task_0j7accfimmemytq9_with_calculation

Student Group

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magnetostatic, flux density, magnetic field strength, coil, flux, exam ee2 SS2021

Exercise E1 Cylindrical Coil
(written test, approx. 6 % of a 120-minute written test, SS2021)

In the cylindrical coil the following information is given:

- Length $l = 30 {~\rm cm}$,
- Winding diameter $d = 390 {~\rm mm}$,
- Number of windings $w = 240$,
- Current through the conductor $I = 500 {~\rm mA}$,
- Material inside: Air
- $\mu_0 = 4\pi\cdot 10^{-7} {{\rm Vs}\over{\rm Am}}$

The proportion of the magnetic voltage outside the coil can be neglected. Determine the following for the inside of the coil:

a) the magnetic field strength (2 points)

Path

$$H = {{N \cdot I}\over{l}} = {{w \cdot I}\over{l}}$$

Putting in the numbers: $$H = {{240 \cdot 0.5 {~\rm A}}\over{0.3 {~\rm m}}}$$

Result

$H = 400 {~\rm A/m}$

a) the magnetic flux density (2 points)

Path

The flux density is given as $B = \mu_0 \mu_{\rm r} \cdot H$:

$$B = \mu_0 \cdot H$$

Putting in the numbers: $$B = 4\pi\cdot 10^{-7} {{\rm Vs}\over{\rm Am}} \cdot 400 ~{\rm {A}\over{m}} \\ = 0.0005026... {{\rm Vs}\over{\rm m^2}}$$

Result

$B = 0.50 {~\rm mT}$

b) the magnetic flux (2 points)

Path

The magnetic flux is given as

$$\Phi = B \cdot A$$

Since the coil is cylindric, the cross section area is given as:

$$A = \pi r^2 = \pi \left({{d}\over{2}} \right)^2$$

Therefore: $$\Phi = B \cdot \pi \left({{d}\over{2}} \right)^2$$

Putting in the numbers: $$\Phi = 0.0005026... {{\rm Vs}\over{\rm m^2}} \cdot \pi \left({{0.39{\rm m}}\over{2}} \right)^2 \\ = 0.00006004... {\rm Vs}$$

Result

$\Phi = 0.060 {~\rm mWb}$