Fundamentals of Electrical Engineering
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Lecture - 29
First order circuits

So next we will start the First order circuit, the this is your chapter 6 right. So, and here we will see the dc transient particularly the, your R L circuit and R C circuit only the we will see that why it is called first order circuit also. So, when this topic is over we will go for ac circuit. So, we start first single phase then 3 phase right. So, first some introduction I have made it for you that in the previous chapters we have considered 3 passive elements resistors capacitors and inductors individually.

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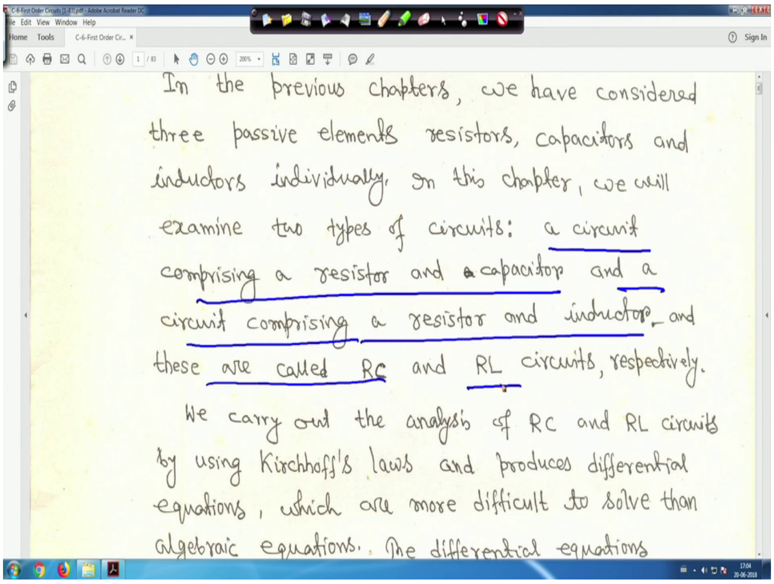

So, in this chapter, we will examine your 2 types of circuit. A circuit you are comprising a resistor and a capacitor and a circuit comprising a resistor and your inductor. I mean we will see the 2 types of circuits that is a circuit comprising a resistor and capacitor and we will see a circuit comprising a resistor and inductor and these are called R C circuit and R L circuit with respectively right. We carry out the analysis of R C and R L circuit by using your what you call KCL your KCL and KVL and produces different equations, which are more difficult to solve then as every equations right. So, just let me this thing.

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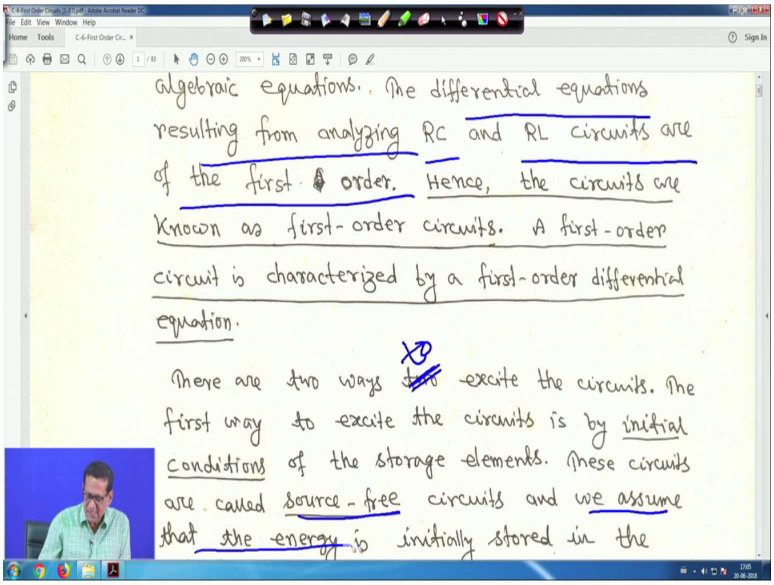

So, the differential equations resulting from analyzing R C and R L circuit, that is your the differential equation resulting analyzing that R C and R L circuits are of the first order right hence it is underlined the circuits are known as first order circuits. A first order circuit is characterized by first order differential equation. So, there are two ways it will be 2 right, I am correcting it right.

So, there are two ways to excite the circuit, the first way to excite the circuit is by initial condition of the storage element right that will be source free circuit right this circuit are called source free circuit; that means, circuit is excited by the initial your what you call that your conditions of the storage your storage elements and this these circuits are source free circuit right. So, actually in that case we assume that the energy is initially stored in that your what you call in that circuit element, just scroll one in that a stored in the capacitor or a inductive element right.

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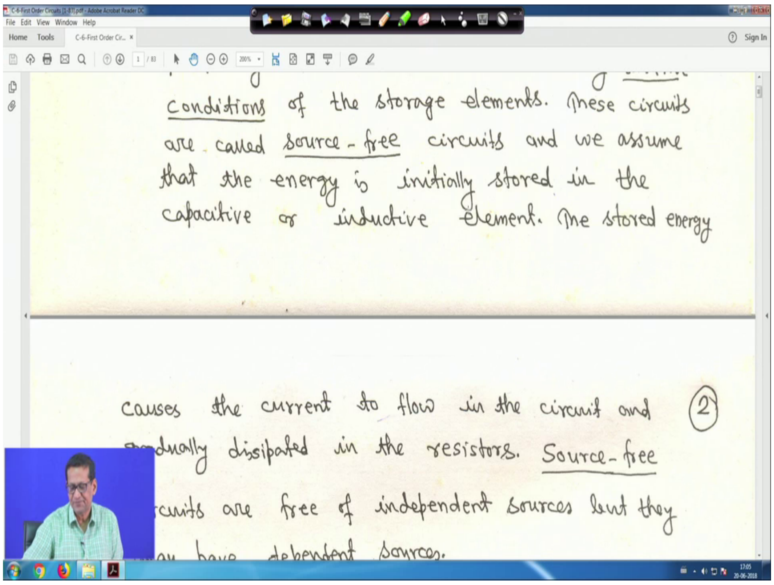

So, this stored energy causes the current to flow in the circuit and gradually dissipated in the resistor.

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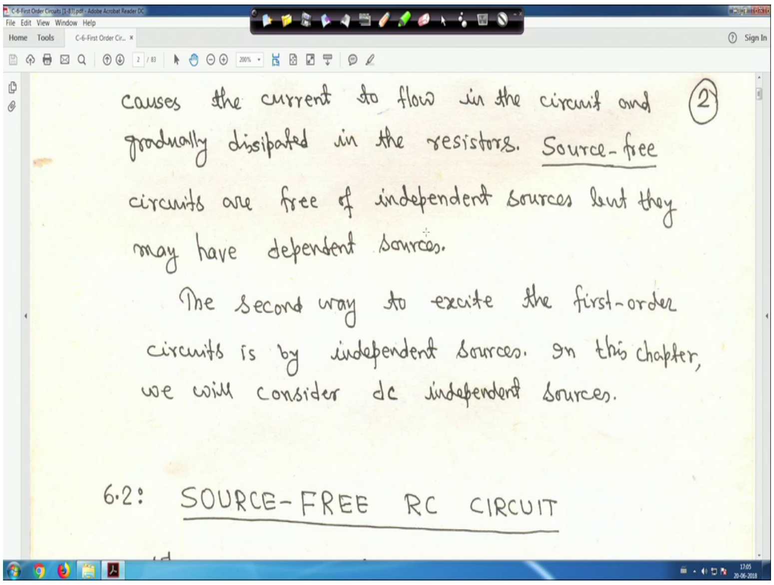

So, source free circuits are free of independent sources, but they may have dependent sources. So, it may have I mean it is it is there will be no independent sources, but they may have dependent sources. The second way second way to excite the first order circuit is by independent sources. So, in this chapter or in this topic we will consider dc independent sources right first will see the source free circuit.

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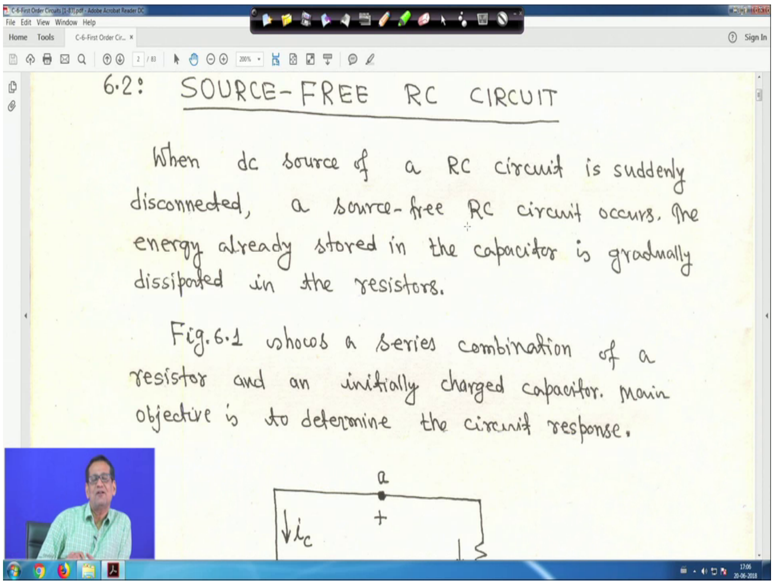

So, whenever you see source free circuit here no then we will see when I will solve numerical 1 or 2 cases or 2 3 cases I will tell you the solution and this way, but here 1 and 2 cases I will not tell you that how 1 and 2 cases obtained I will give you your what you call that you think that how it has come, but that will come later. So, when dc source of a R C circuit is suddenly disconnected, a source free R C circuit occurs right. So, the energy already stored in the capacitor is gradually dissipated in the resistor.

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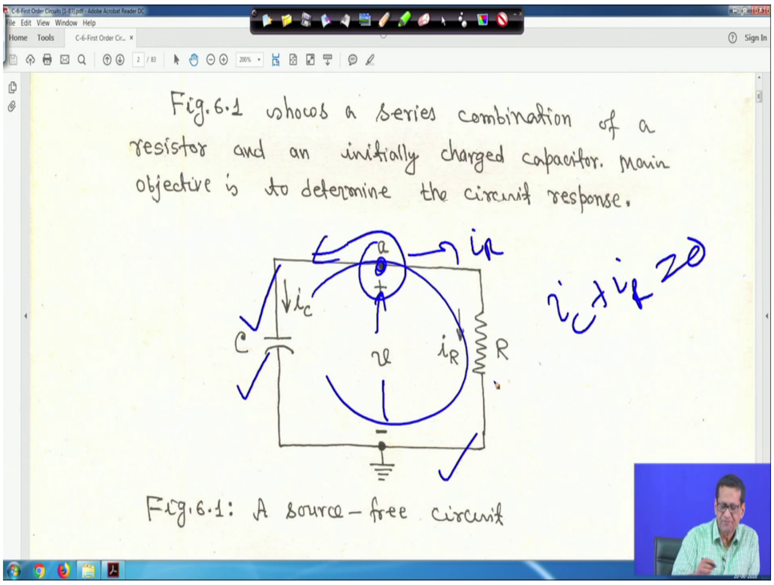

So; that means, figure 1 suppose it shows us series combination of a resistor and an initial energy your charge initial sorry initially charged capacitor. So, main objective is to examine the circuit response.

So, in this case this, this capacitor was initially charged and resistor is there; all though i C and i R it is a it is a simple circuit, but at this point if you apply KCL, I if you take like this that i C is going this way and i R is going this way both are leaving. So, i C plus i R equal to 0 right already the same circuit, but for some analysis we will do that and this is your this side is your voltage right this is the voltage, v is the voltage that was the capacitor or across the resistor it is same right.

So, it is a source free circuit there is no independent source in the circuit, assuming that this capacitor was initially charged and if you apply KVL at this point it will be i C plus i R is equal to 0 right so, this is a source free circuit.

