Syllabus

Physics 313 -- Electricity & Magnetism

Electrical and magnetic interactions are the most important ones in daily life--consider that friction, contact, and cohesive forces (like the ones holding your body together), as well as chemical bonds are all electrical in character. In fact, with the single exception of the gravitational force, our experience with forces is solely electromagnetic. For the purposes of studying the nature of many physical systems (solids, liquids, and gases, for instance), one need only consider the electromagnetic interactions (the gravitational forces are negligibly weak by comparison and the nuclei are stable, making consideration of intra-nuclear forces irrelevant). This fact certainly implies that learning about electromagnetism is important (it does not imply, however, that studying solids is easy!)

Besides its very practical importance, there is a kind of "philosophical" reason to study electromagnetic theory. The theory of electromagnetism is a model physical theory, in the sense that it can be expressed very simply in terms of a few mathematical axioms (Maxwell's equations and the Lorentz force law), with all results following mathematically from the axioms. Furthermore, the axioms are relativistically covariant, meaning that the theory is consistent with Special Relativity. The elegance of the mathematical formulation and the very general applicability of the theory make it a kind of standard of comparison for the evaluation of other physical theories.

In this first course on Electricity and Magnetism, we will begin by learning some methods of vector calculus, the natural language for the description of electromagnetic phenomena. We then will study static fields, the fields produced by stationary charge distributions and steady currents. Considerable ingenuity is required to express even static problems in our mathematical language, and we will develop a variety of tools and methods for handling various source configurations. Later, we will consider the problem of time-varying sources, in the quasi-static (slow time variation) limit, where field energy remains local to the region of the sources. With our knowledge of time-varying phenomena, we will be able to formulate the fundamental Maxwell equations. Finally, we will see how the Maxwell equations identify light as an electromagnetic wave and predict its propagation velocity.

Class Meetings: 6th hour MTuThF.

Instructor: Tom Moses, Office: D116 SMC, ext. 7341, tmoses@knox.edu.

Text: M. D. J. Griffiths, Introduction to Electrodynamics, 4th ed. (Pearson Education, New York, 2013). Good references on vector calculus are Div, Grad, Curl and All That, H. Schey (Norton, NY, 1973) and the Schaum's Outline Vector Analysis.

Homework: Problem sets will be due, typically, Tuesdays and Fridays in class. It is usual in physics courses that the homework is an important vehicle (probably the most important one) for learning the subject and it is therefore vital not to fall behind--catching up can be really difficult! I want to emphasize this point especially in Electricity & Magnetism, a subject that can be very mathematically elegant (translation: you can get lost fast), although the subject is also very physical and "picture-oriented."

You are encouraged to work together on homework problems, with the proviso that each person's homework write-up must be their individual product (no duplicates). The use of online aids (solution manuals, tutors, etc.) is forbidden; it's also counter-productive—the skills you learn figuring out the homework problems are the best preparation for the exams. That said, everyone needs a hint sometimes, and I am happy to dispense them—as many as you need. So please feel free to consult me in my office or lab anytime regarding the homework problems or any other questions about the course.

Exams: There will be a two midterm exams and a final exam.

Midterm 1	Tuesday, October 10
Midterm 2	Monday, October 30

Grade Weighting:

Homework	15%
Math Review Quiz	5%
Participation/attendance	5%
Midterm 1	20%
Midterm 2	20%
Final	35%

Approximate Calendar:

Week		Topic	Reading
Week	1-2	Vector calculus	Ch 1
	2-3	Electrostatics	Ch 2
	4	Potentials, Laplace's equation, multipoles	Ch 3
	Exam 1		
	5	Special techniques, Electric fields in matter	Ch 3, 4
	6-7	Electric fields in matter	Ch 4
	7	Magnetostatics	Ch 5
	Exam 2		
	8	Magnetostatics	Ch 5
	9	Electrodynamics	Ch 7
	10	Electrodynamics, EM waves	Ch 7, 9