Electrical Machines - I
Prof. Tapas Kumar Bhattacharya
Department of Electrical Engineering
Indian Institute of Technology, Kharagpur

Lecture - 33
Polarity Test and Sumpner Test

Welcome to 33rd lecture on Electrical Machines I.

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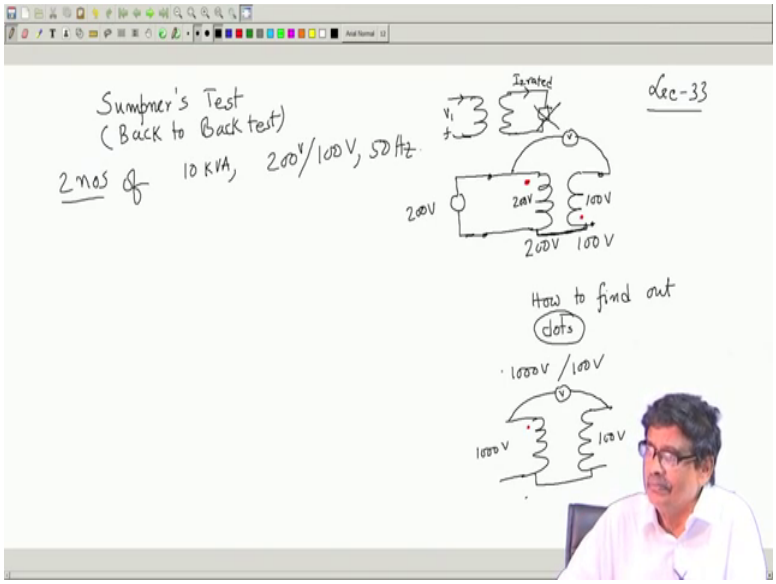

And you know we will be discussing first another very popular test which is called Sumpner test Sumpner Sumpner's test which is also called sometimes back to back test back test ok. And as I was telling if you carry out the open circuit test only core loss will be there and if you carry out short circuit test only copper loss will be there. Both the losses will be there when the transformer will be put two operations at rated condition. At that time, so, neither the open circuit test during the open circuit test nor during the short circuit test, the temperature rise of the machine will not be the actual temperature rise when the transformer will be in operation.

So, what is the solution? Solution is in the laboratory then try to load the transformer in the laboratory connect the load and apply rated voltage at rated frequency and connect a load such that rated current also flows and so on. Then temperature rise can be measured, but unfortunately for a large transformers for example, a transformers of ratings of 200

KVA 500 KVA distribution transformer or more I mean ratings, then such a load day will not be available in the lab.

And not only that during open circuit test from the source you are drawing only the core loss powered which is responsible core for core loss only. During short circuit test burden on the supply you are putting is only of what amount of power? Very little power which will be corresponding to short circuit test. But if you put to actual loading of a large transformer in the lab, that huge amount of power is to be drawn from the supply this must be understood.

So, during testing always try to draw less power from the supply at the same time see that whatever is your objective of the test that is performed. What is the difference? If the temperature rise is different, because in open circuit test on the very low temperature rise and so on.

See because of temperature rise, temperature difference the resistance of the windings or the resistance which are representing losses their values will change. Suppose during short circuit test you calculate r 1 re 1, equivalent resistance refer to primary, but when the transformer is put to use that should be corrected because of temperature rise there is temperature rise coefficient r t is equal to r 0 into 1 plus alpha t etcetera.

Anyway, so to have a better idea of the temperature rise of a transformer one test which is called back to back test or Sumpner test is carried out it was suggested by most probably Sumpner. And it is very interesting test, not only the test is interesting, but at the same time since you are studying transformer for the first time it will also enhance your understanding whatever we have discussed earlier that is why I have chosen this topic to be included here.

In this test what is done do not use actual loading no never uses actual loading, but at the same time creates such a situation that transformer will feel that it is fully loaded that is rated voltage applied, rated flux will be there and also windings will carry rated current ok. But without drawing very large power from the source only it will draw the powers corresponding to copper loss and corresponding to core loss that is the beauty of the test, sometimes it is called phantom loading type thing ok.

Now let us see what this test means, only condition for this test to be successful is that you have to take two similar transformers not with a single transformer you can do that two transformer because the transformers are manufactured in large numbers. So, after manufacturing you test them take two at a time and test them although you can do individual open circuit short circuit test that is there.

But to carry out the test you require two identical rated identical is a very (Refer Time: 06:44) term we do not know identical very similar rated transformer. For example, I will take two transformer whose I will use of course, small rating say 10 KVA just to give you a feel of what is going on. 10 KVA 2 numbers of 10 KVA 200 volt, 100 volt 50 Hertz single phase transformers suppose you take.

