Electrodynamics I

Physics 321

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Lecture and Office Hours
Lecture meets on M-W-F from 12:00–12:50 p.m. in Physics 123.

Office hours will be held on M 2:30–4:00 p.m., Tu 1–2 p.m., W 3–4 p.m., Th 11a.m.–noon.

Text
David Griffiths, "Introduction to Electrodynamics," fifth edition, Cambridge University Press, 2023.

additional texts for reference (these can be found in course reserves at the library):

John David Jackson, "Classical Electrodynamics," Third edition, John Wiley & Sons, 1999.

Wolfgang K. H. Panofsky & Melba Phillips, "Classical Electricity and Magnetism," Second edition, Dover, 2005.

Edward M. Purcell & David J. Morin, "Electricity and Magnetism," Third edition, Cambridge University Press, 2013.

Andrew Zangwill, "Modern Electrodynamics," Cambridge University Press, 2013.

Website
Course information, lecture notes, and reading assignments can be found at: http://people.reed.edu/~jfrankli/Courses/P321.F24/

Homework assignments will be posted on the course website.

Evaluation
Each class meeting will be accompanied by a reading assignment, and three to four homework problems. While the problems will be associated with the

lecture, they are not due until Friday at noon (so that each Friday, you will turn in problems that have been assigned on the previous Friday, Monday and Wednesday).

You have spent some time in your laboratory courses thinking about communicating scientific ideas in that experimental setting. In this class, we will also practice our theoretical communication skills in the form of "presentation problems." You must complete one of these longer form written problems over the course of the semester. Every other week I will post two presentation problems by Friday at 5 p.m. Should you choose one of them, the writeup is due by Friday at noon two weeks after they are posted (send a pdf to me via e-mail). The writeups should include (an example can be found at the course website):

- A clear statement of the problem in your own words, and with your own emphasis. (20%)
- The problem's connection to work we have done in class. (20%)
- A clear and correct solution to the problem. (40%)
- Possible extensions or implications stemming from your solution. (20%)

While only a few students will write up any given presentation problem, everyone should think about and solve these problems.

In addition to homework and the presentation problem, there will be a "take-home" midterm examination due on October 18th, an in-class midterm on November 25th, and a cumulative 3 hour final given during final's week.

The scoring break down is:

Homework (lowest two assignments are dropped)	20%
Presentation	20%
Midterm Exam (due 10/18)	20%
Midterm Exam (11/25)	20%
Final Exam	20%

To quote from Mary Boas's excellent "Mathematical Methods in the Physical Sciences" (3rd ed. John Wiley & Sons, 2006): (replace "mathematics" with "physics" in the current setting) "To use mathematics effectively in applications, you need not just knowledge but *skill*. Skill can be obtained only through practice. . . The *only* way to develop the skill necessary to use this material in your later courses is to practice by solving many problems. Always study with pencil and paper at hand. Don't just read through a solved problem — try to do it yourself! Then solve similar ones from the problem set for that section . . ."

Sage advice — collaboration with peers where it is allowed (homework, in this class) can be useful, but only after you have internalized a problem by thinking about it on your own first. In general, I believe you should start problems by yourself. If, after thirty minutes or so, you have made no headway, contact me (the problem may well be unclear in its statement, or ill-posed) in office hours or via e-mail. After that, think about working with your peers who have gone through a similar process (remember that the work you turn in must be your own).

I would avoid the internet (with its "similar problems" and "hints and suggestions" searches) at all costs, but if you must use it, you must also cite the resources you have used. ChatGPT and other forms of AI that produce effectively uncitable (and, in many cases, useless) information are expressly forbidden for all components of this class.

Course Targets

By the end of the course, students should be able to:

- Find the electric and magnetic fields associated with with a given set of charge and current distributions. (Maxwell's equations)
- Find the charge and current distributions associated with a given set of electric and magnetic fields. (Maxwell's equations)
- Develop the electric potential and magnetic vector potential for either of the cases above, and understand the lack of uniqueness in that process.
- Find the force on a charge given the electric and magnetic fields, and, with appropriate initial conditions, describe properties of the charge's motion under the influence of the provided fields. (The Lorentz force)
- Solve (using, for example, the Method of Frobenius) and identify properties of solutions to the Poisson problem (uniqueness, appropriate boundary values, for example).
- Use multipoles to approximate complicated charge distributions, and use idealized multipole fields to approximate the potentials of those distributions. (Taylor series)

- Present technical information clearly and efficiently.

Week	Date	Topic
1	9/4	Vector Analysis
	9/6	
2	9/9	
	9/11	
	9/13	
3	9/16	Electrostatics
	9/18	
	9/20	
4	9/23	
	9/25	
	9/27	
5	9/30	Electrostatic Potential
	10/2	
	10/4	
6	10/7	
	10/9	
	10/11	Electric Fields in Matter
7	10/14	Midterm (take home) posted
	10/16	
	10/18	Midterm (take home) due
Fall Break		
8	10/28	Magnetostatics
	10/30	
	11/1	
9	11/4	
	11/6	
	11/8	
10	11/11	Magnetic Fields in Matter
	11/13	
	11/15	
11	11/18	Electrodynamics
	11/20	
	11/22	
12	11/25	Midterm (in class)
	11/27	
	11/29	**Thanksgiving**
13	12/2	
	12/4	
	12/6	Electrodynamics in Matter
14	12/9	
	12/11	