COURSE INFORMATION

PHYS 671: Electromagnetic Theory II

Course Blackboard Learn website available @ webcourses.niu.edu!

General Information

Location: FR 237 (conference room)
Time: Fall Semester of 2014, Tuesdays and Thursdays, 2:00 – 3:15 pm
Instructor: Dr. Bela Erdelyi
    E-mail: berdelyi@niu.edu
    Phone: (815) 753-6484
    Office hours: after classes, 3:15 – 4:30pm in LT 225

Duration: 15 weeks, i.e. 29 lectures + Final
Credits: 3
Exams: 1 midterm, during regular class – October 14, 2014
    Final: comprehensive, emphasizing 2nd part – December 9, 2013 @ 2:00pm in FR 237
Sources for Exams: the exams will be closed book/electronics. You may bring up to 4 pages (2 sheets, 4 sides) of helping material with you to the exams.
Grading: 40% homework + 25% midterm + 35% final
Letter Grades: an aggregate numerical value of at least 50% of the total points is required to pass the course with a C, with no component (homework, midterm, final) worse than 25%. The cutoff for an A grade will be approximately 85%, and lower grade level cutoffs every 5-10% (A-: 80%, B+: 75%, B: 70%, B-: 65%, C+: 60%, C: 50%, C-: 40%, D: 25%)
Homework Assignments: 5 sets (one set after each chapter), with clearly defined due dates/times. Late turn in of homework permissible only under unusual circumstances.
Course Expectations: read assigned material before lectures, attend the lectures, participate in discussions, read the appropriate sections of the textbook again after lectures, complete and turn in homework in a timely manner, solve as many problems as you can, take the exams. Expect to spend 6-9 hours per week outside classes on this course. You are encouraged to set up study groups, work together on problems, but the solutions turned in must be your own. Cite any material you used from publications, the web, etc. Homework turned in should be professional, clearly legible, showing all work, steps involved, derivations, etc. It is recommended to type up all homework solutions in Latex, Word, or Mathematica, etc.

Course Description

This course aims at providing a rigorous foundation for advanced classical electrodynamics and some of its applications. Particular focus is given to time-dependent phenomena stemming
from the axiomatic definition of electrodynamics based on the microscopic Maxwell equations, and their consequences in vacuum and matter; and for source distributions and their associated fields and waves.

**Prerequisites:** previous course(s) on electricity and magnetism at the level of D.J. Griffiths, Introduction to Electrodynamics, 3rd edition, Prentice-Hall, 1999; or passing PHYS 670

**Required textbook:** J.D. Jackson, Classical Electrodynamics, 3rd edition, Wiley, 1999, ISBN 0-471-30932-X. We will develop selected topics from Chapters 11-16, with a, hopefully, slightly more modern perspective.

**Optional Readings.** For a deeper understanding, you may also want to consult these:
- J. Franklin, Classical Electromagnetism
- W. Panofsky and M. Philips, Classical Electricity and Magnetism

**Syllabus**

**Chapter 1. Mathematics of Electrodynamics and PHYS670 Review**
- Lecture 1. Scalar, Vector and Tensor Fields, Vector Analysis, and Integral Identities
- Lecture 2. Special Functions, Complex Notation, Fourier Transforms, and Delta Functions
- Lecture 3. Maxwell Equations
- Lecture 4. Waves, radiation, guides and cavities, diffraction and all that

**Chapter 2. Special Theory of Relativity (Jackson Chapter 11)**
- Lecture 5. Introduction to STR, its principles and Lorentz transformations
- Lecture 6. Kinematics in STR; momentum, energy, and forces
- Lecture 7. Structure and mathematical properties of the theory
- Lecture 8. Covariant representation and transformation of fields

**Chapter 3. Dynamics of Particles and EM Fields (Jackson Chapter 12)**
- Lecture 9. Lagrangian formalism
- Lecture 10. Hamiltonian formulation
- Lecture 11. Canonical transformations, Symplecticity
- Lecture 12. Examples of charged particle motion in EM fields
- Lecture 13. Field Lagrangian, Hamiltonian, and interacting particles

**Midterm.**
- Lecture 14. Exam
- Lecture 15. In-class exam solutions
Chapter 4. Collisions, Energy Loss and Scattering of Charged Particles (Jackson Chapter 13)
  Lecture 16. Coulomb collisions
  Lecture 17. Cherenkov radiation and elastic scattering by atoms
  Lecture 18. Multiple angular scattering
  Lecture 19. Transition radiation

Chapter 5. Radiation from Moving Charges (Jackson Chapter 14 and 15)
  Lecture 20. Fields of a moving point charge
  Lecture 21. Radiation of point charges in accelerated motion
  Lecture 22. Synchrotron light sources
  Lecture 23. Radiation emitted during collisions
  Lecture 24. Bremsstrahlung in Coulomb collisions
  Lecture 25. Radiation damping

Chapter 6. Classical Models of Charged Particles (Jackson Chapter 16)
  Lecture 26. Abraham-Lorentz self-force
  Lecture 27. Current approaches to the evaluation of the self-force

Course Review
  Lecture 28. Fun with Electrodynamics
  Lecture 29. Review for Final; Q&A

Accessibility Statement

Northern Illinois University is committed to providing an accessible educational environment in collaboration with the Disability Resource Center (DRC). Any student requiring an academic accommodation due to a disability should let his or her faculty member know as soon as possible. Students who need academic accommodations based on the impact of a disability will be encouraged to contact the DRC if they have not done so already. The DRC is located on the 4th floor of the Health Services Building, and can be reached at 815-753-1303 (V) or drc@niu.edu.