Answer on Question #79469- Physics- Electric Circuits

Question: *A current carrying square whose side 20cm... And the current through that is 10A.. Find the magnetic field intensity at centre of the square*

Answer:

In order to solve the problem, let us recall that: 1) magnetic field is a vector field; 2) magnetic field obeys the superposition principle. This means that the net magnetic field in the center of a square is the vector sum of the fields created by each side of the square independently

According to Biot–Savart law [1] and right-hand rule [2], the current passing through each side of the square creates magnetic field in the center of the square which direction is perpendicular to the square (for example, towards the reader if the current goes counter-clockwise - see fig.1).

One can show (see [3], p.1 for details and notations) that a direct wire of a finite length with current creates at arbitrary point P magnetic field which magnitude can be obtained via the following expression (the notations from [3] are conserved):

$$B = \frac{\mu_0}{4\pi}\frac{I}{R}(\sin\theta_2 - \sin\theta_1) = \frac{\mu_0}{4\pi}\frac{I}{R}\sqrt{2}, \quad (1)$$

where $\theta_2 = 45^\circ$, $\theta_1 = -45^\circ$; $R = a/2 = 10$ cm for the considered case.

Hence, the net magnetic field is equal to:

$$B_{net} = 4B = \frac{\sqrt{2}\mu_0}{\pi}\frac{I}{R}. \quad (2)$$

Substituting numerical values in (2), we obtain:

$$B_{net} = \frac{\sqrt{2}\cdot 4\pi\cdot 10^{-7}}{\pi}\frac{10}{10^{-1}} = 4\sqrt{2}\cdot 10^{-5} \approx 57\ \mu T. \quad (3)$$

Consequently, the magnetic field is equal to 57 μT perpendicular to the square.

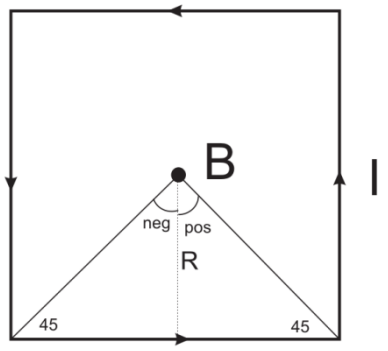

Figure 1.

[1] (Electronic resource) https://en.wikipedia.org/wiki/Biot–Savart_law

[2] (Electronic resource) https://en.wikipedia.org/wiki/Right-hand_rule

[3] (Electronic resource) http://www.phys.uri.edu/gerhard/PHY204/tsl216.pdf