

Basic Electric Circuits
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Module 10 - Sinusoidal Steady State Analysis 2
Lecture 47 - Balanced Three phase connections

Namaskar, so in the last session we were discussing about the phase sequence of three phase circuit, so we will continue our discussion from that point onwards and let us see.

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The slide is titled "PHASE SEQUENCE OF THREE-PHASE VOLTAGES". It contains a bullet point: "Being three-phase voltages 120° out of phase with each other, there are two possible combinations." Below this is a phasor diagram with three vectors labeled V_{an} , V_{bn} , and V_{cn} originating from a common point. V_{an} is horizontal to the right. V_{bn} is at 120 degrees below the horizontal axis. V_{cn} is at 120 degrees above the horizontal axis. The angles between the vectors are marked as 120 degrees. Below the diagram is another bullet point: "First is the abc sequence or positive sequence shown in the above figure and expressed mathematically as:" followed by three equations: $V_{an} = V_p \angle 0^\circ$, $V_{bn} = V_p \angle -120^\circ$, and $V_{cn} = V_p \angle -240^\circ = V_p \angle 120^\circ$.

When we talk about the three-phase voltage source phase sequence we see there are two possible combination of phase sequencing.

In first sequence we discuss that we call it as *abc* or positive sequence where the reference voltage that is V_{an} is leading V_{bn} by 120 degree and V_{bn} is again leading V_{cn} and by 120 degree. So we can write,

$$V_{an} = V_p \angle 0^\circ$$

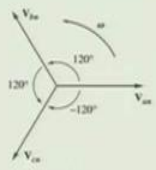
$$V_{bn} = V_p \angle -120^\circ$$

$$V_{cn} = V_p \angle -240^\circ = V_p \angle 120^\circ$$

In that case if you see *abc* sequence is rotating in counter clockwise and it is in the direction of the rotation of the rotor of the generator.

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• The second possible phase combination is *acb* sequence or *negative sequence* as shown in the figure below.



• This is expressed mathematically as.

$$\underline{V_{an}} = V_p \angle 0^\circ$$

$$\underline{V_{cn}} = V_p \angle -120^\circ$$

$$\underline{V_{bn}} = V_p \angle -240^\circ = V_p \angle 120^\circ$$

Now next possible combination is *acb* sequence which is called as a negative sequence, so in that case what happens that you are reference phasor that is $\underline{V_{an}}$ leads $\underline{V_{cn}}$ and $\underline{V_{cn}}$ leads $\underline{V_{bn}}$ by 120 degree, so what we write mathematically,

$$\underline{V_{an}} = V_p \angle 0^\circ$$

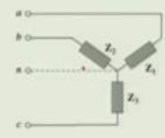
$$\underline{V_{cn}} = V_p \angle -120^\circ$$

$$\underline{V_{bn}} = V_p \angle -240^\circ = V_p \angle 120^\circ$$

So now in that case if you see the phase sequence *abc* will rotate in this direction which will be opposite to direction of the rotation of the rotor.

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- Like the generator connections, a three-phase load can be either wye-connected or delta-connected, depending on the end application.
- Figure below shows a wye-connected load.

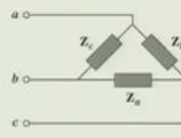


- The neutral line in the above figure may or may not be there, depending on whether the system is four- or three-wire.

Now like the generator connection which we discussed previously three phase load can also be either your wye connected or you can say star connected or delta connected and it depends upon what type of end application you have related to that particular load, so in the case wye connected you will have the loads components connected in star combination with neutral it may be available or may not be available it is not necessary that you will always have neutral physically present and reachable for connections, so here you might have three phase three wire system for the load or you can have three phase four wire system for the load.

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- Figure below shows a wye-connected load.



- A neutral line is topologically impossible for a delta connection.

Now next combination is delta connected, so this is basically the delta connected configuration. Here you will see abc are connected in triangular fashion and your phase ABC is taken out from the load and if you see this arrangement in this particular arrangement you cannot take the neutral connection out because it is topologically impossible to take the neutral connection from the delta connected load.

