Electromagnetism (PHYS 295) Course Syllabus

Spring 2025 v2.1

1. Introduction to Phys 295:

Ah, the elegant world of electric and magnetic fields! (We'll see that they are really two aspects of one electromagnetic field.) This is a rich subject that has driven developments in both in technology (most communication technology, electrical grid, radio, cell phones, GPS, windmills, maglev trains, ...) as well as theory. Electromagnetism is in some sense the 'ideal' theory in that it unified the apparently unrelated fields of electricity, optics, galvanism (study of currents), and magnetism. In your Hamilton education this is your first exposure to a *field theory*: These theories have a dynamical manifestation entirely separate from the dynamics of particle motion. This won't be apparent for a while but it will be clear once we have the vacuum Maxwell equations at the end of the semester.

So much for lofty heights. The subject is also full of new concepts, handy gadgets, and mathematical techniques. Initially we will focus on questions like, "What is the field of the following configuration?" and, "Given these charges, what happens to those charges?"

We will follow the development of the subject in our wonderful text Purcell and Morin.

2. Texts:

- Edward Purcell and David Morin, *Electricity and Magnetism* 3rd edition. Purcell's text is a classic - one of the best in physics - and Morin has updated it. It starts with statics (no moving charges) for electrical fields outside and inside materials and then proceeds with magnetic fields. Dynamics towards the end and with it light! This is the main text.
- David Morin, *Special Relativity for the enthusiastic beginner* We'll draw from this during our study of SR, mostly the first chapter, which is free through his website: The pdf of Chapter 1. The whole text is available at low cost through amazon.
- George Ellis and Ruth Williams, *Flat and Curved Spacetimes* I will include a pdf of a section of this book on the course website so you can read an introduction to spacetime diagrams. A great book but sadly too long for just a couple of weeks of study. If you are interested in spacetime I highly recommend it.

3. Instructor:

Seth Major – if you are comfortable doing so, please call me "Seth."
pronouns : he/him
email : smajor@hamilton.edu
web : academics.hamilton.edu/physics/smajor/
phone : x4919
office : Sci G064

Class: MWF 10 - 10:50 AM in Science Center G047

Office Hours: My official hours are:

- After every class
- Thursday morning and ∼2:30 - 4:30 PM, and

Pro-tip: "Office hours are the most important part of the class. That's where I learn the most."

4. Course info:

All materials syllabus, problem sets, extra links, etc. will be available online on the course web page. Current versions will be labeled by a version number in the top right of the first page.

5. Assignments

5.1. **Problem sets:** I will try to post the weekly problem sets on the Wednesday of the week before they are due. This will give you extra time to juggle your work schedule. I find that sometimes I have to modify the assignments as we discover where we are in uncovering material in class. The pdfs have a version number on the top right to track this.

We will have roughly weekly problem sets, likely 11 in total. Please write up your complete solutions with care. For hints on how to accomplish this see section 7. Solutions will be due at the beginning of class, 10 AM on Friday.

You have 5 automatic extension tokens during the semester. The policy is as follows: To opt in for one of these, write me an email *before* the beginning of class on Friday. The request can be for any reason at all, illness, busy, travel, etc. You then have the weekend to complete your solutions. You can submit them via email for a time stamp or by sliding written (or printed) solutions under my door *no later than 9 AM Monday morning*. After this weekend extension, the assignment score decreases by 20% per day (24 hours). Be sure to check that your name is on the solutions and that they are legible.

6. Grades:

There are 5 parts to the grade:

(1) Participation 10%. Except for days you have travel or are ill (and if so please rest!) I expect that you will attend class having completed the reading.
(2) Problem sets (45%). These are posted on the course web page.
(3) Mid-term: (20%) We will have one mid-term in "week 7" of the semester, which will be the week of March 5.
(4) Final (25%): This closed-book final during the registrar-scheduled time during finals week.

7. On writing up your work for others i.e. problem set solutions!

For full credit for your solutions you must find the correct answer **and** present your result clearly. You can receive full credit only when you show clearly what you did.

