# 60167 - Nanoscience and nanotechnology

### Guía docente para el curso 2011 - 2012

### Curso: 1, Semestre: 0, Créditos: 8.0

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## Información básica

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### Profesores


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### Recomendaciones para cursar esta asignatura

The course describes the basic tools, concepts and phenomena needed to understand nanoscience and nanotechnology. Emphasis is made on the fabrication and characterization methods of nanometric entities. It is recommended for students to have a background on scientific degrees such as physics or chemistry. Other courses of the Master complementary to the present one are “Técnicas experimentales en Física”, “Materiales funcionales”, “Physics of Materials in Big Installations”.

### Actividades y fechas clave de la asignatura

- Matriculation from 21/07/2011 to 28/07/2011 and from 21/09/2011 to 06/10/2011
- First course date : 19/09/2012.
- Last course date: 20/01/2012.
- Theory: Monday and Tuesday from 11:00 to 12:00 and from 11:00 to 13:00 respectively in "Seminario de Tercer Ciclo de Física Aplicada"

- Lab classes. To be announced by the professor.

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## Inicio

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## Resultados de aprendizaje que definen la asignatura

### El estudiante, para superar esta asignatura, deberá demostrar los siguientes resultados...

**1:**
The student will be able to understand some phenomena taking place at the nanoscale

**2:**
The student will be capable of choosing the right technique to grow each type of nanostructure

**3:**
The student will be able to use some equipment inside a clean room environment

**4:**
The student will be able to choose the appropriate equipment to measure one particular property of the nanostructure

## Introducción

### Breve presentación de la asignatura

Nanotechnologies are spreading quickly across many domains of our every-day life, including cosmetics, pharmaceutics, textiles, construction, nanoelectronics, telecommunications, etc. In this course, the student will learn the different types of entities, materials and devices which are present in those applications. Furthermore, the different fabrication and characterization techniques used in nanoscience will be shown.

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## Contexto y competencias

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## Sentido, contexto, relevancia y objetivos generales de la asignatura

### La asignatura y sus resultados previstos responden a los siguientes planteamientos y objetivos:

The course in Nanoscience and nanotechnology can be recommended to any student who is interested in learning about the increasingly important field of Nanoscience and Nanotechnologies. The goal is to make the student familiar with the language of Nanoscience as well as to learn how to obtain nanostructures and how to characterize them. The student will apprehend a few fascinating applications and phenomena occuring at the nanoscale. At the end of the course, the student should be able to use and apply some of these techniques to real scientific and even practical problems of his interest.

### Contexto y sentido de la asignatura en la titulación

Together with the courses on “Técnicas experimentales en Física”, “Materiales funcionales” and “Physics of Materials in Big Installations”, the present course forms a very complementary and profound introduction to the concepts, experimental tools and applications of the modern research in nanomaterials.

### Al superar la asignatura, el estudiante será más competente para...

**1:** to use the right language in the field of Nanoscience and Nanotechnology

**2:**
to be aware of the technological impact of Nanoscience and Nanotechnology

**3:**
to identify the current interesting research topics in Nanoscience and Nanotechnology

**4:**
to know the growth methods of nanoscale objects

**5:**
to distinguish amongst the different lithography methods and their characteristics

**6:**
to know the tools for the characterization of nanosystems and the information obtained from them

**7:**
to be able to establish the different steps to accomplish to obtain a nanodevice

### Importancia de los resultados de aprendizaje que se obtienen en la asignatura:

The Nanosciences and nanotechnologies are modifying our habits of living. Examples such as advanced microprocessors and memories, cosmetics and pharmaceutical products, advanced biomedical applications, etc. give evidence for a rapidly evolving society and technology that requires individuals with enough basic knowledge to understand those changes and even lead those changes. Only by means of interdisciplinary courses such as the present one, the student can achieve a comprehensive understanding of this changing world.

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## Evaluación

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## Actividades de evaluación

### El estudiante deberá demostrar que ha alcanzado los resultados de aprendizaje previstos mediante las siguientes actividades de evaluacion

**1:**
**Continuous Evaluation**

1. A continued evaluation will take into account the personal work of the students throughout the course. The students will receive a questionnaire for each of the different sections of the course. The evaluation (50% of the final mark) will reflect the quality of the solutions given to these questionnaires.
2. After the practical exercises performed in the laboratory, the students will have to write a report including the description of the tasks performed as well as the analysis of the obtained results. The average mark obtained with these reports will constitute the 50% of the final mark.

