Fundamentals of Electrical Engineering
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Lecture – 04
Basic Concepts, Examples (Contd.)

So, we have back again, as we have studied little bit of energy right what our so, one different example then again we will go to the circuit theory just to give you some you know some ideas, regarding energy then I for example, like this is example 1.12 that is example 12. A residential consumer consumes 800 kilowatt hour in the month of March right determine the electricity for the month using the following rate schedule right.

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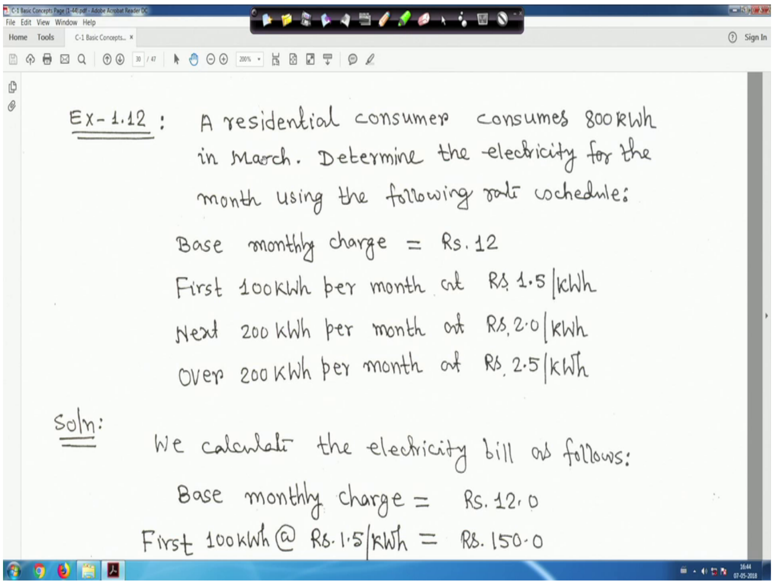

For example base monthly charge is rupees 12 first 100 kilowatt hour per month at rupees 1.5 per kilowatt hour, say next 200 kilowatt hour per month at rupees 2 per kilowatt hour and over 200 kilowatt hour per month at rupees 2.5 kilowatt hour right.

Now, we have to calculate the electricity bill so, base monthly charge is rupees 12 now 100 kilowatt hour at rupees 1.5 per kilowatt hour therefore, 100 kilowatt hour at rupees 1.5. So, 100 into 1.5 so, it is rupees 150, then next 200 kilowatt hour per month rupees 2 per kilowatt hour.

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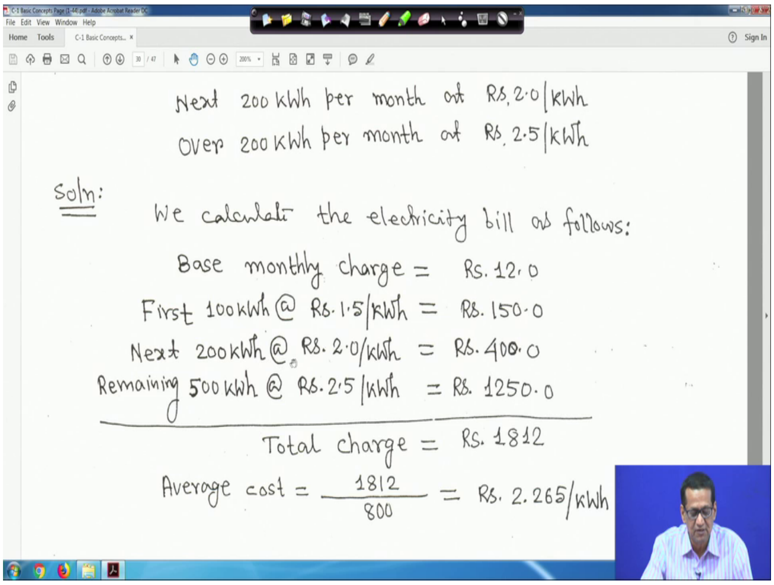

So, it is your next 200 kilowatt hour at rupees 2 so, it is 2 into 200 so, rupees 400.

Now, totally is your 800 kilowatt hour, now here it is 100 plus, 200, 300 kilowatt hour already we have computed rupees 150 and 400 remaining will be 500 kilowatt hour , but the 800 minus 100 minus 200 so, remaining 500. So, 500 kilowatt hour remaining 500 kilowatt hour will be at rupees 2.5. So, it is given 2.5 per kilowatt hour. So, rupees 2.5 per kilowatt hour so, 500 into 2.5 so, rupees 1250, but monthly base charge is rupees 12. So, ru plus 150 plus 400 plus rupees 1250 if you add up all total charge will be rupees 1812 right.

Now, total your, what you call, annual your residential energy it is consume 800 kilowatt hour. So, if you take the average. So, average cost per this thing will be rupee or rupees 1812 divided by 800 kilowatt hour. So, that comes approximately on an average rupees 2.265 per kilowatt hour and this is simple example, because we have taken know that energy we are talking of. So, just for p in to your time power into time right, one before going to the next example one sometimes we call in English rhymes. That energy is power multiplied by hour, another I can put in better way that electrical energy is power multiplied by hour right. So, that is kilowatt hour, because kilowatt is the power and hour is the time.

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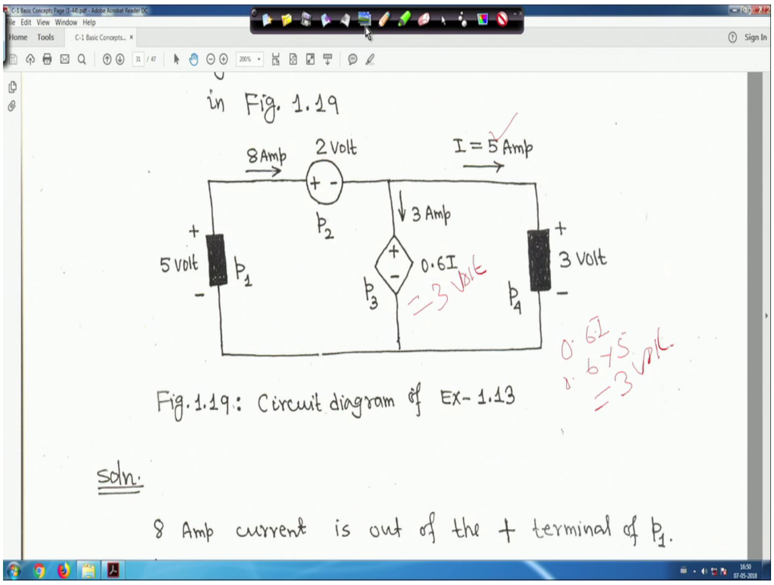

So, next is so, this is a simple example I took for you. So, hope it is understandable very simple thing right. Next example 13 so, you have to determine the power absorbed or supplied by each component of the circuit as shown in figure 19, this is figure 19 this is one electrical element is 5 voltage give plus minus, it actually either supply it or a absorbed we will see later. That p power, power p 1 this is a voltage source right this at this is another dependent voltage source and this is another, another source is there, but the terminal plus minus 3 voltage given.

So, we have to find out that power absorbed or supplied by each of the source, now look this 8 ampere current, this is the 8 ampere current, it is first you let us start from this from your this element, which I have voltage across it is 5 volt right. So, and power we have to find out p 1 is the power supplied or absorbed.

So, this 8 ampere current actually this current actually come leaving the plus terminal right. Leaving the plus terminal means it is where your what you call sign will be negative when power supplied actually right, because this 8 ampere if you look at the direction of the current this 8 ampere current actually leaving the plus terminal.

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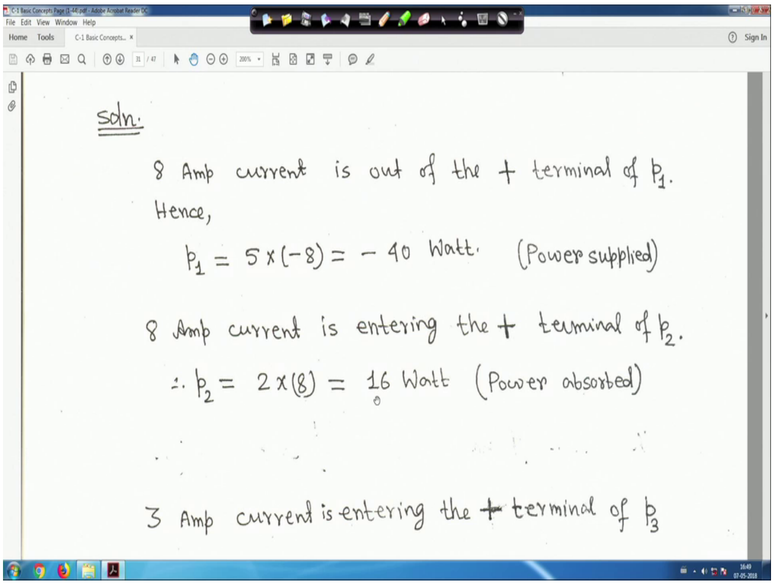

So, p 1 will be your minus 5 into 8 minus 41 that is supplied, look into that, that 8 ampere current is out of the plus terminal everything I have written for you, but I am explaining it. So, p 1 will be 5 into minus 8 so, minus 41. So, power supplied now here so, p 1 is the power supplied.

