Fundamentals of Electrical Engineering

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Lecture – 03
Basic Concepts, Examples (Contd.)

So, we have seen few examples some one or two more we will see small example.

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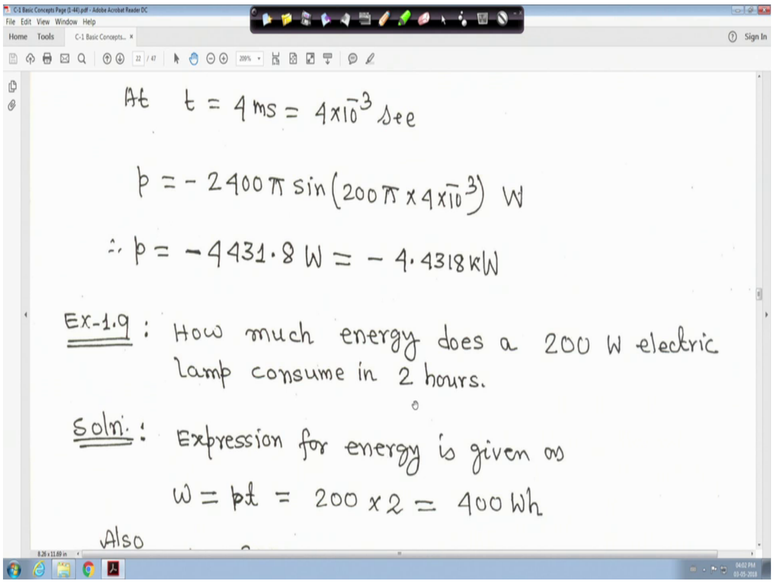

For example or this thing example 1.9 right, that how much energy does a 200 watt electriclamp consume in 2 hours right. So, expression for energy is given as your you know that it is the p into t right.

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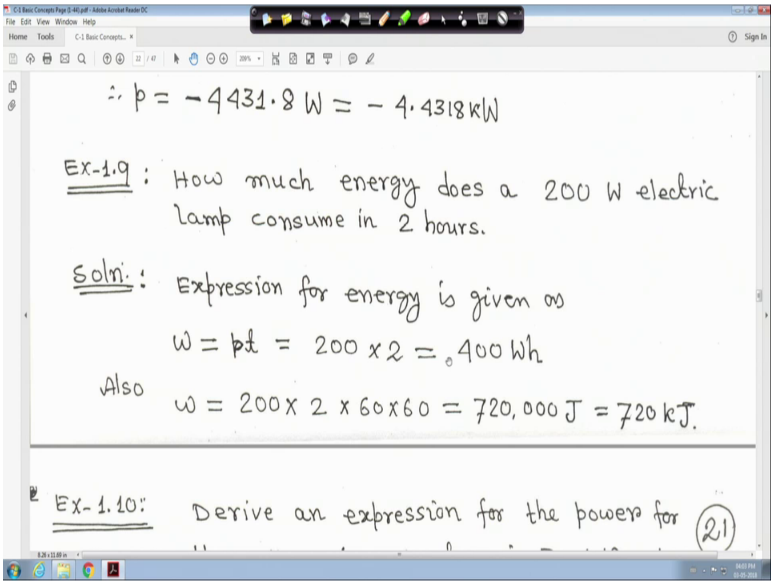

So, basically it is watt hour. So, this is power and this is your time. So, 200 watt and it is for 2 hour. So, 200 into 2 so, 400 watt hour right, but we know that joule per second is equal to watt because you have seen p is equal to d w by dt w is the work done so, in joule. So, it is joule per second right therefore, 1 hour is equal to your 60 into 60, 3600 second.

So, this is 200 into 2. So, 400 into 1 hour this is hour right. So, 1 hour is equal to 60 into 6. So, this much of joule that is 720,000 joule and is equal to your 720 kilo joule, because joule per second is equal to watt as well as you make this watt hour into watt second we are making this one watt second because one hour is equal to your 60 into 60, so, 3600 second multiplied by this 200 into 400. So, this much of watt second and joule per second is equal to watt. So, joule is equal to watt second. So, this much; that means, this unit actually watt second is equal to this joule is equal to 720 kilo joule.

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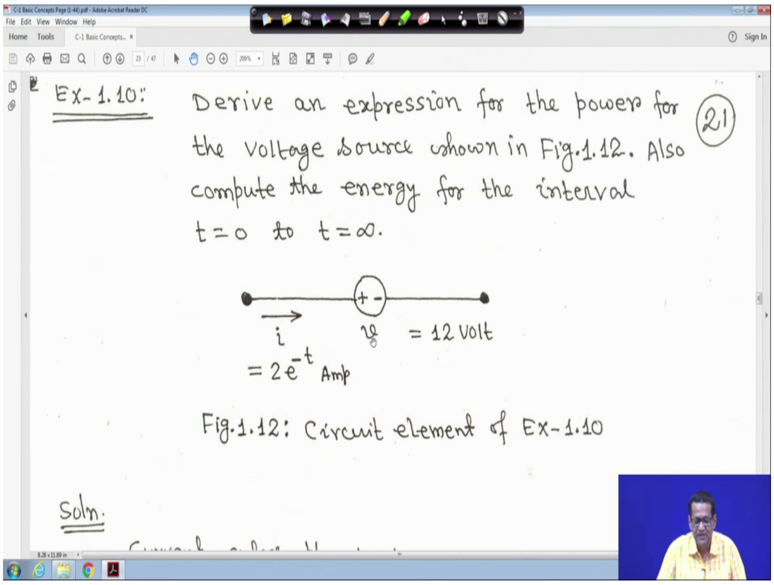

So, small example; now, another example tell this is here look whenever we are taking time function here it is a we are anyway we are interested for initially for the dc circuit, but when we will go for single phase ac and 3 phase ac circuits at the time detail we learn, but little bit idea little bit of you know flavor you will get here that that much. So, for example, example 10 it is given derive an expression for the power for the voltage source shown in figure 1.12 this is your figure 1.12 also compute the energy for the interval, t is equal to 0 to t is equal to infinity right.

So, this is that this is the figure circuit element right, now this is the voltage source, now current i is equal to is given 2 into e to the power minus t ampere, this is the current i is equal to 2 it is the time function i is equal to say 2 into e to the power minus t ampere and this voltage v it is equal to 12 volt.

