task_ezrkjzifcegttcpc_with_calculation

Student Group

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Multiphase systems, RMS, power, exam ee2 SS2021

Exercise E20 Multiphase systems
(written test, approx. 4 % of a 120-minute written test, SS2021)

A symmetrical three-phase consumer in delta connection is considered in the following.

A voltage with the RMS value $U_{\rm RMS} = 110~\rm V$ is applied between the terminals of each winding.

Through each of the windings, there is a current with an RMS value $I_{\rm RMS} = 5 ~\rm A$ and a phase shift of $\varphi = +25°$ compared to the voltage.

a) Draw the circuit diagram.

b) Specify the RMS value of the phase current $I_\rm L$ and the string current $I_\rm S$.

c) Specify the RMS values of the phase voltage $U_\rm L$ and the string voltage $U_\rm S$.

Path

Since the given current of $I_{\rm RMS} = 5~\rm A$ is running through each winding, this is also the string current $I_{\rm S}$.

For the phase current, the phase current on the node must be considered. The sum of all currents must be zero: $\sum_i I_i = 0$.

By this (and showing in the example in the image below), One can see, that $I_\rm L= \sqrt{3} \cdot I_{\rm RMS} = \sqrt{3} \cdot 5~\rm A$

Since the given voltage of $U_{\rm RMS} = 110~\rm V$ is applied between the terminals of each winding, this is also the string voltage $U_\rm S$.

For delta configuration, the phase voltage $U_\rm L$ is equal to the string voltage $U_\rm S$.

Result

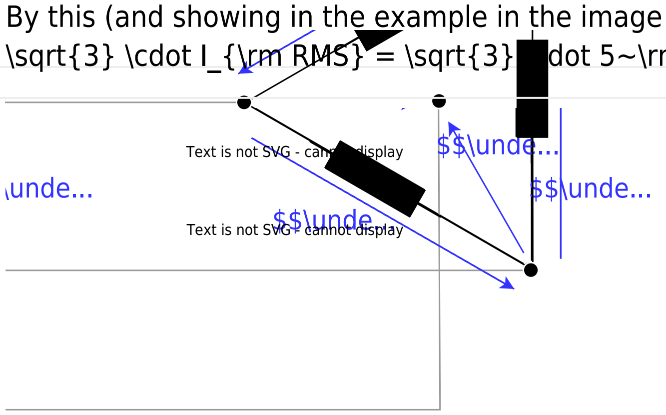
- $U_{\rm S} = 110~\rm V$
- $U_{\rm L} = 110~\rm V$
- $I_{\rm S} = 5~\rm A$
- $I_{\rm L} = 8.66~\rm A$

The active power P is given by: $P = 3 \cdot U \cdot I \cdot \sin(\varphi)$

$$\begin{align*} P &= 3 \cdot 110{~\rm V} \cdot 5{~\rm A} \cdot \sin(25°) \\ &= 1610.888...~\rm W \end{align*}$$

Result

$W = 1.61 ~\rm kW$



one single phase as an example