PHYSICS 350 – ELECTRICITY AND MAGNETISM

Fall Semester 2021 TR 10:30–11:45 WAT 420/Online
Instructor: Eric B. Szarmes (szarmes@hawaii.edu)
Office: Watanabe Hall, Room 212; *Office hours:* to be announced

Course Description: Electrodynamics occupies a unique position in the physics curriculum. Of the four fundamental forces, it alone governs – together with the principles of quantum mechanics – *all* of the local physical interactions of everyday life. It also presents students with their first example of a fully developed and self-consistent field theory. This course develops the fundamentals of classical electrodynamics as embodied in Maxwell's equations, the Lorentz force law, and the constitutive relations describing static and time-varying electric and magnetic fields in vacuum and in matter. The treatment also develops and utilizes the mathematical tools of vector differential and integral calculus, special functions, and the techniques of mathematical physics. The course is designed to emphasize the rich mathematical and physical content of the electromagnetic field, and to provide a solid foundation for more advanced study.

Textbook: David J. Griffiths, *Introduction to Electrodynamics, 4th ed.,* Cambridge University Press, 2017

Course website: https://laulima.hawaii.edu → PHYS-350-001 [MAN.80026.FA21]
→ PHYS-350-002 [MAN.88616.FA21]

Grade distribution:

Weekly Homework:	50%
Quizzes/Midterms:	Q(5%) / M1(15%) / M2(15%)
Final Examination:	15%

Grade assignment:

A+	90 >	B+	76–82	C+	62–68	C–	40–52
A	82–90	B	68–76	C	52–62	D/F	< 40

In-class section: The primary format of PHYS 350 will be in-class lectures. The complete lecture notes for each class will be made available on Laulima prior to each class, and during the class itself I will discuss selected features of the topics covered.

Periodic quizzes will be administered and submitted in class. All exams will be take-home and submitted online.

- Prior to each class, lecture notes will be made available under the **Resources** tab on the Laulima website.

Online section: In addition to the in-class lectures, PHYS 350 will include an online section for students who are unable to attend in person. The online format will consist of real-time recordings of the in-class lectures over Zoom, but students should attend in real-time if possible.

Periodic quizzes will be simultaneous with the in-class quizzes, and will be administered and submitted online via Laulima. All exams will be take-home and submitted online.

- Prior to each class, Zoom meeting details will be posted under the **Announcements** tab on the Laulima website, and lecture notes will be made available under the **Resources** tab.
- After each class, links to the cloud recordings will distributed under **Announcements** as soon as they are available (24–48 hours after class).

Homework: Weekly homework is to be submitted by the specified date and time by uploading solutions to Laulima. You are welcome to write out your homework by hand (legibly!), in which case you can upload scans or smart-phone photos. Certainly, word-processor or LaTeX formats are also most welcome. Examinations (both midterms and final) will be completed at home and submitted online.

Submission and administration of all graded course work (homework, quizzes, exams) will be the same for both the in-class and online sections.

- Homework assignments will be posted and submitted through the **Assignments** tab on the Laulima website.

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Corrections: Up until one week after any problem set is returned to you, you may submit corrections to any problem on that problem set, together with the original problem set, for up to 3 points per problem (out of 10). Corrections must be done on the original problem set (written directly on the original writeup for small corrections) or on a separate page (attached to the original problem set for longer corrections) as needed. If you are not sure where you made your original error, or have trouble understanding anything about a problem for which you lost points, you may consult with me to discuss any questions you may have.

Late Fee Policy: I encourage you to complete and submit all homework, even if it is late! The goal of the course is to learn the material, and the problem sets are designed to help with this. But it is also true that it is easy to fall behind, and equally important to keep up.

To encourage you to submit your homework on time, I will charge a late fee of 2 points per day. Thus, submission on the due date after start of class is 2 points reduction, submission one day later is 4 points reduction, etc. For modestly late homework, I don't think this is too great, but obviously becomes more serious the later the homework. I will not let any late fees reduce your score to less than 50% of your raw score.

If you submit corrections, then the additional 3 corrections points (per problem) are applied to the original score, not the late fees.

Late homework will not be accepted after one calendar week past the due date, nor after the last day of instruction.

Office Hours: The schedule for 'office hours' will be determined during the first week of class, and they will be held as live Zoom meetings. However, if you can't make office hours, or if you ever have any questions at any time, I am very responsive via email.

COURSE OUTLINE

Dates	**Topics**	**Chapter**
8/24–9/7	introduction; status of electrodynamics; review of vector analysis; vector differential calculus; vector integral calculus; the Dirac delta function	1
9/9–9/23	electrostatics; the electric field **E**; Coulomb's law; divergence and curl of electrostatic fields; electric potential; work and energy in electrostatics; properties of conductors	2
9/28–10/7	Laplace's equation; boundary conditions and uniqueness theorems; method of images; separation of variables; multipole expansion; monopoles and dipoles	3
October 5	*Midterm Exam #1*	
10/12–10/21	electric fields in matter; polarization; dielectrics and induced dipoles; field of polarized objects; the electric displacement **D**; linear and nonlinear dielectrics; permittivity	4
10/26–11/4	the magnetic field **B;** magnetostatics; the Lorentz force law; forces and currents; the Biot-Savart law; vector properties; Ampere's law; magnetic vector potential	5
November 2	*Midterm Exam #2*	
11/9–11/16	magnetic fields in matter; magnetization; torques and forces on magnetic dipoles; the auxiliary field **H**; magnetic media; permeability	6
11/18–12/2	the electromotive force; electromagnetic induction; Faraday's law; Maxwell's correction to Ampere's law; Maxwell's equations in vacuum and in matter	7
12/7–12/9	problems; review	
Dec 13–17	*Final Exam Week*	