COURSE DATA

Data Subject	
Code	43071
Name	Interaction of radiation with matter
Cycle	Master's degree
ECTS Credits	4.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
2140 - Master's Degree in Medical Physics	Faculty of Physics	1	First term

Subject-matter

Degree	Subject-matter	Character
2140 - Master's Degree in Medical Physics	1 - The physics of radiation	Obligatory

Coordination

Name	Department
VIJANDE ASENJO, JAVIER	180 - Atomic, Molecular and Nuclear Physics

SUMMARY

This subject has as primary target to discuss the main properties of the interaction of those radiations of interest in medical physics with matter. These concepts will be one of the basic pillars that will allow us to quantify in the following subjects as diverse situations as the effect of radiation over live tissue or the possibility of detecting those radiations. This subject in divided into three main blocks according to the type of ionizing radiation considered, photons, charged particles and neutrons.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

No existen requisitios previos

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

2140 - Master's Degree in Medical 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.
- Be able to access the information required (databases, scientific articles, etc.) and to interpret and use it sensibly.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Know how to write and prepare presentations to present and defend them later.
- Be able to access to information tools in other areas of knowledge and use them properly.
- To prepare a clear and concise memory of the results of your work and the conclusions obtained.
- Use the different exhibition techniques oral, written, presentations, panels, etc., to communicate the knowledge, proposals and positions.
- Project the knowledge on specific problems and know how to summarize and extract the most relevant arguments and conclusions for their resolution.
- To acquire a critical attitude that allows you to make reasoned judgments and defend them with rigor and tolerance.
- Critically analyze both his/her work and that of the colleagues.
- Acceder a herramientas en el área de Física que puedan ser susceptibles de aplicación a la Medicina y valorar su aplicabilidad e interés.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

When finalizing the education-learning process the student should be able to:

- To know the main characteristics of the interaction of the radiation with matter.
- To be able to handle scientific computing tools to quantify such interaction

DESCRIPTION OF CONTENTS

1. Exponential Attenuation

(a) Simple exponential attenuation.
(b) Half-value layer, tenth-value layer, attenuation coefficients, interaction cross sections.
(c) Narrow vs. broad beam attenuation.
(d) Buildup factor.
(e) Spectral effects in attenuation, beam hardening and softening.
(f) Reciprocity theorem.
(g) Energy transfer coefficient, energy absorption coefficient.

2. Photon Interactions with Matter

(a) Thomson scattering
(b) Rayleigh scattering
(c) Photoelectric effect
(d) Compton scattering
(e) Pair production, triplet production
(f) Photonuclear reactions
(g) Relative predominance of individual effects as a function of energy and atomic number
(h) Fluorescence yield and Auger effect

3. Interactions of charged particles with Matter

(a) Stopping power (collisional and radiative), range, straggling.
(b) Restricted stopping power, LET (linear energy transfer).
(c) Orbital electron interactions
(d) Nuclear interactions
(e) Energy distribution of electrons in matter (charged particle spectrum)

4. Neutron Interactions with Matter

(a) Neutron types by kinetic energy
(b) Neutron sources
(c) Neutron beam specifications
(d) Neutron interactions including scatter, absorption kinematics, and cross sections
(e) Neutron quality factor

5. Computing lab: Basic Monte Carlo techniques. Penelope

(a) Basic Monte Carlo techniques.
(b) Applications: Penelope

6. Computing lab: Interaction of photons with matter.

(a) Xmudat code: Cross-section databases.
(b) Using Penelope for simulating the interaction of photons with matter.

7. Computing lab: Interaction of charged particles with matter.

(a) Calculating the stopping power in a medium for incoming heavy charged particles.
(b) Range and Bragg curve.
(c) Calculating the stopping power in a medium for incoming electrons and/or positrons.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	24,00	100
Laboratory practices	16,00	100
Attendance at events and external activities	0,00	0
Development of group work	4,00	0
Development of individual work	4,00	0
Study and independent work	20,00	0
Readings supplementary material	5,00	0
Preparation of evaluation activities	7,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	5,00	0
Resolution of online questionnaires	5,00	0
TOTAL	**100,00**	

TEACHING METHODOLOGY

MD1 - Study material based on textbooks (ebook).
MD2 - Videoconferences to solve doubts about theory topics.
MD3 - A questionnaire with conceptual questions and numerical exercises will be proposed for each of the topics.
MD4 - Videoconferences to resolve doubts of the questionnaires and exercises.
MD5 - Practical laboratory classes. The students will present a small memory with the results of each practice.

EVALUATION

The evaluation will be made during the development of the subject. During the development of each topic, a questionnaire will be opened that the student will have to solve within a fixed period of time that ends one day after the subject has been closed.

Questionnaires	60
Calculation practice	40
Total	100

Those students who have not opted for the online evaluation or who have not passed it, may opt for an exam during the period enabled for this purpose, both in the first and in the second call.

REFERENCES

Basic

- P. Andreo, D. T. Burns, Alan E. Nahum, J. Seuntjens and Frank H. Attix, Fundamentals of Ionizing Radiation Dosimetry. John Wiley & Sons. 2017
- James E. Turner, Atoms, Radiation and Radiation Protection. Wiley-VCH. 2nd edition. 2004.
- Radiation Physics for Medical Physicists, Ervin B. Podgorsak, Springer Verlarg 2017

Additional

- Brian J. McParland, Nuclear Medicine Radiation Dosimetry, Springer, 2011