Basic Electrical Circuits
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Lecture - 28
Solution to the Assignment on Unit 03 and 04

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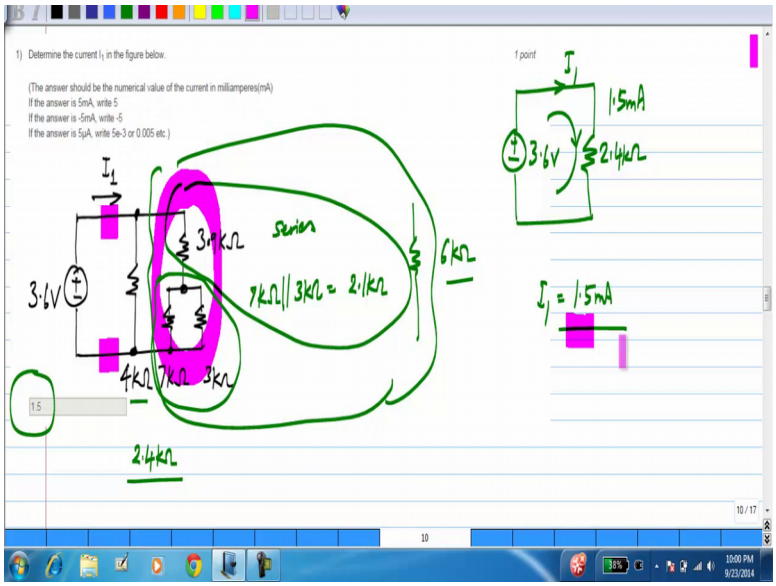

Now, I discuss answers to the questions in the second assignment the one 1 unit three and four. So, here you ask to find the current I 1 and number of resistors are given basically you have to form parallel combination and series combination of these find a single equivalent resistance across the voltage source and find the current from that. So, first you see that this two are in parallel and the parallel combination transfer to be you can easily calculate this, this is 2.1 kilo ohm. And we have this 2.1 kilo ohm and this and series, so the series combination as 2.1 kilo ohm plus 3.9 kilo ohm.

So, effectively this whole thing looks like a single six kilo ohm resistor and series and we have the six kilo ohm and four kilo ohm in parallel because we have this entire combination and parallel four kilo ohm, so six and four in parallel which gives you which gives you 2.4 kilo ohm, 6 kilo ohms parallel 4 kilo ohms. So, now, we effectively have picture like this three point six kilo ohms and 2.4 kilo ohms, so with 3.6 kilo ohms across to 2.4 kilo ohm. So, this 3.6 across to 2.4 kilo ohm a current of 1.5 milli amps will be flowing like this and direction of I 1 is given to be the same. So, I 1 simply equals 1.5 milli amps that is what is given here as usual follow these interactions you are ask to give

the numerical value of the current and milli ampere which is 1.5.

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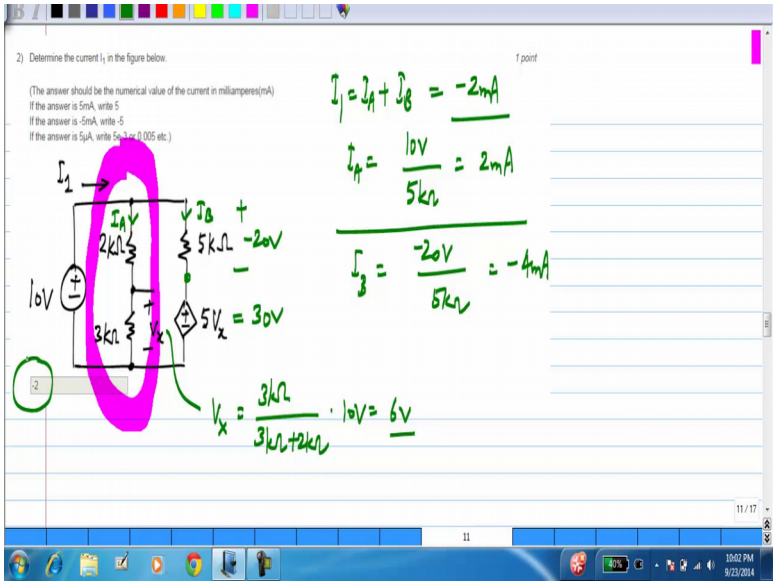

