COURSE OF STUDY *Physics (LM-17)*

ACADEMIC YEAR *2024-2025*

ACADEMIC SUBJECT *General Relativity*

General information	
Year of the course	2nd
Academic calendar (starting and ending date)	1st semester: September - December 2024
Credits (CFU/ECTS):	6
SSD	FIS/02
Language	English
Mode of attendance	Recommended, not compulsory

Professor/ Lecturer	
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Telephone	
Department and address	Dipartimento Interateneo di Fisica , Via Amendola 173, 70126 Bari
Virtual room	
Office Hours (and modalities: e.g., by appointment, on line, etc.)	In presence and online, under request

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
150	40	15	95
CFU/ECTS			
6	5	1	

Learning Objectives	Introduction to general relativity and to the formalism of Riemannian geometry. Applications to the study of relativistic gravitational systems.
Course prerequisites	Special relativity, classical field theory, elements of theoretical physics of the fundamental interactions.

Teaching strategie	Class lectures/exercises using blackboard.
Expected learning outcomes in terms of	
Knowledge and understanding on:	● Understanding the scientific method, the nature, and the methods of research in Physics ● Knowledge of mathematical and probabilistic methods for physics ● Knowledge of the Einstein theory of general relativity and of the formalism of the Riemannian geometry
Applying knowledge and understanding on:	o Ability to identify the essential elements of a phenomenon o Ability to use analogy to apply known solutions to new problems (problem solving) o Ability to use analytical and numerical mathematical computation tools o Application of the tensor calculus in a Riemannian manifold in order to describe the main relativistic gravitational effects.

Soft skills	*Making informed judgments and choices* ● Ability to work with increasing levels of autonomy, including taking responsibility in project planning and managing facilities. ● Ability to discuss and to compare different relativistic models of fundamental interactions. *Communicating knowledge and understanding* o Competence in communication in Italian and English in advanced fields of Physics o Ability to present a gravitational problem in a complete way and with an appropriate scientific language. *Capacities to continue learning* ● Acquisition of basic knowledge tools for continuous learning and knowledge updates ● Ability to approach the specialistic literature and to independently choose the method of solving a problem of relativistic gravitation.
Syllabus	
Content knowledge	Principle of equivalence and principle of general covariance. The local group of diffeomorphism. Tensor calculus in a Riemannian manifold. Covariant differentiation. Geometric gravity in the Newtonian limit. Geodesic motion. The Riemann curvature tensor and the Einstein equations. The weak field limit. Gravitational waves. Schwarzschild solution and black holes.
Texts and readings	S. Weinberg, *Gravitation and Cosmology* (John Wiley & Sons 1972) M. Gasperini, *Theory of Gravitational Interactions* (Second Edition, Springer International, 2017). Sean Carroll, *Spacetime and Geometry: An Introduction to General Relavitiy (Cambridge Univ. Press, 2019)*
Notes, additional materials	None
Repository	

Assessment	
Assessment methods	Written exam and oral colloquium.
Assessment criteria	• *Knowledge and understanding* knowledge and understanding of the basic aspects of general relativity and of the formalism of Riemannian geometry • *Applying knowledge and understanding* ability to perform simple calculations concerning relativistic gravitational interactions; • *Autonomy of judgment* ability to discuss the main differences/ analogies with the other fundamental interactions;

	• *Communicating knowledge and understanding* ability to present and to discuss with a professional language the geometric properties of gravity; • *Communication skills* ability to access the specialistic literature • *Capacities to continue learning* ability to extend and apply the formalism of curved space-time geometry to different sectors of physics
Final exam and grading criteria	Numerical rating from 0 to 30 attributed on the ground of the evaluation criteria listed above.
Further information	