Electrical Distribution System Analysis
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Lecture – 30
Direct Approach Based Load Flow Analysis Part II

In the last class we have seen Direct Approach Based Method and, initially I introduced this method.

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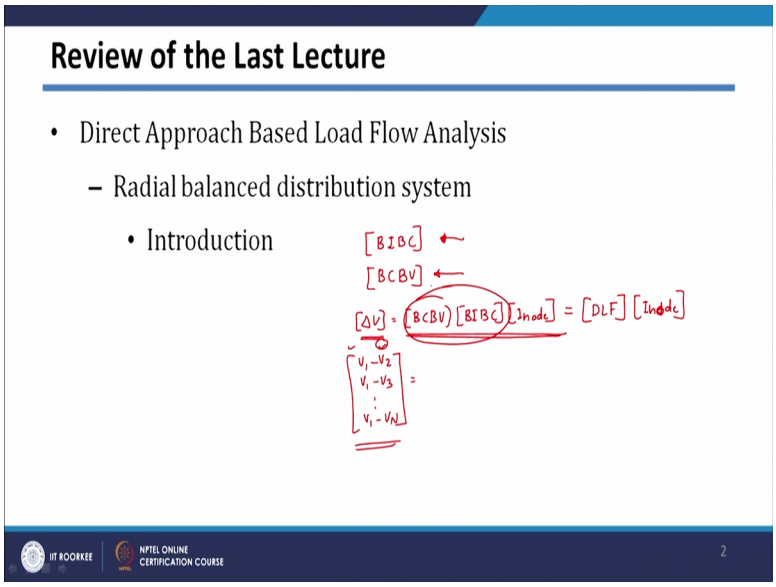

And we have seen that you can actually form two matrices which we call it as actually BIBC matrix, which is Bus Injunction to Branch Current matrix, which converts your bus injunction to directly into branch current.

So, basically it is similar to your backward sweep and, then we form another matrix which is called as BCBV matrix, which basically converts your Branch Current to Bus Voltages and this is nothing, but similar to your forward sweep.

And we have seen that you V get this is equal to means, if you multiply this BCBV multiplied by BIBC multiplied by your I node, we can get the voltage difference and this voltage difference, we have seen that it is basically V 1 minus V 2, V 1 minus V 3 and to go up to V 1 minus V N, if there are N number of nodes into the system.

So, we can get the voltage difference with respect to your first node and, this collectively we called BCBV multiplied by BIBC we call it as matrix DLF, which is multiplied by if so, if you no matrix DLF, we can directly multiplied by I node which are basically nodal currents, we will get voltage difference. Now, let us see how we can get this BIBC and BCBV matrices from your system data.

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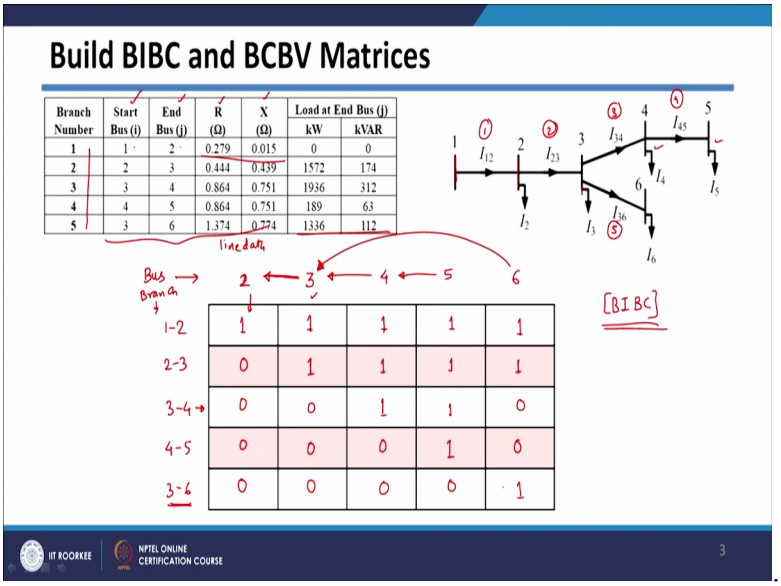

So, let us say you are having this system data, similar system data which we are consider for backward forward sweep algorithm, I have taken it here. And as I told you these are actually branch numbers. So, this is branch number 1, branch number 2, branch number 3, branch number 4 and this is branch number 5.

