Approval date: 22/06/2023

COURSE GUIDE

Field and Particle Theory (26711C2)

Grado (Bachelor's Degree)	Grado en Física	Branch	Sciences
Module	Relatividad y Teoría de Campos y Partículas	Subject	Teoría de Campos y Partículas

Year of study	4º	Semester	2º	ECTS Credits	6	Course type	Elective course

PREREQUISITES AND RECOMMENDATIONS

It is advised to have passed the following subjects: Calculus I and II (Análisis matemático I y II), Linear Algebra and Geometry (Álgebra lineal y geometría), Mathematical Methods for Physics (Métodos matemáticos de la física), Mechanics and Wave Physics (Mecánica y ondas), Analytic Mechanics (Mecánica analítica y de los medios continuos), Quantum Physics (Fundamentos cuánticos).

BRIEF DESCRIPTION OF COURSE CONTENT (According to the programme's verification report)

- Relativistic fields (scalar fields; Dirac equation, antiparticles; vector fields; gauge symmetry).
- Standard Model (quarks and leptons, electroweak and strong interactions; Higgs boson).
- Elementary particle collisions and decays.

SKILLS

GENERAL SKILLS

- CG01 - Skills for analysis and synthesis
- CG05 - Skills for dealing with information
- CG06 - Problem solving skills
- CG08 - Critical thinking
- CG09 - Autonomous learning skills
- CG10 - Creativity

SUBJECT-SPECIFIC SKILLS

- CE01 - Knowing and understanding the phenomena of the most important physical

theories
- CE05 - Modelling complex phenomena, translating a physical problem into mathematical language
- CE09 - Applying mathematical knowlegde in the general context of Physics

LEARNING OUTCOMES

- Understand the concept of of fields and their crucial role in the interplay of special relativity and quantum mechanics.
- Learn and understand the physics laws that govern the subatomic world and the fundamental constituents of nature.
- Learn how to compute observables that allow to compare experimental data with theoretical predictions in particle physics.

PLANNED LEARNING ACTIVITIES

THEORY SYLLABUS

1. Introduction. Lorentz and Poincaré symmetries. Particles and Fields.
2. Classical field theory.
3. Quantization of free fields.
4. Field interactions. S matrix and Feynman rules.
5. Observables: cross sections and decay widths.
6. Quantum Electrodynamics. Elementary processes at tree level.
7. Gauge theories and spontaneous symmetry breaking. The Standard Model.

PRACTICAL SYLLABUS

1. Problem workshops: discussion of the solutions to the proposed problems.

RECOMMENDED READING

ESSENTIAL READING

- Maggiore, A modern introduction to quantum field theory, Oxford University Press, 2005
- M.D. Schwartz, Quantum Field Theory and the Standard Model, Cambridge University Press, 2014.
- M.E. Peskin, D.V. Schroeder, An Introduction to Quantum Field Theory, Addison-Wesley, 1995.

COMPLEMENTARY READING

- A. Lahiri, P.B. Pal, A first book of Quantum Field Theory, Narosa Publishing House, 2nd

edition, 2005.
- S. Weinberg, The quantum theory of fields (I and), Cambridge University Press, 1995.

RECOMMENDED LEARNING RESOURCES/TOOLS

- The Particle Adventure: https://www.particleadventure.org/
- High-Energy Physics Literature Database (INSPIRE): https://inspirehep.net/
- The Review of Particle Physics (Particle Data Group): https://pdg.web.cern.ch/pdg/
- UGR High Energy Theory Group: https://ftae.ugr.es

TEACHING METHODS

- MD01 - Theoretical classes

ASSESSMENT METHODS (Instruments, criteria and percentages)

ORDINARY EXAMINATION DIET

- Continuous evaluation: 30% of the final mark. Participation in the lectures, discussions, solution to the proposed problems, tests.
- Final exam: 70% of the final mark.

EXTRAORDINARY EXAMINATION DIET

- Final exam corresponding to 100% of the final mark.

SINGLE FINAL ASSESSMENT (evaluación única final)

- Same a extraordinary assessment session.