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- A wye- or delta-connected load is said to be unbalanced if the phase impedances are not equal in magnitude or out of phase.
- A balanced load is one in which the phase impedances are equal in magnitude and in phase.
- For a balanced wye-connected load,

$$\underline{Z}_1 = \underline{Z}_2 = \underline{Z}_3 = \underline{Z}_Y$$
- For a balanced delta-connected load,

$$\underline{Z}_a = \underline{Z}_b = \underline{Z}_c = \underline{Z}_\Delta$$
- We recall from our previous discussions that,

$$\underline{Z}_\Delta = 3\underline{Z}_Y \quad \text{or} \quad \underline{Z}_Y = \frac{1}{3}\underline{Z}_\Delta$$
- So we can say that a wye-connected load can be transformed into a delta connected load, or vice versa using Y- Δ transformation discussed earlier.

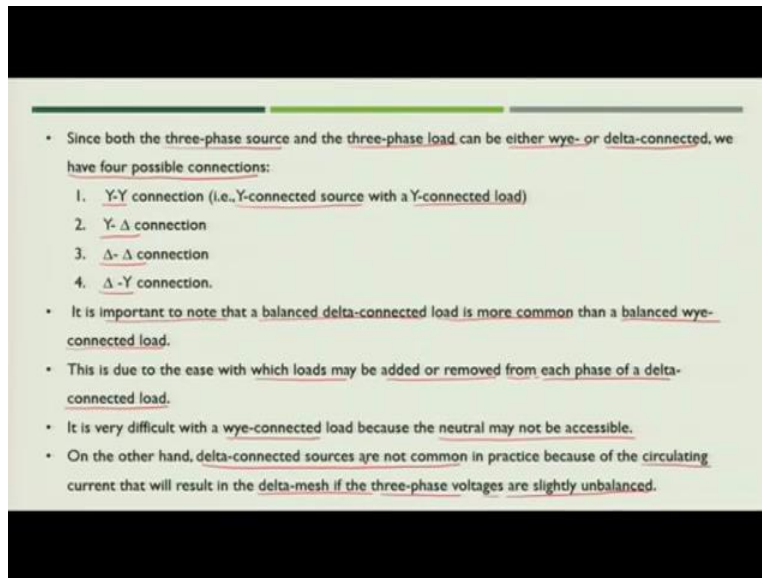
Now whether it is star connected or delta connected will say that if it is unbalanced then the phase impedance will not be equal, and the phase sequence will also be out of phase.

So, you will have the magnitude as well as phase both either of two will be out of phase or you can have magnitude as well as phase both out of phase, so when you say the load is balanced it means that phase impedances in all three legs of the load are equal and in phase, in phase means you will have equally connected with respect to phase. So, in case of balanced star connected or wye connected load you will have $\underline{Z}_1, \underline{Z}_2, \underline{Z}_3$ all same so you will have \underline{Z}_Y , so \underline{Z}_Y is nothing but a phasor quantity so you will see the magnitude as well as phase both are same in all the three legs.

In case of balanced delta connection you will have $\underline{Z}_a = \underline{Z}_b = \underline{Z}_c = \underline{Z}_\Delta$, so for star connected we will specify individual legs impedance as \underline{Z}_Y . In case of delta connected we will specify as \underline{Z}_Δ . Now we have already discuss the star delta transformation in our previous lecture, so taking reference of the star delta transformation we earlier proved in case of $\underline{Z}_\Delta = 3\underline{Z}_Y$ when you convert delta connected network into star connected network.

Similarly, $Z_Y = \frac{1}{3}Z_\Delta$ if you connect if you convert a star connected load into delta connected load, so we can say that the star connected or wye connected load can be transformed into delta connected load, or vice versa with the help of the star delta transformation which we discussed earlier.

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Now since you can have source and load both three phase connected in either star or delta connected fashion, so we can have now four possible combinations of the connections between source and load as,

1. Y-Y connection (i.e., Y-connected source with a Y-connected load)
2. Y- Δ connection
3. Δ - Δ connection
4. Δ -Y connection.