Now, this 8 ampere current is entering into the positive terminal, whenever it enters into the positive terminal means this source actually absorbing power. So, in this case it is 2 volt and 8 ampere. So, p 2 will be 8 into 2, 16 watt that is power absorbed. So, if you look into that 8 ampere current is entering the plus terminal of p 2. So, p 2 will be 2 into 8, 16 watt power absorbed right.

Now, next is the 3 ampere now here in here it is now this 8 ampere, current 3 ampere is going here, 5 ampere is going here. Now this is a dependent voltage source, now you see that this is 0.6, I and this is 5 ampere. So, if you multiply 0.6 into I it will be 3 ampere just hold on. So, if it is your 0.6 I so, it will be 0.6 I, I is equal to here it is 5 ampere. So, it will be 0.6 into 5 so, it will be 3 volt; that means, volt for I is equal to 5 ampere voltage of the dependent your dependent voltage source it is actually is equal to 3 volt right 3 volt.

Now, this 3 ampere current is entering into the your what you call positive terminal so, power is being absorbed. So, it will be 3 ampere in to 3 volt. So, p 3 will be 3 into 3, 9 watt that is absorbed right so, in the just hold on.

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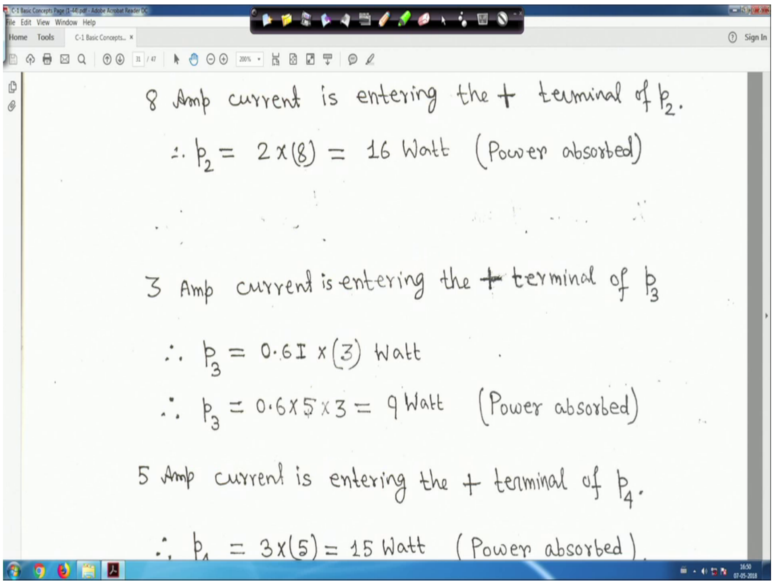

So, in this case your; so, if you see that p 3 is equal to your 0.6 into 5 I told you that is 3 volt into 3 ampere. So, 9 watt power absorbed right.

So, next is this 5 ampere, this 5 ampere current entering to the positive terminal right; that means, as I entering into the positive terminal means it is power absorbed. So, it will be p 4 will be 5 ampere into 3 volt so, 15 watt. So, p 4 will be 3 into 5 that is 15 watt power absorbed. So, power supplied is it is taken minus 40 watt and your power absorbing that is 16 watt, here it is 9 watt. So, 16 plus 9, 25 here it is plus 15 so, 40 watt. So, power supplied is minus sign indicates power supplied. So, supplied is 45, 40 watt and absorb is also 40 watt so, perfectly matching. So, now, absorbed as your power supplied and power absorbed I hope this thing is clear to you now right.

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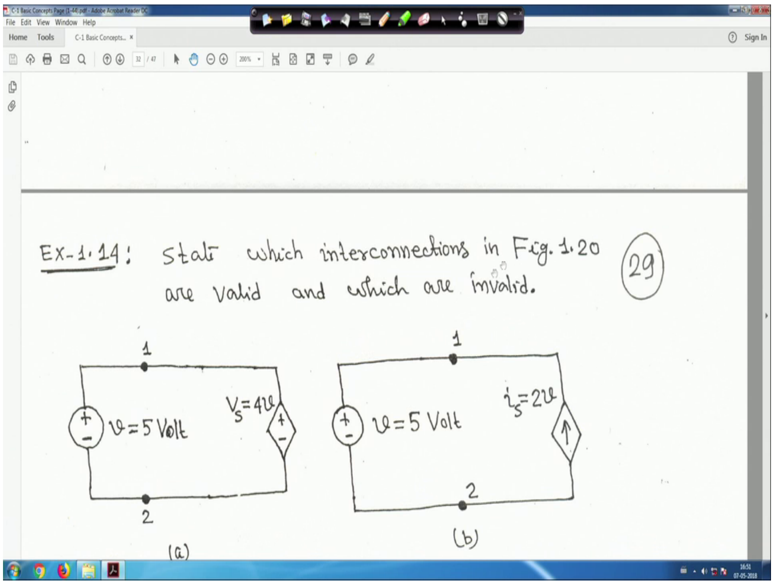

Next is another example now this is actually state which interconnects in figure 20 are valid and which are invalid you have to tell, there are 4 connections that which connections are valid and which connections are in connections are invalid.

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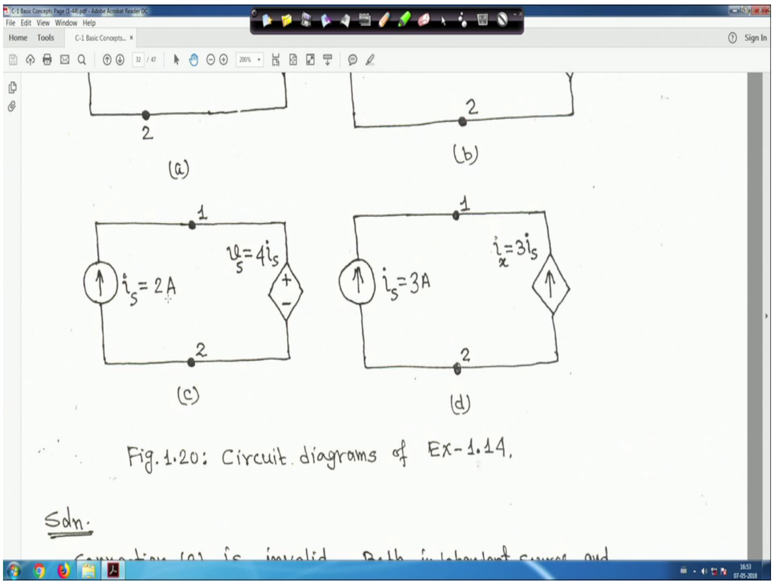

Now, take this connection 1 here, the volt this is terminal 1 and terminal 2. So, across terminal 1 2 that is voltage sources connect V is equal to 5 volt, now when across 1 2 also it dependent voltage source is connected V s is equal to 4 V. So, if you put 5 V of V is equal to 5. So, V s will be 4 into 5 so, 20 volt so, but across the it is your across the say your 1 2 same terminal you cannot connect 2 different voltage source. So, this is an invalid connection so, this is invalid connection.

Now, if you come to this one here, V is equal to 5 volt and is equal to 2 into V. So, is V is 5 volt. So, is basically 2 into 5; that means, your 10 ampere. So, it is a valid circuit connection there, even voltage source is there, one dependent current sources. So, this is a valid connection so, but this is invalid connection.

Now here if you come here a current source is given is equal to 2 ampere, but it dependent voltage source V s is equal to 4 is, but this is equal to 2 ampere. So, V s is equal to 4 into 2 8 volt. So, it is a current source it is a dependent voltage source, there is series actually later we will see that. So, it is a valid connection this is a valid connection at they are connected across terminal 1 2 so, it is a valid connection.

Now, this one a current source is there is i s equal to 3 ampere and a dependent current source is there where i x is equal to 3 into i s. Now when i s is equal to all I am not writing I am telling from my mouth I think it is understandable to a simple thing. So, i s is equal to 3 ampere so, i x i is equal to 3 into 3 so, 9 ampere, but this is 3 ampere and this is coming 9 ampere. So, it is not possible right so, this is an invalid circuit.

So, this circuit this one invalid and this one is invalid and this 2 are valid circuit, b and c are valid circuit connection and a and d these are invalid connections right. So, hope it is understandable to you because the why I have taken this one. So, at the starting from the beginning we have to know all these things because later stage we have to solve different type of problem. So, staring from the beginning we have to clear our you know ideas.

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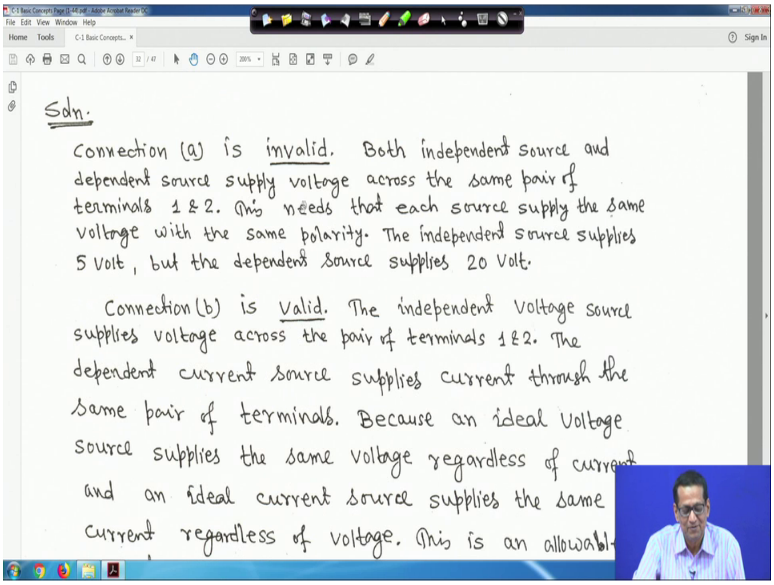

So, all these things I have written here, but later you can go through these, when you will go through the bleed your you can go through ones, but I have explain that exactly what it is right. So, everything I have written here, but I have explain. So, not for that your what you call going through this.

