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

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

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

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