Fundamentals of Electrical Engineering
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Lecture – 09
Basic Laws (Contd.)

Well, welcome back right; so, in this case we have just way in this circuit we have made R 2 is short circuit.

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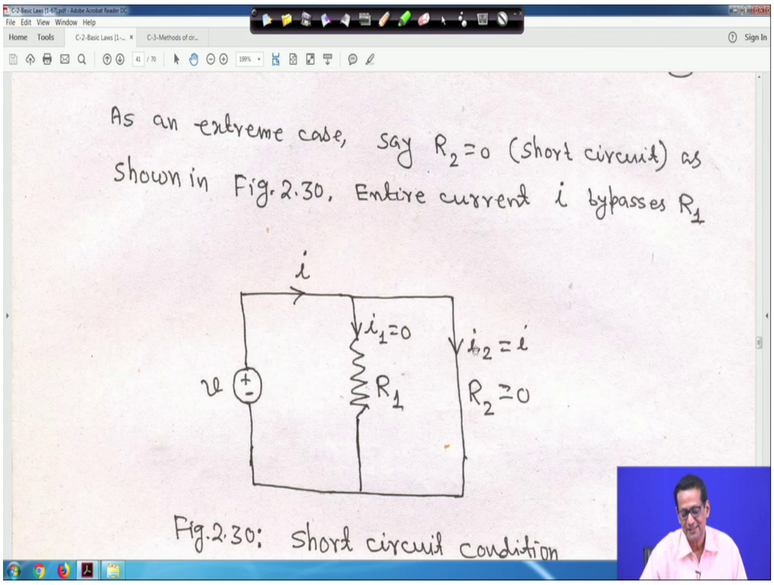

So, R 2 is equal to 0 you can make R 1 short circuit also that all current will pass through this only right so; that means, it will totally bypass that your R 1 right. So, your; so, all the currents will flow i 2 actual will be equal to i right.

If you make a short circuit that is why when anything is get shorted know we get some you know anything short circuit as soon happen we get a shock right you shock sometimes short circuit it carries huge, I means more amount of current because it is basically current will be b divided by the resistance of the wire, because this one will be bypass as this short circuit is gets a low resistance path; that means, huge current will flow. So, low resistance means high current right

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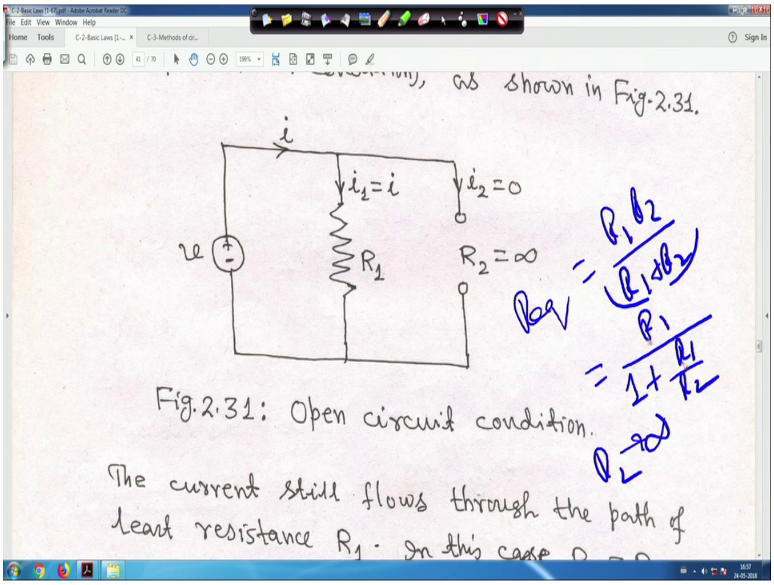

So, similarly all these things are written here you can its similarly if it is a open circuit open circuit means R 2 is equal to infinity. So, there will be no current through R 2 if R 2 is an open circuit; that means, all the current i 1 is equal to I will pass through R 1 if it is an open circuit right. So, it is it is understandable right. So, this is a open circuit condition. So, in that case R 2 is equal to R 1 because R 2 is infinity will your what you call your then Req will become your what you call that your ah R 1 ki mean if you if you do not try to multiply this if you will just something like this right.

Suppose Req is equal to R 1 I R 2 by R 1 plus R 2 right now if you divided by your what you call R 2 then that will become R 1 and if you R 1 R 2. So, this one I am making first R 2 by R 2 1 plus R 1 by R 2 right. Now R 2 tends to infinity right. So, this R 1 by R 2 will become 0. So, basically it and it will be one. So, basically it will become R 1. So, that is why it is open circuit rq Req will be is equal to R 1 understandable right.

