UNIVERSITY OF MISSISSIPPI
Department of Physics and Astronomy
Graduate Electromagnetism II (Phys. 722) — Prof. Leo C. Stein — Fall 2023

Graduate Electromagnetism II Syllabus

Class schedule:	MWF 0900–0950, Lewis 109
Office hours:	R 1000–1100, 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): • cavities and waveguides, • magnetohydrodynamics, • special relativity and index gymnastics, • covariant and potential formulation of electromagnetism, • Lagrangian formulation of electromagnetism, • Noether's theorem and conservation laws, • partial wave decomposition, • diffraction and scattering theory .

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. 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.

Schedule (subject to change)

M	Aug	21	Lecture 01:	(Medical)
W	Aug	23	Lecture 02:	Admin. Lightning review of EM I
F	Aug	25	Lecture 03:	Review of EM I; Starting dispersion relations
M	Aug	28	Lecture 04:	Dispersion relations; Cavities and waveguides
W	Aug	30	Lecture 05:	Cavities and waveguides
F	Sep	01	Lecture 06:	Magnetohydrodynamic waves
M	Sep	04		Labor Day – Holiday
W	Sep	06	Lecture 07:	Magnetohydrodynamic waves
F	Sep	08	Lecture 08:	Magnetohydrodynamic waves
M	Sep	11	Lecture 09:	Special relativity
W	Sep	13	Lecture 10:	Lorentz vectors, tensors, velocity, momentum, force
F	Sep	15	Lecture 11:	Special relativistic kinematics, causal structure
M	Sep	18	Lecture 12:	Maxwell's eqs. and Lorentz force law in 4d language
W	Sep	20	Lecture 13:	Potential formulation, gauge invariance
F	Sep	22	Lecture 14:	Lagrangian formulation of electrodynamics
M	Sep	25	Lecture 15:	Densities, fluxes, conservation laws
W	Sep	27	Lecture 16:	Energy-momentum-stress tensor
F	Sep	29	Lecture 17:	Symmetries and Noether's theorem
M	Oct	02	Lecture 18:	Radiation from arbitrary relativistic motion
W	Oct	04	Lecture 19:	Angular, spectral distribution of energy
F	Oct	06	Lecture 20:	Radiation spectrum from circular motion
M	Oct	09	Lecture 21:	Radiation spectrum from circular motion
W	Oct	11*	Lecture 22:	Synchrotron sources
F	Oct	13*	Lecture 23:	Synchrotron sources
M	Oct	16	Lecture 24:	Beginning scattering
W	Oct	18	Lecture 25:	Beginning scattering
F	Oct	20	Lecture 26:	Beginning scattering
M	Oct	23	Lecture 27:	Born approximation
W	Oct	25	Lecture 28:	Partial wave expansion
F	Oct	27	Lecture 29:	Partial wave expansion
M	Oct	30	Lecture 30:	Diffraction
W	Nov	01	Lecture 31:	Diffraction
F	Nov	03	Lecture 32:	Diffraction
M	Nov	06	Lecture 33:	Optical theorem
W	Nov	08	Lecture 34:	Thomson scattering
F	Nov	10	Lecture 35:	Radiation from collisions
M	Nov	13	Lecture 36:	Bremsstrahlung
W	Nov	15	Lecture 37:	Bremsstrahlung
F	Nov	17	Lecture 38:	Radiation-reaction self-force
				Nov 18–26 Thanksgiving Holidays
M	Nov	27	Lecture 39:	Abraham-Dirac-Lorentz self-force
W	Nov	29	Lecture 40:	Hamiltonian formulation
F	Dec	01	Lecture 41:	Hamiltonian formulation
				Dec 04–08 Final exams

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