Fundamentals of Electrical Engineering
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Lecture – 57
Single Phase Transformer (Contd.)

Ok, we are back again. So, next is Leading Power Factor Load right.

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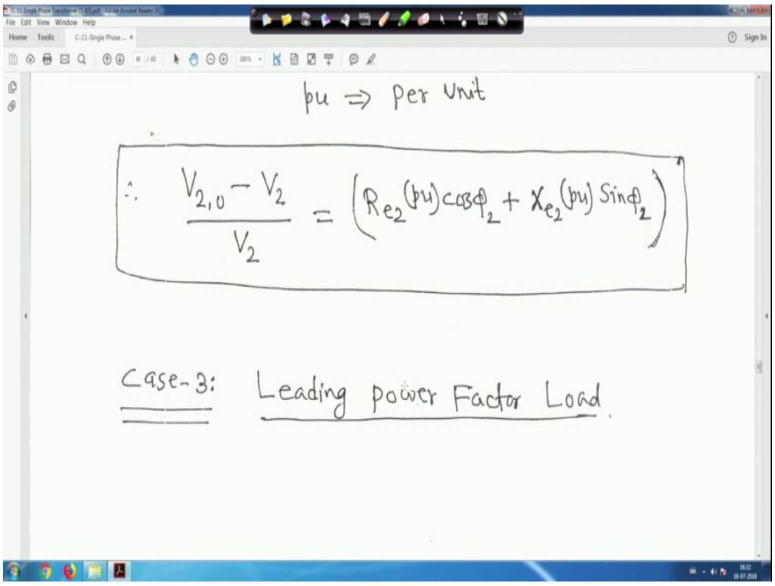

So the way, we have done Lagging Power Factor Load, same way we will do it your Leading Power Factor. In this case current is leading right.

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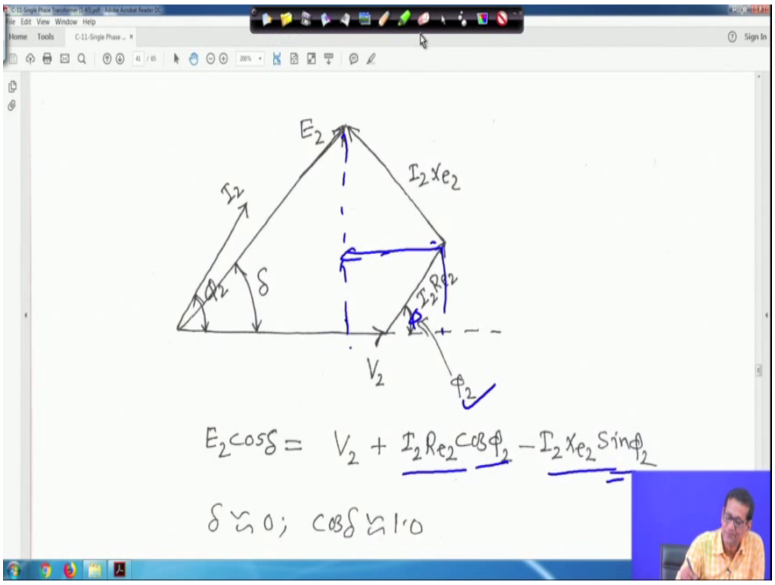

Look that E 2 square is equal to I did not do it for you. This is your job that you please do it. I have made the approximation one right. So, this is my, I current is this is my V 2. So, I 2 current is leading. The voltage I 2 is leading voltage V 2. So, this is my E 2. So, this is my this angle I angle phi 2 is between I 2 and V 2 and angle delta is between E 2 and V 2 everything is clearly marked right.

So, take your what you call the horizontal projection; therefore, E 2 cos delta will be V 2 right. I mean it will be this E 2 cos delta right I mean this one right, whatever this thing this one we take; so, E 2 E 2 cos delta will be your V 2. First you make it like this V 2 plus this one is I 2 R e 2 cos phi 2 because this angle is marked here phi 2 right and this going like this. So, take its projection right.

So, that will be then you have to subtract it right. So, it will be minus I 2 X e 2 sin phi 2 right because you what you call you have to find out E 2 your cos your delta. So, it will be first you make V 2 plus this one, then this one you also find out how much it is. So, it is minus I 2 X e 2 sin phi 2 right.

So, just 1 minute. So, that and we assume delta is equal to 0; so, cos delta is equal to 1 right.

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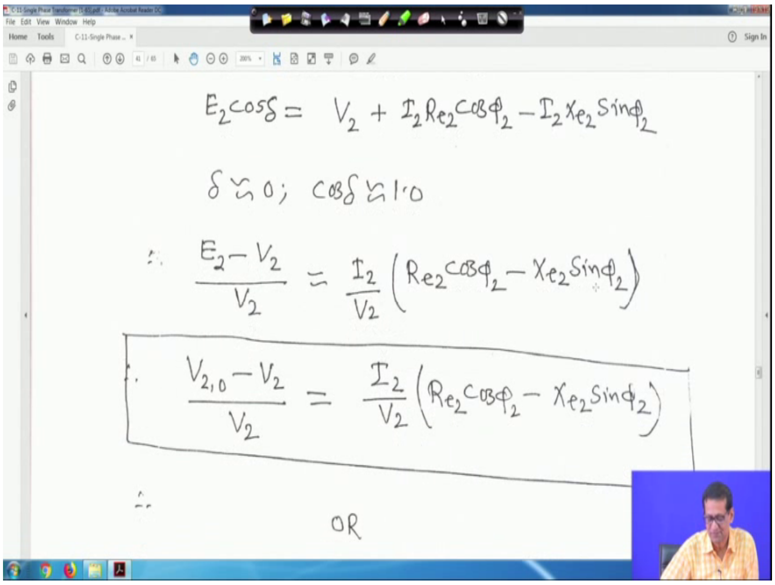

So, E 2 minus V 2 upon V 2 is equal to same way we will do it I 2 upon V 2 R e 2 cos phi 2 minus X e 2 sin phi 2.

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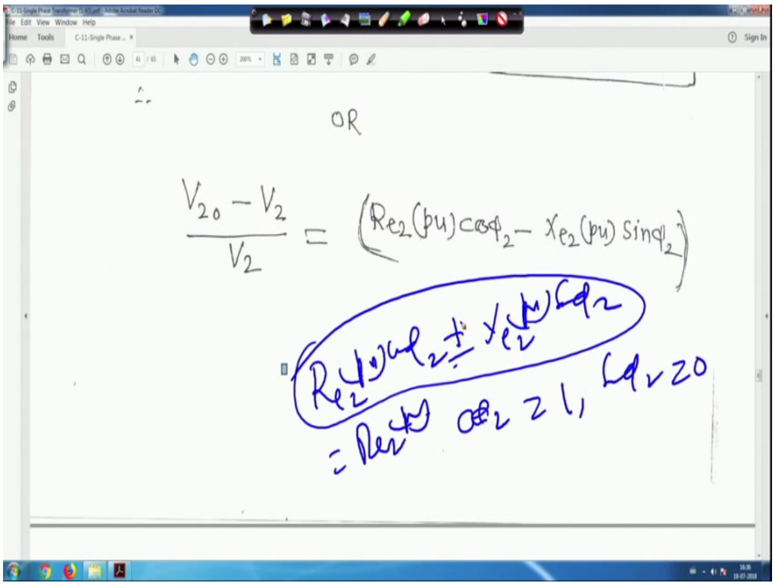

So, V 2 0 minus V 2 upon V 2 will be actually is equal to same way that Z V 2 is equal to V 2 upon I 2. So, you will get R e 2 per unit cos phi 2 minus X e 2 per unit sin phi 2 right. So, if it is your what you call that in general that for Lagging Power Factor sign is plus for regulation; for Leading Power Factor sign is minus right and other thing if you do that your what you call that your that unity power factor let me go to that; that your unity power factor load the regulation right. Here it is here; that means, here also here look here also you can write know this one is equal to R e 2 divided by V 2 upon I 2.

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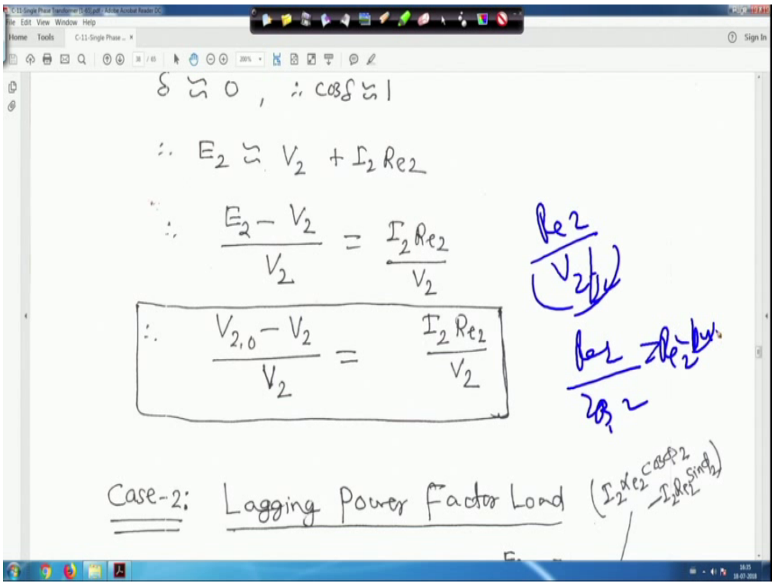

So my, this is my R e 2 divided by Z B 2. This is actually is equal to R e 2 per unit right and unity power factor load so, cos phi is equal to 1 right. So, that means, that means, that means, in general that formula of the regulation right formula of the voltage regulation of a transformer. So, in general, it will be I am making it here for you. It will it will be R e 2, then per unit cos phi 2; I can write plus minus X e 2 per unit sin phi 2. If it is a lagging power factor, if it is a unity power factor your cos phi 2 is equal to 1 and sin phi 2 is equal to 0 right.

So, phi 2 is equal to 0. It will be simply R e 2 per unit right or and if it is a lagging power factor, it will plus this term. If it is a leading power factor, it will be minus right. This you have to keep it in your mind in general. So, if you just if you remember this only this formula, this formula; so, unity power factor phi 2 is 0 right. For lagging power that sign should be your what you call plus right and for leading power factor sign should be minus right. So, this is for your this thing.

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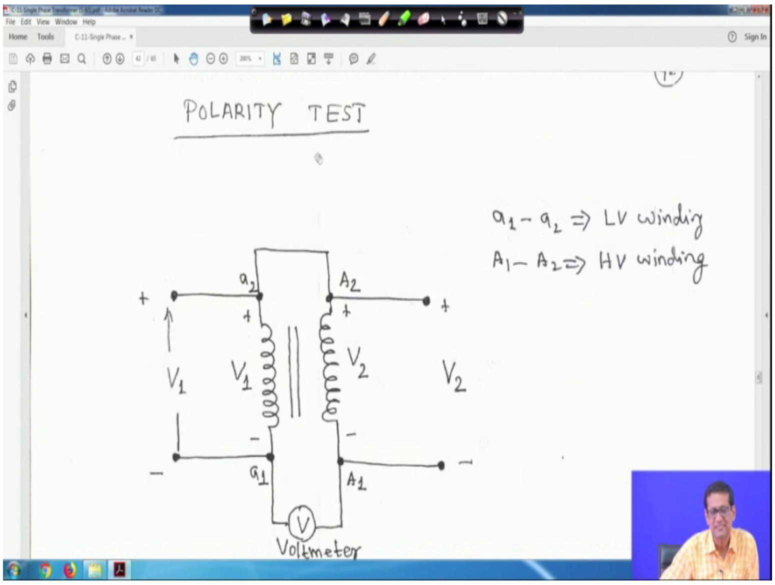

Next is Polarity Test. Here that how we exchange test the polarity in your laboratory when you will do it, definitely you will do like this. So, suppose this is Polarity Test.

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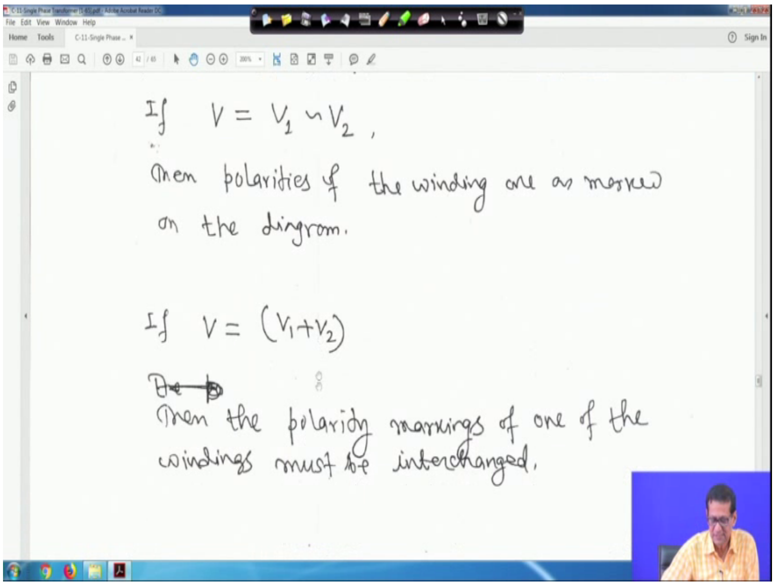

So, a 1 a 2 Low Voltage winding and capital A 1 capital A 2 is High Voltage winding. This thing is given right. So, one thing is there a suppose this polarity is not like this a 1 a 2, it is plus minus a 2 is plus here it is minus. Here capital A 2 plus and capital A 1 minus. This voltage is V 1, V 1 and this is V 2, V 2 and on voltage Voltmeter is connected your across capital A 1 and small a 1 and this is the polarity now it is marked right.

Now, if V 1 it is difference operator. I am using V 1, it is difference of course, a difference operator V 2 right; why, I have why I have made this symbol? This is I am giving you a small exercise that why I am writing V 1 difference or V 2 the difference operator. It is actually like tilde right; so, this one written as and if it is like this right. Then, the polarities of the winding are as marked in the diagram.

If you get like this, then you but why I have used difference operator right, then the polarity as it is marked you have what you call in the diagram it will remain as it is. It will not change, it is unchanged if you get the reading of the Voltmeter is like this if you get like, but I have used difference operator? It is a small your what you call exercise for you right.

