Physics 031: Introduction to Quantum Mechanics
Lehigh University, Spring 2018

Instructor: Ariel Sommer
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Office hours: by appointment (please email)
Class: TR 9:20 – 10:35 am, Lewis 316

Textbook: Kenneth S. Krane, *Modern Physics*, 3rd ed, Wiley, 2012

Overview: This course will introduce special relativity and quantum mechanics – two amazing scientific developments of the 20th century that revolutionized our understanding of the physical world.

Topics:
Chapter 2. The special theory of relativity.
Chapter 3. Particle-like properties of electromagnetic radiation.
Chapter 4. Wave-like properties of particles.
Chapter 5. The Schrödinger equation.
Chapter 6. The Rutherford-Bohr model of the atom.
Chapter 7. The hydrogen atom in wave mechanics.
Chapter 8. Many-electron atoms.
Chapter 10. Statistical Physics.

Homework: Homework will be assigned weekly. The purpose of the homework assignments will be to help you build your understanding of the course material. You are expected to turn in homework on time. You may work together on the homework, but make sure that you are able to complete the problems on your own. The work you turn in must be your own.

Late homework: Homework turned in one class-period late will be worth 75% credit, two class-periods late 50%, and no credit after that. Please contact me if you would like to request an extension due to illness or other circumstances.

Reading: Sections in the book will be assigned as reading.

Quizzes: Short in-class quizzes will be given once per week. The quizzes will provide an opportunity for you to demonstrate your understanding of the material and receive feedback. Your two lowest quiz scores will be dropped.

Exams: The course will have two midterm exams and a final exam. The final exam will be comprehensive and consist of three sections. You will have the opportunity to replace your lowest midterm exam score with your score from the corresponding section of the final exam.

Missed exams/quizzes: If you notify me in advance that you will miss a quiz or exam, I will schedule an alternative time for you to take it. After it's been missed, you may take a quiz or exam for 50% of the possible points.

Grading: Final grades in the course will be based on homework (15%), quizzes (10%), midterms (20% each), final exam (30%), and participation (5%).

Prerequisites: Physics 013, 021, or 023; Math 205 (can be taken concurrently).

Accommodations for Students with Disabilities: If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, Williams Hall, Suite 301 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.

The Principles of Our Equitable Community: Lehigh University endorses The Principles of Our Equitable Community [http://www.lehigh.edu/~inprv/initiatives/PrinciplesEquity_Sheet_v2_032212.pdf]. 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.

Learning Outcomes:
After taking the course, students will be able to solve basic problems in special relativity and quantum mechanics. Students passing the course will be prepared for continuing study in courses such as Phys 355 (Nonlinear Optics), Phys 362 (Atomic and Molecular Structure), Phys 364 (Nuclear and Elementary Particle Physics) and Phys 369 (Quantum mechanics). Students passing the course will be able to demonstrate the following skills:

- Apply the concepts of length contraction, time dilation, and relativistic velocity addition. Apply the Lorentz transformations to predict time and distance measurements and simultaneity.
- Understand the conservation of momentum and energy at relativistic speeds. Predict the dynamics of relativistic collisions.
- Understand the physics and scientific implications of the photoelectric effect, the Compton scattering of photons by electrons, and blackbody radiation.
- Calculate the de Broglie wavelength of a particle, understand wave behavior of particles including diffraction and interference, apply the uncertainty principle to quantum measurements.
- Describe quantum states of particles using a wavefunction, understand the probability interpretation of the wavefunction.
- Employ the Schrödinger equation to calculate the energy levels and eigenstates of particles in free space and potential wells, including square wells and the harmonic oscillator, understand quantum tunneling, be familiar with the qualitative properties of solutions to the Schrödinger equation.
- Understand the properties of atoms (Rutherford scattering and line spectra) leading to the Rutherford-Bohr model
- Understand the quantum mechanical model of the hydrogen atom, identify the allowed quantum numbers for spin and orbital angular momentum
- Predict the outcome of a Stern-Gerlach measurement, predict the Zeeman splitting of energy levels in a magnetic field
- Apply the Pauli exclusion principle to predict the possible electron configurations and angular momentum states in multi-electron atoms, apply the concept of charge screening to predict atomic properties, explain the properties of the periodic table.