Some Advice for Problem Sets: Before attempting a problem, review your lecture notes and do the reading. This may seem obvious, but often this is done only when a difficulty is encountered.

(1) Start the problem set early! Start the problem set early! Start the problem set early!
(2) Work slowly, carefully, and thoughtfully through the problem. It is better to work slowly but get the right answer than to work faster and make unnecessary mistakes.
(3) Start your work on white board, blackboard, or scrap paper so you don't freeze trying to get every step the correct.
(4) Make a clear sketch. A well drawn figure can save a tremendous amount of time.
(5) Work with friends. It is more fun!
(6) To avoid a round-off error, do not round numbers early in the calculations.
(7) In setting up longer problems express physical quantities in terms of dimensionless variables.
(8) Make use of spreadsheets - it will save time, prevent round off error and make it easy to adjust parameters. Start off with building a template with all relevant constants, c, e, etc.
(9) Check your final answers: Do they make sense? A simple dimensional analysis can catch a big mistake. Question numeric answers.

(10) Use a reasonable number of significant digits in your answer, usually no more than 3. More digits do not make a result more accurate. Way too many sig figs will result in up to 10% reduction.
(11) Write out final copy from your solution notes. If you make a mistake at the end or a problem, don't erase what you did before or rewrite everything. Just cross out or mark what you found to be wrong and continue with a correct solution. (This shows the grader that you checked what you have completed.)
(12) Present the answer in the form asked for. For example, if an electric field (which as you know is a vector quantity) is asked for, do not just give the magnitude.
(13) Celebrate your final answers with a box.
(14) Attend office hours! Attend office hours! Attend office hours!
(15) Collaborate but write up your own solutions *this includes any Mathematica code, spreadsheets, or similar computation.*
(16) When you work with friends and your solution is founded on some of their ideas, you must cite them. The format is not important but most students acknowledge these discussions with a note next to the solution.
(17) If you use other resources such as solutions you must cite these. If you use online material cite the url where these were obtained.
(18) Write down clearly and unambiguously with whom you worked on the problem and any resources you consulted.
(19) If you find where Morin writes something like 'don't panic when you encounter a quintic equation' let me know where for a bonus point on the homework.
(20) Build a top notch, easy to access set of records for the course - notes, problem sets, and corrected solutions. They may turn out to be an invaluable resource for you in the future...

8. Staying healthy

We should all be mindful about the stresses of life on the Hill. There are times that we may feel overwhelmed, anxious, or depressed. The Dean of Students Office and Counseling Center have resources available on campus to help and support:

- Counseling Center (www.hamilton.edu/offices/counselingcenter, 315-859-4340) offers individual and group therapy, peer counselors and psychiatric treatment. If you need immediate assistance, phoning the Counseling Center and selecting option 2 will connect you with a counselor, 24 hours a day, 7 days a week. Campus Safety is available 24/7 for urgent concerns at 315-859-4000.
- Associate Dean of Students for Student Support, Sarah Solomon (315-859-4600; ssolomon@hamilton.edu)
- Associate Dean of Students for Academics, Adam Van Wynsberghe (315-859-4600; avanwyns@hamilton.edu)
- Your faculty advisor, RA and Area Director in your residence hall

9. An Approximation to the Weekly Schedule

What follows is preliminary!

Week	Date	Topic	Reading
1	22 January	Electrostatics	Ch 1
2	29 January	Electric Potential	Ch 2
3	5 February	Div & Grad	Ch 2
4	12 February	Conductors	Ch 3
5	19 February	Currents	Ch 4
6	26 February	Special Relativity	see website
7	5 March	Fields of moving charges	**Exam** Ch 5
8	12 March	Magnetic fields & Curl	Ch 6
Spring break starts March 14			
9	2 April	Induction	Ch 7
10	9 April	**Maxwell's equations**	Ch 9
11	16 April	AC circuits	Ch 8
12	23 April	Electric fields in matter	Ch 10
13	30 April	Magnetic fields in matter	Ch 11
14	7 May	Review	...
Final Friday May 16 @ 2 - 5 PM			

Enjoy!

Seth Major
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