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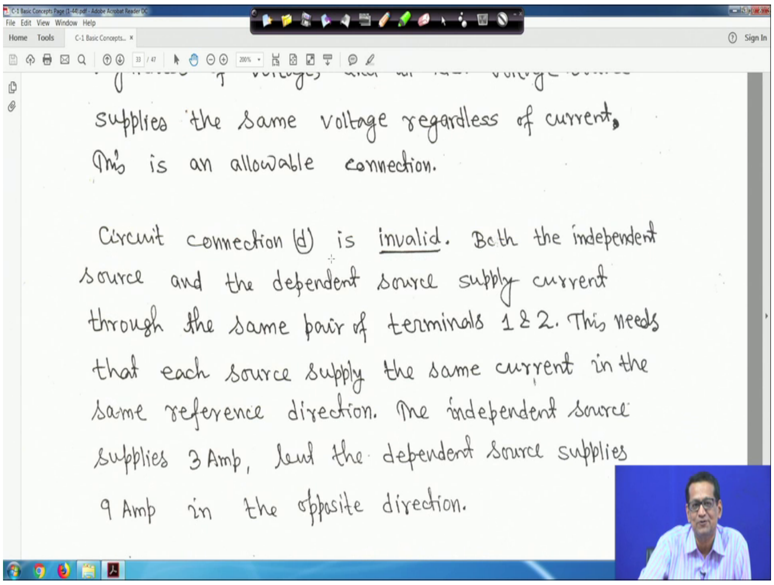

Now, this one now determine the power supplied that absorbed by is component in figure 1.21, but I am telling 1.21.

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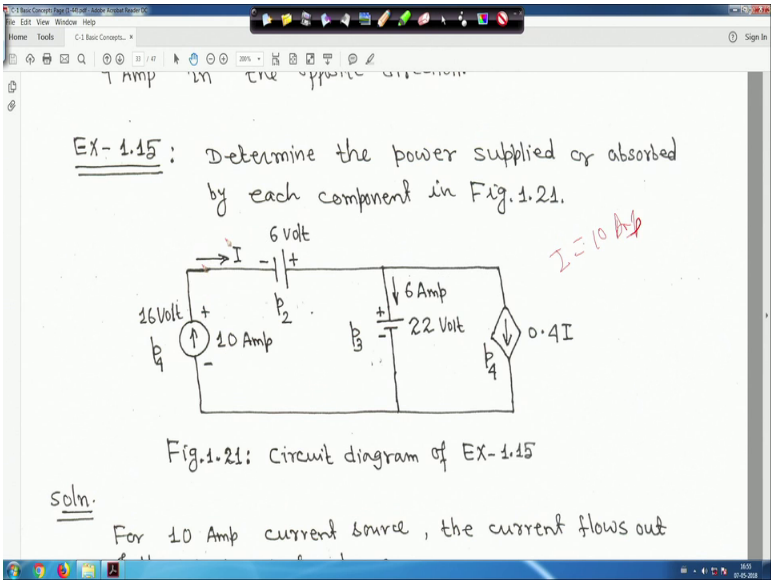

That is chapter 1.21 figures I am telling figure 21. So, here 1, 2, 3, 4, 4 elements are there and current is I this 10 ampere this I actually is equal to 10 ampere. So, this is I, this is your, I right and this I is equal to actually 10 ampere. So, this I is equal to 10 ampere, this I is equal to 10 ampere.

Now, this, your what you call this I 10 ampere, this is leaving the terminal this one this 16 volt source just hold on this your this is 16 volt source.

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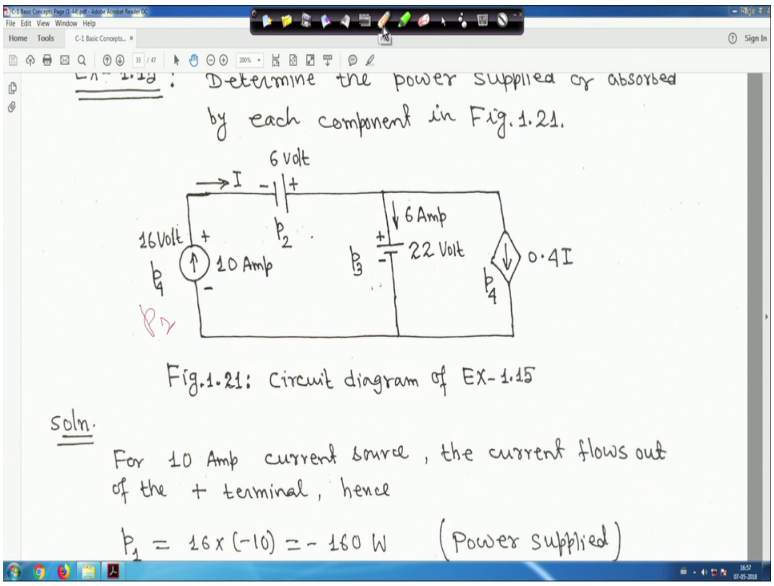

So, 10 ampere current is leaving the terminal your what you call positive terminal so; that means, power supplied, as you leaving this power this thing. So, this is 16 volt source here and this is your sorry this is 16 volt and this is actually current source plus minus this voltage across this is 16 volt. So, this is a current source.

So, 10 ampere current it is entering into this your, what you call this negative terminal of 6 volt. So, this is a current source and voltage across this is 16 volt this is a current source I have over looked actually it is a current source and this is a voltage this is a voltage source, this is a voltage source and this is a dependent current source.

So, in this case and across this voltage is 16 volt, then first we have to find out p 4, p 4 is there p 2, p this is p 1, this is actually p 1, just hold on let me correct this is actually your p 1 right this is p 1. So, just hold on. So, this is p 1 I have corrected that. So, now, this current source so, it is actually supplying power because it is leaving this terminal. So, p 1 will is equal to 6 it will be minus 16 into 10.

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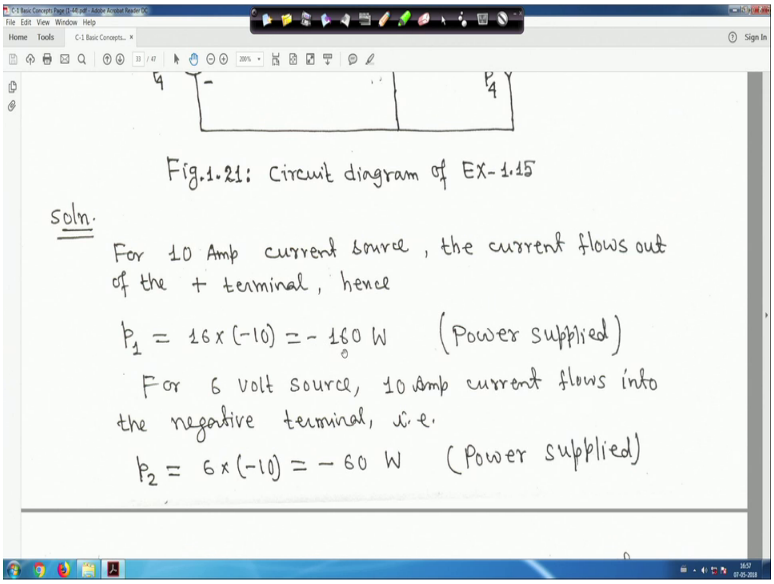

So, minus 160 watt. So, p 1 is equal to 16 into minus 10 minus this is power supplied right.

Now, next is if you look into this, this 10 ampere current entering the negative terminal other way actually it is leaving the current leaving the plus terminal, because this is entering a minus terminal ok, but because either entering minus terminal or leaving the plus terminal; that means, 6 volt also it is supplying power because this is the direction of the current. If current is flowing this direction, so basically this current entering to the minus terminal leaving the plus terminal. So, p 2 actually this shows actually your what you call it is supplying power. So, it will be minus sign right.

So, in that case p 2 will be 6 into minus 10 minus 60 watt power supplied. So, this is your 6 into minus 10, this is the 10 ampere current source say is that current source supplying 10 ampere current here this current is 10 ampere so, it is minus 60 watt.

Now, next is this 6 ampere, another 6 ampere current entering into this 22 volt source. So, it is it is entering into the positive terminal. So, as it is entering into a positive terminal means this voltage source actually this source actually is absorbing this absorbing power. So, it will be p 3 will be 22 into 6 so, it will be 132 watt.

