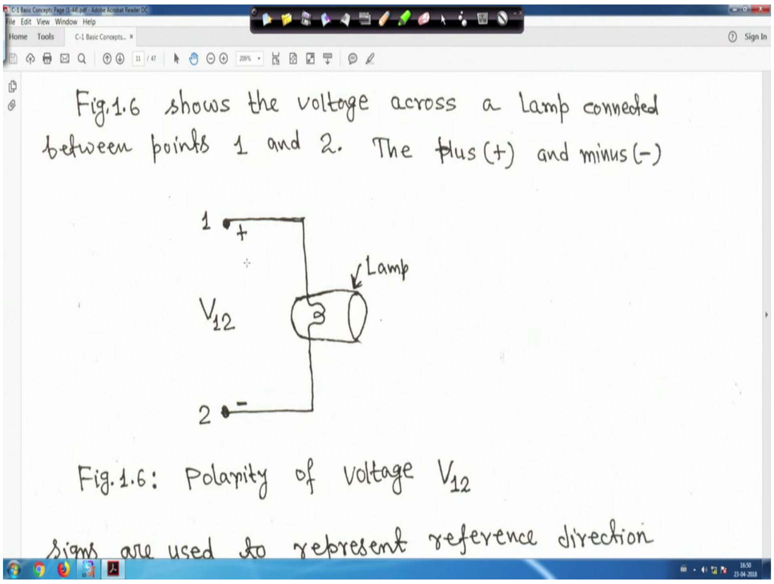
Fundamentals of Electrical Engineering
Prof. Debapriya Das
Department of Electrical Engineering
Indian Institute of Technology, Kharagpur

Lecture – 02
Basic Concepts, Examples (Contd.)

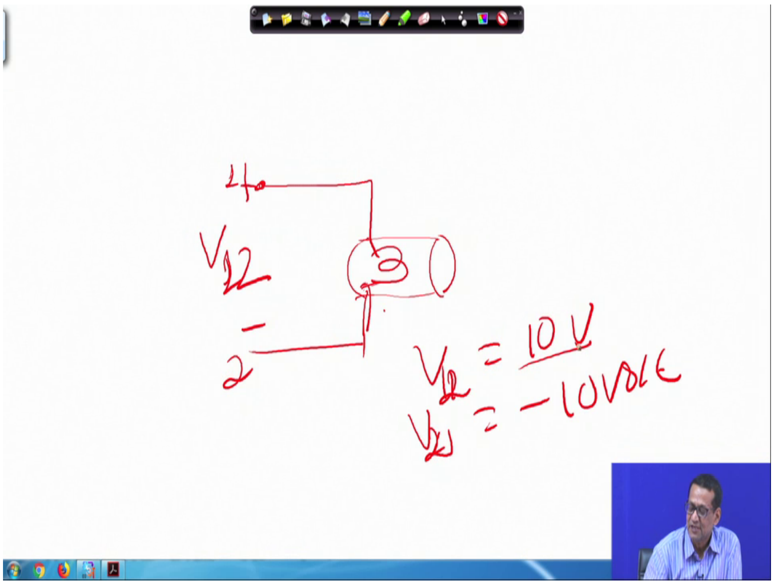
So, come back to you know this V 12 and V 2 1 for example, right.

(Refer Slide Time: 00:20)



So, that this is actually this is point 1 right.

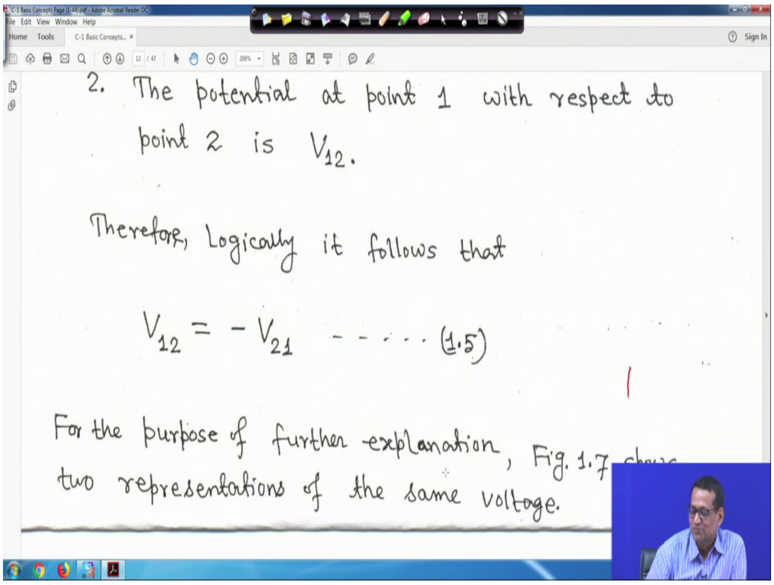
(Refer Slide Time: 00:31)



And this is your lamp right this is I am drawing something like this is your lamp and this is your point 2 this is point 2 this is plus, this is minus. So, this voltage is your V 1 2 right. So, if V 1 2 is equal to say a 10 volt this is plus minus therefore, V 2 1 V 2 1 will be minus 10 volt right. If you make V 1 2 that is if this is plus this is minus may be 10 volt, then V 2 1 will be minus 10 volt this is understandable right.

So, size are used to represent the reference direction of voltage polarity. The voltage V 1 2 can be interpreted I told you this one that best way this one the potential point 1 with respect to point 2 is V 1 2. Therefore, logically it follows that just I told you that V 1 2 if V 1 2 is 10 volt then V 2 1 will be minus 10 volt therefore V 1 2 is equal to say minus V 2 1.

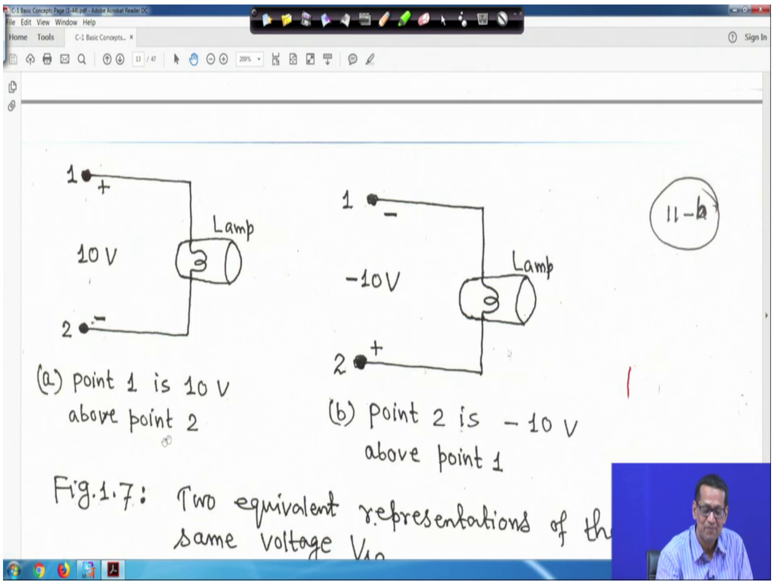
(Refer Slide Time: 01:51)



So, for the purpose of further explanation come to the figure 1.7 right 2 representation of the same voltage you come here right.

