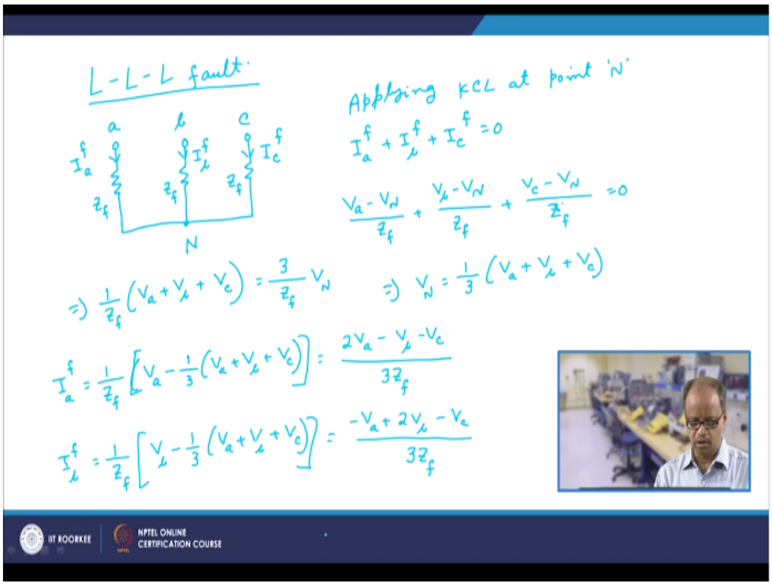
Computer Aided Power System Analysis

Prof. Biswarup Das
Department of Electrical Engineering
Indian Institute of Technology – Roorkee

Lecture - 55
Fault Analysis (Contd.)

Hello friends. Welcome to this lecture on computer aided power system analysis. In the last lecture, we have started the derivation of the admittance matrix correspondingly different types of symmetrical and unsymmetrical fault. In the last lecture, we have looked into 3 different types of fault; one is L-G and then L-L and then L-L-G. Today, we would be looking into the other remaining two types of faults that is L-L-L and L-L-L-G.

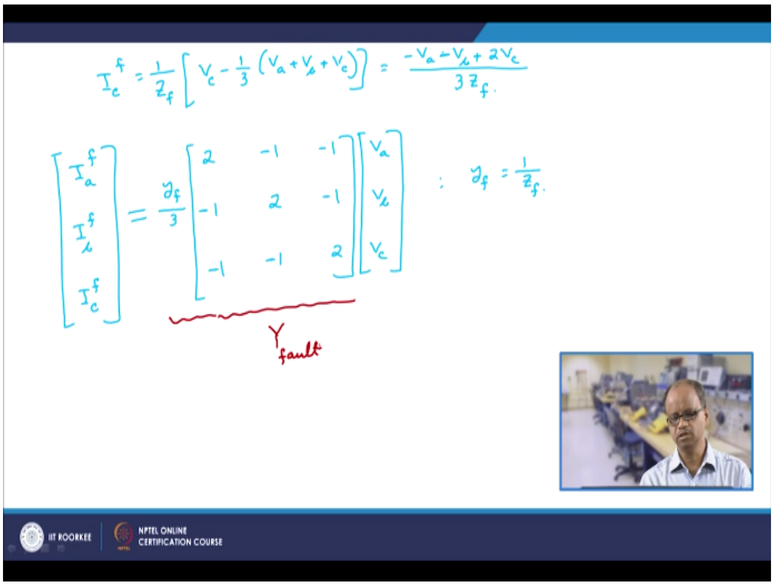
(Refer Slide Time: 01:15)



So let us start so fault analysis, so what we are doing is so now we are considering L-L-L fault. So this L-L-L fault is we have a, b, c we have so this is an L-L-L fault please note that so this is Iaf, Ibf, Icf and these are all zf, zf, zf. So let us see that these are all given as zf. So now let us so that this point is N neutral points, so then therefore applying KCL at N, applying KCL at point N that Iaf+Ibf+Icf=0 so we get Va-VN/zf+Vb-VN/vf+Vc-VN/zf=0.

