

Electromagnetic Fields I

Fall 2023

Kansas State University

Physics 532 Lec

MWF 11:30 a.m.

Cardwell 222

Physics 532 Rec

T 11:30 a.m.

Cardwell 222

Main Text: *Introduction to Electrodynamics*, 3rd or 4th ed., (chapters 1–7) by David J. Griffiths.

Supplemental Text: *Div, Grad, Curl and all that*, 3rd ed., by H. M. Schey.

Professor: Gary Wysin, Cardwell 106.

Office Hours: ?? MTW 12:30–1:30 ?? or by appt.

Email: wysin@phys.ksu.edu.

<http://www.phys.ksu.edu/personal/wysin/>

Overview:

Electromagnetic fields are present everywhere and the theory of electromagnetism represents one of the basic unified field theories we know in physics. The goal of this course is to acquire an understanding of mostly *static* electric and magnetic fields in vacuum and in electromagnetically polarizable media. That will be a preparation for EM Fields II where there will be more explanation of *dynamic* EM phenomena such as EM waves. Electromagnetism stands as one of the four fundamental forces, but also it is the one most manipulated and applied in technology by humanity. Anyone trained in physics needs to know how electromagnetism works for its own intrinsic value as well as that knowledge being applicable to understanding the other three fundamental forces or fields. The mathematics learned for understanding and describing EM fields is equally applicable in quantum mechanics and other physics theories.

We will cover the first seven chapters of the Griffiths text. Some of the topics include vector calculus that applies to other fields besides electromagnetism. Some of that mathematics may be review for some students, for others it is probably new. I will plan to go mostly in the same order of topics as in the text. If you want to cover some other topic(s) not in the text then let me know of your interests.

Please attempt to read the relevant chapters before lectures. If you don't read something before coming to lecture, you could be lost or at a disadvantage. In class many things may not be clear to you, so, please ask questions. You may not be the only one who wants and really needs a further explanation. Maybe the misunderstandings you have will be answered in class if you actively participate.

Course Work and Grading:

Homework (25%):

Homework is due on Mondays. At the start of class, either the written work will be collected, or, a short quiz (about 10-15 minutes) on the topics of the homework will be given. Your lowest homework score will be dropped.

The purpose of homework is for you to have understanding and practice in problem solving and in communication of that solution. You can discuss problems with your classmates but **you must write your solution on your own**, so that you understand it. If you work with other people then you should acknowledge that on the paper, for instance, by writing something like "I worked with Elizabeth Electromagnet on this assignment." You should cite any published or online sources you use.

You can probably google problems find a solution online. But what is the value of that? A big part of learning is using your brain to work over something, either consciously or unconsciously. Being knowledgeable in a field does not mean knowing how to "research it" on the internet. You're not an expert if you have to look everything up. And we don't want to read or grade copied solutions, besides that being an honor code violation. Please try to think that you are training to become an expert in the field, to whom other people come for questions. Someone has to be an expert, why not you?

Generally, a problem solution should state the problem to be solved (what is given and what is to be found or derived), the basic concept or physics ideas that are used to solve it, and then a combination of word explanations and mathematics that is used to elaborate the solution. If some interesting result is found you might also explain why it is expected, or why it makes sense based on physics principles, or perhaps why it is unusual. It should be written so other students in the course could understand it. Try to be as clear and organized as possible. If you can't write clearly by hand then you aren't communicating. You may need to type your work (i.e., LaTeX or something like that). But it shouldn't be only math formulas.

In-class Practice (15%):

For the **recitations** we may have in-class discussion and practice on extended problems either individually or in small groups. These may also include presentations at the board. Clearly to get credit for that you must be present. Your lowest recitation score will be dropped.

Mid-Term Exams (40%):

There will be two written mid-term exams, see the schedule for the expected dates and topics to be covered. None will be dropped, so it is important to verify the schedule and be sure to be present for the exams.

Final Exam (20%):

The comprehensive final exam takes place 11:50 a.m.–1:40 p.m., Monday, Dec. 11 in Cardwell 222.

Grading Scale:

The grading scale to be used is A (100–88%), B (88–76%), C (76–64%), D (64–52%), F (52–0%). The course is available with either a standard letter grade or the A/Pass/F option.