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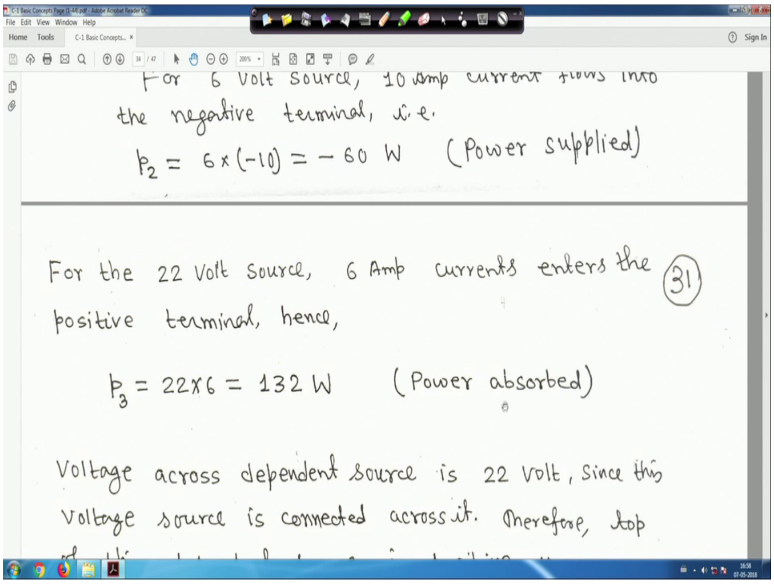

So, p 3 will be your 22 into 6, 132 watt so, power absorbed right. Next is that, this is your, another your dependent current source. So, here your what you call here 0.4 I. So, I is equal to 10 ampere just hold on I am writing for you.

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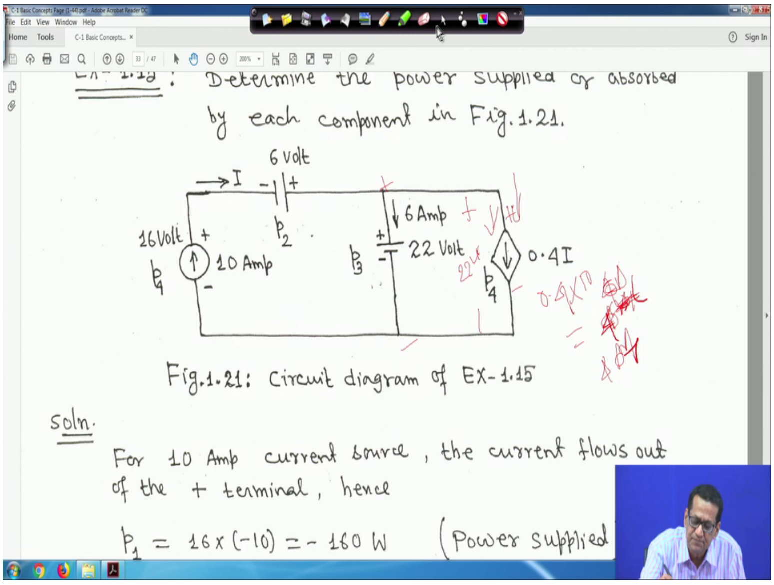

So, 0.4 I so, this is your 0.4 and I is equal to 10, so, this is actually 4 volt right this is 4 volt. And this one your this is actually plus terminal, this is minus terminal right. So, this is at this actually this is an wire only this is a wire only. So, plus minus means here it is plus, here it is minus; that means, here it is plus, here it is minus, when this is plus actually this is minus; that means, the direction of the current is this way so; that means, current is actually entering into the positive terminal. That means, this source this dependent current source actually absorbing power I hope you are understanding will be clear loop this is plus minus; that means, this is plus, this is minus.

And this your current direction is this way. So, this plus this is plus minus means this is also plus, this is also minus and this is the direction of the current; that means, current is entering into the positive terminal because this is positive terminal; that means, this show and this here it is your what you call here, it is this is your current source sorry this is 4 into 10, it is your 4 ampere sorry it is current source. So, it is 4 ampere right, it is4 ampere sorry right.

So, this is your 4 ampere, now what is the voltage. So, no other electrical element is there. So, across this across this current source the voltage is also 22 volt because here it is across this is 22 volt. So, same voltage will be impressed across this your this your dependent current source.

So, this is actually your 4 ampere so; that means, 22 into 4 the power absorbed by this source will be 88 watt. So, if you just hold on. So, I am deleting this one right just hold on right. So, if you come to this, that is your this is your actually this is p 4. So, this is actually your p 4 is equal to look 22 into that 0.4 into 10 4 ampere. So, 88 watts so, power absorbed.

Now, if you add 132 and your 88 this is power absorbed whatever it will come 220 or so, right and if you see the power supplied it is 160 minus and minus 60 so, minus 220. So, it is exactly matching. So, this way you have to understand I hope you have understood this because no other element. So, whatever 22 volt is there that will be impressed across this dependent current source.

And I is equal to your 10 amperes so, it is 4 into I so, 4 ampere and voltage across this your dependent current source is 22 volt. So, 22 into 4 because whatever volt I told you just now that to showing polarity sign, this way you can I means just you have just we have to your what you call, we have to clear our concept about all this things.

Then only we can we can solve things easily. So, there should not be any path for confusion or anything even when I am writing also one or two places I am over looping your, what you call over loop looking on this, but this is current source it will be 4 ampere. So, by mistake I wrote 4 volt so, it is your what you call this. So, this is your 4 ampere. So, I hope it is understandable to you right.

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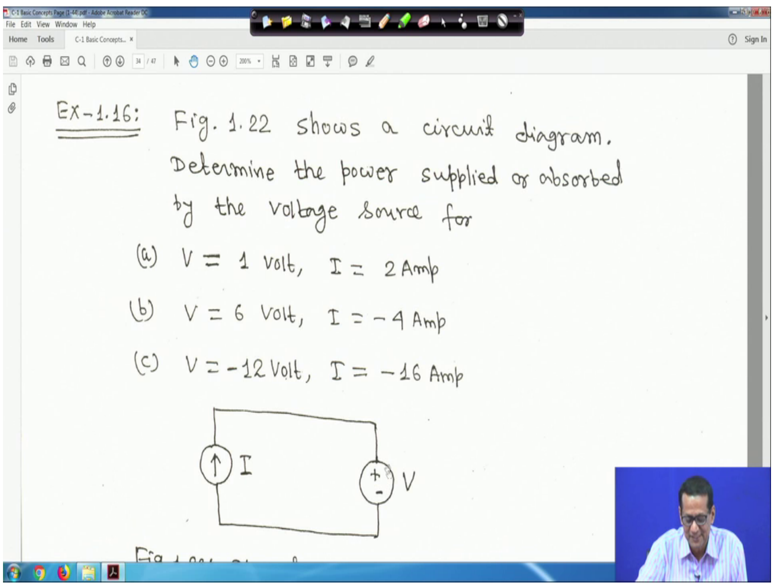

So, next one you look. So, right so, next one is this is these are the very small thing, but very tricky when you are starting your learning this course. So, if you clear our concept about this you will find things are very interesting in the later stage right.

So, for example, figure 22 shows a circuit diagram determine the power supplied or absorbed by the voltage source, but first one it is given V is equal to 1 volt and I is equal to 2 ampere you have to find out that power supplied or absorbed by the voltage source; that means, this voltage source right. So, first one is given V 1 is equal to 1 volt and I is equal to 2 ampere.

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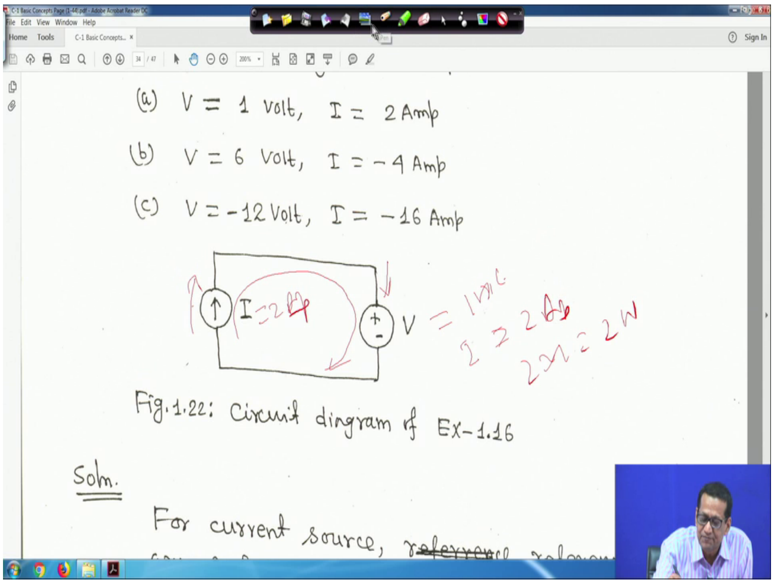

So, when I is equal to 2 ampere right, when I is equal to 2 ampere. So, I is equal to 2 ampere right 2 ampere [vocalized-noise and this is the direction of the current, this is the direction of the current; that means, the current actually flowing like this; that means, this current actually entering into this per your plus terminal ; that means, the voltage source actually this is actually it absorbed power because it is a entering into the positive terminal that means, but voltage is 1 volt.

So, V is equal to it is given for this case 1 volt and I is equal to is given your 2 ampere 2 ampere. So, it will be 2 into 1 that is 2 watt power absorbed by the voltage source. So, here I have so, this is actually just hold on I. So, I am rubbing this. So, it will be power absorbed by the voltage source. So, just hold on right. So, this one your this is the 2 watt the power absorbed.

