Universidad Zaragoza

Academic Year/course: 2021/22

60033 - Physics of magnetic materials

Syllabus Information

Academic Year: 2021/22
Subject: 60033 - Physics of magnetic materials
Faculty / School: 100 - Facultad de Ciencias
Degree: 538 - Master's in Physics and Physical Technologies
589 - Master's in Physics and Physical Technologies
ECTS: 5.0
Year: 1
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

This course describes the main phenomena and experimental methods associated with the field of magnetism and magnetic materials. Emphasis is made on the quantum theory of magnetism and related properties of interest for technological applications. It is recommended for students who have a previous solid background in Quantum Physics, Statistical Physics and Solid State Physics. Other courses of the Master that are complementary to this are: ?Material Science?, ?Statistical Physics of Critical Phenomena and Complex Systems?, ?Nanoscience and Nanotechnology?, ?Quantum Theory of Condensed Matter Physics? and ?Low Temperature Physics and Quantum Technologies?.

Magnetism is a discipline that has been an important part of the History of Science itself. During the 20th century, it underwent four revolutionary changes: understanding of the Quantum origin, its extension to high frequencies (dynamics and resonance), the consumer market applications and very recently, the emergence of spin electronics. The subject describes the main phenomena, theoretical developments and experimental methods associated with modern magnetism. Emphasis is made on the quantum theory of magnetism and on the properties of magnetic materials and their applications.

2. Learning goals

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

A continuous evaluation will take into account the personal work of the students throughout the course. The students will receive a questionnaire of different sections of the course and a selected topic to be developed and presented in class. The evaluation (70% of the final mark) will reflect the quality of the solutions given to these questionnaires and the oral presentation.

The course will also comprise three practical sessions in the laboratory. After such sessions the student will produce a report on each including the objectives and obtained results. The evaluation of these reports will be 30% of the final mark.

The course has been primarily designed for students who are able to attend the lectures on site. However, there will also be an evaluation test for those students who are either unable to attend these lectures or who fail in their first evaluation. The test will consist on solving a questionnaire evaluating the expected results of the course. The questionnaire will consist of the following two parts: (i) one questions related to the main concepts discussed in the course. The student will be given three hours to solve this part. It will be evaluated from 0 to 10 and the result will amount to 70 % of the final mark; (ii) A practical exercise in which the student will be asked to describe the elements and configuration of an experimental set-up appropriate to measure a given material magnetic property. The student will then be asked to operate the set-up in the laboratory. Allocated time: three hours. It will be evaluated from 0 to 10 and the result will amount to 30 % of the final mark.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course is oriented towards achievement of the learning objectives. It favors the acquisition of theoretical and experimental expertise in the field of magnetism and magnetic materials. In order to get these results, we have programmed activities that improve the active and continuous implication of students within the different topics.

The course consists of two distinct training activities: lectures (4 ECTS); and laboratory sessions and elaboration of reports (1 ECTS). These activities will allow the student to acquire the desired knowledge on the topics of the course and experimental competence in modern magnetism.

4.2. Learning tasks

The course includes the following learning tasks:

- Lectures on the main topics of the course.
- Laboratory practice sessions. The student will conduct the experiments and prepare a report with the obtained results.

The teaching and assessment activities will be carried out in person unless, due to the health situation, the provisions issued by the competent authorities and by the University of Zaragoza arrange to carry them out on-line.

4.3. Syllabus

The course will address the following topics:

Lectures

Topic I. Introduction.
Topic II. Diamagnetism. Paramagnetism.
Topic III. Ions in solids: Crystal Electric Field.
Topic IV. Exchange interactions.
Topic V. Ferromagnetism. Other magnetic order.
Topic VI. Magnetic Anisotropy. Domains.
Topic VII. Magnetic materials and applications.

Laboratory practice sessions

1. Temperature and field dependence of the magnetization with a SQUID.
2. Magnetic anisotropy with a VSM.
3. Observation of magnetic domain walls by Lorentz microscopy.

4.4. Course planning and calendar

Further information concerning the timetable, classroom, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the Faculty of Science http://ciencias.unizar.es/

4.5. Bibliography and recommended resources

http://biblos.unizar.es/br/br_citas.php?codigo=60033&year=2019