DIM-SAP-232 Quantum Physics

SEMESTER: Spring

CREDITS: 3 ECTS (4 hrs. per week / 2 months)

LANGUAGE: English

DEGREES: SAPIENS program

Course overview

This course is aimed to introduce basic concepts and ideas on Quantum Mechanics. The lectures will focus on essential physical principles supported by mathematical developments when required. Every idea will be also illustrated with some technological application. The students will participate actively in the discussions and the course is aimed to combine work outside the class (pre-lectures and homework) as well as active discussions and peer instruction during class time.

Prerequisites

Students are expected to have a good understanding of:

- classical mechanics
- electric potential (Coulomb's Law, electric fields, Gauss' Law, electric potential, capacitance, circuits, magnetic forces and fields, Ampere's law, induction, electromagnetic waves)
- ray optics (polarization, geometrical optics)

Course contents

1. Photons. Light waves behaving as particles. Light Absorbed as Photons: The Photoelectric Effect. Light Emitted as Photons: X-Ray Production. Light Scattered as Photons: Compton Scattering and Pair Production. Wave–Particle Duality, Probability, and Uncertainty.
2. Particles Behaving as Waves. Electron Waves. The Nuclear Atom and Atomic Spectra. Energy Levels and the Bohr Model of the Atom. The Laser. Continuous Spectra. The Uncertainty Principle Revisited.
3. Quantum Mechanics. Wave Functions and the One-Dimensional. Schrödinger Equation. Particle in a Box. Potential Wells. Potential Barriers and Tunneling. The Harmonic Oscillator.
4. Atomic Structure. The Schrödinger Equation in three Dimensions. Particle in a Three-Dimensional Box. The Hydrogen Atom. Electron Spin. Many- Electron Atoms and the Exclusion Principle.

5. A Brief Introduction to Molecules and Condensed Matter. Types of Molecular Bonds. Structure of Solids and Energy Bands. Semiconductors and Superconductivity.

Textbook

- Young, H.D., Freedman, R.A. (2012). *University Physics, Volume 3 (Chs. 37-44).* 13th Edition. Pearson
- Longair, M.S. (2003). *Theoretical Concepts in Physics: An Alternative View Theoretical Reasoning in Physics*. 2nd Edition. Cambridge University Press**.**
- Griffiths, D. J., & Schroeter, D. F. (2018). Introduction to quantum mechanics. Cambridge university press.

Grading

The grade will be determined by one midterm (30%), homework (30%), and a final examination (40%). The exams are all closed notebook, closed textbook (calculator is allowed). The course will not be graded on a curve, i.e., there is no bound on the numbers of A's, B's, C's etc.

Students will have the chance to retake the exam. The resulting grade will be computed as follows: 30% of the midterms and 70% of the final exam.

Use of AI

The use of AI to create entire works or relevant parts, without citing the source or the tool, or without explicit permission in the assignment description, will be considered plagiarism and will be regulated in accordance with the University General Regulations.

The use of Artificial Intelligence for homework is allowed, setting Level 3 of the Perkins et al. (2024) Assessment Scale, including idea generation, drafting, feedback, and refinement. Students should critically evaluate and modify the AI suggested outputs, demonstrating their understanding. You may use AI to assist with specific tasks such as drafting text, refining and evaluating your work. You must critically evaluate and modify any AI-generated content you use.