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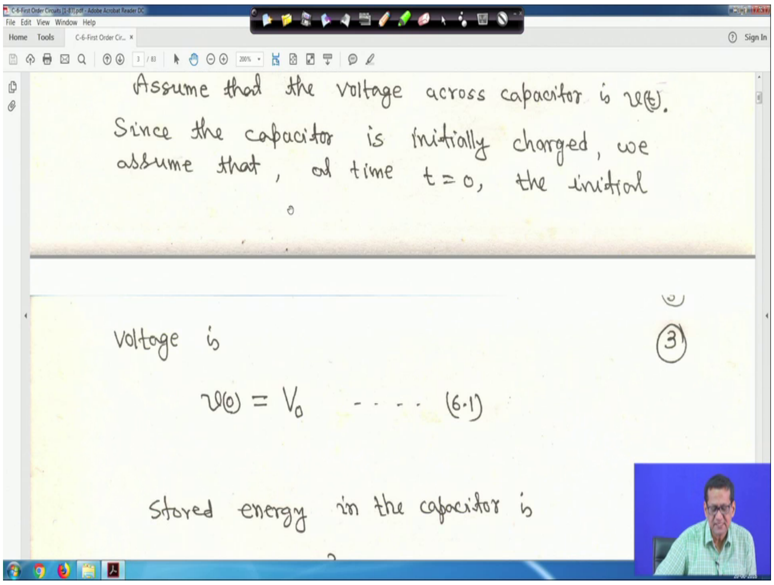

Now so, assume that the voltage across the capacitor is vt since the capacitor is initially charged we assume that time t is equal to 0 the initial voltage V 0 is equal to V 0 right.

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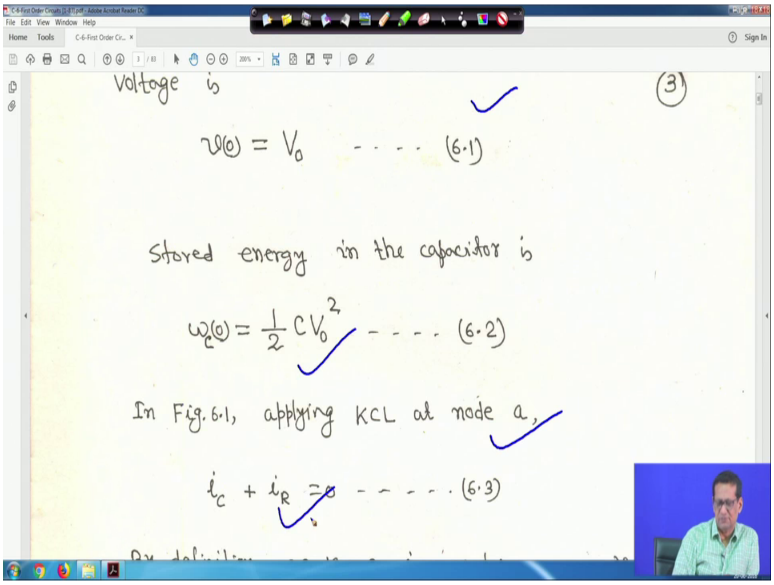

So, in this case we assuming t is equal to 0 that is V 0 is equal to your capital V suffix 0 is the initial voltage. Now, stored energy in the capacitor initially that w c 0 is equal to half C V 0 square right just hold on. So, just hold on. So, in this case the stored energy in the capacitor is this w c 0 is equal to half C V 0 square right. So, applying KCL at node I told you i C plus i R is equal to 0 right. So, let me clear it.

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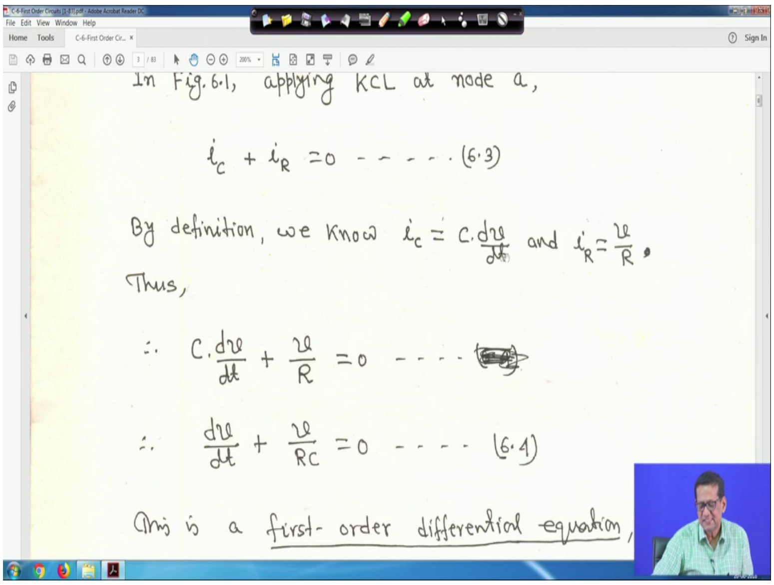

So, by definition we know that i C is equal to C into dv by dt, and at the same time i R is equal to v by R.

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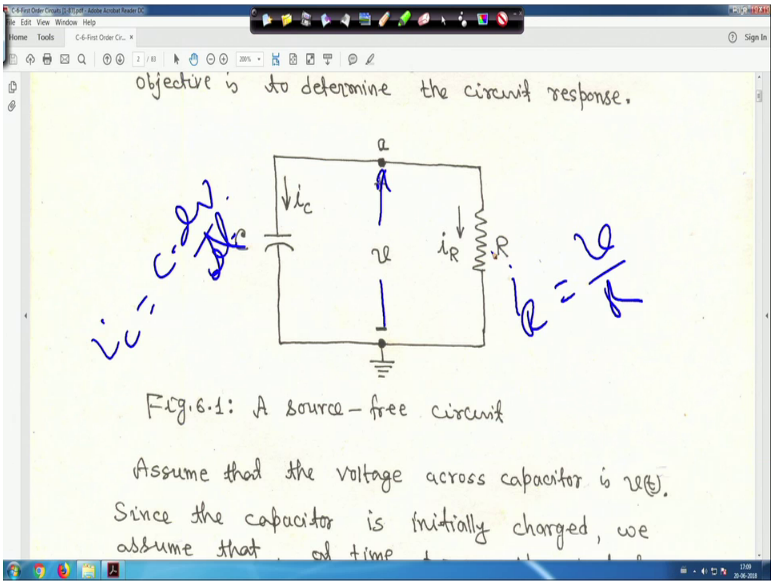

If you come to this circuit if you come to this circuit that your this voltage I told you, this voltage is your v. So, i R is equal to v upon R right because same voltage that was the capacitor across a resistor.

So, v is equal to i R so, i R r into i R so, i R is equal to v by R similarly here also your i C is equal to C into dv by dt right. This v is across the same this capacitor as well as the resistor. So, let me clear it. So, in this case your this is C into dv by dt plus v by R is equal to 0 because i R is equal to v by R is equal to 0 or dv by dt plus v by R C is equal to 0.

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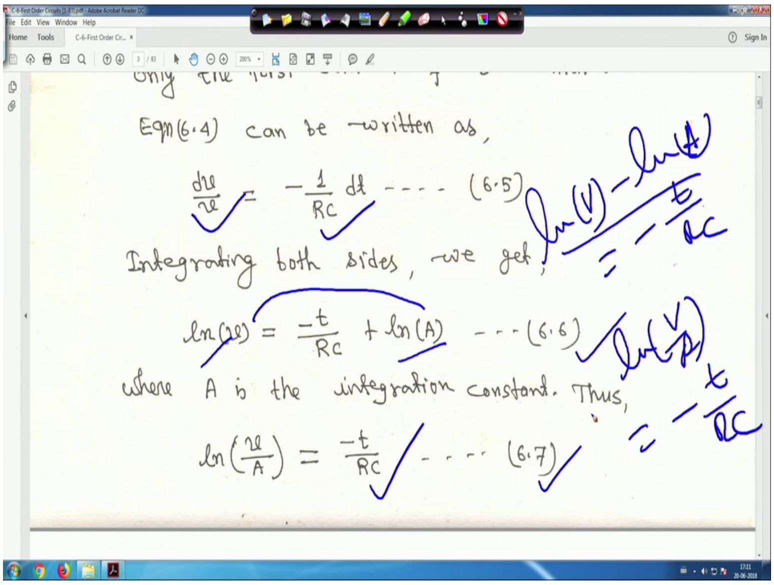

So, this is a first order differential equation, since only the first derivative of v is involved. So, equation 4 can be written as we can write dv by v is equal to minus 1 upon R C dt. So, this one you can write that you are dv by v is equal to minus 1 upon R C dt this because equation 5. Integrate both side this side you will get ln v natural log minus t upon R C plus some constant ln a we have taken instead of a or c 1 C 2 directly we have taken ln a for simply simplicity so, this is equation 6.

Now, A is the integration constant, thus ln if you I mean if you make this one ln v bring this one to this side, left side minus ln A right is equal to minus t upon RC. So, this side this side can be written as ln V upon A is equal to minus t upon R C that is what it is written here right so, this is equation 7. So, let me clear it.

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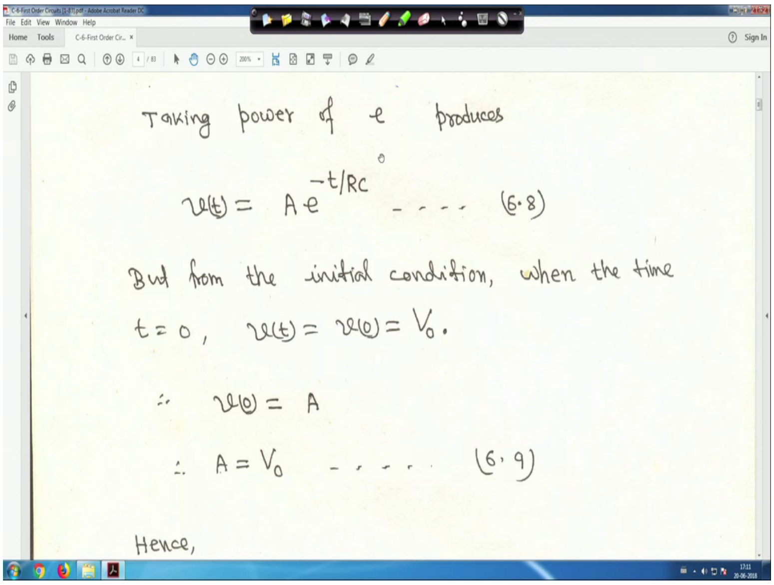

So, taking power of e I mean now if you take power of e it is given. So, vt is equal to A into your e to the power minus t upon R C, actually it was given here no here it was given here right. So, here you are here it is given ln means it is log of base e. So, v upon A is equal to e to the power minus t upon R C or v is equal to A into e to the power minus t upon R C as e is a function of t that is why I writing dt right.

So, just so, that is why you are writing v t is equal to A e to the power minus t upon R C. Now, but from the initial condition when the time t is equal to 0, v t is equal to v 0 is equal to capital V suffix 0 right. Therefore, at t is equal to 0 if you write, then it will become this part will become 1 and it will V 0 equal to A. So, that is A is equal to V 0 right; because v 0 is equal to earlier we are writing v initial condition v 0 is equal to capital V suffix 0. So, this is equation 9 I am not given equation number therefore, my V t is equal to V 0 e to the power minus t upon R C this is equation the 10.

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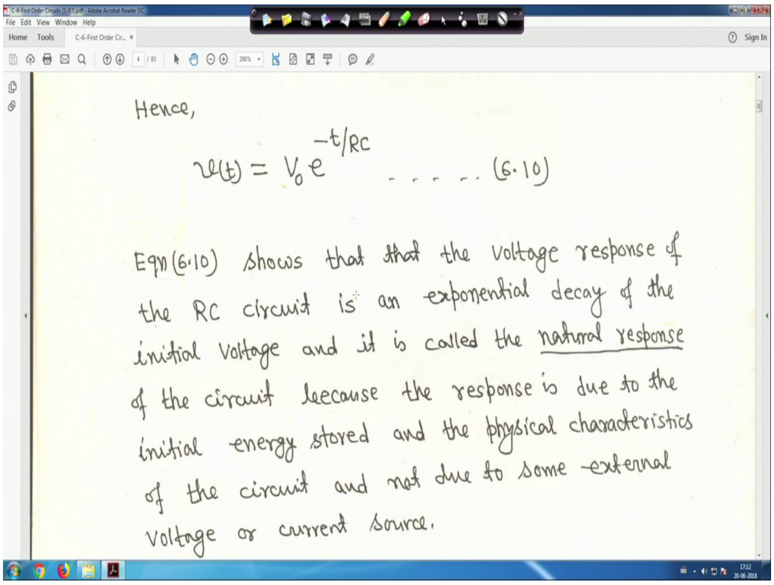

Equation 10, shows that the voltage response of the R C circuit is an your what you call is an exponential decay of the initial voltage, and it is called the natural response of the circuit because it is given e to the power minus t upon RC. So, naturally it is the exponential decay of the initial response, and it is called the natural response of the circuit because this response is due to the initial energy stored and the physical characteristic of the circuit and not due to the external voltage or current source right.

