Network Analysis
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Lecture - 02
Voltage and Current Sources

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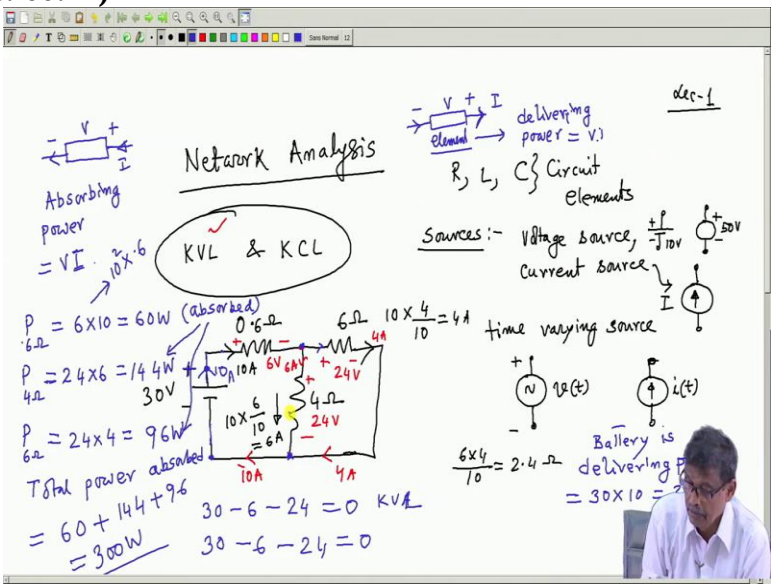

So, we will continue our discussion on KVL KCL and power balance taking from the last lecture, so, we considered the simple circuit with respect to this simple circuit only I will build up the thing, so, that you understand. So,

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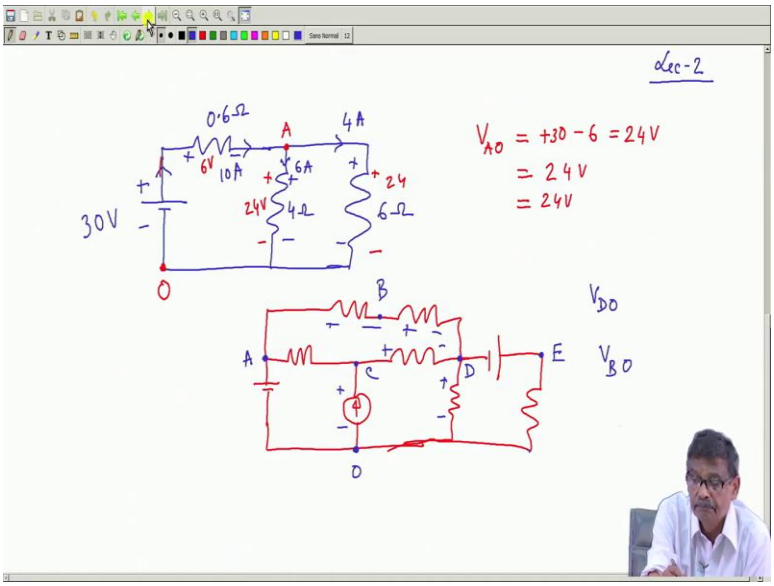

Our circuit was I will really draw here it is 30 volt there was a source with the help of this simple circuit I try to highlight many of the interesting things here. So, these are simple circuit we considered 0.4 ohm 6, 0.6 ohm and this was 4 ohm 4 and that is 6. This was 4 ohm and that is 6 ohm and we found out various currents in the circuit it was 6 ampere after solving this arcade from our school days knowledge series parallel thing and this was 4 ohm 4 ampere and this was 10 ampere.

This circuit was solid and we then immediately can identify which of these fellows is delivering power this 30 volt source must be delivering power because through the +10 ampere is coming out, voltage drop here is of this polarity. Therefore, it is absorbing power similarly voltage here after will be up this polarity it is absorbing power is absorbing power and 300 watt was balanced. I will now tell you another important thing we say that potential difference exists between 2 points.

For example, I say that this point let me call this is O and this point is say A. Now the next question is if I connect a voltmeter, across AO between O and A if I connect an ideal voltmeter what will be surrounding? How to find it out and that voltage I will call it VAO that is I am interested to know potential of this point A with respect to O. So, this is the thing you should greet potential of A with respect to O I want to find out what should I do.

