Fundamentals of Electrical Engineering
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Lecture – 46
Resonance and Maximum Power Transfer Theorem (Contd.)

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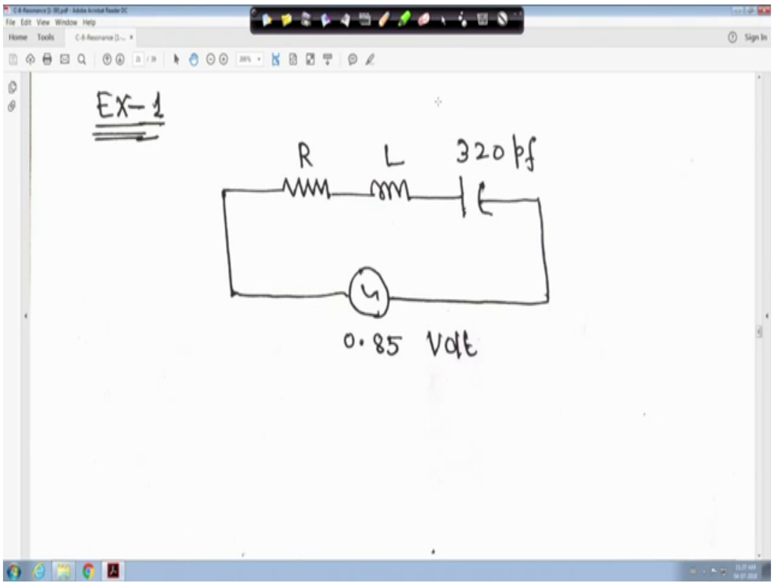

So, far what whatever little bit theories are there for resonance we have seen it. Now, we will take a simple example right. So, this is a simple series RLC circuit. This is R L is given, and this is 320 peak of farad. And if you want this instantaneous polarity, you can take plus minus, and this voltage is 0.85 volt right. So, this will be RLC circuit what we have to do it. So, it is written in it.

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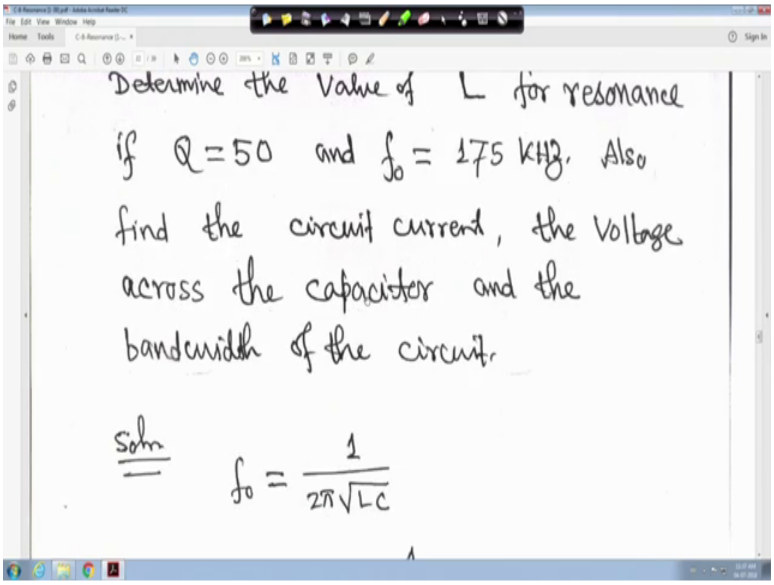

So, this is example L that you have to determine the value of L for your what we call for resonance if Q is equal to 50 right and f 0 is equal to 175 kilo hertz. Also find the circuit current, the voltage across the capacitor and the bandwidth of the circuit right. So, this is the problem, this is the circuit, this is the circuit, and this is the what we have to determine everything is given here right.

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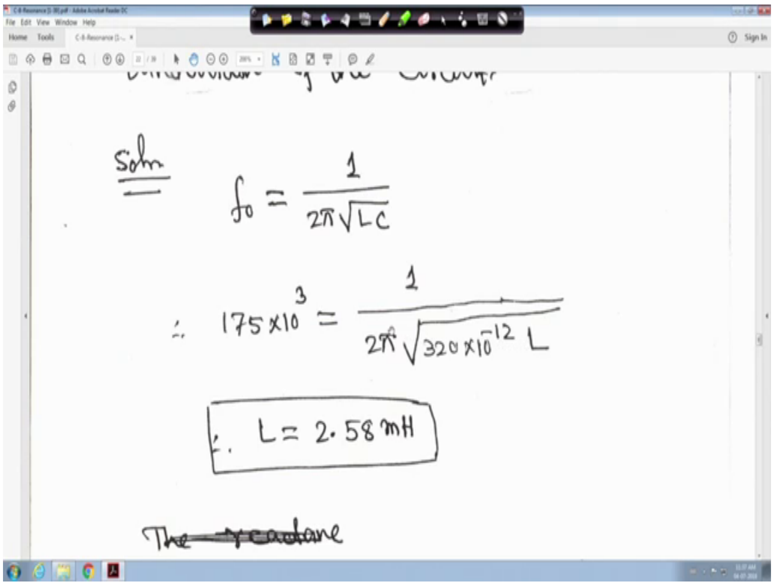

So, first thing we know that resonance frequency f 0 is equal to 1 upon 2 pi root over LC. So, f 0 is given 175 kilo hertz. So, it is 175 into 10 to the power 3 is equal to 1 upon 2 pi root over your what we call C is given 320 peak of farad, 320 into 10 to the power 12 into L from which you will get L is equal to 2.58 milli Henry right.

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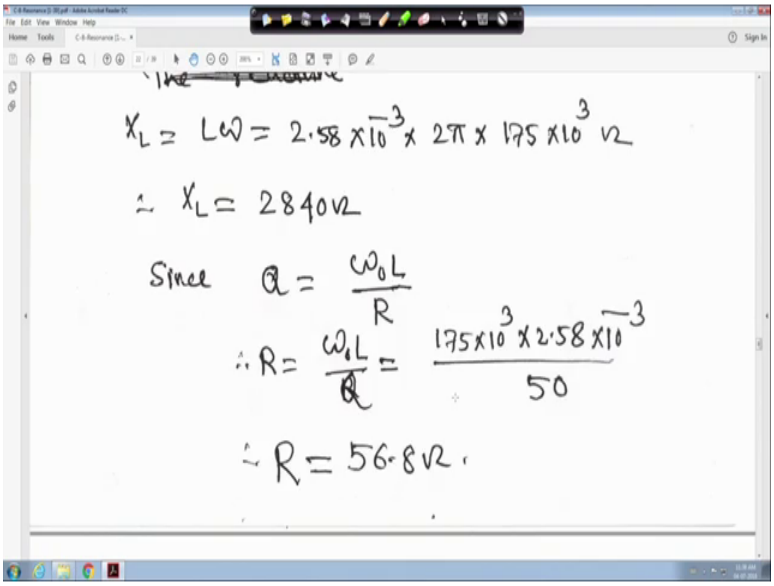

Now, we know that X L is equal to L omega, so L we have got it 2.58 into 10 to the power minus 3 right, it is in Henry into your 2 pi into f 0 is equal to 175 into 10 to the power 3 hertz right so that means X L is equal to L omega, this much of ohm. So, it is 2840 ohm right. So, quality factor Q is equal to omega 0 L upon R right. So, omega 0 your a your what you call this omega 0 that means R is equal to omega 0 L upon Q right.

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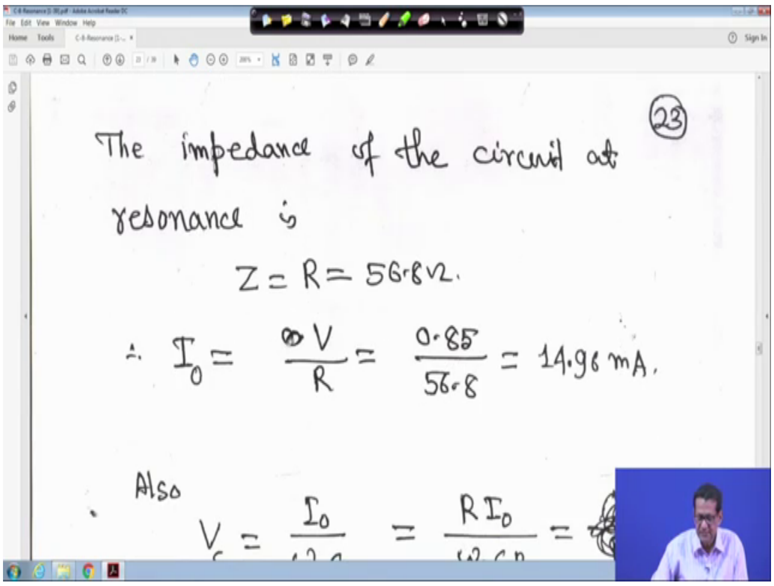

So, here your you just substitute or substitute your all these values. So, you will get your R is equal to 56.8 your ohm right. So, this way actually your L we have got that is your 2.58 milli Henry. And you if your f 0 is given this one right 2 pi f 0 one thing is there, one correction is there. Here it is your omega 0 your omega 0 is equal to 2 pi f 0 right, I think one 2 pi is missing right. Just check this answer I think this answer is correct, perhaps this I missed this one, it will be omega 0 right.

So, Q is equal to your 50, Q is equal to 50 is given, R is equal to omega 0 L upon this thing. This you please check it right hope this is correct. So, next this one R you have got then the impedance of the circuit of the resonance is that that at resonance X L is equal to X C, so Z is equal to R it is 56.8 ohm. So, I 0 is equal to V upon R, so V is given 0.85 volt divided by R, so 14.96 milli ampere right.

So, also V C is equal to I 0 upon omega 0 C, so this means it is R I 0 by numerator and denominator you multiply by R, R I 0 upon omega 0 C R, so that means, V C is equal to Q V right. So, that means, if you your what you call you know that your R I 0 is equal to your what you call R I 0 is equal to V and omega 0 C R that is 1 upon omega 0 your C R is equal to Q, so it will be Q into V right. Therefore, voltage across the capacitor will be 50 into 0.85; V is 0.85 volt, and Q is 50, so 42.5 volts.

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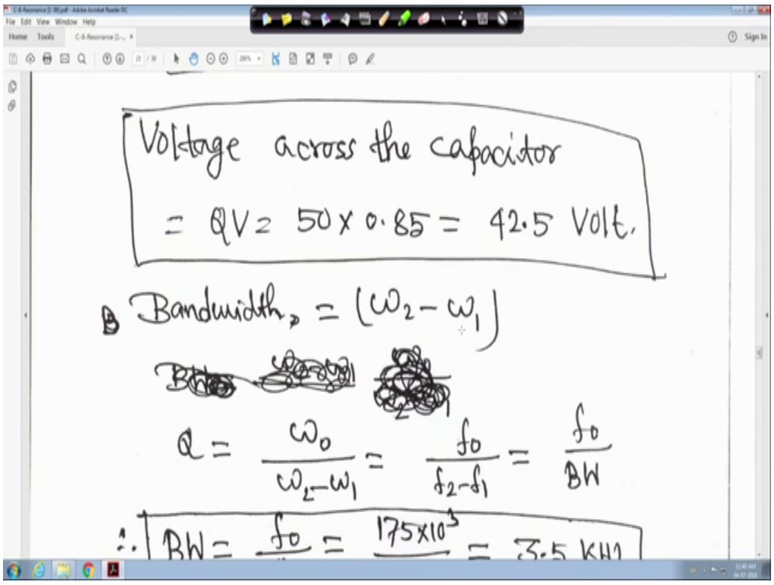

And bandwidth is omega 2 minus omega 1 or it is radian per second or f 2 minus f 1 in hertz right. So, Q you know we have derived this Q is equal to omega 0 by omega 2 minus omega 1 is equal to you can write f 0 upon f 2 minus f 1 is equal to f 0 by bandwidth. Therefore, bandwidth is equal to f 0 by Q. When you take in terms of f 0, it is in hertz, so 175 into 10 to the power 3 divided by Q is equal to 50, so 3.5 say kilohertz right, so bandwidth.