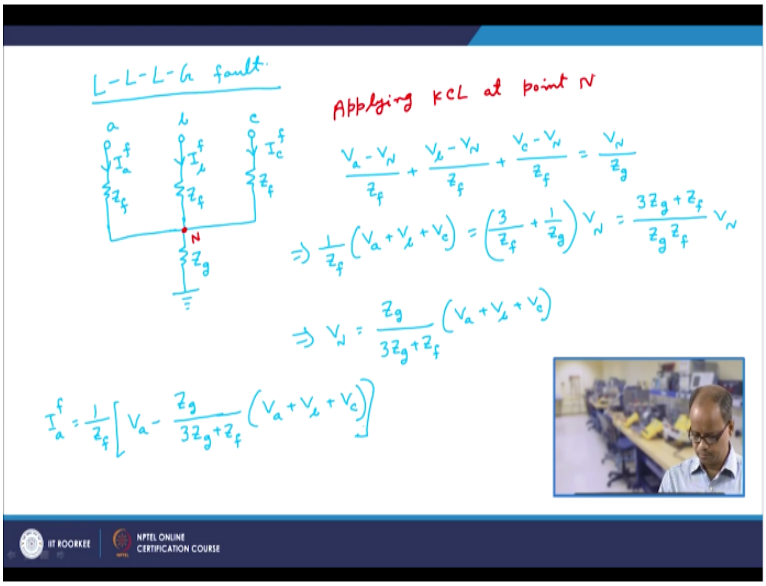
So then therefore, 1/zf*Va+Vb+Vc is=3/zf*VN or in other words VN is nothing but the average of Va+Vb+Vc. So then therefore, Iaf would be 1/zf*Va-1/3 Va+Vb+Vc so that is=2Va-Vb-Vc/3zf. Similarly, Ibf would be 1/zf*Vb-1/3 Va+Vb+Vc=-Va+2Vb-Vc/3zf.

(Refer Slide Time: 05:02)



And Icf is 1/zf*Vc-1/3 Va+Vb+Vc so it is –Va-Vb+2Vc/3zf. So then therefore, if I put all of them in a matrix form, it would be yf/3 2 -1 -1 -1 2 -1 -1 -1 2 Va Vb Vc where yf is=1/zf. So then therefore, this quantity is nothing but Y fault right. So this is Y fault, which is easier. So now let us look at L-L-L-G fault.

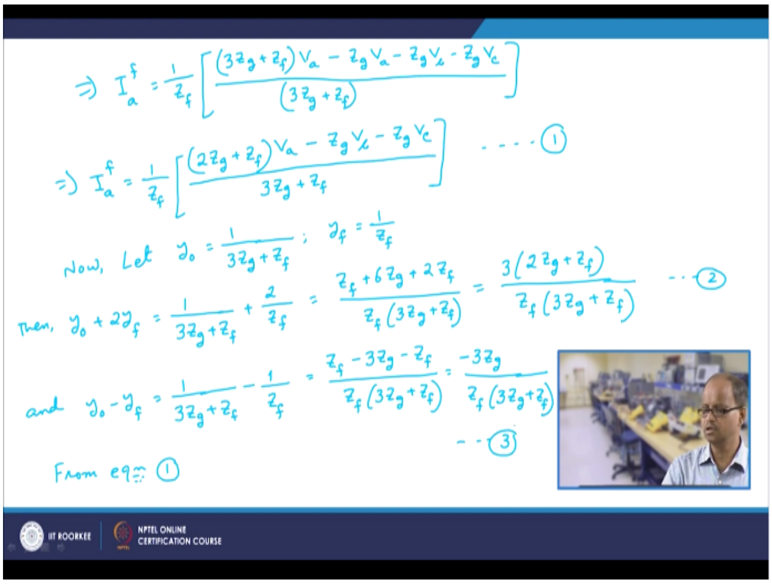
(Refer Slide Time: 06:59)



So now we are looking at L-L-L-G fault. So what we have, we have is and then we have so what we will have is so if a, b, c all are zf, zf, zf, zg, Icf, Ibf, Iaf. Again, as usual we take this point to be let us say N, this point is N, so applying KCL at point N, what we can write down, we can write down that Va-VN/zf+Vb-VN/zf+Vc-VN/zf is=VN/zg. So then therefore, we have 1/zf*Va+Vb+Vc is=3/zf+1/zg*VN.

So it is 3zg+zf/zg zf*VN, so then therefore VN would be simply zg/3zg+zf*Va+Vb+Vc. So this would be the VN. So then therefore, Iaf would be 1/zf Va-VN, -VN is zg/3zg+zf*Va+Vb+Vc.

