

Introduction to Quantum Mechanics

Prof. Anders Knospe

Course Information:

Course Number: PHY 31

Semester: Fall 2020

Meeting Day and Time: Tuesday and Thursday, 9:20–10:35 a.m. Eastern Time

Meeting Location: Virtual

Instructor's Contact Information:

Office: Lewis Lab 416

Office Phone: 610-758-6431 (86431 on campus)

Main Physics Office Phone: 610-758-3931 (83931 on campus)

Email: ank220@lehigh.edu

Pronouns: My pronouns are he/him/his. Please feel free to tell me yours.

Office Hours:

Tuesday 1:00–2:00 p.m. Eastern Time

Thursday 4:00–5:00 p.m. Eastern Time

Or by appointment.

I will be physically present in my office and also available for virtual meetings at these times. You are welcome to visit me in person or we can talk online. If you visit in person, you must wear a face mask over your mouth and nose at all times. Use of a face shield in addition to a mask is encouraged, but not required. In-person office hours may be reduced or discontinued if the COVID-19 situation worsens. For virtual meetings, I will be logged into the Zoom room throughout the designated time. Please say hello when you log in so I know that you are there. If I have stepped away from the computer for a minute, please be patient and stick around: I will come back.

Virtual Class Meetings:

Class meetings will be conducted synchronously through Zoom. The connection information is available on CourseSite. I request that you keep your camera on, unless it would be a hardship for you. This is so we can see each other and hopefully connect a bit better, despite the unusual mode of instruction. Please keep your microphone muted unless you need to speak. I may record Zoom sessions for the benefit of students who are unable to attend the meetings. Please read the “Statement on Education During COVID-19” at the end of this syllabus.

Course Description: The past 120 years have seen many important experimental and theoretical developments that have dramatically changed our understanding of physics. The first part of this course will be an introduction to Special Relativity, which describes space, time, and the motion of objects very differently from classical physics. The remainder of the course will cover basic quantum mechanics, which describes the behavior of microscopic, atomic, and subatomic systems—behavior which is very different from what we expect classically. The course will also provide an introduction to nuclear and particle physics.

Prerequisites:

1. PHY 013 or PHY 021 or PHY 023
2. Vectors, complex numbers, trigonometry, derivatives, and integrals
3. Basic mechanics
4. Basic electricity and magnetism

Course Learning Objectives:

By the end of this course, students will

1. be able to perform calculations based on various phenomena in Special Relativity.
2. know the experimental evidence for Special Relativity.
3. be able to explain the particle nature of light and the wave nature of particles.
4. be able to calculate simple solutions of the Schrödinger equation.
5. be able to explain how quantum mechanics gives rise to the structure of the periodic table.
6. be able to describe the different types of elementary particles.

Required Texts:

1. K. S. Krane, *Modern Physics, 4th Edition*, John Wiley & Sons (2019), Hoboken, NJ, ISBN-13: 978-1119590583
2. I will provide supplemental written material free of charge through CourseSite.

Homework:

Homework will consist of a selection of problems, including some from the textbook. Generally, each homework assignment will cover two lectures and will be due at 5:00 p.m. Eastern Time on the Tuesday after it was assigned. There will be occasional exceptions to this structure, so please keep track of the due dates as each assignment is announced.

Homework will be graded on a scale from 0-100%, with your score rounded up to the nearest integer. For example, if you receive 113 points out of 125 possible points, your score will be 91% (which is 90.4% rounded up).

A late penalty will be assessed as follows:

0–24 hours late: 25% penalty

24–48 hours late: 50% penalty

48–72 hours late: 75% penalty

More than 72 hours late: no credit, but feedback will still be provided

The late penalty is based on your score, not the total number of points possible. For example, if your pre-penalty score is 113/125 and you turn in the assignment 1.5 days late, your final score will be $\frac{113}{125} \times 50\%$ rounded up to the nearest integer, so 46%. Your lowest homework score will be dropped when your midterm grade is determined. The lowest three of all of your homework scores (including those considered for the midterm) will be dropped when your final grade is determined.

In-Class Presentations:

You will be required to present an example problem to the class, and after the class has had time to work on that problem, you will present the solution. The problems will be assigned 2 or more days before the relevant class meeting and will relate to the material to be covered that day. You should check in with me the day before your presentation to ensure that you have the correct answer and that you are presenting the material clearly. The format is flexible: you can prepare slides, use a whiteboard program, or even make a video. Each presentation will be worth half of one homework assignment, but cannot be dropped. You will be graded on the accuracy and clarity of your presentation. You will be required to do this at least once before the first exam. I will announce before the first exam whether further presentations will be required. (This is just to maintain flexibility: if these presentations are not effective over Zoom, I do not want us to be

locked into them for the whole semester.) If doing such a presentation would be a hardship for you, please contact me and we can figure out a substitute assignment.