So, now look at this problem. So, a voltage divider connected to a load RL as shown in figure 2 your 32 you have to ex you have to obtain an expression for v 0

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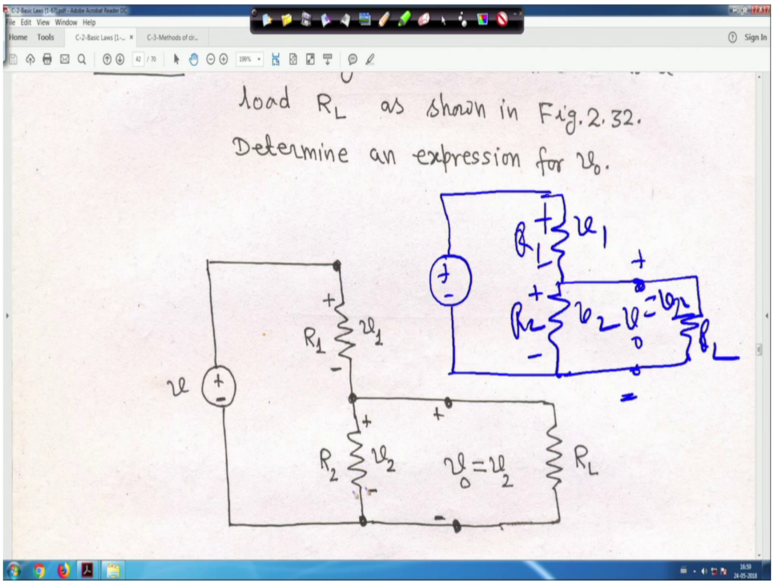

Now, actually it will circuit is like this I am just explaining you, actually the it is with the problem it is said that ah that you have a voltage divider circuit across the R 2 a load resistance r load is connected whose resistance is RL, actually it is something like this that your circuit wise like this is a voltage divider circuit, this is v. So, if you take a series circuit is a voltage divider circuit R 1 right you have R 2 right and this is the circuit this is R 1 this is your R 1, and this is your R 2 right. And this is plus minus terminal the way, it has been marked I marking this is plus minus this is your v 1 and this is your v 2.

Now, across this is the series circuit across this what we are doing we are connecting one load right say a resistor is connected, this resistance is RL right and voltage across this it is giving suppose this is giving plus and this is minus this v 0 is equal to actually v 2, because it is connected it is connected across the across the your resistance R 2. So, naturally whatever voltage will be there across RL, it will be the same voltages v 2. So, across the RL this RL voltage is actually v 0. So, when it is connected across that your resistor R 2. So, v 0 is equal to v 2 right.

So, this is the circuit this is the circuit is given. So, let me clean it right. So, this is the problem. So what though therefore, resistor RL act as a load on the voltage divider circuit right.

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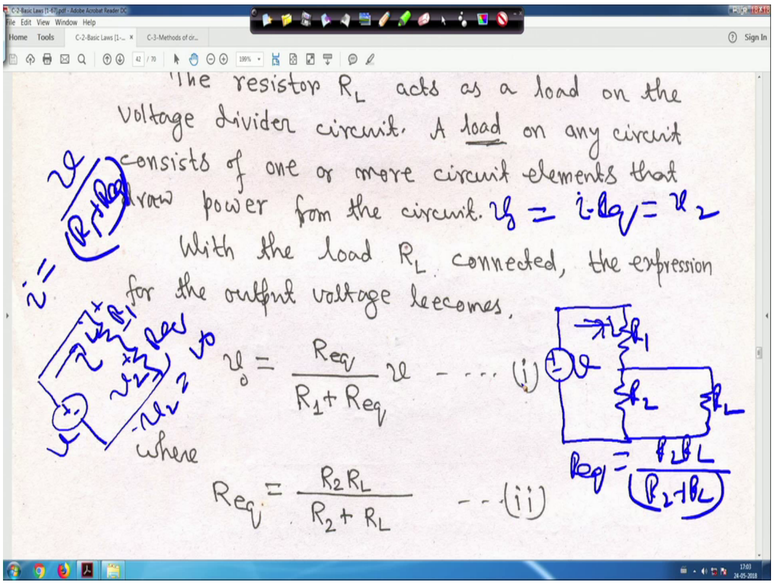

Now what we will get you have to find out v 0 is equal to now with the with the load RL connected the expression for the output voltage become v 0 is equal to Req plus your divided by R 1 plus Req. So, I making it here again how it is coming right. Here write of it is little bit that is why getting less space for making this connection. So, question is that first let me I will I will do it I will clean it I will do it I will clean it. So, this is your voltage source this is your voltage source right.

So, you have the circuit like this is R 1, this is R 2 right and here your load resistance is connected this is making in short this is R 1, R 2 and this is your RL right. Now this R 2 and RL it is in they are in they are a parallel right so; that means, equivalent of this R 2 and RL Req will be equal to R 2 into RL divided by R 2 plus RL. Because R 2 and RL they are in parallel just we have seen in the parallel resistance. So, they are in parallel Req of R 2 and RL equivalent is Req is equal to R 2 RL by your R 2 plus RL.

