Introduction to spintronics

Academic Year: (2023 / 2024) **Review date: 12/02/2024 13:28:40**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: ACEDO GALLARDO, PABLO

Type: Electives ECTS Credits : 6.0

Year : 5 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Materials science and engineering
Solid State Fundamentals for Engineering
Electronic Engineering Fundamentals
Quantum Physics

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG4. Solve mathematical, physical, chemical, biological and technological problems that may arise within the framework of the applications of quantum technologies, nanotechnology, biology, micro- and nano-electronics and photonics in various fields of engineering.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CG6. Develop new products and services based on the use and exploitation of new technologies related to physical engineering.
CG7. Undertake further specialized studies, both in physics and in the various branches of engineering.
CE17. Understand and handle the fundamental concepts of Quantum Physics, its relationship with Classical Physics, and its application to the understanding of the physics of atoms and molecules, as well as solving simple one- and three-dimensional quantum problems and applying approximate resolution methods.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require

creating and innovative thinking.
RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.
RA4. To be able to successfully manage themselves in the complex situations that might arise in their academic or professional fields of study and that might require the development of novel approaches or solutions.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

OBJECTIVES

To learn what is spintronics and the physical fundamentals supporting it. To understand the working principles of some basic spintronics devices, and the materials used to develop them.

Introduction to the current paths for future spintronics: spinorbitronics, magnonics, spincaloritronics, new materials and advanced computational techniques.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction. Magnetism and magnetic materials. Connection between quantum concepts and macroscopic magnetic measurements. Spin and spin-orbit coupling.
2. Spintronics. Definition, origin and classes.
3. Origin of spintronics. Magnetoresistance, spin valves. and magnetic tunnel-junctions.
4. Spin transfer torque. Applications in the development of spintronics devices.
5. Magnetic domains.¿
6. Optical Spintronics. Ultrafast demagnetization and Spin Hall effect.
7. Spin injection and transport in semiconductors.
8. Spintronics devices.
9. Advanced spintronics: spinorbitronics and quiral systems. Antiferromagnets.
10. Advanced spintronics: magnonics, caloritronics and advanced computation.
11. Advanced spintronics based on new materials.

LEARNING ACTIVITIES AND METHODOLOGY

AF1. THEORETICAL-PRACTICAL CLASSES.
AF3. STUDENT INDIVIDUAL WORK OR GROUP WORK.
AF8. WORKSHOPS AND LABORATORY SESSIONS.
AF9. FINAL EXAM.
MD1. THEORY CLASS.
MD2. PRACTICAL CLASS.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

SE1. FINAL EXAM. 50%
SE2. CONTINUOUS EVALUATION.

- Partial Exam: 20%.
- Students' projects and practical work: 30%.

BASIC BIBLIOGRAPHY

- J.M.D. Coey Magnetism and magnetic materials, Cambridge University Press, 2010

- Puja Dey, Jitendra Nath Roy Spintronics. Fundamentals and Applications, Springer, 2021

ADDITIONAL BIBLIOGRAPHY

- A. Fert Nobel lecture: Origin, development and future of spintronics, Rev. Mod. Phys. 80, 1517 , 2008

- Several Authors The annual Magnetism Roadmaps of. J. Phys. D: Applied Physics , IOP, 2021