ECE5340/6340: Homework 2

Write your section (ECE5340 or ECE6340) by your name. Turn in a printed copy containing the problem solutions, plots, and the code used to generate them. Remember to comment and format the code so is legible to the graders. Label the plots appropriately, including units for each axis and for the values plotted. Assume all units to be SI units unless stated differently. Due Wednesday 1/25 BEFORE class begins.

Problem 1

Consider a single-turn circular coil having a diameter of 0.5 m, placed in the y=0 plane, with its center at the point (x=1, z=1). A current of 1A is circulating in the coil in the clockwise direction when looking at the coil from the positive octant (i.e. from point x=1, y=10, z=1).

1. [10*points*] Draw the setup described above by hand, including the Cartesian coordinate axes, the coil, and indicate the direction of the current in the coil and the coordinates of the center point of the coil.

2. [15*points*] Create a line plot of the magnitude of the B field over a line crossing the point (x=0.75, y=10, z=0.75) and parallel to the Y-axis, between y=1 and y=10.

3. [25*points*] Create a plot of the magnitude of the B field at the plane y=5, in the area delimited by $-5 < x < 5$ and $-5 < z < 5$

Problem 2

1. [10*points*] Using the Divergence Theorem, and starting from the integral form of Gauss's Law for E fields, derive the expression for the differential form of the same law.

2. [10*points*] What is the total net magnetic flux passing through a spherical closed surface? And the total net magnetic flux passing through a cuboid closed surface? What if the cuboid is missing a face (e.g. the surface is not closed)?

3. [10*points*] Why is the divergence of a B field equal to zero?

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4. [10*points*] On your own words: What is circulation of a vector field over a curve? In terms of physics, what does it represent?

5. [10*points*] If the circulation of a vector field over a curve is zero, what can we say about the vector field?