Then and current flowing through this is I this is your I this is the current and voltage that is v right. So, then further its equivalent circuit I am just trying to make it here just see this is your voltage v therefore, this resistance is R 1 right and this equivalent resistance of this is Req. And this is the current i. So, i will be is equal to your what you call that i is equal to I am making it here, that I is equal to it will be v divided by R 1 plus Req right this is your i this current is i right.

So, this v upon your R 1 plus Req right then what will be the your v 0 right v 0 is equal to. So, this i v 0 is equal to what will given? It will be Req into i, because this equivalent this is your Req this voltage v 0 is equal to v 2 this was plus hope everything is understandable to you this is minus. So, these voltage was given v 2 right and v 2 is equal to writing here and v 2 actually is equal to your v 0 right so; that means, I have to put it I have to find out some space.

So, making it here right therefore, v 2 actually v 2 is equal to v 0 v and therefore, v 0 that is equal to v 2 is equal to your i into Req right because this is this I current is flowing here. So, v 0 is equal to v 2 right v 2 is equal to v 0. So, v 0 is equal to ieq is equal to your v 2; so, i into Req. So, it is the your this is your i current is this i is flowing through this circuit. So, i is equal to v upon R 1 plus Req n. So, if you put i is equal to v upon your R 1 plus Req, you will get that your what you call Req upon R 1 plus Req into v because i is equal to v upon R 1 plus Req. So, here it is Req into i. So v upon R 1 plus Req into your Req upon R 1 plus Req into v; so, this is equation 1.

Hope things we have understood, because write of it is more. So, finding somehow I am making it here hope things are understandable to you right. So, where Req is equal to i just derived for you R 2 RL upon R 2 plus RL how it is coming I have told you. So, this is equation 2. So, let me clean it right.

So, equation 1 and 2; so, from equation 1 and 2 you will get. So, here Req we got R 2 RL upon R 2 plus RL.

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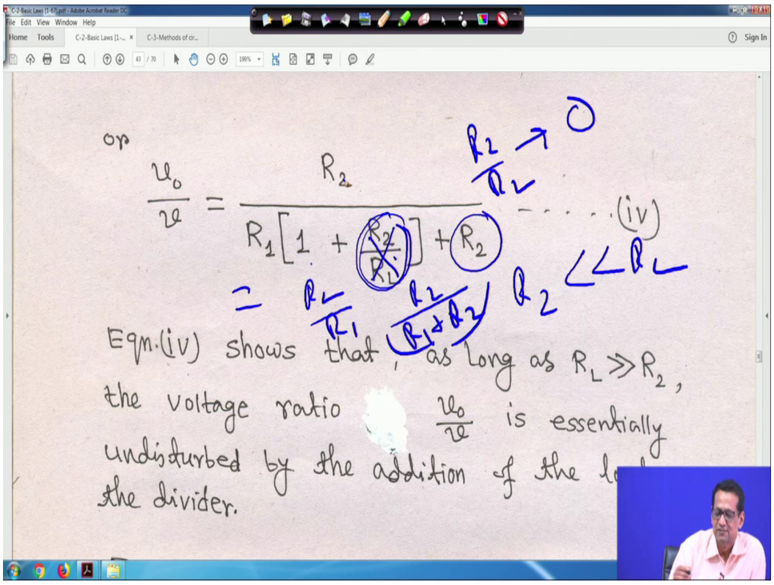

Here you substitute Req is equal to R 2, RL plus R 2 here numerator Req and denominator also R 1 plus here you substitute Req and simplify little bit. If you simplify we can write in this form that v 0 is equal to R 2 divided by R 1 into 1 plus R 2 upon RL plus R 2 into v this is equation your 3 right.

And R v 0 by v take the ratio of this v 0 by v; that means, divide both side by v it is becoming R 2 upon R 1 into 1 plus R 2 upon RL plus R 2 right; that means, equation for shows that as long as RL much greater than your R 2, the or R 2 is negligible suppose R 2 is very small compare to RL right for example, just hold on right for in R 2 is very small compare 2 RL here I am writing RL is much greater than then R 2; that means, other way R 2 is much less than then RL right. If it is so that means, R 2 by RL it will tend to actually 0 approximately 0.

Therefore v 0 by your what you call your in that case the and this R 2 is also neglected. So, in that case what will happen the v 0 upon your v, it will become essentially undisturbed because the in that case what will happen v 0 v if you follow this is the R 2 is neglected, but the R 2 is very small compare to RL right. So, this term should not be there and this term also should not be there right.

So,. basically it will become your if you do not this R 2 upon R 1 right such that v 0 by v is essentially undisturbed by the addition of the load on the divider. So, I mean you have to make little bit of your what you call some understanding that R 2 is very very easy your what you call. So, as long as RL much greater than R 2 or R 2 is your very very small compare to RL there so; that means, your; that means, this term you can eliminate otherwise this will be if you if you this 2 if it is totally neglected R 2, then it will become R 2 by R 1 otherwise this term can be eliminated compare to 1 because if this is very small compare to 1.

