#### ECE 3318

#### Applied Electricity and Magnetism

**Exam 1**

#### March 26, 2024

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Instructions**

1. This exam is open-book and open-notes.
2. Cell phones, laptops, ipads, and any other devices that have communication functionality are not allowed during the exam.
3. Show all of your work. No credit will be given if the work required to obtain the solutions is not shown.
4. Write neatly. You will not be given credit for work that is not easilylegible.
5. Leave answers in terms of the parameters given in the problem.
6. Show units in all of your final answers.
7. Circle your final answers.
8. Double-check your answers. For simpler problems, partial credit may not be given.
9. If you have any questions, ask the instructor. You will not be given credit for work that is based on a wrong assumption.
10. Remember the UH Academic Honesty Policy. You must not receive or give assistance to anyone else during the exam, or communicate with anyone other than the instructor during the exam.

**TABLE OF INTEGRALS**

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**Problem 1 (30 pts.)**

An electron beam of radius *a* flows along the *z* axis. The volume charge density inside the beam is given by

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The velocity of the electrons in the *z* direction is *v*0.

(a) Find the current density vector *J* inside the beam.

(b) Find the total current (in amps) flowing in the *z* direction inside the beam.

(c) Find the current (in amps) that flows upward through a small circular surface *S* of radius *δ* (where *δ* is much smaller than *a*) that is inside the beam, centered on the *z* axis. The surface *S* is tilted at an angle of 45o up from horizontal.

**ROOM FOR WORK**

**ROOM FOR WORK**

**Problem 2 (40 pts.)**

A spherical nonuniform volume charge density *ρv* [C/m3] exists inside of a spherical region *r* < *a*. This charge density is given by

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Surrounding this spherical charge region is a thin spherical shell of surface charge density  of radius *b*.

Surrounding the thin spherical shell of surface charge density is a PEC spherical shell of inner radius *c* and outer radius *d*. This PEC shell is neutral.

(a) Find the electric field vector in all five regions: *r* < *a*, *a* < *r* < *b*, *b* < *r* < *c*, *c* < *r* < *d*, *r* > *d*.

(b) Find the voltage drop *VAB* between point *A* (the origin) and point *B* (on the outer surface of the PEC shell, at *r* = *d*).

(c) What is the surface charge density on the inner surface of the PEC shell, at *r* = *c*?

(d) How much charge flows to ground if the outer PEC shell is grounded?





**ROOM FOR WORK**

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**Problem 3 (30 pts.)**

A circular loop of nonuniform line charge density *ρl* has a radius of *a* and lies in the *z* = 0 plane. The line charge density is given by

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Find the electric field component  at the point (0, 0, *h*) on the *z* axis.

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**ROOM FOR WORK**

**ROOM FOR WORK**