

Physics 6561 – Electrodynamics

Fall 2023

I was at first almost frightened when I saw such mathematical force made to bear upon the subject, and then wondered to see that the subject stood it so well.

—Michael Faraday, letter to James Clerk Maxwell, 1857.

Shortly after discovering radio waves:

It's of no use whatsoever ... this is just an experiment that proves Maestro Maxwell was right - we just have these mysterious electromagnetic waves that we cannot see with the naked eye. But they are there. —Heinrich Hertz, 1888

Lecturer: Michael Niemack, PSB 389, niemack@cornell.edu

TA: Tim Skaras, PSB 425J, tgs52@cornell.edu

Text: The primary text will be *Modern Electrodynamics* by A. Zangwill. An alternative text that may be useful is *Classical Electrodynamics* by J. D. Jackson, 3rd edition.

Lectures: Tuesdays and Thursdays, 10:10 AM-11:25 AM, Rockefeller 115.

We will use Poll Everywhere to answer questions in class: <https://PollEv.com/michaelniemack281>

While the questions will not be graded, they will count for participation points. **You must register and log into Poll Everywhere to receive participation points.**

Study Halls and Office Hours (Zoom connections can be requested):

Study hall and homework session with Skaras every Wednesday 6-7:30 pm in 403 PSB.

Skaras' office hours are: Mondays 1-2pm in 301 PSB and Tuesdays 2-3pm in 403 PSB.

Niemack's office hours are Fridays from 10:30-11:30am in 389 PSB or down the hall in 301 PSB.

Term paper: A term paper and presentation will be due at the end of the semester. The assignment will be to write a paper and present calculations on “My Favorite Effect”. Each student will select a different physical effect or another topic of interest that involves electromagnetism for their term paper, which will be due on Dec. 4. Students will also give a short presentation on the topic near the end of the semester in class. More details and a sign up sheet will be discussed in class.

Problem Sets: Problem Sets will be due on the following Thursdays: August 31, September 14, September 28, October 12, October 26, November 9, and November 30. Late homework will not be accepted. Discussion and collaboration on the problem sets is encouraged, but you

must write up your own solutions.

Quizzes: Short quizzes based on the previous problem set will be given in class on the following Thursdays: September 7, September 21, October 5, October 19, November 2, and November 16. Make up quizzes will not be offered, but your lowest quiz grade will be dropped.

Final Exam: During December exam period, date TBD.

Grading distribution: Homework 25%, quizzes 25%, term paper 25%, final exam 25%.

Course webpage: We will use Canvas (<https://canvas.cornell.edu/courses/54676>) to distribute assignments and solutions. Problem sets should be turned in on Canvas. The term paper must be submitted on Canvas, which uses the TurnItIn feature to check for plagiarism. We encourage use of the discussion forum on Canvas to discuss homework.

Topics: We will examine diverse solutions to Maxwell's equations. Topics include Green's functions, multipole expansions in electrostatics and magnetostatics, wave propagation, dielectrics, waveguides, and radiation. We will also study the covariant formulation of Maxwell's equations from the principles of relativity, least action, and gauge invariance.

Reading Schedule: The sections of Zangwill below overlap with material in lecture and homework assignments. The order covered may differ from this tentative list. Complementary readings are available in Jackson and are listed below.

Schedule and Zangwill readings

Week 1 (Aug. 22, 24; Lecture 1-2) - §1.1-1.5, §3.1-3.5, §7.1-7.3, §8.1-8.2, 8.4

Week 2 (Aug. 29, 31; L3-4; Problem Set 1) - §8.3, 8.5, §1.6, §3.4, §7.4-7.9

Week 3 (Sept. 5, 7; L5-6; Quiz 1) - §7.6-7.11, §4.5-4.6

Week 4 (Sept. 12, 14; L7-8; PS2) - §4.1,4.2, 4.4, 4.7, §7.7, §10.1-10.3

Week 5 (Sept. 19, 21; L9-10; Q2) - §2.1-2.6, §10.1-10.5, §12.1-12.3, §22.1-22.4

Week 6 (Sept. 26, 28; L11-12; PS3) - §11.1-11.2, §13.1-13.3, 13.6, 13.9 §14.1-14.4, §16.1-16.3

Week 7 (Oct. 3, 5; L13-14; Q3) - §16.4-16.5, §17.1-17.6

Week 8 (Fall break, Oct. 12; L15, PS4) - §19.1-19.7

Week 9 (Oct. 17, 19; L16-17; Q4) - §15.1-3, 15.8 §20.1-20.6

Week 10 (Oct. 24, 26; L18-19; PS5) - §21.1-21.8

Week 11 (Oct. 31, Nov. 2; L20-21; Q5) - §22.1-22.8

Week 12 (Nov. 7, 9; L22-23; PS6) - §24.1-24.5

Week 13 (Nov. 14, 16; L24-25; Q6) - §23.1-23.5

Week 14 (Nov. 21; L26, Thanksgiving) - Presentations

Week 15 (Nov. 28, 30; L27-28; PS7) - Presentations

Complementary Jackson readings

Introduction.

Chapter 1 except for §1.12 and 1.13

Chapter 2

Chapter 3 except for §3.13

§4.1-4.4

§5.1-5.14 and §5.18

§6.1-6.4 and 6.7-6.11

§7.1-7.5,7.8,7.10

§8.1-8.5 and §8.7

§9.1-9.3

§10.1-10.2

Chapter 11 except for §11.8 and 11.11

Chapter 12 except for §12.5-12.6

§14.1-14.3

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