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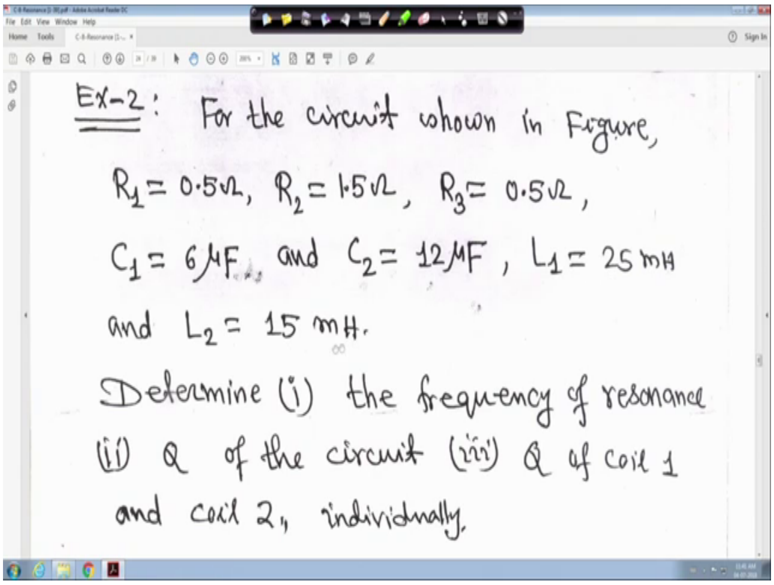

Now, example 2 so, this is simple example right, only thing is that this your what you call here I told you just (Refer Time: 04:35) omega 0 is actually 2 pi into f 0, I might have missed 2 pi, just check the answer right whether it is 2 pi is taken care or not right, so it is (Refer Time: 04:45) 56.8 just check. So, this one your next is for the circuit shown in figure that R 1 is equal to I will show you the circuit R 1 is given 0.5 ohm, R 2 1.5 ohm, and R 3 is equal to point ohm; C1 6 microfarad, and C 2 12 microfarad, L 1 25 milli Henry, and L 2 15 milli Henry. So, determine the frequency of the resonance that is first one; second one, Q of the whole circuit; and 3 Q of coil 1 and Q of coil 2 individually.

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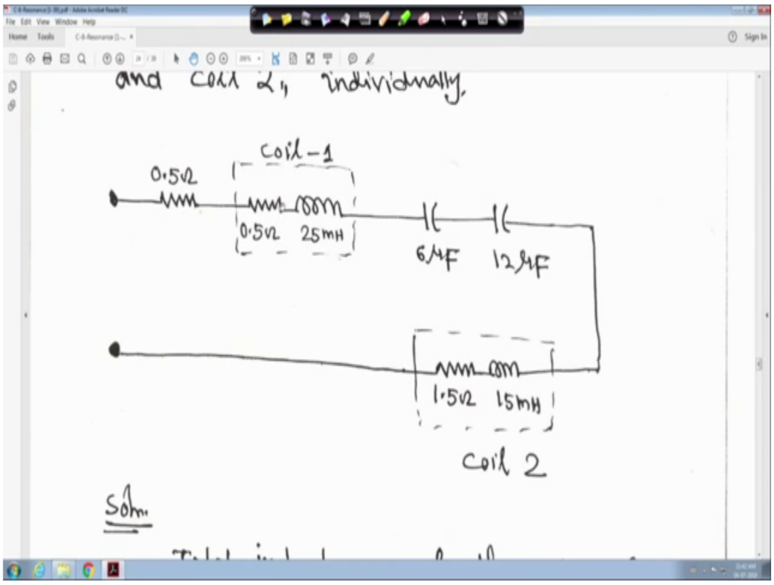

So, this is my series circuit, this is resistance is given 0.5 ohm. This is coil 1, its resistance is 0.5 ohm, inductance is 25 milli Henry. These two capacitors are there in series 6 microfarad, and 12 microfarads right. And this is the coil 2, resistance is 1.5 ohm, and inductance is 15 milli Henry. This is the problem. So, now question is impedance of the circuit. So, L this the your 25 milli Henry, and 15 milli Henry find out the total equivalent your what you call L. So, it is 25 plus 15 means 40 milli Henry right. And these two capacitor are in series means it is equivalent to the view obtain the resistance series in parallel. So, it will be 6 into 12 by 6 plus 12 right, so this will be 4 microfarad.

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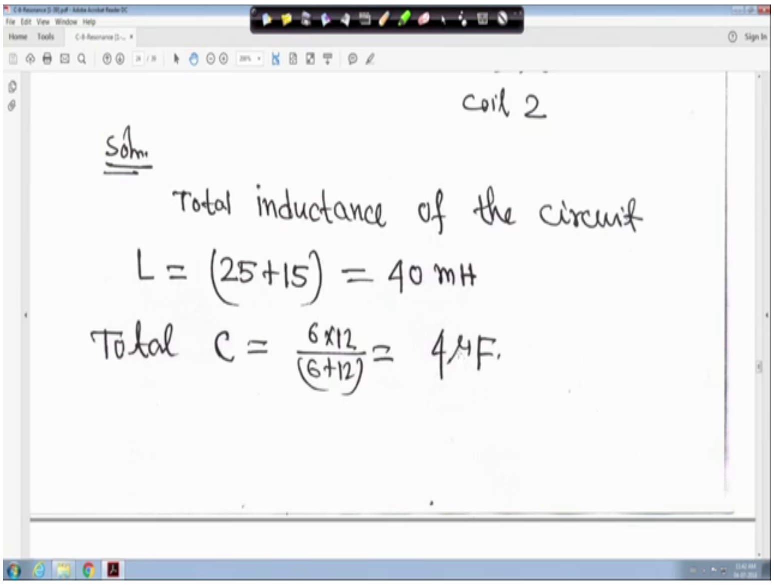

So, C is equal to 6 into 12 upon 6 plus 12 is equal to 4 micro Farad. And then R your what you call we know that f 0 is equal to 1 upon 2 pi root over L C. It is 1 upon 2 pi (Refer Time: 06:11) 40 milli Henry. So, 40 into 10 to the power minus 3 into 4 into 10 to the power minus 6, the capacitor 4 micro farad; so, these actually will get f 0 is equal to 10 to the power 4 by 8 pi hertz by your 8 pi hertz or omega 0 is equal to 2.5 into 10 to the power 3 radian per second either you have hertz or radian per second right.

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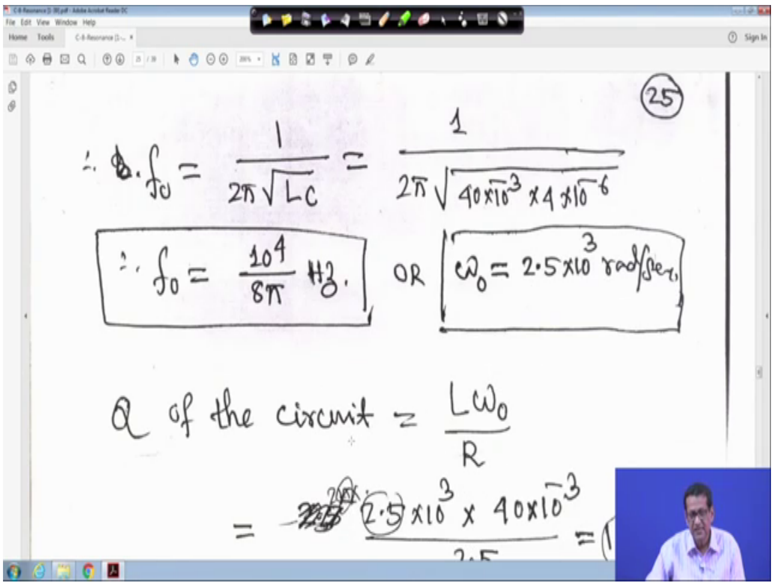

So, now Q of the whole circuit it will be L omega 0 upon R right. So, L we have got your what you call that wherever your this thing (Refer Time: 06:42). This is your L 40 into 10 to the power minus 3 whole circuit this is correct 2.5 into 10 to the power minus 3 10 to the power 3 radian per second is equal to actually this will become 40 is equal to 40. So, this is not there right. This is my class note, so all corrections made actually same thing I have scanned it here for you right.

So, this is 40 right. So, this is correct, therefore this is not twisting. This is actually 40 it is written here correct this is 40 here right. So, Q of the whole circuit is 40 right. So, let me clear it. So, then this one that Q of coil 1 it is L 1 omega 0 upon R 1 for the coil omega 0 is 2.5 into 10 to the power your what you call this omega 0 is equal to 2.5 into 10 to the power 3 radian this thing your what you call it is radian per second it is given here omega 0.

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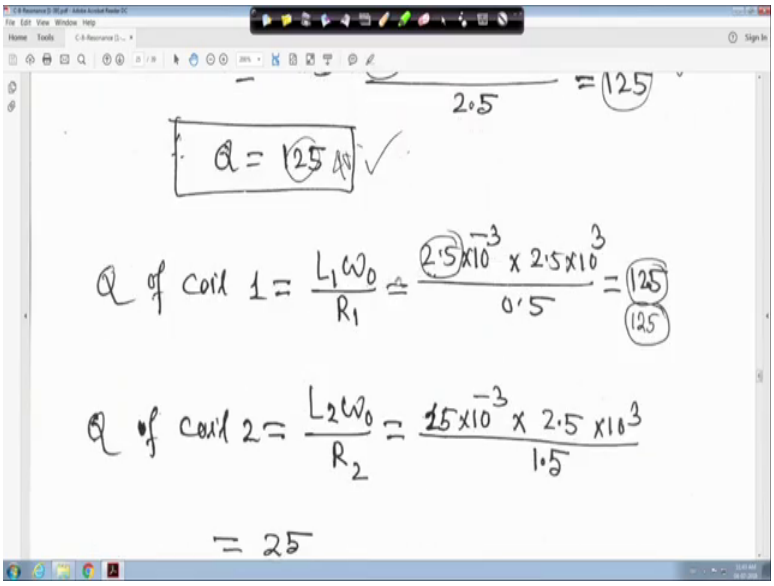

And L 1 is equal to your this one L 1, here L 1 is equal to actually this one 25 milli Henry right. So, here your here this one it will be your let me correct it will be L 1 is equal to 25 not 2.5 right. So, in this case this answer is 12.5 it will be actually 125 right. So, just check just check it will let me let me make it half right. So, it is 25, so, this is cancelled right, and this is 2.5, so answer will be 125 right. So, this is not 12.5, because it is 25 milli Henry by mistake I took it. This is my class note everything it is corrected actually right. So, similarly L 2 omega 0, L 2 15 milli Henry, and your that is 15 into 10 to the power minus 3, and it will be omega 2.5 into 10 to the power 3 upon R 2 is equal to 1.5 right.

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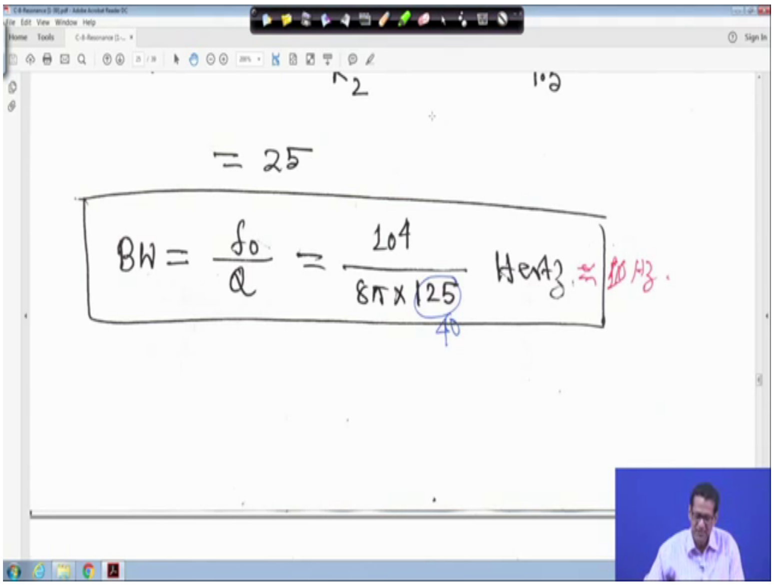

If you calculate it right, so just if we calculate it, it will be 25. So, please check all these squares then by little bit it will be calculation all these three please do it of your own right, see that all calculations are correct. So, bandwidth is we know we have done it band width is equal to f 0 upon Q right. So, your what you call you substitute or you substitute your all this thing f 0 is equal to we have got it 10 to the power 4 upon 8 pi hertz.