What you should do is this you start your journey from the point O and try to reach point A and when I say I want to reach point A, I have several options I can go this way I can go this way starting from O and I can go this way whichever way whichever path you choose VAO will be an unique numbered. So, let us see suppose you go by this way, so, I will write VAO. So, I will start my journey from O from this I am going like this.

So, from this to this there is no voltage drop no resistance in this part, then from this to this there is a voltage rise - to +, so, right +30 volt then from these to these what is the voltage drop here 6 volt 10 into 0.6 and it is from + to - and then -6 volt. So, so that this voltage will become equal to 24 volt. Therefore, potential difference if you connect a voltmeter between these 2, I will say VAO is 24, I expect that voltmeter to read 24 volt.

As I told you, it does not matter, how you reach point A starting from O, for example, if you go byered this path, then from here to here there is no voltage drop but from here to here, the voltage drop is this +-6 ampere volt, so 24 volt. So, you have reached this point then from these to these every state, so, that is also 24 volt. Similarly, this is also byered this path, these to these no voltage drop from this to this.

The voltage drop is +-24 volt because 4 into 6, so, 24 volt and then from this to this no voltage drop therefore, you should understand it will be often necessary as we go further into other aspects of circuit analysis, it is often necessary to find out the voltage between any 2 points of a network. For example, if I consider a slightly complicated network like this, this is some resistance, although I have not told anything about current sorts etc.

But suppose there are circuit like this and to highlight the point suppose a circuit exists like that all the values are known and as I told you by applying simple KVL KCL in closed loops and KCL at the junctions he will be able to solve this circuit that will be the main part of the course that will discuss, but what I am trying to tell, see there are no several junctions existing here. For example, you say this point is A, this point is suppose O this point is B this point is C, this point is D, this point is suppose E.

This O point is all over this is also because no element exists here, what I am telling if I ask you to calculate what is the voltage VDO It has got a meaning so, what I am telling that to find out video potential of D with except O, you start your journey from O and try to reach point D byered any part you like for example in this case, I will try to reach the point D byered this path O to C, I will go then C to D and while going I will note down what is the voltage drop here.

We can must know with polarity, similarly, I must know the voltage drop here then I will be voltage rise or voltage drop if it is a voltage right is + sign, if it is voltage drop there will be minus sign you can reach it and this result video will be unique for a given circuit with all the circuit elements and source sources non sources. Similarly equal reach a D byered this path you have to then take only 1 voltage drop.

You could reach this circuit byered this path but video will remain same from these to these voltage rise perhaps depending upon current etc. I will mark the polarity of the voltage here then take +- +- reached D similarly, I could reach the points in this path. Therefore, given a circuit after you have solved the circuit, you can you know all the currents in the branch of the circuit after knowing all the currents.

You know the voltage drop existing across each elements and then I told you that choose 2 junctions 2 points in the circuits you should be able to calculate the voltage existing between any 2 points in the circuit. For example, somebody maybe interested to know VBO then he should start his journey tried to reach P and algebraically some the voltage drop across the elements that he encounters along that particular part we could choose this point and that point understood.

So, this is how I can calculate the voltage between any 2 points in the circuit. And we shall use that knowledge often in circuit analysis. Essentially it means that when you calculate VBO whatever will be the number if you connect a volt meter between VO that will be the reading of the volt meter ideal volt meter clear so, this is the idea of a volt resistance. I mean potential difference between any two points. Now, I will

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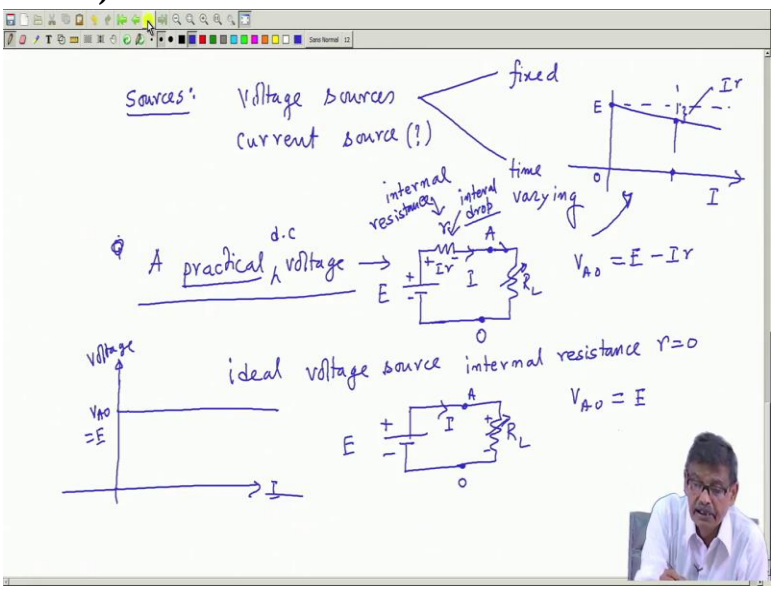

