EMT Computational Project.

Project choice: e-mail 2-5 lines long project idea by 5:00 pm 11/10/2021. Project should be related to EMT and preferably be related to your thesis project or a research project you have been working on.
The project should focus on the solution of Laplace's or Poisson's equation using a computer. Recommended software to use include Mathematica Mathlab, Comsol Multiphysics, and/or Phyton. Note that this does not require the problem to be an electrostatic problem as also other type of problems we discuss during the semester including charge transport and magnetostatic problems will result in similar math. For example the charge transport equation is:

$$\nabla \cdot \vec{J} = \nabla \cdot \sigma \nabla \Phi = -\frac{\partial \rho}{\partial t}$$

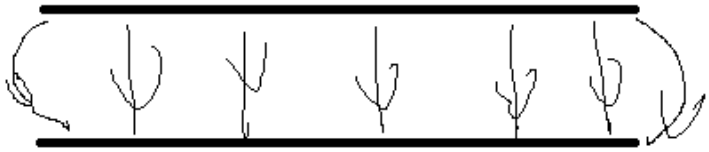
Where σ is the conductivity and ρ is the volume charge density. For the stationary case where ρ is independent of the time and σ is constant through the sample this equation becomes:

$$\sigma \nabla \cdot \nabla \Phi = \nabla^2 \Phi = 0$$

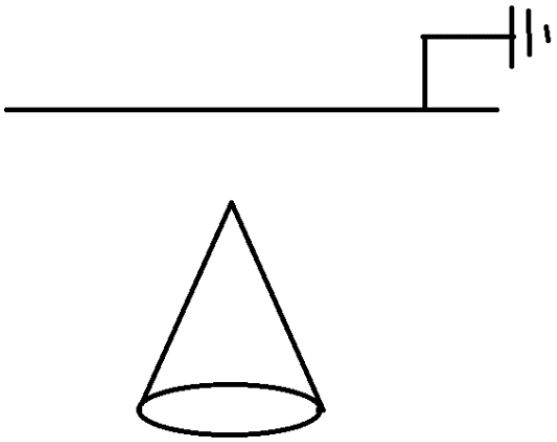
Which is Laplace's equation. So, we can use all the good stuff of chapters 1 through 4 in Jackson. You might need to think a little on what the boundary conditions are for such problem in terms of $\vec{J} = \sigma \nabla \Phi$ or Φ.
Note that solving Laplace's equation might be meaningful beyond EMT. In the past some of the students have shown interest in solving the heat continuity equation. In this case different parameters and a slightly different differential equation but the same math.
The definition and scope of the project will be fixed on 11/9/2021.
White paper: (due Friday 5:00 PM 11/12/2021): Half a page to explain, what you are calculating and why it is meaningful to calculate this. Also include what method, i.e. software you will use to make the calculation. Introduce the geometry of your calculation, introduce the physics equation to be solved, and discuss boundary conditions if relevant for your problem.
Preliminary Calculation Code: (due Monday 5:00 PM 11/22/2021): Working calculation code for the problem you described in your white paper.
PowerPoint summarizing the results of your calculation: (due Monday 5:00 PM 11/29/2021): Include on your slides what, why, and how you calculated, include results, and conclusions. Note that the length of your presentation should be no longer than 15 minutes.
Student presentations: on Monday 11/29/2021 and Wednesday 12/1/2021.
Transfer exercise: (due Sunday 12/5/2021): up to one-page paper that can be given to another students that takes over your project and that will give him/her a flying start. Most jobs in the high-tech are team-work assignments. In particularly when you work shifts in the high tech industry, at the end of the day you have to transfer your project status to the next team of engineers and scientist who will work the night shift. The objective of this last assignment is to practice this transfer. So, I would like you to write up to one page of advice and guidance you would like to give to a new student who needs to perform an electrodynamics simulation/calculation using the technique you used. So, where do they start and what is important. In this advice you can refer to available tutorials, u-tube videos, manuals, and other resources you have used during the project. The objective is to give that new student a flying start and allow her/him to modify your code to solve their problem. You most probably should start off with a short summary as what the code does that you programmed. Note that I'm not interested in you summarizing a copy of the tutorial, or manual.