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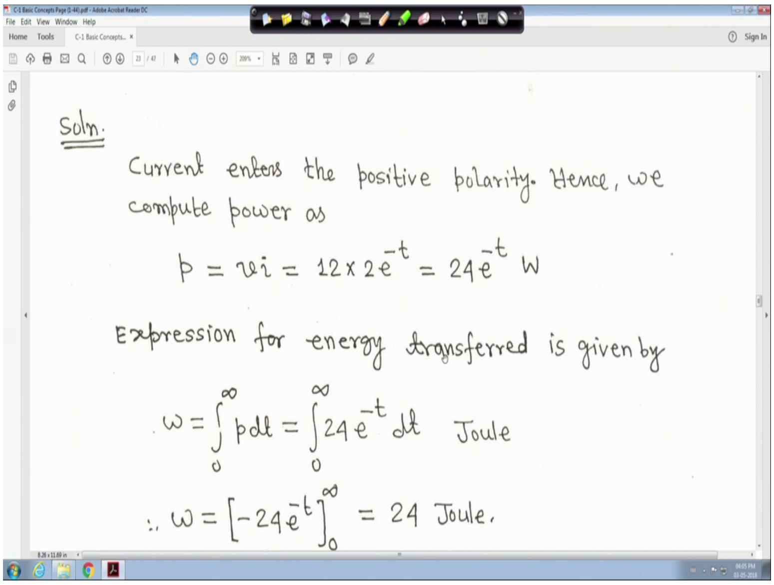

So, question is that that first thing is that this is a voltage source and current entering into the positive terminal right current entering into the positive terminal, but in this case just power expression will calculate that p is equal to you know that v into i therefore, current enter the positive polarity hence we can compute power as p is equal to vi. So, it is v is equal to 12 volt it is 12 volt right and i is equal to 2 into e to the power minus t ampere therefore, it is 12 into 2 e to the power minus t 24 e to the power minus t watt these a time function, later we will see in ac circuit time function we will see, but just to give you a flavor.

So, expression for energy transferred is given by it is given in between time t is equal to 0 to t is equal to infinity. So, here that; that means, your what you call energy transfer limit 0 to infinity p into dt right. So, you know p is power and t in terms of time second. So, what second it comes it will be joule then right.

So, it is 0 to infinity 24 e to the power minus t dt. So, you integrate this much of joule you integrate this. So, it will be minus 24 e to the power minus t 0 to infinity put this values you will get it is 24 joule right. So, expression for energy transferred it is actually 24 joule, I think this is simple thing it is understandable to all of you right slowly and slowly you have to understand now each and everything.

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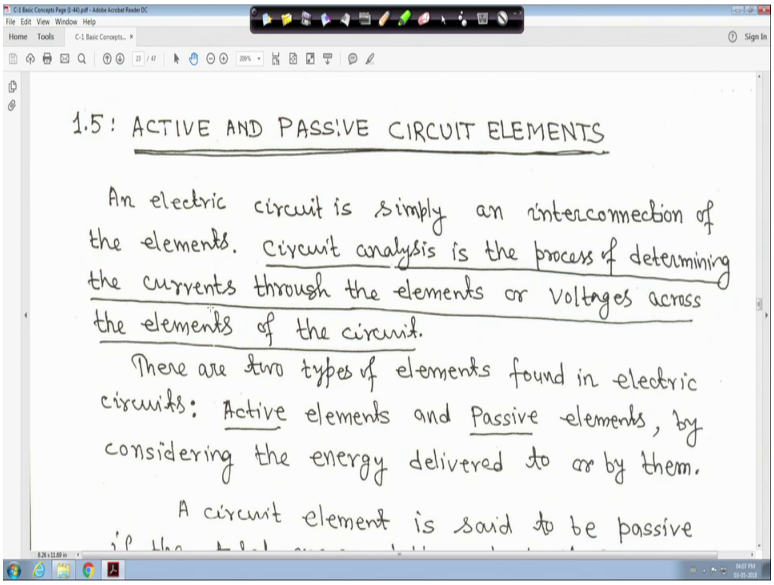

So, active and passive circuit elements. So, an electric circuit is simply an interconnection of the elements earlier we have discussed above this right. So, circuit analysis is the process of determining the currents through the elements or the voltage across the elements of the circuit, either you have to find out the current through an element or the voltage across this elements right. So, that is our circuit analysis.

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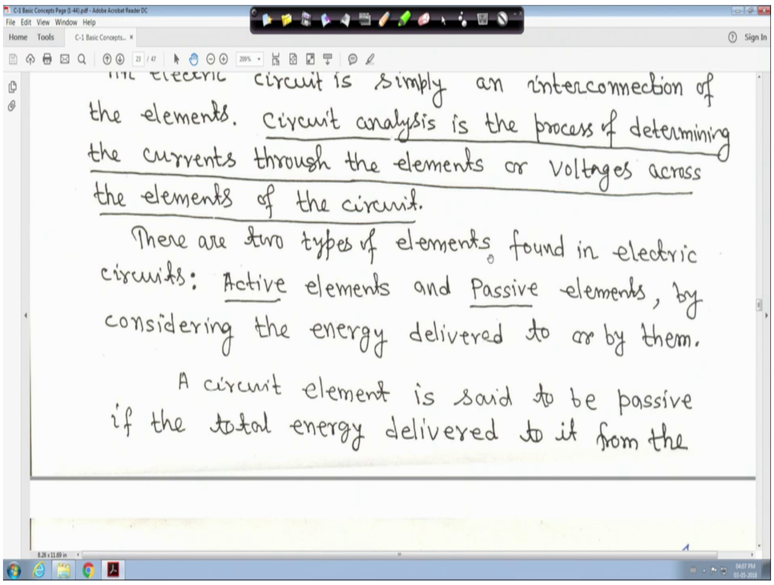

So, basically there are 2 types of elements found in electric circuit one is active element, another is passive elements, actually active elements are those, which are not passive or in the other way passive elements are those we cannot active something like this right, by considering the energy delivered to or by them right.

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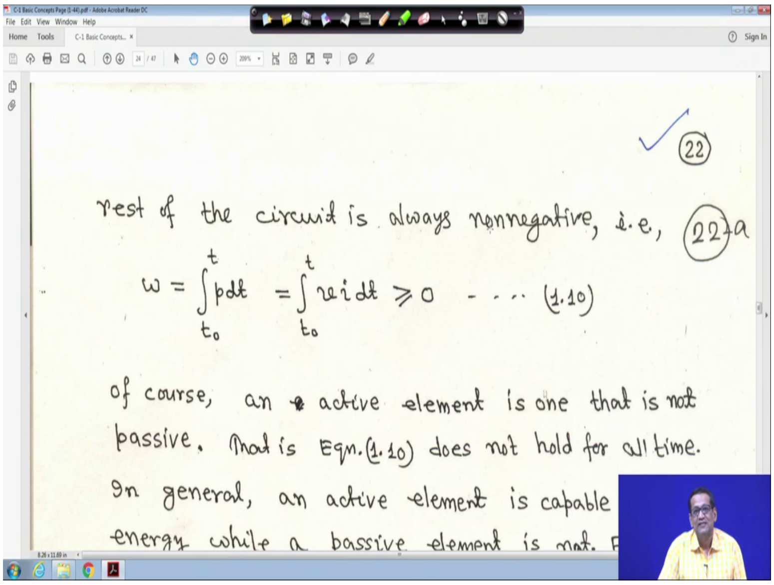

So, a circuit element your is said to be passive if the total energy delivered to it your from the rest of the circuit is always nonnegative; that means, it is I mean it is it can be 0 or positive right. So, a circuit element is said to be passive, if the total energy delivered to it from the rest of the circuit is nonnegative; that means, that the rest; that means, that suppose energy is equal to given for any initial time t 0 to t p into dt is energy because p is power and time watt second actually is equal to joule.

