Solid-state implementation of quantum technologies

Academic Year: (2023 / 2024) **Review date: 23-04-2023**

Department assigned to the subject: Physics Department

Coordinating teacher: TORRONTEGUI MUÑOZ, ERIK

Type: Electives ECTS Credits : 3.0

Year : 2 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Calculus
Quantum physics
Advanced quantum physics
Basic knowledge in Python and Computer algebra

DESCRIPTION OF CONTENTS: PROGRAMME

Part 1.- Devices / implementations
- Spin, charge and valley in quantum dots
- Flux and charge in SQUIDs
- Hybrid systems, cavities

Part 2.- Decoherence models
- Phonons, Caldeira-Leggett model
- Circuit impedance
- Spin bath

Part 3.- Transport
- Rate equations
- Pauli blockade
- Cooper pair splitting

Part 4.- Measurement and readout
- Cavity-qubit models
- Dispersive shift
- Dicke model, superradiance
- Spin readout

Part 5.- Control
- AC driving and artificial gauge fields
- Adiabatic control

LEARNING ACTIVITIES AND METHODOLOGY

Educational activities:

Theory lessons
Tutorial sessions
Practical quantum programming activities
Individual student work

Educational Methodologies:

Classroom lessons by lecturers in which the main concepts will be developed. Bibliography will be provided to students as a complement to the main lessons

Solution of practical exercises in the classroom and also individually by students.

Practices on quantum programming.

ASSESSMENT SYSTEM

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

Assessed exercises solved individually by each student (40 %) and final exam (60%)

BASIC BIBLIOGRAPHY

- P. Forn-Diaz et al., Ultrastrong coupling regimes of light-matter interaction, Rev. Mod. Phys. 91, 025005 , 2019

- R. Hanson et al Spins in few-electron quantum dots, Rev. Mod. Phys. 79, 1217 , 2007

- W. G. van der Wiel et al. Electron transport through double quantum dots, Rev. Mod. Phys. 75, 1, 2003

- Y. Makhlin et al. Quantum-state engineering with Josephson-junction devices, Rev. Mod. Phys. 73, 357 , 2001

- Z.-L. Xiang et al Hybrid quantum circuits: Superconducting circuits interacting with other quantum systems, Rev. Mod. Phys. 85, 623 , 2013