Computer Aided Power System Analysis
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Lecture – 60
Fault Analysis (Contd.)

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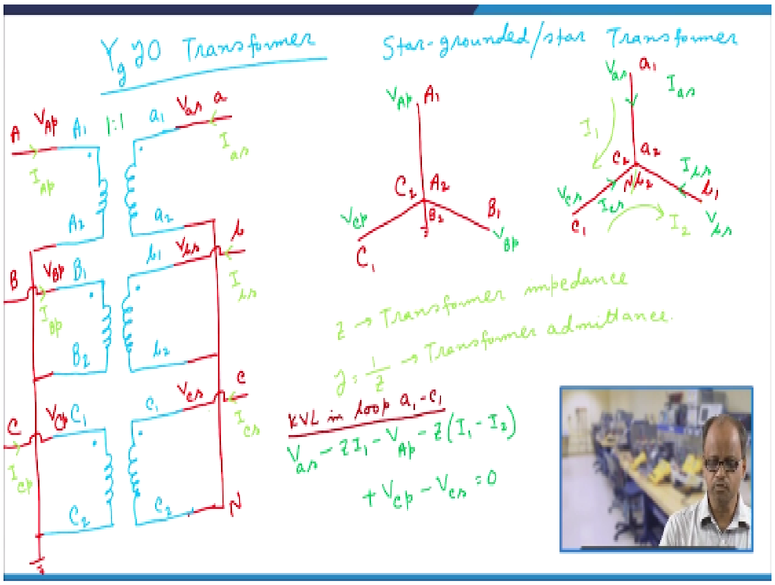

Welcome friends, to this lecture on computer power system analysis who have been discussing about the modelling of yj, y0 transformer, so we have first taken this particular transformer connection, this is the circuit diagram, this is the vector diagram and then we have taken the loop currents and then we have written 2 KVL equations; one KVL equation is a1; in the loop a1, c1, another in the loop b1 c1.

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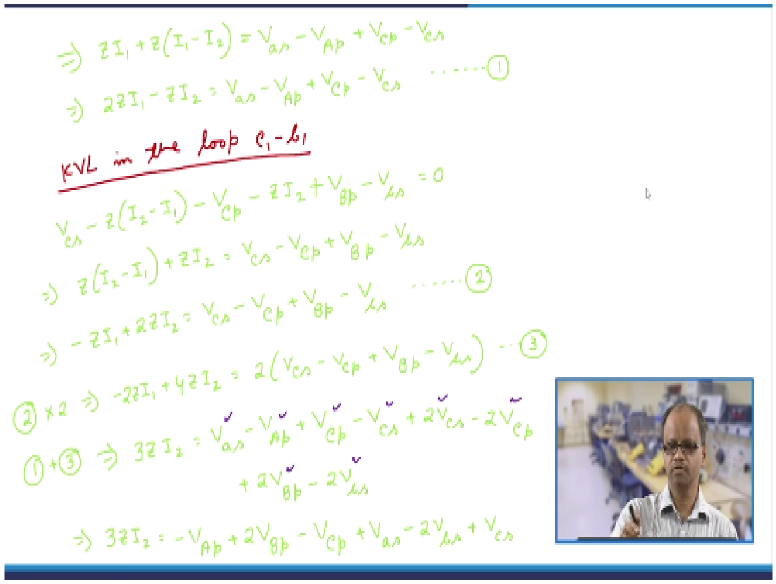

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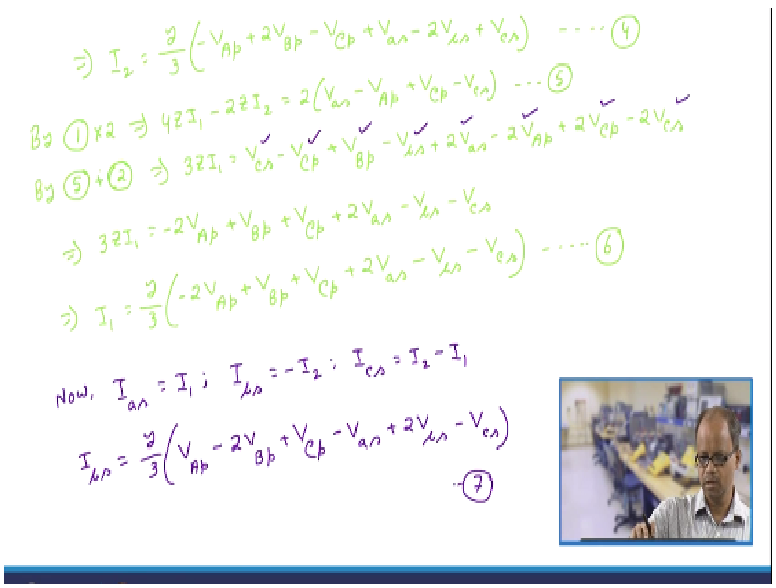

