Computer Aided Power System Analysis
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Lecture – 53
Fault Analysis (Contd.)

Hello so welcome to this lecture on computer aided power system analysis. We have been discussing the formulation of Y bus matrix of 3phase unbalanced system we have first looked into the case where there is no transformer but now we are in the process of looking into the case where there is 1 transformer in a network. So far we have been looked into the case that we have actually taken into taken into consideration a very small system.

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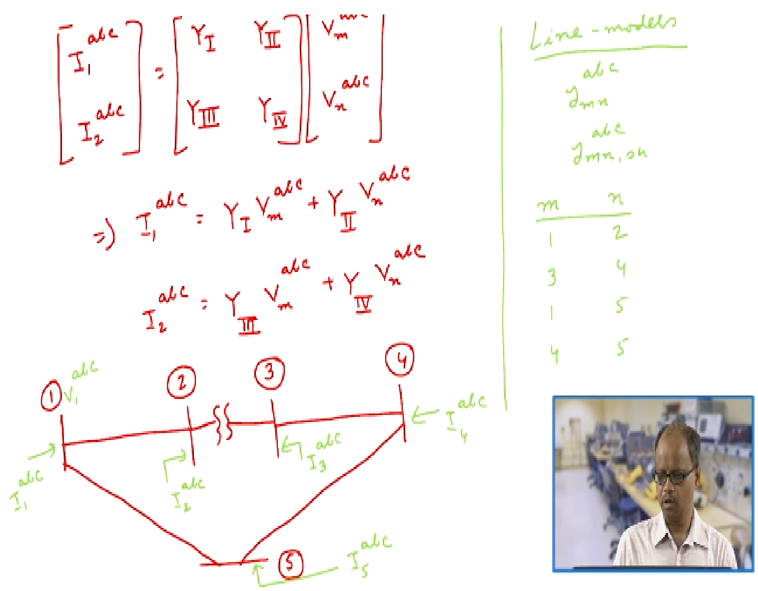

Which is shown here which is basically a fibre system 1 2 3 4 5 and there are basically 4 lines between the buses 1 2 3 4 1 5 and 4 5 and we have also 1 transformer 3 phase transformed between bus 2 and 3 and we are also earlier shown that any 3 phase unbalance transformer having okay any kind of transformer connection can be modelled by this kind of equation I1 abc I2 abc= this y1 y2 y3 y4 *vm abc and vn abc.

We have also indicated that what are those currents I1 I2 as well as what are those buses vm and vn. So now today we would be actually a continuing from this and we have also written the equation corresponding to bus1.

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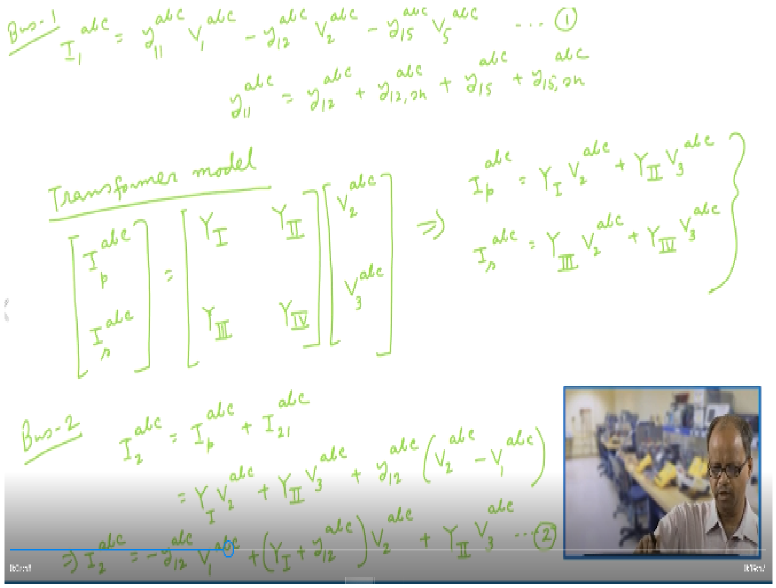

As shown here and we and now we would be now essentially writing the equations for bus 2 bus 3 bus 4 bus 5 and after that you would be writing these equations writing those equations in a matrix form to ultimately form the Y bus matrix. Now for the purpose of writing the equation in at bus 2 and bus 3 let us denote that this bus 2 is denoted as bus m so let us say that bus 2 is bus m and let us say that bus 3 is bus m.

So let us say that this is I1 abc and let us say this current is I2 abc. so then therefore as far as this transformer model is concerned it will be looking like this that the. So when the transformer model would be transformer model would be actually we should not write here I2 abc because here we are simply writing because our earlier we have already denoted I2abc as the injected current in bus 2 and I1 abc as injected current at bus 1.

