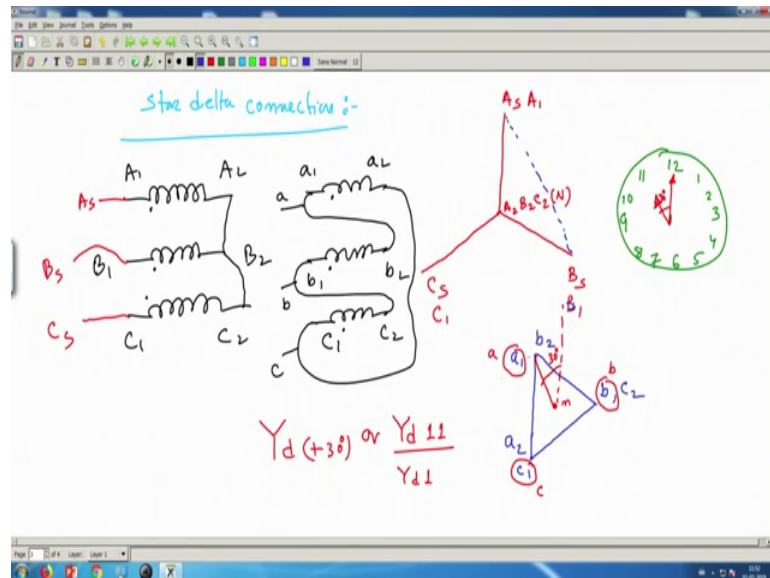


Electrical Machines - I
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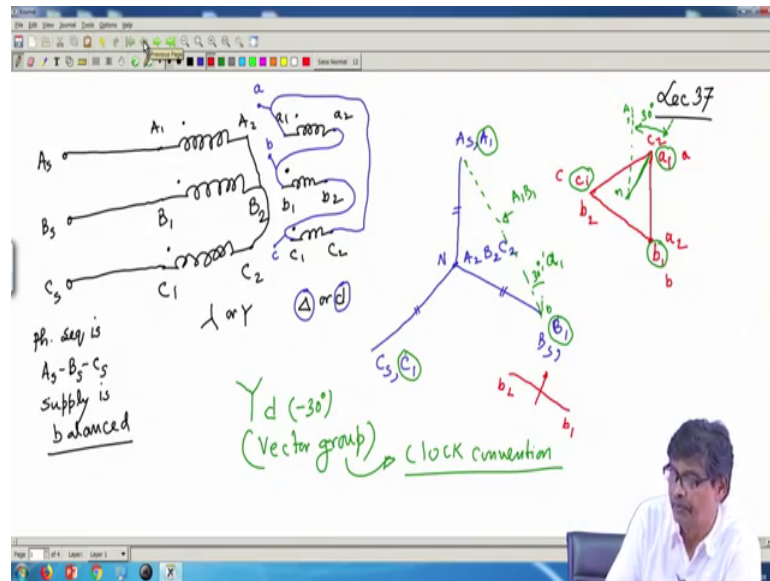
Lecture - 38
Vector Group (Contd.)

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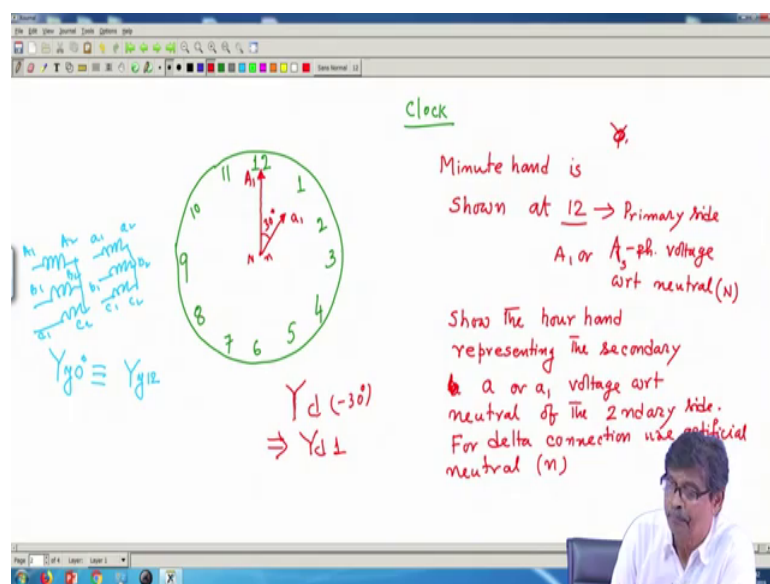


Welcome to lecture number 38 and you recall that we were discussing two connections Yd 11 and previously Yd 1 we have done and I hope you have got the idea what and do not forget that not only the phase voltages but also the line to line voltages suffer same degree of either lag or lead on both the sides.