And their connections so, starting bus and ending bus is given in this columns, their impedance that is resistance and reactance is given in this column. So, this is nothing, but your impedance of line section which is between 1 and 2 node so, as I told you we call it as a line data and this is nothing, but your load which is connected at any j-th bus.

Now to form your BIBC matrix which is basically bus injunction to branch current matrix, where we want to convert your bus injunction to branch current; so, what we can do to form it let us say this is corresponding to bus number 2, 3, 4. 5 and 6. So, here I am giving this as a bus numbers and, here I am giving your branch numbers. So, branch number now between 1 and 2 and, then it is between there is between 2 and 3, 3 and 4, 4 and 5 and then 3 and 6.

So, you have to build a logic to built this BIBC matrix directly like this. So, here since this node is node 2 is connected to node 1, let us say I am putting one it here and it is not connected to other nodes so, 0 0 0 0.

Now, if there is connection between node 2 and node 3 means, if there is connection between node 2 and node 3, what you have to do you have to copy this column and put it here so, I will just copy and put as it is since there is connection between 2 and 3. So, it is copied and pasted here and then it is nothing, but branch 2 and 3 so, at branch 2 and 3 I need to replace it by 1 so, this will be replaced by 1.

Similarly, next time if we go to next section, if there is connection between 3 and 4, we know that there is connection between 3 and 4 so, what you have to you have to copy the column corresponding to 3 at 4th location. So, here I copied this column as it is and since this is 3 4th branch so, at row number 3 4 we need to put 1. So, here at 3 since it is 3 4th branch, we need to put 1 here.

Now, see next step that is see the connection between there connection between 4 and 5, we know that there is connection between 4 and 5 here, so, copy the column corresponding to 4th node in 5th location. So, 1 1 1 0 0 and since this is corresponding to branch 4 5 at the branch 4 5 we need to put 1 here. So, here since it is corresponding to branch 4 5 we need to replace it by 1 here.

Now, there is no connection between 5 and 6. So, here the connection not between 5 and 6 however, there is connection between 3 and 6. So, there is actually connection between 3 and 6. So, what you have to do? You copy the column corresponding to 3 at 6 location; so, here I copied that column as it is.

And since it is 3 6 branch number 3 6; so wherever the branch number 3 6 is coming at corresponding location we need to replace this entry by 1; so, this entry will be replaced by 1. So, we can see that by building this logic into your program, you can automatically build your BIBC matrix directly. Now, let us see how we can build your BCBV matrix.

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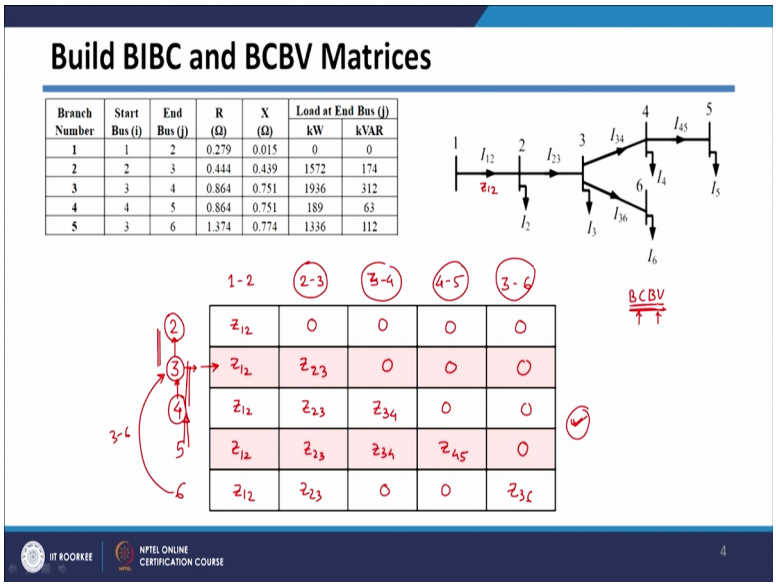

So, we have seen that your BCBV matrix converts your branch currents to your bus voltages. So, here therefore, we need to write bus voltages so, bus number 2, bus number 3, bus number 4, 5 and 6 and here there should be branches. So, it is actually 1 2, 2 3 3 and 4, 4 to 5 and 3 to 6. Now, since there is connection between 1 and 2 here we need to put the impedance of this branch Z 1 2 into this column because 1 2 is connected to 2.

