Syllabus

Subject

Subject / Group	11291 - Spintronics / 1
Degree	Master's in Advanced Physics and Applied Mathematics
Credits	3
Period	2nd semester
Language of instruction	English

Professors

Lecturers	Office hours for students					
	Starting time	Finishing time	Day	Start date	End date	Office / Building
María Rosa López Gonzalo rosa.lopez-gonzalo@uib.es	10:00	11:00	Monday	09/09/2019	09/09/2020	208 IFISC
David Sánchez Martín david.sanchez@uib.es	14:00	15:00	Tuesday	09/09/2019	29/05/2020	205 (IFISC, Edifici Instituts de Recerca)
Llorenç Serra Crespí llorens.serra@uib.es	14:00	15:00	Monday	16/07/2019	31/07/2020	209, edifici Instituts

Context

Spintronics is an emerging field of physics which exploits the properties of the spin degree of freedom. Exciting discoveries in recent years include giant magnetoresistance, spin torques and spin Hall effect. From a more practical point of view, spintronic devices will have a significant impact in future electronics due to their lower power consumption and their novel functionalities.

Requirements

Recommended

Quantum mechanics. Solid state physics.

Skills

Specific

* ESQ7 - Understanding of the magnetic properties of solids and their applications for nanoelectronic devices.

Date of publication: 03/07/2019

* CE1 - Students must possess the learning skills that enable them to combine specialized knowledge in Astrophysics and Relativity, Geophysical Fluids, Materials Physics, Quantum Systems or Applied Mathematics, with the versatility that provides an open training curriculum..
* CE2 - Students must possess the ability to use and adapt mathematical models to describe physical phenomena of different nature
* CE3 - To acquire edge-line knowledge in the international scientific research context and demonstrate a full comprehension of theoretical and practical aspects, together with the scientific methodology.

Generic

* CG1 - Sistematic comprehension of a field of knowledge and its related skills and research methods
* CB6 - Possess the knowledge and its understanding to provide the basis or opportunity to be original in developing and/or applying ideas, often within a research context..
* CB7 - Students can apply the broader (or multidisciplinary) acquired knowledge and ability to solve problems in new or unfamiliar environments within contexts related to their field of study
* CB10 - Students gain the learning skills that enable them to continue studying in a way that will be largely self-directed or autonomous

Basic

* You may consult the basic competencies students will have to achieve by the end of the Master's degree at the following address: http://estudis.uib.cat/master/comp_basiques/

Content

Range of topics

1. Introduction

   Magnetism in solids. Zeeman effect. Magnetic interactions: exchange and superexchange. Ferromagnetism. Stoner model. Magnetic semiconductors. Spin-orbit interaction in semiconductors: Rashba and Dresselhaus.

2. Spin decoherence

   Spin relaxation. Bloch equations. Times T1 and T2. Elliot-Yafet and Dyakonov-Perel mechanisms. Hyperfine interaction.

3. Nanoscale spintronics

   Giant magnetoresistance. Tunnel magnetoresistance. Spin-torque transfer. Spin field-effect transistor. Ferromagnetic-semiconductor interfaces. Spin Hall effect.

4. Spin quantum computation

   Qubits. Quantum dots.

Teaching methodology

In-class work activities (0.72 credits, 18 hours)

Date of publication: 03/07/2019

Modality	Name	Typ. Grp.	Description	Hours
Theory classes		Large group (G)	Lectures.	18

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Aula Digital platform.

Distance education tasks (2.28 credits, 57 hours)

Modality	Name	Description	Hours
Individual self-study	Problems.	Solve the proposed list of problems.	20
Individual self-study	Presentation.	Present and discuss a relevant paper in the field of spintronics.	37

Specific risks and protective measures

The learning activities of this course do not entail specific health or safety risks for the students and therefore no special protective measures are needed.

Student learning assessment

Frau en elements d'avaluació

In accordance with article 33 of Regulation of academic studies, "regardless of the disciplinary procedure that may be followed against the offending student, the demonstrably fraudulent performance of any of the evaluation elements included in the teaching guides of the subjects will lead, at the discretion of the teacher, a undervaluation in the qualification that may involve the qualification of "suspense 0" in the annual evaluation of the subject".

Problems.

Modality	Individual self-study
Technique	Papers and projects **(retrievable)**
Description	Solve the proposed list of problems.
Assessment criteria	

Final grade percentage: 50%

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Presentation.

Modality	Individual self-study
Technique	Papers and projects **(non-retrievable)**
Description	Present and discuss a relevant paper in the field of spintronics.
Assessment criteria	
Final grade percentage: 50%	

Resources, bibliography and additional documentation

Basic bibliography

Fabian, Jaroslav, et al. "Semiconductor spintronics." Acta Physica Slovaca. Reviews and Tutorials 57.4-5 (2007): 565-907.

Wolf, S. A., et al. "Spintronics: a spin-based electronics vision for the future." Science 294.5546 (2001): 1488-1495.

Date of publication: 03/07/2019