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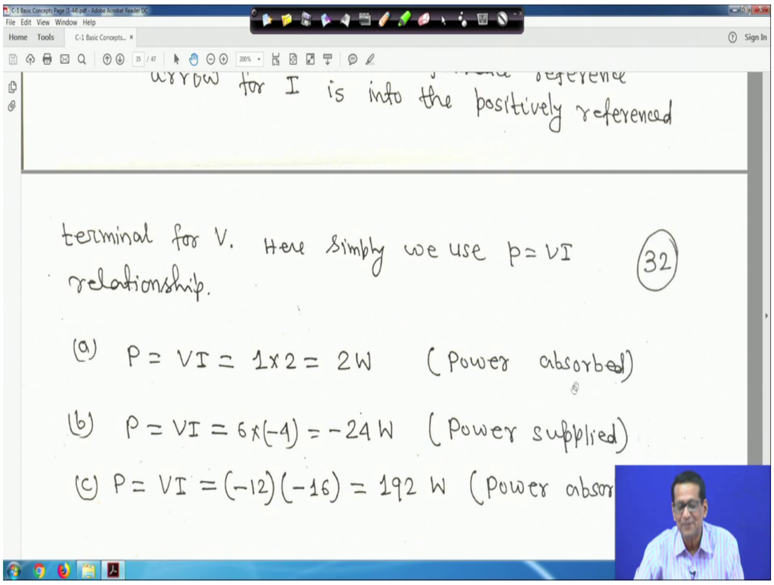

Now, next one it is given look the V is equal to 6 volt, but I is equal to minus 4 ampere. So, in this circuit I am I am drawing it again for your understanding it is the case b, it is the for this case this is case b. So, V is equal to 6 volt , but your current is I is equal to minus 4 ampere ; that means, the direction of the current will be reverse so; that means, if I for yours understanding if I draw it like this.

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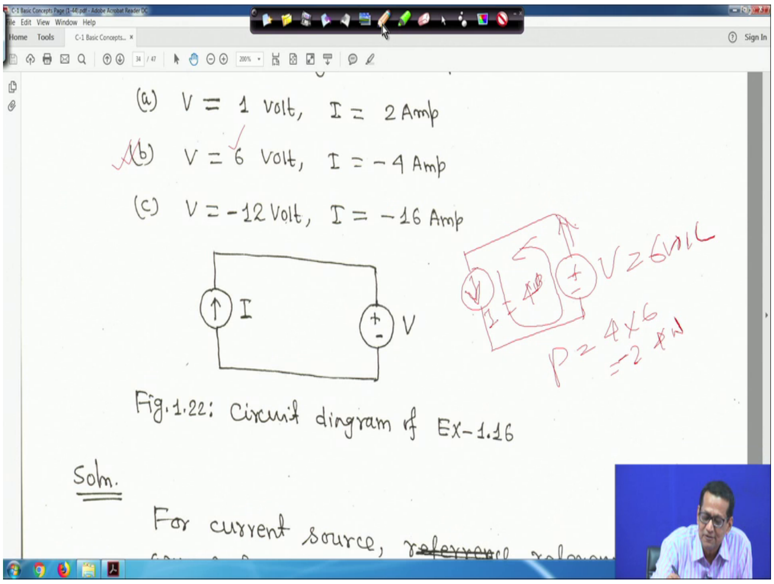

If I draw it like this the, because I is equal to minus 4, in this direction so, I making this arrow this direction and this is your voltage source, voltage is 6 volt. So, V is equal to 6 volts second case it is in the second case V is equal to 6 volt and I is minus 4 ampere this direction; that means, this direction I is equal to I can write positive 4 ampere and this current actually is flowing like this it is flowing like this; that means, the current actually leaving the voltage terminal because it is direction is like this.

So, basically the current actually leaving the your plus terminal; that means, your power, power will be your I is given 4 ampere and voltage is 6 volt. So, p it will be 24 watt, but it is leaving the plus terminal; that means, power supplied. So, minus 24 so, power supplied by the voltage source right. So, that so, let me clean this one again I will be back to you right. So, just hold on so, if you come to this your, this is your p is equal to VI power supplied the second case right.

Now, third case it is given that v is equal to minus 12 volt and I is equal to minus 16 ampere. So, in this case just for your understanding again I will draw the, for the case c. So, this is your just hold on this is your case c it is V is equal to minus 12 and I is equal to minus 16 ampere. So, what you can do the easiest way, rather than complicating the thing.

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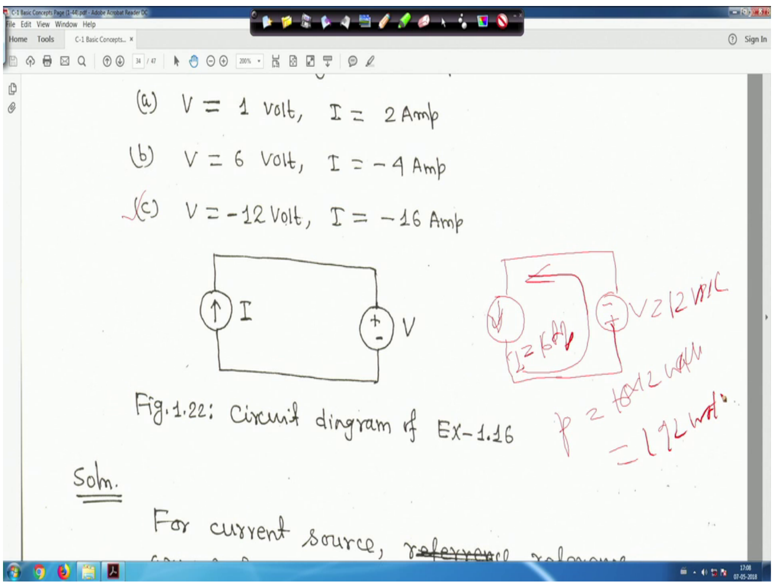

So, this is my current source right as I is equal to minus 16 ampere. So, direction of I is given. So, this is the positive dire I is when I is positive this is the direction is given, it is minus 16 means you just make the arrow downwards right and this one your voltage also voltage source also it is given minus 12 volt. So, this one if you make minus and this is make plus so; that means, voltage is equal to we can write 12 volt and this is your I, I is equal to you write your 16 ampere, what I did for your understanding as V is equal to minus 12 volt I have reverse the direction of the current because it is sorry I is equal to minus 16 ampere. So, I have reverse the direction of the current and V is equal to minus 12 volts. So, I have reverse the polarity.

So; that means, the current is flowing in this direction current is flowing in this direction; that means, the current actually entering into the positive terminal of the voltage source; that means, it is absorbing power. So, p will be is equal to your 16 into 12 watt this power it is being absorbed by this voltage source because it is entering into the positive terminal right.

So, it will be actually 192 watt right. So, I hope you have got it this right. So, make things simpler way to better we should not make the thing complicated way. So, make the things simplest way such that you will understand each and every thing ok. Then now let me clean this one. So, that is why the all calculation I have made this power absorbed 192 watt everything is here, but everything I am trying to make it for you.

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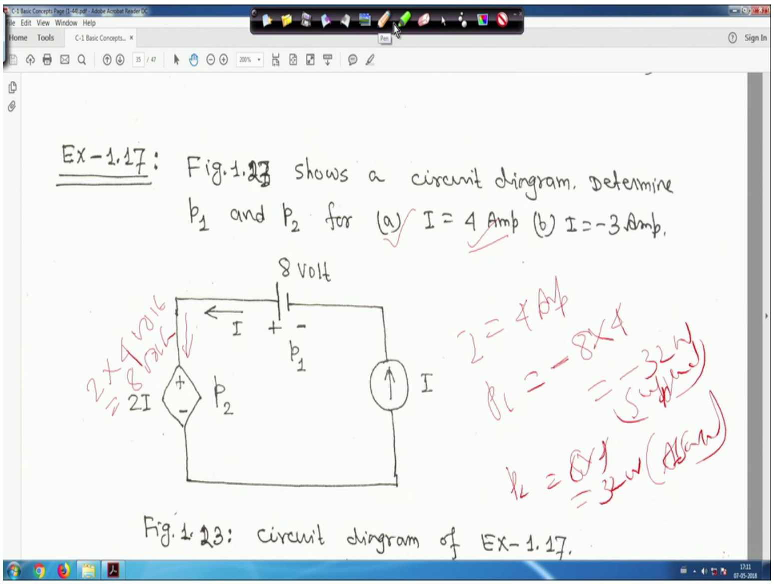

Then this figure this is for example, 17 now figure 27 sources circuit diagram determine p 1 and p 2 for I is equal to 4 ampere and I is equal to minus 3 ampere right.

So, when I is equal to this is a your dependent voltage source, this is a dependent voltage source and first case is I is equal to 4 ampere. So, first case that I equal to 4 ampere right and it is a dependent voltage source. So, this it is 2 I so, here voltage will be 2 into your 4 because first case this case it is I is equal to 4 ampere.

So, in this case what will happen that, this is your 2 into 4 this is volt ; that means, it is 8 volt right and this I is equal to 4 ampere this current actually entering into the positive terminal of this dependent voltage source ; that means, your; that means, this 4 I this I is equal to 4 ampere first leaving this voltage leaving this plus terminal; that means, when you leaving the plus terminal; that means, voltage p 1 that is the 8 volt source it is actually supplying power.