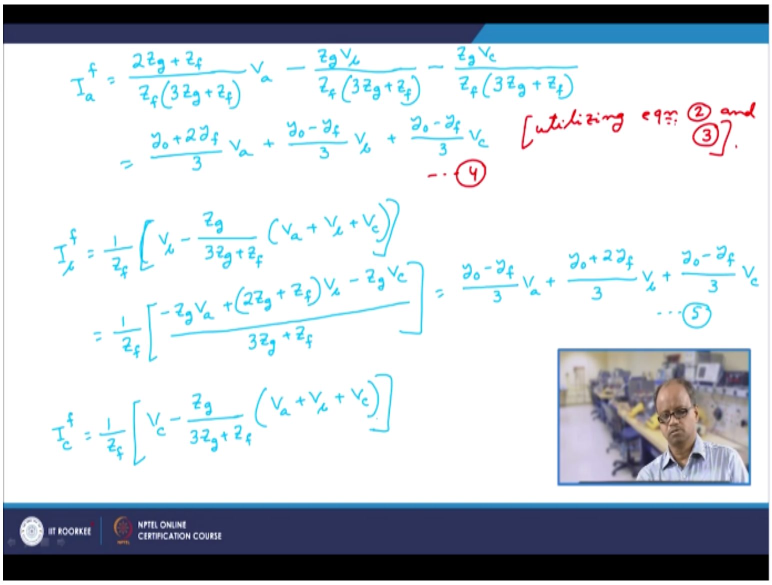
(Refer Slide Time: 11:13)



So now what we have, we have so then therefore Iaf is=1/zf*3zg+zf*Va-zg Va-zg Vb-zg Vc which we will see into 3zg+zf. So then therefore, Iaf would be 1/zf 2zg+zf*Va-zg Vb-zg Vc/3zg+zf. Now suppose we define now let y0 is given by 1/3zg+zf and yf is given by 1/zf. So then therefore then y0+2yf what I get, y0 is 1/3zg+zf+2yf is 2/yf so that would yf+6zg+sorry this should be zf.

So 6zg+2zf/zf*3zg+zf so this can be written as 3*2zg+zf/zf*3zg+zf that we can write so this is equation 1 and y0-yf will be 1/3zg+zf-1/zf is=zf-3zg-zf/zf*3zg+zf it is -3zg/zf*3zg+zf.

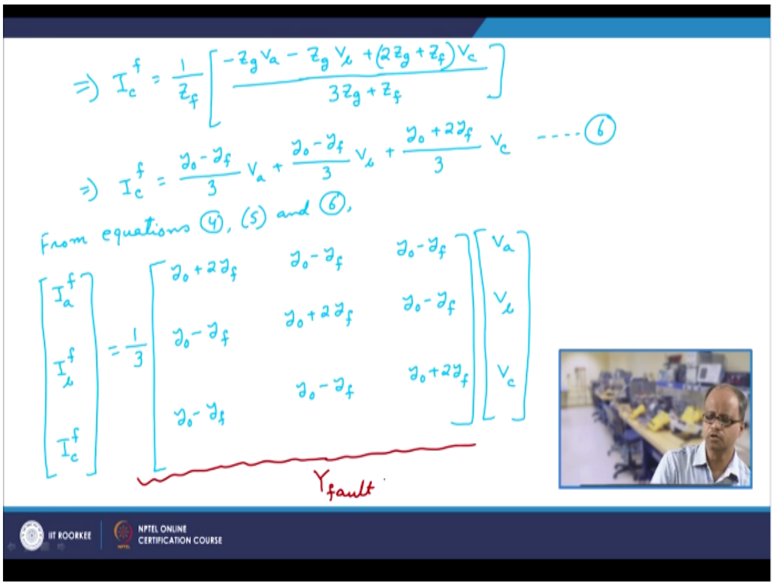
(Refer Slide Time: 16:42)



So then therefore now from equation 1 Iaf is=2zg+zf/zf*3zg+zf*Va-zg Vb/zf 3zg+zf-zgVc/zf*3zg+zf. Now here if you do utilize these two relations, it can be written as this is y0/2yf so it is essentially y0+2yf/3*Va and this says+y0-yf/3*Vb+y0-yf/3*Vc. Let us say this is equation 2, this is equation 3. So then write down utilizing equation 2 and 3. So this is the expression of Iaf. So let us say this is equation 4.

So similarly if we look that the expression of Ibf it will be 1/zf*Vb-zg/3zg+zf*Va+Vb+Vc. So if you repeat all these derivations as compared as you have done here so we will find that it is nothing but 1/zf*this is –zg Va+2zg+zf*Vb-zg Vc/3zg+zf. So it would be also similarly it turn out to be y0-yf/3 Va+y0+2yf/3 Vb+y0-yf/3 Vc. This is equation 5. Similarly, for the expression Icf would be 1/zf*Vc-zg/3zg+zf*Va+Vb+Vc.