And then first thing what you have to do is that you have to carry out the polarity test, I will also take opportunity to explain to you how to ascertain polarity test. Because that is essential to carry out the test, unless you do not know the polarity it will be not possible to carry out the testing it cannot be left to chances. Now, what do I mean by polarity we told you very simple that suppose you have a transformer whose rating is 200 volt and 100 volt ok.

Now, what you do here is you apply, because the dot convention is not known. Dot convention that is if I put a dot here what to put dot there I know what it means theoretically. And also I can ascertain that without doing any test provided you know the sense of the winding, but in general for a practical transformers only two terminals will come out from the primary two terminals comes out from the secondary. And windings really you cannot see is not it will be inside a sort of black box I mean steel box everything will be there two terminals only come out here two terminals will come out there that is the problem.

But as I told you dots must be known, in fact, for three phase transformer connection that is also essential to know. In case of open circuit test, short circuit test you do not bother it is not necessary as you understand now, for this particular test why it is necessary. Now, as I told you in this case if what you do you apply rated voltage see how to find out; find out dots.

So, what you do is this? You apply say to this winding 200 volt you apply and there is no dot markings here. Now, but you are free to choose one dot terminals of any of these

windings; for example, you say that this is this side you take it chalk and mark this is my dot terminal of this winding.

But that is what you cannot do now here, if this is positive at any one time which terminal is positive on the other side that is the goal ok. Now, this diagram what you do is this then you short these two terminals, you make connected take a piece of wire connect these two terminals and take a voltmeter connect it here, that is what you do.

Now the moment you apply 20 volt here no matter whether you have connected this or not by transformer principle 100 volt will appear here. And this 100 volt I am not sure, whether this is dot or this is dot. The thing is suppose let us assume this is dot suppose, suppose this is also dot. These two coils are connected in series as you can see and I am measuring the voltage, what will be the volt meter reading? 100 volt because there in this is plus this is plus 100 volt. What could be the other possible reading? It could be like this dot may be here also I am not sure. If that is the case then what will be the volt meter reading 300 volt.

So, it is this volt meter reading which will help me to put dot correctly either here or there depending upon the looking at the volt meter reading. If this reads the difference of this two voltage, then I will put dot there. If it volt meter reading gives sum of these two voltage I will put dot here very simple logic nothing like that. Only one thing is this about this test the comment is suppose the ratio of the transformer is very large. For example, you have a transformer whose rating is say 1000 volt stroke 100 volt suppose you have a transformer, in this case then what will happen is this.

So, if you apply 1000 volt here, you will certainly get 100 volt no doubt and you are free to choose one dot terminals of one of the coils. So, I will suppose choose here and what I told I will connect these two points here and I will connect a voltmeter there. In this case the volt meter readings will be either 1100 or 900 one of them will come, but you will see with a practical voltmeter these two voltages are close by a. So, a slight misinterpretation or some somewhat wrong reading of the voltmeter you really cannot ascertain that is the problem.

If the ratios of the voltages are high then difference and addition become of the same order therefore, it will be very difficult to distinguish these two readings confidently. So, in such cases when the voltage ratios are high, it looks like this method is not reliable.

So, what people do is this in this case for very large voltage ratios another simple test can be done and that is called the DC kick test DC kick test.

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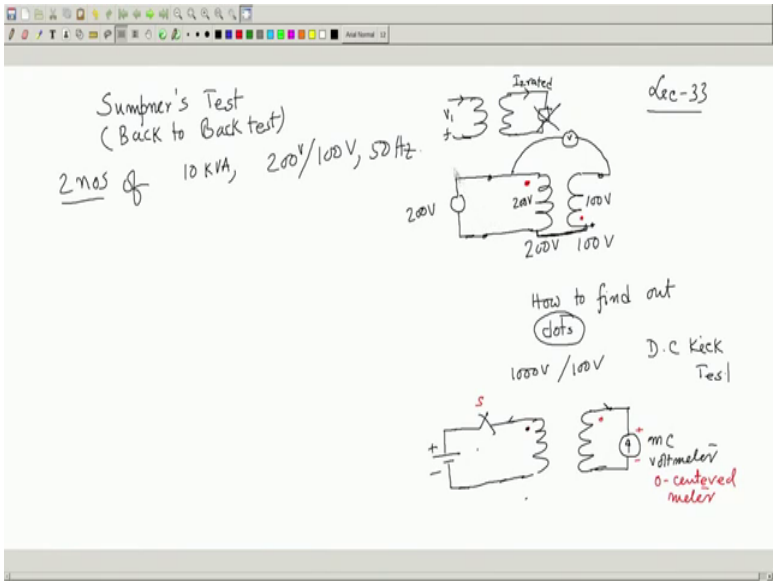

Very simple test what is done, you do not require also large supply rated voltage those things may not be required what you do? You connect a switch here much simpler than this you switch here and take a DC source batteries say. And here you connect a 0 centered moving coil voltmeter mc voltmeter that is all and the positive of the battery wherever you are connecting put the dot there, one you can you are free to choose. Now, and it is also a voltmeter connected between these two points, now you close this switch. The moment you close the switch it is not AC supply, but there will be a sudden change in flux.

