60040 - Radiation detection systems

Información del Plan Docente

Academic Year	2016/17
Academic center	100 - Facultad de Ciencias
Degree	538 - Master's in Physics and Physical Technologies
ECTS	5.0
Course	1
Period	Second semester
Subject Type	Optional
Module	---

1.Basic info

1.1.Recommendations to take this course

In this course, students are introduced to radiation detection techniques. It will emphasize on the principles of operation and basic characteristics of the various radiation detectors and on a detailed description of electronics and pulse processing. It will also review the most important applications in industry, medicine and particle physics. The course does not require following any special curricular path. Nevertheless, it is advised to have a degree in physics or engineering or, at least, some elementary background in radiation properties and electronics. Other courses of the Master complementary to the present one are "Intelligent Instrumentation" (first semester) and "Técnicas de Imagen y Radiofísica" (second semester).

1.2.Activities and key dates for the course

Classes will start and finish in the date indicated by the Faculty of Sciences.

- Lectures: 4 sessions / week. Dates to be decided.
- Lab classes: They will be announced by the professor at the beginning of the course.
- Evaluation sessions: To be decided.

2.Initiation

2.1.Learning outcomes that define the subject

The student will show the following results:

- The student is capable of describing the energy spectra of different radiation sources and distinguish their different signals.
- The student is able to identify the most suitable detector for each kind of radiation and energy.
- The student knows the basic physics underlying the process from the particle energy deposition (heat, light, charge) to the production of electrical pulses.
- The student is able to understand the effect of radiation and electronic noise on devices and electronic circuits.
- The student is able to analyse electronic analog circuits for signal processing.
- The student is able to configure an ionizing radiation detection system.
- The student is able to estimate the effect of radiation in semiconductor devices.
- The student is able to use in the laboratory different detection systems and interpret their results.

2.2.Introduction

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Some of the basic tasks of the daily routine of a scientist are learning new techniques, planning of an experiment, setting-up and troubleshooting the measuring system, calibrating the apparatus, data taking, analysing the results and maintaining their equipment. This course will provide the students with a better understanding of experimental problems encountered in a scientific laboratory. It includes basic, rigorous and practical information about detectors, detection techniques and associated electronics.

3.Context and competences

3.1.Goals

The course can be recommended to any student who is interested in learning experimental physics procedure. They will learn the physics and electronics needed to understand the functioning and operation of the principal types of radiation detectors and to allow them to design, set-up and carry out real experiments in a scientific laboratory. They will also learn the characteristics of the pulse signals from the detector and the signal processing techniques that can be implemented. They will see the most relevant detection techniques at the forefront of modern radiation detection systems.

3.2.Context and meaning of the subject in the degree

The present course, together with the courses on "Intelligent Instrumentation" and "Técnicas de Imagen Radiofísica", constitutes a thorough formation on experimental techniques very useful for future researchers not only in the field of radiation detection but in other domains of physics and engineering.

3.3.Competences

- Consolidation of basic skills and interrelationship between the various fields of physics and physical technologies (CE3).
- Integrate knowledge, handle complexity, and formulate judgments with limited information, in the area of physics and physical technologies (CE4).
- Deepen in the analysis, processing and interpretation of experimental data (CE5).
- Know the level of importance of the research and the industrial applications of physics and physical technologies, as well as their social, economic and legal impact (CE6).
- Understanding of radiation sources.
- Understanding of physical principles r elated with the radiation detection, types of radiation detectors and their field of application.
- Understanding of the components of the detectors and electronics used for pulse signal processing.
- Understanding of mathematical methods for signal processing.
- Analysis, design and experimental characterization of electronic circuits used in radiation detection systems.
- Understanding of the effect of radiation and noise on devices and electronic circuits.

3.4.Importance of learning outcomes

This course will enable the student to design, planify, set-up and carry out experiments in a scientific laboratory. It will provide the student with a basic but solid formation on radiation detection and electronics that should allow him/her in the future to learn, implement and use efficiently new detection techniques in a laboratory of a university, research center, industry, hospital, etc. In summary, it will reinforce his/her experimental skills.

4.Evaluation

A continued evaluation, solving problems and questions during the classes, will take into account the personal work of the students throughout the course. A 50% of the final mark will be derived from it.

The course will also comprise several practical sessions with elaboration of written reports. A 50% of the final mark will

reflect their laboratory work and their corresponding written reports.

Unique global proof:

The course has been designed for students who are able to attend the lectures on site. However, there will also be an evaluation test for those students who are either unable to attend these lectures or who fail in their first evaluation.

This global evaluation will be done in official calls during the examination periods established by the Science Faculty of the University of Zaragoza. The global examination will consist on two parts:

1. One part will contain problems and questions related with the main concepts discussed in the course. The student will be given 90 minutes to solve this part. It will be evaluated from 0 to 10 and the result will count as 50 % of the final mark.
2. A practical exercise in which the student will be asked to describe the elements and configuration of an experimental set-up used in the course and will then be asked to mount the set-up in the laboratory. Allocated time: 90 minutes. It will be evaluated from 0 to 10 and the result will count as 50 % of the final mark.

"Matrícula de Honor" calification: The "Honor Registration" (Matrícula de Honor), will be given to students with a final mark equal to or greater than 9. In the case that there were more students with this mark than the number of "Honor Registration" allowed by the University of Zaragoza for a subject in a single academic course, the "Honor Registration" will be awarded to the students with best final mark up to the allowed number of students.

5.Activities and resources

5.1.General methodological presentation

This course is organized by combining theoretical and practical lessons. In order to achieve the intended goals the strategy chosen by the teaching staff consists of using lectures for presenting to the students the basic knowledge required to face the problem solving and laboratory work. Interactive problem resolution classes and laboratory sessions will be conveniently intertwined.

The course is organized in three training activities: theoretical lectures (3 ECTS); interactive problem resolution clasess (1 ECTS) and laboratory work (1 ECTS).

5.2.Learning activities

1. Lecture classes on the main topics of the subject.
2. Interactive problem resolution classes.
3. Laboratory work. The student will conduct experiments and prepare reports with the obtained results.

5.3.Program

1. Radiation sources and interactions.
2. Physics foundations and general properties of radiation detectors.
3. Gas-filled, scintillation, semiconductor, bolometric and hybrid detectors.
4. Radiation spectroscopy.
5. Applications of detector systems.
6. Analog signal processing.
7. Pulse processing and shaping: basic components.
8. Noise and electronic devices.
9. Amplifiers and equivalent input noise generators.
10. Radiation effects on electronic circuits.
11. Detection and measurement systems.

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5.4.Planning and scheduling

Final calendar has to be set. It will be announced well in advance.

5.5.Bibliography and recomended resources