Syllabus
PHYS 831: Electrodynamics 1
Kansas State University
Fall 2020

Instructor: Dr. Matthew Berg
Lecture: Tu/Th 9:30-10:45 in CW 130
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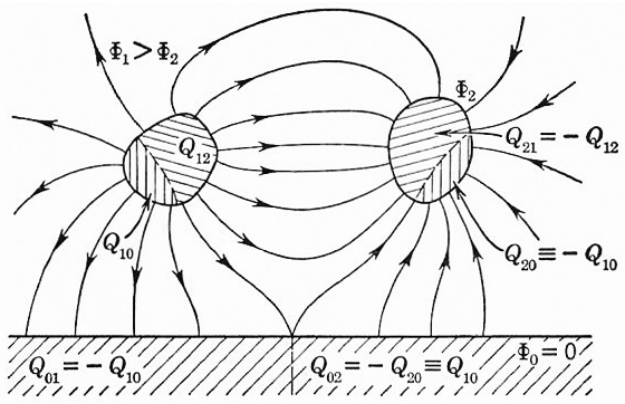

Course text: J. D. Jackson, *Classical Electrodynamics* (3rd ed., Prentice-Hall, 1999)

Prerequisites: PHYS 532 [Electromagnetic Fields 1] and PHYS 801 [Mathematical Methods of Physics]

Overview: The purpose of this course is to provide you with an advanced knowledge of electrodynamics and practice with the various mathematical techniques used in this field. Because the course has Mathematical Methods as a prerequisite, I will try hard to focus more on the physical aspects rather than making this class a *tour de force* on special functions. While some new concepts will be presented, much of the general topics discussed will not be new to you. What *will* be new is to see how many of the assumption/simplifications that restricted the scope of problems that you could solve before, e.g., in PHYS 532, are removed. The result will be to expand your analytical abilities in electrodynamics, which will also be valuable in other subjects and perhaps even in your research pursuits.

Outline: In general, this course will focus mostly on electrostatics, i.e., time-independent phenomena, while next semester will deal more with dynamics. Yet, there will be some degree of dynamics this semester as well, more toward the end when we look at magnetic phenomena. Overall, I intend to follow the structure of the book with a few asides and supplements here and there. A general outline is as follows:

- Introduction and mathematical review [§I]
- General concepts in electrostatics [Ch. 1]
- Boundary value problems in electrostatics [Chs. 2-3]
- Electric multipoles and dielectrics [Ch. 4]
- Magnetostatics and Faraday's law [Ch. 5]

Homework: Given the complexity of this material, there is only so much I can convey during the lectures and the way that you really master the material is through solving problems. Thus, we will

have a number of problem sets consisting of problems from the text, fragments thereof, and other relevant *ad hoc* problems. The intent is not to 'kill-you-dead' with the book's infamously difficult problems, but rather to gradually develop the analytical skills that are needed in the field. Indeed, many of the mathematical techniques will almost surely be seen in other courses. I will try to keep the time demands associated with homework reasonable since I know that you have other classes and research to do. Homework will constitute 60% of the grade.

Guidelines for homework:

- Discuss the problems with your classmates as much as you want, but do your **own** work and write your own solutions!
- Please take care to present your work in a neat, readable, and logical manner.
- You **must** cite any source that you use for your solutions other than what is contained in the course text. This includes websites.
- You will find the program *Mathematica* helpful to relieve much of the algebra and calculus tedium typically involved. If you use *Mathematica*, you need to include a printout of your code with your solutions. You will not have access to it during the exams, so be sure you can perform all of the operations that you use it for by hand.
- In the case of an incorrect solution, I will give credit for arguments and/or illustrations that show you know it is incorrect and why; this goes for the exams as well. I may also acknowledge any effort obviously beyond what is asked for in a problem, such as graphical presentations of solutions, etc.

Exams: There will be a midterm and final exam, and these exams will collectively constitute the remaining 40% of the grade.

Grades: The grade breakdown will be: 90-100% A, 80-89% B, 70-79% C, 60-69 D, and F<59%. Final grades will be rounded to the nearest 1% in your favor.

Supplementary references:

- D. J. Griffiths, *Introduction to Electrodynamics*, (4^{th} ed. Pearson, 2013). While the book is somewhat below the level of this course, it is probably the best text on the topic yet written.
- E. M. Purcell, *Electricity and Magnetism*, (Berkeley Physics Course, 1965). An eerily good book for the basics.
- A. Zangwill, *Modern Electrodynamics*, (Cambridge University Press, 2013). Same level of difficulty as Jackson, but often more enlightening and shows many neat applications of the material.
- M. Abramowitz, I. A. Stegun, *Handbook of Mathematical Functions with Formulas, Graphs, and Mathematical Tables*, (National Bureau of Standards Applied Mathematics Series, Vol. 55, 1964). An absolutely critical reference for the properties of various special functions and difficult integrals. An updated on-line version is the NIST Digital Library of Mathematica Functions at: `https://dlmf.nist.gov/`

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