Therefore, we expect there will be instantaneously there will be an induced voltage and if this is dot happens to be dot and see moving coil meters has got plus minus marking is not moving coil meters has got plus minus marking if current enters it gives positive. So, 0 centered meter do you taken 0 centered meter. So, you close this switch there will be a deflection in the moving coil voltmeter a short duration steady state will soon be reached. If it gives positive deflection you are sure this is also dot, if it gives negative if this is dot this is dot.

So, anyway this is called DC kick test, you select this voltmeter reading such that steady state current does not exceeds the rated current of this meter these things, but very

interesting test. So, anyway this test by doing this simple test we can find out the in polarity of a transformer ok, so you do this. Now, coming back to Sumpner contest, so two numbers of similarly rated transformer you take and then connect like this that is this is one transformer.

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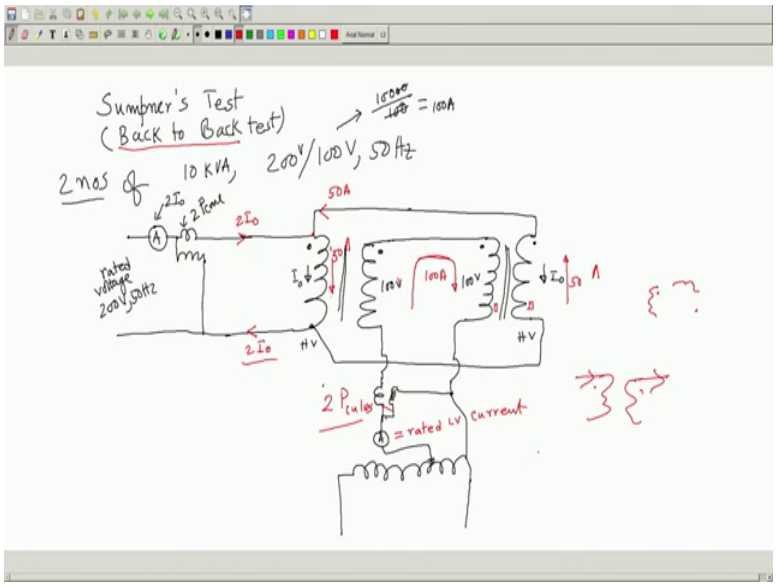

And it is secondary is here and suppose I know the dots, even if you do not know then you have to do those two tests to find out either of this two tests conveniently, this is transformer one ok. This is one transformer practical transformer and you take the other transformer which I have drawn here it is core and here also suppose these two are dots.

Now the connection, suppose these are the HV side HV side in this gate 200 volt 100 volt both are available in the lab we will not bother. So, what you do, you connect this two transformer HV in this case HV it could be LV a also no problem and connect them in parallel. And then here in this side you connect an ammeter and then wattmeter very interesting test and apply rated voltage.

That is in this case for this transformer I will apply 200 volt 50 Hertz is not that is what I will do. Suppose secondary I have not done anything they are open, what do you think this ammeter will read and this wattmeter will read, If you apply this these two transformers are manufactured by the same manufacturer of same ratings they are expected to have same parameters same core loss these that etcetera it is a very good assumption.

Therefore, the current the no load current will be drawn, this transformer will draw it is no load current only no load current secondary are open this transformer also will draw no load current. Therefore, I would expect this ammeter will read 2 times the no load current that is whatever ammeter reads divide by 2 and tell that the no load current of each of the transformer is half of this that is what.

And what this wattmeter is going to read, wattmeter with the secondary open for both the transformers wattmeter will only record the core losses some of the core losses of this two transformer, because rated flux is there in both the transformer. Therefore, it will also read 2 times the core loss is not, this wattmeter will relate and ammeter will read 2 times the no load current and this wattmeter will read 2 times the core loss component of current.

Now, as I told you this that is all it is almost like an open circuit test is not secondaries are open. But now comes the interesting part what is done now and what will be will there be induced voltage here? Yes it is value is 100 volt just I am putting this number, so that things are very clear what I am talking about this way [FL]. Suppose I join by a piece of wire these two terminals and these two I bring it here, here these two terminals. If I connect a voltmeter across this what will be the reading of the voltmeter you think a bit and then tell, because polarities are this is plus this is plus, so they are opposing.

