UNIVERSITY OF MISSISSIPPI
Department of Physics and Astronomy
Graduate Electromagnetism I (Phys. 721) — Prof. Leo C. Stein — Spring 2022

Graduate Electromagnetism I Syllabus

Class schedule:	MWF 0900–0950, Lewis 109
Office hours:	Mondays 1400, Lewis 205
Course website:	https://duetosymmetry.com/teaching
Professor:	Leo C. Stein (he/him; you can call me "Leo" or "Dr. Stein")
Email:	⟨lcstein@go.olemiss.edu⟩
Office:	205 Lewis Hall

Accessing homeworks/exams will be through Google Classroom. If you are in this course and do not have access to the virtual classroom, email Leo ASAP!

Texts

There is no required textbook for this course. However, for your own studies and reference, I recommend getting a standard text. There are lots of options, e.g.

- Schwinger et al., *Classical Electrodynamics*.
- Jackson, *Classical Electrodynamics*.

Course goals and learning outcome

This is the first half of a standard course on electromagnetism in the graduate curriculum for physics.

Key concepts (time permitting): • special relativity and index gymnastics, • covariant and potential formulation of electromagnetism, • Lagrangian and Hamiltonian formulations of electromagnetism, • Noether's theorem and conservation laws, • Green's function solutions, • multipole expansion, • radiation, • partial wave decomposition, • scattering, • EM fields in media .

Goals: Understanding of electro- and magneto- statics and dynamics; relevance to physical systems; strengthen tools of vector/tensor calculus; applying multivariate/tensor calculus and special mathematical tools (e.g. Green's functions and the multipole expansion). These goals are to enhance students' mathematical reasoning, critical thinking, and analytical reasoning.

Evaluation

Grade type: Letter grade A–F

Grade ranges: (subject to change)
- A: 88% and up
- B: 75–87%
- C: 65–74%
- D: 55–64%
- F: <55%

Grade breakdown: (subject to change)
- 50% Homework
- 20% Midterm
- 30% Final

Homework, tests, and final exam

Homework assignments will be announced via the course web site, and they must be turned in by midnight on the due date. Late homework will be penalized 20% per day (exceptions and extensions permitted with good cause). Homeworks and exams may be physically handed in, or submitted as PDFs or JPGs via the course web site (electronic submission is preferred). Homework must be easy to read: please clearly write down your name and the problem set number, do not use a red pen. The midterm and final exam will be open-book and open-notes, and a calculator will be permitted.

Attendance

There is no strict attendance requirement, but you are strongly advised to attend class. Attendance has a strong correlation with performance. I recommend that you read the book sections in advance and come ready to participate. If you miss an exam or cannot turn in homework, please inform me beforehand and get a doctor's note if applicable. Absences from tests count as zeros, unless they are justified. If you must be absent during a test for a University sponsored event, you must discuss this with me before the test date.

Academic Integrity

Violations of the University's policy of academic integrity will result in a failing grade and other disciplinary actions. A student with a documented case of plagiarism or cheating in this course will receive a failing grade for the course and may face disciplinary action by the University, including expulsion.

In particular, do not turn in problem set solutions copied from online or a solutions manual. Copying solutions does nothing to enhance your learning. If I see this then you will get an automatic 0 for the problem set. It if happens more than once I will report it to the chair of the department.

Disability Access and Inclusion

The University of Mississippi is committed to the creation of inclusive learning environments for all students. If there are aspects of the instruction or design of this course that result in barriers to your full inclusion and participation, or to accurate assessment of your achievement, please contact the course instructor as soon as possible. Barriers may include, but are not necessarily limited to, timed exams and in-class assignments, difficulty with the acquisition of lecture content, inaccessible web content, and the use of non-captioned or non-transcribed video and audio files. If you are approved through SDS, you must log in to your Rebel Access portal at https://sds.olemiss.edu to request approved accommodations. If you are NOT approved through SDS, you must contact Student Disability Services at 662-915-7128 so the office can: 1) determine your eligibility for accommodations, 2) disseminate to your instructors a Faculty Notification Letter, 3) facilitate the removal of barriers, and 4) ensure you have equal access to the same opportunities for success that are available to all students.

Other

If a change in the syllabus becomes necessary during the semester, it will be discussed in class and then posted on the course website. The course website will also contain up-to-date information on the class schedule, homework assignments and complementary material.

