Fundamentals of Electrical Engineering

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Lecture – 44
Resonance and Maximum Power Transfer Theorem

So next we are back again, so, next parallel RLC circuit right, look whenever making it trying to cover each and everything, it will be helpful for you right. And just you I mean things are very simple and as it has been taken from the different books. Books are given in that your what you call all the list of the book, that is and something it is something in my class notes right.

So, something I have tried something of my own also, for our understanding. So, any good book you should follow, the books which I have referred there in your this thing your 4-5 books referred just see those books right. All these books are available right in your library also all these books will be available.

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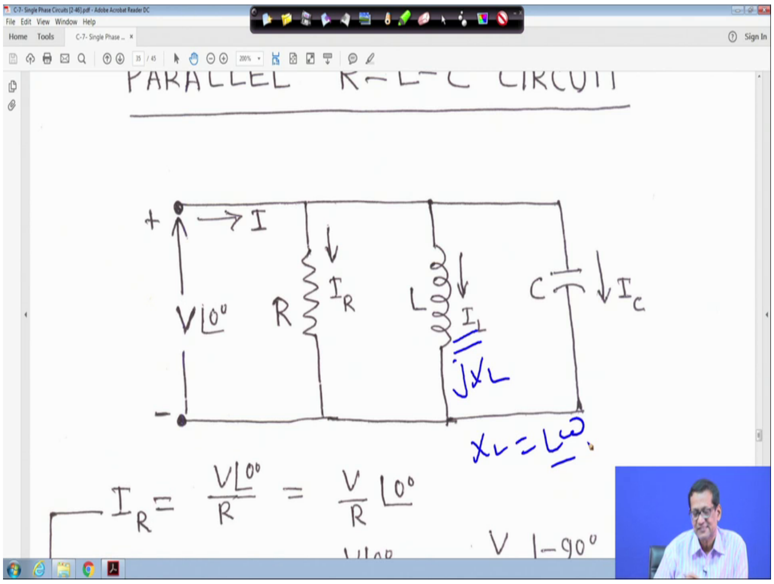

So, now this is a simple parallel circuit right RLC circuit, voltage source V is given, R, L and C, all these things are parallel. So, current flowing through this R is I R, through L, I L and through I C right. So, what we have to do is that is a parallel circuit. So, let us see I R, I L, I C and I, this total current is I, I is equal to I R plus I L plus I C right kcl if you apply here.

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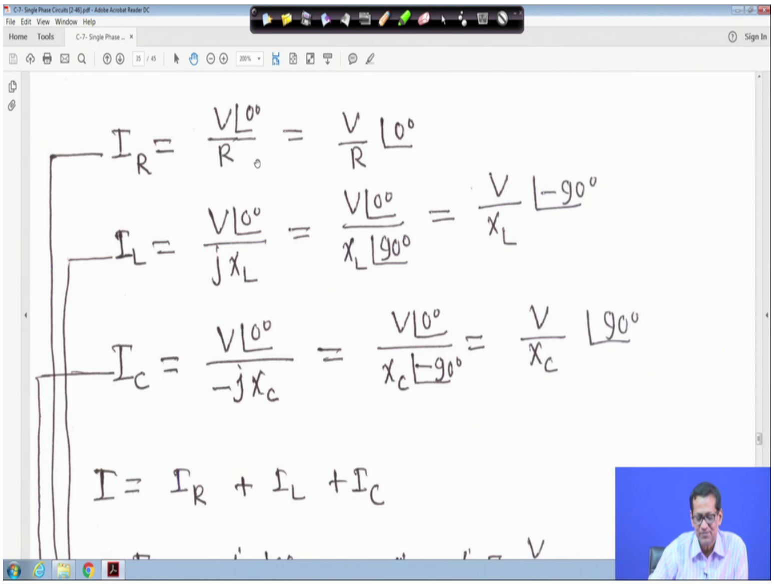

So, I R is equal to we are taking this V angle 0 degree, this is reference voltage is given. So, parallel circuit so, V angle 0 upon R so, V R angle 0 right, this is the I R. I L is equal to V angle 0 upon jX L, this is your whenever it will be given like these this is your this thing. So, it is actually will take jX L right, X L is equal to L omega right, this is your what we call that your X L is equal to L omega. So, this is jX L we take so, we take jX L similarly, for the capacitor when will take actually it is your what you call.

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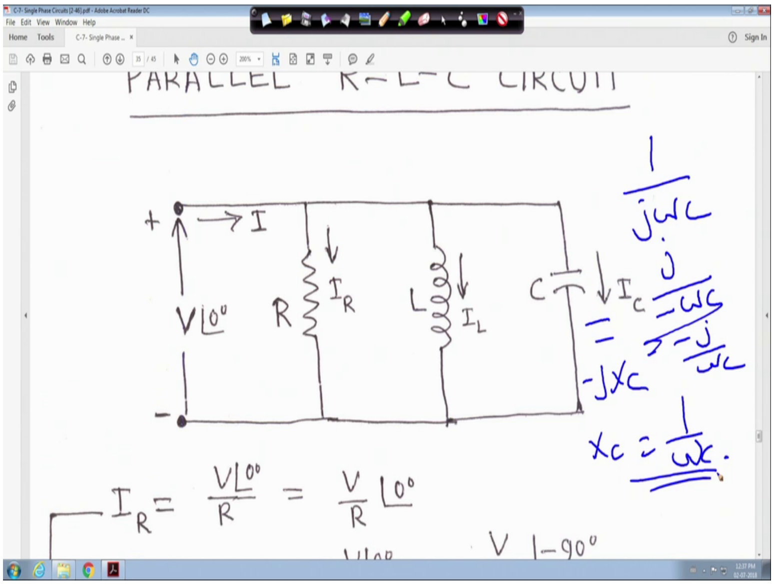

We will take minus jX C and X C is equal to 1 upon omega C right, this way we will take, generally 1 upon j omega C this will be this thing. If you multiplying numerator and denominator it will be j by j square j square is minus. So, minus omega C is equal to minus j by omega C right.

So, that is why we write minus jX C and X C is equal to 1 upon omega C right. So; that means, your this one; that means, V angle 0 upon jX L is equal to V angle 0 X L 90 degree. So, V upon X L angle minus we have seen in the pure inductive circuit your what you call current lag we have seen it.

Similarly, for capacitor we see the currently it is the voltage, V angle 0 minus jX C. So, it is V angle 0 X C is angle minus 90 degree because, of j minus j it is minus 90 degree. Here because of j it is plus 90 degree so it will be V upon X C 90 degree. So, I is equal to I R Plus I L plus I C right.

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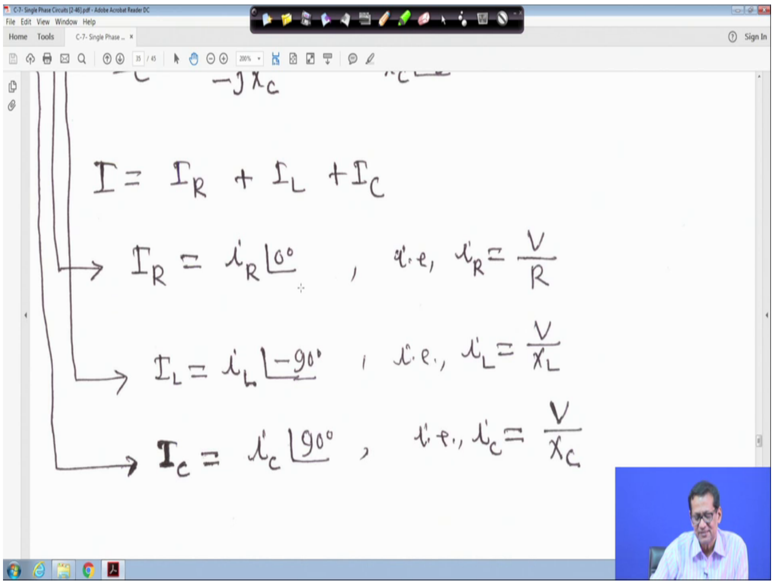

So, IR is equal so, i R angle 0 because, your resistive circuit this is your circuit and this is your this is your what we call V upon R angle 0. So, IR is equal to your i R angle 0 that is i R is equal to V upon R, IL is equal to i L angle minus 90 degree. This i L is nothing, but V upon X L this is the magnitude. Similarly, IC is equal to i C angle 90 degree, i C is nothing, but V upon X C right.

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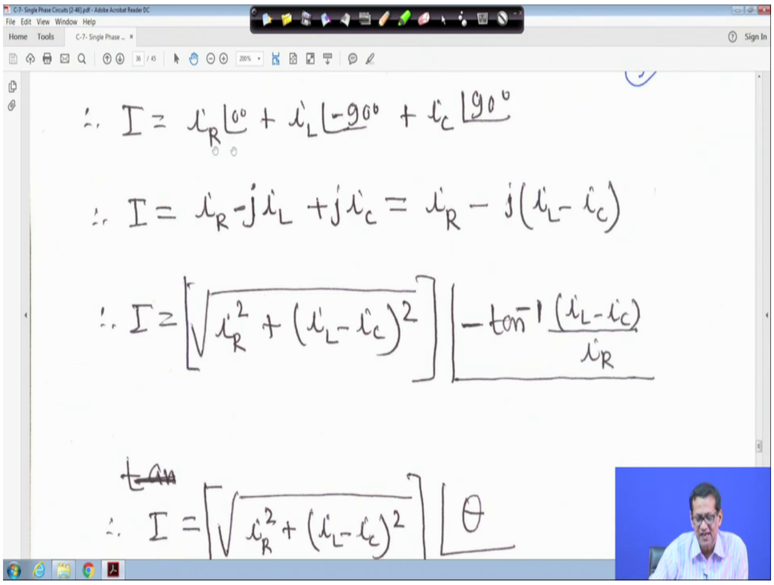

So, now if you add the total current I will be IR angle 0 plus i L angle minus 90 degree plus i L angle 90 degree. So, its magnitude will be root over IR square plus i L minus i C whole square and angle is minus tan inverse i L minus i C upon R.

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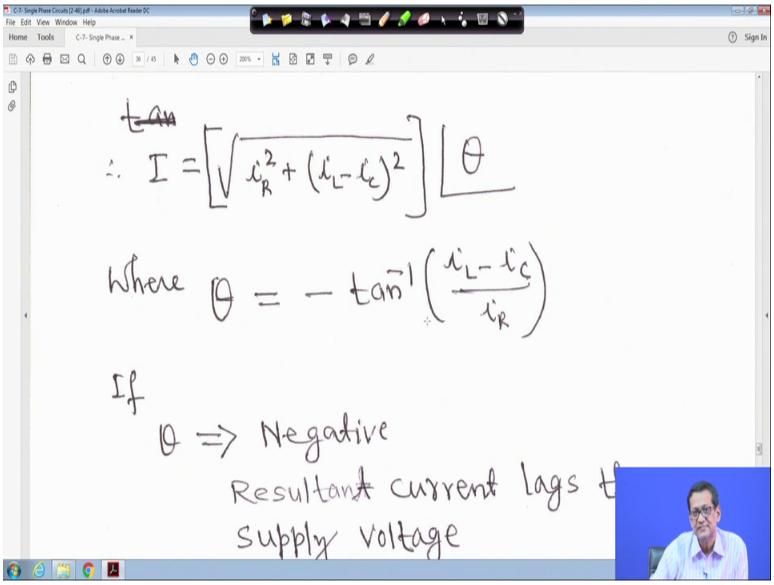

This is now, understandable to you therefore, you can write this is the magnitude of the current I into angle theta and theta is equal to minus tan inverse i L minus i C by R right.

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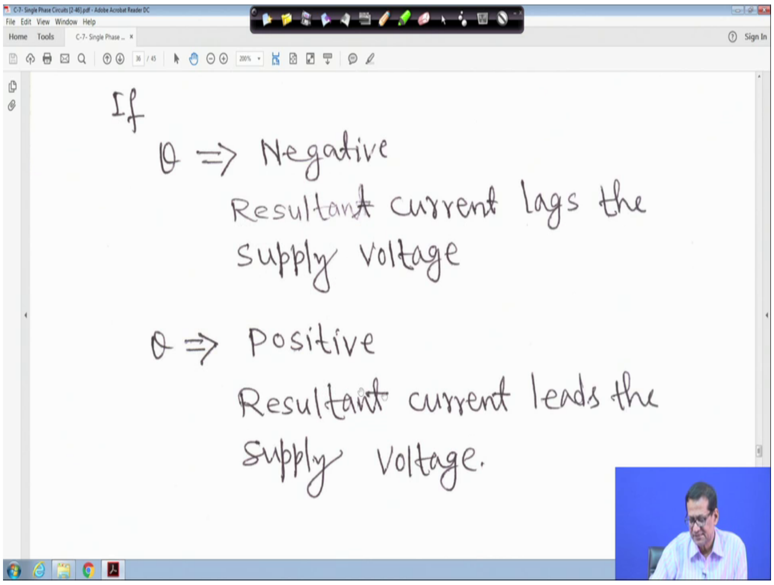

Theta negative then resultant current lags the supply voltage if theta is negative and if it is positive resultant current reach the supply voltage right.

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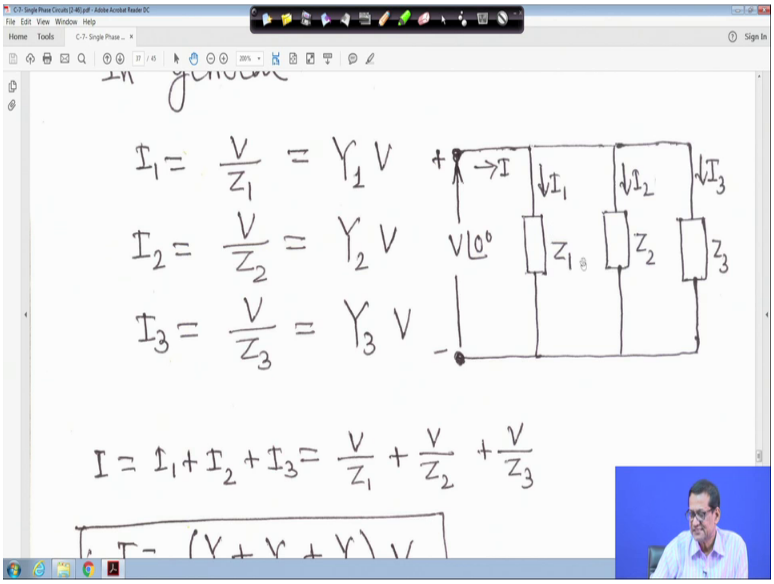

So, in general this is the circuit here in general. So, here suppose in general if it is Z 1, Z 2, Z 3. So, it is not pure R it may be some impedance, some impedance, some Z 1, Z 2, Z 3. So, I1 will be V upon Z 1 parallel circuit will be Y 1 V, I 2 will be V upon Z 2, it will be Y 2 V and I3 is equal to V upon Z 3, it is Y 3 V right therefore, I is equal to I 1 plus I 2 plus I 3 right.

So, it will be V upon Z 1 plus V upon Z 2 plus V upon Z 3 right therefore, I is equal to Y1 plus Y 2 plus Y 3 V.