For example come here. So, here it is point 1 it is 1 and 2 this is a lamp.

(Refer Slide Time: 02:10)

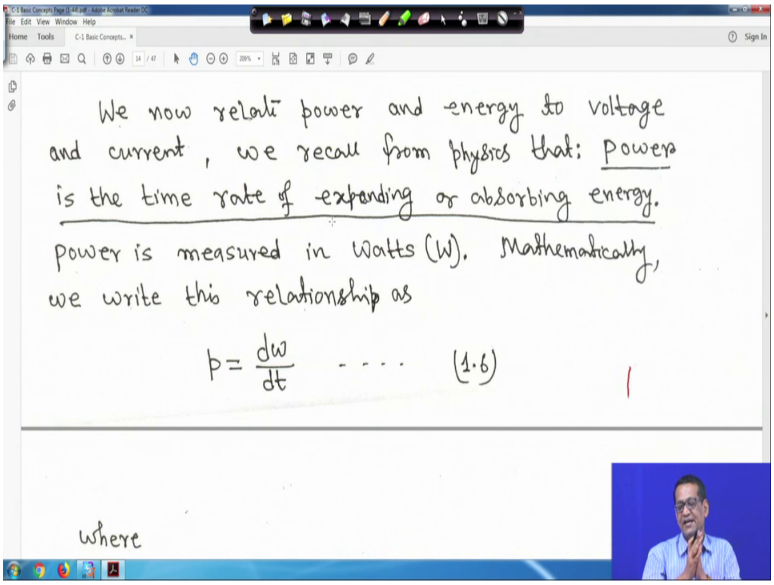


So, it is 10 volt. So, point meaning is point 1 is 10 volt above point 2 this is the meaning right. Similarly if it is this is 1 this is 2 now polarity has changed suppose this is minus this is plus. So, this has been minus and this has been made plus and this has become made minus. Therefore, say this one also can be like this is a plus this is a plus thing. So, point 2 is minus 10 volt above point 1; so, whenever you talk like this, you take plus as their reference point right. If it is like if it is given like this; that means, point 1 that is a plus terminal point 1 is 10 volt above point 2.

And here it is here it is 2 here it is minus 1, but minus 10 volt; that means, point 2 is minus 10 volt above point 1 understandable right understandable you will take this is plus terminal as your reference point from there you will take meaning is same. So, here it is point 2 is minus 10 volt above point 1; here it is point 1 is 10 volt above point 2 understandable right. So, 2 equivalent representation of the same voltage V 1 2 either this representation or that representation both are equivalent to each other right.

So, whatever was whatever was there; that has been just now that has been explained. Therefore, this your in general a voltage drop from 1 to 2 is equivalent to the voltage rise from 2 to 1 meaning is same. So, next is power and energy.

(Refer Slide Time: 03:58)



So, power and energy calculation are very important in circuit analysis because only current and voltage actually both do not serve all the purpose because output maybe power. For example, suppose at your residence the bulb is there tube light is there these are all represented by power.

So, therefore, voltage and current are useful variables in an electric circuit, but they are not sufficient by themselves. One reason is that useful output of the system often is non electrical and this output is conveniently expressed in terms of power and energy. And second thing is that output or if you take an electrical elements or devices; their power output is maybe limited maybe 40 watt maybe 1000 watt, but it is limited right.

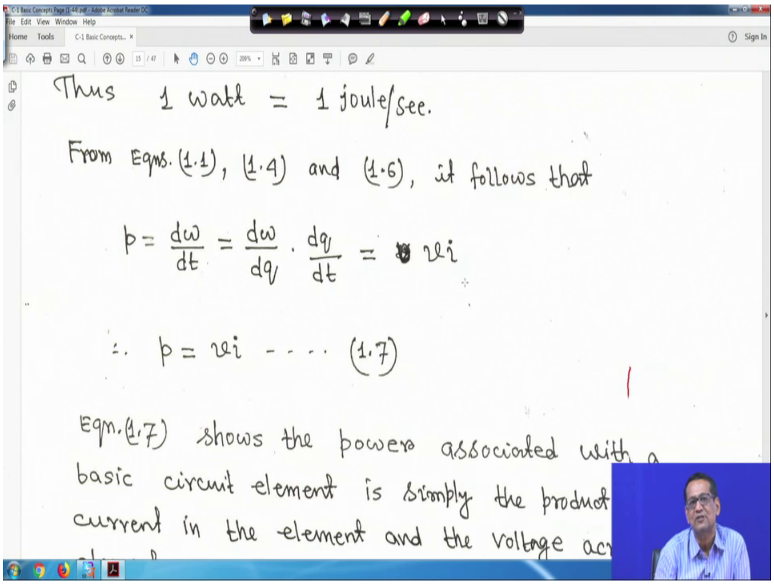
So, another reason is that all practical devices have limitation on the amount of power that they can handle just some devices or specification is there. If you see anything can be bulb or any light or fan, you will find some specification is there and one important specification is the power right. For example, we all know from our experience that is 60 watt bulb gives more light than a 40 watt bulb because 60 watt is powerful than 40 watt we also know that when we pay our electricity bills we are actually paying for the electric energy that is watt hour consume over a certain period of time right we or that whatever electric bill if you pay this is watt hour.

In general it will higher you your higher values of unit that is kilo watt hour right. So, sometimes in this rhymes we define energy like this that energy is power multiplied by hour because if you look it that energy is power multiplied by hour because it is a watt hour watt into hour right. So,. we know we now we now relate the power and energy to voltage and current, because we have to relate now power and energy to the voltage as well as the current. So, power is the time rate of a expanding or a absorbing energy.

So, power is measured in watts. So, mathematically p is equal to dw by dt, it is actually your what you call that is a time rate of a expanding or absorbing energy. So, it is p is equal to dw by dt where p is the power in watts right w is the energy in joules right and t is the time in second. So, that is 1 watt from this equation 1 watt is equal to your 1 joule per second it is one joule per second right.

So, once again the power actually is measure in watts. So, mathematically this is p dw by dt and from that from that physics the definition is power is the time rate of expanding or absorbing energy. Simply do not write the power is the time rate of energy then it is not correct better you should write power is the time rate of expanding or absorbing energy right.

