Quantum (PHYS 290) Syllabus

Fall 2025 v1.5

1. Introduction to Phys 290:

Welcome to quantum! It is a strange and fascinating area of physics. It is the first physics course I enjoyed and also the first physics course I taught. I see Phys 290 as primarily an introduction to quantum mechanics. To me this means working with the mechanics long enough so that by the end of the course you know how it works. As with all physics, there is some beautiful math and some spectacular experimental methods behind it. Another goal of the course is to see both of these in action and start to take them on as you own. Along with developing mathematical techniques, experimental methods this semester we'll also work on formal writing about physics, and coding.

In terms of material we'll be solving Schrödiner's equation in one spatial dimension, introducing spin and angular momentum, and working through (some of) the structure of the hydrogen atom. This will be much of the first six chapters in Townsend's *Quantum Physics* - a great guide through much of the material. (Here and there I will supplement with other reading.) But first off we will study aspects of e&m waves and complex numbers.

2. Text:

- John Townsend, *Quantum Physics: A Fundamental Approach to Modern Physics* 1st edition. This is the main text.
- John Taylor, *An Introduction to Error Analysis* Of 195 fame and our source for essential methods of working with uncertainties in lab and in coursework.

3. Additional resources:

- Richard Feynman, The Feynman Lectures , CalTech Physics has now made available online the text with photos, audio recordings, etc.!!
- Robert Eisberg and Robert Resnick, *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*
- George Greenstein and Arthur Zajonc, *The Quantum Challenge*
- Richard Feynman, *QED: The Strange Theory of Light and Matter*

4. 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 G052

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

Office Hours: My office hours are:

- After class Mondays and Wednesdays
- Thursday afternoons 1:30 - 5 PM, and
- Times don't work? Email me to set up a time to meet.

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

5. 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.

6. Assignments

6.1. **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 9. Be sure to check that your name is on the solutions and that they are legible. Solutions (on paper) will be due at the beginning of class, 10 AM on Friday.

Extensions/Late assignments/etc.: Solutions turned in later than the deadline have a reduction of 20% per day (24 hours). But you have 3 automatic extension tokens during the semester. The policy is as follows: To opt in for any reason at all, illness, busy, travel, etc., write me an email *before* the beginning of class on Friday. You then have the weekend to complete your solutions. Submit the paper copy to me, or by sliding written (or printed) solutions under my door G052 *no later than 9 AM Monday morning*. After this weekend extension, the assignment score decreases by 20% per day (24 hours).

7. Labs:

To build our experimental skills set - and writing! - we have labs. They start September 1 (Labor day!). The labs are available on the course web page. You should also bring a bound composition book to use as your lab notebook. If you still have space, you are welcome to reuse your Phys 190 lab notebooks.

The second text by John Taylor, familiar from 190-5, is devoted to a careful treatment of uncertainties. Although some of you have already encountered these in Phys 190 (or other physics courses) this book is a great source for introductory through advanced material such as you might use in research. It is an essential reference for this and later courses.

The lab sessions are mandatory. It will generally not be possible to make-up labs. You may be able, however, to switch labs to help with conflicts. Please see or email your lab instructor in advance to see whether a switch is possible.

Lab Instructors:
Seth Major - Friday Lab

Megan Smith - Tuesday Lab
Email: msmith@hamilton.edu
Office: G053

8. Grades:

There are 5 parts to the grade:

(1) Problem sets (30%). These are posted on the course web page.
(2) Labs: (25%)
(3) Mid-term: (15%) We will have one mid-term in "week 7" of the semester, which will be during class on October 13.
(4) Final (20%): This closed-book final during the registrar-scheduled time during finals week.
(5) Participation (10%): Attendance in class, office hours, lab, colloquia, etc.

There is some flexibility in this, primarily the weighting of final, midterm, and participation vs. another project - a staged live reading of *Copenhagen* with suitable background study. This will be a *if you have interest and time* event.

9. 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, tablet, 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. That way you can use it all semester long (and longer!) without having to re-enter constants bunches of times.
(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.* When you work with friends and your solution is founded on some of

their ideas, you must cite them. Citation may be informal. The format is not important. Most students acknowledge these discussions with a note next to the solution.

(16) If you use other resources such as solutions you must cite these. If you use online material cite the url where these were obtained.

(17) Write down clearly and unambiguously with whom you worked on the problem and any resources you consulted.

(18) If you find where Townsend writes something like 'My colleague said we need a wave equation. Well, I found one!' let me know where and who said this for a bonus point on the homework.

(19) 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...

(Thanks to folks at MIT engineering for some of these tips.)

10. 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

11. An Approximation to the Weekly Schedule

What follows is rough and preliminary!

Week	Date	Topic	Reading
1	29 August	Light and $\mathbb{C}$ numbers	Ch 1
2	5 September	Light	Ch 1
3	12 September	Atom Interferometry	Ch 2
4	19 September	Schrödinger's Equ'n	Ch 2 **PS Pause**
5	26 September	1D QM	Ch 3
6	3 October	1D QM	Ch 4
7	10 October	ψ - meaning?, Hamiltonian	**Midterm** Ch 3
Fall break starts October 14			
8	24 October	1D scattering	Ch 4
9	31 October	Principles	Ch 5
10	7 November	QM in 3D	Ch 6 **PS Pause**
11	14 November	Hydrogen atom	Ch 6
12	21 November	Angular momentum	
Thanksgiving break			
13	5 December	Identical particles	Ch 7
14	12 December	Review	...
Final Tuesday December 16 @ 7 - 10 PM			

Enjoy!

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