Syllabus Physic 557, Electrodynamics I

Text

1. *The Classical Theory of Fields* by Landau and Lifshitz
2. *Classical Electrodynamics* by Jackson
3. *Modern Problems in Classical Electrodynamics* by Brau

Approach

In most textbooks, including Jackson's, Maxwell's equations are derived empirically through Coulomb's law, the law of Biot and Savart, Faraday's law, and Maxwell's inclusion of displacement current. This approach has been presented twice to most of physics graduate students. Landau and Lifshitz developed a theoretically more elegant approach. Starting from special relativity and using Hamilton's principle, relativistic dynamics and Maxwell's equations are derived. This approach sets classical electrodynamics in broad base of theoretical physics, and provides insights to solving many interesting problems that might be hard to solve starting from traditional approach. Landau and Lishitz might be too dense and is not always easy to learn from. Brau has developed much easier version. We will consult both textbooks in our course. We will also use Jackson, since it is a classic and is still valuable because of many useful problem sets and thorough treatment of application of electrodynamics in various settings.

Outline

1. Special relativity
2. Relativistic mechanics from Hamilton's principle
3. Dynamics pf charges in a given electromagnetic field (use of vector potential in mechanics problems, guiding center drift theory, and adiabatic invariants)
4. Transformation of the fields
5. The field equations from Hamilton's principle
6. Conservation theorems and the stress tensor (examples where momentum in field plays an important role)
7. Electrostatics and magnetostatics (solution of problems with symmetry, multipole expansions, circuit elements)
8. Electromechanic systems
9. Maxwell equations for continuous media (polarization vector and magnetization vector, forces on magnetized and polarized material)
10. Boundary value problems
11. Wave guides and resonant cavities
12. Multiple expansions for small source
13. Radiation

Grading Policy

Homework 20%, Midterm 20%, Final 60%