

Academic Year/course: 2022/23

39153 - Quantum Mechanics

Syllabus Information

Academic Year: 2022/23

Subject: 39153 - Quantum Mechanics

Faculty / School: 100 - Facultad de Ciencias

Degree: 577 - Joint Program in Physics and Mathematics

ECTS: 5.0

Year:

Semester: First semester

Subject Type: Optional

Module:

1. General information

1.1. Aims of the course

The aims of the course are aligned with the following Sustainable Development Goals (SDGs):

- Goal 4: Quality Education

2. Learning goals

3. Assessment (1st and 2nd call)

4. Methodology, learning tasks, syllabus and resources

4.3. Syllabus

Contents:

1. The Postulates of Quantum Mechanics. States, dynamical variables and operators. Evolution and measurements.
2. The density matrix. General and pure states. Compound systems. Tensor product. Partial trace. Entanglement. Schmidt decomposition. Purification. Identical particles.
3. Interferences. Beam splitter and the parametric down conversion.
4. Quantum information. The EPR experiment and the Bell's inequalities. No cloning theorem. Quantum cryptography. Teleportation.
5. Quantum Computation. Classical and Quantum gates. Teleportation again. Algorithms (Deutsch-Jozsa, search algorithms, Simon, Quantum Fourier Transform, Shor, etc.). Physical realizations, optical photons and ion traps.
6. Many body systems. Phonons and Photons.
7. The path integral. Feynman's propagator. The free particle. The Schrödinger equation. The Harmonic oscillator. Perturbation theory.
8. Special relativity, notations. Lagrangian density and the Energy-Momentum Tensor. Symmetries and the Noether theorem. Covariant formulation of the Electromagnetism. Gauge invariance.
9. The Klein-Gordon equation. Interactions.
10. Particles with spin 1/2. The Dirac equation. Symmetries and interactions. Non relativistic limit.
11. Spin 1/2 particles in an external field. The relativistic Hydrogen atom. Selfadjoint extensions of the Hamiltonian.

4.5. Bibliography and recommended resources

<http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=39153>