Physics 1351 (10461)
Intermediate Electricity and Magnetism
Fall 2021 (2221)

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Text: *Introduction to Electrodynamics* (Fourth Edition) by David J. Griffiths, Chapters 1 - 7

The Course: In this course, we will develop electromagnetic theory, culminating in Maxwell's Equations. The course begins with necessary mathematical background in vectors and vector calculus (some review, some new). Electrostatics begins with Coulomb's Law and includes Laplace's and Poisson's equations, associated boundary conditions, boundary value problems, and the behavior of electric fields in matter, including linear dielectrics. For magnetostatics we start with the introduction of the magnetic field, electric current, and the Lorentz force law. The Biot-Savart law and Ampére's Law will be used to calculate the magnetic field associated with a steady current. The behavior of magnetic materials will be examined. Electromagnetic induction (Faraday's Law) is next. Finally, Maxwell's fix of Ampére's Law leads to the complete Maxwell Equations.

This is an intermediate level course in classical electricity and magnetism. Along with Physics 1372, it provides the preparation necessary for the corresponding graduate core course if you go on to graduate school. A solid background in electricity and magnetism should also serve you well no matter what type of career you pursue after your undergraduate study.

The prerequisites for this course are a minimum grade of "C" in both Physics 0175 (or 0476) and Math 0240. Corequisite is Math 0290 or 1270 (differential equations)

Course Objectives: The student will be able to:

- State Maxwell's Equations, constitutive relations, boundary conditions, and a variety of other important concepts, results, and facts about classical electromagnetism (see list of topics at end of this syllabus) in both mathematical form and conceptually.
- Apply important methods of mathematical physics to solve problems in classical electromagnetism (once again, see list), and be able to interpret the results conceptually.

Lectures: Tuesdays and Thursdays, 9:30 – 10:45 am, in 102 Thaw Hall. In-person lectures will begin on September 13. For the first two weeks, the lectures will be delivered remotely via Zoom accessed in Canvas. These lectures will be recorded and uploaded to Canvas. If you wish, you may attend these lectures in 102 Thaw. It is anticipated that the lectures will be displayed on the screens in the room. However, you should bring your laptop (headphones also recommended) just in case and to participate in surveys, "clicker questions", etc. After September 13, lectures will be delivered in-person and not recorded.

- "Clicker questions" may be used during lectures, administered using TopHat. You should sign up for TopHat. You will receive an invitation by e-mail. See Canvas for instructions.
- There will be a weekly quiz administered during lecture, based on one of the week's homework problems. The quiz will be given on the homework due date.

Homework: Homework problems will be assigned weekly. Much of the learning in this course takes place by doing the problems. It is important to do the homework problems on time and not fall behind. You are allowed to work with others on the homework if you find this helpful, but your solutions should be your own. You are encouraged to form study groups with other members of the class. Cite any assistance, whether from books or people. Do not consult solutions available on the internet. Late homework will not be graded, particularly if it is so late that the solution has been made available and the set has already been graded. Homework will be graded on a 2-point scale: 2 = correct, 1 = attempted, 0 = no attempt. However, the weekly 15-minute quiz based on the homework will be graded in detail. Homework assignments will be made available in Gradescope in Canvas, and you will upload your solutions into Gradscope for grading.

Exams and Grading: There will be two "in-term" exams, scheduled for Thursday, October 7, and Thursday, November 18, and a final exam, scheduled for Tuesday, December 14, 10:00 – 11:50 am. The "in-term" exams will each count 100 points. The final exam will be worth approximately 150 points. The homework will contribute 50 points. The weekly homework quizzes plus TopHat questions will count 100 points. The course total will be about 500 points. Your numerical score will be converted to a letter grade. The scale will depend on the difficulty of the exams, so I would like to maintain some flexibility rather than commit to a fixed scale at the beginning.

Reserve Books: A list of books on classical electrodynamics and related topics appears on the back of this sheet. These books will be placed on reserve in the Engineering Library in Benedum Hall. If there is some other book you wish to be placed on reserve, let me know.

Canvas Site: I will use a Canvas site to post announcements, lecture materials, homework assignments (in Gradescope), homework solution sets, etc. You will upload your homework solutions into GradeScope within Canvas. Although this course will be taught in-person, the Online Student Toolkit created by the University Center for Teaching and Learning may be helpful.

Student Opinion of Teaching Surveys:

Students in this class will be asked to complete a *Student Opinion of Teaching Survey* (OMET survey). Surveys will be sent via Pitt email and appear on your Canvas landing page towards the end of the course. Your responses are anonymous. Please take time to thoughtfully respond, your feedback is important to me. Read more about *Student Opinion of Teaching Surveys*.

Academic Integrity:

Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. Furthermore, no student may bring any unauthorized materials to an exam, including dictionaries and programmable calculators.