That means this is called your natural response of the circuit, because the response is due to the initial energy stored and the physical characteristic of the circuit right and not due to some external voltage or current source, because there is a source free circuit. So, this is called the natural response right of the circuit. So, let me clear it.

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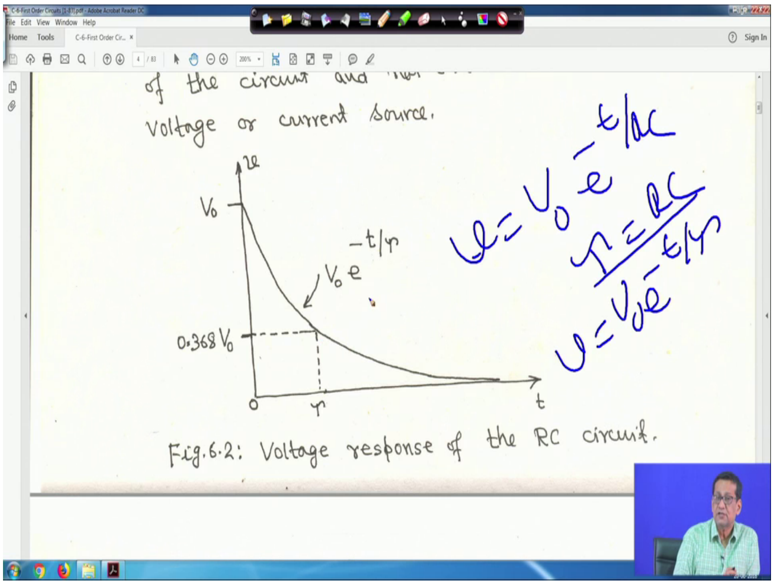

So, now if we plot if we plot that V is equal to V 0 e to the power minus t upon tau, that is your that is v v is equal to your V 0 e to the power minus t upon R C, if we take tau is equal to R C then v is equal to V 0 e to the power minus t upon tau, tau is equal to R C tau actually is called the your time constant right will see that.

So, that is why this plot is V 0 is equal to e to the power minus t upon tau now let me clear it. So, voltage response this is the voltage response of the R C circuit now and when I will come to tat, but I am telling.

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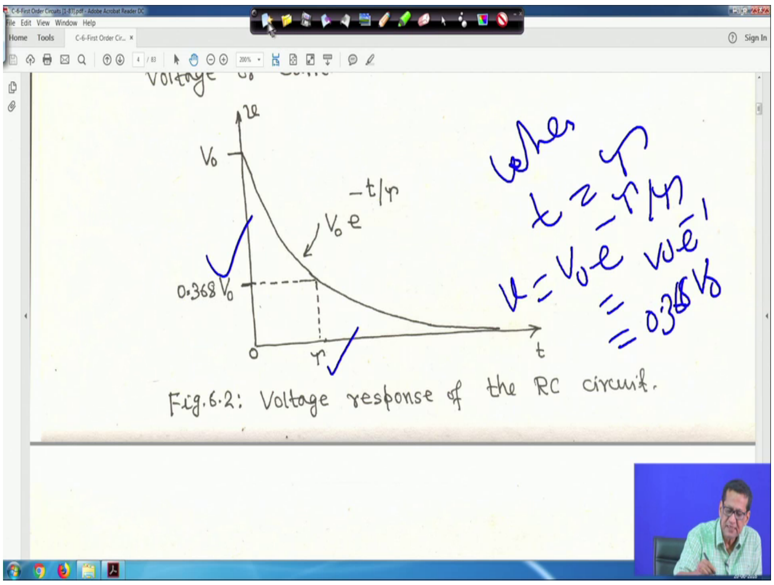

That when t is equal to tau, when t is equal to tau then v will be is equal to V 0 e to the power minus tau by tau that is V 0 e to the power minus 1 that will become 0.368 V 0 that is here it is written here. So, when t is equal to tau, then it is 0.368 V 0 right. So, let me clear it now I will come to some explanation. So, figure this is your figure 2 this is your figure 2 figure 2 shows the natural response.

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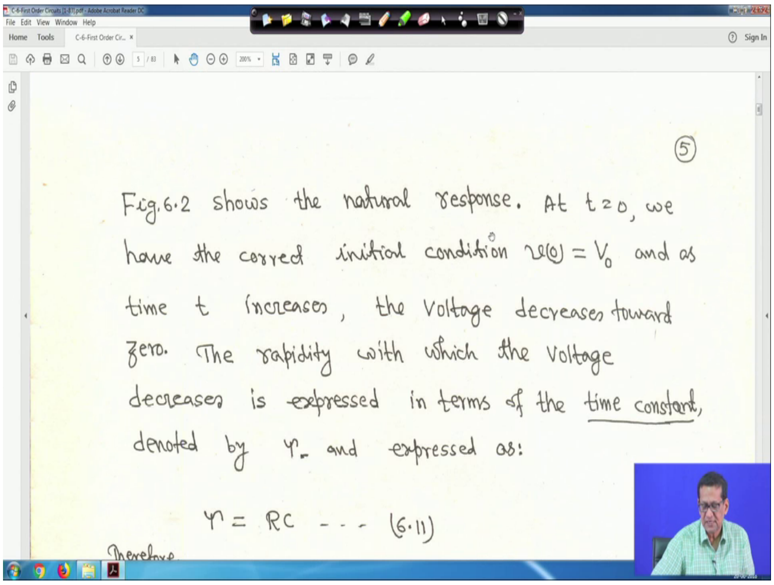

At t is equal to 0 we have the correct initial condition V 0 your what you call your v is equal to V 0 at is equal to 0. So, it is v is equal to V 0 right and as time t increases the voltage decreases towards 0. The rapidity, which we with which the voltage decreases is expressed in terms of the time constant denoted by tau right and expressed as tau is equal to R C this is the time constant of that circuit. Therefore, equation 10 can be expressed as v t is equal to V 0 e to the power minus t upon tau I told you.

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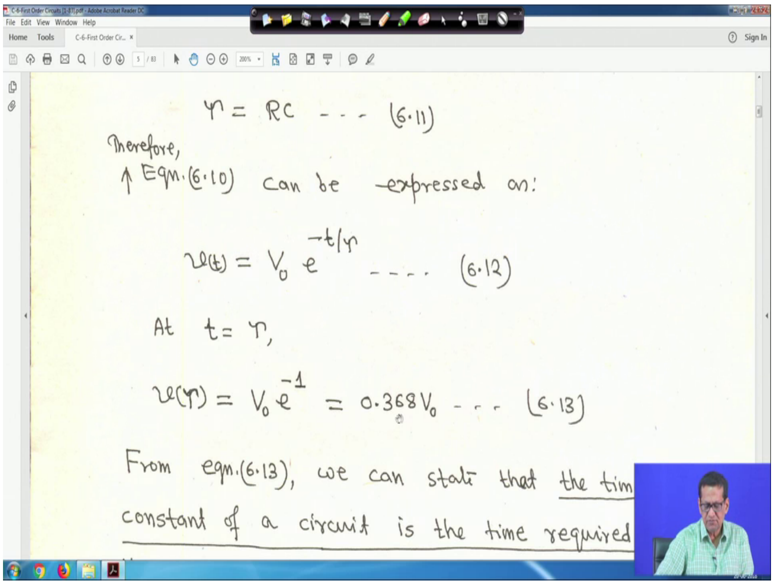

So, at t is equal to tau V tau is equal to V 0 e to the power minus 1 that also I told you is equal to 0.368 V 0; that means, this one 0.368 V 0 right.

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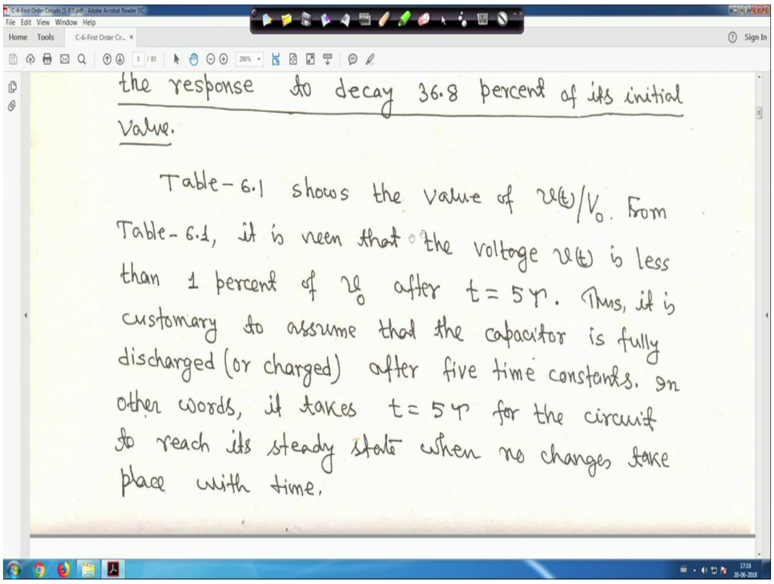

So, that means equation 13 we can state that the time constant of a circuit is the time required for the response to decay, 36.8 percent of its initial value. This is 0.368; that means, if you take in percentage that is 36.8 percent of initial value is V 0 right.

We can state that the time constant of the circuit is the time required for the response to decay 36.8 percent of its initial value. Now table I have make a table, table 1 shows the value of v t by V 0 from there your from table 1 it is seen that the voltage v t is less than 1 percent of V 0 after t is equal to 5 tau. I mean this is v is equal to v t is equal to V 0 e to the power minus t upon tau; that means, v t by V 0 is equal to e to the power minus t upon tau.

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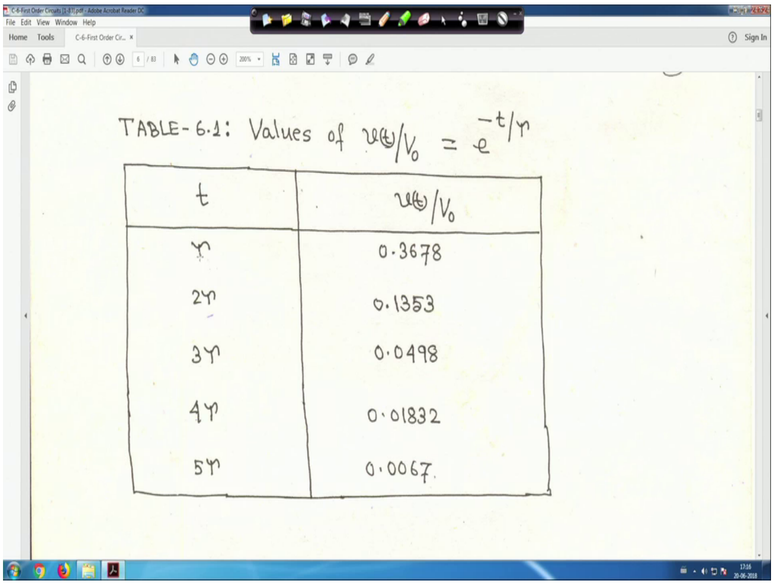
TABLE-6.1: Values of $v(t)/V_0 = e^{-t/\tau}$

t	$v(t)/V_0$
τ	0.3678
2τ	0.1353
3τ	0.0498
4τ	0.01832
5τ	0.0067

When t is equal to tau says becoming 0.3678 when 2 tau 0.1353 and so on up to when 5 tau it is 0.0067 less than 1 percent right less than 1 percent. Therefore that when t is equal to 5 tau right, it is less than 1 percent thus it is your here what you call customary to assume that the capacitor is fully discharged right fully discharged or fully charged when it will be in other way right after 5 time constant.

