

Fall 2017

Syllabus

Physics 402: Electricity & Magnetism II

TTh 9:30-10:50 am in Small Hall room 235

Undergraduate prerequisites: PHYS 401

Instructors

Prof. Seth Aubin

Office: room 255, Small Hall, tel: 1-3545

Lab: room 069, new wing of Small Hall, tel: 1-3532

e-mail: saubi@wm.edu

web: <http://www.physics.wm.edu/~saubin/index.html>

Md Tanjib Atique Khan

Office: room 320 (cubicle 10), Small Hall

e-mail: mkhan01@email.wm.edu

Office hours: Aubin: Wednesday, 4-5 pm; Khan: Tuesday, 2-3pm.

Course Objectives

The primary purpose of this course is to introduce the basic physics and applications of time-dependent electromagnetic fields.

The course will cover the following topics:

- Electromotive force, Faraday's law
- Ohm's law, inductance
- Maxwell's equations, Maxwell stress tensor
- Electromagnetic field momentum and Poynting vector
- Electromagnetic waves in vacuum and matter
- Electromagnetic potentials, gauges, retarded potentials
- Waveguides and transmission lines
- Optics and diffraction theory
- Dipole radiation, radiation reaction
- Electromagnetic simulation software
- Relativistic electrodynamics, $F^{\mu\nu}$, covariance

Course Materials

Text: Most of the course materials and problem sets will be taken from the following required text for the course:

Introduction to Electrodynamics by D. Griffiths, Prentice-Hall (4th ed.).

Software: Electromagnetic numerical simulations will be taught with the software FEKO (by Altair), which is installed on the computers in the Electronics Lab (Small Hall 230).

Some course materials will also be taken from the following texts:

Classical Electrodynamics, by J. D. Jackson.

Modern Electrodynamics, by A. Zangwill

The Feynman Lectures on Physics, by R. Feynman, R. Leighton, M. Sands.

Evaluations

Your final grade for the course will be determined from the following grading weight distribution:

Problem sets:	45%
Participation:	10%
Midterm:	15%
Final Exam:	30%

Problem sets: The problem sets are the main evaluation of learning for the course and also serve as a significant means of learning the material. Students are expected to do the problems on their own (not as a team effort with other students), though discussion and limited oral consultation with other students is encouraged. The solution manual for the main text is not an acceptable source for solving problem sets before they are due.

Participation: The classroom presentation of course material will involve class discussions. All students are expected to participate in these discussions, since they will help elucidate the course material. Participation also reflects class attendance and the occasional quiz.

Midterm: The midterm will cover course material from the first half of the course.

Final exam: The final exam will cover all the material in the course, but with an emphasis on the second half of the course.

Important academic deadlines

Add/drop deadline: Friday, September 8, 2017

Withdraw deadline: Friday, October 27, 2017

Weekly Schedule (tentative)

Week 0: 8/31

Review of Electrostatics & Magnetostatics

Brief review of time independent electric & magnetic fields in vacuum and matter.

Week 1: 9/5-7

Introduction to Electrodynamics

Faraday's law, Lenz's law, electromotive force, inductance.

Week 2: 9/12-14

Maxwell's Equations

The unification of electricity & magnetism, displacement currents.

Week 3: 9/19-21

Electromagnetic Momentum

Momentum of EM fields, Maxwell's stress tensor, Poynting vector.

Week 4: 9/26-28

Electromagnetic Waves in Vacuum

Wave solutions to Maxwell's equations, light, and polarization.

Week 5: 10/3-5

Introduction to Optics: EM waves in matter

Reflection and refraction at a dielectric interface.

Week 6: 10/10-12

Optics continued

Brewster's angle, total internal reflection, EM waves in conductors.

----- Fall Break -----

Week 7: 10/19

Midterm

Week 8: 10/24-26

Transmission Lines and EM Resonators

TEM transmission lines, coaxial cables, and Fabry-Perot cavities.

Week 9: 10/31-11/2

Potentials, Gauges, and Fields

Coulomb and Lorentz gauges, retarded potentials, Liénard-Wiechert potentials.

Week 10: 11/7-9

Radiation Fields

Radiation from accelerating charges, synchrotron radiation.

Week 11: 11/14-16

Dipole Radiation

Dipole radiation, basic antenna theory, radiation reaction, synchrotron radiation.

Week 12: 11/21

Wave Optics: Diffraction Theory

Fraunhofer and Fresnel diffraction. Diffraction integrals. EM simulation.

----- Thanksgiving Break -----

Week 13: 11/28-30

Lorentz Transformation

Lorentz invariance, relativistic mechanics, 4-vectors.

Week 14: 12/5-7

Relativistic Electrodynamics

$F^{\mu\nu}$, Lorentz invariance, covariant formulation of Electromagnetism.

Dec 11, 2017, 9am-noon

Final Exam