

# task\_w3m7fo4hjahkzogw\_with\_calculation

## Student Group

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magnetostatic, flux density, coil, toroid, exam ee2 SS2021

**Exercise E5 Toroidal Coil**  
**(written test, approx. 5 % of a 120-minute written test, SS2021)**

A magnetic field with a flux density of at least  $50 \text{ mT}$  is to be achieved in a ring-shaped coil (toroidal coil).

The coil has 60 turns, wound around soft iron with  $\mu_{\text{r}} = 1200$ .

The average field line length in the coil should be  $l = 12 \text{ cm}$ .

Result  
 $I = 0.664 \text{ A}$

What is the minimum current that must flow through a single winding?

Path

The magnetic field strength of a toroidal coil is given as:

$$H = \frac{N \cdot I}{l}$$

Based on the flux density the magnetic field strength can be derived by  $B = \mu_0 \mu_r H$ .

By this, the formula can be rearranged:

$$H = \frac{N \cdot I}{l} \quad || \quad \frac{B}{\mu_0 \mu_r} = \frac{N \cdot I}{l} \quad || \quad I = \frac{B \cdot l}{\mu_0 \mu_r \cdot N}$$

$$\text{Putting in the numbers: } I = \frac{0.05 \text{ T} \cdot 0.12 \text{ m}}{4\pi \cdot 10^{-7} \frac{\text{Vs}}{\text{Am}} \cdot 1'200 \cdot 60} = 0.6631... \frac{\text{T} \cdot \text{m}}{\frac{\text{Vs}}{\text{Am}}} = 0.6631... \frac{\text{Vs}}{\text{m}^2} \cdot \text{m} \cdot \frac{\text{m}}{\frac{\text{Vs}}{\text{Am}}} = 0.6631... \text{ A}$$

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