And if you get if you get your V is equal to V 1 plus V 2 right. So, everything is marked actually if you get V 1 V 1 plus V 2, then the polarity margins of one of the winding must be interchanged either this side or this side; you just interchange right. Then, your what you call your then, if you get V is equal to V 1 plus V 2. I mean if it is additive right. So, then the polarity markings of one of the windings must be interchanged. So, this is all for polarity test nothing is there actually alright.

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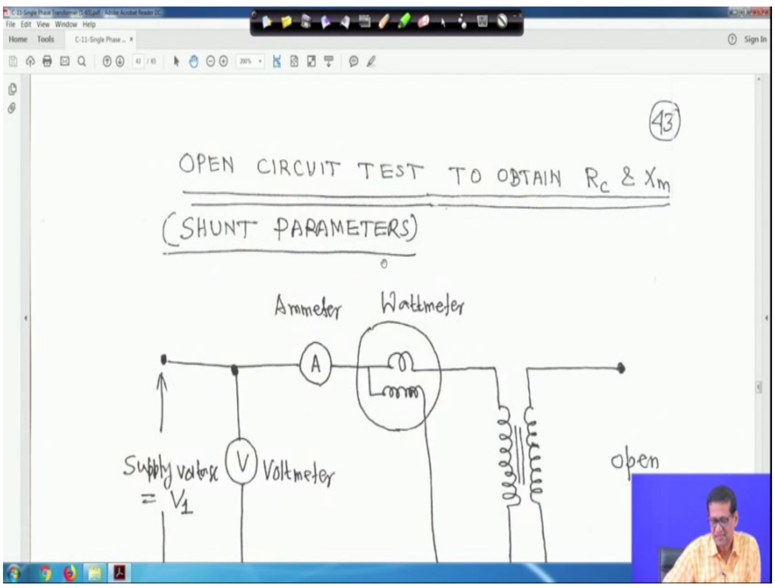

Now, Open Circuit Test to obtain R c and X m; that means, for the transformer, we have to find out the your what you call the parameter right particularly R c, X m, R 1, X 1, R 2, X 2; all these things you need to obtained. So, generally open circuit test we for to obtain R c and X m that is a shunt we call a shunt parameter because these are connected in parallel. These are shunt parameters right; we will perform actually open circuit test.

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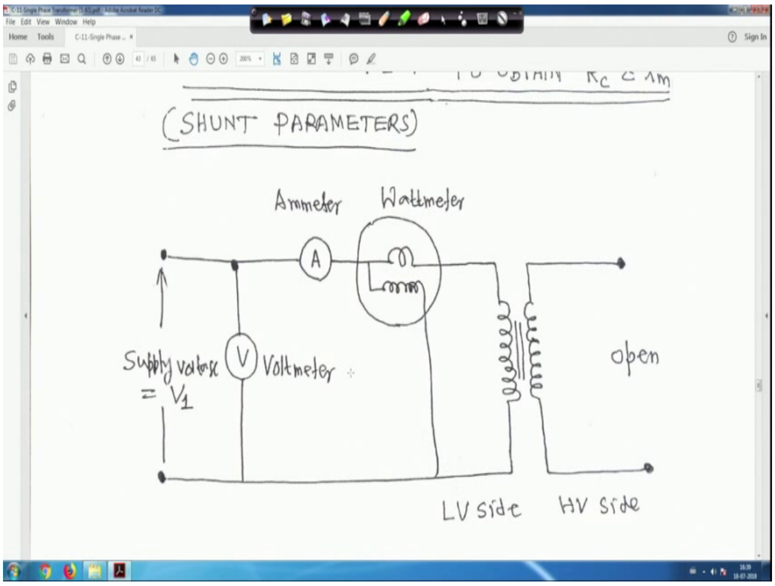

Now, for open circuit test, what we have to do is you need you have to connect 1 ammeter; 1 Voltmeter is there and secondary side that high voltage side actually remain open actually in the laboratory actually its open circuit test or short circuit test whatever it is; it can be performed on either side right.

But in the laboratory right that generally we will perform that this one on LV side your what you call the supplier that your open circuit test, you perform on the LV side and not on the high voltage side right. So, but either side, it can be done; either side, sometimes suppose that voltage level may not be available right. So, because that your what you call the high voltage may not be available in the laboratory that is why we perform your what you call open circuit is your what you call this on the your low voltage side. So, this is the low voltage side for open circuit test right.

But short circuit test in the laboratory performed on the high voltage side. But let me tell you one thing, it can be done on either side; you will get the same result right. So, this is the Ammeter is connected 1 Wattmeter is connected and 1 Voltmeter is here. In this supply voltage is V 1 right.

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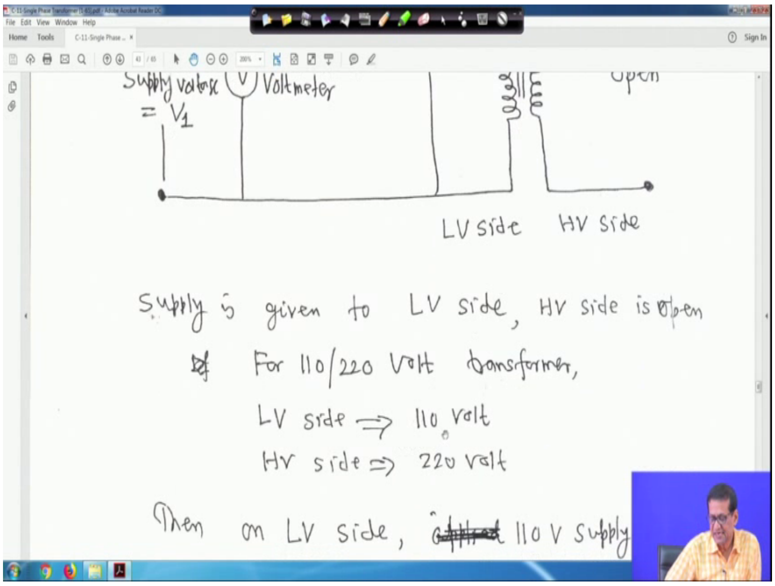

So, if you so supply is given to l voltage side and you have to suppose in the laboratory you have 110 by 220 volt. Suppose your transformer is 110 by 220 Volt in the laboratory say then, low voltage side is 110 Volt and high voltage side is your what you call 220 Volt.

Then, on low voltage side 110 Volt is given this side actually 110 Volt is given. Suppose for example, if this low voltage side is 110 Volt and the high voltage side suppose transformer you have 2000 Volt 2 KV. In the laboratory that 2 KV may not be available right that is because for open circuit test you need full voltage. That is why you perform open circuit test on the low voltage side in the laboratory, but either side, it is possible. I mean you will get the same result same parameters value R c and X m.

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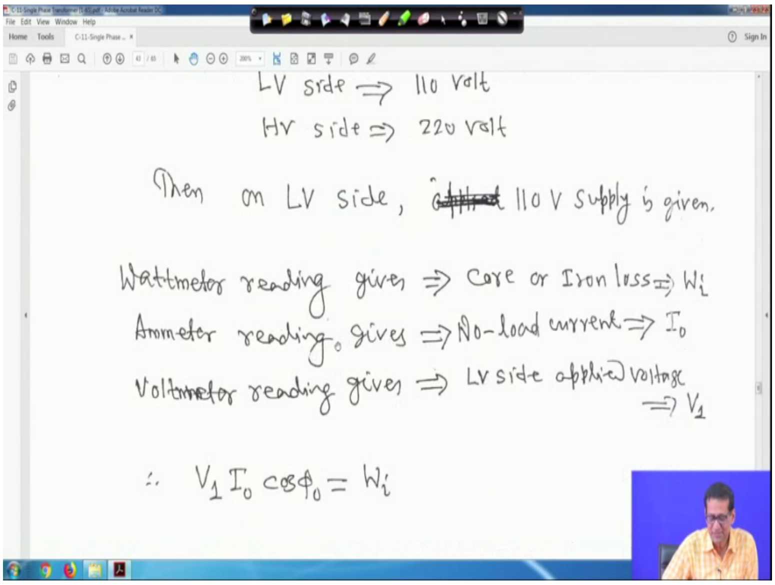

So, your what you call that Wattmeter reading is actually in that case wattmeter, this side is open that is secondary is open. There is no load on the secondary; it is written open circuit right. So, whatever Wattmeter will give, it will basically give you the core loss right that is your it is the term because an open circuit is carries no load current right and Ammeter will give you the I 0, the no load current and Wattmeter will give you the no load power loss right and this is the voltage you are giving 110 Volt.

So, in that case everything is written here Ammeter will give no load current I 0 and your Voltmeter will be your applied voltage is V 1. So, this Wattmeter reading is known, Ammeter current I 0 is known, supply voltage V 1 is also known; therefore, you can get phi 0. Therefore, V 1 I 0 cos phi 0 is equal to W i.

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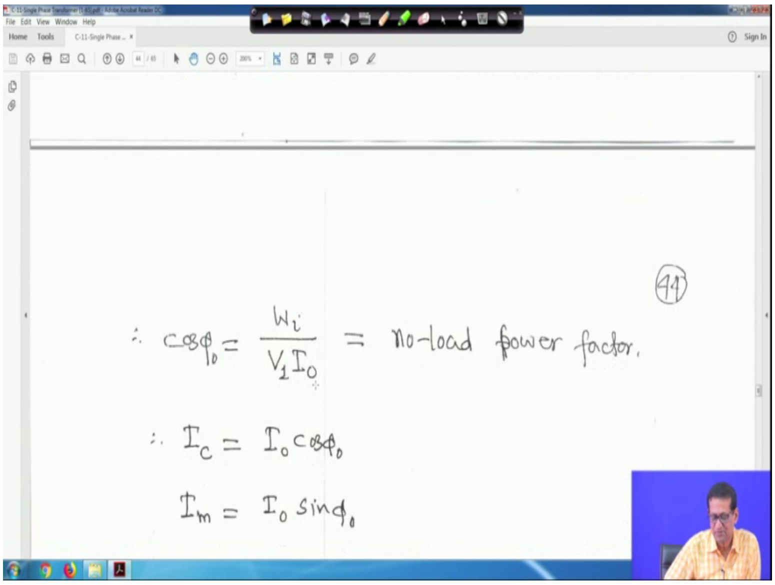

That means cos phi 0 is equal to W i upon V 1 I 0 that is no load power factor right and see and therefore, if you get cos phi 0. So, I c you will get I 0 cos phi 0, we have seen before. I m we will I will get I 0 sin phi 0 you will get it right. Therefore, your equivalent circuit say this is R 1 and X 1.

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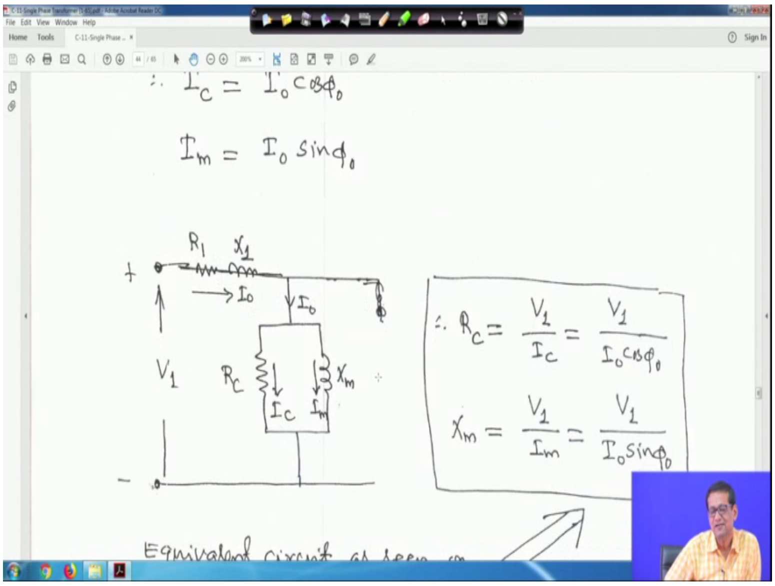

This is the current I 0, this side is o[pen]- your what you call the that your what you call that your secondary side is open circuited.

So, nothing is drawn after these right; nothing is drawn R 1 and X 1 put it here and this is the current I 0. Therefore, your what you call R c will be V 1 upon I c and I c you have got it because cos phi 0 you got it I c you know I 0 you know cos phi 0. Now, therefore, R c will be V 1 upon I c that is V 1 upon I 0 cos phi 0. Similarly, X m will be V 1 upon I m. So, V 1 upon I 0 sin phi 0. Actually this I 0 current is very small and in the winding resistance of the transformer is also very small. Therefore, this loss your what you call that no at your no load, the winding loss in the transformer is negligible right.

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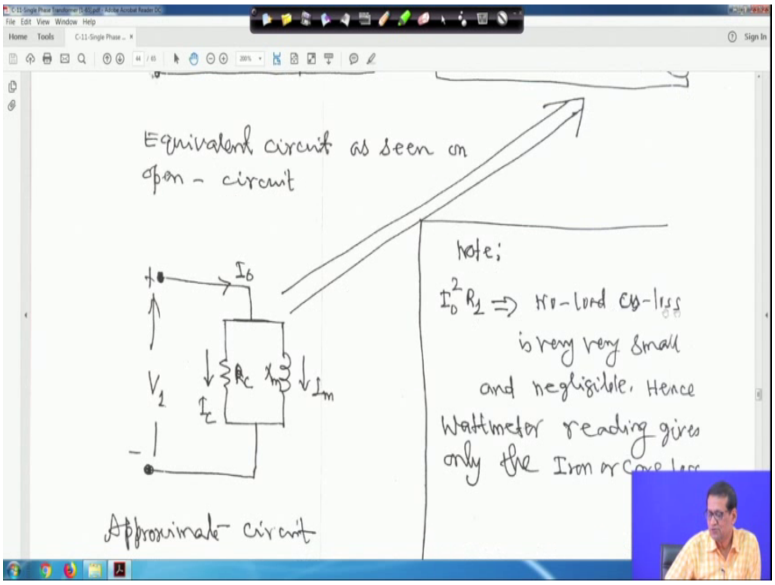

Therefore, this is the circuit, but equivalent circuit as seen from this when this R 1 X 1 say it is not there neglected. Therefore, this is the equivalent circuit for no load right and everything marked by an arrow right. So, that is I 0 square R 1 no load copper loss is very very small, negligible right. And here, Wattmeter reading gives only iron or core loss. So, what your what you call for open circuit test?

