COURSE DATA

DATA SUBJECT

Code: 43070
Name: Atomic and nuclear structure. Radioactivity
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

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CASES RUIZ MANUEL RAMON

SUMMARY

The course "Atomic and Nuclear Structure - Radioactivity" provides essential knowledge of Atomic and Nuclear Physics necessary to understand many current applications and devices used in Radiotherapy, Medical Physics, and Nuclear Medicine. Atomic Structure is closely related to the production of X-rays, the absorption of electromagnetic radiation in matter, the stopping power of charged particles, and many imaging techniques, particularly those based on nuclear magnetic resonance and the photoelectric effect, as well as the principles of numerous measuring instruments. Radioactivity is linked to brachytherapy and nuclear medicine and contains the fundamentals of radiological protection.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

A basic working knowledge of Atomic and Nuclear Physics is required

COMPETENCES / LEARNING OUTCOMES

2140 - Master's Degree in Medical Physics

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. The components of the atom

The electron. Millikan experiment.
Rutherford experiment. The atomic nucleus. Rutherford model of the atom.
Atomic spectroscopy. Rydberg formula.

Bohr model of the atom.
The proton.
The neutron.
Photons.
Wave-particle duality.
Isotopes. Isotope separation.
Atomic magnetism. Magnetic moments.
Spin. Stern-Gerlach experiment.

2. Atomic Structure

Quantum model of the atom.
Orbitals. Energy spectra.
Fine structure. Spin orbit interaction.
Two electron atoms.
Screening.
Complex atom spectra.
Periodical System and shell structure.
Ground atom states. Hund rules.

3. Nuclear Structure

Nuclear forces.
Mass and abundance of nuclides.
Nuclear binding energy.
The nuclear radius.
Nuclear electromagnetic moments.
Nuclear shapes.
Nuclear excited states.
Shell model.
Liquid drop model. Collective models.

4. Radiactive decay modes

Nuclear level diagrams. Alpha decay. Beta decay. Electronic capture (EC). Gamma emission. Annihilation radiation. Internal conversion. Auger electrons. Neutron sources. Radioactive products of nuclear fission.

5. Radioactive decay laws

Radioactive units. Activity. Specific activity.
The Radioactive Decay Law. Decay constant, half-life and mean lifetime.
Fluctuations in Radioactive Decay.
Multimodal decays. Partial decay constants.
Quantum theory of radioactive decays
Growth of daughter activities.
Serial radioactive decay. Bateman equations.
Radioisotope Production by Irradiation
Natural radioactivity. Natural series.
Radon decay.
Radioactive dating.

6. Laboratory experiments

"Measurement of the half-life of a short-lived radioisotope with a NaI(Tl) detector"

WORKLOAD

PRESENCIAL ACTIVITIES

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

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	2,00
Individual or group project	0,00
Independent study and work	18,00
Preparation of lessons	30,00
Preparation for assessment activities	10,00
Resolution of case studies	0,00
Total hours	**60,00**

TEACHING METHODOLOGY

MD1 – Theoretical lectures delivered and viewed online.
MD2 – Laboratory practical classes.
MD3 – Videoconferences for resolving questions about proposed problems.
MD4 – Videoconferences for solving calculation exercises.

EVALUATION

Written tests will be conducted both in-person and online. The weighting of the different assessment components in both examination periods will be:

- Written tests carried out throughout the course: 30%

- In-person written exam on the contents covered in the theoretical and practical classes: 50%

- Evaluation of written reports on assignments and practicals: 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. The assessment criteria will be the same for both examination periods. Additionally, the minimum grade required in the in-person written exam to average with the other components is 3.5 out of 10.

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

- James E. Turner, Atoms, radiation and radiation protection , Wiley-VDH, 3rd. edition, 2007.

- B. H. Bransden, C. J. Joachain, Physics of atoms and molecules, Prentice-Hall, 2th ed.

- K. S. Krane. Introductory Nuclear Physics. Wiley 1988.

- E. B. Podgorsak, Radiation Physics for Medical Physicists, Springer, 2006.
- Leo W.R., Techniques for Nuclear and Particle Physiscs Experiments, Springer Verlag (1987)