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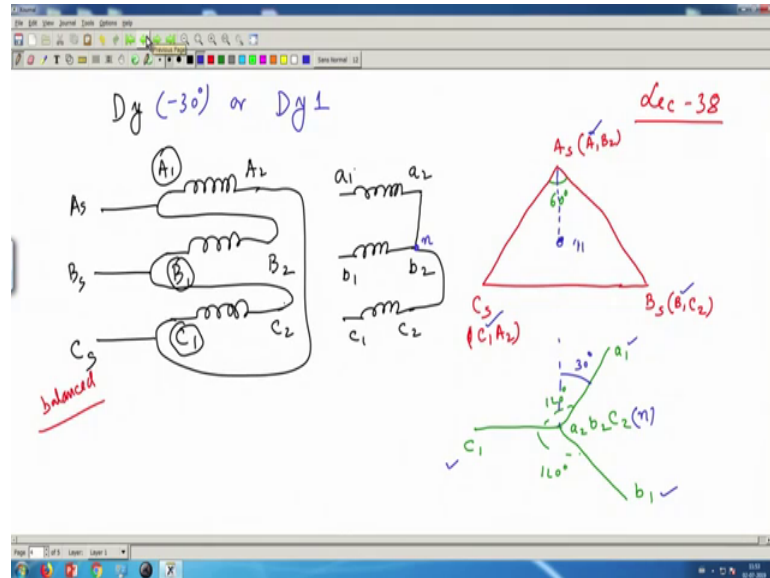


And then I have discussed about the clock this thing and we found that there are two connections possible; so, Yd 11 or Yd 1.

Mind you if somebody says the connection is Yd 3, no you cannot realize it because these such voltages are not available you must understand this point is not. It so happens that 30 degree phase displacement only possible with star delta connections. Therefore, anything you cannot get means Yd 2 somebody says I have connected the transformer

this is ridiculous, you cannot get it for a balanced 3 phase transformer this is just I point out. So, you should be very methodical in drawing this.

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Now, let us connect the same way, but now rather quickly these connections say D y I would like to connect. I am not telling mentioning the vector group yet suppose and, but I know there are two correct ways of connecting delta. So, primary I have to connect delta secondary star and two ways of connecting star. So, suppose I say that two valid delta connections are there. So, A 1 A 2, this is the primaries B 1 B 2 and this is C 1 C 2 and one of the valid connection is go this way that is first let me try.

So, this is the primary connection I will do and obviously, from A 1 B 1 that is the convention I am following C 1 I will take the output, and not output I will connect my source As Bs and Cs this is what I will do and secondary small a 1 a 2 small c 1 c 2. See I have taken a given input as if a 1 b 1 c 1. So, I would like to have outputs taken from a 1 b 1 c 1 on the secondary side. So, suppose I shorted star connections.

Now, what I will be doing I have to draw the primary voltage phasors, voltage is coming across each winding, and as I told you to begin with you better draw supply voltage is balanced and phase sequence abc balanced. So, what you do is this, you draw this vector diagram that primary vector as this primary side is delta connected draw it like this with this is as line to line voltage I am drawing Bs and Cs is not A. This is the balance 3 phase voltage what else AB BC CA they are 120 degree apart.

Now, A s is connected to A 1 and B 2. So, I write here this point is A 1 B 2 either of them or together same point As is connected to A 1 and B 2 similarly Bs is connected to B 1 and C 2. So, this point is same as B 1 and B 2 no C 2 capital and Cs as you can see it is connected to C 1 and A 2 same Cs is nothing, but C 1 and A 2 is not? This is the thing [FL] what is the voltage applied across the primary of the transformer A? A 1 A 2 where is A 1 A 2? This is A 1 this is A 2.

