Midterm Exam No. 03 (2015 Spring)

PHYS 205B: University Physics

Date: 2015 Apr 16

____________________ (Name)

____________________ (Signature)

Instructions

1. Total time = 75 minutes.
2. There are 10 questions in this exam.
3. Equation sheet is provided separately.
4. To obtain partial credit for your work you need to show your work in detail and organize it clearly.

1. (**10 points.**) A particle with positive charge $q = 3.20 \times 10^{-19}\,\mathrm{C}$ moves with velocity

$$\mathbf{v} = (2\,\hat{\mathbf{i}} + 3\,\hat{\mathbf{j}} - \hat{\mathbf{k}})\,\frac{\mathrm{m}}{\mathrm{s}} \tag{1}$$

through a region where both a uniform magnetic field $\mathbf{B}$ and a uniform electric field $\mathbf{E}$ exist. Calculate the total force $\mathbf{F}$ on the moving particle (in unit-vector notation) if

$$\mathbf{E} = (4\,\hat{\mathbf{i}} - \hat{\mathbf{j}} - 2\,\hat{\mathbf{k}})\,\frac{\mathrm{V}}{\mathrm{m}} \tag{2}$$

and

$$\mathbf{B} = (2\,\hat{\mathbf{i}} + 4\,\hat{\mathbf{j}} + 1\,\hat{\mathbf{k}})\,\mathrm{T}. \tag{3}$$

2. (**10 points.**) A horizontal conductor in a power line carries a current of 6000 A flowing from South to North. Earth's magnetic field of $60.0\,\mu$T points toward the North and is inclined downward at 72° to the horizontal. Find the magnitude and direction of the magnetic force on 160 m of the conductor due to Earth's field.

3. (**10 points.**) Two long straight wires enter a room through a window. One carries a current of 3.0 A into the room while the other carries a current of 5.0 A out. What is the magnitude of the path integral $\oint \vec{\mathbf{B}} \cdot d\vec{\mathbf{l}}$, where the path of integral is about the edge of the window and is counterclockwise when you look at it from outside the window?

4. (**10 points.**) A charged particle initially moving with constant speed v enters a region of magnetic field $\mathbf{B}$ pointing into the page. It is deflected as shown in Fig. 4.

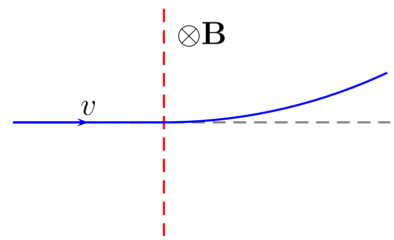

Figure 1: Problem 4

(a) Is the charge on the particle positive or negative?

(b) What curve characterizes the path of the deflected particle?

5. (**10 points.**) A wire carrying current i has the configuration shown in Figure 2. Two semi-infinite straight sections, both tangent to the same circle, are connected by a circular arc, of central angle θ, along the circumference of the circle, with all sections lying in the same plane. What must θ be in order for B to be zero at the center of the circle?

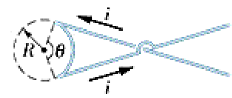

Figure 2: Problem 5.

6. (**10 points.**) An elastic conducting material is stretched into a circular loop of 13 cm radius. It is placed with its plane perpendicular to a uniform 0.600 T magnetic field. When released, the radius of the loop starts to shrink at an instantaneous rate of 72 cm/s.

   (a) What is the direction of the induced current?

   (b) What emf is induced in the loop at that instant?

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 $L = 10\,\mathrm{cm}$, $v = 5.0\,\mathrm{m/s}$, $B = 1.2\,\mathrm{T}$, 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.

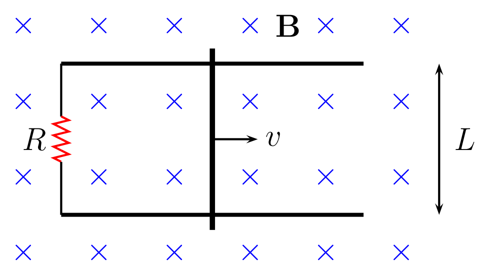

Figure 3: Problem 7

8. (**10 points.**) Figure 4 shows five snapshots of a rectangular coil being pushed across the dotted region where there is a uniform magnetic field directed into the page. Outside of this region the magnetic field is zero. Determine the direction of induced current in the loop at each of the five instances in the figure.

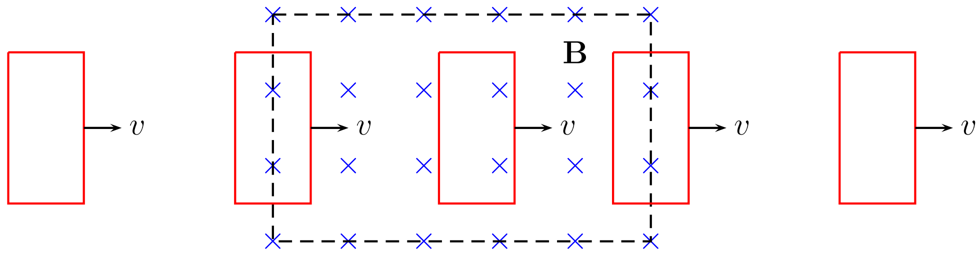

Figure 4: Problem 8

9. (**10 points.**) A car travels northward at 75 km/h along a straight road in a region where the Earth's magnetic field has a vertical component of 0.50×10^{-4} T. What will be the emf induced between the left and right side, separated by 1.7 m?

10. (**10 points.**) The current in an RL circuit builds up to one-third of its steady state value in 3.30 s. Find the inductive time constant.