#### ECE 3318

#### Applied Electricity and Magnetism

**Exam 2**

#### April 28, 2022

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**General Instructions**

1. This exam is open-book and open-notes.
2. Show all of your work. No credit will be given if the work required to obtain the solutions is not shown.
3. Write neatly. You will not be given credit for work that is not **easily** legible.
4. Leave answers in terms of the parameters given in the problem.
5. Show units in all of your final answers.
6. Circle your final answers.
7. Double-check your answers. For simpler problems, partial credit may not be given.
8. If you have any questions, ask the instructor. You will not be given credit for work that is based on a wrong assumption.

**TABLE OF INTEGRALS**

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Problem 1 (35 pts.)

An annulus of surface charge density lying in the *z* = 0 plane is described by

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a) Calculate the potential function  at an observation point located at  in rectangular coordinates on the *z* axis, assuming that the potential is zero at infinity.

b) How would your answer change if the potential is now zero at the origin?



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****ROOM FOR WORK

ROOM FOR WORK

Problem 2 (30 pts.)

An infinite power line carrying a current in the *z* direction runs along the *z* axis. This produces a magnetic field that is described by

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where

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Find the output voltage of a rectangular loop sensor that is in the *xz* plane near the power line as shown below. Make sure that you get the sign right! (You can use Lenz’s law to help with this.)



ROOM FOR WORK

ROOM FOR WORK

Problem 3 (35 pts.)

A spherical conducting PEC shell of radius *a* is surrounding by another PEC shell of larger radius *b*. Between the two shells is a dielectric material having a relative permittivity . The inner shell is at a potential of  volts and the outer shell is at a potential of volts.

a) Find the potential function Φ in the region *a* < *r* < *b*.

b) Find the surface charge density  on the outer surface of the inner PEC shell, at *r* = *a*.

c) Find the capacitance between the two PEC shells, using your answers to the above parts.

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ROOM FOR WORK

ROOM FOR WORK

BONUS PROBLEM (5 pts.)

A video was recently add to the Blackboard site, showing a car being struck by lightning. Give the two basic electrostatic principles that were illustrated in the video, which explain the following:

(1) why the antenna on the car was struck;

(2) why the driver inside the car was safe.