UNIVERSITY OF MISSISSIPPI
Department of Physics and Astronomy
Grad Electromagnetism I (Phys. 721) — Prof. Leo C. Stein — Spring 2026

Grad Electromagnetism I Syllabus

Class schedule:	TTh 0800–0920, Lewis 109
Office hours:	TBD, 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 Blackboard. 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*.

I list some additional references:

- Wald, *Advanced Classical Electromagnetism*. Better treatment of point particles, the self-force, and some other topics than most texts.
- Griffiths, *Introduction to Electrodynamics*. An undergraduate textbook but very easy to follow.
- Thorne and Blandford, *Modern Classical Physics*. Very comprehensive (∼1500 pages) covering much more than electrodynamics. Includes intro to magnetohydrodynamics and plasma physics. PDFs of pre-publication notes currently available at `http://www.pmaweb.caltech.edu/Courses/ph136/yr2012/`.
- Sturrock, *Plasma Physics*. Specialist text, but starts from scratch and I found it easy to follow.
- PDFs available online from Russell Herman (UNC Wilmington); David Tong (Cambridge); Philip Nelson (UPenn); Richard Fitzpatrick (UT Austin); Alan Guth (MIT)

Course goals and learning outcome

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

Key concepts (time permitting): • methods for electro/magnetostatics, • Green's function methods, • static multipole expansion, • radiation, • special relativity, • radiative multipole expansion, • Liénard-Wiechart potentials .

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 Blackboard, and they must be turned in by the stated time 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 digitally via Blackboard. 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.

Use of Generative Artificial Intelligence

Generative AI refers to technologies like ChatGPT or similar tools, that can draw on a large corpus of training data to create new written, visual, or audio content. The point of education is not just to correctly answer problems, but to deeply understand a topic for yourself. Copying output from generative AI constitutes plagiarism, and there is no guarantee that the tool is responding correctly (it is just like autocompletion). Further, my opinion is that using generative AI will short-circuit the learning process and will be detrimental to your education. I therefore discourage you from using tools like OpenAI's ChatGPT, Google's Gemini, Microsoft's Copilot, Anthropic's Claude, etc.

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.

Schedule (subject to change)

Expressions in parentheses refer to sections of Jackson (marked with J) or other texts that are useful references for these topics.

T	Jan	20	Lecture 01:	Admin. Overview. Maxwell's Eqs. Vector spaces/index notation basics.
Th	Jan	22	Lecture 02:	Transformation of tensor components. Tensor derivatives.
T	Jan	27	Lecture 03:	Tensors cont'd. Statics: Basics, Gauss's law and Ampère's law.
Th	Jan	29	Lecture 04:	(Electro)Statics: Uniqueness; method of images. (J2.1)
T	Feb	03	Lecture 05:	Delta functions and Green's functions. (J1.7–1.10)
Th	Feb	05	Lecture 06:	Separation of variables. (J2.9)
T	Feb	10	Lecture 07:	Basis expansions. Legendre polynomials, spherical harmonics, Fourier. (J2.8)
Th	Feb	12	Lecture 08:	Reduced Green's functions. Variation of parameters.
T	Feb	17	Lecture 09:	Electrostatic multipole expansion (Legendre poly version). (J3.2)
Th	Feb	19	Lecture 10:	Electrostatic m'pole expansion (spherical harmonic version). (J3.5, 3.9–3.10, 4.1)
T	Feb	24	Lecture 11:	Electrostatic m'pole expansion (spherical harmonic version) cont'd.
Th	Feb	26	Lecture 12:	Tensor symmetries. Electrostatic m'pole expansion (tensor version).
T	Mar	03	Lecture 13:	Electrostatic multipole expansion (tensor version) cont'd.
Th	Mar	05		In-class midterm
				Mar 07–15 Spring Break
T	Mar	17*	Lecture 14:	Effective sources and magnetostatic multipole expansion.
Th	Mar	19*	Lecture 15:	The D and P fields. Energy/forces/torques on dipoles. (J4.3–4.7)
T	Mar	24	Lecture 16:	Interaction of dipoles and multipoles.
Th	Mar	26	Lecture 17:	Magnetostatics and induction.
T	Mar	31	Lecture 18:	Displacement current; electrodynamics. (J6.1)
Th	Apr	02	Lecture 19:	Gauge transformations. Wave equations. (J6.3)
T	Apr	07	Lecture 20:	Radiative Green's function. (J6.4) Dipole radiation. (J9.2–9.4)
Th	Apr	09	Lecture 21:	Radiative multipole expansion. (J9.7)
T	Apr	14	Lecture 22:	Poynting vector, energy in radiation, and conservation. (J6.7)
Th	Apr	16	Lecture 23:	Poynting vector, energy in radiation, and conservation. (J6.7)
T	Apr	21	Lecture 24:	Special relativity (J11.2–11.4)
Th	Apr	23	Lecture 25:	Lorentz vectors, tensors, velocity, momentum, force (J11.4–11.5)
T	Apr	28	Lecture 26:	Special relativistic kinematics
Th	Apr	30	Lecture 27:	Liénard–Wiechert potentials. (J14.1)
				May 04–08 Final exams

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