And then after getting these 2 KVL equations, we have solved them and after solving, you have got the expressions of I1 and I2 and from the expressions of I1 and I2, we have also got the expressions of Ias, Ibs and Ics and this Ias, Ibs and Ics they are already shown in the vector diagram, so then therefore, if I now translate this Ias, Ibs and Ics, so then therefore, they if you can see they are actually entering this, I mean this 3 currents; Ias, Ibs and Ics, they are actually entering the neutral point from the terminal.

So then therefore, Ias, we can write down, we can actually show that Ias would be in this direction similarly, Ibs would be in this direction because they are entering and Ics would be also in this direction and in the primary side, our current direction would be IAP, this would be capital BP and this would be I capital CP, now according to our convention or rather according to a dot convention.

So, then therefore in this winding, there is a current ICP which is going in this direction, which is going into the dot terminal at the primary side, whether the current at the secondary side is also going into the dot at the secondary side but as we have already discussed in the last lecture that essentially, the dot convention is that the current entering the dot terminal at the primary side and the current leaving the dot terminal at the secondary side, they are in phase.

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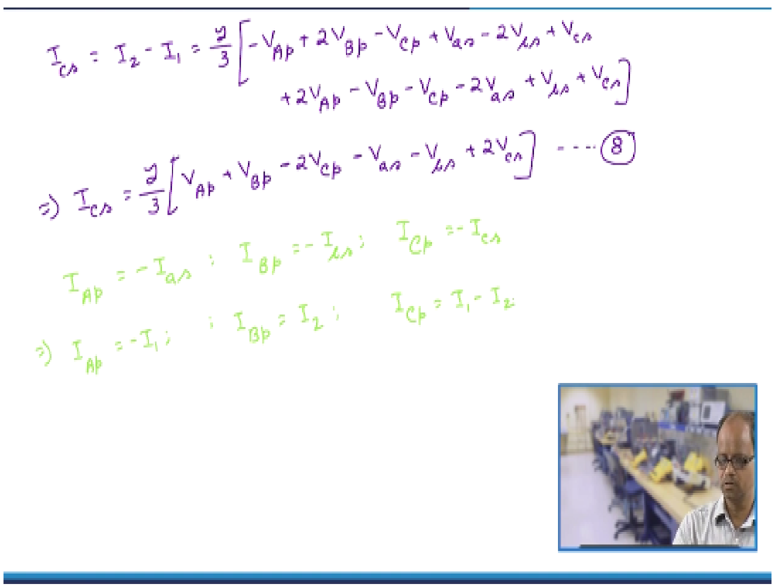

So, then therefore these 2 currents are anti phase in each other, so then therefore we can say that IAP, so then therefore I can say at the primary side IAP = -Ias, IBP = -Ibs, ICP = -Ics, so then therefore, IAP is nothing but – Ias and Ias = I1, so then therefore it is = -I1, so then therefore utilising this, so then IAP = I1, Ias = actually –I1, IBP = -Ibs means that I2 and ICP = -Ics means I1 – I2, so I1 – I2.

