Physics 408b, Spring 2025

Part-II of Electricity & Magnetism (undergraduate)

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Class times: Tu,Th 2:00-3:50 PM, ONLINE or GFS-222
Office hours: Online, Tu,Th 4:00 - 5:00 PM, must request appointment in advance
Additional course information, assignments, at BRIGHTSPACE
Grader: xxx , SSC-xxx, email: xxx

Pre-requisites

Necessary background, to understand the topics covered and benefit from this course, include

- Part-I of Electricity & Magnetism, e.g. Phys.408a at USC, or its equivalent elsewhere
- Completion of a course on Mathematical Physics or equivalent mathematics.

Recommended Book

D. Griffiths, Introduction to Electrodynamics, 4nd edition.

Grading

(See: Behavior Violating University Standards, section 11 (pages 8-19) – Academic integrity and more, and university policies on scientific misconduct)

25% homework, due on Thursdays at noon, the week after the HW is assigned.
15% class participation and discussions (reported by the students at the end of each HW)
30% midterm exam (closed book, 2 sheets of notes), Tue. Mar. 4, 2-4 PM, in class in person
30% final exam (closed book, 2 sheets of notes), Thu. May. 8, 2-4 PM), in class in person

Course content and goals:

The topics correspond roughly to the second part of the textbook by D. Griffiths, chapters 7 through 12. The schedule, of 27 lectures, 2 reviews, 1 midterm exam and 1 final exam, appears below. If time does not permit to cover all, a selection will be made among the listed topics. Learning how to solve problems is essential to understand this material. Therefore, some emphasis will be given to problem solving in lectures, class discussions and assigned homework. The goal is to impart a good understanding of electrodynamics so that the student may apply this knowledge in future employment or use it as a strong background for deeper studies and research in related physics and engineering disciplines.

Student Liason

All courses in the Department of Physics & Astronomy have an assigned Faculty Liaison to serve students as a confidential, neutral, informal, and independent resource when they wish to discuss issues concerning their course without directly confronting their instructor. The Faculty Liaison for this course is Prof. Jack Feinberg (feinberg@usc.edu, (213) 740-1134, SSC 327).

Approximate Schedule of
27 Lectures, 2 Reviews, 1 Midterm Exam and 1 Final Exam

Selected topics in Griffith's book as listed below will receive the main emphasis in each lecture.

Chapter 7- Electrodynamics (5 lectures, Jan. 14,16,21,23,28)
7.1. Electromotive Force: Ohm's Law (296), Electromotive Force (303), Motional emf (305).
7.2. Electromagnetic Induction: Faraday's Law (312), The Induced Electric Field (317), Inductance (321), Energy in Magnetic Fields (328).
7.3. Maxwell's Equations, Electrodynamics Before Maxwell (332), How Maxwell Fixed Ampère's Law (334), Maxwell's Equations (337), Magnetic Charge (338), Maxwell's Equations in Matter (340), Boundary Conditions (342).

Chapter 8 - Conservation Laws (3 lectures, Jan. 30, Feb. 04,06)
8.1. Charge and Energy: The Continuity Equation (356), Poynting's Theorem (357).
8.2. Momentum: Newton's Third Law in Electrodynamics (360), Maxwell's Stress Tensor (362), Conservation of Momentum (366), Angular Momentum (370).
8.3. Magnetic Forces Do No Work (373).

Chapter 9 - Electromagnetic Waves (5 lectures, Feb. 11,13,18,20,25)
9.1 Waves in One Dimension: The Wave Equation (382), Sinusoidal Waves (385), Boundary Conditions: Reflection and Transmission (388), Polarization (391).
9.2 Electromagnetic Waves in Vacuum: The Wave Equation for E and B (393), Monochromatic Plane Waves (394), Energy & Momentum in Electromagnetic Waves (398).
9.3 Electromagnetic Waves in Matter: Propagation in Linear Media (401), Reflection and Transmission at Normal Incidence (403), Reflection and Transmission at Oblique Incidence (405).
9.4. Absorption and Dispersion: Electromagnetic Waves in Conductors (412), Reflection at a Conducting Surface (416), The Frequency Dependence of Permittivity (417).
9.5. Guided Waves: Wave Guides (425), TE Waves in a Rectangular Wave Guide (428), The Coaxial Transmission Line (431).

Midterm – Review: Thu. Feb.27, 2025**, online**
Exam: Tue.Mar.4, 2025, 2:00-4:00 PM, in person GFS 222, closed book, 2 pages (1 sheet) of notes allowed**.**

Chapter 10 - Potentials and Fields (4 lectures, Feb. 28, Mar. 6,11,13,25 – Note Spring vacation: March 16-3)
10.1. The Potential Formulation: Scalar and Vector Potentials (436), Gauge Transformations (439), Coulomb Gauge and Lorenz Gauge (440), Lorentz Force Law in Potential Form (442).
10.2. Continuous Distributions: Retarded Potentials (444), Jefimenko's Equations (449),
10.3. Point Charges: Liénard-Wiechert Potentials (451), The Fields of a Moving Point Charge (456).
Review before midterm 2.

Chapter 11 - Radiation (4 lectures, Mar. 27, Apr. 1,3,8)

11.1. Dipole Radiation: What is Radiation? (466), Electric Dipole Radiation (467), Magnetic Dipole Radiation (473), Radiation from an Arbitrary Source (477).
11.2. Point Charges: Power Radiated by a Point Charge (482), Radiation Reaction (488), The Mechanism Responsible for the Radiation Reaction (492).

Chapter 12 - Electrodynamics and Relativity (6 lectures, Apr. 10,15,17,22,24,29)
12.1. The Special Theory of Relativity: Einstein's Postulates (502),The Geometry of Relativity (508), The Lorentz Transformations (519), The Structure of Spacetime (525).
12.2. Relativistic Mechanics: Proper Time and Proper Velocity (532), Relativistic Energy and Momentum (535), Relativistic Kinematics (537), Relativistic Dynamics (542).
12.3 Relativistic Electrodynamics: Magnetism as a Relativistic Phenomenon (550), How the Fields Transform (553), The Field Tensor (562), Electrodynamics in Tensor Notation (565), Relativistic Potentials (569).

Review before final. May.1,2024, **online**

Final Exam – Thu. May.8, 2025, 2:00-4:00 PM, in person GFS 222, closed book, 2 pages (1 sheet) of notes allowed.

Important Dates

First day of classes: Monday, January 13, 2025
Last day to add: Friday, January 31, 2025
Last day to change to Pass/No Pass: Friday, January 31, 2025
Last day to drop without a mark of "W" and receive a refund: Friday, January 31, 2025
Last day to withdraw without a “W” on transcript or change pass/no pass to letter grade: Friday, February 28, 2025
Last day to drop with a mark of "W": Friday, April 11, 2025
Last day of classes: Friday, May 2, 2025
End of session: Wednesday, May 14, 2025