Now, there is no connection between other branches. So, here there will be 0, then you have to see the connection if there is connection between 2 and 3. So, copy the column copy the row corresponding to 2 and put it at row number 3. So, it will be Z 1 2 0 0 0 0. And since it is actually branch 2 3, we are considering it here at 2 3 location, we need to replace it by your impedance of 2 3. So, it will actually impedance of 2 3.

Now, let us see another case where there is connection between 3 and 4. So, what we have to do copy the row corresponding to 3 put it a 4th location it will be Z 1 2, Z 2 3, 0 0 as it is I copied it. Now, this is corresponding to branch 3 4, because you are considering branch 3 4 here. So, at branch number 3 4 location, we need to replace it by impedance of 3 4 so, it will be Z 3 4 here.

Now, for branch number 4 node between 4 5 there is branch so, copy the row corresponding to 4th node and, put at as 5th location because, there is connection between 4 and 5. So, it will be Z 1 2, Z 2 3, Z 3 4, 0 0 and it is 4 5 branch number 4 5 at 4 5 location we need to replace it by impedance of 4 5 so, this is Z 4 5.

However; there is no connection between 5 and 6 so, but there is connection between 3 and 6 what we need to do is copy the row corresponding to 3 put it here, Z 1 2, Z 2 3, 0 0 0 and since it is branch number 3 6 at branch number 3 6 location put the impedance of put the impedance of Z 3 6. So, this is how we need to build your BCBV matrix and, your you need to build logic based on this particular process and, once you build the logic you can directly get your BCBV matrices.

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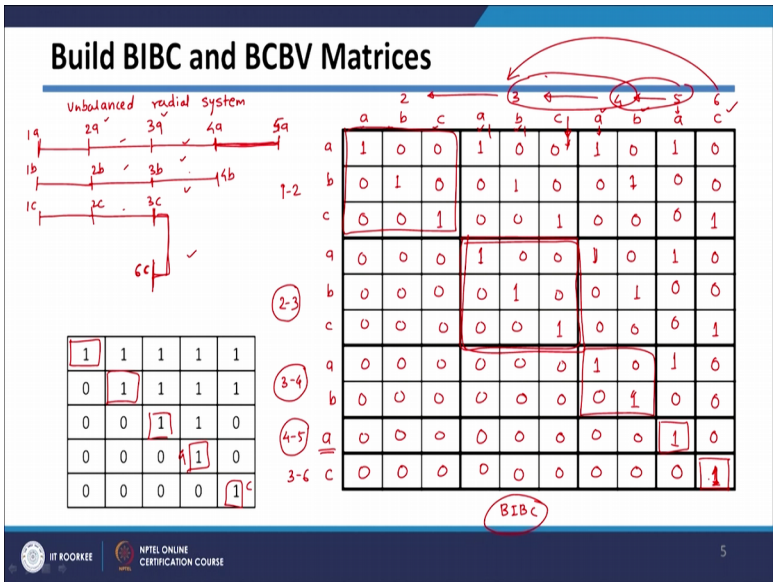

Now, let us see how we can use this for unbalance system. So in case of unbalance system; so, for unbalanced radial system so, here we are not considering till now weekly may system. So, in case of unbalance radial system, let consider this unbalanced radial system let us say this is your branches between 1 and 2, then between 2 and 3, 3 and 4, 4 and 5 and then there is 6 here.

So, here this 1 a, 1 b, 1 c this is 2 a, 2 b, 2 c this 3 a, 3 b, 3 c, 4 a, 4 b here we are considering only two lines which are going ahead. So, only two phase system is here and here, only single phase system which is going ahead. So, here we are having 5 a and here since it is actually c phase here so, it is actually 6 c. So, it is branch bus number 6 we are considering it here.