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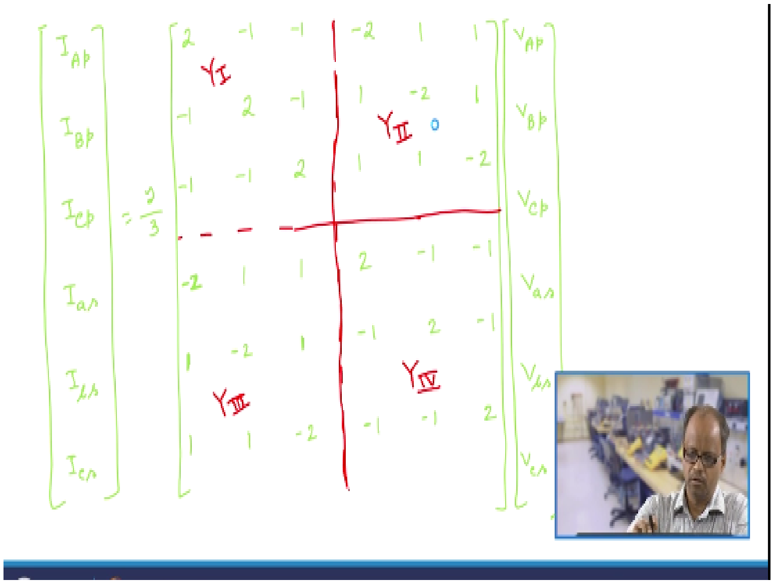

So, if I now write down, so now we have got these 6 currents now, we have only to write down the equations, so then therefore, what you have got IAP, IBP, ICP, Ias, Ibs, Ics, there will be y/3 obviously, because every current expression as got y/3, so then it will also have y/3, so VAP, VBP, so then what so IAP is = -I1, so IAP is -I1 and -I1 means –I1, so it is 2 -1-1, so it is -I1, so it is 2-1-1.

And then it is -2+1+1, so this is IAP, IBP = I2, IBP = I2 means -1 2 -1-1 2 -1 I2 and then 1-2+1, ICP = I1 – I2 and this is nothing but – Ics, so it is - Ics means -1-1 +2, so it is -1-1 +2 and it is +1+1-2 and Ias is nothing but just it is opposite, so Ias is nothing but just its opposite, so it is -2 1 1 2 -1 -1, Ibs is opposite, so 1 -2 1 -1 2 -1, Ics is also just opposite, 1 1 -2 -1-1 2, so then therefore here again we do this partition.

Again, here will be this partition and here this partition, so this partition and this is Y1, so this is Y1, this is Y2, this is Y3, this is Y4 and again as we can see Y2 and Y3 they are transpose to each other, so this is how the modelling of Ygy transformer is carried off as in another example, we will not do this detailed calculation now because by now we have fairly understood the basic process.

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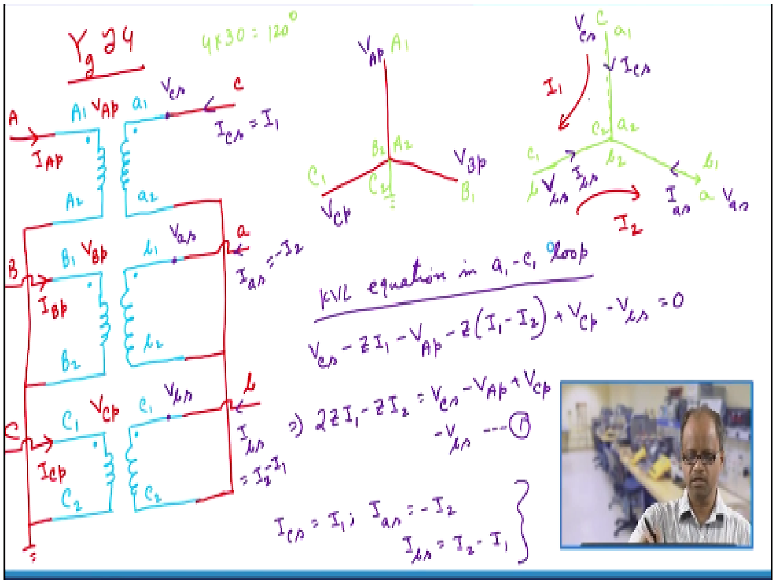

But we will just now go very quickly, so as in another example, so let us look at that if what happens, if Ygy, let us say 4, so let us say Ygy, 4, so what we do is again, we have; so we had drawing this 3 winding, again A1, A2, B1, B2, C1, C2, so and this, this, this, so this is again dot dot dot dot dot dot, so this is A1, A2, B1 B2, C1 C2, so we first showed them into ground, so this is phase A, so this is IAP, this voltage is VAP.

