UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Laboratory of Solid State and Quantum Technologies II

2425-1-F1701Q147

Aims

Development of experimental knowledge related to the solid state physics and quantum technologies by means of advanced techniques based on magnetoresistance, electron spin resonance or superconductivity with quantum cryogenic devices.

Contents

Realization of experiments in quantum technologies and condensed matter physics.

Detailed program

The course consists of one or more laboratory based experiments performed by groups of 2/3 students. The laboratory activities will be introduced with lectures about the correlation between physical properties of solids, quantization effects and experimental methodologies. Beside the design of the experiments and the characterization of the physical systems under study, the activities will be complemented with data analysis and a written scientific report.

Example of proposed experiments:
• Quantum sensing: realization of an experimental set-up for the demonstration of a magnetic quantum sensor with crystal defects in diamonds.
• Characterization of magnetic sensors based on giant magnetoresistance, spin valve and anisotropic magnetoresistance.
• Electron spin resonance spectroscopy in magnetic two-dimensional crystals.
• Characterization, control and read-out of a superconducting qubit.

• Characterization of a single-optical photon cryogenic detector for quantum technology applications.
• Characterization of a parametric amplifier with quantum noise level.

Prerequisites

Bachelor degree in Physics or equivalent matter and first module of the course.

Teaching form

On site laboratory based experimental activities.
72 hours of laboratory activity in interactive mode in person, including introductory lectures conducted in person and in delivery mode.

Textbook and teaching resource

Texbooks available as e-books through the University Library as well as lectures notes.

1. J. M. D. Coey (2010) “Magnetism and magnetic materials” Cambridge University Press
2. Doherty et al. Physics Report, 528 (2013)
3. Segawa T. F. Nanoscale quantum sensing with Nitrogen-Vacancy centers in nanodiamonds – A magnetic resonance perspective Progress in Nuclear Magnetic Resonance Spectroscopy 134–135 (2023) 20–38
4. Eaton G.R., Eaton S.S., Barr D.B. and Weber R.T. “Quantitative EPR”. Springer-Verlag/Wien (2010)
5. A.M. Zagoskin. "Quantum Engineering - Theory and Design of Quantum Coherent Structures", Cambridge University Press (2011) Ulteriori articoli scientifici relativi ai dispositivi studiati saranno forniti durante il corso.

Semester

Second semester

Assessment method

The evaluation method is based on a group’s written report as well as on a final oral examination to ascertain the knowledge and the communication skills gained in the context of the topics studied. There will not be available partial examinations. In addition, the evaluation will be based on the ability demonstrated by the students to conduct the experiments in the laboratory.

Office hours

Appointments can be arranged with the lecturers from Monday to Friday at any working hour via email. The information about the addresses and the teacher’s offices are available through the University’s website.

Sustainable Development Goals

INDUSTRY, INNOVATION AND INFRASTRUCTURE