Physics 304 (4 credits)
Electricity and Magnetism

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Office Hours: MWF 1:30-2:30, other times by appointment.

Course Description:

The experiments on electricity and magnetism by Franklin, Coulomb, Oersted, Ampere, Faraday, and others were given a complete theoretical framework by Maxwell in the late 19th century. The electromagnetic force is ubiquitous, being responsible for such "mechanical" forces as friction and the normal force. It is also the only one of the four fundamental forces for which a complete theory has been satisfactorily worked out. It has withstood such tests as Einstein's theory of relativity (in some sense, special relativity grew out of Maxwell's results).

The course will begin with a brief study of vector calculus, which is used throughout the course. Topics include electrostatics, electric fields in matter, magnetostatics, magnetic fields in matter, electrodynamics, and electromagnetic waves.

Prerequisite: Physics 101. Vector calculus will be used extensively, though it is not a prerequisite.

Course Requirements and Grading:

For each class I will assign a section to be read, with accompanying problems. You must read the assigned section and do the problems before coming to class. Class time will be spent with my highlighting particularly important or difficult points, going over questions on the reading, and going over problems. Problems will be collected at each class and checked or given a zero. Homework and class participation can change your total test grade by one grade (*i.e.*, from a B to a B+ or a B-).

Two, one hour midterm quizzes (dates to be announced), each accounting for 25% of the total test grade. One, two hour final exam, accounting for 50% of the total test grade.

Attendance: required, especially in light of the way I will be conducting class.

Text: Introduction to Electrodynamics, 3rd ed. by Griffiths. The text is widely popular with both students and instructors, and is used by almost every college and university.

Physics 304: Tentative Schedule

Week 1: Vector analysis (Sections 1.1, 1.2, 1.3): vector algebra, differential and integral calculus.

Week 2: Vector analysis (Sections 1.4, 1.5, 1.6): curvilinear coordinates, Dirac delta function, fields.

Week 3: Electrostatics (Sections 2.1, 2.2, 2.3): the electric field, div and curl, the electric potential.

Week 4: Electrostatics (Sections 2.4, 2.5): work and energy, conductors.
Special Techniques (Section 3.1): Laplace's equation.

Week 5: Special Techniques (Sections 3.2, 3.3, 3.4): the method of images, separation of variables, multipole expansions.

Week 6: Electric fields in matter (Sections 4.1, 4.2, 4.3): polarization, field of a polarized object, the electric displacement.

Week 7: Electric fields in matter (Section 4.4): linear dielectrics.
Magnetostatics (Sections 5.1, 5.2): the Lorentz force law, the Biot-Savart law.

Week 8: Magnetostatics (Sections 5.3, 5.4): div and curl, the magnetic potential.
Magnetic fields in matter (Section 6.1): magnetization.

Week 9: Magnetic fields in matter (Sections 6.2, 6.3, 6.4): field of a magnetized object, auxiliary field, linear and non-linear media.

Week 10: Electrodynamics (Sections 7.1, 7.2, 7.3): emf, induction, Maxwell's equations.

Week 11: Conservation laws (Sections 8.1, 8.2): charge, energy, momentum.
Electromagnetic waves (Section 9.1): 1-D waves.

Week 12: Electromagnetic waves (Sections 9.2, 9.3, 9.4): waves in a vacuum and in matter, absorbtion and dispersion.

Week 13: The potential formulation (Section 10.1): gauge transformations.