

Answer on Question #50582-Physics-Electric Circuits

Wire of finite length l carrying current I produces magnetic field of B Tesla at a distance of $d = 10\text{ cm}$ on the perpendicular bisector of its length. If this wire is converted into a circular loop of single turn, find the expression for magnetic field at its center?

Solution

Magnetic field of B Tesla at a distance of d on the perpendicular bisector of its length is

$$B = \frac{\mu_0 I}{2\pi d} \frac{l}{\sqrt{l^2 + d^2}}.$$

Magnetic field at the center of the circle is

$$B' = \frac{\mu_0 I}{2r}.$$

So,

$$B' = B \frac{\pi d \sqrt{l^2 + d^2}}{rl}.$$

The wire is converted into a circular loop:

$$l = 2\pi r \rightarrow r = \frac{l}{2\pi}.$$

$$B' = B \frac{\pi d \sqrt{l^2 + d^2}}{\frac{l}{2\pi} l} = 2\pi^2 \left(\frac{d}{l}\right) \sqrt{1 + \left(\frac{d}{l}\right)^2}.$$