Second question again some combination of resistors and control source as given ask to calculate I one. So, first of all we have to solve for what this control sources does and V x is given to be the voltage across this three kilo ohm resistors now this combination of two and three kilo ohm is in series and that whole thing appear across ten volts. So, from the voltage divided theorem you know that V x is three kilo ohm by three kilo ohm plus two kilo ohm point ten volts which is six volts. So, V x is six volts so; that means, that 5 V x is 30 volts . So, now, what is I 1 I one is the combination of this current let me call that I A and ib. So, I 1 equals I a plus I B; I A is easily calculated to be current through this series combination which is 10 volt the series combination that own resistance is five kilo ohms that is 2 milli amps. We have to calculate I B you notice that this five kilo ohms we can use Kirchhoff's voltage law around this consisting of ten volt source the voltage control voltage source and five kilo ohm you will find that the voltage across the five kilo register in this direction as minus twenty volts this you should able to do. So, I B you find this to be minus twenty volts divided by five kilo to minus four milli ampere and I 1 which is the sum of I A and I B you turn on to be minus two milli ampere. So, the answer is given to be minus two.

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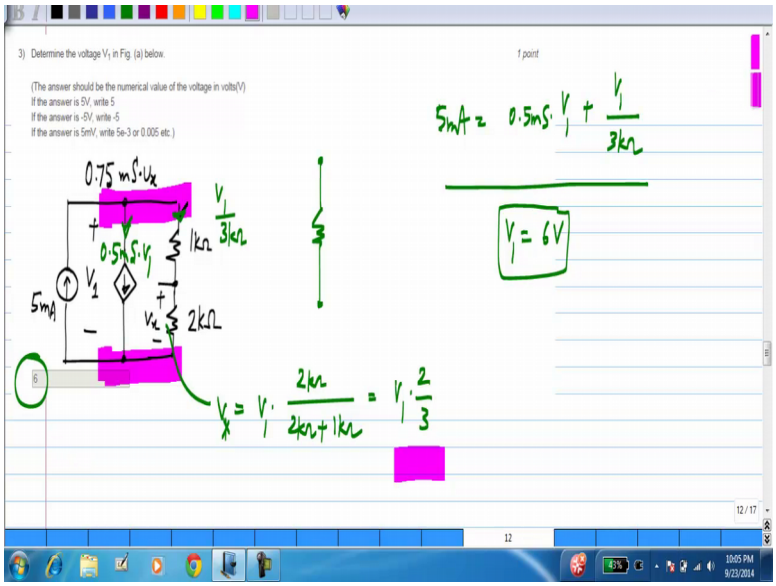

In this case, it is same kind of problem, but with the different sources instead of voltage source we applied a current source here and you are ask to find and the voltage V 1 again you have to find what the rest of the circuit look like what does it mean the rest of the circuit will look like a single resistances, so that is what you have to find or basically you calculate how much current goes there how much goes there and calculate the voltage and so on. So, now, there is a control source here which is controlled by this V x across the these two terminals we have V 1 whatever it is we do not know what V 1 is here what its a variable now if I cross this two terminals we have V 1 tell V x is calculate from the voltage divided theorem to be v one.

So, V x equal V 1 times two kilo ohm by two kilo ohm plus one kilo ohm remember V 1 appears across this series combination and v x is across two kilo ohm. So, this is basically V 1 time two by three. So, the current in this control source is point seven five milli Siemens times v x which is point seven five milli Siemens times that much. So, if you calculate that you will get this current b of milli Siemens time V 1 and the current and other branch V 1 is across this series combination, so the current in that branches basically V 1 divided by 3 kilo ohms. So, now we have to write Kirchhoff's current law at this note it says that five milli amp current equals half milli Siemens one plus V 1 divided by three kilo ohms ok. So, this is all that is there to earth and from this V 1 can be calculated to be six volts you solve for V 1 from this and the answer is six volts

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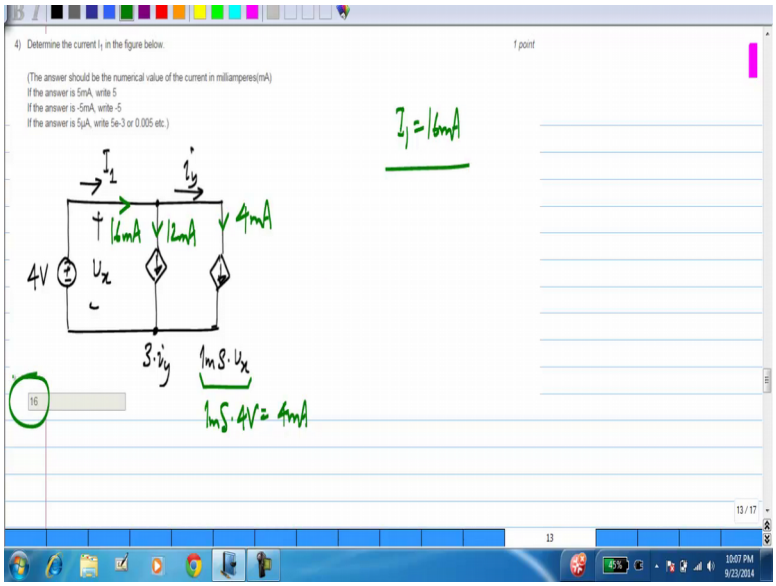

