Fundamentals of Electrical Engineering
Prof. Debapriya Das
Department of Electrical Engineering
Indian institute of Technology, Kharagpur

Lecture – 47
Three-phase circuits

Ok. So, with this single phase circuit is over right. So, my suggestion is you follow some your what you call some good books for solving numericals right. And next, we will come to the three-phase circuit. So, generally power generation in three-phase circuit nothing will be told here just giving you some flavor, because our objective is to study the three-phase circuit analysis.

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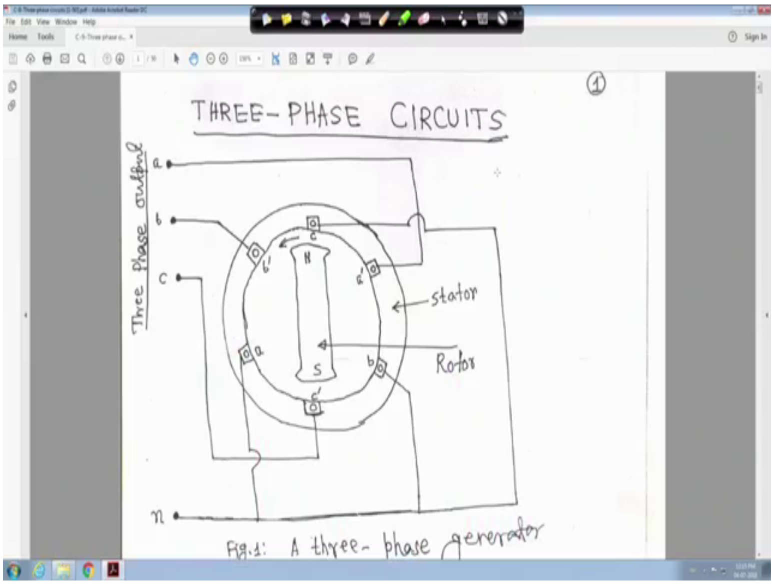

So, generally you your what we call that a simple your what you call three-phase generator, we call alternator have been drawn here right. So, suppose this is suppose for example, for your understanding suppose this is a magnet right. And magnet is rotating, it goes direction of the rotation given anti-clockwise direction, it is rotating.

And magnet is surrounded by right magnet is the your surrounded by that your some your what we call phase three-phase your that three wind, the three-phase winding called right. Here what we call this winding are called your what we call this we call that static. This is this rotor this rotor actually rotating this magnet is rotating, we call this a rotor, this plane is rotor right. And surrounded by some winding so you call it is static, so we call it is stator.

So, question is that generally suppose this is for conductor a, suppose if you take a page if the current is entering into this, then read as it is in leaving. Similarly, for b also b dash, and similarly for c c dash right. So, this physically this winding are 120 degree, 120 degree apart right, so total is 360 degree. Similarly, a a dash, b b dash and c c dash basically physically they are 120 degree apart right.

Now, question is that so this is a rotor, surrounded by a static part called rotor and this static part that winding are placed 120 degree apart right. But, as it is revolving the magnitude is revolving there will be flux (Refer Time: 02:19) that there your what we call in this your three different winding, so which are placed 120 degree apart right, because of that output that your what we call the voltage will be induced in this winding.

So, you have a magnet say, suppose it is revolving right and it is surrounded by your static part called stator. And everywhere that windings are there that a a b b a a dash b b dash and c c dash. And these winding that 120 degree your physically 120 degree a apart. And when you revolve in this, your what we call that flux linking all these three windings, which are placed 120 degree apart. Therefore, voltage will be induced, so that is why, if we look in to that from a dash say terminal is taken as a, this is the, it is leaving if a is entering into that page, and therefore a dash is leaving the page right.

And here it is entering, it is leaving right. And similarly, for b dash if you look, this terminal is taken b. And for c dash, it is taken c this c dash it is taken c right. And another c if you see a, then your b your b, and then your c, all this three bounds together, and this numerical is formed right. So, this is called neutral point n. All three are bound together and a numerical point is formed, and this is a, b, c that three terminals right.

So, this is a three-phase generator, sometimes we call it is your what we call it is alternator. So, this is it is (Refer Time: 03:49) generator (Refer Time: 03:51) that together it is different. Just you start the three-phase circuit that is this rotor; this is magnet say suppose it is revolving. And you have winding, which are 120 degree apart right. So, as it is if it magnet is revolving that means, flux linking here this your what we call this your what we call this winding, so voltage will be induced right. So, this is your; that means as it is 120 degree apart how this happen right.

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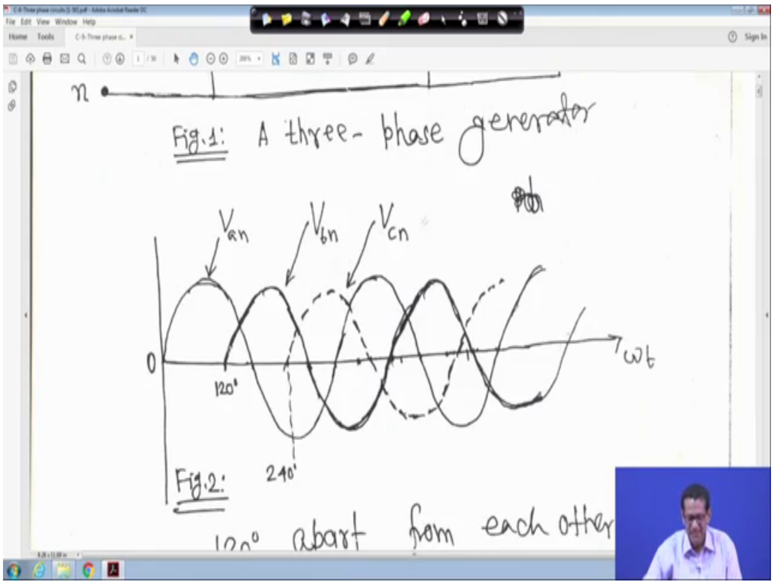

So, let me just let me make it this thing. So, in this case if you look into that that voltage V a n, V b n, and V c n is taken. So, here we have marked that your a, b, c, so one voltage will be a to n, then another will be b to n, another will be your c to n, so V a to n, V b to n, and V c to n right. So, a n, b n, c n, we call we will come to that we call it is a phase voltage.

So, what will happen is if we follow the your what we call the this V a n, then V b n, it is moving it is say moving like these anti-clockwise direction right. So, V a n, so it is your what we call it is moving like this, then V b n, it is I told they are 120 degree apart physically right. Then it is V b n it starts from here, and V c n of course it will come like this, but V b n and V c n that means, V a n is leading V b n by 120, V b n your leading V c n by 120 degree.

And other way V b n is lagging from V a n by 120 degree, and V c n is lagging from V b n by 120 degree, and V c n is lagging from V n from V n by 240 degree, because this V n is reaching it is peak fast than V b n right. So, V a n is leading V b n, V b n is leading V c n. And angle is 120 degree apart right a, b, c these are your what we call 120 degree apart. We assume that our V a n is the reference based on that. And this is your omega t, and this is the voltage phase voltage right. So, this is the sinusoidal representation of V a n, V b n, and V c n. Only one thing I tell when you say a n, you take a terminal is positive, and n terminal is your what you call negative right in instantaneous polarity in instantaneous polarity.

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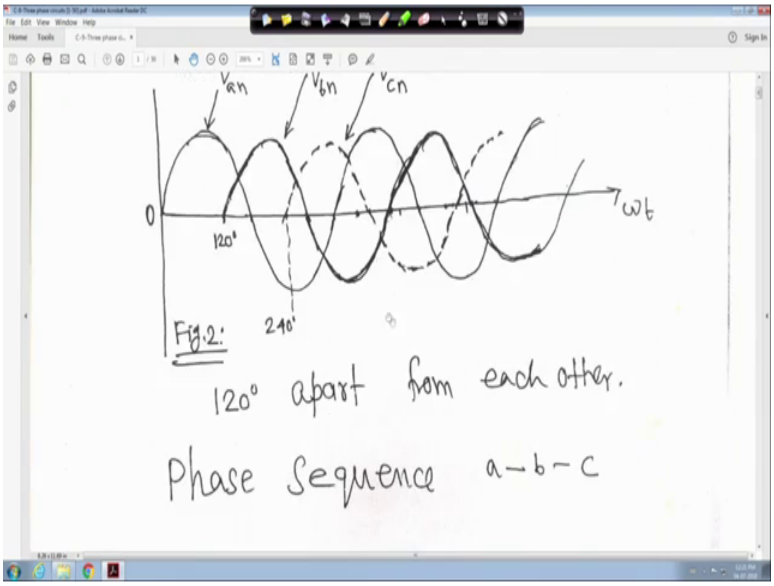

So, in this case you have 120 degree apart from each other. This phase sequence, we call a-b-c phase sequence right we call a-b-c phase sequence. If you want to make a-c-b also, it can be done. But, phase sequence is a-b-c later we will see that right.

