COURSE DATA

DATA SUBJECT

Code: 43071
Name: Interaction of radiation with matter
Cycle: Master's Degree
ECTS Credits: 4
Academic year: 2026-27

STUDY (S)

Degree	Center	Acad. year	Period
2140 - Master's Degree in Medical Physics	Facultat de Física	1	First quarter

SUBJECT-MATTER

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

COORDINATION

VIJANDE ASENJO JAVIER

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

COMPETENCES / LEARNING OUTCOMES

2140 - Master's Degree in Medical Physics

Acceder a herramientas en el área de Física que puedan ser susceptibles de aplicación a la Medicina y valorar su aplicabilidad e interés.

Be able to access the information required (databases, scientific articles, etc.) and to interpret and use it sensibly.

Be able to access to information tools in other areas of knowledge and use them properly.

Critically analyze both his/her work and that of the colleagues.

Know how to write and prepare presentations to present and defend them later.

Project the knowledge on specific problems and know how to summarize and extract the most relevant arguments and conclusions for their resolution.

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.

To acquire a critical attitude that allows you to make reasoned judgments and defend them with rigor and tolerance.

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.

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

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	24,00
Laboratory	16,00
Total hours	**40,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	8,00
Independent study and work	25,00
Preparation of lessons	15,00
Preparation for assessment activities	12,00
Resolution of case studies	0,00
Total hours	**60,00**

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

Assessment will take place throughout the course. Written tests will be conducted in-person and/or online. To this end, questionnaires will be opened for each topic during the course, which students must complete within a set time frame. The weighting of the different assessment components in both examination periods will be:

¿ Written tests carried out throughout the course: 70%

¿ Written tests on the advanced seminars delivered: 10%

¿ Reports on the contents developed during the course¿s practical sessions: 20%

Attendance at in-person practical sessions is mandatory in order to pass the course in both the first and second calls, and the minimum passing grade is 5 out of 10.

Students who do not achieve a minimum grade of 5 out of 10 in the written tests carried out throughout the course must take an exam during the official examination period, in both the first and second calls.

Evidence of copying or plagiarism will result in failure to pass the subject and in appropriate disciplinary action being taken. Please note that, in accordance with article 13. d) of the Statute of the University Student (RD 1791/2010, of 30 December), it is the duty of students to refrain from using or participating in dishonest means in assessment tests, assignments or university official documents.

In the event of fraudulent practices, the ¿**Action Protocol for fraudulent practices at the University of Valencia**¿ will be applied (ACGUV 123/2020):

https://www.uv.es/sgeneral/Protocols/C83sp.pdf

REFERENCES

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

- Radiation Physics for Medical Physicists, Ervin B. Podgorsak, Springer Verlarg 2017