PHYS 931: Electrodynamics 2  
Kansas State University  
Syllabus  
Spring 2017

Instructor: Dr. Matthew Berg  
Lecture: Tu/Th 9:30-10:45 in CW 130  
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Plot of the electric field emitted from a radiating dipole antenna by Heinrich Hertz, 1893.


Prerequisites: PHYS 633 [Electromagnetic Fields 2], PHYS 801 [Mathematical Methods of Physics], and PHYS 831 [Electrodynamics 1]

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 to you is to see how many of the assumption/simplifications that restricted the scope of problems that you could solve before, e.g., in PHYS 633, are removed. The result will be to substantially expand your analytical abilities in electrodynamics, which will also be highly valuable in other subjects and perhaps even in your own research pursuits.

Outline: In general, this course will focus mostly on electrodynamics, i.e., time-dependent phenomena. Overall, I intend to follow the structure of the book as we move through the material with a few asides and supplements here-and-there. Thus, a general outline is as follows:
• Induction [Ch. 5]
• Maxwell’s equations [Ch. 6]
• Electromagnetic waves: plane waves, waveguides, basic optics [Chs. 7 & 8]
• Electromagnetic radiation [Ch. 9]
• Electromagnetic scattering [Ch. 10]
• Selected topics in relativistic electrodynamics [Chs. 11-16]

**Homework:** Given the complexity of this material and that there is only so much I can convey during the lectures, the way that you will really master the material is through solving problems. Thus, we will have approximately eight 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 commonly needed in the field. Indeed, the mathematical techniques alone will almost surely be seen again 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 your 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.

• You will find the program *Mathematica* extremely helpful to relieve much of the algebra and calculus tedium typically involved in these problems. 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 reward any effort obviously beyond what is asked for in a problem, such as graphical presentations of solutions, etc.

**Exams:** There will a midterm and final exam and these will constitute the remaining 40% of your grade. The final will be in-class, whereas the midterm may be take-home or in-class depending on how the course proceeds.

**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*, (4th ed. Pearson, 2013). While somewhat below the level of this course, this is probably the best textbook on the topic ever written.


- 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.


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