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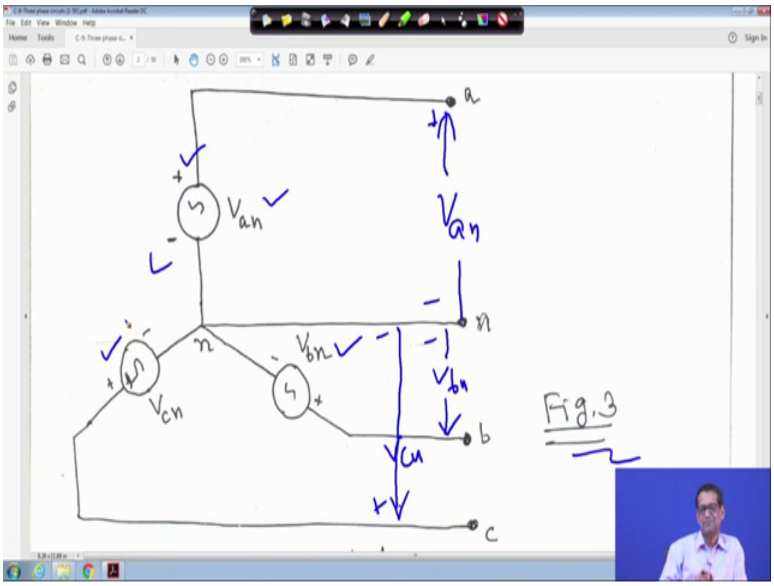

So, if now if it is as it is shown that is neutral is formed, suppose if it is a star connected that means, just I told you whenever we write V a n that means, this voltage actually V a n right. When we make arrow means, it is plus and instantaneous this is minus. So, this factor this is plus, this is minus. Similarly, when you take V b n, so it will be V b n right this is my arrow, so this V b plus, so this is here minus.

Similarly, my your V a b c n; so, V a n, V b n, V c n, so here it is your what we call this is my V c n right. This arrow means positive nothing is shown means negative right. So, V a n, V b n this is figure 3. So, this is voltage V a n, this is V b n, and this is your V c n right so that means, basically what a your you have you have a magnet if it is rotating it is rotating, and is surrounded by a static part that is called stator, where windings are placed 120 degree apart right, 120 degree apart as the magnet is rotating right.

So, voltage will be induced your what we call in all this three different coil, which are 120 degree apart right, physically it is apart right. And if you take for example, voltage induced in V n as the reference, then V b n lags from V n by 120 degree, and V c n lags from V b n 120 degree, otherwise V c n lags from V a n by two 240 degree right. This is the philosophy. So, so this is that your, this is your we call this is your star connection right that if star delta formation you (Refer Time: 08:19), this is also star. But, as this is ac one new (Refer Time: 08:24) is there it may be there may not be there, but here it is n is called the numerical part (Refer Time: 08:28).

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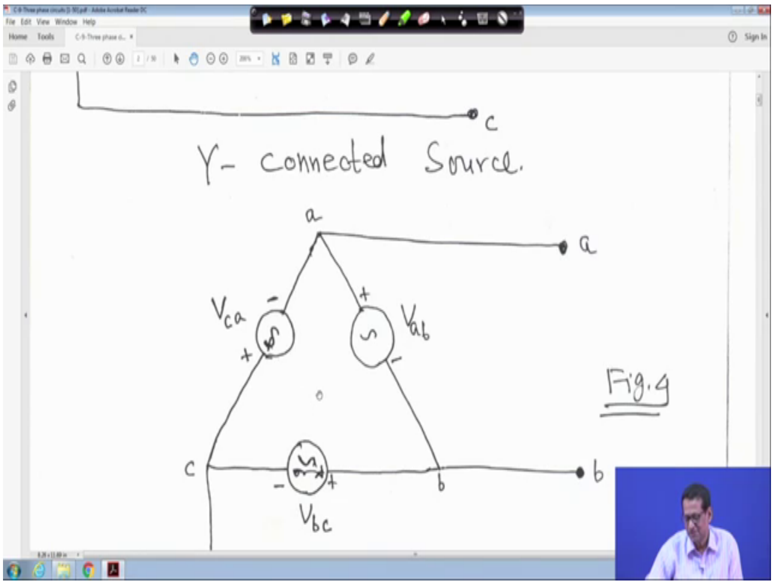

So, now this is actually star connected source, this source is star connected right. But, if it is a delta, there will be no neutral. If it is a delta, if the source is delta connected right, now look into that in this case there is no new term. In this case V a b right if V a b means this, when you say when you say V a b that means, a is instantaneous polarity, a is positive right. And your b terminal is your negative right, it is negative, so that means when it is V a b this is positive, this is negative, it is V a b you can write V a b, arrow means positive arrow means positive, and here no arrow means negative.

Similarly, V b c right; So, V b c means there should not be any confusion, when you say V b c that b should be positive. So, here I write it is V b c, so it is plus, it is minus. It is instantaneous polarity. Here it is V a b negative, here it is V b c positive instantaneous polarity right so, no there should not be any confusion. And if it is V a b could V b c and if it is V c a, when you take V c a, this is my V c a, so this is my c this is positive right, and another side is negative.

So, whenever we say V a b a positive, b negative. V b c means b positive 1st one is positive, 2nd one is negative right, this instantaneous polarity. And this is actually your, what we call the three-phase your delta connected source, because this is delta connected, and this is your delta connected source that was star connected and this is delta connected right. So, let me clear it, so this is figure 4.

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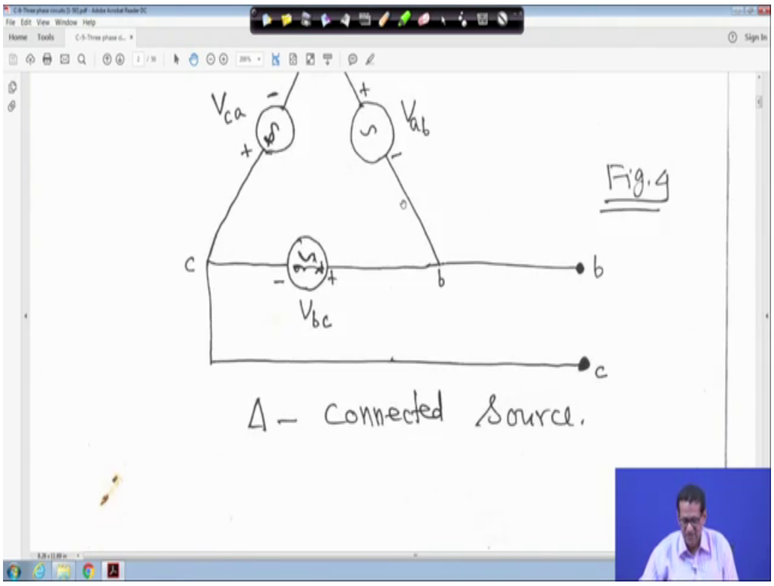

Now, so V a n voltage between line a and neutral line n right neutral line n, this I told you.

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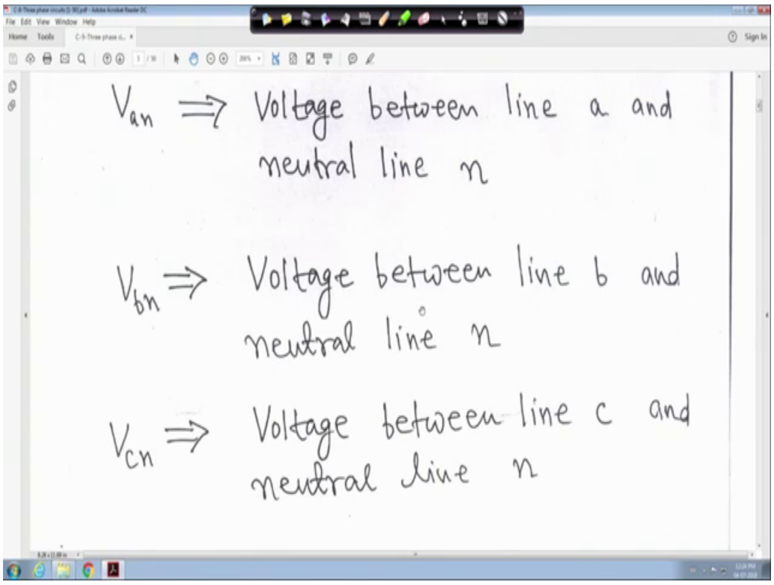

Similarly, V b n voltage between line b and neutral line n, and V c n voltage between line c and neutral line n right line right a n, b n, c n. Therefore, V a n, V b n, V c n they are called phase voltages that means, if line to neutral, then it is phase voltages. (Refer Time: 10:33) whatever voltage is going to get, it is basically the phase voltage like if you get 220 volt or so right in line to line is different. And whatever in your (Refer Time: 10:43) and how it will get that is basically phase voltage line to neutral right.

