Study programmes: BACHELOR STUDIES – Astronomy and Astrophysics

Course name: Quantum Theoretical Physics

Lecturers: Maja Burić, Edib Dobardžić and other lecturers

Status: Optional

ECTS: 8

Attendance prerequisites: Mathematics 2, Fundamentals of Theoretical Mechanics, Methods of Mathematical Physics

Course aims: The aim of the course is to introduce students to quantum-mechanical description of nature and to basic quantum phenomena. A further aim is to teach them to apply quantum-mechanical formalism to physical problems in atomic, nuclear and molecular physics as well as in condensed matter physics.

Course outcome: Students should understand properties of the Schroedinger equation and its solutions, and be able to relate them with the behavior of the real physical systems. Students should be able to solve simple problems in one, two and three dimensions and in finite physical systems, and and also to apply perturbation theory.

Course content:

1. Introduction: Black body radiation, interference, Compton effect, Bohr atom. 2. Time-dependent and stationary Schroedinger equation. 3. Statistical interpretation: probability density, continuity equation. 4. Free particle, evolution of the Gaussian wave packet. 5. Potential wells and barriers, bound states, energy levels. 6. Tunell effect, WKB approximation. 7. Harmonic oscillator. 8. Elements of the quantum-mechanical formalism:states and observables, Dirac notation. 9. Uncertainty relations, Ehrenfest theorem. 10. Canonical quantization, creation and annihilation operators. 11. Symmetries: parity, translations. 12. Angular momentum. 13. Particle in a spherically-symmetric potential, spherical harmonics. 14. Hydrogen atom. 15. Spin 1/2, Pauli matrices. 16. Identical particles, Pauli principle. 17. Time-independent perturbation theory, Stark and Zeeman effects. 18. Time-dependent perturbation theory, radiative transitions in atoms. 19. Variational method. 20. Emlements of the scattering theory.

Literature:

1. P.J.E Peebles, Quantum Mechanics, Princeton University Press, 1992
2. W Greiner, Quantum Mechanics. An Introduction, Springer, 2007
3. E. Merzbacher, Quantum Mechanics, Wiley, 1997
4. E. Dobardzić, Quantum Physics, http://www.bg.ac.rs
5. S. Elezović-Hadžić, V. Prokić, Elementary problems in Quantum Mechanics, University of Belgrade, 1996

Number of hours: 7	**Lectures**: 4	**Tutorials**: 3	**Laboratory**: -	**Research**: -

Teaching and learning methods:

Lectures, example classes, numerical simulations, demonstration experiments. Example classes follow the lectures. The following demonstration experiments complement the course: 1. Electron interference on graphene. 2. Measurement of reflection and transmission coefficients . 3. Visualisation of infinite potential well model. 4. Zeeman effect.

Assessment (maximal 100 points)

Course assignments	points	Final exam	points
Lectures	5	Written exam	25
Exercises / Tutorials	-	Oral exam	45
Colloquia	-	Written-oral exam	-
Essay / Project	25		