In other wards it takes t is equal to 5 tau for the circuit to reach its steady state, when no changes takes your when no changes takes place with time; that means, for this graph if you come if you go up to tau, 2 tau up to 3 tau up to 5 tau. So, the time is equal to t is equal to 5 tau after that you will find almost no change right it is almost this is the steady state. So, that is your what you call this stable shows that this table shows right.

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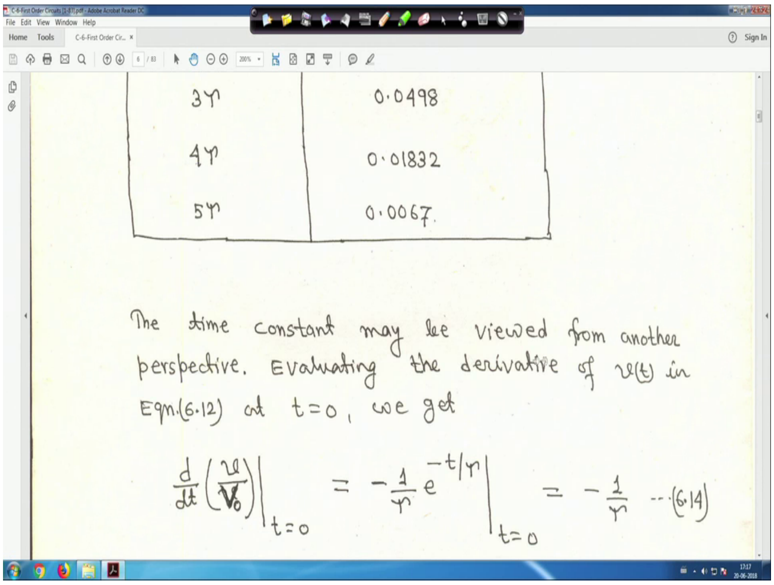

So, the time constant may be viewed from another perspective. Evaluating the derivative of v t in equation 12 at t is equal to 0. So, it in equation 12 if you come to the these equation 12 this is your equation 12, v t is equal to V 0 e to the power minus t upon tau right take the derivate of this right I will come to that you take the you take v by V 0 then e to the power minus t by tau right. So, d dt of v by V 0 you take at t is equal to 0, it becomes minus 1 by tau e to the power minus t upon tau and at t is equal to 0 right it becomes minus 1 upon tau right so, this is equation 14.

Now from equation 14 we can state that the time constant is the initial rate of decay or the time taken for v by V 0 to decay from unity to 0 assuming a constant rate of decay this initial slope at t is equal to 0, your what you call interpretation of the time constant is used in the laboratory to determine tau graphically from the response curve displayed on an oscilloscope right.

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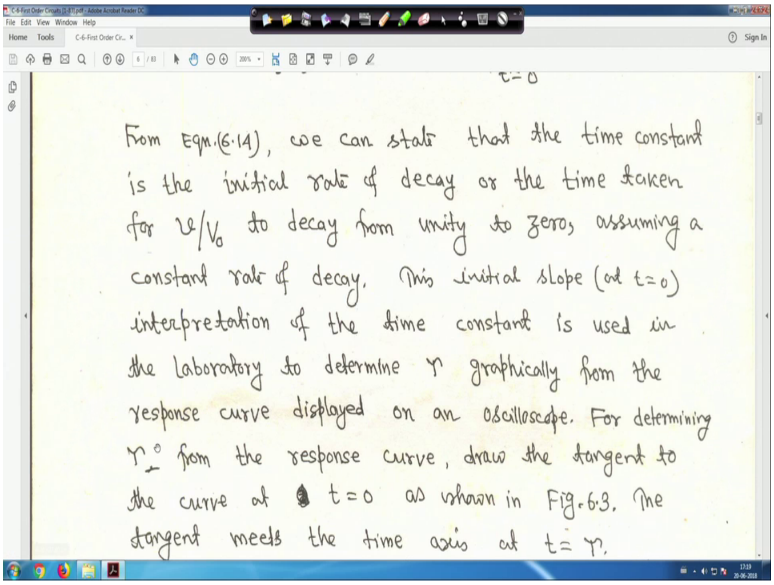

So, for determining tau from the response curve, draw the tangent to the curve at t is equal to 0; that tangent meets the time axis at t is equal to tau; that means, that t is equal to 0 at t is equal to 0 if you draw a tangent it will meet here at tau right here it will meet at tau right.

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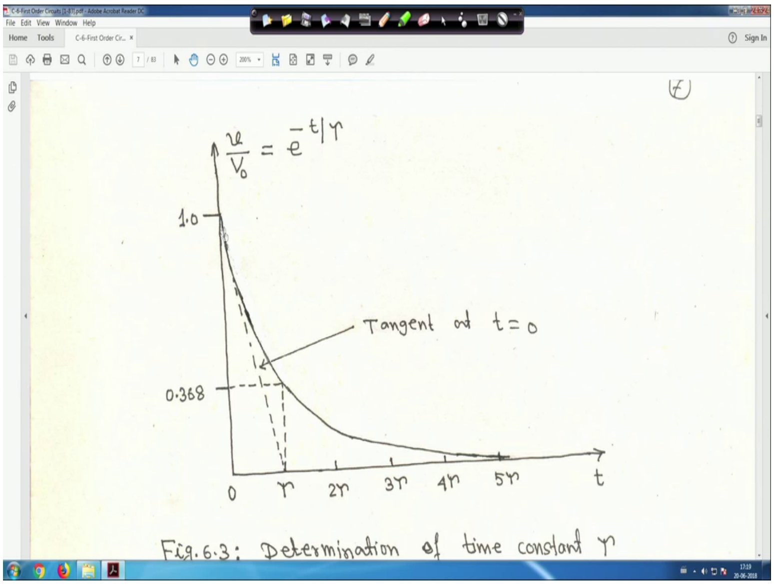

And this tangent is a at t is equal to your 0, somewhere from somewhere you draw the tangent and it will meet at tau right.

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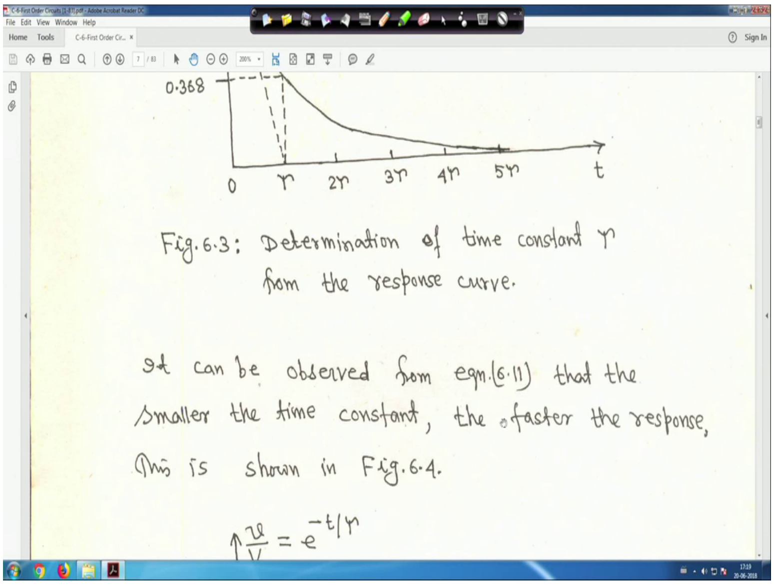

So, this is determination of time constant tau from the response curve, this way also you can find out your time constant at the laboratory, where whatever graph you get from that you can do it. And then 2 tau 3 tau up to 5 tau it is shown right. So, it can be observed from equation 11 if you come to equation 11 right hold on this is tau is equal to R C right. So, it can be observed from equation 11 that the smaller the time constant the faster the response this is shown in figure 4.

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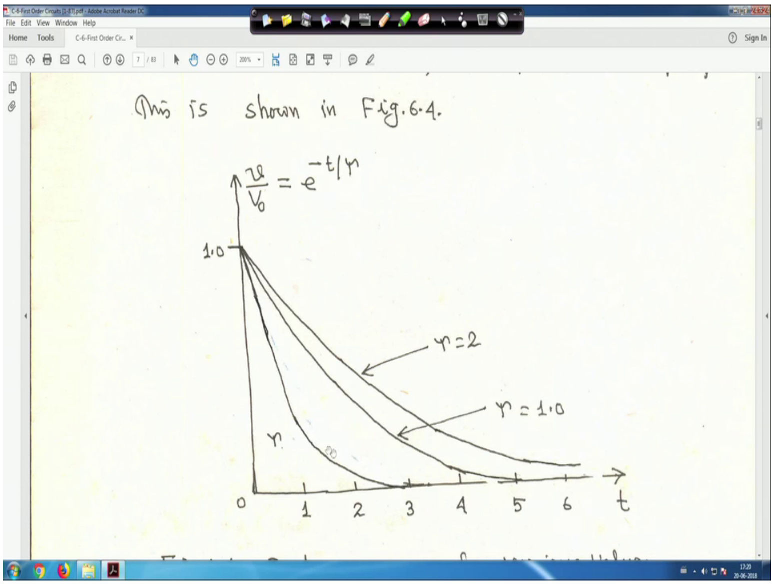

I mean if the when tau is equal to 2 response is slower, when tau is equal to 1 much faster than tau is equal to 2, if you further tau decreases response will become faster right. So, this side is taken v upon V 0 is equal to e to the power minus t upon tau the ratio is taken on the y axis. So, this is the response curve for various values of the time constant tau. At any rate whether the time constant is small or large, the circuit reaches steady state at t is equal to 5 tau because it is less than 1 percent that your what you call the ratio whatever you have taken right. So, circuit reaches steady state at t is equal to 5 tau right.

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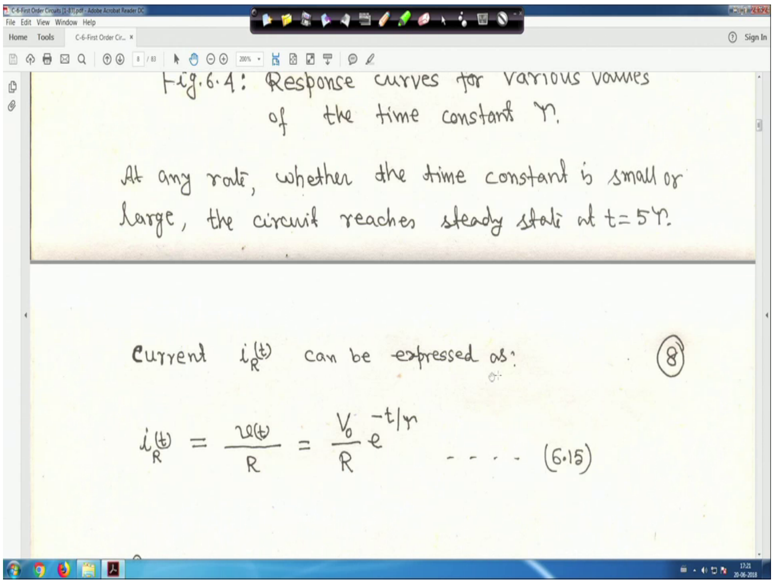

Therefore, current i R t can be expressed as i R t is equal to v t upon R we have seen in the circuit same thing. So, it will be V 0 upon R e to the power minus t by tau this is the current i R right. The power dissipated in the resistor is v t is equal to v t into i R. So, if you put v t is equal to your V 0 e to the power minus t upon tau, and i R is equal to this one this expression equation 15 in multiply you will get V 0 square upon R, e to the power minus 2 t upon tau this is equation 16 right.