So, when it is leaving the plus terminal it will be minus and voltage is V is equal to 8 into I is equal to your 4 ampere this is the 4 ampere, minus 4 so, this will be minus 32 watt right this is the power supplied right, this is power supplied.

Now, the another thing is this current is entering into the dependent voltage source the plus terminal; that means, this source actually absorbing power. So, here it is 8 volt and 4 ampere current is entering because I is equal to 4. So, it will be p 2 will is equal to 8 into 4 so, 32 watt. So, this is actually power absorbed right. So, hope this thing is totally clear to you so, let me clean this right.

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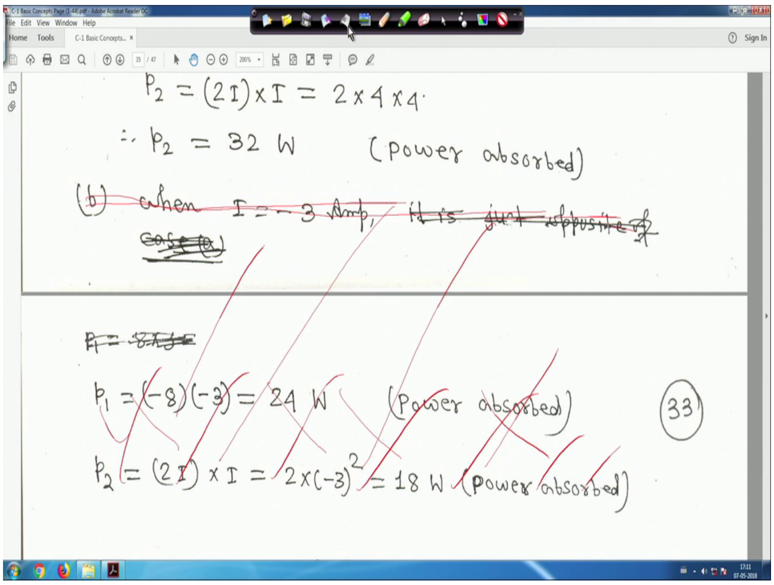

Second case I is equal to minus 3 ampere, just tell me one thing this one second case this one please do not read I am I am striking it off right, second case your this one the second case this do not read here it is that calculation here, it is wrong this do not read. I will explain what exactly this one you should not read, the second case I am explaining on this your what you call on that on the problem itself just hold on. So, this you should not read for the second case right.

So, now I am going back to that problem, let me clean this. So, just hold on. So, second case your, I is equal to your minus 3 ampere, now what will happen, if I is equal to minus 3 ampere. So, what I will do I will redraw the circuit. So, in this case just hold on so, in this case that I is equal to minus 3 ampere.

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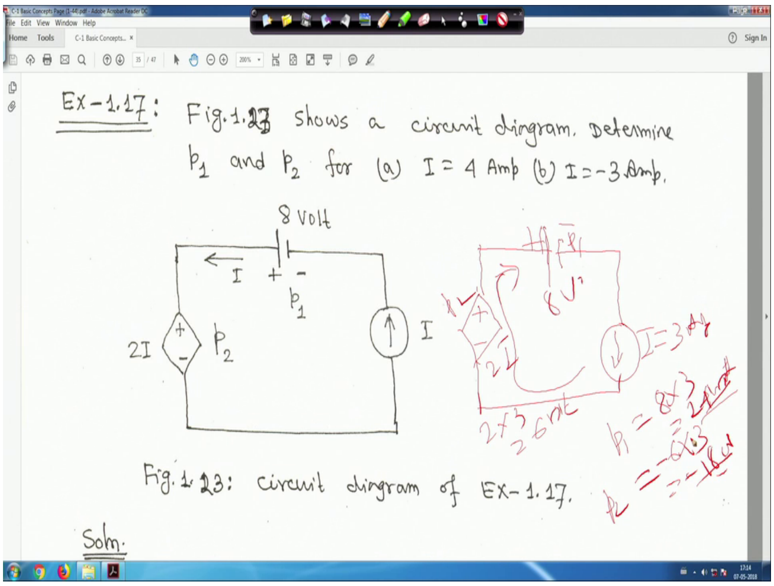

So, what I will do, this is dependent voltage source, this is plus minus, this is your sorry this is your voltage source, this is plus, this is minus 8 volt source, this is the current source right and as it is I is equal to minus 3 ampere. So, a delete siring upwards as it is minus 3. So, we have taking this direction say I is equal to 3 ampere and this is my 8 volt and this is your 2 I right this is dependent voltage source.

Now, in this case here it will be 2 into 3 that is equal to 6 volt right, now this is 8 volt. So, if you look into that this 3 ampere current actually if current is moving like this moving like this. So, 3 ampere current is this is actually p 1 and this is your p 2. So, in this case 3 ampere current entering into the your what you call positive terminal of this voltage source so; that means, power absorbed by this voltage source this is p 1. So, p 1 will be is equal to 8 volt into that 3 is equal to 24 watt right 24 watt. So, this power absorbed.

Now, and in this case for dependent voltage source this actually leaving the plus terminal so, p 2 will be negative power supplied and p 2 will be is equal to your, this is minus sign power supplied. So, it is 6 volt 2 into 3 dependent voltage source 6 volt it is 6 into this 3. So, it is minus 18 watt this is actually what you call the power supplied by the, this is absorbed and this is minus sign means power supplied.

So, if you add these 24 minus 8 18 algebraic sum. So, 6 difference is there my question is to you power balance has to be matched because absorbed power plus your supplied power is equal to 0, but here it is 24 minus 18, 6 watt. So, difference is there where that power has gone.

So, just hint is that you calculate I am not telling, this source actually is supplying another 6 watt power right this current source then only it will match. So, you find out from where you will get this 6 watt, this is an example this is a your what you call problem for you should solve this one right.

So, at a so, I am. So, this is the problem actually. So, whatever I have rubbed it there do not go through this is the problem. So, 6 differences is there I am telling you this current source actually supplying 6 watt, but you calculate from how 6 if that 6 watt you calculate from your said the how can you calculate that I will not tell here, but it is an exercise for you right

So, I am let me clean this. So, do not see that one. So, now, this one you have to tell which is we are what you call valid connection and which is invalid connection that is the thing look this is 1 2 terminal. So, across this 10 volt this is also 10 volt. So, this two sources are connected actually in parallel later we will see. So, this is a valid connection right because 10 volt 10 volt valid connection.

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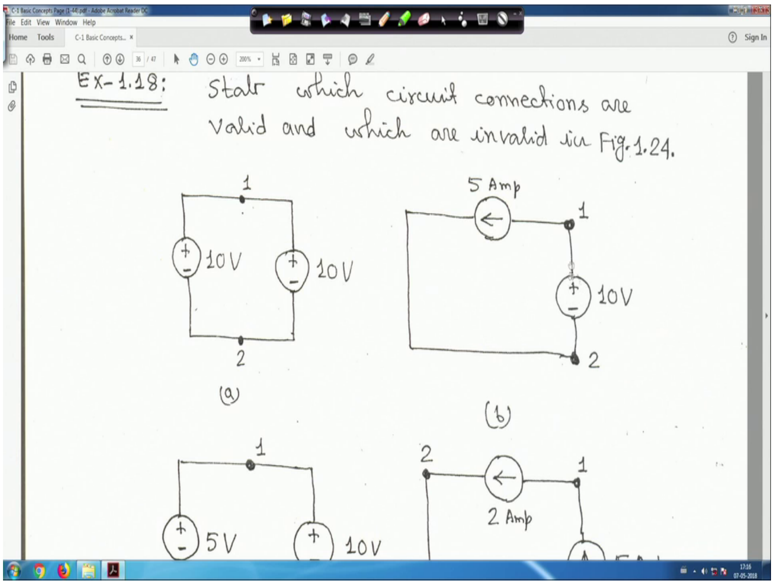

Now, here one 5 ampere current source is there a 10 voltage 10 another 10 both are connected across terminal 1 2 absolutely no problem this is also a valid connection right. This two are valid connection because any across any terminal, you can only connect the equal voltage source. If there is a difference is then that is invalid connection that is not possible and any current source and this voltage source this is also a valid connection.

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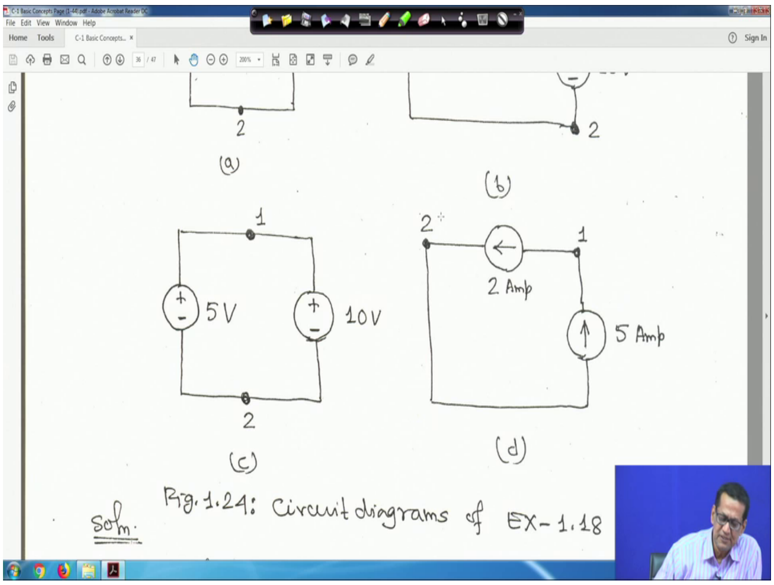

Now, this one across this terminal 1 2 this is a 5 volt and this is a 10 volt it cannot be 2 cannot be different right it has to be same because they are connected across the same terminal. So, this is invalid connection.