Now it is important to note here that the balanced delta connected load is more common in the network than the balanced Y connected load, because it is easy with the delta connected load that you can add or remove the load from each phase of the delta connected load.

It is difficult in case of wye connected or star connected because it is not always possible to have neutral, which is accessible from outside for the connection, so that is why the balanced delta connected load is more feasible for reconfiguring or taking any leg out or doing the changes in the delta connected load.

But on the other hand you will not see delta connected source as a common practice because if you have the delta connected source you will see the circulating current because delta will create a delta mesh which will cause a current to circulate within the delta network of the source and this will be because of any slight unbalance in the voltages of the three phases, so because of this you will have circulating current and this will cause the overheating of the coils of the generator, so that is why we generally avoid the delta connected source.

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EXAMPLE:

◆ Determine the phase sequence of the set of voltages $v_{an} = 200 \cos(\omega t + 10)$, $v_{bn} = 200 \cos(\omega t - 230)$, $v_{cn} = 200 \cos(\omega t - 110)$!

SOLUTION: We first convert the voltages to phasors as,

$$\mathbf{V}_{an} = 200 \angle 10^\circ, \mathbf{V}_{bn} = 200 \angle -230^\circ, \mathbf{V}_{cn} = 200 \angle -110^\circ$$

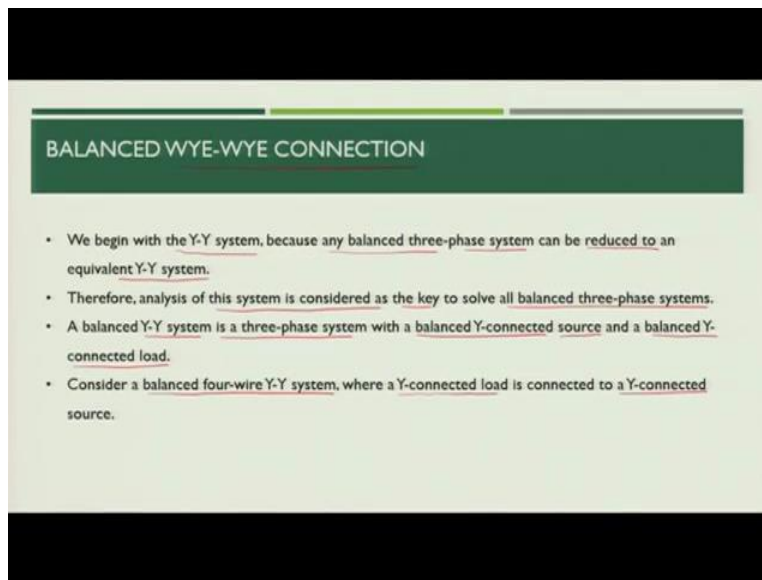
We notice that \mathbf{V}_{an} leads \mathbf{V}_{cn} by 120° and \mathbf{V}_{cn} in turn leads \mathbf{V}_{bn} by 120° .
Hence, we have an *acb* sequence.

Now let us take one example in which we need to determine the phase sequence of the set of voltages like $v_{an} = 200 \cos(\omega t + 10)$, $v_{bn} = 200 \cos(\omega t - 230)$, $v_{cn} = 200 \cos(\omega t - 110)$. What we have to do first, first we will convert it into phasors, so $\mathbf{V}_{an} = 200 \angle 10^\circ$, $\mathbf{V}_{bn} = 200 \angle -230^\circ$, $\mathbf{V}_{cn} = 200 \angle -110^\circ$

We notice that \mathbf{V}_{an} leads \mathbf{V}_{cn} by 120° and \mathbf{V}_{cn} in turn leads \mathbf{V}_{bn} by 120° .

Hence, we have an *acb* sequence.

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BALANCED WYE-WYE CONNECTION

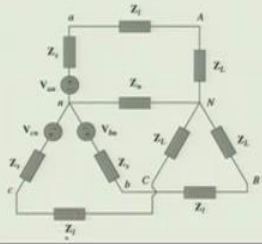
- We begin with the Y-Y system, because any balanced three-phase system can be reduced to an equivalent Y-Y system.
- Therefore, analysis of this system is considered as the key to solve all balanced three-phase systems.
- A balanced Y-Y system is a three-phase system with a balanced Y-connected source and a balanced Y-connected load.
- Consider a balanced four-wire Y-Y system, where a Y-connected load is connected to a Y-connected source.