So, ultimately it will become R 2 upon R 1 plus R 2 if your R 2 is too small right compare to R 1 then you can neglect it will become R 2 upon R 1, otherwise if R 2 is compare to RL is much smaller, then this term can be eliminated right this term should not be there, and compare to because 1 plus 0.00 something become. So, it will be approximately R 1 plus this R 2 let it be there. So, in that case R 2 upon R 1 plus R 2, but if R 2 is also very small compare to R 1 then it will be R 2 upon R 1, but R 2 is very small means in that case v 0 by v ratio will be very small right. So, this is the this is some kind of understanding let me clean it right.

So, take one small example; so, this example 1 one small exercise will be given for you it is given the resistors used in the voltage divider circuit shown in figure your 33 have a tolerance of plus minus 5 percent.

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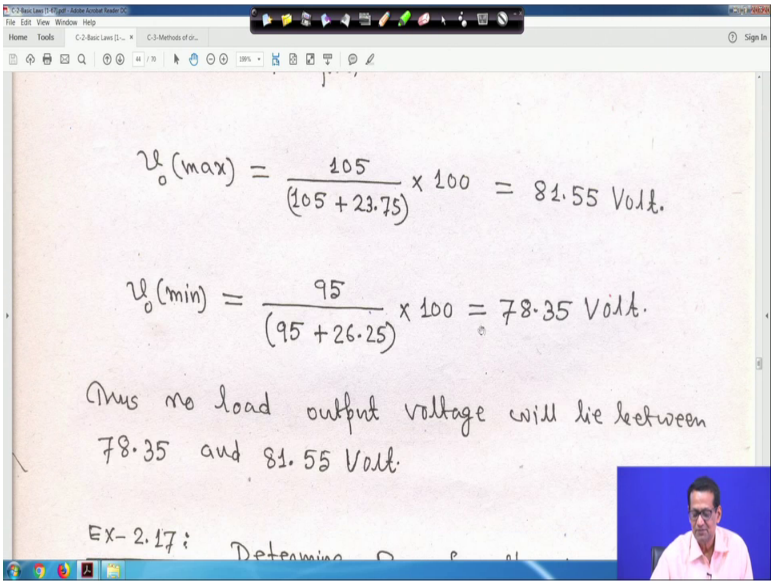

So, find the maximum and minimum value of v 0 you have to find out there all the resistance tolerance is given plus minus 5 percent it is given it is a simple that voltage divider circuit hundred volt source this across R 1 voltage is v 1 and resistance R 1 is equal to 25 ohm and this one v 2, resistance R 2 is equal to 100 ohm and same as before that v 0 is equal to v 2. So, you have to find out that maximum and minimum value of v 0 what will be the maximum value and what will be the minimum value tolerance is given plus minus 5 percent.

Now, one thing I have written, but it is an exercise for you, I have not done it here that is from the at the maximum value of v 2 occurs when R 2 is 5 percent high and R 1 is 5 percent low, why that you find out yourself right this is an exercise for you. Similarly, the minimum value of v 2 occurs when R 2 is 5 percent low and R 1 is 5 percent high this is also you find out. Note that v 0 is equal to v 2 because earlier just now your load resistances RL we connected we have seen that it is v 0 upon v 2 right

So, question is that maximum value v 2 occurs when R 2 is 5 percent high and R 1 is f percent low why you find out right. Similarly minimum value of v 2 occurs when R 2 is 5 percent low and R 1 is 5 percent high from your intrusion you find out this is not. So, this is not solved here why this is an exercise for you, but, but in that case what will happen that 5 percent your I told, that v 0 max will happen that when your v 2 R 2 is 5 percent higher R 1 is 5 percent low. So, R 2 is 5 percent high means it will be 105 and your R 1 is 5 percent low; that means, it will be your 23.75 right whatever it comes.

So, that is v 0 max we will get 81.55 volt similarly for v 0 minimum it is 5 percent low and 5 percent high. So, it is actually 95 by 95 5 plus 26.25; so, 78.35 volt; that means, it is been ask that your find the maximum and minimum value of v 0. Therefore, minimum value of v 0 will be 78.35 volt and maximum will be 81.55 volt that max min 5 increase or your what you call, that your decrease that it is from your intrusion you please find it out right.

So, that you do little bit exercise mathematical exercise, little bit see the circuit right now next is another problem.

