#### ECE 3318

#### Applied Electricity and Magnetism

**Final Exam**

#### May 13, 2021

**Please read carefully the Zoom instructions on the first page and the general instructions on the second page.**

**Zoom Instructions**

* You are not allowed to use your computer, or any other device, to communicate with anyone other than the instructor during the exam.
* If you wish to ask a question during the exam, please use the “chat” feature of Zoom to chat with the instructor (please chat only with the instructor, not with “everyone”).
* Please leave your camera on during the entire exam.
* Please leave yourself muted unless the instructor asks you to unmute yourself.
* By taking this exam, you agree to the UH Academic Honesty Policy. You understand that the penalty for violating the UH Academic Honesty Policy will be most severe, including getting an F in the course and/or getting expelled from the university.
* The exam has three parts (three problems). Make sure that you upload your solution (as a pdf file) to each problem during the allowed time window. Late submissions may not be accepted, or will be assigned a penalty.

**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 (25 pts.)

A wire of radius *a* is inside of a conducting tube of radius *b* as shown below. A voltage of *V*0 volts is applied between the wire and the pipe (which is at zero volts). The pipe is filled with air, which has a dielectric breakdown field strength of *Ec* [V/m]. The ratio *b*/*a* is assumed to be known and fixed.

a) Find a formula for the largest radius of the wire that will allow for dielectric breakdown to occur. Your answer should be in terms of *V*0, *Ec*, and *b*/*a*.

b) Assume that  and . Solve for the value of the wire radius *a*. Assume that we keep the radius *b*/*a*  to be fixed at a value of 100.



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****Problem 2 (25 pts.)

An infinite power line of radius *a* running in the *z* directionis at a height *h* above the surface of the earth as shown below. The power line carries a current in the *z* direction that is given by

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A small coil is placed on the surface of the earth at *x* = *d*. The coils has *N* turns and has a loop area of *A* [m2]. A top view of the coil is shown at the bottom.

Find the output voltage *v*(*t*) from the coil.

Since the earth is assumed to be nonmagnetic, you may neglect the presence of the earth in your calculations. (In other words, assume that the earth does not affect the magnetic field from the power line.)

















Problem 3 (25 pts.)

A transmission line runs in the *z* direction. It consists of two thick metal plates, each of thickness *t*, as shown below. Assume that the plates carry a DC current, with *I* [A] flowing in the *z* direction on the top plate, and *I* [A] flowing in the -*z* direction on the bottom plate.

Find the magnetic field vector in the region  (inside the top plate).

You may assume that the width of the plates *w* in the *x* direction is large compared to the vertical height of the structure, and that the current inside each plate is spread out uniformly.

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Problem 4 (25 pts.)

A wire carrying a current of *I* [A] runs vertically in the *z* direction from *z* = - ∞ up to a point on the *y* axis at *y* = *y*0. The wire then bends and runs along the *y* axis out to *y* = + ∞.

Find the magnetic field vector *H* at an observation point on the *z* axis, located at *z* = *h*.

You do not have to evaluate any integrals that appear in your answer. However, carry out the calculations to the point where all that is left is the evaluation of calculus integrals, which one could find in a table of integrals. (The integrands should not have any vectors in them.)













Problem 5 (25 pts.)

A coil is wrapped around an iron core with a relative permeability of as shown below. The cross-sectional are of the core is *A* [m2]. All segments of the core (including the middle segment) have the same cross-sectional area *A*. Each segment of the core has the same length.

Find a formula for the inductance of the coil.