So, this t is equal to t 0 t. So, p is equal to vi say t, but mathematically you can represent like this. So, t 0 to t limit it is vi dt it will be greater that equal to 0, then you can say it is a passive elements.

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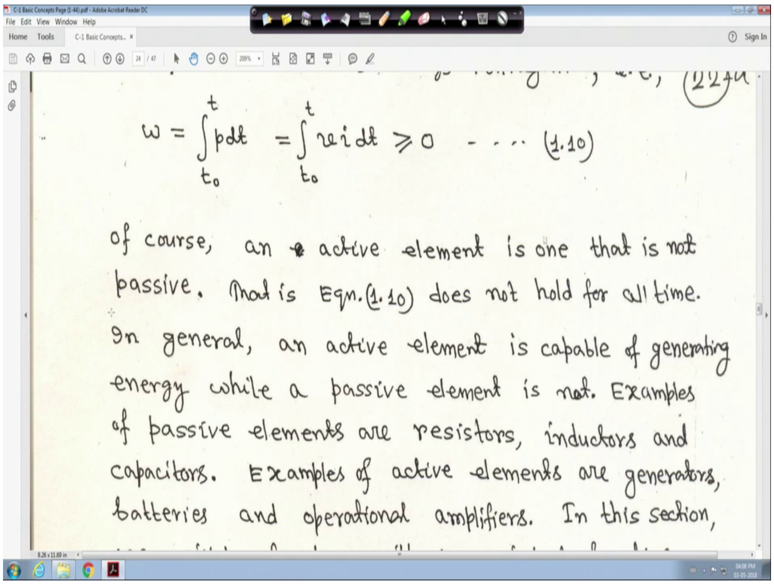

Of course, an active element is one that is not passive just opposite right. So, if this is equation 1.10 first that was a equation 10 right. It does not hold for all time in general an active element is capable of generating energy, while passive element is not active element it will generate energy, but passive element it cannot generate.

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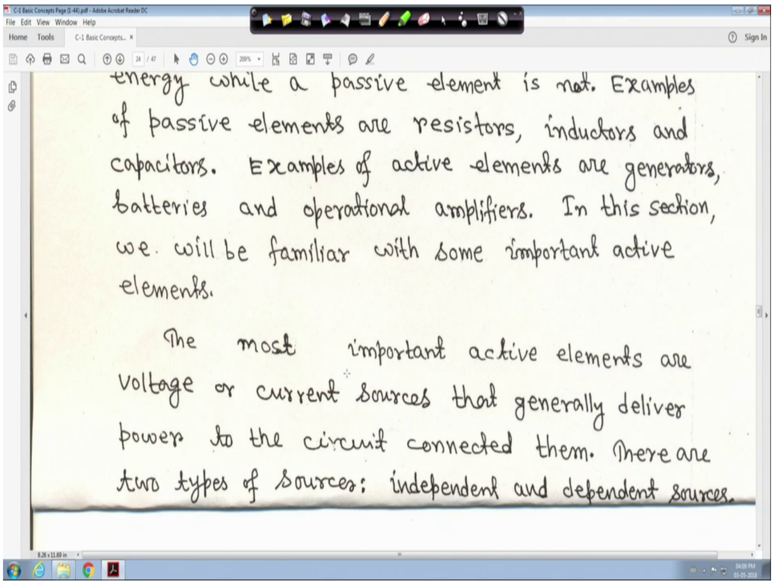

For example that passive elements are resistors in general resistors, inductors and capacitors these are actually passive elements right and example of active elements are it is generators, batteries and operational amplifiers.

So, these are certain things you should keep it in your mind. So, passive elements are resistors inductors or capacitors and active elements example are generators, batteries and your operational amplifiers. So, in this section we will be familiar with some of the your what you call that important active element.

So, the most important active elements are voltage or current sources right. So, that generally deliver power to the circuit connected to them, either voltage source or current source just I would like to tell one thing in that introduction video, I mention that thing that only handle independent sources, but let me tell you later I thought that your dependent sources also will be covering very simple thing then everything will be concrete right.

So, dependent source also will be there, but very simple later you will know very simple. So, both your independent and dependent both sources will be considered right. So, there are 2 types of sources independent and dependent sources. So, will consider a both all the in the introduction be device said only independent later I realize no both will consider right.

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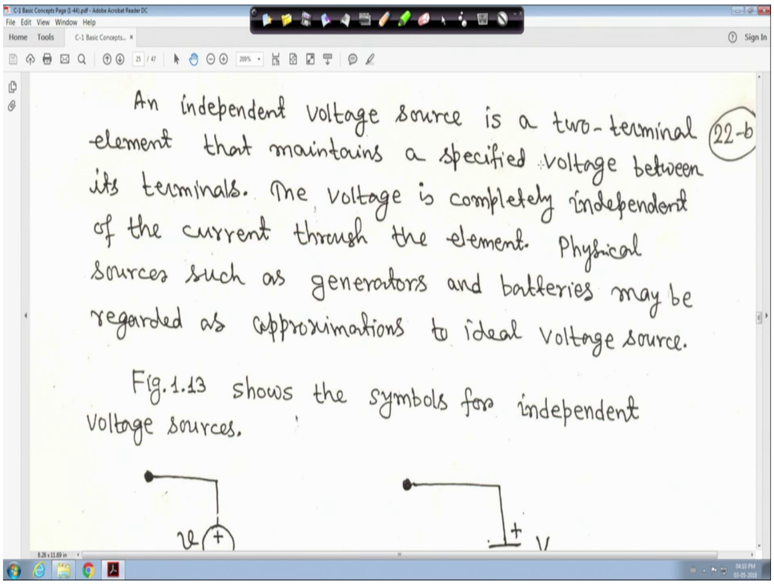

So, an independent voltage source is a basically a two - terminal element for example, your this is a voltage source say two terminal element right and symbol I will come to that later right.

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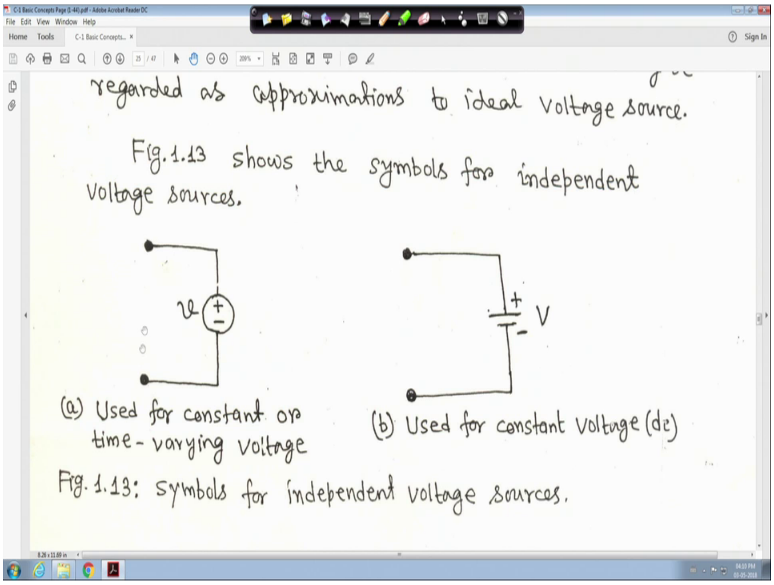

And that maintains a specified voltage between these 2 terminal between this terminal it is your, this voltage is specified right between this 2 terminal right. The voltage is completely independent of this voltage is completely independent of the current right or it is independent of the voltage of some other parts of the circuit right. So, physical sources such as generators and batteries may be regarded as appropriations to ideal voltage sources. So, either generator and batteries you can you can be regarded as your ideal voltage sources that way we will think.

