Laboratory on quantum computing

Academic Year: (2023 / 2024) **Review date: 28/04/2023 01:35:26**

Department assigned to the subject: Physics Department

Coordinating teacher: PUEBLA ANTUNES, RICARDO

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- Quantum computation
- Matrix quantum mechanics
- Wave quantum mechanics

OBJECTIVES

CB6. To possess and understand concepts and ideas that provide a basis or opportunity to be original in the development and/or application of ideas, often in a research context.
CB9. That students know how to communicate their conclusions and the ultimate knowledge and reasons that support them to specialized and non-specialized audiences in a clear and unambiguous manner.
CB10. That students possess the learning skills that will enable them to continue studying in a manner that will be largely self-directed or autonomous.
CG2. Knowledge of scientific and technical subjects that enable them to learn new methods and technologies, as well as to
be highly versatile in adapting to new situations.
CG4. Ability to solve scientific and technological problems that may arise within the framework of the applications of quantum technologies in various fields of physics and engineering.
CG6. Ability to develop new products and services based on the use and exploitation of new quantum technologies.
CG7. Ability and knowledge to enable the enrolment in specialized studies at the PhD level, either in related fields of physics or in the various branches of engineering.
CE6. Knowledge of the principles of quantum computing and its basic elements: qubits, gates and circuits, as well as knowledge and ability to handle various quantum algorithms.
CE7. Ability to generate codes that implement simple quantum algorithms, to identify the kind of problems that can be advantageously solved with them and to identify the potential physical implementations of a quantum computer.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to python and Qiskit
2. Single qubit
   - Bloch sphere
   - Quantum gates
3. Multiple qubits
   - Quantum circuits
   - Two-qubit gates
   - Quantum gate equivalence
   - Simulators vs quantum computers
3. Quantum algorithms
   - Grover
   - Quantum Fourier Transform
   - Shor
4. Density matrix

LEARNING ACTIVITIES AND METHODOLOGY

AF1. Theoretical classes.
AF2. Practical classes.
AF3. Computational practical sessions.
AF4. Group work.
AF5. Student individual work.
AF6. Midterm and final exam.
MD1. Class presentations by professor using electronic and audiovisual resources to convey the main key concepts of the subject, providing relevant bibliography to complement the learning by the students.
MD3. Resolution of practical cases in an individual or group manner.
MD4. Class presentation and discussion, chaired by the professor, of topics related to the subject.
MD5. Individual or group work and reports.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

SE1. Class attendance and participation (5%)
SE2. Individual or group works and reports done during the course (35%)
SE3. Final exam (60%)

BASIC BIBLIOGRAPHY

- M. A. Nielsen and I. L. Chuang Quantum computation and quantum information, Cambridge, 2010

BASIC ELECTRONIC RESOURCES

- IBM Quantum . Qiskit: https://qiskit.org/textbook/preface.html