

## SUBJECT TEACHING GUIDE

### G71 - Physics of Elementary Particles

Double Degree in Physics and Mathematics

Degree in Physics

Degree in Physics

Academic year 2024-2025

1. IDENTIFYING DATA					
Degree	Double Degree in Physics and Mathematics Degree in Physics Degree in Physics			Type and Year	Optional. Year 5 Optional. Year 4
Faculty	Faculty of Sciences				
Discipline	Subject Area: Physics of Elementary Particles Mention in Fundamental Physics				
Course unit title and code	G71 - Physics of Elementary Particles				
Number of ECTS credits allocated	6	Term	Semester based (1)		
Web					
Language of instruction	Spanish	English Friendly	Yes	Mode of delivery	Face-to-face

Department	DPTO. FISICA MODERNA
Name of lecturer	PABLO MARTINEZ RUIZ DEL ARBOL
E-mail	pablo.martinez@uncan.es
Office	
Other lecturers	RUBEN LOPEZ RUIZ CLARA LASAOSA GARCIA

### 3.1 LEARNING OUTCOMES

- To understand the basics of the Standard Model of Particle Physics .
- To Know the relevance of a model of Elementary Particles to understand the microscopic world .
- To understand the characteristics of the elemental forces and the properties of the particles .
- To Identify the most relevant processes of interaction of a particle passing through a physical medium .
- To Know the detection techniques employed and the relevant instrumentation .
- To know how to handle simple detectors and some conventional analysis techniques .
- To understand the basic ideas used in particle accelerators .
- To know the basic experimental results supporting the Standard Model and the current lines of research according to the proposed theoretical models.

### 4. OBJECTIVES

- 1- Know the Standard Model of elementary particles, and fundamental forces.
- 2- Know the tools of calculation processes of interaction between particles.
- 3- Understand the detection techniques and key technologies. Application in current experiments.
- 4- Knowing the current research lines in the field.

### 6. SUBJECT PROGRAM

#### CONTENTS

1	Introduction Reminder of basic concepts. Dirac Equation for spin 1/2 particles. Solutions of the equation for particles and antiparticles. Physics interpretation.
2	Experimental techniques. Particle detectors. Accelerators.
3	Physics observable Cross sections and decays Interaction by exchange of particles
4	Electromagnetic interaction Electron-positron annihilation Tools for the evaluation of matrix elements Weak interaction. Weak interaction as a Gauge model: Weinberg-Salam model. Experimental evidences.
5	QCD, jets and gluons. Strong interaction as an interchange of gluons. Strong coupling constant. Asymptotic freedom. Confinement. Beyond the Standard Model.  QCD, jets and gluons Strong interaction: gluon exchange Strong coupling constant Asymptotic freedom and confinement

7. ASSESSMENT METHODS AND CRITERIA				
Description	Type	Final Eval.	Reassessn	%
Exercises to be solved/defended along the course + Partial Exams + Final exam (theory+practical exercise)	Written exam	Yes	Yes	50,00
Practice on the measurement of the Z mass	Activity evaluation with Virtual Media	No	No	25,00
Practice on particle detection methods.	Laboratory evaluation	No	No	25,00
TOTAL				100,00
Observations				
<p>The evaluation will be done as follows:</p> <p>1.- Exams consisting of both theoretical questions and resolution of exercises.</p> <ul style="list-style-type: none"> <li>+ 25% of the grade -&gt; First exam</li> <li>+ 25% of the grade -&gt; Second exam</li> <li>+ There is the possibility to redo the exams in a final exam. In this case the highest grade will be kept.</li> <li>+ It will be needed to score at least 3/10 to allow averaging with the practical sessions.</li> <li>+ The realization of proposed exercises and its exposition in class will score 1 additional point over the final grade of the exams.</li> </ul> <p>2.- Practical sessions</p> <ul style="list-style-type: none"> <li>+ 25% of the final grade -&gt; Practice 1</li> <li>+ 25% of the final grade -&gt; Practice 2</li> <li>+ Each practice will require the elaboration of a report. The final grade will be the average of the student activity in the lab and the report. The absence of the report means that the practice will not be evaluated. If both reports are missing the student will be considered not presented.</li> </ul>				
Observations for part-time students				
As much as possible the professor will help to follow the course. The practical sessions are 'in person' and should be performed in the designated period.				

## 8. BIBLIOGRAPHY AND TEACHING MATERIALS

### BASIC

Modern Particle Physics, Mark Thomson, Cambridge Univ. Press

Particle Physics, BR Martin & G. Shaw, Ed Wiley,