## COURSE DETAILS

Title (of the course):	FÍSICA NUCLEAR Y DE PAR	RTÍCULAS	
Code: 100512			
Degree/Master:	GRADO DE FÍSICA		Year: 4
Name of the module	to which it belongs: ESTRUCT	URA DE LA MATERIA	
Field: NUCLEAR Y P.	ARTÍCULAS		
Character: OBLIGAT	ORIA	Duration: SECOND TERM	
ECTS Credits: 6.0		Classroom hours: 60	
Face-to-face classroo	m percentage: 40.0%	Study hours: 90	
Online platform: http	s://moodle.uco.es/moodlemap		

## LECTURER INFORMATION

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## PREREQUISITES AND RECOMMENDATIONS

#### Prerequisites established in the study plan

To have, at least, B1 Level in English.

#### **Recommendations**

-Math and numerical methods skills up to second course level. -Quantum Physics knowledge. -Previous enrollment in "Quantum Mechanics" & "Atomic and Molecular Physics" courses. -General and specific competences up to this level.

This is a course aimed for the final year of the Physics Degree and shares many of the competences with previous courses. This means that a certain level of math and physics knowledge and skills have been attained by the students. Our goal is to fix and improve this level.



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## INTENDED LEARNING OUTCOMES

CB1	the skills to analyse and summise
CB2	organisational skills
CB3	written and oral communication
CB4	Information management skills
CB5	Problem solving
CB8	Independent Study
CB9	Creativity.
CB11	Sensitivity towards enviromental issues
CE1	Knowledge and understanding of the most importante phenomenons and physics theory
CE2	Ability to estimate orders of magnitude for interpretting various phenomemons
CE5	The ability to model various phenomenons, changing them from a real problem, to a mathemtical language
CE7	Ability to present information in a clear way, both inside and out of the classroom.

### **OBJECTIVES**

-To know the ultimate constituents of matter, their interactions and the basic elements of the models developed for their study and know the order of the physical magnitudes involved in the processes between elementary particles (CB5, CB7).

-To know basic nuclear phenomenology and understand and handle some simple models developed for its description (CB7, CB11, CE1, CE2, CE3, CE5).

-To know the most important properties of the main nuclear decay processes (CB4, CE3).

-To know the principles, techniques and measurement instruments in the theoretical and/or experimental study of the structure of matter (CB2, CB3, CB8, CB9, CE2, CE4, CE7).

### CONTENT

#### **1. Theory contents**

Introduction to the Nuclear Physics.
Nuclear structure.
Shape factor of nuclear charge.
Nuclear mass and binding energy.
Nuclear quantum numbers: spin, parity, and isospin.
Nuclear electromagnetic moments.
Unit 2: Radioactivity and radiological protection.
Types of nuclear decay.
Radioactive decay law.
Graphical representation of the mass parabola.
Dosimetry and radiological protection.
Protection measures.
Unit 3: Nuclear models and nuclear phenomenology.
Collective models. The liquid drop model: rotations and vibrations.
Single particle models. The nuclear shell model and the Fermi gas.

Unit 1: Properties of the atomic nuclei.



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Unit 4: The nucleon-nucleon interaction. -Deuteron: properties and wave function. -Nucleon-nucleon diffusion. Phase shifts. -Yukawa potential. -Nucleon-nucleon potential. **Unit 5: The Standard Model.** -Classification of elementary particles. -The four fundamental interactions. Unit 6: The Quark Model. -Quantum numbers of hadrons. -The SU(3) flavor symmetry. -Baryon and meson multiplets in SU(3). -Hadron wave functions. Unit 7: Symmetries and conservation laws. -Relativistic invariance. -Charge conjugation C. -Parity P. -CP symmetry. -Time reversal T and CPT theorem. -Local symmetries: Gauge invariance.

#### 2. Practical contents

The practical contents consist of in-class problem solving. More complex problems will also be solved through the use of computer codes. In this case, a report with the work carried out and the results will have to be turned in. The faculty will provide all problem sets and computer codes.

### SUSTAINABLE DEVELOPMENT GOALS RELATED TO THE CONTENT

Quality education Gender equality Reduced inequalities

## METHODOLOGY

#### General clarifications on the methodology (optional)

# Methodological adaptations for part-time students and students with disabilities and special educational needs

The methodological adaptations for this type of students will be decided in meetings between the teaching staff and the students in order to personalize the solutions in the possible cases that arise. In the case of part-time students, they will enroll in the group that best suits their needs, in order to facilitate their attendance. In the case of students with special educational needs, the teacher will have a meeting with them individually to establish the most appropriate adaptations for each particular case, following the indications of the report issued by the Inclusive Education Unit.



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## Face-to-face activities

Activity	Large group	Medium group	Total
Assessment activities	3	-	3
Case study	-	20	20
Lab practice	-	4	4
Lectures	33	-	33
Total hours:	36	24	60

## **Off-site activities**

Activity	Total
Activities	30
Information search	15
Reference search	15
Self-study	30
Total hours	90

## WORK MATERIALS FOR STUDENTS

Case studies Exercises and activities Lessons summary

## Clarifications

Working material will be provided through the subject web page.

