you assign plus sign from left to right. So + 1 6 and 5 are also from left to right see 1, 5, 6 are involved. So this will be also +1. And all other will be zero this is cut set 1. Why I am named it 1 because everyone is involved. Similarly I have to make a cut set involving this twig 2 is it cut set 2 how this can be done?

This I will do it like this, this is cut set 2 is it a valid cut set 2? Yes because it involves only 1 twig and 1, 2, 3 links and it is cut set 2 and in this cut set 2 I have to write down the KCL at the

cut set. So, at this cut set from top to bottom if you see this decide the plus sign this twig deduction. So this is +1 twig 5 it is also from this side to this side same as 2 so 5 will be 1, 4 it will be opposite -1 right to left and 6 will also +1 0 0 over.

And then cut set 3 involving this element this twig and this will be this one. So at cut set 3 once again the deduction is decided by 3 3 is from this way to this way. So that is from left to right. So it is +1. Then 4 and 6 these are minus 6 will be plus from this to this so 6 will be plus and 4 will be minus Sorry this one so 3 plus so 6 is also plus and 4 is minus. So, this is how Q metrics is formed and then I have to get the y Matrix.

Y matrix as I have done already earlier is it not this I am not repeating that y matrix does not change that number change 1, 2 so let me write because of 1 2 3 4 are change so y Matrix will be let me write so element 1 is this one so this will be half. So all other entries are 0 5 entries are 0. Element 2 I have called this one is element 2 so 1 by 4 0 1 by 4 0 0 0. Element 3 this one I have called element 3 so this is 1 by 1 others are 0 and element 4 is this 1 by 0.5 and other entries are 0 and element 5 this one which is half.

I mean you can write much better way 1 2 3 4 1 by 2 element 5. And finally element 6, element 6 is this one it is 1 by 5. So, anyway this y matrix is a 6 by 6 Matrix all the diagonal elements are present. Q is known so Q y Q transpose I will calculate. Similarly is and vs I can write down will it change from the southern so let me write down. Let is will be 6 entries will be there they will be a column vector. So i1 nothing is there, 2 i2 is this one 4 ampere is there plus or minus this -4 then 3 and no other branches so these are all 0.

1 2 3 4 5 6 is over vs will be this column vector where the branch one have got no voltage no voltage, branch 2 no voltage 0. Branch 3 yes, there is a voltage +10 volt and -10 volt, minus or plus this is the arrow so -10 volt and then the ve3, ve4 is nothing ve5 is +8. See this plus minus you must understand and practice 1 2 3 4 5 and in branch, there is nothing. And once you know, this will be able to calculate.

And I am not writing those numbers and I will tell you that how to do it. So calculate this in the same way get the twig voltages and after you get the twig voltages element voltages can be found out how? How twig voltage and element voltages are involved Q transpose into element voltages into twig voltage is equal to element voltage. So, once I know voltage across each element then I will be able to calculate the currents here and their other details. Thank you.