Now let us talk about the connections we saw that there are first four possible combinations that is Y-Y, Y delta, delta-delta and delta-Y connections between source and load, so we will first start with Y-Y connection for the source and load, why we are starting with Y-Y connection because any balanced three phase system can be reduced to a Y-Y system with the help of star delta transformation, so therefore this system is considered as a key to solve the all balance three phase system.

Now a balanced three phase Y-Y system is a three phase system with a balance Y connected source and a balanced Y connected load. Now let us consider three phase four wire Y-Y connected system where star or Y connected load is connected to star connected source.

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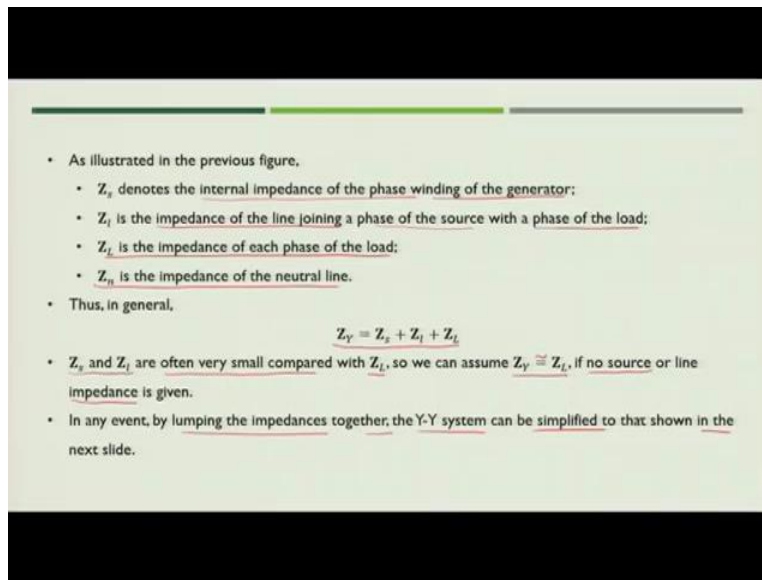
- We assume a balanced load so that load impedances are equal.
- Although the impedance Z_Y is the total load impedance per phase, it may also be regarded as the sum of the source impedance Z_s , line impedance Z_l , and load impedance Z_L for each phase, since these impedances are in series.



So how it will look like if you see this figure the source is Y connected V_{an} is connected to the a phase of the load through internal resistance or internal impedance of the source, so we will call it as source impedance and then you will have transmission line impedance and then the load impedance. So now the phase A of the source is connected to phase A of the load through transmission line, similarly, phase B of the source is connected to phase B of the load through the transmission line and then phase C of the load is connected to phase C of the source through the transmission line.

Now the neutrals of both source as well as load are connected through wire having impedance equal to Z_n . So now you can see this combination is three phase four wire arrangement where the source impedance as well as the transmission line impedance is considered for the analysis.

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- As illustrated in the previous figure,
- Z_s denotes the internal impedance of the phase winding of the generator:
- Z_l is the impedance of the line joining a phase of the source with a phase of the load:
- Z_L is the impedance of each phase of the load:
- Z_n is the impedance of the neutral line.
- Thus, in general,
$$Z_Y = Z_s + Z_l + Z_L$$
- Z_s and Z_l are often very small compared with Z_L , so we can assume $Z_Y \approx Z_L$, if no source or line impedance is given.
- In any event, by lumping the impedances together, the Y-Y system can be simplified to that shown in the next slide.

