

task_wjttvmydrskzhcim_with_calculation

Student Group

| First Name | Surname | Matrikel Nr. |
|------------|---------|--------------|
| | | |
| | | |
| | | |

Table of Contents

| | |
|--|---|
| Exercise E1 Component Parameters (written test, approx. 10 % of a 120-minute written test, SS2021) | 2 |
|--|---|

complex voltage divider, RMS, inductor, exam ee2 SS2021

Exercise E1 Component Parameters
(written test, approx. 10 % of a 120-minute written test, SS2021)

Determine the component parameters of a motor (motor presents a resistive inductive load!) For the next exercises consider the following RMS values of the series resistance R_{M} and the inductance L_{M} are to be determined below. Both results in the impedance of the motor. But two different frequencies, f_1 and f_2 was applied.

This resulted in the recorded current of

Derive in general the equation for the absolute value of the impedance of the motor.

$$Z = \sqrt{(2\pi \cdot f \cdot L_{\text{M}})^2 + R_{\text{M}}^2}$$

$$R_{\text{M}} = 10 \cdot \Omega$$

$$L_{\text{M}} = 10 \cdot \text{mH}$$

Since we have the absolute values of the impedances from the specified formulas from f_1 and f_2 (independent) This has the advantage that R_{M} will cancel out:

$$Z_2^2 - Z_1^2 = (2\pi \cdot f_2 \cdot L_{\text{M}})^2 + R_{\text{M}}^2 - \left((2\pi \cdot f_1 \cdot L_{\text{M}})^2 + R_{\text{M}}^2 \right)$$

The complex impedance Z for a resistive inductive load R_{M} and L_{M} in series circuit is given as

$$\underline{Z} = R_{\text{M}} + j \cdot X_{L_{\text{M}}}$$

$$\underline{Z} = R_{\text{M}} + j \cdot 2\pi \cdot f \cdot L_{\text{M}}$$

Now we can rearrange to L_{M} :

The Pythagorean theorem can derive the absolute value:

$$|Z|^2 = Z \cdot Z^* = (R_{\text{M}} + j \cdot 2\pi \cdot f \cdot L_{\text{M}}) \cdot (R_{\text{M}} - j \cdot 2\pi \cdot f \cdot L_{\text{M}}) = R_{\text{M}}^2 + (2\pi \cdot f \cdot L_{\text{M}})^2$$

$$Z_2^2 - Z_1^2 = \left(R_{\text{M}}^2 + (2\pi \cdot f_2 \cdot L_{\text{M}})^2 \right) - \left(R_{\text{M}}^2 + (2\pi \cdot f_1 \cdot L_{\text{M}})^2 \right) = (2\pi \cdot f_2 \cdot L_{\text{M}})^2 - (2\pi \cdot f_1 \cdot L_{\text{M}})^2$$

$$Z_2^2 - Z_1^2 = (2\pi \cdot L_{\text{M}})^2 \cdot (f_2^2 - f_1^2)$$

$$L_{\text{M}} = \sqrt{\frac{Z_2^2 - Z_1^2}{(2\pi)^2 \cdot (f_2^2 - f_1^2)}} = \sqrt{\frac{50^2 - 5^2}{(2\pi)^2 \cdot (100^2 - 5^2)}} = 14.346 \cdot 10^{-3} \text{ mH}$$

$$L_{\text{M}} = \frac{U_2}{I_2} = \frac{50 \text{ V}}{5 \text{ A}} = 10 \text{ mH}$$

And then to R_{M} :

$$L_{\text{M}} = \frac{1}{2\pi} \sqrt{\frac{Z_2^2 - Z_1^2}{f_2^2 - f_1^2}}$$

With the values:

$$L_{\text{M}} = \frac{1}{2\pi} \sqrt{\frac{(10 \cdot \Omega)^2 - (6.25 \cdot \Omega)^2}{(100 \text{ s}^{-1})^2 - (5 \text{ s}^{-1})^2}} = 14.346 \cdot 10^{-3} \text{ mH}$$

The resistance value R_{M} can be derived from $Z_2^2 = (2\pi \cdot f_2 \cdot L_{\text{M}})^2 + R_{\text{M}}^2$

$$R_{\text{M}}^2 = Z_2^2 - (2\pi \cdot f_2 \cdot L_{\text{M}})^2$$

$$R_{\text{M}} = \sqrt{Z_2^2 - (2\pi \cdot f_2 \cdot L_{\text{M}})^2}$$

The values have to be inserted also for R_{M} :

$$R_{\text{M}} = \sqrt{(10 \cdot \Omega)^2 - (2\pi \cdot 100 \text{ s}^{-1} \cdot 0.014346 \cdot 10^{-3} \text{ mH})^2} = 4.3301 \cdot 10^{-3} \cdot \Omega$$

From:

<https://wiki.mexle.org/> - **MEXLE Wiki**

Permanent link:

https://wiki.mexle.org/electrical_engineering_and_electronics/task_wjttvmydrskzhcim_with_calculation

Last update: **2024/07/04 01:51**