Quizzes and Exams:

Reading Quizzes: I will assign short automated online quizzes to verify that you have done the assigned reading. Your lowest reading quiz score will be dropped when your midterm grade is determined. Your lowest three reading quiz scores (including those considered for the midterm) will be dropped when your final grade is determined. In general, reading quizzes will be due at the start of the corresponding lecture. Late reading quizzes are not allowed and will receive no credit. You will have only one attempt to complete each reading quiz. Each quiz will be time-limited; the limit will be somewhere around 5–10 minutes and will be announced in the quiz description. To discourage random guessing, you will be penalized for incorrect answers. I have designed the quizzes so that on average, a person who guesses randomly will receive 0 points. For example, if four options are given as answers to a question, and only one option is correct, the correct answer is worth 1 point and each incorrect answer is worth $-1/3$ point. Reading quizzes will be graded on a scale from 0-100%.

Exams: There will be three take-home, open-book exams assigned throughout the semester. Late exams are subject to the same percent penalties as late homework unless a compelling excuse can be provided.

Collaboration with other students is strictly forbidden on all quizzes and exams.

Grades Breakdown:

Your final grade will be determined as follows:

20%: First Exam

20%: Second Exam

20%: Final Exam

10%: Reading Quizzes

30%: Homework and In-Class Presentations

Grading Scale:

94–100 = A

90–93 = A–

87–89 = B+

84–86 = B

80–83 = B–

77–79 = C+

74–76 = C

70–73 = C–

67–69 = D+

64–66 = D

60–63 = D–

< 60 = F

I reserve the right to curve grades upward if the class average is too low.

Communication:

Please use CourseSite forums to ask any questions that may be of interest to the other students. There is a forum for general logistical questions (“When is assignment X due?”...) and there will be specific forums for physics-related questions for each unit of the course. A private email to the professor should only be used for questions that are specific to you. If you send me a general question via private email, I will not answer the question and will instead request that you post it to the forum.

Statement on Education During COVID-19:

To meet the challenge of teaching and learning during the COVID-19 pandemic, Lehigh instructors and students will be adopting new forms of instruction and interaction; following new guidelines around classroom behaviors; enhancing communications; and doing our best to be patient, flexible, and accommodating with each other. In remote synchronous meetings, students are expected to attend just as they would any other Lehigh class. Zoom classes work best when all students come to class ready to participate and follow the instructor’s guidelines regarding use of web-cameras. You may be asked to turn your camera on during active learning sessions in Zoom. If you have a strong preference not to do so, please contact your instructor to let them know. Students should respect the in-classroom privacy of their instructors and fellow students by not taking screenshots or recording class sessions. Some instructors will record Zoom sessions; however, any recorded live sessions will be shared only with students in the class and will be deleted at the end

of the semester. In our physical classrooms, Lehigh has established a policy requiring everyone to wear face coverings when in public spaces inside buildings on our campus and to maintain social distance. This policy applies to our physical classroom. Thank you in advance for following this rule. Students who do not wear a face covering during in-class meetings will be reminded to put their face covering on. If they do not do so, they will be asked once again to do so or leave the classroom.

Student Senate Statement on Academic Integrity:

We, the Lehigh University Student Senate, as the standing representative body of all undergraduates, reaffirm the duty and obligation of students to meet and uphold the highest principles and values of personal, moral and ethical conduct. As partners in our educational community, both students and faculty share the responsibility for promoting and helping to ensure an environment of academic integrity. As such, each student is expected to complete all academic course work in accordance to the standards set forth by the faculty and in compliance with the University's Code of Conduct.

The Principles of Our Equitable Community:

The Principles of Our Equitable Community: Lehigh University endorses The Principles of Our Equitable Community (www.lehigh.edu/diversity). We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

Accommodations for Students with Disabilities:

Lehigh University is committed to maintaining an equitable and inclusive community and welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact Disability Support Services (DSS), provide documentation, and participate in an interactive review process. If the documentation supports a request for reasonable accommodations, DSS will provide students with a Letter of Accommodations. Students who are approved for accommodations at Lehigh should share this letter and discuss their accommodations and learning needs with instructors as early in the semester as possible. For more information or to request services, please contact Disability Support Services in person in Williams Hall, Suite 301, via phone at 610-758-4152, via email at indss@lehigh.edu, or online at <https://studentaffairs.lehigh.edu/disabilities>.

Lehigh University Policy on Harassment and Non-Discrimination:

Lehigh University upholds The Principles of Our Equitable Community and is committed to providing an educational, working, co-curricular, social, and living environment for all students,

staff, faculty, trustees, contract workers, and visitors that is free from harassment and discrimination on the basis of age, color, disability, gender identity or expression, genetic information, marital or familial status, national or ethnic origin, race, religion, sex, sexual orientation, or veteran status. Such harassment or discrimination is unacceptable behavior and will not be tolerated. The University strongly encourages (and, depending upon the circumstances, may require) students, faculty, staff or visitors who experience or witness harassment or discrimination, or have information about harassment or discrimination in University programs or activities, to immediately report such conduct.

If you have questions about Lehigh's Policy on Harassment and Non-Discrimination or need to report harassment or discrimination, contact the Equal Opportunity Compliance Coordinator (Alumni Memorial Building / 610.758.3535 / eocc@lehigh.edu).