So, here it is 10 to the power 4 upon 8 pi, and Q is equal to whatever you have got right, Q is equal to your over overall thing is 40. This Q we got is 40 right this 40. So, it is corrected here it is 40 right. So, if you do it approximately, it will become 10 hertz right. So, this is the bandwidth this is not 125, this is 40, because you got this is 40. So, this will be approximately 10 hertz. So, this is one.

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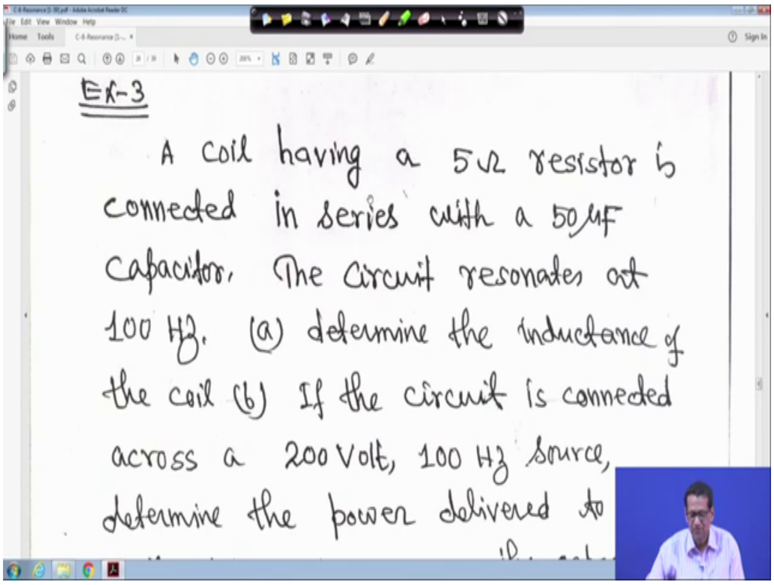

So, another one is example 3. A coil having a 5 ohm resistor is connected in series with a 50 micro farad capacitor.

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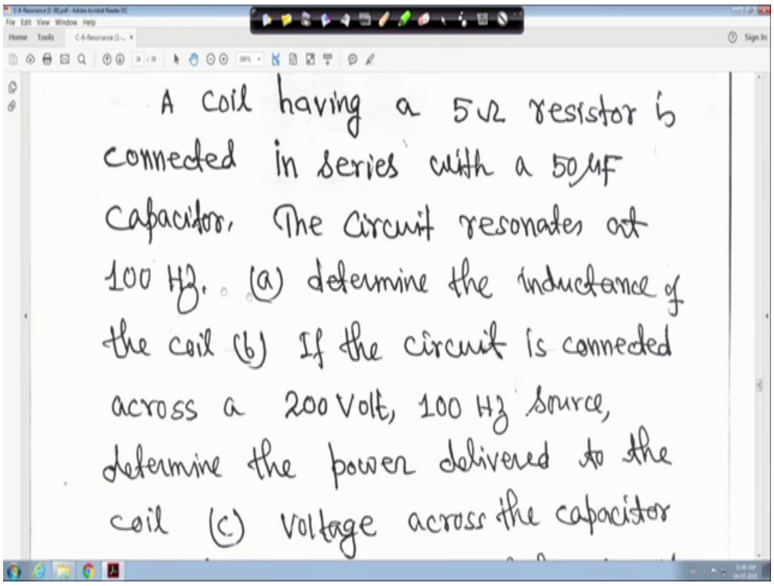

The circuit resonates at 100 hertz that means your f 0 is equal to 100 hertz; a, determine the inductance of the coil; b, If the circuit is connected across a 200 volt 100 hertz source, determine the power delivered to the coil.

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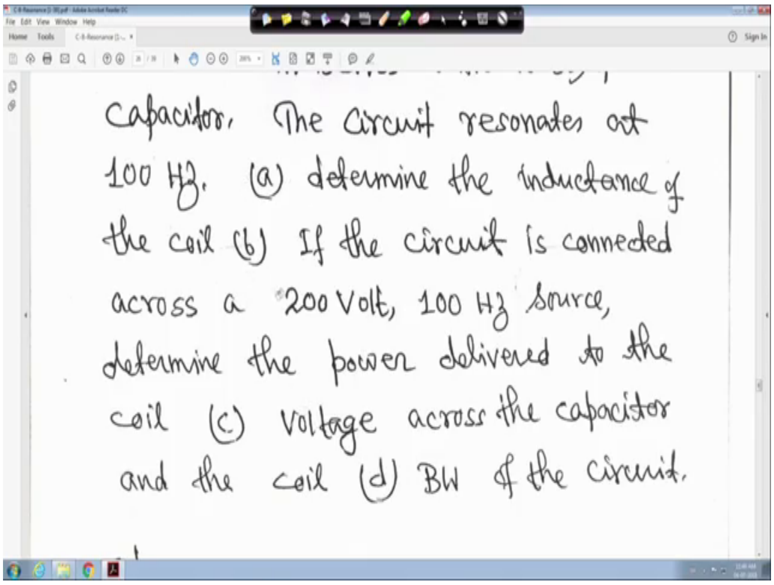

And c, now the last one (Refer Time: 09:54) voltage across the capacitor and the coil, voltage of the capacitor and the coil, and d is the bandwidth of the circuit. This is the thing you have to find it. When you read this video lecture, first you note it down right, then you solve the problem. So, you are what you call, so circuit you can do of your own circuit is not drawn it is very simple thing right. So, at resonance omega 0 is equal to 1 upon root over L C that you know.

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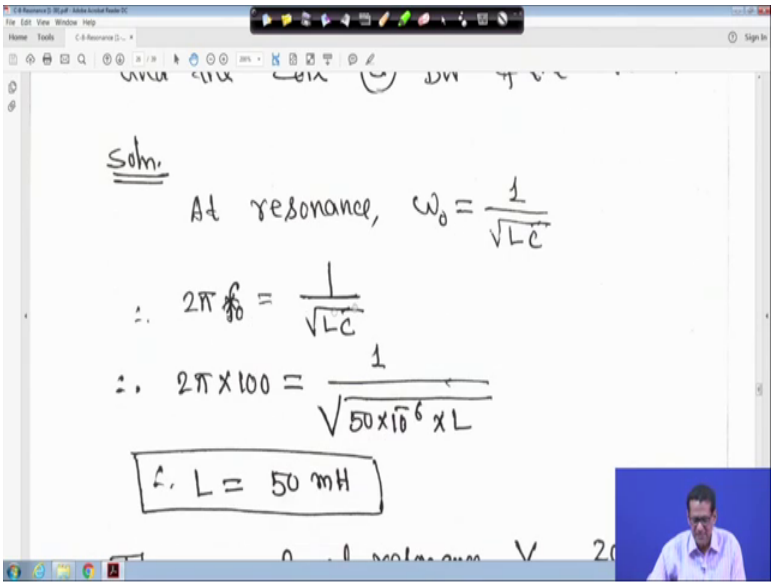

So, 2 pi f 0 is equal to 1 upon root over L C. So, f 0 is given 100 hertz.

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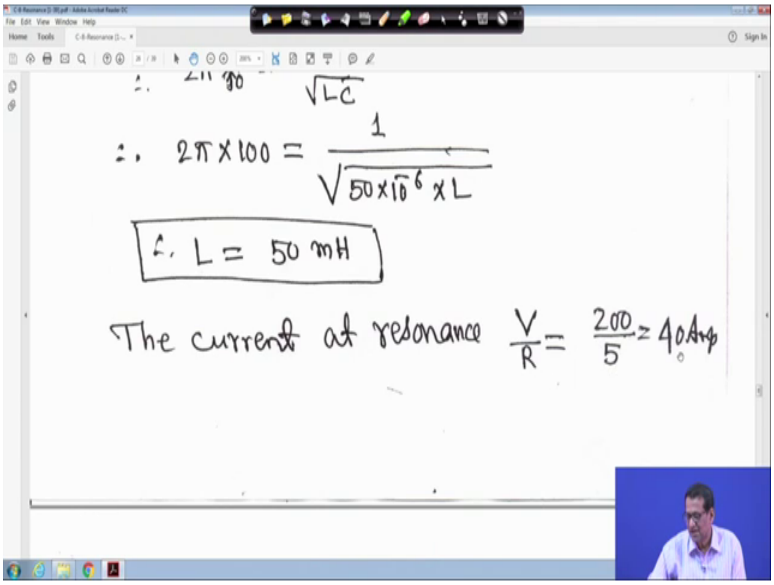

And C is given 50 micro farad, so 50 into 10 to the power minus 6 farad and it is L. So, L will become (Refer Time: 10:30) is 50 milli Henry. Now, the current at resonance will be V upon R, because X L is equal to (Refer Time: 10:37). So, the current is maximum so 200 by 5, so current is 40 ampere right. Now, power dissipated in I square R, so 40 square into 5 8000 Watts is equal to 8 kilo watt right.

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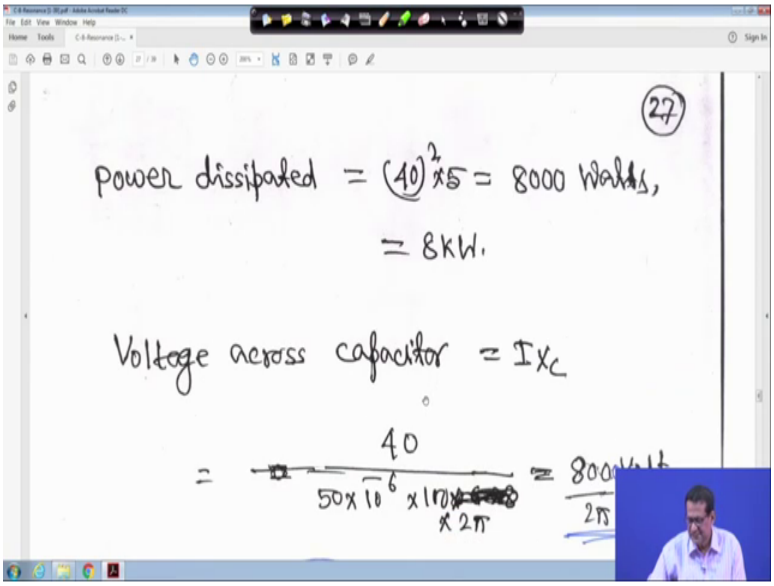

So, voltage across this capacitor voltage across capacitor magnitude I X C right so, I is 40 ampere, and X C is equal to 1 upon omega C, C is equal to 50 micro farad. So, 50 into

10 to the power minus 6 farad into 2 pi into 100. So, it comes around 8000 by 2 pi volt right. Approximately this is this is your 1273.2 volt. This is this is not this thing, this is the correct one 1273.2 volt right.

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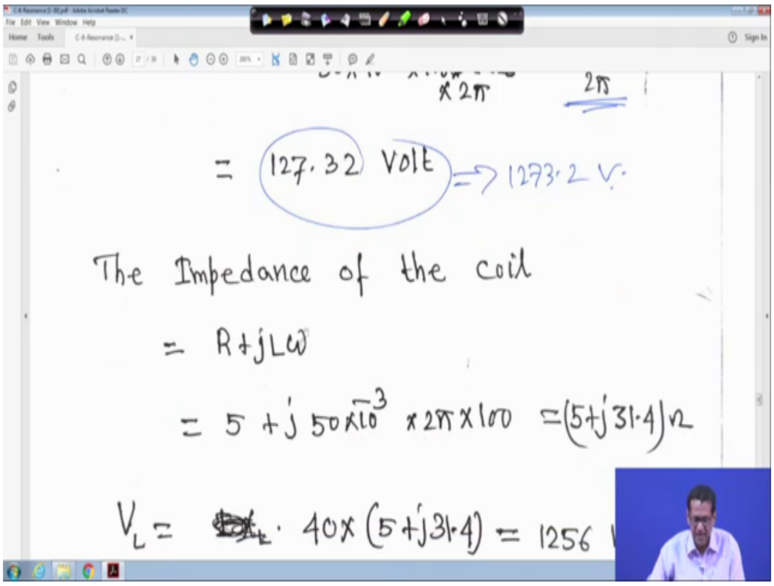

So, the impedance of the coil R plus j L omega so, it is 5 plus j L is 50 into 10 to the power minus 3 into 2 pi into 100 right. So, it is 5 plus j 31.4 ohm. So, V L is equal to I into your Z, so this is 40 is the current we have got into this jth you will get its magnitude it 12 your 1256 volt we have taken magnitude only that your what you call this an angle is not written here right. So, our interest magnitude only, so this one actually it will be multiplied by 40 you just check it right, and root over 5 square plus 31.4 square whatever it comes just check it will be 1256 volt right.

