VNIVERSITAT DE VALÈNCIA

Course Guide
43303 Medical applications of nuclear and particle physics

COURSE DATA

Data Subject	
Code	43303
Name	Medical applications of nuclear and particle physics
Cycle	Master's degree
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
2150 - M.D. in Advanced Physics	Faculty of Physics	1	First term

Subject-matter

Degree	Subject-matter	Character
2150 - M.D. in Advanced Physics	4 - Nuclear and particle physics	Optional

Coordination

Name	Department
ZUÑIGA ROMAN, JUAN	180 - Atomic, Molecular and Nuclear Physics

SUMMARY

The subject of Medical Applications of Nuclear and Particle Physics focuses on the applications of nuclear and particle physics to medicine (such as medical diagnosis by imaging), and on the biomedical sciences. One goal is to provide fundamental knowledge about the physics underlying these imaging techniques based on the detection of ionizing radiation (such as computed tomography (CT), single photon emission computed tomography (SPECT) and positron emission tomography (PET). The course also includes a detailed study of the functioning of the main detectors used in different types of imaging modalities. The student will become familiar with those detector parameters that influence the scanner efficiency and therefore the quality of the final image. Apart from that, other new techniques and detectors under investigation or development will be introduced. This course includes the study of those physical phenomena that influence the quality of the reconstructed image. addressing the subject to be completed fundamentals the methods used in the tomographic image reconstruction and quantitative analysis. 2 ECTS of the course includes laboratory sessions to facilitate the understanding of concepts studied and their implementation. These sessions include, among other activities, detectors operation, selection and data processing, image reconstruction and quantification.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

OUTCOMES

2150 - M.D. in Advanced Physics

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Students should communicate conclusions and underlying knowledge clearly and unambiguously to both specialized and non-specialized audiences.
- Students should demonstrate self-directed learning skills for continued academic growth.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Ser capaz de gestionar información de distintas fuentes bibliográficas especializadas utilizando principalmente bases de datos y publicaciones internacionales en lengua inglesa.
- Saber organizarse para planificar y desarrollar el trabajo dentro de un equipo con eficacia y eficiencia.
- Ostentar la preparación para tomar decisiones correctas en la elección de tareas y en su ordenación temporal en su labor investigadora y/o profesional.
- Poseer la capacidad para el desarrollo de una aptitud crítica ante el aprendizaje que le lleve a plantearse nuevos problemas desde perspectivas no convencionales.
- Estar en disposición para seguir los estudios de doctorado y la realización de un proyecto de tesis doctoral.
- Comprender de una forma sistemática el campo de estudio de la Física y el dominio de las habilidades y métodos de investigación relacionados con dicho campo.

- Concebir, diseñar, poner en práctica y adoptar un proceso sustancial de investigación con seriedad académica.
- Realizar un análisis crítico, evaluación y síntesis de ideas nuevas y complejas en el área de la Física.
- Analizar una situación compleja extrayendo cuales son las cantidades físicas relevantes y ser capaz de reducirla a un modelo parametrizado.
- Evaluar la validez de un modelo o teoría propuesto por otros miembros de la comunidad científica.
- Saber modelizar matemáticamente los problemas físicos sencillos nuevos, conectados con problemas conocidos. Ser capaz de expresar en términos matemáticos nuevas ideas.
- Elaborar una memoria clara y concisa de los resultados de su trabajo y de las conclusiones obtenidas en el área de la Física.
- Exponer y defender públicamente el desarrollo, resultados y conclusiones de su trabajo en el área de la Física.
- Conocer los procesos más importantes de la interacción de la radiación con la materia, las técnicas de detección de la radiación, el funcionamiento de los detectores y la instrumentación utilizada actualmente en los experimentos de Física Nuclear y de Partículas.
- To know the main applications of nanoparticles and nanostructured materials obtained or functionalised using a molecular approach- in magnetism, molecular electronics and biomedicine.

LEARNING OUTCOMES

At the end of the teaching-learning process the student will have learned to:

1. Knowing the processes, techniques, sensors and measuring instruments in the field of Nuclear and Particle Physics.
2. Learning to design, simulate and perform an experiment.
3. Fluently use of computer applications and equipment for processing and analyzing data and for the presentation of results and reports.
4. Knowing the main applications of Nuclear and Particle Physics and be able to sense new applications.
5. Knowing the type of accelerator required for a given experiment or application.
6. Know the major systems and medical imaging techniques and their applications.
7. Learning the detailed operation of radiation detectors used for diagnosis and therapy.
8. Applying acquired knowledge to different case studies.
9. Understanding the complete process of obtaining the image from the radiation detection to display and the effect of the underlying physical phenomena.

DESCRIPTION OF CONTENTS

1. Introduction

a. Introduction to the subject.
b. Physics in medicine.
c. Applications of nuclear and particle physics to medicine.
d. Basic concepts in medical imaging.

2. Medical physics detectors and readout electronics

a. Scintillator crystals;
b. Photodetectors;
c. Gas detectors;

3. Imaging systems for ionizing radiation

a. Detection Systems for X-rays (radiography and CT).
b. Gamma cameras and single-photon emission CT (SPECT) scanners.
c. Positron emission tomography (PET) scanners.

4. Tomographic imaging

a. Transmission tomography (CT) and positron emission tomography (SPECT and PET).
b. Magnetic resonance imaging and multimodality.
c. Image degradation phenomena: Physical principles

5. Image Reconstruction

a. Data processing and format. Basic concepts of digital image
b. Image Reconstruction: Analytical methods
c. Image Reconstruction: Iterative methods (algebraic and statistical methods)
d. Compensation for image degradation phenomena
e. Image quality, evaluation and analysis-

6. Therapy based on ionizing radiation

a. Radiotherapye and brachytherapy
b. Hadron therapy

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Laboratory practices	12,00	100
Other activities	4,00	100
Seminars	3,00	100
Preparing lectures	40,00	0
Preparation of practical classes and problem	61,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

English version is not available

EVALUATION

English version is not available

REFERENCES

Basic

- Physics in Nuclear Medicine. S. R. Cherry. J.A. Sorenson, M. E. Phelps. Ed. Saunders.
- Techniques for Nuclear and Particle Physics Experiments. W. R. Leo. Ed. Springer.
- Radiation Detection and Measurements. G. F. Knoll. Ed. Wiley.
- The essential physics of medical imaging. J. T. Bushberg, J. A. Seibert, E. M. Leidholdt, J. M. Boone. Ed.: Lipincott, Williams & Wilkins.

Additional

- Radiation Physics for Nuclear Medicine. Eds. M. C. Cantone, C. Hoeschen. Ed.: Springer
- Medical Imaging Physics. W. R. Hendee, E. R. Ritenour. Ed.: Wiley-Liss.
- Emission Tomography: The fundamentals of PET and SPECT. Editores: M. N. Wernick. J. N. Aarsvold. Ed.: Elsevier Academic Press.

- Positron Emission Tomography: Basic Sciences. Editores: D. L. Bailey, D. W. Townsend. P. E. Valk. M. N. Maisey. Ed.: Springer.
- Medical Imaging: Signal and Systems. J. L. Prince, J. M. Links. Ed.: Pearson Prentice Hall