Physics 3420 Electricity and Magnetism I Spring 2015

This is the first of a two-semester sequence of advanced classical electromagnetism. It uses the tools of vector calculus for solving static and dynamic properties of electromagnetic fields. The topics we will cover include electrostatics (fixed charge distributions), magnetostatics (steady current distributions), electric and magnetic properties of matter, and an introduction to time-dependent systems.

What we cover, and why: This class should be your second course in E&M, but the first course in a true field theory. Classical electrodynamics in the form of Maxwell's equations is one of the most successful physical theories that we presently have. While it is a classical theory in that it doesn't incorporate quantum mechanics, it is entirely consistent with special relativity. In fact, conflicts between electromagnetism and Newtonian mechanics drove Einstein's development of special relativity. Furthermore, Maxwell's unification of electricity with magnetism was the first and best example of the unification of forces in physics. This was a model for much development of 20th century physics, and remains so today.

Further, classical E&M is at the root of a huge number of practical applications. Essentially all of the phenomena of everyday experience (sights, smells, texture, etc.) arise from a balance of electromagnetic interactions and quantum mechanics. Also, E&M is essential in understanding the physics nearly every aspect of our technological society, such as electric power generation, electronics, optics, communications, and so forth. Clearly, to understand the physical world, we need to understand electricity and magnetism. Your first course on the topic (PHYS 2415 or 2610) served as an introduction to these ideas, but in this course you begin to learn how to really work with them in an effective way.

Prerequisites: Introductory Electromagnetism (PHYS 2415 or 2620); Ordinary differential equations (MATH 3250 or 3255). The course builds on the foundations of introductory electromagnetism, and uses the tools of differential equations.

Meeting Time: MWF 10:00-10:50 AM, in Physics 204,

Instructor: Cass Sackett **Email**: sackett@virginia.edu

Email is the best way to reach me if you need to make sure I remember what you say

Office: PLSB Room 104 **Office Hours**: 4:30 to 5:30, Monday and Tuesday, or by appointment.

Course materials (required):

Textbook: JD Griffiths*, Introduction to Electromagnetism*, 3rd Edition (Prentice Hall)

Supplementary and alternative texts are available in the Physics library reserves.

In-class response: iClicker2

Purchase at the book store, or use one you already have. Register your clicker on Collab.

Activities notebook: Any new standard notebook, clearly labelled with your name on the cover.

Assessment:

Homework	25%
Class Participation	15%
Midterm exams	30%
Final exam	30%

Grading Method: Individual exams will be graded on a scale set by the instructor; barring unforeseen problems, all the exams will use the same scale. Your final grade for the course will be determined by combining all points earned in the four categories listed above. That total point score will then be compared to a different scale to determine your final letter grade. I will make sure that the exam scales and final scale are consistent for a student who did comparably well on the homework and participation components.

Homework:

Homework assignments will be due every week on Wednesday. The homework is very important for developing your understanding of the course material. Expect these to be challenging assignments: don't put them off to the last minute, and try to set aside at least eight hours per week for them. (If you find yourself consistently spending more than eight hours on the assignments, let me know and I can try to help with your approach.) My plan is for each week's assignment to cover material from the previous Monday through Friday, so you can work on the assignments over the weekend.

Collaboration: Knowing how to collaborate productively with your colleagues is extremely useful, for this this class and for nearly any scientific career you might have. For this reason, I strongly encourage you to work on the homework with friends or a study group. However, productive collaboration requires that you learn how to balance letting other people help with actually learning the material yourself. A good strategy for this is to start by working on the assignment on your own. Make a serious effort, at least 20 minutes per problem. If you are making progress, go ahead and finish. If you get stuck, set it aside and work on another problem. After going through the assignment this way, get together with your study group and compare progress. If you got something your friends didn't, explain what you did. Similarly, have them explain things that you missed. If there are problems none of you could do, work on them together as a group. Try to do that early, so that if you are still stuck, you can come see me for office hours.

Regardless of how you choose to collaborate, there is one key rule**: DO NOT JUST COPY SOMEONE ELSE'S WORK**. It is fine to look at your friend's paper, to have them do a problem for you on a blackboard, or even to read through an online solution. Go over it as many times as you need until it makes sense. But the final assignment you turn in needs to be something you personally wrote, <u>without having anyone else's work in front of you to refer to</u>. This rule is not about academic integrity or the honor system; homework assignments are not pledged and they are not meant as assessments. The rule is about making sure you actually learn what the assignment is meant to teach.

Late Homework: To facilitate grading, all homework assignments need to be turned in on time, at the start of class on the day due. If you have an illness or family emergency that prevents you from completing the assignment on time, contact me via email. Otherwise, late work will receive no credit.

Class Participation:

I plan to have a lot of in-class activities. We will use iClickers regularly for in-class polling. Normally, you will get full credit for the correct answer, or half credit for any answer (to encourage participation). Sometimes there will be more than one right answer.

