Physics 215: Introduction to Quantum Physics
Lafayette College Spring 2024

Instructors

Class
David Nice
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Lab
Scott Shelley
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Course Communications and Website

E-mail will be used for communications outside of class. Course documents will be posted on Moodle.

Course Locations and Times

Class: Hugel 017, Monday, Wednesday, Friday; 9:30-10:20
Lab: Hugel 042, Tuesday, 1:15-4:00

Office hours

I will have weekly office hours:

- Wednesday 10:30-11:30
- Thursday 11:00-11:50 & 4:00-5:00

These times may change as the semester evolves. Up-to-date office hours will be posted on Moodle.

Text

Quantum Physics: A Fundamental Approach to Modern Physics by John S. Townsend, 2010, University Science Books, ISBN 978-1-891389-62-7.

Prerequisites

The prerequisite for this course is Physics 133 or 152. By the transitive property of prerequisites, this implies that the following are also prerequisites: Physics 131 or 151; Math 161; and Math 162.

Homework

There will be weekly homework assignments, due Friday in class. Mathematica components of homework will be due Moodle at the same time. Late homework papers will be accepted for

50% credit through class time Monday. If you cannot complete a homework due to illness, family emergency, or similarly compelling reason, contact me. (Also see the section on "Dean's excuse policy" in the Student Handbook.)

I *strongly* encourage you to work with other students on the homework. First try the problems yourself. When you get stuck, talk to someone else about them. Physics is hard. You won't get all the problems on your own. Working with others is absolutely essential in advanced physics classes.

I have extensive office hours. You will find some homework problems very challenging or confusing. Please come and visit. I am here to help. This is how you learn.

Labs

You will undertake and analyze several experiments over the course of the semester. Some will be directly associated with what we are doing in class; others will be more tangentially related, but still important to your understanding of quantum mechanics.

Two lab sessions will be used for exams.

Exams

There will be two midterm exams. They will be given at the lab time on February 29 and April 11. Each midterm exam will be on the material covered in the preceding weeks of class (i.e., midterm #2 will be on material covered in class after midterm #1).

There will be a final exam covering all material in the course. The final exam will be scheduled by the registrar.

Detailed policies for each exam (length, open/closed book, etc.) will be announced in advance of each exam.

Colloquia

From time to time, the Physics Department will have talks given by outside speakers on topics of current research. I strongly urge you to attend these talks. You will be given 20 extra credit homework points (equivalent to two problems) for each colloquium you attend.

Grades

There must be grades. Your grade will be calculated using:

Lab	15%	Exam #1	15%	Final exam	25%
Homework	30%	Exam #2	15%		

I will post grades on Moodle. The exam grades may be re-scaled depending on the difficulty of the exam. I will use the following numerical score when setting letter grades:

A	92.500 and higher	C	72.500−76.499
A−	89.500−92.499	C−	69.500−72.499
B+	86.500−89.499	D+	66.500−69.499
B	82.500−86.499	D	62.500−66.499
B−	79.500−82.499	D−	59.500−62.499
C+	76.500−79.499	F	59.499 and below

What to call me

Please, let's all use first names. Call me David.

The revolution begins now

The theory of quantum mechanics, developed early in the twentieth century, was a revolution in how we understand the physical world. To this day, the rules of quantum mechanics seem bizarre and un-intuitive, yet they are absolutely needed to explain experiments involving matter at microscopic scales. They provide a foundation for advanced work in physics, and they form the basis of most modern physics research, underlying everything from nanotechnology to cosmology.

An approximate schedule of topics is given below. The schedule will evolve over the semester. Topic and text coverage for each week will be listed on the homework assignments.

Week	Topic	Text Chapters	Exams
1	Quantum mechanics overview; photon energy	1	
2	Complex numbers; oscillations; probabilities	1	
3	Probability amplitudes and interference; de Broglie wavelength	1,2	
4	Wave functions; normalization; expectation value; Schrödinger equation	2	
5	Momentum; operators; time-indep. Schrödinger eqn.; Particle-in-a-box	3	
6	Orthonormal functions; Hamiltonian	3	*Exam #1*
7	One-dimensional potentials	4	
	Spring break		
8	Barriers; Harmonic oscillator; Operators & observables; Dirac δ function	4	
9	Operators, eigenfunctions; Uncertainty principle	5	
10	Uncertainty (cont'd); Three-dimensional wavefunctions	5,6	
11	Angular momentum; spherically symmetric potentials	6	*Exam #2*
12	Spherically symmetric potentials (cont'd); spherical harmonics	6	
13	Hydrogen atom; Zeeman effect; spin	6	
14	Fine structure, hyperfine structure, multiparticle systems	6,7	
	Final exam week		*Final exam*

Outcomes

After completing this course, you will be able to....

- Understand the experimental need for quantum mechanics
- Qualitatively and quantitatively interpret quantum mechanical wavefunctions
- Understand properties of quantum mechanical operators
- Calculate wave functions in situations such as square-well potentials and hydrogen atoms
- Use quantum mechanical methods to analyze single- and multi-particle systems.
- Use computer-based tools such as Mathematica for physical problem solving
- Use advanced lab equipment, including a high quality optical spectrometer
- Understand the use of orthonormal bases in physics calculations

Intellectual honesty

You are expected to abide by the principles of intellectual honesty outlined in the Lafayette Student Handbook available at `http://conduct.lafayette.edu`.

Learning is a collaborative process. Discussion and collaboration on homework in this course is very strongly encouraged. "Collaboration" does not mean "copying." You must understand and individually write out your answer to each problem.

You may use resources on the internet, including generative artificial intelligence based tools, if they help you learn the material in this course. However, you should work out assigned homework problems on your own, or with help from other human beings such as your classmates and/or instructor.

Exams must be done on your own, using only materials specifically allowed. This will be discussed in detail before each exam.

Accommodation

My policy. It is important to me that you do well in this class. If you have any disabilities which you feel may interfere with your ability to succeed and prosper in this class, please contact me to discuss ways of accommodating them.

Mandatory statement for any Lafayette course with a disability policy. In compliance with Lafayette College policy and equal access laws, I am available to discuss appropriate academic accommodations that you may require as a student with a disability. Requests for academic accommodations need to be made during the first two weeks of the semester, except for unusual circumstances, so arrangements can be made. Students must register with the Office of the Dean of the College for disability verification and for determination of reasonable academic accommodations.

Mandatory Moodle privacy statement

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.

Mandatory credit hour statement

The student work in this course is in full compliance with the federal definition of a four credit hour course.