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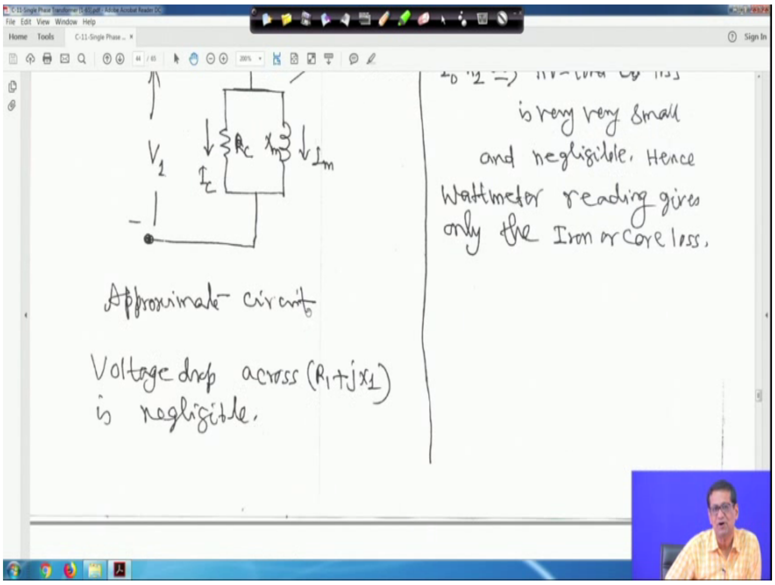

Now, so the voltage drop across R 1 plus j X 1 is negligible because I 0 is very small right. So, this is your approximate circuit.

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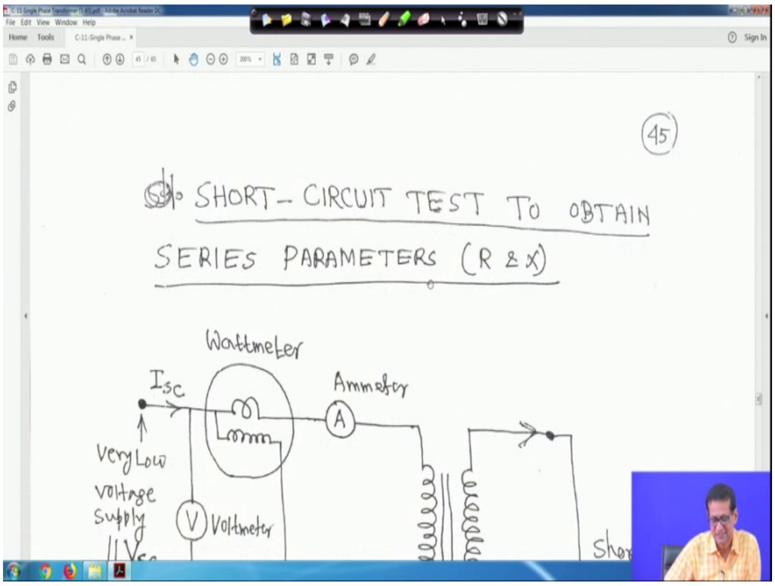

Now, Short - Circuit Test to obtain the series parameter that is your resistance and reactance.

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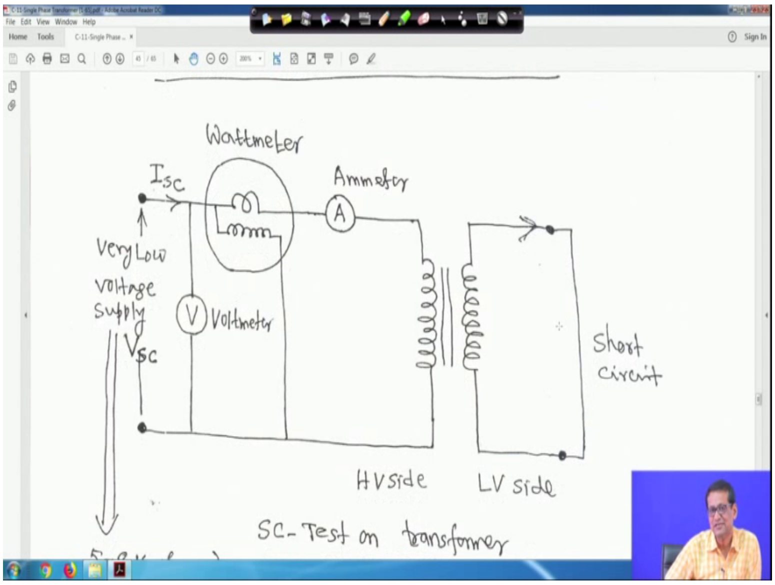

Now, actually in a transformer there now this is the Short - Circuit Test. Short - Circuit Test is performed on the high voltage side because when we perform the Short - Circuit Test that we need hardly 5 to 8 percent of the total your voltage on the high voltage side right, to flow the your what you call the rated current or full load current say the secondary is the your what you call low voltage side is the short circuit not secondary is low voltage side is the short circuited right.

So, to allow that rate[e]- your full load current to flow or rated current to flow, this short circuit; this low voltage side, it needs very small voltage right maybe 5 to 8 percent of the rated voltage on the high voltage side. So, it is written here very low voltage supply and this is V s c. So, this supply is given for an your, what you call for an instrument called VARIAC, variable resistance supply.

Just if you just move it like this then, fuse will blow right because it will use current. So, this is as this is my short circuit current, this is the Voltmeter is connected, Wattmeter is connected and this is Ammeter and this is the your what you call that low voltage value short circuit, it is shorted right.

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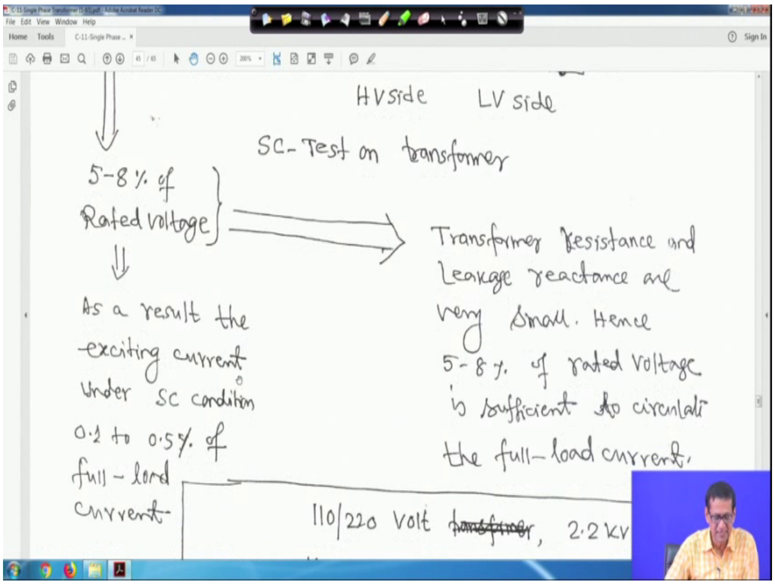

Now, in this case 5 to 8 percent of the rated is required to allow that your full load current or your rated current. So, as a result the exciting current your what you call current under short circuit condition 0.1 to 0.5 percent of the full load current. So, exciting current means I 0; so, that is negligible very very small right. And transfer resistance and leakage reactance are very small; here 5 to 8 percent of rated voltage is sufficient to circulate the full load current. Because it is short circuited, it is short circuited right and transformer resistance and leakage reactance is very very small size right.

So, Wattmeter reading actually will give you the copper loss and this Ammeter reading will that give the your what you call full load current.

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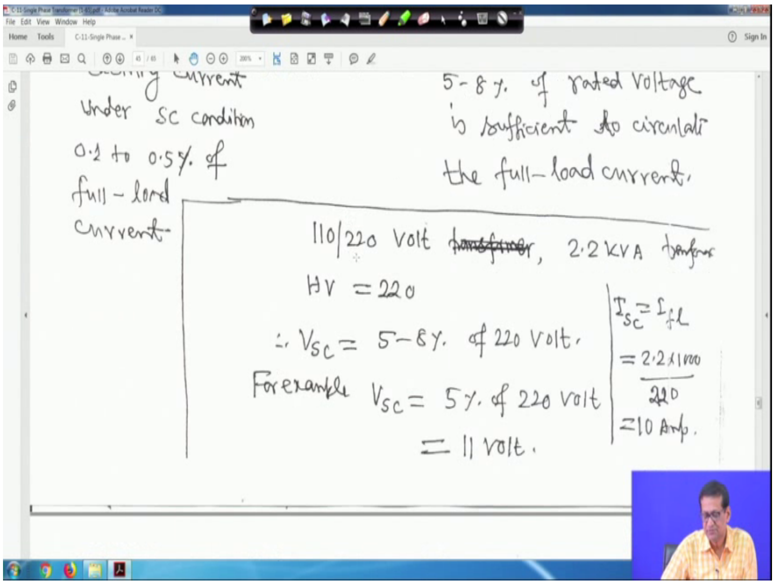

So, in this case if it is suppose 110, 220 volt. So, and say transformer for example, if it is 2.2 KVA transformer. So, high voltage side actually 220 volt. So, short circuit voltage you need 5 to 8 percent of 220 Volt; that means, your 5 to 8 percent means roughly your 5 percent of 220 Volt means hardly 11 volt.

So, if your what you call if your 11 Volt about 11 Volt you supply a rated current that is the full load current that 2.2 KVA transformer. So, 2.2 into 1000 by high voltage side voltage is 220. So, 10 Ampere; that means, you will allow that 10 Ampere current to flow right.

And five if a 5 percent is 11 volt. So, around 11, 12 or 13 Volt, you will find the 10 Ampere current is flowing. So, that VARIAC you have to move it very slowly. Suppose, if you move it very fast; then, fuse will be off. Again you have to the your what you call again you have to switch off the supply and you have to reconnect the fuse wire right.

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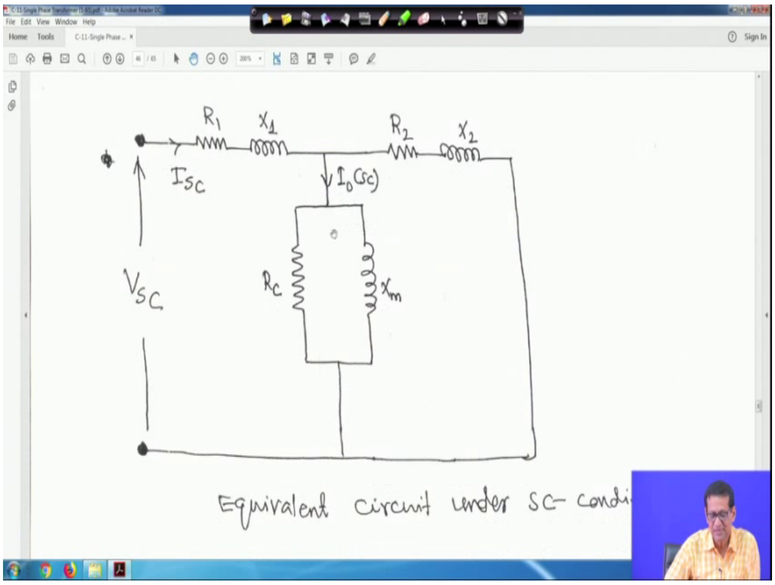

Therefore, this is the equivalent circuit you have studied for a transformer right and this is the short circuit current and this is I 0 this thing, but this your what you call this I 0 is very small percent of the I s c. So, this term we will neglect. This loss in the R c we actually we will neglect right wattmeter in the Wattmeter reading that equivalent circuit under short circuit condition.

If you neglect this, this part because I this component this loss here will be very negligible here very negligible.

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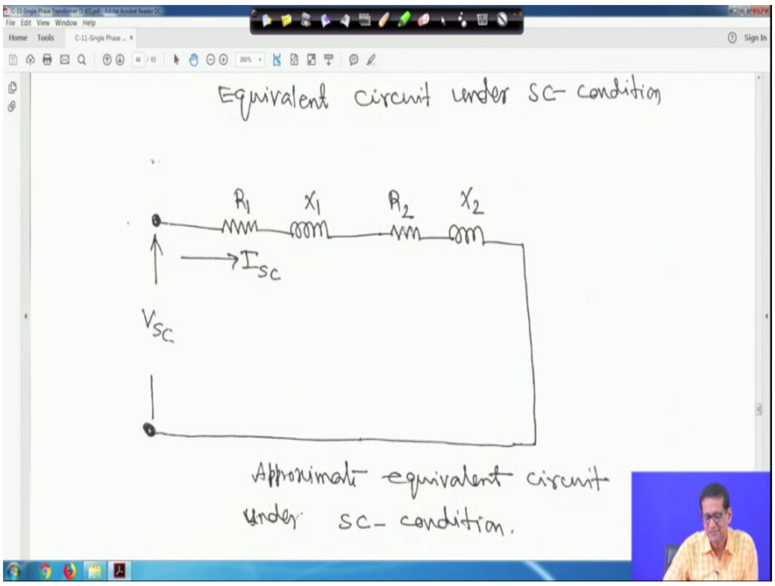

So, that means, it will be a simple circuit right; simple series circuit. So, you will get your R 1 X 1, R 2 X 2 are all in series right. So, it is the approximate equivalent under short circuit condition. So, voltage is equal to V s c current is equal to I s c.

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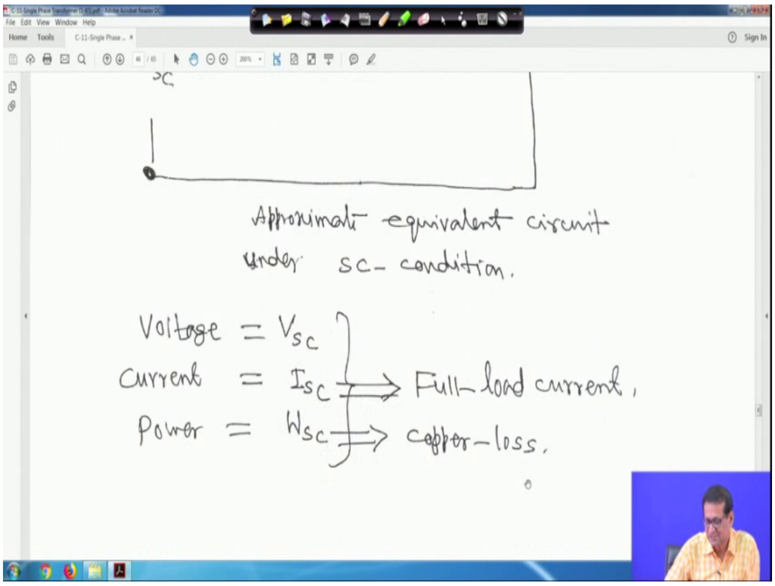

And power is equal to W s c that is the Copper-loss. I s c is the Full-load current and V s c is the voltage; what I told you reconnect under short circuit condition to the low voltage side that is 5 to 8 percent right.

