Course guide
295924 - ESTAMHE - Emerging Science and Technologies for Advanced Materials, Health & Environment

Last modified: 24/06/2026

Unit in charge: Barcelona East School of Engineering
Teaching unit: 748 - FIS - Department of Physics.
713 - EQ - Department of Chemical Engineering.
702 - CEM - Department of Materials Science and Engineering.

Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2026 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: YOURI ALEXANDROVICH KOUBYCHINE MERKULOV

Others: Pere Bruna (Física 748)
Maria Pau Ginebra (Ciència i Enginyeria de Materials (CEM) 702)
Jordi Llorca (Enginyeria Química 713)

PRIOR SKILLS

- Basic general physics
- General background in instrumentation
- Basics of probability and data analysis
- Basics in programming

REQUIREMENTS

- Basic general physics
- General background in instrumentation
- Basics of probability and data analysis
- Basics in programming

TEACHING METHODOLOGY

- Theory classes
- Monographic seminars by invited speakers
- Solution of exercises (individual work)
- Practical works in laboratory,
- Project-based learning (work in small groups)

LEARNING OBJECTIVES OF THE SUBJECT

- Learn main principles of operation of particle accelerators and main engineering aspects.
- Get acquainted with main applications of electron beams in medicine, materials science, chemistry and industry.
- Get acquainted with particle accelerators, specifically synchrotrons, used for various fields of research.
- Learn main experimental technics used at synchrotron radiation beamlines.
- Learn techniques of analysis of experimental data in materials science and chemistry.

STUDY LOAD

Type	Hours	Percentage
Hours large group	60,0	100.00

Total learning time: 60 h

CONTENTS

1. Particle accelerators

Description:
1.1 Introduction to particle accelerators
1.2 Physical principles of operation and engineering aspects
1.3 Large facilities: ALBA synchrotron and CERN collider
1.4 Review of accelerators research and industrial applications

Related activities:
Theory classes
Solution of exercises
Activity 1. Design of an electron storage ring (analytically or with AT MATLAB)
Activity 2. Practical work at the ALBA synchrotron

Full-or-part-time: 37h 30m
Theory classes: 23h 30m
Guided activities: 8h
Self study : 6h

2. Synchrotron radiation

Description:
2.1 Fundamental concepts of synchrotron radiation
2.2 The Nature of Light: Methods of generation
2.3 Experimental techniques in chemistry and materials science
2.4 Discovery of new materials

Related activities:
Theory classes
Solution of exercises
Activity 3. Laboratory practice X-ray photoelectron spectroscopy (XPS)
Activity 4. Processing data of an experiment with synchrotron radiation

Full-or-part-time: 34h 30m
Theory classes: 15h
Guided activities: 8h
Self study : 11h 30m

3. Applications of electron beams

Description:
3.1 Electron-matter interactions
3.2 Electron beams for discovery of new materials
3.3 Green industry: sterilization, industrial radiography, flue gas cleaning
3.4 Medical applications: radiation therapy and nuclear medicine

Related activities:
Theory classes
Solution of exercises
Activity 5. Presentation of an article

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

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

Individual assignments: 30%
Laboratory practices: 30%
Projects: 25%
Seminar given by student: 15%

BIBLIOGRAPHY

Basic:
- Chao, Alex; Chou, Weiren. Reviews of accelerator science and technology. Singapore: World Scientific, 2008-2009. ISBN 9789814299343.
- Rossbach, J.; Schmüser, P. "Basic course on accelerator optics". CERN Accelerating science [on line]. CERN, 2005. Available on: https://cds.cern.ch/record/247501?ln=ca.- Chastain, Jill, King, Jr. Roger. Handbook of X-ray photoelectron spectroscopy [on line]. Minnesota, US: Physical Electronics, Inc., 1995Available on: https://mmrc.caltech.edu/XPS%20Info/XPS%201995%20Phi.pdf. ISBN 096481241X.
- Bayguinov, P.O.; Fisher, Max R.; Fitzpatrick, James A. J. "Assaying three-dimensional cellular architecture using X-ray tomographic and correlated imaging approaches". Journal of Biological Chemistry [on line]. 2020, vol. 295, núm. 46, p. 15782-15793 [Consultation: 17/09/2026]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/science/article/pii/S0021925817504044.

RESOURCES

Other resources:
Course presentations (at the UPC Atenea digital campus)
Manual of the practical works (at the UPC Atenea digital campus)
Bruce Ravel's XAS Education Materials at https://bruceravel.github.io/XAS-Education/ />