(Refer Slide Time: 07:10)



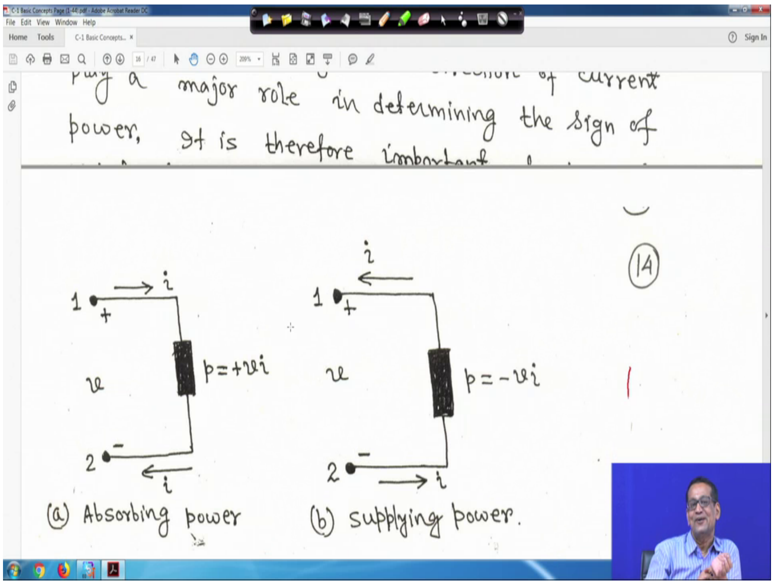
So, therefore, from equation 1.1 we have seen right I is equal to dq by dt and so on. So, and 1.4 and 1.6 this equation is 1.6 therefore, p is equal to dw by dt is equal to we can write this equation dw by dq into dq by dt right. And dw by dq we have seen it is V and from equation 1.1 I is equal to dq by dt it is i, from equation 1.4 it is your dw by dq is equal to v.

So, p is equal to v into i right. So, this is actually p is a power. So, this is equation 7. I think I need not write it again now it is understandable that, dw by dt we write it in partial derivative that your chain chain rule of their differentiation rather, but dw by dq into dq by dt. And dw by dq is equal to v and dq if that is d dw by dq is equal to v that is from equation 1.4 and i is equal to your dq by dt that is from equation 1.1. So, power is equal to voltage into current right.

So, equation 1.7 shows the power associated with basic circuit elements is simply the product of the current in the element and the voltage across the element. Therefore, power is a quantity associated with the pair of terminals and we have to be able to tell from our calculation whether power is being delivered to the element or supplied by the element. If the power has a plus sign this is this is interesting this you have to understand; if the power has a plus sign power is been delivered to or absorbed by the element.

If power is a plus sign right or later we will see in the numericals and other thing, we will be accustomed with this. And if on the other hand the power has a minus sign right that is power is being supplied by the element so, but, but how do we know when the power has a positive or a negative sign right; so, this is the question. So, polarity of voltage and direction of current play a major role in determine the sign of power it is therefore, your important to see this right.

(Refer Slide Time: 09:32)



So, this one look at this one this is a simple circuit element say something it is say it is something. So, this is plus this is minus right. So, current is this current is plus sorry this terminal is plus current is flowing from this direction and here actually what we will do that, whenever a current your entering the positive terminal; you will take the sign of current is positive. So, this current is entering the terminal means from plus terminal the current is flowing.

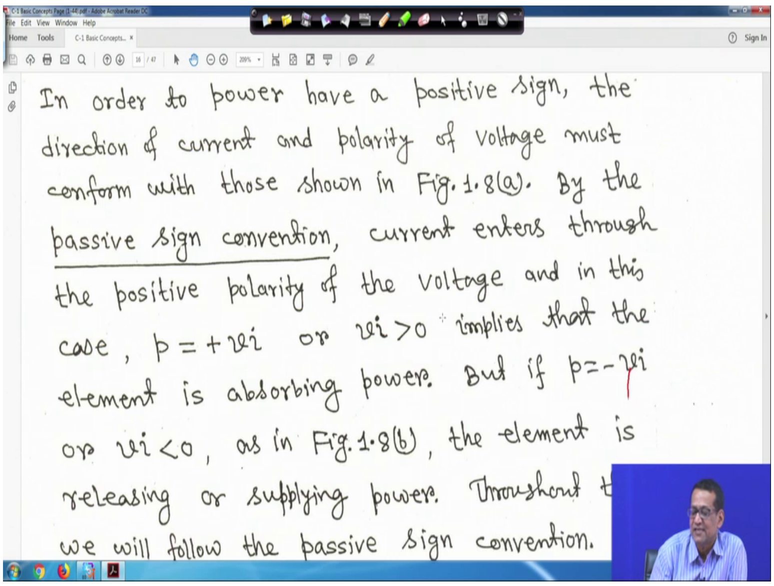
So, p is equal to v into i right. So, that is why the power is positive; that means, this element actually is absorbing the electrical power so; that means, when i is leaving the plus terminal or entering into the plus terminal right. So, not leaving when it is entering into the your what you call this your plus terminal; that means, current flowing in this direction. So, p is equal to v i. Now it is actually entering the terminal and when the current is leaving the plus terminal you take minus sign, at the same time you can understand that actually the i the current is going into the element from plus.

So, current is your what you call entering into the plus terminal and when current is leaving the plus terminal; it is leaving the plus terminal. So, current signs your symbol i you will take your direction it will be negative. So, p is equal to minus vi v inverse as it is v, but i is there is a sign will change it will be minus vi right this thing you have to this is absorbing power and this in this case element is supplying power, because p is equal to minus v into a i right.

So, one is entering into this your; what you call plus terminal, another is leaving the plus terminal. So, when it is entering into the plus terminal sign should sign of current should be plus and when is leaving the plus terminal it should be minus. This certain things I mean basic thing you have to keep it in mind right. So, so reference polarities for power using the passive sign convention. Now in order to power have a positive sign right the direction of current and this rate thing is nothing actually right.

So, direction of current and polarity of voltage must confirm with those shown in figure 1.8 a and b. Now whatever I told right by the passive sign convention current enters through the positive polarity of the voltage and this case p is equal to vi, because this current is entering through their positive polarity. Whenever current entering through the positive polarity. So, sign i that current your sign it should be taken as a plus that is why p is equal to plus vi and in this case current this thing current is leaving the plus terminal we should take minus that is why p is equal to minus vi right.

