

task_ddjurcpk494go2q1_with_calculation

Student Group

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electric field, magnetic field, exam ee2 SS2024

Exercise E1 Capacitor**(written test, approx. 12 % of a 120-minute written test, SS2024)**

2. With the graph of the magnitude of $B(r)$ with parameters B_0 of the diagram 4.06 shows the cross-section of a coaxial cable with (0.6 origin | 0) centered in the diagram. Describe dimensions and labels for the diagram appears:

Path

- Inner conductor: $+3.3 \sim \text{mA}$, $+10 \sim \text{nC}$ (current into the plane of the diagram)
- for $(0.1 \sim \text{mm} | 0)$: $B_{\text{in}} = 5.28 \sim \text{mG}$
- Outer conductor: $-3.3 \sim \text{mA}$, $0 \sim \text{nC}$ (current out of the plane of diagram)
- for $(0.55 \sim \text{mm} | 0)$: $B_{\text{out}} = 6.985 \sim \text{mG}$

The magnitude of the electric displacement field D can be calculated by: $\int D$

In general, the D -field is proportional to $\frac{1}{r}$.

Here, in any position r from the center, the surrounding area is the surface of a cylindrical shape (here for simplicity without the round endings).

This leads to: $D(x) = \frac{Q}{A}$, $B(x) = \frac{Q}{I \cdot 2\pi r}$

This is proportional to the area within this radius. Therefore, the formula $H = \frac{I}{2\pi r}$ gets $H(x) = \frac{I}{2\pi r}$ at $r = 0.1 \sim \text{mm}$ and $B_{\text{in}} = \frac{\mu_0 I}{2\pi r}$ at $r = 0.1 \sim \text{mm}$.

So, we get for $B_{\text{in}} = \frac{\mu_0 I}{2\pi r}$ at $r = 0.1 \sim \text{mm}$, and $B_{\text{out}} = \frac{\mu_0 I}{2\pi r}$ at $r = 0.55 \sim \text{mm}$.

For x within the outer conductor one also gets a linear proportionality with a $\begin{aligned} D_{\text{in}} &= \frac{Q}{2\pi r_{\text{in}}} \\ D_{\text{out}} &= \frac{Q}{2\pi r_{\text{out}}} \end{aligned}$

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 $(0.1 \sim \text{mm} | 0)$ and $(0.55 \sim \text{mm} | 0)$?

Path

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 $r_{\text{o}} = 0.55 \text{ mm}$:

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

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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