Only magnitude written here, this is actually if I make it, I should make it bar (Refer Time: 12:14) taken here 1256 volt right. So, now Q of the coil will be is equal to your what you call it will be 31.4 by 5 right, because it is X L is 31.4 right and R is 5, so it is 6.3 right. It is a it is basically your what we call the Q 0 of the coil. So, it is X L X L is basically the L omega by R.

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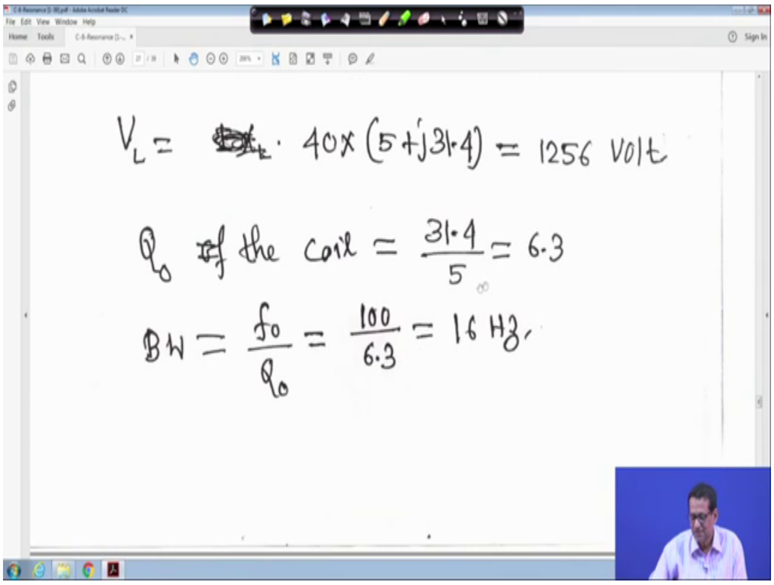

So, L omega is actually 31.4 divided by R is 5, so 6.3. And bandwidth is equal to f 0 upon Q 0 100 upon 6.3 is equal to 16 hertz right. So, this is the simple thing,

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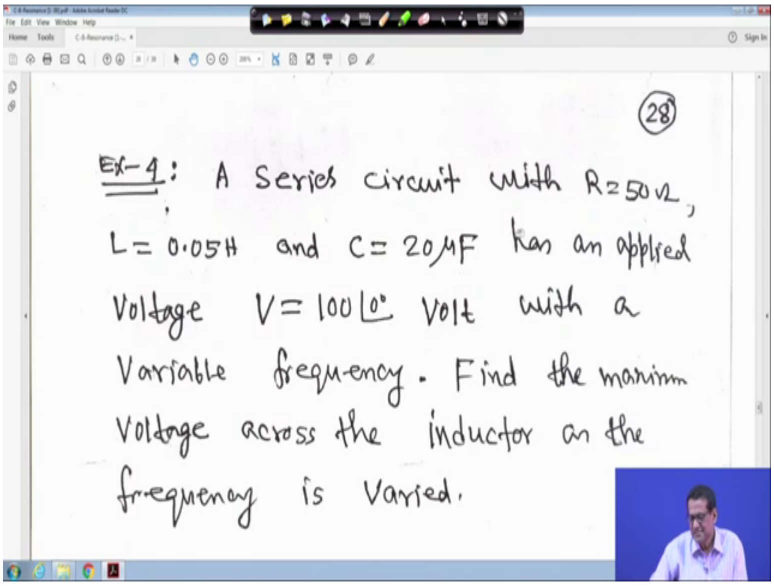

Now, example 4, a series circuit with R is equal to 50 ohm, L is equal to given 0.05 Henry, C is 20 micro farad has an applied voltage V is equal to 100 angle 0 volt with a variable frequency. Frequency is variable here. Find the maximum voltage across the inductor as the frequency is varied. You have to find out the maximum voltage right across the inductor as the frequency is varied. Now, now Z is equal to root over R square plus L omega minus 1 upon omega C square that is X L minus X C square. Therefore, current I is equal to magnitude V upon magnitude of the current root over R square plus l omega minus omega C square whole square right.

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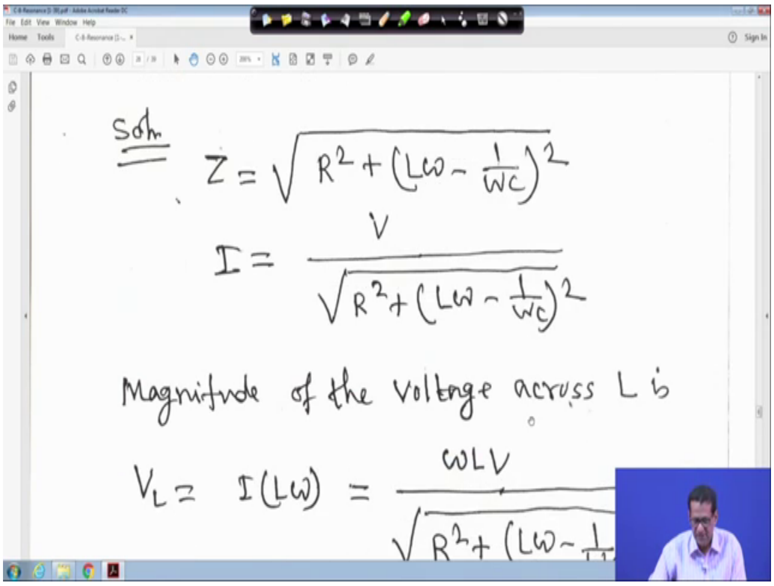

So, magnitude of the voltage across L V V L will be I into L omega (Refer Time13:39) magnitude so that means, X L is accelerating I into X L, so X L is equal to L omega. So, it will be omega L V upon root over R square plus L omega minus omega C whole square.

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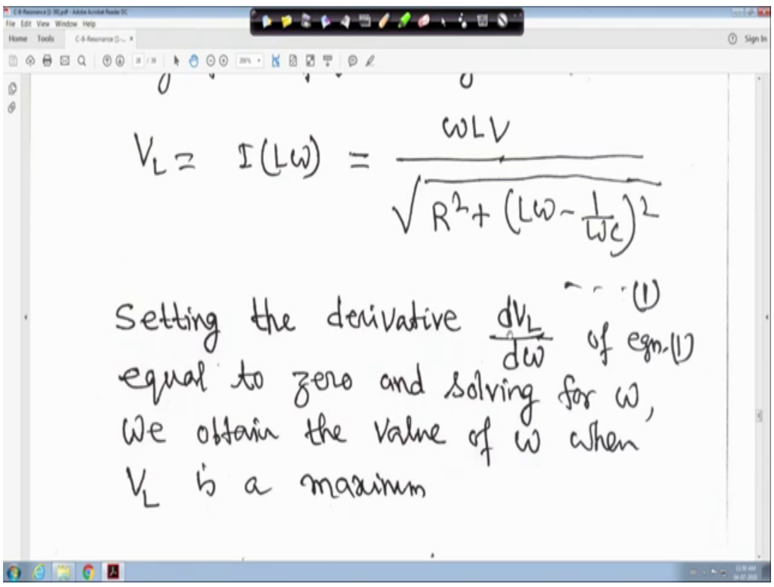

So, setting the derivative d V L upon d omega 0 you take the derivative of this equation 1 with respect to omega right. So, and what you call is equal to 0, and solve for a omega we obtain the value of omega when V L is maximum right, so that means, d V L upon d omega is equal to this one. It is simplified and written to the power minus half you please do little bit of your own. I mean what is there this your X L minus omega square it is expanded right.

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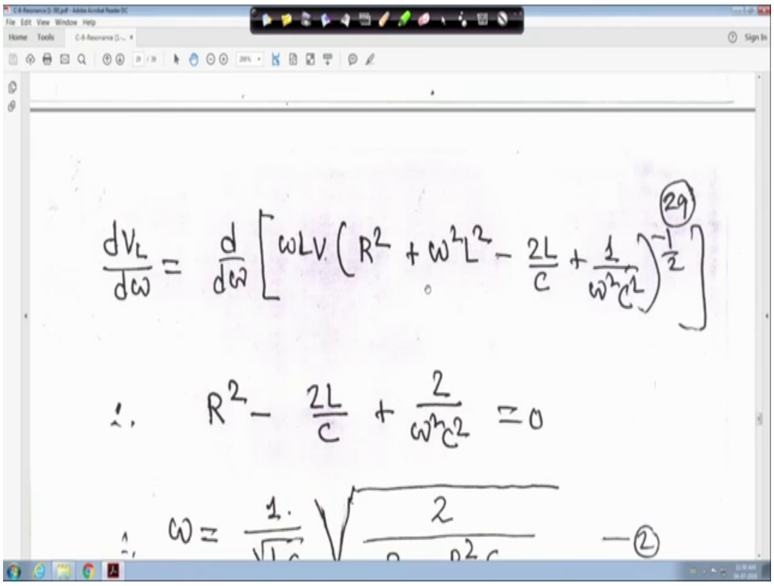

And put your square root here, so 2 to the power minus half right, because it is your omega V upon root over this one, so minus 1 upon R, then you take the derivative. If you derivate and simplify, you will get R square minus 2 L upon C plus 2 upon omega square C square is equal to 0 you will get it that means omega is equal to 1 upon root over L C into root over 2 upon 2 minus R square C upon L right.

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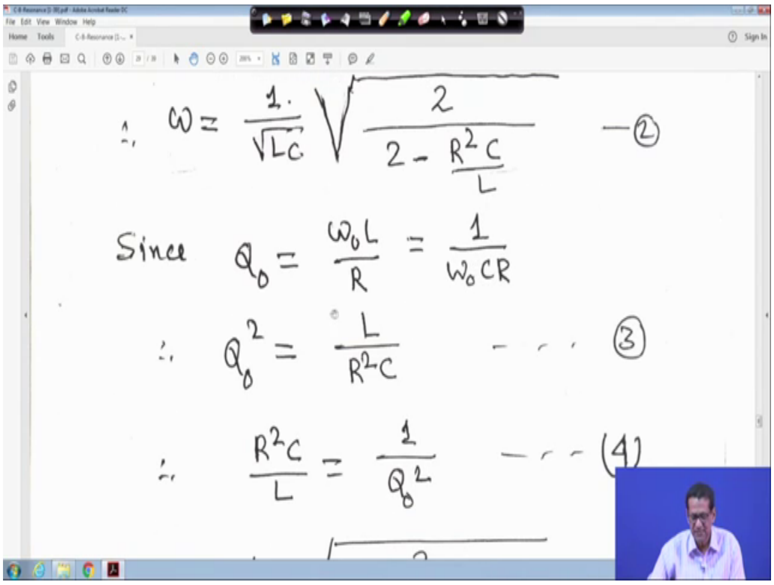

But, we know we have derived it that Q 0 is equal to omega 0 L upon R that we have done is equal to you know 1 upon omega 0 C R that also we have done. And if we also we are if we multiply Q 0 into Q 0, you will get Q 0 square is equal to 1 upon R square C this also we have derived, this also we have derived that means, these term is the reciprocal of this one R square C upon L is equal to 1 upon Q 0 square. So, here you put 2 minus it will be 1 upon Q 0 square right.