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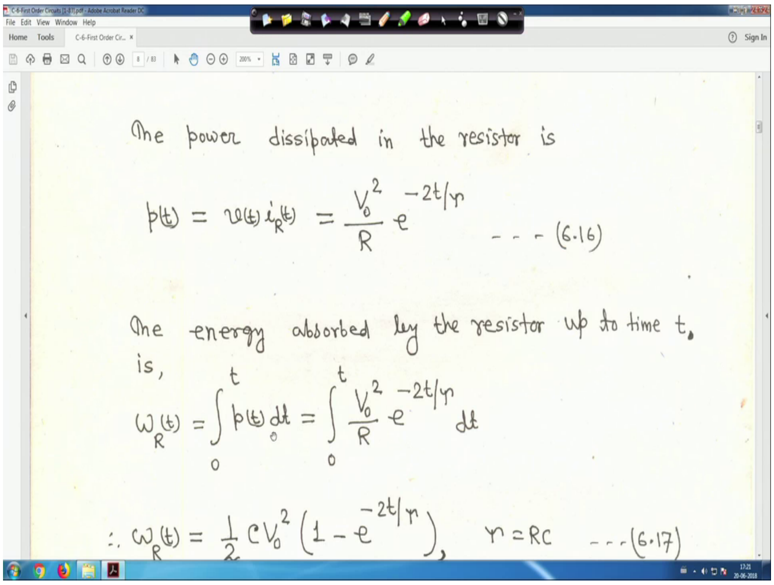

So, the energy absorbed by the resistor up to time t that w R t is 0 to t p t dt right p is a function t, 0 to t this is v equation 16, V 0 square upon R e to the power minus 2 t upon tau dt right. If you entry at this you will get your tau is equal to R C that time constant half C V 0 square into 1 minus e to the power minus 2 t upon tau. Note that as t tends to infinity omega r infinity is equal to half C V 0 square that is omega C 0 right.

So, initially initial energy stored in the capacitor is eventually dissipated in the resistor. So, if your t tends to infinity, then it is simply becoming half C V 0 square because this term will not be there and is equal to initially stored w C 0 right. So, initial energy stored in the capacitor eventually dissipated in the resistor. So, we will take some example.

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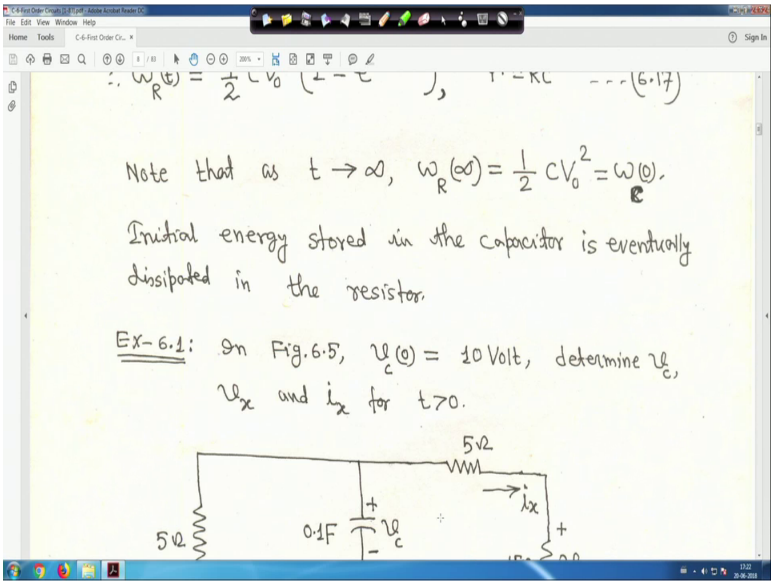

So, this is hope this source free R C circuit will be understandable to you right actually nothing is there only very simple thing very simple thing right

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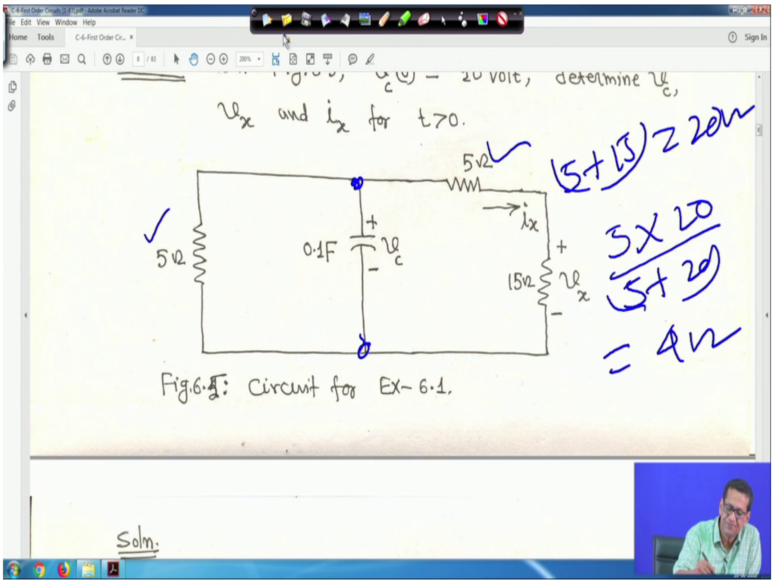

So, here your a simple circuit of a this thing is taken, a series parallel your parallel circuit right. So, 5 ohm resistor is there, 0.1 microfarad capacitor sorry 0.1 farad is there, voltage across is v c this 5 ohm resistor and this is 55 and 15 both are in series and taken separate given separately and current through is i x. And voltage across 15 ohm resistor is vx you have to you have to find out initial values of the your capacitor voltage that is your 10 volt is given v c 0. You have to determine we have to determine v c that is your this one then v x and i x for t greater than 0, these we have to find it out right. Now, first we obtain the equivalent or Thevenin resistance across the capacitor terminal.

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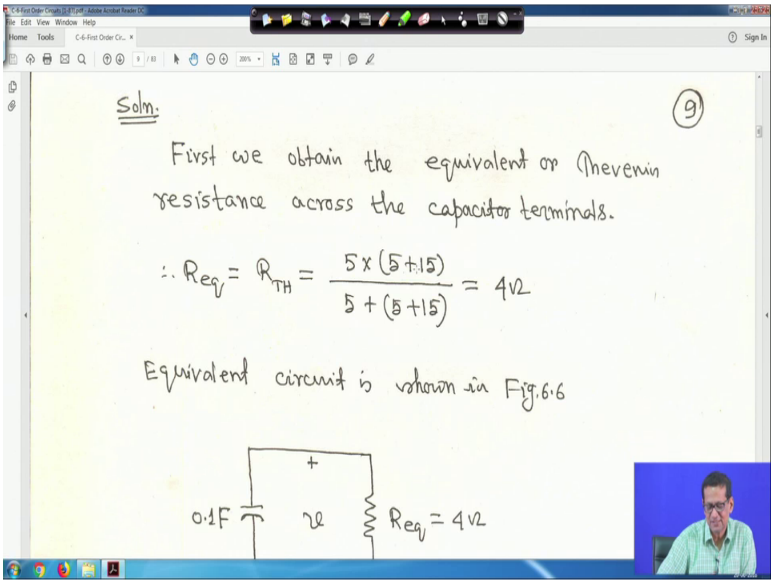

So Thevenin resistor, Thevenin resistance so, we have studied right Thevenin equivalent. So, in this case if you try to find out your what you call that your that your across these this 2 terminal, what will be the Thevenin resistance though this 5 ohm and 15 ohm so, 20 ohm. So, it is here it both are in series. So, let us see it is equal to 20 ohm; that means, and 5 ohm these 2 are in parallel. So, it will be 5 into 20 divided by 5 plus 20. So, it will be 4 ohm right 100 by 25. So, 4 ohm.

So, let me clear it. So, if you if you find out Req is equal to R Thevenin it is 5 into 5 15 plus 5, and 5 plus 5 plus 15 this is same thing your what you call 4 ohm right I have little all these things have written like this right, but there I showed the calculation.

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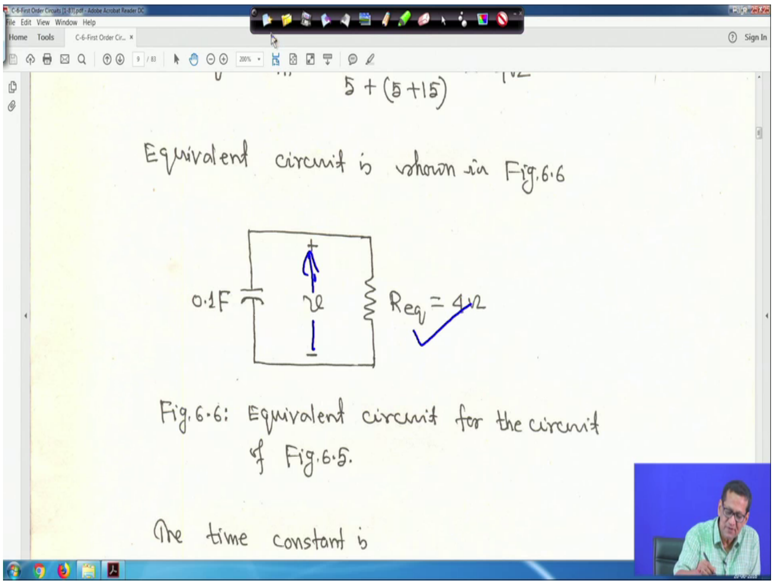

Therefore, equal equivalence circuit will be this capacitor it is a source free circuit. So, 0.1 farad, and this R this is Req is equal to 4 remember for this kind of thing we have to make the R Thevenin first equivalent right. Let us see how things happen and this voltage is this voltage is v; that means, across the 0.1 farad capacitor it is be across R also it is your Req also it is v right. So, let me clear it. So, the time constant is tau is equal to we have seen RC. So, it is R eq here into c. So, R eq is 4 into C 0.1 so, 0.4 second right.

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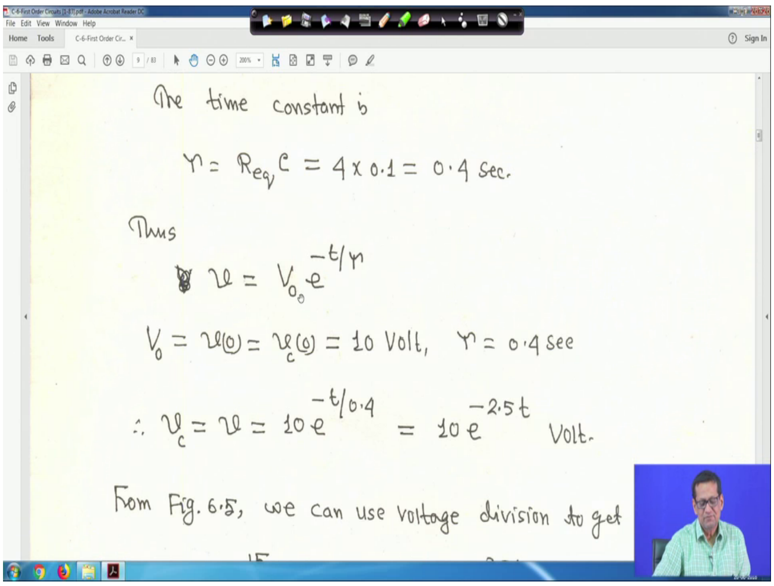

And v is equal to you know V 0 e to the power minus t by tau, but V 0 is given 10 volt. So, V 0 is equal to V 0 is equal to v c 0 is equal to 10 volt it is given and tau is equal to 0.4 second therefore, v c is equal to v is equal to 10 e to the power minus t upon 0.4. So, that is 10 e to the power minus 2.5 t volt, this is the simple thing from the previously developed your formulas we are just putting the data.

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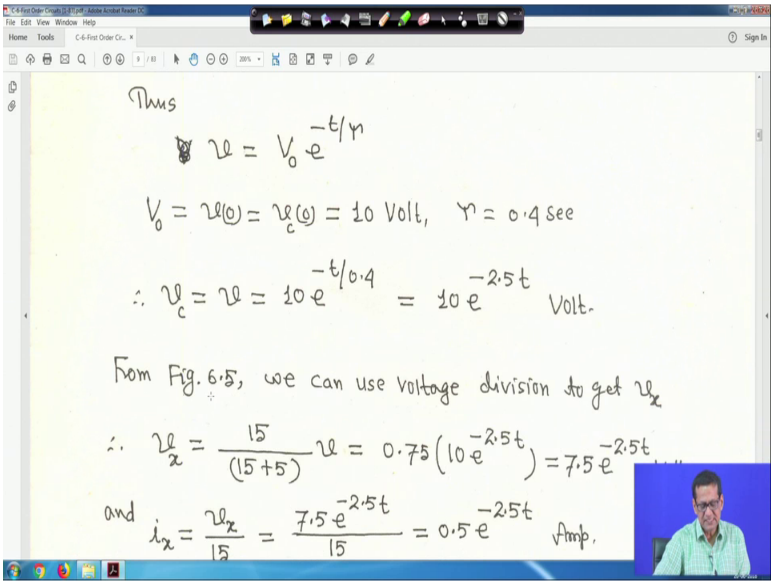

So, from figure 6.5 we use the voltage division to get v x right. Now if you come to this if you come to this figure so, first suppose if this voltage is v.