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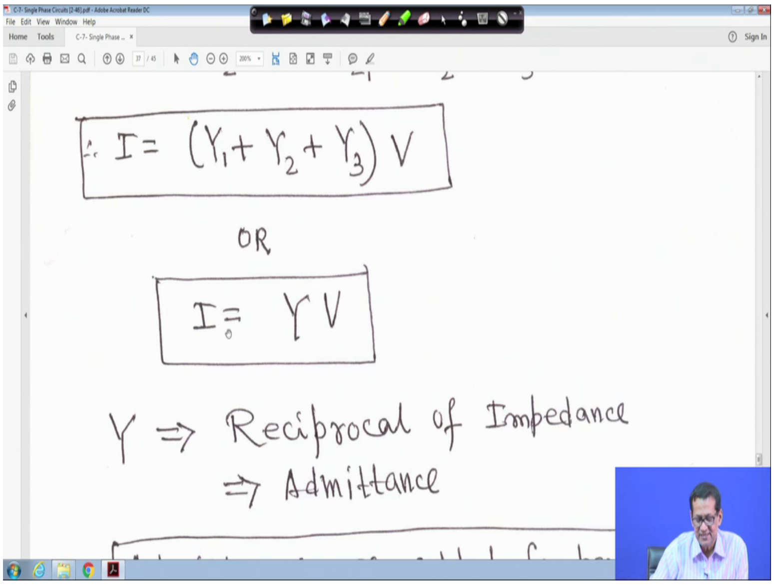

Or I is equal to YV or Y is equal to reciprocal of impedance that is called admittance just now we have seen right.

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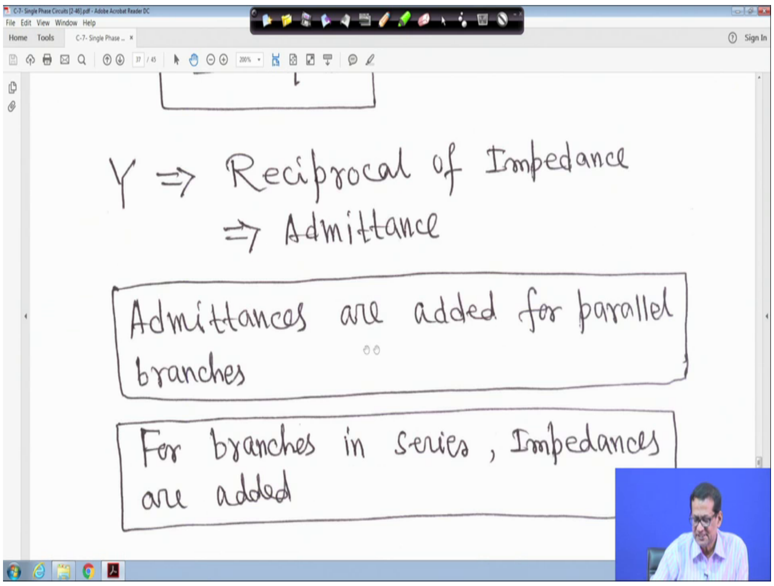

So, admittance are added for parallel branches, for branches in series impedance are added and for branches in parallel right admittance are added right. So, now, parallel equivalent, next is this is the simple thing right this is the simple example will do.

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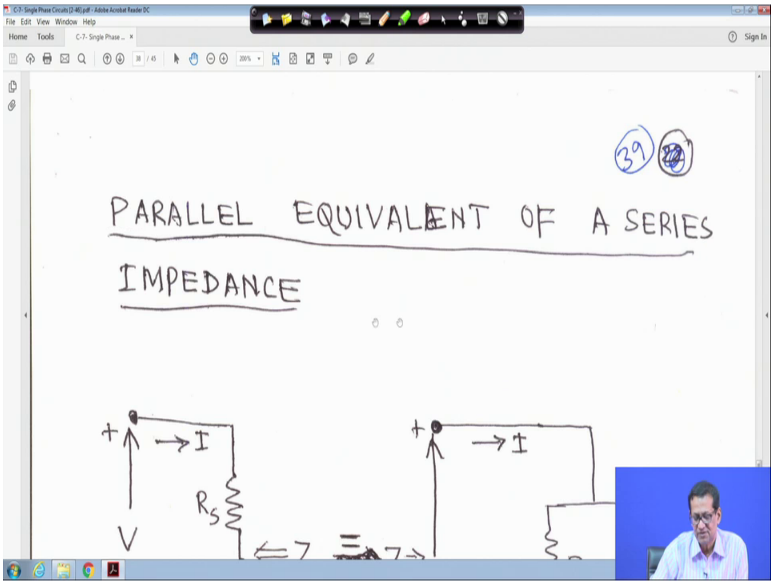

Now, next is that parallel equivalent of a series impedance right.

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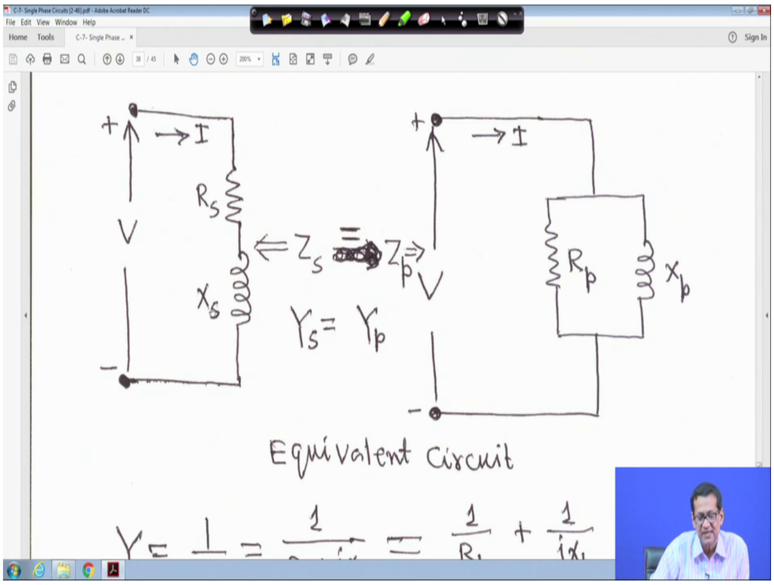

For example this is my series impedance R S and X S and this is my supply voltage V. Now, question is that we want this one is equivalent R P and X P these 2 circuits are equivalent to each other right. That means, Y S is equal to Y P; that means, series admittance is equal to parallel admittance and this branch is R P and X P.

We have to obtain R P and X P in terms of R S and X S this is eh here what we call that parallel equivalent of a series impedance. So, this is series, what we want is parallel equivalent right. So, in this case we know Y is equal to 1 upon Z. So, 1 upon Z means for C is equal to 1 upon R S plus jX S this we define Y S. And this is my parallel equivalent is equal to we can write 1 upon R P plus 1 upon jX p because this is inductive so, 1 upon plus jX p.

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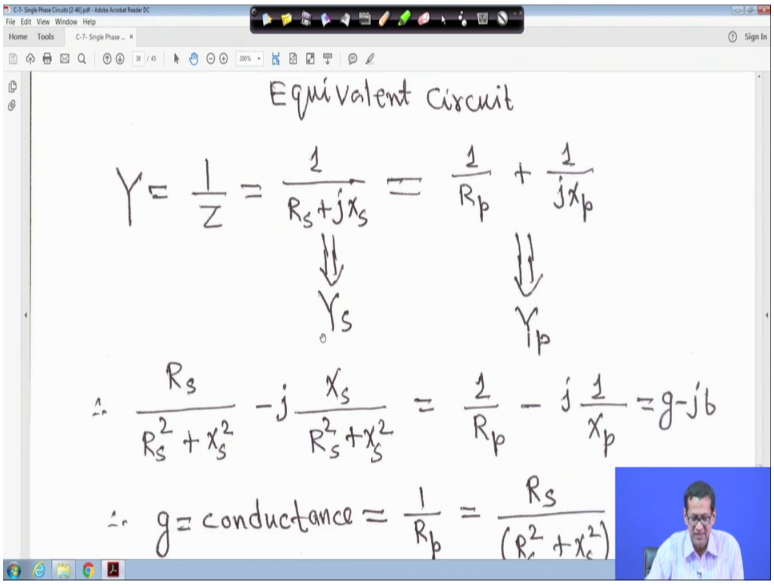

This is equals to Y P right or this R S plus jX S you multiply numerator and denominator by R S minus jX S you multiply and then we will get R S upon R S square plus X S square minus jX S upon R S square plus X S square is equal to it is 1 upon R p minus j 1 upon X P. This one, this term you multiply numerator and denominator by j. So, 1 upon R p minus j upon X p that is equal to g minus j b say.

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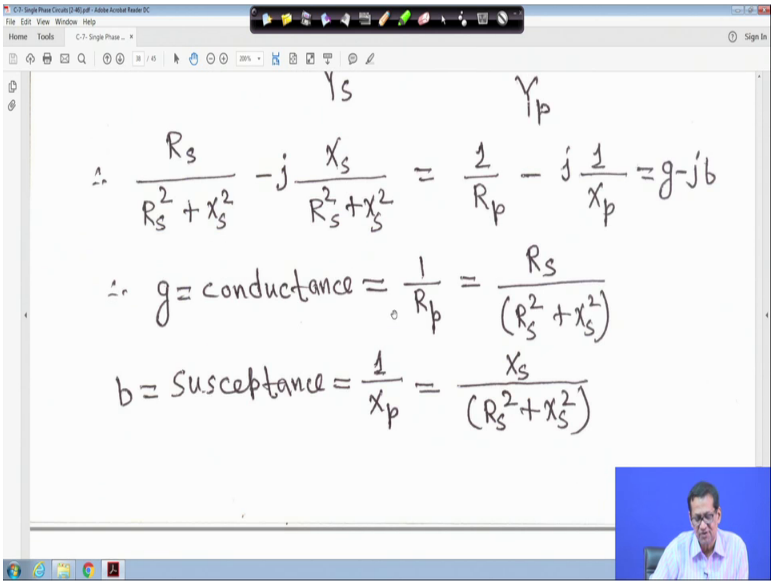

G is equal to conductance is equal to 1 upon R p. So, 1 upon R p is equal to separate real and imaginary part, 1 upon R p is equal to R S upon R S square plus X S square this one right. And similarly your 1 upon X p is equal to X S upon R S square plus X S square this is 1 upon X or just go right, R p is equal to R S square plus X S square upon R S, X p is equal to R S square plus X S square upon your X S right.

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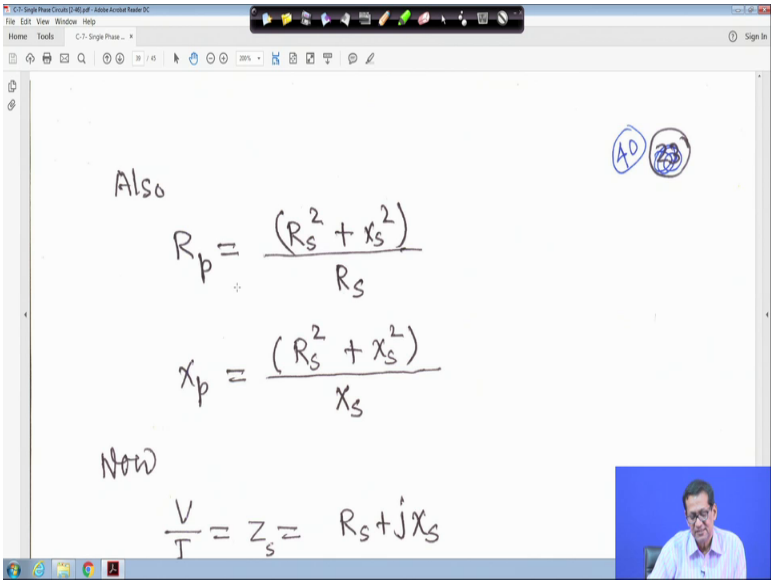

So; that means, this is that parallel your series one series impedance R S plus jX S can be represented by 2 parallel connecting a or what we call impedance. One is of course, is fairly resistive R p is equal to this one and X P is equal to this one. This is called your parallel, this is called your what you call that your series parallel equivalent of a series impedance, this is also possible right.

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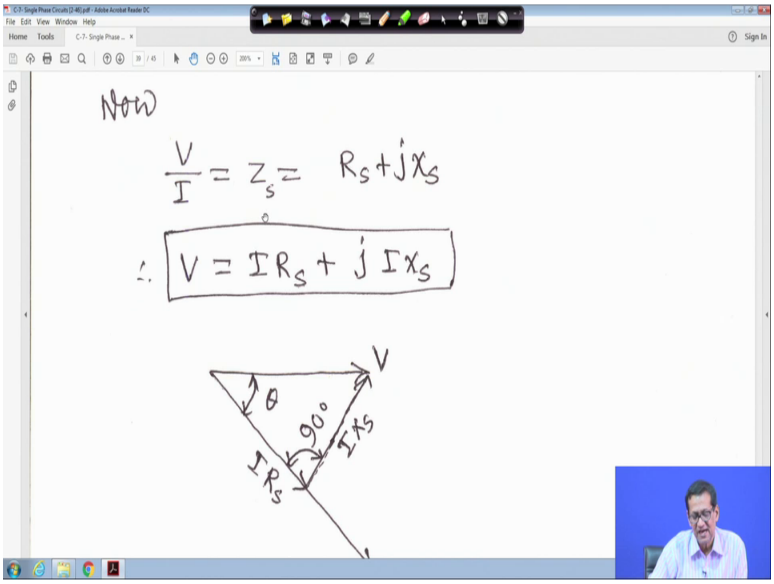

And we know V by I is equal to say Z S for the series circuit, it is R S plus jX S therefore, V is equal to IR S plus jIX S. So, V is my reference thing and what we call this is the current I say R in it is inductive circuit. So, I is lagging by an angle theta. So, this one my IR S and this is my IX S right and this angle is 90 degree not marking again by blue ink, but this is 90 degree. So, this is understandable.

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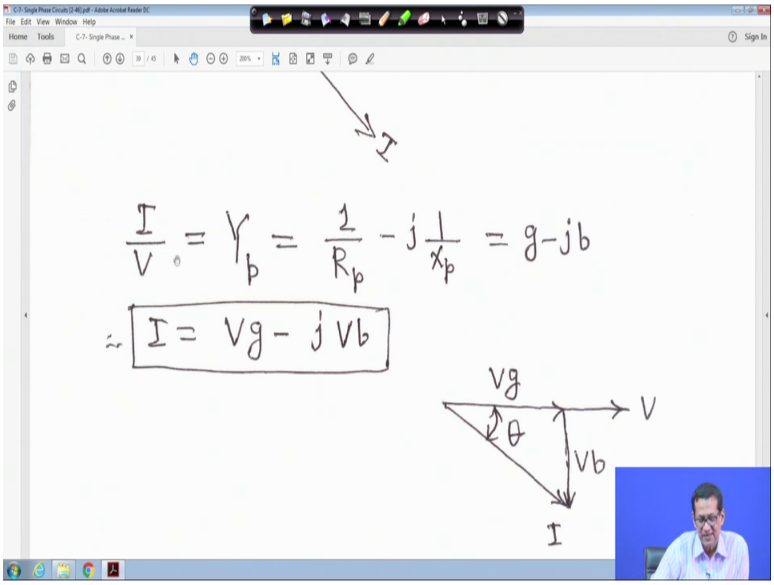

Similarly, for parallel equivalent I by V is equal to I P because, it is admittance that is why I by V and is equal to 1 upon R P minus j 1 upon X p is equal to g minus jb right. Therefore, my I is equal to you multiply I by V is equal to g minus jb therefore, I is equal to V g minus jV b.

