

task_wjttvmydrskzhcim_with_calculation

Student Group

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complex voltage divider, RMS, inductor, exam ee2 SS2021

Exercise E16 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 series resistance R_{M} and the inductance L_{M} are to be 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.

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

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

$$L_{\text{M}} = 100 \cdot \text{mH}$$

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

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

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

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} :

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

$$L_{\text{M}} = \frac{(100 \cdot \text{V})^2 - (50 \cdot \text{V})^2}{(2\pi \cdot 100 \cdot \text{s}^{-1})^2 - (2\pi \cdot 6.25 \cdot \text{s}^{-1})^2}$$

$$L_{\text{M}} = \frac{(10000 - 2500) \cdot \text{V}^2}{(2\pi \cdot 100 \cdot \text{s}^{-1})^2 - (2\pi \cdot 6.25 \cdot \text{s}^{-1})^2}$$

$$L_{\text{M}} = \frac{7500 \cdot \text{V}^2}{(2\pi \cdot 100 \cdot \text{s}^{-1})^2 - (2\pi \cdot 6.25 \cdot \text{s}^{-1})^2}$$

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$$L_{\text{M}} = \frac{7500 \cdot \text{V}^2}{(2\pi \cdot 100 \cdot \text{s}^{-1})^2 - (2\pi \cdot 6.25 \cdot \text{s}^{-1})^2}$$

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:

$$L_{\text{M}} = \frac{1}{2\pi} \sqrt{\frac{(100 \cdot \text{V})^2 - (50 \cdot \text{V})^2}{(100 \cdot \text{s}^{-1})^2 - (6.25 \cdot \text{s}^{-1})^2}}$$

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

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

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