Student ID Number: ________

PRELIMINARY EXAMINATION

Department of Physics
University of Florida
Part B, January, 2016, 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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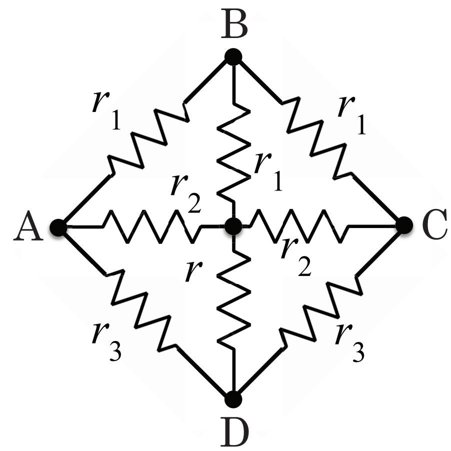
B1. **(Korytov)** Eight resistors are connected as shown in the figure.



(a) [**4 points**] What is the equivalent resistance between points A and C?

(b) [**6 points**] What is the equivalent resistance between points B and D?

Hint: Before taking a brute force path of writing out Kirchoff's law equations, take a moment to contemplate over potentials and currents in the circuit, should some difference potentials be applied across the pairs of circuit points specified in the problem. You may find that with some good reasoning the problem can be greatly simplified.

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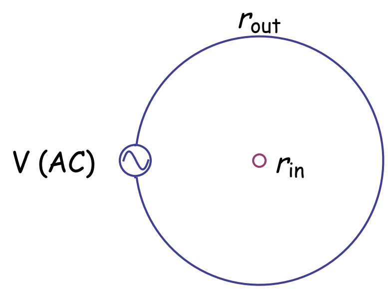
B2. **(Saab)** Two concentric loops have radii r_{in} and r_{out}, with $r_{in} \ll r_{out}$. The loops are made from a wire which has a resistance per unit length of ρ. An AC voltage is applied to the outer loop given by: $V_{out}(t) = \mathcal{E}_0 \sin(\omega t)$.

Note 1: You can assume that the self-inductance of the loops is negligible, *i.e.*, $R_{loop} \gg \omega L_{loop}$

Note 2: If you do not know/recall the specific numerical factors for the various terms in the solution, at least express your answer in terms of the appropriate powers of the provided physical variables such as $r_{out}, r_{in}, \rho, \ldots$



(a) **[6 points]** What is the magnitude of the induced current in the inner loop? (Hint: *Use the fact that $r_{in} \ll r_{out}$ to simplify the determination of the magnetic flux Φ_B in the inner loop.*)

(b) **[2 points]** At a given moment in time, in what direction is the instantaneous current in the inner loop with respect to the current in the outer loop?

(c) **[2 points]** If the outer loop is rotated by 90° along an axis that passes through the diameter of the loop, what is the new magnitude of the induced current in the inner loop?

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DEPARTMENT OF PHYSICS

UNIVERSITY OF FLORIDA

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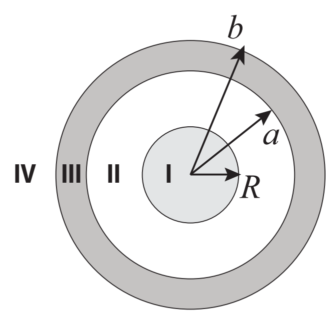
B3. **(Obukhov)** A non-conducting sphere of radius R carries a charge density

$$\rho = \frac{k}{r}$$

in the region $r \leq R$, where k is a positive constant and r is the distance from the center of the sphere (see the figure). The sphere is surrounded by a thick, concentric conducting metal shell with an inner radius a and an outer radius b. The shell carries no net charge.



(a) [**2 points**] Find the surface charge density at the inner and the outer surface of the conductor.

(b) [**4 points**] Find the electric field $\vec{E}$ in all four regions (i) $r < R$; (ii) $R < r < a$, (iii) a$< r < b$, and (iv) $r > b$.

(c) [**3 points**] Find the potential V at the center of the sphere using infinity ($r = \infty$) as a reference point.

(d) [**1 point**] If the outer shell is grounded, what would be the potential at the center of the sphere using the same reference point as in part (c)?