So let us say that we denote this is primary abc and let us say this is secondary abc. So let us say that this as IP abc and let us say this as Is abc and this is bus m and this is bus n. So then therefore according to this and according to whatever you have all discussed the transformer model Ip abc and Is abc =Y1 Y2 Y3 Y4 v2 abc v3 abc. So then therefore Ip abc can be written as Y1 v2 abc Y2 v3 abc and Is abc can be written as Y3 v2 abc+Y4 v3 abc.

Please note that all these currents and voltages is that all complex quantities so now with this we do this now we are ready to write down the equation at bus 2. So at bus 2 the equations would be now I2 abc would be noting but Ip abc+I21 abc. So let us say this current as I21 abc so let us say this current is I21 abc. So then therefore at bus to I2 abc =Ip abc+I21 abc Ip abc is we write from here Y2 v2 sorry Y1 v2 abc +Y2 v3 abc and I21 abc would be essentially.

It would be Y12 abc *v2 abc-v1 abc we have already defined what is mean Y12 abc. So then therefore I2 abc would be given by now we write -Y12 abc v1 abc+ we take the v2 abc together so it is Y1+y12 abc *v2 abc +Y2*v3 abc so this is equation 2.

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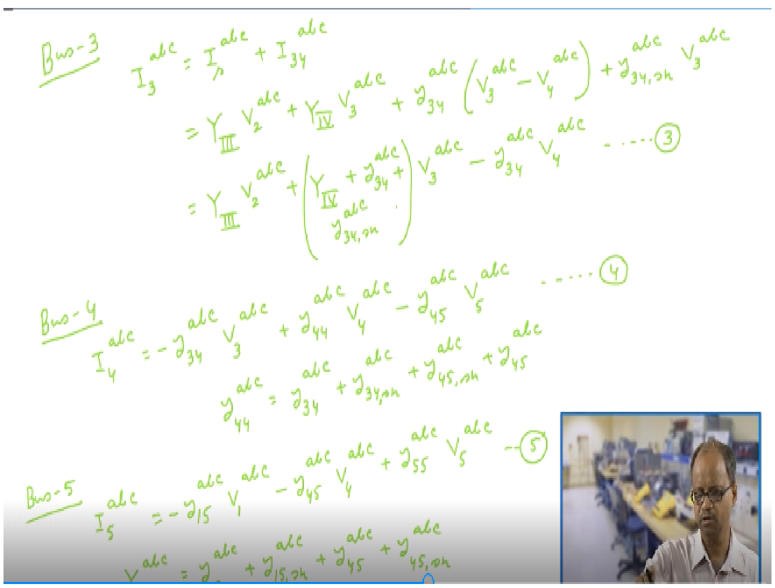

Okay now you write the equation for bus 3 at bus 3 what are the equations at bus 3 if I3 abc is the injected current so that current would be this current + let us say this is I34 abc so I3 abc= Is abc +I34 abc so I3 abc will be =Is abc +I34 abc Is abc is given by Y3 v2 abc +Y4 v3 abc so Y3 v2 abc +Y4 v3 abc and Y34 abc would be Y34 abc*v3 abc -v4 abc. So it would be Y3 v2 abc+ we collect the terms of v3 abc together so it is Y4+y34 abc *v3 abc-y 34 abc *v4 abc.

So this was equation 3 well so these are the only so these are the equation at us 2 and 3 we need to write down explicitly and bus 4 and 5 this equations would be very simple at bus 4 and 5 what would be the equation it would be – y34 abc Bus 4 I4 abc would be -y34 abc *v3 abc +let us say y44 abc *v4 abc and then -y let us say 45 abc *v5 abc and where y44 abc is nothing but y44 could be sorry actually there is something missing here.

Basically this currents also will have please note that this current also will have some shunt component which is neglected. So here it should be y12 shunt abc*v2 abc so therefore y12 shunt abc*v2 abc this term would be added here. So here also there is another term will come and this term would be y12 shunt abc. So this term would be y12 shunt abc and + this. So that would be the case similarly here also +should be y34 shunt abc*v3 abc.

So then here also we will have Y34 shunt*abc here so it will be this so y44 abc would be nothing but y34 abc+y34 shunt abc+y45 abc shunt+y45 abc and bus 5 again so this is the question 4 so I5 abc = is nothing but -y15 abc *v1 abc-y45 abc*v4 abc+y55 abc*v5 abc this is equation 5 and sorry y55 abc =y15 abc+y15 shunt abc+y45 abc+y45 shunt abc so these are the 5 equations. So now after writing all this 5 equations we are now ready to write down the matrix forms.

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So we write in matrix form so I got I1 abc I2 abc or I3 abc v1 abc v2 abc and again we do the partition. So now when we do this partition after that it will be very easy to write so then this partitions would be so I1 so I1 is – sorry y11 abc y11 abc-y12 abc and then -y15 abc 0 0. Please note that all these are actually 3*3 everything is 3*3 all these matrices then bus 2 -y12 v1 abc and then Y3 v3 abc 0 0 it is not there this equation is not there.

