ECE 107: Electromagnetism

Project

You are suggested the Project in the following two pages. You are allowed to work in pairs.

Alternatively you can come up with your own project, related to the course. Such a project can be on any part of the course or on anything related to your interests/job as long as it fits the course material. If you decide to go with an alternative project, please consult the Instructor.

Suggested Project

Consider a parallel plate capacitor shown in Fig.1(a). The side width of the plates is w, the thickness of the plates is negligibly small, and separation between the plates is d. The plates are made of perfect electric conductor and the space between them is filled with vacuum.

1) Assume that the potential on the bottom and top plate is $-V_0/2$ and $V_0/2$, respectively. Formulate an integral equation for unknown surface charge density distribution ρ_s on the plates. You can use the formulation in Set 5, slide # 20. Then, formulate a discretized problem, i.e. a linear system of algebraic equation, for the discretized charges (see Fig. 1(b)). You can use the formulation in Set 5, slides # 21, 22. (This item is assigned for completeness of the project report and it does not require any new derivations.)

2) Write a computer code to find the discretized charges Q_n and then to find the capacitance C. You are advised to use Matlab due to its simplicity and the presence of built-in functions for visualization. You also are allowed to use any other programming language/package (e.g. MathCad, Mathematica, C, C++, Fortran, Pascal, etc.).

3) Assume that $w = 1cm$ and $d = 3mm$. For these parameters, generate a figure representing the surface charge distribution on one of the plates (for example, in Matlab you can use the function "surf", or "image" to generate such a plot). Be careful in the choice of the patch size: The size should be sufficiently smaller than a AND d. Try different sizes to see how they affect the result.

4) Assume that $w = 1cm$ and d varies between $1mm$ and $4cm$. Plot the dependence of the capacitance C vs. the separation d (take as many points as you feel are sufficient to represent the dependence properly). Every point in this dependence is obtained by solving the formulated integral equation for the (discretized) surface

charges and then finding the capacitance. On the same figure, plot the capacitance of the parallel plate capacitor obtained via the approximate formula $C = \varepsilon_0 a^2 / d$. Comment on when this formula is closer to the results obtained via the numerical solution.

Your report should consist of two (or more) figures (as detailed in items 3 and 4) and a printout of your computer code.

Please, use Set 5, Slides # 20-22. Please, see the TA and Instructor in case you have questions as to how to implement the code and generate the results.

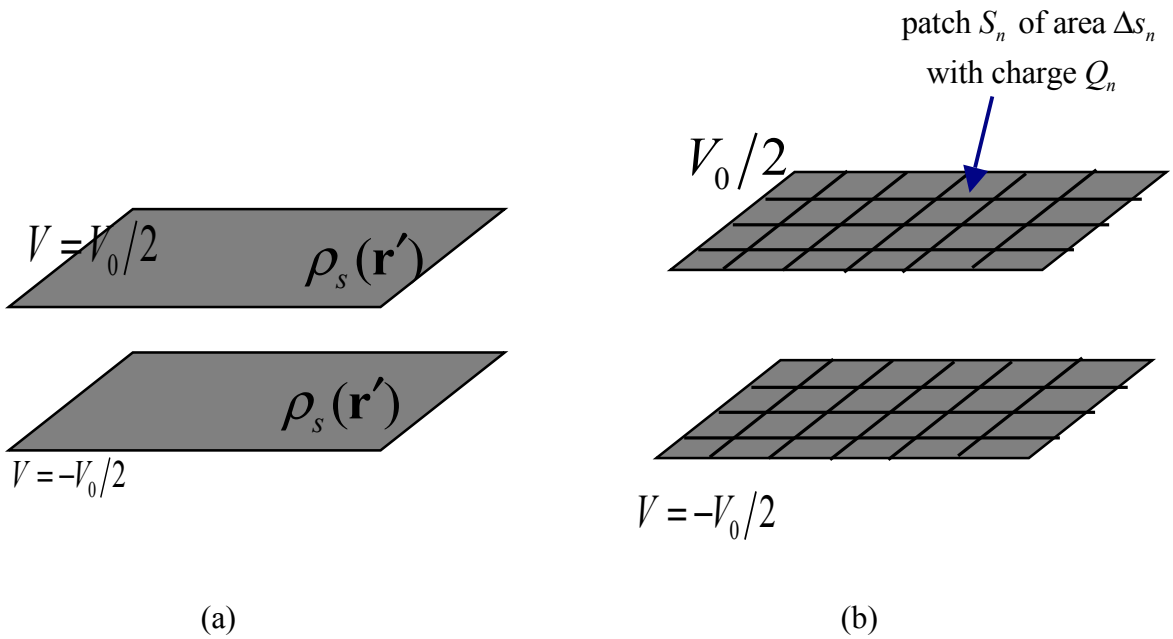

Fig. 1: (a) Parallel plate capacitor; (b) Discretized problem.