

Syllabus

Physics 5573 - Spring 2022 Electrodynamics I

Instructor: Bruce Mason

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Office Hours: Anytime, email to make sure I'm available. Thursday and Friday afternoons are likely good times, but I'll try to be available as much as possible.

Class Goals:

- Explore and understand classical field theory
- Develop and use concepts of E&M fields - Boundary conditions, charge/current/field connections, basic time dependence
- Expand problem-solving skills and techniques, recognizing problems
- Apply math methods and expand math background
- Qualifier preparation

Texts:

Our main text is: "*Classical Electromagnetism in a Nutshell*", Anupam Garg. ISBN - 978-0-691-13018-7

This is listed in the OU Bookstore, connected to the course in one.ou.edu (<https://one.ou.edu>). Both electronic and paper versions are available. I'm using the e-book.

This is also available, for less, on Amazon: <https://www.amazon.com/Classical-Electromagnetism-Nutshell-Anupam-Garg/dp/0691130183> (<https://www.amazon.com/Classical-Electromagnetism-Nutshell-Anupam-Garg/dp/0691130183>)

A few comments about this book:

- This book is more readable than the standard text by Jackson and, I feel, has more connections to physics.
- The text has quite a few "Exercises" embedded in the reading, some with answers and some not. As is true for reading any science textbook (or review article, etc.) you should have paper and pencil or tablet or something to take notes and work through some of these exercises. In the listed reading, some exercises will be recommended you do and on others will be recommended you skip on first reading.

- As you read, be sure to note questions that you have and post them on the discussion board here on Canvas so we can be sure to address them in class.
- In closely reading the text, I've been a bit disappointed that there are some typos that I missed in my initial review of the book. We'll set up a page here on Canvas where we can keep track of these.

Other Texts and Resources that can be useful. I'll work on getting these on reserve at the library.

"*Classical Electrodynamics*", J. D. Jackson. This is a classic for a reason. It is comprehensive and thorough. It is also very dense and the physics motivation for the calculations is limited in many cases. There are probably plenty of copies available from other grad students if you want to use this as a reference. ([Amazon](https://www.amazon.com/Classical-Electrodynamics-Third-David-Jackson-dp-047130932X/dp/047130932X) [_ \(https://www.amazon.com/Classical-Electrodynamics-Third-David-Jackson-dp-047130932X/dp/047130932X\)_](https://www.amazon.com/Classical-Electrodynamics-Third-David-Jackson-dp-047130932X/dp/047130932X))

"*Introduction to Electrodynamics*", David Griffiths. Almost all of you used Griffiths for an undergraduate E&M course. Although we will be going beyond the level of this text, it's going to be useful as a starting point and a review. Again, there should be copies available in the department.

"*div, grad, curl, and all that*", H. M. Schey. This is another undergraduate text but a concise and readable introduction to vector calculus. This is, again, a starting point and review.

Topics:

In this class we'll be covering the topics listed below. The dates and topics are (somewhat) subject to change depending on the progress and interests of you the students. It's more important that you learn and understand the physics concepts and problem-solving approaches than to cover lots of topics without getting a good grasp on them.

Electro- and Magneto Statics: 1/19 - 2/18, Ch. 3 & 4, Appendix A & B

- Coulomb's law, Electric Potentials and Fields, E-Field Energy - Coordinate systems, integration, delta functions
- Field equations, Poisson, Dipole energy - Fourier and Multipole Expansions
- Magnetic dipoles and Fields - More Multipole Expansions
- Currents, Ampere, Biot-Savart - Magnetic moments and loops, Vector potentials, Gauge invariance

Electromagnetics and Maxwell: 2/21 - 3/25, Ch. 5 - 7 (Sec. 40 - 42)

- Induction and Faraday/Maxwell - Time dependence, B-field Energy, Displacement current
- Time-dependent potentials - More gauge invariance
- Conservation Laws - Poynting vector, field momentum, Stress tensor
- Wave equations - Propagating fields, polarization

Electromagnetism in Materials: 3/28 - 4/22, Ch. 13 - 16

- Polarization, Magnetization, and Macroscopic fields - bound charge, bound current, D and H , dielectric constant and permeability
- Electrostatics and conductors - Boundary conditions, capacitance, images, more multipole expansions
- Dielectrics and Magnetic materials - Susceptibility, boundary conditions

Topics of Interest: 4/25 - 5/6

- Review of previous topics or other applications of E&M in materials as chosen by the class.

Assignments:

Homework: 30% - There will be 2 homework assignments for each section of the class, or a total of 6 assignments. These assignments will include exercises to practice skills and problems that will require you to determine way(s) to approach the solution. Some of these questions, of both types, will be past qualifier problems.