Now, one is look at the symbol here, one circle is there and it is plus minus this can be represented by dc as well as ac both you can dc one of the symbol right, I am not there not ac I said say time varying I will say time varying right. So, either plus minus it can be regarded as your dc source or time varying and this one value you make that one your what you call plus minus if you make the larger your larger one larger continuous line is plus and smaller one is minus. So, this is actually v or dc source right.

But this one it can be used for constant or time varying voltage this can be this symbol meaning for both. So, if you use this symbol also absolutely correct or if it is a pure dc then this one this one also can be used for a pure dc. So, these 2 are symbol for your independent voltage sources right.

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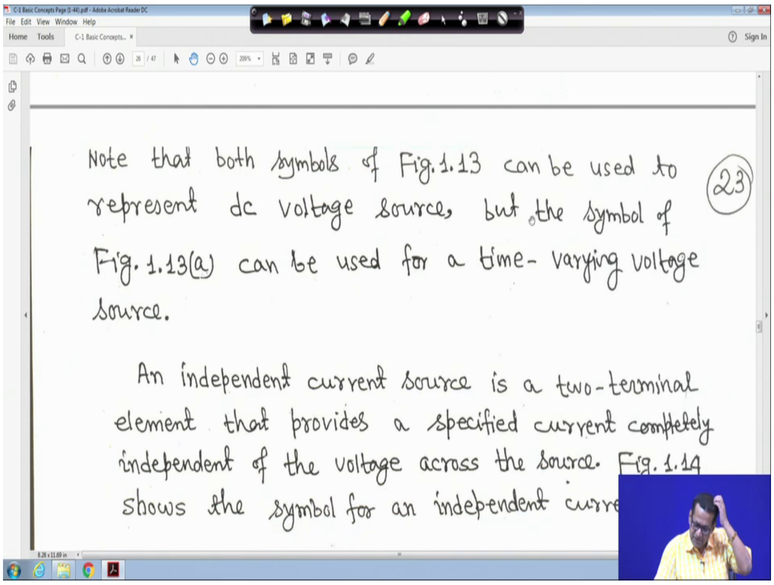

So, similarly so, can be. So, that is why the; whatever I said that can be used to represent dc voltage source, but the symbol of this thing can also. So, be used for a time varying voltage source, but dc as well as time varying both can be made.

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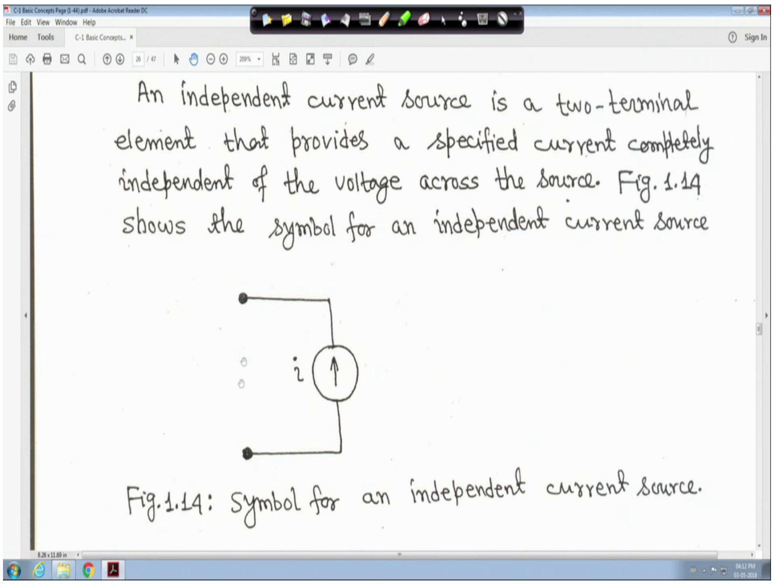

So, an independent current source, when it is independent current source again it is a two - terminal elements, it is a two - terminal element that provides a specified current right your, what you call completely independent of the voltage across the source. So, this for this current source whatever it is there is completely independent of the voltage across the source right. So, this is totally these a symbol of the current source and these current source if this symbol is true for both dc as well ac right this symbol is two or both will ac we will see later.

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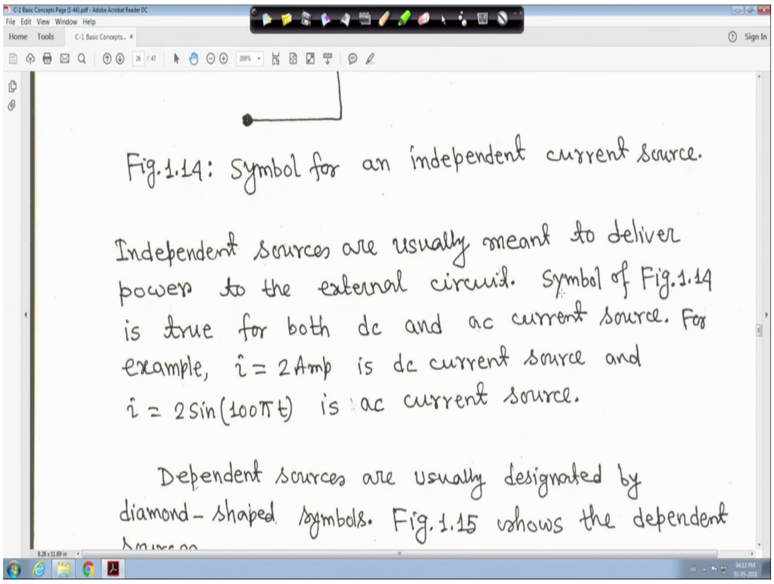

So, independent sources are usually meant to deliver power to the, your external circuit. So, this symbol this figure one is a true for both dc and ac I have told you right. So, example i is equal to 2 ampere, if it is i is equal to 2 ampere say if i is equal to 2 ampere here right then it is a pure dc source and if i is equal to say 2 sin 100 pi pi t then it is an ac current source, but this symbol this symbol is same for both dc as well as ac, when we will go much deeper we will know all this things in detail right.

So, not making much exerciser wherever necessary I will do it. So, these thing is understandable right.