(Refer Slide Time: 12:36)



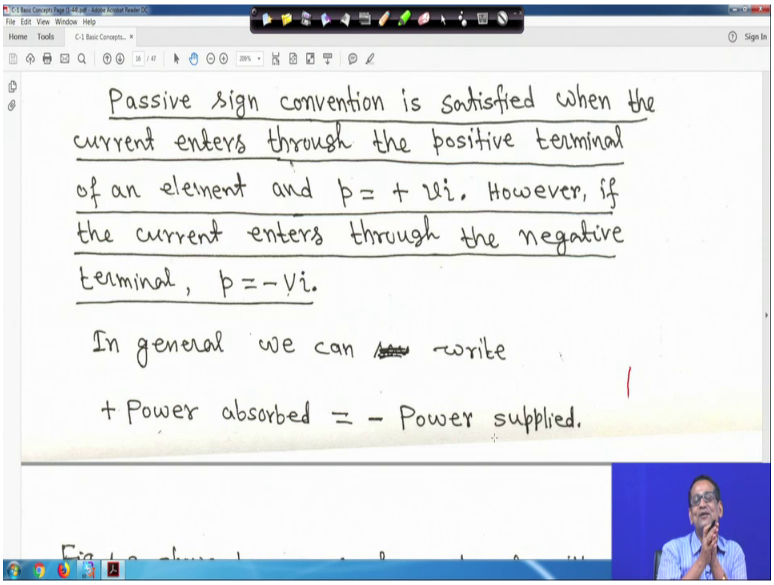
Therefore; so, by the passive sign convention current enters through the positive polarity of the voltage, and this case p is equal to vi; that means, vi greater than 0 right. So, vi greater than 0 implies that the element is absorbing power and when p is equal to when p is equal to minus vi right. So, element your what you call in this case vi negative as figure b the element actually is releasing or supplying power. Throughout the text or throughout this course we will follow the passive sign convention.

So, I suggest once again when we because later stage we will solve any problem is another thing. So, basic thing should be initially it should be clear right so; that means, when current entering to the positive terminal i should be positive, when current leaving the your positive terminal i should be negative. So, when it is positive then it is element is absorbing power when it is negative element this element minus vi means it is supplying or delivering power right that is why it is minus vi.

So,. So, passive sign convention is satisfied I told you when the current enters through the positive terminal of an element and p is equal to plus vi; however, if the current enters your through the negative terminal, then p is equal to minus vi; that means, if you look at the diagram other way I think it is current entering through the negative terminal here also I have made I here it is another way is that current entering through the positive terminal it is i. So, p is equal to plus vi current enter is your negative terminal p is equal to minus vi. Otherwise current entering through the positive terminal or leaving through the negative terminal.

The way you can easy easiest way is current entering through the positive terminal. So, it is plus vi, current entering through the negative terminal it is minus vi current entering through the positive terminal element is absorbing power, current entering through the negative terminal element is supplying or delivering power, I hope you have understood this right this is require right.

(Refer Slide Time: 14:52)



So, in general we can write power absorbed is equal to minus of power supplied. Same concept like your the way it will be the I 1 2 is equal to minus I 2 1, V 1 2 is equal to minus your V 2 1 similar way you can write plus power absorbed is equal to minus power supplied because power balance or energy balance equals to now this has to be satisfied. Now look at that figure this figure one point it shows 2 cases of element with absorbing power.

If you look into that here power entering into the sorry current entering into the positive terminal this is plus right and this is the 5 volt. So, what will be the power? V is equal to 5 volt 4 is and I is equal to 4 ampere. So, power will be 5 into 4. So, 20 watt right because current entering into the positive terminal same thing you look, this is at this is now we have made this is 2 plus this is minus and it is here it is in the a entering into the positive terminal.

But here also if you look into that current is entering through the positive terminal because current goes like this goes like this and goes like this right. So, in this case your just hold on; so, in this case this is i is equal to 4 ampere. So, this is that your what you call current going like this going like this going like this is 4 ampere. So, current entering through the positive terminal and in this case here also current entering through the positive terminal goes like this, goes like this is also 4 ampere. So, ultimately both the cases current entering through the positive terminal, but here it is 1 2 here also 1 2, but this has been in plus this has been in minus.

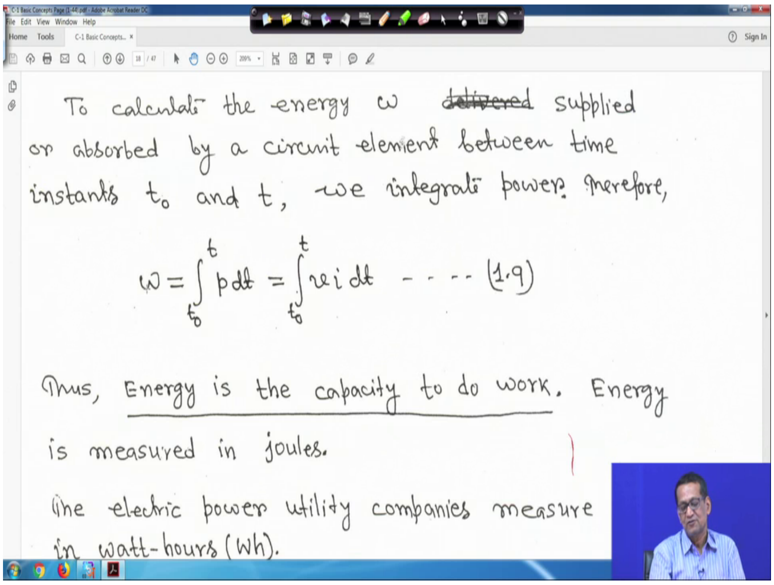
So, in this case also p is equal to 5 into 4 so; that means, your what you call 20 watts. So, both the cases element actually is absorbing the power right. So, both circuits apply it is absorbing the power. So, both the both the your what you call both the circuit actually absorbing the power. So, I hope you have understood this right. So, both the circuit it is p is equal to 20 watt 5 into 4 here also 5 into 20 only thing is that. We see that current entering through that your positive terminal here also it goes like this I showed you.

So, little bit you know you should understand this then things will be easier for your later stage. Now this one now this one if you look that 2 cases of an element with a supplying of power. In this case if you look that current actually entering into the negative terminal just I will for your this thing I will just I will make it like this for this one this is 4 ampere:. so, current is going like this. So, it is this direction is given here. So, current actually entering through the negative terminal.

So, I should be taken as a negative; so, p is equal to minus 4 into 5; so, minus 20 watt; that means, this element actually supplying the power. Similarly here also current is entering into the negative terminal; so, it is going like this. So, current enter into the negative terminal, here also it is minus your therefore, this will be minus 4 into 5. So, minus 20 watt; that means, power is negative. So, this element is supplying power right or delivering power right.

