Network Analysis
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Lecture # 05
Mesh Analysis-II

So, we are discussing about how to solve networks using mesh analysis our there are 2 terms are there loops and mesh any closed party you find that is a loop and Meshes 1 Meshes also loop but within the mess there will be no further loop existing. So, given a network identify the meshes assume the mesh currents in a particular direction that is all mesh currents I have assume this in clockwise direction and then I do not the KVL equation. Let us take a numerically how simple it becomes now you can.

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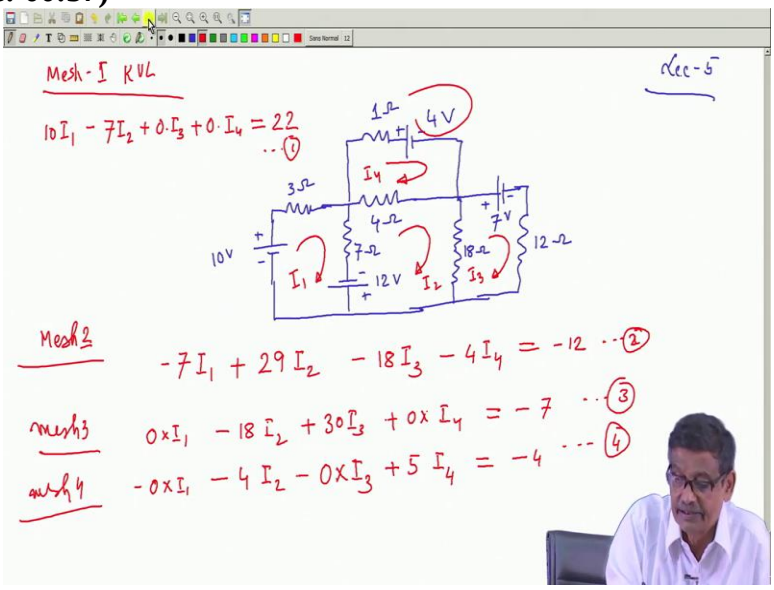

Easily see suppose you have a network like this I will put some numbers said, this is 3 ohm, this is 4 ohm This is 7 ohm this is suppose + - 10 volt, this is + - 12 volt and this is another resistance said 18 ohms and here is another branch which is 12 ohm and here is a voltage, 7 volt and here is another branch where is a voltage there say 1 ohm and this is a + - 4 volt suppose this is the network all the currents are to be found out.

Now, since I know now Mesh analysis I will try to apply that how many measures are there 1, 2, 3, 4 how many loops are there many, this is a loop but unfortunately in this loop there are so

many meshes present similarly, this is also a loop but 2 Meshes are there. So, I will identify the meshes I have identified then what I will do I will assume the currents assign current to each Meshes.

That is I1 this is supposed I2 and this is I3 assigned and this is another Mesh within which nothing is present. And this is suppose I4 and mind you what really have assumed is this branch current I1 this branch current I4 and this brunch current I3 and others can be derived if one wish to find out anyway this is I have done therefore I have to generate 4 equations first in mesh 1 I will right here mesh 1 KVL in mesh 1 very simple to write.

I will not spend any time or bothering too much about + - this that those are days are gone now. Now, what I will do is coefficient of I1 will be some of all the resistance is present here 3 + 7, 10I1 coefficient of I2 will it exist here there is a common resistance between these 2, 7, so - 7I2 coefficient of I3. No, it will not be present there is mesh 1 and mesh 3 is not shading at resistance between them. So, + 0 into I3.

Then will there be a term involving I4 in this mess, no common resistance common wall between these 2. So, + 0 into I4. In fact these terms are not there and this must be equal to the sources present in mesh 1. Now, what are the Sources present see there is 10 volt and 12 volt, this 10 volt + is in the same direction of I1 the polarity of 12 volt is also in the same direction of I1. So 10 + 12 they are both of them are positive so 22.

This is equation 1 is over, in mesh 2 let us write down mesh 2 you come here, coefficient of I1, will there be a coefficient of I1. Yes, common resistance between these 2 meshes is 7 it is - 7I1 preceded by negative side coefficient of I2 will be some of all the resistances mesh to some of all the resistances so, 18 + 4, 22 + 7, 29 and that will be + will there be a coefficient of I3 here in mesh 2, S common resistance so - 18 into I3 will there be I4.