Similarly, this 1 2 ampere currents source and another 5 ampere in the same it is not valid because it is a simple circuit. So, this is invalid connection this is invalid connection here it is invalid 5 ampere here it is 2 ampere it is not possible. So, because a 5 ampere 2 ampere cannot flow like this I write the either it has to be 2 or it has to be your what you call this 5, but both the way we have connected it is invalid connection similarly here also it is invalids connection.

So, a b are valid connection c d are invalid connection. So, everything written there everything is written there. So, just you will jus you will go through.

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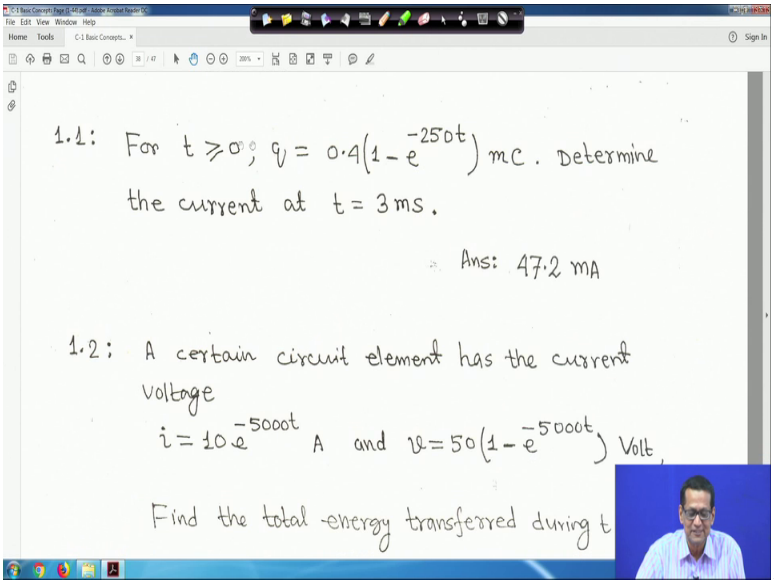

Now, these are all exercise. So, exercise 1 answers are given not reading again when you will read this video you can pause and see this problem. So, your this is problem 2 so, answers are given hope these all answers are correct you will solve it, now problem 3.

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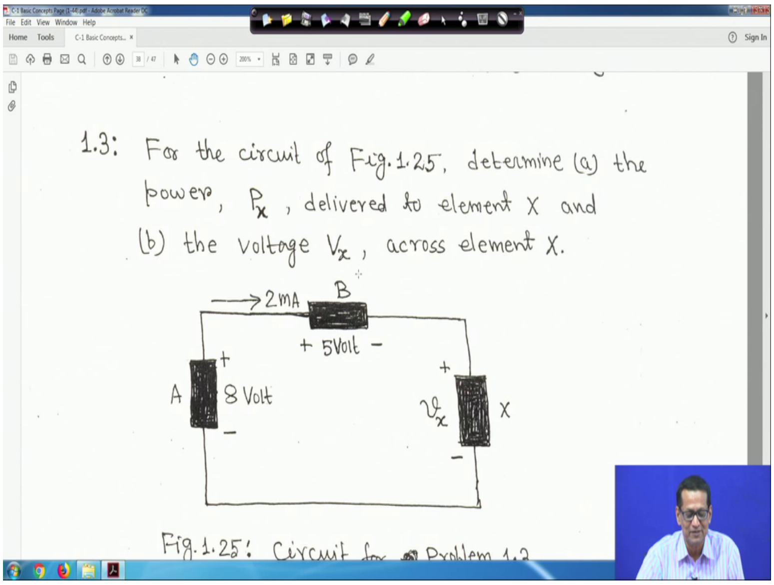

So, this is also your powers absorbed power supplied problem right. So, all answers are given and problem 4.

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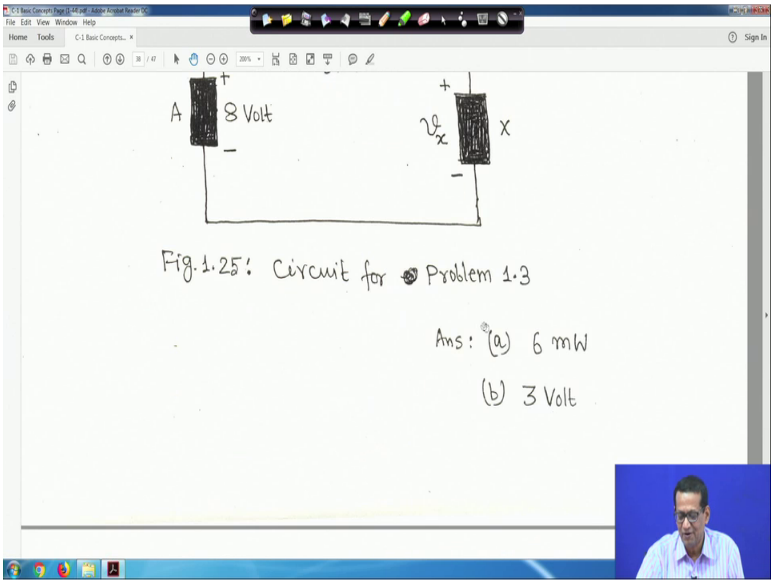

This is also given the total charge entering the element this is also answers given.

So, this is problem 5. So, we will do this all valid or invalid connections so, you will solve this one right.

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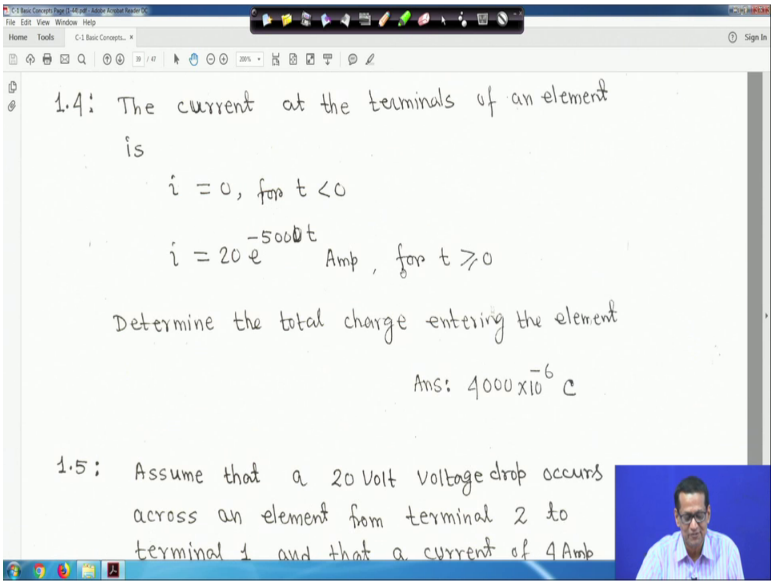

So, this is one then and answer for everything, this is a valid or invalid connection it is actually circuit inside the box absorbing or supplying power right.

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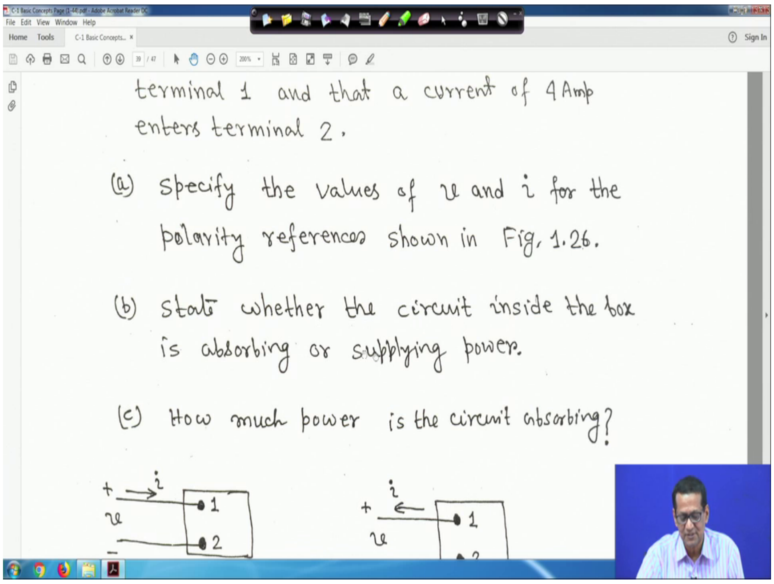

Everything is given you read this problem very carefully very carefully and do this a b c all the all the c d 4 connections are there.

