

Approval date: 11/06/2024

COURSE GUIDE

General Relativity (26711C1)

Grado (Bachelor's Degree)	Grado en Física	Branch	Sciences				
Module	Relatividad y Teoría de Campos y Partículas	Subject	Relatividad General				
Year of study	4 ^o	Semester	1 ^o	ECTS Credits	6	Course type	Elective course

PREREQUISITES AND RECOMMENDATIONS

- Métodos Matemáticos I, II, III
- Análisis matemático I, II
- Álgebra lineal y Geometría
- Mecánica y Ondas
- Electromagnetismo

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

- Review of Special Relativity
- Bases of Differential Geometry
- Einstein equations
- Classical Tests of General Relativity
- Exact solutions: black holes, gravitational waves and cosmological models

SKILLS

GENERAL SKILLS

- CG01 - Skills for analysis and synthesis
- CG02 - Organisational and planification skills
- CG05 - Skills for dealing with information
- CG06 - Problem solving skills
- CG08 - Critical thinking
- CG09 - Autonomous learning skills

SUBJECT-SPECIFIC SKILLS

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



theories

- CE02 - Estimating the order of magnitude in order to interpret various phenomena
- CE03 - Knowing and understanding the mathematical methods necessary to describe physical phenomena
- CE05 - Modelling complex phenomena, translating a physical problem into mathematical language
- CE09 - Applying mathematical knowledge in the general context of Physics

LEARNING OUTCOMES

- Knowledge of General Relativity as the modern theory of gravity
- Comprehend the importance of symmetries in Physics and being able to apply them
- Notions of geometry in curved space
- Knowledge of the Einstein equations and its implications
- Knowledge of black holes, gravitational waves and cosmological models

PLANNED LEARNING ACTIVITIES

THEORY SYLLABUS

1. Special Relativity - Lorentz transformations
2. Minkowski space; four-vectors; Lorentz group
3. Relativistic mechanics and electromagnetism in covariant formulation
4. Manifolds and general coordinate transformations
5. Tensor calculus; affine connections; covariant derivative
6. Curvature tensors; geodesics
7. The Equivalence Principle
8. The energy-momentum tensor
9. The Einstein Equations
10. Physics in curved space
11. Classical tests of General Relativity
12. Schwarzschild black hole: causal structure and interpretation
13. Gravitational waves: linearised theory; gravitational waves as perturbations; detection
14. Cosmological models: FWR metrics; cosmological solutions

PRACTICAL SYLLABUS

1. Problems and exercises of the theory
2. Asistence in specialised seminars

RECOMMENDED READING

ESSENTIAL READING

- Bert Janssen, Teoría de la Relatividad General, Universidad de Granada, 2020
- Bert Janssen, Gravitación y Geometría, Editorial Universidad de Granada, 2021.
- R. D'Inverno, Introducing Einstein's Relativity, Oxford University Press, 1992.



- S. Carroll, Spacetime and Geometry, Addison-Wesley, 2004.
- S. Weinberg, Gravitation and cosmology, Wiley, 1972.

COMPLEMENTARY READING

- C. Misner, K. Thorn, A. Wheeler, Gravitation, Freeman, 1973
- R. Wald, General Relativity, Chicago University Press, 1984.
- H. Stefani, General Relativity, Cambridge University Press, 1982.
- B.F. Schutz, A first course in General Relativity, Cambridge University Press, 1985.
- J. Hartle, Gravity, Addison-Wesley, 2003.
- E. Poisson, A relativist's Toolkit, Cambridge University Press, 2004.
- T.P. Cheng, Relativity, Gravitation and Cosmology, Oxford University Press, 200

TEACHING METHODS

- MD01 - Theoretical classes

ASSESSMENT METHODS (Instruments, criteria and percentages)

ORDINARY EXAMINATION DIET

Continuous evaluation:

- Exercises to be handed in & tests (30%)
- Final exam (70%).

In order to succeed for this course, the student must obtain at least 50% of the score of the final exam.

EXTRAORDINARY EXAMINATION DIET

The extraordinary assessment session will consist of the same tests as the Unique Final Evaluation. The student will have the opportunity to obtain 100% of the score.

SINGLE FINAL ASSESSMENT (evaluación única final)

Final exam (100%)

ADDITIONAL INFORMATION

Información de interés para estudiantado con discapacidad y/o Necesidades Específicas de Apoyo Educativo (NEAE): [Gestión de servicios y apoyos \(https://ve.ugr.es/servicios/atencion-social/estudiantes-con-discapacidad\)](https://ve.ugr.es/servicios/atencion-social/estudiantes-con-discapacidad).

