SYLLABUS

Meeting Times

Lectures:	TR	9:00-9:50 am
	F	3:10-4:00 pm
4th hour:	T	10:00-10:50 am
Room:	Hugel Science Center 017	
Office Hours:	M	9:00 am - 10:30 am
	T	2:30 pm - 4 pm
	W	10:30 am - 12 pm

Contact Information

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Course Overview The goal of this course is to introduce you to the basic principles of quantum mechanics, leaving behind classical physics and guiding you in the mathematical formalism scientists use to describe matter and energy at the atomic and sub-atomic level. To do this, we will consider several experiments that have no classical explanation and work on developing a mathematical framework that can describe this new way of thinking. This course will be counterintuitive at times, but will show you the ways to get at some truly powerful physics that plays a significant, though often unseen, role in your everyday lives.

Learning Outcomes By the end of this course, you will be able to understand and apply the principles of quantum mechanical theory to a variety of complex situations that you will confront in various fields of physics. This includes being able to derive and interpret solutions to the Schrödinger equation for various potential energy configurations (infinite well, harmonic oscillator, finite well, free particle, Coulomb potential), along with both time-independent and time-dependent perturbation theory. Additionally, you will be be able to apply and discuss the ideas of wave-particle duality, uncertainty, superposition, Dirac notation, quantum numbers, spin angular momentum, and orbital angular momentum as they relate to topics in physics.

Course Policies Attendance at scheduled class meetings, including the 4th hour, is mandatory. We will not always make use of the designated 4th hour, but I expect your attendance when we do. In preparation for class meetings, I encourage you to read the relevant sections of the text *before* class so that the material is not completely unfamiliar to you when we start discussing it together. Additionally, there will be several departmental colloquia at various points throughout the semester that you are required to attend as part of this course. These talks will be about current research in various fields of physics and will serve to give you some insight as to what is going on in the wide, wide world of research as well as what makes a good (or bad, as the case may be) scientific presentation.

Course Texts

Introduction to Quantum Mechanics, 3nd ed. by David J. Griffiths and Darrell F. Schroeter (Cambridge University Press, 2018)

Suspended in Language, by Jim Ottaviani, illustrated by Leland Purvis (G.T. Labs, 2009)

Supplementary texts you may find useful:

The Feynman Lectures on Physics, Vol. III by Richard Feynman (Addison-Wesley, 1965)
A Modern Approach to Quantum Mechanics, 2nd ed. by John S. Townsend (University Science Books, 2012)

Grading Grades are determined on the following basis:

Participation:	5%	Mid-term Exam I:	15%
Reading Responses:	10%	Mid-term Exam II:	15%
Problem Sets:	30%	Final Exam:	25%

Participation Your participation grade in this class will be based on your attendance at class meetings and departmental colloquia, your in-class contributions including discussions and asking questions, as well as office hour attendance.

Assignments

Reading Responses: Starting midway through the semester, each **Friday**, we will spend a portion of class discussing a new chapter in *Suspended in Language* aka the "Bohr book". As preparation, you will be asked to complete a reading response prior to our meeting and be prepared to discuss your thoughts on the week's reading. Hopefully, you will start to be able to put the development of quantum mechanics in the early 1900's in context with what was occurring in other aspects of global society at the time. It doesn't get more "liberal artsy" than this.

Departmental Colloquia: At the class following each departmental colloquium, we will discuss it for a few minutes to see what you (and I) found interesting and what we did/did not like. Attendance at each colloquium will count as a "problem" toward a colloquium problem set that will be weighted equally with the other problem sets you complete.

Problem Sets: Homework will be assigned on a weekly basis and will generally be due on **Thursdays** at the start of class (**9 am**). Late assignments will be docked an additional 25% for each 24 hour period after the due date, unless you have received an exemption from me ahead of time. Please plan to manage your time accordingly.

Over the course of the semester, I will allow for one "freebie" late assignment with no consequences or questions asked. If you use this option, you will have until an additional 48 hours after the assignment is due to turn it in before the late penalty is applied. Please write on the top of the assignment "*This is my freebie.*"

A few notes about assigned problem sets:

- It is to your advantage to do the assigned homework. I have chosen the problems to help *you* learn the material. Physics can be a complicated thing, but repeatedly working with it (and at it) is essential in order to gain physical intuition and get comfortable with the mathematical theory.
- Feel free to use computational aids for some of the mathematics if you prefer, but be sure to clearly comment your work and do note that there is some advantage to working things out by hand. Not being able to solve problems "by inspection" could end up hurting you on an exam where you may not be permitted to use computational tools and, frequently, there are mathematical tricks you can use to easily simplify a problem that you will not appreciate if you ask a program to do the work.
- I encourage you to work on these problem sets collaboratively, though I do expect you to take 10-15 minutes to give a problem "the old college try" on your own so you enter into discussion with others having some ideas to contribute. You will make your life easier as well as improve your understanding if you work with others (either by explaining it or having it explained to you). I expect solutions to be written up individually (or, if your handwriting is illegible, typed), and all collaboration should be properly acknowledged.
- I expect your problem sets to be clearly and logically organized. This means that:
  - Each problem should start on a **new** page.
  - Write out the problem (or an abbreviated version containing all relevant information). Draw a picture/diagram if useful.
  - Clearly work out the problem, commenting your work as you go. Problem sets should never contain just the math; use words to describe what you are doing and to reference where in the text an equation came from and why it is relevant.
  - Remember to keep track of units (by writing them out with all your calculations)! Do the units work out as you expect they ought to at the end of a problem? Dimensional analysis is the easiest check to ensure you have tackled the problem correctly.
  - Box your final solutions or major milestones as you do the problem. This makes it easier to grade and also for you to follow your own work when you look it over.
  - Comment on the significance of your answer. (Does it make sense? Is it what you expected? Why or why not?)
  - Attach a cover page to your problem set. This can be the problem sheet or something else, but it should have your name and a clear acknowledgement of all those you have collaborated with on the assignment. This includes fellow students, faculty, etc. (anyone who you consulted or worked with).
  - Please see me if you have any questions about this! I know it seems a bit ridiculous listed out like this, but I promise that it will serve you well in the long run. Writing in science is different from the traditional humanities paper, but the point is the same: to clearly and effectively communicate something. This will help you to accomplish that.

