University of Louisville
College of Arts and Sciences

Department of Physics and Astronomy PhD Qualifying Examination (Part I)

Spring 2015

Paper B – Electromagnetism

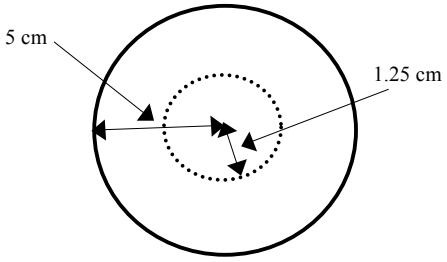
Time allowed – 90 minutes

Instructions and Information:

- Answer both questions
- This is a closed book examination
- Start each question on a new sheet of paper – use only one side of each sheet
- Write your identification number on the upper right hand corner of each answer sheet
- You may use a non programmable calculator
- Partial credit will be awarded.
- Correct answers without adequate explanations will not receive full credit.
- Make sure your work is legible and clear
- The points assigned to each part of each question is clearly indicated

E&M Basic

A solid (non conducting) sphere 5 cm in radius carries a uniform volume (negative) charge density. The electric field 1.25 cm from the sphere's center has magnitude 25 x 10^3 N/C.



(a) Write down Gauss's law (3)

(b) By applying Gauss's law over a sphere of radius 1.25 cm determine the volume charge density. [Use $\varepsilon_0 = 9 \times 10^{-12}$ F/m] (10)

(c) Use Gauss's law to determine another distance at which the electric field has the same magnitude. (12)

(d) Copy the diagram to your answer sheet and use dotted lines, to represent the surface over which you are applying Gauss's law (the Gaussian surface) in part (c). (2)

(e) Draw some representative electric field lines outside the sphere (use solid lines). Make sure you specify their direction with arrows. (2)

(f) Evaluate the net charge on the sphere. (6)

E&M Intermediate

(a) State and explain with the aid of a diagram the Biot-Savart law. Be sure to label the diagram clearly and define all the variables you have used. (15)

(b) A semicircular arc of current (I), radius a, lies in the xy plane with its center at the origin. Use the Biot-Savart law to obtain an expression for **B** at the origin due to this arc of current. (20)

(c) A complete loop, carrying I, is created by connecting the ends of this loop to another semicircular loop, with the same radius, lying in the xz plane. Determine the **B** field due to the complete current loop. (15)

(d) A point charge +q is located at the origin having velocity v_0 in the +z direction. What is the force exerted on q by the current loop ? (15)