PHYS-344

Quantum mechanics for non-physicists

Manucharyan Vladimir

Cursus	Sem.	Type
Communication systems	BA5	Obl.
Computer science	BA5	Obl.
Electrical and Electronical Engineering	BA5	Opt.
Minor in Quantum Science and Engineering	H	Opt.
Quantum Science and Engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	Oral
Workload	150h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course introduces quantum mechanics to students who are interested in pursuing quantum science and technology but have not gone through the standard bachelor physics curriculum. The students will develop quantum intuition by working out numerical examples based on qubits and oscillator systems.

Content

1. Review of classical physics in the context of quantum phenomena
Planetary motion and atoms, radiation and quantization, stochastic processes and interference.
2. Mathematical language of quantum mechanics
Quantum states, operators, matrices, uncertainty, and time-evolution.
3. Basic quantum systems
Particle-in-a-box, harmonic oscillator, anharmonic oscillator, tunneling.
A quick look into stationary perturbation theory.
4. Coupled quantum systems
Entanglement, density matrix, measurement, and decoherence.
A quick look into Fermi's golden rule.
5. Exploring the quantum
Cavity quantum electrodynamics, quantum control, quantum non-demolishing measurements
6. Introduction to quantum computing
(time permitting)

Keywords

Quantum physics
Quantum information
Qubit

Learning Prerequisites

Required courses

Calculus, Linear algebra, Differential equations

Recommended courses

Complex calculus, Mechanics, Electromagnetism

Important concepts to start the course

Complex numbers

Matrices and linear algebra
Familiarity with Python

Learning Outcomes

By the end of the course, the student must be able to:

- Solve basic problems in quantum mechanics
- Manage self-study of modern quantum science

Teaching methods

Lectures and exercises

Expected student activities

Attend lectures and exercise sessions, do the homework

Assessment methods

Oral exam

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

1) "Feynman's lectures on physics", vol III, selected chapters.
Available online at https://www.feynmanlectures.caltech.edu/III_toc.html
2) "Quantum mechanics: the theoretical minimum" by Lenny Susskind.
Video lectures based on this book are available online
at https://theoreticalminimum.com/courses/quantum-mechanics/2012/winter/lecture-1
3) "An Introduction to Quantum Computing" by Kay, Laflamme, and Mosca (introductory chapters).
Online version available at https://batistalab.com/classes/v572/Mosca.pdf
4) "Exploring the Quantum" by Haroche & Raymond. This book is for advanced students who are interested in learning more material

Ressources en bibliothèque

- The Feynman Lectures on Physics / Feynman
- An Introduction to Quantum Computing / Kay, Laflamme & Mosca
- Quantum mechanics: the theoretical minimum / Susskind
- Exploring the Quantum / Haroche & Raimond

Références suggérées par la bibliothèque

- An Introduction to Quantum Computing / Kay, Laflamme & Mosca
- Quantum mechanics: the theoretical minimum / Susskind
- The Feynman Lectures on Physics / Feynman

Moodle Link

- https://go.epfl.ch/PHYS-344