Midterm Exam No. 03 (2022 Fall)

PHYS 205B: UNIVERSITY PHYSICS

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

Date: 2022 Nov 10

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 4.
2. Total time = 75 minutes.
3. There are 4 conceptual questions and 3 problems in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to show your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. (**5 points.**) What is the dimension of

$$\frac{1}{\sqrt{\mu_0 \varepsilon_0}}. \tag{1}$$

2. (**5 points.**) What is the magnitude and direction of the magnetic force on an electron when it is moving in the direction of the magnetic field?

3. (**5 points.**) Draw the magnetic field lines of a solenoid of finite length.

4. (**5 points.**) Figure 1 shows a rectangular coil immersed in a magnetic field directed into the page. Determine the direction of induced current in the loop if the magnitude of the magnetic field is increasing monotonically.

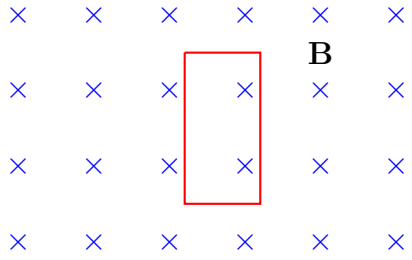

Figure 1: Problem 4.

5. (**10 points.**) A current of 1.0 A is maintained in a single loop in the shape of a square of sidelength 5.0 cm. Determine the magnetic dipole moment of the loop.

6. (**10 points.**) Figure 2 shows two infinitely long parallel current carrying wires coming out of the plane perpendicular to the 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 exerted by the wire carrying I_2 on the wire carrying current I_1. Given $I_1 = 1.0\,\text{A}$, $I_2 = 2.0\,\text{A}$, $x = 12\,\text{cm}$, and $y = 8.0\,\text{cm}$.

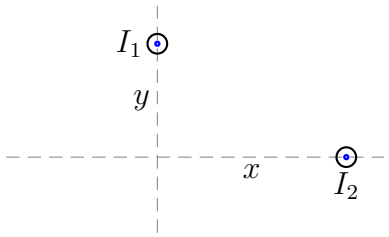

Figure 2: Problem 6

7. (**10 points.**) Figure 3 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 $L = 5.0\,\text{cm}$, $v = 10.0\,\text{m/s}$, $B = 0.30\,\text{T}$, and $R = 3.0\,\Omega$. Determine the magnitude and direction of the induced current in the loop.

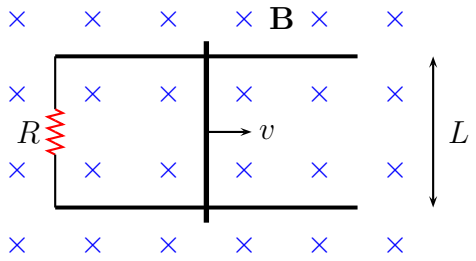

Figure 3: Problem 7