Now since these three are in series Z_s , Z_l and be load impedance Z_L you can club all of them as,

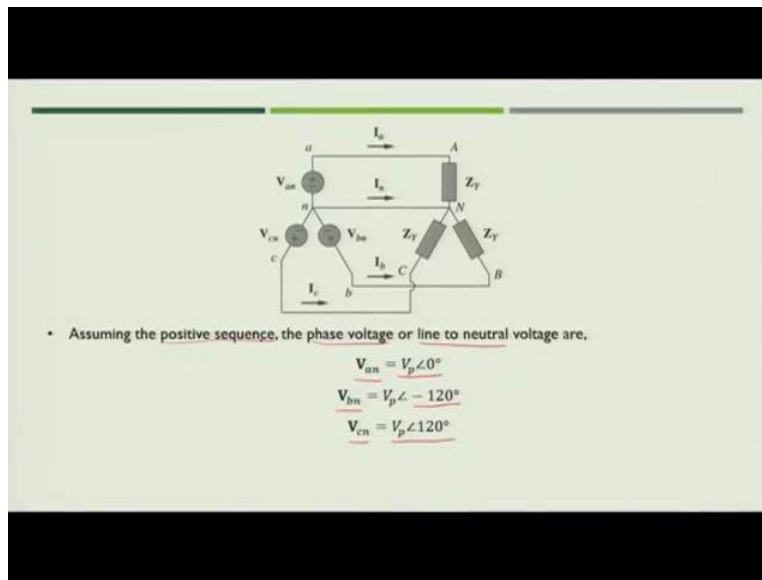
$$Z_Y = Z_s + Z_l + Z_L$$

Where,

- Z_s denotes the internal impedance of the phase winding of the generator
- Z_l is the impedance of the line joining a phase of the source with a phase of the load
- Z_L is the impedance of each phase of the load
- Z_n is the impedance of the neutral line.

Now in the power system network the Z_s and Z_l are often very small as compared to Z_L , so we can assume $Z_Y = Z_L$ even if no source or line impedance is given in the question. In any event by lumping the impedance together, the Y-Y system can be simplified to that circuit which we shown in the next slide.

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So if you see in this case what we have done, we have simplified the arrangement which we saw in the previous slide and we lump the \mathbf{Z}_s , \mathbf{Z}_l for transmission line and the load impedance through a impedance called \mathbf{Z}_Y , so now it is much simplified and easy to understand now you say that both phases of source and load are connected, A is connected A, B is connected to B of the load, C is connected to C of the load. Now let us assume that the current which is flowing in the line connecting phase A of the source to load is \mathbf{I}_a , similarly the line connecting phase B of the source to phase B of the load is \mathbf{I}_b and a line connecting C phase of the source to C phase of the load is \mathbf{I}_c .

We will also assume there is some current \mathbf{I}_n which is flowing in the neutral wire connecting neutral of the source to neutral of the load. So, the values of the voltage source, since we have assumed positive sequence will be,

$$\mathbf{V}_{an} = V_p \angle 0^\circ$$

$$\mathbf{V}_{bn} = V_p \angle -120^\circ$$

$$\mathbf{V}_{cn} = V_p \angle 120^\circ$$

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- The line to line voltages or simply the line voltages V_{ab} , V_{bc} , and V_{ca} are related to the phase voltages as,

$$V_{ab} = V_{an} + V_{nb} = V_{an} - V_{bn} = V_p \angle 0^\circ - V_p \angle -120^\circ$$

$$= V_p \left(1 + \frac{1}{2} + \frac{j\sqrt{3}}{2} \right) = \sqrt{3}V_p \angle 30^\circ$$
- Similarly,

$$V_{bc} = V_{bn} + V_{nc} = V_{bn} - V_{cn} = \sqrt{3}V_p \angle -90^\circ$$

$$V_{ca} = V_{cn} + V_{na} = V_{cn} - V_{an} = \sqrt{3}V_p \angle -210^\circ$$
- Thus, the magnitude of the line voltages V_L is $\sqrt{3}$ times the magnitude of the phase voltages V_p or

$$V_L = \sqrt{3}V_p$$

Now if you are asked to find line to line voltage or simply the line voltage, line voltage would be V_{ab} , V_{bc} or V_{ca} .