Workshops: 30% - On many (but not all) Wednesdays we'll be working in groups on tutorial workshops. These have been designed to help you better understand the physics concepts and approaches to problem solutions. You'll be working together, teaching each other, and developing solutions as a group. Of course, I'll be joining each group to both answer and ask questions.

Mid-term Tests: 20% - There will be two mid-term tests, one after Statics and one after time-dependent fields. The exact dates will be determined considering progress of the class and assignments in other classes.

Final: 20% - The final is scheduled for Monday, May 9. It will be comprehensive, with problems taken from other assignments from the semester.

Class Philosophy:

One result that comes out consistently from education research and cognitive science is that effective learning requires engagement, effort, and personal sense-making. That requires that you develop a clear understanding of what you do and don't know and be responsible for creating, organizing, and connecting your knowledge.

The workshop classes are an important time for you to engage with the content. I hope everyone can help organize and direct the class by communicating your questions and difficulties. We'll be using the Canvas discussion board for some of this, but always, please, speak up in class, email, or drop by with suggestions.

Further Class Policies

Academic Honesty -

You will be expected to abide by The University of Oklahoma's Policy on Academic Honesty, which can be found at <http://integrity.ou.edu> (<http://integrity.ou.edu/>) and outlined in the OU student handbook. In this course, there are many times when collaboration with fellow students is both expected and encouraged. These include solution of homework problems, work in recitation sections, and review questions. Use of the textbooks and other class resources is also allowed on these exercises. Getting help from TAs and Action Center Tutors (and the instructor, of course) is encouraged, although having them complete assignments for you is considered academic misconduct. Tests are individual efforts and no unauthorized help is allowed. Doing an assignment entirely for another student, or putting your name on work that you haven't done, is academic misconduct.

Religious Observance -

It is the policy of the University to excuse absences of students that result from religious observances and to allow, without penalty, the rescheduling of examinations and additional required classwork that may fall on religious holidays. It is the responsibility of the student to make alternate arrangements **at least one week prior to the actual date of the religious holiday.**

Attendance -

Attendance in lectures is not required but it is encouraged, and is required to receive class participation points. Attendance and active participation in recitation sections is required to receive full credit. Full benefit from attending class requires active participation. Students who have not actively participated in the class will likely find the quizzes and tests difficult.

Make-up Tests -

Those who will need to miss a test due to a sanctioned University event should let me know as soon as possible. Those missing a test due to unforeseen circumstances such as an illness should let me know as early as possible, and provide me with a written note. (Medical details need not be given although doctor's notes are appreciated.) Makeup tests will be held as soon after the test as possible, preferably within two days.

Late Assignments -

All assignments will have a due date listed. Late assignments will not be accepted for full credit, except for reasons such as those outlined above for make-up tests. Late submission of pre-class questions and makeups for in-class participation will not be possible. Late submission of homework problems will be allowed, for reduced credit as described above.

Disabilities -

The University of Oklahoma is committed to providing reasonable accommodation for all students with disabilities. Students with disabilities who require accommodations in this course are requested to speak with me as early in the semester as possible. Students with disabilities should register with

the Office of Disability Services prior to receiving accommodations in this course:

<http://www.ou.edu/drc/> [\(http://www.ou.edu/drc/\)](http://www.ou.edu/drc/).

Title IX Resources and Reporting -

For any concerns regarding gender-based discrimination, sexual harassment, sexual assault, dating/domestic violence, or stalking, the University offers a variety of resources. To learn more or to report an incident, please contact the Sexual Misconduct Office at 405/325-2215 (8 to 5, M-F) or [smo@ou.edu \(mailto:smo@ou.edu\)](mailto:smo@ou.edu). Incidents can also be reported confidentially to OU Advocates at 405/615-0013 (phones are answered 24 hours a day, 7 days a week). Also, please be advised that a professor/GA/TA is required to report instances of sexual harassment, sexual assault, or discrimination to the Sexual Misconduct Office. Inquiries regarding non-discrimination policies may be directed to: Bobby J. Mason, University Equal Opportunity Officer and Title IX Coordinator at 405/325-3546 or [bjm@ou.edu \(mailto:%20bjm@ou.edu\)](mailto:bjm@ou.edu). For more information, visit <http://www.ou.edu/eoo.html> [_\(http://www.ou.edu/eoo.html\)](http://www.ou.edu/eoo.html).

Family -

I realize and understand that family comes first and there may be times when class assignments will be superseded by family issues. Please contact me as early as possible if any such issues arise so that we can address them. For those of you with children and you need to bring them to school, please feel free to do so.

Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please contact your professor or the Disability Resource Center at 405/325-3852 as soon as possible. Also, see <http://www.ou.edu/eoo/faqs/pregnancy-faqs.html> [_\(http://www.ou.edu/eoo/faqs/pregnancy-faqs.html\)](http://www.ou.edu/eoo/faqs/pregnancy-faqs.html) for answers to commonly asked questions.