So, in this case also we can use exactly similar logic build your matrices. So, whenever your building your BIBC matrix, we need to put node numbers here. So, here the node numbers are corresponding to 2 3 4 5 and 6 since in at 2 bus number 2, we are having all

the 3 a b and c. Similarly at bus number 3 we are having all the 3 phases a b c at 4 your having two phases a and b at 5th, we are having only one phase that is a and at 6 we are having only one phase that is c here.

And here we are having this line numbers. So, these line numbers we node 1 from 1 to 2 this is from 2 to 3 this from 3 to 4 this is from 4 to 5 and this is from 3 to 6. So, for 1 to 2 all the 3 phases are existing so, a b c from 2 to 3 again all the 3 phases so, a b c and from 3 to 4 your having only two phase a and b and, at between 4 and 5 you are having only one phase that is a phase and between 3 and 6 we are having only c phase.

Now, here similar to your earlier BIBC matrix, we have which your considered for single phase equivalent system, or balance system in unbalance system here, since there is actually 1 and 2 they are connected, you have to put the unity matrix here which is basically like this 1 and 2 they are connected and, all other columns will be 0 0 0 like we have put for balance system.

Now, since there is you have to see the connection between 2 and 3 there is connection between 2 and 3. So, what would you have to do is copy the column corresponding to 2 and paste it at location 3. Since all the 3 phases are existing in 3. So, we need to copy all the 3 phase columns that is a b c columns and put at a b c locations the 1 0 0 0 1 0 0 0 1 and, then I just copied it it is as it is and, then next step is since it is connection between 2 and 3. So, at columns or rows corresponding to 2 and 3, it should be replace by unity matrix inside this 1.

So, here this will be replace by your unity matrix here, it will be 1 1 1 here. Now, see the connection between 4 and 3 and 4. Since there is connection between 3 and 4 here, we need to copy the column corresponding to 3, but only there are actually a and b phases. So, copy the column corresponding to a and b phases input at 4th node location that so, this one 0 0 1.

So, I am just copying this column here and this column here and, then your having 0 0 here then 1 0 0 1 0 0 0 0 0 0 ok. And then next step as I told you since it is a we are considering this 3 4 branch. So, at 3 4th row we need to put unity matrix, but since there are only two phases, we have only unity matrix of 2 by 2 size so, here we need to put 2 by 2 matrix.

Now, there is connection between 4 and 5 so, copy the column corresponding to 4 however, there is only a phases so, copy the column corresponding to a phase put it here. So, here 1 0 0 1 0 0 1 0 0 0. And the next step as we know since this is branch number 4 and 5 at 4 and 5 we need to put unity matrix; however, size of this is only 1 by 1 so, we need to replace this entry by 1.

Now, there is no connection between 5 and 6; however, there is connection between 3 and 6 which we are talking about. So, copy the column corresponding to bus number 3; however, only c phase is resisting here. So, we need to column copy the column corresponding to c phase. So, which is basically this column here. So, if I can copy it as it is. So, it will be 0 0 1 0 0 0 0 as copied column and, then since we are talking about branch number 3 6 at branch number 3 6 location we need to put unity matrix, but here since there are only c phases extreme it unity size will be 1 by 1.

So, this is how actually we have to build your BIBC matrix for 3 phase system and, if you compare of BIBC matrix of similar system, we have considered balanced balance 6 bus system and, this unbalanced 6 bus system. We can see that structure is similar only in this case we are getting the matrix depending upon. So, instead of one here since there are actually all the 3 phases existing between 1 and 2.

We are getting 3 by 3 unity matrix here again between 2 and 3 again, we are having all the 3 phases we are getting here 3 by 3 matrix, here between 3 and 4 only 2 phases are existing so, it will be actually 2 by 2 matrix and here only a phases existing and here only c phases existing. So, we are getting 1 by 1 unity matrix here.

