UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Radiation Detectors

2627-1-F1703Q048

Aims

Throughout the course, students will learn about some of the most common detection techniques for charged particles, neutrons, and low-energy photons (up to 20 MeV), which are used in various fields of experimental and applied physics. They will apply what they learn in class through 20 hours of laboratory work with the tutor (2 CFU).

Contents

Recalls on radiation-matter interactions, radioactivity, basic principles of gas and semiconductor detectors as well as scintillators. General properties of ionizing radiation detectors. Neutron interactions with matter and their detection. Alpha, beta and gamma spectroscopy. Signal shaping and processing. Background problems and detector shieldings

Detailed program

Brief recall of radiation interaction with matter and of radiation sources.

Counting statistics and error propagation. Optimization of counting experiments, limits of detectability and distribution of time intervals.

General properties of radiation detectors: spectra, counting curves and plateau; efficiency; energy, time and position resolution; dead time.

Gas detectors: ionization chambers, proportional counters, Geiger counters.

Scintillators: general approach of detection with scintillators, general characteristics of inorganic, organic, plastic scintillators. Photodiodes and photocells, photomultipliers.

General considerations on gamma radiation spectroscopy with scintillators. Response functions.

Semiconductor detectors: Ge, Si and other solid state detectors.

Bolometers.

Neutron interaction with matter and their detection.

Signal shaping and processing: device impedances, coaxial cables, shaping

Nuclear Electronics devices: basic units for signal shape processing, counting, timing studies.

Multichannel pulse analysis.

Background problems and detector shielding

Prerequisites

All the Physics topics encountered during the Undergraduate Physics Classes, in particular Electromagnetism, in vacuum and in matter, Special Relativity, Structure of Matter and Introduction to Nuclear Physics.

Teaching form

If deemed necessary, the course will be taught in English.
However, individual instructors can decide in any case to teach some classes in English.

Coursework consisting of lectures and laboratory sessions:

- 18 1.5-hour lectures conducted in a face-to-face lecture format (DE), equivalent to 4 CFU
- 5 4-hour laboratory sessions using nuclear electronics equipment, conducted in an interactive face-to-face format (DI), equivalent to 2 CFU

Textbook and teaching resource

G.F. Knoll, "Radiation Detection and Measurement", 4th ed., Wiley & Sons
W.R. Leo, "Techniques for Nuclear and Particle Physics Experiments", 2nd revised ed., Springer & Verlag

Slides of the lessons are available online.

Semester

First semester

Assessment method

Oral examination using open questions on the topics covered in class. There are no tests during the course

Starting from a very general and broad question the student is required to answer in a complete way with a clear and well organized exposition. This part allows to assess the candidate's ability to present complex topics in a clear way and her/his analysis and synthesis skills, together with a correct scientific language. During the speech, details will be asked.

The following skills will be tested:

- The ability to present the knowledge acquired in an organic and clear way, also to an audience of university students not yet trained in the subject,
- The ability to relate the concepts acquired to the various topics covered during the course, demonstrating mastery of the subject and the use of correct scientific language.
- The ability to use the concepts learnt to propose approaches or strategies to solve experimental situations not specifically discussed in the lecture.

The colloquium lasts typically 1 hour

Erasmus students may take the exam in English if they prefer.

Office hours

The rendez-vous must be agreed in advance with a phone call or by email

Sustainable Development Goals

QUALITY EDUCATION | INDUSTRY, INNOVATION AND INFRASTRUCTURE