Homework No. 09 (Spring 2024)

PHYS 205B: UNIVERSITY PHYSICS

School of Physics and Applied Physics, Southern Illinois University–Carbondale

Due date: Thursday, 2024 Apr 4, 4:00 PM, on D2L

Instructions

- You are encouraged to use any of the resources to complete this homework. However, the extent to which you depend on resources while doing homework is usually a measure of how much extra work you need to put in to master the associated concepts. Solutions should be the last resource.
- Describe your thought process in detail and organize it clearly. Make sure your answer has units and the right number of significant digits.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assessments → Assignments).

Problems

1. (**10 points.**) Using Ampère's law show that the magnetic field due to a solenoid carrying a current I is given by,

$$\vec{\mathbf{B}} = \begin{cases} \hat{\mathbf{z}}\,\mu_0 I n, & \text{inside the solenoid,} \\ 0, & \text{outside the solenoid,} \end{cases} \tag{1}$$

   where n is the number of turns per unit length.

   Solution

2. (**10 points.**) A resistance R is connected to a battery V. Imagine an abstract Ampèrian loop c encircling the wires as described in Figure 1. Using Ampère's law evaluate

$$\oint_c \mathbf{B} \cdot d\mathbf{l} \tag{2}$$

   along the closed curve c.

   [2023S MT03 P01]

3. (**10 points.**) An infinitely long wire of circular cross section and radius a carries a steady current I. Another wire, in the form of a cylindrical shell and concentric to the first wire, has inner radius b and outer radius c, such that $a < b < c$. The region enclosed by $a < \rho < b$ and $c < \rho$ is empty space. The outer wire carries the same current I in the opposite direction. Let the direction of z-axis be along the wire.

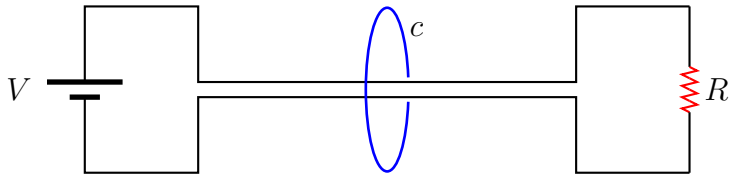

Figure 1: Problem 2

(a) Use Ampere's law to find the expression for magnetic field in the four regions, $\rho < a$, $a < \rho < b$, $b < \rho < c$, and $c < \rho$.

(b) Plot the resulting magnetic field as a function of ρ.

[Solution not provided.]