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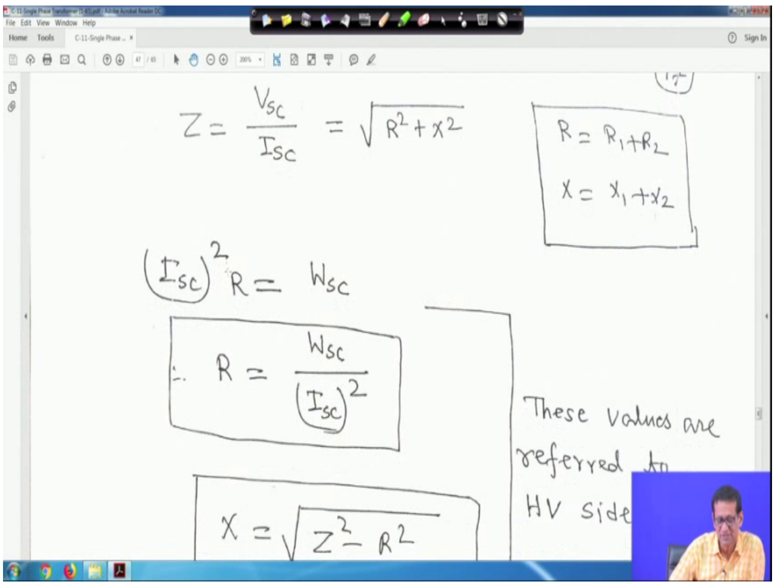

So that means, Z is equal to now V s c upon I s c that is impedance of the transformer we will get, that is root over R square plus X square right. Actually, R is equal to R 1 plus R 2 and X is equal to X 1 plus X 2 X 2 right.

Another thing you know that I s c square R the copper loss is equal to Wattmeter reading because total R is R 1 plus R 2. So, I s c square R is equal to W s c the Wattmeter reading right. Therefore, R is equal to W s c upon I s c square. So, we get R 1 plus R 2 right. These values all are referred to high voltage side because short circuit test is performed on the high voltage side right. Therefore, this is my Z we got.

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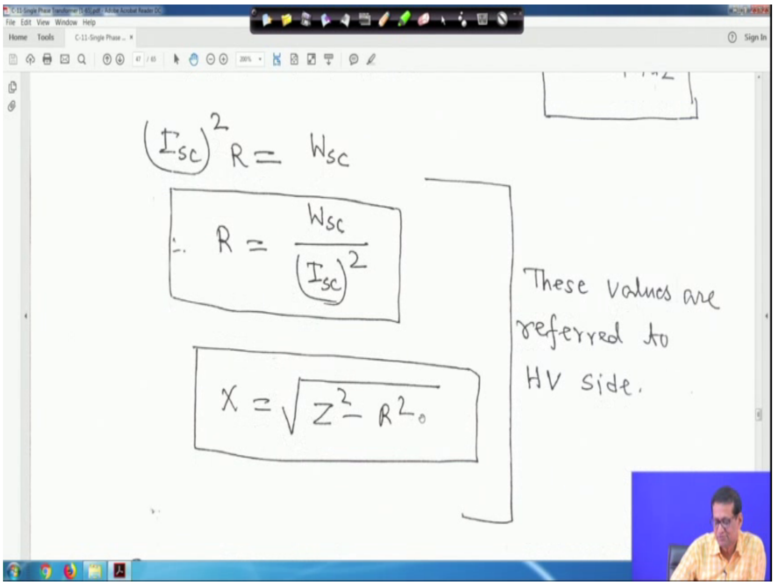

So, this is X equal to then root over Z square minus R square right, but Z is a your what you call X also is equal to X 1 plus X 2 together; R also R 1 plus R 2 together right. But, but how we will separate this right?

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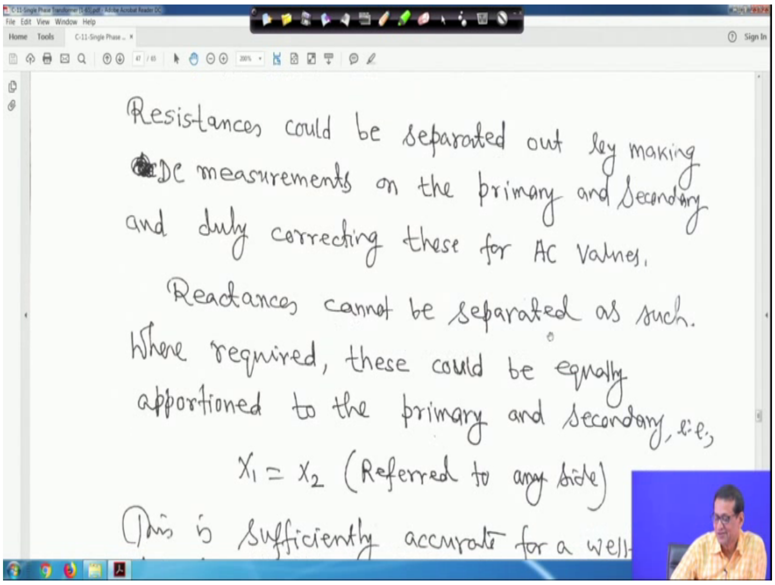

So, generally resistance could be separated out by making DC measurement on the primary and secondary and duly you are correcting these for AC values. This one, I am not doing in this video course, but I am telling you that from your you try to find out that how to find out the resistance suppose if it is asked that each side of the transformer winding, you measure the resistance right. How you will do this? It that resistances could be separated out by making DC measurement right on the primary and secondary and duly correcting those for AC values. This you should try to do it now of your own right.

That and second another thing is that your reactance's cannot be separated as such right, but where you right where your you required, these could be equally your approximated to the primary and secondary side.

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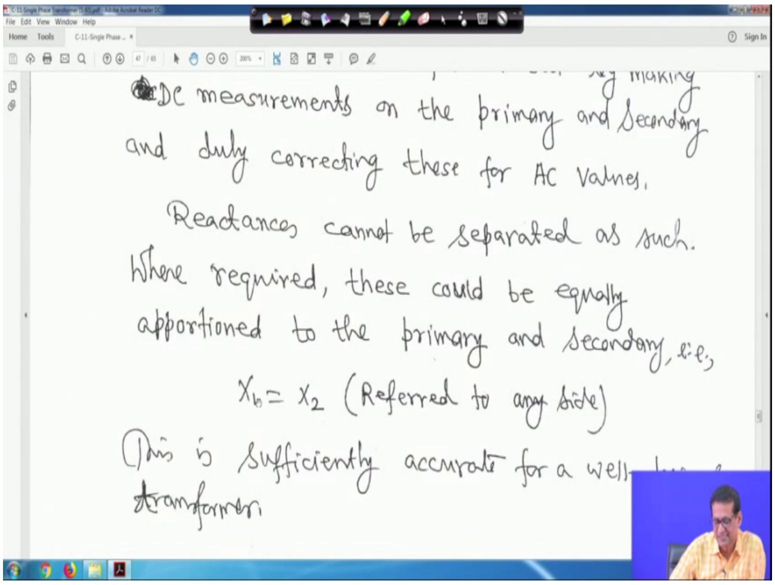

For a well designed transformer generally reactance is X 1 is equal to X 2 referred to any side right. This is sufficiently accurate for a well designed transformer and for R 1 R 2, just an exercise for you just you see you know you put the you put in on the forum that sir we are doing like this and we will we will we will give the answer whether you are correct or not right.

So, another thing numerical, we will come later.

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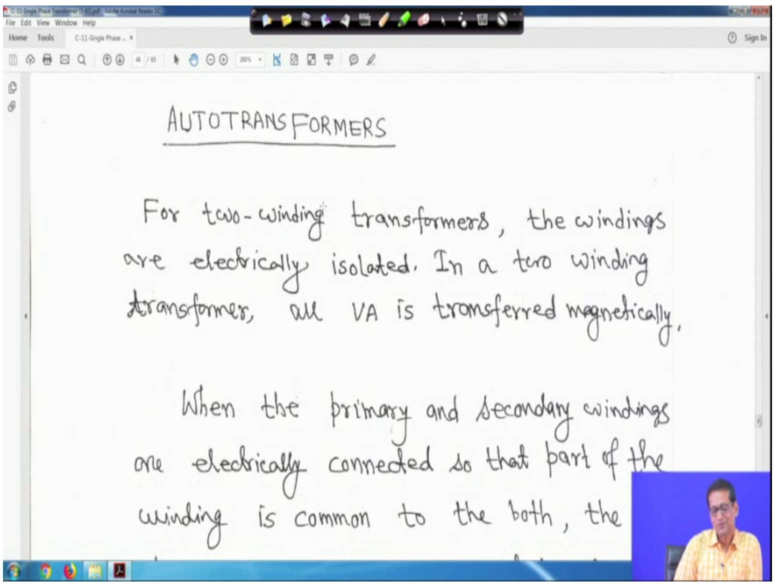

Another things is Autotransformer that your what you call that basically it is a your two-winding transformer right; Autotransformer and so, so far whatever I have talked know something I have said also; one example is also not means an Autotransformer, but some instrument name I have taken. So, you tell me give one example of Autotransformer right, where Autotransformer is being used right.

So, something I have written perhaps right for two-winding transformers, the windings are electrically isolated that you have seen right. In a two-winding transformer, all Volt ampere is transferred magnetically that also you have seen for single phase transformer.

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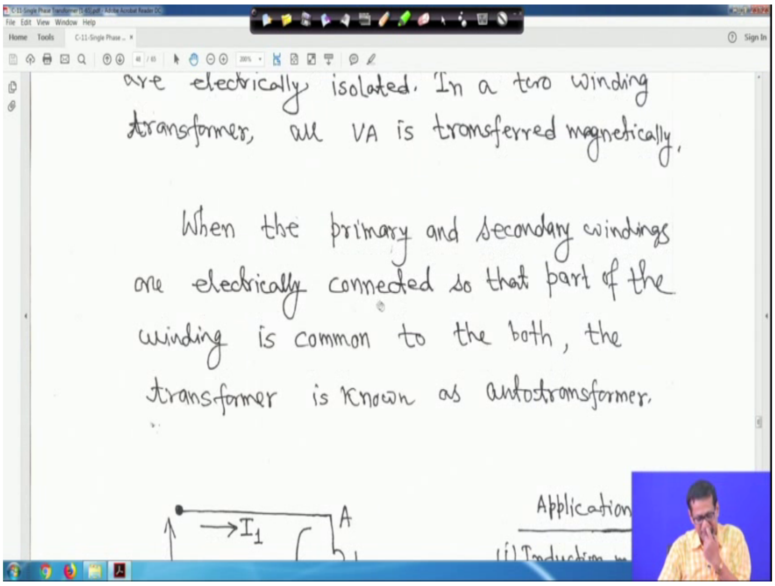

When the when the primary and secondary winding are electrically connected. So, that part of the winding is common to both, the transformer is known as Autotransformer. That means, actually primary secondary that is your, what you call windings are electrically connected to that part of the wilding is common to both right. In that case, we call this as a Autotransformer.

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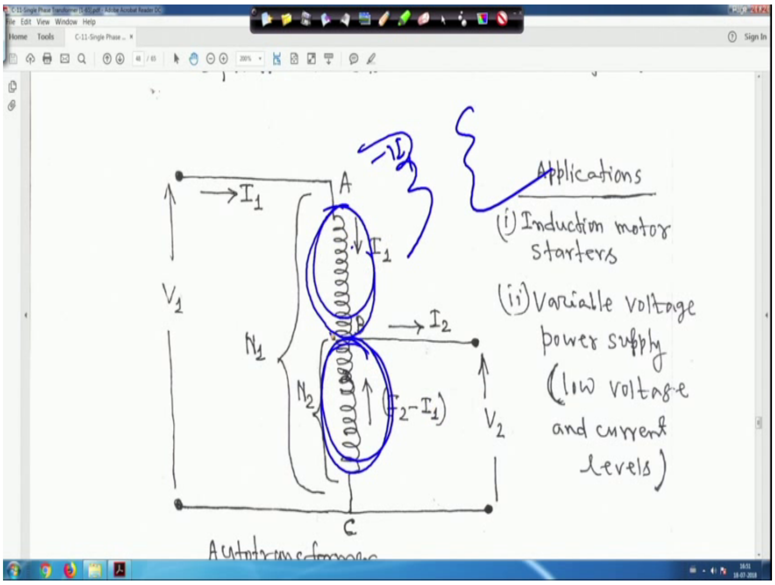

For example, application here something is written that induction motor starters variable voltage power supply that is VARIAC right; just I mentioned and your low voltage and current your low voltage and current levels right.

So, basically if you if you consider like this, first little bit we have to understand; there should not be any confusion. Before doing anything I am just trying to tell you suppose this is only 1-1 winding is there that you can see only 1 winding. Now for example, if I want it is a two-winding transformer, then what I will what we will do? This one we consider as 1 winding and this one, we consider another winding right. For two-winding transformer as if as if this is 1 as if this way you imagine. So, if you consider this part. So, current is flowing here is I 1 right and if you consider this part it is I 2 minus I 1 right.

This way I mean this as if this part is 1 winding and this part is 1 winding like a two-winding transformer whatever we have studied there. Just now whatever we have studied so far right; so, in that case your what you call this is the current flowing your through this is I 1 and current suppose if load is connected, this is I 2 and this if you take in this direction, current will be I 1 minus I 2, but I have taken in this direction. So, it will be I 2 minus I 1 right. So, for from A to C, this is A and this is total winding number of turns is N 1 and for B to C number of turns is N 2 and current flowing A to B is I 1 and your C to

B in this direction is I 2 minus I 1 and this is the current I 1 and this is the voltage V 1 and this is the voltage V 2 right same as whatever.