So, just hold on right. So this is actually took minus 20 watt and minus 20 watt. So, hope this one and this one concept is clear to you right from the beginning in this course, you have to you know if you your what you call if you make this understanding is you know clear, then later stage you will find things are very easy. So, there should not be any confusion or anything right. So, when you will go through this course and when you will see if you have any doubt, you can put the question and you are ask a question or you know forum we will we are there to your what you call answer all your queries, but understanding is your more important.

(Refer Slide Time: 19:22)



So, now for any electric circuit law of conservation of energy must be obeyed right. For this reason at any instant of time little bit I hope it is it is it is your readable you can make it must be obeyed for this reason at any instant of time, the algebraic sum of the power in a circuit must be 0. Therefore, we can write in general sigma power is equal to 0 sigma p is equal to 0 our meaning is in a circuit you may have many voltage sources and many electrical elements right.

So, sources many cases power will be delivered and power will be absorbed. So, total power delivered right and total or in a other way I can put that power delivered plus your power your delivered or a supplied plus power absorbed is equal to your 0. So, therefore, in this case in the case of power also that your sigma p is equal to 0; that means, summation of all the power or later we will see later we will see how this your what you call this power delivered is equal to power absorbed right that we will see later.

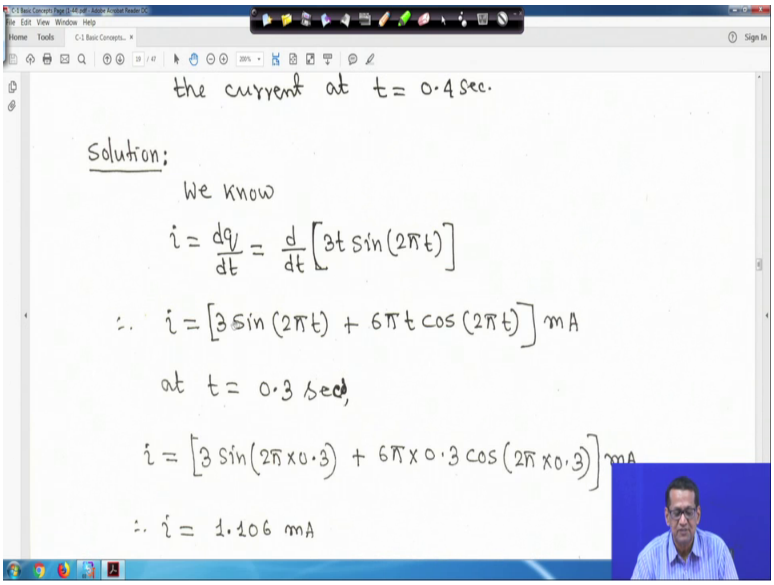
So, sigma in general summation is equal to 0 this is it. So, this equation 1.8, it confirms you confirms the fact that the total power supplied to the circuit your must bal is the total power absorbed right. So, this is the concept that way we write sigma p is equal to 0; this one we will see much later when I will take the example as it is as. Now to calculate the energy w, supplied or absorbed by a circuit element between time say t 0 and t we integrate power therefore, we know that power is equal to your dw by dt right therefore, dw is equal to I am not writing understandable, earlier we have seen the power is equal to dw by dt

So, dw will be is equal to pdt if you integrate. So, w is equal to time t 0 to 2 pdt, but p is equal to vi you substitute here p is equal to vi therefore, time is t 0 to t dt right therefore, this energy is the that therefore, the energy is the capacity to do work. So, energy is measured in joules. So, the w is measured in joule right. So, the electric power utility companies measure energy in watt hour or kilo watt hour right. So, 1 watt hour is equal to 3600 joules.

These are the standard this thing you can you can you can keep it in your mind now we will come to few small example right small example. So, I hope up to this before going to this few more example, I hope up to this you have your understood your what you call the basic concept the current the voltage the power and the passive sign convention right and then in the case of power that your what you call that plus or minus that absorbed or delivered, similarly in the case of voltage that which point is higher than the other point 1 point is higher than higher point other point that per your voltage, all this things hopefully you have understood right

Therefore one hour is equal to 3600 joules right now come to that few simple examples that how much charge is represented by 5524 electrons this is example 1.

(Refer Slide Time: 22:46)



So, each electron has e is equal to minus 1.602 into 10 to the power minus 19 coulomb that we know here is 5524 electrons will have minus 1.602 into 10 to the power minus 19 coulomb per electron into 5524 because each electron has this thing this much of coulomb that is why you writing; you are writing minus 1.602 into 10 to the minus coulomb per electron you are writing into 5524 electrons. So, total will be 8.849 into 10 to the power minus 16 coulomb right.

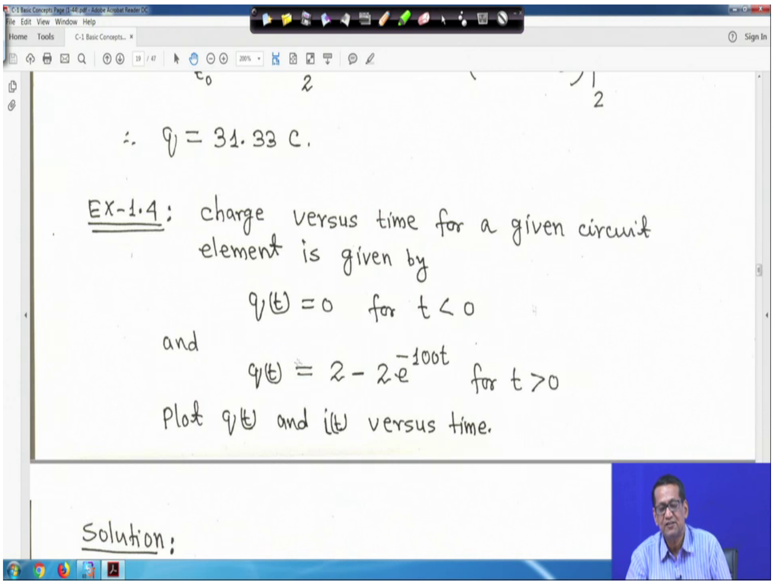
Here little bit has been cut for scanning. So, this is actually coulomb now example 2; the total charge entering a terminal is this is actually this is actually page number 17 given by q is equal to say 3 t sin 2 pi t say milli coulomb right. So, determine the current at t is equal to 0.4 second. Very simple thing q is given. So, we know that i is equal to dq by dt. So, ddt of 3 t sin 2 phi t right; so, this is your 2 pi t.