# EVALUATION

Intended learning	Exams	Placement reports	Problem solving
CB1	Х	Х	х
CB11			х
CB2	Х	Х	Х
CB3	Х	Х	Х
CB4	Х	Х	Х



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Intended learning	Exams	Placement reports	Problem solving
CB5	Х	Х	Х
CB8		Х	Х
CB9	Х	Х	Х
CE1	Х	Х	Х
CE2			Х
CE5	Х	Х	Х
CE7	Х	Х	Х
Total (100%)	75%	10%	15%
Minimum grade	5	5	5

(\*)Minimum mark (out of 10) needed for the assessment tool to be weighted in the course final mark. In any case, final mark must be 5,0 or higher to pass the course.

#### Method of assessment of attendance:

Attendance at continuous assessment tests is mandatory to pass the subject.

#### General clarifications on instruments for evaluation:

The assessment tools are the following: "Exam", "Placement Reports" and "Problem Solving".

The exam consists of two parts: one of theory questions and another of problem solving. The minimum grade for this assessment tool to be considered will be applied to the theory questions part and the problem solving part, separately, so that if the student does not reach the minimum grade in one or both parts, this assessment instrument will not be considered. Otherwise, that is, if the student reaches the minimum grade in both parts of the exam, the exam grade is the average grade of both parts.

The continuous evaluation consists of "Placement Reports" and "Problem Solving". The "Placement Reports" refer to the reports of the (virtual) laboratory sessions. "Problem solving" refers to the resolution in class of time-limited individual exercises using bibliographical material. Attendance at the continuous assessment tests and the submission of their corresponding documents are mandatory to pass the subject. The grades obtained in the continuous evaluation tools will be kept in all the ordinary calls of the current academic year.

Students who have enrolled in the subject in previous years, and who prove that they have taken the continuous assessment tests, will be exempt from repeating said continuous assessment in the current academic year.

# **Clarifications** on the methodology for part-time students and students with disabilities and **special educational needs**:

In the evaluation for part-time students and students with special educational needs, the necessary evaluation mechanisms will be designed based on the teaching methodology used in each case.



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# Clarifications on the evaluation of the extraordinary call and extra-ordinary call for completion studies:

The evaluation criteria for the extraordinary call and the extraordinary call for completion of studies will be the same as those used in the ordinary calls for the current academic year.

Students who pass the extraordinary call exam or the extraordinary call for completion of studies must prove that they have taken the continuous assessment tests.

In any case, the student who wishes to take either of these two exams must contact the coordinator of the subject, at least ten days before the exam, to resolve any issue.

## Qualifying criteria for obtaining honors:

An overall grade of 9.0 out of 10 is required (Artículo 80.3 del Reglamento de Régimen Académico de la Universidad de Córdoba).

## BIBLIOGRAPHY

### 1. Basic Bibliography

A. Ferrer Soria, Física Nuclear y de partículas, Universidad de Valencia 2015.

K.S. Krane, Introductory nuclear physics, Wiley 1987.

D. Griffiths, Introduction to Elementary Particles, Wiley 2008.

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### 2. Further reading

W.S.C. Williams, Nuclear and Particle Physics, Clarendon 1991.

W.E. Burcham, M. Jobes, Nuclear and Particle Physics, Prentice Hall 1994.

M. Alonso y E.J. Finn, Física Vol. III: Fundamentos cuánticos y estadísticos, Fondo educativo interamericano 1971.

S.S.M. Wong, Introductory nuclear physics, Wiley 1999.

P.E. Hodgson, E. Gadioli and E. Gadioli-Erba, Introductory nuclear physics, Oxford 1997.

R.B. Firestone and V.S. Shirley, Table of Isotopes, Vol. I and II, Wiley 1996.

A. Bettini, Introduction to Elementary Particle Physics, Cambridge 2014.

B.R. Martin and G. Shaw, Particle Physics, Wiley 2017.

D.H. Perkins, Introduction to high energy physics, Cambridge 2000.

F. Halzen and A.D. Martin, Quark & Leptons: An Introductory Course In Modern Particle Physics, John Wiley & Sons 2008.

A. De Angelis and M.J.M. Pimenta, Introduction to Particle and Astroparticle Physics: Questions to the Universe, Springer 2015.



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## COORDINATION CRITERIA

Common evaluation criteria Tasks deadlines

## SCHEDULE

Period	Assessment activities	Case study	Lab practice	Lectures
1# Week	0,0	0,0	0,0	3,0
2# Week	0,0	2,0	0,0	3,0
3# Week	0,0	2,0	0,0	3,0
4# Week	0,0	0,0	2,0	3,0
5# Week	0,0	2,0	0,0	3,0
6# Week	0,0	2,0	0,0	3,0
7# Week	0,0	0,0	2,0	3,0
8# Week	0,0	2,0	0,0	3,0
9# Week	0,0	2,0	0,0	3,0
10# Week	0,0	2,0	0,0	3,0
11# Week	0,0	2,0	0,0	3,0
12# Week	0,0	2,0	0,0	0,0
13# Week	0,0	2,0	0,0	0,0
14# Week	3,0	0,0	0,0	0,0
Total hours:	3,0	20,0	4,0	33,0

The methodological strategies and the evaluation system contemplated in this Course Description will be adapted according to the needs presented by students with disabilities and special educational needs in the cases that are required.



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