Electrodynamics I

Physics 831	Fall 2015
TU 9:30 - 10:45	Cardwell 130
3 credit hours	**KSU - Physics**

Instructor: Prof. Gary Wysin, wysin@phys.ksu.edu
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PHYS831 www: http://www.phys.ksu.edu/personal/wysin/ED-I

Goals of Course

1. Analyze and apply electric and magnetic field concepts. What are sources of static EM fields? How do boundaries affect the physics? How do different sources and geometries produce different field configurations? What energies are involved? How do we analyze magnetostatics? How is energy propagated in EM waves? Mostly for classical fields, but quantization of EM fields may be mentioned.

2. Learn and use advanced mathematical physics techniques. These are various topics that might be covered in a Math Methods course, having to do with solving the famous equations used in physics (Laplace, Poisson, wave equation, Green's functions, orthoganal functions, etc.)

Concepts

1. Static fields, boundary value problems.
2. Effects of materials, polarizations.
3. Eelectromagnetic energy, energy conservation.
4. Dynamics: propagating waves, dispersion.
5. Dynamics: interactions of fields and charges.

Techniques

1. Laplace Eq., images, orthog. functions.
2. Poisson equation, Green functions.
3. Vector, tensor, differential calculus.
4. Complex variables (2D statics & dispersion.)
5. Generating functions, eigenfunctions.

Importance of Electrodynamics

Electromagnetic effects occur in nearly all natural phenomena, although there may not always be obvious macroscopic effects. Where macroscopically observable effects occur, the idea of fields is extremely useful and conceptually necessary to describe the situation. Knowledge of the physics and math used for EM fields can be generalized to gravity and other fields.

ED theory is the most well-known example of a classical theory that is conceptually unified by the field concept. Furthermore, it has an essential relevance to relativity. The mathematical techniques used are applicable to many other problems, especially quantum mechanics. Finally, an understanding of ED at the classical level is the basis for following any quantum field theories.

Grading and Requirements

Grades will be recorded in K-State Online Canvas, and determined as follows:

Task:	Points:	Grading scale:
a) Exam 1, Chs. I, 1, 2	250	A: 1000–880
b) Exam 2, Chs. 3, 4, 5	250	B: 880–760
c) Exam 3, Chs. 6, 7, 8	250	C: 760–640
d) Homework+Presentations	250	D: 640–520

Homework
There will be around 12 homework assignments, intended for applying your understanding of the topics. You can obtain credit for doing the HW by presenting solutions orally and also handing in your written solution, with each problem worth up to 50 points. I hope everyone could present at least four during the semester; the total HW scores will be scaled to 250 points. Concise and clear explanations are expected; avoid excessive algebra or other tedious details.

Lecture Notes
See the physics web pages for the course (www: http://www.phys.ksu.edu/personal/wysin/ED-I) for lecture notes based on my interpretation of the writings in the Jackson text.

Disabilities
Students with disabilities who need classroom accommodations, access to technology, or information about emergency building/campus evacuation processes should contact the Student Access Center and/or their instructor. Services are available to students with a wide range of disabilities including, but not limited to, physical disabilities, medical conditions, learning disabilities, attention deficit disorder, depression, and anxiety. If you are a student enrolled in campus/online courses through the Manhattan or Olathe campuses, contact the Student Access Center at accesscenter@k-state.edu, 785-532-6441; for Salina campus, contact the Academic and Career Advising Center at acac@k-state.edu, 785-826-2649.

Plagiarism
As scientists in training, high professional standards of integrity and ethics are expected of you. While you are encouraged to discuss questions with me or with other students, what you hand in must be your own work. **Copying from others, textbooks, internet, is considered plagiarism.** Assignments are intended to be written out individually, unless I have stated that an assignment is collaborative.

