

task_n1kwu944m7jac3tf_with_calculation

Student Group

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Exercise E16 Magnetic Circuit

(written test, approx. 9 % of a 120-minute written test, SS2024)

1. Calculate the resulting resistance R_m in the core with a cross-sectional area of $A=300 \text{ mm}^2$ and an average circumference of $l=3 \text{ dm}$.

Path

l, Φ

$R_m = 0.884 \cdot 10^{-6} \text{ m} \cdot \frac{l}{\mu_0 \mu_r N^2 A}$

First we have to find the magnetic resistance in a closed loop based on the sources:

$R_m = \frac{l}{\mu_0 \mu_r N^2 A} = \frac{3 \text{ dm}}{4\pi \cdot 10^{-7} \text{ Vs/Am} \cdot 1 \cdot (1200)^2 \cdot 300 \cdot 10^{-6} \text{ m}^2} = 0.884 \cdot 10^{-6} \text{ m}$

To get the flux Φ , the Hopkinson's Law can be applied - similar to the Ohm's Law:

$\Phi = \frac{\sum N I}{R_m} = \frac{1200 \cdot 100 \text{ mA} + 33 \cdot 3 \text{ A} - 270 \cdot 0.3 \text{ A}}{0.884 \cdot 10^{-6} \text{ m}} = 67.8 \cdot 10^{-6} \text{ Vs} = 67.8 \cdot 10^{-6} \text{ Vs}$

On the core, there are three coils with:

- Coil 1: $N_1 = 1200$, $I_1=100 \text{ mA}$
- Coil 2: $N_2 = 33$, $I_2= 3 \text{ A}$
- Coil 3: $N_3 = 270$, $I_3=0.3 \text{ A}$

Refer to the drawing for the direction of the windings, current, and flux!

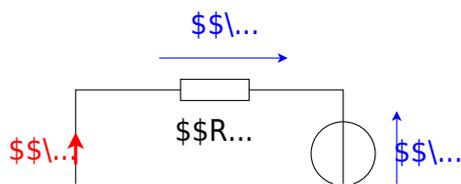
1. Draw the equivalent magnetic circuit that fully represents the setup. Name all the necessary magnetic resistances, fluxes, and voltages.

Result

- Since the material, and diameter of the core is constant, one can directly simplify the magnetic resistor into a single R_m .
- For the orientation of the magnetic voltages θ_1 , θ_2 , and θ_3 , the orientation of the coils and the direction of the current has to be

taken into account by the right-hand rule.

- There is only one flux Φ
- The magnetic voltages are antiparallel to the flux for sources and parallel for the load.



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