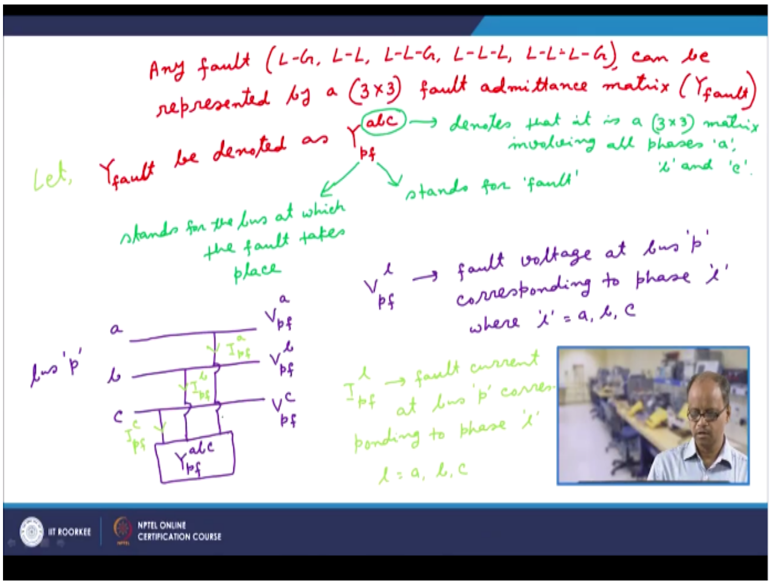
(Refer Slide Time: 21:39)



So it would be Icf would be 1/zf-zg Va-zg Vb+2zg+zf Vc/3zg+zf. So in other words Icf is essentially y0-yf/3*Va+y0-yf/3*Vb+y0+2yf/3*Vc. So from equation 4, 5, 6 we can write down, what you can write down, you can Iaf Ibf Icf=1/3 so it is y0+2yf y0-yf y0-yf this is y0-yf y0+2yf y0-yf this is y0-yf y0-yf y0+2yf and this is into Va Vb Vc. So therefore this is the Y fault matrix.

So this is the Y fault matrix, so then therefore if we know that what is the fault impedance at any phase and what is the ground fault impedance, you can simply find out the Y fault matrix. So then what does it mean?

(Refer Slide Time: 25:11)



So it means that for any fault either L-G or L-L or L-L-G or L-L-L or L-L-L-G any fault can be represented by a 3 x 3 fault admittance matrix so this is Y fault. In short, when we would be writing as in Y fault let us denote as Y fault as Y let us say pf abc. So here what does this p stands for, p stands for here essentially let Y fault be denoted as we should write that Y fault be denoted as Ypf abc.

So what are the different quantities which they signify p, p stands for the bus at which the fault takes place, f stands for fault and abc denotes that it is a 3 x 3 matrix involving all phases abc. So this is the notation, so then therefore now suppose there is a bus so this is phase a, phase b, phase c and this is bus p and let us say there is some fault and so then therefore there is some fault we can simply represent it as some fault which is let us say Ypf abc, so then this fault can be represented as Ypf abc.

Now if this voltages are Vpf a, this voltages are Vpf b and this voltages are Vpf c so why this voltages are Vpf let us say l stands for fault voltage at bus p corresponding to phase l where l is=a, b or c right. So then therefore, Vpf a stands for the fault voltage at bus p corresponding to phase a, this is fault voltage at bus p corresponding to phase b and fault voltage bus p corresponding to phase c.

And let us say these currents are denoted as Ipf a, this is let us say Ipf b and let us say this is Ipf c right. So similarly, Ipf and let us say these currents are Ipf a, Ipf b and Ipf c where Ipf l is the fault current at bus p corresponding to phase l where l is again a, b, c. So now so then this is the case, so now what we have, so I have bus p, it has got 3 phases a, b, c and it can have any voltage sorry it can have any type of fault it can occur, let us say L-G or L-L or L-L-G or whatever.

So then therefore as we have already seen that any fault can be represented by a fault admittance matrix which is written as Ypf abc and because of this Ypf abc so then therefore this bus voltages are now let us say fault voltages Vpf a, Vpf b and Vpf c and as well as the current flowing to the fault are given by Ipf a, Ipf b and Ipf c right. So then therefore, this is the representation of the fault and this representation is perfectly general representation because this representation takes into account any type of fault.

Now with this representation we are now in a position to analyze the effect of the fault accordingly at any bus of any large scale power system. This issue would be taken in the next lecture. Thank you.