

Printed Name: \_\_\_\_\_

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## PHYSICS 222 - SECTION 1

### EXAM 4

April 27, 2009

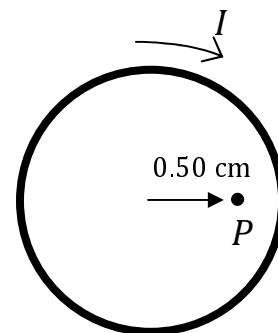
**Instructions:** When you are told to begin, check that this examination booklet contains all the numbered pages from 2 through 4. Read each problem carefully so that you are certain what it is asking. Do not panic or be discouraged if you cannot do every part of every problem. If a part of a problem depends on a previous answer you have not obtained, define a symbol for it and proceed to maximize your credit. Keep moving to finish as much as you can!

**You must show your work.** The purpose of this exam is to show how well you understood the material we have covered. You must include an adequate explanation, including correct equations where applicable, for full credit. A number with no explanation will not get credit. **Show your answer's units**, and give an adequate number of significant digits. Completely numerical solutions showing no equations are not eligible for partial credit. Do not use scratch paper. Indicate any work on the backs of the pages that you wish to be considered.

**Box your answers.**

This examination is administered under the Cadet Honor Code. All suspected violations must be reported appropriately. The seat next to you must be unoccupied. No talking is permitted during the examination, apart from questions to the instructor. You may use a scientific calculator, but may not use "advanced features", including graphing, solving, derivatives, integrals, symbolic manipulation, or equation storage capabilities. Any other electronic devices, including headphones, cell phones, PDAs, and MP3 players, may not be used during the exam in any way. You may use the equation sheet distributed with the exam. No other notes or textbooks may be open during the exam.

1. **[18pt]** The figure shows the cross-section of a 30 cm long solenoid with a cross-sectional area of  $2.4 \text{ cm}^2$ . The solenoid has 1600 turns of wire. If the time  $t$  is given in seconds, the current in the wire is  $I = (40.0 t^2 + 1.80)$  Amperes.



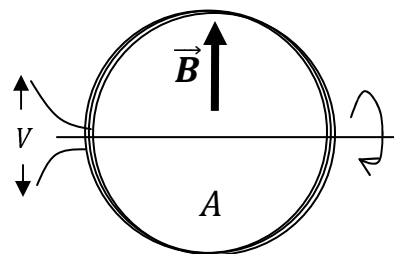
- (a) [5pt]** What is the magnetic flux through the cross section shown at  $t = 0$ ? Is it into or out of the page, if the current circles clockwise about the solenoid?

- (b) [4pt]** What is the inductance of the solenoid?

- (c) [4pt]** What emf is generated in the solenoid at time  $t = 0$ ?

- (d) [5pt]** What is the electric field at point  $P$ , a distance of 0.50 cm from the center? Give the magnitude and direction (up, down, left, right, into or out of the page).

2. [16pt] A coil of area  $0.100 \text{ m}^2$  with 125 turns of wire is rotating at  $60.0$  cycles per second with the axis of rotation perpendicular to a  $0.025 \text{ T}$  magnetic field, as shown. At this instant in the picture, the top of the coil is coming toward you and the bottom is moving away from you. The two wires coming out on the left are the ends of the coil.



- (a) [6pt] What is the maximum voltage measured between the two lead wires as the coil rotates?
- (b) [2pt] What is the orientation of the coil with respect to the magnetic field when the maximum induced voltage occurs?
- (c) [4pt] What are the magnitude and direction (clockwise, counter-clockwise, or zero) of the current flow if the coil is attached to a  $100 \Omega$  resistance, at the instant shown in the figure? Neglect the coil's resistance and inductance.
- (d) [4pt] What is the average power generated in the coil over a complete revolution?

3. **[16pt]** The electric field of a plane radio wave propagating in the  $x$ -direction points along the  $y$ -axis and has the functional form  $E_y = (0.120 \text{ V/m}) \sin(kx + \omega t)$ . The frequency of the transmission is 900 MHz (Hz = cycles per second).

(a) **[2pt]** Which direction (left or right) is the wave moving along the  $x$ -axis?

(b) **[4pt]** What is the wavelength of the wave, which is typical of a cellular telephone transmission?

(c) **[4pt]** What is the amplitude of the magnetic field vector?

(d) **[2pt]** When the electric field has its maximum upward value, which way does the magnetic field point?

(e) **[4pt]** What is the average intensity (power per unit area) of the wave?