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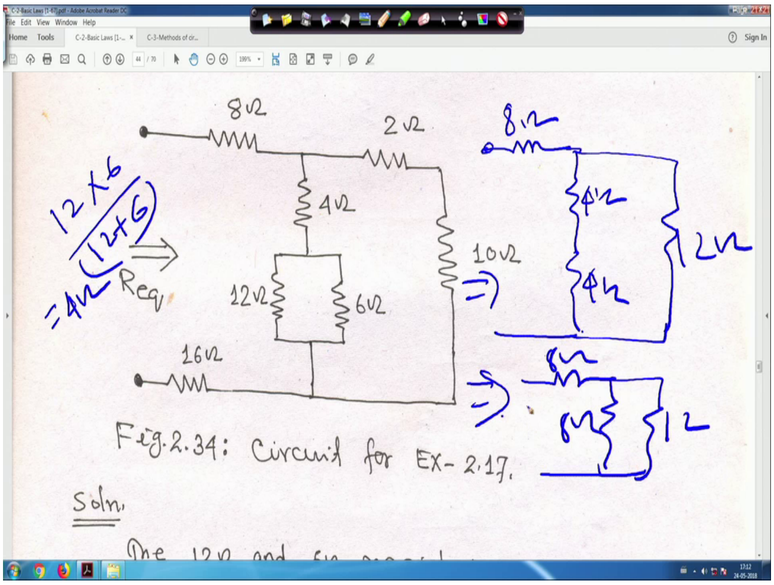

Determine that Req for the circuit shown in figure here this is 34. So, you have to find out that your what you call your equivalent resistance of the circuit series parallel circuit. You are looking from left to right that is this is your Req this is your Req right not marking by color ink. But this is your Req this is your equivalent this is a simple circuit is given, you have to make that your what is the equivalent Req of the circuit across the terminal across these 2 terminal this is one and this is another one across these 2 terminal your you have to find out right.

That means just for your this thing this is suppose Req means you have to find out across this what is the equivalent your resistance, what is the equivalent resistance across this terminal are this thing Req this is your Req right you have to find out looking from left to your what you call right. So, how we will do it let me clean it.

So, here 2 ohm and if you look that 2 ohm and this 2 ohm and 10 ohm these 2 resistance are in series right. At the same time this 12 ohm and 6 ohm there in parallel right. So, 10 plus 2 it will be 12 and 12 6 there in parallel. So, 12 into 6 by 12 plus 6; so, 72 by your 18. So, 4 ohm a 4 ohm 4 ohm again we will be in series and again this 8 ohm will be in parallel to 12 ohm resistance.

Now, see how is it right? So, before going n to that I making rub making some calculation for you. So, this is your 8 ohm resistance this is your terminal, this is your 8 ohm resistance right this is your 4 ohm and this 12 and 6 there in parallel right. So, it will be your equivalent will be making it here, it will be 12 into 6 by 12 plus 6 right. So, it will be 72 by 18 that actually is equal to your 4 ohm right.

So, this will be equivalent to 4 ohm right and this 2 and 10 these 2 are series. So, 10 plus 2 it will be your 12 ohm now further this is equivalent of this is equivalent of this. So, further this is your 8 ohm and this is also 8 ohm right and here also it is 12 ohm. So, 12 and 8 are in parallel right. So, basically it will be 12 into 896 divided by 12 plus 8 20. So, 96 by your 20 plus this 8 that is your that is your that is your what you call that is your R equivalent right.

So, solutions are there. So, I am just cleaning it right. So, 12 and 6 ohm resistors are in parallel.

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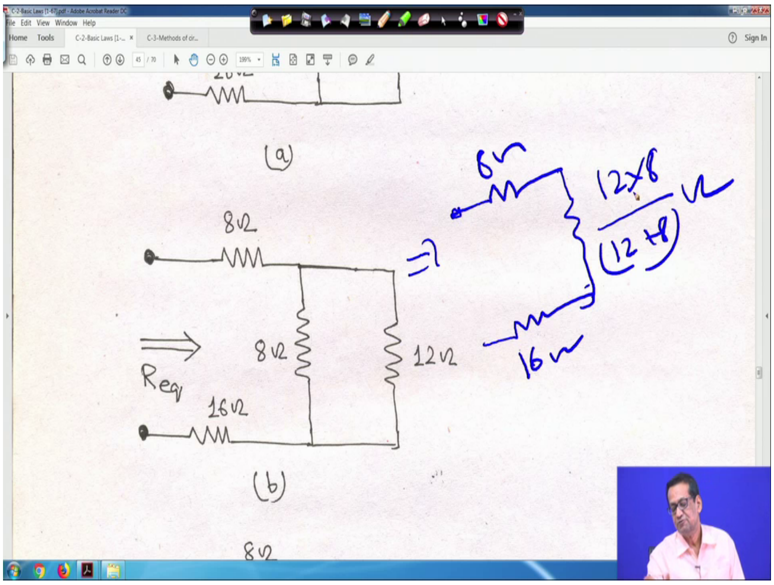

So, their I just told you that 12 into 6 it will be 4 ohm right and similarly this 2 I told you 2 and 10 are in series the 12 ohm. So, this is the equivalent circuit I one more thing here one 6 ohm resistance is there, I have missed it right I have missed it in the previous calculation that here circuit here one 16 ohm resistance is there I have missed that one. In the previous circuit I have missed that one when I will making it by ink pen I have a one look this one. So, the 16 ohm is also there right

So, anyway; so, this is that equivalent 8 ohm 4 ohm 4 ohm and 4 plus 4 8 your 8 and 12 are in parallel. So, it is a further the simplification that 8 ohm, this 8 and 12 are in parallel and 16 ohm right. So, basically this equivalent circuit actually it is if you this one equivalent is this is 8 ohm right and here it is your 16 ohm, and this 8 and 12 are in parallel right. So, it will be 12 into 8 the 12 plus 8 right whatever it come 96 by 20. So, 8 plus 90 your what you call 96 by 20 plus 16 that will be your equivalent resistance right.

