

ELEC 1908 Assignment 3: ANSYS - An Introduction to Electrostatic and Magnetic Simulation.

~~Submit by email to Colin Fernandes~~

~~Due: March 12th at 11:35AM~~

Submit by email to David
Due: March 15 at 1:30

Assignment Outline

For this assignment you will be using ANSYS to model a few simple electrostatic geometries. ANSYS is an incredibly powerful design suite that offers a host of powerful and integrated simulation tools. This software is used widely in industry across a host of engineering fields. During this assignment you will be able to visualize and represent the electric field lines as they exist in electrostatic systems. You will have ANSYS access throughout your degree and can utilize the visual assistance at any point to compliment your learning process. Below is a list of what to do for the assignment:

- **Tutorial:** First complete the "Maxwell 2D Magnetostatic Solenoid Problem" tutorial supplied by ANSYS. This can be found in Local Disk (C:)-Program Files-AnsysEM-AnsysEM17.1-Win64-Help-Maxwell-GSG. This is a very thorough tutorial that will walk you from design to results. **The diagrams and simulation results are not to be included in your assignment. NOTE: There are 2 magnetics based questions to be answered in your assignment report.** This tutorial is extremely important to familiarize yourself with how to run ANSYS.
- **Simulation components:** There are 4 different designs to make in ANSYS. For each the following is required in your report: Voltage plots, Electric Field plots, and concise answers to the research questions.
- **Report:** The report for this assignment will follow the basic requirements of assignment 1. To be made in L^AT_EX. Citations used where external resources were used, no need to cite ANSYS documentation.

Field in Coaxial Cable (Square):

Simple 2D geometry of a Coaxial Cable. The inner material is a 20x20 mm square. It is made of copper and has a source of 10 V. The outer material is a circle of r=20mm, it has a source of 0 V and is made of Teflon.

- Using ANSYS maxwell 2D, construct the geometry seen in figure 1. The inner square is copper. The rest of the space within the circle is Teflon.
- Plot the equipotential lines, and the electric field lines.
- Calculate the electric field strength at one of the corners and compare your values with that obtained from the simulation.
- In which direction do you have to move the conductor (square material) in order to get a maximum electric field at the right-bottom corner?
- Move the conductor in any direction (as much as you want) and recalculate the electric field at that point. Compare your results with that predicted by the simulation as you did before. Is there anything special about an electric field at a sharp point?
- Can there be a non-zero electric field in the insulation/dielectric? What happens to an electric field in a dielectric?

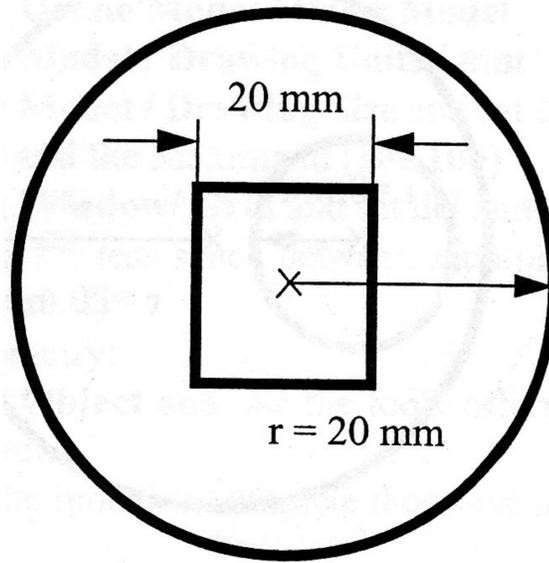


Figure 1: 2D slice of coaxial cable with a square conductor within a circular dielectric. The copper center is at 10V while the outer edge of the Teflon is 0V.

Einzel Lens

Construct an Einzel Lens in 2D for electrostatic simulation.

- Using ANSYS maxwell 2D, construct the geometry seen in figure 2. Use the materials and excitations as seen.
- Plot the equipotential lines, and the electric field lines.
- Explain how an Einzel lens works and a practical application of the lens.