Tell you something about the sources before I take up this circuit elements are L and C separately sources as I told you sources may be voltage sources or it may be current source.

Current source is perhaps it is very we are not familiar with that you go to the market. You can buy a battery, which is nothing but voltage source, but go to a shop ask for a current source it is not dead that is the thing. Of course, in practical circuit you can develop a current source using electronic devices.

Like current source inverter those things are there but, in the market you will not be able to purchase the current source, but a battery you can always purchase voltage source we are used to things started with voltage sorts, there was battery then people started thinking it is only voltage source generate voltage to get power. So, rotating machines this that all these things are in general voltage sources. So, a voltage source could be a fixed voltage source fixed or it could be time varying.

As I told you a fixed voltage source in general both these sources could be ideal and non-ideal (FN: 13:22) ideal fixed a practical voltage source, a practical DC voltage source DC means constant voltage like a battery, a practical means it will have some internal resistance r and this is the emf in the circuit and these are the 2 terminals which is available from the battery terminals you really do not have any access to this terminal.

So, this is called internal resistance of the source and across these 2 terminals you connect your load say a light load resistance current flow, but what happens is this, this the voltage across these 2 points is not same as E, because we have just learned if it is A if you call this point O with r and L RL connected, this is I what will be the voltage drop here Ir so what is VAO, is the voltage which is appearing across your load resistance for example, a lamp.

How much is that voltage from this to this will start - to + it is +E then from this to this -Ir and I will reach point O. So, depending upon the current, this voltage which is actually appearing across the load will be less than E because and the remaining voltage will be dropped inside the battery that is called internal drop. This is how not a voltage source this is a practical voltage source. What is an ideal voltage source, Ideal voltage source internal resistance is 0.

That is each representation will be just like that. And here if you connect a load resistance RL then what is VAO potential of A with respect to O, VAO is the voltage which is coming across RL is not current resource. How much it will be start from O reach A that is only E There is no internal resistance like this. So, it will remain always E no matter what is the value of I, you want bearing RL, voltage across the load will remain same always Constance.

But here with internal resistance there will be internal drop inside the battery which is a function of current. Therefore, if you draw the characteristics of a ideal voltage source against current when I is 0, means when this RL is disconnected, when I is 0 no RL is connected that is suppose imagine there is a sweet it is open circuited. What will be with I = 0 this voltage will be equal to E, but with I increasing that voltage will have a drop like this.

So, it is a function of current of course, the internal resistance of a practical source should be small is not otherwise all the powers inside the battery, there will be large power drop in the battery will become hot and for no one going to buy a battery with large internal resistance one must see that. So, this will be the V I characteristics of a practical voltage source y is equal to y - CX, so, -MX + C slope of the line can be calculated.

So, for any current particular current time who decides that current if you change RL I will change. Therefore, for this current, this is the total voltage and this much, will be your Ir. So, from means subtract Ir you get this is the voltage applied across Ir they simply tells that what about an ideal voltage source. It will be like this this axis is I and this axis is suppose voltage No matter whatever is the current here the voltage available across the load VAO = E it will be a flat line.