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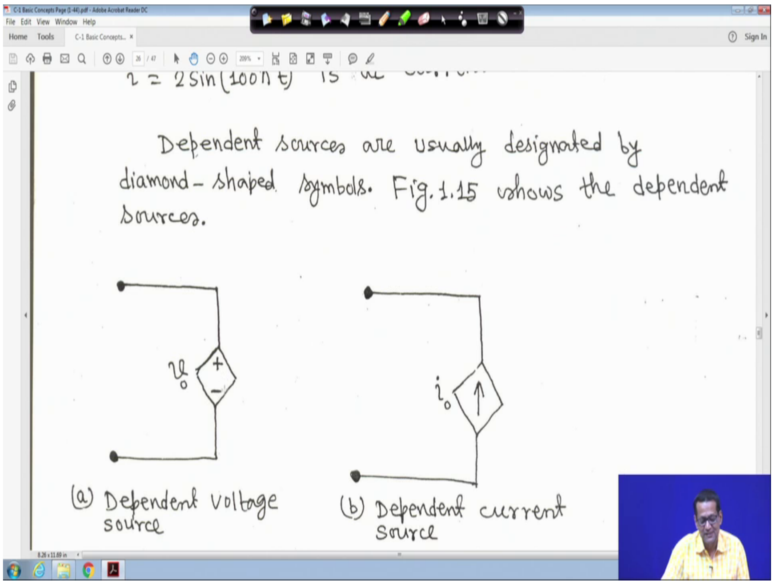

So, now dependent sources are usually these dependent sources are usually a diamond shape. So, for example, this is plus minus this is dependent current source right an arrow is shown upward here right just for the purpose of example and this is your dependent voltage source; that means, dependent voltage source means this voltage whatever it is it may be function of current in the some part of the your some branch of the circuit or may be a function of some voltage across some elements of the circuit.

Similarly, this current is may be the function of some other branch current in the circuit or may be function of some voltage across the, your circuit. So, these are dependent. So, these are not ideal these are not constant these are dependent sources. So, symbol is this is diamond shape and this symbol is your like this that is the dependent sources these dependent voltage source and this is dependent current source.

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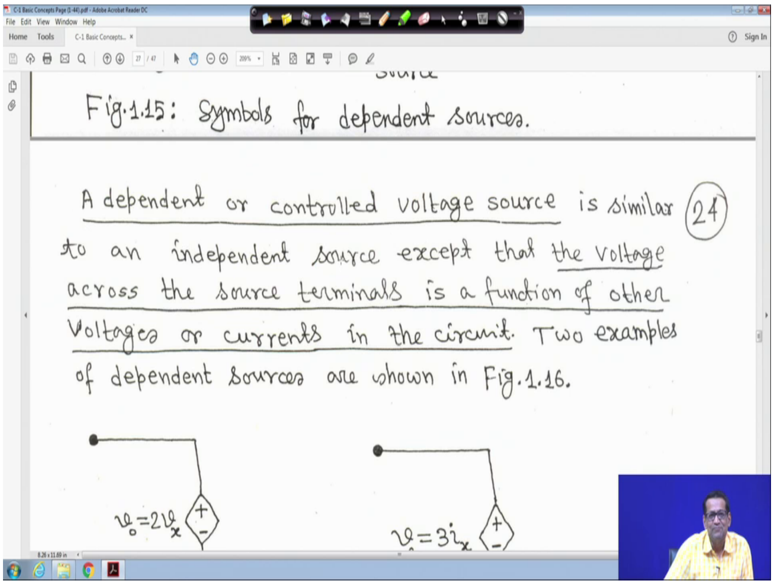

So many things are written here, but whatever I am telling meaning is same right. So, and a dependent or controlled voltage source is similar to an independent source, except that the voltage across the source terminals is a function of other your what you call other voltages or current in the circuit for example, look.

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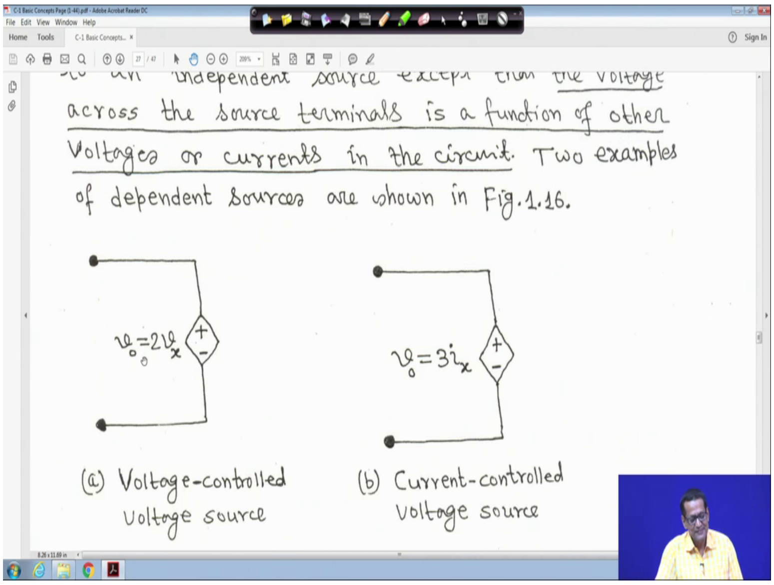

This is this is actually your dependent voltage source v 0 is given 2 into v x is general you can take a into v x right a maybe 1 2 3 4 what is ever and below less than 1 also.

So, it is some 2 into v x is taken for, this is v x actually is the voltage in the circuit across some other branch right, but just symbolically it is shown that v 0 is equal 2 v x, a v x changes then v 0 will change right. So, this is actually called voltage controlled voltage source, because this v 0 is function of this voltage across some other element in the circuit say x. So, that is why it is written say v x. So, this is actually they voltage controlled voltage source, because v 0 is a function of v x and this v x is the voltage of the circuit act was some other element x right this why you imagine at the stage.

Similarly, this is also this voltage v 0 it is taken 3 into i x, sometimes we call this is a gain parameter 3, it is 3 it may be 4 5 2 1.2 it does not matter, just for the purpose of explanation we have taken v 0 is equal to 3 into i x. If the i x is the current through some other branch some branch x a and i x is changing to a v 0 is changing; that means, it is a it is actually called current controlled voltage source because these voltage source v 0 is function of the current, that is why it is called current controlled voltage source CCVS in short it is voltage controlled voltage source VCVS right.

So, this is actually dependent source that your v is equal to you r v 0 is equal to 2 v x or v 0 is equal to 3 i x these are called dependent source that is v 0 in case it may be function of voltage or may be function of current also right. So, this is when it is function of voltage it is called voltage controlled voltage source when these function of current it is called current controlled voltage source because it is because v 0 is a function of the current, I hope this is simple thing I hope it is understandable to you.

