Fall 2010 **Syllabus**

Physics 402: Electricity & Magnetism II

MWF 9:30-10:50 am in Millington Hall room 230

Undergraduate prerequisites: PHYS 401

Instructors

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Office hours: Aubin: Wednesday, 5-6 pm; Field: TBA.

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
- 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 (3^{rd} ed., 1999).

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 significant means of learning the material. Students are expected to do the problems own (not as a team effort with other students), though discussion and limited oral consultation with other students is encouraged.

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 rare quiz.

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

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

Weekly Schedule

Week 0: 8/26 **Review of Electrostatics & Magnetostatics**
Brief review of time independent electric & magnetic fields in vacuum and matter.

Week 1: 8/31-9/2 **Introduction to Electrodynamics**
Faraday's law, Lenz's law, electromotive force, inductance.

Week 2: 9/7-9 **Maxwell's Equations**
The unification of electricity & magnetism, displacement currents.

Week 3: 9/14-16 **Electromagnetic Momentum**
Momentum of EM fields, Maxwell's stress tensor, Poynting vector.

Week 4: 9/21-23 **Electromagnetic Waves in Vacuum**
Wave solutions to Maxwell's equations, light, and polarization.

Week 5: 9/28-30 **Introduction to Optics: EM waves in matter**
Reflection and refraction at a dielectric interface, EM waves in conductors.

Week 6: 10/5-7 **Waveguides and Transmission Lines**
High frequency electronics, waveguides, and transmission lines.

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

Week 7: 10/14 **Midterm**
Coulomb and Lorentz gauges, retarded potentials, Liénard-Wiechert potentials.

Week 8: 10/19-21 **Potentials, Gauges, and Fields**
Coulomb and Lorentz gauges, retarded potentials, Liénard-Wiechert potentials.

Week 9: 10/26-28 **Dipole Radiation**
Dipole radiation, basic antenna theory, radiation reaction, synchrotron radiation.

Week 10: 11/2-4 **Wave Optics: Diffraction Theory**
Fraunhoffer and Fresnel diffraction. Diffraction integrals.

Week 11: 11/9-11 **Kramers-Kronig, Bremstrahlung & Cerenkov radiation**
Causality and EM waves. Simple relativistic effects involving EM fields.

Week 12: 11/16-18 **Catch-up week**
Catch-up week or software tools for simulating EM fields.

Week 13: 11/23 **Lorentz Transformation**
Lorentz invariance, relativistic mechanics, 4-vectors

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

Week 14: 11/30-12/2 Relativistic Electrodynamics
$F^{\mu\nu}$, Lorentz invariance, covariant formulation of Electromagnetism.

Dec 7, 2010, 9am-noon Final Exam

N.B. The above the schedule is tentative. The classes covering Kramers-Kronig, Bremstrahlung, and Cerenkov radiation will only be taught if time allows and other core topics from Griffiths have already be covered.