COURSE INFORMATION

PHYS 671: *Electromagnetic Theory II*

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

General Information

Location: ONLINE 100%
Time: Fall Semester of 2020, Mondays and Wednesdays, 3:30 – 4:45 pm
Instructor: Dr. Bela Erdelyi
E-mail: berdelyi@niu.edu
Phone: (815) 753-6484
Office hours: before Wednesday class, 2:00 – 3:00pm; or
contact me by email or on the course website
Duration: 15 weeks, i.e. 27 lectures + Midterm + Final
Credits: 3
Contact hours: 2.5
Laboratory: n/a;
Exams:
- *1 midterm*, during regular class – October 19, 2020
- *1 final*: comprehensive, emphasizing 2nd part – December 7, 2020 @ 2:00 – 3:50 pm

Sources for Exams: the exams will be closed book/electronics. You may use up to 4 pages (2 sheets, 4 sides) of helping material with you to the exams. The exams will be uploaded to the course website and submissions also will be to the course website. Details to be discussed when approaching the midterm exam.
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%, D: 40%)
Homework Assignments: 4 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. 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.
This is the second part of the course, with emphasis on charged particles, their dynamics and their radiation in a relativistic setting.
At the end of the course, students will understand charged particle and electromagnetic fields dynamics, interactions, physical phenomena arising in applications, and their mathematical treatment; and will have developed skills in problem solving utilizing, analyzing, and synthetizing these concepts.

Catalog description: Radiation from moving charges, relativistic formulation of electro-dynamics, collisions and scattering, multipole radiation, radiation damping and self-forces.
Prerequisites: 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 more nuanced understanding, you may also want to consult other textbooks too, such as these:

J. Franklin, Classical Electromagnetism
L.D. Landau and E.M. Lifshitz, The Classical Theory of Fields
W. Panofsky and M. Philips, Classical Electricity and Magnetism

Syllabus

Chapter 0. Getting Started

Lecture 0. Technical setup and introduction to the course

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. In-class homework solutions
Lecture 15. Exam

Chapter 4. Collisions, Energy Loss and Scattering of Charged Particles (Jackson Chapter 13)

Lecture 16. Energy loss in collisions (kinematics)
Lecture 17. Energy loss in Coulomb collisions (cross-section)
Lecture 18. Energy loss in Coulomb collisions (cutoffs, straggling)
Lecture 19. Multiple Coulomb Scattering
Lecture 20. Cherenkov radiation
Lecture 21. Transition radiation

Chapter 5. Radiation from Moving Charges (Jackson Chapter 14 and 15)

Lecture 22. Fields of a moving point charge
Lecture 23. Radiation of point charges in accelerated motion
Lecture 24. Bremsstrahlung
Lecture 25. Radiation damping

Course Review

Lecture 26. In-class homework solutions
Lecture 27. Review for Final; Q&A

Academic Integrity Statement

Good academic work must be based on honesty. The attempt of any student to present as his or her own work that which he or she has not produced is regarded by the faculty and administration as a serious offense. Students are considered to have cheated if they copy the work of another during an examination or turn in a paper or an assignment written, in whole or in part, by someone else. Students are guilty of plagiarism, intentional or not, if they copy material from books, magazines, or other sources without identifying and acknowledging those sources or if they paraphrase ideas from such sources without acknowledging them. Students guilty of, or assisting others in, either cheating or plagiarism on an assignment, quiz, or examination may receive a grade of F for the course involved and may be suspended or dismissed from the university.

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.

A word about anxiety

These are extremely stressful times. You are not alone in feeling it. We are all living with unsettling uncertainty and it affects the way we perceive the world, ourselves and others. Such feelings may be persistent or may come on suddenly. Let's all promise to be patient with each other and help support a healthy learning environment. If you or somebody you know is struggling with anxiety or other issues, do not hesitate to reach out. Resources available include the DRC, Student Counseling Services or call 815-306-2777. As always, in the event of a crisis call for immediate help via 911 or other general support services listed here.

Dated: August 17, 2020