But when you consider two-winding transformer as if this is 1 winding and this is another winding, when you see the autotransformer we will make in different way right.

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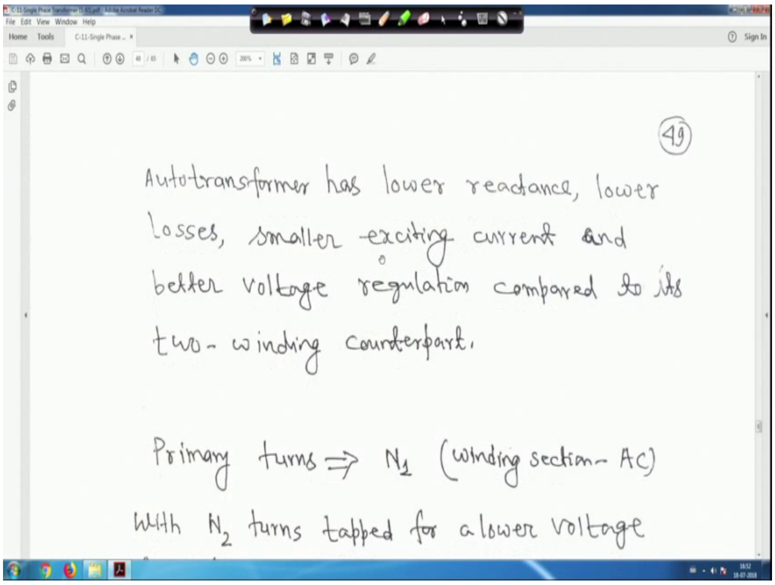

So, in this case, so this is an Autotransformer, but we have to compare these 2 right. So, in this case, so Autotransformer has your what you call some lower reactance, lower losses, smaller exciting current and better voltage regulation compared to two-winding your counterpart right. So, primary turns N 1.

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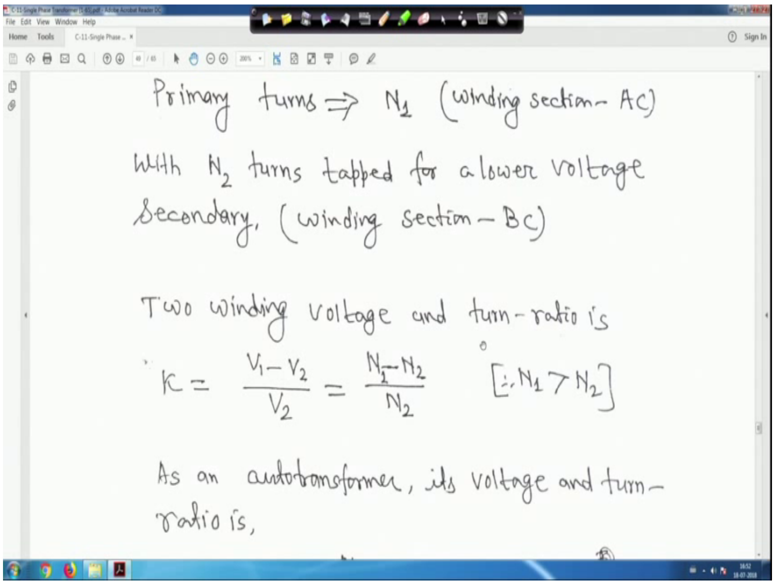

I told you winding section AC with N 2 turns tapped for a lower voltage secondary winding section BC this I told you.

Now, two-winding voltage and turns ratio right. So, for two-winding voltage, I told you that this for two-winding transformer this is 1 winding right.

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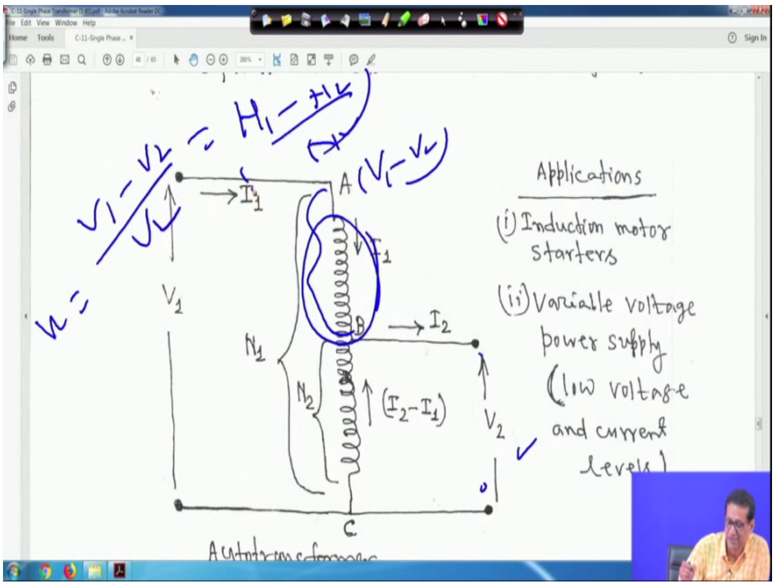

This is 1 winding. This voltage V 1, this voltage is V 2. So that means, this voltage is V 1 minus V 2. I mean here, this voltage is V 1 minus V 2 and this is my V 2 right if it is a two-winding transformer. Therefore, my K actually will be will be equal to V 1 minus V

2 by V 2 for two-winding transformer. That means, this one can be written as N 1 minus N 2 divided by N 2 right. This portion only this portion you have to understand here, there should not be any confusion right.

So, in this case ; so in this case, same I am writing K is equal to V 1 minus V 2 upon V 2, N 1 minus N 2 upon N 2; of course, N 1 greater than N 2.

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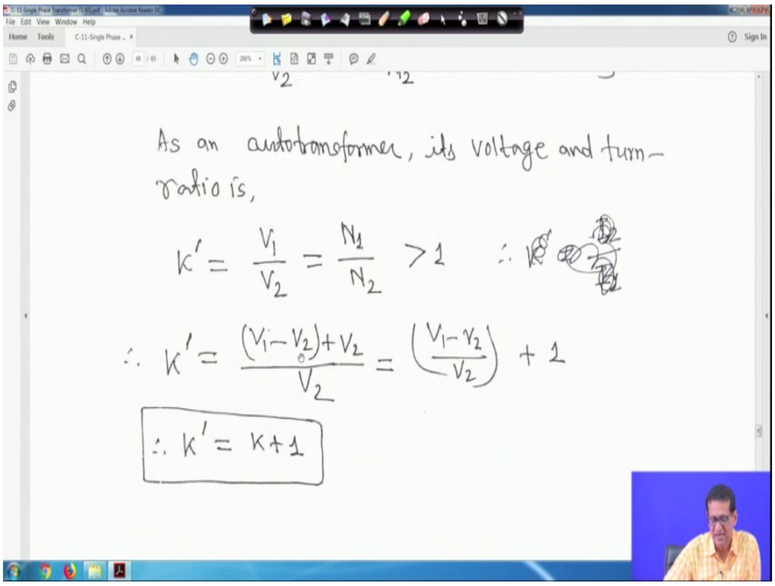

Now, when you take Autotransformer as an autotransformer its voltage and turns ratio will be V K dash is equal to V 1 upon V 2.

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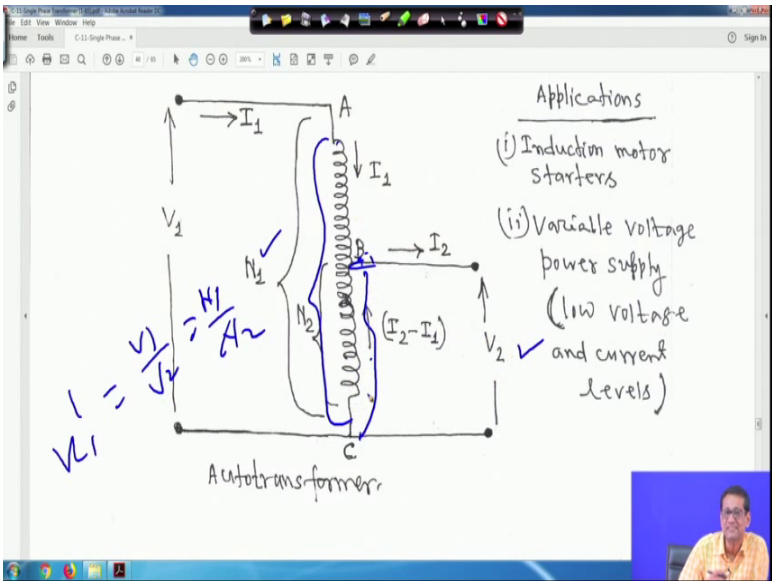

For Autotransformer, the same winding we are using for both right. So, for autotransformer, this is your one turn that is your N 1 and this is another turn, same winding; something we are tapping it out right, same winding. So, voltage is V 2 right.

So, for autotransformer suppose K dash is equal to say V 1 by V 2 is equal to N 1 upon N 2 right. When we are taking as autotransformer, this full transformer and part of this we are that voltage we are tapped from this your what you call from some part say between your between A and C that is B and C right. So, in this case ; so, in this case your K dash is equal to V 1 upon V 2 is equal to N 1 upon N 2 that is greater than 1. Because N 1 greater than N 2 from the diagram. Therefore, K dash it was V 1 V 2 that K dash can be written as you add V 2 subtract V 2. So, K dash is equal to V 1 minus V 2 upon V 2 sorry V 1 minus V 2 plus V 2 upon V 2 right.

So, this can be written as V 1 minus V 2 upon V 2 plus 1 because V 2 V 2 V 2 by V 2 is 1. Therefore, V 1 minus V 2 upon V 2 is equal to k. So, K dash is equal to K plus K 1. This is the relationship between the autotransformer turns ratio and that two-winding transformer ratio, the way we have considering right.

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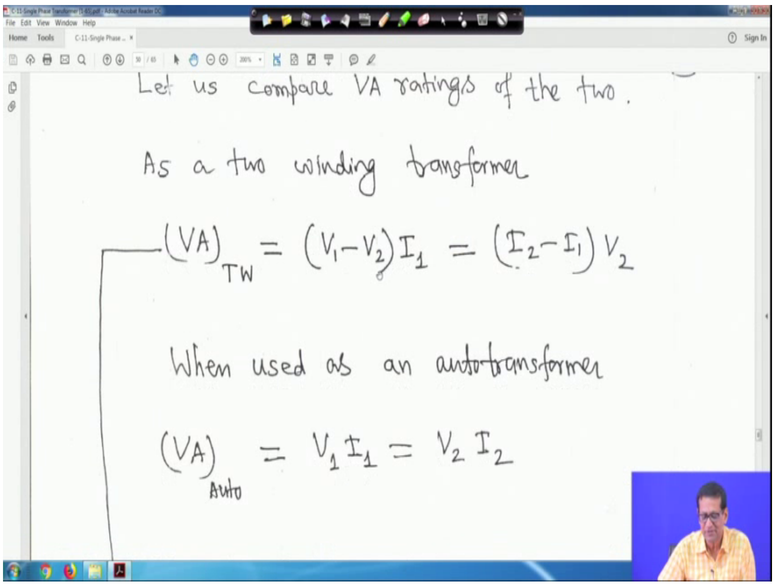

Now, let us compare Volt ampere rating of the 2 right as a two-winding transformer, I told you the voltage is your what T W stands for two-winding. TW stands for two-winding. So, Volt for two-winding transformer that your V 1 minus V 2 into I 1 is equal to I 2 minus I 1 into V 2, as if you if you if you go like this as if this is one winding, this is your one winding.

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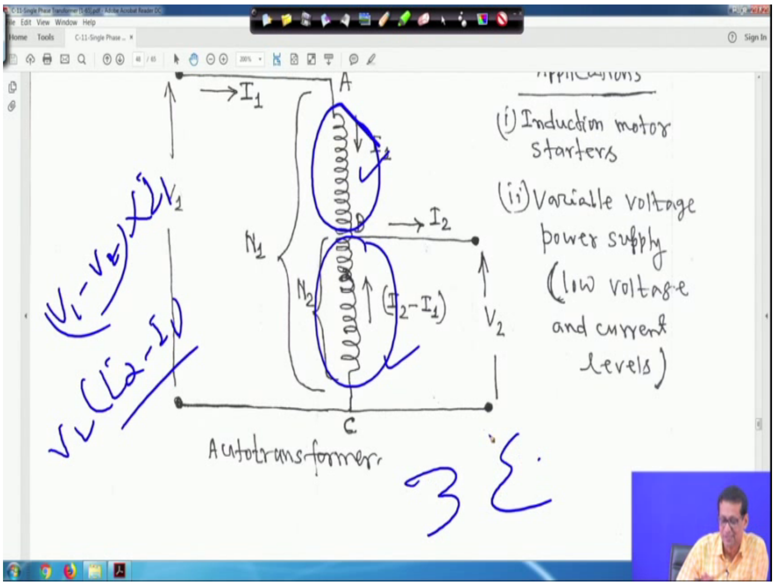

So, as if (Refer Time: 22:51) voltage here total is V 1, this is V 2. So, voltage here V 1 minus V 2 and current flowing through this is I 1. This is the Volt ampere rating for this winding as if 2 windings are separate this way you imagine and this is another winding is there voltage is V 2 into your I 2 minus I 1 right; both have to be same if the rating Volt ampere rating. As if this is one winding, as if this is another winding; I mean it is like this, it is like this and here it is voltage for this one voltage is your V 1 minus V 2 and current is your I 1 and here voltage is V 2 current is I 2 minus I 1 this way imagine right.

So, that is why that is why it is V 1 minus V 2 into I 1 is equal to I 2 minus I 1 into V 2.