Calculation projects:

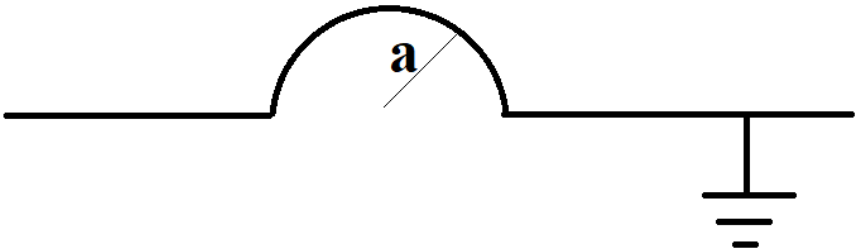
a. Calculate the electric field near the edges of a parallel plate capacitor and determine how the fringing field affects the energy stored in the capacitor.



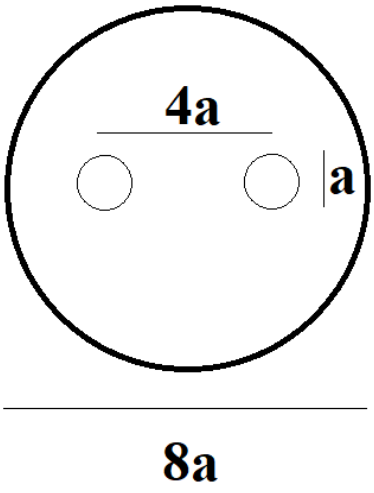
b. Calculate the electric field in between a sharp conical tip and a grounded plane.



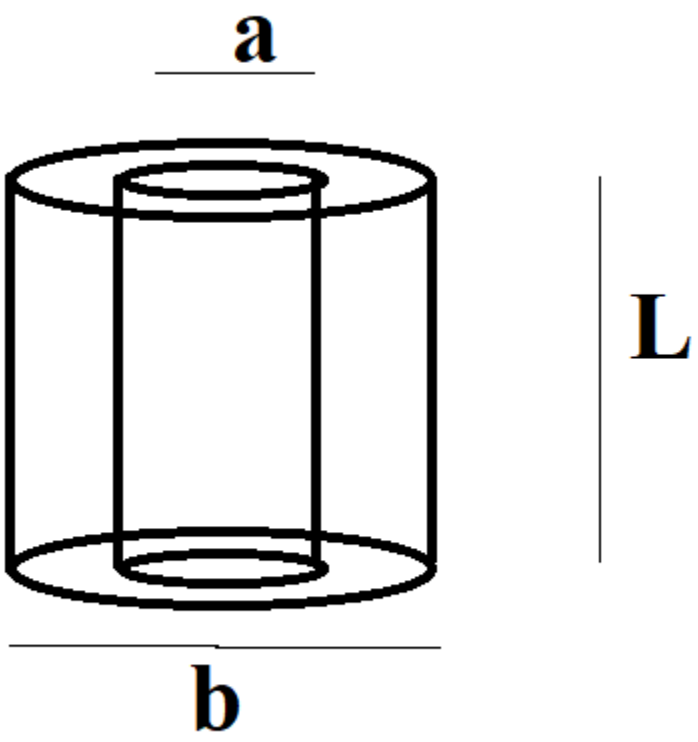
c. Calculate the electric field of a point charge that is located near the grounded structure sketched in the figure below.



d. Calculate the charge transport in a cylindrical sample. Assume both electrodes have a diameter of a. And the cylindrical sample has a diameter of 8a. Furthermore assume that the electrodes are placed in the sample of the circular sample.



e. Calculate the magnetic field caused by a coil with finite dimensions, i.e. inner diameter a, outer diameter b, and length l. Assume that a homogeneous current density is flowing in the coil that is equal to J.



f. Calculate the force a charged particle experiences in a neutral conducting shell, assuming the charged particle is located off-center, i.e. at (0.5a,0,0) where a is the radius of the sphere.