Midterm Exam No. 03 (Spring 2025)

PHYS 205B: UNIVERSITY PHYSICS

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

Date: 2025 Apr 15

(Name) (Signature)

Instructions

1. Seating direction: On even-numbered seats in alternate rows, B, D, F, ...
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. Academic misconduct will lead to a failing grade in the course.

1. (**5 points.**) An electron that has velocity $\vec{\mathbf{v}} = \hat{\mathbf{i}}\, 2.0 \times 10^6\,\mathrm{m/s}$ moves through a magnetic field $\vec{\mathbf{B}} = \hat{\mathbf{k}}\, 0.30\,\mathrm{T}$. Find the magnetic force on the electron.

2. (**5 points.**) Figure 1 shows a current carrying wire that is on the z axis. The directions of currents, either going into the page or coming out of the page, is shown in the figure. Draw the direction of the magnetic field at the point P.

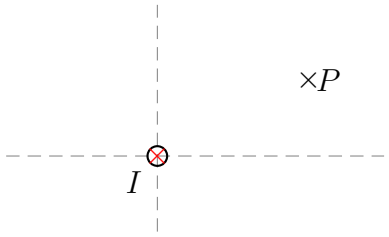

Figure 1: Problem 2

3. (**5 points.**) Two infinitely long straight wires parallel to each other carry steady currents I_1 and I_2 in opposite directions as shown in Figure 2. What are the directions of the magnetic force exerted by the wires on each other?

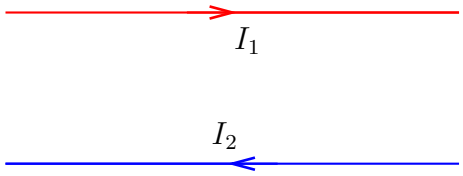

Figure 2: Problem 3

4. (**5 points.**) Figure 3 shows a snapshot of a rectangular coil being moved through a uniform magnetic field directed into the page. Determine the direction of induced current in the loop at the instance shown in the figure.

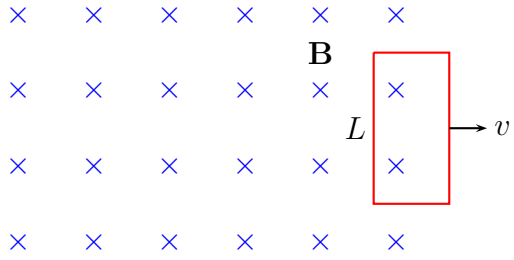

Figure 3: Problem 4.

5. (**10 points.**) A loop in the shape of a right triangle of sides $a = 3.0\,\text{cm}$ and $b = 2.0\,\text{cm}$, carrying a current $I = 2.0\,\text{A}$, is placed in a uniform magnetic field of strength $0.30\,\text{T}$ going into the page. See Figure 4. Determine the magnitude and direction of the force on side 1 of the triangle.

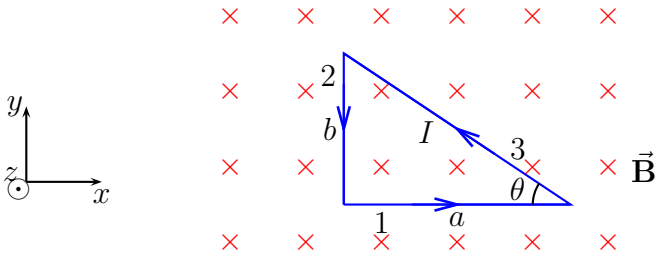

Figure 4: Problem 5.

6. (**10 points.**) Figure 5 shows two current carrying wires, in a plane. 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 magnetic field at the point $\times$, the origin. Let $I_1 = 1.0\,\mathrm{A}$, $I_2 = 2.0\,\mathrm{A}$, $x = 12\,\mathrm{cm}$, and $y = 8.0\,\mathrm{cm}$.

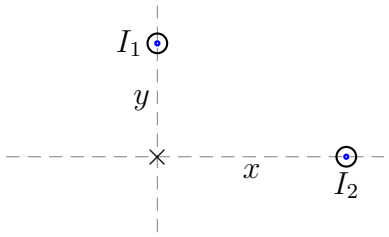

Figure 5: Problem 6

7. (**10 points.**) Figure 6 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 $R = 0.40\,\Omega$.

   (a) Is the magnetic flux in the loop increasing or decreasing?

   (b) What is the direction of the induced current in the loop?

   (c) Determine the magnitude of the induced current in the loop.

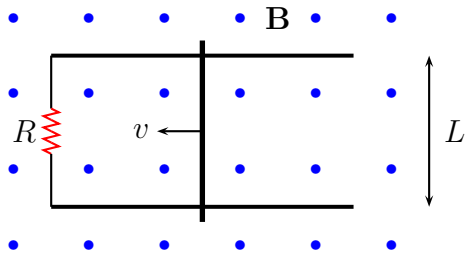

Figure 6: Problem 7