



Physics 541

Electromagnetic Theory

Tuesday and Thursday, 2:30 to 3:45 PM,

Nielsen Physics Building, Room P306.



Prof. Cristian D. Batista

210 South College

Office Hours: Tuesday and Thursday 11:00 AM to 12:00 AM

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Zoom: <https://tennessee.zoom.us/j/4991007715>

Canvas: we will use canvas as the primary medium of communication

Course Description: This course will expose you to the main concepts of classical electrodynamics, that describes the phenomena that we experience on a daily basis. We will also use this opportunity to introduce the important notions of gauge transformations and the interaction of the electromagnetic field with different media. The main notions and concepts that play a fundamental role in electromagnetism will reappear in the advanced courses of quantum mechanics, quantum field theory, solid state physics, relativity and statistical mechanics. Building a solid basis in electromagnetism is also crucial for experimental physics because most measurement devices involve basic principles of electromagnetism.

Prerequisites: I will assume that you have a solid background in linear algebra and single- and multivariable calculus, including some familiarity with concepts related to ordinary differential equations. Experience with these topics is highly recommended and necessary for success in this course. You do not have to be an expert in the material, but you should have taken these classes, or you should get the relevant textbooks and teach yourselves as needed.

Contents

1. *Electrostatics.* Introduction to electrostatics. Gauss's law. Poisson and Laplace equations with Neumann or Dirichlet boundary conditions. Method of images. Separation of variables. Laplace equation in spherical and cylindrical coordinates. Green functions.
2. *Multipoles and Electrostatics of Macroscopic Media.* Multipole expansion. Boundary problems with dielectrics. Molecular polarizability and electric susceptibility. Dielectric media.
3. *Magnetostatics.* Biot Savart law. Differential equations and Ampère's Law. Vector potential. Macroscopic equations and boundary conditions. Faraday's law of induction. Energy in the

magnetic field.

4. *Maxwell Equations and Conservation Laws.* Maxwell displacement current. Vector and scalar potentials. Gauge Transformations. Green functions of the wave equation. Retarded solutions of the fields. Equations of macroscopic electromagnetism. Poynting's theorem and conservation laws.
5. *Plane Electromagnetic Waves.* Plane waves in a non-conducting medium. Linear and circular polarization. Reflection and refraction of waves. Frequency dispersion characteristics of dielectrics and conductors and plasmas.
6. *Radiating Systems.* Fields and radiation of a localized oscillating source. Electric dipole fields and radiation. Center-fed linear antenna.
7. *Special Theory of Relativity.* Mathematical properties of space-time of special relativity. Transformations of electromagnetic fields.

Main text: Classical Electrodynamics, John David Jackson.

Additional texts:

Undergraduate level textbook

- Introduction to Electrodynamics, David J. Griffiths.

Graduate level textbooks

- Classical Electromagnetic Theory, Jack Vanderlinde.
- The Classical Electromagnetic Field, Leonard Eyges.

Grade Distribution:

Homework	30%
Midterm Exam	30%
Final Exam	40%

Course Policies:

- **General**

- Computers are not to be used unless instructed to do so.
- Quizzes and exams are closed book, closed notes.
- **No makeup quizzes or exams will be given.**

- **Grades**

- Grades in the **C** range represent performance that **does not meet expectations**; Grades in the **B** range represent performance that **meets** the expectations; Grades in the **A** range represent work that is **excellent**.

- Students are responsible for tracking their progress by referring to the online gradebook.

- **Assignments**

- Students are expected to work independently. **Offering** and **accepting** solutions from others is an act of **plagiarism**, which is a serious offense and **all involved parties will be penalized according to the Academic Honesty Policy**. Discussion among students is encouraged, but when in doubt, direct your questions to the professor.
- **If you turn in the homework late, then I will reduce the mark by 50% for each 24-hour period it is overdue unless you have made prior arrangements with me.**

- **Academic honesty and integrity:** By taking this course, you agree to the following statement: “An essential feature of the University of Tennessee, Knoxville is a commitment to maintaining an atmosphere of intellectual integrity and academic honesty. As a student of the university, I pledge that I will neither knowingly give nor receive any inappropriate assistance in academic work, thus affirming my own personal commitment to honor and integrity.”

All work submitted by a student is expected to represent his/her work. Students are expected to complete their homework without assistance from others. Students are expected to perform all work in conformance with the University policies regarding Academic Honesty. I will pursue any cases of academic dishonesty that arise during the course.

- **Students with disabilities:** Any student who feels they may need an accommodation based on the impact of a disability should contact Student Disability Services in Dunford Hall, at 865-974-6087, or by video relay at, 865-622-6566, to coordinate reasonable academic accommodations.
- **University civility statement:** Civility is genuine respect and regard for others: politeness, consideration, tact, good manners, graciousness, friendliness, affability, amiability and courteousness. Civility enhances academic freedom and integrity and is a prerequisite to the free exchange of ideas and knowledge in the learning community. Our community consists of students, faculty, staff, alumni, and campus visitors. Community members affect each other’s well-being and have a shared interest in creating and sustaining an environment where all community members and their points of view are valued and respected. Affirming the value of each member of the university community, the campus asks that all its members adhere to the principles of civility and community adopted by the campus: <http://civility.utk.edu/>.