So, if you take the derivative of this one. So, it is i is equal to 3 sin 2 pi t plus 6 pi t cosine of 2 pi t that is milli ampere because it is it is is actually it is in milli coulomb. So, that is why you are writing it is milli ampere. So, at t is equal to 0.3 seconds; so, put here t is equal to 0.3 second. So, in this case i is equal to 3 sin 2 pi into 0.3 plus 6 pi into your 0.3 cosine of 2 pi into 0.3 milli ampere. So, after computing this we will get i is equal to 1.106 milli ampere at t is equal to 0.4 second right.

So, here know here actually here it is it should be it should be your what you call 0.3 because here I have taken t is equal to 0.3 so, but here by you know while writing is it has been made 0.4 it should be 0.3. So, there should not be any confusion. So, here it is a it is you know it is a screen, we cannot make a correction here. So it is actually this one actually will be this one actually will be t is equal to 0.3 huh. So, there should not be any confusion. So, that is why here we made t is equal to 0.3.

So, next one is determine the total charge the example 1 0.3 determine the total charge entering a terminal between t is equal to 2 second and t is equal to 4 second. So, current passing through the terminal is given i is equal to 2 t square minus t ampere.

(Refer Slide Time: 25:45)

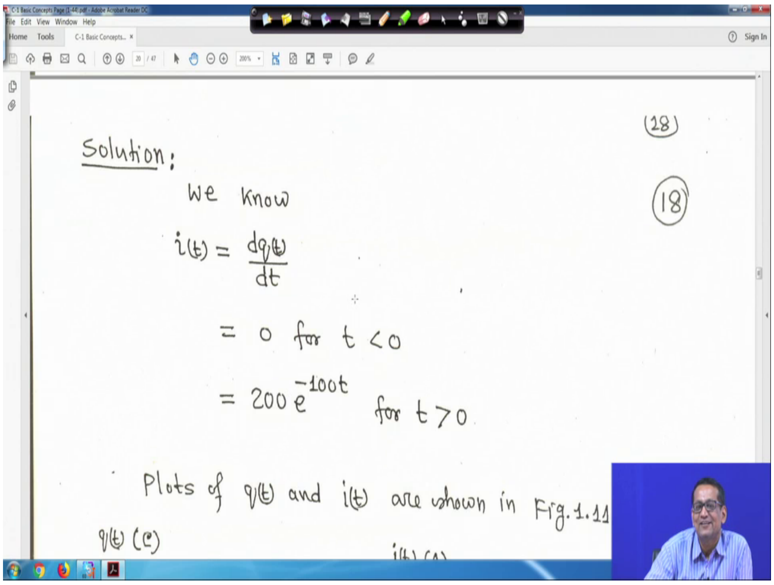


This i is given right and time span is given 2 t is equal to 2 second to 4 second. So, by using equation 1.2 that we know the i is equal to dq by dt i is equal to dq by dt.

So, dq is equal to idt; so, q is equal to integration ydt, but time limit is t 0 to t. So, this is from equation 1.2 right. So, it is t 0 is given this is given 2 t is equal to 2 second and t is equal to 4 second. So, here actually t 0 is equal to 2 second here right this is t 0 equal to 2 second and this is your t is equal to 4 second right. So, it is 2 to 4 2 t square minus t into dt. So, if you integrate this it will be 2 by 3 t cube minus t square by 2 limit is 2 to 4.

If you simplify right. So, you will get q is equal to 31.33 coulomb right. So, next is example is say 1.4. So, charge versus time for a given circuit element is your given by qt is equal to 0 for t less than 0 right and qt is equal to 2 minus 2 into e to the power minus 100 t, for t greater than 0. you have to plot qt and it versus time. Qt is already given only it you have to plot it you have to find out then plot both right. So, solution we know that it is equal to dq by dt.

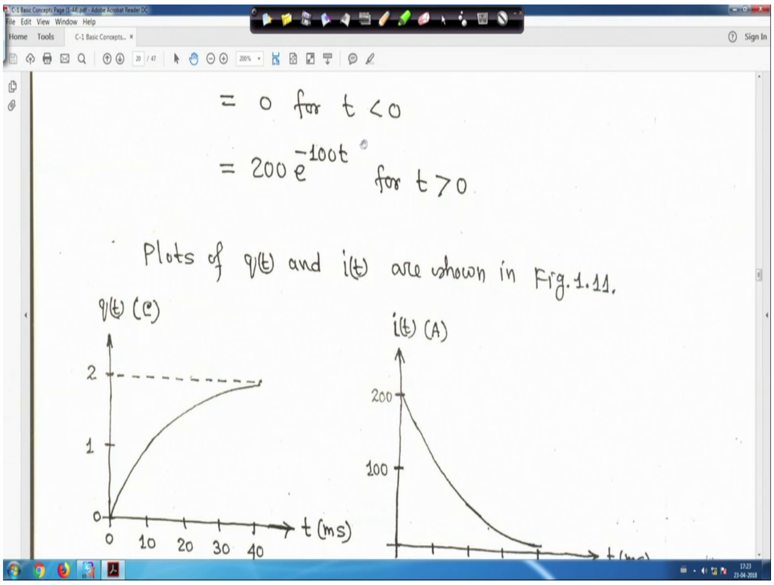
(Refer Slide Time: 27:19)



So, it is given qt is equal to 0 for t less than 0 right therefore, your it is actually if you take the derivative also for t less than 0. So, actually whenever we take then it is less than 0 means say it is something like this the past history of the circuit, later in transient we will try to see this say it is past history of the circuit. So, that is why it is mathematically represent that is your what you call that t less than 0. So, in this case qt is equal to 0.

So, for t less than 0; so, this is 0 and when qt is equal to 2 minus 2 into e to the power minus 100 t you take the derivative dqt by dt. So, here if you do so, then it will be 200 e to the power minus 100 t for t greater than 0. Now plot of qt and it shown in figure 2 this is the plot of your qt qt already given right qt is already given right. So, in this case if t is equal to you put in this expression, if you put t is equal to 0 right then what will be there the e to the power 0. So, actually 1; so, 2 minus 2 0.