The presence of I4 felt here in mesh 2, S - 4I4 and this must be equal to the sources acting in mesh 2, only 1 source is acting 12 volt. And the polarity of this is such it is in the opposite of I2. Therefore, it will be - 12 so, equation 2 in no time I will be able to write similarly in mesh 3

KVL I am write here in various mesh in mesh 3 you see will there be a coefficient of I1 in mesh 3 No, there is no common resistance between these 2 meshes. So 0I1 coefficient of I2 in 3.

S - 18I2 coefficient of I3 in this mesh so, some of these resistances + 30 if I make a mistake, please bear with me logic is important 20, 30I3 will there be coefficient of I4 in the KVL equation of Mesh to be no there is no common resistance. So, + 0 into I4 and so, all the contribution of all the Mesh currents as voltage drop in a particular mesh that is 3 in this case I have taken into consideration.

Only thing on the right hand side I have to write down about sources there is only 1 source present 7 volt and the direction of plus is opposite to the saddle, therefore, it is - 7 watt. So, this is the third equation and finally mesh 4 very quickly, let me write coefficient of I1 in mesh 4 are 0 coefficient of I2 in mesh 4 S there will be because there is a common resistance - 4I2 coefficient of I3 in mesh 4 0 and coefficient of I4 should be some of all the resistances present in this mesh.

Which is 5, + 5 into I4 here it should be strictly speaking minus since it is multiplied by 0 got the point O means 0 So, anyway to be consistent and + 5 into I4 4 + 1 and it should be equal to so all the Mesh currents drop have been taken into account on the right hand side sources in mesh 4 the sources this 4 volt and its direction is opposite to this arrow so current deduction arrow so it should be - 4 this is the 4 equation.

These 4 equations are independent equations independent algebraic equation involving the 4 anodes. And these 4 equations can be solved I am not discussing about how to solve these equations algebraic equation 4 anodes, Cramer's rule this that you apply or go on reducing number of variables this that you do you get this at the end all the mesh currents you will be get it and as it appears, it may so, happen that 1 of the Mesh currents become negative.

In numbers says - 2 ampere, I3 becomes In any case that means, I do will be flowing this way those interpretations you can easily do, but nonetheless after you solve this branch currents will be a very easy task in this resistance and 10 volt battery this will be I1 only in this branch it will

be either I1 – I2 if you show it from top to bottom, bottom to top I2 – I1 and so on. Therefore, you see however, slightly complicated networks.

You give at least I am not spending practically any time to write down the KVL equations because I know this logic this is what it is going to be. That is the advantage I mean you want writing in this mesh analysis how many equations here to solve as many meshes up there. That is Fine. Now, I will take another interesting example.

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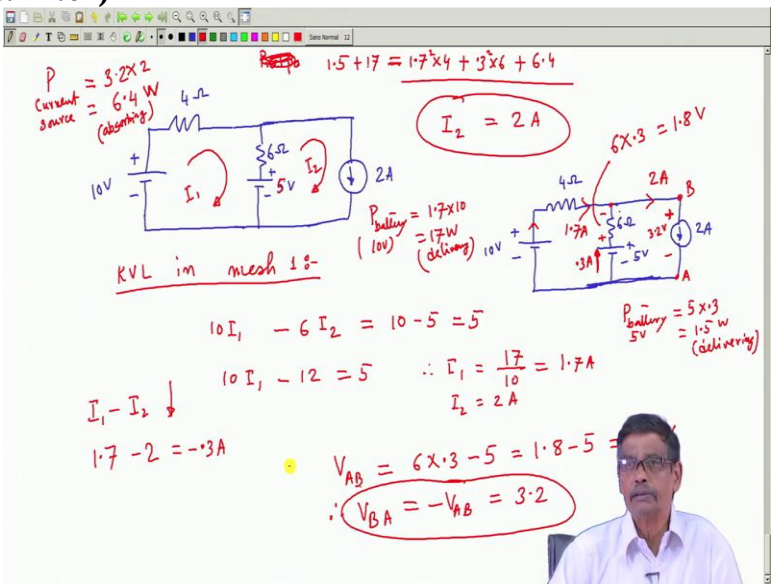

To highlight because so far I have taken only voltage sources. There may be a situations where current sources will be present. For example, let us take in this case of course, I will not unnecessarily multiply the number of meshes I know what it is. So, let us consider a simple example. Say you say that you have a network like this for this is + - 10 volt you can generate your own problems and that is how I am doing it.