Suggested Weekly Schedule

<u>Date</u>	<u>Book reference</u>	<u>Topics</u>
1. Aug. 21–	ix–xv, 1.1,1.2,2.1	Intro. & scope, electric fields, vector algebra, differential calculus.
2. Aug. 28–	1.3–1.6	E -fields and flux, Gauss' Law, curvilinear coords., 1D δ -functions.
3. Sep. 5–	2.1–2.3,	3D delta-functions, electric potential definition and examples.
4. Sep. 11–	2.3–2.4	Work & energy, conductors, capacitance, boundary conditions, Laplace eqn.
5. Sep. 18–	2.5, 3.1–3.2	Solving Laplace's equation: grid, method of images, separation of vars.
6. Sep. 25–	3.3–3.4	Laplace eqn. in spherical coords., monopoles & dipoles.
7. Oct. 2–	4.1–4.2	Multipole theory, expansions for $V(\mathbf{r})$; Atomic polarizability.
Oct. 6	Chaps. 1–3	Midterm Exam 1, Vector calculus and electrostatics in vacuum.
8. Oct. 9–	4.3–4.4	Dielectric materials, electric polarization, electrostatic energy in media.
9. Oct. 16–	5.1–5.2	Magnetic forces on charges & currents, current density.
10. Oct. 23–	5.3–5.4	Biot-Savart & Ampere's Laws for magnetic fields, magnetic vector potential.
11. Oct. 30–	6.1–6.2	Magnetic materials, magnetization and bound currents.
12. Nov. 6–	6.3–6.4	Solving for fields in magnets, linear & nonlinear magnetic media.
13. Nov. 13–	7.1–7.2	Ohm's Law, electromotive force, Faraday's Law of induced emf.
Nov. 17	Chaps. 4-6	Midterm Exam 2, Electrostatics in dielectrics, magnetostatics.
Nov. 20–24	none	Thanksgiving Break.
14. Nov. 27–	7.2 & notes	Inductance and magnetic energy, RLC circuits and impedance..
15. Dec. 4–	7.3	Maxwell's equations, physics & symmetry, review.
Dec. 11	Chaps. 1–7	Comprehensive Final Exam, 11:50 a.m. – 1:40 p.m., CW 222.

Mandatory University Statements - please read carefully

Academic Honesty: Kansas State University has an Honor and Integrity 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 and Integrity System. The policies and procedures of the Honor and Integrity 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 and Integrity System website can be reached via the following URL: www.k-state.edu/honor. A component vital to the Honor and Integrity 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.

Disabilities: At K-State it is important that every student has access to course content and the means to demonstrate course mastery. Students with disabilities may benefit from services including accommodations provided by the Student Access Center. Disabilities can include physical, learning, executive functions, and mental health. You may register at the Student Access Center (k-state.edu/accesscenter) or to learn more contact: Manhattan/Olathe/Global Campus - Student Access Center (accesscenter@k-state.edu, 785-532-6441), K-State Salina Campus -Julie Rowe; Student Success Coordinator (jarowe@k-state.edu, 785-820-7908).

Students already registered with the Student Access Center please request your Letters of Accommodation early in the semester to provide adequate time to arrange your approved academic accommodations. Once SAC approves your Letter of Accommodation it will be e-mailed to you, and your instructor(s) for this course. Please follow up with your instructor to discuss how best to implement the approved accommodations.

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.

Mutual Respect and Inclusion: At K-State, faculty and staff are committed to creating and maintaining an inclusive and supportive learning environment for students from diverse backgrounds and perspectives. K-State courses, labs, and other virtual and physical learning spaces promote equitable opportunity to learn, participate, contribute, and succeed, regardless of age, race, color, ethnicity, nationality, genetic information, ancestry, disability, socioeconomic status, military or veteran status, immigration status, Indigenous identity, gender identity, gender expression, sexuality, religion, culture, as well as other social identities.

Faculty and staff are committed to promoting equity and believe the success of an inclusive learning environment relies on the participation, support, and understanding of all students. Students are encouraged to share their views and lived experiences as they relate to the course or their course experience, while recognizing they are doing so in a learning environment in which all are expected to engage with respect to honor the rights, safety, and dignity of others in keeping with the K-State Principles of Community <https://www.k-state.edu/about/values/community/>.

