COURSE DATA

DATA SUBJECT

Code: 46810
Name: Introducción a la física nuclear y a la radiactividad
Cycle: Master's Degree
ECTS Credits: 3
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
2273 - Master¿s Degree in Environmental Radiation Protection	Facultat de Física	1	Annual

SUBJECT-MATTER

Degree	Subject-matter	Character
2273 - Master¿s Degree in Environmental Radiation Protection	Introducción a la física nuclear y a la radiactividad	COMPULSORY

COORDINATION

YAHLALI HADDOU NADIA

SUMMARY

The course "Introduction to Nuclear Physics and Radioactivity" provides an in-depth understanding of the fundamental principles of radioactivity and nuclear energy. Students will explore the constituents and properties of nuclei, as well as the nature of the nuclear forces acting on them. They will become familiar with the different types of radioactive decays and learn to apply the laws governing their time evolution, calculating activity and understanding the radiation emitted.

In addition, the radioactive decay patterns of radionuclides and their energy spectra will be studied. The main mechanisms of interaction of radiation with matter will be analysed, together with their general applications. Students will also acquire knowledge of the units and magnitudes used in radioactivity and radiation protection.

The course will address the origin of sources of environmental radioactivity, both natural and artificial, and the associated environmental problems. Criteria for the control and monitoring of radioactivity in the environment will be taught, as well as the environmental impact of nuclear energy production facilities and the fuel cycle.

Finally, atomic and nuclear structure models will be applied to explain the origin and nature of radiation,

justifying the production of nuclear energy. This course provides a solid foundation for those interested in nuclear physics, radiation protection and the nuclear energy industry. Therefore, this subject will help students to acquire the specific learning outcomes of the subject and the general learning outcomes of the syllabus of which it is part.

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 requirements have been established for this subject.

COMPETENCES / LEARNING OUTCOMES

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Be able to apply the appropriate scientific concepts and data processing tools in the diagnosis and solution of problems arising from environmental radioactivity.

Characterise and understand the different basic processes that act and regulate the distribution and fate of radionuclides in the water, soil and atmosphere.

Demonstrate knowledge and understanding of ionising radiations that provide a basis or opportunity to be original in developing or applying ideas, often in a research context in the field of environmental radioactivity.

Have basic skills in instrumentation methods and data processing techniques for determining relevant quantities for the analysis of problems arising from environmental radioactivity.

Have the learning skills that allow students to continue to study in a manner that may be largely self-directed or autonomous.

Identify, state and comprehensively analyse the problems arising from environmental radioactivity.

Identify and apply technologies, tools and techniques in the field of environmental radiation protection.

Integrate radiological protection into the environmental and sustainable development framework.

Know how to apply knowledge and problem-solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to the field of study.

Propose practical solutions, according to applicable environmental legislation, for suitable environmental management tools and assessment of environmental radiological risks.

DESCRIPTION OF CONTENTS

Basic Atomic and Nuclear Physics Elements

1. Introduction: Nomenclature and previous phenomenology.

2. Nuclear model of the atom. Atomic structure. Absorption and emission of energy by atoms. Atomic spectra.

3. Structure of the atomic nucleus. Nuclear forces. Atomic and mass numbers Isotopes Nuclear nomenclature

4. Mass-energy equivalence. Mass defect and binding energy.

Block 2. Radioactivity

5. Concept of radioactivity. Types of radioactive decay. Radiation α, ß and γ.

6. Law of radioactive decay. Activity of a radioactive source. Radioactive chains. Radioactive equilibrium. Bateman's laws

7. Sources of environmental radioactivity: natural and artificial. Natural radioactive series. Cosmic rays.

Radiation-matter interaction.

8. Interaction of radiation with matter.

9. Braking power. Bethe-Bloch formula.

10. Properties of ionisation. Bragg curve. Range and Straggling.

11. Interaction of neutral particles (RX, photons, neutrons) with matter. Photon attenuation and mass attenuation coefficient.

12. Magnitudes and units.

Block 4. Nuclear energy

13. Types of reactors.

14. Nuclear fuel cycle.

15. Environmental impact of nuclear energy.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	30,00
Total hours	**30,00**

NON PRESENCIAL ACTIVITIES

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

TEACHING METHODOLOGY

MD1	Participatory lecture
MD3	Problem solving and group discussion and practical exercises
MD4	Individual or group tutorials, with teacher-student interaction
MD5	Plaiming, carrying out, tutoring and presentation of assignments
MD6	Evaluations and exams

EVALUATION

4. Examination

Description: AF11 Assessment and self-assessment (synchronous virtual). Methodology: MD6 Assessments and exams. There will be a written exam, in which several problems and questions of direct application of the theory seen in the course will be posed. A minimum mark of 5.0 is required to pass the course.