In that case also V is that reference thing, current anyway lagging by theta. So, this is my V g so, this portion is V g and this is my imaginary part V b so, this is my V b. So, both admittance and both impedance this figure diagram when you call IR S plus I this thing jIX S right that is V and when you when you consider admittance it will V g minus jV b both have been shown right. So, now, series parallel circuit so.

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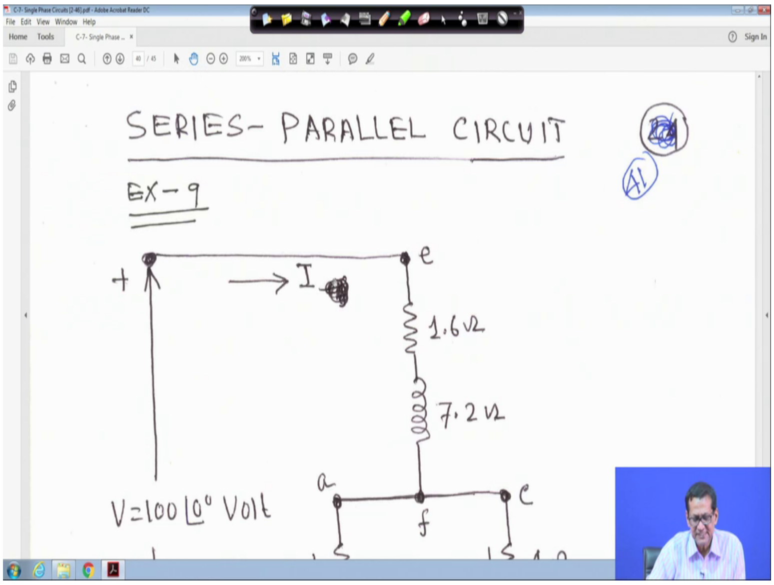

Suppose take this example that is one series parallel circuit.

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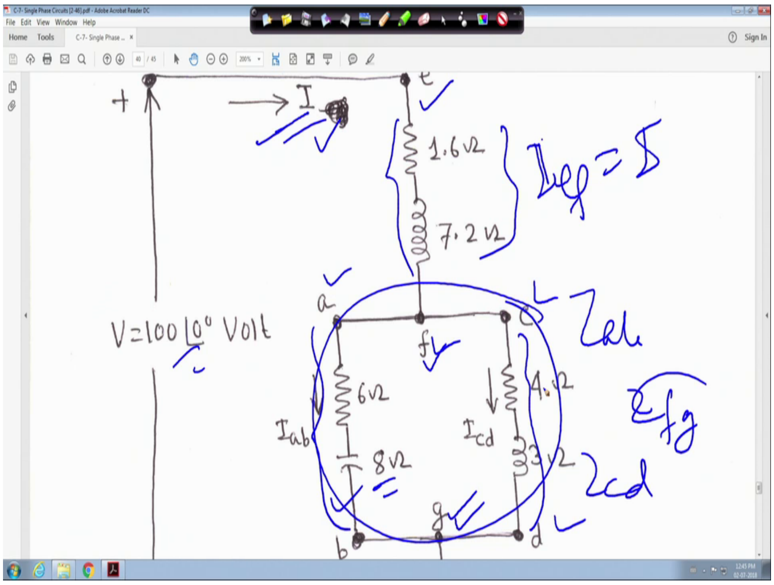

So, this circuit actually it is your this point you have to find out this is the current I and this point is a, this is b, this is c, this is d, this point is e, this is f and this point is g right.

So, this is a see this is series part and this 2 are parallel part. So, everywhere a, b, c, d, e, f, g it is marked right and first thing is this 2 are parallel 4 plus j 3 and 6 minus j 8 it is in parallel right make their equivalent series first; make their equivalent series first with that you add this one right.

After that you divide V by Z you will get the I right so, this is my fg. So, this way it has been it has been marked right your I your I ef is equal to I, this is I right and your Z your what you call this Z fg right this, this is your f point and this is g point. So, you find out that this 2 are in parallel this 4 plus j 3 and are in parallel you find out say equivalent.

So, again and again I will not come to the circuit, but everything is marked. So, this is my this part impedance is Z ab, this part impedance is Z cd right and equivalent is will be Z fg when this 2 parallely be taken right. Similarly for reciprocal will be your admittance. Again and again I will not come to the circuit.

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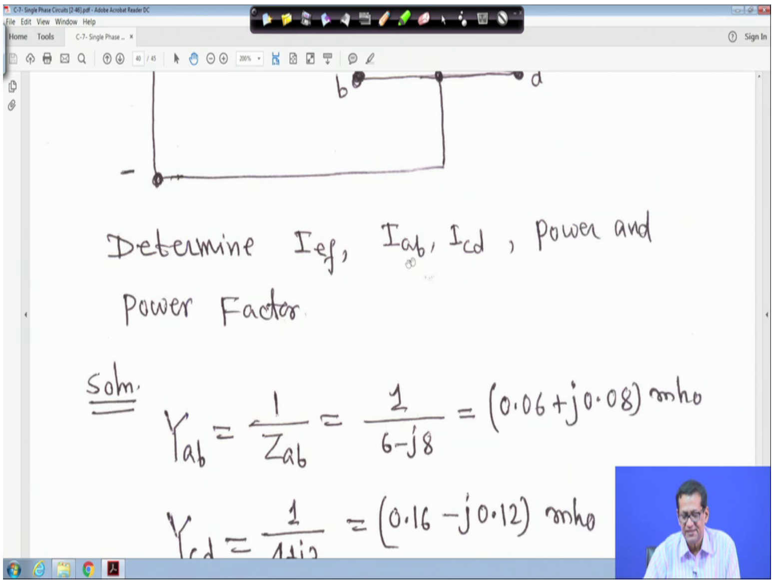

So, you have to find out I ef, I ab, I cd, power and power factor.

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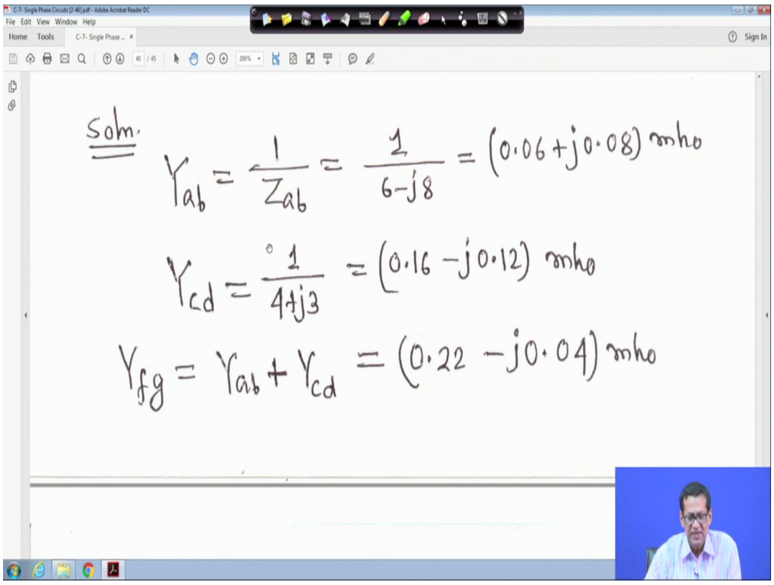

So, Y ab is equal to when you will do this please draw the circuit first right. So, 1 upon Z ab is 1 upon 6 minus j 8 it comes this per value. Similarly, Y cd you do it, it will be 0.16 minus j 0.12 mho right. So, Y fg admittance, Y ab plus Y cd this much is coming.

Now, Z fg is equal to 1 upon Y fg so, it is coming 4.4 plus j 0.8 ohm right. So, Z eg now you add Z ef plus Z fg first what you do, first we compute the admittance of a parallely parallel circuit is easy for calculation.

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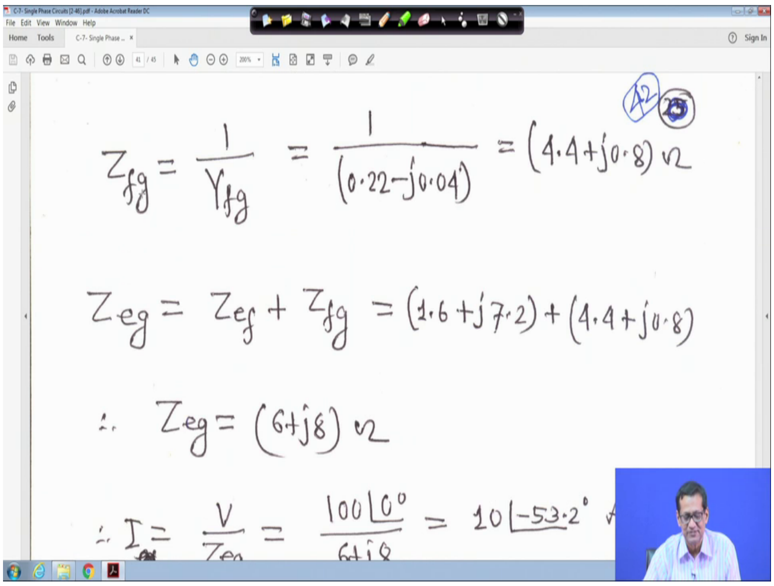

And then we add and then we are converting finding out the Z fg 1 upon Y fg. So, this much we got, now Z eg the total impedance will be your Z ef plus your this much Z ef is given in the circuit 1.6 plus j 7.2 and this one you add. So, it is coming 6 plus your Z e your what you call 6 plus j 8 ohm.

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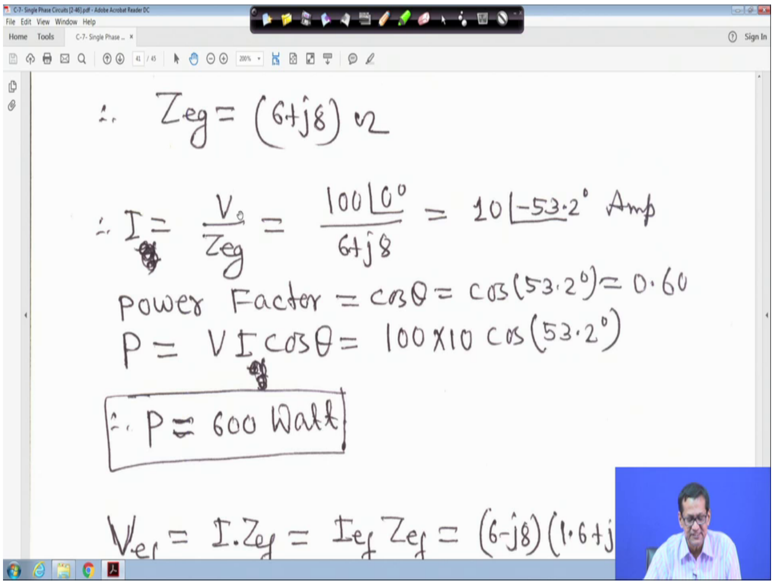

Therefore, current I should be is equal to V upon Z eg. So, this is coming 10 angle minus 53.2 degree ampere. So, power factor is equal to cos theta. So, angle between the voltage as current is 53.2 degree lagging. So, it is 0.60 right and P is equal to VI cos theta.

So, 100 into 10 cosine 53.2 degree so, P is equal to 600 watt right. So, next is V ef is equal to I into Z ef. So, the I is equal to I ef I told you at the beginning so, it is 6 minus j 8 into 1.6 plus j 7.2.

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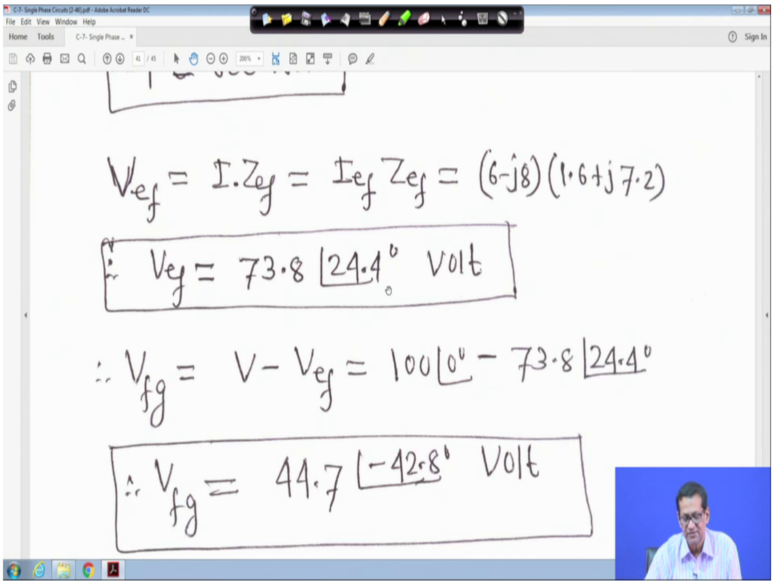

So, this is your 73.8 and angle 24.4 degree volt. Similarly, V fg is equal to v minus V ef you apply kvl here right, then you will get 0 here what we call V fg we apply the kvl in the circuit. So, am not going to the circuit again and again just you draw and look it you have done this circuit everything, only consider instantaneous polarity and solve it. So, it will be 100 angle 0 ohm minus 73. angle 24.4 degree. So, this is coming actually 44.7 and angle minus 42.8 degree volt right.

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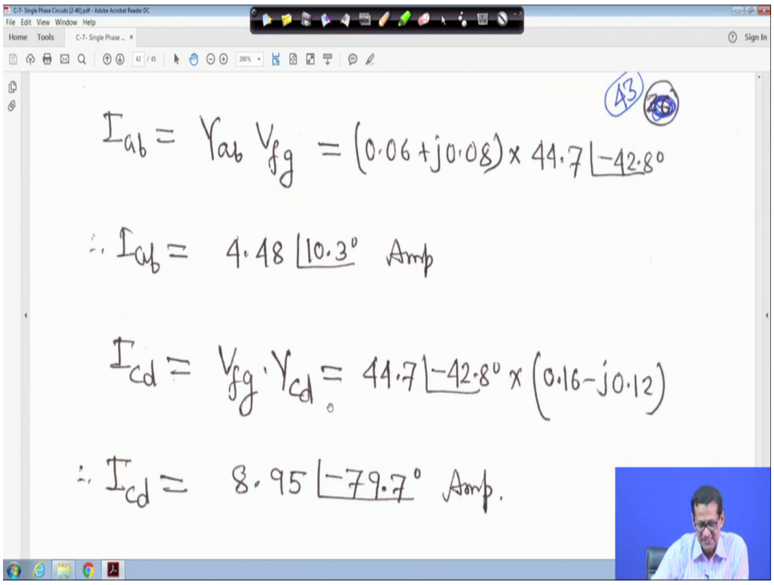

Now, I ab is equal to Y ab V fg. So, it is your Y ab you got and V fg now we have we computed here V fg. So, I ab will be this one, 4.48 angle 10.3 degree ampere. Similarly, I cd will be V fg in to Y cd. So, it will get 44.7 angle this one into your Y cd, it is coming 8.95 angle minus 79.7 degree ampere right.