So, this is phase B, voltage is VBP, current is IBP, this is phase C, voltage is VCP, current is ICP, so this is what we have just now denoted, now let us draw the vector diagram, so we draw the vector diagram with this, this and this, let us say this is A1, of course this is ground let, A2, B1, B2 and C1, C2, so this is what we have done, so now we are drawing the; now, it is Ygy 4; Ygy 4 means (()) (11:25) side, it will be lagging the primary side by 120 degree.

Because 4 * 30 is 120 degree, so hundred A phase of the secondary side will be lagging the primary side by 120 degree, so then therefore this would be phase A, this would be phase B and this would be phase C, now if this is phase A, so then therefore this would be B1 B2, and this winding is C1 C2, so here also it would be small c1 c2, you should actually write them a little bit capital, so this is capital C1 and capital C2 and the small C1 and C2.

And this is A1 and A2 because these 2 windings from the same, so then what we are doing; we again drawing A2 B2 C2 together, so we are connecting A2, B2, C2 and we are not grounding the connection and we say that this is phase A1 is now is actually denoted as phase C, B1 is now actually denoted as phase A and C1 is denoted as phase B, right, so A1 terminal would be denoted as phase C, B1 terminal should be denoted as phase A.

And C1 terminal would be denoted as phase B, so as usual because here also we do not have anything, so we will take to current I1 and I2, so when we take 2 current I1 and I2 and then we start our journey from here, so now KVL in; so now we write the KVL equation in let us say a1 c1 loop. Now at a1, this is actually Vcs, so now therefore this potential should be Vcs, this potential should be denoted as Vvs and this potential should be denoted as Vcs.

So, this potential should be denoted as Vcs, so what we are doing; we are actually writing down the loop equation in C1 C2, we started from C1 to C2 go to A2, then A1 and then come back, then a1 and then come back to c2; c1, so C1 C2 then A2 A1 come back to C1, so this is the; or A1 A2, C2 C1 come back, so when you start from here, it is Va1, Vas – zi1; z is the impedance and now here the voltage here in this branch is VAP.

So, this is also in this direction, this is also in this direction, so voltage here is VAP, so this would be –VAP, so this is –VAP, now we are going in this direction, now in this direction, total current is I1 – I2, so the drop is - z * I1 - I2 and in this direction, what is the voltage; in this direction, the voltage is actually VBP, sorry it is in this direction, so we should write it is; the voltage is VAP, voltage is VBP, voltage is VCP.

So and this direction, voltage is VCP but this polarity is from positive to negative here, so where going here, so it is +VCP because it is arise and then it is a drop – Vvs, so that = 0, so then therefore 2z1 sorry, 2z, so then therefore 2zI1 – zI2 = Vas – VAP + VCP – Vvs, so this is equation 1, if now write down KVL equation in C1 B1 B2.

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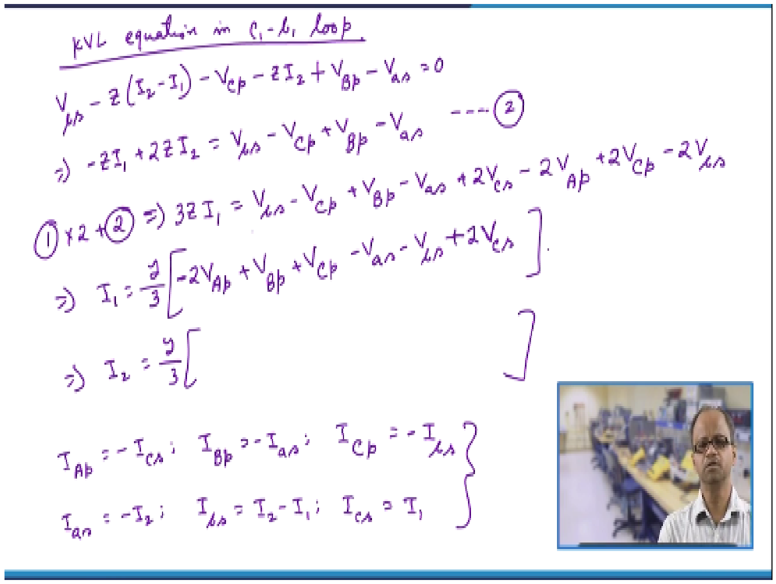

Now, write down KVL equation in c1 b1 loop, if I now write down KVL equations in c1 b1 loop, so it is Vbs, so Vbs – z, in this direction current is I2 –I1 zI2 – I1 -; in this direction the voltage drop is this reflected voltage drop is Vcp, so Vcp, then in this direction the drop is current drop that is the basically, the drop due to current is zI2, now in this direction where travelling the voltage is drop is from here to here, where it would be actually here to here.