And we have say another voltage source like this is suppose 6 ohm and this is suppose 5 volt and suppose there is a current sources here shown ideal current 2 ampere and you have been asked to calculate currency in all the branches. Now, you see in this network how many meshes are there 2 meshes are there what is I want to solve it by mesh analysis So, what I have to do is, I have to assign then mesh current I1 and I will mesh current I2.

That is what I will assign is not 2 meshes are there mesh currents and I have to write down KVL in mesh 1 and mesh 2 and Mr. But, you see, here it is an ideal current source this current is 2 ampere no matter what these other values are there any values you connect here, this branch current has to be 2 ampere. Now, in this problem what I am telling the I2 value is already known, this mess current is 2 ampere.

Nothing can be better than that I have to find out all the mess currents. Then I have to I will be able to find out any branch currents I light as I told you earlier. Therefore, in this case, I2 I will it is given 2 ampere. That is why I am telling if in a circuit current source is there. Do not jump to this logic that I somehow I must convert it to a voltage source, it is not necessary. Sometimes it is very advantageous.

If a current source is present in any branch, it means that but branch current is known why you should disturb that that is what I want. Anyway this I2 is now KVL in mesh 1 what will be with in KVL coefficient of I1 will be 4 + 6, 10I1 coefficient of I2 this is 5 volts I have taken it will be - 6 into I2 So, this is – 6 into 2 and only 2 meshes, so, 2 mesh currents and on the right hand side I should write down the sources acting in mesh 1 it will be 10.

Because validity of battery such that it takes this I1 detection - 5 is not that is equal to 5. Now, as I told you here how many unknowns it is already known, therefore, I will write or 10 I1 – I2 value is 2 ampere - 12 = 5. Therefore, I want will be 17 by 10 that is 1.7 ampere is it that is what I will do, because I2 is already known no point that is I will not try to write down the KVL in mesh 2 whichever mesh current is known.

I will not going to write down that not necessarily although does it mean that KVL will not be satisfied yes it will be, but you see in a current source if this current is 2 ampere this voltage you have to take these drop. Now drop here, drop in this current source and drop this of this 5 volt that some of you will be 0 that is KVL no one can avoid that. But unfortunately if you want to write down the KVL at the beginning.

You do not know what is the voltage across heat got the point you must, but anyway it is so nice that then suppose I say let me complete this problem completely. So, this I1 is correctly calculated. So, I1 is correctly calculated just check that if any mistake this is 4 + 6, 10I1 – 6I2 = 10 - 5 and I2 is known to be 2 ampere because of this it is hopefully correct (FL: 18:38) then after you have got the mesh current so I1 is this and I2 is 2 it is a good practice not always necessary

When you are very much used to it to redraw the circuit. I will redraw this circuit I mean it is suggested at least when you are those who are getting initiated to this circuit analysis they can find these interesting things. What I am telling this was the original circuit 2 ampere redraw the circuit + - 10 volt and this is 4 ohm and this is 6 ohm and this is + - 5 volt and this is this but after I have solved this circuit.

I know that this bug showed the branch currents I1 it has become positive that means, the direction of I1 in 4 ohm remains same and it is 1.7 ampere I write that I2 in any case is 2 ampere now, this branch current apply KCL here this brand currently will be how much I1 – I2 if you right from top to bottom, what is I1, I1 is 1.7 - 2 ampere. So, this will become - 0.3 ampere is not 0.3 ampere from top to bottom.

That means actual current is flowing from this one 0.3 ampere yes it should be 1.7 + .3 is 2 ampere C in the network ultimately I am interested to know what is the branch currents flowing in various parts got the point. Another point I so, this current becomes 0.3 now, I redraw the circuit. So, the actual directions of the current like that then what will be the voltage drop across this resistance. Now, do not bring back this KVL mesh equations.