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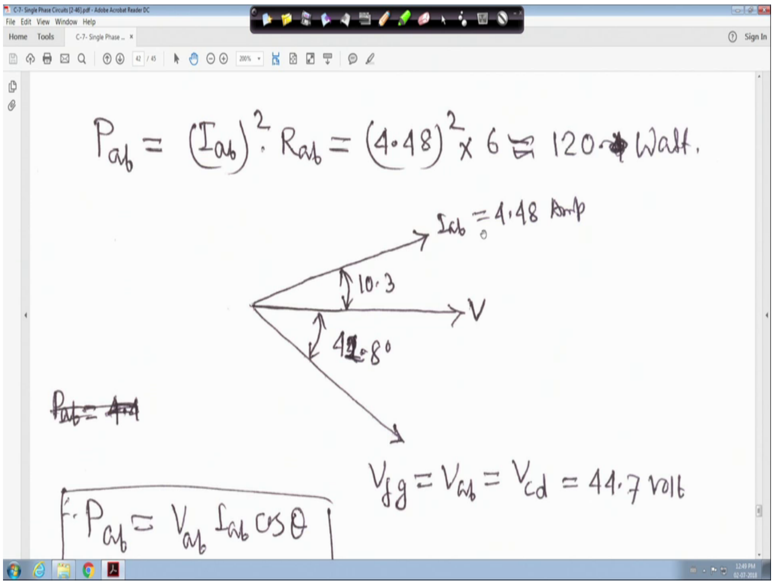

So, at P ab power loss is equal to I ab square R ab. So, it is I ab is equal to 4.48 square and R ab is equal to 6 so, it is 120 watt right.

So, again and again I have not come to the circuit then it will consume lot of time, I will suggest please draw this when you look into this video link lecture, you please you please draw the circuit faster. And all these calculations other things if you find any error, you just let me know that whether let me know such that I can rectify myself. Even when am telling with many things 1 or 2 places because, so, many things are there. So, 1 or 2 places am making small error somehow, but I have rectified right immediately.

So, if you have any doubt you can put all that questions in the forum I will give you the answer right. So, whenever you I tell again and again whenever look in to this video lecture first you draw the circuits, then you look what has been done.

So, this is my present diagram this is V is the reference one right angle 0 degree and I ab actually leading voltage 10.3 degree. So, that is why it is leading and your I and other current that your this one your V fg that is 44 point V I mean if you come to that V fg come to this, it is Y ab that is your what you call this is leading and if you come to your V fg it is lagging from this reference voltage V. So, minus 42.8 degree that is why this voltage is 42.8 degree, it is lagging, this all voltages are same 44.7 degree.

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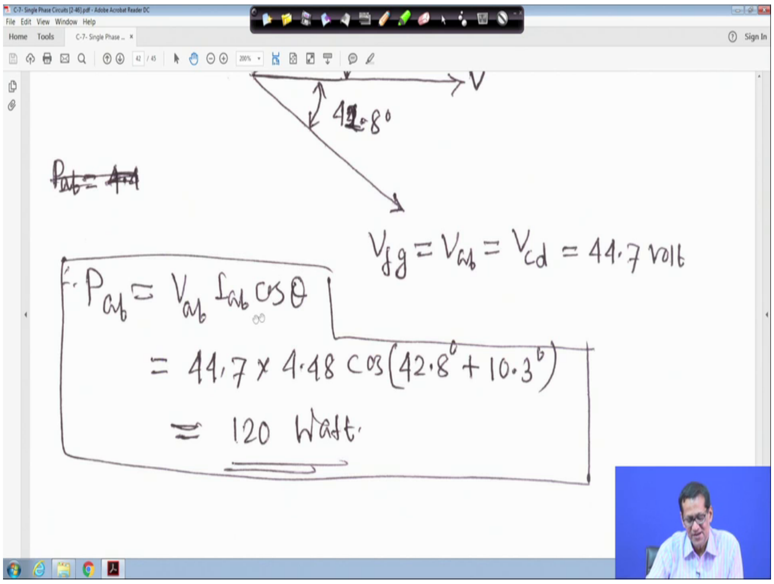

Now, if you think in terms of power factor P ab is equal to V ab I ab cos theta V ab 44.7 into 4.48 cosine of this one. Because, cos theta means angle between your this I ab and this your V ab. This is V fg is equal to V ab angle between I ab and V ab. So, 42.8 plus 10.3, this is the power factor angle right, that is why it is taken 42.8 plus 10.3 degree right.

So, it is 120 watt similarly, we saw I ab square R ab is equal to 122 R; that means, it is matching if it is not; that means, how much calculate some if it is not somewhere calculation has gone wrong somewhere right so, this is 1.

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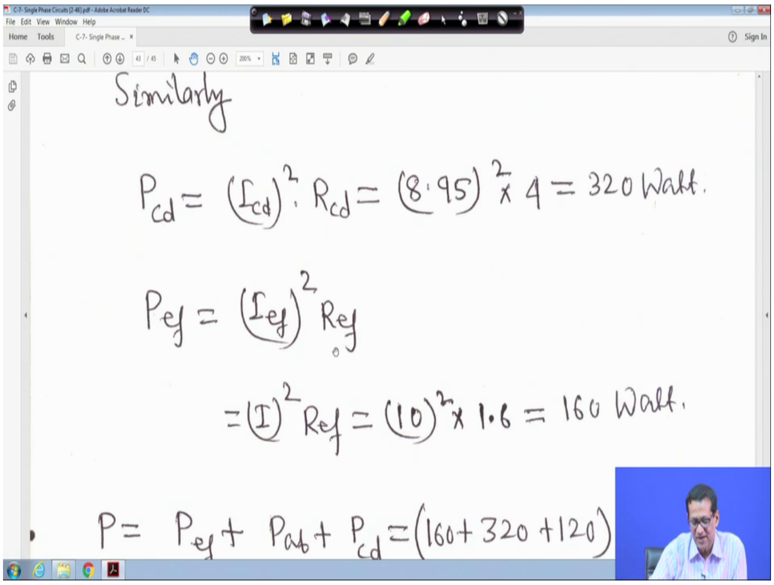

Similarly, your P cd is equal to I cd square R cd, it is 320 watt right and P ef, I ef square I ef square R ef so, it is coming out 160 watt. So, total P is equal to P ef plus P ab plus P cd it is 600 watt right.

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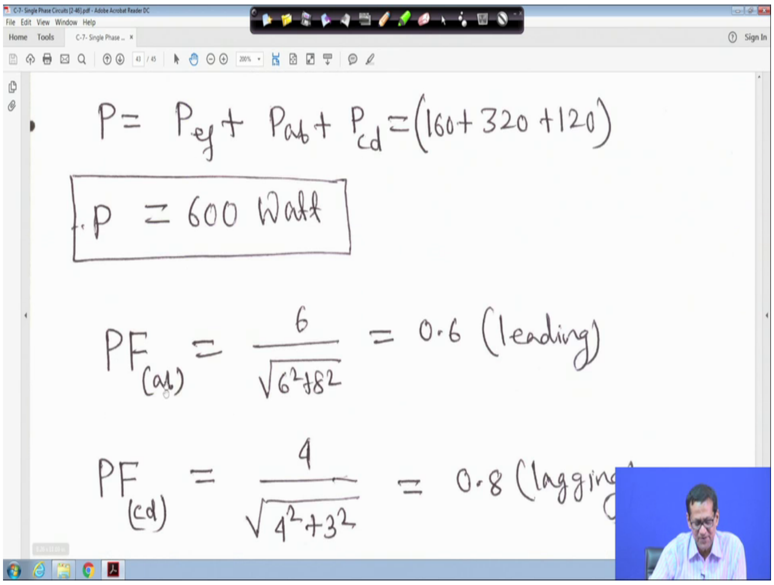

And power factor your for ab 6 upon root over 6 square plus 8 square, it is 0.6 leading. Power factor for cd part it is 4 upon root over 4 square plus 3 square 0.8 lagging. This one you do it of your own right and if you given that draw phasor diagram.

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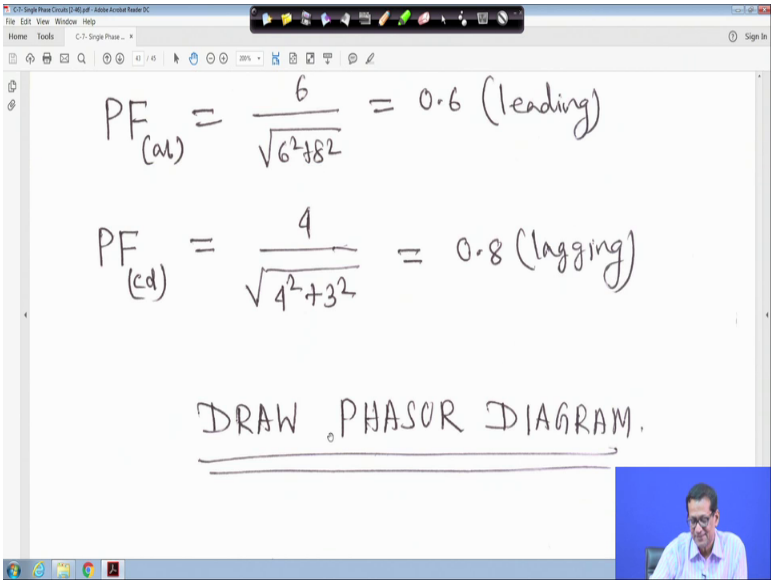

You please draw the complete phasor diagram, I have not drawn for you right. So, this is your what you call your this is the way few examples we have taken this you solve your purpose right.

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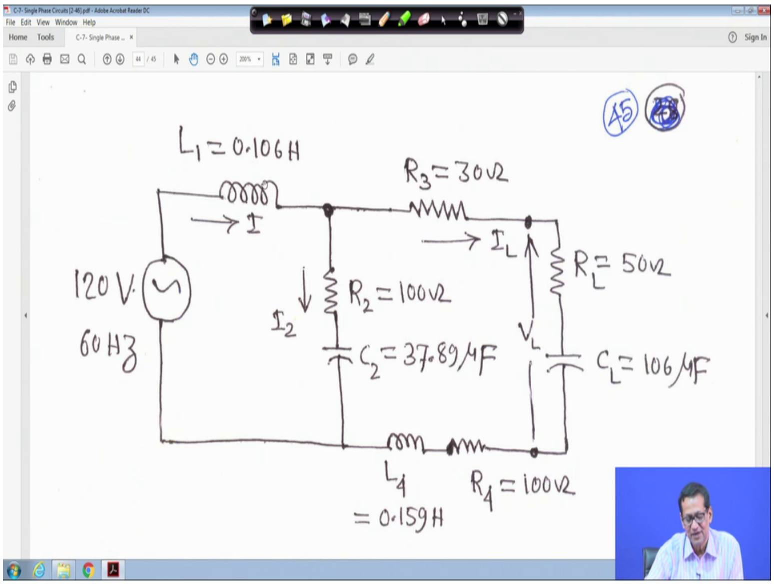

So, now another one is this problem your what you call is given to you L1, I your what you call L 2, your L 1 is given 0.106 and C 2 is given 37.89 micro farad. C L is your 106 micro farad, L 2 is not there, and R 3 is there 30 ohm, R L is 50 ohm right and this is V L.

In this problem you have to find solve for I, I 2, I L, voltage is 120 volt rms, that means you take the reference 120 angle 0 degree and frequency at this 60 hertz. You take f is equal to 60 hertz, this problem we will solve and as standard circuit kcl, kbl this is one thing.

Second thing you will find out suppose you will find out I L using (Refer Time: 16:44) theorem right that will do using (Refer Time: 16:47) theorem you will do this right. And also using this what we call and in say your simply kcl, kbl. You should find out all this thing and answers are given.

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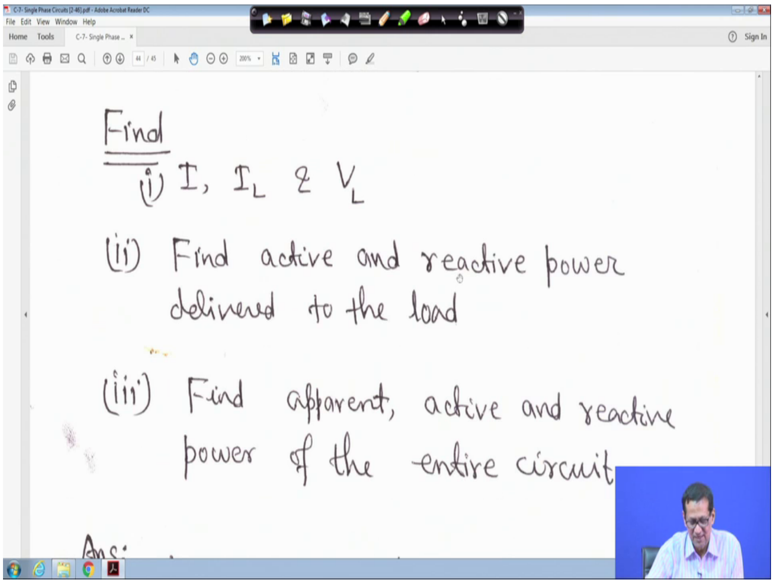

All these things had been asked what you have to do is and answers are given right.

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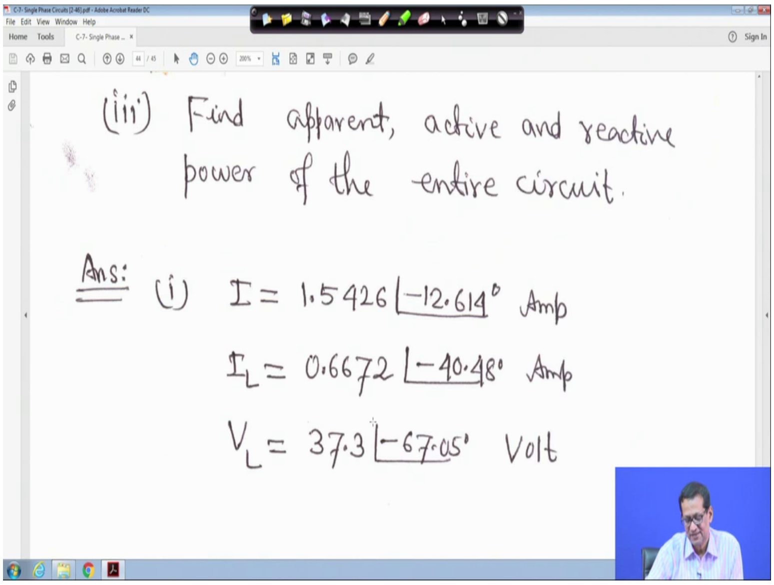

These are the answers, but here frequency 60 hertz by mistake do not take 50 hertz then this answer will not come. So, frequency f is your 60 hertz right.

