Instructor & GSI

- Martin White (mwhite@berkeley.edu)
- [redacted] ([redacted])

Office hours

- MW: Tue, 9:00-10:00am, 355 Campbell Hall.
- [redacted]: [redacted], [redacted]

Grading

- Homework (1/3), take-home final (2/3).
- Problem sets go out Thursday morning and are (typically) due the following Thursday by 5pm. Solutions will be posted after the deadline. Only on very rare occasions will late homework be accepted.

Textbook/References

- No text is *required* for this course, though having an E&M text will serve you well if you intend to continue with Physics! None of the lectures or problem sets will require you to have a specific book, and any material you need will be posted to this web site. This is a graduate course, so we won't slavishly follow a single text, and besides textbooks are expensive.
- **Jackson**'s "*Classical Electrodynamics*" is a good book, slightly dated, and many of the lectures follow the topics and examples in this book, though there will also be other material and the order will be different.
- **Zangwill**'s "*Modern Electrodynamics*" is another good book, more recent, with a nice selection of topics and clear explanations.
- **Garg**'s "*Classical Electromagnetism in a Nutshell*" is also a nice, more recent, book.

Syllabus

- Review of E&M (J1&6&11&12, G1&23&24, Z2&22&24)
  - Maxwell's equations, units, orders of magnitude
  - Tensors, 4-current, field strength.
  - Gauge transformations, Lorenz & Coulomb gauge.
- Special relativity (J11&12, G23&24, Z22&24)
  - Lorentz transformations, invariant interval.

    - Velocity addition and rapidity
    - Examples
    - Lagrangian & Hamiltonian description, action principle.
    - Stress-energy tensor, Poynting vector
    - Examples
    - Adiabatic invariants
- Superconductivity (Weinberg, QFT)
    - Superconductivity and spontaneously broken gauge symmetry.
- Electrostatics (J1&2&3&4, G3&14&15, Z3&4&5&6&8)
    - Poisson equation, Dirichlet & Nuemann boundary conditions, uniqueness of solutions
    - Greens functions
    - Image charges
    - Examples
    - Corners and edges
    - Spherical and cylindrical coordinates
        - Legendre polynomials, spherical harmonics, Bessel functions
        - Greens' function expansions
    - Multipole expansion
- Magnetostatics (J5, G4&16&18, Z9&10&11&12&13)
    - Analogy with electrostatics
    - Examples
- Material media (J4&7, G7&8&13&18&20&21, Z17&18)
    - Plane waves, energy and momentum flow
    - Stokes parameters
    - Radiation spectrum
    - Matching conditions, Fresnel equations
    - Dispersion and frequency dependence
    - Kramers-Kronig relations
    - Attenuation, skin depth.
- Electrodynamics, radiation & scattering (J7&8&9&14, G19&20&21&22&25, Z19&20&21)
    - Plane waves with sources
    - Retarded potentials and fields
    - Near and far fields
    - Larmor formula
    - Fields of charges in orbital motion
    - TE & TM modes
    - Antennae
    - Diffraction
    - Synchrotron radiation
    - Radiation in collisions
- Special topics
    - As time permits