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- Assuming the positive sequence, the phase voltage or line to neutral voltage are,

$$V_{an} = V_p \angle 0^\circ$$

$$V_{bn} = V_p \angle -120^\circ$$

$$V_{cn} = V_p \angle 120^\circ$$

That means the voltage between a phase and b phase, so this will be your V_{ab} then similarly the voltage between b and c is the V_{bc} and similarly again between c and a will be V_{ca} .

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- The line to line voltages or simply the line voltages V_{ab} , V_{bc} , and V_{ca} are related to the phase voltages as,

$$\begin{aligned} \underline{V}_{ab} &= \underline{V}_{an} + \underline{V}_{nb} = \underline{V}_{an} - \underline{V}_{bn} = V_p \angle 0^\circ - V_p \angle -120^\circ \\ &= V_p \left(1 + \frac{1}{2} + \frac{j\sqrt{3}}{2} \right) = \sqrt{3}V_p \angle 30^\circ \end{aligned}$$
- Similarly,

$$\begin{aligned} \underline{V}_{bc} &= \underline{V}_{bn} + \underline{V}_{nc} = \underline{V}_{bn} - \underline{V}_{cn} = \sqrt{3}V_p \angle -90^\circ \\ \underline{V}_{ca} &= \underline{V}_{cn} + \underline{V}_{na} = \underline{V}_{cn} - \underline{V}_{an} = \sqrt{3}V_p \angle -210^\circ \end{aligned}$$
- Thus, the magnitude of the line voltages V_L is $\sqrt{3}$ times the magnitude of the phase voltages V_p or

$$V_L = \sqrt{3}V_p$$

So now we need to find out the value of the line to line voltage or we simply say the line voltage V_{AB} you can write as V_{AN} plus V_{NB}

$$\begin{aligned} \underline{V}_{ab} &= \underline{V}_{an} + \underline{V}_{nb} = \underline{V}_{an} - \underline{V}_{bn} = V_p \angle 0^\circ - V_p \angle -120^\circ \\ &= V_p \left(1 + \frac{1}{2} + \frac{j\sqrt{3}}{2} \right) = \sqrt{3}V_p \angle 30^\circ \end{aligned}$$

Similarly,

$$\underline{V}_{bc} = \underline{V}_{bn} + \underline{V}_{nc} = \underline{V}_{bn} - \underline{V}_{cn} = \sqrt{3}V_p \angle -90^\circ$$

$$\underline{V}_{ca} = \underline{V}_{cn} + \underline{V}_{na} = \underline{V}_{cn} - \underline{V}_{an} = \sqrt{3}V_p \angle -210^\circ$$

Thus, the magnitude of the line voltages V_L is $\sqrt{3}$ times the magnitude of the phase voltages V_p or

$$V_L = \sqrt{3}V_p$$

Now if you see \underline{V}_{ab} leads \underline{V}_{bc} by 120° and \underline{V}_{bc} leads \underline{V}_{ca} by 120° so that the line voltages sum up to zero as do the phase voltages.

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- Also the line voltages lead their corresponding phase voltages by 30° as illustrated in the figure below.
- The figure also shows how to determine V_{ab} from the phase voltages.
- Notice that V_{ab} leads V_{bc} by 120° and V_{bc} leads V_{ca} by 120° so that the line voltages sum up to zero as do the phase voltages.

So, in the line voltage you will see that these are leading with respect to their phase voltages by 30 degree, so we also see that the line voltage is now root 3 times of the phase voltage in magnitude.

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- Applying KVL to each phase in the following figure,

$$I_a = \frac{V_{an}}{Z_Y} \quad I_a = |I_a| \angle \theta$$

$$I_b = \frac{V_{bn}}{Z_Y} = \frac{V_{an} \angle -120^\circ}{Z_Y} = I_a \angle -120^\circ$$

$$I_c = \frac{V_{cn}}{Z_Y} = \frac{V_{an} \angle -240^\circ}{Z_Y} = I_a \angle -240^\circ$$

