UCLouvain

lphys1332

2025

General Relativity

The version you're consulting is not final. This course description may change. The final version will be published on 1st June.

5.00 credits	30.0 h + 22.5 h	Q1

Language :	French > English-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	It is recommended that students master the notions of classical mechanics including in particular the notions of special relativity as developed in the course LPHYS1231.
Main themes	This teaching unit is a basic introduction to Einstein's ***general relativity*** .
Learning outcomes	**At the end of this learning unit, the student is able to :** **a. Contribution of the teaching unit to the learning outcomes of the programme** **AA1 :** 1.1, 1.3, 1.4 **AA2 :** 2.1, 2.4 **AA3 :** 3.2, 3.5 **b. Specific learning outcomes of the teaching unit** At the end of this teaching unit, the student will be able : 1 1. to think critically about Newton's universal gravitation; 2. to look at familiar phenomena (inertia, free fall, tides, etc.) from a different angle; 3. to understand gravitation as an apparent force that manifests itself through a space-time curvature; 4. to visualize the expansion of the universe on the basis of a Copernican principle; 5. to fully appreciate the impact (in the very long term) of fundamental research that feeds today's applied research.
Evaluation methods	Written exam including questions on the development of concepts in physics in connection to universal gravity (from Newton to Einstein) and their coherent mathematical formulation (from vectors to tensors). Basic knowledge of the teaching unit is assessed, but the main exam objective is to assess the capability of analysing and solving a new problem of gravitation. Mastering analytical calculations and presenting coherently the corresponding results are mandatory.
Teaching methods	Teaching activities are alternating between traditional lecturing, guided learning and inquiry-based learning during the exercise sessions. On the one hand, the traditional lectures aim at introducing, in a clear and rigorous way, the concepts that support the foundations of the modern theory of gravitation. Illustrations will be provided in a guided learning way in order to initiate students to the cognitive reasoning of the physicist. The introduction of mathematical models, as well as the ways to solve them, will be presented in a explicit, interactive and pedestrian manner on the black board. Exercise sessions, on the other hand, aim at the cognitive training of the students to solve a completely new problem in General Relativity. Problems are given one week in advance and the students are expected to work alone on these questions before showing up in class. The class itself consists in the pedestrian presentation of the solution, either by the teacher, or by the students themselves, in an inverted class.
Content	These lectures provide the required expertises and technical competencies to tackle any problems in the field of gravity. In the era where space-time distorsions induced by black hole mergers are routinely measured, where radio-telescopes picture the shadow of supermassive black holes hidden in the center of galaxies, Einstein's **General Relativity** has become a cornerstone of the expertises needed for the physicist and engineer of tomorrow. These lectures will rigorously introduce the concepts, motivations as well as the technical details and mathematics of General Relativity according to the following themes: • Shortcomings in Special Relativity and Newton gravity • The Equivalence Principle • Dynamics of the gravitational field • The Schwarzschild's geometry • Black holes and worm holes

	• Weak fields and gravitational waves
Bibliography	- "A first course in General Relativity", B. Schutz. - "Spacetime and Geometry", Carroll - "General Relativity", Wald - "Gravitation", Misner, Thorne and Wheeler. - "Relativité Générale et Cosmologie", J-M. Gérard (Moodle)
Faculty or entity in charge	PHYS

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Additionnal module in Physics	APPHYS	5		🔍
Minor in Physics	MINPHYS	5		🔍
Master [120] in Physics	PHYS2M	5		🔍
Master [120] of Education, Section 4 : Physics	PHYS2M4	5		🔍