Classroom Health Requirements

- Students are expected to comply with the University's protocols when they are in effect. Currently, a mask requirement is in place for vaccinated and unvaccinated people. As a result, proper mask wearing is required indoors and in the classroom. Current protocols can be found at https://coronavirus.olemiss.edu/.
- Students who have a diagnosed health concern that interferes with the wearing of face masks may contact the Student Disabilities Services (SDS) Office to seek a University-approved accommodation. Please contact SDS at https://sds.olemiss.edu/ for more information.
- If students test positive for COVID-19 at any health care facility, they must contact the Student Health Center at 662-915-7274. (Faculty and staff should contact the Employee Health Service at 662-915-6550.) University Health Services will coordinate contact tracing to lessen the likelihood of spread.
- Students with COVID-19 should seek medical attention at the Student Health Center and contact their instructor to let them know that they will be missing class due to a health-related issue.
- If you are exposed to someone with COVID-19, you should contact the Student Health Center to get tested three to five days following exposure and follow the guidance recommended by the Health Center. If you are not fully vaccinated, you should follow quarantine protocols found at https://coronavirus.olemiss.edu/students/.

Non-adherence with Health Requirements

- Currently, COVID-19 guidelines for the Fall 2021 semester include face masks for vaccinated and unvaccinated people inside University buildings; therefore, students should not be in classroom spaces when they are out of compliance with these guidelines unless they have an accommodation approved by Student Disability Services.
- The University's Academic Conduct and Discipline Policy states that "disorderly behavior that disrupts the academic environment violates the standard of fair access to the academic experience." Failure to adhere to health requirements during the COVID-19 emergency will be deemed as disruptive to the classroom and will be enforced following the Academic Conduct and Discipline procedures.
- The University of Mississippi has adopted a tiered disciplinary protocol for non-adherence to COVID-19 health requirements. This disciplinary protocol is maintained by the Office of Conflict Resolution and Student Conduct: https://conflictresolution.olemiss.edu/covidupdates.

Schedule (subject to change)

W	Jan	19	Lecture 01:	Admin. Overview. Maxwell's Eqs. and special relativity
F	Jan	21	Lecture 02:	Special relativity, index gymnastics, Minkowski, tensors
M	Jan	24	Lecture 03:	Lorentz vectors, tensors, velocity, momentum, force
W	Jan	26	Lecture 04:	Lorentz vectors, tensors, velocity, momentum, force
F	Jan	28	Lecture 05:	Special relativistic kinematics, causal structure
M	Jan	31	Lecture 06:	Maxwell's eqs. and Lorentz force law in 4d language
W	Feb	02	Lecture 07:	Potential formulation, gauge invariance
F	Feb	04	Lecture 08:	Lagrangian formulation
M	Feb	07*	Lecture 09:	Lagrangian formulation of electrodynamics
W	Feb	09*	Lecture 10:	Densities, fluxes, conservation laws
F	Feb	11	Lecture 11:	Energy-momentum-stress tensor
M	Feb	14	Lecture 12:	Symmetries and Noether's theorem
W	Feb	16	Lecture 13:	Boundary value problems, uniqueness
F	Feb	18	Lecture 14:	Method of images
M	Feb	21	Lecture 15:	Delta functions and Green's functions
W	Feb	23	Lecture 16:	Separation of variables
F	Feb	25	Lecture 17:	Basis expansions
M	Feb	28	Lecture 18:	Legendre polynomials and spherical harmonics
W	Mar	02	Lecture 19:	Static multipole expansion
F	Mar	04	Lecture 20:	Magnetostatics and dipoles
M	Mar	07	Lecture 21:	Macroscopic media: dielectrics
W	Mar	09	Lecture 22:	Macroscopic media: magnetized materials
F	Mar	11	Lecture 23:	Averaging from microscopic to macroscopic
				Mar 12–20 Spring Break
M	Mar	21	Lecture 24:	Electromotive force, induction
W	Mar	23	Lecture 25:	Electrodynamics: Helmholtz decomp., Lorenz gauge
F	Mar	25*	Lecture 26:	Wave equation Green's function, adv. and ret. solutions
M	Mar	28	Lecture 27:	Plane waves, general radiation
W	Mar	30	Lecture 28:	Reflection at interfaces
F	Apr	01	Lecture 29:	Dispersion in media
M	Apr	04	Lecture 30:	Waveguides
W	Apr	06	Lecture 31:	Radiative multipole expansion
F	Apr	08	Lecture 32:	Radiative multipole expansion
M	Apr	11*	Lecture 33:	Rad'n from moving point charge, Lienard-Wiechart potentials
W	Apr	13	Lecture 34:	Self-force and Abraham-Dirac-Lorentz force
F	Apr	15		Good Friday – Holiday
M	Apr	18	Lecture 35:	Scattering
W	Apr	20	Lecture 36:	Partial wave expansion
F	Apr	22	Lecture 37:	Born approximation
M	Apr	25	Lecture 38:	Diffraction
W	Apr	27	Lecture 39:	
F	Apr	29	Lecture 40:	
				May 02–06 Final exams

*=Leo has another responsibility (e.g. conference). So far, this schedule is just a suggested order.