Electrical and Computer Engineering
ECE3712 Electromagnetic Fields and Waves

Matlab Project on Electrostatics

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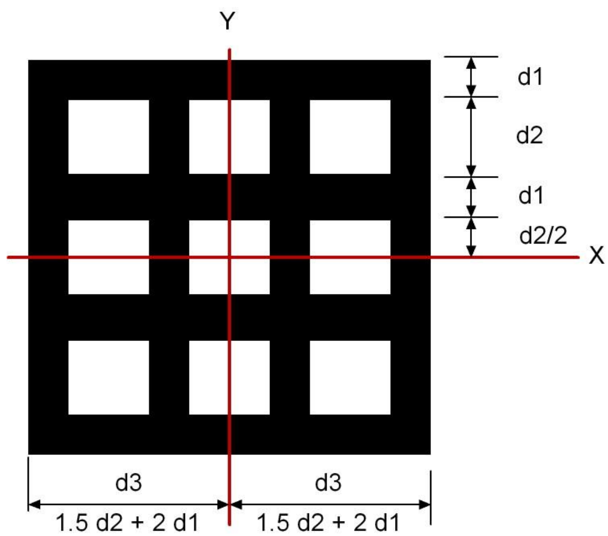
A metal plate is oriented in the X-Y plane centered at X = 0 and Y = 0. The positive z axis is out of the page. There are nine square openings in the metal plate with dimension d2 by d2. All the metal channels have a width dimension of d1. The uniform surface charge density for the metal plate $\rho_S = +0.1\ \mathrm{C/cm^2}$.



Use are to initially use the discrete summation solution in MATLAB of the integral form of Coulomb's Law with discrete charges ΔQ from the surface charge density ρ_S and a small surface area ΔS, determine the resulting **E** at a point P(x,y,z).

$$\mathbf{E} = \int \frac{dQ}{4\pi\,\varepsilon_o\,R^2}\,\mathbf{a_R}$$

$$\mathbf{E} = \sum \frac{\Delta Q}{4\pi\,\varepsilon_o\,R^2}\,\mathbf{a_R} = \sum \frac{\rho_S \Delta S}{4\pi\,\varepsilon_o\,R^2}\,\mathbf{a_R}$$

Note that $\Delta Q = \rho_S\ \Delta S$. The point P(x,y,z) should be entered as a variable for x, y, and z should range from:

$$-0.7\ d3 \le x \le 0.7\ d3 \qquad -0.7\ d3 \le y \le 0.7\ d3 \qquad 0.1\ d3 \le z \le 10\ d3$$

Note that d3 = 1.5 d2 + 2 d1. Out of range entries of x, y or z should normally be *flagged* in the code. This is to avoid the electrostatic field anomaly and calculation difficulty due to the *fringing effect*. You are to reference and discuss in the Report what is meant by the *fringing effect*.

For the distances d1 and d2 use your birth date in cm and birth month in cm with the smaller (or equal) number as d1 and the larger (or equal) number as d2. Note For example, June 16th means d1 = 6 cm and d2 = 16 cm.

You should use a value for ΔS that can approximate the integral formulation for **E** from the discrete summation. As an example of this, you could compare a ΔS = 0.1 x 0.1 cm (1 x 1 mm) solution to that obtained for 0.01 x 0.01 cm (0.1 x 0.1 mm) and 0.001 x 0.001 cm (10 μm x 10 μm) for the resultant **E**. Obviously your choice of the relative size of ΔS depends upon the values of d1 and d2. This should be critically discussed in the Report.

Plot you results for the resulting **E** in Cartesian coordinates. You are to investigate the best practice for the 3D plot for **E** in MATLAB. Plot the results for **E** with:

1. −0.7 d3 ≤ x ≤ 0.7 d3, y = 0, and z = d3/2
2. −0.7 d3 ≤ x ≤ 0.7 d3, y = 0, and z = 8 d3
3. −0.7 d3 ≤ x ≤ 0.7 d3, y = d3/2 and z = d3/2
4. −0.7 d3 ≤ x ≤ 0.7 d3, y = d3/2, and z = 8 d3

You are also to demonstrate the *fringing effect* by plotting **E** for x > d3, y = 0 and z = d3/2 and critically compare the result for **E** with those above.

Queries and concerns for you project should be directed to the Instructor in a timely manner. This project is to be written using the *Project Report Format* and an upload to Canvas is due no later than 11:59 PM Wednesday March 14, 2018 for time and date stamping (after Spring Break). Late submission will result in a grade reduction of one-half a letter grade per day. A hard copy is required on Tuesday March 27th in class.

This project is an example of an electrostatic deflection plate in scanning electron microscopy where the resulting **E** collimates (focuses) the electrons. *www.tedpella.com*