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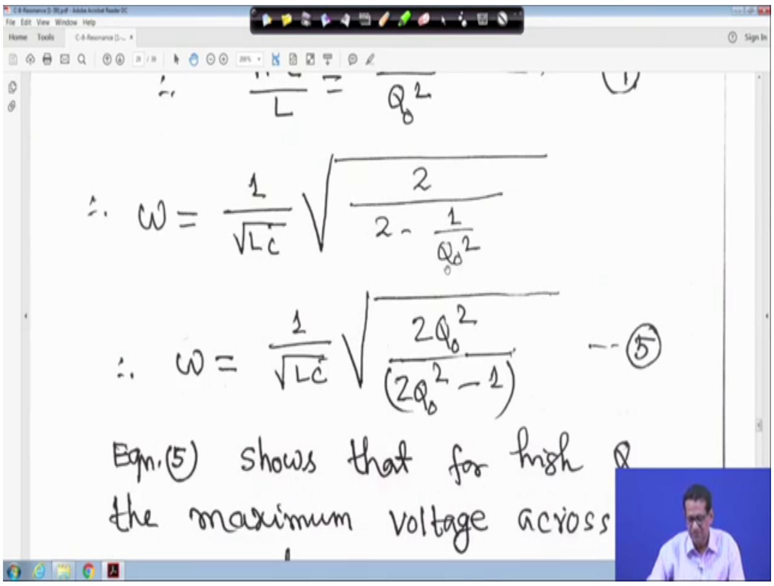

This all this thing we derived so, that means by omega will be is equal to after upon substitution 1 upon root over L C 2 Q 0 square upon 2 Q 0 square minus 1. So, equation 5 shows that for a high Q the maximum voltage your across L occurs at your this omega 0 approximately 1 upon root over L C. Q is very high if Q is very high, then 2 Q 0 square right your what you call minus 1 approximately 2 Q 0 square right. So, this one after Q 0 is very high, so this term will become unity, in that case if it is omega upon oh sorry 1 upon root over L C, so that is your approximate value 1 upon root over L C.

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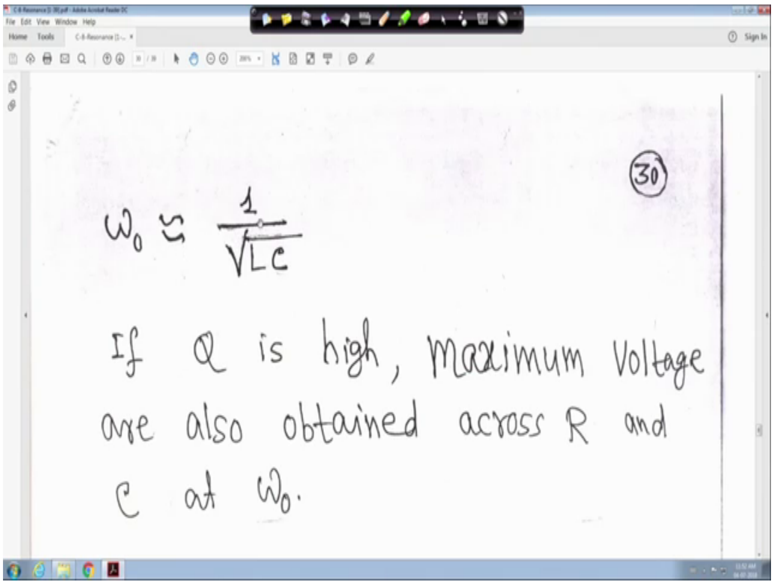

Now, if Q is high, maximum voltage are also obtained across R and C at omega 0 that is your resonance frequency right.

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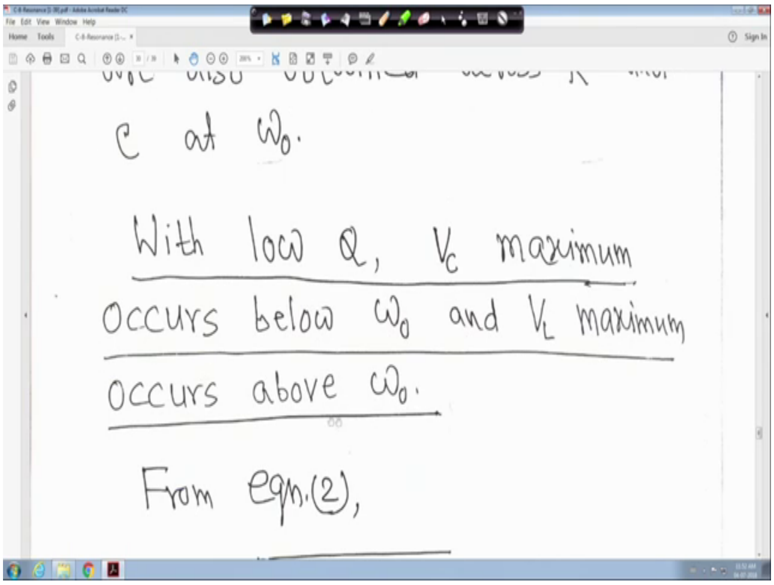

So, with low Q, V C maximum occurs below omega 0, and V L maximum occurs above omega 0. This is a small exercise to you. You look at this expression and with low Q, V C maximum occurs below omega 0, and V L maximum occurs at above omega 0 this one exercise small exercise for you right. Already we have done it for resonance.

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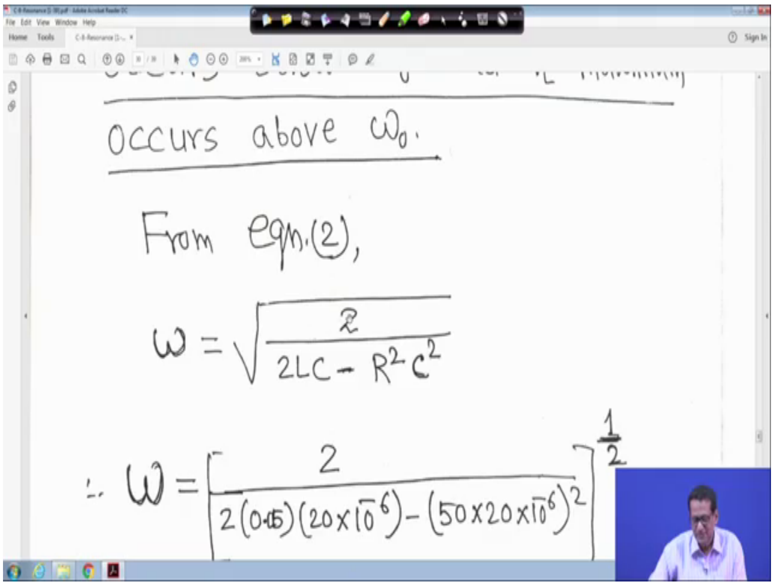

Now, from equation 2, so omega is equal to you can simplify writing root over 2 upon 2 L C minus R square C square then from this equation that is from your from this equation from this equation, now this is equation 2. From equation 2 we can write like this. So, you can write like this. So, C R L all values are given you substitute all this value. Everything is given you will get omega is equal to 1414 radian per second this is the answer right. When you take d V L upon d omega is equal to 0, this is the answer right for which voltage across the inductor will be maximum right. So, so X L is equal to L omega 70.7 ohm, X 0 is equal to X C is equal to 1 upon omega C 35.4 ohm please calculate all these things.

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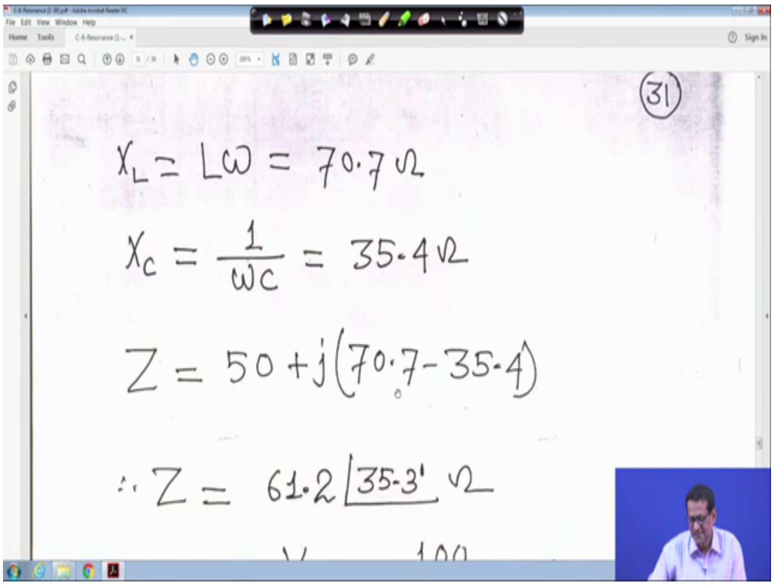

And Z will be then R plus j your X L minus X C. So, whatever it comes it is 61.2 angle 35.3 degree ohm right. Therefore, I is equal to V by Z we get the magnitude that is 100 angle 61.2, so 1.635 ampere right. So, this all these things you please calculate direct substituted for getting omega right. So, it just make this calculation. Therefore V L max will be I into your X L that is your what you call that is your 70.7 right.

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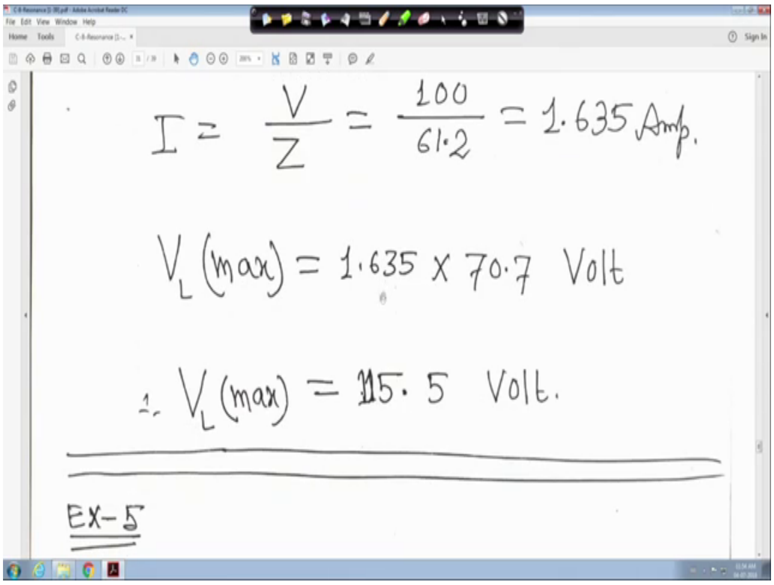

So, you get 115.5 volt. This example is very interesting one right. So, this is the VL max.

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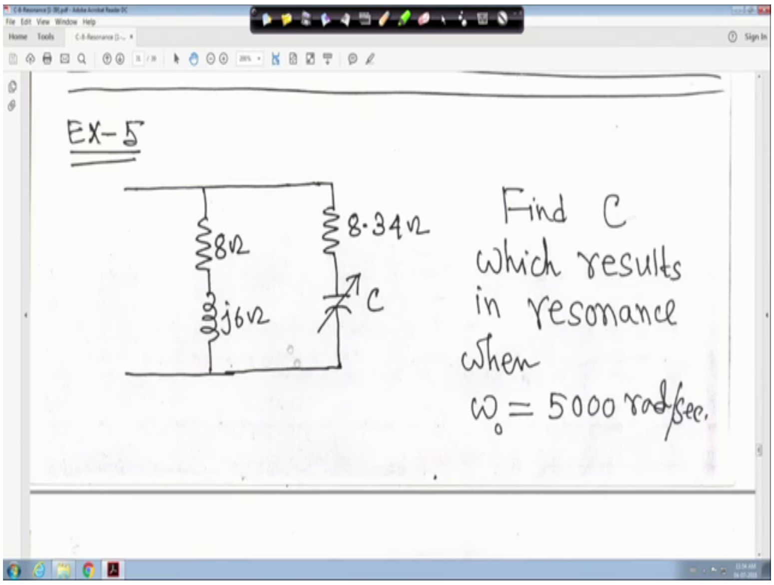

So, example 5 in this case this parallel circuit is there. This is an inductive circuit, so 8 plus j 6 ohm. And this is your capacitive circuit 8.34 ohm, but this C is varying C X C varying. You have to find C, which results in a resonance omega 0 is equal to 5000 radian per second right. So, in this case this problem is very simple, because omega 0 is given. So, in the parallel circuit; so, Y is equal to 1 upon 8 plus j 6 plus 1 upon 8.34 minus j X C right.

