Student ID Number: _____

PRELIMINARY EXAMINATION

Department of Physics
University of Florida
Part B, January 6, 2015, 14:00–17:00

Instructions

1. You may use a calculator and CRC Math tables or equivalent. No other tables or aids are allowed or required. You may **NOT** use programmable calculators to store formulae.

   (a) All of the problems will be graded and will be tabulated to generate a final score. Therefore, you should submit work for all of the problems.

   (b) For convenience in grading please write legibly, use only one side of each sheet of paper, and work different problems on separate sheets of paper. The sheets for each problem will be stapled together but separately from the other two problems.

   (c) Your assigned student **ID Number**, the **Problem Number**, and the **Page Number** should appear in the upper right hand corner of each sheet. Do **NOT** use your name anywhere on the Exam.

   (d) All work must be shown to receive full credit. Work must be clear and unambiguous. Be sure that you hand your completed work to the Proctor.

   (e) Each problem is worth 10 points.

   (f) Following the UF Honor Code, your work on this examination must reflect your own independent effort, and you must not have given, nor received, any unauthorized help or assistance. If you have any questions, ask the Proctor.

University of Florida Honor Code: We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: *"On my honor, I have neither given nor received unauthorized aid in doing this assignment."*

DO NOT OPEN EXAM UNTIL INSTRUCTED

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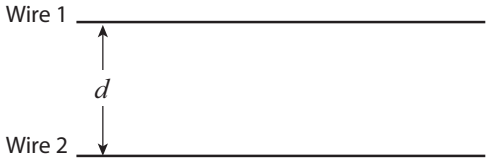
B1. **EM Question From Biswas**

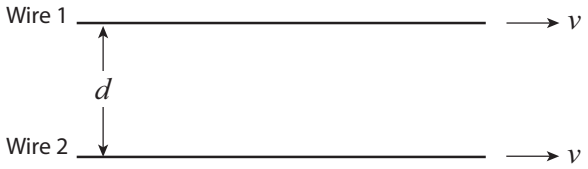
Two infinite lines (wires) of charge with uniform charge density λ are a distance d apart.



(a) **[2 points]** What is the electrostatic force dF on an infinitesimal length dl of wire 1 due to the electric field of wire 2? Show the direction of the force in the figure.

(b) **[2 points]** Find the total electrostatic force on a length L of wire 1 due to the electric field of wire 2 is:

Now suppose that the two wires are moving with a velocity v as shown below:



(c) **[2 points]** What is the current due to the moving charges in each wire?

(d) **[2 points]** Find the magnetic force on a length L of wire 1 due to wire 2 is and show the direction of the force in the figure.

(e) **[2 points]** At what speed (if any) will the two forces cancel each other out? (Calculate the value.)

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B2. **Question From Whiting**

A long coaxial cable has a solid inner circular core of radius a and a thin outer concentric conductor a distance b from the center.

(a) **[6 points]** Derive an expression for the self-inductance per unit length of the cable.

(b) **[4 points]** Use this to give an expression for the energy stored per unit length of the cable if it carries a constant current I.

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DEPARTMENT OF PHYSICS

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B3. **- Qiu**

A very long solenoid of radius a, with N turns per unit length, carries a current I_s. Coaxial with the solenoid, at radius $b >> a$, is a circular ring of wire, with resistance R. When the current in the solenoid is decreased at a small rate, $dI_s/dt = \delta$, a current I_r is induced in the ring.

(a) **[2 points]** Calculate the induced current I_r in the ring in terms of the N, a, b, R, δ.

(b) **[2 points]** Determine the power delivered to the ring from the solenoid.

(c) **[3 points]** Calculate the Poynting vector just outside the solenoid by find the electric field due to the changing flux in the solenoid and the magnetic field due to the current in the ring.

(d) **[3 points]** Determine the power transferred from the solenoid to the ring using the Poynting vector obtained in (c).

A helpful integral

$$\int \frac{dx}{(c^2+x^2)^{\frac{3}{2}}} = \frac{x}{c^2(c^2+x^2)^{\frac{1}{2}}}$$