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

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

#### ECE 2317

#### Applied Electricity and Magnetism

**Final Exam**

#### Dec. 10, 2014

#### 11:00 a.m. – 2:00 p.m.

1. This exam is open-book and open-notes notes. No devices that may be used to communicate are 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.

­­­­­­­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Signature

Prob. 1 (25 pts.)

A uniform surface charge density *ρs*0 lies in the *z* = 0 plane in the region *ρ* < *a*, 0 < *φ* < *π* /2. (This is the region that is inside of a circle, in the first quadrant of the *xy* plane.)

a) Calculate the potential Φ(*z*) on the positive *z* axis at (0, 0, *z*), assuming that the potential is zero at the origin.

b) Calculate the electric field component *Ez* on the positive *z* axis at (0, 0, *z*).

*y*

*z*

*a*

*x*

*r*

*ρs*0

ROOM FOR WORK

Prob. 2 (25 pts.)

A perfectly conducting metal sphere with a radius *a* is above an infinite conducting floor as shown below. Assume that the floor is at a potential of zero volts. The center of the sphere is at a height of *h* above the floor.

Find the maximum voltage *V*0max that can be placed on the sphere before the air breaks down at the bottom of the sphere. Assume that the air has a breakdown field strength of *Ec*.

Sphere

*h*

Air

ROOM FOR WORK Prob. 3 (25 pts.)

A high-voltage power line has a radius of *a* and the center is at a height of *h* above the ground. The line is infinite in the *z* direction. The current on the line in the *z* direction is

.

The current may be assumed to flow along a filament at the center of the line. The frequency is low enough that at any instant of time, the problem can be treated as a magnetostatic problem.

If we assume that the earth is acting as a good conductor, then the magnetic field at any point on or above the earth can be found using image theory, in which the earth has been replaced by an image current that is flowing in a direction opposite to the original current, at a distance *h* below the surface of the earth.

a) Find the magnetic field vector *H* at a point on the surface of the earth that is directly below the power line (at *x* = 0).

b) Find the magnetic field vector *H* at a point above the wire at *x* = 0, *y* = *d* (where *d* > *h* + *a*).

*y*

*x*

Earth

Power line

*h*

ROOM FOR WORK

Prob. 4 (25 pts.)

An infinite wire has a 90o bend as shown below. Find the magnetic field vector *H* at a point on the *y* axis at a distance *h* from the origin.

*y*

*z*

*h*

*x*

*r*

*I*

ROOM FOR WORK

Prob. 5 (25 pts.)

A parallel-plate transmission line consists of two flat strip conductors as shown below, which are infinite in the *z* direction. Assume that *w* is large compared to *h*, so that you may neglect fringing.

a) Determine the stored magnetic energy per unit length in the *z* direction.

b) Calculate the inductance per unit length in the *z* direction from the stored energy.

# *I*

*x*

*y*

*w*

*z*

*I*

*h*

*I*

ROOM FOR WORK