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

#### ECE 3318

#### Applied Electricity and Magnetism

**Final Exam**

#### May 9, 2017

**11:00 a.m. – 2:00 p.m.**

**CBB-122**

1. This exam is open-book and open-notes. A calculator is allowed (as long as it cannot be used to communicate), but no other device (laptop, phone, tablet, etc.) is allowed.
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

**TABLE OF INTEGRALS**

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Problem 1 (20 pts.)

A spherical shell of uniform surface charge density *ρs*0 has a radius of *a* and is centered at the origin. Find the voltage drop *VAB*, where point *A* is the origin and point *B* is a point on the *z* axis at *z* = 2*a*.

**Room for Work**

**Room for Work**

Problem 2 (20 pts.)

There are two spherical electrodes that are situated inside of a tank of conducting liquid, which has a conductivity of *σ*. Each spherical electrode has a radius of *a*, and the separation between the centers of the spherical electrodes is *h*.

Find the resistance between the two spherical electrodes (i.e., the resistance seen between the points *A* and *B*). Assume that the tank is large enough so that the electrodes may be assumed to be within an infinite conducting medium. Also assume that the electrodes are far apart compared with their diameters. Ignore the effects of the connecting wires. (This is a reasonable assumption if the wires are insulated.)

Assume that the origin is at the center of the left electrode, and that the *x* axis runs horizontally to the right. Therefore, the center of the right electrode is at *x* = *h*.

**Room for Work**

**Room for Work**

Problem 3 (20 pts.)

A conducting slab carries a current of *I* Amps in the *z* direction. The slab has width *w* and thickness *d*. Below the slab is a sheet of planar surface current, carrying a total of *I* amps in the negative *z* direction. The sheet also has width *w*. The problem is infinite in the *z* direction, and a cross section of the problem is shown below.

The width *w* is large enough so that you may assume that the magnetic field in the problem does not depend on *x*. Also, assume that the volume current density inside the slab is uniform, and the surface current density on the sheet is uniform.

Find the magnetic field vector in all four regions:

a) *y* < 0

b) 0 < *y* < *h*

c) *h* < *y* < *h*+ *d*

d) *y* > *h*+*d*

**Room for Work**

**Room for Work**

Problem 4 (20 pts.)

A square loop of current *I* lies in the *z* = 0 plane, centered at the origin, as shown below. Find the magnetic field *H* on the *z* axis.

You may use symmetry as much as possible to help you. For example, what direction will the magnetic field be in at the observation point? How will the contributions from the four different sides compare when calculating this component of the magnetic field? You may use your answers to these questions to save you time.

**Room for Work**

**Room for Work**

Problem 5 (20 pts.)

Two coils are wound on a transformer core as shown below. Find a formula for the mutual inductance *M*21 between the two coils, in terms of the parameters given. Make sure that you get the sign right!



**Room for Work**

**Room for Work**