COURSE DATA

Data Subject	
Code	43292
Name	Quantum field theory I
Cycle	Master's degree
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
2150 - M.D. in Advanced Physics	Faculty of Physics	1	First term

Subject-matter

Degree	Subject-matter	Character
2150 - M.D. in Advanced Physics	1 - Introduction to theoretical physics	Optional

Coordination

Name	Department
CIERI ., LEANDRO JAVIER	185 - Theoretical Physics

SUMMARY

In Quantum Field Theory course I the student will learn the rudiments of mathematical formalism developed to study particle physics. Klein-Gordon, Dirac, and Proca fields will be introduced . The student will learn to calculate cross sections and decay widths, using the Feynman rules and the elementary processes of quantum electrodynamics. An introduction to the concept of renormalization will be given.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

OUTCOMES

2150 - M.D. in Advanced 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.
- Ser capaz de gestionar información de distintas fuentes bibliográficas especializadas utilizando principalmente bases de datos y publicaciones internacionales en lengua inglesa.
- Ostentar la preparación para tomar decisiones correctas en la elección de tareas y en su ordenación temporal en su labor investigadora y/o profesional.
- Analizar una situación compleja extrayendo cuales son las cantidades físicas relevantes y ser capaz de reducirla a un modelo parametrizado.
- Evaluar la validez de un modelo o teoría propuesto por otros miembros de la comunidad científica.
- Exponer y defender públicamente el desarrollo, resultados y conclusiones de su trabajo en el área de la Física.
- Conocer la fenomenología de las partículas elementales. Conocer cómo se clasifican las partículas elementales y las interacciones fundamentales. Comprender la relación entre el microcosmos y la formación del macrocosmos.
- Conocer los dispositivos experimentales. Conocer la experimentación con la materia elemental y manejar los resultados.

LEARNING OUTCOMES

At the end of the teaching-learning process the student will have learned to:

1. Select and correctly use various sources of information in both traditional and electronic format. Know the basics of file own field: inspire, spiers, arXiv.
2. Properly handle and interpret qualitative and quantitative physical data which validate the known theories in the field.
3. Analyze information from physical systems.
4. Prepare documents and reports in a text written in an understandable way organized,

documented and illustrated.

5. Articulate oral discourse, structured, consistent, with good diction and use of technical vocabulary.
6. Understand the arguments used in the field of theoretical physics.
7. Understanding the mathematical description of physical processes of particle creation and destruction. Understanding the formalism of quantum field theory in the mathematical description of physical models.
8. Use the basic concept of a constituent of matter. Knowing the phenomenology of elementary particles. Know how to classify the elementary particles and fundamental interactions.
9. Describe the processes of collision and disintegration of particles at the tree. Being able to develop and use the techniques of approximation in the calculation of particle interactions. Being able to predict physical quantities (cross sections, lifetimes, ...) of particles from a given theory.
10. Understand the concept of particle-mediated interaction and the methodology of quantum field theory.

DESCRIPTION OF CONTENTS

1. Introduction: the need for a quantum theory of fields

2. Quantization of the scalar field: the Klein-Gordon field

3. Interacting fields I: S matrix, cross sections and decay widths.

4. Interacting fields II: perturbation theory, Wick theorem and Feynman rules

5. Spin 1/2 fields: Lorentz covariance and solutions of the Dirac equation

6. Spin 1/2 fields: quantization and discrete symmetries

7. Interacting fields III: Yukawa theory

8. Spin 1 or Gauge fields: photons and Proca fields

9. QED: Elementary processes

10. Introduction to Renormalization

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	40,00	100
Seminars	3,00	100
Other activities	3,00	100
Development of group work	10,00	0
Development of individual work	11,00	0
Preparing lectures	43,00	0
Preparation of practical classes and problem	40,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

MD1 - Standar theory lecture

MD2 - Discussion of articles (readings).

MD3 - Problem solving

MD4 - Problems

MD8 - Conference of experts

EVALUATION

The evaluation of the course is based on:

- Written examination on the lectures and practices: based on learning outcomes and specific objectives of the course (60%).

- Continuous evaluation of the student in the classes of theory and practice: participatory assistance, conducting exercises in the classroom, resolution of proposed problems (40%).

REFERENCES

Basic

- F. Mandl and G. Shaw, "Quantum Field Theory", John Wiley & Sons, 1984 (Revised 1993).
- M.E. Peskin and D.V. Schroeder, "An Introduction to Quantum Field Theory", 1995
- C. Itzykson and J.B. Zuber, "Quantum Field Theory", McGraw-Hill, 1980.
- J.D. Bjorken and S.D. Drell, "Relativistic Quantum Fields", McGraw-Hill, 1965
- S. Weinberg, "The Quantum Theory of Fields", Cambrigde University Press, 1995