**2:**
**Global Evaluation**

The course has been 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 want to improve the mark after the continuous evaluation. The test will consist of solving a questionnaire connected with the expected results of the course. The questionnaire will consist of the following two parts:

1. One part will contain 7 questions related with 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 count as 50 % of the final mark.
2. A practical exercise in which the student will first be asked to describe the elements and configuration of

an experimental set-up for growth or characterization used in Nanoscience. The student will be subsequently asked to use the set-up in the laboratory. Allocated time: three hours. It will be evaluated from 0 to 10 and the result will count as 50 % of the final mark.

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## Actividades y recursos

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## Presentación metodológica general

### El proceso de aprendizaje que se ha diseñado para esta asignatura se basa en lo siguiente:

The results programmed for this course include achieving theoretical as well as practical expertises in the field of research of phenomena associated with the nanoscale. The main two approaches for the fabrication of nanostructured materials will be shown:  top-down, consisting of the patterning of a macroscopic material, and bottom-up, where atoms and molecules are forced to build a molecular building. The main topics to be discussed are:

*I Preparation of Nanostructures:* bottom-up as well as top-down approaches will be taught. Physical, Chemical, and Biochemical approaches will be discussed.

*II Characterization techniques in Nanoscience:* Local probe microscopies, surface techniques, neutron and x-ray techniques as well as other Physical, Chemical and Biochemical characterization techniques will be treated.

*III Applications of Nanoscience: Nanotechnology:* Applications in domains such as Electronics, Sensors, Biomedicine, etc. will be the target of this part.

The teaching mode is via theory as well as and practical works comprising the use of a Clean Room for the work on optical- and electron/ion lithography, the laboratory of film growth, the facilities for advanced microscopies and for nanocharacterization.

## Actividades de aprendizaje programadas (Se incluye programa)

### El programa que se ofrece al estudiante para ayudarle a lograr los resultados previstos comprende las siguientes actividades...

**1:**

This course is organized by combining theoretical and practical lessons.

Theoretical lessons:

Lectures for the main group. These lessons aim at the acquisition of the basic knowledge required in nanoscience and nanotechnology. These lessons will be supported by the recommended bibliography, as well as by audiovisual material, powerpoint presentations and complementary information, all of them available for the students in digital form. Participation of the student along the lectures will be continuously stimulated by the teachers and exercises to be solved will be proposed. Autonomous work of the student is required and tutorial support will be always at student disposal.

Practical lessons:

Five practical work sessions will be organized using existing research equipments in the Faculty of Sciences in Campus Plaza San Francisco or in the Building of Research Institutes in the Campus Río Ebro. Teachers as well as technicians will help the student to use the required tools and will guide him/her in the writing of the report. The data will be provided for the subsequent student’s analysis.

## Planificación y calendario

### Calendario de sesiones presenciales y presentación de trabajos

The detailed content of the theoretical courses is:

*I Preparation of Nanostructures:* Vacuum technologies. Technologies for the growth of thin films: sputtering, laser ablation, molecular beam epitaxy, evaporation. Artificial methods for fabrication: optical lithography, electrón and ion beam lithography, local probe lithography nanoimprinting. Self-assembly and self-organization. Nanometric organic structures. Nanometric inorganic structures. Biochemistry sistems for Nanotechnology. Nanoparticle functionalization.

As part I is the most important one in the course, it will take almost 50% of the theoretical courses foreseen (typically up to 5th April).

*II Characterization techniques in Nanoscience:* Local probe microscopies: STM, AFM, MFM. Scanning and Transmisión Electrón Microscopy: TEM, SEM. Surface characterization techniques: XPS, Auger, RBS, RHEED, BET. Neutron and x-ray techniques for the characterization of thin films and nanostructures: XRD, XRR, PNR, SANS, GISANS. Physical, Chemical and Biochemical characterization techniques.

Part II will be given just after part I, and will take the next 25% of the theoretical course (typically up to 4th May).

*III Applications of Nanoscience: Nanotechnology:* Storage and processing of information. Sensors. Biosensors. Biochips. Bioferrofluids and magnetic carriers. Nanoelectromechanical systems (NEMS). Contrast agents for MRI. Applications in telecommunications. Drug delivery. Miniaturization in Electronics. Societal implications of Nanoscience.

Part III will last up to the end of the course, at the beginning of June.

The practical works comprise:

1.- Growth of thin films and heterostructures

2.- Optical lithography

3.- Nanolithography

4.- Scanning Probe Microscopy

5.- Magnetic relaxation of ferrofluids

The exact dates of the practical work will be announced by the corresponding teachers and will depend on the availability of the required equipment.

The guided visits through the laboratories will allow the student to enlarge his/her knowledge on the nanoscience tools, as well as the current research lines developed in this topics in Zaragoza and the corresponding researchers.

## Bibliografía

### The student can use the following references during the course

## Referencias bibliográficas de la bibliografía recomendada