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

#### ECE 3318

#### Applied Electricity and Magnetism

**Final Exam**

#### May 7, 2019

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 volume charge density *ρv* exists everywhere in free space. The charge density in spherical coordinates is described by

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Find the electric field vector at any point in space.

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Problem 2 (20 pts.)

A conducting spherical electrode of radius *a* is suspended with its center at a height *h* above the bottom of a large metal tank filled with a conducting medium having a conductivity *σ*. Derive a formula for the resistance between the electrode and the metal tank. The tank is large enough to be considered as infinite. The electrode and the tank may be assumed to be made of perfect conductors.



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Problem 3 (20 pts.)

A high-power coaxial cable has an inner tube-shaped conductor, which is a tube of inner radius *a* and outer radius *b*. The inner conductor carries a current of *I* amps in the *z* direction. The outer conductor of the coax is a tube of inner radius *c* and outer radius *d*. This outer tube carries a current of -*I* amps in the *z* direction.

a) Find the magnetic field vector in all five regions: *ρ* < *a*, *a* < *ρ* < *b*, *b* < *ρ* < *c*, *c* < *ρ* < *d*, *ρ* > *d*.

b) Calculate the magnetic stored energy in a one-meter long section of line, assuming that the conducting tubes are nonmagnetic (*μ* = *μ*0). (Please see the note below.)

c) Calculate the inductance per unit length of the line. (Please see the note below.)

**Note:** For parts (b) and (c), you may leave your answers in terms of integrals of *ρ*. That is, you do not have to evaluate any integrals in *ρ* that appear in your answer*.*



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Problem 4 (20 pts.)

An infinite wire is shown below. The wire consists of two semi-infinite vertical segments and a horizontal segment of length 2*h*.

Find the magnetic field vector at a point on the *y* axis at *y* = *y*0 (where *y*0 > 0).



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Problem 5 (20 pts.)

A coil with *N* turns is wound on a high-permeability core as shown below. The core is square-shaped with an air gap in it. The cross-sectional area of the core is *A* square meters, and the relative permeability of the core is *μr*.

a) Find the inductance of the coil.

b) Find the magnitude and direction of the magnetic flux density vector inside of the air gap. (You may assume that the direction pointing vertically up is called the *z* direction.)

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