I will also be assigning pre-class and in-class assignments to work on. You will do these assignments in your activities notebook, which you should bring to class every day. Please don't use that notebook for taking regular notes, it should only contain have the activity assignments.

At the end of most class sessions, I will collect a random sample of notebooks and check those students' work for the day. Here again you will receive full credit for a correct answer and half credit for any reasonable effort. If you aren't present or don't have your notebook, you won't get any credit (but see below).

You will also receive participation credit for completing the course evaluation at the end of the semester.

Absences: I know that sometimes you will miss class for various reasons. Up to six times over the semester, you can let me know (before class) that you will be absent. Your clicker scores for that day won't be counted toward your grade, and I will remove your name from consideration for the random notebook collection.

If you have a documented chronic issue that forces you to miss more class than that, please let me know so we can work out accommodations.

Classroom Etiquette: When anyone (instructor or student) is addressing the class, you should give your undivided attention, and certainly not distract your classmates with private conversation. In general, if I have to ask twice for the class to quiet down, I will start deducting participation credit from everyone. However, questions relevant to the discussion are encouraged at any time!

We will have in-class assignments where you are allowed to work together. This will no doubt be noisy, but if it gets too loud no one will be able to think. So please make an effort to use your quiet, indoor voices in these situations.

Please be sure to turn off your cell phones before coming to class.

Exams

Midterm exams:

There will be three midterm exams, held in evenings outside of regular class time. Planned dates are:

Thursday, Feb 5, 7:30 to 8:30 PM
Thursday, Mar 5, 7:30 to 8:30 PM
Thursday, Apr 8, 7:30 to 8:30 PM

Please check your schedule now for conflicts with these dates. If you have a conflict, let me know as soon as possible. I will schedule a makeup exam time with you. I like using evening exams because they give us a little more time without needing to worry about rushing from one class to the next.

The midterm exams will be closed-book, but you may use one 3x5 note card, prepared as you like. Key mathematical formulas will be provided with the exam. The exams will be held in Physics 204.

Final exam:

The final exam will be comprehensive over all the material of the course. It will be held **on Saturday, May 2 from 9 AM to noon**. The exam will be closed book, but you may use one 8-1/2 x 11 note sheet, prepared as you like. Key mathematical formulas will be provided with the exam. The exam will be held in Physics 204.

Academic Integrity:

As noted above, you are encouraged to work together on homework assignments, and they are not pledged. Nonetheless, clear violation of the no-copying rule would demonstrate a lack of integrity and lead to a score of zero on the problem in question.

Some in-class assignments will also be collaborative. However, presenting another student’s work as your own is an honor violation, as is allowing your own work to be so presented. This includes using another student’s clicker for in-class response.

For midterm and final exams, you must work by yourself. Collusion with other students or use of non-allowed resources is a clear violation of the honor code. Evidence of cheating will result in a score of zero on the exam and be referred to the Honor Committee.

Course Learning Goals

I. Organized knowledge:
- You should be able to articulate the “big ideas” from a topic in electromagnetism.
- You should be able to filter this knowledge to access the information needed to apply to a particular physical problem.

II. Connections between math and physics:
- You should be able to translate a physical description of an electromagnetism problem to a mathematical equation necessary to solve it.
- You should be able to explain the physical meaning of the mathematical formulation of an electromagnetism problem.
- You should be able to achieve physical insight through the mathematics of a problem.

III. Problem-solving techniques:
- You should be able to choose and apply a problem-solving technique that is appropriate to a particular problem (eg., separation of variables, method of images, direct integration).
- You should be able to apply these problem-solving approaches in novel contexts (i.e., to solve problems which do not map directly to ones you’ve seen before).
- You should be able to justify your approach for solving a particular problem.
  a. Approximations: You should recognize when approximations are useful, and use them effectively.
  b. Symmetries: You should recognize symmetries and be able to take advantage of them.
  c. Integration: Given a physical situation, you should be able to write down the required partial differential equation, or line, surface or volume integral, and correctly calculate the answer.
  d. Superposition: You should recognize and use the fact that in a linear system solutions may be formed by superposition of components.

IV. Anticipating and checking solutions:
- When appropriate, you should be able to articulate your expectations for the solution to a problem.
- You should be able to check the plausibility of a solution by methods such as symmetry, limiting behavior, relation to known solutions, units, dimensional analysis, and numerical orders of magnitude.

V. Intellectual maturity:
- You should accept responsibility for you own learning. You should be aware of what you do and don’t understand about physical phenomena and classes of problems. This is evidenced by asking sophisticated, specific questions; being able to articulate where in a problem you experienced difficulty; and take action to move beyond that difficulty.

The course activities (lectures, in-class activities, and homework assignments) are meant to help you meet these objectives. Assessments (midterms and final exam) are meant to show whether you have met them.