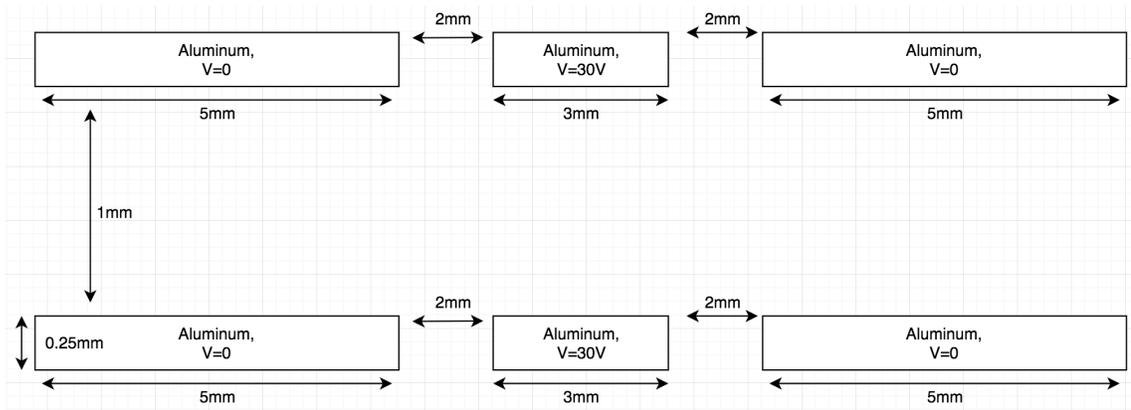


Figure 2: 2D horizontal slice of a tube einzel lens.

Magnetics Questions

Answer the following two questions in your assignment.

- Describe the Lorentz force in 2-3 sentences. Name a technology that is an application of the Lorentz force.
- Define eddy currents caused by a magnetic field. Keep the answer to 2-3 sentences.

All components in the list must be included in the report. Include citations to sources used.

Capacitor

Construct a 3D electrostatic simulation of a capacitor.

- Using ANSYS maxwell 3D, construct the geometry seen in figure 3. The top and bottom are aluminum while the space between is air. The top plate will be at 5V while the bottom in 0V.
- Plot the equipotential lines, and the electric field lines.
- Knowing the area, and distance between the plates. Calculate the capacitance of this capacitor. change insulating material (space between the plates)to Teflon. What is the new capacitance (Use the material properties screen for the relative dielectric constant)? No need to simulate this change of dielectric, simply calculate the new value and comment on the difference.

All components in the list must be included in the report

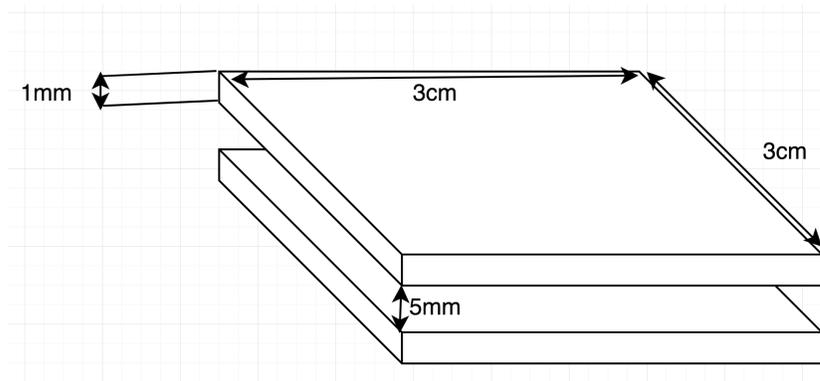


Figure 3: 3D schematic of a parallel plate capacitor in air.

Design Section

You are to design a 100pF capacitor for an integrated chip (IC). The design parameters are listed below:

- The supply voltage is 5V (Put one conductor at 5V the other at 0V).
- The footprint of the capacitor should be minimized, as chip space is extremely valuable.
- The conductor will be aluminum (Al).
- Suggested dielectric: silicon dioxide (SiO_2). You are allowed to choose another dielectric provided you can reference a respected source (proper publication or textbook) to the material's use in silicon IC fabrication.
- The electric field between the plates cannot be above the breakdown voltage of your dielectric. Include simulation results to prove this spec has been met.

Good luck! :)