Network Analysis
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Lecture # 03
Simple Networks with Voltage and Current Sources

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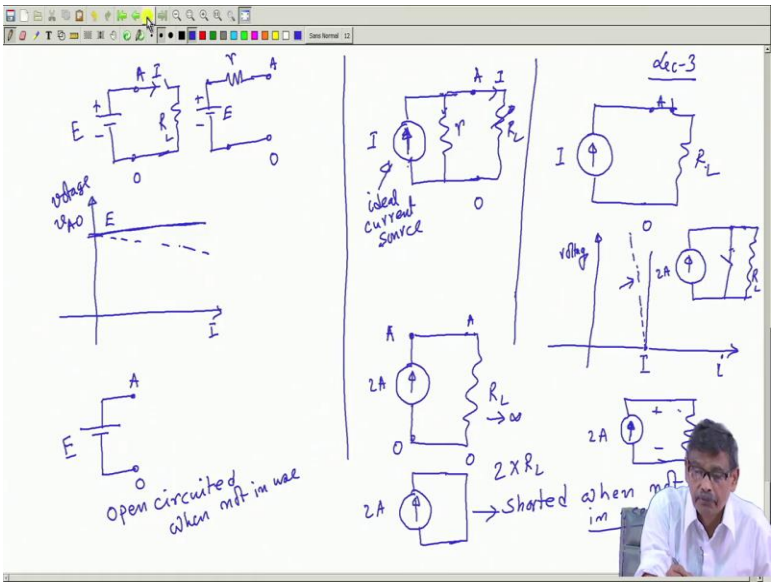

So, welcome to third lecture on network analysis and we have been discussing about sources and we have seen that ideal voltage source is like this and practical voltage source is like this some internal resistance. It is like this and these are the 2 terminals of the source and this is the emf of the battery and the characteristics of an ideal voltage source if he escaped that it will deliver a current I. So, this axis is suppose I this axis is suppose voltage VAO.

I am skating potential of A with respect to O and it will be VAO will be constant E this is the characteristics no matter how much current you draw how much current do you draw is decided by RL connected across the set across this battery. So, RL can be reduced and larger and larger current be drawn. Of course, I should not reduce RL too much so that it exceeds the rated current of the battery but this will be the Vi characteristics of this one and of a practical voltage source with an internal relations.

This will be this 1 this we have seen. Now, in the same line we have a current source the practical current source can be represented like this and here is some current time fixed current time and this is the thing and this r is said to be the internal resistance of the this E in both the cases this portion is ideal is not no internal resistance here this it is similarly, this current showed somebody draws like this it means.

this current will be constant and a practical current source can be represented in this way with some internal resistance and an ideal current source will be represented I is instant of writing ISC I will simply right now, I how much current it will deliver to understand that, 1 can interpret instead of a voltage source or current sources is present that ISC = E/r was plot in, but once that is done. I can think of this thing like this A.

Therefore, the characteristics of ideal current source if this is I and this is voltage and here you will connect load RL. It says that whatever is the strength of this current source that current I am that current will remain constant at this value I voltage may change between this a point. For example, if you have a 2 ampere currents source somebody says ideal current source connect RL if RL = 1 ohm the voltage across this will be 2 volt.

If you connect 4 ohm RL = voltage across it will be 8 volt that is why voltage can be anything of course anything means it should not disturb the installation level of RL. So that it will be destroyed, but there must be some RL should be connected here and voltage can be anything. So, this arrow indicates a current source ideal current source is such that if it is connected in a circuit, this branch current gets fixed.

No matter what will be the voltage across is so, this voltage will be unknown. In case of an ideal battery, the voltage is fixed current could be anything decided by RL understood. Therefore, a practical current source can be thought of as an ideal current source in parallel with a resistance then this resistance can be thought in as a part of this all network activity connect across cell, it looks like that then see a practical current source this portion is ideal.

Ideal current source and then these are and the other impedance connected across these, are can be thought of part of this, who prevents you to do that and therefore, voltage across it will be decided by this I and basically valent resistance. It could be anything depending upon the value of RL, RL make a load resistance, but internal resistance of the current source will not change Therefore, they depending upon the strength of the current source.

