task_abh4vhlgczdbni37_with_calculation

Student Group

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signal analysis, RMS, exam ee2 SS2021

Exercise E16 Signal Analysis
(written test, approx. 6 % of a 120-minute written test, SS2021)

At an AC consumer, the following time functions of voltage and current were measured (independent). The quantities are available in the consumer arrow system. (hard)

- $u(t) = 50{~\rm V} \cdot \cos (6000 {{1}\over{\rm s}} \cdot t + 4) $
- $i(t) = 30{~\rm A} \cdot \sin (6000 {{1}\over{\rm s}} \cdot t + 5) $

a) Determine the amplitude values $\hat{U}$, $\hat{I}$ and the RMS values U, I

Path

- The amplitude values $\hat{U}$, $\hat{I}$ are given directly by the coefficient of the cosine and sine functions
- For the RMS values of sinusoidal functions the amplitudes have to be multiplied with ${{1}\over{2}}\sqrt{2}$

Result

Amplitude values:

- $\hat{U} = 50{~\rm V}$
- $\hat{I} = 30{~\rm A}$

RMS values:

- $U = 35.4{~\rm V}$
- $I = 21.2{~\rm A}$

b) Determine the frequency f and the phase angle φ in degree (°). (medium)

Path

The frequency can be derived by the term in the sine function: $$\begin{align*} \omega &= 6000 {{1}\over{\rm s}} = 2\pi \cdot f \\ f &= {{6000}\over{2\pi}} {{1}\over{\rm s}} \\ f &= 954.93... ~\rm Hz \\ \end{align*}$$

For the phase φ, we have to subtract $\varphi_i $ from φ_u.
But to get these values, both the $u(t)$ and $i(t)$ need to have the same sinusoidal function! Therefore:

- $\varphi_i = 5$
- $\varphi_u = 4 + {{\pi}\over{2}}$

By this we get for φ $$\begin{align*} \varphi &= \varphi_u - \varphi_i \\ &= 4 + {{\pi}\over{2}} - 5 \\ &= 2.14159... \\ \end{align*}$$

Converted in degree: $$\begin{align*} \varphi &= 2.14159... \cdot {{360°}\over{2\pi}} \\ &= 32.7042...° \\ \end{align*}$$

Result

- $f = 955 ~\rm Hz$
- $\varphi = +32.7°$

The phase is positive, therefore the element is (resistive-)inductive.