Course guide
230469 - ES - Solid State

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Compulsory subject).

Academic year: 2022 ECTS Credits: 6.0 Languages: Catalan

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

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Knowledge of the structure of matter and its properties at molecular and atomic level. Ability to analyze the behavior of materials, electronics and biophysical systems, and the interaction between radiation and matter.
2. Knowledge of the interactions at different matter scales. Ability to analyze functional capabilities of physical systems at various scales.
3. Knowledge of structural and functional applications of materials. Knowledge of the physical systems of low dimensionality. Ability to identify systems and/or materials suitable for different engineering applications.

General:
3. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

Transversal:
2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
1. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.

TEACHING METHODOLOGY

There will be two theoretical and one practical weekly sessions. The theoretical lectures will be devoted to a careful presentation of the basic concepts and the main results which will be illustrated with some examples. The practical sessions will be devoted to the solution of a variety of exercises and problems.
LEARNING OBJECTIVES OF THE SUBJECT

Be familiar with the atomic structure of crystalline and non-crystalline solids.
Recognize the global relationship between the macroscopic properties of solids and their crystalline structure and atomic bond.
Have knowledge of the vibrational properties of solids, and their influence on the thermal and acoustic properties of materials.
Have knowledge of the electronic structure of solids and the bands theory. Relate them to the properties of insulators, semiconductors and conductors.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>65,0</td>
<td>43.33</td>
</tr>
<tr>
<td>Self study</td>
<td>85,0</td>
<td>56.67</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

CONTENTS

1. Crystalline structures.
   Description:
   1.1. Periodic arrays of atoms.
   1.2. Two and three-dimensional crystal structures.
   1.3. Crystal coordinates and indexes.
   1.4. Wave diffraction in a crystal.
   1.5. Reciprocal lattice and Brillouin zone.

   Full-or-part-time: 50h
   Theory classes: 21h 40m
   Self study : 28h 20m

2. Dynamics of the crystal lattice.
   Description:
   2.2. Vibrations in diatomic crystals.
   2.3. Quantum Description: energy quantization.
   2.4. Momentum of phonons. Inelastic scattering.

   Full-or-part-time: 25h
   Theory classes: 10h 50m
   Self study : 14h 10m
3. **Phonons.**

**Description:**
3.2. Heat capacity.
3.3. Anharmonic interactions.
3.3.1. Thermal expansion.
3.3.2. Thermal conductivity.
3.3.3. Phonon-Phonon collisions.

**Full-or-part-time:** 25h  
Theory classes: 10h 50m  
Self study : 14h 10m

4. **Electrons in solids.**

**Description:**
4.2. Three dimensional free-electron gas.

**Full-or-part-time:** 15h  
Theory classes: 6h 30m  
Self study : 8h 30m

5. **Electronic band structure.**

**Description:**
5.1. Quasi-free electron model. Conduction and valence bands.
5.2. Bloch theorem.
5.3. Tight binding model.
5.4. Semiclassical model of an electron in a periodic potential.
5.5. Metals and insulators.
5.6. Semiconductors.
5.6.1. Electrons and holes. Effective mass.
5.6.2. Concentration of intrinsic carriers.
5.6.3. Impurities: doped semiconductors.

**Full-or-part-time:** 35h  
Theory classes: 15h 10m  
Self study : 19h 50m

**GRADING SYSTEM**

There will be a final exam (EF) and a partial exam (EP). The final score will follow from max{EF, 0.60*EF + 0.40*EP}. There will be reevaluation of the final exam.
BIBLIOGRAPHY

Basic:

Complementary: