##### DO NOT BEGIN THIS EXAM UNTIL TOLD TO START

# Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_SOLUTION\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

#### ECE 2317

#### Applied Electricity and Magnetism

**Exam 1**

#### Oct. 18, 2012

1. This exam is closed-book and closed-notes notes. A formula sheet is provided.
2. Show all of your work. No credit will be given if the work required to obtain the solutions is not shown.
3. Perform all your work on the exam in the space allowed.
4. Write neatly. You will not be given credit for work that is not **easily** legible.
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. Make sure you sign the academic honesty statement on the next page.

Academic Honesty Statement

I agree to abide by the UH Academic Honesty Policy during this exam. I understand that the punishment for violating this policy will be most severe, including the possibility of getting an F in the class and/or getting expelled from the University.

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Signature

FORMULA SHEET





























**TABLE OF INTEGRALS**

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TABLE OF COORDINATE SYSTEM FORMULAS

 

 

 































Problem 1 (20 pts.)

**Give short answers to the questions below.**

1. What are the advantages of grounding an object? Give at least two.

(1) Safety (less likely to have a shock or a spark that could cause an explosion).

(2) To reduce noise due to static buildup on equipment.

1. What is the name of the principle that says you are fairly safe if you stay inside your car if it is struck by lightning?

The Faraday cage effect.

1. The IEEE convention says that current flows in the direction that positive charge move in. Who was the person that was originally responsible for this convention?

Benjamin Franklin

1. True or false: By grounding a part of a circuit, we ensure that this point of the circuit has a voltage of zero.

False. Grounding has nothing to do with the selection of a reference point.

1. True or false: In statics, there can never be a voltage drop between two points inside an isolated conducting object, even if the object is not a perfect conductor.

True. Since the object is isolated, there is no current density inside the object in static equilibrium, and hence from Ohm’s law there is no electric field inside.

Problem 2 (20 pts.)

A round copper wire has a diameter of 1 [mm]. The wire is oriented so the axis is running along the *z* direction. The wire carries a 60 Hz current, so that *f* = 60 [Hz]. The current in the *z* direction as a function of time *t* is given by

.

Determine an equation for the velocity vector *v* as a function of time for the electrons inside the wire that are moving. You may assume that the density of the electrons in the conduction band (the electrons that are free to move) is



and that each electron has a charge of

.

Solution



so

.

Hence, we have

.

Evaluating this, we have



or

.

**Extra Room for Work**

Problem 3 (30 pts.)

A spherical distribution of volume charge density (in [C/m3]) is characterized by



where *A* is a constant.

a) Calculate the electric field vector for both *r* < *a* and *r* > *a*.

b) Derive an expression for the voltage drop *VAB* where *A* is the origin and *B* is at infinity. You do not have to evaluate any integrals that appear in your answer. In other words, you can leave your answer in the form of one or more integrals.

Solution

Part (a)

From Gauss’s law we have

 .

The charge enclosed is:

*r* ≤ *a*:



*r* ≥ *a*:



Hence, we have

*r* ≤ *a*:



*r* ≥ *a*:



Part (b)



so

 .

**Extra Room for Work**

Problem 4 (30 pts.)

A uniform surface charge density *ρs*0 lies on the surface of a hemisphere, as shown below. The hemisphere is described by *r* = *a* and *z* > 0.

Determine the *z* component of the electric field vector (i.e., *Ez*) that exists at the origin.

(Note: there should only be a *z* component of the electric field at the origin, from symmetry.)

*x*

*y*

*z*



Solution



We have



We then also have



Hence



or



Hence we have



The final result is



**Extra Room for Work**