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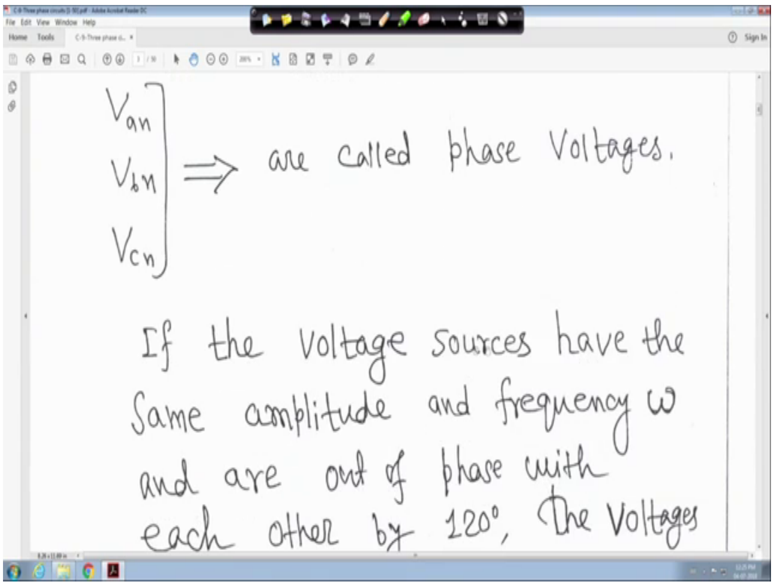

So, V a n, V b n, V c n are called phase voltages right. Now, if the voltage sources have the same amplitude and frequency omega and are out of phase with each other by 120 degree, the voltages are said to be balanced that means, this voltage sources have the same voltage magnitude and the frequency at they are 120 degree, I mean phase shift phase difference between there is exactly 120 degree at that time, you can tell the voltage is balanced right. If it is not if one of the difference, then it is unbalanced but, we will study only balanced thing for this source right.

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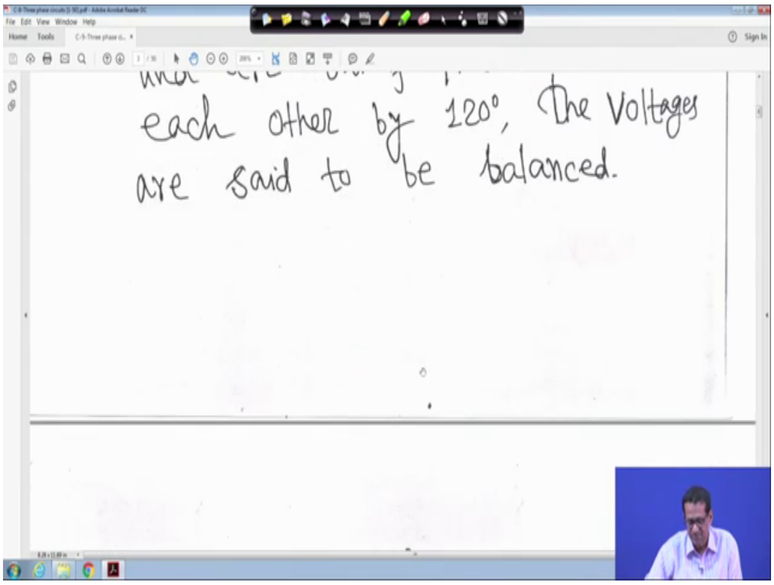

So, this implies that if it is so that V a n plus V b n plus V c n is equal to 0. This is a phasor quantity right. I will show why it is 0, if you do it, it will become 0. V a n plus V b n plus V c n is equal to 0, this is equation 1.

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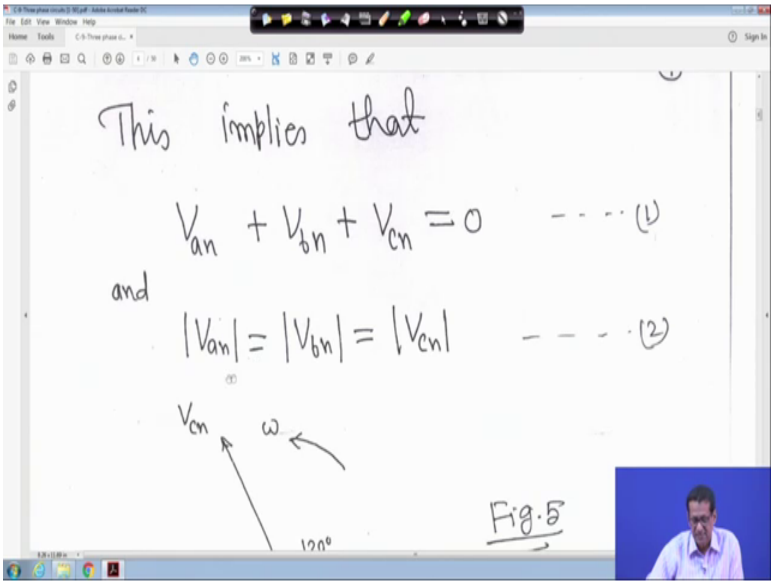

That means that means if for balanced voltage, magnitude V a n is equal to magnitude V b n is equal to magnitude V c n right. These are the magnitude when I am putting mod, these are magnitude right.

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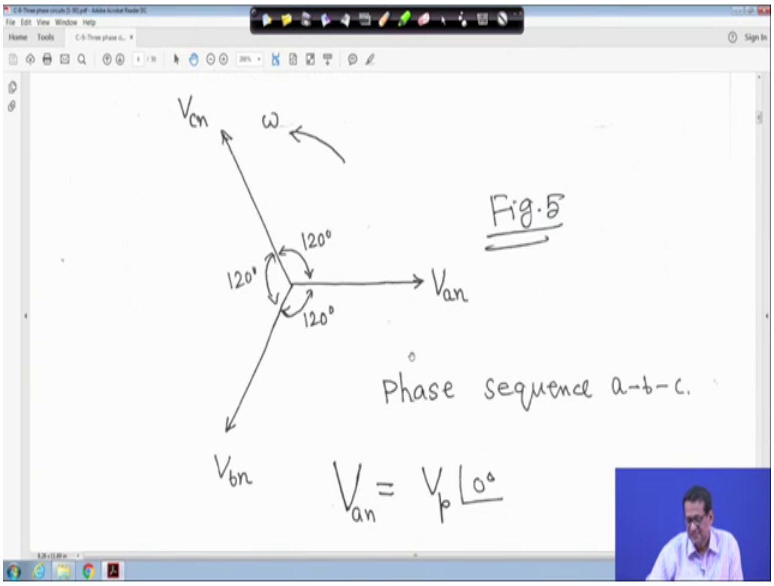

Now, if you draw the phasor diagram, then V a n is the reference one, so we call this is the phase sequence is a-b-c. So, because b lags from a, c lags from b, so phase sequence is a-b-c right. So, when it is V a n, we write V a n is equal to V p angle 0 degree this is reference. And V p is equal to my phase voltage. V p p actually suppose we call phase, so it is phase voltage magnitude. And it is angle is 0, this is V a n. Now, V b n actually and all these phase basically this one is equal to V p all magnitudes are same, this is V p this is called phase voltage right.

So, in this case your V a n is equal to V p angle 0 degree. Therefore, V b n is lags from V a n by 120 degree. So, V b n is equal to your V p angle minus 120 degree right. These are all magnitudes the same. Then V c n will be this is my V c n, this is my V c n this is my V c n right. So, this is my V c n this angle is 240 degree so V c n lags from V a n by 240 degree. So, therefore let me clear it. Therefore, this one your V c n is equal to V p angle minus 240 degree is equal to you can say V p angle 120 degree.

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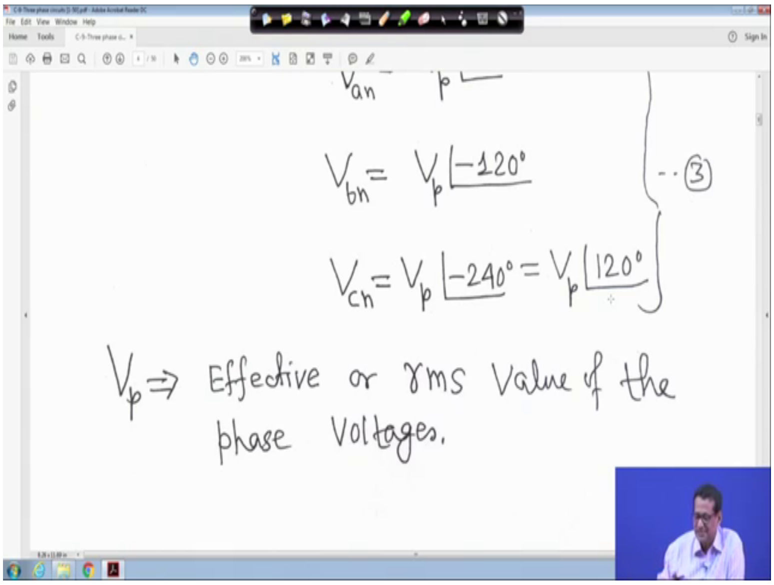

Otherwise, this V c n this is lagging by 240 degree or V c n anyway it is given V a n by 120 degree, because V c n 120 degree by 120 degree, so that means your this one this one you can make V p angle 120 degree. If you have any if you have any other thing if you have that is that is your what we call that is your philosophy right, so V p angle minus 240 degree, suppose it is multiplied by 1. So, it is one angle 360 degree.

If you add these two, it will be V p angle 120 degree; so, basically leading this one by 120 degree right. So, anywhere so this is your V p is equal to 120 degree. V p is effective or rms value of the phase voltage. Here you are taking (Refer Time: 14:14) sin omega t or cosine omega t. So, it is rms value of the phase voltage. So, whatever we say V p is the phase voltage these are all rms value right, everything is rms value.