(Refer Slide Time: 28:31)

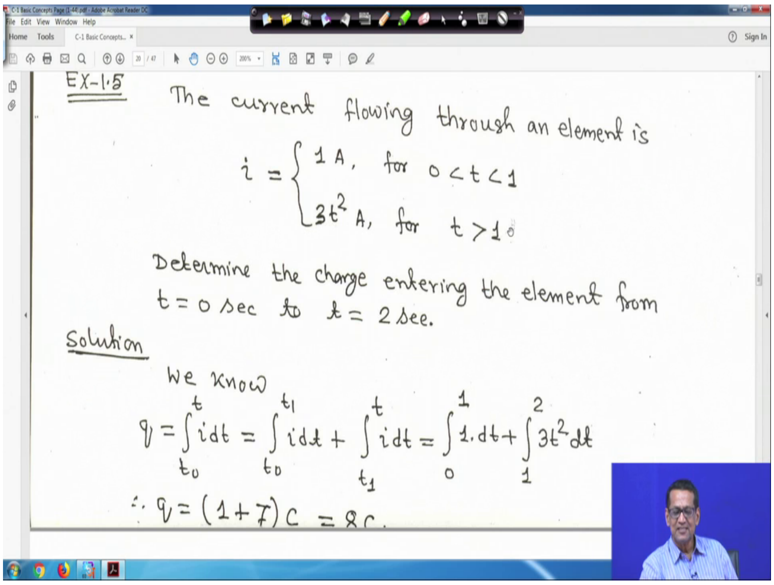


So, graph starts from 0 and right and when your when t is increasing it is in millisecond. So, when t is increasing finally, it will reach to the steady state the 2 right.

When here when t is your increasing like t greater than 0 and t is increasing say t tends to infinity right so; that means, this term will vanish only 2 will be there. So, that is why it is your (Refer Time: 28:54) approaching and that is qt is coulomb that is 2 coulomb and this is the current right it is the current when t is equal to 0, current is 200 ampere because when t is equal to 0 this term is 1. So, it is 200; so, it is starting from 200 right.

And when t is your increasing, when t is increasing this current actually approaching towards 0 and when t tends to infinity t is going to infinity right this term will vanish it will be 0. So, at steady state current will be your 0. So, this is the plot of your this thing it versus time and this is your qt versus time this is the plot. So, a plot of charge and this is the plot of current right.

(Refer Slide Time: 29:42)



So, example another example say 1.5, the current flowing through an element is that i is equal to one ampere for t greater than 0 and t less than 1.

And second thing if it is 3 t square ampere for t greater than 1 and in when current time is in between 0 and 1, the current is one ampere that is current is constant and when for t greater than 1, it is 3 t square ampere say it is given. So, we have to find out the charge entering the element from t is equal to 0 second to t is equal to 2 second. So, this is the determining the charge entering the element from t is equal to 0 second to t is equal to 2 seconds.

So, we know that q is equal to t 0 to idt is just we have seen right and t 0 to t 1 idt plus t 1 to t i dt then you have a 2 time interval this is say t 0 and this is t 1; t 1 is one second. So, 0 to 1. So, t 0 to t 1; so, this is t 0 actually t 0 actually 0 and t 1 is one second right another thing is you want in between 2 second. So, another is that t 1 to t; so, t 1 again is one second this is one and t is equal to 2 second. So, 2 I hope it is understandable to you because when you are understanding this t 0 to t. So, that you have 2 intervals one is 0 to 1 and another is t greater than 1, but you have to find out in between 0 to 2 second.

So, 0 to 1 that is t 0 is equal to 0 and t 1 is equal to 1 right and then this one then t 1 to t t 1 is equal to 1 then 1 to 2 second and t is equal to 2 what is the idt this is the idt. So, this can be written as 0 to 1, i is equal to your 1 into dt because this is giving one ampere. So, i is equal to in this case i is equal to in between the interval 0 and 1, i is equal to one ampere. So, that is why it is one into dt plus in between the and when t greater than one it is 3 t square a. So, 1to t 1 to, but we want to in between 0 and 2 seconds. So, 1 to 2 it will be 3 t square into dt.

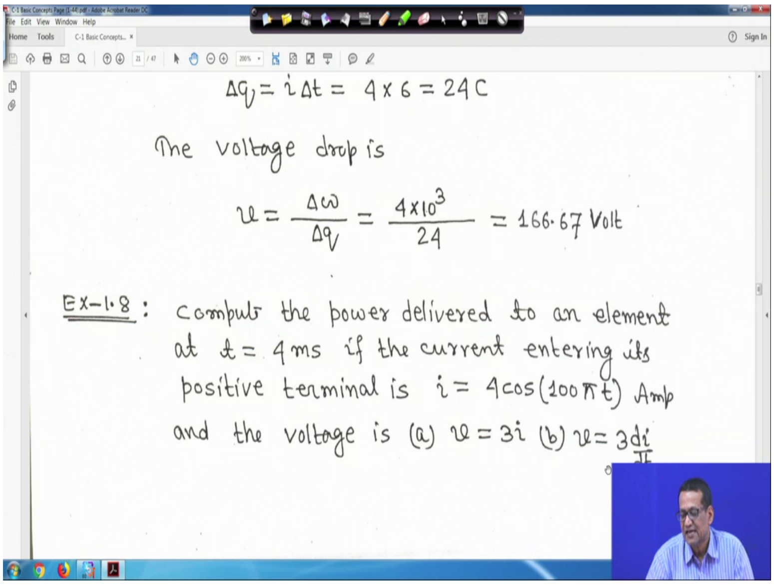
This simple thing, but I hope you have understood this right when you will integrate and solve it you will get q is equal to 8 coulomb this is actually 8 c 8 coulomb right. So, I repeat once again for your you know understanding because and if you start in the very first year that it is one in between 0 and one that is this is t 0 is equal to 0 t 1 is equal to 1, but you have to you have to determine the charge entering the element from t is equal to 0 second to t is equal to 2 second.

But first you have to consider this because 0 to 1. So, this is one ampere. So, t 0 to t idt and then t 0 to your what you call this one t 0 to t 1 then t 1 to t right t 1 to t and then your is equal to the 0 to 1 in between 0 to 1 current is one ampere. So, one into dt plus that it is greater than one therefore, it is one to 2 3 t square dt because expression is 3 t square it is greater than 1, but you one in between 1 and 2; that means, this 3 t square d dt.

If you integrate this it will be your 1 plus 7. So, 8 coulomb right I hope you have understood this simple thing now another thing another example is this is actually page number 19 here. So, electrical energy is converted to heat at the rate of 8 kilo joule per minute in a resistor your what you call and charge flowing through it at the rate of 300 coulomb per minute.

So, what is the voltage difference across the resistor terminal? So, electrical energy is converted to heat at the rate of 8 kilo joule per minute in a resister and charge flowing through it at the rate of 300 coulomb per minute. So, what is the voltage difference across the resistor terminal? So, in this case we know that your v is equal to p upon i right that is the power; that means, p is given 8 kilo joule per minute. So, it is 8 into 10 to the power 3. So, 1000 joule per minute and q is given that 300 coulomb per minute. So, it is 300 coulomb per minute.