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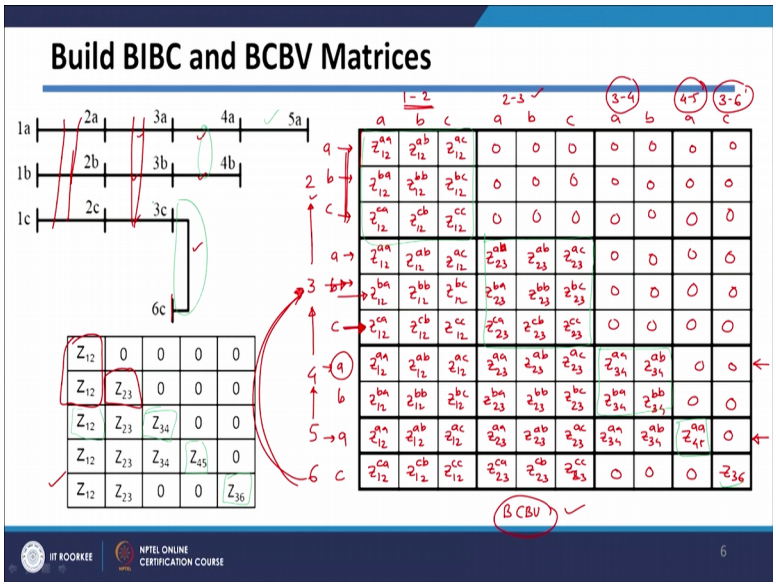

So, this how we can build your BIBC matrix. Let us see how we can build your BCBV matrix. So, BCBV matrix for 3 phase system. So, in this case we have seen that here that there will be bus numbers 2 3 4 5 and 6 and, here there will be branch number so, there is branch between 1 and 2, 2 and 3, 3 and 4, 4 and 5 and then there is 3 and 6.

So, in this case we need to copy the row, so here we in case of BCBV matrix we need to put the impedances. So, here the impedance matrix first we start with 1 and 2 since, it is connected 2 we will start with impedance matrix of 1 and 2. So, it is actually Z a a, Z a b, Z a c, Z b a, Z b b, Z b c, Z c a, Z c b, and Z c c and since it is corresponding to 1 2. So, these are actually basically branch number between 1 and 2. So, branch 1 2 we can write it here and it is not connected to anywhere so, all the other entries will be 0.

Now, similar to your BIBC matrix we need to see the connection. So, here there is connection between 2 and 3 which is basically this and all the 3 phases are existing. So, copy the rows corresponding to two since there is connection between 2 and 3 put at 3rd. Since we in the in this case we have not to copy all the 3 phases. So, it is again Z a a, Z a b, Z a c, Z b a, Z b b, Z b c, Z c a, Z c b and Z c c and, just I am copying it as it is so, it will be 1 2 1 2 everywhere.

And this since I am copying it as it is it will be like this. So, I just copied in there connection between 2 and 3, row corresponding two is copied at bus number 3. And then next step we know that we need to replace this part by impedance of 2 3, because we

were talking about line number 2 3. So, these actually line number 2 3. So, here we need to put the impedance of 2 3 so, again here all the three phases are existing so, a b Z sorry, a Z a b, Z a c, Z b a, Z b b, Z b c, Z c a, Z c b and Z c c and this is corresponding to branch 2 3 so, it will be 2 3 here.

Then there is see the connection between 3 and 4 so, only two phases are getting connected between 2 3 and 4. So, in this case so, this is corresponding to a b c phases as I told you so, a b c, a b a and c and this is corresponding a b c, a b and c a b a and c. So, rows corresponding to a and b phases only need to be copied and pasted it here.

So, here it will be 1 2 a a 1 2 a b Z 1 2 a c, Z 1 2 b a, Z 1 2 b b, Z 1 2 b c which is copied a and b row similarly here we need to copy this one Z 2 3 b a, Z 2 3 b b, Z 2 3 b c and as it is. And as Is told you next step is since it is branch 3 4, we need to put at this location we need to replace this by impedance of branch 3 4. Since there are only two phases are executing between 2 3 and 4. So, it will be just 2 by 2 matrix. So, Z a a, Z a b, Z b a and Z b b and since it is of 3 and 4 so, we need to put 3 and 4 here.

