

Academic Year: ( 2023 / 2024 )

Review date: 20-06-2022

Department assigned to the subject: Materials Science and Engineering and Chemical Engineering Department

Coordinating teacher: TORRES CARRASCO, MANUEL

Type: Electives ECTS Credits : 6.0

Year : Semester :

**DESCRIPTION OF CONTENTS: PROGRAMME**

Introduction.- Historical development of nanomaterials. Nanomaterials versus Bulk solids. Analogies and differences. Classification of nanomaterials

Fundamentals.- Size & Scale. Atoms, Molecules, Clusters and Supramolecules. Structure and Bonding in Nanomaterials. Hierarchical Structures. Zero-Dimensional nanomaterials: nanoparticles. One-Dimensional nanomaterials: nanowires & nanorods. Two-Dimensional nanomaterials: Thin films and monolayers

Properties and Size dependence of properties

Nanomaterial Synthesis (bottom-up, Top-down): Chemical routes. Electrochemical methods. Microwave synthesis, Vapor growth Thin films methods: chemical vapor deposition, physical vapor deposition (sputtering, laser ablation). Mechanical methods: ball milling, mechanical attrition. Sol-gel methods.

Pulsed Laser Ablation. Micromachining Methods. Special nanomaterials: carbon nanotubes, fullerenes, nanowires, porous silicon.

Nanomaterial characterization techniques: Scanning and Transmission Electron Microscopy, Scanning Probe Microscopies: Atomic Force, scanning tunneling microscopy, Diffraction and scattering techniques, Vibrational spectroscopy, Surface techniques, Thermal characterization, Electrical measurements

Applications: Nano-electronics, Nano optics, Nanoscale chemical- and bio-sensing, Biological/bio-medical applications, Photovoltaic, fuel cells, batteries and energy-related applications, High strength nanocomposites.

Environmental and health risks associated with the use of nanomaterials

**LEARNING ACTIVITIES AND METHODOLOGY**

AF1. THEORETICAL-PRACTICAL CLASSES. Knowledge and concepts students must acquire. Receive course notes and will have basic reference texts. Students partake in exercises to resolve practical problems

AF2. TUTORING SESSIONS. Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher. Subjects with 6 credits have 4 hours of tutoring/ 100% on-site attendance.

AF3. STUDENT INDIVIDUAL WORK OR GROUP WORK. Subjects with 6 credits have 98 hours/0% on-site.

AF8. WORKSHOPS AND LABORATORY SESSIONS. Subjects with 6 credits have 8 hours/100% on-site instruction.

AF9. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course. It entails 4 hours/100% on-site

MD1. THEORY CLASS. Classroom presentations by the teacher with IT and audiovisual support in which the subject's main concepts are developed, while providing material and bibliography to complement student learning

MD2. PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group

MD3. TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with teacher as tutor. Subjects with 6 credits have 4 hours of tutoring/100% on-site.

MD6. LABORATORY PRACTICAL SESSIONS. Applied/experimental learning/teaching in workshops and laboratories under the tutor's supervision.

## ASSESSMENT SYSTEM

SE1. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course. The percentage of the evaluation will be 50%.

SE2. CONTINUOUS EVALUATION. Assesses papers, projects, class presentations, debates, exercises, internships and workshops throughout the course. The percentage of the evaluation will be 50% of the final grade.

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| <b>% end-of-term-examination:</b>   | 50 |
| <b>% of continuous assessment (assignments, laboratory, practicals...):</b> | 50 |

## BASIC BIBLIOGRAPHY

- Gogotsi. Nanomaterials Handbook, CRC Press, 2006
- M.R. Wiesner; J-I. Bottero; Environmental Nanotechnology: applications and Impacts of nanomaterials, Mc. Graw Hill, 2000
- P. C.N.R. Rao; A. Muller; A.K. Cheetham Nanomaterials Chemistry: new developments and new directions , Wiley-VCH, 2007
- Poole & F.J. Owens Introduction to Nanotechnology , Ed. Wiley , 2003
- Vollath. Nanomaterials: an introduction to synthesis, properties and applications, Wiley-VCH, 2008