

task_ddjurcpk494go2q1_with_calculation

Student Group

First Name	Surname	Matrikel Nr.

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electric field, magnetic field, exam ee2 SS2024

Exercise E6 Fields of an coax Cable**(written test, approx. 12 % of a 120-minute written test, SS2024)**

2. With the graph of the magnitude of $E(r)$ with r in mm (see Fig. 4.06) shows the cross-section of a coaxial cable with 0.6 mm inner conductor diameter and 0.55 mm outer conductor diameter. The diagram uses proper dimensions and labels for the diagram appears:

Path diagram

Inner conductor: $+3.3 \text{ mA}$, $+10 \text{ nC}$ (current into the plane of the diagram)

Outer conductor: -3.3 mA , 0 nC (current out of the plane of diagram)

- for $(0.1 \text{ mm} | 0)$: $E_{\text{r}} = 528 \text{ V/m}$
- for $(0.55 \text{ mm} | 0)$: $E_{\text{r}} = 0.985 \text{ V/m}$

The magnitude of the electric displacement field D can be calculated by: $\int D \cdot dA = Q_{\text{enc}}$.

In general, the E -field is proportional to $\frac{1}{r}$ for the situation between two conductors (here for simplicity without the round endings). Here, for any position radius r , the surrounding area is the surface of a cylindrical shape (here for simplicity without the round endings).

Force the surface A within the surface of the cylinder as there is no D field outside the conductor. within a circle with the radius r .

This leads to: $D(x) = \frac{Q}{A} = \frac{Q}{2\pi r \cdot l}$. This is proportional to the area within this radius. Therefore, the formula $H = \frac{Q}{2\pi r \cdot l}$ gets $H(x) = \frac{Q}{2\pi \cdot l \cdot x}$ at $x = 0.1 \text{ mm}$ and $H(x) = \frac{Q}{2\pi \cdot l \cdot x}$ at $x = 0.55 \text{ mm}$. This leads to a formula proportional to x .

For x within the outer conductor one also gets a linear proportionality with a $D_{\text{r}} = \frac{Q}{2\pi \cdot l \cdot r}$ and $D_{\text{r}} = \frac{Q}{2\pi \cdot l \cdot r}$.

Hint: For the direction, one has to consider the sign of the enclosed charge. By this, we see that the D -field is positive. But here, again only the magnitude was questioned!

.. What is the magnitude of the magnetic field strength H at $(0.1 \text{ mm} | 0)$ and $(0.55 \text{ mm} | 0)$?

Path diagram

The magnitude of the magnetic field strength H can be calculated by: $H = \frac{I}{2 \pi \cdot r}$

So, we get for H_{i} at $r_{\text{i}} = 0.1 \text{ mm}$, and H_{o} at $r_{\text{o}} = 0.55 \text{ mm}$:

$$\begin{aligned} H_{\text{i}} &= \frac{I}{2 \pi \cdot r_{\text{i}}} = \frac{+3.3 \text{ A}}{2 \pi \cdot 0.1 \cdot 10^{-3} \text{ m}} \\ H_{\text{o}} &= \frac{I}{2 \pi \cdot r_{\text{o}}} = \frac{+3.3 \text{ A}}{2 \pi \cdot 0.55 \cdot 10^{-3} \text{ m}} \end{aligned}$$

Hint: For the direction, one has to consider the right-hand rule. By this, we see that the H -field on the right side points downwards.

Therefore, the sign of the H -field is negative.

But here, only the magnitude was questioned!

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