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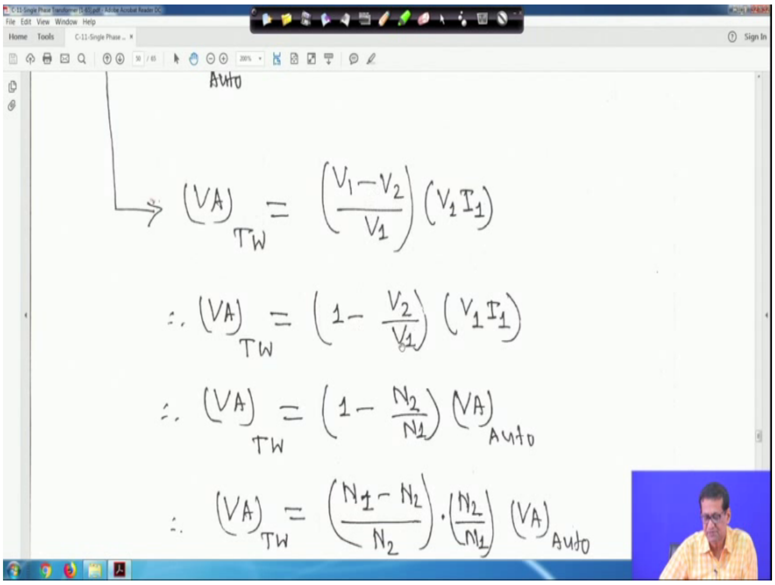

When used as an autotransformer, so Volt ampere will be what will be V 1 into I 1 because same winding we are using. So, for autotransformer; so for autotransformer right, for autotransformer, this is the whole winding.

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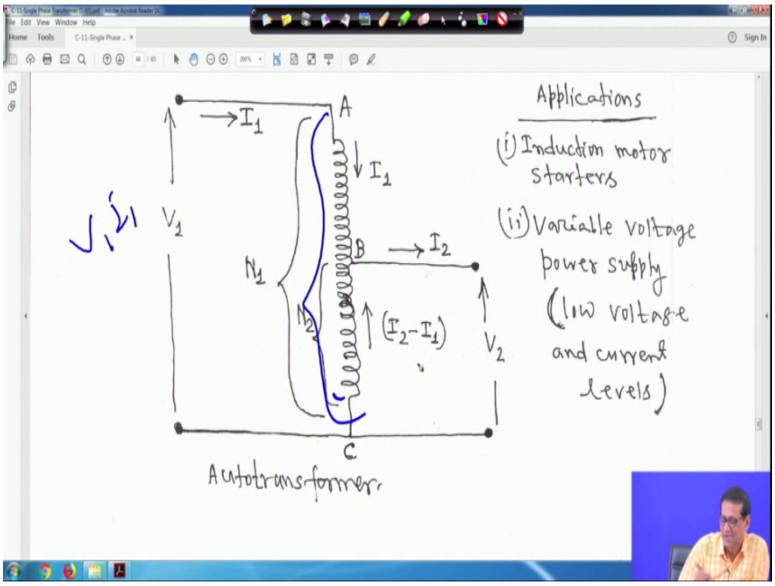

As if this this way I think primary and secondary right. So, for autotransformer if you take, the this is the V 1 and current is I 1 say V 1 I 1 right and output we are taking V 2 into your what you call your this thing your I 2 minus I 1 right.

So, in this case for your for autotransformer, for autotransformer your sorry V 1 I 1 is equal to V 2 minus I sorry V 2 I 2 actually here hold on. For autotransformer input I have to see the input; input here this is the whole winding. Input here is V 1 I 1 and output here is current is I 2.

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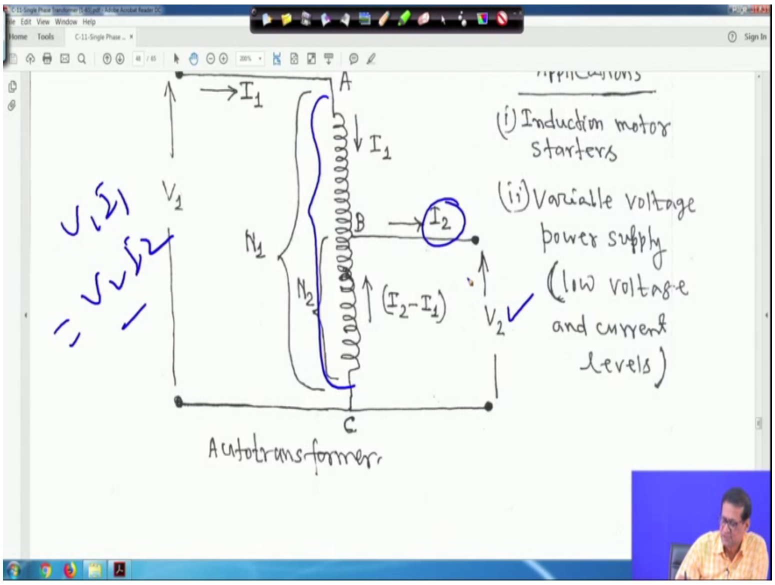

So, this is V 2 is equal to V 2 I 2 right because this is the current I 2 going to the load and voltage your here it is V 2; so, if is ideal case only. So, it is V 2 into I 2 is equal to V 1 into I as an autotransformer right.

So, this is an autotransformer; therefore, we can right V A two-winding transformer is equal to we can write your this your here if you come that V A two-winding transformer V 1 minus V 2 into I 1, this one. So, divide numerator and denominator by V 1 here. Here you divide if you do. So, it will be V 1 minus V 2 upon V 1 into V 1 I 1 right or V A two-winding transformer is equal to this, this bracket part you can write 1 minus V 2 upon V 1 into V 1 I 1.

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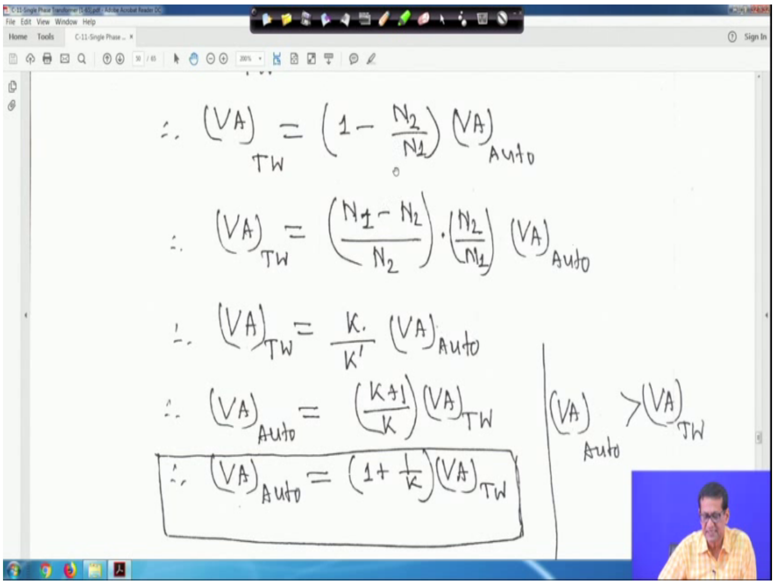

Or you can write V 2 by V 1 is equal to N 2 by N 1 1 minus N 2 upon N 1 and V 1 I 1 that is Volt ampere rating of the autotransformer. This is V A auto right because it is V 1 I 1 is equal to V 2 I two. So, it is or V A auto transformer.

Therefore, if you simplify all these things right that V A this one your what you call this N 1 minus N 2 upon N 1. So, numerator and denominator this term you multi[ply]- numerator denominator this term you multiply by N 2. Therefore, what will happen you can write N 1 minus N 2 upon N 2 into N 2 upon N 1 Volt ampere auto right. Therefore, this N 1 minus N 2 upon N 2 your what you call your into N 2 minus N 1 is nothing but K upon K dash V A auto. These portions please do it all this thing relationship is given that K dash is equal to your K plus 1. So, there you use all this relationship. So, you will get V A two-winding transformer is equal to K by K dash your what you call V A auto right.

So, this your this is your K and K dash is equal to already given N 1 upon N 2. So, it is K upon K dash V A auto right or you can write V A auto is equal to your K dash is equal to we have put K plus 1 because we have seen earlier K dash is equal to K plus 1 cross multiply right. But and put K dash is equal to K plus 1. So, V A auto will be K plus 1 upon K into V A two-winding transformer or V A auto will be 1 plus K is equal to V A two-winding transformer. That means, V A auto is greater than your V A two-winding transformer that is that is Volt ampere rating of the autotransformer greater than your Volt ampere rating of the two-winding transformer right.

Because your K is greater your what you call K is always your what you call greater than 0 right. So, naturally V A auto what will be greater than V A of two-winding transformer. With this your single phase transformer is over and you will see few a numerical's right and this is very simple thing and nothing is there. Just there should not be any confusion of autotransformer very simple thing right.   So, take one example.

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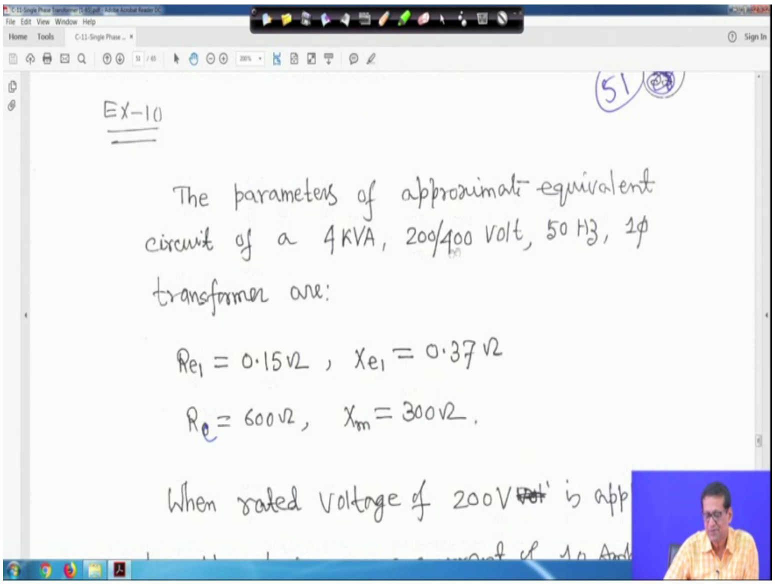

The parameters of approximate equivalent circuit of a 4 KVA, 200 by 400 Volt, 50 Hertz single phase transformer. These are the parameters given. R e is equal to X e and R c is equal to given 600 Ohm. X m is given right.

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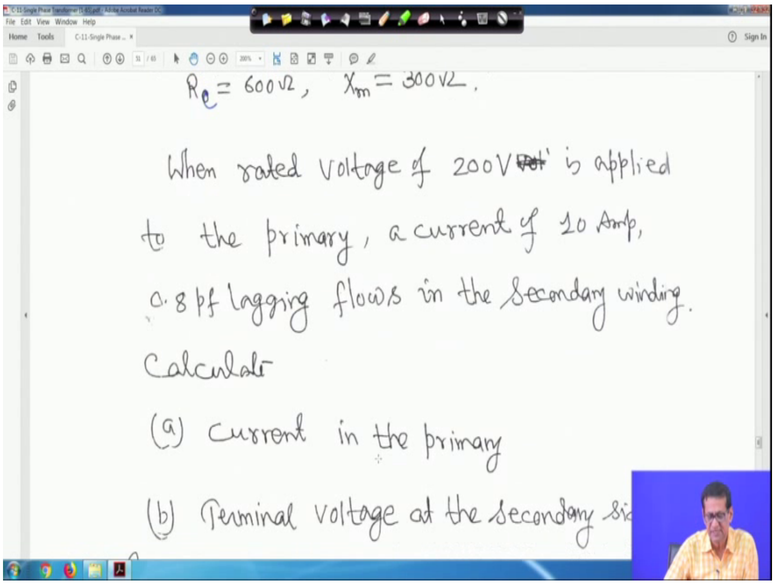

Now, when rated voltage of 200 Volt is applied to the primary a current 10 Ampere 0.8 power factor lagging flows in the secondary winding, you have to calculate. So, this is your problem this is your problem right.

When rated voltage of 200 Volt is applied to the primary a current of 10 Ampere 0.8, power factor lagging your flows in the secondary winding; you have to calculate current in the primary terminal voltage at the secondary side. It is very simple. This is the circuit right.

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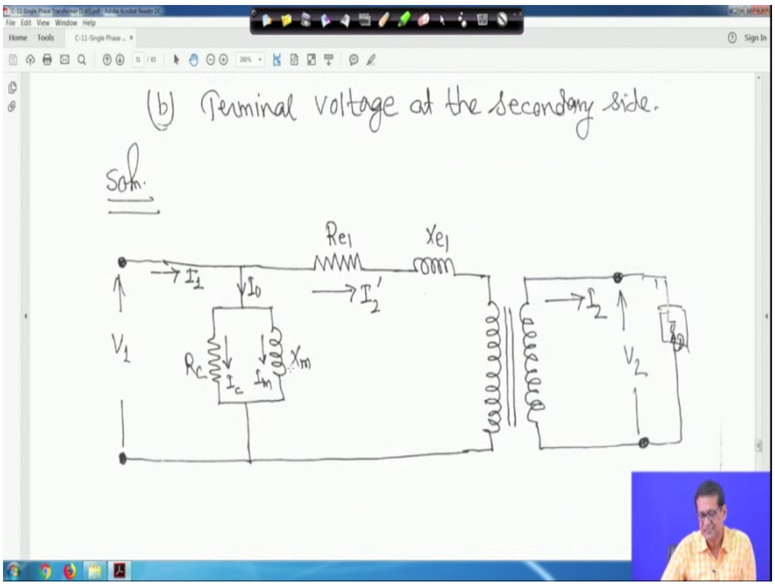

So, this is your my equivalent circuit R e 1 X e 1 right. This one your what you call a this side a load is given. So, everything your in terms of primary side.

So, in that case, your now when we earlier we have seen it know when we transform this to that side, it will be coming out V 2 dash is equal to K V 2 and dash lines shows the load.