So Y1+y12+y12 shunt abc so this is what it is and bus 3 Y3 v2 abc Y3 we have actually got 2 this is Y2 Y2 abc then -Y34 abc this is 0 this is 0 and this one is Y4+y34 abc+y34 shunt abc then what we have is bus 4? bus 4 is -y34 -y44 -y45 0 0 and bus 5 is -y15 v1 -15 then -y45 y55 0 0. So this is the Y bus matrix we can see that it is a 15*15 matrix as usual and it is 15*1 vector as usual.

Here also 15*1 vector so now here you can see that this matrices Y1 Y2 Y3 and Y4 they are already appearing here but eliminate other elements although this particular admittance matrices are made by this way but the problem is that if suppose for example if they are a very large system where there are a very large number of transform transformer say for example there is an let us say a 5000 bus system and let us say there are 200 transformers.

And these 200 transformers are connecting are actually connected between let us say are different buses. So then the question is that how do we evolve an automatic algorithm computer algorithm so that these transformer matrices would be automatically embedded into the Y bus matrix right. Now just by looking at these particular matrix it is not very clear that where these elements will be appearing.

Only thing is that we are being able to say that because this particular matrices i mean because this particular transformer is connected between bus 2 and bus 3 so then therefore this 4 matrices Y1 Y2 Y3 and Y4 are only appearing at the elements connected to bus 2 and bus 3 but then suppose for example if there are let us say 200 such transformers which are connected between different 2 sets of buses.

So then therefore how and how an automatic computer algorithm can be made so that these matrices would be automatically embedded into the bus admittance matrix. So to understand that what do we will do now that we will now again reconsider the earlier system as shown only thing is that we will now simply remove this transformer.

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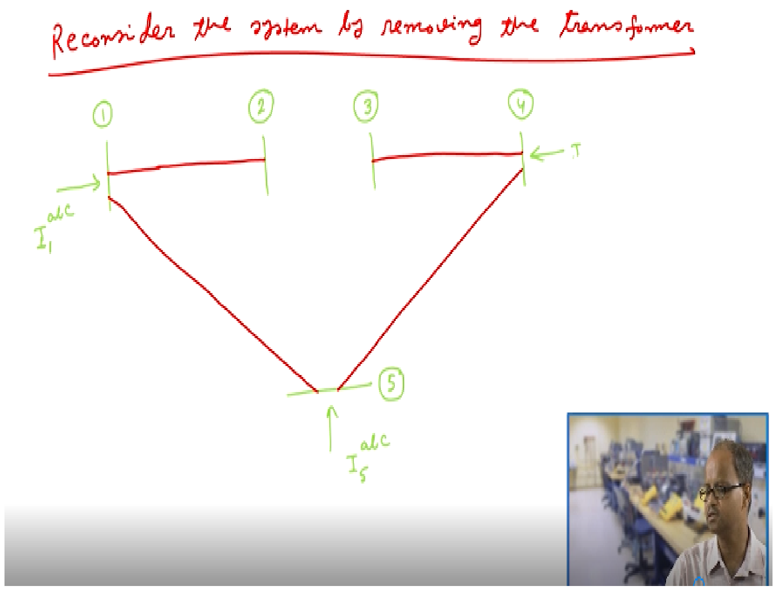

So now we what we will do is not we will reconsider the system. By removing the transformer so if I reconsider the system by removing the transformer then this system looks like this so I have got bus 1 and then bus 2 bus 3 bust 4 and bus 5 so this was bus 1 this was bus 2 bus 3 this is bus 4 this is bus 5 and we have also this lines are connected between bus 1 and 2 between bus 3 and 4 between bus 4 and 5 and between bus 4 and 5.

So here essentially does the same system we are considering. Please note that it is the same system we are considering as we have shown only thing is that we have not removed the transformers so then therefore there is nothing connected between these 2 buses as if that basically there is open circuit between these 2 buses bus 2 and bus 3 and as usual now what well do as usual we also write I1 abc then I5 abc.

These are the injected currents I4 abc I3 abc and I2 abc. And of course these voltages are v1 abc v2 abc v3 abc abc v4 abc v5 abc. So now this is the system in which this origin on the transformer has been altogether removed so now what do we do is that now we will write down the Y bus matrix of this system in which there is no transformer so then when you write down the Y bus matrix of this system.

So we write down the Y bus matrix of this system so it is reduced system. So what we will do is that we will essentially write down the Y bus matrix of this particular reduced system and then we will compare this Y bus matrix of the reduced system with the original Y bus matrix whatever we are just now written and then by comparing these 2 Y bus matrices we would be able to find out an automatic algorithm by which these 4 sub matrices corresponding to a transformer. That is, Y1 Y2 Y3 Y4 can be automatically embedded into the overall system Y bus matrix so this exercise would be doing into the next lecture, thank you.