

Physics 370: Electromagnetic Theory

Spring Semester 2008 (4 Credits)

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Class Homepage: <http://phys370.cabanela.com/>

Required Textbook: David J. Griffiths, *Introduction to Electrodynamics (3rd Edition)*. \$130.00 New, \$97.50 Used at MSUM Bookstore. I've seen this classic textbook considerably cheaper online, but you can expect the book to take a few weeks to arrive if you purchase it online... you don't want to fall behind.

Description: This course expands on the coverage of electromagnetic theory you had in your Introductory Physics courses. I will introduce you to the application of some mathematical techniques from vector calculus and apply them to the theory of electromagnetism. Our goal is actually to work a bit backwards, developing the theoretical descriptions of electrostatics, electric currents, and magnetism (both in a vacuum and in matter), and showing how all the various components can be put together into four elegant equations call Maxwell's Equations. Maxwell's equations also illuminate the way to an understanding of light as an electromagnetic wave and provide the basis of what would eventually be developed by Einstein into the theories of Relativity. **Prerequisites:** MATH 366, PHYS 201

Course Objectives:

By the end of this course you should be able to (**not** in order of appearance in the course):

- apply the mathematical techniques from vector and differential calculus to electromagnetic problems. You'll be expected to understand not only the mathematical rules but the physical concepts behind the vector field, the divergence and curl of a vector field, and the delta function.
- understand how to exploit symmetries and boundary conditions to solve certain electrostatics problems.
- apply the technique of separation of variables to solve certain types of partial differential equation problems typical in electrostatics.
- explain the origin of electric fields in relation to electric charges.
- relate the electric field to the electric potential and the work done by the motion of electric charges in that potential.
- describe the arrangement of electric and magnetic fields near and inside conductors and dielectric (non-conducting) materials.
- describe the relationship between moving electric charges and magnetic fields and how their interact.
- combine the ideas behind Gauss' law, Faraday's law, and Ampere's law to produce Maxwell's Equations, the four equations that describe all electromagnetic phenomena.
- explain the nature of light as an electromagnetic wave and the implications of this explanation of light.

Grade Assessment:

Grading in this course will be based on the following criteria:

- **Problem Sets: (40%)** Electromagnetic theory is notoriously challenging, in part because of the mathematical rigor and in part because it can be very abstract. Since you have probably (unless you are an electronics buff) applied electromagnetic theory on a daily basis, you probably have not developed an intuitive feel for solving the problems that come up in electromagnetism. The assigned problem sets are crucial to developing your mathematical skills and electromagnetic intuition. I encourage you to exert all reasonable efforts in tackling the problem sets I assign and maybe a few additional Griffiths problems in preparing for exams. You must be clear about your line of thinking and show not only mathematics, but write out your reasoning. **Full credit on problem sets will only be given to students who clearly show me not only their mathematical approach to the answer, but clearly state their reasoning.**
 - I will provide solutions to all the problem sets shortly after they are turned in.
 - **ON COLLABORATING WITH OTHERS:** You may work together to check each other's work. **However, the work you present must be your own.** You will get little out of the problem sets if you just copy someone else's solutions. To avoid the appearance of plagiarism, I would also strongly suggest you state clearly if you work with someone on your homework.
- **In Class Activities: (10%)** I will try to provide some in class activities during some of the lectures in order to provide something more entertaining than my voice. Participation in these activities will be rewarded.
- **Exams: (15% for each midterm, 20% for final)** There will be two mid-term exams during the semester in addition to the final exam. Study Guides showing the list of topics covered or each exam will be provided.

Final grades will be assigned on the scale below; **plusses and minuses will be used.** I reserve the right to adjust the grade curve if necessary.

A	B	C	D	F
≥90%	80%-90%	65%-80%	50%-65%	<50%

Academic Honesty

From the Student handbook

(http://www.mnstate.edu/sthandbook/academic_info/academicpolicies.htm#academichonesty):

The University expects all students to represent themselves in an honest fashion. In academic work, students are expected to present original ideas and give credit for the ideas of others. The value of a college degree depends on the integrity of the work completed by the student. When an instructor has convincing evidence of cheating or plagiarism, the following actions may be taken: assign a failing grade for the course in which the student cheated or instructors may choose to report the offense, the evidence, and their action to the Dean of their college or the Vice President for Academic Affairs. If the instructor (or any other person) feels the seriousness of the offense warrants additional action, the incident may be reported to the Student Conduct Committee through the Student Support Services Office. The Student Conduct Committee will follow procedures set out in the Student Conduct Code. After its review of the case and a fair, unbiased hearing, the Student Conduct Committee may take disciplinary action if the student is found responsible (see Student Conduct Code for details).

A student who has a course grade reduced by an instructor because of cheating or plagiarism, and who disputes the instructor's finding, may appeal the grade, but only by using the Grade Appeal Policy, which states that the student must prove the grade was arbitrary, prejudicial, or in error.

In this course, all instances of academic dishonesty will be reported to the Dean of the College of Social and Natural Sciences for informational purposes. Any academic dishonesty believed to be intentional will result in a failing grade for the entire course.

Special Accommodations

Students with disabilities who believe they may need an accommodation in this class are encouraged to contact Greg Toutges, Coordinator of Disability Services at 477-5859 (Voice) or 1-800-627-3529 (MRS/TTY), CMU 114 as soon as possible to ensure that accommodations are implemented in a timely fashion.

Tentative Schedule

This schedule is tentative and possibly way too optimistic, so I reserve the right to adjust as necessary.

Week of...	Course Topic	Chapters to Read	Schedule Notes
Jan. 6	Vector Analysis	Griffiths Chapter 1	
Jan. 13	More Mathematical Preliminaries	Griffiths Chapter 1	
Jan. 20	Electrostatics	Griffiths Chapter 2	
Jan. 27	Electric Potential & Work / Conductors	Griffiths Chapter 2	
Feb. 3	Special Techniques	Griffiths Chapter 3	
Feb. 10	Images	Griffiths Chapter 3	Midterm #1: Friday, Feb. 15
Feb. 17	Electric Fields in Matter	Griffiths Chapter 4	
Feb. 24	Polarization and Electric Displacement	Griffiths Chapter 4	
Mar. 2	Spring Break		
Mar. 9	Magnetostatics	Griffiths Chapter 5	
Mar. 16	Vector Potentials	Griffiths Chapter 5	
Mar. 23	Magnetic Fields in Matter	Griffiths Chapter 6	Midterm #2: Friday, Mar. 28
Mar. 30	Boundary Conditions	Griffiths Chapter 6	
Apr. 6	Electrodynamics	Griffiths Chapter 7	You will have a guest lecturer this week as Dr. C will be observing in Chile.
Apr. 13	Maxwell's Equations	Griffiths Chapter 7	
Apr. 20	Electromagnetic Waves	Griffiths Chapter 9	

Our Final Examination is scheduled for Tuesday, May 6 at 12:00 pm.