So, just hold on right; so 96 by 20 is 4.8 ohm 8 ohm sum it up all. So, Req will be 8 because all are in series now 8 4.86 all are in series. So, 8 plus 4.8 plus 16; so, 28.8 ohm this is the answer right. Now, determine now another example you take determine R 1 2 for the circuit the circuit is given, again we have to find out the equivalent resistances R 1 2. Now before analyzing this circuit just you have to little bit you have to see this that how things are given.

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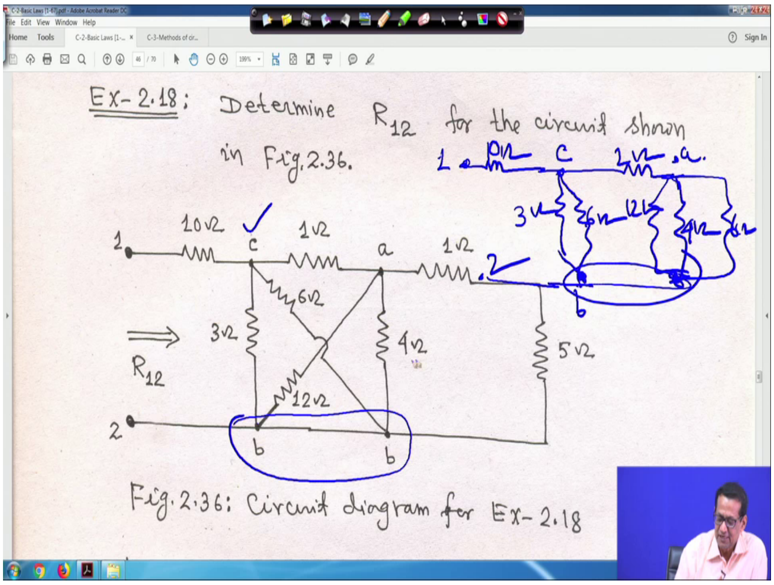

So, this is 10 ohm resistance right it is one ohm it is one ohm this one and 5 these 2 are in series. So, 5 plus 1 is 6

Now, this is a common node right this is one node only this is node b, that is why here it is mark b, here it is mark and these are not connected this 12 ohm 6 ohm not centerline connected, that is why that is why it is shown that it is not connected right. So, this is a common node.

Now, if you try to make the equivalent that from your intrusion you can find out, basically this 4 and 12 one in parallel. Similarly this 6 and 3 are in parallel. If you have if I read a little bit for your understanding just try to try to accommodate here.

So, this is your node 1 this is actually 10 ohm right and this is your node suppose this is your c as per this thing it is c right and this is actually your 3 ohm and this one this b this is a common node because b is a common node right. So; that means, this your what you call this c 2 b this is 6 ohm actually it is in parallel. So, if I make if I make like this is my this is my b point, then your this 6 ohm also is in parallel to this your 3 ohm across 3 ohm resistance then; that means, this one actually 6 ohm is connected like this right.

Then it is one then one ohm resistance is here this is your one ohm resistance, and this terminal is your what you call a terminal this is actually 4 ohm right and then this a to b it is a this 12 ohm resistance also parallel to this 4 ohm; that means, this actually this is actually your 12 ohm right, but and this is this is actually common node right this is actually common node right. And finally, this is actually common node, but basically their circuit like this and 1 and 5 they are in series. So, total will be 6 ohm so; that means, 4 and 12 are in parallel because this is a common node, this is a common node right, but may be it like this.

Such that your what you call say your clear your and this is of course, this is your 0.2 such that understanding will be clear. So, that means, 3 and 6 are in parallel 4 and 12 are in parallel. So, I am cleaning it right; so that means, that the when we write 12 and 4 ohm parallel 12 ohm parallel to 4 this way we write so; that means, 12 into 4 upon 12 plus 4. So, 3 ohm; so, just now I told you that your 12 ohm and 4 ohm parallel similarly 6 and 3 are in parallel similarly 3 ohm and 6 ohm are in parallel, just I told you. So, 3 into 6 upon 3 plus 6; so, 2 ohm right and one ohm and 5 ohm they are these 2 are in series equivalent circuit I showed you. So, this is 6 ohm right.

Therefore after making all this simplification this is your say equivalent circuit now. So, this is it is 2 ohm this is 2 ohm, but this is a common node.

