Course plan

Subject	**Physmatics**		
Matter	Cross-disciplinary		
Degree	Physics, Mathematics		
Study program	------	**Reference no.**	---------
Term	Second term	**Type**	Cross-disciplinary
Level	Bachelor degree	**Course/Year**	2019-2020
ECTS units	3 ECTS		
Language	English		
Lecturer in charge	Luis Miguel Nieto		
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Office hours	Please check the timetable		
Department	Física Teórica, Atómica y Óptica		

1. Placement of the subject in the study program

1.1 Context

Theoretical physics emphasizes the links to observations and experimental physics, which often requires them to use heuristic, intuitive, and approximate arguments. The term "mathematical physics" is used to denote research aimed at solving problems inspired by physics within a mathematically rigorous framework. In this sense, mathematical physics covers a very broad academic realm distinguished only by the blending of pure mathematics and physics. Although related to theoretical physics, mathematical physics in this sense emphasizes the mathematical rigour of the same type as found in mathematics.

1.2 Relationship with other subjects

Such mathematical physicists primarily expand and elucidate physical theories.
Because of the required level of mathematical rigour, workers in mathematical physics often deal with questions that theoretical physicists have considered to be already solved. However, they can sometimes show that the previous solution was incomplete, incorrect, or simply too naïve. Examples are the attempts to infer the second law of thermodynamics from statistical mechanics or the subtleties involved with synchronisation procedures in special and general relativity.

The effort to put physical theories on a mathematically rigorous footing has inspired many mathematical developments, like the development of quantum mechanics and some aspects of functional analysis parallel each other in many ways. The mathematical study of quantum mechanics, quantum field theory, and quantum statistical mechanics has motivated results in operator algebras. The attempt to construct a rigorous quantum field theory has also brought about progress in fields such as representation theory. Use of geometry and topology plays an important role in string theory.

1.3 Requirements

It is recommendable that the students have acquired the knowledge and capabilities provided by the courses of Linear Algebra and Geometry, Mathematical Analysis and Differential Equations.

2. Competencies and capabilities

2.1 General

T1. Analysis and synthesis skills.
T2. Organization capability.
T3. Oral and writing communication skills.
T4. Problem solving strategies.
T5. Team work capability.
T6. Autonomous work and learning capabilities.
T7. Skills of adaptation to new mathematical methods.
T8. Capability to apply generic methods to particular scenarios.
T9. Creativity.

2.2 Specific

E1.Capability to deliver a presentation on academic topics and research work.
E2. Capability to get into new fields of study and research.
E3. Capability to work out the necessary approximations to make complicated problems manageable.
E4. Computation skills leading to the development of original software, as well as to the application of conventional software packages.
E6. Teaching skills at academic level.
E7. Capability to integrate the knowledge from different areas in order to apply it to solve complex problems.
E8. Understanding of the most common mathematical methods, both analytical and numerical ones.

3. Aims

To provide an elementary introduction to the topics

4. Contents

- The superposition principles.
- Variational calculus and minimal surfaces.
- The Riemann hypothesis.
- Group theory in Physics.

5. Schedule

CHAPTERS	LOAD (ECTS)	TIME PERIOD
All the material	3	30 March – 14 April

6. Methodology

- Theoretical and practical 1 hour in-class lectures.
- Practical exercises will be given.

7. References

1. G. Arfken, Mathematical Methods for Physicists, Academic Press (1985).
2. I. M. Gelfand, S.V. Fomin, Calculus of Variations, Prentice Hall (1963).
3. V.I. Arnol'd, Mathematical Methods of Classical Mechanics, Springer-Verlag (1978).
4. H. Goldstein, Classical Mechanics,, Addison Wesley (1980).

8. Time distribution of students' activities

IN-CLASS ACTIVITIES	TIME (h)	OUT-OF-CLASS ACTIVITIES	TIME (h)
Theoretical lectures (T/M)	20	Autonomous individual work.	25
Practical lectures (A)	10	Preparation of exercises to be handed in.	20
In-class total time	**30**	**Out-of-class total time**	**45**

9. Assessment

PROCEDURE	OVERALL WEIGHT	REMARKS
Several assignments will be offered to be addressed at home.	60%	Compulsory
Final exam, with practical questions to be assessed in a 10 point grading scale.	40%	Compulsory

10. Final remarks