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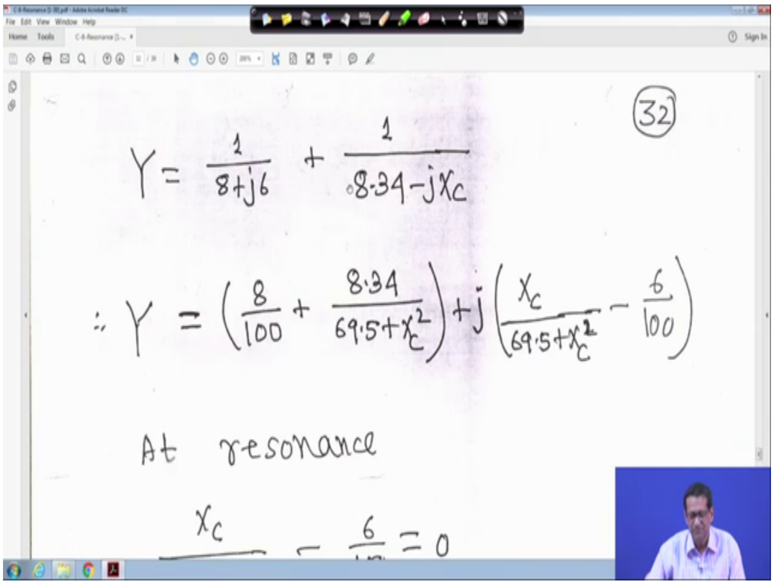

So, this is the Y. So, now you just your what you call this one you multiply numerator and denominator by 8 minus j 6. Here also numerator and denominator you multiply by 8.34 plus j X C. Then you simplify you will get this is the real part and this is the imaginary part. And at resonance this imaginary part will be 0 right. Therefore, if this of this part is 0, then X C upon 69.5 plus X C square minus 6 upon 100 is equal to 0. If we solve it, right you will get two values of X C one is (Refer Time: 19:05) so X C is equal to 8.35 ohm that is equal to 1 upon omega 0 C right.

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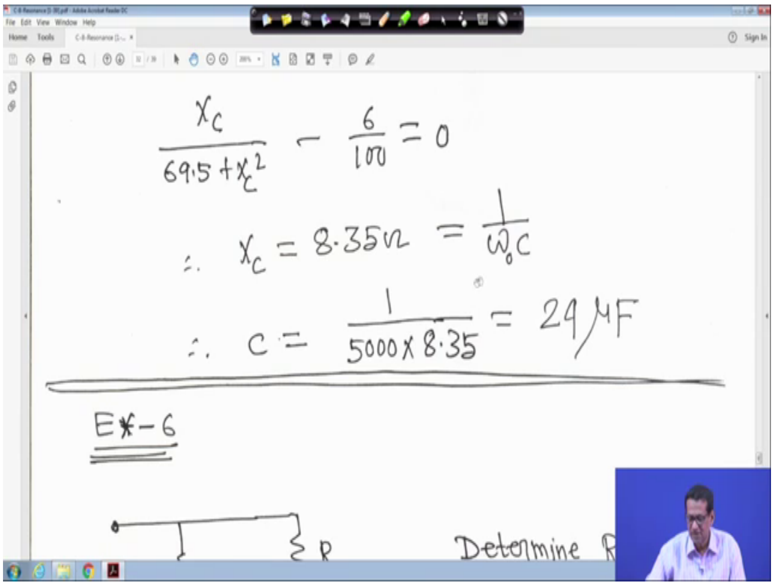

So, if you solve, now that your what you call the omega 0 is given 5000 radian per second it is given. Suppose C is equal to you will get 24 microfarad right. This is the answer.

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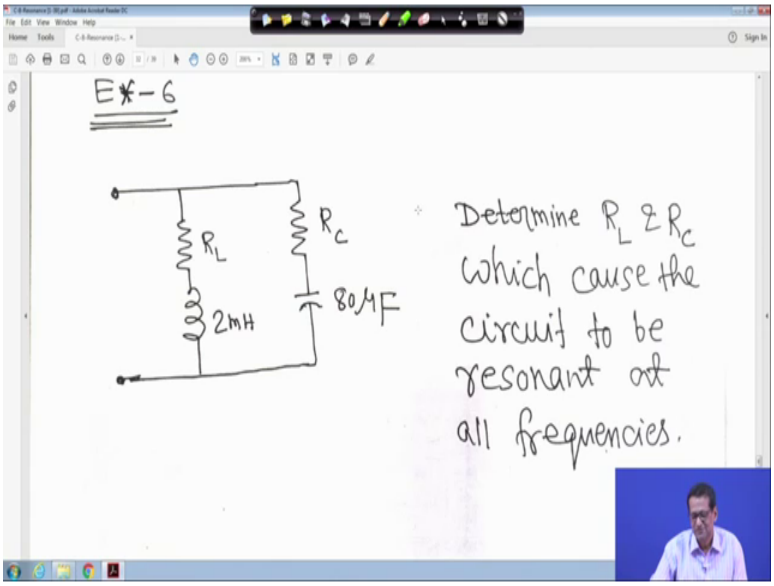

Now, next one is determine your determine R L and R C for this circuit R L and R C which causes the circuit to be resonance at all frequencies right. All frequency means that here we have derived that your what we call 1 upon root over L C into multiplied by some factor. Now, if I recall, now I will not really hope I write correctly. If I recall correctly correct that it is root over L C, say omega is equal to, then the factor that your R L square minus L by C divided by R C square minus L by C something like this.

If R L square is equal to R C square right is equal to L by C, so it actually resonance at all the frequency, because this square root comes it will become actually 0 by 0 undefined. So, it would circuit with resonance will happen at in all frequencies right (Refer Time: 20:17) you have to find out what is the R L and R C this one this condition. So, answer is not given here I given intentionally I did not write the answer. So, please do it whenever you do it, let us know the answer I will tell you the correct answer (Refer Time: 20:28) right.

So, with this with this your resonance part is over. So, some typical examples we have seen after that very simple thing it is that is the maximum power transfer theorem for D C circuit we have seen. So, for A C circuit also very simple it is we will see the maximum power transfer theorem. Concept is from that D C we have already started. So, A C we will see little bit.

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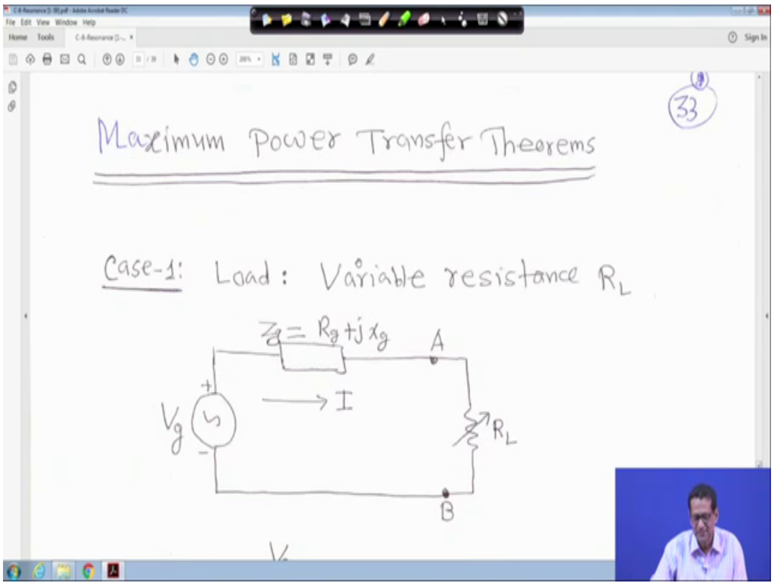

So, this is the maximum power transfer theorem for A C circuit. Now, there are 2 3 cases 3 cases; so, case 1 load right. The variable resistance is R L suppose this is my voltage source V 0 is given for a circuit, plus minus polarity is marked current flowing through this I. And this is Z g is equal to say R g plus j x g impedance is given, and this R L is variable right. In the case of D C circuit, because in D C supply. And this was also your what you call this is R Thevenin this is one V Thevenin in the case of your D C circuit.

So, here also suppose this is given and then what will be your value of R L for the maximum power transfer theorem right. So, if you see the current magnitude, I will be equal to V g approximate that angle is 0, V g angle 0 right. If you and it should not be in confusion in here right this will be V g angle 0 degree that we have take in the magnitude. So, current is I is equal to V g upon this is the series impedance together, so R g plus R L plus j x g right. So, this is my current magnitude.

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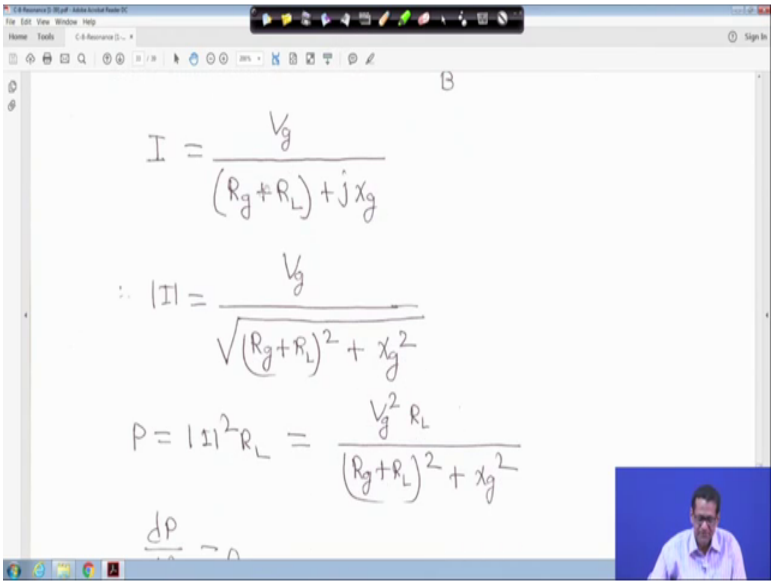

Now, now your what you call, therefore your this one is just hold on. This is the given phasor this is actually then we put angle 0 degree, because V g I told you angle 0 degree, this is a phasor because we have put j, so it is it is phasor quantity not magnitude. Now when you take the magnitude, you will take the absolute right. It is V g upon root over R g plus R L square plus x g square right. So, this is the magnitude, therefore power actually across R L always across at R L in magnitude I square into R L. So, this can be V g square into R L by R g plus R L square plus x g square right.

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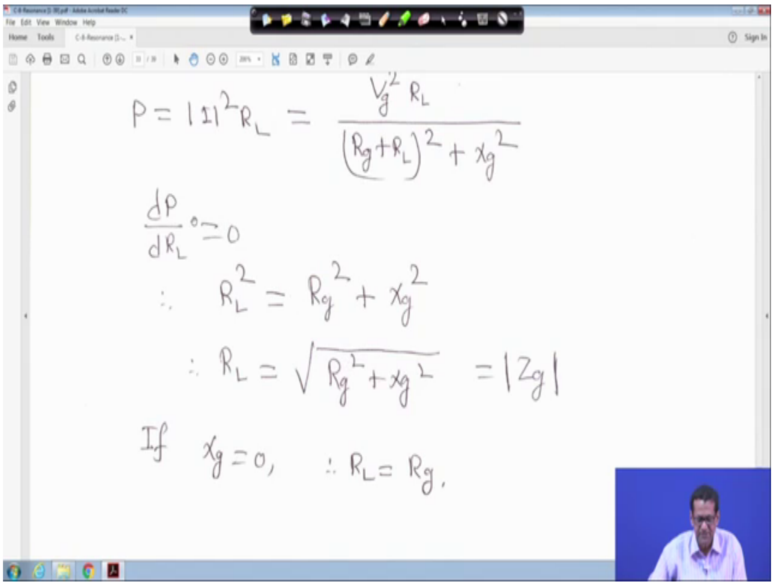

Now, for maximum power transfer theorem d P upon d R L is equal to 0 right. If you solve if you make it 0, you will get R L square, you will get R g square plus x g square that means R L is equal to root over R g square plus x g square, and that is equal to magnitude of Z g. Because, Z g Z g was given r g plus j x g, so its magnitude Z g is equal to root over it is capital R root over R g square plus it is it is capital, X it is also capital X capital X g square right, so that is why R L is equal to root over your sorry magnitude of Z g right.