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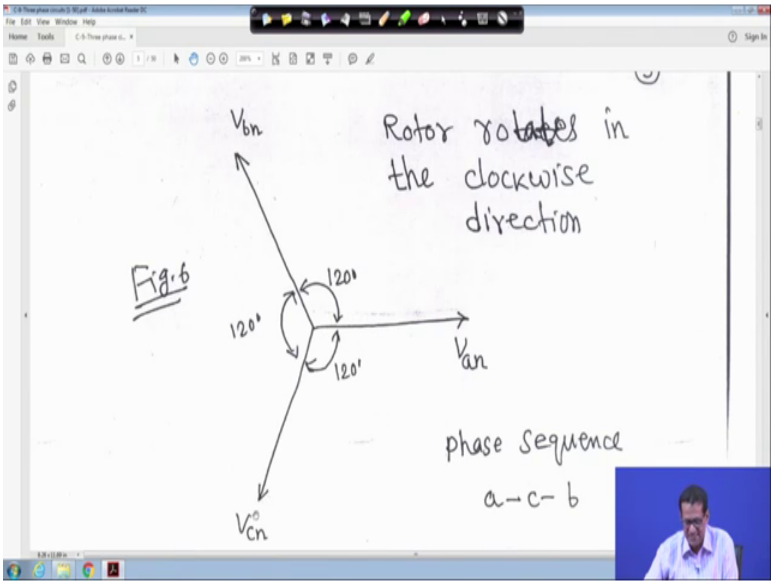

Now, rotor rotates in the clockwise direction. In this case in this case, we have taken say V a n, then c, and then b, if this is phase a-c-b sequence. If it is a-b-c sequence, where a-b-c and a-c-b sequence is a-c-b; here it is showing just here we have taken the (Refer Time: 14:44), then it is anti-clockwise direction rotor rotating. But, in this case if we take in this your, what we call in this case rotor rotating in the clockwise direction that means, this way omega right. So, in this is a c and a-c-b sequence right. So, this one you have to keep it in mind.

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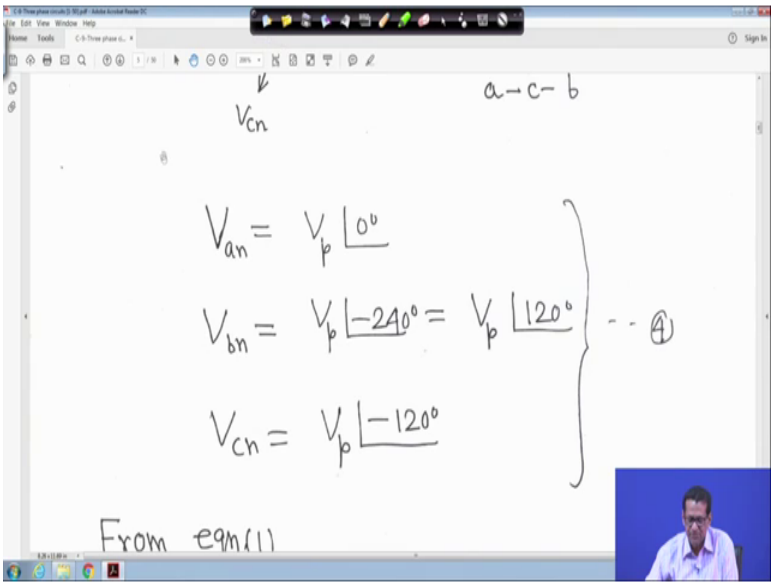

So, now therefore V a n is equal to V p angle 0 degree we got, V b n angle your 120 degree for this case a series sequence and V c n is equal to V p angle minus 120 degree. This is for your a-c-b sequence same as before, only one thing is changed. Now, from equation 1 V a n plus V b n plus V c n, V a n is equal to V p angle 0 degree plus V b n is equal to V p angle minus 120 degree plus V p angle 120 degree.

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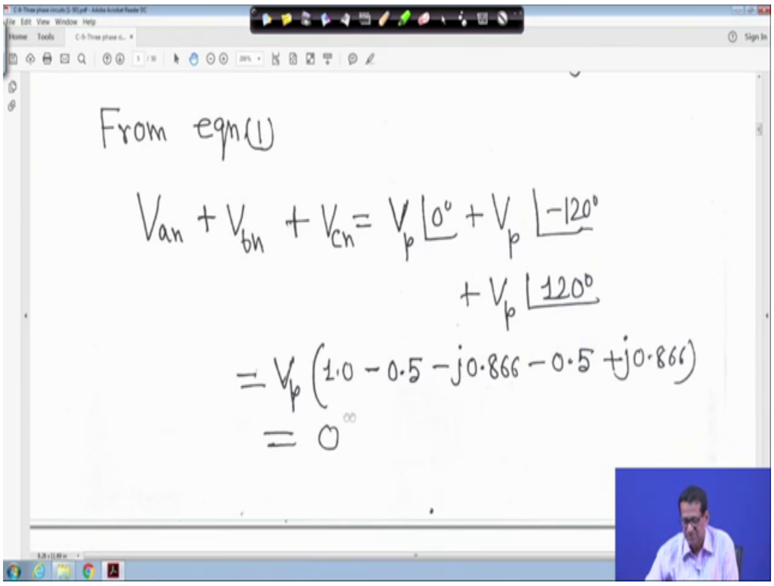

If we just simplify, it will be 1 minus 0.5 minus j 0.866, then minus 0.5 plus j 0.866, it will become 0. So, for balance source V a n plus V b n plus V c n must be equal to 0. If it is unbalanced may be 0, may not be 0 right. Zero does not means your, what you call that it is your what you call zero your it does not mean that you will become balanced, because these parameters are taken in such a fashion. Suppose, these has become your what we call is your what you call this your 0 right. But, for the sake of your understanding at this stage you just assume that your if this is 0, there will be your, what we call for balanced voltage source V a n plus V b n plus V c n is equal to 0 right.

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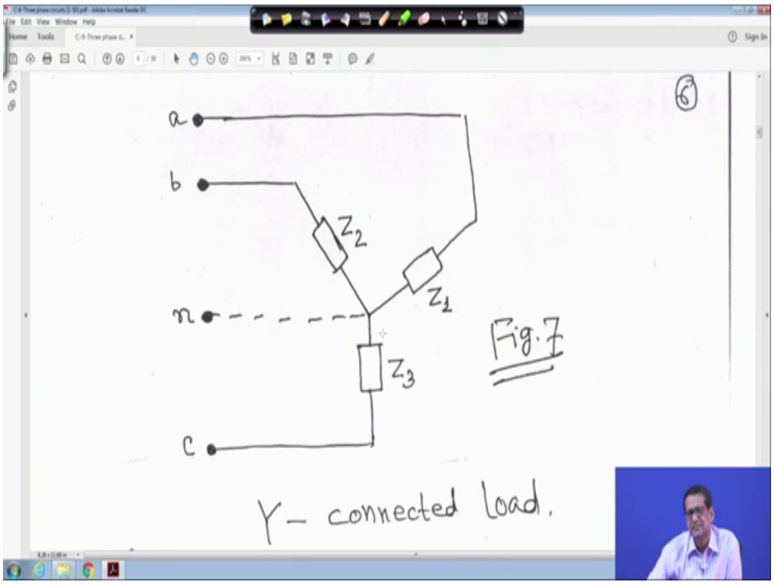

So, now question is that your star connected load, this is whatever we saw this is for star or delta connected source. Now, we will see the star connected load right. So, in this case your, what we call this is I have made you the star connected load this is Z 1, Z 2, Z 3. And star connected load, it will be balanced. And phase a-b-c is given this neutral dash line is given, it may be there may not be there you right may be there or may not be there.

So, in that case what will happen, this one actually just one minute this one actually for balance phase it is your what we call it is your always 0. In the case of current, it is different in this case the balance is actually zero right. So, now question is that a-b-c this is a dash line. This is neutral may be there, neutral may not be there. So, this is Z 1, Z 2, and Z 3 this is figure 7.

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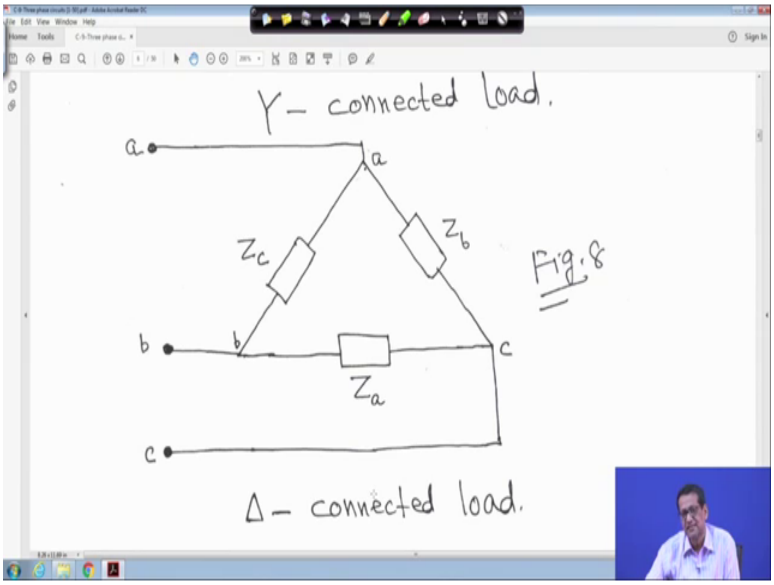

So, for star connectivity this is for star connected this is star connector in a-b-c circuit, you have called this star connected. And this is your delta connected, it is your Z c, Z b, and Z a. So, star delta sample that we have shown at DC circuit there, it was resistance here it is impedance right. And here also a, b, and c all are mass. So, this is delta connected load.