Fourth problem, we have only control sources and fix voltage four volts is applied across this control sources. And you are ask to find I 1 again you said down all the equations for the current sources some of them will be unknown and some of them will be based on known quantities in this case this voltage control current source is one milli Siemens V x, where is V x is directly across the four volts source, so we V x simply equal four volts. So, this current which is one milli Siemens four volts is four milli amperes. So, this iy is four milli amperes and this second control source is the current control current source to this three times I y. So, I y is four milli ampere this twelve milli ampere and this I 1 by simple application of Kirchhoff's current law you find to be this 12 milli amp plus four milli amp. So, I want transfer to be should be sixteen milli amps.

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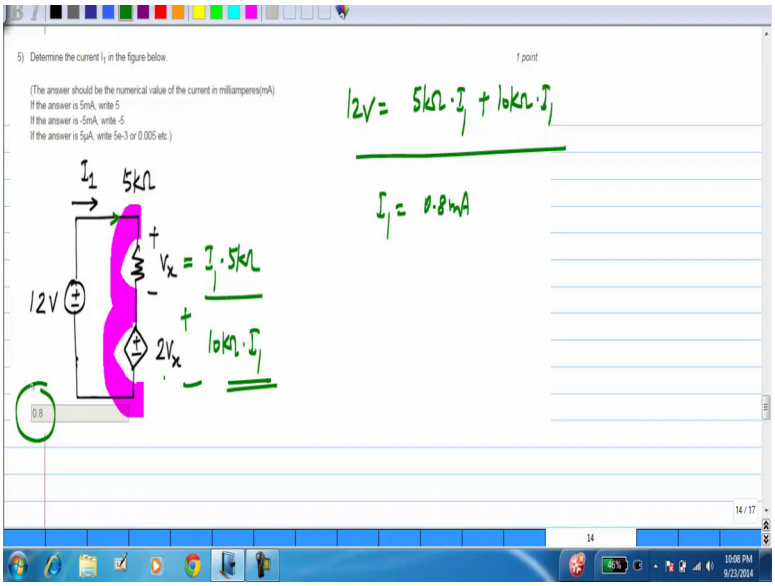

Now the next problem all this problem all the same there are different combinations of resistance and control sources and independent sources. And in this case twelve volts is connected across series this combinations of five kilo ohm resistors and a voltage control voltage source and you are ask to find I one. So, again you just said down the equations and finally, you will able to solve for the unknown I 1. So, if I 1 is flowing here that is what given I 1 is flowing through this register we know that V x has to be I 1 times five kilo ohm I 1 is at unknown will calculate it later, but v x is I 1 times five kilo ohm from ohms law and the voltage across this voltage control voltage sources two times V x which is ten kilo ohms times I 1. Now applying the KVL around this entire loop, we get twelve volts to be the voltage across the resistor plus the voltage across the voltage control voltage source. So, twelve volts equals five kilo ohms I 1 plus ten kilo ohms I 1 and from this you will easily calculate I 1 to be point eight milli ampere.

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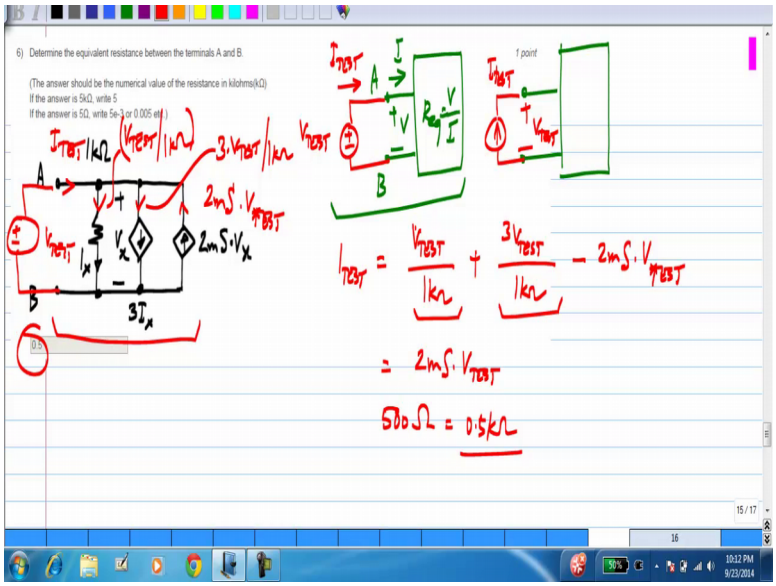

