ELEC-E8422 An Introduction to Electric Energy

Exercises - Lecture 2 3-phases system

EX 1 wye and delta connections

The phase voltage of a wye connected 3-phases source is $\overline{V}_{an} = 230\angle -40°$. The source is feeding a delta connected 3-phases load, the impedance of which is $\overline{Z} = 10\angle -30°$.

a. Draw the circuit sketch of this situation
b. calculate the line-to-line voltages of the source ($\overline{V}_{ab}, \overline{V}_{bc}, \overline{V}_{ca}$)and the phase currents of the load ($\overline{I}_{ab}, \overline{I}_{bc}, \overline{I}_{ca}$)

EX 2 impedances

The phase voltage of a wye connected 3-phases source is $\overline{V}_{an} = 230\angle 0°$. The source is feeding a delta connected 3-phases load, the impedance of which is unknown. The measurement of the c-phase current gives $\overline{I}_c = 10\angle 75°$. Calculate the load impedance, i.e., the impedance of one branch of the delta connected load.

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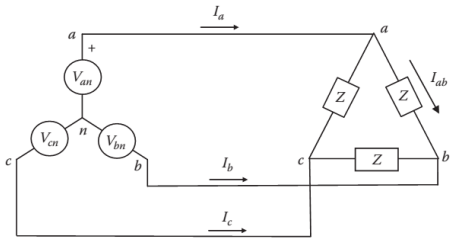
Exercises - Lecture 1 AC circuits

EX 1 wye and delta connections

The phase voltage of a wye connected 3-phases source is $\overline{V}_{an} = 230\angle -40°$. The source is feeding a delta connected 3-phases load, the impedance of which is $\overline{Z} = 10\angle -30°$.

c. Draw the circuit sketch of this situation.
d. calculate the line-to-line voltages of the source ($\overline{V}_{ab}, \overline{V}_{bc}, \overline{V}_{ca}$)and the phase currents of the load ($\overline{I}_{ab}, \overline{I}_{bc}, \overline{I}_{ca}$)

Solution



From th electure slides, one can find an equation for the line-to-line voltage:

$$\begin{aligned}\overline{V}_{ab} &= \overline{V}_{an} - \overline{V}_{bn} \\ &= 230\angle -40° - 230\angle(-40 - 120)° \\ &= 398.4\angle -10°\end{aligned}$$

$$\begin{aligned}\overline{V}_{bc} &= \overline{V}_{bn} - \overline{V}_{cn} \\ &= 230\angle(-40 - 120)° - 230\angle(-40 - 240)° \\ &= 398.4\angle -130°\end{aligned}$$

$$\begin{aligned}\overline{V}_{ca} &= \overline{V}_{cn} - \overline{V}_{an} \\ &= 230\angle(-40 - 240)° - 230\angle -40° \\ &= 398.4\angle 110°\end{aligned}$$

the angle of the line-to-line voltage ca could also be -250° (-250+360=110)

The currents are calculated from the voltage over the impedance, i.e.,

$$\overline{I}_{ab} = \frac{\overline{V}_{ab}}{\overline{Z}} = \frac{398.4\angle -10°}{10\angle -30°} = 39.84\angle 20°$$

$$\overline{I}_{bc} = \frac{\overline{V}_{bc}}{\overline{Z}} = \frac{398.4\angle -130°}{10\angle -30°} = 39.84\angle -100°$$

$$\overline{I}_{ca} = \frac{\overline{V}_{ca}}{\overline{Z}} = \frac{398.4\angle 110°}{10\angle -30°} = 39.84\angle 140°$$

Note that the currents are also 120 degrees phase-shifted from each other.

EX 2: impedances

The phase voltage of a wye connected 3-phases source is $\bar{V}_{an} = 230\angle 0°$. The source is feeding a delta connected 3-phases load, the impedance of which is unknown. The measurement of the c-phase current gives $\bar{I}_c = 10\angle 75°$. Calculate the load impedance, i.e., the impedance of one branch of the delta connected load.

Solution

Let us first calculate the voltage over on of the branches of the delta-connected load, i.e., the line-to-line voltage, e.g.

$$\begin{aligned}\bar{V}_{ab} &= \sqrt{3}\bar{V}_{an}Ð30°\\ &= \sqrt{3}(V_{an}Ð0°)Ð30°\\ &= 398.4Ð30°\end{aligned}$$

The load current can be calculated from the source current as, e.g.,

$\bar{I}_{ab} = \dfrac{\bar{I}_a Ð 30°}{\sqrt{3}}$, where

$$\begin{aligned}\bar{I}_a &= \bar{I}_c Ð -120°\\ &= (10Ð75°)Ð -120°\\ &= 10Ð -45°\end{aligned}$$

so that

$$\begin{aligned}\bar{I}_{ab} &= \frac{\bar{I}_a Ð 30°}{\sqrt{3}}\\ &= \frac{(10Ð -45°)Ð 30°}{\sqrt{3}}\\ &= 5.77Ð -15°\end{aligned}$$

The impedance can then be calculated as:

$$\begin{aligned}\bar{Z} &= \frac{\bar{V}_{ab}}{\bar{I}_{ab}}\\ &= \frac{398.4\angle 30°}{5.77\angle -15°}\\ &= 69.05\angle 45°\ \Omega\end{aligned}$$