Accommodations In accordance with Lafayette College policy, reasonable academic accommodation and support services are available to students who have a documented disability. It is your responsibility to provide me with the appropriate paperwork from the Accessibility Services Office. More information is available at https://hub.lafayette.edu/.

Gender Inclusion This is a gender-inclusive classroom. I have been provided with a class roster and your legal names. I will gladly honor any requests to be addressed by a different name or pronoun than appears on the class. Please make me aware of any preferences.

Moodle Privacy Statement Please note that Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Courses using Moodle will make student information visible to other students in this class. Please remember that this information is protected by these federal privacy laws and must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

Federal Credit Hour Compliance Statement The student work in this course is in full compliance with the federal definition of a four credit hour course. Please see the Registrar's Office web site (https://registrar.lafayette.edu/wp-content/uploads/sites/193/2013/04/Federal-Credit-Hour-Policy-Web-Statement.doc) for the full policy and practice statement.

Tentative Lecture Schedule and Associated Readings

* denotes meeting times during the 4th hour

T	Aug. 27	Wave-Particle Duality I	The Feynman Lectures, Vol. III, Ch. 1
R	Aug. 29	Wave-Particle Duality II	The Feynman Lectures, Vol. III, Ch. 1
F	Aug. 30	Wavefunctions & Probability	Griffiths 1.2-1.4
T	Sept. 3	Momentum & Uncertainty	Griffiths 1.5-1.6
T*	Sept. 3	Schrödinger Eqn	Griffiths 2.1
R	Sept. 5	**no class** (Professor Exarhos away)	-
F	Sept. 6	**no class** (Professor Exarhos away)	-
T	Sept. 10	Infinite Square Well I	Griffiths 2.2
T*	Sept. 10	Infinite Square Well II	Griffiths 2.2
R	Sept. 12	Quantum Harmonic Oscillator I	Griffiths 2.3
F	Sept. 13	Quantum Harmonic Oscillator II	Griffiths 2.3
T	Sept. 17	Free Particle I	Griffiths 2.4
R	Sept. 19	Free Particle II	Griffiths 2.4
F	Sept. 20	Bound and Scattering States	Griffiths 2.5
T	Sept. 24	Delta Function Potential	Griffiths 2.5
R	Sept. 26	Finite Square Well I	Griffiths 2.6
F	Sept. 27	Finite Square Well II	Griffiths 2.6
T	Oct. 1	Scattering States & QM Tunnelling	-
R	Oct. 3	QM Formalism & Linear Algebra I	Griffiths 3.1-3.4, Appendix A
F	Oct. 4	QM Formalism & Linear Algebra II	Griffiths 3.1-3.4, Appendix A
T	Oct. 8	**Mid-Term Exam I**	
R	Oct. 10	Dirac Notation I	Griffiths 3.6
F	Oct. 12	Dirac Notation II	Griffiths 3.6; *SiL* Ch. 1-2
T	Oct. 15	**no class** (Fall Break)	-
R	Oct. 17	Schrödinger in 3D I	Griffiths 4.1
F	Oct. 18	Schrödinger in 3D II	Griffiths 4.1; *SiL* Ch. 3-4
T	Oct. 22	Hydrogen Atom I	Griffiths 4.2
R	Oct. 24	Hydrogen Atom II	Griffiths 4.2
F	Oct. 25	Hydrogen Atom III	Griffiths 4.2; *SiL* Ch. 5-6
T	Oct. 29	Orbital Angular Momentum I	Griffiths 4.3
R	Oct. 31	Orbital Angular Momentum II	Griffiths 4.3
F	Nov. 1	Spin Angular Momentum I	Griffiths 4.4; *SiL* Ch. 7-8

T	Nov. 5	Spin Angular Momentum II	Griffiths 4.4
R	Nov. 7	Addition of Angular Momenta	Griffiths 4.4
F	Nov. 8	Catch-Up/Review	*SiL* Ch. 9-10
T	Nov. 12	**Mid-Term Exam II**	-
R	Nov. 14	Identical Particles	Griffiths 5.1
F	Nov. 15	Atoms	Griffiths 5.2; *SiL* Ch. 11-12
T	Nov. 19	Solids & Band Structure	Griffiths 5.3
R	Nov. 21	Time-Independent Perturbation Theory	Griffiths 7.1-7.2
F	Nov. 22	Fine Structure & Zeeman Effect	Griffiths 7.3-7.4; *SiL* Ch. 13-14
T	Nov. 26	Time-Dependent Perturbation Theory	Griffiths 11.1
R	Nov. 28	**no class** (Thanksgiving Break)	-
F	Nov. 29	**no class** (Thanksgiving Break)	-
T	Dec. 3	Light-Matter Interactions I	Griffiths 11.2
R	Dec. 5	Light-Matter Interactions II	Griffiths 11.3
F	Dec. 6	Catch-Up/Review	-

FINAL EXAM (comprehensive): date and time TBD by the Registrar