So, it will be 0 voltage. So, between these two terminals although this is a connected by piece of wire etcetera, but voltage existing between these two point is 0, so here voltage is 0. Now, what you do? You take an auto transformer here I mean I should say very active in the laboratory I should draw some space is necessary. So, you connect it like this and here once again you connect an wattmeter and an ammeter and make an arrangement, so that you can apply small voltage here across this.

If the pointer was at this point no voltage you have applied and net emf acting in this circuit is 0 nothing happens. Now, what you do with this primary energized mind you, you apply little voltage increase slowly ok. Then what will happen this is the what is the net emf acting in the circuit now this 100 volt 100 volt will cancel out there as if not there. So, applied voltage divided by, so apply a little voltage current will start flowing is not current will flow. If current flows suppose for some low applied voltage suppose current.

So, increase this voltage such that rated current flows what is the rated current of this side? It is staying as I told you given the transformer rating immediately calculated rate currents that is always important. 10000 by 100 is not 100 ampere is the rated current of the LV side, perhaps the test would have been better if you have energized 100 volt side current anyway 100 ampere for understanding we are doing.

So, I will apply such a voltage such that 100 ampere flows here, but the moment 100 ampere flows suppose this way 100 ampere is flowing this way. This is a secondary, primary of a transformer having a magnetic core and this is also primary, secondary having a it is own separate magnetic core. But flux in the core cannot be changed because kvl is to be satisfied here that good old listening argument.

Therefore, through the dot 100 ampere coming out for this transformer means that through this dot 50 ampere must flow through the dot current communists through the dot 50 ampere must flow. Now, similarly for this transformer it is just happening in opposite way, as I told you if these two are dots you can consider these two are dot as well and remove this, see these are the things you must understand. So, through the dots here 100 ampere is coming out; therefore, in this case through this dot a 100 ampere must flow as so, called is not.

Student: 50.

50 ampere sorry that is correct, so 50 ampere must flow is not. Therefore, I force some current to flow in this secondary coil in this case LV side. I think it would have been better for this transformer even to consider 100 volt to be the rated supply because ammeter rating and wattmeter, but anyway for just understanding purposes.

So, this is 100 ampere and then reflected current here 50 ampere 100 ampere, reflected current this way. Apply kcl here what will happen? 50 ampere comes in this direction is it not 50 ampere comes in and 50 ampere comes in here. So, this 50 ampere business never comes here, this current still remains two I naught whatever is the no load current got the point that is the most important thing. Now, this transformer windings are carrying rated currents therefore, rated copper loss will take place and rated flux is also present.

So, rated core loss will also take place and also winding cir carrying rated current, so rated copper loss, so both the losses are present here. This watt meter draws supply from this supply which is equal to 2 times the core loss of individual transformers, this watt meter will record what? Only the copper loss 2 times the full load copper loss is not, because this current equivalent resistance this set. From this source second source here which can supply large current this ammeter reading of course, will be not two times these are in series to. So, rated LV side current this ammeter then should be based on this one 100 ampere.

So, this is equal to rated LV current in this case LV side current. So, apply such a small why small voltage will generate large current it is because of the fact that net emf acting in this circuit was 0, 100 volt 100 volt which was caused by this application of 200 volt here they always cancel out. And therefore, you can pump current now into this network, so it will read p copper loss. Therefore, transformer will feel I am being used under full load condition is not, because my windings are carrying rated current and my code is also carrying rated flux both the losses are at their rated values.

So, temperature rise and if you do this test for a long time say 1 hours. So, that the thing attains a steady temperature I mean telling just like that put some thermometer there you I mean just telling that I can measure the temperature rise at some convenient places to say temperature rise here. What I am telling? That temperature rise must be higher compared to either for open circuit test whatever will be the temperature rise or short circuit test.

Therefore, by estimating this copper losses, I will now will be able to estimate the equivalent resistance I square this ammeter reading into r equivalent from this I will be able to calculate new r equivalent. And from short circuit test whatever r equivalent I calculated it will be higher than that and from this variation of the resistance I should be able to predict what is the temperature rise.

So, anyway this is a very nice test for which you do not require 10 KVA load, it will only draw core loss and copper loss. So, and it why it is called back to back test is also understood you connect the secondaries in back to back manner. But only condition is you must connect them in after noting down these dots correctly for dots do the previous test.

You should not connect the secondaries just like that, this is dot this is dot connect them then 200 volt will appear is not then your basic idea of carrying out the test will be lost. Any way I stop here today, but this circuit how it works please think physically what is happening then it will further definitely it will enhance your understanding of transformer always remember a transformer two winding transformer.

If secondary carries rated current, primary will also carry rated current the direction of the current is decided by the dots if through the dots rated current is coming out. Through the secondary through the dots current will come out and these concepts I have used not only for two winding transformer, but also while analyzing the auto transformer ok. So, with this I stop here I could not start three phase transformer next time we will start.

Thank you.