Fall 2015 **Syllabus**

Physics 402: Electricity & Magnetism II

TTh 9:30-10:50 am in Small Hall room 233

Undergraduate prerequisites: PHYS 401

Instructors

Prof. Seth Aubin
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Office hours: Aubin: Wednesday, 5-6 pm; Karpie: 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 (4^{th} 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.
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 4, 2015
Withdraw deadline: Friday, October 23, 2015

Weekly Schedule (tentative)

Week 0: 8/27 **Review of Electrostatics & Magnetostatics**
Brief review of time independent electric & magnetic fields in vacuum and matter.

Week 1: 9/1-3 **Introduction to Electrodynamics**
Faraday's law, Lenz's law, electromotive force, inductance.

Week 2: 9/8-10 **Maxwell's Equations**
The unification of electricity & magnetism, displacement currents.

Week 3: 9/15-17 **Electromagnetic Momentum**
Momentum of EM fields, Maxwell's stress tensor, Poynting vector.

Week 4: 9/22-24 **Electromagnetic Waves in Vacuum**
Wave solutions to Maxwell's equations, light, and polarization.

Week 5: 9/29-10/1 **Introduction to Optics: EM waves in matter**
Reflection and refraction at a dielectric interface.

Week 6: 10/6-8 **Optics continued**
Brewster's angle, total internal reflection, EM waves in conductors.

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

Week 7: 10/15 **Midterm**

Week 8: 10/20-22 **Transmission Lines and EM Resonators**
TEM transmission lines, coaxial cables, and Fabry-Perot cavities.

Week 9: 10/27-29 **Potentials, Gauges, and Fields**
Coulomb and Lorentz gauges, retarded potentials, Liénard-Wiechert potentials.

Week 10: 11/3-5 **Radiation Fields**
Radiation from accelerating charges, synchrotron radiation.

Week 11: 11/10-12 **Dipole Radiation**
Dipole radiation, basic antenna theory, radiation reaction, synchrotron radiation.

Week 12: 11/17-19 **Wave Optics: Diffraction Theory**
Fraunhofer and Fresnel diffraction. Diffraction integrals. EM simulation.

Week 13: 11/24 **Lorentz Transformation**
Lorentz invariance, relativistic mechanics, 4-vectors

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

Week 14: 12/1-3 **Relativistic Electrodynamics**
$F^{\mu\nu}$, Lorentz invariance, covariant formulation of Electromagnetism.

Dec 16, 2015, 9am-noon **Final Exam**