UNIVERSITY OF SOUTH CAROLINA
Department of Physics and Astronomy

Physics 504 January 9, 2012

Syllabus

Instructor: Brett Altschul (office PSC 703; 777-4985; `baltschu@physics.sc.edu`)
Office Hours: Wednesday 1:00–2:00 p.m.
Lectures: Monday, Wednesday, and Friday 10:10–11:00 a.m. (CLS 510)
Recitation: Monday 1:25–2:15 p.m. (PSC 006)
Attendance is mandatory on exam dates and optional (but highly encouraged) the rest of the time.

Topics: This course will cover classical electromagnetic theory: electrostatics, magnetostatics, electromagnetic fields in materials, induction, and electromagnetic waves.

Textbook: Griffiths, *Introduction to Electrodynamics*
This is usually considered the best modern text at the advanced undergraduate level, and it's the book I learned from. Griffiths' writing is somewhat more opinionated than that of most textbook authors; it is how *he* thinks about electrodynamics. If you want a different perspective, there are many other books, old and new, that cover much the same material. For a somewhat more advanced treatment of the same topics, I recommend the standard graduate textbook, Jackson's *Classical Electrodynamics*, which also covers many additional topics that we won't have time for in this course.

Grading: There will be (approximately) weekly homework assignments, due in class, upon which 40% of your grade will be based. If you need extra time for an assignment, e-mail me; reasonable requests for extensions will generally be granted.
The other 60% of your will come from three equally weighted exams exams, given on **Fri., Feb. 10**, **Fri., Mar. 23**, and **Tues., May 1**. (The last of these is during the final exam period and is scheduled for 9:00 a.m.)
Since this is a mixed graduate and undergraduate class, graduate students will receive less partial credit on assignments and exams.

Course Outline:

1. Vacuum Electrostatics
   (a) Coulomb's law
   (b) The electric field
   (c) Gauss's law
   (d) Calculating electric fields
   (e) The electrostatic potential
   (f) Electrostatic energy
   (g) Conductors and capacitors
   (h) Laplace's and Poisson's equations
   (i) Boundary value problems

(j) Method of image charges
(k) Separation of variables
(l) Dipoles and multipoles

2. Electric fields in matter

(a) Dielectrics; molecular basis of polarization
(b) Gauss' law in dielectrics
(c) Fields of linear dielectrics
(d) Energetics of linear dielectrics

3. Magnetostatics

(a) Currents, Ohm's law, and resistance
(b) The Lorentz force law
(c) Biot-Savart and Ampère's laws
(d) Calculating magnetic fields
(e) The vector potential and gauge invariance
(f) Magnetic fields in matter: diamagnets, paramagnets, and ferromagnets
(g) Magnetization

4. Electrodynamics

(a) Motional electromotive force
(b) Electromagnetic induction: Faraday's law
(c) Mutal and self inductances
(d) Magnetic energy
(e) Maxwell's equations
(f) Displacement current

5. Radiation

(a) Waves: one and three dimensions
(b) Wave equations for electric and magnetic fields
(c) The Poynting vector
(d) Guided waves
(e) Waves at interfaces: reflection and refraction