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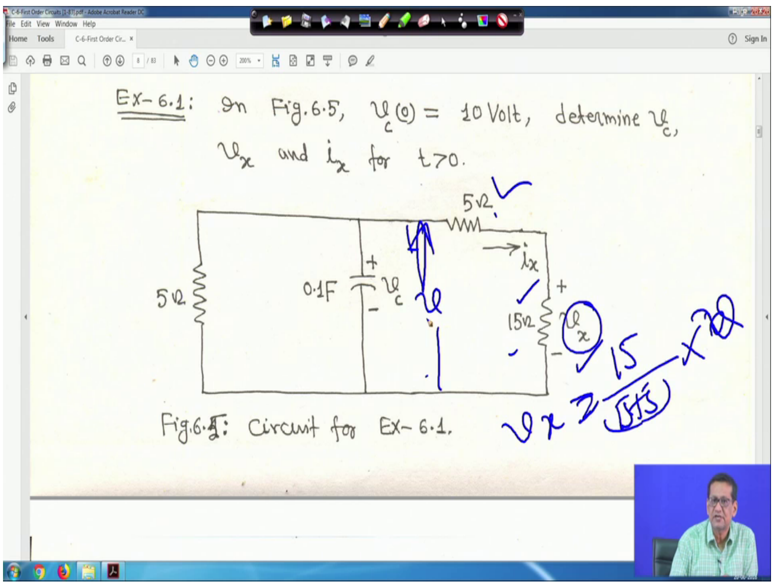

Suppose if this voltage is v right then voltage division this is v x. So, voltage division because 5 and 15 ohm are in series so, it will be 15 by 15 plus 5 into this v that will be your v x, this voltage across this is v. So, it will be 15 divided by 15 plus 5 because it is 15 here it is 5 into your this voltage, this voltage v that is voltage division right. So, let me clear it. So, this is what we have done here this is v x is equal to 15 upon 15 plus. So, it will be v, v we have got 10 e to the power minus 2.5 t, v is equal to v c v is equal to v c. So, it is 0.75 into 10 e to the power minus 2.5 t.

So, it is 7.5 e to the power minus 2.5 t volt right and i x is equal to v x upon 15, because across this across 15 ohm resistance the voltage is v x. So, naturally you can take i x is equal to v x by 15. So, v x we have got. So, i x is equal to v x upon 15 so, it will be 7.5 e to the power minus 2.5 t upon 15 is equal to 0.5 e to the power minus 2.5 t ampere this is your i x right this answer all answers you have got. Now, next example I hope you are understanding this I hope you are understanding this.

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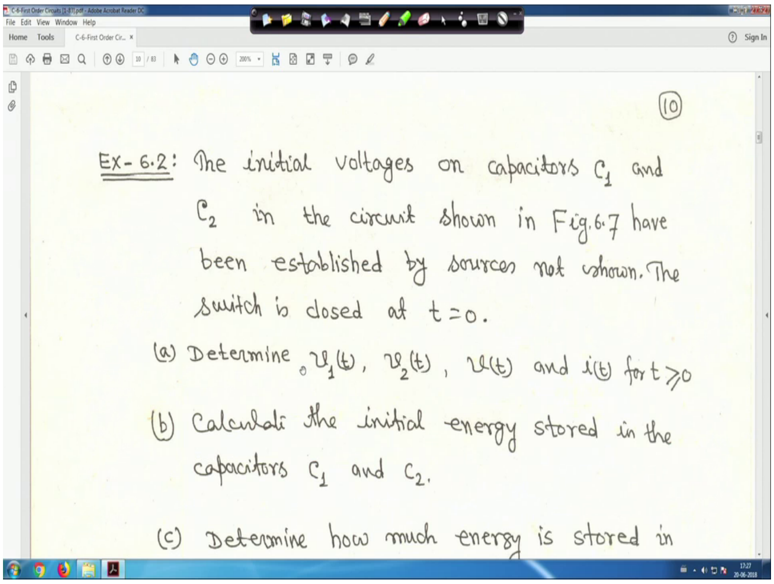

So, the initial voltage on the capacitor C 1 and C 2 in the circuit, I will show you shown in figure 7 have been established by sources not shown sources not shown, but initial conditions have been established this is the language of the problem the switch is closed at t is equal to 0. Therefore you determine v 1 to v 2 to sorry v1 t v 2 t then v t and i t for t greater than 0 right. Sorry next you calculate the initial energy stored in the capacitors C 1 and C 2 right.

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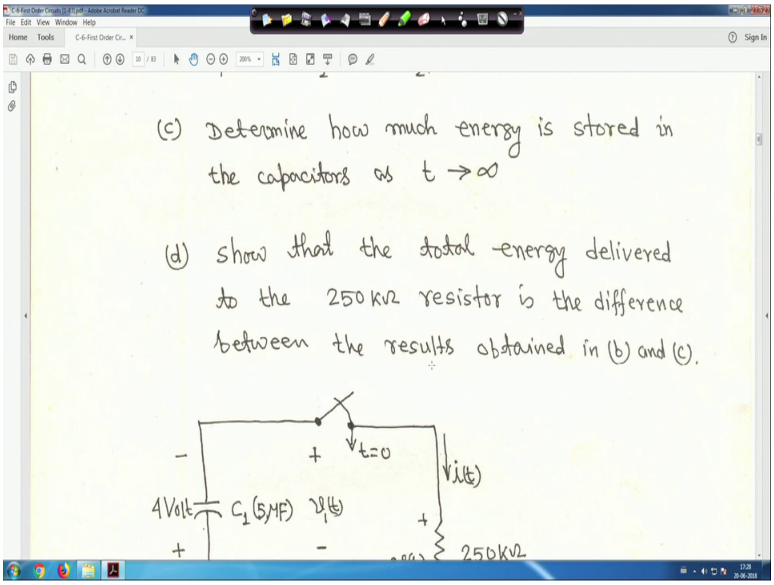

Next is determine how much energy stored in the capacitor and t tends to infinity and so that the stored energy delivered to that 250 kilo resistor is the difference between the result obtained in b and c. So, these are the 4 thing you have to make it right.

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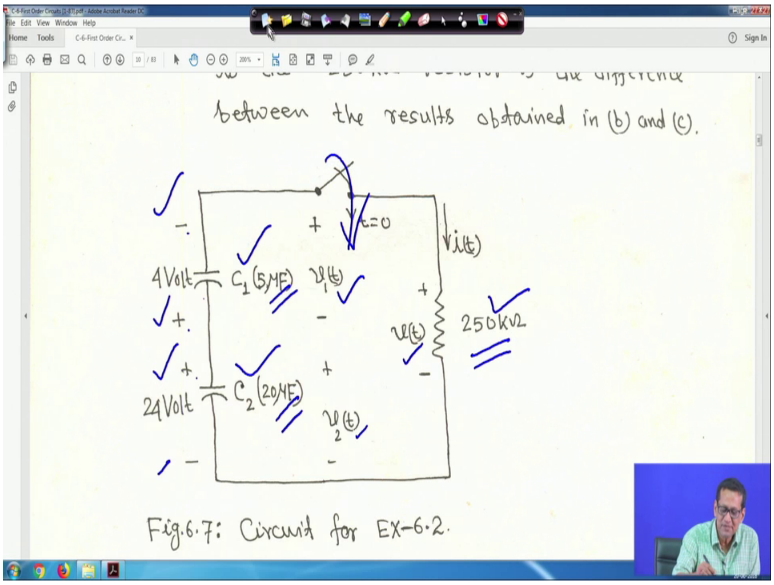

Now, here one thing I will not tell you I will just this thing, but first this is the circuit is given and look at the polarity right. So, here we have taken we want this is the capacitor C 1 it is 5 microfarad this is capacitor C 2 20 microfarad, and this is plus minus some where I have marked plus minus. So, this is v 1 t v 2 t right.

So, v one t means across C 1 v 2 t means across C 2 and this is 250 kilo ohm resistor and across the voltage is vt and current flowing through is i t and switch was such capacitor was charged, switch was open now switch is closed at t is equal to 0 right. So, question is look at the polarity here polarity is given here it is minus, but here it is minus and here it is plus this is the this is there tricks in the problem.

So, I will simply write it and one only 1 or 2 place I will tell you look at this when you solve this problem, you will see that the polarity of this whatever it is given, it is minus this is plus and again here it is plus here it is minus. So, you can easily you can easily your what you call, you can easily make it that how what is the initial conditions right. So, let me clear it. So, this all this things are given, I mean all these your what you call this is given and you have to find out right.

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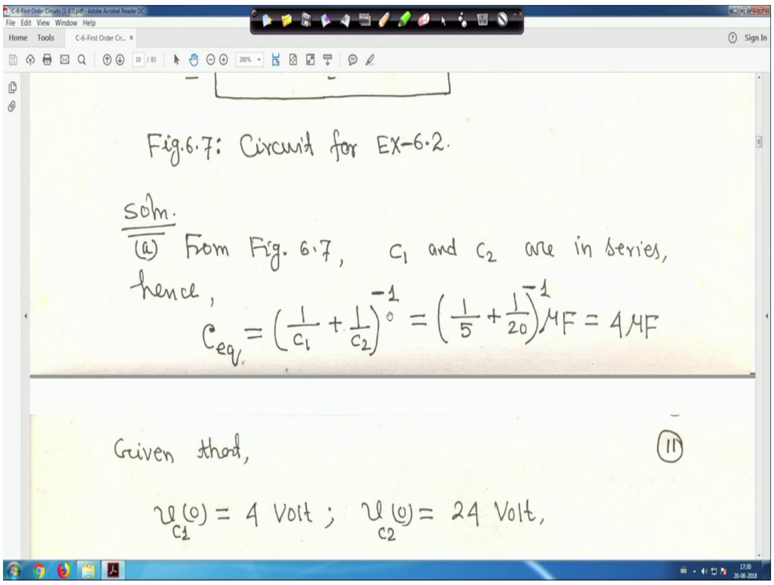

So, now question is and initial voltage that is given 4 volt and here it is 24 volt right, but look at the polarity and accordingly we have to choose the sign of that what you call that initial voltage. So, and so, these polarity is marked. So, figure this actually this 2 capacitors are in series 5 microfarad and 20 micro C 1 and C 2 so, its equivalent to the way you do the parallel resistor. So, therefore, here it is Ce q is equal to 1 upon C 1 plus 1 upon C 2 to the power minus 1 reciprocal right.

So, 1 upon 5 plus 1 upon 20 its reciprocal it becomes 4 micro farad that is c equivalent and given that v c 1 0 just I am writing that 4 volt and v c 2 0 24 volt right. So, this is the initial condition therefore, v c eq will be v c 2 0 minus v c 1 0 that is 20 volt.

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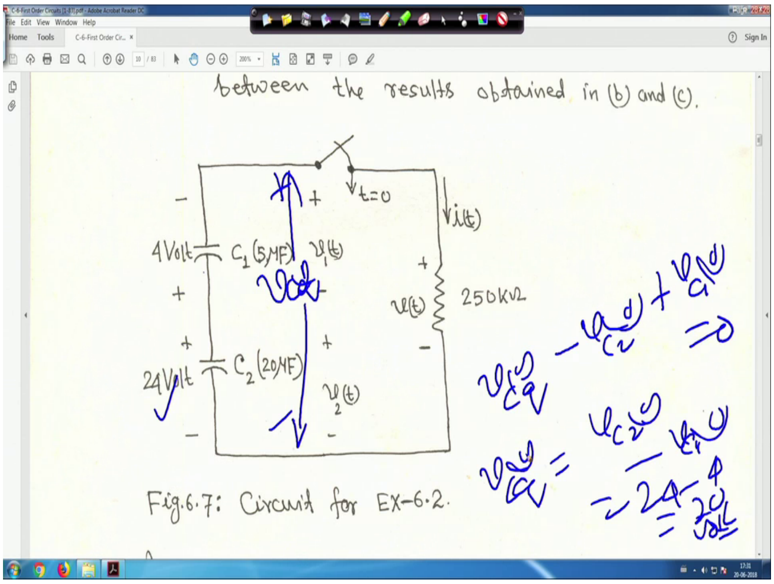

Because if you try to take your what you call a your this thing suppose if I want to take this eq equivalent right that is v c eq 0, suppose if I want right and if this is my this is my plus and this is my minus. So, it will be v cq right then minus your v c 2 0 then plus v c 1 0 is equal to 0 right.