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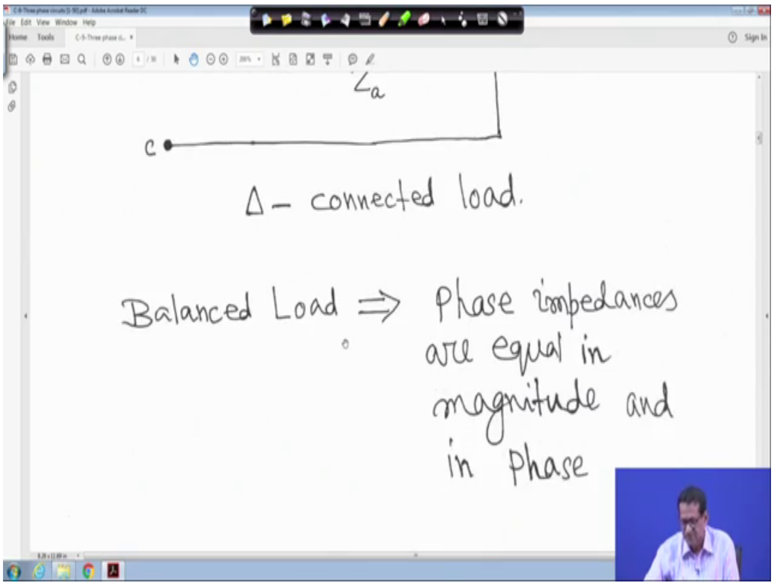

Now, for balanced load phase impedance are equal in magnitude and in phase right that means, your Z 1, Z 2, Z 3 are in this same magnitude and same angle right, then it is balanced.

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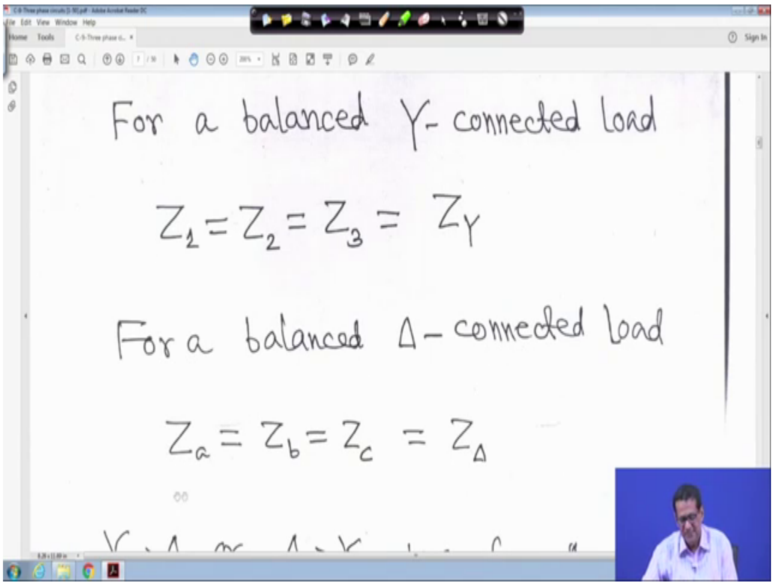

Similarly for here, so that means that for a balanced star connected load say Z 1 is equal to Z 2 is equal to Z 3 is equal to Z Y that is Z star right, we call Z Y. For a balanced delta connected load Z a will be is equal to Z b is equal to Z c is equal to Z delta equal. We will consider only balanced thing.

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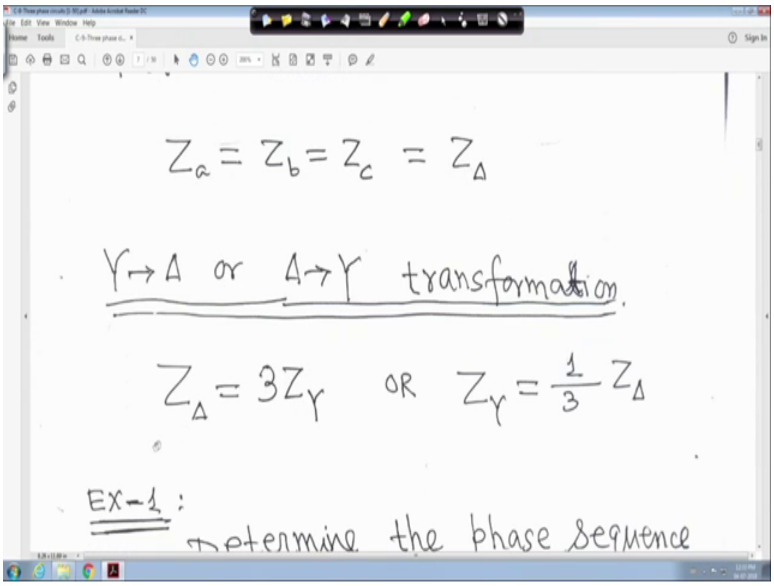

And star delta transformation or delta Y transformation. The way we have made it for DC circuit, same way we do it; you will get Z if Z delta is will be 3 Z Y right or Z Y will be 1 by 3 Z delta same way you do it, you will get it right. So, I am not doing further, because means every things are being done for DC circuit the same thing that probably there will be resistance, here it is impedance right.

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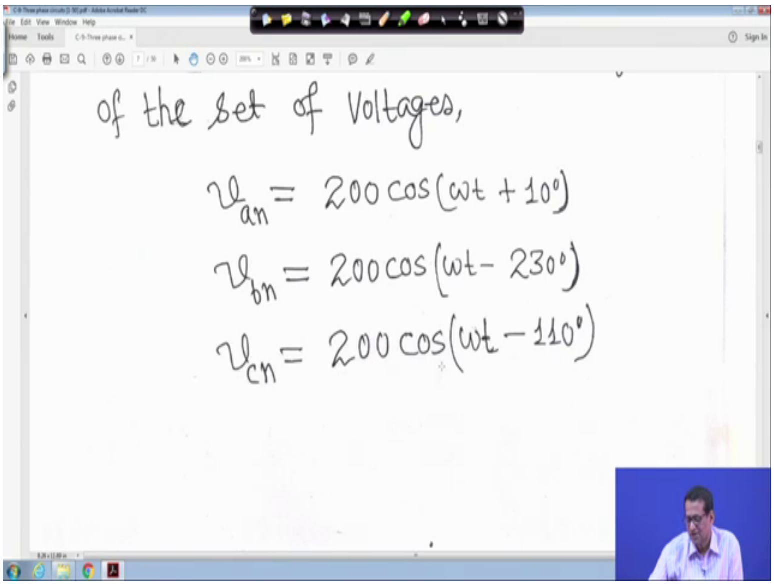

Take a small example, determine the phase sequence of the set voltages, V a n is given 200 cos omega t plus 10 degree, V b n 200 cos omega t minus 230 degree, and V c n 200 cos omega t minus 110 degree 110 degree right.

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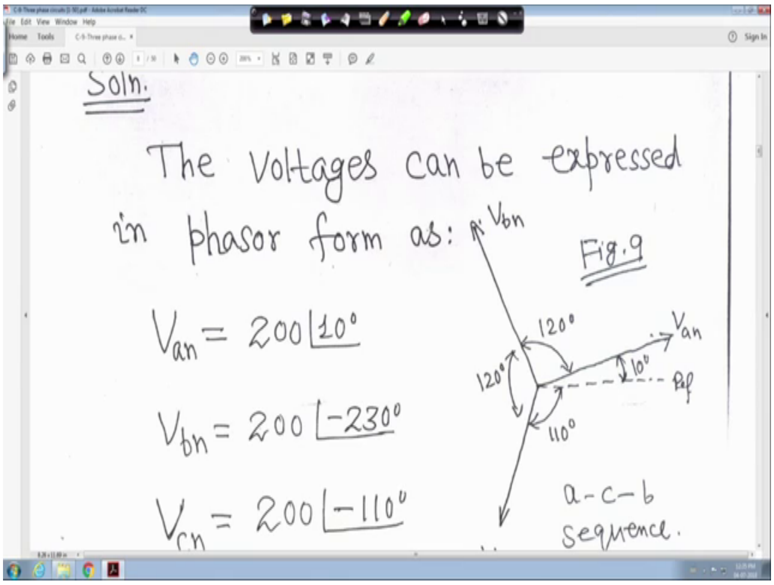

So, if you draw the phasor diagram right, suppose this is your reference point. So, V a n is equal to your 200 angle 10 degree right, it is given your 200 angle 10 degree or whether this cosine also basically nothing but your sin delta right. So, this is sin 90 degree minus theta cos theta or cos 90 degree minus theta sin theta, there should not be any confuse right.

So, here it is your reference line. So, V a n if you got 10 degree, and with respect to that if you draw the reference V b n in 110 degree, because it is your what we call sorry V c n is given 110 degree, and V b n is minus 230 degree. And this is with respect to reference this is if we see this is your 100 your, so this is your I mean this one is this one is your with respect to this is your 230 degree right from with reference.