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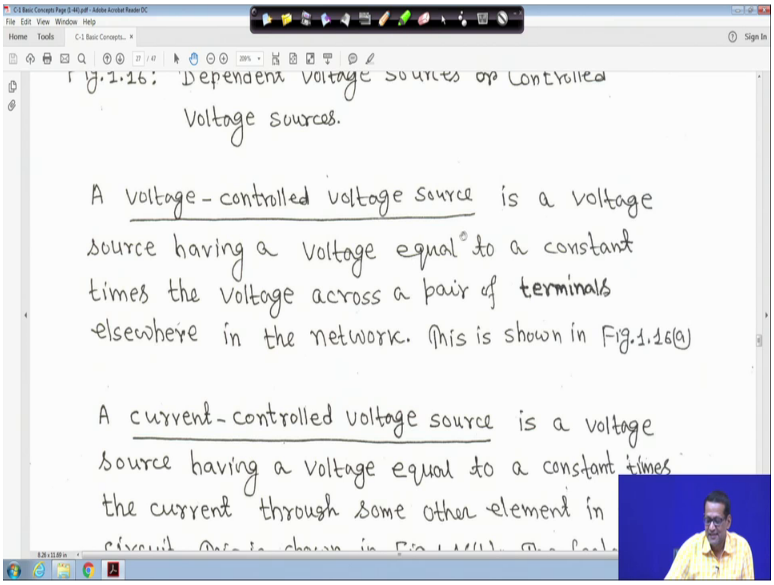

Similarly, that means, whatever I said that everything, everything is written here this is figure 1.6 say 1.0 ab. So, whatever I said everything, everything is everything is written here. So, I am not reading or not telling further everything is written here right and only thing is that here in this case whenever it is your dependent on the current so, this parameter this 3 you will call the gain parameter right.

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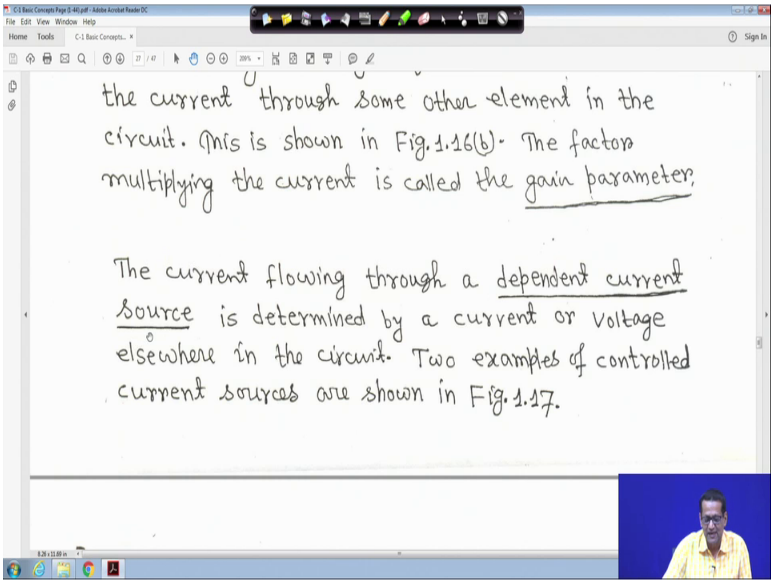

So, now the now next is the next is this is your what you call voltage source, now current flowing through a dependent current source is determined by a current or voltage elsewhere in the circuit for example.

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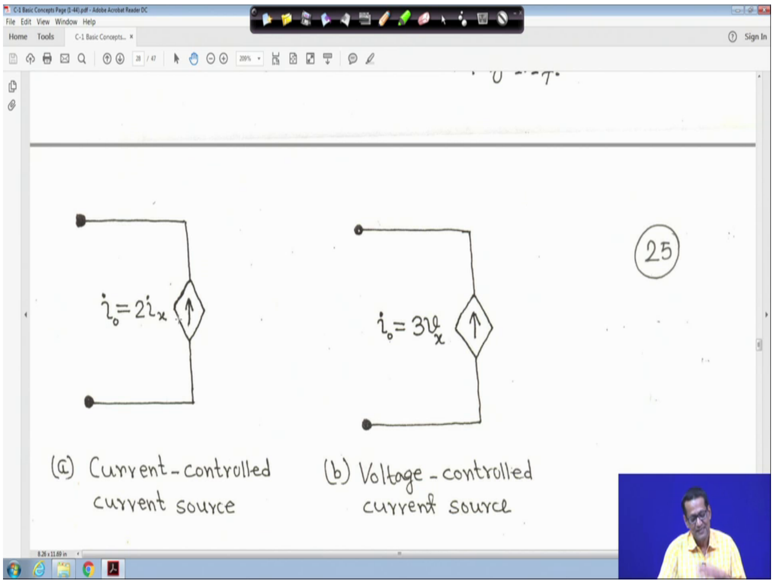

This is for example, say current controlled current source. So, this is a dependent current source this is i 0 is equal to say 2 into i x say 2 is it is 2 i have taken it may be 3 4 less than 1 whatever it is it does not matter right, but further purpose of explanation say it is 2 into i x.

So, this is actually current controlled current source because this i 0 the current is function of the current i x, i x may be the current of some element your in the your branch size current i x flowing some branch x a. So, this actually that i 0 is equal to 2 into i x so; that means, it is current controlled current source whenever this is function of this one it is function of current i x. So, it is current controlled current source CCCS we call right.

Similarly, this current when i 0 is 3 v x it is voltage controlled current source because this i 0 is function of the voltage v x. So, it and this v x is maybe it is the voltage across your across the branch say x right. So, i 0 equal 3 your what you call this 3 i have taken 3 it may be 1 2 3 4 it does not matter this is also called gain parameter.

So, i 0 is equal to 3 v x and this is your what you call voltage controlled current source. And another thing is that whenever we are showing this is plus minus it is shown right similarly for the current source whenever this arrow is upward this I mean it is; that means, that means current is leaving this terminal. So, this arrow this is your what you call that arrow upward means the current is leaving upward I mean current is moving flowing upward. So, current is flowing like this flowing like this right.

So, this I mean if it is like this just hold on right. So, this is the that your what you call current is flowing like this, similarly this is your what you call that your upward this thing direction. So, current is flowing like this right. So, this is actually your upward direction is shown, if it is downward direction then naturally it will be reversal direction will be in other way so, this is the meaning that your upward.

So, this is your, what you call current source right just hold on. So, this is actually this currents source we are now now we are you have seen that your what you call a dependent voltage source and your dependent current source, both are dependent on either voltage or current right now. So, whatever I said that is your in the our this circuit everything, everything is explained here, everything is explained here.

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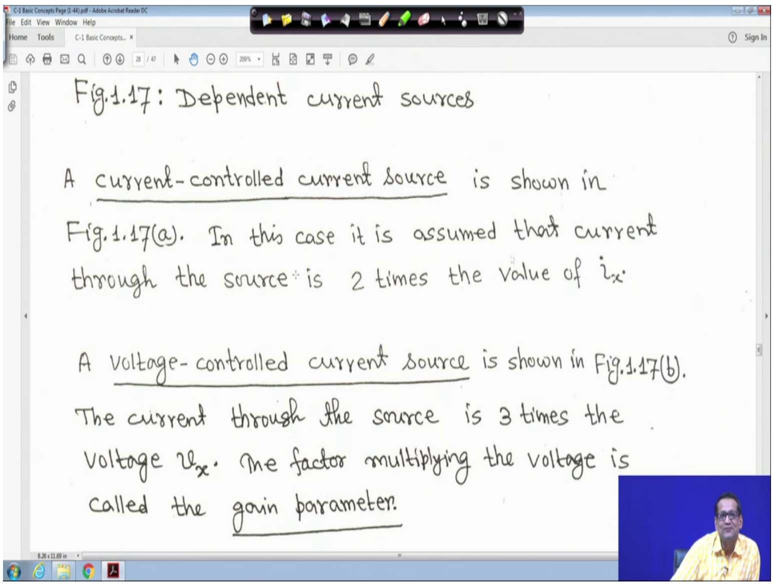

So, it is simple thing. So, not I mean this thing going do not to repeat this again right so.

