

task_wjttvmydrskzhcim_with_calculation

Student Group

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Exercise E21 Component Parameters**(written test, approx. 10 % of a 120-minute written test, SS2021)**

For the next exercises consider the following circuit. The motor presents a resistive inductance and!

Results of the measurements, an AC voltage with a constant RMS value of $U_{\text{RMS}} = 50 \text{ V}$ are determined below. Both results in the impedance of the motor.

This resulted in the recorded current of

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

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

$$R_{\text{M}} = 4.3301 \cdot \Omega$$

$$L_{\text{M}} = 14.346 \cdot \text{mH}$$

b) Since we have $|Z_1|$ and $|Z_2|$ from b) we can subtract two of the formulas from a). This has the advantage that R_{M} will cancel out:

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

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

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

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

Now we can rearrange to L_{M} :

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

$$L_{\text{M}} = \frac{(50 \text{ V})^2 - (50 \text{ V})^2}{(2\pi)^2 \cdot (100 \text{ Hz})^2 - (50 \text{ Hz})^2}$$

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And then to L_{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:

$$L_{\text{M}} = \frac{1}{2\pi} \sqrt{\frac{(10 \cdot \Omega)^2 - (6.25 \cdot \Omega)^2}{(100 \text{ Hz})^2 - (50 \text{ Hz})^2}} = 14.346 \cdot \text{mH}$$

The resistance value R_{M} can be derived from $|Z_2|$

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

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

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

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

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

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

