

## SUBJECT TEACHING GUIDE

### G75 - Radiophysics

#### Double Degree in Physics and Mathematics

#### Degree in Physics

Academic year 2023-2024

1. IDENTIFYING DATA					
Degree	Double Degree in Physics and Mathematics Degree in Physics			Type and Year	Optional. Year 5 Optional. Year 4
Faculty	Faculty of Sciences				
Discipline	Subject Area: Radiophysics Mention in Applied Physics				
Course unit title and code	G75 - Radiophysics				
Number of ECTS credits allocated	6	Term	Semester based (1)		
Web	<a href="https://moodle.unican.es/course/view.php?id=7840">https://moodle.unican.es/course/view.php?id=7840</a>				
Language of instruction	Spanish	English Friendly	Yes	Mode of delivery	Face-to-face

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### 3.1 LEARNING OUTCOMES

- Understanding the impact of ionizing radiation in areas such as Medicine or Environment.

- How to handle the relevant statistical parameters when studying a radioactive process.

- Natural and artificial sources of radiation.

- Knowledge of the principles of the simplest radiation detectors.

- Estimation of the pertinent radiological protection measures.

- Understanding the forms of clinical use of radiation.

- Knowledge of the uses of radioactivity in environmental measurements.

### 4. OBJECTIVES

Knowledge of the statistical methods to analyze the radioactivity measurements.

Practical knowledge of the Minimum Detectable Activity, MDA.

Natural radioactive chains and secular equilibrium. Origin of the different radiation sources (cosmogenic and anthropogenic) of interest in the evaluation of environmental radiation.

Knowledge of the main aspects of the interaction of ionizing radiation and neutrons with matter.

Knowledge of the fundamental aspects of the interaction of radiation with living organisms and their influence in the formation of radiological images.

Knowledge of the properties of the following detectors: Ionization chamber, Geiger, scintillators and solid state semiconductor detectors.

Knowledge of the concept of Absolute Efficiency of a Detector.

Knowledge of the magnitudes and units used in radioactive dosimetry and radiological protection.

Legal regulations of the Radiological Protection.

Radiological protection rules to be applied in diagnosis and therapeutic processes which involve ionizing radiations.

Analysis of the risk/benefit, from a dosimetric point of view, of diagnosis and therapy processes that use ionizing radiations.

Physical bases and main instruments and methods for the clinical use of ionizing radiations in diagnosis and therapy.

Radiation measurements as a tool in environmental evaluations (paleoclimate, drift and sedimentation, radon in the environment, geochronology).

6. COURSE ORGANIZATION	
CONTENTS	
1	Unstable nuclei and radioactivity. The origin of radioactive nuclei. Environmental radioactivity. Radioactive chains. Cosmic rays. Applications: Geochronology, Chronological dating, Sedimentation rate, Paleoclimatology. Fundamental law of radioactive decay and secular equilibrium. Radioactive decay and secular equilibrium. Neutron activation. Radon in the environment. Radioactive decay and secular equilibrium. Neutron activation.
2	Statistical methods applied to radioactivity measurements. Binomial, Poisson and Gauss distributions. Mean and variance. Minimum detectable activity, MDA.
3	Interaction of radiation with matter. Stopping power and range for heavy charged particles. Range and bremsstrahlung radiation associated with beta radiation. Mass absorption coefficient for beta particles.
3.1	Alpha and beta particles attenuation across a material.
3.2	Interactions of photons with matter: Photoelectric, Compton and pair production effects. Total linear and mass absorption coefficient. Interactions of neutrons with matter.
4	Radiation detectors. Gas ionizing detectors: Ionization chamber, proportional counter and Geiger-Müller detectors. Dead time. Efficiency.
4.1	Scintillator detectors: Efficiency and resolution. Semiconductor detectors: n-p unions, depleted region. High purity Germanium detectors: Resolution and efficiency. Neutron detectors.
5	Dosimetry with a gamma semiconductor or NaI detector. Calibration, efficiency, resolution of a scintillator detector. Neutron flux, activation of In foils, NaI scintillator detector. Alpha particle attenuation with a americium or uranium source.
6	Medical diagnosis using non ionizing radiations: Echography, ultrasound scan. Magnetic Nuclear Resonance imaging.
7	Radiological magnitudes and units. Activity. Exposure. Absorbed Dose. Equivalent Dose. Effective Dose. Dosimetric magnitudes for the personal safeguard. Relevant magnitudes applied to the patient's safeguard.
8	Biological effects of the ionizing radiations. Cell and organ responses to the ionizing radiation.
8.1	Use of radioactivity in healthcare facilities. Radioactive substances without encapsulation. Radiodiagnosis and Radiotherapy
9	Radiological Protection. Basic principles: Distance, time, shielding. Technical Units and Hospital Services for Radiological Protection. Radiological protection in the Spanish law.
10	Radiological Protection in healthcare facilities for radiodiagnosis, radiotherapy and nuclear medicine. Radiological protection of the patients and of the staff.
10.1	The organigram in a "Radiophysics and Radiological Protection Service" at a Hospital.
10.2	Calculation of shielding parameters.
11	Guarantee of the quality in medical facilities that use ionizing radiation.
12	Quality control in healthcare facilities that use ionizing radiations. Calibration and cross contrast of detectors.
12.1	Practical examples of the quality control in medical facilities where ionizing radiations are in use.
13	Radiation dose to the patients in nuclear medicine, radiotherapy and radiodiagnosis procedures.
13.1	Practical examples of the determination of dose rate on patients.
13.2	Methodology for the determination of the presence of radiation and radioactive contamination in healthcare facilities.

## 7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Final exam. It includes a retake of the Partial Exams of the first part of the subject and Test questions about the second part of the subject (including both questions about theory and practical work)	Others	Yes	Yes	50,00
Partial Exam for the evaluation of Chapters 1 to 3	Written exam	No	Yes	15,00
Partial Examination of the Chapters 4 and 5 of the first part: Questions and Problems.	Written exam	No	Yes	15,00
Two written reports and one oral presentation about the three experiments of the first part of the subject.	Others	Yes	No	20,00
<b>TOTAL</b>				<b>100,00</b>

### Observations

Partial exams of questions and problems of Chapters 1-5 (first half, minimum mark of 3.5) can be recovered both in the Ordinary Final Exam (January/February) and in the Extraordinary (February) Exam. The exams corresponding to the second half, Chapters 6-13 and the corresponding practical work, will be divided in two parts (theory and exam about practical work). They will be test-like exams with questions with five possible answers and they will take place during the Ordinary Final Exam.

Two written reports about the experiments of the first part must be completed. One oral presentation of the third experiment must be performed (no report should be presented for this experiment).

Final Extraordinary Exam (February): Written exam with questions about both parts of the subject (60% of the mark). The mark of the laboratory work of the first half will be kept but the failed parts will be evaluated by a written exam. The exam regarding the practical work of the second half can be retaken as well.

### Observations for part-time students

The students must attend to six of the nine practical sessions proposed (eight laboratory and one classroom practical sessions), delivering the corresponding written reports. For each practical session in which the student does not participate, they should complete a report about a topic proposed by the professors. This part represents 40% of the final score.

The students must take the Final Ordinary Exam, obtaining a mark equal or above three over ten. This exam will represent 60% of the final score

## 8. BIBLIOGRAPHY AND TEACHING MATERIALS

### BASIC

Radiation detection and measurement  G. F. Knoll, Ed. Wiley, Second Edition (1989)