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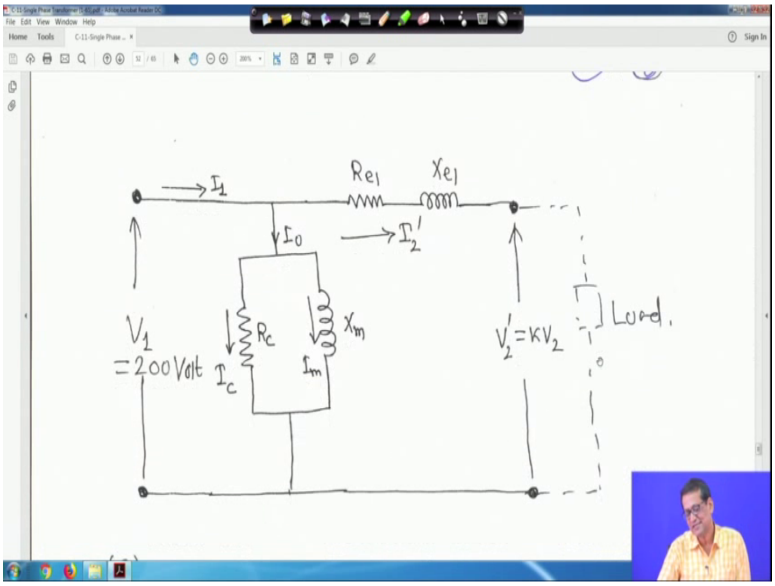

Earlier, we have seen this circuit this side 2 hundred Volt parameters are given R e 1 X e 1 R c X m all are given.

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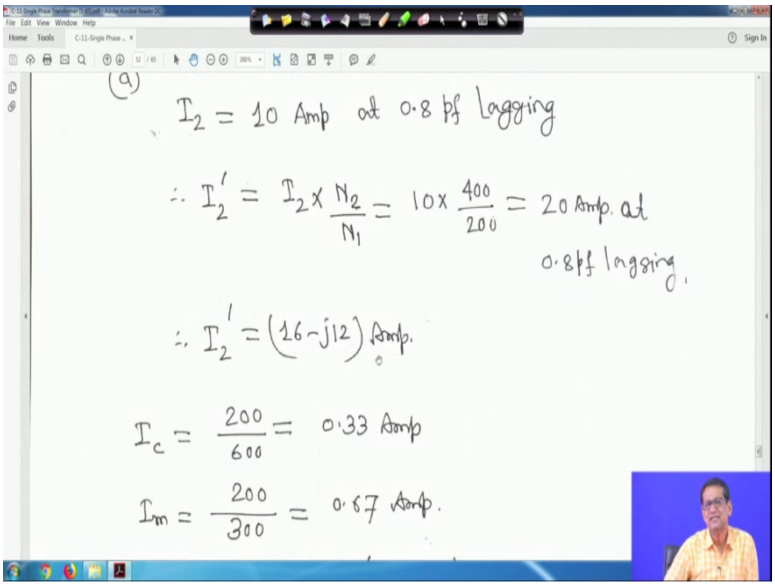

So, I 2 is given also 10 Ampere right. I 2 is given 10 Ampere at 0.8 power factor lagging. So, I 2 is on the secondary side. So, I 2 dash you have to bring it to the referred to the referred to the primary side. So, I 2 dash will be I 2 into N 2 upon N 1 because N 1 I 2 dash is equal to N 2 I 2. So, I 2 dash is equal to this much. So, I 2 dash you will get 20 Ampere at 0.8 power factor lagging right. That is 36.87 degree lagging; that means, I 2 dash will be 16 minus j 12 Ampere. Directly now it is understandable; so, directly we are writing.

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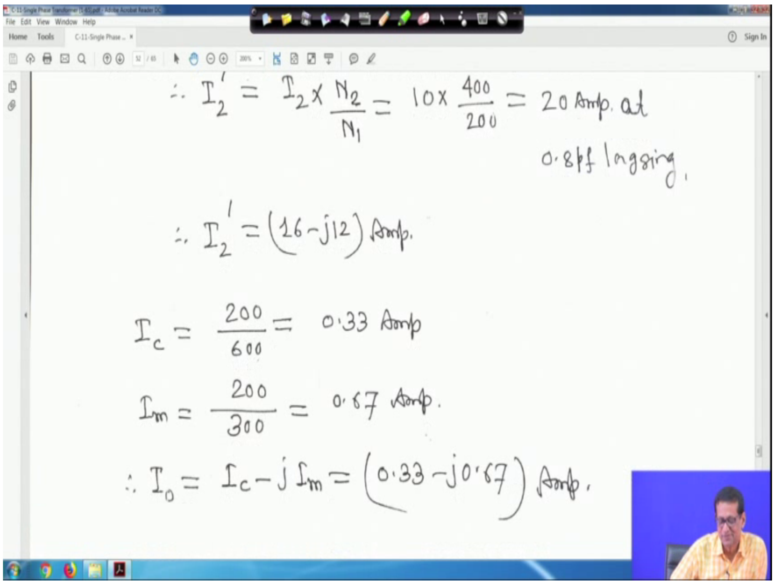

And I c will be 200 by 600 because R c 600 Ohm; terminal voltage is 200. So, this much and I m is equal to 200 by 300 this much right. So, I c I 0 is equal to I c minus your j I m. So, this is the current I that is no load current I 0.

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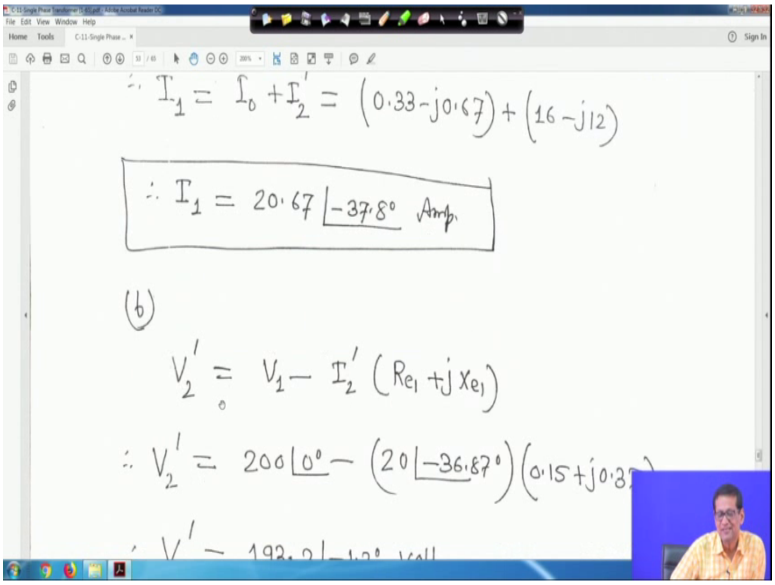

Therefore I 1 is equal to I 0 plus I 2 dash. You just add these two, you will get I 1 is equal to 20.67 angle minus 37.8 degree ampere right and V 2 dash, we know this earlier we have solved an problem. We have seen the derivation also. V 2 dash will be V 1 minus I 2 dash R e 1 plus j X e 1 right.

So, in that case you will get V 2 dash after solving you will get your 193.2 angle minus 1.2 degree.

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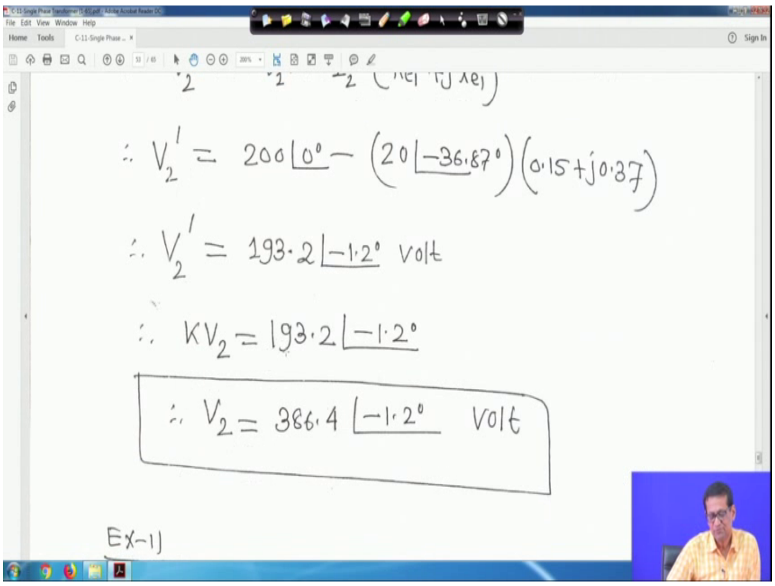

And you know that your what you call this Volt and you know V 2 dash is equal to K V 2 we know that. So, V 2 will be your what you call 386.4 angle minus 1.2 degree Volt because your K is equal to your half right. So, that Volt ratio is given 200 by your what you call 400 right. So, this problem is a simple problem.

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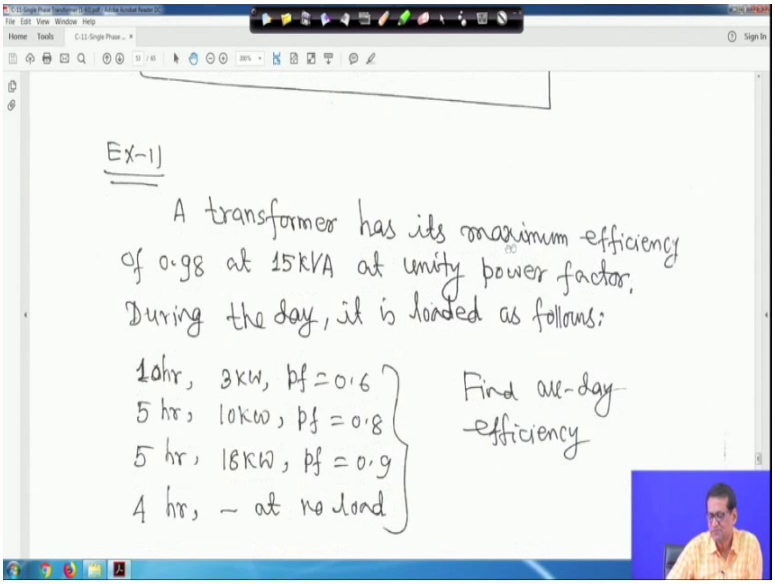

Now, example 11: a transformer has its maximum efficiency of 0.98 at 15 KVA at unity power factor. During the day, it is loaded as follows right it is because we have find out all day efficiency. So, for 10 hour, it was 3 Kilowatt, power factor 0.6 right. Lagging, it generally lagging; but not mentioned here right; so, 5 hour, 10 Kilowatt, power factor is 0.8 right and your 5 hour, 15 Kilowatt, power factor 0.9 and 4 hour, at no load. So, total if you add it 24 hours right and find all day efficiency. So, 10 hour, 3 kilowatt. So, basically 3 Kilowatt into 10 means 30 Kilowatt hour right.

So, similarly like this.

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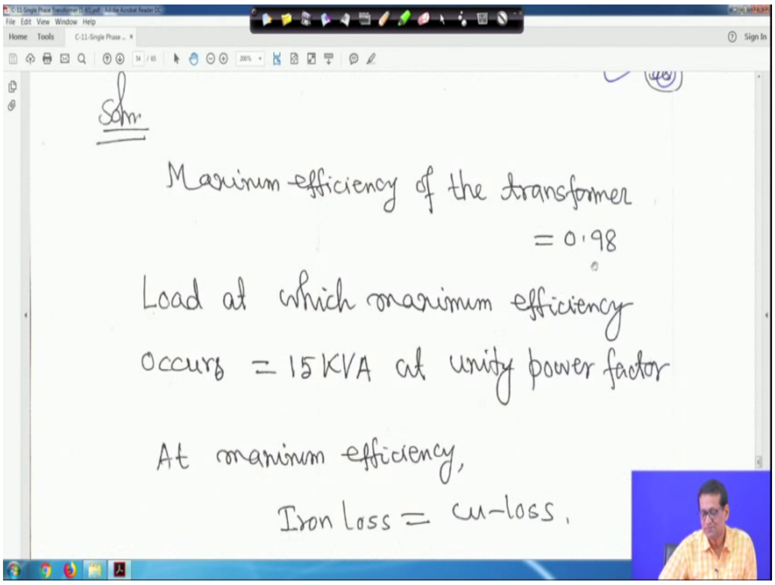

So, maximum efficiency of transformer is 0.98 that is given. Now load at which the maximum efficiency occurs that is 15 KVA at unity power factor that is given, that maximum efficiency of 0.98 at 15 KVA at unity power factor.

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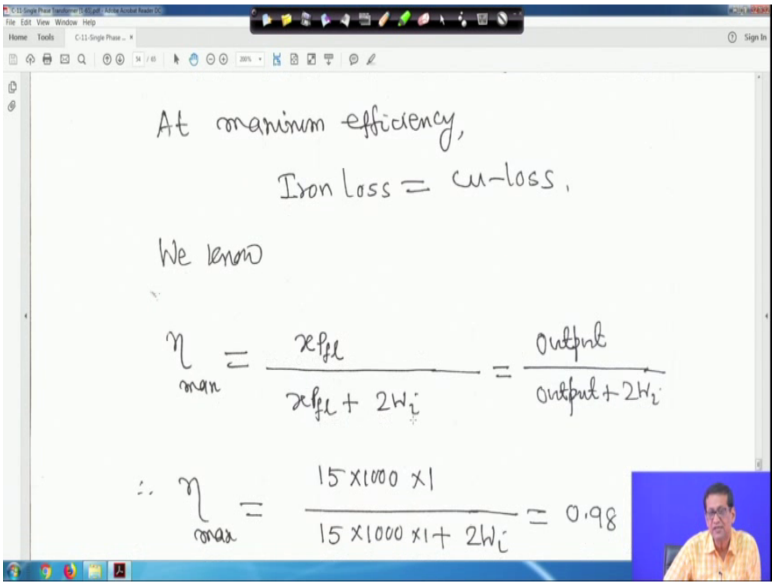

That means, my at maximum efficiency iron loss is equal to copper loss that we have derived. We know that for maximum efficiency nu zeta max is equal to X p f l upon X p f l plus 2 W i that we have derived that is output by output plus 2 W i right.