The characteristics should be like this voltage can be anything VAO across the current source. Now, 1 important thing although it is still I am telling you repeating you I am not sure about the practical availability of the current source from concepts we are trying to develop the property of a current source it must do like that. Therefore, it looks right this point is very important suppose there is and a practical current source 2 ampere.

Suppose, it is available with two terminals A and O should I keep it open circuited. That is the first thing we must understand, if it is available, this current source will always try to drive a current of 2 ampere in this branch with no load resistance connected A and O it is supposed open circuited then also it will try to drive a current 2 ampere it means that open circuit means watt RL tending to infinity is not then only these 2 points will be open circuited.

Therefore, it looks like a current source. If gate open circuited, what will be the voltage between these 2 points then A and O 2 into RL and RL tending to infinity. So infinite very large voltage will appear. Therefore, it looks like if a current source is really available, then it should not be kept open circuit because across A and O then high voltage will exist which may be very dangerous to the persons who is using the current source and making a circuit like that.

It should never be open circuited Instead a current source ideal current source which has got no internal resistance, no internal resistance with infinite internal resistance. They should be kept shorted current source terminals should be kept shorted, when not in use. An ideal voltage source should be kept open circuited between A and O open circuited when not in use, because I know what is the voltage source. So, this is the difference between and for that, I do not require big theories.

I understand if somebody insists that a current sources is a fellow which always drives to drive a current of 2 ampere, no matter what impotency you connect across heat, then it looks like if you keep it open circuited that means RL connected between A and O is infinitely large open circuit still it will try to force the current of 2 ampere them large voltage will appear which will be dangerous to the persons who will be handling.

This current source and so on. So, current source when not in use should be kept short circuited. Therefore, to use a current source the practical circuit will be like this 2 ampere suppose current source you are switch should be parallel across the load resistance RL ideal current source. When you do not want to deliver power to RL it should be shorted what is the voltage between these 2.0, 2 ampere will circulate here because it is kilo resistance shorted.

No power is delivered to the load when you want to deliver power to RL using this current source open this therefore, you see if you imagine all sources available our current source then to energize a circuit your switch should be accurate parallel across the load like this going to be in news you open it 2 ampere will flow anyway this very interesting things and should be understood.

So, a practical current source will consume certain current here, but a ideal current source does not consume anything total current it delivers you can sketch the voltage versus current characteristics of a practical current source, it will be I, when no load is connected, but it will be slightly less current these will be the characteristics because this load current I will be I - this internal current of the current source. So, it will be somewhat like this.

I think you have got the point with this in mind, we can proceed part so, I will then say that Inner Circle there may be sources and till now I am considering sources which is not a function of time it is voltage fixed voltage source it is current source. It is a fixed current source and so on. And if it is a battery, ideal battery, the voltage across the battery is known nothing to be founded current will be decided by whatever in between us you connect.

If it is an ideal current source current in that branch wherever that current source will represent that is known, but voltage is across the current source is to be calculated from the whatever impedance or resistance you have connected in the network. Let us consider a very simple example. We will

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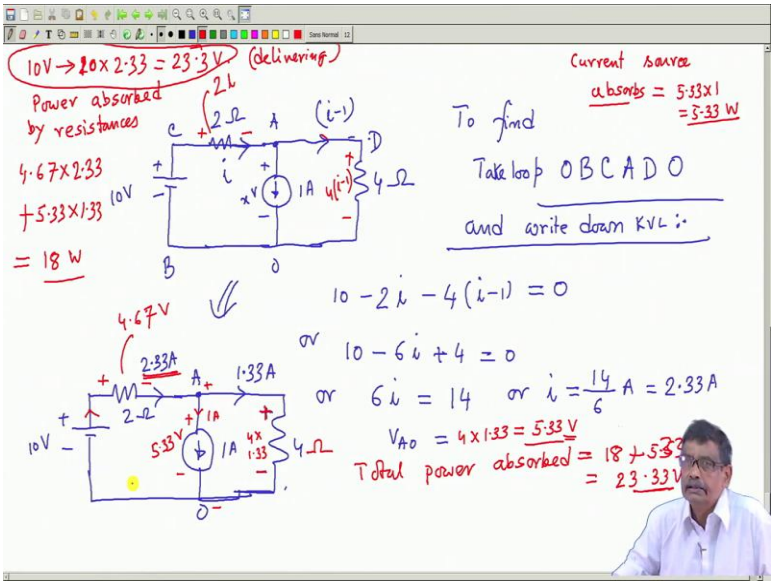