Now if you apply KVL to each phase what you can write the value of

$$I_a = \frac{V_{an}}{Z_Y}$$

$$\mathbf{I}_b = \frac{\mathbf{V}_{bn}}{\mathbf{Z}_Y} = \frac{\mathbf{V}_{an} \angle -120^\circ}{\mathbf{Z}_Y} = \mathbf{I}_a \angle -120^\circ$$

$$\mathbf{I}_c = \frac{\mathbf{V}_{cn}}{\mathbf{Z}_Y} = \frac{\mathbf{V}_{an} \angle -240^\circ}{\mathbf{Z}_Y} = \mathbf{I}_a \angle -240^\circ$$

Now here \mathbf{I}_a is the phasor quantity, so the angle of current \mathbf{I}_a with respect to \mathbf{V}_a will be depending upon the phasor value of \mathbf{Z}_Y . So in the analysis we have to be very careful about the phasor value of \mathbf{Z}_Y so that we get the proper value of \mathbf{I}_a in phasor terms with respect to \mathbf{V}_a .

Now if you sum up,

$$\mathbf{I}_a + \mathbf{I}_b + \mathbf{I}_c = 0$$

So that,

$$\mathbf{I}_n = -(\mathbf{I}_a + \mathbf{I}_b + \mathbf{I}_c) = 0$$

or

$$\mathbf{V}_{nN} = \mathbf{Z}_n \mathbf{I}_n = 0$$

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• It can be readily inferred that,

$$\mathbf{I}_a + \mathbf{I}_b + \mathbf{I}_c = 0$$

• So that,

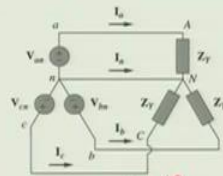
$$\mathbf{I}_n = -(\mathbf{I}_a + \mathbf{I}_b + \mathbf{I}_c) = 0$$

or

$$\mathbf{V}_{nN} = \mathbf{Z}_n \mathbf{I}_n = 0$$

- Therefore, the voltage across the neutral wire is zero.
- The neutral line can thus be removed without affecting the system.
- In long distance power transmission, conductors are used in multiples of three with the earth itself acting as the neutral conductor.
- Power systems designed in this way are well grounded at all critical points to ensure safety.

- Applying KVL to each phase in the following figure.



$$I_a = \frac{V_{an}}{Z_Y}$$

$$I_b = \frac{V_{bn}}{Z_Y} = \frac{V_{an} \angle -120^\circ}{Z_Y} = I_a \angle -120^\circ$$

$$I_c = \frac{V_{cn}}{Z_Y} = \frac{V_{an} \angle -240^\circ}{Z_Y} = I_a \angle -240^\circ$$

Now since $I_n = -(I_a + I_b + I_c) = 0$, the neutral current will also be zero in that case the voltage difference between source neutral to load neutral will be equal to zero because there is no current flowing, so therefore the voltage across the neutral wire will be zero. So neutral line can thus be removed because since, there is no current flowing you can remove the neutral wire and this is economically very important to understand that if the system is completely balanced the neutral wire is not required and we save cost of laying the neutral wire from source to load.

So, in a long-distance power transmission the conductors we use are in multiple of three because we are talking about the three phase system, so the conductors will be in multiple of three and earth will act as neutral conductor.

Now power system is designed in the way that the system is well grounded at all critical points why because we want to make ensure the safety of the system as well as the person who work on the power system network.

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- While the line current is the current in each line, the phase current is the current in each phase of the source or load.
- In the Y-Y system, the line current is the same as the phase current.
- We will use single subscripts for line currents because it is natural and conventional to assume that line currents flow from the source to the load. $I_{aA} = I_a$
- An alternative way of analyzing a balanced Y-Y system is to do so on a "per phase" basis.
- We look at one phase, say phase a , and analyze the single-phase equivalent circuit in the below figure.

Now while the line current is the current in each line, the phase current is also same in this case because phase current is the current in each phase of source or load and when we talk about the Y-Y connected system we will see that the line current is same as the phase current. So, what we will do we will use single subscript for line current we will not write as I_{aa} we will simply write as I_a for the line current because it is understood that we are talking about the current which is flowing from source to load, so that is why we drop the second subscript and we simply write as I_a .

