**Using Vector Calculus to Solve Problems in Electricity and Magnetism**

Dr. Steven L. Richardson

Howard University and Harvard University

Fridays 2:00 p.m. – 3:30 p.m. (Zoom Lecture)

Fridays 3:30 p.m. – 4:00 p.m. (Zoom Problem Session)

srichards22@comcast.net



Jupiter’s electromagnetic field is a giant torus!

There is an old but true adage that, “Mathematics is too important to be left just to the mathematicians to do.” Clearly mathematics is a very powerful tool which touches every aspect of science and engineering. In particular, many undergraduate STEM majors find the subjects of multivariable calculus and vector calculus to be quite challenging. In this CIQM summer course we are going to use the beautiful subjects of electricity and magnetism to show how vector analysis and vector calculus actually work. We will cover the following topics: Coulomb’s law, the electric field, Gauss’s law, the electrostatic potential, electrostatic work and energy, capacitors, electric dipoles, and an introduction to magnetostatics. It will be assumed that the student has certainly seen these subjects in an introductory physics course, but we will revisit them in more detail through a series of clear lectures and problem sets.

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**Lecture 1 (Friday, June 19, 2020):** Review of Vector Analysis and How to Work in Cartesian, Cylindrical Polar, and Spherical Polar Coordinates

**Lecture 2 (Friday, June 26, 2020):** Line Integrals, Surface Integrals, and Volume Integrals

**Lecture 3 (Wednesday, July 1, 2020):** Introduction to the Gradient, Divergence, and Curl of Vector Fields (note special date of lecture as Harvard University is closed on Friday, July 3, 2020 because of holiday)

**Lecture 4 (Friday, July 10, 2020):** Coulomb’s Law and the Electric Field

**Lecture 5 (Friday, July 17, 2020):** Solving for the Electric Field in Selected Problems: I

**Lecture 6 (Friday, July 24, 2020):** Solving for the Electric Field in Selected Problems: II

**Lecture 7 (Friday, July 31, 2020):** Gauss’s Law and Its Applications

**Lecture 8 (Friday, August 7, 2020):** Electrostatic Energy and the Electrostatic Potential

**Lecture 9 (Friday, August 14, 2020):** Solving for the Electrostatic Potential in Selected Problems: I

**Lecture 10 (Friday, August 21, 2020):** Solving for the Electrostatic Potential in Selected Problems: II

**Lecture 11 (Friday, August 28, 2020):** The Divergence Theorem and Its Applications

**Lecture 12 (Friday, September 4, 2020):** Stokes’ Theorem and Its Applications and Introduction to Magnetostatics