

PHY 599: Advanced Electricity and Magnetism I

General Information

Course title: Advanced Electricity and Magnetism I.

Semester/Section: Spring 2023

Credit hours: 3

Meeting time and location: T, TH 2:20-3:35 Physical sciences Rm 218

Instructor: Ryan Behunin

Instructor email: ryan.behunin@nau.edu

Office location: (bldg. 19) rm 212

Office hours: T, TH 1:00-2:00pm

Course Prerequisites

Undergraduate Electricity and Magnetism I & II

Academic Catalog Description

PHY-599 introduces the modern theory of electrodynamics. Topics include boundary value analysis of electrostatics, magnetostatics, Maxwell's equations in matter, and electromagnetic waves. The mathematical analysis of electromagnetic problems using partial differential equations, eigenfunctions, and Green's functions will be emphasized.

Course Purpose

PHY 599 will introduce students to modern electrodynamic theory and methods, including; Special function approaches to analytical solutions to electrostatic, magnetostatic and electrodynamic problems; Maxwell's equations in matter; Multipolar analysis; Conservation laws; and Electromagnetic energy and momentum. Mathematical analysis of Maxwell's equations is a central component of this class, including eigenfunction analysis, partial differential equations, and vector calculus. Completion of this course will prepare students to analyze and solve a variety of problems in electricity and magnetism.

Intended Course Student Learning Outcomes

Upon successful completion of this course, students will:

- Be able to apply Maxwell's equations to analyze problems in electrostatics, magnetostatics, and wave propagation
- Understand energy and momentum stored in the electric, magnetic and electrodynamics fields
- Be able to predict forces on charges and currents and analyze related dynamics

- Analyze electric and magnetic phenomena of complex systems using multipolar treatments
- Understand the behavior of electricity and magnetism in dielectrics and metals
- Master mathematical analysis of partial differential equations, including
 - decomposition of common derivative operators in convenient coordinate systems, and identification of solutions using special functions
 - identifying physical solutions using boundary conditions and symmetries
 - expressing formal solutions as eigenfunction expansions

Required Textbook

Modern Electrodynamics, A. Zangwill, Cambridge University Press

Tentative Schedule of Topics to be Covered

Week 1: Mathematical Preliminaries/Maxwell's Equations

Week 2: Electrostatics

Week 3: Electrostatics

Week 4: Electric multipoles

Week 5: Conducting matter

Week 6: Dielectric matter

Week 7: Laplace's Equation

Week 8: Poisson's Equation

Week 9: Steady Current

Week 10: Magnetostatics

Week 11: Magnetic Multipoles

Week 12: Magnetic force and energy

Week 13: Magnetic matter

Week 14: Dynamic and quasistatic fields

Week 15: General electromagnetic fields

Week 16: Waves in vacuum

Assessment of Student Learning Outcomes

Assessment will be comprised of graded homework assignments, a midterm exam, and a final exam. Homework will be assigned roughly on a weekly basis. Homework will comprise (60%) of your grade, the midterm exam will comprise (15%) and the final exam will comprise (25%). Exams will be graded strictly to truly reflect your understanding of the material, curving of exam scores as well as dropping the lowest homework score may be considered.

Academic Deadlines and Important Dates

January 17 th	First Day of Instruction
March 13 th -17 th	Spring Break
May 12 th	Last Day of Term

Office Hours

Office Hours are not to be used as a substitute for class attendance. Come to office hours prepared to discuss course material.

CLASS POLICIES

Check the course Bblearn page often for announcements. E-mail is the best way to contact me. We receive a lot of e-mail, to ensure your email is not accidentally lost always include a subject that begins: **PHY599_Email Request_Your Last Name_Date**. Please be as detailed as possible in your request. DO NOT assume by sending email your request has been received. You will receive a response email from the instructor. If you do not receive a response from the instructor acknowledging your request by the next class period, it is your responsibility to bring this to the instructor's attention before or after the following class period to ensure my receipt and acknowledgement of email.

Academic honesty is mandatory. While group work is highly encouraged, you are expected to complete your own assignments. Anyone cheating on exams or homework will receive a zero for the associated assignment, and further academic sanctions may be imposed.

Class culture and expectations

The best way to learn advanced physics curricula is to complete assigned reading and be prepared to discuss this material class, begin homework early, and study for exams and work on homework in groups. PHY 599 is intended to be an interactive class. Students are expected to ask questions during/after class.

Cell phones should be silenced or turned off during class. Students will not use cell phones, laptops, tablets, etc., in class for non-course related activities. Distractions such as music, messaging, social media, web browsing and interacting with anything not relevant to the course is not allowed. You may be dismissed from class if you are creating a distraction for yourself or others during class.

Grading System

The course grading will be determined by homework scores (70%) and exams (30%). Letter grades will be assigned according to: $A \geq 90 > B \geq 80 > C \geq 70 > D \geq 60 > F$.