Then we can see there is connection between 5 and 4 so, but only a phase is existing. So, column so, row corresponding to a copy it and paste it here. So, Z 1 2 a a, Z 1 2 a b, Z 1 2 a c, Z 2 3 a a, Z 2 3 a b, Z 2 3 a c, Z 3 4 a a, Z 3 4 a b and 0 0 so, I just copied this particular row and pasted it here and, as I told you next step is basically since we are talking about branch number 4 5, we need to replace this entry by impedance of 4 5 and 4 5 only one phase is existing. So, therefore, there will be actually 1 by 1 matrix so, it will basically 4 5 a a.

Now, there no connection between 5 and 6, but there is connection between 3 and 6. So, in this case we need to copy row corresponding to 3; however, it should be actually c phase because, here we are getting only c phase which is connected to c phase of bus 6. So, copies c phase entries of 3rd node here. So, 1 2 c a, Z 1 2 c b, Z 1 2 c c, Z 2 3 c a, Z 2 3 c b, Z 2 3 c c 0 0 0 0 and since we are talking about line between 3 and 6 which is this, this particular entry need to be replaced by impedance of 3 6 that is basically Z 3 6.

So, this is how actually we have to build your BCBV matrix, again structure is if you compare the structure of balance system and unbalance system it is similar. So, this was the matrix which you have got for balance system. So, only thing is. So, whenever there is all the 3 phases exist, in this section and in this section so, these entries will be 3 by 3

entries. So, we can see that here we are getting this entries which are basically 3 by 3 entries.

And then here we are having actually this basically entry is 2 by 2, because we are having only two branches here, this entry will be 1 by 1, because only one phases existing here and, this entry will be again 1 by 1, because only 1 phase is existing here. So, we can see that this BCBV and BIBC matrices can be easily built by knowing your system data. So, here from knowing this connections, or you can say from the line data we can build your BIBC matrices and BCBV matrices ok.

So, in today's lecture we have seen how to get your BIBC and BCBV matrices from the configuration of the system, or if you know the line data of the system, how we can get BIBC and BCBV matrices, you have seen how the logic is found and based on this logic, we can develop your code and build BIBC matrices. ah.

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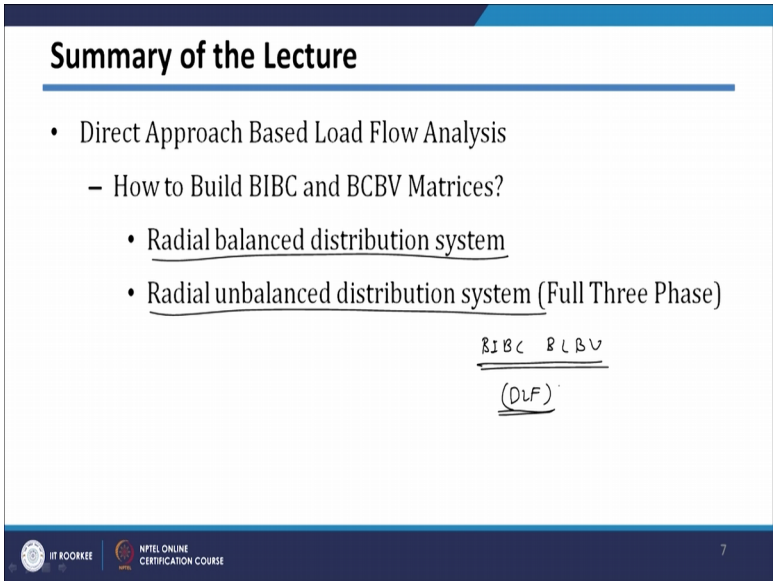

So, basically in today's lecture, we have seen how to get this BIBC and BCBV matrices, for radial balanced distribution system and radial unbalanced system.

So, we have found so we know that once you get this BIBC and BCBV matrices, you get your what is called as distribution load flow matrix and, how we can use this load flow distribution load flow matrix, for solving the load flow will see in next lecture, which is

basically based on step by step process of this algorithm based on the direct load flow approach.

Thank you.