Quantum technologies

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

Department assigned to the subject: Physics Department

Coordinating teacher: TORRONTEGUI MUÑOZ, ERIK

Type: Electives ECTS Credits : 6.0

Year : Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Quantum physics
Advanced quantum physics
Quantum computation and information

DESCRIPTION OF CONTENTS: PROGRAMME

1. Physical realizations of quantum simulators & computers.
- Trapped ions.
- Nuclear spin.
- Cold atoms.
2. Superconducting quantum computers.
- Superconducting quantum circuits.
- Superconducting qubits.
- Quantum gates.
3. Quantum computer programming.
- IBM Quantum Experience and QisKit. Rigetti Forest. Google OpenFermion.
4. Quantum optimizers.
- Adiabatic quantum computing.
- Quantum annealing.
- Applications
5. Quantum metrology and sensors.
- Magnetic field sensors.
- Gravitational field sensors.
- Atomic clocks

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
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.
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.

Although the final grade is obtained with the indicated percentages, to pass the subject it is MANDATORY:

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

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

BASIC BIBLIOGRAPHY

- G. J. Milburn Quantum Technology, Allen & Unwin, 1996

ADDITIONAL BIBLIOGRAPHY

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

BASIC ELECTRONIC RESOURCES

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