Go slowly here for example, let us consider a network like this a battery and a say current source 1 ampere right. And when have drawn a current source like this I have told it is an ideal current source and there is supposed and resistor systems in this market, I want to find out the current in various parts of the circuit. And let us say let us take simple example, say this is supposed 2 and this is suppose 4 like this (FN: 16:03)

I know I have formerly not defined what is a loop what is a maze have not done anything like that still as if I am in school days I know KVL KCL based on that I will solve this circuit. Now, first point is what I have been asked there are two sources, one is a 10 volt ideal voltage source 1 ampere current source is present and these 2 resistances are known problem is to find out the currents in all the branches in this circuit that is what I have to find out.

1 point which is not I will not say it will act to your knowledge but one thing is clear since we have to find out current seen all the blank case, I will be happy to see in a circuit current sources present why I am telling this because in that case this branch current is already known 1 ampere

what to find out there are this branch. This is another branch, these currents are unknown, but in this branch current is already known so, to find out.

That is you should not be upset because of presence of many current sources present in a circuit. Rather I will say it more current sources are present at least your labor is going to be less to find out currency in other branches because those branches which are hosting current sources, those currents are already known, because network problem is essentially source voltage source currents will be known.

You have to find out the currents sum various branch in that simple low at if you look at then I will say look here in this circuit, this branch current is already solved for me, because of what because somebody is telling there is a constant current. So, an ampere now, how to solve this current, I will solve this current in this way. Now, while solving this current by using KVL KCL what I will do is this I will assume this current.

For example, this current I say this is I ampere then I come to this point and I find at this junction KCL has to be satisfied and this fellow this branch current is 1 ampere. So, this current must be i - 1 ampere is not this is what I will try to find out but, so, there is 1 unknown small i that I have to find out. So, KCL I have already applied now, I have to apply KVL is this 1, this exercise please go through it very carefully.

KVL is true for any close to path in this path, this voltage, and voltage between these 2 points suppose this point is A this point is O some of these voltages must add up to 0 similarly, in this part this voltage and this voltage must sum up to 0. All things are known but you see the voltage across the current source is unknown that is whatever will be the voltage drop across this one I am not sure that is another unknown next volt because as I told you.

Current source delivers constant current, but the voltage accuracy that is between these 2 points will be decided by these impedances and other things connected across the current source. So, that voltage is not known when you start solving a problem and this is not surprising. In ideal battery case also it is like this in a circuit only having batteries and other resistances voltage

across the battery is known but how much current it is delivering is decided by the in between connected.

So, the converse thing is with the current source is that it is delivering a constant current in this direction with this arrow indicates that but unfortunately the voltage across the current source is not (FN: 21:12) anyway, but the KVL is set will be satisfied in this loop and also in this loop in this outer closed loop any closed loop you take up and KVL will be satisfied. So, I is the unknown.

So, let me take this loop O say B, C, A, D, O this loop I will take the take loop I will start my journey from O , then I will go to B then I will go to C then I will go to A then I will go to D and then I will come back to O this is the loop let us consider (FN: 22:17) second important point is the moment you have assumed the direction of the current I write down the voltage drop across this 2 ohm resistance with this polarity because I have assumed like this, so this side is + this side is - and this voltage drop is 2i.

Similarly, I have assumed the current to flow from top to bottom, which is i - i and I will write down the voltage drop here with this side as 4 into i - 1 that is all then I Take loop this and apply and write down KVL in that KVL and write down KVL in this loop obviously. So, start your journey from O to V no voltage drop 0 then B to C here is there is a voltage rise - to + so right down + 10 volt then C to A + to - of what magnitude excuse me 2i plus to minus.

Then A to D no voltage drop, because no resistance here no battery except represent then from D to O yes, there is a voltage Drop - 4 - 1 and then after that you reach O this point and this point assemble and KVL says me that this is equal to 0. So here is 1 unknown 1 equation. So, I just solve this equation so 10 - 6i + 4 is it = 0 or 6i =14, is it or i = 14 by 6 so much ampere, 14 by 6 ampere if everything calculated these say 2.33 ampere is this correct.