So, this is would be VBp; + VBP; so it would be +VBP – this is phase A, so this is phase A as Vas = 0, so then therefore –zI1 + 2zI2, Ves – Vcp + VBP – Vas, so this is equation 2, solve equation 1 and 2, so once we solve equation 1 and 2, so what we do is; we do 1 * 2 + 2, so what we get; 1 * 2 + 2, so 1 * 2 is sorry, 1 * 2 is 4z I1 – 2z I2 + 2 -; so it is we get 3z I1 = this Vbs – Vcp + VBP – Vas, 1 * 2 means, + 2 Vas – 2VBP – 2VAP +2 VCP; -2VAP, it is A, it is VAP + 2VCP – 2Vbs.

So, we get i1 = y/3 * -2VAP + VBP + VCP and then what you have got; it is actually, it is Vcs, because this is Vc, so this potential is Vcs, this potential is Vas, so we shall write them, this potential is Vas because v1 is A phase, a1 is C phase, c1 is B phase, so this potential which is Vcs – zI1 – VAP – zI1 – I2 + VCP and – this; this is Vcs, so it is Vcs, so then here also it should be Vcs, so it is a mistake, VCS, so it should be Vcs; Vcs – VAP + VCP – Vs, so it is VCS.

So, 1 * 2, so we are doing 1 * 2, so it is 2 VCS, it should be 2VCS – Vas – Vbs - + 2Vcs, right so this is I1, so similarly, we can write down the I2, similarly I2, can be solved y/3 is something I took and can be solved, once we solve for I1 and I2, so then therefore from here I can say that Ic = I1, so I can say that Ics =; so now here the current is Ics, so the current is Ics, so that is = I1, here the current is Ibs because no, this is Ias, sorry, this is Ias, because this phase C, so voltage Vcs, current is Ics and this is phase A.

B1 is phase A, so this should be Vas, this should be Vbs because this is phase B, so then this voltage is; this terminal is C1 but it is denoted as phase B, so then voltage would also be Vbs, this terminal is B1, this is denoted at phase A, so the voltage is Vas and the current is Ias and here this current is Ibs, Ics = I1, so we can write down that Ics = I1 and then we can write down Ias = -I2 and Ibs = Ibs is I2 – I1.

So, Ics = I1, Ias = -I2 and this is = I2 – I1, so once we get this expression of I1 and I2, so from there I get Ics = I1 because Ics is entering this point, so this = I1, Ias is entering this point, so here it is Ics, here it is Ias, and here it is Ibs, Ias = -I2 and Ibs is I2 – I1, so then therefore of this is IAP, so then therefore, IAP is again = - Ics, IBP =; it is IBP = -Ias and ICP = -Ibs, IAP = -Ics, IBP = -Ias and ICP = -Ibs.

So, we have got this 6 equations, so and again we write that Ics = I1, Ias = - I2, so Ias = - I2 Ibs = we just writing this I2 - I1, Ics = I1, so these are the 6 equations and formulas we can see that all these equations are representable as with respect to VAP, VBP, VCP and Vas, Vbs, Vcs, so once you write them, we can similarly write down the Y bus matrix as you have done for the last case, as we have done for this case.

So, this is the OA, any given transformer can be modelled, so similarly instead of let us say Ygy, you can have also Ygd or may be Yd, so by applying the same principles, we can always model any three phase transformer having the standard vector group, so once we have this three phase transformer, so then therefore as this example show we really do not need to memorise this Y matrices.

These particular Y matrices can be easily derived from the very basic fundamental principle, so one this Y matrices are obtained, so after that they can be used very easily in our fault analysis, so thank you.