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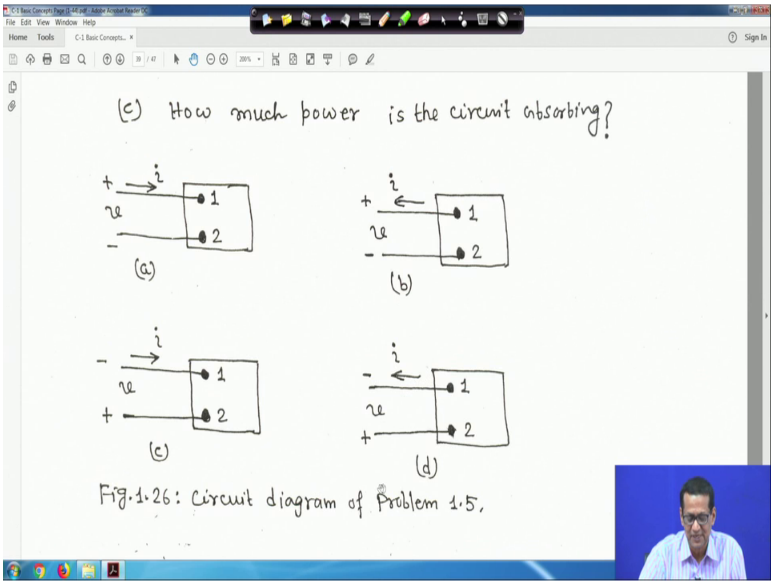

Accordingly we will make it answers are also given right.

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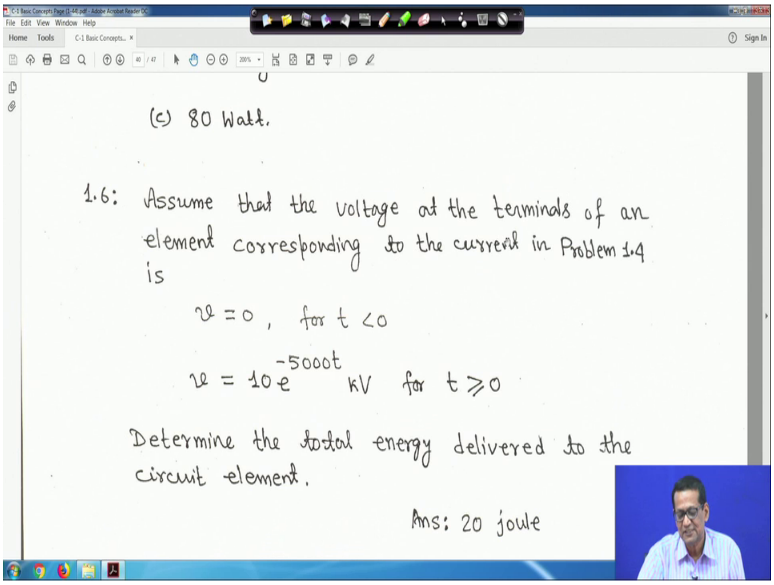

And problem 6 this is your voltage your voltage 0 for say time varying voltage actually given.

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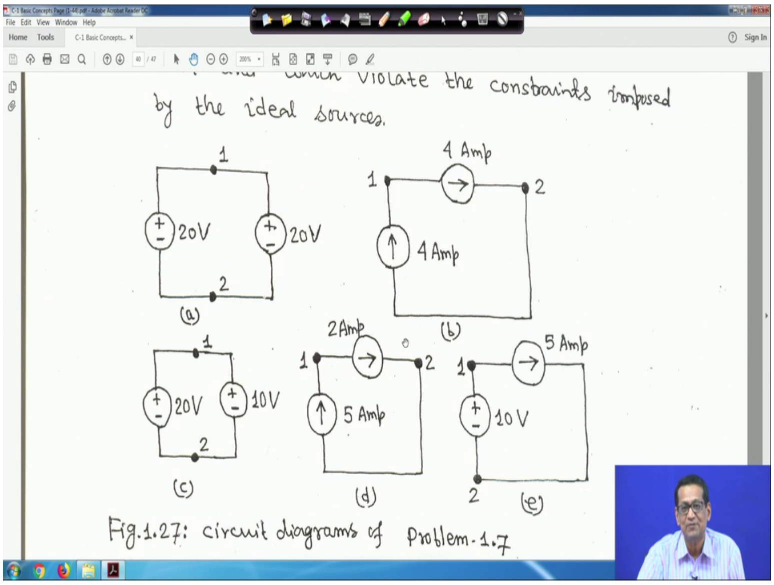

So, you have to find out the energy delivered answer is given. So, this is there are 5 connections there, you have to see that whether how many of them are valid or invalid right this is there are 5 connections and all answers are given.

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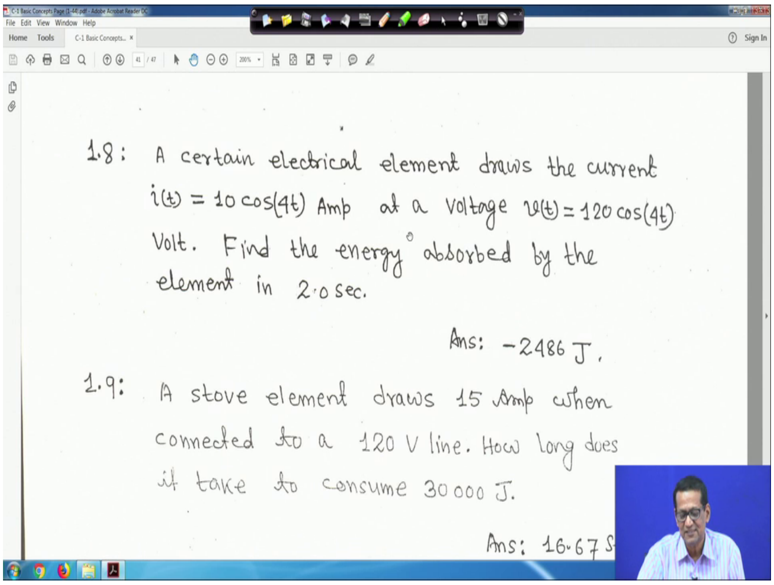

And this is also a time varying we will see for a ac circuit, but this is simply given you have to find out the energy the joule absorbed right.

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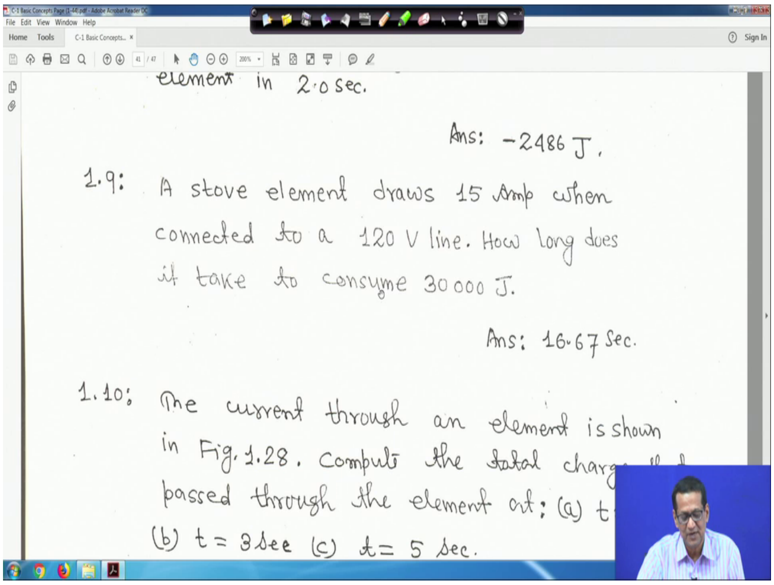

And this is another simple problem right you have to find out that that you have to just answer is given right, that stove element this much, when connected to a this long how long does it take to consume 30000 joules. So, answer is given and this is the last one.

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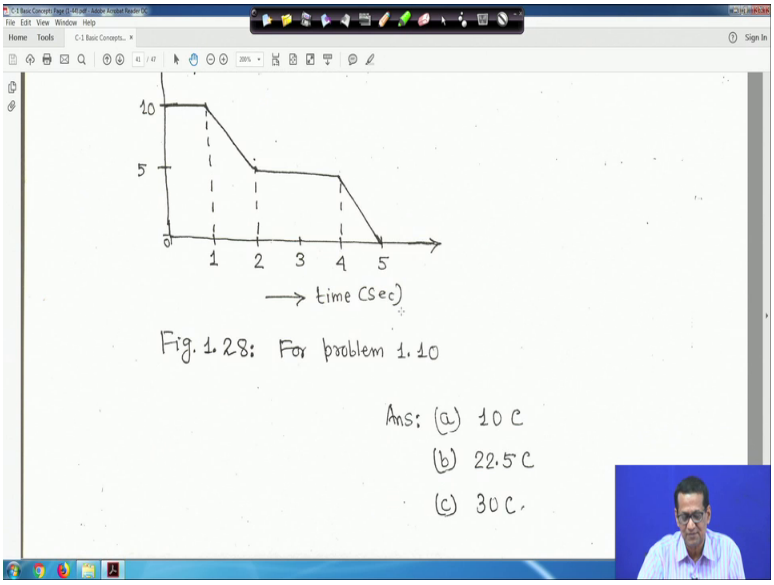

This is the current time varying your, what you call current is given right you have to find out total passed charge through the element right and these answers are given. So, everything is given.

Thank you very much we will be back again.