And for like your if x g is equal to 0 like your D C maximum power transfer theorem, the naturally R L is equal to your R g. There we do (Refer Time: 23:28) in that case it was R L is equal to (Refer Time: 23:31) what DC circuit (Refer Time: 23:32) similar thing. So, this is actually for that means that means for this circuit you have to keep it in mind, for this kind of circuit R L will be your root over R g square plus j x g square is equal to mod g right. But, never be never be R L is equal to R g right it will be root over mod g root over R g square, it will be mod g root over R g square plus x g square R L is equal to right. So, this is your R L.

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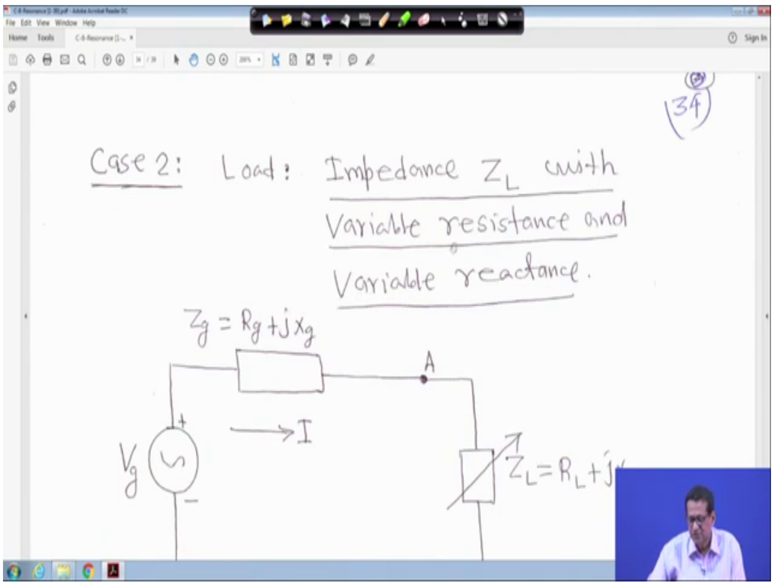

So, now case 2; then in this case, that impedance Z L with variable resistance and variable reactance. So, here also here also your what you call this is also my V g angle 0, angle is not shown here, polarity is shown here. And this is suppose j x g is equal to R g plus j x g right. It is something like your v (Refer Time: 24:21) and j (Refer time: 24:22) say this the current I and this Z L is variable both R L and X L are variable right, so that is why that is that is that is given here, impedance Z L is variable resistance and variable reactor both are variable. So, so we have to find out the value of your what you call that your what you call the impedance right. So, now current I is equal to V g upon then you add R g plus R L plus j x g plus j x l, like your series circuit whatever you do.

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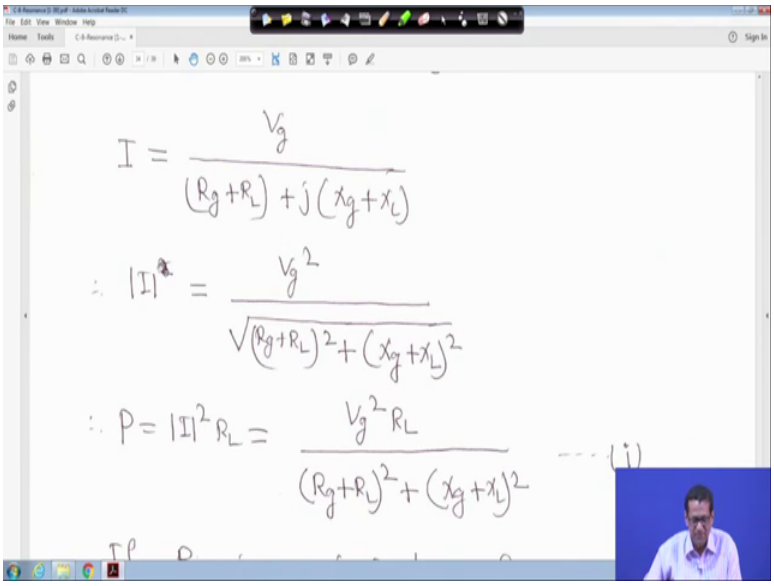

So, this is my this thing. So, magnitude of the current I your what you call here one, here one this thing is there. This should not be there. right. So, it is vg upon your what you call and here if you want, you can put this one this angle 0. So, magnitude of I is equal to V g upon root over R g square plus R L square plus x g plus X L square right. Now, P is equal to your I square R L is equal to V g square R L divided by R g plus R L square plus x g plus X L square this is equation 1 right. So, let me. So, this is not a square this is here well here I correct here I forgot. So, this is not there V g upon this 1. It is understandable to you.

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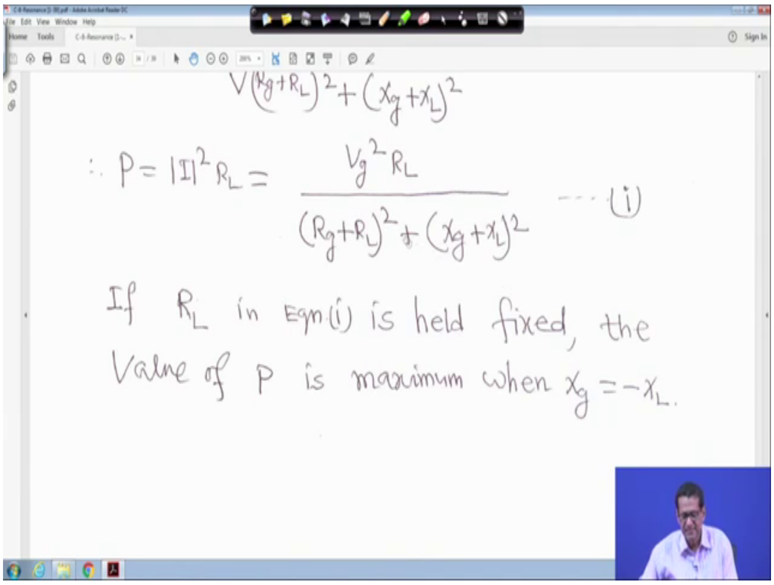

So, now if R L in equation 1 this equation is held fixed, suppose R L we have fixed in it say R L is held fixed. The value of P is maximum when x g is equal to minus X L. So, if you said x g is equal to minus X L that means, x g plus X L is equal to 0. So, this term will vanish, therefore, power is maximum if R L is held fixed right. So, in that case the value of the P is maximum, because x g minus X L x g is equal to minus X L means x g plus x g plus X L is equal to 0 I mean this term will not be there. So, in that case it will be V g square upon R L by R g plus R L square.

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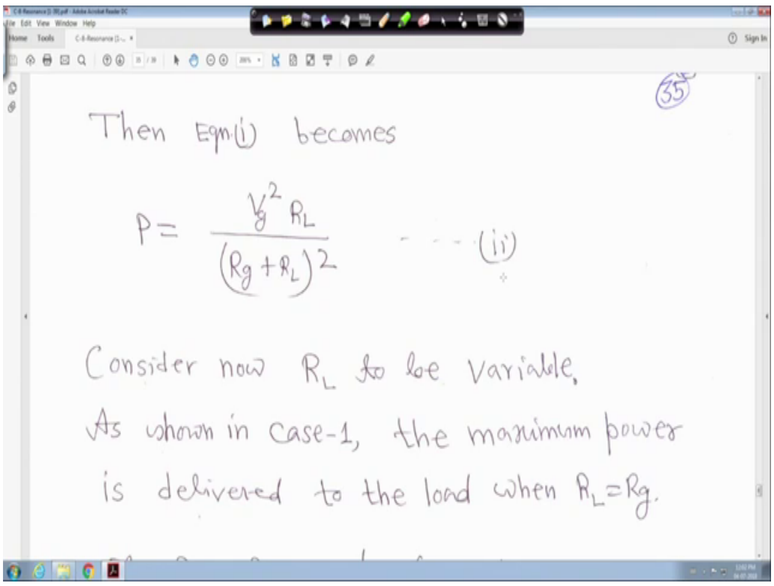

If R L is held fixed, so that means, equation one will become your V g square upon this is vg square into R L upon R g plus R L square this is equation 2 right. Now, if you as consider now R L to be variable right (Refer Time: 26:34) in DC circuit R L to be variable. As shown in case 1 the maximum power is delivered to the load when R L will be is equal to R g, there also you said for the first case X g is equal to f 0 then R L is equal to R g. In that case, your what we call that X L is equal to that means, therefore the maximum power is delivered to the load R L is equal to R g. If R L is equal to R g, and X L is equal to minus X g.

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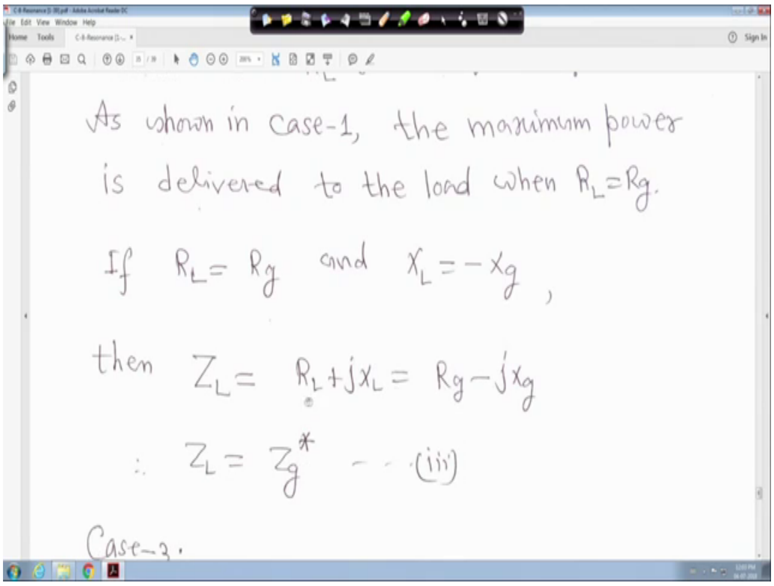

Then Z L is equal to R L plus j x L here is the circuit there, Z L is equal to R L plus j x l. And here you put X L is equal to minus x g for maximum part of the theorem. So, here if we put that X L is equal to your what you call minus X g, then Z L is equal to R g minus j x g then Z L is equal to Z g conjugate, because your Z g actually is equal to your R g plus j x g. Therefore, Z g conjugate is equal to R g minus j x g right that is why for maximum power transfer theorem, when both R L and your X L your both are your what we call variable, then this is the condition for maximum power transfer maximum power transfer that Z L is equal to Z g conjugate right.

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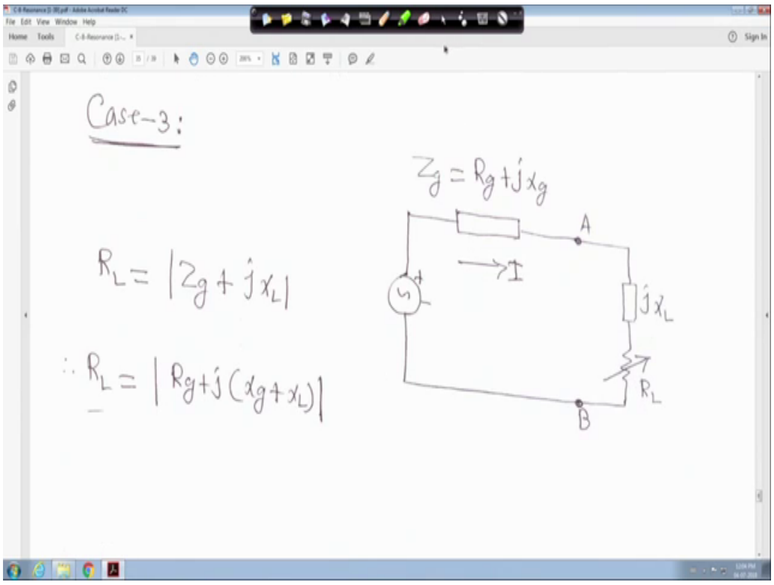

Another one is the case 3. In this case in this case your Z L is there, where X L is fixed, but R L is variable. This is the case 3. So, in that case, you please do it. So, in that case you directly add this one, you will get R g plus j x g plus X L. So, in that case what will happen, R L will become absolute Z g plus j x l. So, R L will be R g plus j x g X this you can do yourself. Therefore, my R L will be is equal to maximum power transfer theorem, it will be R g square plus X g plus it is capital is taken does not matter this one is square. This is this is for maximum transfer straight forward we are writing like this right. This your this your this thing and this thing your right. So, it will be R g plus j x g plus X L right. So, these three cases is R there right.

