Course Guide
44418 Fundamentals of nanoscience

COURSE DATA

Data Subject	
Código	44418
Name	Fundamentals of nanoscience
Cycle	Master's degree
ECTS Credits	4.5
Curso académico	2017 - 2018

Study (s)

Degree	Center	Acad. year	Period
2208 - M.U. en Nanociencia y Nanotecnolog²a Molecular	FACULTY OF CHEMISTRY	1	First term

Subject-matter

Degree	Subject-matter	Character
2208 - M.U. en Nanociencia y Nanotecnolog²a Molecular	2 - Fundamentals of nanoscience	Obligatory

Coordination

Name	Department
CORONADO MIRALLES, EUGENIO	320 - QUđMICA INORGĆNICA

SUMMARY

The students will acquire the fundamentals and get acquainted with quantum mechanics phenomena that most commonly manifest at the nanoscale. Also the students will get acquainted with the basics of nanochemistry as a tool for building complex systems starting from basic units and their application in various research areas.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

There are no specified enrollment restrictions with other subjects of the curriculum.

OUTCOMES

2208 - M.U. en Nanociencia y Nanotecnología Molecular

- Students can apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
- Students are able to integrate knowledge and handle the complexity of formulating judgments based on information that, while being incomplete or limited, includes reflection on social and ethical responsibilities linked to the application of their knowledge and judgments.
- Students have the learning skills that will allow them to continue studying in a way that will be largely self-directed or autonomous.
- Students have the knowledge and understanding that provide a basis or an opportunity for originality in developing and/or applying ideas, often within a research context.
- To possess the necessary knowledge and abilities to continue with future studies in the PhD program in Nanoscience and Nanotechnology.
- For students from field of knowledge (e.g. chemistry) to be able to scientifically communicate and interact with colleagues from another field (e.g. physics) in the resolution of problems laid out by the Molecular Nanoscience and Nanotechnology.
- To know the fundamentals of solid state physics and supramolecular chemistry necessary on molecular nanoscience.
- To know the methodological approaches used in Nanoscience.
- To know the main techniques for molecular systems nanofabrication.
- To acquire the conceptual knowledge about molecular systems self-assembly and self-organisation.
- To assess the relationships and differences between the materials macroscopic properties and those of unimolecular systems and nanomaterials.
- To know the main molecular nanomaterials technological applications and to be able to put them in the Material Science general context.

LEARNING OUTCOMES

The students will acquire the fundamentals and get acquainted with quantum mechanics phenomena that most commonly manifest at the nanoscale. Also the students will get acquainted with the basics of nanochemistry as a tool for building complex systems starting from basic units and their application in various research areas.

DESCRIPTION OF CONTENTS

1. Fundamentals in nanoscience.

0) Introduction:

a) Top-down and bottom-up approaches in Nanoscience.
b) Low dimensionality: Basic concepts and examples of 0-, 1-, 2-dimensional nanostructures.

1) Nanophysics:

a) Nanomechanics.
Review of defects and phonos in solids.
Nanocrystals: the Hall-Petch relationship at the nanoscale.
Nanowires: deformation mechanisms at the nanoscale.
2D materials: graphene, mechanical properties and defects.

b) Nanomagnetism.
Review of basic concepts: Magnetic interactions.
Superparamagnetism.
Macroscopic quantum tunneling.
Magnetoresistance.

c) Nanotransport.
Review of basic transport concepts: conductivity, diffusivity, Einstein relation.
Landauer formalism.
Conductance quantization.
Quantum tunneling.
Resonant quantum tunnelling.
Coulomb blockade.
The Kondo effect.

d) Nanooptics.
Review of basic concepts: Excitons and plasmons.
Optical properties of 0D, 1D, and 2D systems.
Low-dimensional plasmonics.

2) Nanochemistry:

a) Nanochemistry principles
Introduction: Historical evolution and interest.
Review of Nanostructures: Nanoparticles, nanotubes, nanowires, films, 3D structures.
Characterization methods of nanostructures: Microscopies and other tools.

b) Fabrication methods of nanostructures
Nanoparticle synthesis.
Abrasion, colloidal synthesis, sol-gel, etc.
Nanotubes and Nanowires synthesis.
Supramolecular chemistry.
From supramolecular chemistry to self-assembling.
Film preparation.
Traditional techniques.
Nanostructured films: SAMs, Layer-by-Layer, Langmuir-Blodgett, etc.

3) Nanobiology

a) Imaging of biomolecules in vitro. Applications.
b) Biomaterials development.
c) Applications of nanomaterials to biomedical problems.

4) Principles of nanotechnology:

a) Future and present applications.
b) Ethical and social impact.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	22.00	100
Seminars	7.00	100
Tutorials	6.00	100
Other activities	2.00	100
Preparation of evaluation activities	57.50	0
Preparing lectures	18.00	0
TOTAL	**112.50**	

TEACHING METHODOLOGY

Theory classes, participatory lectures

Articles discussion.

Chaired debate or discussion.

Practical cases or seminar problems discussion.

Seminars.

Problems.

Laboratory practices and demonstrations and visit to installations.

Experts conferences.

EVALUATION

Written exam about the subject basic contents	70-90%
Attendance and active participation in seminars.	0-10%
Questions answering	10-20%

REFERENCES

Basic

- G.A. Ozin, A.C. Arsenault: Nanochemistry. The Royal Society of Chemistry, 2005.
P.J. Collings, Liquid Crystals: Natuers delicate of Mater. 2ª Ed., Princenton University Press, 2002.
Ulman, An Introduction to Ultrathin Organic Films: from Langmuir-Blodgett to Self-Assembly, Academic Press, San Diego, 1991.
Allen J. Bard, Integrated Chemical Systems: A Chemical Approach to - Nanotechnology, Wiley, John & Sons,1994.
- Nanoscopic Materials. Emil Roduner. RSC Publishing, 2006.
- G.L. Hornyak, J. Dutta, H.F. Tibbals, A.K. Rao, Introduction to Nanoscience. CRC Press (2008)
- G.L. Hornyak, H.F. Tibbals, J. Dutta . Fundamentals of Nanotechnology. CRC Press (2008)
- Supriyo Datta. Quantum transport: From Atom to Transistor, Cambridge University Press, 2005