#### ECE 3318

#### Applied Electricity and Magnetism

**Final Exam**

#### May 6, 2025

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

**General Instructions**

1. This exam is open-book and open-notes.
2. Cell phones, laptops, ipads, and any other devices that have communication functionality are not allowed during the exam.
3. Show all of your work. No credit will be given if the work required to obtain the solutions is not shown.
4. Write neatly. You will not be given credit for work that is not easilylegible.
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. Remember the UH Academic Honesty Policy. You must not receive or give assistance to anyone else during the exam or communicate with anyone other than the instructor during the exam.

**TABLE OF INTEGRALS**

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**Problem 1 (30 pts.)**

A metal pipe of radius *a* is surrounded by a larger metal pipe of radius *c*. The region between the two pipes is filled with two different materials, as shown below. Material 1 has a conductivity of  and exists in the region . Material 2 has a conductivity of  and exists in the region . The length of the structure is *L*.

Find a formula for the total resistance between the inner and outer pipes. You may use any formulas from the class notes that you wish.



ROOM FOR WORK

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**Problem 2 (30 pts.)**

A bus line consists of two thick metal slabs (each with thickness *h*) as shown below. The structure is infinite in the *z* direction. Both slabs carry a DC current of *I* Amps in the *z* direction. (The current flows in the same direction inside both slabs.) Assume that *w* is large enough so that so that you may neglect fringing.

a) Find the magnetic field vector *H* inside the air gap, for .

b) Find the magnetic field vector *H* in the upper slab region, for .

c) Find the magnetic field vector *H* above the top slab, for .

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**Problem 3 (40 pts.)**

Find the magnetic field at the observation point *r* from the infinite wire shown below. The wire carries a DC current of *I* Amps, and it extends to infinity in the positive *x* direction and to infinity in the positive *z* direction. Do this by calculating the magnetic field from the two parts of the wire (horizontal and vertical) as indicated in the parts below.

a) Find the magnetic field vector *H* from the horizontal part of the wire.

b) Find the magnetic field vector *H* from the vertical part of the wire.



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**Bonus Problem (30 pts.)**

A type of transformer consists of three coils that are wound on a core as shown below (note how the coils are wound and the current reference directions). Also note that all segments of the core have a cross-sectional area of *A* and a length of *L*. Assume that the relative permeability of the core  is high enough so that we can neglect flux leakage.

a) Draw the magnetic circuit for this structure, assuming that all three currents are arbitrary. (Make sure that you show the polarity of the voltage sources in your circuit.)

b) Find a formula for . You may ignore coil #3 for this calculation.

c) Find a formula for the mutual inductance , where you can ignore coil #2. (Take advantage of your answer to part (b) to the extent possible, to save work.)



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