In this case, you are asked to calculate the equivalent resistance between the terminal A and B. What does it means if you are given a box and you have terminals a and b if there ask to find the equivalent resistances what it really means is you apply a plus voltage and find the current that flows. Please note this directions clear fully you after suppose to find the equivalent resistance of this box. So, you should choose the voltage and current consistent with passives and conversions for this box. So, let say this is V and I has to be that way according to passive sign covens ions and the equivalent resistance will be V by I. So, that is what the meaning of the equivalent resistances. So that is why I chosen V test and I test to be with this polarity. I can do this alternatively sometimes it may be more convenient to apply a current source instead I will apply I test.

I find the voltage that develops across the circuit now in this case to find I test from V test or in this case to find V test from I test I have to resort to regular circuit analysis. So, I will apply a V test here and then I have a numbers of unknown I needs to find and all of this things first a fall I have ix to be the current to this one kilo ohm resistances and you see that V test appears directly cross one kilo ohm. So, one the current here has to be V test divided by one kilo ohm and this is current controlled the current source and it says that the current this way three time I x. So, the current in this is three times that it is three time V test by 1 kilo ohm.

Let me point out this, this is that current that is that current. And finally, here we have a voltage controlled current source pointing upwards. Please mind the directions, it is two milli Siemens times V x and V x is nothing but V test because V x is you see is across

this two terminal and that is exactly what V test is. So, we have a current in this direction of two milli Siemens times V x what is that I wanted to find I wanted to find the current that is flowing into this circuit as a result of the applied test voltage. So, this I test will be the sum of this three currents mind you this two current are flowing down wards and this one is flying upwards. So, I test is V test by one kilo ohm plus three V test by one kilo ohm minus two milli Siemens times v x and if you write out the whole thing you will find this to be basically this milli Siemens times V test this usually 3 milli Siemens times V test. So, will have 2 milli Siemens time V test this is V test by the way because V x equal V test. So, V test by I test will be 1 by 2 milli Siemens which is equal to 500 ohm and you are ask for the resistances kilo ohm. So, this is 0.5 kilo ohm

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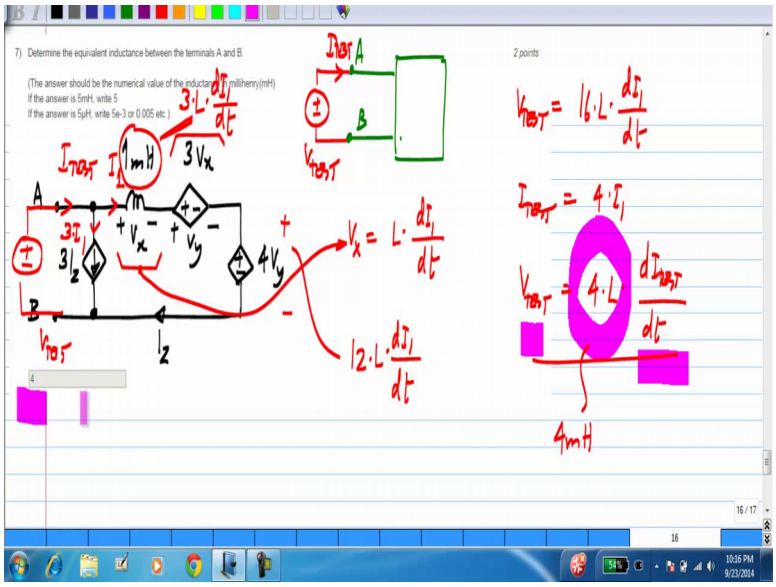

Next problem you are supposed to find the equivalent inductance. So, if you have box it does not matter what is in the box by external measurement you find that lets say this is a and b you apply a certain V test and find the current I test. So, if I test happen to the proportional to V test whatever is inside look like a register and the ratio gives you a resistance if I test happens to be proportional to the time derivative of V test then whatever is inside the capacitor and the proportionality constant give a capacitance and similarly if I test happen to be the integral of V test whatever is inside is an indicator and the proportionality constant gives you the reciprocal of inductance. So, again all I have to do find the relationship between this test voltage V test and the resulting current I test now let me define a variable here which is I 1.