(Refer Slide Time: 33:56)



So, that is 26.67 joule per coulomb that is the voltage joule per coulomb is equal to voltage we have seen earlier

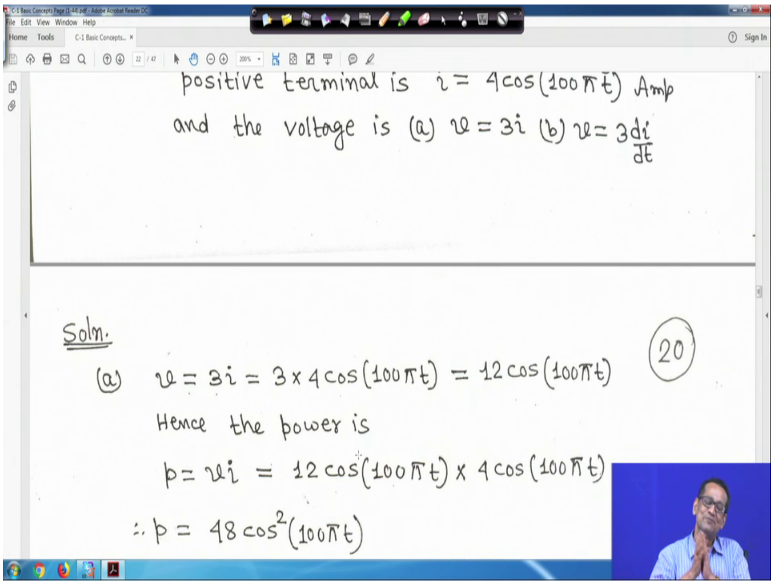
So, v is equal to 26.67 volt. So, and another thing is and a energy source your forces a constant current of 4 ampere for 6 second to flow through a lamp. If 4 kilo joule is given off in the form of light and the and heat energy determine the voltage drop across the lamp. So, it is telling that energy source forces your what you call a constant current of 4 ampere for 6 second to flow through a lamp right.

If 4 kilo joule is given off in the form of light and heat energy determine the voltage drop across the lamp. So, total charge is q you know you know that i is equal to dq by dt. So, in general we can write that dq is equal to i dt. So, here we are writing delta eq is equal to i into dt right. So, delta eq. So, i is given 4 ampere this is your 4 ampere the constant and your time t is 6 second. So, delta t is equal to 6 second. So, 4 into 6 that is 24 coulomb.

So, and the voltage drop you know voltage is equal to that your potential difference is equal to dw upon dq. So, the here we are writing for the your in v is equal to right in delta w by delta eq. So, it is given 4 kilo joule. So, 4 into 10 to the power 3 divided by delta q we got 24 coulomb. So, it is one 166.67 volt. Now 1.8 compute the power delivered to an element at t is equal to 4 millisecond if the current entering its positive terminal is i is equal to 4 cos 100 pi t your ampere.

So, and the voltage is and the voltage is a is equal to is given v is equal to 3 i one expression another is given v is equal to 3 di by dt. So, the it is it is hours that compute the power delivered to an element at t is equal to 4 millisecond, if the current entering its positive terminal is i is equal to 4 cos 100 pi t ampere and the voltage is v is equal to 3 i and v is equal to 3 di dt right. So, solution is simple v is equal to 3 I so, 3 into 4 cross 100 pi t.

(Refer Slide Time: 36:34)

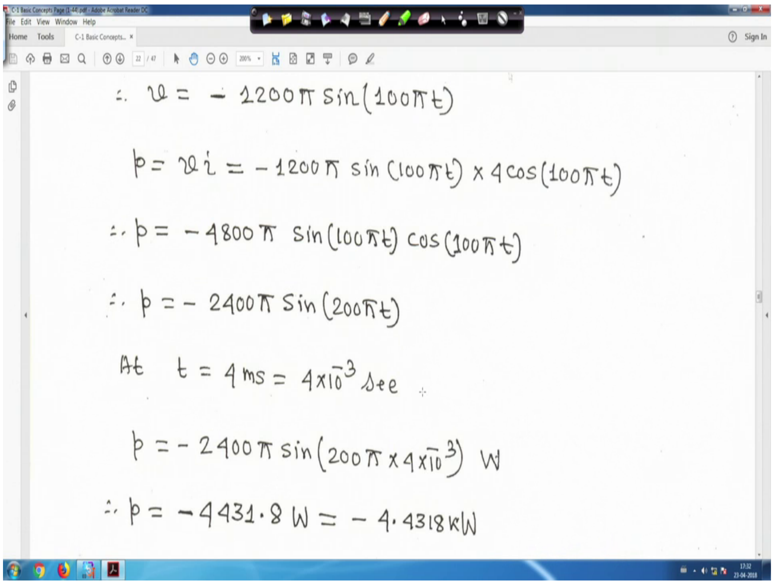


So, 12 cos 100 pi t; hence the power is p is equal to v i listen one thing this is we are covering then general it is a DC dc circuit DC codes, but one or two simple example of your sine cosine function I am taken and detail sine cosine detailed your in terms of sine cosine and single phase power or 3 phase power that will come when the AC circuit.

Here just to give you a feeling of that you know time function power and this thing, but later you will see that in single phase circuit we will power your power computation is different and 3 phase also something interesting, but here it is it is here simple it is given in terms of time function just to give you a feeling, but that this is just to know little bit of energy power the basic concept.

So p is equal to if you make vi, it will be expression if you multiply all these 2 it will be 48 cos squared 100 pi t, but when t is equal to 4 millisecond.

(Refer Slide Time: 37:38)



That is 4 into 10 to the power minus second you substitute here t is equal to 4 your millisecond, then you will get p is equal to 48 cos square whatever its comes inside you will get p is equal to 4.603 watt. Now also another thing is given that v is equal to 3 di by dt.

So, it is 3 and ddt di is given the expression of i is given 4 cos 100 pi t. So, here it is your i is equal to 4 cos 100 pi t. Take the derivative v is equal to minus 1200 pi sin 100 pi t. So, p is equal to v into i. So, this is the expression of v and this is the expression of i 4 cos 100 pi t you multiply right and you will get p is equal to minus 2400 pi sin 200 pi t at t is equal to 4 millisecond that is 4 into 10 minus 3 second you put here t is equal to 4 into 10 to the power minus 3 you put it here, you will get it is p is equal to minus 4431.8 watt that is minus 4.4318 kilowatt right.

So, course; so up to up to this these are some more example we will see later. So, up to this we will it will give you some feeling, but regarding time variation of current and voltage, but all time variation other things we will see for single phase thing, but this is a only first will be consider you know DC circuit, basic concept, then basic laws, basic theorems right this is transient or first order circuit only and next we will your what you call, but these are the power cut your current everything taken in time such we will give some flavor in the at the beginning right so.

Thank you very much.