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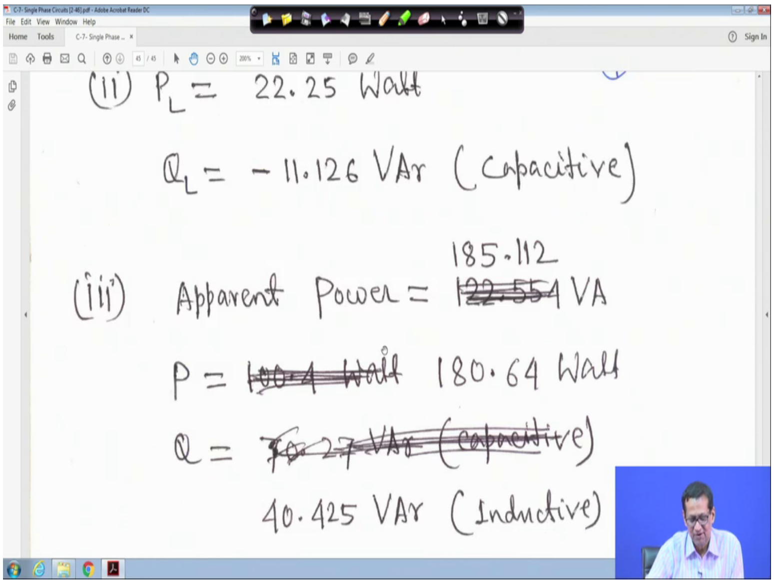

So, and all these your what we call all these answers are answers are given so, all these answers are given. So, with this right our single phase AC circuit at least this part is over right. So, at least single phase ac circuit is over and you will solve many problems take any book and you please do it.

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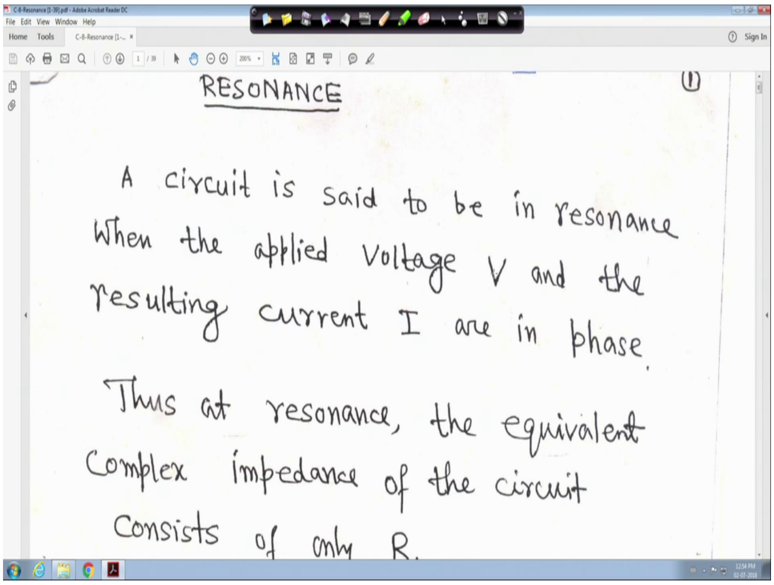

So, a circuit now we will go to the resonance circuit then we will see the maximum power factor theorem for single phase this is circuit. A circuit is said to be in resonance right, in resonance when the applied voltage V and the resulting current I are in phase. When V and I both are in phase a circuit can be said that is in resonance right.

So, now, in that case what will happen? If circuit is a resonance so, in V and I in what you call in phase; that means, that circuit will become a as you it is a something like an equivalent your resist resistive circuit right. So, thus at resonance the equivalent complex impedance of the circuit consists of only resistance right.

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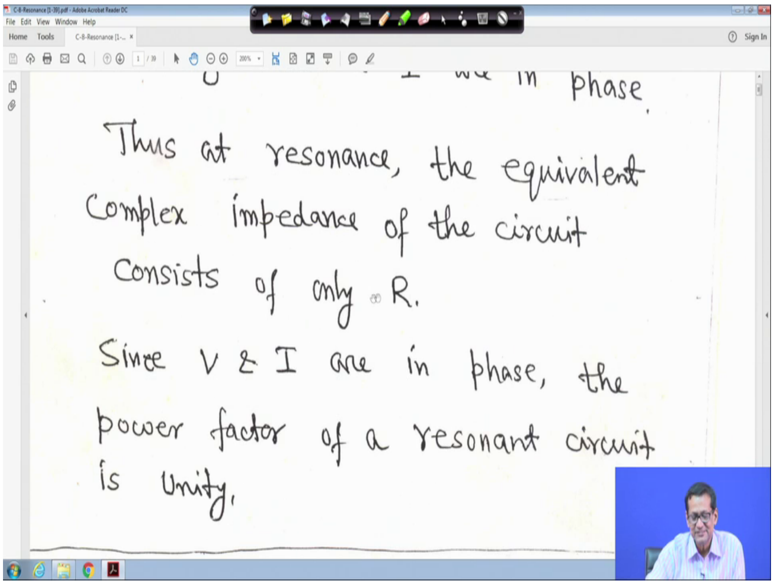

Since later will see this, since V and I are in phase the power factor of a resonant circuit is unity right. Suppose you have a series RLC circuit, R Plus jX L minus X C, when X L is equal to X C that is resonance of condition occur right, will come to that.

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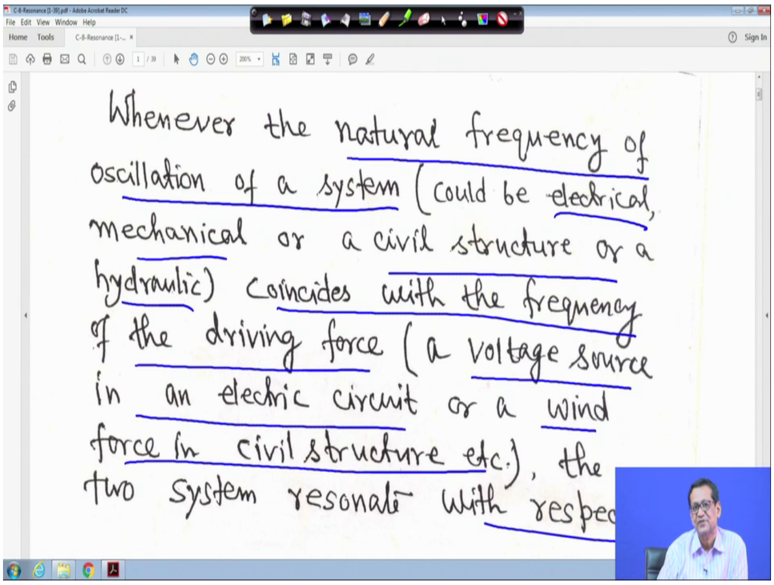

Whenever; now, this is one general thing, whenever the natural frequency; whenever the natural frequency of oscillation of a system could be electrical, mechanical or a civil structure or a hydraulic right coincides with the frequency of the driving force a voltage source in an electric circuit or a wind force in civil structure etc, the 2 system resonant with respect to each other right.

So, whenever if the natural frequency of the oscillation of a system right if it coincide with the frequency of the driving force right then the 2 system resonance with respect to each other. Resonance is very it is not good for this system right.

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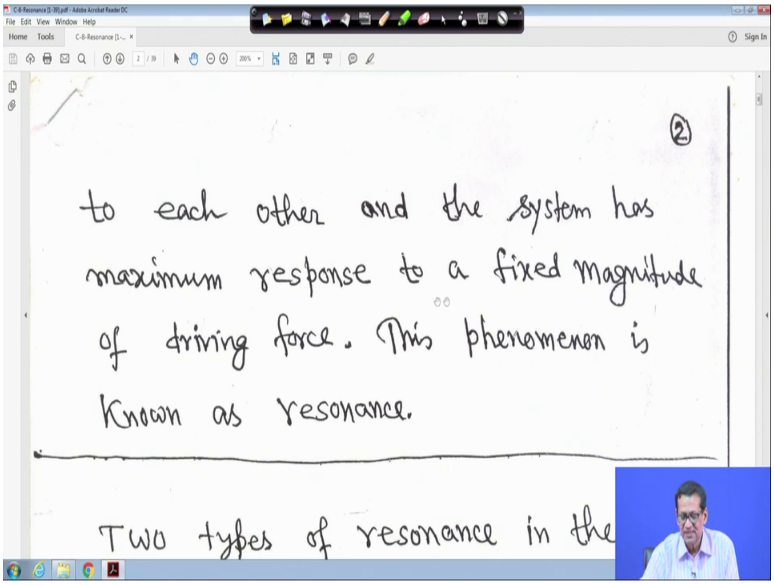

So, in that case your and maximum and in that case has a maximum response to a fixed magnitude of driving force. So, this phenomena is known as a resonance. Similarly, for electrical circuit particular series RLC circuit when it is a resonance condition the current is maximum right, we will come to that. Generally 2 types of resonance in the electric circuits.

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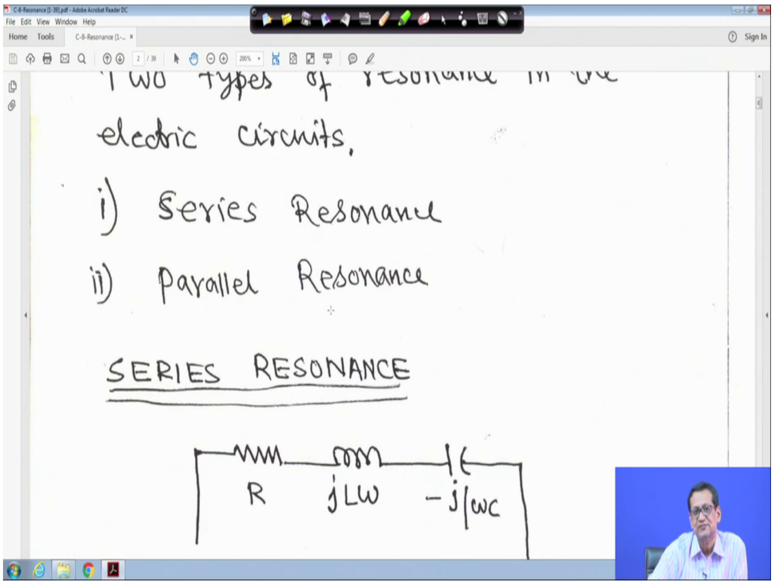

One is the series resonance, another is the parallel resonance right. So, first we will see the series resonance.

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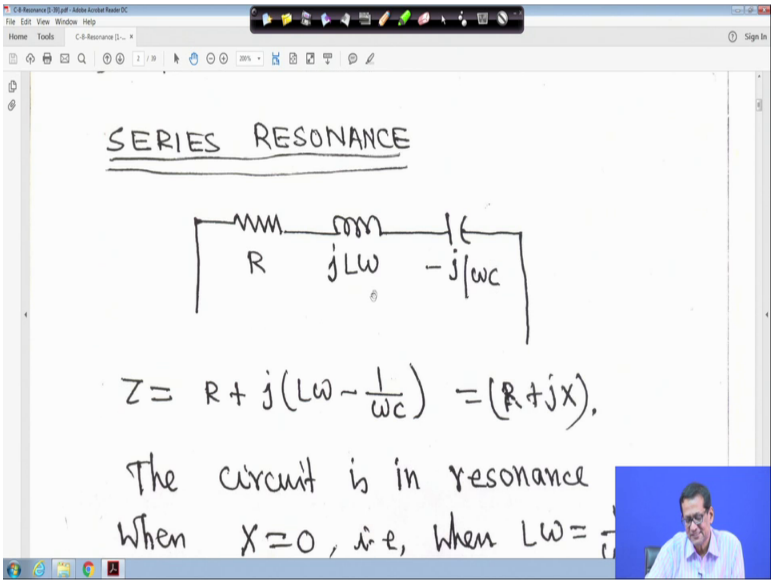

So, in the case of series your simple RLC circuit are j L omega minus j upon omega C right. So, Z is equal to impedance Z is equal to R Plus j L omega minus omega C is equal to you can right say R Plus jX in this form right.

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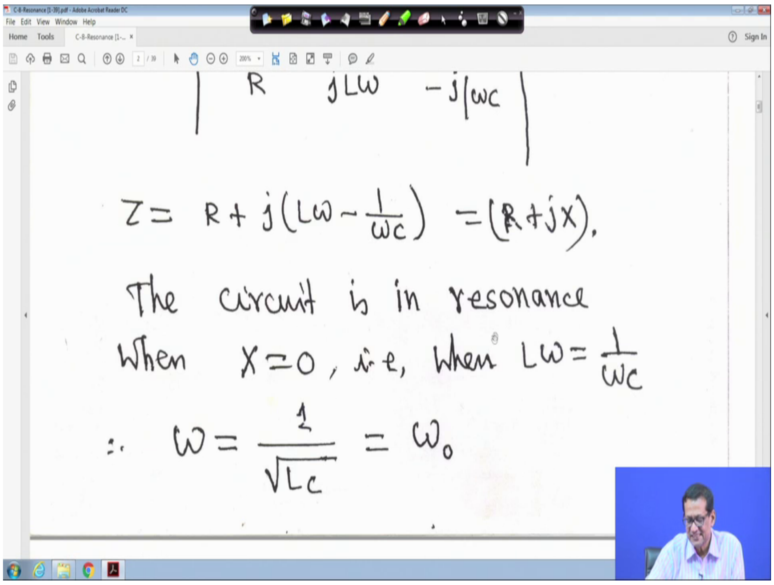

The circuit is in resonance when X is equal to 0 that is when X is equal to 0 means that L omega minus omega 1 upon omega C is equal to 0 means that L omega is equal to 1 upon omega C; that means, omega is equal to your 1 upon root over L C is equal to omega 0. This omega 0 we will call that your what we will call that is the resonance frequency omega 0 right.

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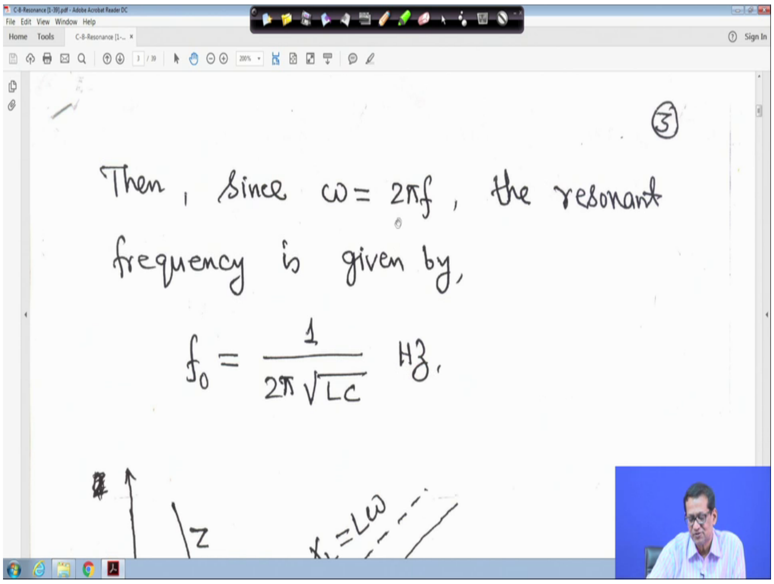

So, since omega is equal to 2 pi f, the resonance frequency is given by f 0 is equal to 1 upon 2 pi root over L C because, omega is equal to 2 pi f is equal to this thing.