Now alternative way of analyzing the balance star-star system is to convert it into per phase because the system is completely balanced you can convert the three system to its equivalent single phase system, so when you convert the three phase system which we are discussing then you get the equivalent circuit as shown in this slide here the V_{an} that is phase voltage is connected to the load Z_Y through the line, so one is line connecting between phase A to A of the source and load and then another line is for connection between neutral of the source and load.

So this will be single phase equivalent of the three phase Y-Y connected system which we discussed.

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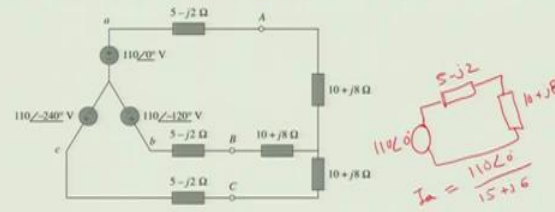
- The single-phase analysis yields the line current I_a as
$$I_a = \frac{V_{an}}{Z_Y}$$
- We use the phase sequence to obtain other line currents.
- So, as long as the system is balanced, we need only analyze one phase.
- We may do this even if the neutral line is absent, as in the three-wire system.

So in this case again you can see from the figure that $I_a = \frac{V_{an}}{Z_Y}$. So we use phase sequence to obtain the other line currents because we know that the phase sequence is ABC, so we can easily find out the values of I_b and I_c with help of current I_a which we got from its single phase equivalent so as long as the system is balanced we need only analysis in case of single phase equivalent, so we can all we may do so even if the neutral line is absent because you can say that neutral is virtually connected for creating the single phase equivalent.

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EXAMPLE:

❖ Calculate the line currents in the three-wire Y-Y system given in the following figure?



SOLUTION: The three-phase circuit is balanced; we may replace it with its single-phase equivalent circuit as discussed previously.

Now let us take one example before closing our today's we have three wire star-star connected system which is given in the figure so we have source completely balanced $110\angle 0^\circ$, $110\angle -120^\circ$, $110\angle -240^\circ$ volt as the phase voltages line impedance is $5 - j2$ in all the three phases and load impedance is $10 + j8$ ohm, so you will see that this load is also star connected and it is connected to the start connected source we have we are not connecting the neutral because system is balanced.

So what we will do we will first create its single phase equivalent so when you create single phase equivalent what you get you will get the voltage source $110\angle 0^\circ$ and then you will have impedance $5 - j2$ and then again the load impedance $10 + j8$, so this will be your single phase equivalent of this circuit. Here, $Z_Y = (5 - j2) + (10 + j8) = 15 + j6 = 16.155\angle 21.8$. So,

$$I_a = \frac{V_{an}}{Z_Y} = \frac{110\angle 0^\circ}{16.155\angle 21.8^\circ} = 6.81\angle -21.8^\circ \text{ A}$$

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• The single-phase analysis yields the line current I_a as

$$I_a = \frac{V_{an}}{Z_Y}$$

• Here, $Z_Y = (5 - j2) + (10 + j8) = 15 + j6 = 16.155\angle 21.8^\circ$.

$$I_a = \frac{V_{an}}{Z_Y} = \frac{110\angle 0^\circ}{16.155\angle 21.8^\circ} = 6.81\angle -21.8^\circ \text{ A}$$

• Since the source voltages are in positive sequence, the line currents are also in positive sequence:

$$I_b = I_a\angle -120^\circ = 6.81\angle -141.8^\circ \text{ A}$$
$$I_c = I_a\angle -240^\circ = 6.81\angle -261.8^\circ = 6.81\angle 98.2^\circ \text{ A}$$

Now since the voltage sources are in positive sequence the line currents will also be in positive sequence, so

$$I_b = I_a\angle -120^\circ = 6.81\angle -141.8^\circ \text{ A}$$

$$I_c = I_a\angle -240^\circ = 6.81\angle -261.8^\circ = 6.81\angle 98.2^\circ \text{ A}$$

With this we can close our today's session in which we discussed mostly about the Y-Y connected balanced system, so in next session we will discuss about star delta or you can say Y delta connected system thank you.