Quantum computation and information

Academic Year: (2022 / 2023) **Review date: 20-06-2022**

Department assigned to the subject: Department of Physics

Coordinating teacher: TORRONTEGUI MUÑOZ, ERIK

Type: Compulsory ECTS Credits : 6.0

Year : 4 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Linear algebra
Quantum physics
Advaced quantum physics

DESCRIPTION OF CONTENTS: PROGRAMME

1. Review of Quantum Mechanics.
- Dirac matricial formalism.
- Evolution of quantum states.
- Density matrix.
- Quantum measurement.
- Quantum phase.
- EPR Paradox and Bell theorem.
- Quantum systems and entanglement.
2. Introduction to Computer Science.
- Turing machines.
- Computational circuits.
- Logic gates.
3. Quantum computational circuits.
- The qubit.
- Qubit operations.
- Quantum gates.
- Open QSAM: a language for the Quantum Experience (QX) by IBM.
4. Quantum algorithms.
- Quantum parallelism.
- Deutsch algorithm.
- Quantum Fourier transform.
- Shor algorithm.
- Quantum search algorithms.
5. Quantum information.
- Quantum noise.
- Quantum operations.
- Quantum error-correction.
- Quantum information and Shannon entropy.
6. Quantum data compression.
7. Quantum cryptography

LEARNING ACTIVITIES AND METHODOLOGY

AF1. THEORETICAL-PRACTICAL CLASSES. Knowledge and concepts students mustacquire. Receive course notes and will have basic reference texts.Students partake in exercises to resolve practical problems
AF2. TUTORING SESSIONS. Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher.Subjects with 6 credits have 4 hours of tutoring/ 100% on- site attendance.
AF3. STUDENT INDIVIDUAL WORK OR GROUP WORK.Subjects with 6 credits have 98 hours/0% on-site.
AF8. WORKSHOPS AND LABORATORY SESSIONS. Subjects with 3 credits have 4 hours with 100% on-site instruction. Subjects with 6 credits have 8 hours/100% on-site instruction.
AF9. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course. It entails 4 hours/100% on-site
MD1. THEORY CLASS. Classroom presentations by the teacher with IT and audiovisual support in which the subject`s main concepts are developed, while providing material and bibliography to complement

student learning
MD2. PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group
MD3. TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with teacher as tutor. Subjects with 6 credits have 4 hours of tutoring/100% on-site.
MD6. LABORATORY PRACTICAL SESSIONS. Applied/experimental learning/teaching in workshops and laboratories under the tutor's supervision.

ASSESSMENT SYSTEM

SE1. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course.The percentage of the evaluation varies for each subject between 60% and 0%.
SE2. CONTINUOUS EVALUATION. Assesses papers, projects, class presentations, debates, exercises, internships and workshops throughout the course.The percentage of the evaluation varies for each subject between 40% and 100% of the final grade.

Despite the final mark is obtained with the indicated percentages, to pass the course it is COMPULSORY to:

- Attend all practical computer sessions and deliver all specific exercises selected by the professors.
- Obtain a grade equal or greater than 3 points out of 10 in the end-of-term exam.

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

BASIC BIBLIOGRAPHY

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

ADDITIONAL BIBLIOGRAPHY

- C. Cohen-Tannoudji, B. Diu, and F. Laloe Quantum mechanics, Vol. 1, Wiley, New York,, 1977

- J. J Sakurai Modern quantum mechanics, Addison-Wesley, 1994