University Policy Statements

Resources for Student Success

Successful university students take advantage of services and resources designed to boost learning and achievement. NAU recommends that you begin with:

- **Supplemental Instruction:** <http://nau.edu/Student-Learning-Centers/Supplemental-Instruction/> Attendance at these course specific sessions has proven to increase grades and reduce D's and F's.
- **Student Learning Centers:** <http://nau.edu/Student-Learning-Centers/> Free drop-in, online, and individual tutoring appointments for math, writing, and over 100 other courses.
- **ResourceConnect:** <http://nau.edu/University-College/Student-Resources/Resource-Connect/> is your online central navigation point for all NAU student resources
- **GPS:** <http://nau.edu/University-College/GPS/Students/Grade-Performance-Status/> and **Action Center:** <http://nau.edu/University-College/Action-Center/> provide messages to keep you academically on track – when you get a message take action!

CLASS POLICIES: NAU's policies on Safe Working and Learning Environments, Students with Disabilities, Institutional Review Board, and Academic Integrity can be viewed at: <http://www2.nau.edu/academicadmin/UCCPolicy/plcystmt.html>

NORTHERN ARIZONA UNIVERSITY POLICY STATEMENTS

SAFE ENVIRONMENT POLICY

NAU's Safe Working and Learning Environment Policy seeks to prohibit discrimination and promote the safety of all individuals within the university. The goal of this policy is

to prevent the occurrence of discrimination on the basis of sex, race, color, age, national origin, religion, sexual orientation, disability, or veteran status and to prevent sexual harassment, sexual assault or retaliation by anyone at this university.

You may obtain a copy of this policy from the college dean's office or from the NAU's Affirmative Action website <http://www4.nau.edu/diversity/swale.asp>. If you have concerns about this policy, it is important that you contact the departmental chair, dean's office, the Office of Student Life (928-523-5181), or NAU's Office of Affirmative Action (928-523-3312).

STUDENTS WITH DISABILITIES

If you have a documented disability, you can arrange for accommodations by contacting the office of Disability Support Services (DSS) at 928-523-8773 (voice), 928-523-6906 (TTY). In order for your individual needs to be met, you are required to provide DSS with disability related documentation and are encouraged to provide it at least eight weeks prior to the time you wish to receive accommodations. You must register with DSS each semester you are enrolled at NAU and wish to use accommodations.

Faculty are not authorized to provide a student with disability related accommodations without prior approval from DSS. Students who have registered with DSS are encouraged to notify their instructors a minimum of two weeks in advance to ensure accommodations. Otherwise, the provision of accommodations may be delayed.

Concerns or questions regarding disability related accommodations can be brought to the attention of DSS or the Affirmative Action Office. For more information, visit the DSS website at <http://www2.nau.edu/dss/>.

INSTITUTIONAL REVIEW BOARD

Any study involving observation of or interaction with human subjects that originates at NAU—including a course project, report, or research paper—must be reviewed and approved by the Institutional Review Board (IRB) for the protection of human subjects in research and research-related activities.

The IRB meets monthly. Proposals must be submitted for review at least fifteen working days before the monthly meeting. You should consult with your course instructor early

in the course to ascertain if your project needs to be reviewed by the IRB and/or to secure information or appropriate forms and procedures for the IRB review. Your instructor and department chair or college dean must sign the application for approval by the IRB. The IRB categorizes projects into three levels depending on the nature of the project: exempt from further review, expedited review, or full board review. If the IRB certifies that a project is exempt from further review, you need not resubmit the project for continuing IRB review as long as there are no modifications in the exempted procedures.

A copy of the IRB Policy and Procedures Manual is available in each department's administrative office and each college dean's office or on their website: <http://www4.nau.edu/ovp/regulatorycompliance/irb/index.htm>. If you have questions, contact Melanie Birck, Office of Grant and Contract Services, at 928-523-8288.

ACADEMIC INTEGRITY

The university takes an extremely serious view of violations of academic integrity. As members of the academic community, NAU's administration, faculty, staff and students are dedicated to promoting an atmosphere of honesty and are committed to maintaining the academic integrity essential to the education process. Inherent in this commitment is the belief that academic dishonesty in all forms violates the basic principles of integrity and impedes learning. Students are therefore responsible for conducting themselves in an academically honest manner.

Individual students and faculty members are responsible for identifying instances of academic dishonesty. Faculty members then recommend penalties to the department chair or college dean in keeping with the severity of the violation. The complete policy on academic integrity is in Appendix G of NAU's Student Handbook <http://www4.nau.edu/stulife/handbookdishonesty.htm>.

ACADEMIC CONTACT HOUR POLICY

The Arizona Board of Regents Academic Contact Hour Policy (ABOR Handbook, 2-206, Academic Credit) states: "an hour of work is the equivalent of 50 minutes of class time...at least 15 contact hours of recitation, lecture, discussion, testing or evaluation, seminar, or colloquium as well as a minimum of 30 hours of student homework is required for each unit of credit."

The reasonable interpretation of this policy is that for every credit hour, a student should expect, on average, to do a minimum of two additional hours of work per week; e.g., preparation, homework, studying.