Now, if you see the if you see the angle between a, b, and c, so angle between V a n and V b n 110 angle 120 degree, this angle is 120 degree right. Now, if you look in to your, what you call this c and b, you will get 120 degree here also between b c 120 degree that means, your sequence is a-c-b right. So, this phase sequence is your a-c-b sequence right. This is whenever apart from zero 120 if it is given like this, you take a reference you take a reference, after that you please draw the phasor diagram, then you will get it this is a-c-b sequence.

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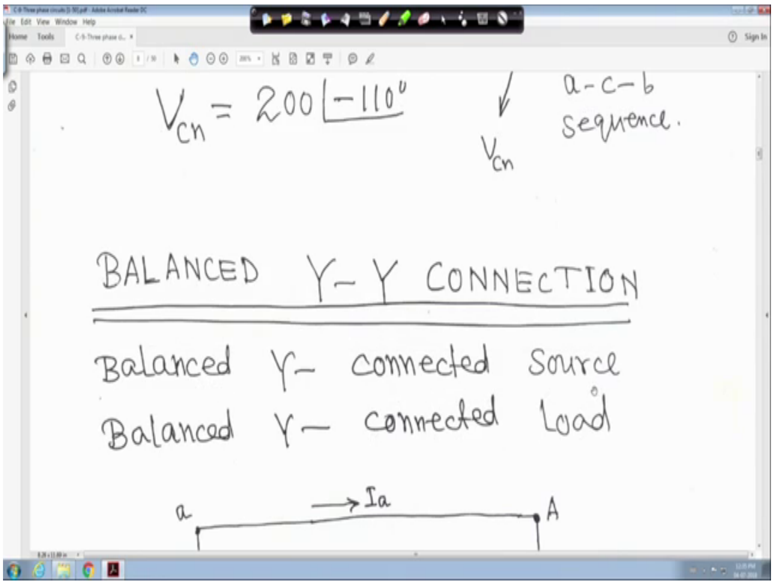

Now, balanced star connection; balanced star connected source and balanced star connected load. When source is rather I mean, we will do how this source balance from it if unbalanced anything is there, I will tell you it is balanced one. So, balanced star connected source and star connected load.

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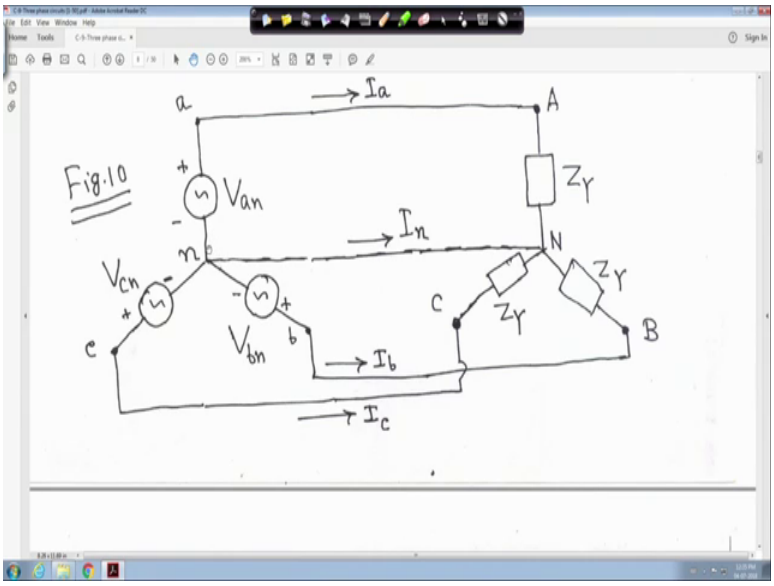

Suppose, this is my star connected source and this is my star connected load right. Here also neutral is there and this two are say connected, you know elements are connected here. And current is the neutral that is I n right. And this is your V a n, V b n, and V c n.

This is given and this is Z Y, Z Y, Z Y right. This is small a, b, c, this is capital A, B, C. This is the source, and this is the star connected load, because in three-phase right and current through this it is I a, this I b, and I c is neutral. This is neutral connected current flowing through (Refer Time: 21:25) I n right. So, if you now this is this is the flow, this is the circuit right.

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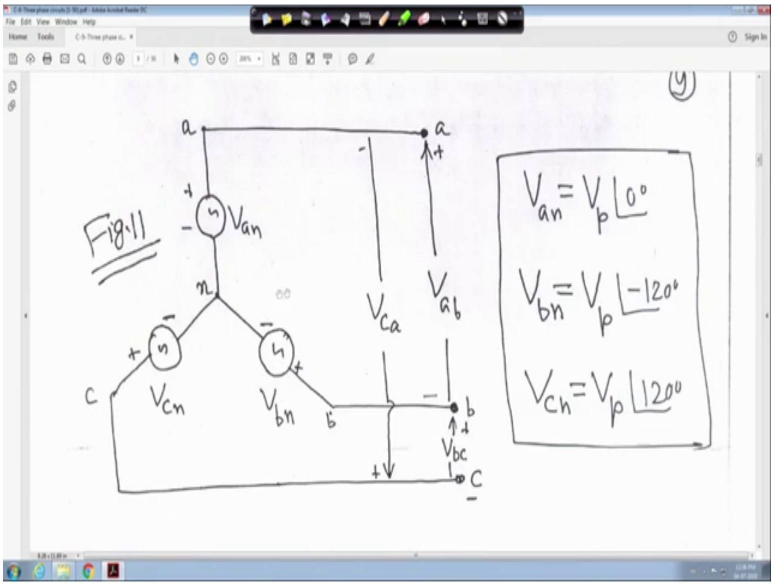

So, now this one you just if you draw only the source side, this is figure 11 if you draw only the source side, this side only right. So, I am not showing a neutral or anything. First let us see the source side no neutral nothing is shown, but that this wire nothing is shown only V a n is here. So, the way I told V a b, a is positive or negative, V b c and V c a right. So, it will be your, what we call that is a, b, c is gone right a, b, c is gone. So, V a n your is equal to V p angle 0 degree, it is balanced V b n is equal to V c angle minus (Refer Time: 22:15) a-b-c sequence. And V c n is equal to V p angle 120 degree right. And this is this is your a n that means, your this voltage. Suppose, if we make like this is my V a n, this is my V b n, this is my V c n.

Now, if you apply k v l if you apply k v l like this if you apply k v l like this right in this in this place if you apply k v l, it will be V a b moving like this plus (Refer Time: 22:44) right instantaneous polarity must be V a b plus V b n minus V a n is equal to 0 right that means, my V a b is equal to V a n minus V b n right. This that V a b is equal to V a n minus V b n that means, your what we call this voltage a to b, we call line to line voltage.

Because, this is line this is your, this is line, so this is also line, so that will be line to line voltage right. And when you call van V b n, V c n, it is line to neutral that is a phase voltage, and this called line to line voltage V a b, V b c, V c a. Similarly, other two (Refer Time: 23:34), you can apply the k v l.

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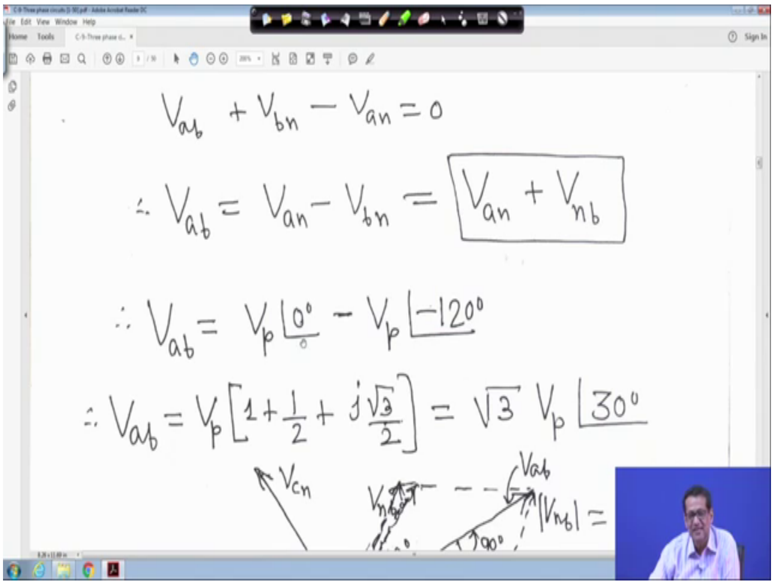

So, so in this case your the whole what I wrote that V a b is equal to V a n minus V b n. So, this one the V b n that V b n is equal to you can write here what we call minus V n b right. Just you obtain the here what we call that what we call n to b right, it is V b n you can write minus V n b that is why, this is V b n is equal to minus V n b that means, positive right. I mean suppose if your phasor if your voltage you say V b n in this side, suppose this is the point. If you want to know V n b, it will be your V n b that is opposite one (Refer Time: 24:18) in the set right, so that is why it is a written plus V n b.

Let me write right, so that means now my V a n is equal to you know V p angle 0 degree. And minus V b n, you know minus V p angle minus 120 degree here we are substituting. If you do so that means, V a b will be V p that means, angle 0 means cos 0, and this one minus of your cos 120 minus j sin 120 degree right. If you do so, it will become 1 plus half plus j root 3 by 2. And if you take your simplify, it you it will become a root 3 into V p angle 30 degree right.