It as it from the memory I have got these can these voltage drop should be 6 into 2.3 that is 1.8 volt with this side + this said - now, that is the thing. Now, as I told you that you have solved this network there is a current source present and the voltage of the current source is not known, current is fixed voltage could be anything as in a battery, ideal battery voltage between the terminal is fixed current.

It will be delivered depending upon what is the connected load is similarly in the current source current gets fixed, but what will be the voltage across it depends upon what are the other things connected across it. So, I want to know what will be the voltage across this current source. Suppose, I say that this point is A this point is B calculate VAB that is the voltage across the current source.

Potential of A with respect to B and I know the rule what it is start from B try to reach a byered any path you like. So, I will choose this path to reach A start from this from this to this no voltage drop no resistance from this to this + to - so put a + voltage rise of 6 into 0.3 that is with the voltage drop here, then from these to these, it is a battery ideal battery + to - 5. So - 5 is not and this will be 1.8 – 5 till become 4.2, - 3.2.

So, potential of A with respect to B is - 3.5 bar 2, 3.2 volt which means that VBA who will be always negative of VAB that is 3.2 volt that is potential the voltage drop actually here will be like this B is that a higher potential compared to A I told you in the previous class, that given a network you should be in a position to calculate potential difference between any 2 points of that network you like these are very good things to know.

If somebody says calculate potential between 2 points A and B of a given network need not be this network. What do you have to do is this solve the network. So, calculate VAB start if it is VAB means potential of A with respect to this start your journey from B try to reach the point A and whatever number you will get that will be the voltage difference. If that becomes +, that means A will be at higher potential than B if that becomes minus it is the other way around.

Therefore, this observations you please try to understand always and then next task you know there are 2 sources what if I ask what this 5 volt is doing this battery is it delivering power or absorbing power 5 volts source if you look at it, this is the polarity of the voltage and true + sign of this battery .3 ampere is coming out. So, battery is delivering the battery is equal to 5 voltage into current is equal to 1.5 volt and I write a comment delivery.

It is delivering power to this network. What this current source is doing this at this battery what it is doing the battery 5 volt then P battery 10 volt what it is doing is it delivering or absorbing power from + 1 7 is coming out so it is delivering so 1.7 into 10 that is 17 watt delivery I did not forget to write this comments what the current source is doing it is also a source in the current source.

We have seen VBA is 3.2 volt with this + this - 3.2 volt and so voltage across the current source with this polarity and it is absorbing current through each positive voltage terminal. Therefore, current source P current source is handling power how much it is voltage into current voltage is this and currently states. So, this will be equal to 6.4 watt is not 6.4 watt but I must write something is it absorbing power or delivering power.

I must write it is absorbing. So, mind you in a network there may be several sources, some of the sources may deliver power some other sources may also absorb power which at the battery and then it observes power. So, a source may be charged in this way. Then what is the other fellows how power balance taking place that I leave to you to compute in the resistances power losses take place. So, net power delivered to the circuit by the sources.

Will be net power delivered by the sources. Order total delivered power in the circuit is 1.5 these battery 5 volt delivered 10 volt + 17 these are delivered power this must be equal to the power absorbed by different elements in this circuit. So, what the fellows what absorbing powered resistance Of course, will observe power always 1.7 square into 4 + 0.3 square into 6 these are the 2 resistances and plus this current source we have noted it is also absorbing power.

I am not sure whether this is coming same as 18.5 volt it has to so, it once again make you feel comfortable everything is in place. So, in a circuit there may be several sources. Therefore, I the final comment is this, when I adopt mesh analysis number of equations to be solved is equal to number of meshes in general. But, if you are lucky that in one of the outer loops there is a current source.

Then you have to solve less equations because that Mesh current is known that you must understand therefore in a network. If you notice that number of meshes I have identified 5, but in two of the outer meshes there are 2 current sources present. Therefore, you have to write down only 3 questions because those mesh currents are known. In my next class I will discuss what happens if a current source appears in the as a common branch between to add just and meshes. Thank you.