Quantum systems simulations - course description

General information

Course name	Quantum systems simulations
Course ID	13.2-WF-FizP-QSS-S16
Faculty	Faculty of Physics and Astronomy
Field of study	Physics
Education profile	academic
Level of studies	Second-cycle studies leading to MS degree
Beginning semester	winter term 2021/2022

Course information

Semester	4
ECTS credits to win	6
Available in specialities	Computer Physics
Course type	obligatory
Teaching language	english
Author of syllabus	• prof. dr hab. Mirosław Dudek

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	30	2	-	-	Exam
Laboratory	30	2	-	-	Credit with grade

Aim of the course

Students should know the methods of numerical simulation of quantum systems and how to apply them to selected problems of quantum mechanics and quantum computing.

Prerequisites

Knowledge of quantum mechanics, knowledge of mathematical methods of physics, knowledge of programming languages - the knowledge and skills that meet the criteria K2A_W01.

Scope

1. Quantum Mechanics:
- Wavepackets (Gaussian wavepacket, diffraction, tunneling),
- Simulation using quantum chemistry methods (orbitals, Slater determinant, Hartree-Fock equations, DFT method),
- Simulations using quantum Monte Carlo.
2. Selected aspects of quantum information (qubit concept, arithmetic operations on qubits, quantum algorithms).

Teaching methods

Teaching methods take the form of lecture, computer lab and exersises. The lecture is is for theoretical introduction. It should be enriched with examples of computer simulations and indications of how and when to use quantum methods. The laboratory should have a practical nature, where students are discussing the lecture material, prepare simulations of simple quantum systems, become familiar with the available libraries to conduct simulations of quantum systems. The suggested programming language - Python.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
Students have a basic knowledge of the methods of computer simulation of quantum systems.	• K2_W01	• a discussion • a quiz • an exam - oral, descriptive, test and other	• Lecture • Laboratory
General knowledge is supported by the ability to implement a detailed quantum model simulations. They can explain the quantum of phenomena under consideration and justify the methods to be used. They have elementary knowledge of quantum computing.	• K2_W01 • K2_W04	• a discussion • a quiz • an exam - oral, descriptive, test and other	• Lecture • Laboratory

Assignment conditions

The lecture ends with an examination to be assessed. Form of a check is a written theoretical problem and practical skills in its implementing. The effects of exercise training are verified by partial rankings on completed tasks, evaluation of written tests and assessment of skills in computer simulation for a specific issue of quantum problems

Overall rating: arithmetic average exam grade and credit.

Recommended reading

[1] W. M. C. Foulkes, L. Mitas, R. J. Needs, G. Rajagopal, Reviews of Modern Physics, Vol. 73, No. 1, January 2001
[2] Leonard I. Schiff, Quantum Mechanics, McGraw Hill Book Company (1968).

Further reading

[1] Internet, Python libraries

Notes

Modified by dr Marcin Kośmider (last modification: 09-05-2021 21:44)