So, V a b is equal to root 3 in to V p that means, V p is the phase voltage and V a b is the line voltage. So, line voltage means is equal to root 3 times phase voltage angle 30 degree. Now, if you look in to this phasor diagram, suppose there is there is very simple it is just a minute only understanding you require. Suppose, this is my V a n, this is my V b n, this is my V c n, so this is 120 degree apart, so this is V b n.

So, if you make 180 degree other side, this is my V n b, this is my V n b. whatever I told you just this is my V n b and their magnitude V n b actually magnitude V n b is equal to V p, V n also V p and V b n also magnitude V p right this is magnitude whether you get this direction or that direction in material. So, magnitude is V p. So, this is this shows the; that means, this voltage magnitude is V p and this one is parallel to this will write here this is also V p right, so that is why it is drawn it here dash line it is shown. So, in now you clear it.

So, this angle is your what we call now whenever you draw this parallel let this results and into one this will be your V a b whatever you have got it here this will be V ab. So, V a b is equal to van plus your V n b we should know V a b is equal to V a n plus V n b right. So, this here that is why here we have made it low, here we made it V a n plus V n b here.

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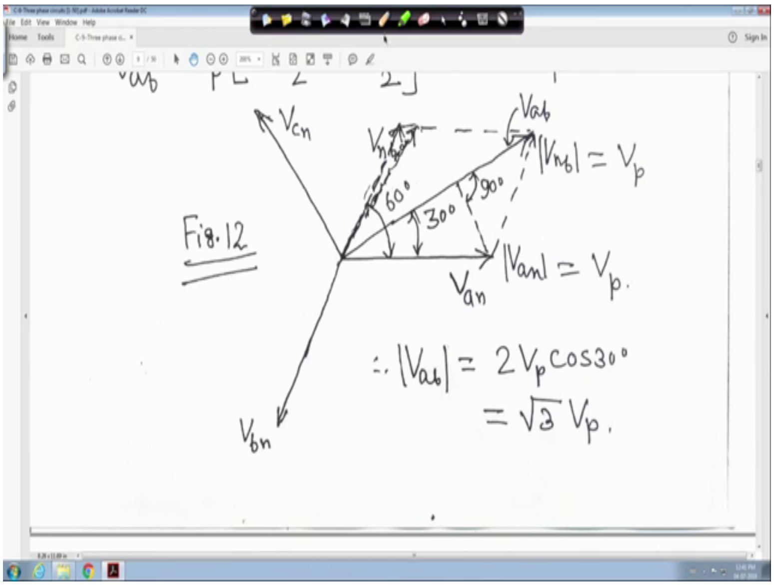

So, that means if you now if you now take the projection of this one, because this is V p, this is V p. So, basically it will be V p cos this angle is 30 degree right; so, V p cos 30 and this is also 30 degree. So, V p cos 30, it will be 2 V p cos 30 with this from here to here V p cos 30, from here to here also V p cos 30. So, it will be 2 V p cos 30 that is magnitude of V a b will be root 3 V p and this angle is your 30 degree right. That means, so whatever we did just now so that means, that line to line voltage magnitude will be root 3 time phase voltage magnitude.

Similarly, for this V c n we get similarly ultimate 120 degree phase shift right. Then if it is V a b like this, then V b c will come here V b c will come here because this angle to this angle, it is 120 degree. So, V b c lagging from V a n by 90 degree because this angle is 90 degree right. So, that means, whatever you did here that your V a b, V a b is equal to root 3 V p angle 30 degree, this is using this phasor relationship and this is from the phasor diagram is rotor c right. So, all angle all angle say between mark right. So, so all angle here it is 60 degree is marked. So, this is your 30 degree this is understandable from simple geometry, this is understandable.

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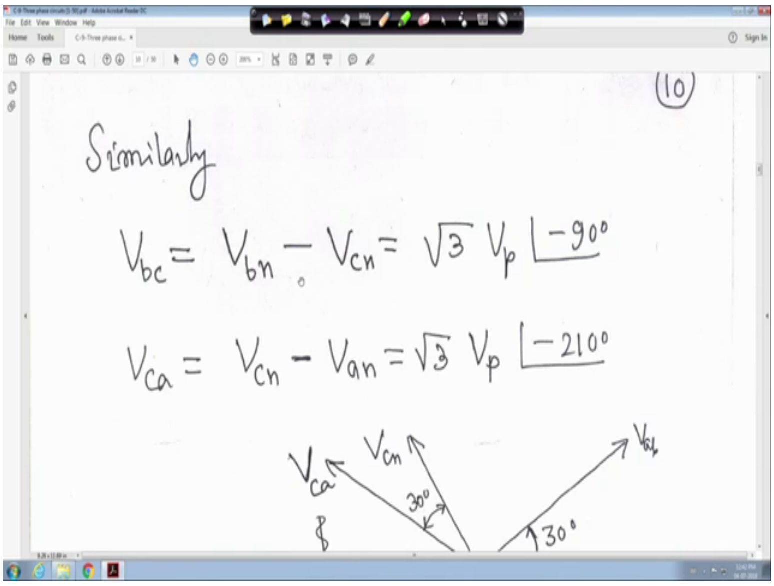

So, similarly V b c also you will get V b n minus V c n root 3 V p angle minus 90 degree. If you do so, same way you will get it. Similarly V c a is equal to V c n minus V a n, you will get root 3 V p angle minus 210 degree. You just do it, you will get it. One I showed it for you, one I showed it for you other you follow it and do the same thing the simple thing.

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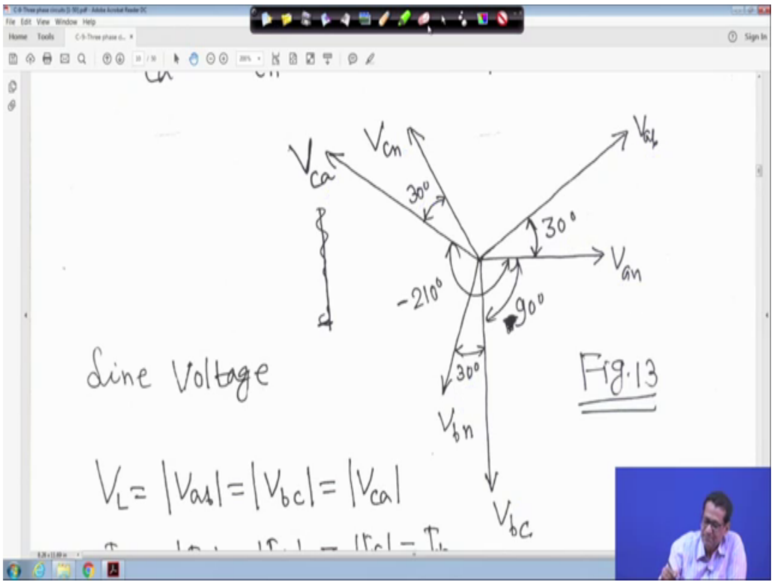

Now, if you draw the complete phasor diagram now your phase voltage and line voltage now look into this your right. So, I told you that V a b, V b c that this V c a, their phase difference will be 120 degree right, but the so that is why this is V a b, this is V b c, this is V ca. So, ab to bc if it is 120 degree then vc to ca it is 120 degree and ca to ab it is 120 here what we call 120 degree right. So, now, that V a n see here what we call and V b c angle between V b c and V a n, it is 90 degree right and all angles are marked right. And angle between V b n and V b c, it is your 30 degree again and angle between V c a will be 30 degree.

So, ab and an, if you look ab and an 30 degree. If you look bc and bn, 30 degree. And if you look ca and cn, it is 30 degree right. So, same figure appearing V a b will reduce V a n by 30 degree. V b n your what we call your v your V b c leading to V b n by 30 degree; and similarly your V c a leading V c n by 30 degree right. So, just you superimpose and just draw the phasor diagram. So, this is line to line voltage, and this is your line to neutral we call phase voltage. And line to line voltage is equal to root 3 times the phase voltage right.

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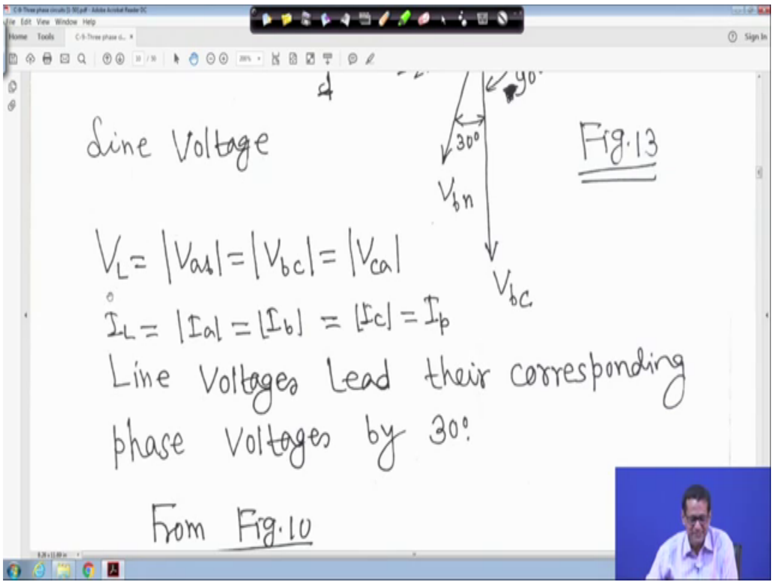

So, line voltages sometimes V L sometimes you call sometimes you write V L line to line voltage some volt they may write V LL line to line voltage it is correct right. But here we have made it your, what we call your V L is equal to magnitude of V b magnitude of V b c all are same magnitude of (Refer Time: 30:00) it is balanced. Similarly, line to line current I L is equal to I a, I b, I c magnitude is equal to phase current. Why line current, for this phase line current is equal to phase current why.

