Quantum computing

Academic Year: (2023 / 2024) **Review date: 26/04/2023 23:33:13**

Department assigned to the subject: Physics Department

Coordinating teacher: TORRONTEGUI MUÑOZ, ERIK

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Quantum physics
Advanced quantum physics
Algebra

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. Knowlege 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. Classical computing.
- Logic gates

2. The qubit
- Bloch sphere
- Quantum gates
- Circuit diagrams
- Linear algebra
- Multiqubits

3. Quantum effects
- No-cloning theorem
- Dense coding
- Quantum key distribution

4. Quantum algorithms

- Grover
- Quantum Fourier transform (phase estimation, Shor)

5. Physical implementations of a quantum computer

LEARNING ACTIVITIES AND METHODOLOGY

LEARNING ACTIVITIES

AF1. Theorical class
AF2. Practical classes
AF4. Team work
AF5. Individual student work
AF6. Partial and final exams

METHODOLOGY

MD1. Presentations in class by the teacher with the support of computer and audiovisual media, in which the main concepts of the subject are developed and the bibliography is provided to complement the learning of the students.
MD3. Resolution of practical cases, problems, etc... raised by the teacher individually or in a group
MD4. Presentation and discussion in class, under the teacher's moderation, of topics related to the content of the subject, as well as practical cases
MD5. Preparation of work and reports individually or in groups

ASSESSMENT SYSTEM

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

SE1. Class participation
SE2. CONTINUOUS EVALUATION. Assesses papers, projects, class presentations, debates, exercises, internships and workshops throughout the course.
SE3. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course.

BASIC BIBLIOGRAPHY

- M. A. Nielsen and I. L. Chuang Quantum computation and quantum information, 10th Anniversary Edition, Cambridge, 2010

- Thomas G. Wong Introduction to classical and quantum computing, Rooted Grove, 2022