Midterm Exam No. 03 (Fall 2024)

PHYS 205B: UNIVERSITY PHYSICS

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

Date: 2024 Nov 12

(Name) (Signature)

Instructions

1. Seating direction: On even-numbered seats in alternate rows A, C, E, ...
2. Total time = 75 minutes.
3. There are 4 short questions and 3 homework-style problems in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to present your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of smart devices, including smart watches, is strictly prohibited. They should stay out of reach during the exam.
8. Restroom breaks are allowed. Under questionable circumstances this might lead up to a Makeup Exam.
9. Academic misconduct will lead to a failing grade in the course.

1. (**5 points.**) A current of what shape and configuration creates a uniform magnetic field. That is, how will you create a uniform magnetic field.

2. (**5 points.**) Crosses × and dots • in Figure 1. represent currents going into the $z = 0$

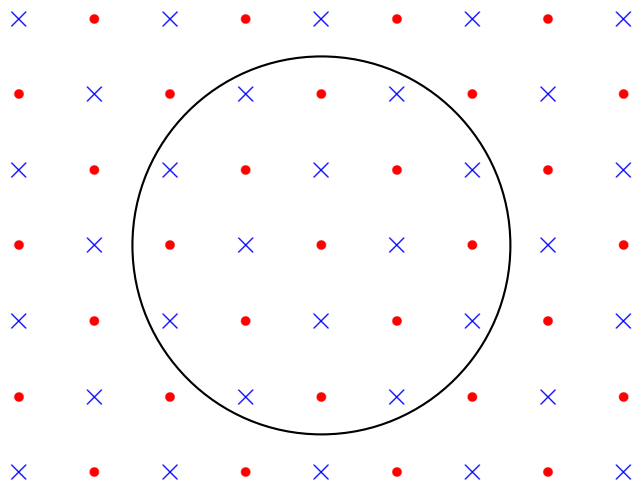

Figure 1: Problem 2

plane and currents coming out of the $z = 0$ plane, respectively. Each current has a magnitude of 1.0 A. Determine the curl of magnetic field

$$\oint \mathbf{B} \cdot d\mathbf{l} \tag{1}$$

for the circular loop shown in Figure 1.

3. (**5 points.**) What is the dimension of

$$LC. \tag{2}$$

Given L is inductance and C is capacitance.

4. (**5 points.**) The momentum in the wind propels a sailing boat. Does electromagnetic waves in vacuum have momentum available for propulsion?

5. (**10 points.**) Figure 2 shows two current carrying wires, separated by a distance $D = 5.0\,\text{cm}$. The directions of currents, either going into the page or coming out of the page, are shown in the figure. Determine the point $\times$ on the line, (which need not be in between the wires,) where the magnetic field is exactly zero. Given $I_1 = 1.0\,\text{A}$ and $I_2 = 0.50\,\text{A}$.

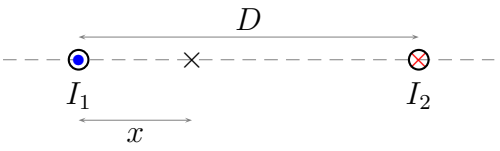

Figure 2: Problem 5

6. (**10 points.**) Figure 3 shows two current carrying wires. The directions of currents, either going into the page or coming out of the page, are shown in the figure. Determine the magnitude and direction of the force per unit length on the wire carrying current I_1. Let $I_1 = 1.0\,\text{A}$, $I_2 = 2.0\,\text{A}$, $x = 6.0\,\text{cm}$, and $y = 8.0\,\text{cm}$.

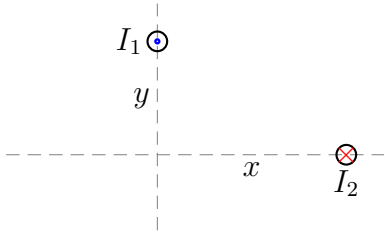

Figure 3: Problem 6

7. (**10 points.**) Figure 4 shows a conducting rod being pulled along horizontal, frictionless, conducting rails at a constant speed v. A uniform magnetic field $\mathbf{B}$ fills the region in which the rod moves. Assume $L = 10.0\,\text{cm}$, $v = 5.0\,\text{m/s}$, $B = 1.2\,\text{T}$, and $R = 0.40\,\Omega$. Determine the magnitude and direction of the induced current in the loop.

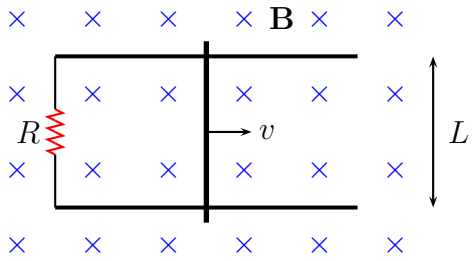

Figure 4: Problem 7