Course guides

230853 - LF - Large Facilities: Synchrotron and Neutron Sources

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics.
Degree: MASTER’S DEGREE IN ENGINEERING PHYSICS (Syllabus 2018). (Compulsory subject).
ERASMUS MUNDUS MASTER’S DEGREE IN BIO & PHARMACEUTICAL MATERIALS SCIENCE (Syllabus 2021). (Optional subject).
Academic year: 2021
ECTS Credits: 5.0
Languages: English

LECTURER

Coordinating lecturer: Pere Bruna Escuer
Others: Pere Bruna Escuer, Youri Alexandrovich Koubychine Merkulov, Luis Carlos Pardo Soto

PRIOR SKILLS

- Basic general physics, specially electromagnetism, propagation of electromagnetic waves in vacuum, metals and dielectrics
- General background in instrumentation
- Solid state physics, specially crystalline structures
- Basics of probability
- Some background in special relativity could be helpful but not mandatory

REQUIREMENTS

None

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.
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.
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

- Master classes
- Practical exercises using software tools
- Laboratory practice
LEARNING OBJECTIVES OF THE SUBJECT

- To get acquainted with the main concepts of charged particle acceleration and principles of operation of synchrotrons
- To understand the principles of generation of synchrotron radiation and neutron beams and know their main characteristics
- To know the main instrumentation used in large facilities
- To recognize the complementarity of each technique (synchrotron and neutron scattering)
- To know the fundamentals of the main techniques in synchrotron and neutron sources
- To know the physical properties of the materials that are possible to measure in large facilities
- To know the fundamentals to analyze the data obtained in large facilities

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Self study</td>
<td>81.0</td>
<td>62.79</td>
</tr>
<tr>
<td>Hours large group</td>
<td>48.0</td>
<td>37.21</td>
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</table>

Total learning time: 129 h

CONTENTS

1. Basics of particle accelerators

Description:

Full-or-part-time: 8h
Theory classes: 8h

2. Generation of electromagnetic radiation

Description:

Full-or-part-time: 4h
Theory classes: 4h

3. Examples of large facilities: colliders, ion accelerators, synchrotron radiation and spallation sources

Description:
CERN accelerator complex and LHC. Neutron sources. European Spallation Source and other examples. Spanish synchrotron radiation source ALBA. New types of synchrotron radiation facilities.

Related activities:
Laboratory practices: Magnetic measurements, RF measurements, Linac energy dispersion measurements

Full-or-part-time: 4h
Theory classes: 4h
### 4. The basics of X-ray and neutron scattering

**Description:**

**Full-or-part-time:** 2h  
Theory classes: 2h

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### 5. Beamlines

**Description:**

**Related activities:**
Specialized seminars by ALBA staff

**Full-or-part-time:** 2h  
Theory classes: 2h

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### 6. Inelastic neutron scattering

**Description:**
Coherent and incoherent scattering. Van –Hoff functions (localized, delocalized and intramolecular motions).

**Full-or-part-time:** 4h  
Theory classes: 4h

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### 7. Neutron applications

**Description:**

**Full-or-part-time:** 2h  
Theory classes: 2h

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### 8. Diffraction at Synchrotron Sources

**Description:**

**Full-or-part-time:** 6h  
Theory classes: 6h
<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Full-or-part-time</th>
<th>Theory classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Hard X-Ray Synchrotron Imaging Techniques and other technics</td>
<td>Hard X-Ray Synchrotron Imaging Techniques. Other applications: Photoemission spectroscopy, Resonant and magnetic XRD, X-ray microscopy, Infrared synchrotron radiation, Inelastic X-ray scattering.</td>
<td>2h</td>
<td>2h</td>
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<tr>
<td>11. Frequentist data analysis</td>
<td>Data and errors: an statistical view. An overview on classical fitting methods. Statistical distributions. Hypothesis testing in classical statistics.</td>
<td>2h</td>
<td>2h</td>
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<tr>
<td>12. Bayesian data analysis</td>
<td>Bayesian statistics: from numbers to Probability Distribution Functions (PDF). Bayes theorem and measurement: where are the PDFs hidden? Fitting functions using a Bayesian approach. Marcov Chain Montecarlo method to obtain Posterior PDFs. Model selection in Bayesian statistics.</td>
<td>4h</td>
<td>4h</td>
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**GRADING SYSTEM**

- Written exams: 40%
- Written assignments: 25%
- Project: 20%
- Laboratory practices: 15%
BIBLIOGRAPHY

Basic:

RESOURCES

Other resources:
- Course presentations (through the UPC Atenea digital campus)