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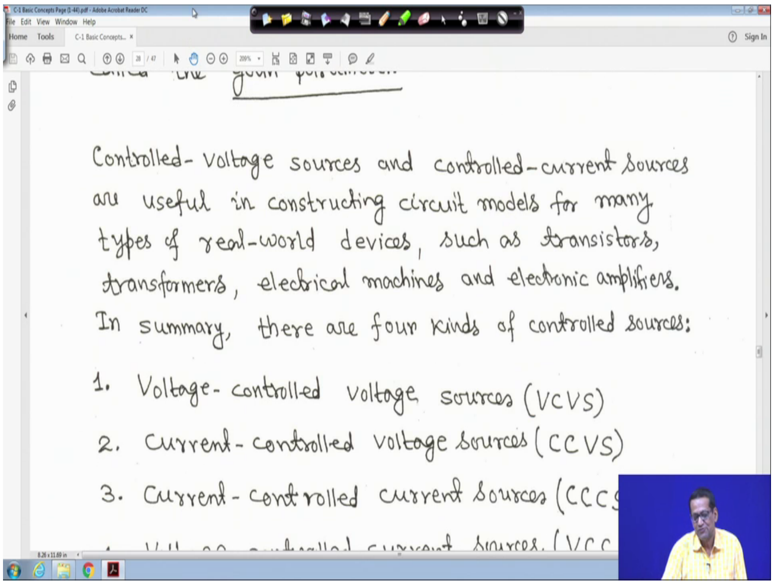

That means the controlled - voltage sources and controlled - current sources right are useful in constructing the circuit models for many types of real world devices such as your such as your transistor, just hold down such as your transistor, then your transformer, then electrical machines and electronic amplifiers right. So, these are the your what you call that this kind of this thing your real time real world application just hold on.

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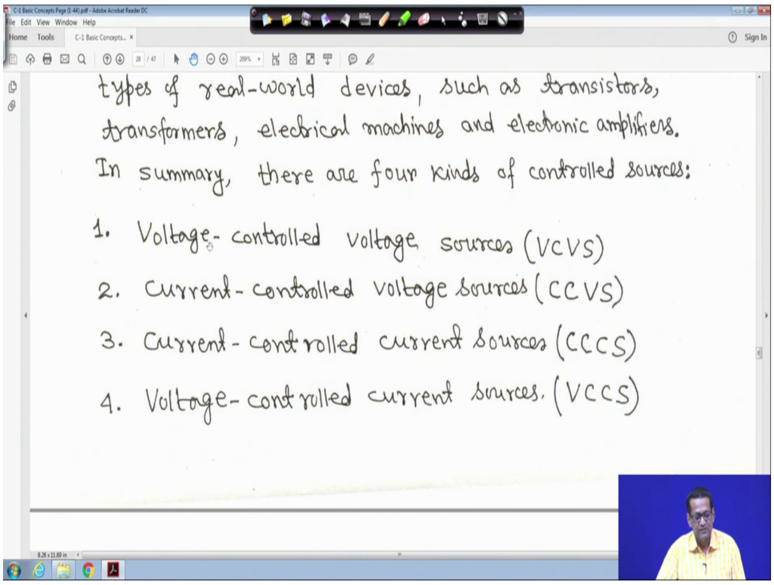

So, this thing so, there are 4 such sources you have shown. So, voltage controlled voltage source we call VCVS, current controlled voltage source already we have shown CCVS, then current controlled current source CCCS and voltage controlled current sources VCCS right these are the 4 thing, next you take another example.

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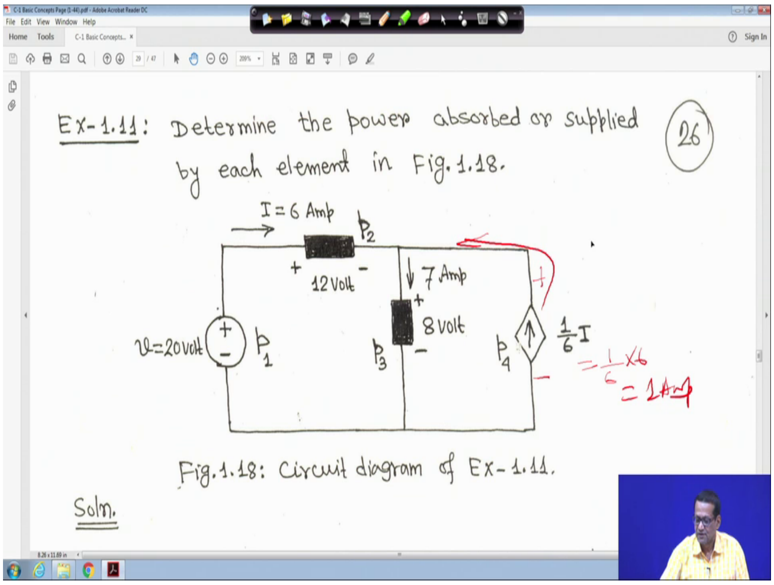

So, determine this circuit is shown this is say example 11. So, determine the power absorbed or supplied by each element in figure this, now you know little bit of you have to understand little bit for example, if you see that the current I is equal to 6 ampere this is 6 ampere. Now voltage is given v is equal to 20 volt plus minus p 1 p 2 here, this is another element p 2, this is p 3 and this is p 4, this is another dependent current source. So, these are the you have to find out power absorbed or power supplied right, power supplied must be is equal to power absorbed. If you see something is not matching then somewhere something has gone wrong in calculation.

Now this is actually some element so, plus minus polarity has been mark, here also voltage source polarity plus minus has been mark, here also polarity plus minus has been mark right and this is your current is shown upward and this current source is showing 1 upon 6 I; that means, if I is equal to 6 ampere here I is equal to look 6 ampere if we put I is equal to 6 here it will be actually 1 ampere.