So, it will be f is equal to 1 upon 2 pi root over LC. So, f 0 is equal to 1 upon 2 pi root over LC hertz, this is the resonance frequency.

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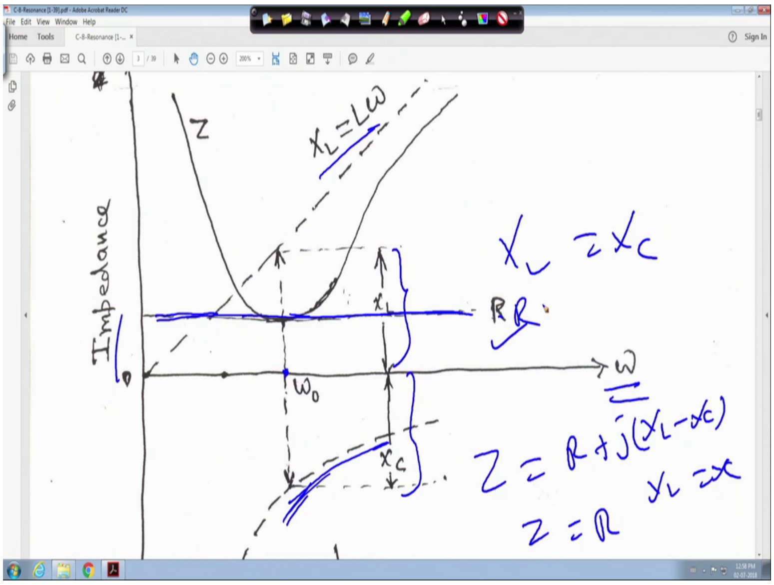

Now, if you plot suppose this is my impedance; if this is my impedance if we plot. So, X L is equal to this is my Z plot, this is my Z plot right. Now, this dash line that your this line it is X L is equal to L omega because it is a straight line passing through the origin right. Similarly, this side X C is equal to 1 upon omega C right, this side is omega and this side is an impedance. This impedance means Z, X L, X C everything right.

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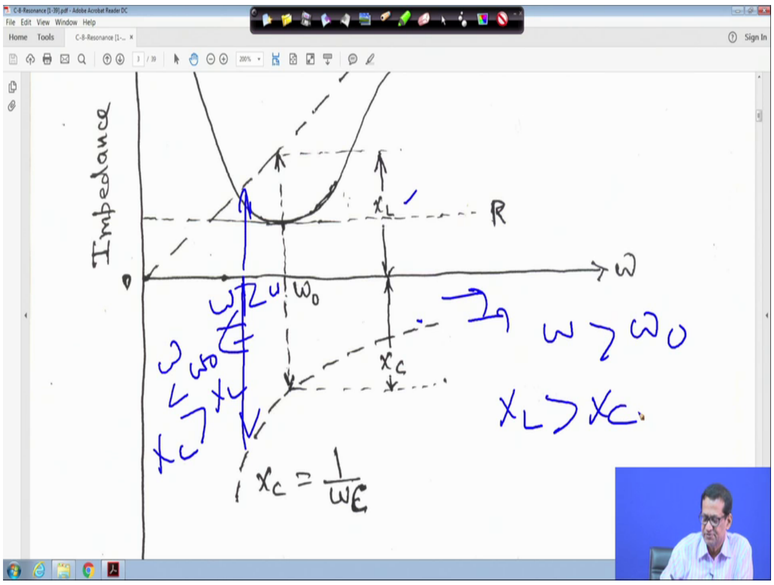

So, X C is equal to 1 upon omega C looks like a rectangular hyperbola right. So, that this dash line is plot right. So, this thing from here to here, from here to here right, from here to here this is my X L and from here to here this is an X C. And at X L is equal to X C that is frequency is equal to this 1 omega 0 right.

So, this is that simple plot for impedance verses your omega, this is omega, this is impedance right. This is my this is my X L is equal to l omega plot and this line this X C is equal to this curve X C inverse or what we call X C is equal to 1 upon omega C plot and this dash line is the resistance R right.

Because, at when X L is equal to X C at that time omega is equal to omega 0 at the time Z is equal R. Because, R Plus j X L minus X C so, X L is equal to X C at resonance. So, Z is equal to R, this dash line is R right. So, at omega is equal to omega 0 I told you X is equal to X 0.

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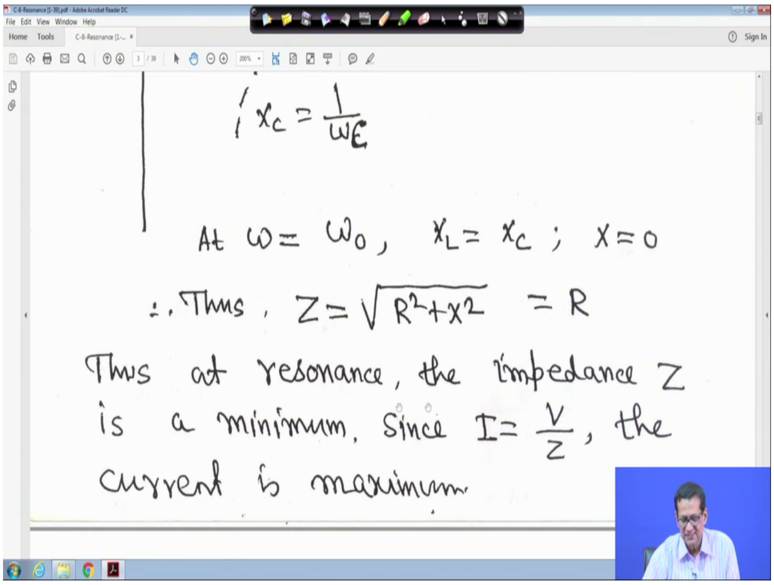

So, impedance Z is equal to X is equal to 0. So, it will be R, thus at the resonance impedance Z is minimum. Since, I is equal to minimum means it is R because X L minus X C 0 impedance is minimum R. So, since I is equal to V by Z as the Z is minimum that resonance that current is maximum right so, now, angle.

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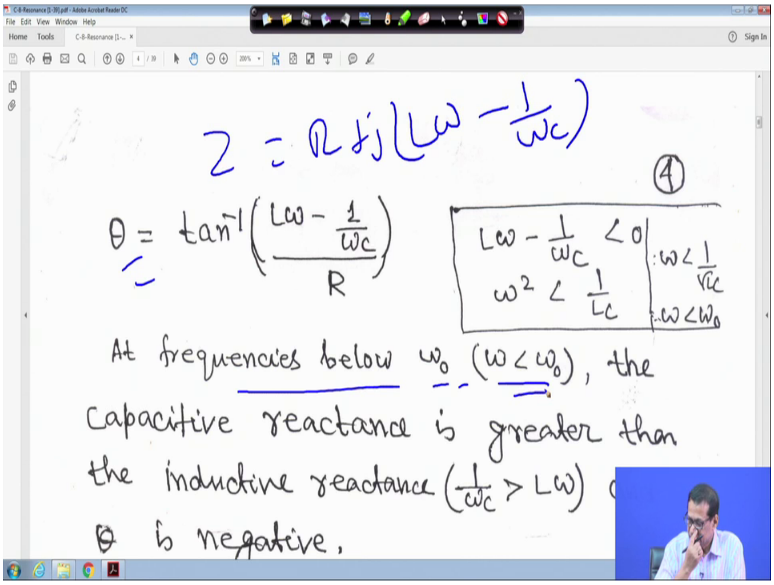

Now, theta is w is equal to tan inverse L omega minus 1 1 upon omega C R because, Z is equal to R plus j it is X L minus your X C right. So, tan inverse tan theta is equal to L omega minus 1 upon omega C upon R. Therefore, theta is equal to tan inverse L omega minus 1 upon omega CR right. Therefore, for example suppose, when you are act frequency is below omega 0 that is when omega less than omega 0 right.

So, in that case if omega less than omega 0, let me come to this diagram. When omega less than omega 0 this side if you come if omega less than omega 0; that means, this region, this region right it. When omega less than omega 0, the capacitive reactance is more then your inductive side right. And in other side capacitance reactance is less, but this one will be X L will be more.

So, this side if you take omega less than X 0 omega here what we call less than omega 0 right, this side omega less than omega 0; that means, your capacitance inductance your reactance X C right it is greater than your X L this side.

And this side your what you call when your omega greater than omega 0 I mean this side right at that time what will happen that X turns to opposite X L greater than X C right. So, if you take any value from here, you will find X L greater than X C.

So, in that; that is why in this case that if omega less than omega 0; that means, that L omega minus omega 1 upon omega C less than 0 that is omega 1 1 upon omega C greater than L omega, that is X C greater L omega. So, from this condition you get omega your less than 1 upon it is root over 1 less than 1 upon root over L C that is your omega less than omega 0.

So, all frequencies below omega 0 that capacitive reactance is greater than the inductive reactance right and this is negative theta therefore, theta is negative. So, in that case theta is negative right.

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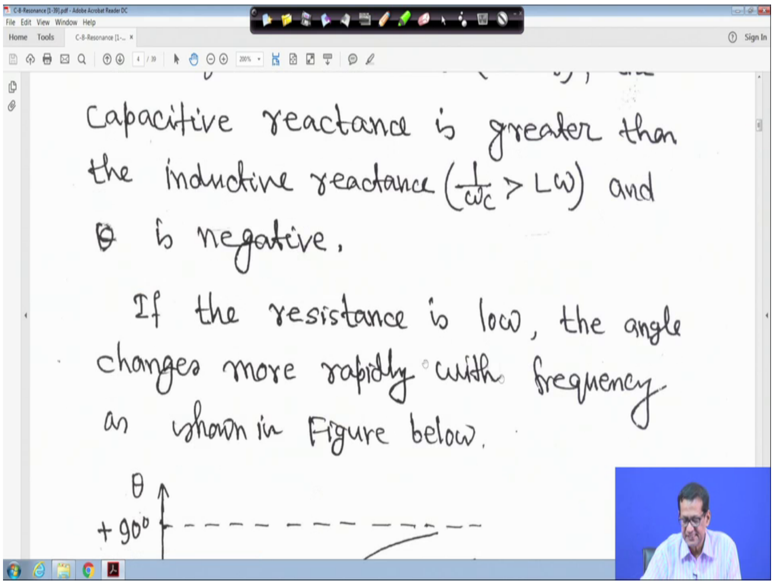

So, if the resistance is low suppose if the resistance is low the angle changes more rapidly with the frequency as shown in figure below suppose this resistance is very small.

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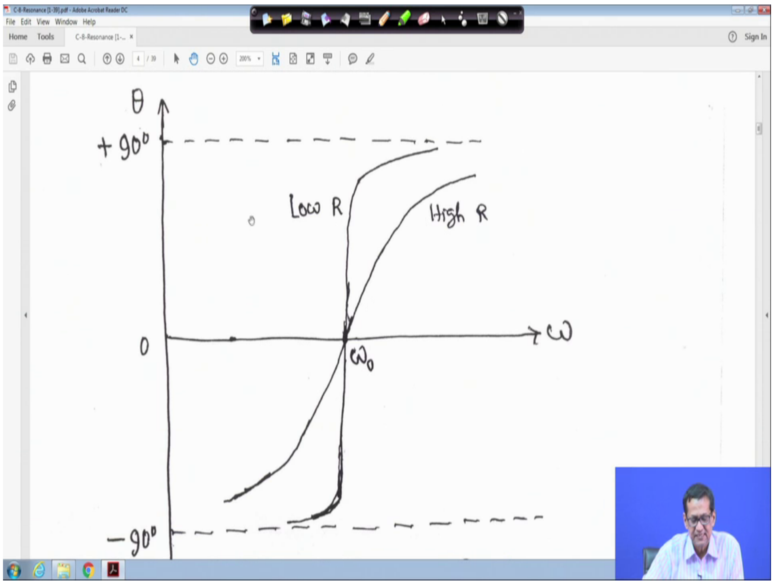

So, for very small resistance this is your omega and this is theta. Theta versus omega curve for small resistance the plot is very sharp look at that and for high resistance this is the plot and this is my omega 0. This side is plus 90 degree, this side is minus 90 degree right.

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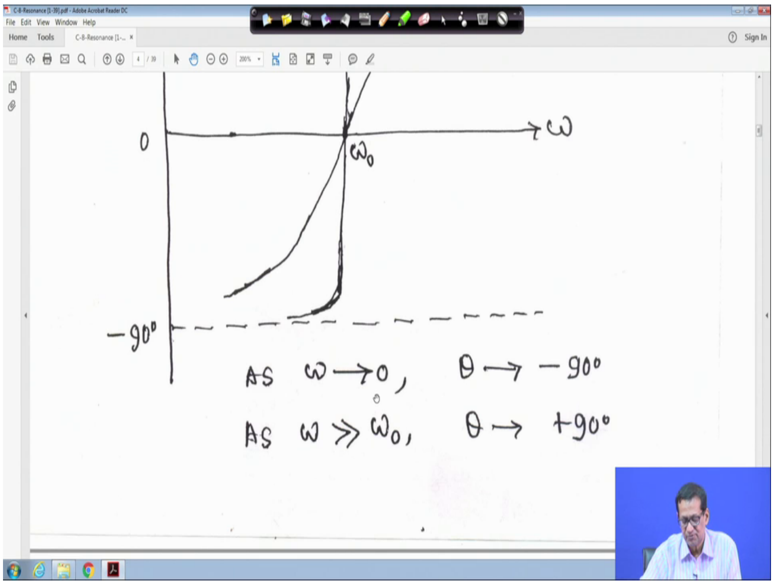

So, as omega tends to 0 theta tends to minus 90 degree, if you come to that if omega tends to 0 this term will be tends to 0, but as omega tends to 0 this term will tends to minus infinity right.

So, in this case 3 term will tends to minus 90 degree, similarly here omega is much higher than omega 0; that means, with this omega is very large this omega upon omega C term is what we call is negligible it will it is very small. But, theta tends to your what we call that plus 90 degree right. So, based on that this your diagram has been drawn right.

