COURSE DATA

Data Subject	
Code	43070
Name	Atomic and nuclear structure. Radioactivity
Cycle	Master's degree
ECTS Credits	4.0
Academic year	2021 - 2022

Study (s)

Degree	Center	Acad. year	Period
2140 - M.D. in Medical Physics	Faculty of Physics	1	First term

Subject-matter

Degree	Subject-matter	Character
2140 - M.D. in Medical Physics	1 - The physics of radiation	Obligatory

Coordination

Name	Department
CASES RUIZ, MANUEL RAMON	180 - Atomic, Molecular and Nuclear Physics
VIJANDE ASENJO, JAVIER	180 - Atomic, Molecular and Nuclear Physics

SUMMARY

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La Estructura Atómica y Nuclear-Radiactividad proporciona los conocimientos esenciales de Física Atómica y Nuclear necesarios para comprender gran parte de aplicaciones y dispositivos utilizados actualmente en Radioterapia, Física Médica y Medicina Nuclear. La Estructura Atómica está íntimamente ligada con la producción de rayos X, la absorción de la radiación electromagnética en la materia, el poder de frenado de partículas cargadas, muchas técnicas de imagen, en particular las basadas en la resonancia magnética nuclear y el efecto fotoeléctrico y los fundamentos de muchos aparatos de medida. La Radiactividad está ligada con la braquiterapia y la medicina nuclear y contiene los fundamentos de la protección radiológica.

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

OUTCOMES

2140 - M.D. 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.

LEARNING OUTCOMES

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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

ACTIVITY	Hours	% To be attended
Theory classes	24,00	100
Laboratory practices	16,00	100
Attendance at events and external activities	2,00	0
Study and independent work	10,00	0
Readings supplementary material	8,00	0
Preparation of evaluation activities	10,00	0
Preparing lectures	15,00	0
Preparation of practical classes and problem	15,00	0
TOTAL	**100,00**	

TEACHING METHODOLOGY

English version is not available

EVALUATION

English version is not available

REFERENCES

Basic

- B. H. Bransden, C. J. Joachain, Physics of atoms and molecules, Prentice-Hall, 2th ed.
- K. S. Krane. Introductory Nuclear Physics. Wiley 1988.

Additional

- James E. Turner, Atoms, radiation and radiation protection , Wiley-VDH, 3rd. edition, 2007.
- E. B. Podgorsak, Radiation Physics for Medical Physicists, Springer, 2006.
- Leo W.R., Techniques for Nuclear and Particle Physiscs Experiments, Springer Verlag (1987)

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

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