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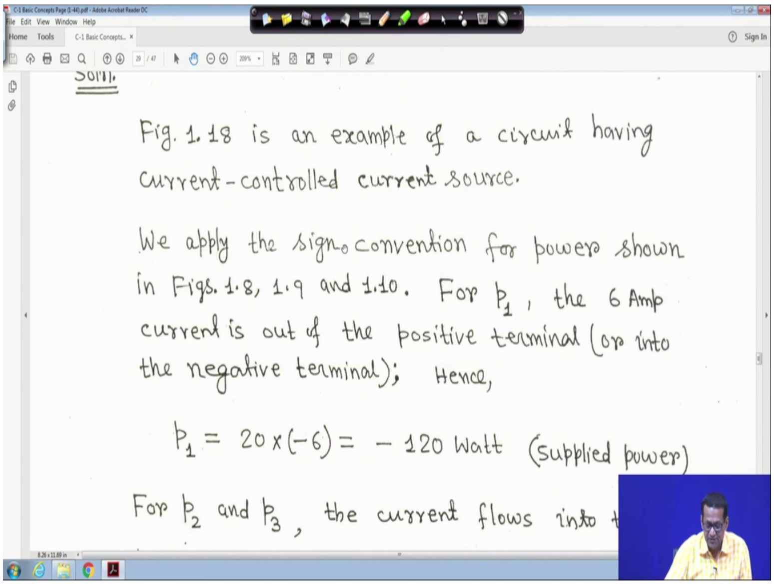

Now, previous when our previous discussion we are seen that, when that your current leaving the this is a voltage source current leaving the your positive polarity or positive terminal; that means, power is supplied and sign will be negative right. So, in this case if you see that this I 1 current is coming out from this source. So, it is actually leaving that your what you call that leaving this plus terminal; that means, power supplied convulsively negative therefore, p 1 will be your minus 20 into 6. So, minus 120 watt it will be power supplied.

So; that means, if you look at here that p 1 is equal to 20 into minus 6 that is minus 120 watt this is the supplied power. So, whenever current is leaving plus terminal it should be minus I told you earlier; that means, power supplied right and this current I is equal to 6 ampere according to this polarity, entering into this circuit into this element right therefore, it this circuit will absorbed power because current entering at the positive terminal; that means, power absorbed should be 12 into 6 p 2 is equal to 12 volt into I is equal to 6 ampere. So, it will be your 12 into 6 so, your thing it will be 72 watt.

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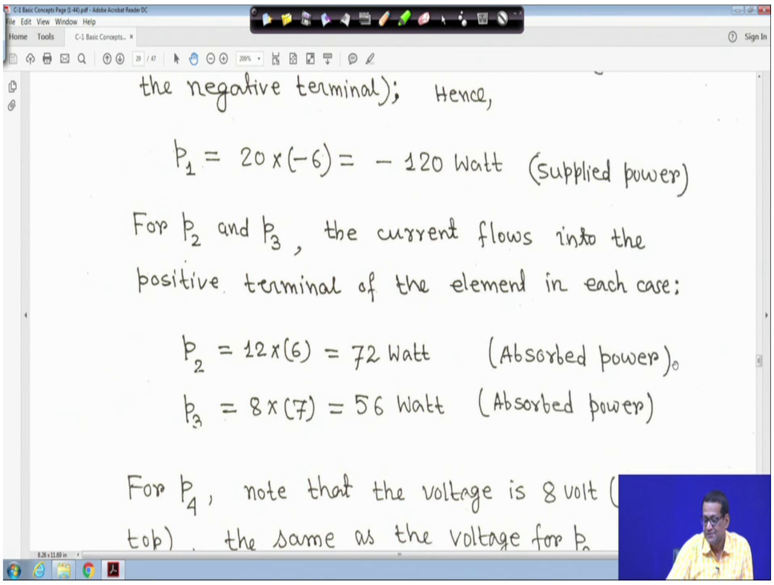

So, here it will see that that in the that your p 2 is equal to 72 that is power absorbed power that is p 2 is equal to 72 watt, again you come to this circuit that again 7 ampere current is entering into this terminal. So, it is a positive; that means, as current entering into the positive terminal it will be power absorbed and voltage is given 8. So, 8 into 7 so, p 3 will be 56 watt power absorbed. So, it is made here that p 3 is equal to 8 into 7, 56 watt right. So, it is absorbed power.

Now, come here this is the current source, now question is that this is this is the current source now here just making it here only right making it here. So, I is equal to 6 ampere; that means, this one is equal to your 1 by 6 into 6 write in here that is your 1 ampere this is 1 ampere. Now question is whether it your what you call it delivered or absorbed power, now look this terminal is plus this is minus; that means, this is the simply wire only this is the simply wire only right.

So; that means, I can mark it here this is plus and this is minus because this is plus minus nothing is there. So, this is plus minus and this current is upward means current is your what you call this one ampere current is moving like this, flowing like this; that means, current actually leaving this terminal the plus plus terminal as well as a leaving means it is power supplied right whenever current leaving the plus terminal this power it is power supplied.

So; that means, this sign will be negative, but is current here is one ampere current here is your what you call 1 ampere now what is the voltage. Now if you come to this your if you come here look that voltage across this your it is 8 into minus 1 6 I told you because current is leaving the plus terminal. So, it is your minus 1 I is equal to 6 ampere. So, it is coming minus 8 watt supplied power; that means, here you come just hold on.

So, whenever I was explaining this, this one your this is your what you call that this voltage actually suppose this is plus minus I mean this point is a this is b then nothing is the also this point is a this is also b.

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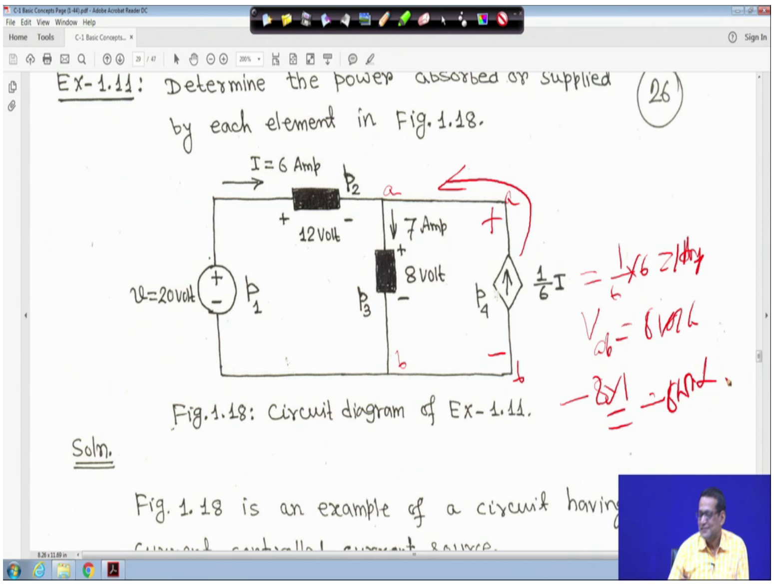

So, this voltage actually if we make like this the v a b is equal to say 8 volt right. So, same voltage here also 8 volt, but current I is equal to your 6 ampere here I is equal to 6 ampere is given look at that point when I am making 6 ampere. So, basically this one will be 1 upon 6 into 6 that is your 1 ampere right and I told you the direction is a upward.

So, current is flowing through this and this is plus minus means this is plus, this is minus right therefore, that current is leaving the plus terminal because this is plus, this is minus it leaving the plus terminal. So, if it is so; that means, it is power. So, your what you call, power supplied by this source it will be actually your this thing will be minus your 8 into 1 so, that is your minus 8 watt right so, this is the concept ok.

Thank you very much we will be back again.