So, on the secondary side this voltage will be if I use a different color it is parallel to this line is not parallel to this line and I will write it here A 1 A 2 got the point. Similarly B 1 B 2 voltage applied across the primary of the b transformer is b 1 b 2 where is b 1 where is b 2 oh this is b 1 this is b two. So, parallel to this small b 1 b 2 will exist and not only that I have joined b 2 with a 2. So, bring this line parallel and it will be here b 2 b 1 not b 2 b 1 parallel to this. So, this angle will be 120 degree apart. Mind you all these angles are 60 degree, I hope you understand that geometry which I am not going. And finally, voltage applied to the primary of the c transformer is c 1 c 2 therefore secondary induced voltage will be parallel to this c 1 c 2 line and c 2 I have joined. So, C 1 left C 2 like this all angles are 120 degree I think you understand that this is the thing

Now, if you choose a connection you get it in this way and your now I have to decide what is the vector group of this connection primary delta d secondary star y I want to know what is the what is the vector group. So, what I will be doing? I will identify on the delta side there is no neutral small neutral that is artificial neutral or centroid of the triangle. So, this is the and I will mark A 1 A 1 B 1 C 1 this is where I will follow the convention, I have connected supply similarly this is my output this is of course, obvious in this case no problem.

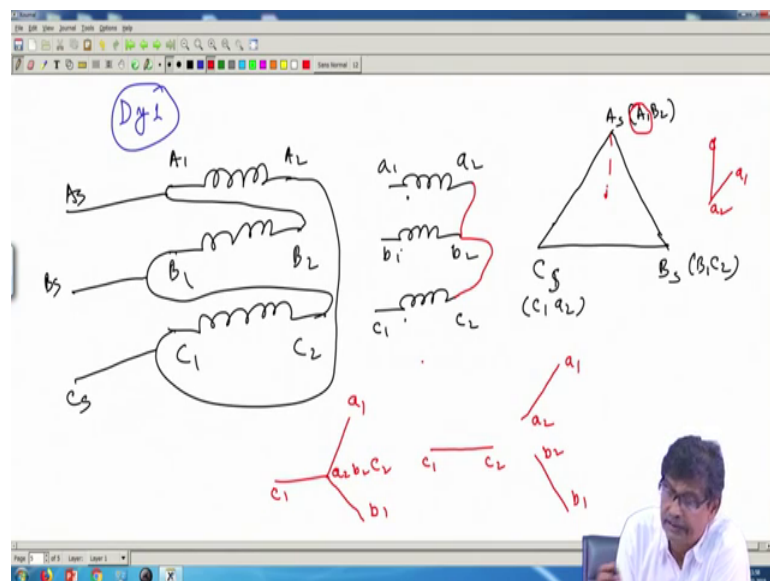
Now, the a phase voltage of the primary side is this vertical line with respect to neutral. This is the secondary neutral it exists this point this is secondary neutral. Now this a phase voltage if you draw a this a phase voltage of the primary is this vertical line. So, this is 30 degree it will be 30 degrees and therefore, I will say that it is Yd secondary voltage lagging the primary voltage with respect to neutral by that I could write it minus 30 degree or you could write D y what should be the time? 12 and this is 1. So, 1 got the point that is in terms of clock convention because your this thing it is here a phase voltage it is there.

Therefore this is how you and also do not forget that line to line voltage here that way also one can do that line to line voltage of the primary side is $A_1 B_1$ what is the line to line voltage of the secondary side it is this one. So, this was this once again can be shown to be equal to 30 degree that is what you must understand.

Therefore both the line to line voltages and phase to neutral voltages, will suffer the same change star delta connection ok. I will just the other connection you can try delta this way that you decide and you will soon discover that that will be $Yd 1$ that I am not repeating, but what I will say to you is this one. The same connection I will do in a slightly different fashion just to make you understand suppose see in this connection when I did, what I have done? I just told connect Dy , I did not specify the phase angle difference this to begin with I did not know what it is. It looks like as if I have connected first then told oh you have connected this is this phase group.

But suppose I want to connect $Dy 1$ oh sorry.

