Engineering Electromagnetics

Laboratory Exercise No. 4: Moving Magnetic Fields

Objective

In this lab, you will use Maxwell's Transient Solver to model Faraday's Law. You will model a

magnetic field moving through and around a coil to induce current within the coil.

A tutorial can be found at the following links:

- https://www.youtube.com/watch?v=LW9TcpkZaZY (Part 1)
- https://www.youtube.com/watch?v=MruPdh$_6$*hi*0 (*Part*2)*https* : *//www.youtube.com/watch?v* = *ZGn* −

1 Current Induced by Magnetic Field

You will demonstrate how the electric and magnetic fields react to a magnet moving through an inductor.

Structure

Coil

1. Create a 5-turn coil with an outer diameter 2 mm and wire thickness of 0.4 mm (diameter).
2. Extend the faces of the coil ends
   a. Select the face
   b. Right Click => Select Surface =>Sweep Along Normal (for 5 mm)
3. Select the coil and face extrusions and unite them
   a. Select all and Right-Click
   b. Edit => Boolean => Unite
4. Change the material to copper

[width=4.62425in,height=3.6118in]media/image1.png

Magnet

1. Create a Regular Polyhedron
   a. A shape of 8 segments
   b. A height of 1 mm and a diameter of 0.5 mm
2. Change the material to NdFe36

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Band

1. Create a Regular Polyhedron
    a. A shape of 12 segments
    b. A height of 25 mm and a diameter of 1 mm
2. Change the material to vacuum
3. (Optional) Change the transparency to 75%
    a. Select and Right-Click
    b. Edit => Properties => Transparent => 0.75

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Region

1. Create a Region
2. The Region can have 0 padding in all directions.

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Simulation

1. Transient for the Solution Setup
2. Add Motion Setup to the Band
    a. Select Band
    b. Go to Maxwell 3D => Model => Motion Setup => Assign Band
    c. Double-check that the motion will be along the z-axis
3. Set the initial position
    a. Go to the Data tab
    b. Set the initial position between the bottoms of the band and coil
    c. Add the negative and positive limits above bottom of the band and below the bottom of the coil
    d. Set the negative limit to the initial position
    e. Set the positive limit translational limit between the band and above the coil
4. Set the velocity
    a. Mechanical tab and set the velocity in mm/s.
    b. Set the velocity to 10 mm/s

Excitation

1. Add a Coil Terminal Excitation
    a. Select the face of the end of the coil and Right-Click
    b. Assign Excitation => Coil Terminal
    c. Number of conductors is one
    d. Do this for each face, they should both be going in the same direction
2. Add a winding
    a. Add the two coil terminals to it
    b. Go to the Properties
        i. Set the type to external solid
        ii. Set the initial current to 0 A

External Circuit

1. Assign the RL Circuit to the coil
    a. Select one of the faces of the coil and Right-Click
    b. Assign Excitation => External Circuit => Edit External Circuit =>Add Circuit
2. Create the RL Circuit
    a. Go to Project and "Insert Maxwell Circuit Design"
    b. Connect a 100 Ohm Resistor and an Inductor in series
        i. No power supply and ground one side
3. Export the netlist, Maxwell Circuit => Export Netlist

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Eddy Currents

1. Add an Eddy Circuit Excitations to the helix(Maxwell 3D → Excitations → Set Eddy Effects).

Mesh Operations

1. Select the coil and Right-Click
    a. Assign Mesh Operations => Inside Selection => Length Based
    b. Number of elements should be 10,000

Solution Setup

1. Add a solution setup.
2. Assign the stop time to when your magnet will finish moving.
    a. Stop time at 10 ms with steps of 0.2 ms
    b. Do this in both the General and Save Fields tab
3. Go the Save Field tab
    a. Change your step size to have at least 10 steps
    b. Click the replace list button

Magnetic Field

1. Add the Magnetic Field Vector or Magnitude
    a. Select the Region and Right-Click
    b. Fields => B => Mag_B or B_Vector
    c. Analyze all and you should be good to go!

Calculator

Use the Ansys calculator to get the current leaving the coil as a function of the magnet passing through the coil. You should be able to plot this as a function of distance or time since the magnet is moving at a constant speed.

Variables

Repeat the example twice with the magnet outside of the coil at different distances. Keep

the magnet perpendicular to the coil.

Laboratory Write-up

Explain your results. Handing in excellent data without explanations is not enough. There should be an introduction to the lab, figures of results, Maxwell code (if necessary; preferably in an appendix), an explanation for each figure, and a summary of what you learned in the exercise.

Use App Note format for this report. Templates can be found on Canvas.