The question is that it is star connected load and star connected your, we will come to this diagram. The star connected load and star connected source right. So, this is this current is going through the line we call line current. And this is your this side AN, BN, CN, this is the phase impedance of the star connected load. So, same current is going here, same current is going here, similarly for the similarly for I b also and similarly for I c also I L also. If you apply KCL, it will be I L plus I b plus I c plus I L is equal to I L right. So, same current is flowing here. And this is the line current this is the current from here to here line a to A is the line, line to line, this small a to A is line, small b to B is line, small c to capital C, it is line, all these cases.

So, it is line current same current here is entering into this phase impedance A to N. So, that is why this line current is equal to your phase current both are same right. Hope this is understandable to you. When you will go through this also consult there is some good books or reference books are given right. So, in this case, so it is line current magnitude is equal to your write as a phase current here. So, line current is equal to phase current magnitude right and line voltage is equal to v square magnitude V a b V b c V c a, so they are all same. And line magnitude of L line current is equal to magnitude I a, I b, I c is equal to the phase current I told you for star circuit line current is equal to phase current right. Now, line voltage is lead their corresponding phase voltages by 30 degree that also we can see from their phasor diagram right.

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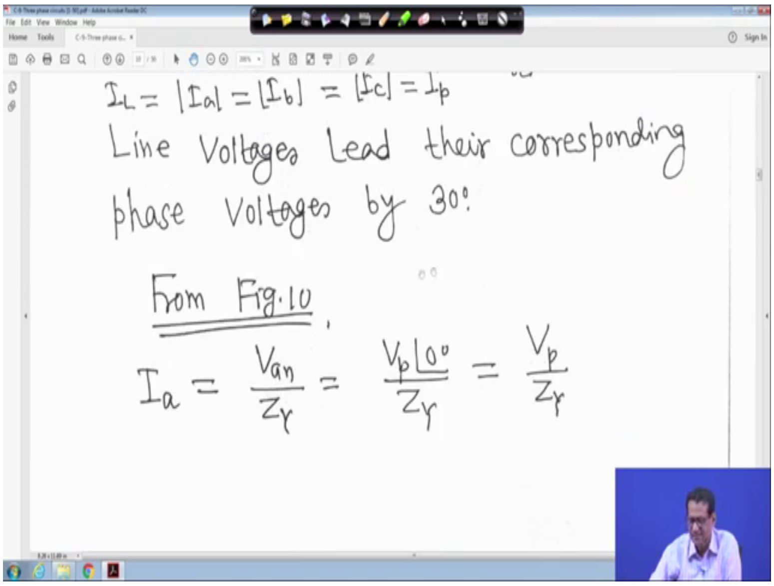

And from figure 10, that means your if you come to figure 10 here it is, from here it is right; that means, from figure 10 one I am writing others I will show. So, from figure 10, these current it is entering here I a. And voltage here it is V AN right that means, my I a is equal to my v an right divided by Z star that is Z Y this is my this is my your what we call V, because voltage here is a V AN. So, V AN upon V Z this V AN is equal to this V AN is equal to nothing is there, here which is simply r nothing is there is equal to your C small an this one, this voltage it becomes because no element is connected here. So, V AN is equal to this V an, that this one you can write van by Z star Z Y right. Similarly, for I b and I c so, will go back to that. So, here we are writing from figure 10 I a is equal to V a n upon Z Y I told you is equal to V a n is equal to V p angle 0 degree by Z Y is equal to V p upon z y right.

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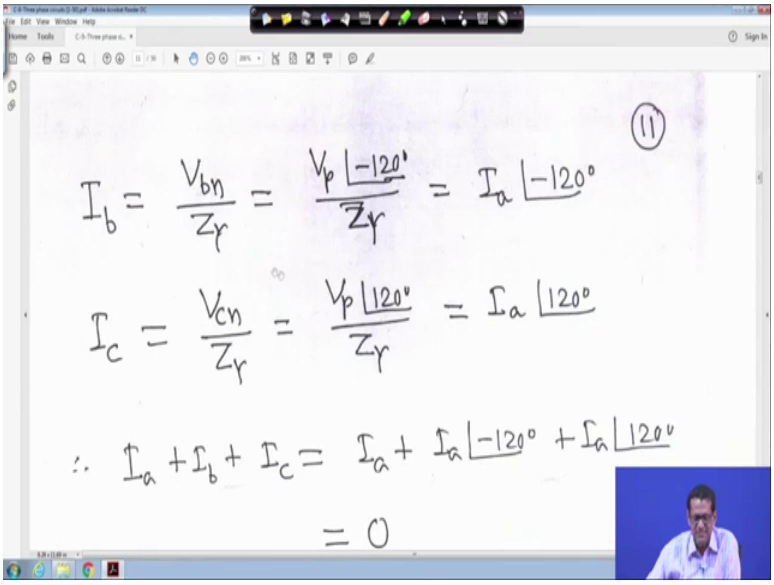

So, similarly I b is equal to V bn upon Z Y is eq[ual] V bn is equal to V p angle minus 120 degree divided by Z Y and V p upon Z Y is equal to in this V p upon Z Y is equal to I a right. So, this V p upon Z Y will be I a you put, so I b is equal to I a angle minus 120 degree. Similarly, I c is equal to V c upon Z Y is equal to angle 120 degree upon Z Y and V p upon Z Y is I a. So, I a angle 120 degree right. Therefore, I a plus I b plus I c is equal to I a plus I a angle minus 120 degree plus I a angle is equal to 0 right.

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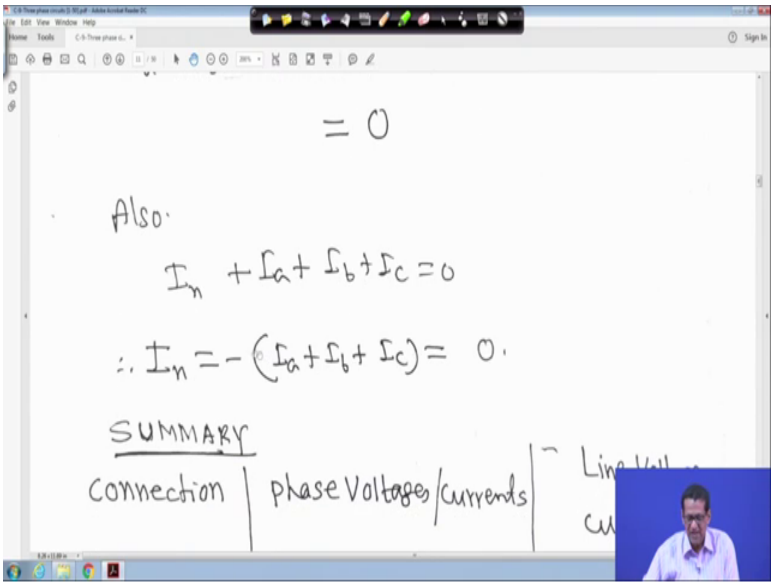

Also I n is equal to sorry if you apply KCL your what we call KCL, you will get in plus I a plus I b plus I c is equal to 0, but I a plus I b plus I c equal to 0. So, therefore, balance shift in is equal to 0, no current is flowing through the neutral right. So, this is the simple philosophy for three-phase circuit.

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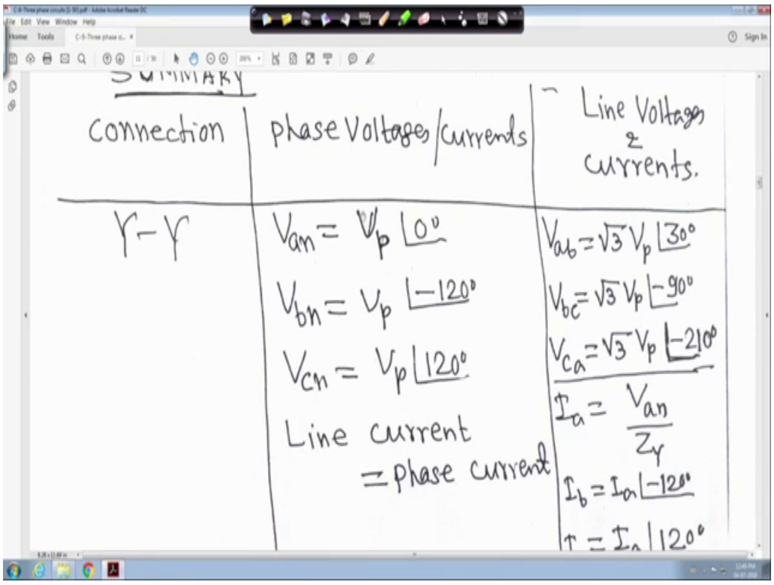

So, this is the summary. So, together the connection starts down star this phase voltage plus current given. So, this is the relationship whatever we had made for star star line current is equal to phase current, line voltage and current, V a b is given V b c is given this is the summary sorry. And I a, I b, I c are given. And this is also given right V a n, V b n, V c n. And for star star line current is equal to phase current right.

Thank you very much. We will be back again.