CLASSICAL ELECTRODYNAMICS I

Homework Set 9

April 21, 2017

1. A cylindrical conductor of radius a has a hole of radius b bored parallel to, and centered a distance d from the cylinder axis ($d+b < a$). The current density $\mathbf{J}$ is uniform throughout the remaining metal of the cylinder and is parallel to the axis. Use Ampère's law,

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} \ ,$$

and the principle of linear superposition to find the magnetic induction $\mathbf{B}$ in the hole. Express $\mathbf{B}$ in terms of the vectors $\mathbf{J}$ and $\mathbf{d}$, where $\mathbf{d}$ is the vector from the center of the cylindrical conductor to the center of the hole.

2. Consider a rectangular loop carrying a counterclockwise current I that is centered at the origin. The two sides of the loop parallel to the x axis have length $2a$ and the two sides parallel to the y axis have length $2b$. Determine the magnetic induction $\mathbf{B}$ for all points located on the z axis.