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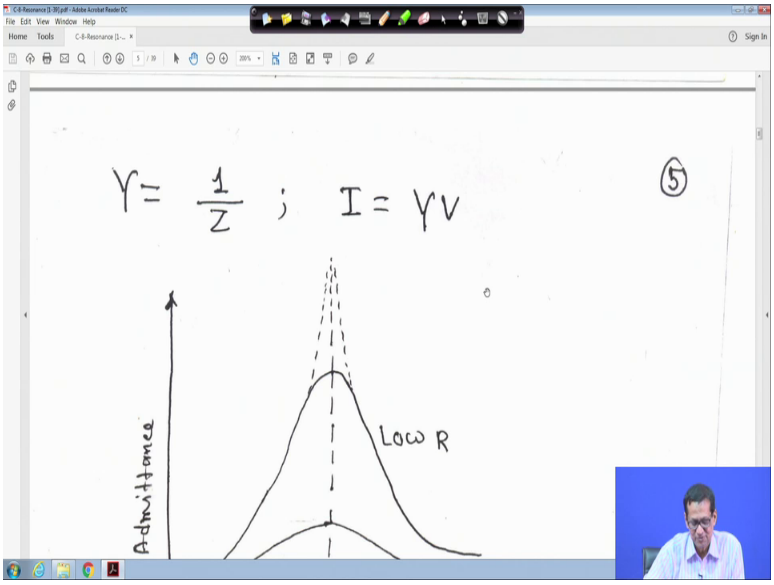

So, now we know that Y is equal to 1 upon Z right that is my I is equal to YV right. So, because we know admittance earlier we have seen.

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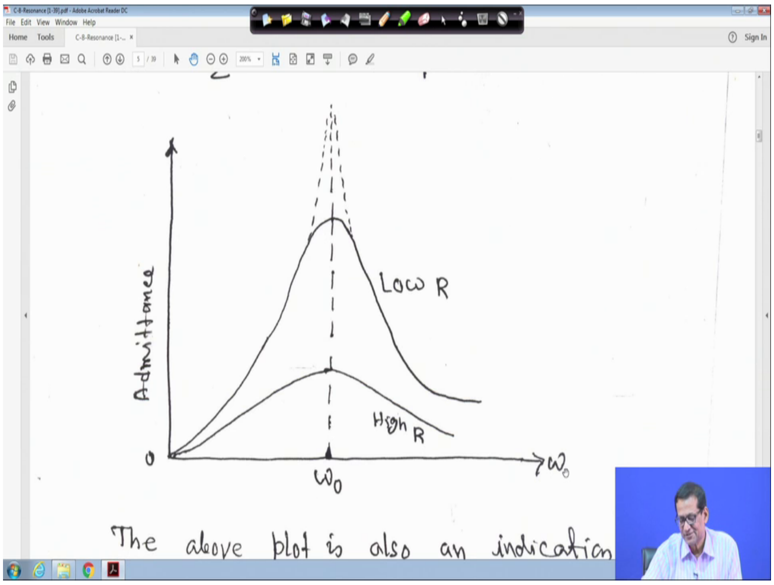

So, if you plot admittance verses omega right. So, if your what you call if your this is this is omega 0, this plot is for the higher value of R and this plot is for the lower value of R. Finally, this dash line when R is very low it is tending to your what you call to infinity right tending to infinity.

So, now, this is your omega admittance versus omega plot, other one we saw this impedance versus omega plot this is admittance versus and this is your omega 0 right. So, if ha high R means admittance is low, low R means admittance is high. This is the plot and if R is very low it tends to infinity right.

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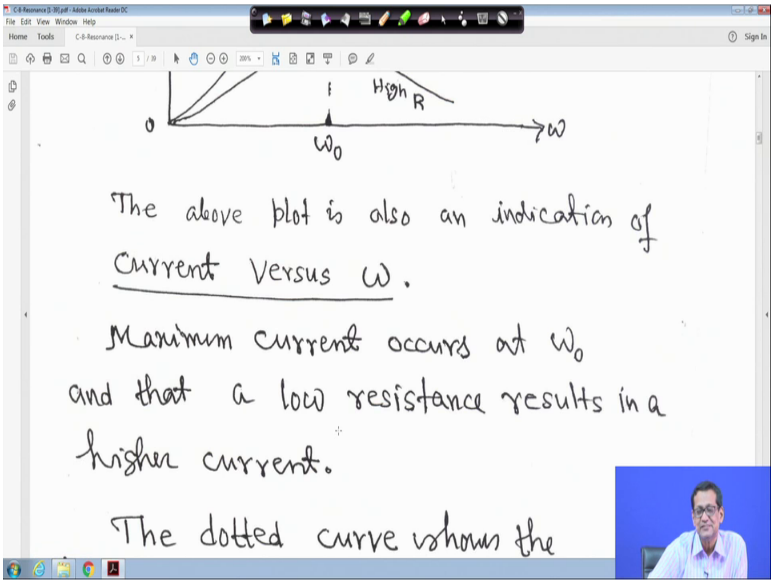

So, the above plot is also an indication of the current verses omega plot. Now, maximum current occurs at omega 0 because, that is at resonance frequency right, a low resistance results in a higher current.

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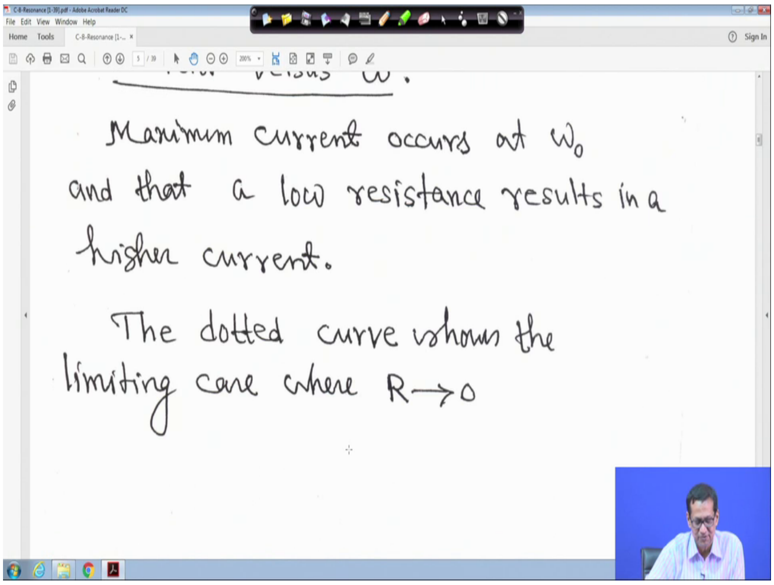

So, that dotted curves shows in the your limiting case the R tends to 0; that means, this one when R tends to 0 this is the dot dash line right or dotted line.

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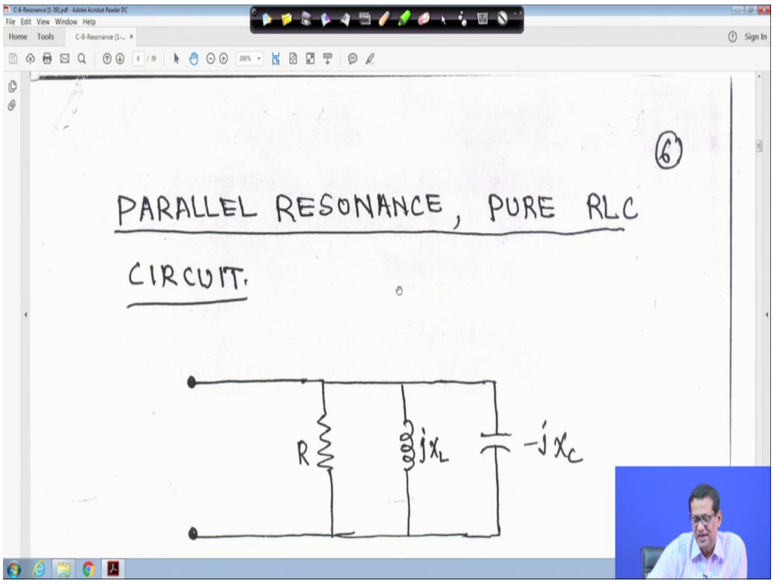

So, now parallel next is the parallel resonance that is pure RLC circuit. So, in this case this is my R, this is my jX L and this is my minus jX C, it is capacitive.

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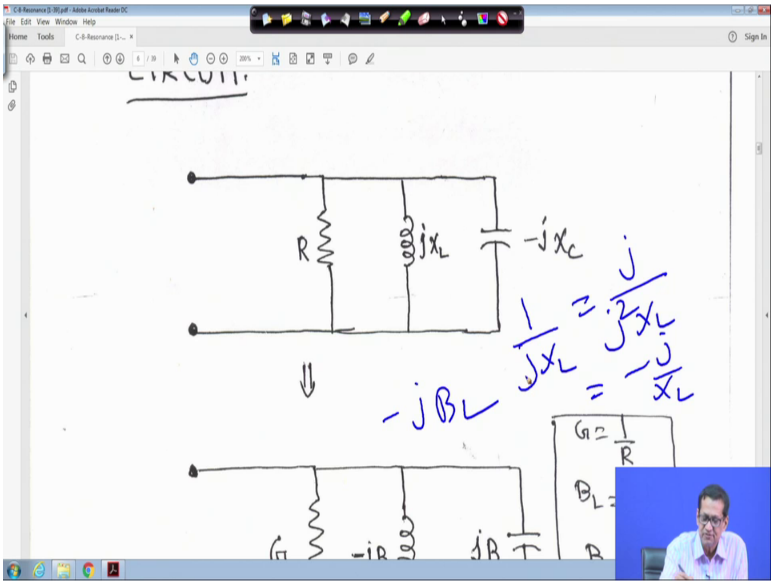

Now, here this R we can get it is a conductance this 2 can be represented minus jB L jB C that is your suseptance right so, it is in suceptance. So, it will become minus jB L here G is equal to 1 upon R, B L is equal to 1 upon X L and B C is equal to 1 upon X C. I mean if you take; I mean if you take your what you call the reciprocal of this 1 1 upon jX L, numerator and denominator you multiply by j. So, j upon j square X L j square is minus 1. So, that is minus j upon X L.

We will take B L is equal to 1 upon X L that is why it is minus j B L right. So, let me clear it so, that is why here we are writing minus jB L. Similarly, capacitor will become jB C it is plus right jB C equal to 1 upon X C.

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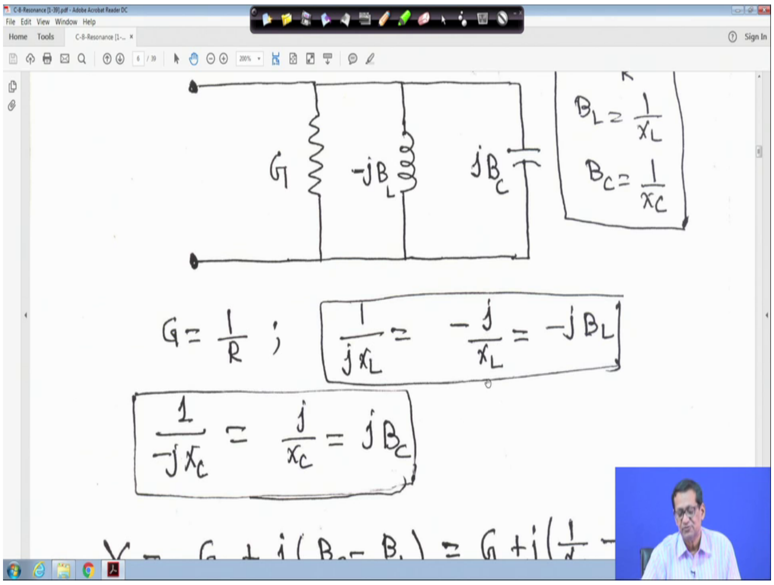

So, G is equal to 1 upon L here for you I have done it for 1 upon jX L is equal to minus jX L is equal to minus jB L and similarly, 1 upon minus jB L X is equal to j upon X C numerator and denominator you multiply by j that all it is jB C.

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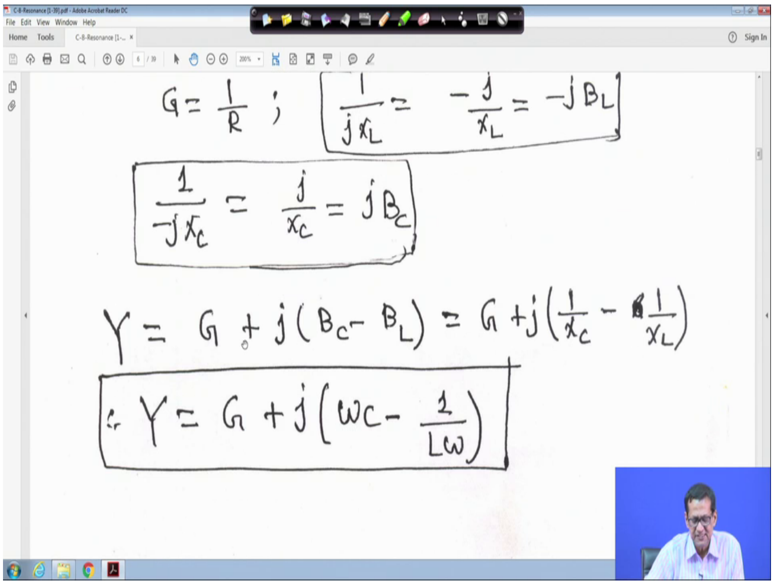

So, admittance Y is equal to G plus j B C minus B L right is equal to G plus j 1 upon X C minus 1 upon X L right. So; that means, Y is equal to G plus j omega C minus 1 upon L omega.

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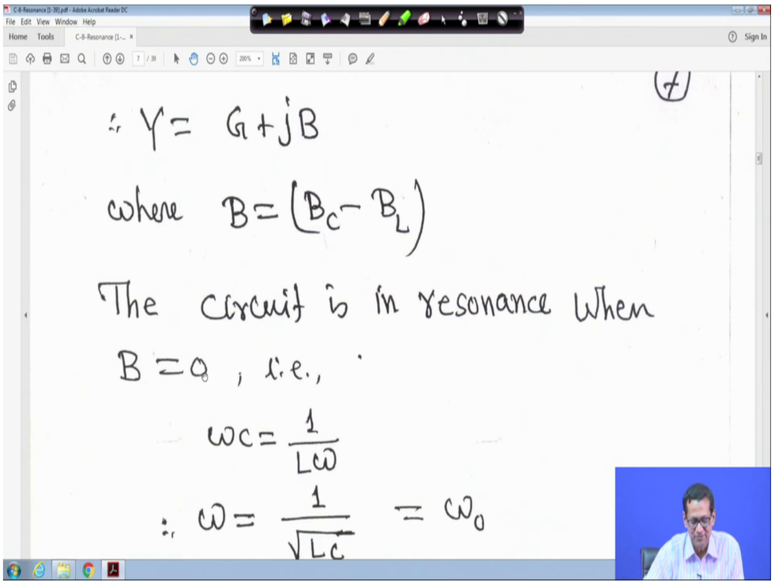

So, the in this case we write Y is equal to G plus jB. So, where B is equal to B C minus B L right, this is my B C and this is my B L just opposite like your series one, but we have made it like this considering admittance. So, this is my B C and this is my B L right.

So, this is my B C and this is my B L, B is equal to, now circuit is in resonance when B is equal to 0. When this part will be 0, the circuit will be in resonance right. Therefore, omega C is equal to 1 upon L omega therefore, omega is equal to 1 upon root over your L C, that is equal to omega 0 same as before same as series circuit right.