Therefore with knowing internal resistance, potential difference VAO demons cost all the time. However, it is not the case when there is internal resistance of the source present. So, this is the scenario at least with DC constant values ideal battery representation and ideal voltage source a practical bolt associated presentation. Now, I shall give you some idea about

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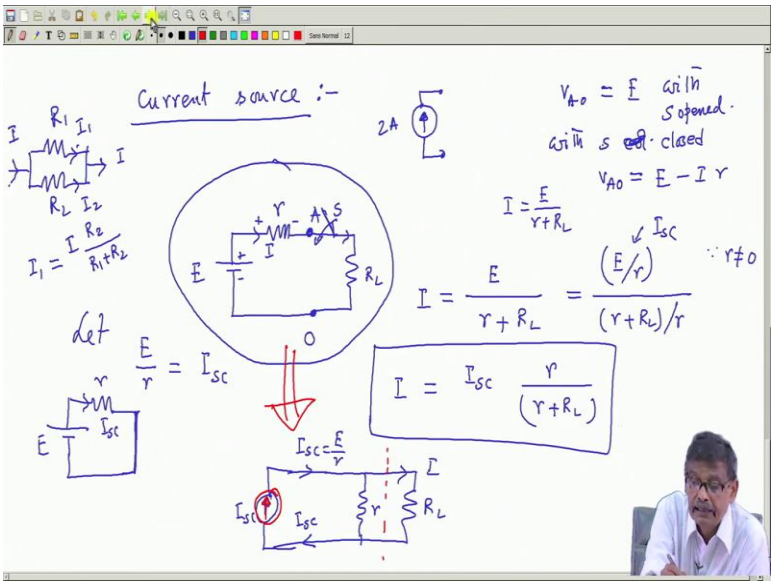

What a current source is. As I told you we are not used to current source and I simply told you it is represented like this a current source maybe a 2 ampere current source for example, a battery ideal battery may be written +-5 volt. So, a current source with two terminals will be represented like this symbolic representation, but where from it comes and why we although we know no current source at least is not used very much by any common users.

Why do you study this and why yet all what is the implication of the current source and how it comes from (FN: 21:43) to explain that I will take this you please follow me very carefully. Suppose you have a practical voltage source with internal resistance, this is the practical voltage source r it is these are the 2 terminals of the battery this terminals is never seen by us inside the battery. So, these are the 2 terminals available to me and I told you this point is A this point is O what will be VAO.

When nothing is connected, no current is flowing VAO start from O from this to this E no current no voltage drop here, + - if this is supposed like this and therefore, with S open VAO = E with is opened here this as weak, which can be connected this side with this open. But with S closed this is what I discuss in just some time before VAO will be with this which closed here then will some current now I the value of the current can be easily calculated.

If you know small r NRL, which is equal to E by r + RL and VAO will be nothing but E from this to this plus from this to this - Ir and I value is this so that will be slightly less as I told you So, I have to bring the idea of a current source I you can think in this way in this surface because we are conversant with voltage source, i is equal to E divided r + RL no doubt about it V = Ir that is the KVL and I is voltage by resistance. (FN: 24:33)

Now, what I will do is this I will do some mathematical operation on this particular expression. What I do I divide numerator and denominator by this small r that is I will say that this is nothing but E by r and r + RL by r it can do that, because r is not equal to 0, it is a practical voltage source. So, I can divide it since r is not equal to 0 practical battery (FN: 25:15) now, this quantity E by r is the property of the source.

It has nothing to do with RL this E and this divided by small r this quantity is detailed decided by the source by nobody else and not your RL is going to change it. So, they let this current let this current E by r we called who this current as ISC what is a physical meaning of this battery with this internal resistance will deliver a current if RL is meant = 0 if these 2 terminals are short circuited, is not it. Then only this ISC will flow if RL = 0 here E by small r.

So this current is a fixed current and is decided by the battery parameters no load is going to change this fellow I am not short circuiting but I am telling you if you short circuit they we battery terminals whatever current it will deliver. That current yes so this can be return as ISC this E by r is ISC into r by r + RL this will be the thing this is my actual circuit I was doing, but somebody says that is fine you are satisfied with this this one fine, but he thinks somewhat ahead thinking that this can also be written like this ISC by r by r + RL. (FN: 27:34)

Now, this point you just try to listen carefully, the next course of argument, what I am telling is this suppose, you have 2 resistances we have used this in the first lecture this idea. Suppose, this current is known I1. Then what will be this this current is I and this current is I1 this current is I2 what will be the value of I1 suppose I is known this will be equal to the total current coming across this parallel coming to this parallel combination.

This is also I total current into the other resistance or 2 divided by r1 + r2 is not we know these parallel current divisions in 2 resistances in parallel. So, here also it looks like that there is some fixed current ISC, our problem is to find out the current flowing through RL in this circuit. We did it by small r + RL but I am also trying to interpret that result from some other point of view that is fine.