So, in the now with this thing, we will take (Refer Time: 28:54) few simple your simple example three four example. Suppose in the circuit of figure 1 that is this is figure 1 I show you. The load Z L consists of a pure resistance R L. Find the value of R L for which the source delivers maximum, it will be to this maximum power right power is using. So, maximum power to the load, determine the value of the maximum power P also right. So, let me clear it.

So, this is the circuit is given. This is 10 j 20 ohm, and this is Z L is given R L that means, it is basically simply R L right. And this is the source 50 angle 0 volt. So, we know R L is equal to mod Z g. So, it will be mod 10 plus j 20. So, root over 10 square plus 20 square. So, 22.4 ohm it will come. Therefore, I is equal to V g upon your that is your what we call Z g plus R L. So, Z g 10 square j 20, and R L we got 22.4, so it will be 1.31 angle minus 31.7 degree ampere right. And therefore, P is equal to I square R, so 1.31 square into R L is equal to 22.4, so it is 38.5 Watt. It is a very very simple problem very simple problem right.

Similarly, example 2; in this case repeat example 1 with Z L is equal to R plus j x l. R L and X L are both variables I mean you repeat this example when Z is equal to your R L plus j x l added, and all data remains same, all data remains same right. So, in this case your what you can do is that your total impedance your we know that for the this one R L and X L both are variable. So, my Z g was 10 plus j 20 and your j 20, therefore Z L is equal to Z g conjugate that will be 10 minus j 20 right.

This way we have seen in our theory therefore, total impedance will be Z g plus Z l Z g is 10 plus j 20 and Z L will be 10 minus j 20, so minus j 20 plus j 20 cancels it will be 20 ohm. Therefore, I will be is equal to 50 angle 0 degree by Z T that is 20 only, so it will be 2.5 angle 0 degree ampere. And P is equal to I square into R, so that is why I square is 25 square, and this is 10, so it will be that is R L 10 ohm it will be 62.5 Watt.

So, only these condition repeat just keep it in mind then everything will find simple right. So, now another thing in the circuit shown in figure this 2 this is figure 2 right. The resistance R g is variable that means, this resistance R g is variable between 2 and 55 ohm that means R g actually that means, if you write like this that means that means, your R g is lying in between these two, and 55 ohm right. Then what value of R g results in maximum power transfer across the terminal ab. This is my terminal A and this is my B. And this is my R g variable R L is 10 ohm this is my your X g 5 ohm right.

So, in this case your what you call voltage is given 10 angle 0. In the network shown in figure 3 the load connected across terminals AB consists of a variable resistance R L right. R L and your what you call and a capacitive reactance X C right. So, in that your what you call, and which is variable between 2 ohm sorry this one, just one minute this one actually your this problem sorry this problem actually I have not solved you have to find it out this is you have to find it out right. This problem actually you find it out this is not solved here right. So, this is this is an exercise for you this is solving right. So, now, next problem is example answer is not given here answer is not given here. So, this is for you actually solve it. I have not solved it here. Actually solve, but I did not put it here you solve it. Now, example 4 in the network shown in figure 3; suppose the load connected across terminal A B consists of a variable resistance R L and a capacitive reactance X C I will show you which is a variable between 2 ohm, and 8 ohm.

Determine the value of the R L and X C, which result in maximum power transfer you have to calculate the maximum power P delivered to the load. This is the problem your what we call written here right. And this is the circuit, this is voltage 50 angle 45 degree. This is 3 ohm this is minus j x c variable, and this is R L. j x c, and R L variable, and this is your 2 ohm j 10 ohm. (Refer Time: 33:38) these two are variable. This is the point A, and this is the point B, and this is the circuit. Now, question is that what is first one is to find out the v (Refer Time: 33:47) v (Refer Time: 33:48) means that we have solve for DC circuit.

So, v (Refer Time: 33:52) means first you remove this one. Suppose it is not there, first you remove it. So, as soon as you remove it then you find out what is the current I right. So, the current I am writing here current I is equal to your 50 angle 45 degree divided by this is 3 plus 2 plus j 10 right. This is the current I right, because this is not there because we are reopening, because on to get the (Refer Time: 34:20) So, this is the current I. So, once you get the current, so this is open circuit I am not drawing the circuit again.

So, this is my VAB this is my v (Refer Time: 34:29), because this is open this is open this is nothing is there. So, this is A, this is B. So, it is VAB is equal to v (Refer Time: 34:36). So, this is my current this is my current I into this is my voltage that is my sorry this is my impedance that is my 2 plus 0 ohm whatever it comes right. So, same thing is written here 50 angle 45 degree. This 3 plus 5 plus j 10 so, this is 5 plus j 10 into 2 plus j 10 into 2 plus j 10. This is my v (Refer Time: 34:57) right. So let me clear it.

So, this is my (Refer Time: 35:03) we will got 45.6 angle 60.3 degree your Z (Refer Time: 35:07) is equal to when this one is not there when this one this point this is open (Refer Time: 35:13) mean you have to (Refer Time: 35:15) DC circuit it is started right. So, it will be three open 2 plus j 2 means parallel. So, it will be 3 into 2 plus j 10 right divided by 3 plus 2 plus j 10 right. So, this is my your this is my Z (Refer Time: 35:31) right. So, if you find out Z (Refer Time: 35:36). So, this will be my your what we call Z (Refer Time: 35:39) 2.64 plus j 0.72 ohm.

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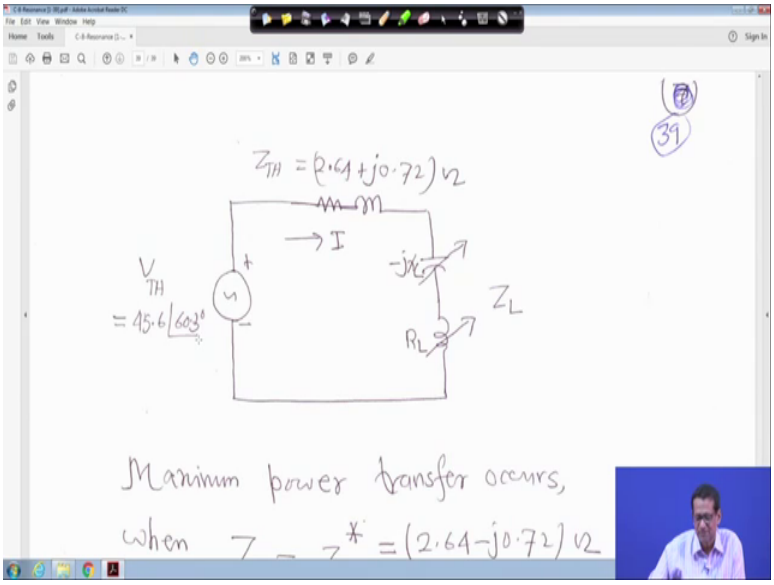

Then the equivalent circuit is this V (Refer Time: 35:45) 45.6 angle 60.3 degree. And this is my Z (Refer Time: 35:49) 2.64 plus j point 7 2. And both variable R L V also variable X is also variable. So, for maximum power if both are variable. So, for maximum power transfer you know Z L is equal to z (Refer Time: 36:02) in this case conjugate, because this is Z (Refer Time: 36:04).

So, it is conjugate, so it will be 2.64 minus j 7.2 ohm, but now x C is adjustable between 2 ohm and 8 ohm. So, the closest value of x C is 2 ohm right, because we will got actually what you call, it is 0.72, but x C only variable between 2 and 8 ohm. So, closest value is 2 ohm only, because as it is 0.7. So closest value is 2 ohm so, x C is taken as 2 ohm right, therefore right.

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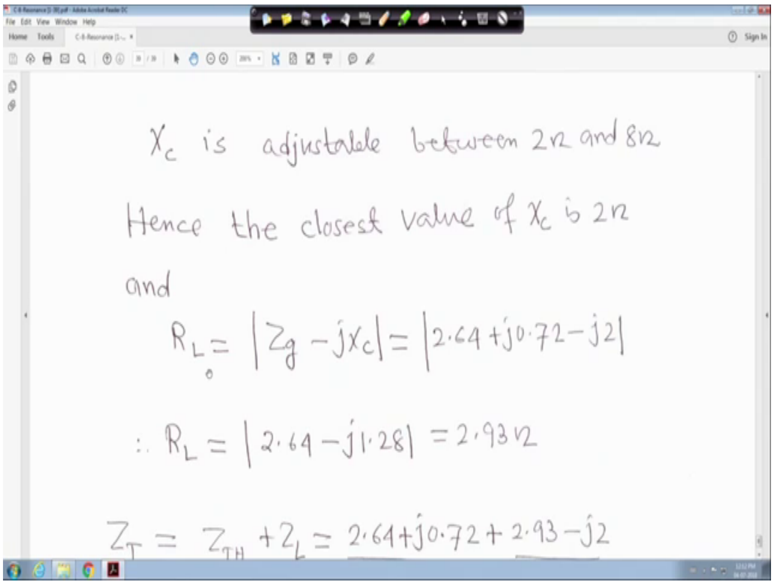

Therefore, R L is equal to mod Z g minus j x c you have already done it; you forget R L and X L are variable. So, in this case, it will be 2.64 plus j 7.2 minus j x c is equal to taken 2 ohm right, so that means, my R L will become 2.93 ohm. Therefore, Z T will become z (Refer Time: 36:52) plus Z L; Z (Refer Time: 36:53) is this one, this 2.64 plus j 0.72 and (Refer Time: 36:59) Z L will become 2.93 minus j 2, because some range is given, here you got something, here you got something, but closest value is 2 (Refer Time: 37:07) x C in between 2 and 8 right.

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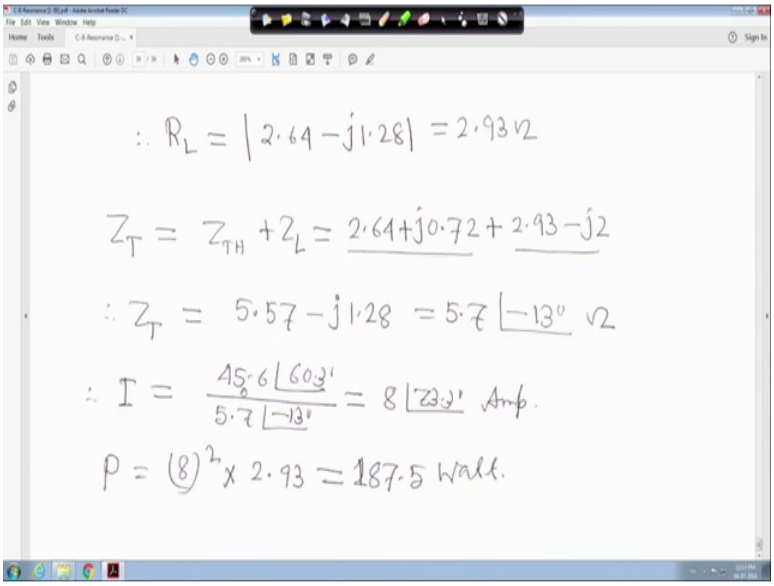

Therefore, your what you call that the you calculate I now Z T got this value, you got this value. Then you get I this one (Refer Time: 37:21) your Z T, you will get 8 angle 73.3 degree ampere. And power is equal to your 8 square in to 2.93 that is 187.5 watt.

Thank you very much; we will be back.