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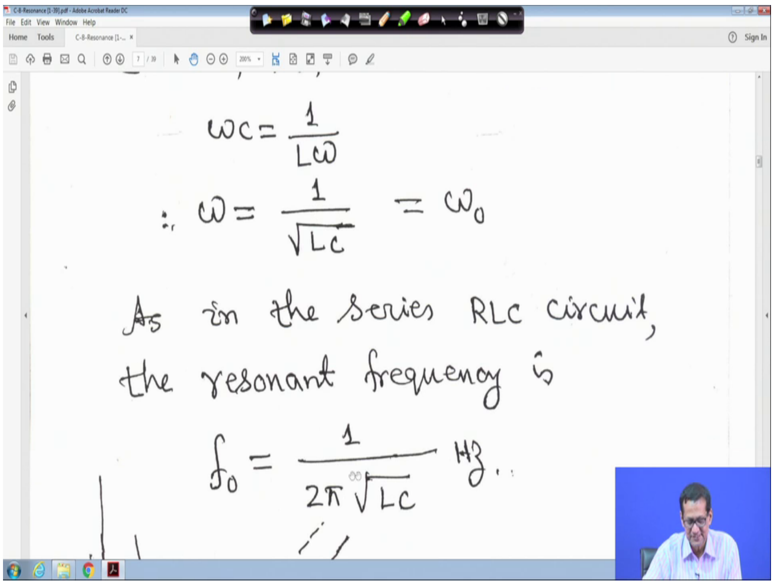

As in the series RL C circuit resonant frequency is f 0 is equal to 1 upon 2 pi root over L C hertz.

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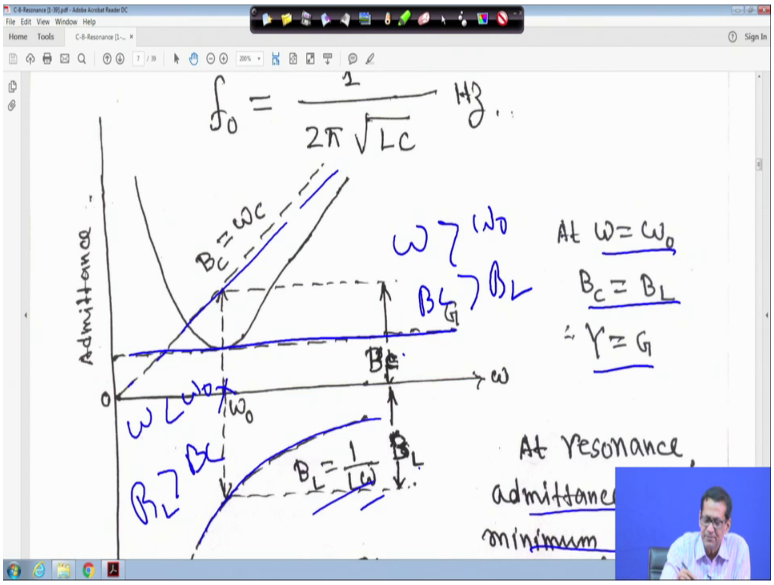

So, if you plot now admittance versus omega same as your what you call now I will do impedance versus omega for series admittance circuit. For parallel, we are plotting admittance versus omega.

So, in this case your, this is my your constant G line. Because, B C is equal to B L right then B C omega and this is my B C is equal to omega this is dash line and this is your B L is equal to omega. It is a rectangular hyperbola, one upon l omega and this is my your what we you call omega 0, that is resonance frequency.

So, at this point your B C is equal to B L right and from the this side you can make out when omega less than omega 0 this side that B L will be greater than B C right. When you will come to this side when omega greater than omega 0 right this side; if you come to this side it will be your B C your greater than your B L right just opposite. So, at omega is equal to omega 0, B C is equal to B L, Y is equal to G right. So, at resonance, admittance is minimum right that resonance parallel circuit and resonance admittance is your what you call minimum.

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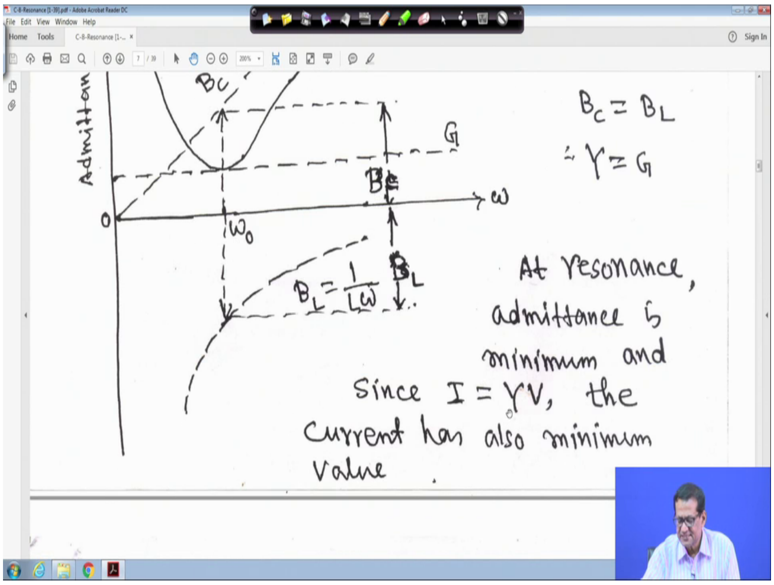

So, in this case and since I is equal to YV so, Y is that admittance the current has also minimum value for the parallel circuit right.

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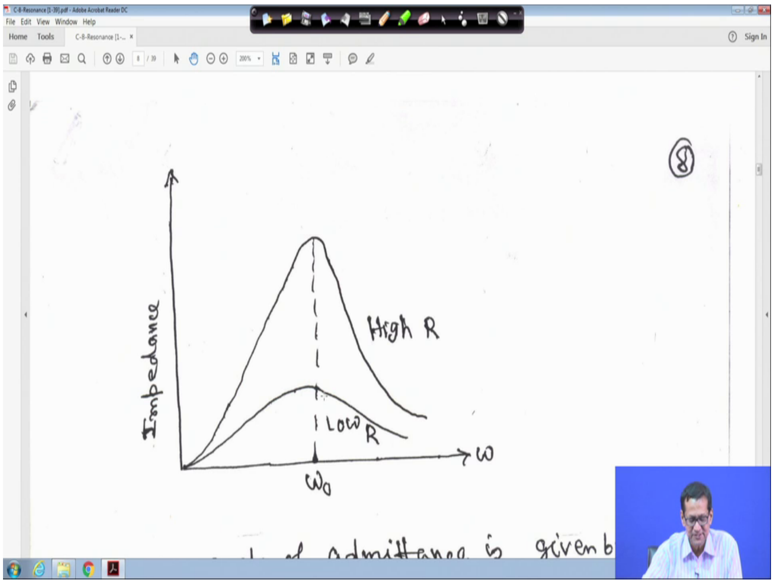

So, now if you plot now just opposite for parallel circuit impedance by omega. So, this is at omega 0 so, this is at low R and this is at higher R. Just you know it is something like your what you call that you compliment to each other series and parallel right.

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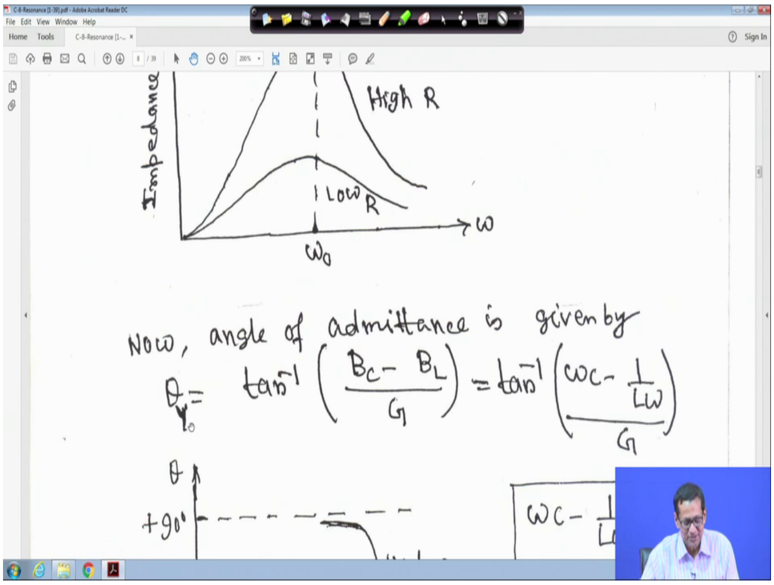

Now, angle of admittance is given by theta what we call this is theta Y Suffix is y capital Y is equal to tan inverse B C minus B L upon G right. Therefore, tan inverse omega C minus 1 upon l omega by G.

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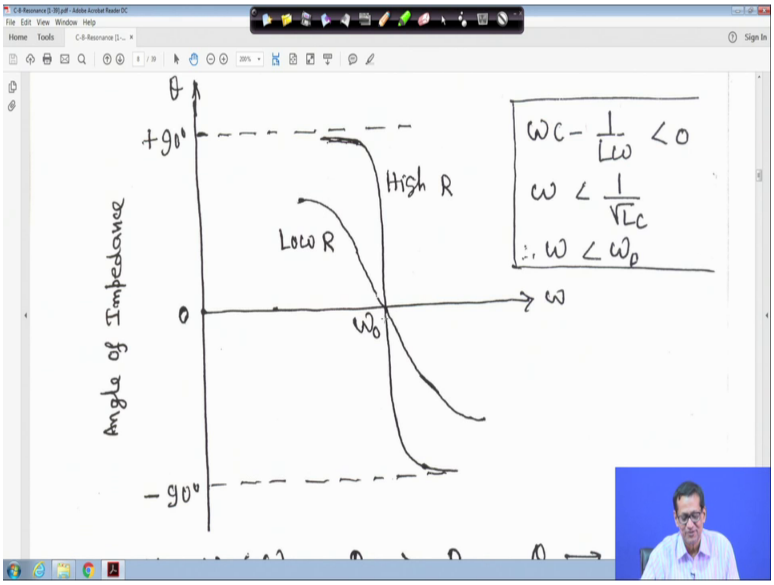

Now, if you plot this one, this is same as before this is angle of a impedance plus 90 degree, this is minus 90 degree right. So, this is very high value of R this is the plot and for low R this is the plot and this is my omega 0. The way we explain the previous one series one it is same, but in this case it is ampere your what we call it is that we has already it is angle of impedance right.

So, if you plot like this it will be and an omega C minus 1 upon L omega less than 0. So, omega less than 0 your omega less than 0 and this is your what we call plot.

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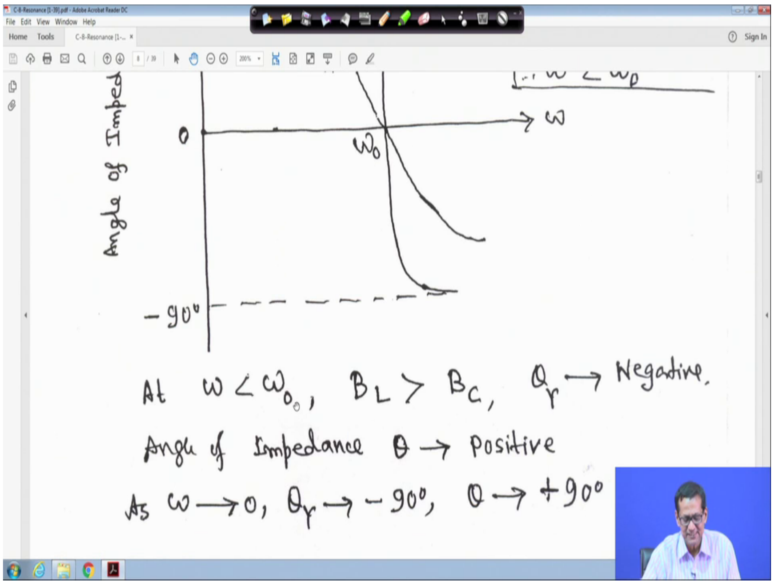

Now, if you see omega less than equal to omega less than omega 0 that is my B L greater than B C. So, theta Y is negative right. So, if you come to this here, your this thing your this one right, it will be G plus j omega C minus L omega this is my B C minus B L right. So, from this condition I see that if you are your what we call if B C minus your B C greater than B L or less than B L accordingly negative and positive angle will come right.

So, same thing is explained here that your what we call when omega less than omega 0 B L greater than B C theta Y will be negative right. And angle of impedance; that means, theta is positive because it is theta Y angle of admittance; if angle of admittance become negative then angle of impedance theta will become positive right.

Similarly, if omega tends to 0 the theta Y angle of admittance becoming minus 90 degree and therefore, the angle of impedance theta will be plus 90 degree right. So, when B L greater than B C that angle of admittance is negative; that means, angle of admittance theta is positive. Because, this is theta Y, similarly at when omega tends to 0 right angle of admittance is minus 90 degree; that means angle of impedance is plus 90 degree right.

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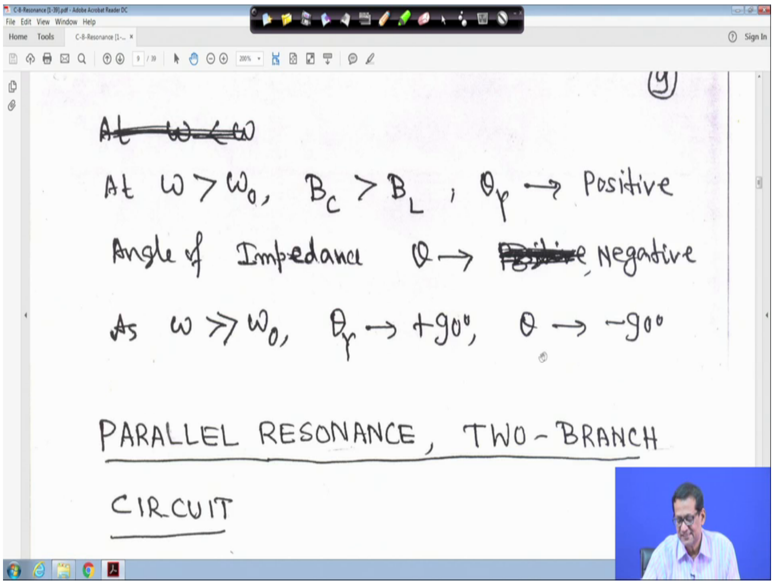

So; that means, at omega greater than omega 0 B C greater than B L that is theta Y that is positive right and angle of impedance theta will be negative. This is just put in that your what we call in that expression very simple thing it is and omega is much much greater than omega 0, at that time you will see theta Y is plus 90 degree. That is angle of impedance will be minus 90 degree.

When omega great omega greater than much much greater than your omega 0; that means, if you come to this; that means, if you come to this that when omega is much much greater than omega 0, much much greater than omega 0 right, then this part is negligible compared to this part right. That means, in that case angle of admittance is your positive right. So, in that case angle of admittance is your what we call that is positive that is 90 degree and therefore, theta is equal to minus 90 degree right so, with this.

Thank you very much we will be back again.