Hours: 4

Evaluation criteria: SE1 Individual written tests of knowledge and resolution of exercises and practical cases. The basic criteria for correction will be the adequacy of the procedures applied in the resolution of the proposed problems, and the accuracy of the solution obtained. Learning outcomes CM1, CM2, and CM5 are assessed.

Monitoring of the distance assessment: Examination monitoring software.

At the time of enrolment, students agree to comply with the conditions established for exam invigilation.

Examination invigilation conditions

In order to ensure that the assessment tests are carried out with the maximum guarantees and with the minimum risk of fraud, students undertake to:

- Identify themselves by means of DNI, NIE, passport, university card or other reliable means.

- Accept the measures adopted by the teaching staff to avoid fraud in the assessment, such as limiting the use of electronic devices, books, notes and other available objects.

- - Comply with the regulations on academic fraud in the assessment process.

Specifically, in the case of the MPRA:

Install, at the beginning of the academic year, the software provided by the university for exam invigilation (Proctoring).

Have two cameras (one of which can be a mobile phone camera).

To ensure the quality of distance learning, the MPRA has an exam proctoring software for non-face-to-face assessments (Smowl).

This programme is integrated in the Digital Classroom of each subject and is used for all the assessments of this subject. Test records and results are recorded in the Digital Classroom, where they are stored for two years. Incident records and image capture during the tests are stored in the software platform for one year.

In order for the surveillance during the evaluations to work correctly, students, at the beginning of the academic year, must undertake to install on their computer the software provided for the surveillance of exams (Proctoring) and to have two cameras, as the operation of this software allows:

- The detection of impersonation by verifying the identity of students and biometric monitoring during the test.

• - -The detection of elements other than those necessary to carry out the assessment: books, other screens, information exchangers, active programmes, control of web browsing, use of copy-paste commands and virtual machines, by monitoring the computer.

- Detection of people other than the person being assessed by monitoring the environment using a second camera (which may be that of the mobile phone).

- Detection of audio and object disturbances, to ensure that students do not receive external assistance during the test; the microphone is activated each time it detects a noise that exceeds the defined threshold and, once activated, it records for 20 seconds and the recording is stored as an event.

- Automatic monitoring, which starts every time the user starts an online activity; the system records images every 60 seconds, in addition to the incidents detected during the whole test; the information is stored for one year on the company's servers and access to these images is restricted according to the company's security protocols.

- The availability of the incident report for the teaching staff after the test has been carried out.

- All the evaluations are carried out under the supervision of the subject's teaching staff; all the students, as well as the teaching staff, connect at the same time and carry out the test at the same time.

Assessment activities	Weight of the final grade	Recoverable (Yes/No)	Minimum mark*	Validation mark**

Individual written tests of knowledge and resolution of exercises and practical cases	50%	Yes	5,0	
Submission of reports and practical and problem-solving reports	20%	no	no	
Submission and defence of tutored works	30%	Yes	5,0	

* The minimum mark is the mark required for the assessment element to be considered in the average mark (with its corresponding weight). If it is not exceeded, it will be marked with 0 points. The student can pass the subject if the final grade is sufficient.

** The validation mark is the mark required for the assessment element to be considered in the average mark (with its corresponding weight). If it is not passed, it will be marked with 0 points. The student cannot pass the subject.

REFERENCES

Basic bibliography

1. Ionising radiation: use and risks. Volume I. Instituto de Técnicas Energéticas (INTE). Xavier Ortega Aramburu, ed., Jaume Jorba Bisbal, ed. Polytechnic University of Catalonia, Barcelona. 1996.
2. Antonio Ferrer Soria. Nuclear and particle physics. 3rd ed. Universitat de València. 2015.
3. Nuclear and particle physics: solved problems. María Shaw Martos, Amalia Williart Torres. 2013.
4. Kenneth S. Krane. Introductory Nuclear physics. John Wiley & Sons.
5. James E. Turner. Atoms, Radiation, and Radiation Protection. Wiley-VCH Verlag GmbH & Co. KGaA.

Supplementary bibliography

1. Detecting Environmental Radioactivity. Manuel García León. Springer. 2022.