

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](mailto: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) Mutual 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