So, I am just looking at that polarity; that means, v cq is equal to v c 2 0 minus v c 1 0. So, it is given 24 volt that v c 2 24 and that is given 4. So, it is 20 volt right. So, this is that your what you call v cq 0 suppose if you look like this right.

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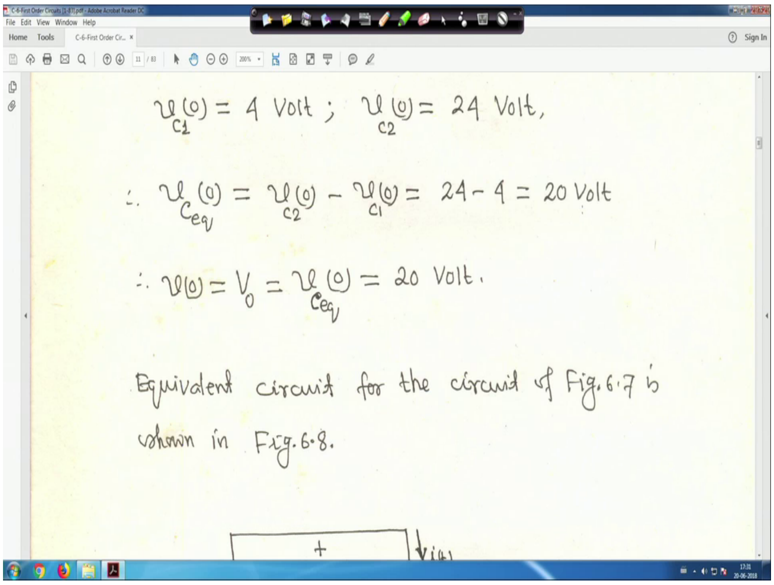

So, that is why that is why that your v cq 0 is equal to 20 volt and V 0 is equal to capital V 0 for v cq 0 is equal to 20 volt because this is the equivalent circuit source free R C circuit whatever we have done and this is 4 micro farad and this is 2 50 kilo ohm.

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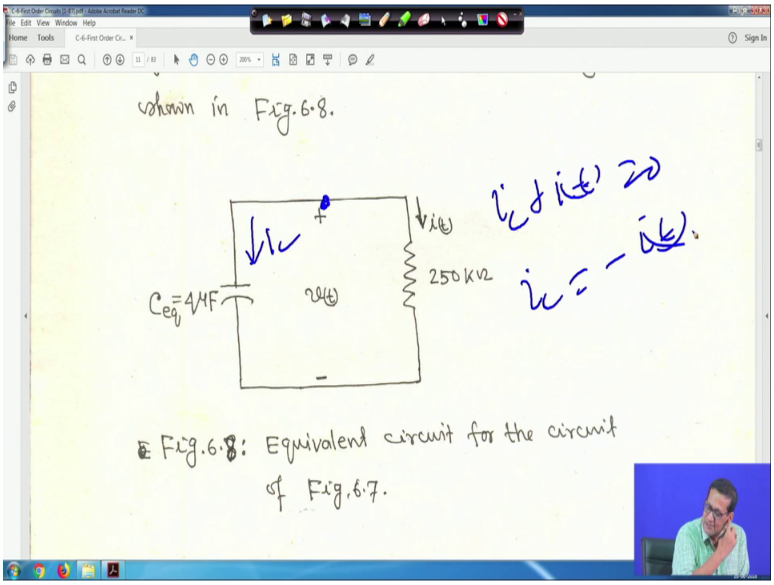

Same we are drawing this is vt this is the equivalent circuit of that one right. Now the time constant is tau is equal to RCq 250 into 10 to the power 3 it is kilo ohm. So, converted into ohm into 4 into 10 to the power minus 6, 4 micro farad so, that is 1 second thus the expression for v t is we know V t is equal to V 0 e to the power minus t upon tau.

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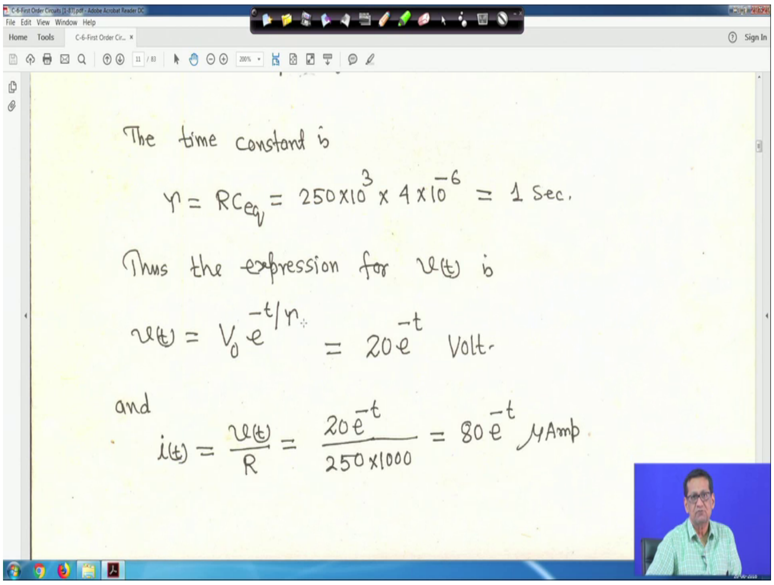

So, it is 20 e to the power minus t volt. So, i t is equal to from this circuit simply v t upon r the earlier we have seen. So, it is 20 e to the power minus t by 250 into 1000 so, 80 e to the power minus t micro ampere right.

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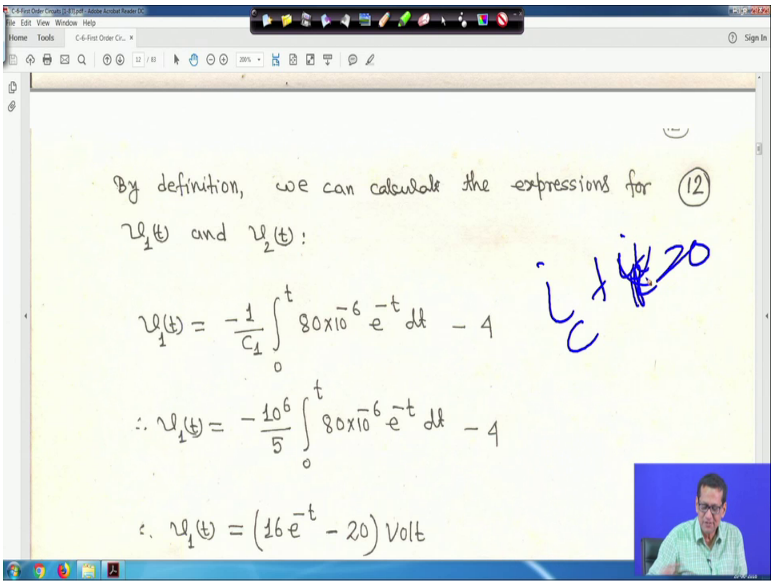

So, by definition we can calculate the expression for v 1 t and v 2 t. So, this we know v 1 t is equal to look at the polarity of v 1 and v 2 right everything. So, just a just we have we have made it know your what you call that i C plus i R is equal to 0 something we have given no. So, our i C plus here what you call that your i t instead of i R you can make it is i t right.

So that means, i C is equal to your, this is the general thing right. So, you have to find out v 1 and v 2 right and this current i C is showing to both to your for C 1 and C 2 both are in series so, both C 1 and C 2. So, what you have to do is, just we have to see just you have to see that we write the equation right in i t is given. So, this is your just hold on, let me let me clear it let me clear it. So, this if you come to this circuit equivalent circuit, this is your i t this is your i t and this is suppose this is my i C right somewhere if you put the way you solve that i C plus then i t is equal to 0 right or my i C is equal to minus i t right.

So, we know i C is equal to c into dv by dt in general, this is your what you call this is your equivalent circuit, but if you if you come to your this circuit original circuit right original circuit, when c is closed when this switch is closed switch is closed this is closed.

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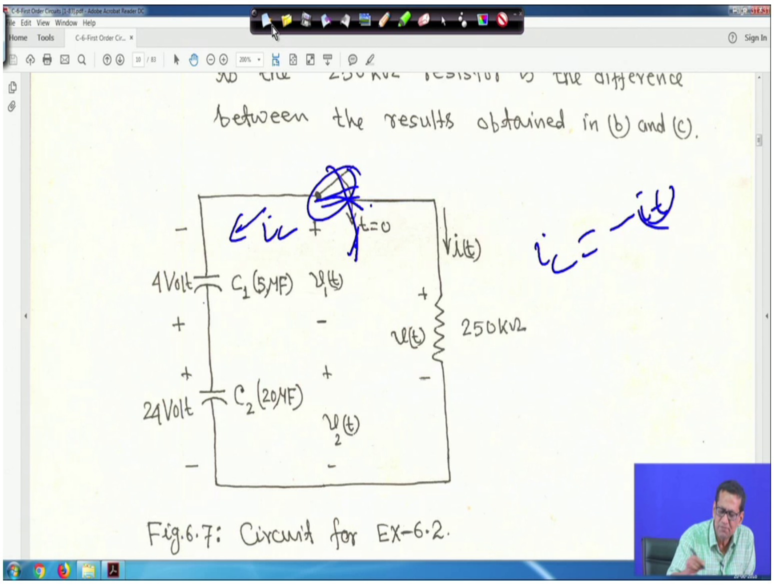

So, this is the i t and say this is current is flowing i c. So, here also i C is equal to i C is equal to then minus it because i C plus i t is equal to 0, this is closed apply case some point at KCL right. So, i C is equal to minus i t right so; that means, i C is equal to one is your what you call that your C 1 dv by dt another will be dv 1 by dt another will be C 2 dv by separately we have to do it.

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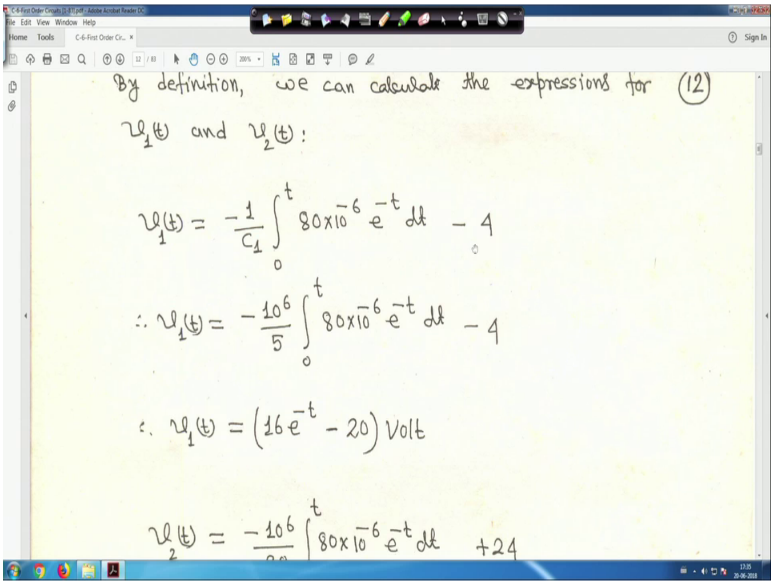

So, if you if you come to now this expression, this equation if you come to this equation we are writing now after you just do the integration. So, it will be minus 1 upon C 1 0 to t this i t expression is there, this i t expression is there when we have got this expression 80 e to the power minus t micro ampere right and 0 to t. And this is we are making it minus 4, that is initial condition v c 0 is given 4 volt, but here we are putting minus 4. So, why we are writing minus 4, just to this is a this is your what you call across your a problem to your you find out that why you are doing it, try to understand try while doing it right. Instead of plus 4 here it is minus 4 right just try to understand this. So, this is a problem to you right.