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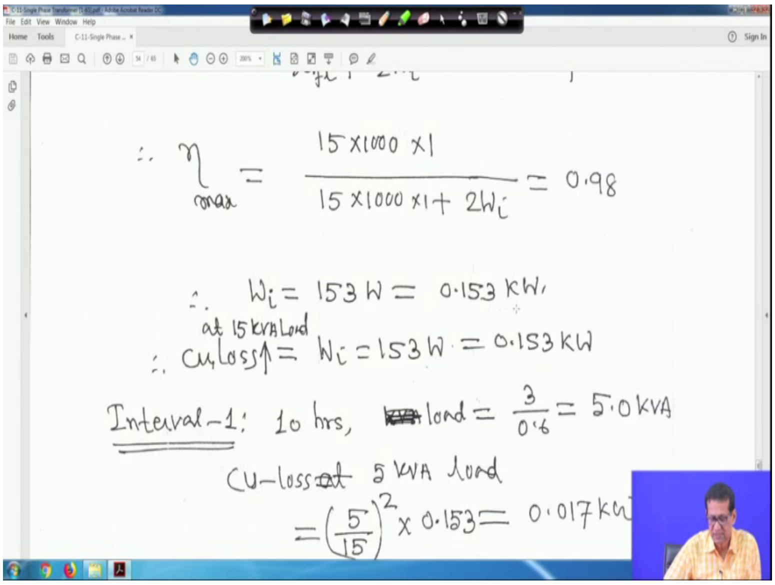

Now, output is equal to 15 KVA at unity power factor. So, 15 into 1000 into 1 that is your this much of Watt because therefore, multiplied by 1000 divided by 15 into 1000 into 1 plus 2 W i is equal to 0.98 because maximum efficiency 0.98 from which we will get W i is equal to 153 Watt; so, 0.153 Kilowatt.

Therefore, copper loss at where your at maximum efficiency iron loss is equal to your copper loss right. So, it is your 0.153 Kilowatt right. Now interval one that is 10 hours load is 3 by 0.6 that is 5 KVA right because power factor is 0.6 and it is 3 Kilowatt; so, 5 KVA. So, copper loss, we have to find out at this load. Copper loss copper loss is proportional to the square of the load. So, this we will keep in mind your rated KVA 15 is given and at that time load is 5. So, it will be 5 by 15 square into 0.153. So, it is 0.017 Kilowatt right because copper loss varying with the load.

So, at that time, if I because this is Kilowatt divided by power factor will give you KVA right.

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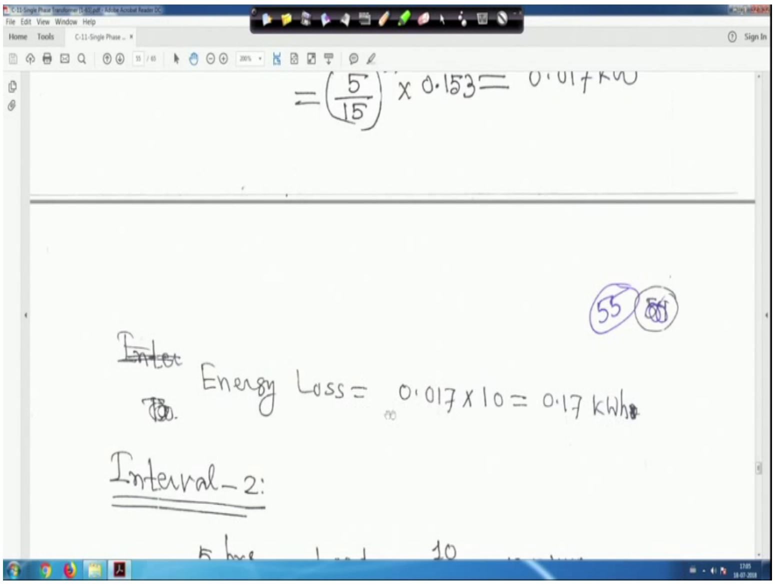

So, this similarly that that will energy loss will be 0.017 into 10. So, that is 0.17 Kilowatt hour right. So, this is your, what you call that energy loss. Similarly if you if you just look into this right; so, at 3 Kilowatt power factor is given it is 10 hour. So, if you just your, what you call that load was 3 Kilowatt. So, we converted it to your KVA and it is dependent on the square of the load. At that time, what is the your what you call in that your what you call that energy loss right.

But if it is a simple load nothing is given. So, 3 Kilowatt into 10 means it will be your, what you call 30 Kilowatt hour right. Little bit we have seen at the beginning I think right for the DC circuit analysis something you have seen; so, similarly your interval to 5 hour.

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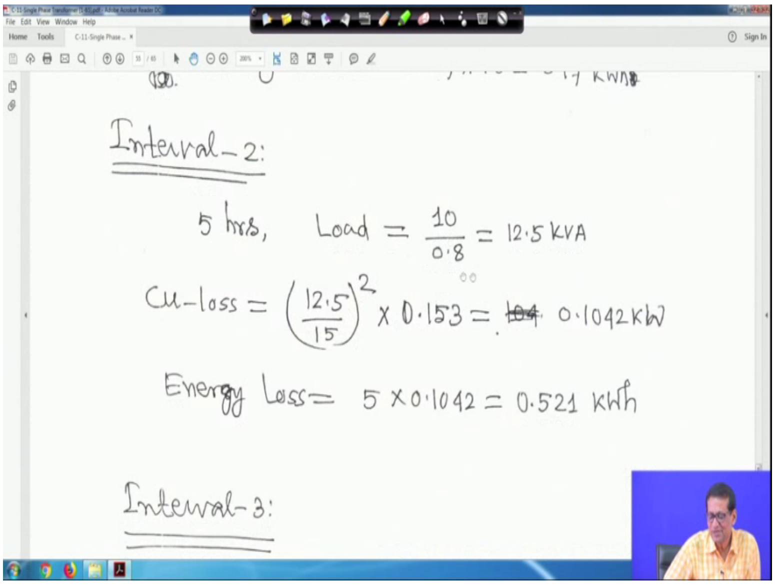

So, load is twelve point 5 KVA because 10 by 0.8; 0.8 is the power factor. So, copper loss will be 12.5 upon 15 square into 0.153; so, 0.1042 Kilowatt. So, energy loss will be 5 into 0.1042 that 0.521 Kilowatt hour right.

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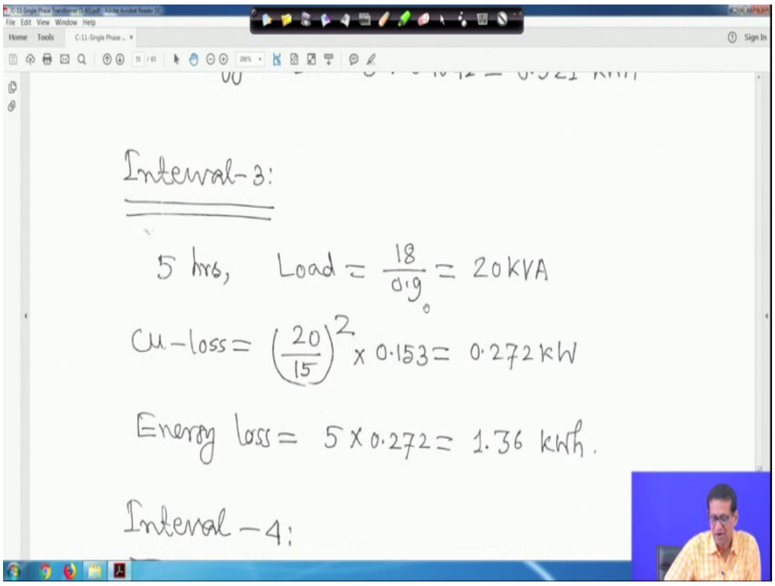

Similarly, interval three, power factor is 0.9 and it is 18 Kilowatt; so, 18 upon 0.9; so, 20 Kilovolt Ampere. So, that time copper loss will be 20 upon 15; that mean, transformer is overload if rating is 15 at 20; that means transformer is overloaded right. So, 20 by 15 square into 0.153; so, 0.272 Kilowatt. So, it is energy loss will be 5 into 0.272; so, 1.36 Kilowatt hour.

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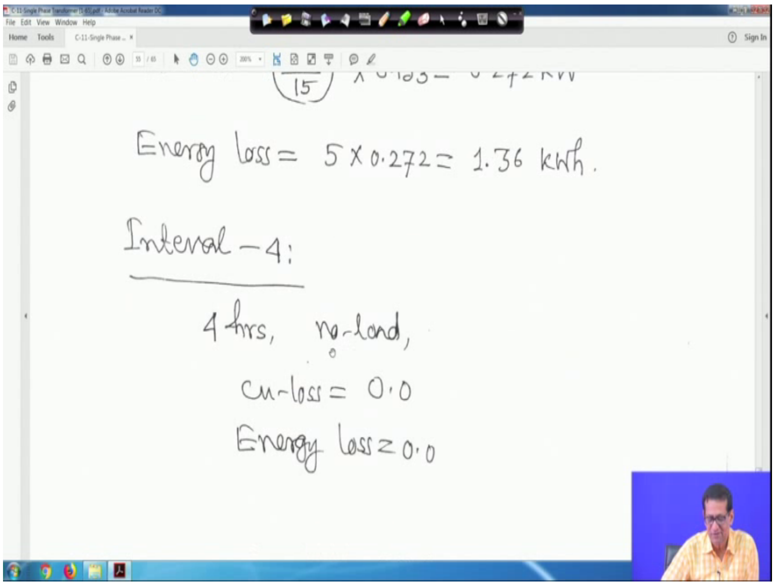

So, interval four, 4 hours no load copper loss is 0 energy loss is 0.

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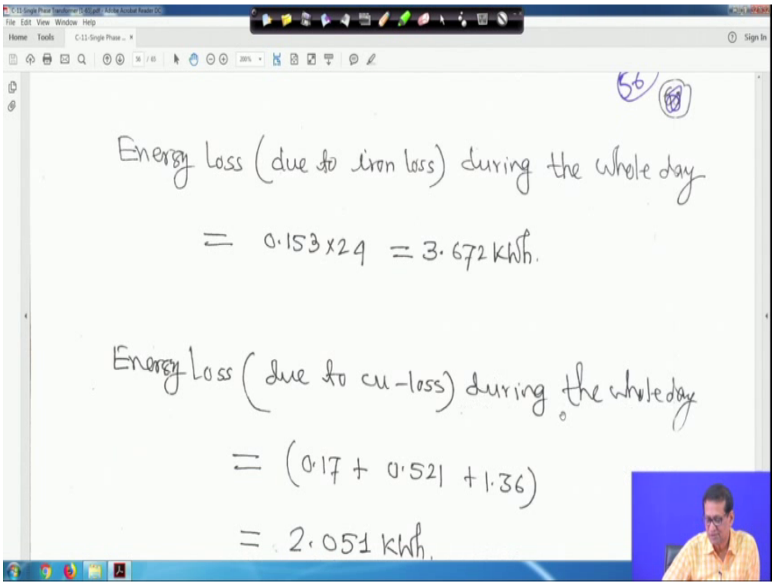

Now, now energy loss due to iron loss plus during the whole day; so, 0.153 because iron loss 0.153 and 24 hours multiplied, it will be 3.672 Kilowatt hour. Therefore, energy loss due to copper loss during the whole day you add 0.17 plus 0.521 plus 1.36; 2.051 Kilowatt hour.

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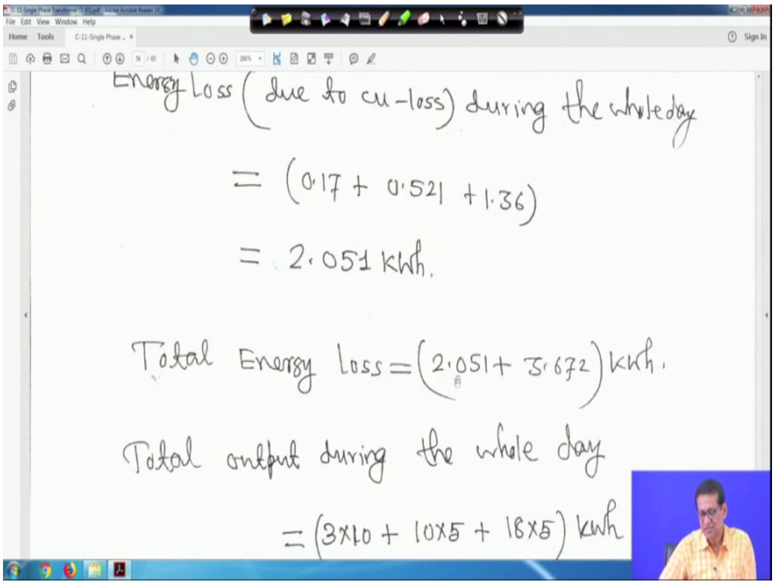

So, total energy loss. So, due to copper loss and iron loss, you add you that is 2.051 plus 3.672 right. Total output during the whole day.

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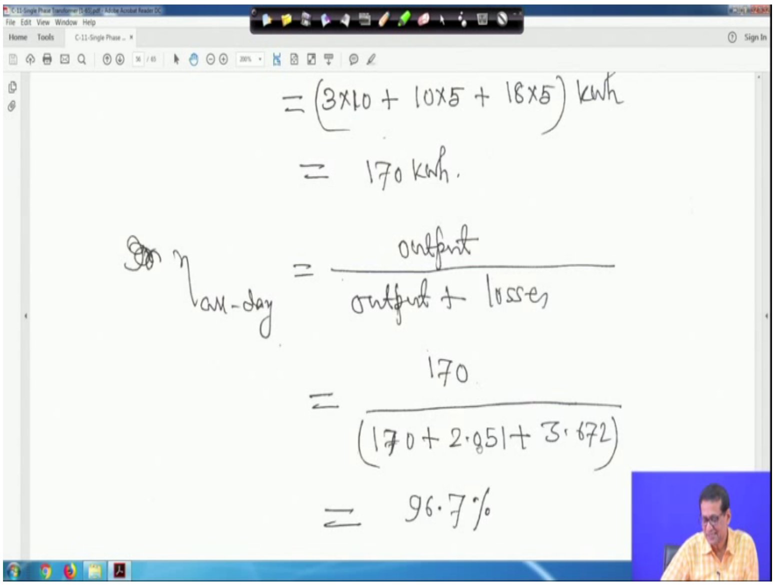

So, it is your 3 into 10 that is output plus 10 into 5 plus 18 into 5. I told you that initially 10 into 30 Kilowatt hour 5 into 10 and plus 18 into 5. This is the output and this is the copper loss right. So, it is 170 Kilowatt hour. So, output your efficiency is equal to all day will be output by output plus losses.

So, this is output is 170 and this is my, your copper loss and this is my energy in terms of energy. So, it will become 96.7 percent right. So, this is your some 1 or 2 more examples are there like autotransformer and your what you call this thing; we will see in the next video lecture.

So, thank you very much.