Midterm Project: ECE 4973/5973 Electromagnetic Fields and Wave Propagation

Due: April 4

1 Project Description

In class we have derived expressions for a rectangular cavity resonator. In this project you will use MATLAB to analyze visualize the cavity as well as FEKO (a method of moments solver). You will compare these results to an experiment completed with your own microwave. If you have not already done so, go to $http://www.feko.info/download$ and request to download FEKO LITE. There will be about a 24 hour delay in between requesting FEKO and receiving a link to download it. Once you have downloaded FEKO, open FEKO and go to the help menu (tiny question mark in upper right hand corner). There are two manuals in particular that you should take note of:

- **Getting Started Manual** This manual will guide you through the features of FEKO.
- **Examples Guide** Many Useful Examples

If you have access to another solver, HFSS, with which you are more familiar, you are welcome to use this solver instead.

1.1 Experiment

Disable the turning plate in your microwave (usually you can just take the plate and roller out). Microwave a pan or plate of the approximate dimensions of your microwave with an even layer of chocolate, marshmallows, or other such meltable/expandable material. In the case of both chocolate and marshmallows being microwaved, I recommend having graham crackers on hand to more tastily dispose of the experimental material. With this experiment, identify the "hot spots" in your microwave. A couple of repetitions to the experiment might be desired to ensure accuracy. If you have access to fax paper, a similar experiment can be conducted.

1.2 Analysis

Given your identified "hot spots" for your microwave oven, measure the dimensions of your oven, and compare these "hot spot" locations to the fields possible for a cavity resonator. Your microwave is operating in the ISM band of 2.4 GHz. Use Matlab to create 2D and 3D plots of the standing waves in your microwave. On a 2D countour plot of the fields, label the "hot spot" locations.

1.3 Simulation

Using FEKO, simulate your microwave. One way to simulate would be to obtain the user/installation manual for your microwave. Within this manual, the feed location should be described. You should also be able to tell where this location is simply by looking inside your microwave. There will be a mica cover over the waveport in your microwave oven. Another way to simulate your microwave would be with an Eigenmode or Characteristic Mode (FEKO only) solution. This does not require a waveport. With this solution type you can look at the fields for each characteristic mode of the oven.

A few other things to try:

1. The addition of the experimental material (chocolate etc.), perturbed the fields within the microwave oven. Using FEKO, determine the relative dielectric constant and loss tangent of your experimental material such that the experimental "hot spots" align with the simulated high field locations.

2. The screen is supposed to fully shield you from microwave radiation. Add the screen instead of a pec wall to the simulation. Is there field leakage?

3. Try moving the waveport and observe the changes (field strength, "hot spot" location, etc).

Those taking 4973 are only required to complete one of these suggested experiments. Each extra experiment will be worth 15 bonus points on the midterm project. Those taking 5973 are required to complete all three suggestions. If you can come up with another investigation, then come speak with me. If I approve, then I will offer it up to the whole class.

1.4 Synthesis

After you have completed your analysis, summarize your findings in a report of up to 15 pages. I am not looking for 15 pages of graphs. Although graphs will play a part in your analysis, the figures should *summarize* your findings. You will be graded upon grammar and clarity of thought. In all of your analysis, constantly question if what you are seeing makes physical sense. If it doesn't, then likely something is set up incorrectly in your simulation.

The following is a recommended outline:

- **Introduction** Outline your analysis in a couple of paragraphs.

- **Body** For each quantity that you were supposed to investigate there should be a section. Within each section there should be at least one graph (or table) summarizing the findings for that analysis. Label all figures. Units are good things. There should be conclusions presented within each section.

- **Conclusion** Give a general summary of your findings across all of the sections.

You have 4 weeks to work on this project. Use your time wisely. This is a large part of your grade. Get started now! If you try to do this the night (or even just a couple of days) before it is due, it will be self-evident and it is unlikely that you will be happy with your grade.

2 Grading Rubric

The grading rubric for the project will be as follows:

- **Clarity - 25%** Understandability of the entire report. Is the report clear and concise? Does it contain any grammatical errors or typos? Appropriate labeling of figures, etc.
- **Experiment - 10%**
- **Analysis - 25%**
- **Simulation - 40%**

For each of the sections, you will be graded upon the following criteria:

- Is the analysis correct?
- Does the student draw appropriate conclusions from the data?
- Is the data presented through the use of clear and concise figures and tables that summarize the analysis?