And otherwise if you cannot do it answer in that forum right do not worry, but first you think. Then similarly v after simplifying this v 1 t is equal to 16 e to the power minus t minus 20 volt, similarly v 2 t is equal to here same thing that i t is there and your whatever capacitors value was there everything is given there right everything is ok. But, here we will putting that initial value v 2 0 24 volt here it is plus sign right do not minus sign look at the polarity there and just think right why we have made it like this. So; that means, if we do it v 2 t is equal to 4 e to the power minus t plus 20 volt right we also can obtain v 2 t by using KVL.

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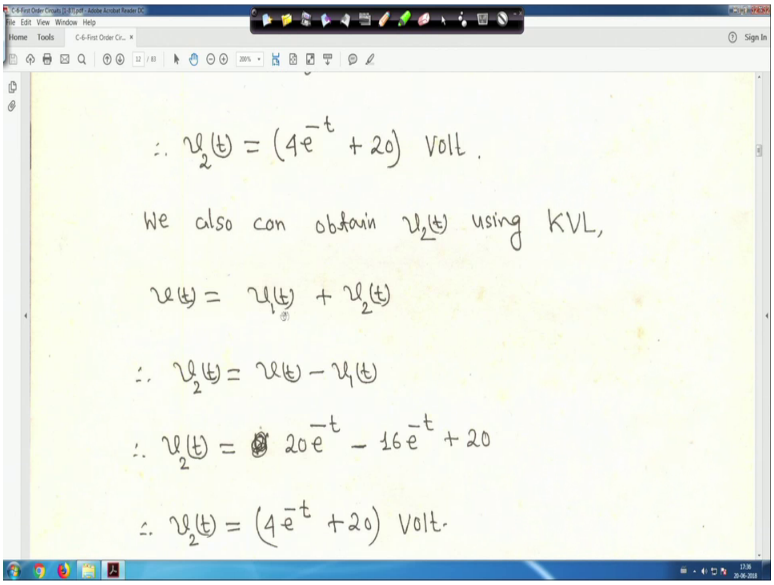

If you apply KVL v t is equal to v 1 t plus v 2 t or v 2 t is equal to v t minus v 1 t, v 2 you got 20 e to the power minus t therefore, v 1 t minus 16, e to the power min us t plus 20. So, if you simplify you will get the same thing v 2 t is equal to 4, e to the power minus t plus 20 volt right.

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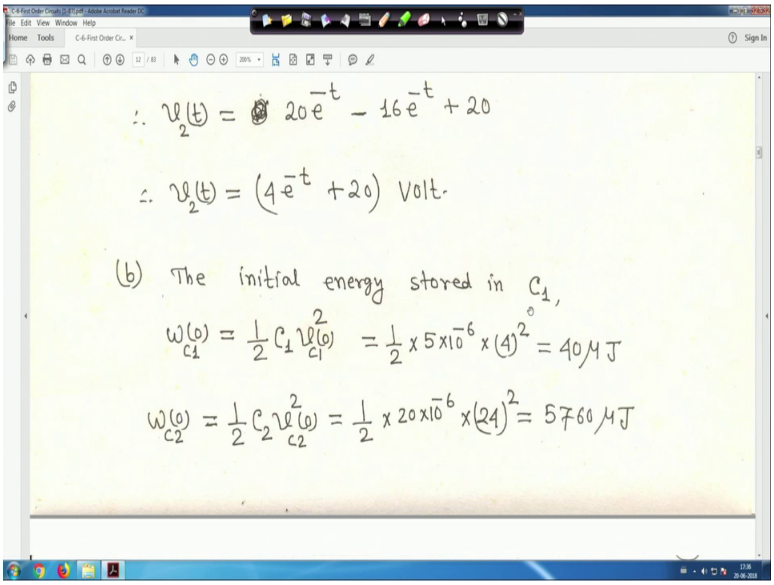

Now b part the initial energy stored in c 1. So, this question is given there where it is minus 4 and here it is plus 24. Initial voltage 4 volt here 24 volt, but this is a question to you right. So, that second part is initial energy stored in C 1 it is w c 1 0 is equal to half

C 1 v c 1 0 square, you put all the values you will get 40 micro joule. Similarly for w b 2 0 if you make half C 2 v c 2 0 square substitute all the values right you will get your 5760 micro joule right.

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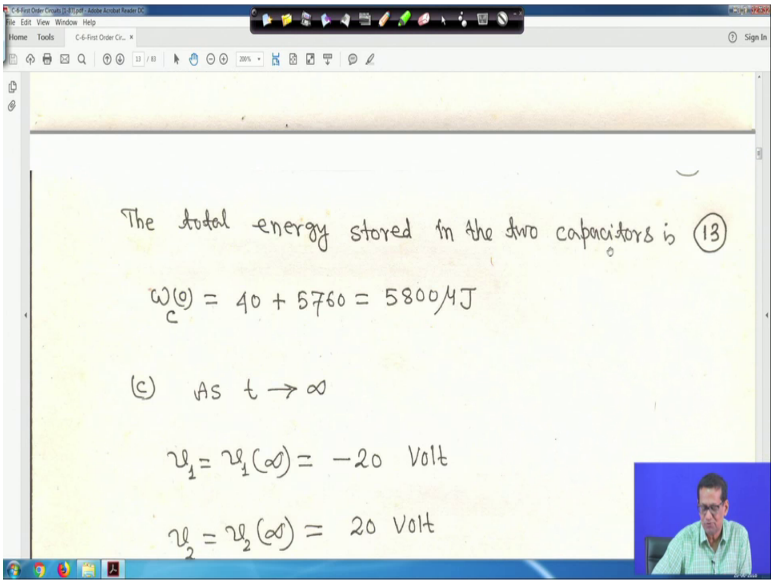

Now, total energy stored in the 2 capacitor you add 40 micro joule plus 5760 micro joule so, 5800 micro joule right. Now, c as t tends to infinity, v 1 is equal to v 1 infinity will get minus 20 volt as t tends to infinity right and v 2 is equal to v 2 infinity you will get 20 volt right. So, all v 1, v 2 expressions are there just see that t tends to infinity how much it is therefore, the energy stored in the 2 capacitors is that is w c is equal to half, that is your 5 plus 20 into 10 to the power minus 6 into 400; 400 means this 20 square right.

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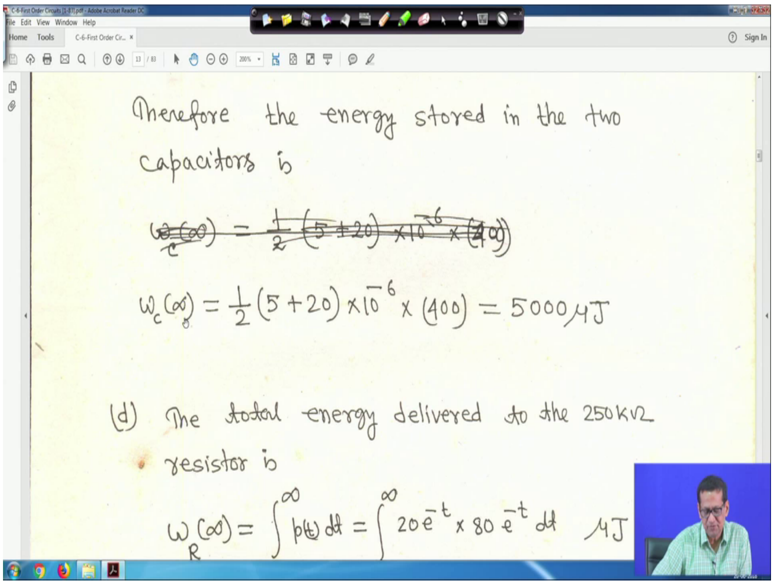

So, minus 20 square is 400 plus 20 square is also 400 right. So, and it is your half C 1 plus C 2 that is 25 micro farad actually, that is 25 into 10 to the power minus 6 400 so, 5000 micro joule but here it is 5800 micro joule. So, there is a difference of this 2 is your how much 800 micro joule.

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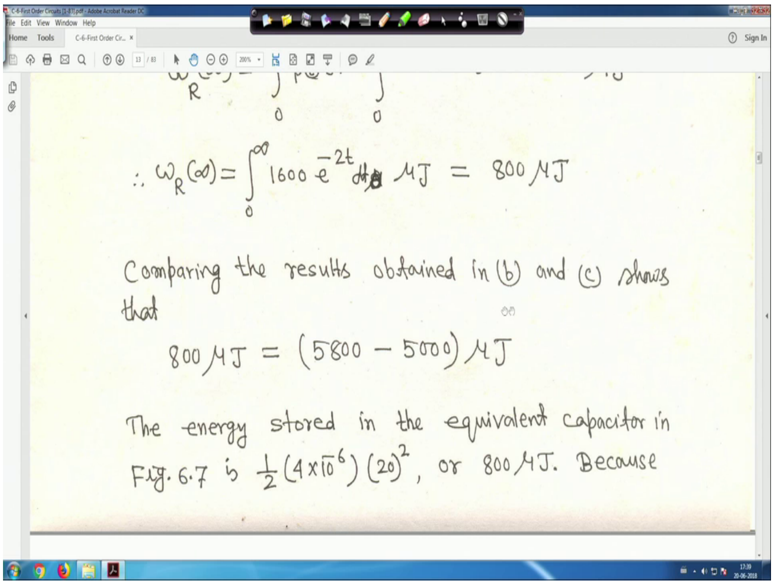

So, the total energy delivered to that 250 kilo ohm resistor is w r infinity is equal to 0 to infinity p t dt. That is 0 to infinity to just p t power is equal to v into i, v is this much i is equal to this much this is micro joule right.

Therefore, 0 to infinity 1600 it is 10 to the power minus 2 t micro joule 800 micro joule right; that means, comparing the result obtained in b and c shows, 800 micro joule is equal to 5800 minus 5000 joule is equal to 800 micro joule. This energy stored in the equivalent capacitor is half equivalent was 4 microfarad half v this square it is 800 micro joule right. So, this 800 micro joule actually dissipated in the your resistor.

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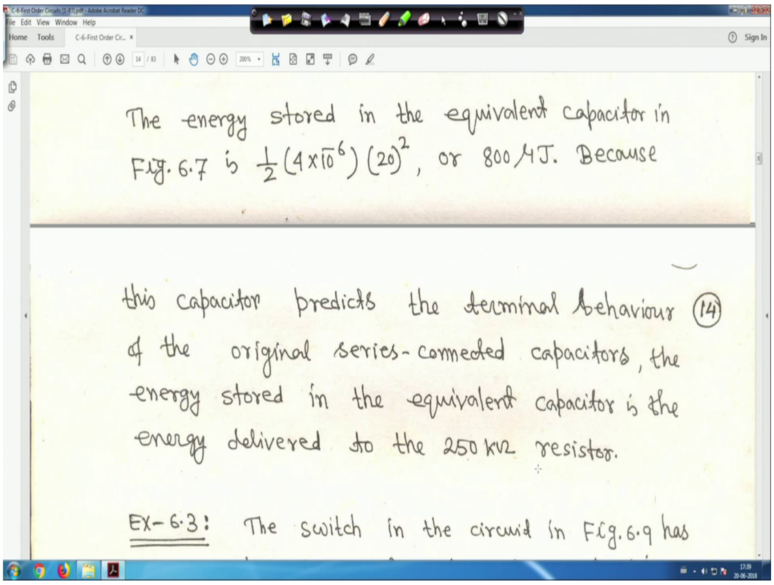

So, because this capacitor predicts the terminal behavior of the original series connected capacitor. The energy stored in the equivalent capacitor is the energy delivered to the 250 kilo ohm resistor. So, this problem this is a good problem for you. So, just when we will get this your video just have a look that what has been done. Then if you understand all these then you will not face any difficulties of solving this kind of problem.

Thank you very much, we will be back again.