Spring 2017 **Syllabus**
Physics 610: Electricity & Magnetism I

TTh 9:30-10:50 in ISC room 0248

Prerequisite: undergraduate E&M (e.g. *Introduction to Electrodynamics* by D.J. Griffiths)

Instructors

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Du: Friday, 2:30-3:30pm

Course Objectives

The primary purposes of this course are to introduce relativistic electrodynamics as a classical field theory and to cover electrostatic and magnetostatic calculation methods.

The course will cover the following topics:

- Maxwell's equations
- 4-vectors, 4-tensors, and Lorentz transformations
- Classical field theory and Noether's theorem
- Lagrangian formulation of electrodynamics
- Conservation of electromagnetic energy, momentum, etc ...
- Thomas precession of spin in an electromagnetic field
- Boundary value problems in electrostatics
- Method of images, Green's functions
- Multipole expansion and spherical harmonics
- Conductors and dielectric media
- Magnetostatic boundary value problems
- Magnetic media

Course Materials

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

Classical Electrodynamics, by J. D. Jackson (3rd ed., 1999).

Modern Electrodynamics, by A. Zangwill (2013).

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

Introduction to Electrodynamics, by J. D. Griffiths (4th ed., 2013).

The Classical Theory of Fields, by L. D. Landau and E. M. Lifshitz (4th ed, 1975).

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. Use of a solution manual (or equivalent) for the homework problems is not acceptable 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 performance on in-class quizzes.

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, January 27, 2017
Withdraw deadline: Friday, March 17, 2017

Weekly Schedule (tentative)

Week 0: 1/19 **Maxwell's Equations Review**
Maxwell equations for fields and potentials, gauges.

Week 1: 1/24-26 **Special Relativity**
Lorentz transformations, Minkowski space, 4-vectors.

Week 2: 1/31-2/2 **Relativistic Electrodynamics**
EM field tensor, EM field of a relativistic point charge, Lorentz 4-force law.

Week 3: 2/7-9 **Classical Field Theory**
Least action principle for fields, Lagrangian for EM systems, Euler-Lagrange equation.

Week 4: 2/14-16 **Noether's Theorem**
Continuous symmetries and conservation laws, EM stress-energy tensor.

Week 5: 2/21-23 **Lorentz Group and Classical Spin**
Lorentz boosts, rotations, group generators, Thomas precession … Thomas-BMT equation.

Week 6: 2/28-3/2 **Intro to Electrostatics**
Discrete symmetries, vector calculus theorems, Coulomb's law, conductors. (midterm?)

---------- Spring Break ----------

Week 7: 3/14-16 **Midterm & Electrostatics**
In class mid-term. Conductors, boundary conditions, electrostatic energy, capacitance.

Week 8: 3/21-23 **Electrostatics: Method of Images and Green's Functions**
Conducting planes and spheres, von Neuman and Dirichlet boundary conditions.

Week 9: 3/28-30 **Electrostatics: Separation of Variables**
Cartesian symmetry, cylindrical symmetry, spherical symmetry, Bessel functions.

Week 10: 4/4-6 **Electrostatics: Spherical Harmonics and Multipoles**
Legendre polynomials, spherical harmonics and identities, dipoles, quadrupoles.

Week 11: 4/11-13 **Electrostatics in Matter: Dielectrics**
Polarization, linear media, electric displacement, bound charges, boundary conditions.

Week 12: 4/18-20 **Magnetostatics I**
Biot-Savart law, Ampère's law, magnetic vector potential.

Week 13: 4/25-27 **Magnetostatics II**
Magnetization, bound currents, auxillary field, multipole expansion … anapoles.

May 8, 2017, 9:00am-noon **Final Exam**