task_0j7accfimmemytq9_with_calculation

Student Group

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

Exercise E3 Cylindrical Coil
(written test, approx. 6 % of a 120-minute written test, SS2021)

A cylindrical coil with the following information is given:

- Length $□ = 30 {~\rm cm}$,
- Winding diameter $□ = 390 {~\rm mm}$,
- Number of windings $□ = 240$,
- Current in the conductor $□ = 500 {~\rm mA}$,
- 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

\begin{align*} H &= {{N \cdot I}\over{l}} = {{w \cdot I}\over{l}} \end{align*}

Putting in the numbers: \begin{align*} H &= {{240 \cdot 0.5 {~\rm A}}\over{0.3 {~\rm m}}} \end{align*}

Result

$H = 400 ~\rm A/m$

b) the magnetic flux density (2 points)

Path

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

Putting in the numbers: \begin{align*} 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}} \end{align*}

Result

$B = 0.50 ~\rm mT$

c) the magnetic flux (2 points)

Path

The magnetic flux is given as \begin{align*} \Phi &= B \cdot A \end{align*}

Since the coil is cylindrical, the cross-section area is given as: \begin{align*} A = \pi r^2 = \pi \left({{d}\over{2}} \right)^2 \end{align*}

Therefore: \begin{align*} \Phi &= B \cdot \pi \left({{d}\over{2}} \right)^2 \end{align*}

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

Result

$\Phi = 60 ~\rm µWb$