MATS8AC MAGNETIC PROPERTIES OF METALLIC MATERIALS AND NANOMATERIALS

MATS8AC Magnetic properties of metallic materials and nanomaterials	ECTS Credits : 2 Duration : 21 hours	Semester : S8

Person(s) in charge:

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Keywords:
Magnetic properties of metals and nanomaterials

Prerequisites:

Quantum Physics
Statistical physics
Electric and thermal properties of materials

General objective :

Magnetic properties of metals and nanomaterials

Program and Contents:

The study of magnetic properties has attracted a lot of interest in the last thirty years owing to their fundamental interest and technological applications. In particular, when the size of the materials is reduced down to the nanometer scale, new properties appear, giving rise to nanomagnetism and spintronics. The importance of such phenomena has been recognized in the 2007Nobel Prize. These properties found new applications in magnetic hard disks, magnetic memories (MRAM), field sensors, micro-wave sources or logic circuits and so much more. These developments are supported by large industries such as IBM, Hitachi Seagate, or Toshiba which are heavily investing in Research and Development.

This course will cover several topics related to magnetism in nanodimensions, starting from the basics. Special attention will be given to the formation of magnetic moments as well as the origin of the various interactions at stake in a magnetic nano object.

A) Origin of magnetism

- A-1) microscopic origin of magnetism: from atoms to solid
- A-2) Localised or free electron models
- A-3) fundamental Interactions: exchange interaction, spin-orbit coupling, crystal field, dipolar interaction and Zeeman energy

B) Magnetic configuration and nanomagnetism

- B-1) Different magnetic states: diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism
- B-2) Magnetism at different scales: magnetic domains, domain wall, size effect

C) Specific properties

- C-1) Magnetic properties: magnetostriction, magnetoresistance, magnetic anisotropy, magnetic susceptibility
- C-2) Use of magnetic materials (Permanent magnet, Magnetic recording, Magnetic memories)

Abilities:

Level	Description and operational verbs
Know	The origin of magnetism
Understand	The fundamental interactions responsible for the magnetic properties of materials
Apply	Describe the main magnetic interactions
Analyse	The large variety of applications ranging from the compass to hard disks
Summarise	Have basic knowledge in optoelectronics.
Assess	Combination of a short written report, a 15-minute oral presentation on a selected subject, personal work during the semester, and a final written test

Assessment:

☑ Written Test	☑ Continuous Control	☑ Oral Report	☑ Project	☐ Written Report