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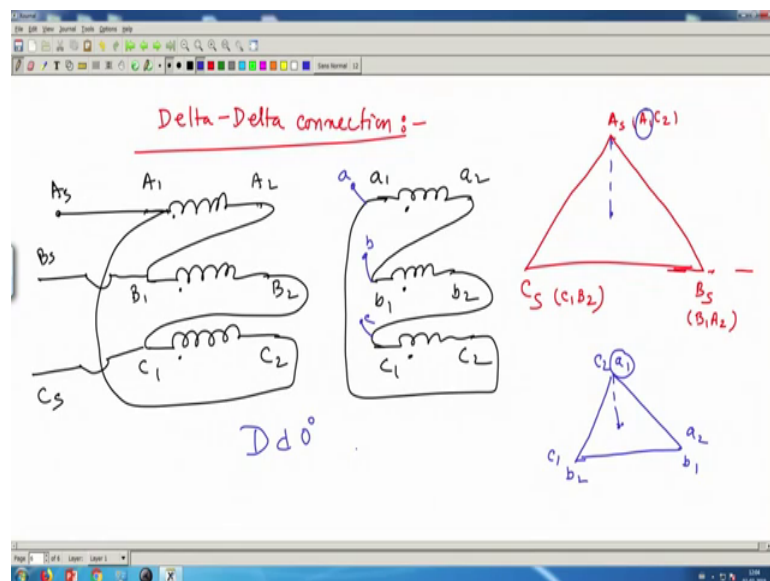
Suppose I now say that connect $Dy 1$ the connection I know now. The point I want to make it is interesting you see this is the 3 transformers you have $A_1 A_2$, this is $B_1 B_2$ and this is $C_1 C_2$ good and this is secondary small $a_1 a_2$ one terminals are dot terminals which I am not writing all the time $b_1 b_2, c_1 c_2$ fine. Then what I am telling you connect this as delta like this for example, same thing I am doing I mean do not worry this is A_s this is supply B_s and this is supply C_s .

Now, after you energize this what I am telling. This is your supply voltages because supply voltage I know it is balanced. So, I will write A_s , draw this triangle 60 degree equilateral triangle C_s and then say that A_s is nothing but $A_1 B_2$ etcetera $A_1 B_2$ and B_s is $B_1 C_2$ and C_s this is C_s ; C_s is $c_1 a_2$ and suppose secondary I have not connected that is what I am telling I want to achieve this one connection. But what I know is this that I have now in the secondary these phasors available to me what is that? Small $a_1 a_2$ this is available then this voltage is available, $c_1 c_2$ and $b_1 b_2$. Why I have shown them in isolation? Because I have not connected yet I do not know, but since you want to connect Dy_1 what you would like to have? Your A_1 voltage with respect to neutral here that is this voltage, secondary a_1 voltage small a_1 must be I mean that way that is in the twelve o'clock if this is your primary you have you would like to have small $a_1 a_2$ here

So, this indicates that you better join $a_2 b_2 c_2$ I mean you ponder over this think these are very interesting. So, such that this will be this way and then say I have joined that is in effect what I am telling, it is not that these connections are arbitrary you can I can tell you make this connection. Then the question is whether delta should be connected this way or delta should be connected that way, connect it and try to get this one achieve this. So, I have practice on this I think I have made things clearer now.

So, this is the better group, similarly you can have last connection here is delta delta connection star star connection is so, simple.

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This I will just mention delta delta connection ok. So, delta delta connection means. See I have not yet told you which connection to use at in what application? I am simply now getting acquainted with you what are the possible things you can do 3 phase means star delta connection it looks like ok. 3 phase transformer, 3 coils there, 3 coils there either of them you connect I am just telling you how to get the correct connections with confidence. So, that is the idea of this lecture.

So, here also I say this is A 1 A 2, this is B 1 B 2 what are the vector group possible here that is what I am examining with delta delta connection and these this is the secondary. Here I will not take much time because you are now used to it small b 1 b 2 and this is small c 1 c 2 proper delta I have to connect. So, these are dots. So, connected this is one of the proper way of connecting and I will give supply connect supply here As to B 1 Bs and to this junction Cs ok.