Then what I will do is this I will rejoin this circuit although it will not be necessary as you become more familiar with the system but it is to begin with it is always better after you have solved the circuit rejoin the circuit like this here was the current source 1 ampere. And here is

another resistance 4 ampere. Then this is 10 volt and now I have solved this circuit and this i as come out to be positive So, this current is 2.33 ampere is flowing and then I apply i - 1 so 2.33 - 1,

This current will be 1.33 ampere, this will be the thing. Now, you see, as I was telling VAO will be how much I can now calculate, what will be the voltage across the current source, it will be start from O straight try to reach A byered this path you if you go you cannot fish out anything because that voltage is the unknown thing. So, if you go byered this path it will be equal to this voltage is 4 into 1.33 is not this voltage will be 6+-.

So how much it is 4 into 1.33, 5.33 volt is it. So, this VAO will be 5.3. So, you see the voltage across the current source for this particular example is 5.33. If you change this resistance to some other value it will have some other voltage. So, this voltage is this watt and what will be the polarity of this voltage mind it the polarity of the voltage because this is this class so, this is plus this is minus is not this will be the polarity of the voltage.

Now, let us do that power audit in this network which you have learned earlier that in any network after You have solved the total power supplied to the network is bound to be equal to the power losses indeed existences or impedances or whatever it is now, at this point I will must I must say that it resistances are such elements, which will always dissipate power, no chance that a resistance will give out power a positive value of resistance i square r whatever.

Power comes to the resistance it is immediately dissipated as it and last forever. In any case, we will see that what, is the voltage are drop here 2 into 2.33 how much 4.667 volt approximately and this voltage is known and this current is one ampere (FN: 29:00). Let us take this 10 volt source what it is doing 10 volt source this current is 2.33 through the + terminal it is coming out so this 10 volt is delivering power.

How much power 20 into 2.336, 7, 2, 10 volt into 2.33 I wrote correctly 2.33 how much what 10 into 10 volt into 2.3 how much what 23.3 watt. So, this battery is delivering power mind it right

delivery (FN: 30:00) what this current source is doing let us see current source is having a voltage drop across the, which is equal to 5.33 volt 4 into 1.33 with this site + this site - and current is so, through the + current is entering. So, this current source is absorbing power. So, so current source observes.

I will write observes how much power the voltage across the, that is 5.33 into the current that is 5.33 watts. Who are the other fellows that are absorbing power this resistance and this resistance. So, I will write please byered with me since I am writing this here they are so power absorbed by resistances will be how much 4.67 into 2 + 4 into 1.33 into current 2.33 is it this is the thing. So, this is 2.33 + the power absorbed by this resistance is 4 1 this is 4 ohm.

I think is it this is own please correct that this is not ampere for that, so this is O so, 4 into 1.33 is the voltage into 1.33. So, how much it is so this is 5.33 so, 5.33 into 4 into 1 point. So, how much this some becomes 18 watt (32:47) then the total power absorbed will be resistance absorbs power, this resistance absorb power that is 18 Watt. So, I will write total power absorbed power has been absorbed by this resistances 18 watt +.

The current source 5.33 which you will be called to 23.33 watts and power delivered by the soul sees also 23.33 so, everything is fine in this circuit got the point. Therefore, what in essence I am telling is that in a network there may be different types of elements we have started with simple things resistances are present and there may be voltage source current sources which are present And I have now told you that if current sources are present.

Then in whichever branch this current sources present that current is known, nothing to be solved here this 1 ampere is conditioned by the presence of this current source as 1 ampere. So, you have to solve the other currents, but voltage across the current source, I do not after I have solved this circuit then I discover that for this particular load and for this circuit VAO is 5.33. So, it is the voltage across the current source which really needs to be calculated.

Then after I have solved this circuit I have done that power audit once again for this circuit see in this circuit resistances will absorb power or energy and that power must be supplied by some

sources not that all the sources will deliver power here is an example this current source does not deliver power it absorbs heat and this battery delivers power. So, this exercise is very much educating and please solve on your own.

This kind of problems and always try to verify after you have solved the circuit that KBL is satisfied in this loop in the outer loop and also power balance exist. A power balance does not exist after calculating you must be wondering something must have gone wrong in your calculations. We will continue with this in the next class. Thank you.