Engineering Electromagnetics
Laboratory Exercise No. 3 – Magnetostatics

Objective

In this lab, you will use Maxwell to visualize several magnetostatic fields in and around coils while the current through the coil is constant. To do this, variations of a coil and current will be modeled using ANSYS Maxwell. You will also use Maxwell to calculate inductance, the importance of core material, and compare the field patterns of a toroidal structure and a linear structure.

1 Magnetic Field in a Coil

1. Create a 1.5 turn copper coil with an inner diameter of 5mm and an outer diameter of 5.5mm
2. Apply an excitation of 100 A to the coil
3. Plot the magnetic field vectors around the coil
4. Comment on the strength and direction of the magnetic field
5. Calculate the inductance of the coil and compare it to Maxwell's calculation
6. Repeat steps 1-4 with a larger and smaller coil (increase/decrease the diameter of the wire itself). Comment on what you observe
7. Repeat steps 1-4 with a larger and smaller current running through the wire. Comment on what you observe

2 Adding Turns to the Coil

1. Create a 3.5 turn copper coil with an inner diameter of 5mm and an outer diameter of 5.5mm
2. Apply an excitation of 100 A to the coil
3. Plot the magnetic field vectors around the coil
4. Comment on the similarities/differences of the original coil from part 1
5. Calculate the inductance of the coil and compare it to Maxwell's calculation
6. Repeat steps 1-4 with current flowing in the opposite direction and explain your results
7. Repeat steps 1-4 with an additional 2 turn in your coil.

NOTE **if your computer is running slow, lower the number of sides of your helix.**

3 Changing the Pitch of the Coil

1. Create a 4.5 turn copper coil with an inner diameter of 5mm and an outer diameter of 5.5mm (make the pitch 4*the radius of the coil)
2. Apply an excitation of 100 A to the coil

3. Plot the magnetic field vectors around the coil
4. Calculate the inductance of the coil and compare it to Maxwell's calculation
5. Repeat steps 1-4 with as small of a pitch as possible. Explain the similarities and differences.
6. Repeat steps 1-4 with a pitch of at least 10 times the size of the radius. Explain the similarities and differences.

4 Making a Toroidal Structure

1. Create a Toroidal Structure out of your segmented helix
2. Apply an excitation of 100 A to the coil
3. Plot the magnetic field vectors around the coil
4. Repeat steps 1-4 with as small of a pitch as possible (as little space as possible). Explain the similarities and differences.
5. Repeat steps 1-4 with larger pitch. Explain the similarities and differences.

5 Try something on your own!

For example, how do the fields change if you make a tapered coil? Be creative!

Laboratory Write-Up

The content of the report is very important. Explain all results in detail. Handing in a lab with excellent data and no explanations is not sufficient. The lab should be in IEEE format, and any hand calculations should be shown in the appendix.