If you feel uncomfortable because of comments or behavior encountered in this class, you may bring it to the attention of your instructor, advisors, and/or mentors. If you have questions about how to proceed

with a confidential process to resolve concerns, please contact the Student Ombudsperson Office. Violations of the student code of conduct can be reported here <https://www.k-state.edu/sga/judicial/student-code-of-conduct.html>. If you experience bias or discrimination, it can be reported here <https://www.k-state.edu/report/discrimination/>.

Discrimination, Harassment, and Sexual Harassment: Kansas State University is committed to maintaining academic, housing, and work environments that are free of discrimination, harassment, and sexual harassment. Instructors support the University's commitment by creating a safe learning environment during this course, free of conduct that would interfere with your academic opportunities. Instructors also have a duty to report any behavior they become aware of that potentially violates the University's policy prohibiting discrimination, harassment, and sexual harassment (PPM 3010).

If a student is subjected to discrimination, harassment, or sexual harassment, they are encouraged to make a non-confidential report to the University's Office for Institutional Equity (OIE) using the online reporting form. Incident disclosure is not required to receive resources at K-State. Reports that include domestic and dating violence, sexual assault, or stalking, should be considered for reporting by the complainant to the Kansas State University Police Department or the Riley County Police Department. Reports made to law enforcement are separate from reports made to OIE. A complainant can choose to report to one or both entities. Confidential support and advocacy can be found with the K-State Center for Advocacy, Response, and Education (CARE). Confidential mental health services can be found with Lafene Counseling and Psychological Services (CAPS). Academic support can be found with the Office of Student Life (OSL). OSL is a non-confidential resource. A comprehensive list of resources is available here. If you have questions about non-confidential and confidential resources, please contact OIE at equity@ksu.edu or (785) 532-6220.

Other Relevant Statements

Copyright Notification: Copyright 2023 (Gary M. Wysin) as to this syllabus and all lectures. During this course students are prohibited from posting on commercial websites or selling notes to or being paid for taking notes by any person or commercial firm without the express written permission of the professor teaching this course. In addition, students in this class are not authorized to provide class notes or other class-related materials to any other person or entity, other than sharing them directly with another student taking the class for purposes of studying, without prior written permission from the professor teaching this course.

Note that the K-State Student Conduct Code prohibits any illegal or unauthorized taking, selling, or distribution of class notes. Students violating this provision will be subject to discipline under the conduct code, including but not limited to possible expulsion from K-State.

Mental Health: Your mental health and good relationships are vital to your overall well-being. Symptoms of mental health issues may include excessive sadness or worry, thoughts of death or self-harm, inability to concentrate, lack of motivation, or substance abuse. Although problems can occur anytime for anyone, you should pay extra attention to your mental health if you are feeling academic or financial stress, discrimination, or have experienced a traumatic event, such as loss of a friend or family member, sexual assault or other physical or emotional abuse.

If you are struggling with these issues, do not wait to seek assistance.

Kansas State University Counseling Services (k-state.edu/counseling/) offers free and confidential services to assist you to meet these challenges.

Lafene Health Center (<https://www.k-state.edu/lafene>) has specialized nurse practitioners to assist with mental health.

The Office of Student Life (k-state.edu/studentlife) can direct you to additional resources.

K-State Family Center offers individual, couple, and family counseling services on a sliding fee scale (<https://www.hhs.k-state.edu/familycenter/>).

Center for Advocacy, Response, and Education (CARE) provides free and confidential assistance for those in our K-State community who have been victimized by violence (<https://www.k-state.edu/care/>).

University Excused Absences: K-State has a University Excused Absence policy (Section F62) <https://www.k-state.edu/provost/universityhb/fhsecf.html>. Class absence(s) will be handled between the instructor and the student unless there are other university offices involved. For university excused absences, instructors shall provide the student the opportunity to make up missed assignments, activities, and/or attendance specific points that contribute to the course grade, unless they decide to excuse those missed assignments from the student's course grade. Please see the policy for a complete list of university excused absences and how to obtain one. Students are encouraged to contact their instructor regarding their absences.

See <http://www.k-state.edu/provost/resources/teaching/course.html> for further information on these University policies.