Now, suppose there also there are only two possibilities here this way you connect secondary you connect also this way same way. Let us see what vector group it results into because of this connection proper delta connection correct [FL].

Now, once again delta connection. So, better draw the primary voltages line to line voltages first because there is no neutral that is why I start with line to line voltage and it is the 3 phase it has nothing to do with transformer this is the supply voltages which are available here you know? Line to line voltages are also balanced As Bs Bs Cs voltage lags by 120 degree you know this and Cs As voltage for the lags by 120 degree ok. I am not putting the arrows that is understood As Bs Cs like this.

And then what is the next step oh as you have connected to capital A 1 and C 2. So, capital A 1 C 2 Bs I have connected to B 1 and A 2. So, B 1 A 2 same potential because of this connection Cs is connected to C 1 B 2 C 1 B 2 is not? This will be the thing secondary voltages a 1 a 2 will be parallel to this line. So, a 1 a 2 b 1 b 2 will be parallel to this line correct or not b 1 b 2 will be parallel. So, b 1 b 2 I will put it here bring it down so, but b 1 is connected to a two.

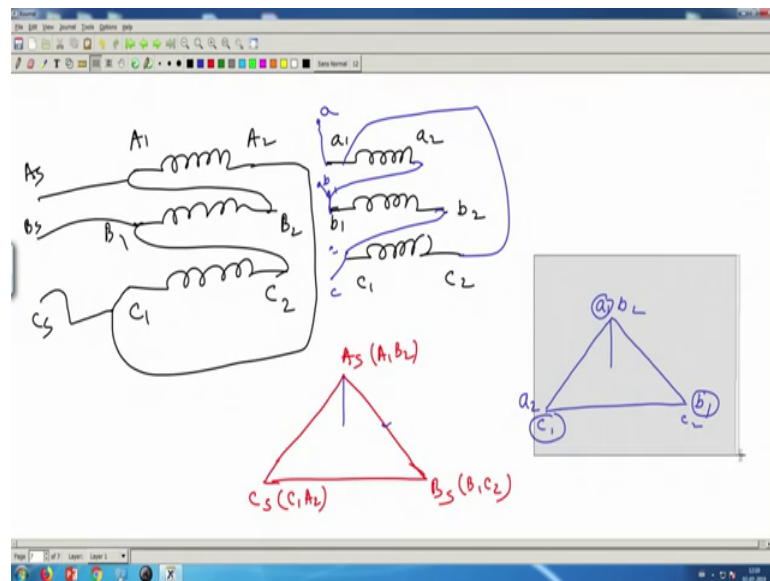
So, b 1 must be placed here b 1 b 2 and finally, you know you bring this c 1 c 2 you get this in triangle where from I will take output to be consistent from a 1 this I will call a, this will call b, this I will call c and this will be the thing what do you think. So, primary is delta, secondary is also delta small letter and what is the phase angle difference; 0

degree because here also no neutral exist, but anyway with respect to artificial. This is vertical line here also this a phase A phase mind you that is also parallel. So, time is 12 that is; so, D d.

Student: 12.

12 or 0 degree whatever you call it.

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Now, the same primary connection if I make say this is A 1 A 2 this is small a 1 a 2 I mean same thing I am drawing you also draw so, that you get used to it I mean small c 1 c 2 and suppose primary I have connected like this as I have told you delta and these are from the junctions supply As supply Bs and supply Cs this is known and secondary I will now connect not this way, but other way these are the only 2 possible delta connections. So, suppose the this I have connected like this and I will take output from these junctions small a going to load from b ones going to b and from c 1 going to c of the supplying load.