University Statement Regarding Academic Honesty
Kansas State University has an Honor System based on personal integrity, which is presumed to be sufficient assurance that, in academic matters, one's work is performed honestly and without unauthorized assistance. Undergraduate and graduate students, by registration, acknowledge the jurisdiction of the Honor System. The policies and procedures of the Honor System apply to all full and part-time students enrolled in undergraduate and graduate courses on-campus, off-campus, and via distance learning. The honor system website can be reached via the following URL: www.k-state.edu/honor. A component vital to the Honor System is the inclusion of the Honor Pledge which applies to all assignments, examinations, or other course work undertaken by students. The Honor Pledge is implied, whether or not it is stated: "On my honor, as a student, I have neither given nor received unauthorized aid on this academic work." A grade of XF can result from a breach of academic honesty. The F indicates failure in the course; the X indicates the reason is an Honor Pledge violation.

Statement Defining Expectations for Classroom Conduct
All student activities in the University, including this course, are governed by the Student Judicial Conduct Code as outlined in the Student Governing Association By Laws, Article V, Section 3, number 2. Students who engage in behavior that disrupts the learning environment may be asked to leave the class.

Copyright Notification

Course Schedule

The textbook for the course is *Classical Electrodynamics*, by J. D. Jackson, (3^{rd} ed., SI units, 1998. or 2^{nd} ed., CGS units, 1975). The tentative schedule is as follows:

Lecture/Date	Topic	3^{rd} ed. Sections
1. 8-25	Limits of classical ED, introduction	I.1-I.6
2. 8-27	Units, electrostatics in vacuum	1.1-1.6
3. 9-1	Poisson and Laplace equations, energy	1.7,1.11
4. 9-3	Green's theorem, boundary problems	1.8-1.10, 1.12-1.13
5. 9-8	Method of images; examples	2.1-2.5
6. 9-10	Green function for sphere, separation of variables	2.6,2.7,2.9
7. 9-15	Orthogonal functions, 2D Laplace eq.	2.8,2.11
Friday 9-18	**First Exam (closed+open book)**	**Chs. I, 1, 2**
8. 9-17	Spherical coords., Legendre polynomials	3.1-3.2
9. 9-22	Azimuthal symmetry, generating functions	3.3
10. 9-24	Azimuthal dependence, spherical harmonics	3.5,3.6
11. 9-29	Cylindrical coords, Bessel functions	3.7,3.8
12. 10-1	Green function expansions	3.9-3.12
13. 10-6	Multipoles, energy, polarization	4.1-4.3
14. 10-8	Dielectrics, polarizability	4.4-4.6
15. 10-13	Energy in dielectrics, capacitors	4.7
16. 10-15	Magnetostatics, vector potential	5.1-5.5
17. 10-20	Magnetic moments, $\vec{M}, \vec{B}, \vec{H}$	5.6-5.8
18. 10-22	Magnetic boundary problems, surface currents	5.9-5.12
19. 10-27	Faraday's Law, EM energy	5.15-5.16
Friday 10-30	**Second Exam (closed+open book)**	**Chs. 3, 4, 5**
20. 10-29	Maxwell's Eqs., Green function for wave eq.	6.1-6.6
21. 11-3	EM field energy, Poynting theorem	6.7-6.9
22. 11-5	Symmetries under transformations	6.10
23. 11-10	Plane waves, polarization	7.1-7.2
24. 11-13	Reflection, refraction at interfaces	7.3-7.4
AA. 11-24,26	**Thanksgiving break, no class**	
25. 11-17	Dispersion, absorption	7.5,7.6
26. 11-19	Group velocity, waves in conductors	7.8,7.7
27. 12-1	Causality, Kramers-Kronig relations	7.10
28. 12-3	Fields in cylindrical waveguides	8.1-8.3
29. 12-8	Rectangular waveguides, energy flow	8.4-8.5
30. 12-10	Dielectric waveguides (optical fibers)	8.10-8.11
Friday 12-18	**2:00-3:50 p.m., Final Exam (closed+open book)**	Chs. 6, 7, 8