You divide by small r then you get this expression and you say that then I think of this formula and say that ISC coming then there are two resistances in parallel r into RL and in this branch this current is ISC is not so, to find out the current flowing through RL in this circuit, somebody thinks somewhat differently. He says that solving this circuit is same as emerging you know E you know internal resistance E by r is calculate and then connect r and RL.

In parallel and you will get back this current I because ISC into small r divided by some of these 2 resistances gives you this current. See always if you look at the things always try to see. This problem can be also imagined in this way. There is somebody sending a constant current I ISC this circuit can be also thought of without any loss of general letting that is another way of looking at this simple problem is to say that.

Look there is a constant current here ISC and there is your this internal resistance of the battery small r and this capital RL there in parallel and this I will denoted by a circle with an arrow the arrow is decided by in which direction battery was sending current, because of that. Now, as I told you up to this portion, up to this portion on the left of this red line is this source portion because you see here small r is there, here is E by r is there Therefore, I will say that

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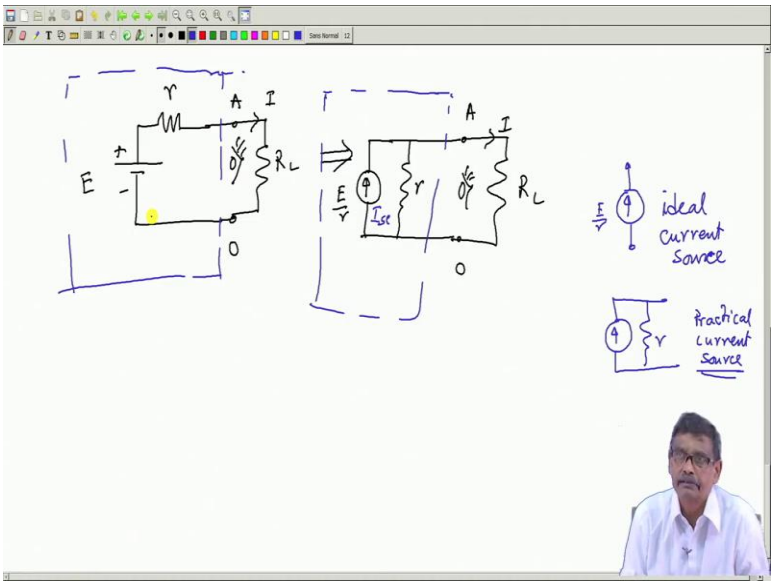

If you have a circuit like this a battery with internal resistance maintain r. This is A this is a suppose O and here is your RL this current is I and this voltage is E what are the things known battery this emf is known internal resistance is know what I am telling you live it with live with it you get everything correct fine. But perhaps somebody thought it to look at it from different angle. He says that oh you are solving this circuit between A and O.

E says here is your RL you are looking into this circuit and you know it is a battery in series resistance. He tells that look to the source site. What exist is this? That is all and E will always get correct current across the load and correct voltage across VAO no problem. See looking at the same thing from different angles gives rise to the fact although we do not know anything about current source whether it can be manufactured or not A, at this stage at least, but somebody says look here.

There was a it was not a emf r in series, but it is there is a constant current existing in this path in parallel with this smaller that is what is present that is if this thing would have been in a black box this 2 things are indistinguishable. This argument is a strong as this argument. He may say no there was no battery in series with a resistance here was the constant current ISC whose value is E by r in parallel with a resistance Therefore, a current source.

I will denote it to will be discussing about this more often than the simple example, but if you start from this it will be easier. Therefore, I now say that this portion only this portion excluding this r is an ideal current source I may say like this, of what magnitude E by r and a current source in parallel with the internal resistance r is a practical current source So, please, although very simple, but try to understand the nice it is of looking at these same things in a different angle between point A and O.

If you look into the circuit, I will say who told you there is E and r in series are inside this black box is actually a current source which supplies constant current. I can interpret it in parallel with a small r resistance. And these are the 2 terminal AO of your dead battery and to the external volt to the right side of this blue line whether you considered this to be present or this E and r in series to be present. It does not make a difference. That is what I am trying to tell. We will continue with this in the next class. Thank you.