Course Information

Course: PHYS 333 Fall 2022
Electromagnetic Theory I

Instructor: Katharina Vollmayr-Lee
152 Olin
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Classes: MWF 11:00 – 11:50 am Olin 264

Office Hours: W 4-5 pm, Tu 2:30-3:30 pm, R 2:30-4 pm, F 8-9:30 am
in Olin 152

HW for every class
best common times

Webpage: For updated information on our course, see the webpage
http://www.eg.bucknell.edu/~kvollmay/phys333_f2022/

Text: David J. Griffiths, *An Introduction to Electrodynamics*, Fourth Edition.

SUPER BOOK!

Objectives: Classical electromagnetism is one of the core subjects in any education in physics. Even though the main structure of the theory has been codified in just a few equations for over 100 years, the field is still interesting, relevant, and the subject of ongoing research. Everyone in this course has had some exposure to electricity and magnetism, but this is a rich subject, and you can study it at deeper and deeper levels. If you continue on in physics, there is another course in electromagnetism at Bucknell, PHYS 334, and you would probably take two more courses on it in graduate school.

This is as much a course in applied vector calculus and partial differential equations as it is a course in electromagnetic theory. Therefore the techniques you will learn, have applications beyond electromagnetism. We will not be studying "useful" device-oriented electronics like some of you did last spring in PHYS 235. Rather, you will be learning about the properties of abstract (but very real!) vector fields that are described by Maxwell's equations (the crown of this course). The unification of electricity and magnetization (and optics, for that matter) into a single (beautiful !) theory which can be described in a few equations represents one of the pinnacles of achievement in theoretical physics.

Beautiful! Math describes "nature"

Goals:

For more general learning goals for physics, astronomy, and biophysics, see

`http://coursecatalog.bucknell.edu/collegeofartsandsciencescurricula/areasofstudy/physicsandastronomy/#goalstext`

For our course the following goals apply:

- "Be able to solve quantitative problems that require an understanding of the fundamental principles in each of the major areas of physics. Show a working knowledge of how a broad array of physical phenomena can be explained using these fundamental concepts."
- "Use critical thinking skills to formulate and solve quantitative problems."

Problem Solving

or more specific, the learning goals for this course are that by the end of this course you should be able to:

- Explain the qualitative meaning of the differential vector calculus operations (divergence, gradient, curl) and to apply them appropriately.
- Explain the fundamental theorems of vector calculus (Stokes Theorem, the divergence theorem, the gradient theorem) and to apply them appropriately.
- Explain and apply the method of images and separation of variables.
- Employ both integral and differential forms of Gauss's Law and Ampere's Law in problem solving.
- Identify qualitatively and quantitatively how electrical and magnetic phenomena are modified in matter.
- Write down Maxwell equations, explain their qualitative meaning and solve them in special cases.

You will be proud of yourself at end of course

Practice:
- Reading Examples
- HW
- some examples in class
- smaller tests

← advice for reading book: for each example in text, try first yourself, before continuing to read

Course Structure: This course will be interactive, and therefore it will be *essential that you come prepared to class.* For each reading assignment you will have to submit a **journal entry.** The purpose of these journal entries is to encourage you to do the reading and to spend class time most effectively. Your journal entry should reflect that you have done the reading and can contain any or all of the following: a summary, comments on what part of the reading was most difficult, easy, and interesting, or general comments about the course. I encourage your feedback. These journal entries will be due 10 am on the day of the class. However, it would be extremely helpful if you could get them to me earlier, to give me time to incorporate your feedback into the lecture planning.

helps you:
- to focus on reading
- one-on-one feedback
- giving me feedback on course (I adjust classes.)

This is where most learning happens

There will be **homework assignments** for each class both for you to be continuously involved with the class material and for me to get feedback on your understanding of the class material. Homework assignments will be due at the beginning of class. I will randomly decide for each problem (based on a tossed die!) whether I grade it (1/2 of the time) or whether you self-grade it. I will provide guidelines for the self-grading, and solution sets for each homework set. (See webpage) Usually I will start the class with a brief summary of the last class. Then the course material will be discussed in lecture form, and will be practiced in the form of in-class problems for which **you** will be working on the blackboard.

Covid-19 & Monkeypox: To keep our classroom community safe, please stay home if you are not feeling well or are at an increased risk of carrying COVID, monkeypox, the bubonic plague, or anything else you don't want to pass along to your classmates. In this case, please contact me immediately, via email, office hours, or in your journal entry, so that we can make arrangements.
For the beginning of the fall semester you are required to wear a mask (covering nose and mouth). Depending on the situation at Bucknell and globally, we will adjust precautions. In case of any concerns, please feel free to share with me via email, during office hours, or via the journal entry.

