EEBE

Interdisciplinary course proposal

Title:

"Emerging Science and Technologies for advanced materials, health & environment"

Teaching staff:

Coordinator: Youri Koubychine (Física 748)

- 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

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

- 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
Large group	60	37,5 %
Small groups	30	18,75 %
Self study	70	43,75 %

Total learning time: 160h

Syllabus

1. Particle accelerators (18h)
    - 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

2 Synchrotron radiation (15h)
- 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

3 Applications of electron beams (12h)
- 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

4 Practical and laboratory work (15h)
- 4.1 Design of an electron storage ring (analytically or with AT MATLAB)
- 4.2 Field experience: laboratory sessions at ALBA (accelerator systems)
- 4.3 Laboratory sessions at UPC (X-ray photoelectron spectroscopy)
- 4.4 Data Science: Processing real experimental data from synchrotron beamlines

Qualification system

Assessment of individual works (20 %)
Assessment of laboratory practical works (30 %)
Assessment of seminar given by student (10 %)
Final exam (40%)

Regulations of works and activities

- The final exam includes multiple choice tests and short exercises.
- The course activities are carried out individually or in small groups either during teaching hours or outside them.
- Solution of home exercises is an individual work, students deliver solution reports.
- Projects are carried out in small groups following the project description. Once the project is finished the groups deliver reports with obtained results.
- Practical or laboratory works are done in small groups following a practice manual. At the end of each work students deliver a report with results.
- Reviewing research papers (work in small groups) proposed by the professors. Each group will make a presentation in class.

Bibliography

Basic:

- Wiedemann, Helmut. Particle Accelerator Physics. Springer-Verlag, 2007.
- J. Rossbach, P. Schmüser, "Basic course on accelerator optics". CAS 2005, pp. 17-88

Other resources: