SUBJECT TEACHING GUIDE

G2002 - General Relativity

Double Degree in Physics and Mathematics
Degree in Physics
Degree in Physics

Academic year 2023-2024

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	General Relativity Matter Mention in Fundamental Physics				
Course unit title and code	G2002 - General Relativity				
Number of ECTS credits allocated	6	Term		Semester based (1)	
Web					
Language of instruction	Spanish	English Friendly	No	Mode of delivery	Face-to-face

Department	DPTO. FISICA MODERNA
Name of lecturer	DIEGO HERRANZ MUÑOZ
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Other lecturers	PABLO GOMEZ NICOLAS

3.1 LEARNING OUTCOMES
- Address typical problems of kinematics and dynamics in Special Relativity.
- Understand the basic principles of General Relativity.
- Relate General Relativity and electromagnetism, establishing their similarities and differences
- Understand the mathematical tools of tensor calculus, numerical methods and differential geometry, necessary to work in General Relativity.
- Obtain and understand Einstein's equations, as well as their Newtonian limit.
- Use the symmetries of space-time to solve problems of relativistic dynamics and kinematics.
- Solve problems in the presence of black holes.
- Study the propagation of gravitational waves.

4. OBJECTIVES
Understand the General Theory of Relativity within the context of modern Physics.
To be able to solve Einstein's equations for simple cases (point mass, black holes, Friedmann equations)
To have a relativistic view of electromagnetism and gravitation.
To know phenomena and experiments on the current frontier of research, such as the detection of gravitational waves and the direct and indirect observation of black holes.

6. SUBJECT PROGRAM	
CONTENTS	
1	History
2	Special relativity. Beginning. Poincaré group. Metric and Minkowski space. Kinematics. Dynamic. Electromagnetism.
3	Physical quantities: Proper time. Proper distance. Redshift. Principles of General Relativity. Equivalence. Covariance.
4	Tensor calculus: physical quantities as tensors, Einstein's notation, handling of tensors in practical calculations.
5	Differential geometry. Curved and metric spacetime. Geodesics and Christoffel symbols. Riemann curvature tensor
6	Deduction of Einstein's equations. Energy-moment tensor.
7	Classic tests of General Relativity. Observations, numerical simulations, experiments
8	Schwarzschild metric. Black holes. Kruskal diagram. Gravitational collapse. Kerr metric. Hawking radiation
9	Linear approximation. Gravitational radiation. Quadripolar formula. Gravitational waves: generation, detection, experiments.
10	Open problems in Relativity.
11	Presentation of papers and final exam

7. ASSESSMENT METHODS AND CRITERIA				
Description	Type	Final Eval.	Reassessn	%
Final exam	Written exam	Yes	Yes	50,00
Presentation of student's work	Work	No	Yes	20,00
Written reports	Work	No	No	20,00
Numerical lab practice	Laboratory evaluation	No	No	10,00
TOTAL				100,00

Observations
Observations for part-time students
Part-time students will have the opportunity to take the final written exam, which will count for 80% of the final grade, and present a written work, which will count for 20% of the final grade.

8. BIBLIOGRAPHY AND TEACHING MATERIALS
BASIC
Hobson, M. P., Efstathiou, G. P. & Lasenby, A. N. General Relativity. (Cambridge University Press, 2006).
Schutz, B. A First Course in General Relativity. (Cambridge University Press, 2009).
Berry, M. V. Principles of Cosmology and Gravitation. (CRC Press, 1989).