College in the Wake of a Crisis: We—as individuals, as a university, and as a nation—are in the wake of many crises. A national racial reckoning, a global pandemic, the #metoo movement, a wave of anti-trans legislation, the increase in anti-Asian hate crimes, sharpened anti-Semitism, and an uncertain economic future combine to create a time of intense stress and increased anxiety. And everyone will experience different levels of stress and anxiety at different times during the semester. As a class community, I encourage us to collectively move through the semester thoughtfully, kindly, and empathetically. I encourage us to communicate (when necessary and comfortable) with each regarding our health and well-being. And perhaps most importantly, I encourage each of us to prioritize self-care and accountability.

Grading: Since the course structure relies on you coming to class prepared, it is important that you work steadily on the reading with journal entries and homework assignments. For this reason, journal entries are due 10 am before class and will *not* be accepted late. Scoring of the journal entries will be on a 2-point scale. You will be able to drop two of your lowest journal entry scores. The journal entries count 5% towards your grade.

Homework will take a considerable amount of your time and is intended to give you plenty of practice. **No late homework will be accepted!** This is because the solution sets will already have been distributed, and because the goal is for you to be working on the problems while we are discussing the material. You will get to drop your lowest two homework grades. You are encouraged to work together on the homework. However your handed in solution set should be a reflection of **your** understanding. That also means that you should not reproduce a solution that you find on the internet. Such academic dishonesty will be taken seriously.

There will be six smaller in class tests, each for the full 50 min class period, but with content of a 20-25 min test. These six smaller tests replace the traditional three larger exams, to hopefully reduce test anxiety and to provide you with continuous feedback. There will be a cumulative final. Attendance is required.

Reading Assignments	5 %
Homework Assignments	30 %
Six Small Tests (each 8%)	48 %
Final	17 %

Accommodations: Any student who may need an accommodation based on the impact of a disability, should contact the Office of Accessibility Resources (OAR) at 570-577-1188 or OAR@bucknell.edu. The office will help coordinate reasonable accommodations for those students with documented disabilities. Please visit https:www.bucknell.edu/Accessibility for more information about the OAR.

Inclusive: We will strive for an inclusive classroom as described in The Bucknell University Solidarity Creed (2015)

"As a member of this community, I will respect the diversity of all individuals, including, but not limited to, their sex, gender, identity, expression, race, ethnicity, age, class, citizenship, sexual orientation, nationality, socio-economic status, religion, physical ability and mental ability," the creed reads in part. "I will commit to educating myself about cultures, identities and experiences other than my own."

For resources on diversity see

`https://www.bucknell.edu/life-bucknell/diversity-equity-inclusion`

Work in Progress for each one of us

see also HW 1.1 and beginning of next class

Course Syllabus

Beautiful Math

Dates	Topic	Reading
Aug. 22/24/26	Vector Fields and Vector Calculus	§1.1 – 1.3
Aug. 29/31, Sept. 2	Vector Calculus and Delta Functions	§1.4 – 1.6
Sept. 5	Test 1	
Sept. 7/9/12	Electrostatics: Coulomb's Law, Gauss's Law	§2.1 – 2.2
Sept. 14/16/19	Electrostatics: Potential, Work, Energy	§2.3 – 2.5
Sept. 21	Test 2	
Sept. 23/26/28	Electrostatics Math Techniques: Laplace's Equations, Method of Images elegant!	§3.1 – 3.2
Sept. 30, Oct. 3/5	Electrostatics Math Techniques: Separation of Variables, Multipole Expansion	§3.3 – 3.4
Oct. 7	math allows us to solve very cool physics problems Test 3	
Oct. 12/14	Electric Fields in Matter: Polarization	§4.1 – 4.2
Oct. 17/19/21	Electric Fields in Matter: Displacement and Dielectircs	§4.3 – 4.4
Oct. 24	Test 4	
Oct. 26/28/31	Magnetostatics: Lorentz Force, Biot-Savart Law	§5.1 – 5.2
Nov. 2	Magnetostatics: Ampère's Law	§5.3
Nov. 4	Test 5	
Nov. 7/9/11	Vector Potential & Magnetic Fields in Matter: Magnetization	§5.4, 6.1, 6.2
Nov. 14/16	Magnetic Fields in Matter: Auxiliary Field H, Permeability	§6.3 – 6.4
Nov. 18	Test 6	
Nov. 28/30	Electrodynamics: Faraday's Law	§7.1 – 7.2
Dec. 2/5	Electrodynamics: Maxwell's Equations The Crown	§7.3
Dec. 9, 8am	FINAL	