Engineering Electromagnetics
Laboratory Exercise No. 1 – Maxwell Tutorial

Objective

Maxwell is the premier software used by engineers for simulating electromagnetic fields in different devices. These devices include motors, actuators, transformers, sensors, and coils. The objective of this lab is to learn the basics of performing a simulation using Maxwell. This first lab will only be used for electrostatic problems, but the steps required to successfully specify a geometry, set up boundary conditions, define an analysis and obtain results are similar for magnetostatic and electromagnetic problems.

Part 1 – Getting Started

The steps below are only designed to get you started. Experiment with the software to increase your understanding of the various steps required to successfully simulate an electrostatic problem.

1 Creating a Project

Before anything can be done in Maxwell, like most software programs, a project file must be created.

1. Open ANYS Maxwell.
2. Begin a new project ("File" → "New").
3. Insert a 3D drawing space into the project ("Project" → "Insert Maxwell 3D Design").
4. Select "Maxwell 3D" → "Solution Type" and check the "Electrostatic" option.

2 Creating the "Line"

Now with the project created, we can begin creating on simulation. Since this experiment is focused on an infinitely-long line, we begin by drawing the line. However, since we have selected 3D design we must actually create an infinitely-long cylinder.

1. Select "Draw" → "Cylinder"
2. Enter the starting coordinates of your cylinder. This is the center of your bottom circle meaning the cylinder will extend up from the point selected. You may choose any starting point. A recommendation is (0,0,-0.5)
3. Enter the radius and endpoint. The endpoint determines the height of your cylinder. Once again you may choose any radius and endpoint, but choosing a height too large will cause simulation time to increase dramatically. The recommendations are a radius of 2 and a height of 10. Choosing a radius less than 1 may cause the electric field lines to not display properly later on in the tutorial.

3 Adding the Charge and Material

Now that we have our cylinder created, we must add "material" to the cylinder. This will give our simulation the same properties as any material we want. Charge is also added to the cylinder for obvious reasons.

1. Click on "Maxwell 3D" → "Excitations" → "Assign" → "Floating"
2. Enter a value for the charge. Any value may be entered. A recommendation is 1000 C.
3. Click on the cylinder and go to the properties tab.
4. On the material line select value and then edit.
5. Choose the material you wish to use here. Any material can be used but a recommendation is a perfect conductor.

4 Add a Region

Once the charge and material have been decided, we must define the region for which our simulation is to run in. To be more specific, this is the are around the cylinder for which Maxwell we compute the magnetic fields.

1. Select the cylinder and click "Draw" → "Region"
2. Choose the percentage offset of your region. This determines how far the region is to extend from your cylinder. You may choose any value between 10% and 50%. Choosing a value more than 50% may cause Maxwell to stop responding or crash. A good choice would be 20% in the x-y plane and 0% in the z plane.

5 Adding Field Lines

The last step is to add the analyzed field lines to the cylinder creating a nice visual of the object and the field lines associated with it. Before adding the lines to the cylinder, the simulation must be completed.

1. Selected "Maxwell 3D" → "Analysis Setup" → "Add Solution Setup." It is recommended to use default settings.
2. Select "Maxwell 3D" → "Analyze All." This will run the simulation.
3. Select "Maxwell 3D" → "Fields" → "Fields" → "E" → "E Vector." Maxwell will ask you to select a geometric shape before applying the fields if you haven't done so already. Make sure to click on the region around the cylinder for this step.
4. Select your region in the column labeled "volume" and click okay.

If done correctly, you should be able to properly view the electric field lines around the cylinder.

Part 2 – Solve an Electrostatic Problem of Your Choice

Now that you have a solid understanding of the process to simulate electrostatic problems, choose something to analyze. Some ideas include how a lightning rod modifies the electric fields, what happens to the electric fields near sharp corners, or whatever. Use your imagination to find a problem that would be difficult to solve analytically.

Part 3 – Laboratory Write-up

Part 1 of the lab is meant to serve as a tutorial so your writeup should be sufficiently detailed that somebody without Maxwell experience could start working with the program.

Part 2 is the problem you chose to solve. Your lab writeup should include a problem statement, the simulation and steps necessary to create it, and an explanation of the results. The explanation is crucial to be able to show that Maxwell is a tool that can solve electrostatic problems that are not easily solved analytically. Handing in excellent data without explanations is not sufficient. If you want a specific format, consider using the IEEE style sets for transaction publications.