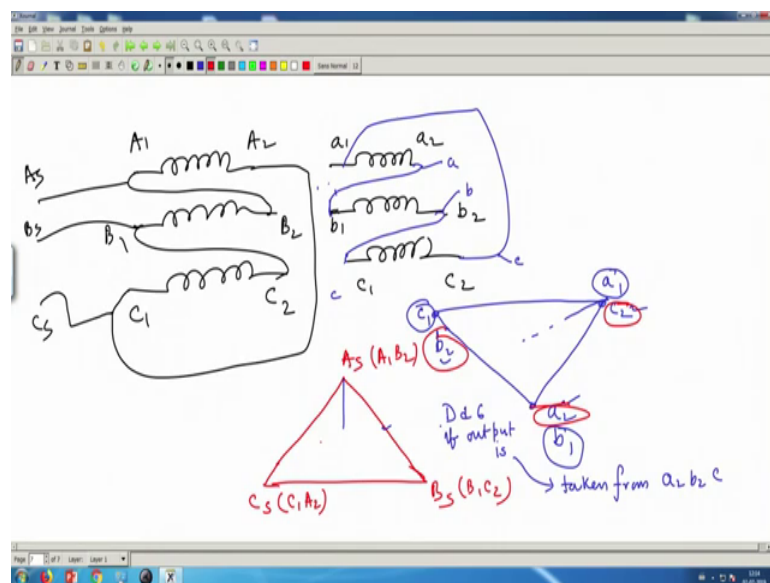
Now, here it is. So, so what should I do? Delta connection draw supply As Bs Cs what is As? A 1 B 2 we have done it A 1 B 2 what is Bs? B 1 C 2 and what is Cs? Cs is C 1 A 2 C 1 A 2 like that. So, A phase voltage secondary voltage A 1 A 2 phasor will be parallel to this line B phase voltage phasor will be parallel to this line with this side small b 1 that side b 2 and C phase voltage.

So, let me start with the a phase voltage, this will be small a 1 a 2 parallel to this is not b phase voltage b 1 b 2 and b 2 is b 1 b 2 is where this 1 b 1 we drawn correctly this? Wrong sorry there is a mistake here see a 1 a 2 is here have I made a 1 a two. So, I a a 1 a 2 here I should draw like this correct or not small a 1 small a 2 parallel small a 1 small a 2 b 1 b 2 is here. So, that is parallel to this, but b 2 is joined with a 1 b 2 where is b 2. So, b 2 is joined with a 1 b b 2 phasor is this; so, b 2 b 1

And finally, I think I have done the same connection is it looks like same thing. So, it will be d d 0 same thing I have done. So, let me change it. So, it will be once again d 2 by mistake I have done it c 2 c 1. So, once again a 1 b 1 c 1 and this is d d 0. See there is no difference between this connection and the previous connection a 2 like that here also these. So, that is why no variety is obtained. I what I intended to do let me correct that. So, anyway this is done.

So, let me do it like this. So, that you understand because this I have already done what I wanted to do is, I will make another valid delta connection, but this way got the point. So, it will be like this, then you say this is a, this is your b got the point I actually did same thing and this is your c. So, in this case then the phasor diagram will be like this, what will be the phasor diagram now? On the secondary side voltage a 1 a 2 here also it will be a 1 a 2 is not this is the thing.

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Now, then or I did once again same. Now b_1 b_2 and parallel to this line, but b_1 is connected to a_2 is not? So, it will be like this b_1 b_2 and finally, c_1 c_2 like this and c_1 is connected to b_2 . So, it will be like this now it is correct c_1 c_2 got the point?

So, in this case if you do then people say that this is a Dd 0 connections sort of. Why I am telling people say I will take output from a_2 b_2 c_2 if I take it is indeed Dd 0, got the point?

Student: (Refer Time: 30:15).

See in this particular case it is like suppose I say that you take the output from a_2 b_2 c_2 then it will appear as a.

Student: 180.

Dd 180 or Dd 6 connection. If output is taken from a_2 b_2 c_2 instead of this one that is you take the output from say this you say a this you say b this you say c in this case you compromise a bit and not that much a 1 for example, yy 6 star star 6 connection what you do? You have to take output from a_2 b_2 c_2 a_1 b_1 c_1 shorted, but nonetheless the phase sequence is maintained and things like that. So, this is the I will circulate with red a_2 b_2 and where is c_2 c_2 a_2 b_2 180 degree apart. Therefore, you see there are various ways of connecting the windings delta star, delta delta, star delta, star star and so, on.

Now, in my next lecture what I am going to tell you is about a transformer which is a 3 phase unit, it is built as a 3 phase transformer at least some little bit of constructional features of course, the connections here I have mentioned I started with threes identical transformers these connections things will be equally valid as we will see, if there is a 3 phase transformer as a single unit. So, we will do that in the next class.

Thank you.