Course guides
230864 - BMSC - Biophysical and Materials Science Characterisation

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics.
Degree: MASTER'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2018). (Optional subject).
ERASMUS MUNDUS MASTER'S DEGREE IN BIO & PHARMACEUTICAL MATERIALS SCIENCE (Syllabus 2021).
(Optional subject).

Academic year: 2021  ECTS Credits: 4.0  Languages: English

LECTURER
Coordinating lecturer: Echebarria Dominguez, Blas
Others: Pradell Cara, Trinitat
Echebarria Dominguez, Blas

PRIOR SKILLS
Knowledge of thermodynamics and solid state physics

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES
Basic:
CB6. (ENG) Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

TEACHING METHODOLOGY
The weekly teaching hours are distributed in theoretical and practical classes, including laboratory sessions. During the theoretical classes, the main concepts and results are explained, with examples to help their understanding. During the practical lessons, typical problems are solved, as well as more conceptual questions.

LEARNING OBJECTIVES OF THE SUBJECT
The aim of the course is to provide an introduction to chemical physics, especially to: liquid solutions (both electrolyte & nonelectrolyte), polyelectrolyte biopolymers, hybrid materials, solid solutions, and heterogenous materials, and on the relevant characterization techniques. On successful completion of the course students will be able to choose the appropriate experimental techniques for a specific purpose, and have a basic knowledge of the chemical physics of aqueous & biological solutions and complex materials.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours large group</td>
<td>33.0</td>
<td>33.00</td>
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<tr>
<td>Self study</td>
<td>64.0</td>
<td>64.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>3.0</td>
<td>3.00</td>
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CONTENTS

Physicochemistry of solutions

Description:
Introduction to inorganic chemical physics of electrolyte & nonelectrolyte solutions: Types of solutions. Thermodynamics of solutions (entropy, free energy and chemical potential; phase diagrams).
Properties of solutions: functional groups, hydrophilic and hydrophobic interactions; solubility; diffusion. Colligative properties: boiling-point elevation, freezing point depression, osmotic pressure. Surface tension, capillarity. Water phase diagram and anomalies; aqueous electrolytes; non-electrolyte solutions.
Electrostatics for salty solutions: biopolymers (polyelectrolytes) and biomembranes in water; Poisson-Boltzmann equation, Debye-Hückel model, electric double layers, ion and proton conduction; transport properties.

Full-or-part-time: 39h
Theory classes: 14h
Self study : 25h

Applications to pharmaceutics, drug formulation, & biophysical pharmacology

Description:
- Experimental techniques for electrolyte and non-electrolyte solutions
- Small Molecules (drugs): HPLC, Chromatography, Mass spectroscopy, ICP-MS
- Characterization of Nanoparticles: Molecular sizes (Dynamics light scattering, DLS), Surface charge (zeta potential, with conductivity measures)
- Characterization of Biomolecules: chromatography, gel electrophoresis, Western Blot. Proteomics

Full-or-part-time: 11h
Theory classes: 4h
Self study : 7h

Physicochemistry of solids

Description:
Introduction to inorganic solid-state chemical physics (cohesive interactions; organic solids and salts); structural and mechanical properties of homogeneous solids; non-miscible systems: morphology and properties of phase-separated materials

Full-or-part-time: 25h
Theory classes: 9h
Self study : 16h
### Laboratory techniques

**Description:**
- Elemental analysis: photoelectron & mass spectroscopy (XPS, UPS, Auger, secondary ion mass spectroscopy)
- Chemical analysis: optical and vibrational spectroscopy (UV-vis, IR, Raman), nuclear magnetic resonance (NMR)
- Morphological analysis: contact angle, powder X-ray diffraction (XRD), tomography (microCT), NMR-imaging, electron microscopy (SEM, TEM, energy loss/secondary electron spectroscopy)
- Phase-change analysis
- Mechanical, electrical and optical characterization
- A pharmaceutical application: optical measurement of the dissolution kinetics and solubility of a drug

**Full-or-part-time:** 25h  
Theory classes: 6h  
Laboratory classes: 3h  
Self study: 16h

### GRADING SYSTEM

The final mark will be calculated taking into account a report on a case study, a midterm exam, handed-in solved problems, and a final exam.