Disability Resources:

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

Copyright Notice:

Course materials may be protected by copyright. United States copyright law, 17 USC section 101, et seq., in addition to University policy and procedures, prohibit unauthorized duplication or retransmission of course materials. See Library of Congress Copyright Office and the University Copyright Policy.

Statement on Classroom Recording:

To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student's own private use.

Inclusivity Statement:

Code of Conduct:

Communication is key to a productive learning environment, and we can maintain productive communication by exhibiting respect for one another. The success of the course for yourself and others depends on all of our commitment to behavior that demonstrates respect for differences, understanding towards others and a willingness to listen and learn. For these reasons, it is unacceptable to harass, discriminate against, or abuse anyone because of race, ethnicity, gender, disability, religious affiliation, sexual orientation, or age. If you witness or are subject to such harassment, please report it to the instructor or to the Office of Diversity and Inclusion: https://www.diversity.pitt.edu/ .

Title IX:

Legal text: "No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance."

As a professor I am a mandatory reporter, and I am required to report violations of Title IX that I observe or am made aware of to the Title IX office https://www.titleix.pitt.edu/ . Title IX violations include, but are not limited to, sexual harassment, sexual violence and verbal or sexual abuse. Within the classroom, behavior in violation might appear as: suggestive jokes or innuendos, inappropriate touching, and unwanted sexual behavior or advances, but my capacity and obligation to report does not end at the classroom.

Reserve Books (Maybe)

One or more of these books may be placed on reserve at the Benedum Library.

1. *Introduction to Electrodynamics* (4th Edition) by David J. Griffiths (QC680 G74 2013)
2. *Electricity and Magnetism*, Edward M. Purcell (QC522 P85 2013)
3. *Electromagnetic Fields and Waves*, Paul Lorrain and Dale M. Corson (QC665 E4L67 1987)
4. *The Feynman Lectures on Physics* (Vol. II) by R.P. Feynman (QC23 F47)
5. *Div, Grad, Curl, and All That*, H. M. Schey (QA433 S28 1997)

Physics 1351
Fall 2021 (2221)
Lecture Schedule
R.P. Devaty

Text: *Introduction to Electrodynamics* (4th Edition) by David J. Griffiths (Chapters 1- 7)

Lecture	**Date**	**Chapters**	**Topics**
1		1.1	Introduce Course; Survey; Math Review (Vectors)
2		1.2-3	Differential and Integral Vector Calculus
3		1.3-4	Integral Vector Calculus; Curvilinear Coordinates
4		1.5-6	Dirac Delta Function; Vector Fields; Helmholtz Theorem; Scalar and Vector Potentials
5		2.1-2	Coulomb's Law; Electric Field; Continuous Charge Distributions; Field Lines; Flux; Gauss's Law
6		2.2-3	Applications of Gauss's Law; Divergence and Curl of **E**; Electric Potential; Laplace and Poisson Equation; Localized Charge Distributions; Boundary Conditions
7		2.3-4	Work and Energy in Electrostatics
8		2.5	Conductors; Induced Charge; Surface Charge; Forces on Conductors; Capacitance
9		3.1-2	Laplace's Equation; Boundary Conditions; Uniqueness Theorems
10		3.2-3	Method of Images
11		3.3	Separation of Variables (Cartesian and Spherical Coordinates)
12		3.3-4	Multipole Expansion; Electric Field for a Dipole
13		4.1-2	Polarization of a Dielectric; Field of a Polarized Object; Bound Charges
14		4.2-3	Electric Displacement; Gauss's Law for Dielectrics; Boundary Conditions
15		4.4	Linear Dielectrics; Susceptibility, Permittivity, Dielectric Constant; Energy for a Dielectric; Forces on a Dielectric
16		5.1	Magnetic Field; Lorentz Force Law; Current
17		5.2	Steady Current; Biot-Savart Law
18		5.3	Divergence and Curl of **B**; Ampére's Law; Comparison of Magnetostatics and Electrostatics
19		5.4	Magnetic Vector Potential; Boundary Conditions; Multipole

			Expansion of Vector Potential
20		6.1	Magnetic Dipole; Diamagnets, Paramagnets, Ferromagnets; Force and Torque on a Magnetic Dipole; Effect of Magnetic Field on Atomic Orbits; Magnetization
21		6.2	Magnetic Field of a Magnetized Object; Bound Currents and Interpretation
22		6.3	Auxiliary Field **H**; Ampére's Law for Magnetized Material; Boundary Conditions
23		6.4	Linear and Nonlinear Magnetic Media; Magnetic Susceptibility and Permeability; Ferromagnetism
24		7.1	Ohm's Law; Electromotive Force; Motional emf
25		7.2	Faraday's Law of Electromagnetic Induction; Induced Electric Field; Inductance; Energy in Magnetic Field
26		7.3	Maxwell's Modification of Ampére's Law; Displacement Current; Maxwell's Equations; Magnetic Charge; Maxwell's Equations in Matter; Boundary Conditions.