Course guide
230865 - MSD - Materials Science of Drugs

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).
(Compulsory subject).
Academic year: 2023 ECTS Credits: 4.0 Languages: English

LECTURER
Coordinating lecturer: Consultar aquí / See here:
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura
Others: Consultar aquí / See here:
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS
Knowledge on fundamental thermodynamics and solid-state physics.

REQUIREMENTS
None.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES
Basic:
CB7. (ENG) Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.
CB8. (ENG) Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicio.
CB9. (ENG) Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades
CB10. (ENG) Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

TEACHING METHODOLOGY
The subject is given in 3 expositive 2-hour lessons weekly in large group, that combine theory and exercises, plus 2 laboratory sessions in small group.

LEARNING OBJECTIVES OF THE SUBJECT
On successful completion of the course, the students will be able to discuss the crystallographic properties of different polymorphs, the equilibrium conditions for a phase or phase coexistence, draw multiphase and/or binary phase diagrams, and distinguish between different equilibrium, metastable, and unstable states, and their relevance for drug formulations.
STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>64.0</td>
<td>64.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>30.0</td>
<td>30.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>6.0</td>
<td>6.00</td>
</tr>
</tbody>
</table>

Total learning time: 100 h

CONTENTS

### Basics concepts of crystallography

**Description:**
Translational order, unit cell, Bravais lattices. Point groups, space groups, crystal systems. Crystallographic planes, reciprocal lattice, Miller indices. From crystal system to molecular structure and geometry: crystals with a base and molecular crystals. Calculation and modelling of diffraction patterns from atomic and structure scattering factors. Solid-state polymorphism of drugs and other organic molecules. Second harmonic generation.

**Specific objectives:**
The student will learn to distinguish and characterize the different structural phases based on their symmetries and the relationships between them.

**Related activities:**
Lectures including theory and problems solving

**Full-or-part-time:** 24h
- Theory classes: 8h
- Self study: 16h

### Phase Equilibrium and phase transitions

**Description:**
Thermodynamic Potentials for hydrostatic pV{T systems; Maxwell relations; TdS equations; General conditions for equilibrium; Fluctuations; Le Châtelier principle.

**Specific objectives:**
The student will acquire the basic thermodynamics needed to be able to understand more advanced and specific concepts in later topics.

**Related activities:**
Lectures including theory and problems solving

**Full-or-part-time:** 18h
- Theory classes: 6h
- Self study: 12h
### Phase transitions and topological pressure-temperature phase diagram

**Description:**  

**Specific objectives:**  
The student will go deep into first-order phase transitions and the notion of relative stability and will know how to construct topological phase diagrams. The student will acquire the experimental capability to characterize a phase transition and the temperature-pressure phase diagram.

**Related activities:**  
Lectures including theory and problems solving  
Lab session 1: Characterization of phase transitions and temperature-pressure phase diagram via calorimetry.

**Full-or-part-time:** 20h  
Theory classes: 6h  
Practical classes: 2h  
Self study : 12h

### Landau theory for phase transitions

**Description:**  

**Specific objectives:**  
The student will be introduced to Landau's theory for phase transitions, and how it can be used to understand the origin of microstructural textures and domains, giving rise to cycles of hysteresis and other phenomena.

**Related activities:**  
Lectures including theory and problems solving

**Full-or-part-time:** 18h  
Theory classes: 6h  
Self study : 12h

### Phases out of equilibrium

**Description:**  
Glass state and glass transition; dynamics and structural relation in the glass state; pressure dependence of the glass transition temperature; non-equilibrium phases and mesophases of drugs. Dielectric spectroscopy.

**Specific objectives:**  
The student will learn the concept of glass state and glass transition and their characteristics, and experimental techniques to characterize them.

**Related activities:**  
Lab session 2: Characterization of relaxation dynamics and glass transition via dielectric spectroscopy and calorimetry.

**Full-or-part-time:** 11h  
Theory classes: 3h  
Practical classes: 2h  
Self study : 6h
Binary systems

**Description:**
Thermodynamics of mixing, thermodynamic potential; types of binary phase diagrams: eutectic, metatectic and peritectic; solubility and miscibility; metastable and unstable states; nucleation vs spinoidal decomposition.

**Specific objectives:**
The student will learn the concepts related to the thermodynamics of binary systems.

**Related activities:**
Lectures including theory and problems solving

**Full-or-part-time:** 9h
Theory classes: 3h
Self study: 6h

---

**GRADING SYSTEM**

Problems solved autonomously concerning Topic 1: 20%
Problems solved autonomously concerning Topic 2-3: 25%
Problems solved autonomously concerning Topic 4: 15%
Problems solved autonomously concerning Topic 6: 10%
Laboratory reports: 30%
Rerevaluation tasks will not be performed.

**EXAMINATION RULES.**

Problems will be performed individually
Laboratory reports will be performed in group.

---

**BIBLIOGRAPHY**

**Basic:**

**Complementary:**

**RESOURCES**

**Other resources:**
Information about Crystallography:
[link]