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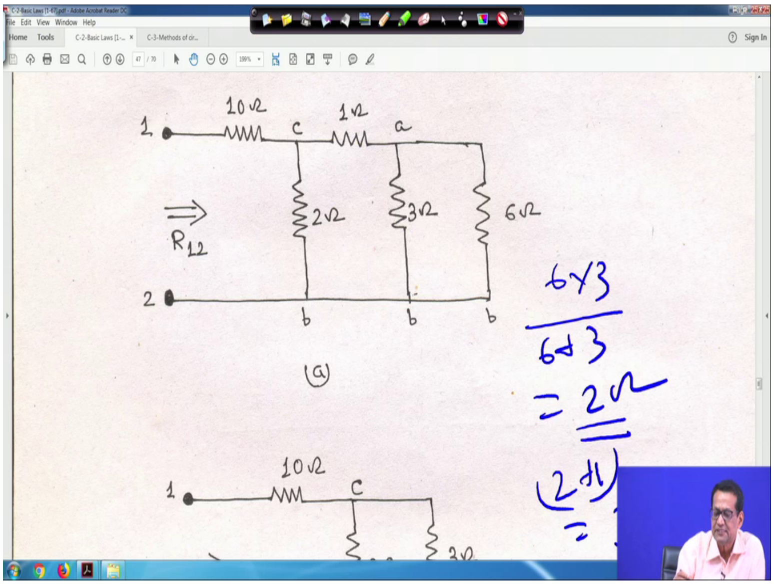

This is a your what you call this is your common node right. Now here also if you look into that 6 and 3 these 2 are in parallel 6 ohm and 3 ohm these 2 are in parallel right. So, if you further simplify if you further simplify. So, 6 into 3 upon I mean if you 6 3 are parallel. So, in this case your it will be 6 into 3 by 6 plus 3 is equal to 2 ohm right.

So, that is why your what you call just hold on. So, that means, with this that one ohm will be in series right if these 2 are in parallel now it will equivalent to 2 ohm as soon as with that one ohm will be in series. So, 2 plus 1 that will be is equal to 3 ohm because this is one ohm equivalent parallel to equivalent resistance of these 2 parallel resistance is 2 ohm with that 1 ohm will be in series. So, total will be 3 ohm

So, I am cleaning it right. So, if you look into the circuit that is why it is 3 ohm with that 2 ohm are in parallel. So, this is 10 ohm is there. So, 2 and 3 are in parallel with that 10 is series. So, it will be 10 plus 2 into 3 by 2 plus 3 right. So, 3 and that is your here it is your what you call this thing. So, this is already 3 ohm I told you that how we are calculating this is I have told you and now 10 ohm plus 2 and 3 are in parallel, this all this things I have told you the 3 ohm equivalent 1 plus this thing right.

So, and this is 10 plus 2 and 3 are parallel. So, 10 plus 2 into 3 upon 2 plus 3 it comes 11.2 ohm, this is the answer right things are understandable to you right.

Now, this is another circuit you find R 1 2 in figure 2 to your 38. So, here also this is a circuit is given, that from here we have to find out your what you call R 1 2. Now look at the circuit right if you look at the circuit you have to find out what is R 1 2 look at the circuit.

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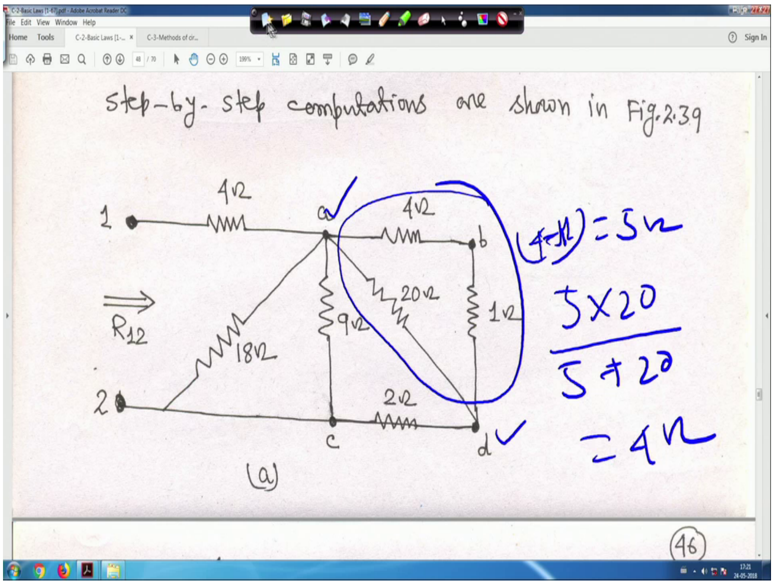

The 5 and 20 this 2 are in parallel because they are connected across your what you call that same terminal a and b right. So,. So, the equivalent 5 and 20 are in parallel; so 5 into 20 upon 5 plus 20 so, 4 ohm right.