Now what is this V x I 1 is flowing through the inductor and V x is across the inductor

and nothing the polarities, I can write that V x will be l times the time derivative of I 1. And I have this voltage control voltage source three V x by the way is that much three V x is simply three types that it is three times L times dI 1 by dt for l is this one milli Henry inductors. So, that is V y, V y is across this voltage control voltage source and have voltage control voltage source here which has a voltage which is four times vy which is basically the voltage here is twelve times L times dI 1 by dt actually. I did not need to define another variables the I z is already define here I z is exactly same as I 1 now I have three times I z over there which is basically three times I 1.

Now applying KVL around this entire loop I will see that V test equals the holder across the inductor plus the voltage across this voltage control voltage sources plus the voltage across that voltage control voltage sources V test is some of those three which is considered to be sixteen times l times dI 1 by dt where L is the one milli Henry inductors and what is I test I test is this I 1 over there plus 3 I 1. So, it is four times I 1 I one is the intermediate variable by eliminating that I see that V test is four times l times dI test by dt. So, like I explained here I have some current through these boxes. So, its consist of these elements and I have some voltage across it the voltage and current are related by this relationship the voltage is proportional to the time derivative of the current and the proportionality constant is four l where l is one milli Henry. So, this is the induction of the whole box it is four milli Henry you are ask for the inductance milli Henry. So, the answer is four.

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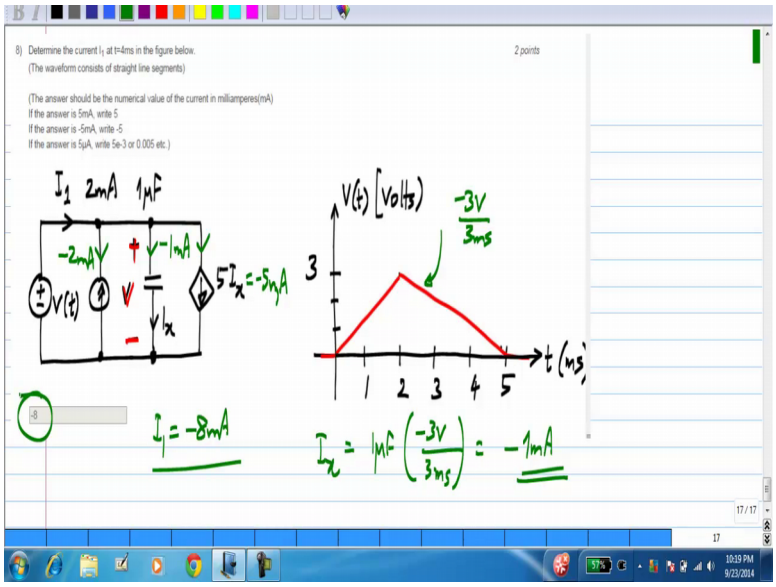

Finally, come to the last problem and you are ask to find the current I 1 at the equals four

milli seconds now we were consist of straight line segments. By now these kinds of thing is routine for you. So, the way form given by the way is that of this voltage source V of t, now first of all you see that this voltage V of t appears directly across the capacitor this is W, whatever appear here is V and I have to find the capacitor current and I x because I needed for other control sources here. So, ix what is the value of ix is basically the capacitance one micro farad the times that times derivative and I will ask for our take for four milli seconds. So, this is what I have to find the time derivative.

So, I would find the slope of this line this is falling by three volts it falls from three volts to zero over a period of three milli seconds. So, slope of this minus three volts by three milli seconds because the voltage is falling. So, the current through the capacitor ix which is c times the time derivative of the voltage defined in this direction is one micro farad times minus three volts by three milli second which is equal to minus one milli ampere, so 5 x minus milli ampere. So, five of x basically minus five milli ampere this is minus one milli ampere that is minus 5 milli ampere and if I take the current in this direction I take it that way because then I 1 simply the some this three current this are fix current source of two milli ampere flowing upwards.

So, in this direction, it is minus 2 milli ampere. So, I have to some all this three current and I see that total current I 1 is minus 5 minus 1 minus 2 which is minus 8 milli ampere. So, the answer is minus eight. So, again some of you have made mistakes in science or calculating the slopes and so on. So, please go back and try to solve it again right from scratch by yourself and then you will be able to solve similar problems in the future what I mean to say is that do not be satisfied just by looking at whatever I worked out. Now redo the solution yourself without looking at it.