DRAFT SYLLABUS*
PHYSICS 153 - ELECTRODYNAMICS

Spring 2024
Harvard University

INSTRUCTOR

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TEACHING FELLOW

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COURSE OBJECTIVE

The objective is to study the physical laws that govern classical electromagnetic interactions and some of their applications. Students will gain a solid understanding of Maxwell's theory of electromagnetism together with its wide real world applications.

LECTURES

Monday and Wednesday 12:00 - 1:15 PM in Jefferson 356.

SECTIONS

Tuesday 7:00-8:15 PM or Wednesday 4:30-5:45 PM in Jefferson 356. Section meetings begin in the second week of class.

COURSE WEBSITE

https://canvas.harvard.edu/courses/126531
Problem sets, solutions, announcements, and other useful information will be posted on the website. You are responsible for checking the website regularly.

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*We will continue updating the draft syllabus until the end of the first week of class.

OFFICE HOURS

Office hours will be announced on the course website.

PREREQUISITES

Physics 15a, b, and c, and Mathematics 21a and b, or permission by the Head Tutor.

PROBLEM SETS

There will be weekly problem sets except during midterm examination weeks. Problem sets will be posted on the website on Fridays by 11:59 PM and are due by 11:59 PM. You are encouraged to work cooperatively on problem sets. Anything that you hand in must be worked through and written down by yourself. Solutions will be posted as soon as the problem sets are collected and late problem sets will not be accepted. Any request for extension should be made ahead of time. The lowest problem set score will be dropped.

EXAMS

We will have two 48-hour take-home midterm exams and a 48-hour take-home final exam. The first midterm exam will be held Friday, March 1, 12 pm through Sunday, March 3, 12 pm. The second midterm exam will be held Friday, April 5, 12 pm through Sunday, April 7, 12 pm. The final exam will be held Monday, April 29, 12 pm through Wednesday, May 1, 12 pm.

AI

The use of ChatGPT or any other generative artificial intelligence (AI) tools in problem sets and exams is not allowed unless stated otherwise.

QUIZZES

We will be administering quizzes during the lectures using Learning Catalytics. Your quizzes will be graded based on your participation rather than the correctness of your answers. You will need to create a student account and bring a web-enabled devise (smart phone, tablet, or laptop) to every lecture. Please visit the Learning Catalytics website at https://learningcatalytics.com/ to create a student account, if you do not currently have one. The procedure for creating your Learning Catalytics account is available here. Your student access code is USLCST-GIBLI-CLINE-EPICS-NADIR-NINES and registration is free of charge to you. You will also need to bring a notebook to work on part of quiz and discussion questions.

LECTURE NOTES

Preliminary lecture notes will be posted by the evening before each lecture and updated lecture notes will be posted in the weekend after the lectures.

READING ASSIGNMENT

A reading assignment will be posted by the evening before each lecture. You are strongly encouraged to complete the reading assignment before every lecture.

TEXTBOOK

Introduction to Electrodynamics, 4^{th} or 5^{th} Edition, by David Griffiths. (Digital copy available here at Harvard Library)

PARTICIPATION

It is important that you participate in questions, answers, and discussions both inside and outside class. Your participation in discussions in class will be particularly beneficial to all of us. You are strongly encouraged to make every effort to raise your questions and concerns. We hope that the lectures will be interactive conversations. Please take seats closer in groups of three or four to help facilitate discussions. Your participation in questions and discussions will earn you up to 2% of bonus points.

GRADING

Problem sets 40%, two midterms 15% each, final exam 25%, quizzes 5%, and participation 2% bonus.

TOPICS

1. **Electrostatics in free space:** electric field; energy; conductors; Laplace's equation and boundary value problem; image charges; separation of variables; multipole expansion.
2. **Electric fields in matter:** polarization; dielectrics.
3. **Magnetostatics in free space:** magnetic field; vector potential.
4. **Magnetic fields in matter:** magnetization; linear and nonlinear media.
5. **Maxwell's equations:** Induced electric field; induced magnetic field; Maxwell's equations; conservation laws.
6. **Electromagnetic waves:** electromagnetic waves in free space, in matter, and across different media; reflection, transmission, and absorption; wave guides.

7. **Electric and magnetic potentials:** Maxwell's equations in terms of electric and magnetic potentials; gauge transformations; retarded potentials; electric and magnetic fields from time dependent and moving sources.
8. **Radiation:** electric and magnetic dipole radiation; antennas; radiation from a point charge.
9. **Relativistic electrodynamics:** relativistic transformations of electric and magnetic fields; the electromagnetic field tensor; classical electrodynamics in covariant form; Maxwell's equations in coordinate independent differential forms.