So, if you draw the equivalent circuit right. So, in this 4 ohm this equivalent of 5 and 24 ohm and it is connected with 1. So, 4 and 1 there in series right; so, look into that a 4 and this 1 ohm rest remain same as it is right rest whatever it was there 4 ohm 8 18 ohm, 9 ohm, 20 ohm and 2 ohm they are and there are node number is marking everything remain same. So, 4 and 1 these are your what you call in series right. So, it will be now your what you call 4 and 1 5 and this 5 ohm resistance and your 20 there in parallel because they are connected across the same terminal.

So; that means, it will if; that means, 4 one 4 plus 1 5 ohm this is your sorry just hold on right. So, this is 4 plus 1 this is your is equal to 5 ohm this is series and across this is 20, with the 5 the 20 are in 5 and 20 there in parallel because they are connected across the same terminal. So, it will be 5 equivalent will be 5 into 20 by 5 plus 20. So, 100 by 25 that is equal to actually 4 ohm.

So, equivalent of this part is equal to actually 4 ohm right. So, let me clean it right. So, that equivalent is 4 ohm right this whole equivalent is 4 ohm and therefore, this 4 ohm and this 2 ohm is here. So, with that 4 ohm equivalent 4 ohm 2 ohm is in series, but do not confuse with this 4 ohm 4 plus 1 5, 5 into 20 by 20 plus your what you call 5. So, hundred by 25 is equal to 4 ohm.

So, equivalent 4 ohm and 2 ohm are in series so; that means, in this circuit 9 ohm and 6 ohm right if you see this is a this is a here 18 is given. So, if you if you see into this is actually common this is actually a common point right.

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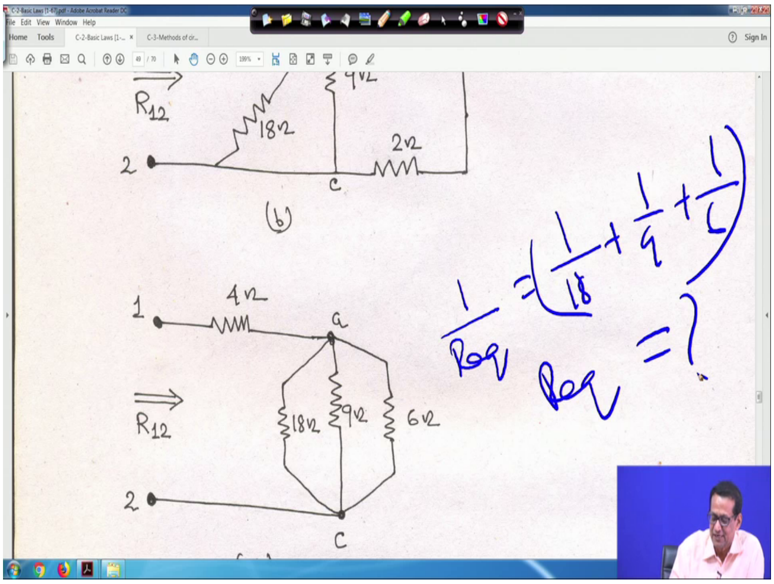

So; that means, and 4 plus 2 is 6. So, 6 ohm 6 ohm 4 plus 2 right is equal to 6 ohm. So, 6 ohm 9 ohm and 18 ohm all 3 are in actually parallel right.

So, I am cleaning it. So, if you look at look at the next circuit. So, 4 ohm 6 ohm 9 ohm and 8 ohm parallel right. So, find out the equivalent of a this 6, 9 and 18 will told you know how to find out that it is your that equivalent of this that 1 upon Req is equal to 1 upon 18 plus 1 upon 9 plus 1 upon 6 right from that you find out Req is equal to how much right.

So, I have calculated so, this all 3 are in parallel. So, 1 upon Req which will 1 upon 18 plus 1 upon 9 plus 1 upon 6. So, let me clean it right. So, with this that we have written 18 parallel to 9 parallel to 6 this way writing equivalent comes actually 3 ohm. So, 4 plus

3. So, it is 7 ohm right. So, answer will be R 1 2 is equal to 7 ohm. So, with this sum 2 3 example is show how to find out your what you call that series parallel your combination of resistance.

Now, question is that in the circuit problem you may encounter something where apart from series or parallel combinations, there will be some circuit where you cannot your reduce the circuit such a simple problem equivalent resistance sometimes some 3 terminals or we will come. So, in that case you have to you have to what you call obtain the equivalent your resistance, that is very important because in circuit analysis and particularly in engineering branch electrical engineering branch these are very necessary.

So, in that case we use that your 3 terminal you have to many cases you will find 3 terminal resistances 3 terminals coming, and in that case you have to find out series parallel combination may not be completely applicable there. So, in that case what will happen, you have to find out some other means such that you can solve this circuit.

So, that is why in that case what we follow, we follow star delta transformation or delta star transformation. Sometimes star we call t network also sometime delta we call pi network right, this way star delta or delta star transformation. So, next we will go to your star delta transformation.

Thank you very much.