LEARNING MODULE DESCRIPTION

GENERAL INFORMATION

1. Module title: Quantum mechanics II
2. USOS code: 04-S1FZ04-P02443
3. Term: Summer term
4. Duration: 30h (lecture), 30h (classes)
5. ECTS: 5
6. Module lecturer: Jarosław W. Kłos (lecture), Julia Kharlan (classes)
7. E-mail: klos@amu.edu.pl (lecture), yulkha@amu.edu.pl (classes)
8. Language: English

DETAILED INFORMATION

1. Module aim (aims)

   The lecture and classes constitute a standard course in quantum mechanics, which is an extension of the courses on the background of modern physics and the foundations of quantum mechanics. The classes are aimed at a deeper understanding of the mathematical apparatus and include a larger number of calculation exercises. The course is quite strictly conducted in backing up the first five chapters of the textbook: David J. Griffiths, Introduction to quantum mechanics.

2. Pre-requisites in terms of knowledge, skills and social competences (where relevant)

   Students should have mathematical knowledge and skills in algebra (at least one semester of classes) and mathematical analysis (at least two semesters of classes), as well as a well-established knowledge of general mechanics, of electricity and magnetism, and of the fundamentals of modern physics.

READING LIST

1. David J. Griffiths, *Introduction to quantum mechanics*, Prentice Hall inc. 1995

SYLLABUS:

Lectures and classes are organised in 10 meetings of 3 hours each.

Week 1:<u>Wave function</u>
statistical interpretation of wave function, normalization, expected values of position and momentum, continuity equation, uncertainty principle

Week 2: <u>Time independent Schrodinger equation</u>
Separation of variables in time-dependent Schrodinger equation, stationary modes and their properties

Week 3: H<u>armonic oscillator</u>
algebraic approach, analytic approach

Week 4: <u>Bound states and scattering states</u>
free particle, wave tunnelling, scattering matrix, scattering on potential step, tunelling across square barrier

Week 5: <u>Linear algebra</u>
vector space, linear independence, inner product, orthonormal basis, linear transformations (Hermitian matrix, unitary matrix), eigenvectors and eigenvalues

Week 6: <u>Hilbert space in quantum mechanics</u>
function spaces, operators as linear transformations, generalized statistical interpretation, generalized uncertainty principle – non-commuting operators

Week 7: <u>Schrodinger equation in spherical coordinates</u>
hydrogen atom

Week 8: Angular momentum
commutation rules, eigenvalues, angular momentum in spherical coordinates, spin ½, electron in magnetic field

Week 9: Identical particles
bosons and fermions, Pauli exclusion principle, exchange interactions,

Week 10: Electrons in solids
free electron gas in 2D and 3D, band structure – Dirac comb